MOJAVE WATER AGENCY

Regional Water Management Plan

Johnson Valley/Morongo Basin Area

May 1993
MOJAVE WATER AGENCY

JOHNSON VALLEY / MORONGO BASIN

REGIONAL WATER MANAGEMENT PLAN

- Technical Memorandums
- Alternative Management Strategies
- Regional Water Management Plan

Robert J. Ohlund, PE

May 1993
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INTRODUCTION

AUTHORIZATION

Boyle Engineering Corporation (Boyle) was retained by Mojave Water Agency (MWA) on November 12, 1991 to provide Engineering Services to prepare a Regional Water Management Plan for the study area shown on Figure 1. This study is to include a technical evaluation of the physical and economic characteristics associated with the regional planning of water resources available to the study area.

This study area consists of that portion of MWA that generally drains easterly to the Colorado River and includes the Morongo Basin and Johnson Valley tributary areas. In a parallel assignment, MWA has retained Bookman-Edmonston Engineering, Inc. (Bookman-Edmonston) to prepare the plan for that portion of the Agency which flows to the Mojave River.

Boyle’s Scope of Work is to address the unique characteristics associated with the study area. In the parallel assignment, Bookman-Edmonston will be responsible for the assembly of the overall, Agency-wide Plan and will incorporate Boyle’s Regional Water Management Plan for the Johnson Valley and Morongo Basin area. Issues that relate to the general policies and management objectives of MWA are to be addressed by Bookman-Edmonston.

PHASE II “ISSUE IDENTIFICATION” OBJECTIVE

Phase I “Data Review and Assessment” was completed and summarized in Boyle’s March 26, 1992 letter report and April 8, 1992 presentation to the Technical Advisory Committee. It was concluded that although the data base is not complete, it is sufficient to proceed with the Water Management Plan. The objective Phase II “Issue Identification,” presented herein, is to summarize pertinent data and identify issues to be addressed in the Regional Water Management Plan.
PHASE III "ALTERNATIVE MANAGEMENT STRATEGIES"

Presented in Section 9 herein are the Alternative Management Strategies developed based on the issues identified in Phase II. All types of alternative strategies are presented to address the issues, assist the environmental consultant in preparation of environmental documents and to serve as a "menu" for the final plan, where the most effective strategies will be chosen from and expanded for the Plan. An initial prioritization of strategies is presented for discussion purposes.

BACKGROUND

The study area is currently supplied solely by groundwater sources. Residential, commercial, industrial and recreational water demands have created overdraft conditions in the Warren Valley Basin and the Joshua Tree Subbasin of the Copper Mountain groundwater basin, the most densely populated areas. Other groundwater basins are projected to be in an overdraft condition with future growth unless another source of water supply is obtained. An additional source of supply to the study area will be the Morongo Basin Pipeline, to be constructed to deliver State Water Project (SWP) water from the California Aqueduct in 1994. Future growth in the area will require management of current groundwater supplies, water use and planned importation of water from the State Water Project.
MOJAVE WATER AGENCY

Regional Water Management Plan

Johnson Valley / Morongo Basin

TECHNICAL MEMORANDUM

ON

WATER USE ISSUES

May 1993
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</table>
INTRODUCTION

Issues related to the water use within the study area #2 are identified and evaluated in this Technical Memorandum. Major water users and suppliers are described, historical water use data are reviewed, and projections of future water demands are provided.

SUMMARY OF FINDINGS

The following were found to be the major water use issues:

1. **Water use exceeds water supply in some areas.**

   An increasing water demand from continued population growth has been requiring over-drafting of some groundwater basins in recent years.

2. **Water conservation.**

   Reduction in per capita use and unaccounted-for water losses is essential to reduce the groundwater basin overdraft. Water conservation should be considered on an equal basis to other elements of a water management plan.

3. **Data collection of groundwater extractions, population, growth rates, and per capita water use should be expanded.**

   A comprehensive data base is required to better estimate future water use, which, in turn defines the magnitude of the water supplies needed.
4. **Unaccounted-for water appears high in some areas.**

An evaluation of unaccounted-for water should be performed for each water system. Water losses from pipe leaks and other sources appear high from 1991 data and may be higher due to the 1992 earthquake activity in the area.

**MAJOR WATER USERS**

Most of the water used within the study area is for domestic purposes. Some minor commercial and industrial uses include the Institute for Mental Physics (IMP), at approximately 40 acre-feet per year. The only major recreational water use is the Blue Skies Country Club (BSCC) which uses approximately 300 acre-feet per year (AF/year) for its 105-acre golf course. There is not a significant amount of irrigated agriculture within the area.

Listed below are the major water purveyors in the study area. The location of the study area and the water purveyor boundaries are shown on Figure 1.


The HDWD’s sole source of supply is groundwater. Production wells draw water primarily from the Warren Valley Basin and will begin significant production from the Means/Ames Valley Basin with the development of the Mainstream Well. The Warren Valley Basin has been over-drafted for more than 20 years, and groundwater levels have declined 20 to 40 feet per year in some areas.

The rights to groundwater in Warren Valley Basin have been adjudicated. HDWD was appointed Watermaster by the court and has conducted several studies, including a Basin Management Plan (Kennedy/Jenks/Chilton, 1991) and a Supplemental Water Delivery and Management Plan (Egan, 1992). Portions of HDWD have been placed on water connection moratoriums in the past, and the area is currently restricted by court order to a 2 percent annual growth rate due to water shortages. Due to conservation efforts, the HDWD per capita consumption is 120 gpd and is expected to reach 115 gpd.
in the future (John Egan, 1990). This is among the lowest per capita usage in Southern California.

In an effort to supplement its water supply, HDWD drilled the Mainstream Well in the Means/Ames Valley Basin, between the boundaries of HDWD and Bighorn Desert View Water Agency (BDVWA). The development of this well led to litigation which was settled in 1991. By agreement with BDVWA, HDWD is limited to extracting 800 acre-feet per year from the Means/Ames Valley Basin and can deliver this water for use only within that basin. A groundwater monitoring program has been established for the basin.

HDWD reached a temporary 5-year agreement with BDVWA in 1991 providing for the sale of 500 acre-feet per year of "surplus water" from BDVWA for emergency use in HDWD where needed. An intertie was constructed (pumping station and pipeline) between the agencies for delivery of the water.

Joshua Basin Water District (JBWD) serves approximately 3,440 customers in the Joshua Tree Subbasin of the Copper Mountain Valley Basin. Groundwater is the sole supply. A mild overdraft condition is reported for the Copper Mountain Valley Basin (Krieger & Stewart, 1984).

Bighorn Desert View Water Agency (BDVWA) serves approximately 1,500 customers north and east of the Bighorn Mountains. It was formerly the Desert View Water District and Bighorn Mountain Water Agency. The water supply comes from five production wells, all reported to be in the Means/Ames Valley Basin.

San Bernardino County Service Area 70 W-1 serves approximately 715 customers east of Landers. It has three production wells in the Means/Ames Valley Basin.

San Bernardino County Service Area 70 W-4 serves approximately 125 customers at Pioneertown. It has six production wells of which some groundwater levels have been reported as declining.
MORONGBASINPIPELINE

The Morongo Basin Pipeline project will import State Water Project (SWP) water from a turnout near Hesperia to a reservoir south of Landers. Each of the five purveyors listed above is participating in the project. See the Technical Memorandum on Surface Water Issues for further discussion on the imported supply.

WATERCONSUMPTION

Historical Use

Population

Historical population information indicates that the study area has experienced growth rates ranging from approximately 2 percent to 6 percent since 1980. HDWD service area experienced an average growth rate of 5.7 percent from 1980 to 1990 (Egan, 1990). The 1990 census data indicated a population of about 38,000 for the study area, with approximately 60 percent living within the Township of Yucca Valley and approximately 20 percent within the community of Joshua Tree. There is also a large part-time and weekend population throughout the study area that cannot be accurately quantified (Krieger and Stewart, 1984).

Groundwater extractions in the study area were approximately 5,800 AF/year in 1991. Per capita use in the study area ranges from 100-180 gallons per capita per day (gpcpd), but is low by comparison to other Southern California usage. Recent conservation efforts in the area have steadily reduced per capita use in the last four years (Kennedy/Jenks/Chilton, 1991).
Consumptive Use

Consumptive use is the percentage of water produced which is evaporated and transpired and so lost to the area. The difference between consumptive use and water produced returns to the groundwater supply. The source of this return water is leaks, septic systems, irrigated water which percolates to the groundwater basin, etc. Consumptive use is assumed herein as 50 percent of production (DWR, 1981).

Unaccounted-for Water

The difference between production and deliveries to the users is identified as "unaccounted-for water" and is defined as a ratio of the difference to the total production. Unaccounted-for water generally consists of system losses due to meter inaccuracies, leakage, flushing of water mains and other non-metered losses in the system. Values of unaccounted-for water for each of the major purveyors based on 1991 data are presented in Table 1. The amount of unaccounted-for water observed in BDVWA, HDWD and JBWD appear high and should be investigated and reduced if the source is in fact a "loss" from the system. Due to the seismic activity experienced in 1992, evaluation of unaccounted-for water should be performed for all systems. This evaluation will help eliminate losses, reduce pumping costs, and provide better records for managing the water supply.

Growth Rate

The growth rate, presented as percent per year, is based upon existing reports, conversations with each agency, and engineering judgment. For the 1990 census, population data were not segregated by purveyor agency boundary. None of the current reports for the study area have utilized the available 1990 census data. A 3.25% overall growth rate was previously developed by Southern California Association of Governments (SCAG) for the desert area population centers based upon 1980 census data. Because the level of detail that SCAG presents focuses on the population centers of Yucca Valley and Joshua Tree, projected growth was discussed with each agency to determine applicable growth rates representing the unique characteristics of each
community within the study area. Table 2 identifies the growth rates assumed for each agency discussed in the following:

**HDWD** - HDWD's Water Supply Master Plan (Egan, 1990) assumed 3.25 percent as the overall growth rate for long-term planning purposes. This rate matches the SCAG long-term projection for the area. The HDWD area is expected to experience the largest growth rate within the study area. However, until additional supply is provided, the township of Yucca Valley is currently under a 2 percent annual growth cap within the Warren Valley Basin. Because HDWD has been successfully increasing supply to the area, this growth cap is assumed to have a negligible affect on this study for long term demand projections.

**TABLE 1**

**UNACCOUNTED-FOR WATER IN 1991**

<table>
<thead>
<tr>
<th>Purveyor</th>
<th>Acre-Feet</th>
<th>Percentage of Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>BDVWA</td>
<td>79</td>
<td>15.6</td>
</tr>
<tr>
<td>CSA W-1</td>
<td>1</td>
<td>0.4</td>
</tr>
<tr>
<td>CSA W-4</td>
<td>3</td>
<td>10.3</td>
</tr>
<tr>
<td>HDWD</td>
<td>624</td>
<td>17.2</td>
</tr>
<tr>
<td>JBWD</td>
<td>315</td>
<td>19.5</td>
</tr>
<tr>
<td>Totals</td>
<td>1,023</td>
<td>17.0</td>
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</table>

Source: Production and water sales records from each Agency.

