Mojave Water Agency
Water Supply Reliability and Groundwater Replenishment Project

CHAPTER 3
INITIAL SCREENING OF ALTERNATIVES AND FORMULATION OF PROJECT ALTERNATIVES FOR DETAILED EVALUATION

3.1 Initial Screening of Alternative Facilities

3.1.1 Potential Alternative Facilities

As noted in the Chapter I, the 2004 Regional Water Management Plan identified a suite of high priority facilities for groundwater recharge and supply (for convenience, these are presented below as Table 3-1).

Table 3-1. Potential high priority recharge and water supply facilities, from the 2004 Regional Water Management Plan and 2004 PEIR.

FACILITY #	FACILITY FUNCTION AND LOCATION	AREA AFFECTED
4	RECHARGE: Oro Grande Wash	Mojave Regional Aquifer, Alto Mid-Regional
5	RECHARGE: Cedar Street Detention Basins	Mojave Mid-Regional Aquifer,
6	RECHARGE: Antelope Wash	Mojave Mid-Regional Aquifer,
11	RECHARGE: HDWD Recharge Basin 3, Warren Valley	Morongo Basin/Johnson Valley
13	RECHARGE: Newberry Springs	Mojave Floodplain Aquifer, Baja
18	RECHARGE: Rock Springs Release	Mojave Floodplain Aquifer, Alto
19	RECHARGE: Hesperia Lakes	Mojave Floodplain Aquifer, Alto
20	RECHARGE: South of Rock Springs	Mojave Floodplain Aquifer, Alto
21	RECHARGE: Temporary sand berms in the Mojave River to accommodate releases from Silverwood Lake to Mojave River	Mojave Floodplain Aquifer, Alto

A majority of these high priority facilities are located in the Alto subarea of MWA's service area, reflecting rapid growth and the need to address groundwater overdraft in this most urbanized portion of the MWA service area. The facilities shown on Table 3-1 were the starting point for the development of fully formed Project Alternatives that would meet Proposed Project objectives and the planning criteria discussed in Chapter II.

By themselves, these facilities do not constitute a project. Under CEQA, all aspects of a project that may affect the physical environment must be included in the project description. For groundwater recharge and storage, there are a number of elements that may affect the physical environment:

- The recharge facilities;
- Facilities for conveying water to the recharge facilities;
- Facilities for extracting water from the recharge facilities and conveying it to users;
- Operational features, such as the source of the water, the amount of water, the quality of water, the timing of delivery, facilities for monitoring the project, and so forth.

The basic characteristics of each element of groundwater recharge and exchange programs are described briefly below.

3.1.2 Recharge facilities

In formulating alternatives, both instream and off-stream recharge facilities were considered, including use of MWA's existing recharge facilities in combination with any or all of the nine potential facilities listed on Table 3-1. Recharge involves the conveyance of water to broad, flat basins where it spreads out and percolates into the ground. Once in the groundwater basin, recharged water tends to mound below the recharge site and to move laterally. Lateral movement is generally more rapid towards areas with the lowest groundwater levels. Extraction wells are therefore sited within and "downslope" from recharge basins, so that they extract water from the mound, which is higher than adjacent water levels, and thus reduce pumping costs.

The recharge process results in some loss of water during conveyance due to canal and pipe seepage, evaporation of water as it spreads out and percolates into the ground, and during extraction and distribution for use. To ensure that there is no net loss of water associated with banking, water banking programs generally include a conservative loss factor of 10%. Thus, if an agency delivers 100,000 acre-feet of water to a groundwater bank, it receives only 90,000 acre-feet in return. Except for releases down Unnamed Wash, MWA deliveries to existing and new groundwater basins would be via buried pipelines. Any seepage via Unnamed Wash will become part of the groundwater flowing into the Mojave River Floodplain Aquifer. Thus, no seepage losses will occur. Similarly, MWA returns of banked groundwater would be via closed pipelines. Losses are thus limited to those associated with evaporation during recharge. In MWA's service area, surface evaporation rates are, at maximum, about 110 inches per year or about an average of 0.30 inches per day (Lichvar et al 2002, for evaporation of playa lakes at Edwards AFB). Given a conservative infiltration rate of 6" per day during recharge, recharge operations would have a maximum evaporation rate of 5%. Actual evaporation during recharge is likely to be somewhat lower because (a) recharge rates in the Mainstem Mojave River and at several other sites are likely to be much higher than 6" per day and (b) recharge is most likely during winter and spring, when evaporation rates are lowest. A 10% loss factor is therefore at least double the maximum projected loss due to evaporation and evapotranspiration.

3.1.3 Facilities for conveying water to the recharge facilities

Before it can be recharged, water must be delivered to recharge facilities. This can be accomplished via pipelines and canals, via existing river channels, or via any combination of these methods. The type and location of conveyance facilities depends on the type and location of the recharge facility. In areas where rivers routinely dry out during the summer, recharge directly into the riverbed means that the river itself can function as a conveyance facility. Off-stream recharge basins require pipelines, canals, and associated pumping and power transmission facilities.

3.1.4 Groundwater extraction and conveyance facilities

Water stored in groundwater basins must be pumped to the surface and then distributed to users or conveyed directly to the banking entity. This requires wells and associated infrastructure to extract groundwater. Groundwater extraction facilities would depend on the location and size of recharge facilities and on the volumes of water to be recharged and extracted.

Water can be moved to users via pipelines and/or canals, with associated pumps and other infrastructure, to convey water to and from recharge areas to MWA service areas as well as to make return deliveries to water banking partners such as Metropolitan. The number and size of water conveyance facilities would depend on the location of recharge and on the proposed operational elements of each alternative. The length of pipelines or canals would depend on the distance of recharge facilities from areas where water would be used. The size of pipelines and canals would depend on the volumes of water to be stored and extracted. The number of pumping plants and the energy require to pump would depend on the elevation of groundwater compared to the elevation of the area to which groundwater was conveyed.

3.1.5 Operational features

3.1.5.1 Proposed Project Magnitude

Physical facilities may be operated in a number of different ways, depending on project goals and available methods for ensuring that water quality, water supply, and water distribution are managed in a manner consistent with the 1996 adjudication and with MWA policies. An initial consideration is the potential volume of water to be banked and returned. The total volume of water to be conveyed, recharged, and returned, or to be exchanged independent of banking operations, depends on the available supply, the needs of the cooperating parties, and the physical capacity of the groundwater basins to be used. Based on preliminary agreements, MWA and Metropolitan have agreed to evaluate water banking/exchange programs involving as little as 75,000 acre-feet of total supply/return/exchange. The maximum volume of water that could be involved in a cooperative water banking program between MWA and Metropolitan is much greater, potentially greater than 450,000 acre-feet over a period of 15-20 years. The actual magnitude of the Proposed Project banking element will thus probably fall within this range.

The Proposed Project facilities will, of course, be utilized by MWA for delivery and recharge of its own supplies, including SWP Table A contract supplies and other supplies such as those available under SWP Article 21. Even in years when Metropolitan is not making deliveries, MWA would use the added recharge and conveyance capacity provided by Proposed Project facilities to meet current and future obligations. Thus, operations of Proposed Project facilities will involve deliveries and extractions in excess of those required for a banking and exchange program. Over the next 15 years (2006-2020), MWA imported water deliveries will average about 47,000 acre-feet per year (MWA 2004b). Assuming MWA also pre-delivers some SWP supplies during this period for later use, total volume of MWA non-banking recharge in existing and new facilities could be 750,000 acre-feet or higher.

MWA deliveries to meet demands will necessarily involve greater imports of SWP supplies in above-normal-to-wet years, because MWA will need to import supplies in those years for storage and later use in dry years. Additional recharge basins, pipelines and other conveyance facilities, and production wells would mean MWA could bring these needed supplies into its service area more rapidly. This will help MWA optimize the water quality of the SWP supplies it imports by allowing MWA to focus on delivery in months when water quality is highest, rather than having to deliver supplies at a steady rate throughout the year.

