Mojave Water Agency
Water Supply Reliability and Groundwater Replenishment Program

CHAPTER 4
DESCRIPTION OF PROJECT ALTERNATIVES

4.1 Basic Operational Scenarios

All of the potential Project Alternatives are based on two potential operational scenarios: (a) traditional water banking and (b) a modified water banking and exchange program. The operational scenarios assume a 20-30-year cooperative banking and exchange program between MWA and Metropolitan, but the basic principles apply to MWA banking and exchange programs which might be undertaken involving other parties. ~~Under both traditional water banking and a modified water banking and exchange program, Metropolitan would assume the conveyance costs of all water supplies it delivers to MWA and receives from MWA.~~* The magnitude of potential programs (the volume of deliveries, storage, and returns) would not be fixed except that:

- It could not exceed Metropolitan's ability to deliver supplies to MWA over the term of the banking agreement, and
- It could not exceed MWA's ability to provide returns equal to 90% of banked supplies delivered by Metropolitan.

Within these constraints, the magnitude of potential programs would vary by alternative and depend on the capacity of existing and proposed MWA facilities to accept and return deliveries.

For both traditional water banking and a modified banking and exchange program, it may be assumed that Metropolitan would utilize its available SWP and Colorado Aqueduct supplies to meet its current demands and to fill storage within its service area before making deliveries to MWA for banking or repayment of MWA pre-deliveries of SWP exchange water. In general, Metropolitan has pursued a strategy of maximizing storage within its service area, including construction of Diamond Valley Lake, to ensure that it has reliable supply in-basin in the event of service interruptions due to earthquake damage to the California Aqueduct and/or Colorado River Aqueduct.

** The above sentence was removed because, at time of the FEIR, this aspect of financial arrangements between Metropolitan and MWA had not been finalized. The issue is also financial and not a CEQA concern.*

This general approach to water reliability management means that Metropolitan would generally deliver supplies during years classified by the SWP as above-normal to wet (see Chapter 11 for definitions). Some deliveries may occur in other year types, because excess reservoir storage from a wet year may be available to meet demands in a subsequent dry to normal year. Nevertheless, deliveries in normal to below normal years are less likely. For example, from 1993 through 2003, Metropolitan delivered SWP supplies to three Kern County water banks in only one below-normal water year, that being 2003 when there was substantial supply available from the previous very wet 2002 winter (DWR 2005).

The Project Alternatives also do not assume that Metropolitan would deliver water from its SWP Table A supply only. Rather, it has been assumed that Metropolitan may purchase SWP or other supplies. In short, ~~depending on approvals by the Department of Water Resources,~~* Metropolitan may deliver water to MWA from a variety of sources.

Another key aspect of banking and exchange operations is the timing of delivery to groundwater recharge. The Department of Water Resources (DWR) makes periodic estimates of total SWP Table A supply available in a given water year. These estimates are based on monitoring of precipitation, and particularly snow pack. Early season estimates (December and January) tend to be conservative and also may reflect short-term variations in annual precipitation. For example, in 1995 (DWR 1997), precipitation was about 90% of normal from October through December, and initial Table A allocations (following a dry 1994) were accordingly low. Substantial precipitation in January triggered an increase in Table A allocations; a subsequent dry February was cause for concern. Very high precipitation in March resolved supply concerns, DWR increased SWP allocations accordingly, and Metropolitan then made deliveries to banks in May and June. Uncertainty about supply early in the water year may therefore delay decisions to bank supplies until it is clear that there will be adequate supplies to meet demands and to make banking deliveries. Historically, Metropolitan's deliveries to banking have been minimal during September through February (DWR 2005). From 1993 through 2003, Metropolitan deliveries to banking from February through August account for almost 80% of total deliveries to water banking programs outside of Metropolitan's service area. Metropolitan's deliveries to groundwater banking projects and demand for return supplies would also vary based on year type and water supply associated with carryover storage from prior years. Although there is no certainty that Metropolitan will be able to deliver water to MWA for banking during this period, it is probable that deliveries will continue to be greatest during the spring and summer, after it is clear that conditions are appropriate for banking.

In contrast, returns of banked water, whether by direct return or by exchange, are generally made in dryer years and when demand is highest. In dryer years, available supplies are well below the capacity of SWP conveyance facilities, and deliveries can be made to meet demand in the high-use months, generally late spring to late fall.

* *The above phrase was deleted because DWR is reviewing policies related to such approvals and thus future Metropolitan delivery of supplies from other sources may or may not be subject to a formal DWR approval process.*

There is no reliable way to predict actual future precipitation and water supply availability, and thus analysis of potential water supply relies on evaluation of data from previous years. No single historic period is likely to be repeated, so one approach utilized by Metropolitan and its other water banking partners has been to select a mix of historic wet to dry years and use the historic SWP allocations for these years to determine whether Metropolitan would be delivering water to the groundwater bank, taking no action, or requesting returns of banked water. Metropolitan has previously used three subsets of the period 1986 to 1999 to reflect representative conditions. The period 1992 to 1999 represents a relatively wet period; the period 1986-1992 represents an extended drought; the period 1987-1996 represents a period of varied supply.

4.1.1 Traditional Water Banking

A traditional water banking operation would involve Metropolitan delivery of supplies to MWA for recharge/storage in years when Metropolitan's available supplies exceed demand, followed by MWA return of banked supplies over a multi-year period. Based on previous banking programs and calculations of losses associated with these programs, a loss factor of 10% would be used to adjust for losses of delivered water during conveyance and recharge. This loss factor is intended to be conservative, accounting for evaporation losses and losses due to percolation into groundwater during conveyance through seepage. For MWA, losses during conveyance will be low because MWA conveyance is in pipelines. In addition, groundwater seepage during recharge would not actually be a loss, because virtually all producers in MWA's service area utilize groundwater. Any recharge is therefore a net gain, whether it is at the recharge basin or occurs during transit.

Evaporation losses are a function of air temperature, soil temperature, and wind. These conditions would vary from month to month and so actual evaporation losses are difficult to predict. An estimate of actual losses associated with evaporation can be made using typical evaporation and evapotranspiration rates for various water uses in desert environments. This type of analysis provides a range of possible evaporation losses -- a worst and best case analysis. For this analysis, the best case may be represented by a typical high-water-use crop (Lahontan Regional Water Quality Control Board, 1990; alfalfa at 52 inches per year), a mid-range may be represented by the calculated evapotranspiration rate at the Victorville CIMIS site (CIMIS 2005; 66 inches per year), and the worst-case can be represented by the average annual evapotranspiration rate for playas at Edwards AFB (Lichvar et al 2002; 110 inches per year). Converted to average daily values, these annual evaporation rates are:

- Alfalfa: 0.14 inches/day
- Victorville CIMIS station 117: 0.18 inches/day
- Edwards AFB playas: 0.30 inches/day

These rates can then be compared to the average daily recharge rate at various Proposed Project locations and the ratio of loss to recharge calculated (Table 4-1). In this analysis, evaporation rates for inland locations such as Hodge, Lenwood, Daggett, Newberry Springs, and Morongo

Basin would likely fall within the medium to high range due to marginally higher temperatures and lower humidity in these locations.

Table 4-1. Range of probable evaporation rates at Proposed Project recharge sites.

SITE	RECHARGE	LOSS RATE AT LOW, MEDIUM AND HIGH AVERAGE DAILY EVAPORATION RATES		
		Low (0.14"/day)	Medium (0.18"/day)	High (0.30"/day)
Mojave River Mainstem	>24 inches/day	0.6%	0.75%	1.25%
Oro Grande Wash	6 inches/day	2.3%	3.0%	5%
Antelope Wash	6 inches/day	2.3%	3.0%	5%
Alto/Oeste	6 inches/day	2.3%	3.0%	5%
Hodge	6 inches/day	2.3%	3.0%	5%
Lenwood	6 inches/day	2.3%	3.0%	5%
Daggett	6 inches/day	2.3%	3.0%	5%
Newberry Springs	6 inches/day	2.3%	3.0%	5%
Morongo Basin	6 inches/day	2.3%	3.0%	5%

Total returns would be equal to not more than 90% of total deliveries, and thus the 10% loss factor would exceed maximum evapotranspiration rates under all conditions. If it is assumed that 50% of banked water is delivered to the Mainstem Mojave River aquifer where percolation rates exceed 2 feet per day, then the net loss associated with evapotranspiration would be 1.45% to 3.125%. A 10% loss factor therefore ensures that actual water banked will always exceed returns.

MWD calculates probable banking deliveries and returns using its Integrated Resources Planning Simulation models (IRP SIM Model, 2003). These models use a 77-year period of record to reflect available water supply and compare this to probable demand for MWD supplies. This comparison results in a prediction of (a) water availability for banking and (b) Metropolitan's need for banked water supplies. The model is then calibrated to reflect MWA's capacity to receive, recharge, and return banked supplies. Given this input, the IRP model then evaluates the probable total magnitude of the banking program. Model output is expressed as a range. Thus, for a given set of facilities and operational plans, the model will predict the minimum magnitude of a program and the maximum magnitude of the program. The IRP Model results (MWD 2005) are affected by two variables:

- MWA's capacity to take delivery of and recharge Metropolitan supplies for banking, and
- MWA's ability to return banked supplies when needed.

To take these factors into account, MWA and Metropolitan evaluated (a) three facility alternatives, each representing a different capacity for delivery and recharge of Metropolitan supplies; and (b) three possible return scenarios (Table 4-2). These scenarios were selected for evaluation because they represent the probable maximum range of traditional banking operations. The Minimum Facilities Alternative represents a project with minimum new delivery and recharge facilities and a range of return scenarios. The Small Projects Alternative represents a project with additional recharge capacity but no change in return capacity. The Large Projects Alternative represents a project with substantial added recharge capacity and an increased capacity to make returns of banked water via direct pumping of groundwater.

Table 4-2. Facility and Operational Scenarios evaluated for the Proposed Project

FACILITIES ALTERNATIVE	MWA RETURN SCENARIO	ANNUAL RETURN CAPACITY (AF)
Minimum Facilities Alternative	Return via pumped groundwater only	18,000
	Return via pumped groundwater and exchange of up to 50% of MWA SWP supplies	40,000
	Return via pumped groundwater and exchange of MWA available SWP supplies minus 5,000 acre-feet	50,900
Small Projects Alternative	Return via pumped groundwater only	18,000
	Return via pumped groundwater and exchange of up to 50% of MWA SWP supplies	40,000
	Return via pumped groundwater and exchange of MWA available SWP supplies minus 5,000 acre-feet	50,900
Large Projects Alternative	Return via pumped groundwater only	34,500
	Return via pumped groundwater and exchange of up to 50% of MWA SWP supplies	56,500
	Return via pumped groundwater and exchange of MWA available SWP supplies minus 5,000 acre-feet	65,400

These scenarios were evaluated using Metropolitan's IRP model under the following assumptions:

- MWA Table A supply is nominally 75,800 acre-feet;
- Table A deliveries would be a percentage of 75,800 acre-feet, depending on hydrology and Department of Water Resources allocations;
- In year 2006, MWA Replacement Water and other obligations are 36,500 acre-feet;
- In year 2020, MWA Replacement Water and other obligations are 58,400 acre-feet;
- MWA Replacement Water and other obligations increase linearly from 2006 through 2020;
- A 25-year banking program, in which it is probable that Metropolitan would bank supplies early in the program and request returns later in the program; and
- Metropolitan would not begin to request returns from the bank until there was at least 75,000 acre-feet of supply in the bank.

To establish a range of possible yields from the banking program, the Metropolitan model is then run under two additional assumptions:

- Metropolitan would deliver supplies to all other banks first, or
- Metropolitan would give MWA priority and deliver supplies to it first.

This modeling analysis provides a very broad range of potential Proposed Project operations. Based on a statistical analysis of the 77-year period of hydrologic record, the model then predicts the probability that a given level of banking and return will occur. The results of Metropolitan's modeling are summarized on Table 4-3.

Table 4-3. Metropolitan modeling analysis of potential magnitude of a water banking program with MWA, for the period 2006 through 2025, by project alternative and operation scenario.

ALTERNATIVE	OPERATION SCENARIO	ESTIMATED TOTAL WATER BANKED IN ACRE-FEET		
		Low	Medium	High
Low Priority Scenario (Metropolitan delivers water to all other banks first)				
Minimum Facilities	Return via pumped groundwater only	0	18000	55000
	Return via pumped groundwater and exchange of up to 50% of MWA SWP supplies	0	25000	75000
	Return via pumped groundwater and exchange of MWA available SWP supplies minus 5,000 acre-feet	0	28000	75000
Small Projects Alternative	Return via pumped groundwater only	0	18000	55000
	Return via pumped groundwater and exchange of up to 50% of MWA SWP supplies	0	25000	75000
	Return via pumped groundwater and exchange of MWA available SWP supplies minus 5,000 acre-feet	0	28000	75000
Large Projects Alternative	Return via pumped groundwater only	0	35000	75000
	Return via pumped groundwater and exchange of up to 50% of MWA SWP supplies	0	40000	90000
	Return via pumped groundwater and exchange of MWA available SWP supplies minus 5,000 acre-feet	0	45000	100000
High Priority Scenario (Metropolitan delivers water to MWA before delivering to other)				
Minimum Facilities	Return via pumped groundwater only	75000	110000	125000
	Return via pumped groundwater and exchange of up to 50% of MWA SWP supplies	155000	185000	225000
	Return via pumped groundwater and exchange of MWA available SWP supplies minus 5,000 acre-feet	175000	240000	290000
Small Projects Alternative	Return via pumped groundwater only	80000	110000	125000
	Return via pumped groundwater and exchange of up to 50% of MWA SWP supplies	155000	185000	225000
	Return via pumped groundwater and exchange of MWA available SWP supplies minus 5,000 acre-feet	185000	240000	290000
Large Projects Alternative	Return via pumped groundwater only	145000	205000	240000
	Return via pumped groundwater and exchange of up to 50% of MWA SWP supplies	220000	270000	335000
	Return via pumped groundwater and exchange of MWA available SWP supplies minus 5,000 acre-feet	240000	320000	390000

Low, medium, and high estimates of potential banking project yield reflect statistical probabilities that, given precipitation and water supply typical of the 77 years from1922 through 1998 there would be a 75% chance of banking the "low" estimate, a 50% chance of banking the "medium" estimate, and a 25% chance of banking the "high" estimate. Thus the medium estimate represents a probable average yield from the banking program. There are several important trends in the modeling.