Technical Memorandum -6- Water Use Issues
### TABLE 2
GROWTH RATE

<table>
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<tr>
<th>Purveyor</th>
<th>Projected Annual Growth Rate</th>
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<tr>
<td>HDWD</td>
<td>3.25%</td>
</tr>
<tr>
<td>JBWD</td>
<td>3.00%</td>
</tr>
<tr>
<td>BDVWA</td>
<td>2.25%</td>
</tr>
<tr>
<td>CSA W-1</td>
<td>3.00%</td>
</tr>
<tr>
<td>CSA W-4</td>
<td>3.00%</td>
</tr>
</tbody>
</table>

**BDVWA** - A 2.25 percent growth rate is estimated for long-term average growth of the BDVWA. The BDVWA rate of growth is considered to be linked to the growth in the Yucca Valley/Joshua Tree area, however at a lower rate. BDVWA is seen as a "bedroom community" to the Township of Yucca Valley. From discussions with BDVWA staff and SCAG projections, the growth rate for BDVWA was assumed at 1 percent below the HDWD growth rate.

**JBWD** - The long-term growth for the JBWD is anticipated to be equal to the SCAG projection of 3.25, representing growth in the community of Joshua Tree.

**CSA W-1** - A 3 percent growth rate is anticipated in the Landers area. This growth rate is considered to be closely linked to growth in the Yucca Valley/Joshua Tree area.

**CSA W-4** - A long-term growth rate of 2 percent is anticipated for the Pioneertown region. This growth rate considers both location and increased conservation efforts expected in the area.
WATER PRODUCTION

Historical Production

Historical well production records by owner for each groundwater basin are summarized in Table 3.

Although the data in Table 3 represents all wells in the study area reported to the State Water Resources Control Board (SWRCB), Division of Water Rights (wells pumping more than 25 acre-feet per year), there is little or no data for Johnson Valley Basin. Additional well information currently being gathered by the Agency for development of the Ordinance No. 8 Well Data Base will provide a better basis for future evaluation.
# TABLE 3

## HISTORICAL WELL EXTRACTIONS BY GROUNDWATER BASIN

<table>
<thead>
<tr>
<th>Basin or Subbasin</th>
<th>Well</th>
<th>Extractions (AF)</th>
<th>81</th>
<th>82</th>
<th>83</th>
<th>84</th>
<th>85</th>
<th>86</th>
<th>87</th>
<th>88</th>
<th>89</th>
<th>90</th>
<th>91</th>
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<tbody>
<tr>
<td>Means/Ames Valley Basin</td>
<td>2N 5E 27</td>
<td><strong>BDVWA (DV#2)</strong></td>
<td>111</td>
<td>86</td>
<td>105</td>
<td>110</td>
<td>134</td>
<td>255</td>
<td>11</td>
<td>33</td>
<td>91</td>
<td>86</td>
<td>66</td>
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<tr>
<td>Means/Ames Valley Basin</td>
<td>2N 5E 27</td>
<td><strong>BDVWA (DV#3)</strong></td>
<td>95</td>
<td>116</td>
<td>67</td>
<td>104</td>
<td>107</td>
<td>90</td>
<td>107</td>
<td>123</td>
<td>98</td>
<td>71</td>
<td>93</td>
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<td><strong>BDVWA (DV#4)</strong></td>
<td>149</td>
<td>126</td>
<td>159</td>
<td>142</td>
<td>105</td>
<td>135</td>
<td>207</td>
<td>163</td>
<td>161</td>
<td>121</td>
<td>88</td>
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<tr>
<td>Means/Ames Valley Basin</td>
<td>2N 5E 1</td>
<td>H GUBLER FARM</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
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<tr>
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<td>*</td>
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<tr>
<td>Means/Ames Valley Basin</td>
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<td><strong>PATTY KARAWCZK</strong></td>
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<td>*</td>
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<td><strong>R00 GLENN EVERETT MILLER</strong></td>
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<td>G STEVE KWAKE</td>
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<td>107</td>
<td>113</td>
<td>77</td>
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<td><strong>BDVWA (BH#3)</strong></td>
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<td>111</td>
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<td>125</td>
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<tr>
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<td><strong>B COUNTY SERVICE 70 W-1 (#3)</strong></td>
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<td>101</td>
<td>75</td>
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<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
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<td>A HI DESERT WATER DIST. (#10)</td>
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<td>53</td>
<td>64</td>
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<td>4</td>
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</tr>
<tr>
<td><strong>Total</strong></td>
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## Copper Mountain Valley Basin

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## Johnson Valley Basin

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<td>*     *     *     40  40  40  40  40  40  40</td>
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**SOURCE:** SWRCB Division of Water Rights

* = DATA NOT AVAILABLE

--- = WELL NOT IN SERVICE
Projected Production

Projected water production is based upon current groundwater extractions, increased at the growth rates discussed in the previous sections, in five-year intervals from 1995 through 2015. Projected water use is presented in Table 4.
## TABLE 4
PROJECTED WATER USE, POPULATION

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(1) Means/Ames Valley Basin 1991 extractions and assumed growth rates:
- 438 AF (BDWVA) @ 2.25%
- 208 AF (CSA 70 W-1) @ 3.00%
- 24 AF (HDWD) @ 3.25%
- 24 AF (CSA 70 W-4) @ 2.00%
- 694 AF @ 2.50%

(2) The consumptive use in Means/Ames Valley Basin for 1991 is negligible, if not a surplus, due to return flows of water produced in Warren Valley Basin and applied over the Means/Ames Valley Basin. Warren Valley Basin's consumptive use is in excess of 50 percent due to the "export" of this flow applied over Means/Ames Valley Basin. It is assumed that 800 AF/year produced from Warren Valley Basin will have a consumptive use component of 100 percent due to its use outside of the basin (800 AF/year based on the "Ames Valley Basin Agreement").

(3) Although there was no reported production in the Johnson Valley Basin in 1991, some use is known to exist, however, it is considered negligible for this study. Scattered population exists within Johnson Valley which has not been quantified.

(4) Accounts for the 500 AF/year emergency drought supply from BDWVA to HDWD and the start-up of the Mainstream Well in Means/Ames Basin which will reduce production in Warren Valley Basin by 800 AF/year and increase production in Means/Ames Valley Basin by the same amount.
REFERENCES


MOJAVE WATER AGENCY

Regional Water Management Plan

Johnson Valley / Morongo Basin

TECHNICAL MEMORANDUM

ON

GROUNDWATER ISSUES

May 1993
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TECHNICAL MEMORANDUM

GROUNDWATER ISSUES

INTRODUCTION

The purpose of this Technical Memorandum is to identify and describe the groundwater issues which should be addressed in developing the Regional Water Management Plan.

Groundwater is currently the sole source of water supply for the study area. The groundwater basins provide important storage of local runoff and potential imported water. In addition to basin overdraft and localized water quality problems, the major groundwater issues relate to the conjunctive use of basin storage in conjunction with imported State Water Project (SWP) water.

SUMMARY OF FINDINGS

The following were found to be the major groundwater issues:

1. Developed groundwater basins.

Warren Valley and Copper Mountain Valley Basins have been in overdraft and have experienced a loss in storage. Warren Valley Basin has experienced the major use, with an estimated loss in storage of approximately 30,000 AF (Fox, Egan 1991). Copper Mountain Valley Basin has reported mild overdraft and declines in groundwater levels. Means/Ames Valley Basin is also estimated to be in overdraft due to the recent water transfer and pumping agreement between Bighorn Desert View Water Agency (BDVWA) and Hi-Desert Water District (HDWD), with overdraft continuing as water demands increase.
2. **Undeveloped Basins.**

Johnson Valley Basin; Giant Rock and Coyote Lake Subbasins of Copper Mountain Valley Basin are relatively untapped and are not significantly developed for domestic use. Planning of future land development in these basins has not been filed with the County of San Bernardino at this time, however the estimated safe yield of these basins could support development, with water treatment necessary in some areas. Groundwater transfers from these basins are also a possibility.

3. **Groundwater quality.**

Groundwater quality problems are mostly from natural causes in localized areas of the developed groundwater basins. Johnson Valley Basin is relatively untapped due to poor water quality (chlorides, sulfate and fluoride). A San Bernardino County sanitary landfill near Landers has reported some localized contamination to the Means/Ames Valley groundwater basin which is being monitored.

4. **Increase natural recharge.**

Streambed modifications and detention basins could be constructed along the larger washes leading to the valley basins, such as Yucca Creek, Quail and Pipes Washes, to increase natural recharge by reducing losses to evaporation. In addition to average runoff, occasional large storm runoff which washes all the way to the dry lakes where it eventually evaporates, could be captured upstream.

5. **Availability of SWP water/Conjunctive use programs.**

Due to the interruptible nature of the SWP supply and uncertainty of surplus water availability, the Plan must be flexible to anticipate the available SWP water to make the most productive use of this source of supply with banking in the groundwater basins.
6. **Artificial recharge projects for use of imported water.**

Several sites in Warren Valley Basin have been identified for artificial recharge. Locations for sites within Copper Mountain Valley Basin (Joshua Tree Subbasin) and Means/Ames Valley Basin should be investigated.

7. **Supplemental extraction wells.**

Additional extraction wells may be needed to be capable of extracting the water banked in the groundwater basins. These would be determined, if necessary, after final selection of recharge sites.

8. **Conjunctive use.**

The groundwater basins are a great asset to maximize the utilization of a conjunctive use program with the importation of SWP water. Economic incentives may be required to encourage groundwater users to pay for imported water which is more expensive than groundwater pumping. Basins could be used to store, or "Bank" surplus SWP water when available for use during future cutbacks or to minimize the cost of imported water.

9. **Groundwater interbasin transfers.**

Transfer of groundwater from basins with less than safe yield production to areas in need of supply warrants study. Any physical, environmental, or economical damage to basins giving up the water should be avoided to make such a program productive. Although treatment of groundwater from some basins (i.e., Johnson Valley) may be required, the associated cost may be economical in comparison to the cost of supplying and treating imported water. Currently, BDVWA is transferring approximately 500 AF/year from the Means/Ames Valley Basin to HDWD for use in the Warren Valley Basin as a 5-year drought relief program.
10. **Groundwater Basin Study.**

To maximize the management of the local groundwater supply, a groundwater study is needed to provide comprehensive estimates of the groundwater basin characteristics such as estimated recharge, inflow, outflow, storage capacity and available water in storage.