In addition to banking and exchange, MWA's need for new facilities is highest in the Alto subarea, where growth is highest. Therefore banking facilities need to be sized to accommodate on-going MWA use, with a focus on the Alto subarea.

3.1.5.2 Recharge and extraction locations

The intent of traditional water banking is to provide for temporary storage of supplies in a groundwater basin. Active banking involves delivery of these supplies to a recharge facility where they are allowed to percolate into the groundwater basin. These supplies build up a mound under the recharge area and are then extracted from the immediate vicinity of the recharge area and returned. Essentially, recharge and extraction take place in the same location. Using the "savings account" concept, this is equivalent to making all deposits and withdrawals from the same branch office of a bank.

A variation on the traditional banking concept involves decoupling of recharge and extraction locations. Under this concept, water can be recharged at one location and extracted for direct return can be made elsewhere within the same groundwater basin. Under this approach, water producers within a given groundwater basin agree to use water extracted from the vicinity of the recharge basin in lieu of using wells at other locations. This approach is undertaken when (a) there is a significant distance between suitable recharge/extraction areas and the return point for direct return of banked water and (b) it is feasible for producers in the banking area to utilize water from the recharge area in lieu of extracting water from groundwater near the return point for return of banked water. Using the "saving account" concept, this approach is equivalent to depositing funds in a branch office and withdrawing them at any other office owned by the same bank. There are opportunities to apply this concept to the Proposed Project.

In MWA's service area, direct return of banked groundwater would probably be made to the California Aqueduct. If water is recharged to the Mojave River Mainstem, a direct return of this water to the California Aqueduct would require pumping water out of the aquifer and then uphill to the aqueduct. This would require new or modified pipelines and the use of significant energy. The facility and energy costs associated with direct return might be lowered if it were feasible for producers in Hesperia, Victorville, and Adelanto to utilize groundwater from the Mojave River Aquifer in-lieu of pumping from the Regional Aquifer in areas near the California Aqueduct. In these areas near the California Aqueduct, groundwater would be allowed to rise naturally and/or be recharged artificially while producers were taking recharged water from other locations. MWA could then utilize new or existing wells nearer to the aqueduct to make a portion of required direct returns to Metropolitan. In such a scenario, all of the cooperating agencies could benefit from lower energy costs for groundwater extraction conveyance.

Another key operational element of the Proposed Project is that banking supplies may be delivered to recharge areas that are some distance from the California Aqueduct. Direct return of this water is infeasible because of the long distances involved, lack of suitable pipelines for return, and the high energy costs of pumping water back to the California Aqueduct. MWA may, however, deliver banked supplies to these locations and then return banked supply via exchange. Under this type of operation, the producers in the vicinity of the Hodge, Lenwood, Daggett, Newberry Springs, Morongo Basin, and other sites far from the California Aqueduct would pump banked water in-lieu of MWA delivery of new supply from the SWP. Returns to Metropolitan would never exceed the volume banked less the 10% loss factor. This type of operation would result in higher groundwater levels in wet years when banked water would be delivered. The net effect of such operations on groundwater levels would always be positive because the 10% loss factor provided for in banking ensures that there will be at least a 5% increase in net deliveries versus returns. Thus, banking in these locations that are 30-50 miles from the California Aqueduct can be accomplished via an exchange program that will result in a steady build-up of groundwater supplies.

3.1.5.4 Water banking and water exchange concepts

Under the 1996 adjudication, MWA is explicitly authorized to enter into a storage agreement with the Mojave Basin Area Watermaster to acquire and store water that may later be used to satisfy MWA's obligations to supply supplemental water. The 1996 adjudication does not specify the nature of these projects. For purposes of alternative formulation, then, both water banking and exchange programs are feasible under the 1996 adjudication.

Traditional Water Banking: In the "traditional" water banking program proposed, Metropolitan would deliver water to MWA, which would store the water and then return it to Metropolitan at a later date, less the 10% loss factor. This type of program operates like a standard savings account: Metropolitan (or any other agency banking water with MWA) would put water into the bank before it could withdraw water, and it could not withdraw more than it had deposited. The traditional savings account concept also generally involves return of banked supplies via pumping and direct return of stored water. From the perspective of Metropolitan, traditional

banking is about saving water available in a wet year to meet needs in a dry year. For MWA, the benefits of traditional banking are (a) groundwater levels are temporarily raised and this reduces pumping costs and (b) the cost of the facilities needed for banking would be subsidized by Metropolitan. For MWA, banking is thus a means of paying for facilities that it can use for its own water supply management.

Modified Water Banking: The traditional savings account banking concept can be modified. Cooperating agencies can agree to exchange supplies depending on their needs and the availability of supplies. Such exchanges are called "time-shift" exchanges. Each cooperating agency may have supply available to it at a time when it does not, in fact, need the supply or have the ability to take delivery of it -- when there is a temporary surplus condition. Each agency may also experience periods when needs temporarily exceed supply. Under a time-shift exchange, one agency delivers its surplus to the other when the other needs it; the water is returned when the second agency has a temporary surplus. Such water exchanges may be made for any beneficial use. Exchanges may be made to meet immediate customer demand, to provide for storage of supplies by the cooperating parties, or for any combination of these uses.

Time-shift exchange programs do not operate under "savings account" rules. The cooperating agencies enter into an agreement to receive and return water on an ongoing basis. The net balance of this program may shift monthly, seasonally, or annually. The only condition is that at the end of the program, the exchanges are balanced.

A combined water banking and exchange program between MWA and Metropolitan would be operated by creating two separate accounts: a groundwater banking account and an exchange account. The groundwater banking account would operate under "savings account" rules. The exchange account would operate under more flexible rules; either agency could have a positive balance at any given time. Under such a rule, MWA could pre-deliver SWP supplies to Metropolitan for its storage or use; when Metropolitan later delivered supplies to MWA for banking, the Metropolitan balance would be reduced to reflect MWA's previous deliveries under the exchange account. A conceptual operations scenario is shown on Table 3-2.

Table 3-2. Conceptual water banking and exchange account for MWA and Metropolitan Water District of Southern California, involving a sequence of deliveries over time. Deliveries from Metropolitan to MWA are net (90% of nominal delivery).

DELIVERIES (IN SEQUENCE)	OVERALL PROGRAM BANK BALANCE (ACRE-FEET)		CHANGE IN MWA GROUNDWATER STORAGE
	MWA	Metropolitan	
MWA: 20,000 acre-feet SWP supply to Metropolitan	+20,000	-20,000	0
Metropolitan: 15,000 acre-feet to MWA	+5,000	-5,000	15,000
Metropolitan: 27,000 acre-feet to MWA	-22,000	+22,000	27,000
MWA: 12,000 acre-feet SWP supply to Metropolitan	-10,000	+10,000	0
MWA: 22,000 acre-feet SWP supply to Metropolitan	+12,000	-12,000	0
Metropolitan: 45,000 acre-feet to MWA	-33,000	+33,000	45,000
MWA: 12,000 acre-feet SWP supply to Metropolitan	-21,000	+21,000	0
MWA: 19,000 acre-feet SWP supply to Metropolitan	-2,000	+2,000	0
Metropolitan: 35000 acre-feet to MWA	-37,000	+37,000	35,000
MWA: 20,000 acre feet SWP and 5000 acre-feet Direct Return from groundwater	-17,000	+17,000	-5,000
MWA: 20,000 acre-feet SWP supply to Metropolitan	+3,000	-3,000	0
Metropolitan: 45,000 acre-feet to MWA	-42,000	+42,000	45,000
MWA: 17,000 acre-feet SWP supply to Metropolitan	-25,000	+25,000	0
MWA: 27,000 acre-feet SWP supply to Metropolitan	+2,000	-2,000	0
Metropolitan: 35,000 acre-feet to MWA	-33,000	+33,000	33,000
MWA: 12,000 acre-feet SWP supply to Metropolitan	-21,000	+21,000	0
MWA: 24,000 acre-feet SWP supply to Metropolitan	+3,000	-3,000	0
Metropolitan: 28000 acre-feet to MWA	-25,000	+25,000	28,000
MWA: 20,000 acre feet SWP and 5000 acre-feet Direct Return from groundwater	0	0	-5,000
Subtotal			**+218,000**
Plus 5% net groundwater storage from 10% loss factor			**+10,900**
NET CHANGE	**0**	**0**	**+228,900**

The conceptual scenario shown on Table 3-2 reflects the potential for a combined banking and exchange program to yield a net increase in groundwater storage in MWA's service area. This potential net increase in groundwater storage would be a result of a result of several factors:

- Metropolitan has substantial groundwater and surface water storage within its service area. Much of this supply is used annually during high demand months and replenished during low demand months. When Metropolitan has storage and MWA has supply in excess of needs, MWA could deliver its excess supply to Metropolitan for either storage or used in lieu of using stored water.
- As SWP contractors, both MWA and Metropolitan have access to supplemental water from the SWP under Article 21 and other programs.
- From 2005 through about 2020, MWA will have SWP Title A supplies that it would not normally take due to restrictions on recharge capacity, funds, and/or demands for makeup

and replacement water from subarea producers. Delivery of these supplies to Metropolitan as part of a time-shift exchange would thus have no effect on MWA supplies and deliveries of groundwater to subarea producers.