First, the priority that Metropolitan places on the bank has a significant impact on total amount of water banked. If Metropolitan makes deliveries to all other banks first, the magnitude of the banking project is quite low, regardless of the capacity of facilities. With a high priority placed on MWA's bank, the potential amount of water is substantially higher for all alternatives and operations scenarios. In practice, Metropolitan is likely to make deliveries on a more balanced basis, depending on conditions at the various banks it utilizes. However, MWA's Proposed Project varies from other banks used by Metropolitan in that it is not substantially constrained by recharge capacity, primarily because existing facilities can take substantial recharge and because there is very rapid recharge via the Mainstem Mojave River. Recharge rates in the Mojave River Mainstem are 5-10 times those of conventional water banks in Kern County. In addition, MWA has greater flexibility in delivery of its own supplies. Kern County's agricultural banking programs are constrained by delivery capacity during periods of high agricultural use. A reasonable estimate of project magnitude can be made assuming that MWA would be able to take delivery of Metropolitan supplies more frequently than other banks. If Metropolitan deliveries to the MWA bank are based on an equal priority given to each of the water banks Metropolitan uses, and adjusted upward by 30% to reflect MWA's ability to take supplies more rapidly and during more periods of the year, then probable bank magnitude for the three facilities alternatives (medium estimate) are summarized on Table 4-4.

Table 4-4. Probable MWA traditional banking program magnitude: medium estimate of banked water, 2006 to 2025, assuming equal priority delivery to Metropolitan water banks.

ALTERNATIVE	OPERATION SCENARIO	EST. WATER BANKED (af)
Minimum Facilities	Return via pumped groundwater only	**~~87,000*~~** **83,200**
	Return via pumped groundwater and exchange of up to 50% of MWA SWP supplies	**137,000**
	Return via pumped groundwater and exchange of MWA available SWP supplies minus 5,000 acre-feet	**174,000**
Small Projects Alternative	Return via pumped groundwater only	**~~87,000*~~** **83,200**
	Return via pumped groundwater and exchange of up to 50% of MWA SWP supplies	**137,000**
	Return via pumped groundwater and exchange of MWA available SWP supplies minus 5,000 acre-feet	**174,000**
Large Projects Alternative	Return via pumped groundwater only	**156,000**
	Return via pumped groundwater and exchange of up to 50% of MWA SWP supplies	**202,000**
	Return via pumped groundwater and exchange of MWA available SWP supplies minus 5,000 acre-feet	**237,000**

**The estimate of 87,000 acre-feet of banking was based on preliminary review of IRP Simulation Model runs and is modified slightly on the above tables based on subsequent conversations with MWD.*

A second trend, seen even more clearly on Table 4-4, is that the ability to make returns to Metropolitan is more important than increased recharge capacity. For example, there is no difference in the magnitude of the banking program for the Minimum Facilities Alternative and the Small Projects Alternative, even though there is more recharge capacity associated with the Small Projects Alternative. The importance of return capacity in determining total bank magnitude is further illustrated by the increase in magnitude for the Large Projects Alternative. A 92% increase in direct return capacity (return via pumped groundwater) from 18,000 acre-feet per year (Small Projects Alternative) to 34,500 acre-feet per year (Large Projects Alternative) results in an 86% increase in total project magnitude. Return capacity thus accounts for a majority of the additional benefits associated with the Large Projects Alternative.

4.1.2 Modified Banking Program (Banking plus Exchange)

Traditional water banking is based on the concept that water must be deposited in the water bank prior to returns, via either exchange or direct return. This rule is intended to protect local groundwater users by preventing pre-delivery of groundwater to a banking partner, and thereby reducing groundwater levels and causing overdraft and its associated problems such as land subsidence. This rule makes sense if (a) direct return is the means by which bank deposits are to be returned and (b) if exchange water is not adequate during a return year and local agencies would have to pump groundwater in lieu of receiving supplemental supplies. This rule effectively limits the water management options of the cooperating parties. Traditional water banking is also generally evaluated on a year-to-year basis, under the assumption that water would be banked in some year types and returned in other year types.

A supplemental exchange program may be added to the traditional water banking program without violating the prohibition on pre-delivery of groundwater to a banking partner. This approach would involve MWA delivery of a portion of its SWP supplies at any time during the banking program when Metropolitan had capacity to take these supplies. MWA would only deliver supplies in this way which it could otherwise not take due to recharge and/or cost considerations. In short, when MWA has SWP allocations in excess of its obligations, there may be opportunities to coordinate operations with Metropolitan on a month-to-month basis to optimize available supply for both parties.

A supplemental exchange program may be added to a banking program because (a) MWA does not now take all of its SWP supply and (b) Metropolitan has a multi-faceted approach to water management, with several key components (Metropolitan 2003):

- Use of reservoir storage to meet peak seasonal water demands when conveyance capacity may be limited; and
- Local agency use of in-basin groundwater supplies to meet peak seasonal demands, followed by Metropolitan replenishment of these groundwater supplies when conveyance capacity becomes available (generally from late fall through mid spring).

Metropolitan operates in this manner because peak demands constrain the ability to deliver available supplies. Thus, for example, the Final EIR for Diamond Valley Lake (Metropolitan 1990) provides use of about 100,000 acre-feet of stored water to meet summer and fall demands. In addition, Metropolitan and its member agencies anticipate a substantial increase in local groundwater use to meet peak season demands, with Metropolitan replenishment of these groundwater supplies increasing from 250,000 acre-feet per year in 2005 to 415,000 acre-feet per year in 2025 (Metropolitan 2003). Finally, Metropolitan operates a number of other water banking programs (primarily in Kern County). Even in normal-to-wet years, Metropolitan may have capacity in these programs but not have available SWP supply to utilize them.
Under a modified banking and exchange program, MWA could participate in Metropolitan's own in-basin and other storage replenishment programs on a month-to-month basis by delivering available SWP supplies to Metropolitan to either:

- Help Metropolitan meet peak demands and thus reduce the use of stored supplies, and/or
- Provide supplies to replenish reservoir storage and/or groundwater reserves.

MWA could make such deliveries without affecting groundwater levels in any year when it had SWP supply in excess of demand, even in years when Metropolitan might deliver supply to MWA. There are two reasons why Metropolitan would take deliveries during a year when it was also delivering water to MWA:

- In a wet year following a drought, Metropolitan may wish to optimize the availability of supply in order to replenish both its in-basin storage and its storage in water banks outside of its service area. For example, in the moderately wet 1993 water year, following a critically dry year (1992), Metropolitan would be able to utilize additional available supply to replenish all elements of its storage and banking programs. Metropolitan might therefore take early delivery of MWA SWP supplies and then return these supplies plus banking deliveries later in the year, when its in-basin capacity had been refilled.
- Within any water year, the availability of supply to Metropolitan depends on the timing of precipitation in the SWP watershed. In many years, moderately dry conditions may occur early or late. Thus, Metropolitan could request delivery of exchange water in a dry January-February, and return this supply and additional supply for banking to MWA following a wet March or April (such as occurred in 1995). As a result of such exchanges, MWA could pre-deliver supplies to Metropolitan for storage within Metropolitan's service area and take returns in the same or a subsequent year.

The extent that such pre-deliveries are feasible is not possible to predict precisely without a model that tracks supply and demand on a monthly or even a weekly basis. Metropolitan's IRP Model does not yet have this capability and thus projections of additional water exchanges under a modified banking program must be made based on a set of reasonable assumptions:

- Opportunities for within-calendar-year exchanges are greatest in the transition between wet-to-dry years and in dry-to-wet years.

- In transition years from wet to dry conditions, the surplus available in the wet year is optimized to restore groundwater storage; as a result, Metropolitan would wish to bank water in its service area before banking water in offsite banks. Under such conditions, MWA could deliver water to Metropolitan early and receive banked water later in the same year.
- In transition years from dry to wet, it may not be clear that a year will be wet until the spring. In these years, MWA could provide supplemental supply early in the water year and then this water would be returned when it became clear that wet conditions would result in high SWP allocations.
- Based on DWR records for 1901-2004, transition years occur about 40% of the time (DWR 2005a).

It is thus probable that supplemental exchanges between MWA and Metropolitan, in which MWA delivers surplus SWP supply to MWD and this was returned by Metropolitan at a later date, would occur in about 6 to 8 years of a 20-year banking and exchange program. A modified water banking and exchange program involving early MWA delivery of available SWP supplies to Metropolitan may have two effects on operations:

- Pre-deliveries to Metropolitan may be used to reduce MWA's obligations for direct return of groundwater water in dry years, thus reducing groundwater pumping in dry years, and/or
- MWA may operate the banking element of the program per the traditional banking concept and pre-deliveries to Metropolitan may be repaid to MWA at a later date.

It is likely that a modified banking and exchange program would involve a combination of these elements, and that the net result would be (a) reduction of the need for direct returns from banking and (b) a net increase in total groundwater stored in MWA over the term of the banking agreement.

An example of this type of operation would be a water year such as July 1994 to June 1995. After the dry water year from July 1993 to June 1994, conditions were also dry throughout the summer and fall of 1994. Nevertheless, even a repeat of the dry conditions of 1993-1994 would have allowed MWA to provide Metropolitan with 3500 acre feet of supply. The subsequent heavy rains of January-March would then have provided Metropolitan with the ability to return this supply and to put water into the MWA bank. This type of intra-annual exchange is feasible in almost all years, but is most likely in transition years. In dry-to-wet transitions, Metropolitan would take water early (when dry conditions still prevailed) and then return water late (after wet conditions had occurred). In wet-to-dry transitions, the reverse would occur.

For purposes of estimating benefits to Metropolitan and MWA, it has been assumed that these transition-year opportunities would result in supplemental deliveries to Metropolitan in about 40% of all years, or 8 years of a 20-year banking program. Given that these supplemental exchanges would probably not occur in years when Metropolitan was requesting returns of banked supplies (dry to below-normal years) or in a series of very wet years, MWA's average annual SWP allocation would be about 80% during these years, or about 60,500 acre-feet per year. During the first 20 years of the proposed banking program, MWA's average annual SWP demand would be about 48,000, leaving an average of about 12,000 acre-feet per year available for supplemental exchange. This would increase the total potential magnitude of the banking and exchange program by about 96,000 acre-feet; that is, MWA would provide Metropolitan with 96,000 acre-feet of its Table A supply which Metropolitan would return to MWA in wet to above-normal years. Table 4-5 summarizes the potential magnitude of the proposed combined banking and exchange program.

In addition, under such a modified program, to the extent that Metropolitan pre-delivers water, MWA may meet a substantial part of local demand with stored water and allow MWD to use MWA Table A. Such a program could affect timing of deliveries. Metropolitan may choose to deliver to MWA first and thus assure availability of MWA Table A water when allocations are higher. Metropolitan may then fall back on its range of traditional banking programs when conditions are dryer. Finally, the addition of a modified exchange program may affect Metropolitan's determination of whether it is more cost-effective to store supplemental water within MWA to maximize potential for return by exchange or through pump-back programs at other locations. Water quality of potential return water may also influence Metropolitan's decisions.

Table 4-5. Probable magnitude of a combined traditional banking program and on-going water exchange program: medium estimate of banked water, 2006 to 2025, assuming equal priority deliveries to all Metropolitan water banks.

ALTERNATIVE	OPERATION SCENARIO	ESTIMATED TOTAL WATER YIELD IN ACRE-FEET		
		Banking	**Time-Shift Exchanges**	**Total**
Minimum Facilities	Return via pumped groundwater only	~~87,000*~~ **83,200**	**96,000**	~~183,000*~~ **179,200**
	Return via pumped groundwater and exchange of up to 50 % of MWA SWP supplies	**137,000**	**96,000**	**233,000**
	Return via pumped groundwater & exchange of MWA SWP supplies minus 5,000 acre-feet	**174,000**	**96,000**	**270,000**
Small Projects Alternative	Return via pumped groundwater only	~~87,000*~~ **83,200**	**96,000**	~~183,000*~~ **179,200**
	Return via pumped groundwater and exchange of up to 50% of MWA SWP supplies	**137,000**	**96,000**	**233,000**
	Return via pumped groundwater and exchange of MWA SWP supplies minus 5,000 acre-feet	**174,000**	**96,000**	**270,000**
Large Projects Alternative	Return via pumped groundwater only	**156,000**	**96,000**	**252,000**
	Return via pumped groundwater and exchange of up to 50% of MWA SWP supplies	**202,000**	**96,000**	**298,000**
	Return via pumped groundwater and exchange of MWA SWP supplies minus 5,000 acre-feet	**237,000**	**96,000**	**333,000**

** The estimate of 87,000 acre-feet of banking was based on preliminary review of IRP Simulation Model runs and is modified slightly on the above tables based on subsequent conversations with MWD.*

The estimates shown on Table 4-5 provide a reasonable basis for evaluating the benefits of a potential combined banking and exchange program. Estimates are based on probabilities of various weather conditions and SWP supply allocations. Actual operations will vary.