**DESCRIPTION OF BASINS**

The groundwater basins in the study area are water-bearing formations of unconsolidated sedimentary rock. Many of them are bounded or traversed by faults. Depths of the basins are generally unknown because of the lack of wells reaching bedrock. Test holes near the communities of Yucca Valley and Joshua Tree are over 750-feet deep without reaching bedrock (USGS, Lewis, 1972). Near Twentynine Palms, east of the study area, water-bearing deposits are believed to exceed 1,000 feet in thickness (USGS, Dibblee, 1968). In this area, an exploratory well hit granite at 2,106 feet (USGS, Smith, 1959).

Several dry lakes exist, mostly in the north, and overlie unconsolidated deposits. Although these areas have high groundwater levels, they are not important water sources because they are fine-grained, yield water slowly to wells, and water is typically poor in quality.

Over the years, the groundwater basins in the study area have been defined in various configurations, sometimes completely independent of one another. Although references to the basins in these various reports are sometimes conflicting, each study has evaluated the same water bearing geologic formations. Unfortunately, a comprehensive presentation of the groundwater basins' characteristics has not been provided in any one report.

However, good data is available in the existing reports which we feel is sufficient to proceed with the Regional Water Management Plan to begin managing the water resources in the study area. As an example of the differing groundwater basin configurations, DWR Bulletin No. 118 (1975) and USGS (Lewis 1972) present conflicting delineations of the basins. DWR (1975) identifies natural recharge and other basin characteristics for the Ames Valley, Copper Mountain Valley, Means Valley, Warren Valley and Johnson Valley Basins. However, USGS (Lewis, 1972) excludes identification and delineation of the Ames Valley Basin and does not
contain comprehensive estimates of storage capacity, natural recharge and safe yield for all the basins. USGS' (1972) delineation of the groundwater basins is based on a report prepared by California Department of Public Works, Division of Water Resources, 1952.

Figure 1 illustrates the basin boundaries as presented by USGS (Lewis, 1972) and the Ames Valley Basin Water Agreement (1991) between BDVWA and HDWD. The Ames Valley Basin Agreement established a legal boundary for the Ames Valley Basin to monitor wells in the area to observe the impact of HDWD's pumping of the Mainstream Well.

DWR Bulletin No. 118 delineation of the basins' boundaries is not clear due to the extremely large scale of the basin map (1" = 30 miles). However, Figure 2 is an approximation of DWR Bulletin No. 118's groundwater basin configuration which appears to have roots back to reports prepared by DWR in the 1950's. Also noted is that subsequent DWR studies have been based on the groundwater basin configuration used by USGS (1972). A groundwater study should be performed to present comprehensive estimates of the groundwater basins characteristics such as natural recharge, inflow, outflow, storage capacity and available water in storage. Better definition of these estimates will maximize the management of the groundwater resources.

The Regional Water Management Plan is not a groundwater study. Data and assumptions are derived from existing reports as the basis of developing strategies to manage the water resources available to the study area. One strategy to be recommended is the preparation of a groundwater study for future refinement of managing the local supply. To proceed with the Regional Water Management Plan, we have reviewed the available reports and have incorporated the following groundwater basin characteristics and assumptions.

**Means/Ames Valley Basin**

The Means/Ames Valley Basin is generally recharged by precipitation in the Emerson Hydrologic Unit, tributary to the Pipes Wash. USGS (Lewis, 1972) defines the Means Valley Basin in an area mostly overlapping the DWR (1975) Ames Valley Basin delineation. The sources of natural recharge and locations where groundwater production currently exists are in an area where the Means and Ames Valley Basins configurations entirely overlap. USGS (1972) estimates the safe yield of the Means Valley Basin to be in the range of 100 AF/year to 1000 AF/year, estimated to be "probably 500 AF/year." DWR (1975) estimates the natural recharge to the Ames Valley Basin to be 700 AF/year. Because the locations of groundwater production occur in
these overlapping areas, an average of USGS' (1972) and DWR's (1975) safe yield estimates equivalent to 600 AF/year will be used for the Regional Plan to represent the source of supply available from the Means/Ames Valley Basin. It should be noted that although USGS (1972) does not identify the Ames Valley Basin by name, it does include evaluation of the same water bearing geologic formations as presented by DWR (1975). For example, there is not an additional 700 AF/year source of supply overlooked by USGS (1972).

It is recommended that management strategies affecting this basin be executed in coordination with a monitoring program to evaluate the effect on the groundwater basins as implemented by BDVWA and HDWD on behalf of production from the Mainstream Well. Future evaluation of the basin using data received from a controlled monitoring program will help better define the basin characteristics and water balance to maximize the management of the groundwater supply.

BDVWA, County Service Area (CSA) 70 W-1 and W-4 are the major purveyors pumping from the basin. BDVWA primarily pumps from the Reche Subbasin, CSA 70 W-1 from both Reche and Giant Rock Subbasins and CSA 70 W-4 from the Pioneertown Subbasin.

The BDVWA/HDWD Mainstream Well Agreement allows HDWD to extract 800 AF/year of groundwater to be used within the basin by HDWD. This 800 AF/year can increase by 0.5 AF/year for each additional new HDWD connection made within the basin. In addition, BDVWA entered into an agreement with HDWD in July 1991 to supply HDWD with 500 AF/year for five years as an emergency drought supply contract. This 500 AF/year is used in HDWD overlying the Warren Valley Basin and would relate to a consumptive use of 100 percent for the Means/Ames Valley Basin.

The following summarizes current extractions from the Means/Ames Valley Basin which will result in overdraft conditions:
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1992 Extractions/Applied</td>
<td>711</td>
</tr>
<tr>
<td>Mainstream Well Agreement</td>
<td>AF/year</td>
</tr>
<tr>
<td>Total Extractions</td>
<td>1511 AF/year</td>
</tr>
<tr>
<td>Consumptive Use (50%)</td>
<td>756 AF/year</td>
</tr>
<tr>
<td>Safe Yield</td>
<td>600</td>
</tr>
<tr>
<td>Current Overdraft</td>
<td>156</td>
</tr>
<tr>
<td>BDVWA/HDWD Transfer</td>
<td>500</td>
</tr>
<tr>
<td>5 Year Overdraft (1992-1996)</td>
<td>656</td>
</tr>
<tr>
<td></td>
<td>AF/year (+ growth)</td>
</tr>
</tbody>
</table>

**Warren Valley Basin**

The Warren Valley Basin is an adjudicated groundwater basin providing water supply to the Township of Yucca Valley, the largest concentrated population center in the study area. Natural recharge to the basin is generally from precipitation in the Warren sub-unit of the Joshua Tree Hydrologic Unit, which includes a portion of the Little San Bernardino Mountains. Many reports have been prepared which estimate the safe or perennial yield of the Warren Valley Basin, with estimates ranging from 200 AF/year (USGS, 1972) to 1800 AF/year (Fox, Egan 1991). For water resource management and preparation of the Regional Water Management Plan, the Adjudication pumping limitation of 900 AF/year should be use for planning purposes. This appears to be a reasonable estimate of allowable extractions to manage the groundwater levels. Once production is reduced to a maximum extraction of 900 AF/year, levels should be monitored to confirm or revise the estimated 900 AF/year yield.

The Warren Valley basin has been overdrafted for some time, depleting storage by approximately 30,000 AF (Fox, Egan 1991) since about 1960. HDWD has acquired a 5 year, 500 AF/year drought supply from BDVWA which will reduce the extractions from Warren Valley Basin by 500 AF/year for five years through 1996. HDWD has also developed the Mainstream Well in the Means/Ames Valley Basin to supply 800 AF/year to an area over the Means/Ames Valley Basin which was previously supplied by wells in the Warren Valley Basin. This will reduce the extractions another 800 AF/year.
Copper Mountain Valley Basin

The Copper Mountain Valley Basin consists of the Joshua Tree, Coyote Lake and Giant Rock Subbasins. Joshua Tree Subbasin is the source of supply to the community of Joshua Tree. Joshua Basin Water District (JBWD) operates production wells within the Joshua Tree Subbasin, located in the southerly portion of the groundwater basin separated from the Coyote Lake Subbasin in the north by the Pinto Mountain Fault. Recharge to the basin is primarily from precipitation in the Copper Mountain Sub-unit of the Joshua Tree Hydrologic Unit which includes a portion of the Little San Bernardino Mountains. Inflow from the Means/Ames Valley Basin may occur and outflow to the east from the Joshua Tree Sub-basin in the direction of Twentynine Palms has been speculated (USGS, 1972).

Safe yield of the Joshua Tree Subbasin is estimated to be 500 AF/year and 50 AF/year for Coyote Lake Subbasin, identified as conservative estimates for planning purposes (Krieger & Stewart). We feel these estimates are adequate for use in the Regional Water Management Plan for managing the water resources. DWR (1975) estimates the total recharge to the Copper Mountain Valley Basin to be 1100 AF/year. The groundwater study recommended in the previous sections should evaluate the possibility of additional supply in the Coyote Lake and Giant Rock Subbasins to determine if the difference of these two recharge estimates does exist. This would require evaluation of natural recharge, inflow and outflow from Means/Ames Valley Basin as well as the Joshua Tree Subbasin. Additional development of wells north of the Pinto Mountain Fault could be investigated for additional supply as groundwater levels have remained relatively constant in the Coyote Lake Subbasin, as reported to USGS for three wells 1N/7E-7P, 22L, and 23A.

Johnson Valley Basin

Johnson Valley Basin is relatively undeveloped due primarily to poor water quality. Although groundwater extractions have not been reported to the State Water Resources Control Board (SWRCB), it is known that some use does exist. This use is assumed to be negligible for development of the Regional Water Management Plan. Recharge to the basin occurs from precipitation in the Johnson Hydrologic Unit including a portion of the San Bernardino and Bighorn Mountains. Groundwater quality is generally poor, somewhat high in chlorides, sulfates and/or fluorides. Water storage within 400 feet of...
land surface is about 250,000 AF, with only 125,000 AF considered available for withdrawal (USGS, 1978). Estimated safe yield is 2300 AF/year (USGS, 1972; DWR, 1975).

State or federally-owned land mostly overlies the Johnson Valley Basin, although a significant amount of privately-owned land does exist. Although future planning of land development has not been filed with the County of San Bernardino, Johnson Valley Basin is a source of water supply for existing and future land development over the basin, although treatment is probably required for domestic uses. Interbasin transfers to the Morongo Basin, Lucerne Valley and/or Mojave River Basin may also utilize this source of supply. The Morongo Basin Pipeline will traverse this basin, offering a possible means to transport groundwater to the areas needing additional supply.

SAFE/PERRNIAL YIELD

Several definitions of "safe yield" are used, often depending on the method of computation. Among the generally accepted definitions are:

1. The yield equal to the long-term average annual aquifer recharge not limited by water quality. This definition will be used for development of the Plan.