- Pre-delivery of supplies to Metropolitan would reduce the bank balance to be returned in dry years, thus reducing the potential need for direct delivery of banked groundwater.
- All deliveries from Metropolitan to MWA would be recharged. The net change in stored groundwater is thus equal to the total volume of water delivered to Metropolitan plus a percentage of the 10% loss factor.

The approach taken to banking, exchanges, and returns from banking is a significant variable in determining Proposed Project magnitude, feasibility, cost, and impacts. Facility size, capacity, and use will vary based on whether a traditional banking program is adopted or whether elements of on-going water exchanges are included in the program. Local agency participation will also help determine the feasibility of using an in-lieu approach to any required direct return.

3.1.6 Riparian Restoration Features

The 1996 adjudication provides for efforts to restore riparian vegetation directly and through water management that may incidentally enhance natural habitats. For example, removal of tamarisk may reduce groundwater use by this non-native weed and incidentally allow for recolonization of the riverbank by willows and cottonwoods, which provide superior habitat and use less water than tamarisk. In addition, groundwater banking may raise groundwater levels to the root zone of willows and cottonwoods, thereby enhancing potential for the restoration of riparian vegetation.

3.1.7 Summary

Each Proposed Project alternative will represent a mix of physical facilities and operational elements. Given the large number of "high" priority recharge and water supply projects identified in the 2004 Regional Water Management Plan and 2004 PEIR, it is evident that there are numerous ways in which these various projects and operations elements could be combined into alternatives. In addition, during scoping of this EIR, the public suggested an additional approach to water conveyance, specifically to conveyance of water supplies from MWA to Metropolitan through construction and operation of a pipeline/canal from the Morongo Basin to the Colorado River Aqueduct.

3.2 Initial Screening of Facility Alternatives

3.2.1 A General Summary of the Screening Process

3.2.1.1 Rationale for focusing on facilities

The Proposed Project's objectives would logically lead to a program that includes operational elements of traditional water banking and modified water banking that includes water exchanges. For practical purposes, both water banking and exchange require available storage, the ability to convey water to this storage, and the ability to return and/or utilize the stored water. MWA does not have access to surface storage, so it must use the overdrafted groundwater basins within its service area for this purpose. Under both banking and exchange scenarios, MWA also does not currently deliver water directly to subarea producers (with the exception of the City of Victorville). This would require construction and operation of a treatment plant. Under all circumstances, the Proposed Project will thus require new facilities for recharge, for conveyance of water, for extraction and distribution, and for return of banked water to Metropolitan or another partner.

3.2.1.2 Approach to facility screening

The location and capacity of facilities to a large extent determines the potential for direct exchange, for banking, for direct return, and for programs involving local use of banked supplies in-lieu of using SWP supplies. Facility siting and analysis of facility capacity and cost are thus a logical initial step in the formulation of alternatives. Accordingly, the first phase of alternative screening was undertaken by Bookman-Edmonston in Association with Science Applications International Corporation (B-E 2004a, B-E 2004b, B-E 2004c, and B-E 2005a, B-E 2005b, and B-E 2005c). In various phases of the initial screening, the following issues were addressed:

- Hydrogeology and water quality
- Environmental and Regulatory Constraints
- Capital and Operations Costs
- Land Use

The initial screening involved meetings with MWA's Technical Advisory Committee and with key local agencies (agencies in the vicinity of the California Aqueduct and thus able to participate actively in banking and exchange). Agencies specifically consulted during the screening (B-E 2004c) were:

- Hesperia Water District
- Victor Valley Water District
- Baldy Mesa Water District
- San Bernardino County Special Districts 70J and 70L.

The first phase of initial alternatives screening was focused on the full range of facility options described in the 2004 Regional Water Management Plan and its 2004 PEIR. These alternative facilities were examined to determine whether there were "fatal flaws" associated with their functioning as part of a long-term water banking and exchange program. Alternative sites for facilities were eliminated if they:

- Would be sites in an area of inappropriate soil conditions such that recharge and extraction of recharged water would be impractical;
- Would involve significant adverse impacts to threatened or endangered species;
- Would not be feasible institutionally; and/or
- Would violate the principles and terms of the 1996 adjudication or the Warren Valley Basin Judgment.

Facility alternatives that were not eliminated based on fatal flaws were next evaluated in terms of their capital cost and their capacity (their ability to meet a substantial portion of the Proposed Project need). This secondary screening was focused on facilities for recharge, which were ranked based on:

- Annual capacity for recharge;
- Cost range (total cost and cost per acre-foot);
- Ability to receive large volumes of water in a short period of time;
- Proximity to the California Aqueduct;
- Operational flexibility; and
- Potential for multiple use and thus for cost-sharing.

Each recharge facility was evaluated based on its practical capacity to receive and store supplemental water supplies. For example, the potential for recharge in the Morongo Basin was evaluated based on the capacity of the existing Morongo Basin Pipeline.

Facilities for water extraction and for return of supplies to any MWA banking partner such as Metropolitan were then evaluated (Bookman-Edmonston 2004a). Infrastructure requirements were evaluated under the assumption that MWA would retain a minimum of 12,000 acre-feet per year of its Table A SWP water for use in the MWA service area, even in dry years. The remaining Table A SWP supply would therefore be available to exchange, thus reducing the need to pump groundwater and return it back to the California Aqueduct. The screening evaluation assumed that MWA would, on average, have about 40,000 acre-feet of SWP Table A supply in years when Metropolitan requested a return of banked water. Thus, on average, there would be 28,000 acre-feet per year of SWP supply available to make returns of banked water. The use of MWA's SWP Table A supplies as a means for returning banked water to Metropolitan therefore minimized the size and cost of facilities for direct pumping and return of groundwater.

Using this process, a variety of extraction and return scenarios were evaluated based on conceptual MWA/Metropolitan banking/exchange programs of different magnitude. The evaluation initially focused on defining the amount of water which would need to be pumped and

returned to Metropolitan in any given year of the conceptual project, based on the following assumptions:

- Net supply would be from 75,000 to 450,000 acre-feet.
- Metropolitan would request equal annual returns from the bank over a 5-year period. Returns would therefore range from 18,000 acre-feet/year to 90,000 acre feet/year.
- To the extent that during dry years returns could not be made via exchange, MWA would need to pump groundwater and return it to the California Aqueduct.