4.2 Facilities

The Proposed Project would involve construction of new facilities (Figure 4-1), with three basic increments of facilities formulated and evaluated for the Project EIR. In addition to using the existing recharge basins and pipelines and the Mainstem Mojave River for groundwater recharge, the Proposed Project would include construction of up to 880 acres of new recharge basins, up to 16-18 miles of new buried pipelines, new wells, and associated facilities such as monitoring wells and pumping stations. Recharge basins would be of essentially similar design, with large areas enclosed in levees and the internal area divided by levees (Figure 4-2) into 5-to-20 acre cells, connected by gates built into the levees.

4.3 Minimum Facilities Alternative

The Minimum Facilities Alternative is intended to optimize use of existing facilities, use of planned recharge facilities, and the use of the Mojave River Aquifer between Mojave Forks Dam and the Narrows to receive and distribute supplies from Metropolitan and MWA. The Minimum Facilities Alternative would utilize the existing capacity of the Mojave River Pipeline and the Morongo Basin Pipeline, including existing turnouts. These pipelines would not be modified. Direct return of banked supplies via groundwater pumping from a well field along the Mojave River would be feasible via a pipeline to the California Aqueduct.

4.3.1 Existing Facilities

4.3.1.1 Mojave River Pipeline and Recharge Facilities

The Mojave River Pipeline connects to the California Aqueduct about 5 miles south of Adelanto, runs due north for 10 miles, then turns east to the existing High Desert Power Plant turnout before turning north to run along the Mojave River to Hodge, Lenwood, Daggett and Newberry Springs, where there are existing recharge sites. The final segment of the pipeline, from Daggett to Newberry Springs is under construction and will be completed before implementation of the Proposed Project. Flow in the Mojave River Pipeline is by gravity. There are no facilities to pump return flows from downstream areas to the California Aqueduct. The Mojave River Pipeline has capacity at the California Aqueduct of 94 cfs (188 acre-feet per day). Capacities of recharge basins along the Mojave River Pipeline are (2004 Regional Water Management Plan):

- Hodge Recharge Basin: 9,000 acre-feet per year
- Lenwood Recharge Basin: 9,000 acre-feet per year
- Daggett Recharge Site: 16,800 acre-feet per year
- Newberry Springs Recharge Site: 6,000 acre-feet per year

Deliveries to the Hodge Facility may be increased because an oversized outlet valve was installed during construction. The nominal delivery rate documented in the 2004 PEIR is used. The Newberry Springs Recharge Site is part of the Mojave River Pipeline Project and is currently in construction. Groundwater is also recharged via the Rock Springs Turnout to the mainstem Mojave River. In addition, there are approximately 30 to 50 acres of new flood detention/recharge where Oro Grande Wash intersects with Green Tree Road. This facility, being constructed by Victor Valley Water District (VVWD), will be used by VVWD to receive SWP supplies provided by MWA. In addition, MWA may also have capacity for recharge and storage of supply at this site. Assuming use of this detention basin for 6 months of the year, capacity would be 3,600 acre-feet per year. Net existing recharge basin capacity for these 5 facilities and Rock Springs Turnout, would be at least 44,400 acre-feet.

Finally, MWA has demonstrated that releases of up to 500 cfs (1000 acre-feet per day) may be made from Silverwood Lake to the Mainstem Mojave River with flows contained within the low-flow channels of the West Fork of the Mojave River. In the 2003-2004 demonstration project, flows from Silverwood Lake were ramped up in 50 cfs increments. At 50 cfs, most flow percolated into the ground before reaching Mojave Forks Dam. Higher flows reached the Mainstem Mojave River, where sand berms had been pushed up to enhance spreading, retard flows, and increase the rate of percolation. For the Minimum Facilities Alternative, MWA would utilize the Mojave River Mainstem for recharge in a similar manner.

4.3.1.2 Morongo Basin Pipeline and Recharge Facilities

The existing Morongo Basin Pipeline connects to the California Aqueduct at Antelope Wash, runs northeast to Rock Springs Road where it crosses under the Mojave River, and then runs east and southeast for about 70 miles to its terminus at 3 recharge basins in the Yucca Valley. There is a 80 cfs turnout to the Mojave River Mainstem at Rock Springs. There are currently no facilities available to provide for pumping of return flows from the Morongo Basin back to the California Aqueduct; none are proposed in the Minimum Facilities Alternative. Capacities at various points along the pipeline (in cfs and acre-feet per day) are:

- California Aqueduct: 110 cfs (220 acre-feet/day)
- Rock Springs Outlet: 80 cfs (160 acre-feet per day)
- Past Rock Springs: 30 cfs (60 acre-feet/day)
- At Morongo Recharge Basins: 15 cfs (30 acre-feet/day)

These existing recharge facilities would not be altered under the Minimum Facilities Alternative.

4.3.2 New Facilities

4.3.2.1 Mainstem Mojave River

In the Mainstem Mojave River, MWA would annually construct sand berms across the riverbed to retard the downstream flow of water, spread out recharge areas, and concentrate recharge in the upstream reaches of the river to the extent feasible. These berms would be pushed up using a scraper or dozer, and would wash out rapidly during natural flows (as they did in MWA's 2003-2004 demonstration project). Water would be delivered to these areas via releases from Silverwood Lake and/or an unnamed wash that discharges to the Mainstem Mojave River about a mile downstream from Mojave Forks Dam (hereafter Unnamed Wash).

4.3.2.2 SWP Delivery via Unnamed Wash

From February 16 through September 15, deliveries to the Mainstem Mojave River via Silverwood Lake and the West Fork of the Mojave River would be constrained to the capacity of the Rock Springs outlet as the result of arroyo toad breeding in the West Fork of the Mojave River. This constraint could limit total recharge of the Mainstem Mojave River because California water supplies vary significantly on a month-to-month basis, even in nominally wet years.

To ensure that recharge capacity of the Mainstem Mojave River is not affected by the arroyo toad constraint, additional capacity for delivery to the Mainstem Mojave River would be developed by constructing a turnout from the California Aqueduct in Summit Valley that could be used alone or in combination with an existing turnout to make releases of up to 500 cfs down Unnamed Wash, which flows east from Summit Valley and joins the Mojave River about a mile downstream from Mojave Forks Dam. This currently undeveloped wash would convey flow to an intake structure and an undercrossing at Arrowhead Lake Road and then across 2500 feet of the Mojave River floodplain within low earthen levees located at approximately the boundary of the 100-year floodplain. Development is planned adjacent to this wash and the wash dedicated as open space. MWA is cooperating with the potential developer (Rancho Las Flores) regarding possible use of Unnamed Wash for recharge deliveries.

Facilities at Unnamed Wash would include a pipeline or canal/channel to convey water from the turnout through the proposed development to the head of the wash, several rock drop structures (artificial water falls) to reduce flow velocities and potential for erosion, a bridge undercrossing at Arrowhead Lake Road, an unpaved 8-foot access road or roads along the wash to allow for maintenance and monitoring, and a flat-car bridge (or bridges) across the wash to allow for maintenance vehicles to cross the wash. These facilities would follow the natural contours of the wash and minimize construction. General alignments have been coordinated with Rancho Las Flores. Continuing coordination will ensure that they are not in conflict with proposed Rancho Las Flores facilities to be developed in the wash as part of their development project.

The turnout at Unnamed Wash may also function to partially serve the Department of Water Resources (DWR) water management objectives for the California Aqueduct. A present, rapid shut down of deliveries to Silverwood Lake in emergencies may create conditions that would create a spill in the Summit Valley reach of the California Aqueduct. Such an uncontrolled spill may be somewhat ameliorated by releases from the turnout. Should DWR initiate planning for facilities to address this potential problem, MWA would cooperate with DWR in planning to minimize potential conflict in operations of the turnout and any facilities proposed by DWR.

4.3.2.3 Mojave River Well Field

The engineering analysis by Bookman-Edmonston (B-E 2004b) concluded that the Mojave River Aquifer had capacity of about 61,000 acre-feet with a dry zone of 20 feet in the upper level of soil to minimize potential for liquefaction effects. The 2003-2004 demonstration project confirmed the high recharge capacity of the Mainstem Mojave River. Even at releases of 350 cfs to 500 cfs, surface flows rapidly percolated into the aquifer and surface flows did not reach the Narrows. These flows move laterally into the aquifer adjacent to the riverbed

Recharge of the Mojave River (hereafter Instream Mojave River Recharge) requires (a) ability to deliver water in all months and (b) on-going extraction and use to balance recharge and extraction rates. The USGS (Stamos 2001) indicates that the Mojave River Aquifer and the Regional Aquifer are connected and that the Mojave River Aquifer recharges the Regional Aquifer at a rate of about 34,300 acre-feet per year (1931-1990 average). Water introduced into the Mojave River Aquifer above Rock Springs could thus be expected to flow laterally and downstream, and this water may be extracted for use by tapping into the adjacent Regional Aquifer. Recharge in this manner would raise water levels in the Mojave River Aquifer and extraction from the adjacent Regional Aquifer would result in a cone of depression that would further increase the difference in hydrostatic pressure, resulting in increased rates of flow from the Mojave River Aquifer to the adjacent Regional Aquifer. As a result, a majority of the water recharged via the Mojave River could be extracted and used in the Alto subarea.

The reach of primary recharge and extraction south of the Narrows is adjacent to Hesperia, Victorville, Apple Valley, and Adelanto, and urban water use in the Alto subarea in 2000 was 47,700 acre feet, resulting in a supply deficit of about 16,800 acre-feet. As the area grows, water use and supply deficits are anticipated to grow. Although annual Alto Basin agricultural water use is projected to decline from about 3,800 acre-feet (2000) to 1,300 acre-feet (2020), urban water use is projected to increase to 78,100 acre-feet per year by 2020, resulting in a supply deficit of 44,700 acre-feet (2004 Regional Water Management Plan).

The Mojave River Well Field and Well Field Delivery Pipelines would be constructed on both sides of the Mojave River south of Bear Valley Road, within about a mile of the river bank. Specific well locations would be evaluated based on detailed hydrogeologic investigations. It is probable that wells would be sited along public roads, primarily in residential and open space areas. Wells would be from 200 to 600 feet deep and would be protected from surface water influences with sheathing. Well sites would be selected based on the following criteria:

- Depth to groundwater,
- Potential for minimizing surface water influence,
- Proximity to public rights-of-way,
- Spacing between wells to optimize groundwater flow rates, and
- Ability to construct in a manner that would be compatible with existing development

4.3.2.4 Well Field Delivery Pipelines

The Mojave River Well Field would deliver raw water to existing pipelines and water treatment facilities serving Hesperia, Victorville, Apple Valley, and Adelanto, with main collector pipelines running north-south on either side of the river to connect the various wells. All connecting and delivery pipelines on the west would be constructed within existing public rights-of-way (roads and/or sidewalks). On the west, this connector pipeline would connect to a pumping station and then run east-to-west along Mesa Street, cross under Interstate 5 and continue until reaching the California Aqueduct. Pipeline peaking capacity would be up to 66 cfs. In years when there were no direct returns to Metropolitan, this capacity would be adequate to deliver 44,400 acre-feet of supply to local producers. If Metropolitan requested direct return of groundwater, the pipeline would have capacity to deliver 30,000 acre-feet to local producers and up to 18,000 acre-feet to the California Aqueduct. Several small pump stations would be required along the route. In addition, there would be four pipelines from this main arterial line to connect with existing City of Hesperia facilities and regional distribution hubs.
On the east side of the river, connector pipelines would run roughly along the alignment of Jess Ranch Parkway, a local road serving a development. Wells and pipelines would then generally follow the alignment of Apple Valley Road south, crossing undeveloped land. The eastern well field would be connected to existing local delivery pipelines near Jess Ranch Parkway.

New facilities needed for the Minimum Facilities Alternative are described on Tables 4-6 through 4-9. A typical view of the Mojave River Recharge during the 2003-2005 pilot project is shown on Figure 4-3. In addition, the Minimum Facilities Alternative would involve use of existing groundwater monitoring wells to monitor the movement of recharged water from north to south in the Mainstem Mojave River in the reach from Mojave Forks Dam to the well field south of the Narrows. Monitoring would be required to ensure that extraction of groundwater at the well field did not result in lowering of groundwater levels below what they would be without groundwater extraction.

Table 4-6. Facilities for the Minimum Facilities Alternative.

FACILITY	PURPOSE	DESCRIPTION
Instream Mojave River Recharge	Improve recharge in the mainstem river	An array of sand berms 2-3 feet in height would be constructed across the riverbed to spread flows out and reduce flow velocity to maximize recharge in the upper and middle reaches of the river.
Mojave River Well Field	Extract groundwater migrating downstream towards the Narrows	A field of up to 25 wells would be sited along both sides of the river and connected with a 36 to 54 inch pipeline. Probable west alignment is along Carob and Orchid street. East alignment is along Jess Ranch Parkway and local streets inland and south.
Mojave River Delivery Pipelines	Deliver groundwater to Hesperia, Victorville, Apple Valley, County areas, Adelanto, and the Mojave River Pipeline	On the west, a new 9-mile 36 to 54 inch pipeline would connect the new well field to existing raw water pipelines operated by subarea producers and link existing Alto basin wells and to the California Aqueduct. On the east, segments of new pipeline would be constructed to connect to existing Apple Valley Ranchos facilities at Jess Ranch Country Club, Jess Ranch Parkway, and the Town Center.
Recharge via Unnamed Wash	Ensure year-round delivery to the Mainstem Mojave River	An up to 500 cfs turnout from the California Aqueduct in Summit Valley with conveyance to the head of Unnamed Wash, which would be bridged at several locations to allow for passage of flows under roads/trails. Several drop structures constructed to reduce erosive flows. A bridge would be constructed at Arrowhead Lake Road and then flow would be between low levees across the floodplain.