2. The yield equal to the minimum annual recharge.

3. In recent years, the term "perennial yield" has come into common use. It can be defined as the rate at which water can be withdrawn perennially under specific physical conditions (land use, import and export of water and wastewater, well pumping and recharge patterns, and amounts of usable storage available, etc.) without producing an undesirable result such as land subsidence, degradation of water quality, uneconomical pumping lifts, etc.
Table 1 summarizes the basins’ characteristics. Because the groundwater boundaries of these basins are not coincident with the water purveyor’s service areas, coordination of the groundwater use between purveyors is necessary to efficiently manage the basins to maintain a dependable source of supply. Table 2 identifies the projected consumptive use through the year 2015 and associated overdraft for the developed basins: Means/Ames Valley, Copper Mountain Valley and Warren Valley Basins. Johnson Valley Basin, with an estimated safe yield of 2300 AF/year, does not have any significant planning for development filed with the County of San Bernardino.

### TABLE 1

**DESCRIPTION OF GROUNDWATER BASINS**

<table>
<thead>
<tr>
<th>Basin</th>
<th>Depth Zone (Feet)</th>
<th>Area Sq. Mi.</th>
<th>Storage (AF)</th>
<th>Safe Yield (AF/Year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Means/Ames</td>
<td>20-220</td>
<td>150</td>
<td>1,200,000</td>
<td>600</td>
</tr>
<tr>
<td>Copper Mountain</td>
<td>20-220</td>
<td>110</td>
<td>830,000</td>
<td>550 (3)</td>
</tr>
<tr>
<td>Johnson Valley</td>
<td>20-300</td>
<td>150</td>
<td>1,300,000</td>
<td>2,300 (4)</td>
</tr>
<tr>
<td>Warren Valley</td>
<td>20-220</td>
<td>20</td>
<td>180,000</td>
<td>900 (5)</td>
</tr>
</tbody>
</table>

(1) Total water storage capacity estimates are presented.
(2) Safe yield is assumed to be equal to the estimated natural recharge. Subsurface inflow and outflow is unknown and is not included. Safe yield may be limited for domestic purposes due to poor water quality in some areas.
(3) Krieger & Stewart, 1984
(4) Lewis, 1972; DWR, 1975
(5) Adjudication pumping limitation
TABLE 2
PROJECTED CONSUMPTIVE USE AND OVERDRAFT
OF DEVELOPED BASINS (1)
(ACRE-FEET)

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Means/Ames Valley</td>
<td>600</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-Consumptive Use (50%)</td>
<td>-</td>
<td>1,330</td>
<td></td>
<td>940</td>
<td>1,060</td>
<td>1,200</td>
<td>1,350</td>
</tr>
<tr>
<td>-Surplus (overdraft)</td>
<td>-</td>
<td>(730)</td>
<td>(340)</td>
<td>(460)</td>
<td>(600)</td>
<td>(750)</td>
<td></td>
</tr>
<tr>
<td>Copper Mtn. Valley</td>
<td>550</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Joshua Tree Subbasin</td>
<td>500</td>
<td>750</td>
<td>860</td>
<td>1,010</td>
<td>1,180</td>
<td>1,390</td>
<td>1,630</td>
</tr>
<tr>
<td>-Consumptive Use (50%)</td>
<td>(250)</td>
<td>(250)</td>
<td>(360)</td>
<td>(510)</td>
<td>(680)</td>
<td>(890)</td>
<td>(1,130)</td>
</tr>
<tr>
<td>-Surplus (overdraft)</td>
<td>(250)</td>
<td>(250)</td>
<td>(360)</td>
<td>(510)</td>
<td>(680)</td>
<td>(890)</td>
<td>(1,130)</td>
</tr>
<tr>
<td>Warren Valley Basin</td>
<td>900</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-Consumptive Use (50%)</td>
<td>2,190</td>
<td>1,080</td>
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<td>1,860</td>
<td>2,180</td>
<td>2,550</td>
<td>3,000</td>
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<tr>
<td>-Surplus (overdraft)</td>
<td>(1,290)</td>
<td>(1,290)</td>
<td>(180)</td>
<td>(960)</td>
<td>(1,280)</td>
<td>(1,650)</td>
<td>(2,100)</td>
</tr>
<tr>
<td>TOTAL</td>
<td>2,000 (2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-Consumptive Use</td>
<td>2,940</td>
<td>3,270</td>
<td>3,810</td>
<td>4,420</td>
<td>5,140</td>
<td>5,980</td>
<td></td>
</tr>
<tr>
<td>-Surplus (overdraft)</td>
<td>(1,540)</td>
<td>(1,270)</td>
<td>(1,810)</td>
<td>(2,420)</td>
<td>(3,140)</td>
<td>(3,980)</td>
<td></td>
</tr>
</tbody>
</table>

(1) Projections are made assuming no action is taken to increase supply or reduce demands. The projections presented here include agreements and transfers of water between BDWQA and HDWD.

(2) Production in the Copper Mountain Valley Basin currently consists of extractions from the Joshua Tree Subbasin with an estimated safe yield of 900 AF/year. The overdraft figures estimated here assume all production is from the Joshua Tree Subbasin. This overdraft may be reduced by development of production in other parts of the basin.

WATER QUALITY

The groundwater quality of existing production wells throughout the study area is generally suitable for existing beneficial uses, mostly residential with some commercial, including golf course irrigation. There are localized areas where salinity or individual constituents exceed recommended limits.
Fluoride exceeds the recommended limit of 1.4 mg/l in some wells in Means/Ames Valley, Copper Mountain, Warren Valley and Johnson Valley Basins. The upper limit of 500 mg/l for total dissolved solids (TDS) and 250 mg/l for chloride and sulfate are exceeded in some wells in Johnson Valley, Means/Ames and Copper Mountain Basins (1992 records of USGS and DWR).

Sources of Groundwater Quality Degradation

Landfills

The only active sanitary landfill on file with the State Regional Water Quality Control Board in the study area is at Landers. Another landfill in Morongo Valley is outside the study area and MWA. The landfill at Landers is owned and operated by San Bernardino County.

SRWQCB has determined that several volatile organics being released from the landfill are having an adverse impact on the groundwater quality, and has issued an abatement order to the County to remedy the problem. The County is currently attempting to determine the extent of the pollution (Sarabi, SRWQCB, 1992).

Underground Storage Tanks

San Bernardino County Department of Environmental Health Services and the Regional Water Quality Control Board have data on existing underground storage tanks and coordinated responsibilities in sealing leaky tanks. While leaks have occurred from tanks in the study area, these two agencies have no record of groundwater contamination (Richards and MacGregor, County and Guarino, Regional Board, 1992).

Septic Tanks/Cesspools

The communities and isolated houses in the study area use septic tanks/cesspools for sewage treatment and disposal. There has been no noticeable elevation of nitrates in the groundwater as a result of this practice (Springer, Regional Board and Stone, State Department of Health Services). However, as development and associated sewage disposal increases,
groundwater quality should be monitored to quickly determine if an adverse impact is created.

GROUNDWATER MANAGEMENT ISSUES

Conjunctive Use

In the study area, conjunctive use refers to the coordinated use of local and imported water. Groundwater basins can be artificially recharged with imported water to hydrologically balance extractions, therefore avoiding overdraft conditions. The percolation of the imported water through the soil acts as the natural "treatment" process. Imported water can be treated and served to the system directly to decrease overdrafting of a groundwater basin. Conjunctive use can also provide banking of imported water so that it can be subsequently withdrawn from storage for use when imported supplies are curtailed.

Conjunctive Use With Local Supplies

Prerequisites to conjunctive use with local supplies are:

1. Ability to increase percolation of intermittent stream flow by streambed modifications and/or retention in recharge areas. Recharge facilities could be in or adjacent to the streambed. Types of projects which should be considered are listed in subsequent sections. Conveyance and recharge facilities are necessary.

2. Direct delivery of imported water to curtail groundwater pumping.

3. Availability of suitable wells to withdraw the percolated water when needed and to avoid evaporative losses from raised groundwater levels.

Issues regarding the capture and recharge of storm runoff and reclaimed wastewater are discussed more fully in the "Surface Water Issues" Technical Memorandum.
Conjunctive Use With Imported Supplies

Issues

Issues regarding implementing conjunctive use with imported supplies are:

1. Availability of MWA’s SWP entitlement.
2. Surplus water availability to MWA under SWP contract.
3. Capacity availability in the California Aqueduct at the same time excess water is in the Delta.
4. Available storage space in groundwater basins, suitable infiltration and transmission rates, and good quality water.
5. Wells of adequate capacity to withdraw stored SWP water when needed.
6. Locations and sizing of transmission and recharge facilities.
7. Demand for direct deliveries of imported water if recharge is not employed.

With the Morongo Basin Pipeline under design, some of these issues appear to be resolved from the local purveyors’ perspective. Availability of surplus SWP water at the East Branch MWA turnout to the Morongo Basin Pipeline can be determined by operational studies of DWR.

Methods

There are three methods for replenishing the groundwater:
1. **Direct Method**

This consists of increasing storage in groundwater basins by using imported water for artificial recharge of the basins. The recharged water would be pumped out by existing wells when demands exceed the safe yield of the basin or surface deliveries of imported water are curtailed because of inadequate supplies (drought or lack of facilities). This method requires construction and operation of recharge projects if not already available. The recharge-extraction sequence permits natural filtration of the recharge water to the groundwater basin. It also utilizes storage and flow in the groundwater basin rather than constructing surface storage and distribution facilities.

2. **Indirect Method**

In this method, storage is allowed to naturally increase in groundwater basins by delivering imported water directly to the users and curtailing pumping ground water by an equivalent amount. This method defers energy costs because of curtailed groundwater pumping and does not have the environmental impact of a recharge project. However, it requires treatment of the imported water to sufficiently meet the intended uses and some expansion to the existing distribution system. Furthermore, any idle wells not used for meeting hourly or seasonal peak demands must be kept operational so they will function when needed during shortages of imported supplies. Natural replenishment of some groundwater basins will take an extended amount of time due to extensive overdrafting and low natural recharge. The interruptible nature of the SWP must be considered for treatment and direct use. If SWP allocation is only available 50 percent of the time, for example, financing, sizing and operation of the treatment facility must be considered during planning and design.
3. **Combination of Direct and Indirect Methods**

The more probable method is a combination of the direct and indirect methods. Imported water can be directly recharged less expensively in the beginning. Later, as demands rise, treatment of SWP may become more feasible, utilizing both methods to meet demands.

**Department of Water Resources vs. Local Program**

There are two major types of conjunctive use programs available to SWP water service contractors: state or local. Because of the need to increase the firm yield of the SWP, DWR is considering several "state" conjunctive use programs. Currently, a program called the Kern Water Bank is being implemented within the Kern County Water Agency, a SWP contractor. In a DWR program, project facilities are financed by the State who has title to the stored water. The amount put in storage is independent of the contractors entitlements. The additional supply is added to the firm yield of the SWP. In case of shortage on the SWP surface water system, DWR can release the stored groundwater to the cooperating SWP contractor, or other contractors.