Actual operation of the banking program would vary from these assumptions, but they provided a basis for comparing the relative capital and operations costs associated with extraction of groundwater and conveyance of this water to the California Aqueduct for return to Metropolitan. Using this methodology, the extraction and conveyance costs associated with four potentially feasible recharge areas were evaluated:

- Alternative T1. Extraction and conveyance from recharge basins along the Mojave River Pipeline between Baldy Mesa Road and Coughlin Road north of the California Aqueduct in the Alto subarea, with conveyance via the Mojave River Pipeline;
- Alternative T2. Extraction and conveyance from recharge basins along the Morongo Basin Pipeline east of the Mojave River, with conveyance via the Morongo Basin Pipeline;
- Alternative T3. Extraction and conveyance from a series of recharge basins in Hesperia and within the Mainstem Mojave River, with conveyance via (a) existing municipal pipelines and (b) new pipelines directly to the California Aqueduct;
- Alternative T4. Extraction and conveyance from recharge basins in the Oeste subarea along the California Aqueduct north of Phelan. Recharge basins were considered both north and south of the California Aqueduct in the 8.8-miles from Caughlin Road to Oasis Road, with conveyance directly from wells to the California Aqueduct via new pipelines;

In addition, the screening evaluation addressed the potential for MWA to meet a requested return with its SWP Table A supply. This analysis assumed that in an average year when Metropolitan might request return of some banked water, MWA would have about 40,000 acre-feet of available SWP Table A supply. The assumption was also made that MWA would retain about 12,000 acre-feet for use within its service area, making 28,000 acre-feet available each year. The Bookman-Edmonston/SAIC screening evaluation concluded by combining various recharge and extraction facilities and comparing net costs for recharge, extraction wells, conveyance pipelines and canals, and operations/energy costs:

- Eleven small projects (75,000 acre-feet of banked supply)
- Twenty-two small-to-medium-sized projects (150,000 acre-feet of total banked supply);
- Sixteen medium-sized projects (225,000 acre-feet of total banked supply);
- Twenty medium-to-large sized projects (300,000 acre-feet of supply); and
- Fifteen large-scale projects (450,000 acre-feet of total banked supply).

These combinations of facilities were evaluated to obtain information about the relative costs of small, medium, and large projects and to determine some of the key factors responsible for these costs.

3.2.1.3 Screening based on Water Quality

As a final step in alternative screening, the 2004 Regional Water Management Plan and its 2004 PEIR were reviewed to evaluate the water quality implications of potential recharge and extraction sites. Water quality is an important issue for both MWA and Metropolitan. State Water Project water has different characteristics than the indigenous groundwater of MWA's service area. These differences in water quality may affect the suitability of water for use. In addition, there are general non-degradation policies in effect for both (a) water delivered to MWA and (b) water returned to Metropolitan via the California Aqueduct.

3.2.2 Screening Variables: Hydrogeology and Water Quality

Groundwater recharge is generally not suitable in areas with extensive layers (lenses) of clay soils, because these soils slow down the movement of water through the soil (percolation rates) and often contain minerals that may leach out of the soil during recharge, resulting in contamination of groundwater. Screening to avoid such sites was therefore an important element of the alternative screening process. Also, with low percolation rates, water to be recharged remains on the surface and evaporates. Therefore, areas of the Regional Aquifer known to have clay soils were eliminated from consideration for recharge and extraction facilities. Other factors included in the hydrogeologic screening were:

- Storage Capacity: The groundwater basin must have capacity to receive the anticipated quantities of supplemental water.
- Lateral Movement: The soils must allow for movement of groundwater laterally towards locations where it will be extracted. Faults and other hydrogeologic barriers should not impede this movement.
- Geochemical Compatibility: The chemicals in the SWP supply and the groundwater must not interact to cause minerals to come out of solution (precipitation) and clog the aquifer.

The supplemental water brought into the MWA service area for recharge under the Proposed Project will be from SWP or other Central Valley supplies (if available). These SWP supplies are of generally good quality, with total dissolved solids (TDS) of about 200 to 400 mg/l (average about 280 mg/l). The indigenous groundwater in some parts of the MWA service area is of marginally better quality, particularly the Mojave River Aquifer in the Alto subarea from Mojave Forks Dam to the Narrows. In the Regional Aquifer and in the Mojave River Aquifer downstream from the Narrows, water quality is frequently worse than SWP supplies. This pattern generally holds for a variety of constituents, although SWP water is almost always lower in arsenic (average 2 µg/l or 2 parts per billion) than the groundwater in the MWA service area, where average arsenic levels range from about 1.7 µg/l to over 70µg/l. The trend is reversed for

nitrates, where SWP nitrate concentrations almost always exceed those of the MWA groundwater. Supplemental water delivered to groundwater may therefore marginally increase total dissolved solids, depending on the season in which it is imported, but will almost universally reduce concentrations of arsenic.

Water quality is a concern for both MWA and its potential partner, Metropolitan. MWA would prefer to import low-TDS water supplies, which will dilute the higher concentrations of TDS and arsenic in lower-basin water supplies. Metropolitan would be concerned about return supplies from areas where indigenous groundwater is very high in TDS, chromium VI and arsenic.

3.2.3 Screening Variables: Regulatory Constraints

The primary constraints on facility siting for water banking and exchange are (a) the presence of the endangered arroyo toad and (b) the 1996 adjudication. The endangered arroyo toad has been found in the West Fork of the Mojave River and in the vicinity of Mojave Forks Dam. It breeds and its young require slow moving pond habitat to mature from early spring through late September to early October. Rapidly flowing water may adversely affect this species. The 1996 adjudication obligates MWA to attempt to equitably distribute supplemental supplies to the various subareas. All parties to the 1996 adjudication are enjoined from "transporting water hereafter Produced from the Basin Area to areas outside the Basin Area." There are also Regional Water Quality Control Board policies governing potential degradation of groundwater.

3.2.4 Screening Variables: Costs

Under the 1996 adjudication, MWA is obligated to secure supplemental water and to establish "fair and equitable prices for Supplemental Water delivered to the Watermaster." Consideration of cost was therefore a basis for an initial screening of facility alternatives. These analyses examined the construction and operations costs of recharge, extraction, and conveyance facilities, both new and existing, within the context of a hypothetical water banking program between MWA and Metropolitan. Passive recharge facilities were evaluated; injection wells were not given detailed evaluation due to water quality concerns (injected water is judged to require treatment to drinking water standards prior to injection). Development of a large regional water treatment plant was also evaluated. Cost categories included:

- Land and rights-of-way. Land and right-of-way costs were based on current data from land sales within the general areas evaluated.
- Construction. Capital costs of facilities were evaluated based on typical industry costs.
- Energy. Energy costs were evaluated based on $0.12/kWh.

Combined capital and energy costs in excess of $200 to $300 per acre-foot were considered prohibitive, as the cost of SWP supply is currently at about $160 per acre-foot.

3.2.5 Screening Variables: Land Use

Portions of MWA's service area are undergoing relatively rapid development, particularly in the Hesperia, Victorville, Apple Valley, and Adelanto areas, as well as in the Barstow area. In these areas, siting of recharge and other facilities would be constrained by existing and planned development. Siting of large recharge basins could potentially divide existing and planned communities in these areas.

3.3 Results of Initial Facility Screening

Except for facilities with "fatal flaws," the purpose of initial screening was not to eliminate facilities or operations options, but to provide insight to assist in formulating alternatives that could reasonably be expected to meet Proposed Project objectives in a cost-effective manner. A fundamental assumption of the Proposed Project is that all subareas will have an opportunity to participate in water banking and exchange under the Proposed Project. The screening evaluation affects the formulation of facility and operational elements in the various subareas.

3.3.1 Fatal Flaws: Use of Mojave Forks Dam

Use of Mojave Forks Dam for recharge would probably not be feasible given potential high impacts to the endangered arroyo toad, high evaporation rates, and regulatory/management issues associated with conversion of this flood control facility to a dual-purpose facility. The Corps of Engineers indicated that conversion of this facility from flood control to a dual-purpose facility would require a local agency to assume full operating costs. These costs would be prohibitive and San Bernardino Flood Control District indicated that it would be unable to assume these costs. Permitting would also be virtually impossible given the status of the endangered arroyo toad. Use of Mojave Forks Dam for water supply was eliminated from further analysis.