Table 4-7. Probable pipeline alignments for the Well Field Delivery Pipelines

SEGMENT	APPROXIMATE LENGTH (miles)	ALIGNMENT
Potential Alignment of Connecting Pipelines: West		
WF1	0.25	Carob Street
WF2	2.0	Orchid Street from Carob to Lemon Street
WF3	1.25	Wilson Road
WF4	0.5	Wilson Road to Orchid Avenue via Talisman Street
WF5	0.75	Wilson Road to Orchid Avenue via Lemon Street
Potential Alignment of Pipelines to deliver water to Hesperia, Victorville, and/or Adelanto		
West1	2.0	Eucalyptus, from Orchid to Santa Fe
West2	2.0	Santa Fe (1 mile north to County service Facility 64; 1 mile south to Mesa)
West3	6.0	Mesa Street from Santa Fe to the California Aqueduct
West4	1.0	Mesa to VVWD reservoirs via Pinion Street
West5	1.0	Mesa to VVWD reservoirs via Amethyst Street
West6	0.5	Mesa to Hesperia Plant 14
Potential Alignment of Pipeline to deliver water to Apple Valley		
East 1	1.0	Along Jess Ranch Parkway south of Bear Valley Road
East 2	1.0	Along golf course boundary parallel to Apple Valley Road
East 3	NA	Short connecting pipelines from wells to existing Apple Valley Ranchos connections at Jess Ranch, Bear Valley, and Town Center

Table 4-8. Facilities design Parameters, Mainstem Mojave River, Minimum Facilities Alternative.

FACILITY	MATERIALS AND DIMENSIONS	CAPACITIES
In stream Mojave River Recharge	Sand berms: Height up to 6 feet Base width: 12 - 18 feet Total area length: 20,000 feet	Combined deliveries from Silverwood Lake, Unnamed Wash, and Rock Springs limited to about 48,800 af/year (44,400 extraction rate plus 10% loss factor).
SWP Delivery via Unnamed Wash	Turnout Capacity 500 cfs Intake capacity 500 cfs Flow velocity at intake 5 f/s Levee type earthen Width between levees 100 year floodplain Level width at crest 5 feet	Delivery capacity 1000af/day
Mojave River Well Field	Number of wells: up to 25 Type: Electric, vertical turbine Project life: 30 years Pumping rate: 3 cfs	Extraction rate, all wells: 150 af/day Annual extraction, 12 months operation: 44,400 af
Well Field Delivery Pipelines	Material: Reinforced concrete pipe Pipeline length 47,000 feet Lateral pipelines 6,800 feet Pipeline Diameter (maximum): 54 inches Pipeline Diameter (minimum): 16 inches Flow rate: 7 feet/second	Capacity (maximum): 66 cfs Direct return capacity from existing wells………………...10 cfs Direct return capacity: 18,000 af/y

Table 4-9. Potential annual recharge for the Minimum Facilities Alternative.

FACILITY	SUBAREA	RECHARGE CAPACITY IN ACRE-FEET
Existing recharge in Morongo Basin	Warren/Yucca Valley	3,475
Existing recharge at Lenwood	Centro	9,000
Existing recharge at Hodge	Centro	9,000
Existing recharge at Daggett	Baja	16,800
Existing recharge at Newberry Springs	Baja	6,000
Existing Green Tree Detention Basin	Alto	3,600
Instream Mojave River Recharge	Alto	44,400
TOTAL GROSS RECHARGE CAPACITY	ALL AREAS	92,275

4.3.3 Operations

4.3.3.1 Recharge and Water Management

The Minimum Facilities Alternative provides for use of facilities for Banking and MWA deliveries to meet demands. The capacity of existing and new facilities is therefore evaluated in terms of ability to meet both banking and on-going operational elements.

A practical limit on the annual recharge to the Mainstem Mojave River would be the extraction capacity of the downstream well field plus the 10% added to account for losses during recharge. With this assumption, and assuming that recharge would generally occur in the cooler months and percolation rates would be high, extraction of 90% of gross recharge would probably result in a slight increase in flow to the Narrows (a portion of the water assumed to be lost). From an operational perspective, net recharge capacity to accept water for banking purposes would be based on (a) subarea producers' ability to take and use banked supplies and (b) MWA's capacity to make returns. This would limit gross annual recharge deliveries to about 48,800 acre-feet in this element of the Minimum facilities Alternative.

Combined gross recharge capacity of combined releases from Silverwood Lake (5 months only), Unnamed Wash (12 months) and Releases from Rock Springs (12 months) would be substantially less than the sum of their total capacity because, following an initial discharge, the net annual discharge to the Mainstem Mojave River would be matched to deliveries from the well field, or about 44,400 acre-feet per year (48,800 acre-feet gross recharge less the 10% loss factor). Peak capacity in fall and winter would be over 1,000 cfs, which could probably not be sustained without surface flow reaching the Narrows. Nevertheless, in fall and winter months, MWA could take short-term high volume deliveries to the Mainstem Mojave River via all three delivery options.

Peak capacity in the period March through September would be in excess of 500 cfs (1000 acre-feet per day), via Unnamed Wash and the Rock Springs outlet. Again, this rate of delivery would be in excess of the sustainable rate, but would allow MWA to take delivery of banking supplies at a high rate when needed.

In the Morongo Basin, Centro, and Baja areas, there would be no effect of banking when compared to other forms of pre-delivery of supplemental supplies. All producers in these areas would continue to use their existing recharge and extraction facilities. Under the 2004 Regional Water Management Plan, MWA would increase recharge capacity at Morongo Basin (2004 PEIR). MWA would continue to deliver water adequate to meet on-going annual replacement obligations (hereafter "replacement water"). In the Morongo Basin, there are projected supply surpluses in the Johnson Valley throughout the period of banking operation. Deficits exist for the other three subareas in the Morongo Basin. Based on 2000 and 2020 average annual water balance data from the 2004 Regional Water Management Plan, Table 5-15, average annual deliveries to the Morongo Basin, Baja, and Centro areas would be:

Basin	2005	2010	2015	2020	2025
Morongo	1,000	1,100	1,600	1,900	1,900
Baja	22,700	11,900	5,900	6,100	6,100
Centro	0	200	1,300	2,700	2,700

These estimates of net deficits in these areas are based on continuation of the current decline in agricultural acreage within MWA's service area. Assuming a 20 to 30 year banking program and using average annual deficit, MWA could bank a substantial volume of water in these basins:

- Morongo: Average annual deficit: 1,450 acre feet
  Total banking capacity: 29,000 acre feet
- Baja: Average annual deficit: 11,400 acre feet
  Total banking capacity: 288,000 acre feet
- Centro: Average annual deficit: 1,350 acre feet
  Total banking capacity: 27,000 acre feet

This volume of banked water would allow MWA to meet all obligations to these subareas during the 20-year term of the banking agreement.

The Minimum Facilities Alternative would use the Mainstem Mojave River as a recharge and natural slow-sand filtration system, with recharge in the southern reaches of the river and recovery of recharged supplies at a well field located downstream of Rock Springs (Figure 4-1). Bookman-Edmonston (2004a) estimated recharge capacity for the Mojave River at upstream from the Narrows at about 61,000 acre-feet; this would ensure a maximum groundwater elevation of 20 feet. To maximize recharge capability of the river, MWA would operate this system on a "put-and-take" basis. MWA would recharge the river at a rate equal to the extraction rate at the downstream well field (less the loss factor). The Mojave River Well Field would be connected to the distribution systems of Alto subarea producers so that water extracted from the well field could be delivered to existing distribution and treatment facilities and used to meet on-going needs. Each of the up to 25 wells would be rated at 3 cfs each, but their actual capacity would be governed by daily variations in on-going demand. At peak operation the Mojave River Well Field could deliver about 54,750 acre-feet. To reflect downtime for maintenance and repair and less-than-peak deliveries during periods of low water use, the probable net extraction from the Mojave River Well Field is about 44,400 acre-feet per year. Based on these considerations, the net recharge capacity available for receiving banked supplies under the Minimum Facilities Alternative is shown on Table 4-10. Capacities on Table 4-10 are net recharge (90% of gross recharge to reflect the 10% loss factor).

Average annual capacity for delivery of supplies for banking (Table 4-10) could be in excess of 45,000 acre-feet per year in all years, except at the end of the proposed banking period (when Metropolitan may or may not be making deliveries). The Minimum Facilities Alternative would also provide MWA with up to 18,000 acre-feet per year of direct return capacity from the Mojave River Well Field and/or from local wells connected to the Mesa Street Pipeline.

Table 4-10. Average annual recharge capacity in acre-feet available for banking, Minimum Facilities Alternative, 2005-2020.

BASIN	RECHARGE CAPACITY	ANNUAL MWA REPLACEMENT DELIVERIES	ANNUAL BANKING RECHARGE CAPACITY
2005			
Morongo	3,475 (pending-expansion)	-1,000	2,475
Centro	18,000	-0	18,000
Baja	22,800	-22,700	100
Alto	48,000	-22,900	25,100
TOTAL	92,275	-46,600	45,675
2010			
Morongo	3,475	-1,100	2,375
Centro	18,000	-200	17,800
Baja	22,800	-11,900	10,900
Alto	48,000	-28,700	19,300
TOTAL	92,275	-41,900	50,375
2015			
Morongo	3,475	-1,600	1,875
Centro	18,000	-1,300	16,700
Baja	22,800	-5,900	16,900
Alto	48,000	-35,700	12,300
TOTAL	92,275	-44,500	47,775
2020			
Morongo	3,475	-1,900	1,575
Centro	18,000	-2,700	15,300
Baja	22,800	-6,100	16,700
Alto	48,000	-44,700	3,300
TOTAL	92,275	-55,400	36,875

4.3.3.2 Maintenance

Routine maintenance activities for the Minimum Facilities Alternative would include annual re-construction of the sand berms in the Mainstem Mojave River, inspections and maintenance of wells, pipelines, and pumps; and inspection, monitoring, and maintenance of the conveyance along Unnamed Wash. Unnamed Wash will be maintained as a semi-natural channel and, except for the drop structures and maintenance access roads, would be managed to maintain existing desert wash-type habitats. Maintenance will be focused on vegetation control in the channel area to (a) minimize potential for channel migration, (b) repair drop structures if necessary, and (c) control growth of vegetation, such as tamarisk, that may develop as a result of more frequent wet conditions and result in reductions in channel capacity.

4.3.4 Construction

The Minimum Facilities Alternative involves construction of conventional temporary recharge berms in the Mojave River Mainstem, two well fields, and a system of distribution pipelines.

4.3.4.1 Instream Mojave River Recharge

Temporary sand berms would be constructed within the dry mainstem channel of the Mojave River. The configuration of these temporary berms may vary based on monitoring or recharge rates for different configurations. In all cases, construction will occur under dry conditions, that is when there is no natural flow in the channel. The berms will be constructed using in-channel sediment; no sediment will be discharged to or removed from the channel area. Berms may be up to 6 feet in height. Within an area 3-4 miles long, the total area affected would be 200-400 acres.

To construct these temporary berms, MWA would utilize track-driven bulldozers or scrapers, accessing the channel at sites currently used by the local flood control agency for its operations in the mainstem channel. These berms will be constructed to temporarily retard the flow of water delivered to these areas from the State Water Project so that this water may be percolated into the groundwater basin below the mainstem Mojave River. Temporary berm construction would not involve fill or draining of Waters of the United States. All construction would be limited to areas 100 feet away from native riparian vegetation along the channel.

It is anticipated that natural flows in the Mojave River will periodically breach and re-distribute the temporary berms within the floodplain. This may occur annually or there may be long periods when the berms will remain in place.

4.3.4.2 Mojave River Well Field

Along the Mojave River, up to 25 wells with a capacity of 3 cfs would be spaced about 1000 to 1700 feet apart and would be distributed on both sides of the river. Alternatively, more wells of lower individual capacity could be placed along the same alignment and spaced more closely. In all cases, wells would be sited along or near the rights-of way for the connecting pipeline (see Table 4-7, above). Well drilling would be accomplished using standard diesel drilling rigs and would involve temporary disturbance of an area about 50 feet by 50 feet (2500 square feet). Wells would be drilled to a depth of 200 to 600 feet. Each well would take approximately 20 to 30 working days to drill to this depth. During construction, the drilling site would be isolated from adjacent areas with sandbags to contain drill spoil and water. In urban and suburban areas, drill spoil would be hauled from the construction site daily. Several wells might be drilled at a given time.

4.3.4.3 Mojave River Delivery Pipelines

In all urban areas, distribution pipelines would be constructed within existing public rights-of-way (generally roads and bike paths). Trenching would be done with a backhoe to a depth equal to pipeline diameter plus 3-to-4 feet. Not more than one lane of traffic would be blocked during excavation, pipeline placement, and reconstruction. For purposes of estimating impacts associated with traffic and noise, it has been assumed that pipelines would be constructed at a rate of 100-200 feet per day, and thus total pipeline construction would take approximately 4 to 8 months, including time for equipment mobilization. More rapid rates of pipeline construction would result in shorter periods of traffic impact and shorter noise exposure times.