In contrast, a local program is financed, owned and operated by the SWP contractor or designated agencies. The amount of water stored underground may be part of the contractor's SWP water entitlement or SWP surplus water. The Metropolitan Water District of Southern California (Metropolitan) has several programs underway with the goals of either providing carry-over storage for use in droughts or reducing seasonal peaking on its surface facilities.

**Recharge Sites**

As stated, when the direct method of recharge for conjunctive use programs is used, recharge sites must be selected and suitable facilities constructed unless already available. Sites should have hydrogeologic
characteristics which will permit percolation of required amounts of water into underground storage, such as:

1. Suitable infiltration rates.

2. Suitable hydraulic conductivity so water can move from the land surface to groundwater.

3. No impermeable formations which would impede flow and cause mounding under the recharge area.

4. Good quality groundwater.

5. Distance from basin boundaries to reduce loss by subsurface outflow.

6. Proximity to imported supply pipeline and extraction wells.

Several recharge and stormwater retention sites have been suggested in Warren Valley Basin as shown on Figure 3 (Sloan and Fox, 1986, 1987; CM Engineering, 1991; Kennedy/Jenks/Chilton, 1991). Deep test holes were drilled at eight recharge sites in Warren Valley Basin. Of the eight, four were selected as highly suitable (Sloan and Fox, December 1987). These were located as follows:

1. Section 28, along Pioneertown Road.

2. East of Palm Avenue between Little League Drive and Yucca Channel.

3. East of Old Woman Springs Road and north of Yucca Channel.
MOJAVE WATER AGENCY
REGIONAL WATER MANAGEMENT PLAN

FIGURE 3
LOCATION OF POTENTIAL RECHARGE SITES
4. West of Bolsa Avenue near Paxton Road.

Locations for eleven recharge sites and nine stormwater retention areas are proposed in the Yucca Valley area (CM Engineering, 1991). These include drainage channels, detention basins, and a golf course. Infiltration rates for detention basins have been estimated to range from 2 to 4 feet per day (CM Engineering, 1991/Fox, 1991).

The types of recharge projects selected should meet the local topographical and hydrogeological requirements. Common types are:

- Streambed modification
- Dikes
- Pits and shafts
- Basins
- Ditches
- Flooding
- Injection wells
- Basins with injection wells

These types of projects could in some cases serve a dual purpose to increase natural recharge as well as serve to recharge SWP water.

With the reduced suspended solids in SWP water, as compared to storm runoff, a wider selection of project types is possible, even recharge wells which have a tendency to plug with silt. However, experience in other areas indicates that basins are the most efficient. Recharge wells should be considered if impermeable strata which would impede downward flow are found at otherwise desirable sites.

In order to make final selections of recharge sites, collection of the following information is recommended:
1. Test well drilling and logging to provide information on:
   a. Subsurface geology, especially presence of impermeable formations
   b. Depths to groundwater.
   c. Quality of groundwater.
   d. Preliminary indications of specific yield, permeability and transmissivity.

   HDWD has collected much of this data for recharge in the Warren Basin.

2. Geophysical surveys to supplement and be correlated with data from test wells.

3. Infiltration tests, using imported water if available. One test program has been developed for Warren Valley Basin (Egan, 1992/Fox, February 24, 1992).

4. Measurement of effects on water levels in nearby wells during infiltration tests to determine possible mounding beneath recharge area and rate of lateral water movement away from area.

5. Tests on compatibility of quality of imported water and native groundwater

Pumping Sites

Many of the active water district wells could be employed in withdrawing stored imported water as part of a conjunctive use program. However, if new wells are required, the following criteria should be considered in locating the new wells:
1. Near recharge area.

2. Where the aquifer is deepest.

3. Away and upgradient from faults.

4. In areas of good quality groundwater.

5. To be dispersed from other wells to avoid pumping interference, lowered groundwater levels, and reduced well capacity.

6. Near the existing conveyance system and points of use to reduce length of connecting pipelines.

In addition, it may be prudent to renovate existing wells and pumps to increase capacities and reduce energy requirements.

**Physical Constraints in Operation of Conjunction Use Program**

When recharging groundwater basins and raising groundwater levels the following conditions should be avoided:

a. Water logging.

b. Inundation of dumps/landfills (if applicable).

c. Rejection of precipitation and runoff percolation.

d. Water losses from outflow and evapotranspiration.

When pumping basins and lowering groundwater levels the following conditions should be avoided:

a. Subsidence.

b. Drying up shallow wells.
c. Lowering water levels on existing wells requiring the lowering of pumps and additional pumping costs.

d. Invasion of poorer quality water.

Impacts to ongoing water resources management activities should be evaluated to avoid conflicts initiated by a conjunctive use program.

Legal and Institutional Constraints

The rights of public agencies to engage in water banking programs were clarified and expanded in the California courts in the 1970’s. In 1975, the State Supreme Court in City of Los Angeles vs. the City of San Fernando, et al and, in 1974, the First Appellate District Court in Niles Sand and Gravel Company, Inc. v. Alameda County Water District, recognized that public agencies have the following rights:

1. Store water in groundwater basins.

2. Protect stored water from expropriation.

3. Recapture the stored water.

These findings are essential to a successful banking program by public agencies who normally own little of the land overlying groundwater basins.

It is important that a conjunctive use project be compatible with local water management programs, primarily use of storage, recharge facilities, and wells. Also, there is a need for mechanisms to encourage groundwater users to switch to the more expensive imported water to reduce overdraft and provide revenues for repayment of SWP costs. Incentives to use imported water include use of pumping assessments and charging lower imported water prices to retail water agencies during off-peak periods.
If the Agency undertakes a conjunctive use program, the Agency should have certain powers to facilitate its implementation. The authority to condemn property for project facilities and levy an ad valorem tax to defray administration costs and pay interest and principal on any outstanding bonds is essential. An assessment on well pumping to pay operating and maintenance costs, purchase of replenishment water and to control extractions may be required. The pumping pattern in the basin can be controlled by varying the amount of the pump assessment.

An example of a legal/institutional constraint in the study area is the pumping limit of 800 acre-feet per year by the Hi-Desert Water District in the Means/Ames Valley Basin. The amount can be increased by one-half acre-foot per year for each new residential water meter installed by the District. All water pumped by the District in the basin must be used in the basin. The controls are set forth in a 1991 agreement between Bighorn-Desert View Water Agency and the Hi-Desert Water District to prohibit exportation of water outside of the Means/Ames Valley Basin.

Monitoring Program

To measure the performance of a conjunctive use project, the existing basic hydrologic data collection would need to be expanded, especially measurements of groundwater levels and quality in some areas. The monitoring program would provide data upon which to base a decision on how much SWP water should be purchased during the ensuing year and whether it should be used directly or recharged to replenish groundwater basins. The monitoring of performance would link the physical results with project costs and could suggest operational changes.

Interbasin Transfers of Groundwater

Although all groundwater basins are within a desert environment with sparse natural replenishment, they vary with respect to amounts of stored water and extractions. The transfer of groundwater from relatively unused, large basins such as Johnson Valley Basin, to overdrafted basins is a management program worthy of consideration,
Basin, to overdrafted basins is a management program worthy of consideration, especially if a pipeline traverses the area.

**Constraints**

There are various factors which should be considered in implementing a basin-to-basin transfer of groundwater. The supply basin giving up the water may experience declining groundwater levels which could dry up wells and increase pumping lifts and costs. Poor quality water may intrude into the pumped basin. Land subsidence could occur in areas with underground clay and silt formations.

**Use of Morongo Basin Pipeline**

With the Morongo Basin Pipeline scheduled for completion in 1994, the engineering and economic feasibility of groundwater transfer from "full" basins to depleted basins along its route has increased. The Morongo Basin Pipeline will commence at the turnout on the East Branch of the SWP near Hesperia and extend east through the desert to a point about midway between Landers and Yucca Valley. It is intended that the Morongo Basin Pipeline will convey SWP water across the Upper Mojave River Valley, Lucerne Valley and Johnson Valley. Water purveyors exist in all of these areas. Groundwater utilization varies among these basins from intense in the Upper Mojave River Valley to sparse in Johnson Valley. The Upper Mojave River Valley Basin is replenished primarily by the Mojave River, and more recently by the SWP water. Water supplies in the Middle and Lower Mojave River Valleys are largely replenished from upstream sources. Any export from the Mojave River Basin is not realistic due to adjudication procedures in process due to overdraft.

Export from Lucerne Valley Basin is unlikely because of overdraft (DWR, 1975) and groundwater quality problems (TDS, nitrate, chloride, sulfate, and fluoride are high for domestic use; DWR, 1975).

Johnson Valley Basin has localized water quality problems but is the closest to the water-short Yucca Valley-Joshua Tree area. Investigation of treatment alternatives for the reported water quality problems may conclude that the cost
of groundwater pumping and treatment is more economical than the purchase and recharging and/or treatment of imported water.

Improvement District "M" of the MWA has been allotted up to 7,257 acre-feet per year (9.9 cubic feet per second flow continuously) of the total SWP entitlement of 50,800 acre-feet per year when available. The Morongo Basin Pipeline is designed for 22 cubic feet per second to provide peak demands. For example, use within the Hi-Desert Water District in May through September is about twice that in November through March (Egan, 1990). Some of the pipeline capacity available during off-peak periods could be used for banking/conjunctive use. Some of this off-peak flow could be groundwater transferred from other basins.
MOJAVE WATER AGENCY

Regional Water Management Plan

Johnson Valley / Morongo Basin

TECHNICAL MEMORANDUM

ON

SURFACE WATER ISSUES

May 1993
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TECHNICAL MEMORANDUM

SURFACE WATER ISSUES

INTRODUCTION

Surface water issues relating to the management of the local and imported supplies within the study area are identified and evaluated in this Technical Memorandum. Local water supplies are provided by storm runoff. Imported water will be supplied as State Water Project (SWP) water through the Morongo Basin Pipeline (MBP).

SUMMARY OF FINDINGS

The following were found to be the major surface water issues:

1. Increase Storm Runoff Capture/Recharge

   The primary local supply of surface water is storm runoff. The potential exists for increasing groundwater recharge through various means of increasing capture of stormwater. The types of recharge projects selected may include streambed modifications, dikes, pits and shafts, basins, ditches, flooding and injection wells. Studies for the Warren Valley Basin indicate that natural recharge could be increased approximately 5 percent with these types of projects.

2. The Drainage Master Plan of the San Bernardino County Department of Transportation/Flood Control should be updated in cooperation with MWA and the local agencies.

   Coordination with the County during preparation of an updated Drainage Master Plan will facilitate achievement of local goals for flood control and potential capture and recharge of storm flows. MWA has begun coordination with the County to achieve these goals.
3. **Wastewater and Graywater Reuse**

Minor local supplies of water may include future wastewater reuse and graywater use.