3.3.2 Post-Screening Analysis of a Facility Alternative not evaluated in the General Screening Process

~~During the initial 30-day period of public scoping comments following issuance of the Notice of Intent to Prepare an Environmental Impact Report, a new approach to return of banked water to Metropolitan was proposed at the April 27, 2005 meeting of the MWA Technical Advisory Committee.~~ *

** The above has been deleted per response to comment from Mr. Chuck Bell, who noted that (a) MWA had misinterpreted his comments and (b) it was not his intention to suggest the alternative that is described in the following analysis. This editorial change does not affect the analysis below, which concluded that the alternative is not feasible.*

The initial screening analysis (see below) had tentatively concluded that banked water from Metropolitan (or other partners) could be recharged in the Johnson Valley and Morongo Basin areas, but that the costs of pumping this groundwater and returning it directly to Metropolitan via the California Aqueduct would be prohibitive. In addition, the volume of water which could be delivered via the Morongo Basin Pipeline would not make up a significant part of the total return to Metropolitan. The initial screening analysis also noted that the inability to directly return water to Metropolitan would not affect the potential for Producers in these areas to participate in the banking program, because during years when MWA was returning banked water to Metropolitan, they could pump groundwater and use this banked water in-lieu of receiving SWP supplies, which would then be available for MWA to exchange with Metropolitan.

The suggested new alternative would involve delivery of banking supplies to the Morongo Basin/Lucerne Valley, where they could be recharged in existing recharge basins and then stored until needed. When Metropolitan requested return of banked supplies, they could be returned directly from the Lucerne Valley via the Morongo Basin Pipeline and/or a new pipeline to the Colorado River Aqueduct. At its nearest point to the terminus of the Morongo Basin Pipeline, the Colorado River Aqueduct is in tunnel. A connection could be made following the alignment of State Highway 62, which intersects the Colorado River Aqueduct about 10 miles from the terminus of the Morongo Basin Pipeline.

This alternative was evaluated assuming:

- A new 24" pipeline connecting the Morongo Basin recharge basins to the Colorado River Aqueduct would cost approximately $126 per linear foot. This is about 1.5 times the cost of pipelines in the Alto Basin because the pipeline would be a high pressure pipe. The cost of the pipeline to the Colorado River Aqueduct would be about $6,650,000;
- Metropolitan's delivery of water to be banked would occur in 3 out of 10 years, during wet years, and the water would be delivered to Morongo Basin over a period of 6 months;
- Deliveries of Metropolitan water for banking in the Morongo Basin recharge areas would be at a rate of 15 cfs, or 30 acre-feet per day. With 15% down time for maintenance and repair, this would result in 155 days of delivery for a total of 4,650 acre-feet x 3 years = 13,950 acre-feet of total banked storage in Morongo Basin.
- Assuming a standard conveyance and recharge holdback of 10%, the total volume of banked water in the Morongo Basin would be 12,550 acre-feet.
- Return of banked water supplies would take place over a period of 3 years, at a rate of about 4,180 acre-feet per year, to be delivered over 9 month period;
- Total extraction capacity in the Morongo Basin is about 1,200 acre-feet per year. Additional wells capable of extracting 2,920 acre-feet per year would be required, an additional 3-4 production wells would be required at a cost of about $500,000 each.
- There would be no energy cost associated with returns from the Morongo Basin to the Colorado River Aqueduct.

Based on these assumptions, the capital costs of delivering 12,550 acre-feet of banked water in the Morongo Basin to Metropolitan via a pipeline to the Colorado River Aqueduct would be:

- Pipeline cost: $6,650,000
- Well cost: $2,000,000
- Total cost: $8,650,000
- Cost per acre-foot: $689

This cost does not include operation and maintenance or the cost of energy. A per-acre-foot cost of about $700 is approximately 2.7 times the current cost of banked water from the three primary Metropolitan cooperative water banking programs in Kern County. It is also approximately 4.5 times the cost of delivering exchange water to Metropolitan and allowing Producers in the Morongo Basin to utilize banked water in-lieu of taking SWP supplies. For these reasons, return of banked supplies via a new pipeline from the Morongo Basin to the Colorado River Aqueduct was eliminated from consideration.

3.3.3 Morongo Basin/Johnson Valley

3.3.3.1 Hydrogeology and Water Quality

The Morongo Basin/Johnson Valley area has existing and planned groundwater basins and there is conveyance to these facilities via the Morongo Basin Pipeline, which has capacity to deliver about 15 cfs (30 acre-feet per day or a maximum of 10,950 acre-feet in a 365-day year). Conveyance capacity exceeds existing recharge capacity, and is approximately 4 times the estimated annual need for supplemental supply/recharge in this area (2004 Regional Water Management Plan and 2004 PEIR). While it may be feasible to deliver supplemental water supplies to the Morongo Basin, some areas appear to have unsuitable soils for active recharge. Specifically, conditions for recharge in some parts of the Lucerne Valley are poor with clay layers in the soils that would prevent effective recharge or result in high evaporation losses during recharge.

Water quality in the Morongo Basin is variable, but generally meets drinking water standards, although in Johnson Valley average levels of sulfates are marginally higher than those allowed under drinking water standards. Comparing average levels of water quality constituents in SWP water to the levels of the same constituents in indigenous groundwater (2004 PEIR) suggests that recharge of SWP supplies would dilute concentrations of some constituents in some indigenous groundwater basins and increase concentrations in other areas (Table 3-3).

Table 3-3. Difference between average indigenous water quality and average SWP water quality in the 4 subareas of the Morongo Basin/Johnson Valley area. Bold face type indicates that average SWP water is superior to indigenous groundwater.

WATER QUALITY CONSTITUENT	DIFFERENCE BETWEEN AVERAGE INDIGENOUS WATER QUALITY AND AVERAGE SWP WATER QUALITY (%)			
	Copper Mountain	**Johnson Valley**	**Means/Ames**	**Warren Valley**
Calcium	**23%**	**289%**	**42%**	**26%**
Magnesium*	174%	**386%**	163%	207%
Sulfate	**23%**	**825%**	**43%**	71%
Chloride	239%	**94%**	282%	211%
Fluoride	**1500%**	**1250%**	**1280%**	**418%**
Manganese	**348%**	20%	Same	**6%**
Iron	**160%**	**204%**	73%	10%
Arsenic	**145%**	5%	**90%**	**115%**
Boron	27%	**210%**	7%	177%
TDS	17%	**224%**	2%	28%
Nitrates	**187%**	5%	**685%**	**1005%**

Average SWP supply is better than indigenous groundwater supply in 25 of 44 cases, and is of worse quality in 18 of 44 cases. In no case would average year SWP supplies have concentrations of water quality constituents in excess of drinking water standards. The use of SWP supplies would result in improved water quality in Copper Mountain and Johnson Valley subareas, but in Means/Ames and Warren Valley supplemental supplies would have mixed effects. Based on these results, it was concluded that water quality would not preclude delivery of SWP supplemental supplies to the Morongo Basin.

3.3.3.2 Regulatory Constraints

The 1996 adjudication "is intended to provide for delivery and equitable distribution to the respective Subareas by MWA of the best quality of Supplemental Water reasonably available." MWA is obligated "to develop conveyance and other facilities to deliver Supplemental Water [to subareas] unless prevented by forces outside its reasonable control such as an inability to secure financing consistent with sound municipal financing practices and standards." Further, MWA is authorized to pre-deliver and recharge supplemental supplies, which may then be used to meet replacement and makeup obligations at a later date.

Finally, the 1996 adjudication provides that "Except upon further order of the Court, each and every Party, its officers, agents, employees, successors and assigns, is ENJOINED AND RESTRAINED [emphasis in adjudication language] from transporting water hereafter Produced from the Basin Area to areas outside the Basin Area."

Although the 1996 adjudication makes a distinction between produced water, replacement water, and supplemental water, pumping of groundwater to meet return obligations from banking is somewhat constrained by the 1996 adjudication. Pumping of banked groundwater for direct return should be limited to ensure that the ability of sub areas to produce groundwater supplies is

not affected. In the Morongo Basin, the potential for local area effects, such as declining groundwater levels from pumping large quantities of stored groundwater out of the subarea, could conflict with Judgment for the Warren Valley Basin (Town of Yucca Valley and Hi-Desert Water District area).