4.3.4.4 Unnamed Wash

Initially, a new gated turnout with a capacity of up to 500 cfs would be constructed along the east side of the California Aqueduct. Pending final alignment of Rancho Las Flores facilities, flow from this turnout would be allowed to pass down the wash. Some construction of an earthen channel may be required to direct flow. In the steeper sections of the wash, drop structures would be constructed with large rock and concrete. A bridge would be constructed at Arrowhead Lake Road to provide for unimpeded flow under the road and low earthen levees would be pushed up along the north and south edges of the channel to limit channel migration during recharge. When Rancho Las Flores completes its final designs for the Summit Valley element of its proposed development, MWA would coordinate with the developer and the City of Hesperia regarding the appropriate alignment of a channel or pipeline from the turnout through the developed areas in Summit Valley. By deferring construction of a pipeline or channel until later, land-use conflicts with Rancho Las Flores will be avoided.

4.4 Small Projects Alternative

The Small Projects Alternative was formulated to evaluate the potential to increase banking and exchange program yields at a minimum cost, while focusing on the Alto Basin, where the supply deficit and future demand is greatest. The Small Projects Alternative would also increase the ability of MWA to take peak short-term deliveries from Metropolitan (or of its own supplies to meet water demands) during periods when available supplies may exceed the capacity of the Minimum Facilities Alternative. This would be necessary if it is assumed that Metropolitan wished to deliver in excess of 48,000 acre-feet, which is the approximate practical limit of the Minimum Facilities Alternative in the Alto Basin (Table 4-11). Note also on Table 4-11 that MWA's ability to use the Mainstem Mojave River for recharge of banking supplies declines over time because MWA would also use this recharge area to make replacement water deliveries with its own SWP supply. The addition of recharge capacity to the Alto Regional Aquifer also adds storage that will not migrate rapidly downstream to the Narrows.

To accomplish this, the Small Project Alternative focuses on developing off-channel recharge capacity along the Mojave River and in the adjacent Regional Aquifer. The Small Projects Alternative consists of all facilities identified under the Minimum Facilities Alternative plus four additional recharge basins (Table 4-12; Figures 4-4 through 4-7). Recharge basins for the Small Project Alternative were sited to take advantage of potential cooperative management agreements with local government, primarily the City of Hesperia.

Table 4-11. Proposed additional facilities along the Mainstem Mojave River, Small Project Alternative.

FACILITY	PURPOSE	DESCRIPTION
Off-Channel Mojave River Recharge and Pipeline	Supplemental recharge during periods of high volume delivery of banked supplies	A new off-channel 100 acre recharge basin would be constructed on the Mojave River floodplain between the Morongo Basin Pipeline and Mojave Forks Dam, to take deliveries from the Morongo Basin Pipeline via a 42" buried pipeline. Two sites are considered: east and west of the Mojave River. Several new wells may be constructed at either site.
Oro Grande Wash Recharge	Recharge of the Alto Regional Aquifer	A new recharge basin of up to 80 gross acres, with 60 acres of effective recharge area, (north and/or south of the California Aqueduct) with delivery from the California Aqueduct. Several new wells may be constructed at the site.
Cedar Avenue Detention Basin	Recharge of the Alto Regional Aquifer	Cooperative use of a proposed flood detention basin for recharge. Gross area of about 60 acres, with net recharge area of 45 acres. A well and pipeline would be installed to provide for returns to the California Aqueduct. Several new wells may be constructed at the site.
Antelope Wash (Ranchero Road)	Recharge of the Alto Regional Aquifer	Cooperative use of a 65-acre flood detention basin for recharge. Gross area of 65 acres with a net area for recharge of 50 acres. Several new wells may be constructed at the site.

4.4.1 Recharge Basins

Recharge basins (Table 4-12) were sited and designed to (a) enhance recharge along the Mainstem Mojave River to accommodate high peak deliveries (b) enhance capability to store banked supplies in the long term with minimal potential for loss. In addition, MWA may construct several new wells at each site.

4.4.1.1 Off-Channel Mojave River Recharge

An off-stream recharge facility about 1.5-to-3 miles south of where the Morongo Basin Pipeline crosses under the Mojave River would be constructed at one of two potential sites along the Mojave River (Figure 4-3). This facility would be located off-channel, and would be used to add peaking capacity to the recharge when deliveries of banked and MWA supplies exceeded the capacity of the mainstem recharge facilities or when flow in the river precluded recharge to the Mainstem Mojave River.

<u>Site 1: West Side Facility</u>. This facility is a modification of a recharge project identified in the 2004 Regional Water Management Plan (Supply Enhancement Project 7, Table ES1, 2004 Regional Water Management Plan PEIR). A facility at this site would be supplied via a 42-inch pipeline constructed within the public right-of-way for Highway 173 (Arrowhead Lake Road).

Table 4-12. Facilities design parameters, Mainstem Mojave River, Small Projects Alternative.

FACILITY	MATERIALS AND DIMENSIONS		CAPACITIES	
Off Channel Mojave River Recharge	Gross area: Net area (80% of gross) Berm height: Berm crest width: Berm slope: Base width: Berm spacing:	100 acres 80 acres 5 feet 12 feet 2H on 1V 32 feet 500 feet	Recharge Rate: Net recharge: Max annual recharge, 10 months operation:	0.75 af/day 45 af/day 13,500 af
Off-Channel Mojave River Recharge Pipeline	Material: Length: Diameter:	Reinforced concrete pipe up to 15,000 feet 42 inches	Gross capacity:	74 cfs
Oro Grande Wash Recharge and Pipelines	Gross area: Net area (80% of gross) Berm height: Berm crest width: Berm slope: Base width: Berm spacing: Distribution Pipelines	80 acres 60 acres 5 feet 12 feet 2H on 1V 32 feet 500 feet 2,000 feet	Recharge Rate: Net recharge: Max annual recharge, 9 months operation:	0.5 af/day 30 af/day 8,000 af
Cedar Avenue Detention Basin and Pipelines	Gross area: Net area (80% of gross) Berm height: Berm crest width: Berm slope: Base width: Berm spacing: Pipeline	60 acres 45 acres 5 feet 12 feet 2H on 1V 32 feet 500 feet 3000 feet	Recharge Rate: Net recharge: Max annual recharge, 6 months operation:	0.5 af/day 22.5 af/day 4,000 af
Antelope Wash Detention Basin (Ranchero Road) and Pipelines	Gross area: Net area (80% of gross) Berm and flow through characteristics based on detention-basin design.	65 acres 27 acres	Recharge Rate: Net recharge: Max annual recharge, 9 months operation:	0.5 af/day 13.5 af/day 3,500 af

<u>Site 2: East Side Facility</u>. This facility would be located on disturbed grasslands on either side of an existing poultry facility about 1.5 miles south of the Morongo Basin Pipeline (south of the existing poultry farm buildings). A facility at this site would be supplied via a 42-inch pipeline within the public right-of-way of an unpaved road that runs about 200-300 feet from the Mainstem Mojave River channel.

Both potential facilities would be located downstream of sensitive habitats around Mojave Forks Dam, is located away from known significant cultural resource sites, has already been disturbed by prior use for water treatment, if not located in an area of potential high density housing, and is somewhat protected from erosive flood flows by an east-west trending hill immediately to the south that reduces potential for highly erosive flows.

Water for recharge at either facility would be delivered via an up to 42" reinforced concrete pipeline along the alignments. Both facilities could be gravity fed. Both recharge sites would be on benches above the river channel outside of the floodway maintained by San Bernardino County Flood Control. Pipeline alignments are described on Table 4-13.

Table 4-13. Pipeline alignments for Off-Channel Mojave River Recharge Pipeline.

SEGMENT	APPROXIMATE LENGTH (miles)	ALIGNMENT
East Alignment		
E1	1.5	River frontage unpaved road from Rock Springs Road to Recharge Site
West Alignment		
W1	1.1	Glendale Road from Rock Springs Road to Calpella Avenue
W2	1.1	Calpella Avenue from Glendale Road to Arrowhead Lake Road
W3	0.6	Arrowhead Lake Road from Calpella Road to Recharge Site

4.4.1.2 Oro Grande Wash Recharge and Pipelines

The Oro Grande Wash drainage flows north, parallel to Interstate 15 west of the City of Hesperia and then flows into the City of Victorville along the west side of I-15. The California Aqueduct crosses the wash about 4000 feet north of Main Street/Phelan Road. MWA has conducted pilot studies of the potential for this wash to serve as a recharge site. It is feasible to deliver water to sites with suitable soils both south and north of the California Aqueduct crossing, and both areas could provide recharge at an acceptable 0.5 feet per day. Recharge in these areas would contribute to the Regional Aquifer. A new turnout would be required to supply this site. Supply to the south side of the aqueduct could require pumping facilities if located sufficiently south of the California Aqueduct. New recharge basins would be located immediately upstream or downstream of the California Aqueduct.

4.4.1.3 Cedar Avenue Detention Basin Recharge and Pipelines

The City of Hesperia Master Plan identifies a 60-acre parcel west of the California Aqueduct near Cedar Avenue as a potential site for collection of runoff from a local wash that ponds along the west side of the California Aqueduct. The site would be used to contain these flows, which would be conveyed to it via a drainage channel along the aqueduct. Soils in the area are suitable for recharge at an acceptable rate of at least 0.5 feet per day. Recharge would be to the Regional Aquifer. The site is located upslope of City of Hesperia wells and would allow for recharge without a significant need for additional extraction facilities. A new turnout would be required from the California Aqueduct to supply this site.

4.4.1.4 Antelope Wash Detention Basin Recharge (Ranchero Road) and Pipelines

The City of Hesperia Master Plan identifies a potential 65-acre detention basin along Antelope Wash adjacent to the Morongo Basin Pipeline. The detention basin would be constructed by raising Ranchero Road, which currently crosses the wash at grade. The 30-foot embankment/berm would be constructed to meet flood detention standards to allow the earthen berm to retain water during flooding (City of Hesperia 2003). Active recharge at this facility would require gating of the culverts/outlet of the road crossing/detention facility. Active recharge would be limited to the lower elevations of the wash. Assuming a recharge rate of 0.5 feet per day and an effective recharge area of 27 acres, the basin would have capability for annual recharge of 3,500 acre-feet. Recharge would be to the Regional Aquifer.

4.4.2 Operation

The four recharge basins added to the overall Proposed Project scope in the Small Projects Alternative, would increase project capacity to receive and recharge combined peak deliveries from Metropolitan and MWA during moderate to wet years (Table 4-14). These elements of the Small Project Alternative would be integrated with those of the Minimum Facilities Alternative in a number of ways.

First, the use of the Mojave River Aquifer is somewhat constrained by the need to extract banked supplies for use or risk the movement of stored supplies through the Narrows. These supplies may not be considered "lost" because they would eventually migrate downstream to downstream basins. But major producers to whom MWA must deliver replacement water would be unable to use these supplies during their slow migration downstream. This would limit subarea producers' ability to use banked water as replacement supplies from MWA.

Thus, once the Mojave River Aquifer is initially recharged, the effective recharge rate is equal to the rate of extraction from the well-field. Assuming that subarea producers agree to utilize the well field to the maximum extent feasible, extractions from the well field (and thus net recharge) are derived from a combination of MWA replacement water delivered via the Mainstem Mojave River and the well field and banked water.

Adding capacity to recharge the Regional Aquifer would therefore allow MWA and banking deliveries when the effective recharge of the Mojave River Aquifer between Mojave Forks Dam and the Narrows had been utilized.

The combination of Regional Aquifer recharge capacity and peaking capacity to the Mojave River Aquifer with an off-stream recharge basin (28,500 acre-feet of added annual recharge capacity) would also allow MWA to accommodate higher peak deliveries. This may be of particular importance in a modified banking and exchange program, where MWA may pre-deliver SWP supplies to Metropolitan, and Metropolitan may need to return these supplies and provide water to be banked in a single season. With new turnouts from the California Aqueduct providing for delivery from Unnamed Wash and use of deliveries from Silverwood Lake, total possible daily deliveries under the Small Projects Alternative would be 737.5 cfs, or 1475 acre-feet per day:

- Silverwood Lake: 500 cfs (1000 acre-feet/day)
- Mojave River Pipeline: 94 cfs (188 acre-feet per day)

- Off-Channel MR Recharge: 80 cfs (160 acre-feet per day)
- Morongo Basin Recharge: 30 cfs (60 acre-feet per day)
- Oro Grande Wash Turnout: 15 cfs (30 acre-feet per day)
- Cedar Avenue Turnout: 11.75 cfs (22.5 acre-feet per day)
- Antelope Wash Turnout: 6.75 cfs (13.5 acre-feet per day)

For short periods, then, the Small Projects Alternative would have capacity to recharge approximately 44,250 acre-feet in a single month.

The added recharge capacity provided by the Small Project Alternative would be available at all times during wet years. Thus, even when the Mojave River was flowing and recharge to the river itself was not feasible, the off-stream recharge provided by the 4 additional facilities of the Small Projects Alternative would be available, allowing for recharge of 56 cfs (112 acre-feet per day or 3360 acre-feet per month). Recharge of the Mojave River Aquifer via releases to the mainstem is clearly the most efficient means of rapid recharge, but when the need to accommodate a short-term pulse has passed, the availability of 33,600 acre-feet of annual (10 month) off-stream recharge capacity would increase overall banking capacity and reduce reliance on the limited total storage capacity of the Mojave River Aquifer and adjacent Regional Aquifer above the Narrows.