4. **Utilization of Imported Water Supply**

Upon completion of the MBP, this new source of supply can be used to balance the overdrafted basins and plan for future demands. Various operational modes including all direct use, all recharge of imported water and combinations of each will need to be examined for each basin.

5. **Peak Demands**

Peak water demands above the Morongo Basin Pipeline delivery rates could be met from local groundwater or stored SWP water.

6. **SWP Water Treatment**

If imported water is used to recharge the groundwater basins, no additional treatment is required. However, if it is delivered directly to urban users, surface water treatment complying with Department of Health Services (DHS) permits, including filtration and disinfection, would be required.

7. **Number, size, and location of water treatment facilities.**

Alternatives to treat and convey SWP water from the MBP terminus to each Agency should incorporate a phasing plan to initially convey raw water for recharge and possibly construct a treatment plant(s) later at locations which will facilitate providing both raw water and treated water to each. Planning of treatment plants should include consideration of the interruptible nature of the SWP.

The study area's share of SWP water, an amount up to 7,257 AF/year depending on drought and facilities, could be released into the Mojave River and "banked" for use at a future date. Subsequently, by exchange or pump out, it could be delivered through the Morongo Basin Pipeline to the study area upon the pipeline's completion. This type of use would be performed by MWA and would require coordination with the adjudication of the Mojave River Basin.

9. Banking in basins along the Morongo Basin Pipeline.

During wet periods in northern California, surplus SWP water is available at a cost less than entitlement water. Also, agricultural water may be available for sale by agriculture contractors and transferred to urban areas. Water from these sources could be banked within the study area to reduce overdraft conditions and offset periodic shortages of SWP water. As discussed in No. 8, unused entitlement water or surplus water could be banked in the Mojave River Basin. Other basins along the pipeline alignment such as Lucerne Valley and Johnson Valley, could be used to bank water. Storage capacity and groundwater quality are factors to be considered for each basin.

10. Seasonal Groundwater Storage Programs

Economically attractive seasonal groundwater storage programs could be undertaken by Mojave Water Agency (MWA) to reduce peaking on the Morongo Basin Pipeline. By utilizing SWP surplus water, MWA could sell imported water at reduced prices during off-peak periods to retailers who would bank the water underground for use during on-peak times. Until demands in the study area build up, excess capacity will be available in the MBP to convey large quantities of water.
LOCAL SUPPLIES

Currently, groundwater is the only supply available to the study area. Potential supplies, other than imported water, are storm runoff and reclaimed wastewater.

**Stormwater Capture**

Occasionally, large storm runoff will flow over parts of the basins and collect in dry lake beds where most is lost to evaporation. Stormwater capture and recharge to the groundwater basins can be increased by implementing various types of recharge projects. Factors to consider include the magnitude and frequency of storms, the location of planned drainage or flood control facilities, and sediment loading. Several locations in the Warren Valley Basin for these types of projects are shown on Figure 1. Increasing natural recharge to the Warren Basin is estimated to achieve approximately a 4 percent increase of the estimated safe yield. For the developed basins (Warren Valley, Means/Ames Valley and Copper Mountain Valley Basins) this would relate up to approximately 80 AF/year of increased recharge.

**Precipitation and Streamflow**

Annual precipitation is highly variable within and adjacent to the study area. Average annual precipitation at selected stations is shown in Table 1.
<table>
<thead>
<tr>
<th>Station Location</th>
<th>Precipitation in Inches</th>
<th>Source</th>
</tr>
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<tbody>
<tr>
<td>Yucca Valley</td>
<td>6.75</td>
<td>Lewis, 1972</td>
</tr>
<tr>
<td>Joshua Tree</td>
<td>4.65</td>
<td>Lewis, 1972</td>
</tr>
<tr>
<td>Twenty-nine Palms</td>
<td>3.89</td>
<td>Pirnie, 1988</td>
</tr>
<tr>
<td>Big Bear</td>
<td>38.96</td>
<td>Pirnie, 1988</td>
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<td>Warren Valley Basin</td>
<td>7-8</td>
<td>CM Engineering</td>
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<td>South of Warren Valley</td>
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<td>North of Warren Valley</td>
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<td>Kennedy/Jenks/Chilton, 1991</td>
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Individual storms in the Yucca Valley/Joshua Tree area produce relatively little rainfall, with 55 percent of the annual precipitation falling between November and March. The remaining precipitation falls during a period when average daily maximum temperatures are approximately 94 degrees (Krieger and Stewart, 1984).
Thirty-two years of hydrologic data (from 1957 to 1989) indicate that on the average precipitation exceeds 0.2 inches per day only 10 days a year. Precipitation less than 0.2 inches a day does not produce significant runoff and, therefore, there is little opportunity for capture and recharge (Kennedy/Jenks/Chilton, 1991). Precipitation less than 8 inches per year is not considered to contribute significantly to basin recharge (DWR, 1967).

The major source of recharge to the local groundwater basins originates in the San Bernardino Mountains, as Table 1 illustrates with rainfall in Big Bear averaging nearly 40 inches/year. This water recharges the basins by either subsurface flow or percolation of streamflow reaching the basins over land.

**Existing and Proposed County Master Planning**

San Bernardino County Department of Transportation/Flood Control (formerly Flood Control District) has begun developing a master plan of drainage for Yucca Valley which will replace the master plan produced in the mid 1970's. This process will provide MWA an opportunity to incorporate into the master plan specific project elements for potential basin recharge. MWA has initiated discussing an agreement with the County to perform this type of work.

**Detention Basins**

The primary purpose of detention basins is to catch runoff from a tributary area to reduce flows and flood damage downstream. Working in coordination with the County, existing and future detention basins could be modified from a single-purpose function to provide a means of capturing stormwater for groundwater recharge. Diversions and offstream spreading basins used solely for recharging are not considered cost effective because they would provide little recharge due to infrequent rain (Kennedy/Jenks/Chilton, 1991).

There are two existing detention basins in the Warren Valley Basin (Kennedy/Jenks/Chilton 1991):
<table>
<thead>
<tr>
<th>Location</th>
<th>Storage Capacity, in acre-feet</th>
</tr>
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<tr>
<td>Old Woman Springs Wash (Site 6, Fig. 1)</td>
<td>20</td>
</tr>
<tr>
<td>Long Canyon Wash (Site 7, Fig. 1)</td>
<td>10</td>
</tr>
</tbody>
</table>

These basins could be deepened and the inlets and outlets modified to provide some groundwater recharge capability (CM Engineering 1991) and increase stormwater detention.

The County has stated that the Old Woman Springs Wash detention basin would be "very workable" for incorporating water conservation. The west part of the basin could be easily scarified and utilized as an infiltration area. Additional data are needed on geohydrological conditions underlying the basins.

There are several existing and proposed flood control channels south of the Twentynine Palms Highway as shown on Figure 1: Yucca Channel, Hospital Canyon Channel, Long Canyon Channel, Burnt Mountain Wash, and Covington Channel. Detention basins could be constructed at the channel entrances or at suitable off-channel sites. They would provide for both flood control and groundwater recharge (CM Engineering, 1991, BSI Consultants, 1979).

**Streambed Modification**

Construction of "small temporary sand dams" (less than 5-feet high) to create instream channel storage has been suggested as one method of increasing groundwater recharge (Kennedy/Jenks/Chilton, 1991). Additional site by site assessment should be undertaken to determine the compatibility with flood control.
Construction of small, temporary earth dikes (a 1-foot high dike beside a 1-foot deep ditch) within existing drainage courses is seen as another potential method of groundwater recharge. Construction of these small depressions would be inexpensive yet effective. Low and moderate flows would concentrate and percolate while larger flows would wash out the streambed modifications (CM Engineering 1991, BSI Consultants 1979). The County states that this method of streambed modification would not significantly affect flood control and is acceptable.

**Artificial Groundwater Recharge**

Groundwater is the principal source of supply for the study area, therefore, increasing recharge to groundwater basins by deep percolation of local surface water is a key issue. Issues pertaining to groundwater are discussed more fully in the Technical Memorandum on Groundwater Issues.

Warren Valley Basin is extracting water at a far greater rate than can be recharged naturally, and as a result, is severely overdrafted. It is estimated that the Warren Valley Basin has experienced a loss of approximately 30,000 AF in storage. The Basin is the primary source of water for Yucca Valley. The main recharge source is subsurface inflow generated from runoff in the San Bernardino and Little San Bernardino Mountains (Malcolm Pirnie, 1988).

The Warren Valley Basin is suitable for artificial recharge with detention basins being the favored recharge method (Kennedy/Jenks/Chilton, 1991). Approximately 11 potential recharge sites and stormwater retention areas have been identified within Yucca Creek and its tributaries as shown on Figure 1 (CM Engineering, 1991). Drainage channels, detention basins, and a golf course, are among the potential recharge areas. Infiltration rates for detention basins have been estimated at 2 to 4 feet per day (CM Engineering 1991).
Wastewater Reuse and Graywater Use

Wastewater in the study area is currently disposed of through individual septic tank systems. Significant water quality problems, especially elevated nitrates in the groundwater, from this disposal have not been reported. However, the impact of continued use of septic tanks should be monitored as the populated areas continue to expand. At present, the downward percolation of septic tank effluent is a source of groundwater basin replenishment. It is estimated that the consumptive use of water extracted is 50 percent, with 50 percent returning to the groundwater basins via leaks in pipelines, landscape irrigation, septic tank percolation, etc.

Reuse of wastewater involves sufficient treatment to permit direct non-potable uses such as irrigation, toilet flushing, and/or groundwater recharge. Graywater use involves segregated plumbing drain systems within homes that enable graywater from showers, laundry, and bathroom basins to be reused outside for subsurface landscape irrigation.

Reclaimed Water

There is no sewer collection system or central wastewater treatment plant in the study area. In the future, if a collection system and treatment plant were constructed, reclaimed wastewater could become a supplemental surface water supply. If this were implemented, most of the well water now used by the golf course (373 acre-feet in 1991) could be made available for potable uses. It has been estimated that implementation of wastewater reuse would cost $32.5 million to produce 1,300 AF/year (Egan, 1990, Kennedy/Jenks/Chilton, 1991).

The primary potential use of reclaimed water is irrigation of the Blue Skies Country Club. Also, because grass and shrubbery would utilize part of the nitrates in the reclaimed water, the potential for groundwater contamination from nitrates would be minimized if efficient irrigation practices were employed (Kennedy/Jenks/Chilton, 1991). However, current consumptive use estimates of 50 percent would increase due to the loss of evaporation/transpiration.
Graywater Use

The State Department of Health Services typically authorizes graywater usage on an emergency basis only. The County of San Bernardino adopted Resolution #91-333 on October 7, 1991, allowing the use of graywater throughout the County for landscape irrigation using approved subsurface systems.