3.3.3.3 Cost and Land Use

Land use and value were not considered constraints in the Morongo Basin, but the cost of pumping water from the Morongo Basin back to the California Aqueduct or to the Colorado River Aqueduct for return to Metropolitan would be prohibitive, both because of the need for additional pumping and conveyance facilities and because of high energy cost to pump supplies upgrade over long distances.

Morongo Basin could participate in water exchange and water banking programs through an in-lieu program. Supplemental water in excess of demands could be delivered, stored, and accounted for by the MWA under their storage account with Watermaster. In years when exchanges or returns from water banking required use of MWA's SWP Table A supplies, this stored water could then be pumped and used by subarea Producers in-lieu of receiving supplemental SWP supplies.

3.3.4 Mojave Basin

3.3.4.1 Hydrogeology and Water Quality

Soils: Soils and recharge conditions vary in the Mojave Basin Regional Aquifer. Soils in the southern portion of the Alto and Oeste subareas were considered suitable for recharge, with estimated recharge rates of about 0.5 feet per day. In the northern portion of the Alto subarea, near George Air Force Base and the City of Adelanto, lenses of clay soils would limit recharge, these lenses of clay potentially extending to areas south of the High Desert Power Project.

Soils in the bed of the Mojave River Mainstem and in the immediate floodplain contain high sand and gravel content and recharge rates for the Mojave River Aquifer were conservatively estimated to be 2 to 3 feet per day. The MWA 2003-2004 demonstration project documented recharge of the Mojave River Mainstem at a rate of up to 350 to 400 cfs, or 700 to 800 acre-feet per day. Equivalent recharge at an Alto or Oeste subarea Regional Aquifer site (at an estimated 0.5 feet per day) would require a recharge basin with a useable capacity of 1400 to 1600 acres, or about 2000 total acres). In the Mojave River Transition Zone downstream of the Narrows, the floodplain aquifer has clay and silt layers of low permeability and would not be suitable for large volume recharge. In the Baja and Centro areas, there are existing and planned recharge basins in the floodplain aquifer.

Soils in Alto and Oeste subarea washes leading to the Mojave River have been investigated and MWA has conducted a pilot project in Oro Grande Wash that demonstrates suitable recharge conditions.

Basin Storage Capacity: Throughout the Mojave Basin, historic overdraft has lowered groundwater levels by as much as 100 feet and there is substantial capacity in the Regional and the Mojave River Aquifer. Most of the overdraft occurred in the Centro and Baja subareas, which had 750,000 and 1.1 million acre-feet of overdraft, respectively (USGS 2001). Historic overdraft has been lowest in the Este and Oeste subareas. The Mojave River Aquifer immediately below the river channel has limited storage capacity because groundwater moves downslope to the Narrows where it is forced to the surface. The initial screening analysis estimated that, at any given time, storage in the Mojave River Aquifer between Mojave Forks Dam and the Narrows is about 61,000 acre-feet. Storage in excess of this would flow to the Alto Transition Zone.

Basin Water Quality: Water quality in the various aquifers of the Mojave Basin is also a concern. The 2004 PEIR provides data on water quality by subarea and aquifer. Table 3-4 summarizes these data in terms of whether groundwater quality meets California drinking water standards. Downstream from the Alto Transition Zone to the Baja subarea, water quality in the Mojave River Aquifer declines rapidly. A similar trend is seen in water quality in the Regional Aquifer. The magnitude of some of the deviations from drinking water standards is great, and data from the 2004 PEIR also show deviations from the average quality of water from the State Water Project. In the Alto and Oeste Regional aquifers and the Mojave River Aquifer south of the Narrows there is only one violation of an average standard (the 18% violation of average arsenic standards in the Alto Regional Aquifer). Blending of low-arsenic supplies from the SWP could have dilution effects related to arsenic; blending the otherwise good quality indigenous groundwater with SWP supplies could have beneficial effects on the quality of banked water directly returned to the California Aqueduct.

In addition to average water quality within each region that may violate drinking water standards, various wells in each area may have much higher levels of constituents such as arsenic, boron, manganese, and TDS.

Table 3-4. Average California Drinking Water Quality standards violated by groundwater in subareas of the Mojave Basin. (2004 PEIR)

SUBAREA	AVERAGE DRINKING WATER QUALITY STANDARDS VIOLATED In mg/l (parts per million) or µg/l (parts per billion)		
Alto	None		
Alto Narrows	None		
Oeste Regional	None		
	Constituent	Standard (Maximum Limit)	Average Concentration
Alto Transition	Arsenic	5 µg/l	12.6 µg/l
	TDS	500 mg/l	518 mg/l
Centro Floodplain	Manganese	50 µg/l	147 µg/l
	Boron	600 µg/l	771.6 µg/l
	TDS	500 mg/l	785 mg/l
Baja Floodplain	Arsenic	5 µg/l	10.4 µg/l
	Boron	600 µg/l	931 µg/l
Alto Left	Arsenic	10 µg/l	11.8 µg/l
Centro Regional	Arsenic	10 µg/l	13.4 µg/l
	Boron	600 µg/l	1351 µg/l
Baja Regional	Arsenic	10 µg/l	73.9 µg/l
	Boron	600 µg/l	1124.7 µg/l
	TDS	500 mg/l	529.5 mg/l

3.3.4.2 Regulatory Constraints

The principal regulatory constraints on water banking and exchange programs in the Mojave Basin were:

- Arroyo toad.

The presence of the arroyo toad in the West Fork of the Mojave River and near Mojave Forks Dam would limit delivery of supplies to the Mojave River Mainstem from Silverwood Lake to the months of October through February.

- 1996 Adjudication

The 1996 adjudication "is intended to provide for delivery and equitable distribution to the respective Subareas by MWA of the best quality of Supplemental Water reasonably available." MWA is obligated "to develop conveyance and other facilities to deliver Supplemental Water [to subareas] unless prevented by forces outside its reasonable control such as an inability to secure financing consistent with sound municipal financing practices and standards." Further, MWA is authorized to pre-deliver and recharge supplemental supplies, which may then be used to meet makeup obligations at a later date.

Finally, the 1996 adjudication provides that "Except upon further order of the Court, each and every Party, its officers, agents, employees, successors and assigns, is ENJOINED AND

RESTRAINED [emphasis in adjudication language] from transporting water hereafter Produced from the Basin Area to areas outside the Basin Area."

Although the 1996 adjudication makes a distinction between produced water, replacement water, and supplemental water, pumping of groundwater to meet return obligations from banking is somewhat constrained by the 1996 adjudication. Pumping of banked groundwater for direct return should be limited to ensure that the ability of subarea producers to maintain their allowed production under the 1996 adjudication is maintained.

3.3.4.3 Capital and Energy Costs

The final screening of various potential combinations of facilities and operations scenarios yielded costs per acre-foot of supply of from $0 to $765, with the range of prices varying by project size:

- Small projects: $0 to $568
- Small to medium sized projects: $196 to $765
- Medium sized projects: $343 to $595
- Medium to large sized projects: $376 to $629
- Large-sized projects: $420 to $737

Several trends were evident in these cost data. First, only alternatives involving exchange of MWA SWP Table A supplies to return banked supplies to Metropolitan resulted in net project costs of less than $300 per acre-foot. Second, use of existing facilities for recharge and use of exchange as a means of returning water to Metropolitan resulted in facility and operations combinations that resulted in the lowest cost. Third, facility and operations costs associated with groundwater extraction and direct return of groundwater to Metropolitan increased rapidly with total project size due the need for proportionally greater use of direct return as project size increased. The initial screening assumed that from 10,000 to 28,000 acre-feet of MWA SWP Table A water would be available for exchange in-lieu of pumping water from the bank and returning it directly to the California Aqueduct. Project costs therefore increased rapidly when the volume of banked water to be returned to Metropolitan exceeded 10,000 acre-feet per year (low threshold) or 28,000 acre-feet per year (high threshold).

Fourth, capital costs for land acquisition in the vicinity of Hesperia, Victorville, Adelanto, and Apple Valley were also a significant component in the cost of larger projects. There is only minimal capital and operational cost for using the Mojave River Mainstem, and recharge rates in this area are 4 to 6 times higher than those in areas outside of the river floodplain. High land costs also led to the conclusion that alternatives involving facilities in these areas should therefore make maximum possible use of recharge in the Mojave River Mainstem, along local washes, and where multi-agency objectives can be met (such as at offstream flood detention basins).