Assuming that recharge capacity is available for only 10 months of the year to allow for operation and maintenance and to exclude periods when precipitation inhibits artificial recharge, the addition of 28,500 acre-feet per year of recharge capacity would allow MWA to increase the rate of recharge by 2,850 acre-feet per month. This would enhance MWA's ability to combine banking deliveries with deliveries of its own SWP Table A and Article 21 supplies.

Table 4-14. Potential annual recharge for the Small Projects Alternative.

FACILITY	SUBAREA	ANNUAL RECHARGE CAPACITY IN ACRE-FEET
Minimum Facilities Alternative		
Existing recharge in Morongo Basin (pre-expansion)	Warren/Yucca Valley	3,475
Existing recharge at Lenwood	Centro	9,000
Existing recharge at Hodge	Centro	9,000[1]
Existing recharge at Daggett	Baja	16,800
Existing recharge at Newberry Springs	Baja	6,000
Existing recharge at Green Tree Detention Basin	Alto	3,600[2]
New recharge, Mojave River via Silverwood Lake, Unnamed Wash, and/or Rock Springs	Alto, Mojave River Aquifer and Regional Aquifer	44,400
SUBTOTAL		92,275
Small Projects Alternative		
Off-Channel Mojave River Recharge	Alto, Mojave River Aquifer	13,500
Oro Grande Wash Recharge	Alto, Regional Aquifer	8,000
Cedar Avenue Detention Basin	Alto, Regional Aquifer	4,000
Antelope Wash Recharge (Ranchero Road)	Alto, Regional Aquifer	3,500
SUBTOTAL		28,500
TOTAL		**120,775**

Notes:
1. Recharge at Hodge may be increased by about 80%; the nominal recharge from the 2004 PEIR and 2004 Regional Water Management Plan has been used.
2. The Green Tree detention basin would be shared by Victor Valley Water District and MWA: 3600 acre-feet of recharge is a conservative estimate of MWA's recharge at the site. Total recharge is likely to be higher.

4.4.3 Construction

The 100-acre Off-Channel Mojave River Recharge would be constructed on gently sloping ground adjacent to the Mojave River. Assuming berms would cover 25% of the gross area of the recharge basin, with average berm height of 5 feet, a crest width of 12 feet to allow for vehicle access, and berm side sloped of 2H on 1V, construction would involve the excavation of about 160,000 cubic yards, all of which would be utilized to construct the perimeter and interior berms. All soil for berm construction can be excavated from the 60-acres of active recharge area, with average excavation depth of slightly greater than 1 foot. Cells will be excavated and soil distributed to create an approximately flat cell invert for uniform recharge.

The pipeline to supply Off-Channel Mojave River Recharge would be constructed within existing public rights-of-way along public roads. Trenching would be done with a backhoe to a depth equivalent to pipeline diameter plus 4-5 feet. Not more than one lane of traffic would be blocked during excavation, pipeline placement, and reconstruction. For purposes of estimating impacts associated with traffic and noise, it has been assumed that pipelines would be constructed at a rate of 100-200 feet per day, and thus total pipeline construction would take approximately 4 to 8 months, including time for equipment mobilization. More rapid rates of pipeline construction would result in shorter periods of traffic impact and shorter noise exposure times.

Recharge basins at the two City of Hesperia flood detention basins and Oro Grande Wash would potentially be affected by infrequent flood flows and would be expected to be damaged. At the Cedar Avenue detention basin, an inlet structure could be constructed to reduce flow rates and levee wash out, but flow rates would nonetheless exceed those during banking operation and internal berms would have to be re-constructed at times.

4.5 Large Projects Alternative

The Large Projects Alternative (Table 4-15 and 4-16 and Figures 4-8 through 4-12) was formulated to evaluate the potential maximum practical recharge and direct return capacity for the proposed banking/exchange program combined with MWA's own use of facilities. It includes all of the facilities for the Minimum Facilities Alternative and the Small Projects Alternative, as well as expanded delivery, recharge, and direct return capacity. It would allow greater peak capacity for recharge and greater capacity for recharge in the Regional Aquifer.

For this alternative, the focus is again on the Alto and Oeste areas because of proximity to the California Aqueduct and the suitability of groundwater in these areas for potential direct return. Under this alternative, the siting of additional facilities for recharge was therefore focused on two Regional Aquifer areas immediately adjacent to the California Aqueduct that were evaluated during the initial screening process.

The Large Projects Alternative would add approximately 580 acres of active recharge capacity for the Regional Aquifer. It would add up to 25 wells for direct return of banked supplies to Metropolitan. These are maximum values for this alternative and the MWA Board may choose construct and operate smaller facilities, based on its deliberations related to cost versus benefit. The maximum extent of development has been assumed in this Project EIR to ensure appropriate level of impact analysis.

4.5.1 Recharge Basins and Associated Facilities

4.5.1.1 Oeste Recharge, Wells, and Pipelines

Recharge basins in the Oeste subarea would be located at two sites immediately adjacent to the California Aqueduct (Figure 4-9 and 4-10). At maximum size, these currently undeveloped sites would have a gross area of about 330 acres, with a recharge capacity of about 260 acres. With a projected recharge rate of about 0.5 acre-feet per acre, these sites could recharge about 130 acre-feet per day, 3900 acre-feet per month and about 35,000 acre-feet per 9-month operational period. In addition, at these sites, indigenous groundwater is of equal or better quality than average SWP supply, except for being marginally higher for arsenic and sulfate. Given that water recharged to these sites would be wet-year supply of better-than-SWP-average quality, the mix of SWP and indigenous groundwater would probably be of good quality and direct return from these sites could therefore be considered. Accordingly, at these sites, wells would be installed and connected to the California Aqueduct with pipelines. Pipelines would be constructed during construction of the recharge basins. Assuming each well could pump 2 cfs and that dry year returns to Metropolitan could be made over a period of 8 months with some allowance for down time, 15 Oeste area wells could provide for the direct return of about 11,000 acre-feet.

4.5.1.2 Alto Recharge, Wells, and Pipelines

Recharge basins in the Alto subarea would be located north and south of Duncan Road at White Road (Figure 4-8), immediately north and adjacent to the California Aqueduct. At this site, recharge basins of up to 150 gross acres (120 net acres of recharge) could be constructed. At maximum capacity and assuming a projected recharge rate of about 0.5 acre-feet per acre, this site could recharge about 60 acre-feet per day, 1800 acre-feet per month and about 16,900 acre-feet per 9-month operational period. In addition, at this site, indigenous groundwater is of equal or better quality than average SWP supply, except for being marginally higher for arsenic and fluoride. Given that water recharged to these sites would be wet-year supply of better-than-SWP-average quality, the mix of SWP and indigenous groundwater would probably be of good quality and direct return from these sites could therefore be considered. Accordingly, at these sites, wells would be installed and connected to the California Aqueduct with pipelines. Pipelines would be constructed during construction of the recharge basins. Assuming each well could pump 2 cfs and that dry year returns to Metropolitan could be made over a period of 8 months with some allowance for down time, 10 Alto area wells could provide for the direct return of about 5,500 acre-feet.

4.5.1.3 Antelope Wash Recharge and Pipelines

In addition to potential recharge basins associated with the proposed detention basin along Antelope Wash, additional recharge capacity is available immediately upstream and downstream of the California Aqueduct. At this site, it would be feasible to develop 100 acres of recharge at the locations shown on Figure 4-10. Assuming a net recharge area of 70 acres, Regional Aquifer recharge rate of about 0.5 acre-feet per acre per day, recharge at this site would be 35 acre-feet per day, or about 9500 acre-feet in a 9 month delivery period.

The draft EIR (Table 5-14) concluded that a 100-acre recharge basin located in Antelope Wash about 0.5 miles upstream and south of the existing Hesperia Airport (upstream recharge site) would affect 4 acres of disturbed habitat, 28 acres of desert scrub habitat, and 68 acres of Joshua Tree/juniper habitat. The draft EIR also noted that the upstream site remained connected to habitats in the San Bernardino Mountains and therefore "remains a viable part of a larger area of wildlife habitat." In addition, the draft EIR noted that Joshua Tree habitats are relatively rare in the area south of Hesperia/Victorville and that the City of Hesperia has a policy to protect Joshua Tree habitats.

Accordingly the draft EIR Section 5.4.7.2 proposed that if a recharge basin was sited at the upstream site in Antelope Wash, that MWA would either mitigate for loss of "locally-protected Joshua Tree habitat" at a ratio of 1:1 or "consider realignment of this basin to a site further downstream."

As discussed in the draft EIR, Section 5.13.1, based on preliminary geotechnical analyses, recharge conditions in Antelope Wash are in general likely to be quite good, both in terms of infiltration rates and in terms of low potential to encounter clay soils which could contain high concentrations of minerals that could leach into groundwater. Relocation of the proposed upstream recharge basin would thus be most beneficial if the relocation was in Antelope Wash. In addition, other potential sites for relocation of the upstream recharge basin had been eliminated from consideration as part of alternative screening processes detailed in Chapter 3 of the draft EIR. The focus of analysis for an alternative site was therefore on the reach of Antelope Wash downstream of the site evaluated in the draft EIR to the area immediately upstream and downstream of the Ranchero Road detention basin (Figure 4-12; combined Ranchero Road site).

This approximately 4000-foot reach of the wash is a broad and relatively flat section from1000 to 1500 feet wide, an area of about 140 acres. The stream gradient is about 50 feet per mile in this reach, and there is minimal cross-channel slope. Habitats in this downstream reach are dramatically different from those at the upstream recharge site. The level of disturbance is higher and the dense stands of Joshua Trees and junipers give way to disturbed desert scrub and desert wash scrub. The wash is particularly disturbed in the reach downstream of the unpaved road along an east-west alignment that approximately bisects the Hesperia Airport runway. In addition, the area downstream of Ranchero Road is routinely disturbed and is being disturbed by construction equipment as part of the Ranchero Road relocation and detention basin project. The area in the vicinity of the new detention basin is being disturbed by construction of the 30-foot-high embankment for the road relocation and detention basin. Once completed, the detention basin is designed to allow a depth at the road embankment of 22 feet, and the maximum flood pool will extend about 600 to 700 yards upstream. Approximately 55% to 65% of the total recharge area in the wash would be within the flood detention basin or immediately downstream. The combining of all Antelope Wash recharge at this site would involve following the natural contours of the wash rather than the 65-acre square parcel evaluated in the draft EIR. The result would be an approximately 135 to 140-acre site that would provide approximately equal net recharge area in the wash as would have been available at the two separate parcels examined in the draft EIR.

Development adjacent to this reach of the wash is moderately more intensive to that along the upper wash site and similar to that at the Ranchero Road site -- there is housing and some commercial development along the rim of the wash. There is no development in the wash itself. There are no paved road crossings of the wash in this reach.

The expansion of recharge at the Ranchero Road site in lieu of developing the upstream recharge site could:

- Reduce proposed project pre-mitigation impacts substantially;
- Marginally reduce total impact area in Antelope Wash; and
- Reduce proposed project mitigation requirements and mitigation costs.

This alternative siting would not substantially affect recharge, construction methods, or construction schedule.

In the FEIR, MWA has therefore evaluated the potential effects of the Antelope Wash recharge basins described in the draft EIR and the potential effects of this proposed mitigation measure.

Table 4-15. Proposed new facilities, Large Projects Alternative

FACILITY	PURPOSE	DESCRIPTION
Oeste Recharge and Pipelines	Recharge of the Regional Aquifer	Up to 330 total acres of recharge basins with a net recharge area of 260 acres; up to 15 extraction wells; new turnout from California Aqueduct.
Alto Recharge and Pipelines	Recharge of the Regional Aquifer	Up to 150 total acres of recharge basins with a net recharge area of 120 acres; up to 10 extraction wells; new turnout from the California Aqueduct
Antelope Wash Recharge and Pipelines	Recharge of the Regional Aquifer	Up to 100 total acres of recharge basins with a net recharge area of 70 acres; new turnout from the California Aqueduct. Several new wells may be constructed at the site. or Expansion of recharge upstream and downstream of the new Ranchero Road embankment. Wells and a pipeline to the California Aqueduct may be constructed at the site.

Table 4-16. Design specifications/capacities, new facilities, Large Projects Alternative

FACILITY	MATERIALS AND DIMENSIONS	CAPACITIES
Oeste and Alto Recharge and Pipelines	Gross area: 480 acres Net area (80% of gross) 380 acres Berm height: 5 feet Berm crest width: 12 feet Berm slope: 2H on 1V Base width: 32 feet Berm spacing: 500 feet Pipeline 25000 feet	Recharge Rate: 0.5 af/day Net recharge: 190af/day Max annual recharge, 10 months operation: 51,000 af
Wells at Oeste and Alto recharge basins	Number of wells: up to 25 Type: Electric, vertical turbine Project life: 30 years Pumping rate: 2 cfs	Capacity: up to 50 cfs Direct return capacity: 16,200 af/yr
Antelope Wash Recharge and Pipelines	Gross area: up to 80 acres Net area (80% of gross) up to 65 acres Berms: Temporary	Recharge Rate: 0.5 af/day Net recharge: 40 af/day Max annual recharge, 8 months operation: 9,500 af

4.5.4.2 Operations

Large Project Alternative facilities would be sized and operated to optimize MWA ability to take deliveries of supplies for banking and deliveries of its own SWP Table A and Article 21 supplies during periods when delivery rates were high (Table 4-17). Thus, the Oeste, Alto, and Antelope Wash recharge basins would be utilized when recharge capacity via the Mainstem Mojave River (Alto subarea) had been used to its practical maximum, or when other factors affected the ability to deliver water to the mainstem (such as mainstem natural flow during a wet year). Assuming that recharge capacity is available for only 10 months of the year to allow for operation and maintenance and to exclude periods when precipitation inhibits artificial recharge, the addition of 61,400 acre-feet per year of recharge capacity would allow MWA to increase the rate of recharge by 6,140 acre-feet per month. This would enhance MWA's ability to combine banking deliveries with deliveries of its own SWP Table A and Article 21 supplies.