Quality of Stormwater and Wastewater

Data on quality of storm runoff is not available for the study area, largely because streams flow for only short periods after storms. Runoff quality is assumed to be similar to other surface flow from the San Bernardino Mountains, probably calcium-bicarbonate in character, low to medium hardness and total dissolved solids.

The quality of wastewater has not been analyzed because sewage disposal is by buried septic tank systems. It would probably approach the relative percentage of minerals in the supply water, with the total dissolved solids from 200 to 300 mg/l more than the supply water because of mineral pickup during use.

IMPORTED SUPPLIES

MWA has a maximum annual entitlement of SWP water of 50,800 acre-feet. Under the SWP contract, MWA can obtain surplus and agriculture water when available. Requests for entitlement water is subject to contract shortage provisions such as experienced in our recent drought. Improvement District "M" (IDM) is allocated up to 7,257 acre-feet per year of SWP water. IDM was formed within MWA Division #2 to establish a funding mechanism to construct facilities to import and pay for water to the study area. The imported water project participants in IDM have entered into an agreement with MWA. Agreement allotment percentages for repayment of project capital and fixed O & M costs and corresponding flow capacities for each participant are presented in Table 2.
TABLE 2

MAXIMUM IMPORTED WATER ALLOCATION
UNDER CURRENT AGREEMENT

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<tr>
<th>Purveyor</th>
<th>Repayment Allotment Percent</th>
<th>Maximum AF/YR</th>
<th>Peak Delivery Rate, in CFS</th>
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<td>Bighorn-Desert View Water Agency</td>
<td>5.4</td>
<td>653</td>
<td>1.19</td>
</tr>
<tr>
<td>County CSA 70 W-1</td>
<td>2.4</td>
<td>290</td>
<td>0.53</td>
</tr>
<tr>
<td>County CSA W-4</td>
<td>0.6</td>
<td>73</td>
<td>0.13</td>
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<td>Hi-Desert Water District</td>
<td>35.4</td>
<td>4,282</td>
<td>7.83</td>
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<tr>
<td>Joshua Basin Water District</td>
<td>16.2</td>
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<td>3.35</td>
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<tr>
<td>Property Taxes</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td><strong>100</strong></td>
<td><strong>7,257</strong></td>
<td><strong>13.26</strong></td>
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</table>

Source: MWA/Improvement District "M" Participant Agreements

**Morongo Baseline Pipeline**

In 1991, final design commenced on the Morongo Basin Pipeline, which will convey water from the California Aqueduct to Improvement District "M" as shown on Figure 2. The Morongo Basin Pipeline will extend approximately 70 miles from a new turnout near the Antelope Valley Siphon to a terminal reservoir north of Yucca Valley. The pipeline is sized for a peak delivery rate of 22 cfs. The terminal reservoir will have a capacity of 5 MG and a minimum water surface elevation of 3,500 feet.
There will be two turnouts along the Morongo Basin Pipeline. One, for BDVWA and one for CSA W-1. Turnouts will be provided at the terminal reservoir for HDWD and JBWD. Two other Morongo Basin Pipeline appurtenances could be utilized as turnouts: a fire hydrant at the proposed booster pumping station and a blowoff located on Reche Road.

**Concepts for the Use of Imported Water**

An important issue to local water agencies within Improvement District "M" is defining the best operational plan for use of untreated SWP water from the Morongo Basin Pipeline, including its 5-MG terminal reservoir. The imported supply needs to be allocated between direct deliveries, recharge of groundwater basins or a combination of the two.

**Operation 1**

One approach would continue to use the existing well supply infrastructure to meet current needs and recharge the basins with all available imported water. Growth would be met with direct deliveries of SWP water or additional artificial recharge.

**Operation 2**

A second approach is to reduce pumping to safe yield amounts and meet remaining demands with treated imported water.

**Operation 3**

A third approach is to meet all requirements with direct deliveries of imported water. Any excess supplies of imported water would be used to recharge groundwater. This method would practically eliminate well pumping and would result in natural groundwater recharge.
Imported water is available at a certain head, depending upon location of the turnout, which may make imported water more favorable than groundwater pumping when introducing it into the existing transmission, storage, and distribution system. However, wells are already connected to the system and new lines would be needed to connect to the Morongo Basin Pipeline.

While SWP water requires treatment prior to direct residential and municipal use, its mineral constituents meet recommended limits, in contrast to some groundwater (excess of fluorides, nitrates, TDS, etc.).

The recharge of SWP water would arrest the declining groundwater levels and reduce well pumping lifts and costs. Over-utilization of the less expensive groundwater would reverse this trend and may create groundwater quality problems.

Another operational issue is whether to meet peak demands by use of direct deliveries of SWP water, SWP water stored underground, or native groundwater. It is assumed hourly demands will be met by local agencies using surface tank storage. Maximum daily use is about twice the average daily use (Egan, 1990).

To satisfy peak daily and monthly water demands, purveyors with both imported water and groundwater sources are faced with several considerations:

1. Availability of imported water supply.
2. Degree of treatment required for both sources.
3. Price of imported water.
4. Operation policy of purveyor of imported water.
5. Hydraulic head of imported water at turnout.
6. Location of turnouts.
7. Need for drilling additional wells and connecting lines.
8. Cost of maintaining wells with a low use factor to meet peak demands.

9. Condition of basin with regard to overdraft.

10. Condition of basin with regard to water quality.

11. Extent of legal control over extractions (adjudications, basin transfers, etc.).

The challenge is to integrate the delivery of SWP water through the Morongo Basin Pipeline with the operation of existing groundwater water production facilities by contracting retail water agencies.

Plans for the Use of Imported Water

The distribution of imported water to the local purveyors will be from points along the Morongo Basin Pipeline, as mutually agreed upon by MWA and the purveyors. Each of the purveyors will be responsible for constructing its own or joint distribution and treatment facilities, as best meets its operational plan. These plans, as currently envisioned by the purveyors, are discussed below to further define the surface water issues.

Bighorn-Desert View Water Agency

BDVWA does not plan to purchase imported water for at least ten years. In the future, BDVWA will draw SWP water from a turnout at Linn Road and Highway 247 (Old Woman Springs Road), where two existing reservoirs are located. BDVWA's future intent is to convert one of the reservoirs to raw water storage and install a small 1 mgd package water treatment plant to permit the use of imported water directly into its distribution system.
BDVWA could install the proposed water treatment plant early and begin in lieu conjunctive use of the underlying groundwater basins. This possibility seems remote since the basins from which they are now pumping are experiencing little or no groundwater level decline.

BDVWA and the County are in a position to temporarily sell or lease their portion of the Morongo Basin Pipeline capacity to other participants, such as HDWD or to others in the Mojave River area to bank water in the Mojave River Basin.

County Service Area 70, W-1

CSA W-1 does not plan on utilizing water from the Morongo Basin Pipeline for five to ten years. Future delivery is planned at a Morongo Basin Pipeline turnout adjacent to the existing tank at Landers Lane, just south of Reche Road. A small treatment plant (150 gpm) will be installed at the tank connecting to the distribution system.

County Service Area 70, W-4

CSA W-4 is presently at 50 percent build out with a total demand of 50 gpm. The long-term plan is to use imported water transported through the HDWD system.

Hi-Desert Water District

HDWD is presently purchasing water from BDVWA on a temporary, 5-year emergency drought supply agreement. An intertie was constructed between HDWD and BDVWA to allow temporary water transfers of up to 500 acre-feet per year at a cost of $400/AF plus energy costs (Egan, 1992).

Because of the Warren Valley Basin overdraft and associated court orders, HDWD is planning to take immediate delivery of SWP water when it becomes available from the Morongo Basin Pipeline terminal reservoir, which will be located on Warren Vista Avenue north of Aberdeen Drive.
Currently, HDWD is evaluating the necessary transmission, treatment, and recharge facilities required for the following options for use of Morongo Basin Pipeline water:

- recharge and extraction
- treatment and direct use
- direct use of untreated water in limited areas (golf course, parks, etc.)
- combinations of the above

Two alternative sites are being considered for water treatment: the "Mesa" site near the Morongo Basin Pipeline terminal reservoir and in Yucca Valley near the intersection of Highway 62 and Linda Lee Drive. The proposed facility would treat 0.9 to 1.1 mgd of Morongo Basin Pipeline water. A treatment and direct use only option was considered briefly but abandoned due to HDWD's need for early recharge of the Warren Valley Basin.

Cooperative use options between HDWD and JBWD, such as a shared water treatment plant or joint transmission facilities, are also being examined.

The management plan being developed also considers the potential of utilizing imported water for conjunctive use of the Warren Valley Basin by coordinating with MWA, Department of Water Resources, and/or JBWD.

**Joshua Basin Water District**

JBWD intends to take delivery of Morongo Basin Pipeline water at the terminal reservoir when it becomes available and utilize it for groundwater recharge. The recharge capability of a wash which traverses the Joshua Tree Sub-basin will be assessed. JBWD has not yet planned a distribution system for imported water.
The number, sizing and financing plans of treatment plants should include evaluation of the interruptible nature of the SWP water. As experienced this year, water deliveries are a fraction of the original requests of supply. The debt servicing and operations of the plants must account for times when SWP supply is reduced.

**Water Quality Issues**

SWP water quality issues relate to its suitability for the intended uses and cost of treatment. The source of SWP water is the Delta, and therefore its quality at turnouts is that of Delta water as modified somewhat by evaporative losses in transit and storage and mixing with local runoff in SWP reservoirs.

The quality of SWP water at the Tehachapi Afterbay, upstream from the proposed turnout for the Morongo Basin Pipeline, for 1991 is presented in Table 3.
### TABLE 3

**SUMMARY OF WATER QUALITY FOR THE STATE WATER PROJECT IN 1991**

Average Monthly Values,  
*In Mg/l, except percent sodium and pH*  
Objectives,  
*Article 19, State Contract*

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Tehachapi Afterbay</th>
<th>State Contract</th>
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<tr>
<td>Total dissolved solids</td>
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<td>440</td>
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<tr>
<td>Chlorides</td>
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<td>110</td>
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<tr>
<td>Sulfates</td>
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<tr>
<td>Nitrate</td>
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<td>Fluoride</td>
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<td>---</td>
</tr>
<tr>
<td>Boron</td>
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<td>0.6</td>
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<tr>
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<tr>
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<td>Percent Sodium</td>
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<td>50</td>
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<tr>
<td>Alkalinity</td>
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<tr>
<td>pH</td>
<td>7.9</td>
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</tr>
<tr>
<td>Suspended Solids</td>
<td>10</td>
<td>---</td>
</tr>
<tr>
<td>Volatile Suspended Solids</td>
<td>&lt; 2</td>
<td>---</td>
</tr>
</tbody>
</table>

* Based on the expected construction of a cross-Delta water transfer system.