Finally, capital and energy costs were higher for all facilities located at a distance of about 3 to 5 miles from the California Aqueduct, because returning water would necessarily require pumping uphill. For these facilities, the cost of well, pipelines, pumps, and energy to return stored water to the California Aqueduct significantly exceeded the cost of using exchange to return banked supplies to Metropolitan Capital and energy costs were lower for recharge/extraction sites near the California Aqueduct, but costs for land and facilities construction remained a substantial portion of overall cost. Energy costs for pumping water from deep groundwater basins in the Regional Aquifer were a substantial component of overall project costs associated with facilities in the Oeste and Alto subareas.

3.3.5 Water Treatment Plant Alternative

A water treatment plant to replace current reliance on groundwater by allowing for treatment and direct use of exchange/banking supplies would not be feasible as an element of a water exchange and/or banking program because treatment plants require a steady delivery rate and water exchange and banking programs are based on the need to capture the variable component of water supply. If the experience of water banks in the Central Valley is representative, then Metropolitan (and other banking partners) would deliver supplies to MWA in relatively large quantities over relatively short periods of time.

A water treatment plant was not eliminated from future consideration, but was determined not to be a suitable approach to an exchange and banking program the function of which is to optimize use of variable supplies. For example, a water treatment plant would not be able to accommodate high-volume short-term deliveries of Metropolitan supplies from San Luis Reservoir or from purchase of Article 21 supplies.

3.4 Formulation of Alternatives for Detailed Consideration

The results of screening provided a quantitative basis for formulation of a final array of Proposed Project alternatives, based on the following conclusions:

1. High energy costs and limited capacity in existing facilities would make direct return from the areas served by the Morongo Basin Pipeline infeasible from a cost perspective. In addition, additional conveyance facilities would not be needed because these areas have relatively low supplemental recharge needs (2004 PEIR) and existing conveyance capacity substantially exceeds the projected supplemental recharge need. These areas have significant potential for groundwater recharge at existing facilities and could participate fully in the Proposed Project with banked supplies returned via water exchanges.

2. Based on the screening analysis, it is apparent that from a hydrogeologic perspective that the best sites for recharge (high percolation rates) and for groundwater quality (fewest and least significant violations of water quality standards) are in the Alto and Oeste areas. Recharge rates and water quality are best in the Alto portion of the Mojave River Aquifer south of the Narrows. Direct return of banked water from these areas is potentially feasible.

3. High facility and energy costs, along with lesser water quality in the Mojave River Aquifer and the Regional Aquifer in the Alto Transition, Centro, and Baja subareas would probably preclude direct return of banked supply from these areas to the California Aqueduct. Participation of these subareas in banking would thus require return via water exchanges.

4. In the Regional Aquifer, low groundwater permeability results in a need for large recharge basins and numerous wells ($750,000 each). Facility costs in the Regional Aquifer in the Alto and Oeste areas would be high because land costs are rapidly rising and because of the number of wells required to extract banked groundwater.

5. The capacity of the Mojave River Aquifer between Mojave Forks Dam and the Narrows was estimated at 61,000 acre feet. In addition, water stored in the Mojave River Aquifer in this reach eventually spills into the Narrows, passing downstream to areas with poor water quality and limited ability to provide for recharge. To make full use of this aquifer would require MWA and local agencies to develop a well field along the river above the narrows to withdraw banked water for use in Hesperia, Victorville, Apple Valley, and Adelanto (including George Air Force Base). The water provided in this manner would be used in lieu of pumping at sites in the Regional Aquifer. In addition, off-stream recharge along the Mojave River in this reach could potentially increase net storage in the aquifer and increase the ability of the aquifer to receive and treat water received from the SWP.

6. Because of high land costs, recharge in the Alto and Oeste aquifers should be focused on (a) use of multi-purpose sites, such as proposed floodwater detention basins along local washes and (b) use of recharge sites immediately adjacent to the California Aqueduct.

7. Traditional banking operations should be combined, to the extent feasible, with a program of water exchanges so that MWA can (a) optimize use of its existing SWP Title A supplies and any supplemental SWP supplies available to it and (b) by pre-delivering water to Metropolitan, minimize the magnitude of return requirements in dry years, which would minimize direct return from groundwater and thus reduce facility costs.

8. Use of the Mojave River Aquifer between Mojave Forks Dam and the Narrows as a primary recharge area would raise groundwater levels in this reach and enhance re-growth of riparian vegetation along the channel. There would be accompanying water losses to evapotranspiration by such vegetation, and these losses would need to be accounted for in analysis of alternatives. To the extent that MWA's Proposed Project would incidentally result in lower water diversions from the Narrows reach of the Mojave River, there would also be benefits to riparian vegetation in this reach. Recharge associated with banking of supplies would be intermittent, and such benefits would therefore be inconsistent and unpredictable.

3.5 Alternatives Carried Forward for Detailed Evaluation

The initial screening process effectively eliminated from consideration a suite of sites with (a) high costs, (b) important water quality problems, (c) conveyance problems, (d) environmental

impacts associated with take of threatened and endangered species and riparian habitats, and (e) operational constraints unsuitable for a banking program. Based on the screening evaluation, it was also clear that benefits and costs of alternatives would increase incrementally, with the lowest costs, yields, and impacts associated with smaller projects that utilized existing facilities, the capacity of the Mojave River Mainstem, and water exchanges to make returns of banked water. As the volume of banked and exchanged water increases, there is a corresponding need for (a) additional facilities to increase recharge and extraction rates and (b) optimizing of the potential for use of water exchanges.

Based on the initial screening, then, MWA concluded that it was appropriate to develop a continuum of alternatives. The Notice of Preparation initially described a potential alternative involving only use of existing facilities, but this alternative was eliminated from individual consideration based on findings of the 2004 PEIR that additional recharge in the Alto subarea was a high priority. This continuum of new facility components was therefore broken into three distinct facility alternatives for the purpose of evaluating relative impacts of logical increments of facility development and to accommodate modeling of the water management aspects of the Proposed Project. However, throughout the EIR, impacts have been described in terms of each increment of facility development so that the relative impacts of any combination of facilities could be rapidly determined by the Mojave Water Agency Board of Directors. The logical progression represented by the three groupings of facilities -- from the Minimum Facilities Alternative with permanent effects to land use of less than 20 acres to the Large Projects Alternative with permanent effects to land use of over 800 acres -- provides MWA's Board of Directors with a set of choices with progressively greater benefits and associated impacts. The largest-scale alternative includes the elements of the smaller-scale alternatives.

Following the intensive screening program that eliminated many alternative facilities and approaches to meeting MWA needs, this incremental approach to alternative formulation is intended to help the MWA Board of Directors identify an optimal mix of recharge and associated facilities:

- No Project Alternative

  Under this alternative, no banking and exchange program would occur. MWA would continue to operate its existing facilities and to plan and construct new recharge and conveyance facilities on an as-needed basis to accommodate increasing deliveries of SWP supplies for recharge to meet on-going (rising) needs to deliver imported water to water producers in the MWA service area.

  The No Project Alternative was defined in the context of MWA's on-going obligations to provide imported water for producers in the various subareas of MWA's service area. As noted above and documented in the 2004 Regional Water Management Plan and the 2004 PEIR, over the 15-year period from 2006-2020, MWA will import and recharge about 750,000 acre-feet of SWP supply to meet projected water supply needs.

The No Project Alternative is therefore not the existing baseline condition. Regardless of whether the Proposed Project for banking and water exchange is approved and implemented, MWA will, as documented in the 2004 PEIR, import an increasing amount of water to meet these water supply needs. The recharge and conveyance of this water to subarea producers will require facilities, which are described in general in the 2004 PEIR and will be developed over a period of years. It is likely that MWA would develop these facilities in cooperation with local subarea producers and, by 2025, would develop recharge and extraction facilities of similar capacity to those for the Proposed Project. It is likely that MWA would continue to use existing recharge outside of the Alto and Oeste subareas. It is likely that MWA would develop additional recharge in the Oeste and Alto subareas. It is likely that use of various local flood detention basins for recharge would be pursued. It is likely that some additional off-channel Mojave River recharge would be pursued, as this recharge would have substantially higher recharge rates than other sites.