Supplies banked in these facilities would recharge the Regional Aquifer, which has a low rate of lateral movement. As a result, banked supplies would mound in the vicinity of the recharge basins, mix with indigenous groundwater, and be available for direct return to Metropolitan via the California Aqueduct if returns could not be made via exchange. The Large Project Alternative would thus significantly increase MWA's capability to receive and return banked water. Note that the nominal recharge capacities of these new recharge areas are quite high.

4.5.3 Construction

Oeste and Alto recharge basins would be constructed on virtually flat land. Construction of these permanent recharge basins would involve excavations to a depth of 1 to 5 feet to provide soil for construction of exterior and interior berms. Typical levee designs for recharge basins are shown on Figure 4-2. An inlet structure in the highest elevation cell will provide for discharges from supply pipelines. Gates will be constructed to allow flow between cells.

Wells at the Oeste and Alto recharge basins would be constructed at and north of the basins, drilled to a depth of from 250 to 800 feet, and separated by about 1500 feet. Construction would be limited to an area of about 0.1 acres (each). Following construction, they would be enclosed in chain link or other protective fencing/walls. They would be connected to a pipeline running to the California Aqueduct that would discharge at a rate of up to 60 cfs.

The Antelope Wash recharge basin would potentially be affected by infrequent flood flows and would be expected to be damaged. High flows in washes could potentially wash out berms completely. Accordingly, the recharge basins developed under the Large Projects Alternative would be constructed as low berms across the washes which could be washed out during flood events and reconstructed rapidly following a flood.

Table 4-17. Recharge and direct return capacity, Large Projects Alternative

FACILITY	SUBAREA	GROSS ANNUAL RECHARGE & DIRECT RETURN CAPACITY IN ACRE-FEET	
		Recharge	**Direct Return**
Minimum Facilities Alternative			
Existing recharge in Morongo Basin (1750 acres)	Warren/Yucca Valley	3,475	0
Existing recharge at Lenwood	Centro	9,000	0
Existing recharge at Hodge	Centro	9,000[1]	0
Existing recharge at Daggett	Baja	16,800	0
Existing recharge at Newberry Springs	Baja	6,000	0
Existing Green Tree Detention Basin	Alto	3,600[2]	
New recharge, Mojave River via Silverwood Lake, Unnamed Wash, and/or Rock Springs	Alto, Mojave River Aquifer and Regional Aquifer	44,400	18,000
SUBTOTAL		**92,275**	**18,000**
Small Projects Alternative			
Off-Channel Mojave River Recharge	Alto, Mojave River Aquifer	13,500	0
Oro Grande Wash Recharge	Alto, Regional Aquifer	8,000	0
Cedar Avenue Detention Basin	Alto, Regional Aquifer	4,000	0
Antelope Wash (Ranchero Road)	Alto, Regional Aquifer	3,500	0
SUBTOTAL		**120,775**	**18,000**
Large Projects Alternative			
Oeste Recharge, Wells and Pipelines	Alto Regional Aquifer	35,000	11,000
Alto Recharge, Wells, and Pipelines	Alto Regional Aquifer	16,900	5,500
Antelope Wash Recharge and Pipelines	Alto Regional Aquifer	9,500	0
SUBTOTAL		61,400	16,500
TOTAL		**182,175**	**34,500**

Notes:
1. Recharge at Hodge may be increased by about 80%; the nominal recharge from the 2004 PEIR and 2004 Regional Water Management Plan has been used.
2. The Green Tree detention basin would be shared by Victor Valley Water District and MWA: 3600 acre-feet of recharge is a conservative estimate of MWA's recharge at the site. Total recharge is likely to be higher.

4.6 Construction Schedule

A detailed construction schedule would depend on the alternative selected and on whether there was simultaneous construction of various project elements. Because construction schedules affect impacts associated with air quality, traffic, noise, and other potential elements of the proposed project, several representative construction scenarios are presented here, based on the following assumptions:

- Recharge basins would be constructed in 40-acre increments requiring 30 working days or 45 total days, and any given recharge basin would be constructed continuously until completed to avoid costs and delays associated with repeated mobilization;
- Wells would be drilled one at a time, requiring about 15 working days or 20 total days each;
- Once pipeline construction was initiated, pipelines would be constructed continuously at a rate of 100 - 200 feet per working day (1.4 calendar days); in recharge/pipeline elements of the project, pipelines and recharge basins would be constructed simultaneously.

Pipeline construction rates will vary considerably depending on conditions. The pipeline proposed from Rock Springs Road to off-channel recharge basins may be constructed at a substantially higher rate because there will be few right-of-way, traffic and utility constraints. Pipeline construction under Interstate 15, however, would be substantially slower. In short, the exact construction schedule will vary, depending on the location of each facility. A rate of 100 feet per day has been used to estimate pipeline construction because a majority of construction will occur in urban areas, in public rights-of-way, with traffic controls, re-paving requirements, and utilities to be maintained during construction. Given these considerations, the estimated time to completion for various elements of the Proposed Project alternatives are shown on Table 4-18. The estimated on Table 4-18 show that critical path for construction will be a function of:

- Rate of construction for pipelines. If, on average, pipelines may be constructed at a rate of 200 feet per day, then total time for construction of this feature may be reduced significantly.
- Phasing. If recharge basins are phased (constructed sequentially in increments of 40 acres and require 45 calendar days for each increment) then the Large Projects Alternative would take 900 calendar days to construct. All other elements of the Proposed Project may be constructed within this 900-day period, but this would require simultaneous construction of various facilities.

Table 4-18. Estimated mobilization-to-completion time for major elements of the three alternatives. Minor appurtenant facilities are assumed constructed in parallel. Mobilization and demobilization are assumed to take 5 working days each and have been added to each "Time to construct."

FACILITY		CONST. UNIT	# OF UNITS	CONST. TIME (Calendar days)	TIME TO CONSTRUCT	
					Calendar Days	Working Days
Minimum Facilities Alternative						
Instream Mojave River Recharge		Day	15	15 days	15	10
Mojave River Well Field		Well	25	20 days	500	350
Well Field Delivery Pipelines		100 feet	581	1.4 day	820	580
Unnamed Wash	Turnout	Day	50	50 day	50	35
	Conveyance	100 feet	25	1.4 days	40	28
	Bridges	Bridge	3	60 days	180	126
	Levees	200 feet	25	1.4	40	28
Small Projects Alternative						
Off-Channel Mojave River Recharge		40 acres	2.5	45 days	120	85
MR Off-Channel Recharge Pipeline		100 feet	200	1.4 day	290	205
Oro Grande Wash Recharge		40 acres	2	45 days	100	70
Oro Grande Wash Pipeline		100 feet	76	1.4 days	110	77
Cedar Avenue Detention Basin		40 acres	1.5	45 days	80	56
Cedar Avenue Pipeline		100 feet	30	1.4 days	42	30
Antelope Wash Recharge (Ranchero Road)		40 acres	Major construction by City of Hesperia			
Large Projects Alternative						
Oeste Recharge Basin		40 acres	8.5	45 days	400	280
Oeste Pipelines		100 feet	250	1.4 day	365	256
Alto Recharge Basin		40 acres	3.5	45 days	170	120
Alto Basin Pipelines		100 feet	50	1.4 day	80	56
Antelope Wash Recharge		40 acres	2.5	45 days	120	85

4.7 Measures for Avoidance and Minimization of Environmental Impacts incorporated into the Project Description

MWA is committed to minimizing the environmental impacts of the Proposed Project and includes the following avoidance and minimization measures as elements of all Proposed Project Alternatives.

4.7.1 Facility Site Selection

To the extent feasible, facilities have been sited to minimize distance from the California Aqueduct and MWA's existing facilities linking service areas to the California Aqueduct. This siting near existing facilities was intended to reduce costs and the need for an extensive network of new conveyance facilities, with their associated costs and environmental impacts.

Siting has also been focused on reducing the potential for effects to the arroyo toad, desert tortoise, Mohave ground squirrel, and cultural resources; thus the Minimum Facilities Alternative, which serves as a baseline for all alternatives: (a) utilizes existing facilities to the extent feasible; (b) optimizes use of the Mojave River Mainstem; (c) avoids known arroyo toad habitats near Mojave Forks Dam; (d) concentrates construction in the urbanizing areas of Hesperia, Victorville, Apple Valley, and Adelanto where wildlife habitat is already highly disturbed; and (e) avoids known significant cultural resource sites along the Mojave River.

4.7.2 Operation Schedule

Operation of the Proposed Project incorporates conditions for the release of water from Silverwood Lake to the West Fork of the Mojave River only during periods when the arroyo toad is estivating and only at rates which the 2003-2004 demonstration project showed to be fully contained within the main channel of the river.

4.7.3 Best Management Practices when Constructing in the Public Right-of-Way

When constructing in an urban setting to construct pipelines and recharge basins, MWA would comply with applicable city encroachment permit policies. These may vary, and therefore typical policies in the Manual on Uniform Traffic Control Devices, California Supplement, Part 6 (Caltrans 2003). These policies specify work schedules and work practices intended to minimize construction impacts on traffic, local businesses, local residents, storm water runoff, and utilities and public services.

4.7.4 Aesthetic Treatment

Where facilities such as wells would be visible, MWA would contain them in structures designed to be compatible with adjacent construction and in consultation with nearby residents. Pipelines will be buried.

4.7.5 Air Quality

MWA would adopt best management practices per the Mojave Desert Air Quality Management District/Antelope Valley Air Quality Management District (AVAQMD/MDAQMD 2004), and incorporated by reference herein.

4.7.6 Noise

The siting of the Proposed Project contributes to avoidance of noise impacts to adjacent business and residents. Only pipelines and wells associated with the Minimum Facilities Alternative would be constructed in public roads adjacent to existing development.
For areas adjacent to residential development MWA would comply with the following construction protocols:

- Permanent above-ground facilities (wells and treatment plant) would be contained within structures that would ensure that adjacent ambient noise levels are below the levels established for facilities in commercial and manufacturing areas.
- Except when more stringent standards apply to construction in the roadway, construction work would be limited to the hours from 7 AM to 7 PM, with no construction on weekends.
- Construction noise would be monitored on site by the construction contractor and portable noise attenuation barriers would be erected between construction and housing if construction noise measured at the exterior of adjacent housing exceeded 65 dBL.

4.7.7 Construction Crew Training, On-Site Biological Monitoring, and Isolation of the Construction Area

To prevent adverse impacts associated with wildlife incidental use of the construction area, MWA would implement the following avoidance and minimization measures:

- Construction and maintenance personnel would participate in a USFWS/CDFG-approved environmental awareness program. Under the program, workers shall be informed about the potential presence of special-status species and that unlawful take of these species is a violation of FESA and CESA. Prior to construction activities, a qualified biologist would instruct construction personnel about the identification and the life history of the various special status species which may inhabit the Proposed Project area. Color photographs would be provided for maintenance on site. Proof of instruction shall be provided to USFWS and CDFG.
- Prior to initiation of construction activities, a qualified biologist would survey the area to confirm that no special-status species are present. If special-status species are present, they would be allowed to move away from construction activities.

4.7.8 Water Quality

MWA would implement best management practices to avoid construction runoff during construction activities, including:

- Daily pre-construction inspection of all construction equipment to ensure that oil and/or gas/diesel fuel are not leaking from equipment;
- Secondary containment for fueling and chemical storage areas shall be provided during construction and Proposed Project operation;
- Secondary containment for equipment wash water shall be provided to ensure that wash water is not allowed to run off the site;
- Silt traps and/or basins would be provided to prevent runoff from the construction site;
- In areas where runoff from construction could adversely affect the Mojave River (such as in the well field and pipeline construction areas of the Minimum Facilities Alternative), materials stockpiles would be covered to prevent runoff;
- Loose soils would be protected from potentially erosive runoff;
- If construction equipment is used within the river channel, equipment will be inspected routinely for fuel, lubricant, and other fluid leaks. Any leaks will be repaired. If necessary, the equipment would be fitted with secondary containment materials at potential oil/fuel leakage sites.

MWA would comply with the terms and conditions of the State's General Stormwater Permit program for construction activities. Issues related to runoff from construction sites will be addressed by preparation and implementation of a Storm Water Pollution Prevention Plan based on the guidance in CalTrans' *Storm Water Pollution Prevention Plan and Water Pollution Control Plan Preparation Manual*, March 2003.