The No Project Alternative therefore reasonably assumes that many of the Proposed Project facilities would be pursued, consistent with the 2004 PEIR. Indeed, this Project EIR addresses the project-specific impacts of these facilities and is intended to provide the MWA Board of Directors and the public with site-specific information regarding the potential for impacts associated with these facilities. The banking and exchange elements of the Proposed Project accelerate the need for these facilities and increase the volume of water deliveries to them. Under the Proposed Project, the magnitude of facilities required to meet combined banking and MWA uses of facilities may be greater than under the No Project Alternative.

The No Project Alternative therefore contemplates development of at least a subset of the facilities described in this Project EIR or their equivalent in capacity; it assumes only that these facilities would be developed at a slower rate. The difference in impact analysis for each of the facilities is therefore a function of (a) the total magnitude of impacts and (b) alternative siting, and (c) timing of construction and associated construction-related impacts.

On a facility-by-facility basis, the magnitude of impacts would not be changed significantly. Changes in impact may occur under the No Project Alternative if the sites evaluated in this Project EIR were rendered unavailable by future conditions, such as by development of the site. In this case, alternative sites would have to be developed. It is unlikely that future development would affect the following elements of the Proposed Project:

(1) Instream Mojave River Recharge (Use of the Mainstem river for recharge would not be constrained by future development because no development of the Mainstem Mojave River channel is possible.)

(2) The Mojave River Well Field and Pipelines. (Construction and use of these facilities would not be constrained by future development because these facilities require a small amount of land and right-of-way and may be integrated into the land uses proposed for the area along the Mainstem Mojave River between Rock Springs and Bear Valley Road. Without a banking program, the pipeline would not be extended to the California Aqueduct.)

(3) Use of existing and planned flood detention basins. (Use of planned flood detention basins would not be constrained by future development because if local entities construct these facilities as planned, their use for groundwater recharge would be compatible with their intended flood management uses, and they may be assumed to be available for this purpose.)

(4) Oro Grande recharge. (Recharge within Oro Grande Wash would not be constrained by future development because development in this large wash would be prohibited by flood damage concerns.)

(5) Antelope Wash recharge. (Recharge within Antelope Wash would not be constrained by future development because development in this large wash would be prohibited by flood damage concerns.)

(6) Unnamed Wash. (MWA proposes to cooperate with the developer of Rancho Las Flores in siting and designing facilities for delivery of water via Unnamed Wash, and thus future development is unlikely to constrain its use for conveyance of water from the California Aqueduct to the Mainstem Mojave River. MWA's Proposed Project would also contain flood flows in the wash to the 100-year floodplain, and thus would not affect development potential in downstream reaches of the wash which are outside of Rancho Las Flores.)

There is, however, potential for future development to affect the siting of recharge basins and associated facilities for off-channel recharge along the Mainstem Mojave River and at the Oeste and Alto recharge sites. Under the No Project Alternative, these facilities might not be developed immediately and re-siting of these facilities could be required by prior development. To meet local needs, it is assumed that extraction wells at these sites would continue to be necessary, but pipelines to the California Aqueduct would not be required.

The ultimate magnitude of the facilities required under the No Project Alternative would probably be similar to that required for the Proposed Project, because by 2020-2025, MWA will need to import and recharge its full SWP contract supply of up to 75,800 acre-feet in years when this amount is available and any Article 21 water that it could obtain as well. This may be necessary to pre-deliver supplies for storage to meet demands in dry years. Following 2020-2025, MWA may also need to acquire and recharge additional supplies to meet increasing demands. This volume of import and recharge would be approximately equal to that of combined MWA and Metropolitan deliveries to banking during the period 2006 through 2015. In addition, greater recharge capacity is important to MWA in order to optimize delivery during periods when SWP water quality is best.

Timing of facility development would also be different under the No Project Alternative. Facilities may be brought on line in an incremental or phased manner over a decade or more, whereas the Proposed Project may require more rapid development of facilities to

accommodate the combination of Metropolitan and MWA delivery and recharge of SWP supplies for both banking and to meet in-basin water demands.

- Minimum Facilities Alternative:

The Minimum Facilities Alternative would represent the lowest cost and lowest direct environmental impact approach. It combines optimal banking use of existing facilities and use of the Mainstem Mojave River for recharge. This alternative would be evaluated in terms of both a traditional water banking program and a program that optimized the use of available MWA supplies in an on-going exchange program with Metropolitan.

- Small Projects Alternative:

A Small Projects Alternative was formulated to include all aspects of the Minimum Facilities Alternative and the development of the most cost-effective additional recharge and groundwater extraction facilities identified in the screening evaluation. Again, this alternative would be evaluated in terms of both a traditional water banking program and a program that optimized the use of available MWA supplies in an on-going exchange program with Metropolitan.

- Large Projects Alternative

For this alternative, an additional increment of recharge and extraction capacity would be added to the Small Projects Alternative by developing some of the larger recharge facilities explored in the screening evaluation, specifically large recharge areas along the California Aqueduct in the Alto and Oeste areas. Again, this alternative would be evaluated in terms of both a traditional water banking program and a program that optimized the use of available MWA supplies in an on-going exchange program with Metropolitan.

This incremental approach to alternative formulation (Table 3-5), allows analysis of Proposed Project benefits, costs, and environmental effects in an incremental manner. Each of the larger-scale alternatives builds on the baseline of the initial Minimum Facilities Alternative. As a result, it will be possible to evaluate the incremental benefits and impacts of adding facilities to the existing MWA water management system. The effects of each additional set of facilities can be evaluated in terms of the effect on the functioning of a traditional water bank and on the potential to optimize water management through an on-going water exchange program.

Table 3-5. Proposed Project alternatives, Mojave Water Agency Water Supply Reliability and Groundwater Replenishment Program (Modified from the April 2005 Notice of Preparation of an Environmental Impact Report)

FACILITIES	RETURN METHOD
Minimum Facilities Alternative	
Mojave River Pipeline (existing)	NA
Morongo Basin Pipeline (existing)	NA
Existing recharge basins at Hodge, Lenwood , Daggett, and Newberry Springs, and Green Tree detention basin (existing or already planned)	Exchange
Morongo Basin recharge basins at Warren Basin (existing)	Exchange
Mojave River mainstem (in river berms)	Direct Return & Exchange
Mojave River Well Field and Pipelines (new)	Direct Return & Exchange
Delivery of SWP supplies to Mojave River via an Unnamed Wash west of the Mojave River	Direct Return & Exchange
Small Projects Alternative: Minimum Facilities Alternative plus Small Projects	
Oro Grande Wash recharge (2 sites)	Direct Return & Exchange
Cedar Avenue Flood Control Detention recharge	Direct Return & Exchange
Antelope Wash Detention Basin (Ranchero Road) recharge	Direct Return & Exchange
Off-channel Mojave River Recharge (2 potential sites)	Direct Return & Exchange
Large Projects Alternative: Small Projects Alternative Plus Major New Recharge Basins	
Oeste Recharge Basins, Pipelines and Wells along the California Aqueduct north of Phelan	Direct Return & Exchange
Alto Recharge Basins, Pipelines and Wells along the California Aqueduct	Direct Return & Exchange
Antelope Wash Recharge downstream of the California Aqueduct	Direct Return & Exchange

Given that each facility alternative will be subjected to evaluation in terms of a traditional water banking program and an on-going water exchange program, a total of six alternatives will be evaluated. By evaluating a full range of alternatives and their environmental effects on a facility-by-facility basis, and addressing the full range of operational possibilities, the EIR will provide the public and the MWA Board of Directors with a comprehensive view of the benefits and impacts of a full range of alternatives. The Board of Directors may then make findings regarding the six alternatives and/or alternatives involving variations of the facilities and operational concepts.