4.7.9 Cultural Resources Management

In general, siting and construction scheduling have reduced the potential for construction of the Proposed Project to impact cultural resources in many areas. There is potential for construction to encounter buried cultural resources within existing roads during pipeline construction and at recharge basins. In these areas, MWA would address potential impacts to buried cultural resources through:

- Construction Personnel Training. Prior to initiation of construction, all construction personnel shall be trained regarding (a) the recognition of possible buried cultural remains and (b) procedures to be followed if archeological materials are discovered. Training would provide that construction in the area of a discovery shall be halted immediately and a qualified archeologist notified.
- Construction Monitoring and resource recovery. In areas near known cultural resource sites, construction monitoring shall be undertaken by a qualified archeologist familiar with the types of historic and prehistoric resources that could be found within the

Proposed Project area. Monitored locations shall include all areas designated as having a high probability of finding subsurface cultural resources. If cultural resources are discovered during excavations, then the monitor would initiate consultation with the State Historic Preservation Office and develop and implement an appropriate resource recovery program.

- Compliance with DHS requirements for the treatment of buried human remains. If human remains are found during construction, MWA would immediately halt construction and implement the notification and treatment protocols required by DHS.

4.7.10 Assurances that Impact Minimization Measures will be implemented

MWA will ensure implementation of impact minimization measures in several ways. First, costs associated with these measures will be a mandatory line item in project budget requests to Metropolitan and to MWA's Board of Directors. Second, as appropriate, MWA will incorporate the above measures, and other specific mitigation measures described in Chapter 5, into construction contracts. Third, MWA will assign a staff mitigation manager to monitor compliance and make appropriate and timely reports to all regulatory and permitting agencies.

Finally, MWA's long-term agreement for the Proposed Project banking and exchange with Metropolitan will identify impact minimization costs as a line item to be cost-shared by MWA and Metropolitan consistent with the cost-sharing provisions of the agreement.

4.8 Project Energy Use and Measures to Reduce Energy Use

4.8.1 Construction Energy Use

Facility construction necessarily utilizes diesel fuel, gasoline, and electrical energy. The vast majority of energy use associated with construction is used by heavy diesel-powered equipment. Estimates of fuel consumption from diesel fueled construction equipment vary, depending on the type of construction and the load factors for each piece of equipment. Approximations of daily fuel consumption during construction can be made by estimating equipment use and using average hourly fuel consumption for each piece of equipment. Total energy use can then be estimated based on probable duration of each element of construction. This approach is shown on Table 4-19.

As Table 4-19 indicates, fuel consumption for project construction will be approximately 920,000 gallons. This assumes that the City of Hesperia would do the initial construction of the Antelope Wash (Ranchero Road) site. Total energy use would not be affected by changes in schedule or rate of construction; acceleration of the schedule would require more equipment and/or higher load factors (hours of use per day).

Table 4-19. Estimated daily/ total diesel fuel consumption for Proposed Project facilities.

EQUIPMENT (# USED)	HOURS/DAY	GALS/ HOUR	GALS/DAY	DAYS OF USE	TOTAL
Mojave River Recharge (Berm Construction)					
Scraper (2)	8	15	240	15	3600
Total 20 years (3600 x 20)					72000
Contingency 25%					18000
TOTAL					**90,000**
Mojave River Well Field (up to 25)					
Scraper (1)	2	15	30	15	450
Loader (1)	2	3	6	15	90
Water Truck (1_	1	5	5	15	75
Dump truck (1)	1	8	8	15	120
Small compactor (1)1	1	0.25	0.25	15	4
Small dozer (1)	1	10	10	15	150
Large drilling rig (1)	8	12	96	15	1440
Subtotal					2329
Contingency 25%					583
Total one well					2911
TOTAL 25 wells					**72,775**
Well Field Delivery Pipelines (approximately 11 miles)					
Backhoe (1)	8	2	16	580	9290
Hydro. Excavator (1)	8	3	24	580	13920
Dump truck (1)	4	8	32	580	18560
Water truck (1)	4	5	20	580	11600
Crane (1)	8	5	40	580	23200
Small compactor (1)	2	0.25	0.50	580	290
Small dozer (1)	1	10	10	580	5800
Subtotal					82660
Contingency 25%					20665
TOTAL					**103325**
Unnamed Wash					
Scraper (2)	8	15	120	110 (average)	13200
Loader (1)	2	3	6	110	660
Water Truck (1)	4	5	20	110	2200
Dump truck (1)	4	8	32	110	3520
Compactor (1)	4	1	4	110	440
Subtotal					20020
Contingency 25%					5005
TOTAL					**25025**
Off Channel Mojave River Recharge (100 acres)					
Scraper (2)	8	15	240	85	20400
Loader (1)	8	3	24	85	2040
Water Truck (2)	8	5	80	85	6800
Excavator (1)	8	10	80	85	6800
Medium Dozer (1)	8	10	80	85	6800
Subtotal					42840
Contingency 25%					10710
TOTAL					**53550**

EQUIPMENT (# USED)	HOURS/DAY	GALS/ HOUR	GALS/DAY	DAYS OF USE	TOTAL
Mojave River Off-Channel Recharge Pipeline					
Backhoe (1)	8	2	16	205	3260
Hydro. Excavator (1)	8	3	24	205	4920
Dump truck (1)	4	8	32	205	6540
Water truck (1)	4	5	20	205	4100
Crane (1)	8	5	40	205	8200
Small compactor (1)	2	0.25	0.5	205	103
Small dozer (1)	1	10	10	205	2050
Subtotal					29173
Contingency 25%					7293
TOTAL					**36466**
Oro Grande Wash Recharge (80 acres)					
Scraper (2)	8	15	240	70	16800
Loader (1)	8	3	24	70	1680
Water Truck (2)	8	5	80	70	5600
Excavator (1)	8	10	80	70	5600
Medium Dozer (1)	8	10	80	70	5600
Subtotal					35280
Contingency 25%					8820
TOTAL					**44100**
Oro Grande Wash Pipeline					
Backhoe (1)	8	2	16	77	1232
Hydro. Excavator (1)	8	3	24	77	1848
Dump truck (1)	4	8	32	77	2464
Water truck (1)	4	5	20	77	1540
Crane (1)	8	5	40	77	3080
Small compactor (1)	2	0.25	0.5	77	38
Small dozer (1)	1	10	10	77	770
Subtotal					10972
Contingency 25%					2743
TOTAL					**13715**
Cedar Avenue Detention Basin (60 acres)					
Scraper (2)	8	15	240	56	13440
Loader (1)	8	3	24	56	1344
Water Truck (2)	8	5	80	56	4480
Excavator (1)	8	10	80	56	4480
Medium Dozer (1)	8	10	80	56	4480
Subtotal					28224
Contingency 25%					7056
TOTAL					**35280**
Oeste Recharge Basins (330 acres)					
Scraper (2)	8	15	240	280	67200
Loader (1)	8	3	24	280	6720
Water Truck (2)	8	5	80	280	22400
Excavator (1)	8	10	80	280	22400
Medium Dozer (1)	8	10	80	280	22400
Subtotal					141120
Contingency 25%					35280
TOTAL					**176400**

EQUIPMENT (# USED)	HOURS/DAY	GALS/ HOUR	GALS/DAY	DAYS OF USE	TOTAL
Oeste Pipelines					
Backhoe (1)	8	2	16	256	4096
Hydro. Excavator (1)	8	3	24	256	6144
Dump truck (1)	4	8	32	256	8192
Water truck (1)	4	5	20	256	5120
Crane (1)	8	5	40	256	10240
Small compactor (1)	2	0.25	0.5	256	127
Small dozer (1)	1	10	10	256	2560
Subtotal					36479
Contingency 25%					9119
TOTAL					**45599**
Alto Recharge Basins (150 acres)					
Scraper (2)	8	15	240	120	28800
Loader (1)	8	3	24	120	2880
Water Truck (2)	8	5	80	120	9600
Excavator (1)	8	10	80	120	9600
Medium Dozer (1)	8	10	80	120	9600
Subtotal					60480
Contingency 25%					15120
TOTAL					**75,600**
Alto Basin Pipelines					
Backhoe (1)	8	2	16	56	896
Hydro. Excavator (1)	8	3	24	56	1344
Dump truck (1)	4	8	32	56	1792
Water truck (1)	4	5	20	56	1120
Crane (1)	8	5	40	56	2240
Small compactor (1)	2	0.25	0.5	56	27
Small dozer (1)	1	10	10	56	560
Subtotal					7979
Contingency 25%					1995
TOTAL					**9974**
Antelope Wash Recharge (100 Acres)					
Scraper (2)	8	15	240	85	20400
Loader (1)	8	3	24	85	2040
Water Truck (2)	8	5	80	85	6800
Excavator (1)	8	10	80	85	6800
Medium Dozer (1)	8	10	80	85	6800
Subtotal					42840
Contingency 25%					10710
TOTAL					**53550**
Oeste and Alto Wells (25)					
Scraper (1)	2	15	30	15	450
Loader (1)	2	3	6	15	90
Water Truck (1)	1	5	5	15	75
Dump truck (1)	1	8	8	15	120
Small compactor (1)	1	0.25	0.25	15	4
Small dozer (1)	1	10	10	15	150
Large drilling rig (1)	8	12	96	15	1440

Subtotal					2329
Contingency 25%					583
Total one well					2911
TOTAL 25 wells					**72,775**
Hauling of Construction Equipment					
Tractor Haul Rig 1	8	5	40	100	**4000**
Crew driving to construction sites. 10,000 trips at 20 miles each way = 40,000 miles at 15 mpg					**2666**
TOTAL ESTIMATED CONSTRUCTION FUEL CONSUMPTION					**914,800**

4.8.2 Operations Energy Use

Operations energy use is difficult to estimate because the volume of deliveries and extractions is not fixed. Energy used to import supplies for banking and exchange programs will, over the long-term be equivalent to that of the No Project Alternative, because long-term water deliveries will be the same as for the project. The Proposed Project simply pre-delivers this water for storage to allow for reliable use over an extended period of time. Operations energy use for extraction and delivery of supplies from groundwater will be affected by the Mojave River Well Field, which will allow for extraction at lower depths than may currently be feasible with wells in the Regional Aquifer. Water migrating from the river channel to the boundary of the Floodplain and Regional Aquifer will raise water levels and reduce energy costs for extraction as extraction is shifted from existing deep wells to these shallower wells.

4.9 Summary and Comparison of Proposed Project Alternatives

The three Proposed Projects structural alternatives, evaluated within the context of a traditional water banking program and a modified banking and exchange program represent the practical range of alternatives for accomplishing the goals and objectives of the Proposed Project. They vary in a number of ways:

- Capacity to receive deliveries of supplies for banking;
- Capacity to store supplies from banking;
- Capacity to return supplies by exchange and by direct return;
- Total land area directly affected by construction and operation;

They have a number of elements in common. Because they would involve use of existing facilities in areas that are too remote to provide for direct return to the extent that banked supplies delivered to these areas could be returned via exchange, they optimize use of these remote facilities to the extent feasible. This approach is also taken in regard to use of the Mojave River Aquifer in the Alto subarea, where the primary constraint on banking is the ability of local agencies to utilize banked water in order to make returns of banking water via exchange. Thus the Proposed Project first optimizes the practical use of existing facilities throughout MWA's service area. A summary comparison of the three alternatives is shown on Table 4-20.

Table 4-20. Summary comparison of alternatives.

PROJECT ELEMENT	ALTERNATIVES		
	Minimum Facilities Alternative	**Small Projects Alternative**	**Large Projects Alternative**
Capacities			
Annual recharge capacity: in acre-feet	**92,275**	**120,775**	**182,175**
Acres of new recharge	**300**	**605**	**1,185**
Instream	**300**	**300**	**300**
Off-stream	**0**	**305**	**885**
Total Acres of New Construction	**68**	**343**	**923**
Permanent Land Use Change	**8**	**305**	**768**
Maximum instantaneous recharge rate (cfs)	**646**	**737**	**1,014**
Capacity for direct return (af/year)	**18,000**	**18,000**	**34,500**
Number of new wells	**up to 25**	**up to 25**	**up to 50**
Estimated Banking Project Yield (See also Table 4-5, above.)			
Traditional water banking	**174,000**	**174,000**	**237,000**
Modified banking/exchange	**96,000**	**96,000**	**96,000**
TOTAL	**270,000**	**270,000**	**333,000**

*Includes 200+ acres of temporary berms in the Mainstem Mojave River

4.10 Required Approvals

The proposed projects would require permits and/or approvals from the following agencies:

- Local jurisdiction plan approvals and encroachment permits, local well construction permits
- California Department of Transportation encroachment permits for construction in state rights-of-way
- U.S. Army Corps of Engineers Section 404 permit for actions within jurisdictional waters, including the West Fork and Mainstem Mojave River, Antelope Wash, Oro Grande Wash, and Unnamed Wash
- U.S. Fish and Wildlife Service Endangered Species Act Section 10(a) permit or Section 7 consultation permit for actions affecting federally listed threatened and/or endangered species
- California Department of Fish and Game, Section 2081 permit for incidental take of threatened and/or endangered species
- California Department of Fish and Game, Section 1600 streambed alteration permit for effects to rivers and washes
- Lahontan and Colorado River Regional Water Quality Control Board Clean Water Act Section 401 certifications

- California General Stormwater Permit from Lahontan and Colorado River Regional Water Quality Control Boards
- California Department of Water Resources potential approval of new turnout(s) from the California Aqueduct and change in point of delivery agreements
- Superior Court, State of California, County of Riverside, approval of any plan provisions for direct return of banked groundwater via pumping of groundwater and delivery to the California Aqueduct;
- Metropolitan Water District of Southern California, approval of its participation in the cooperative banking and exchange program

** Following discussions during the public comment period, Metropolitan was added as a CEQA Responsible Agency because it may take action to participate in the proposed project.*