SWP water can be used directly for irrigation and recharge of groundwater basins but must be treated for domestic use to comply with DHS permit requirements. Treatment would include coagulation, flocculation, sedimentation, filtration, and disinfection. A non-chlorination-type disinfection, such as ozone, is now frequently used for SWP water because of the high potential for total trihalomethane formation potential (TTHMFP). Trihalomethane (THM) can be produced when certain organics in water are treated with chlorine.

Costs of treatment would vary with size of treatment plant and exact treatment train selected.

Numbers, sizes, and locations of water treatment plants are other water quality issues. One regional plant to serve the three major water purveyors in the study area would probably be less costly than three separate plants because of the economics of scale. However, this may require parallel water pipelines to provide both treated water for domestic service and raw water for basin recharge to all three service areas.

Recharge of SWP water to replenish groundwater supplies should have no adverse impact on groundwater quality. The chemical character of SWP water varies from calcium bicarbonate to sodium chloride depending on conditions in the Delta. Groundwater in the study area is predominantly sodium sulfate or sodium chloride. The total dissolved solids (TDS) of both imported and local waters is about the same, with TDS in groundwater tending to increase with continued use, especially in basins with little or no subsurface outflow such as Johnson Valley and Warren Valley (Malcolm Pirnie, 1988). Localized areas with high concentrations of fluoride or other constituent probably should not be selected for recharge sites. As there is little "mixing" of groundwaters because of the low velocity, localized water quality problems are not readily solved by "dilution" with recharge waters.

Although the percent sodium of SWP water slightly exceeds objectives, the concentration would need to be considerably higher than 50 percent to cause deflocculation of clay particles (USGS, Hern, 1978) and reduced infiltration rates at recharge sites:
The quality of SWP water can be expected to improve after completion of Delta facilities, which will facilitate the movement of higher quality Sacramento River water from the north Delta to the California Aqueduct intake in the south Delta. Preliminary studies indicate that the mineral composition of export water can be more significantly improved by south Delta improvements (DWR, 1988). Delta improvements should reduce chloride, bromide, sodium, sulfate, TDS, and organics in the export water. The character should be calcium bicarbonate.

Storage Issues

There is an opportunity to bank or store SWP water in groundwater basins to meet demands during curtailment of SWP water deliveries and to reduce basin overdraft (see Technical Memorandum on Groundwater Issues "Conjunctive Use"). Such a program can be implemented because of the availability of surplus water in the Delta during wet periods and groundwater basin storage space. The banking and subsequent use of local surface water is now taking place naturally but can be improved by increasing the opportunity for recharge with imported water.

The availability of surplus water at each turnout of the California Aqueduct, under various assumptions of flow in the Delta and construction of new SWP facilities, can be estimated by DWR using simulation models. The MWA maximum annual entitlement of 50,800 acre-feet of SWP water has been allocated, with Improvement District "M" receiving up to 7,257 acre-feet per year. Surplus water could be allocated using this same formula or be based on other criteria, such as overdraft conditions, capacity of facilities, available storage space, and existence of willing buyers at the time. No SWP water, entitlement or surplus, can be conveyed to Improvement District "M" until completion of the Morongo Basin Pipeline in 1994, although there has been some discussion of the District banking its entitlement in advance in the Mojave River Basin (Kennedy/Jenks/Chilton, 1991).

Additional imported water could be banked if MWA were able to increase its SWP entitlement or execute a water transfer contract for water from the DWR Water Bank, or an individual or other agency, on a short- or long-term basis. Recent legislation and experiences gained during the current drought have facilitated the transfer of water normally used for agriculture to municipal and industrial water users (Boyle, 1992).
As discussed in the "Conjunctive Use" section of the Technical Memorandum on Groundwater Issues, a banking program requires knowledge of the following:

1. Amounts, timing and costs of entitlement and surplus SWP water.

2. Unused capacity in the Morongo Basin Pipeline.

3. Available basin storage space.

4. Recharge and extraction sites.

In addition to satisfying requests for water during shortages of imported water, banked water can be used to meet seasonal, monthly, and daily peak demands.

Some wholesale water agencies have avoided the capital investment in surface storage and transmission capacity required to meet the peak demands of retail water agencies by developing economically attractive seasonal groundwater storage programs. Under one wholesale water pricing policy, the wholesaler sells water at a reduced cost during off-peak periods and the retailers bank the water in groundwater basins. Then instead of over-loading the wholesalers' distribution system during peak periods, the retailers pump previously banked ground water. The program:

1. Allows wholesaler to import more water when available.

2. Increases local water production from wells during peak demand periods.

3. Increases local water production during shortages of imported supplies.

As discussed in the Technical Memorandum on Groundwater Issues, the legal framework for public agencies to store and retrieve water in groundwater basins has been authorized by the court.
MOJAVE WATER AGENCY

Regional Water Management Plan
Johnson Valley / Morongo Basin

TECHNICAL MEMORANDUM
ON
TRIBUTARY WATERSHED ISSUES

May 1993
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<td>4</td>
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</table>
TECHNICAL MEMORANDUM

TRIBUTARY WATERSHED ISSUES

INTRODUCTION

The purpose of this Technical Memorandum is to identify issues related to the watersheds tributary to the study area. This includes determining which agencies have jurisdictional/legal control of the watersheds, and assessing the potential impacts of their activities on the downstream water supply.

SUMMARY OF FINDINGS

The following were found to be the major tributary watershed issues:

1. **Adequate data is not available to determine large storm runoff to the basins within the study area.**

   Additional data is needed to better quantify stormwater runoff volumes at specific locations. Rain gages, stream flow gages and evaporation pans should be installed to begin recordation of data.

2. **There are programs being carried out in the Johnson and Emerson Hydrologic Units, tributary to the study area.**

   These activities are administered by the U. S. Forest Service (USFS), U. S. Bureau of Land Management (BLM), and to a lesser degree, the San Bernardino County Department of Transportation/Flood Control.
3. **Sediment flow rate to downstream areas may increase.**

The USFS states this could occur as a result of storms, fires, and activities on private lands within the forest. Erosion and sediment movement could occur on cattle lands supervised by BLM. The Rattlesnake Canyon area in Johnson Valley is an example.

4. **The biological quality of the water flowing from the forest is not controllable.**

Because of increased visitation and animal activity within the forest, the biological water quality throughout the USFS Forest area is not controllable. This problem is more prevalent in those parts of the forest with perennial streams outside of the study area.

5. **Notwithstanding the issues listed above, little or no water-related impacts are expected in the study area from activities in the tributary watersheds.**

**WATERSHED DEFINITION AND CHARACTERISTICS**

The location of hydrologic, or watershed boundaries in the study area are illustrated on Figure 1. The hydrologic areas were defined by the Department of Water Resources (DWR), Southern District, as a portion of the Colorado River Basin drainage province designated as Area Code X.

Five drainage areas encompass the bulk of the study area: Warren, Copper Mountain, Emerson, Means and Johnson. Two of the areas, Warren and Means, are contained almost completely within the study area. The watershed boundaries of the other three all extend beyond the borders of the Mojave Water Agency (MWA). The hydrologic unit name, major drainage features, and elevation range of each watershed are provided in Table 1.
TABLE 1
WATERSHED CHARACTERISTICS

<table>
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<tr>
<th>DWR Watershed</th>
<th>Subarea (a) Name</th>
<th>Drainage Features</th>
<th>Elevations</th>
<th>Approximate Drainage Area (Sq. Mi.)</th>
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<td>8.AO</td>
<td>Warren</td>
<td>Yucca Creek</td>
<td>5100</td>
<td>3000</td>
</tr>
<tr>
<td>8.BO</td>
<td>Copper Mtn.</td>
<td>Quail Wash</td>
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<td>2400</td>
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<td></td>
<td></td>
<td>Copper Dry Lake</td>
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<td>5.00</td>
<td>Emerson</td>
<td>Pipes Wash</td>
<td>8800</td>
<td>2400</td>
</tr>
<tr>
<td>4.00</td>
<td>Means</td>
<td>Means Lake</td>
<td>5000</td>
<td>2600</td>
</tr>
<tr>
<td>2.00</td>
<td>Johnson</td>
<td>Melville Lake</td>
<td>8000</td>
<td>2800</td>
</tr>
</tbody>
</table>

(a) California Dept. of Water Resources

PRESENT SITUATION

Total annual runoff from watersheds is a function of watershed area precipitation and watershed losses as discussed below. The magnitude and duration of flood flows are a function of the characteristics of the storm, watershed, and stream channel. Evaporation is also another factor in determining the hydrologic balance of the study area. Unfortunately, evaporation data is not available.
Annual Precipitation

The majority of precipitation data available for the study area is concentrated in the Yucca Valley/Joshua Tree area. The Joshua Tree Hydrologic Unit (8.00), which includes the Warren (8.A0) and Copper Mountain (8.B0) Subunits, contains three precipitation gages and a stream gage on Quail Wash. Two other precipitation gages are located near Morongo Valley, but are outside of MWA. The only other rain gage in the study area is located in the Johnson Hydrologic Unit (2.00) near Melville Lake.

Thirty-two years of hydrologic data indicate that the average precipitation exceeds 0.2 inches per day only 10 days a year. Precipitation less than 0.2 inches per day does not produce significant runoff for recharge purposes. On an annual basis, precipitation less than 8 inches per year is not considered to contribute significantly to basin recharge. Rainfall ranges from 40 inches in Lake Arrowhead to 3.5 inches in Twentynine Palms. Rainfall in the desert region is often sporadic, sometimes bringing the entire "average" annual rainfall in one summer thunderstorm, or experiencing two to three times the average rainfall in one year. Table 2 summarizes average annual precipitation in the study area and at gages located near the study area (James, 1992). The precipitation and stream gage locations are shown on Figure 1. Precipitation and streamflow are also discussed in the "Technical Memorandum on Surface Water Issues."

Watershed Losses

Watershed losses are considered to be depression storage, vegetation interception, transpiration, evaporation, and infiltration. The major factor affecting loss rates is the nature of the soil itself. The soil surface characteristics, its ability to transmit water to subsurface layers, and total storage capacity are all major factors in controlling the infiltration rate and all other losses.

Soils are classified into four hydrologic soil groups by San Bernardino County. The groups are designated A through D and represent runoff potential from low to high, respectively. Conversely, they also represent infiltration rates from high to low, respectively. Due to the large size of the study area, the tributary watershed is represented by all of the soils groups to varying degrees, depending on locale. The following are the County's description of each soil group classification:
GROUP A: Low runoff potential. Soils having high filtration rates even when thoroughly wetted and consisting chiefly of deep, well-drained sands or gravels. These soils have a high rate of water transmission.

GROUP B: Soils having moderate infiltration rates when thoroughly wetted and consisting chiefly of moderately deep to deep, moderately well to well drained sandy-loam soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission.

GROUP C: Soils having slow infiltration rates when thoroughly wetted and consisting chiefly of silty-loam soils with a layer that impedes downward movement of water, or soils with moderately fine to fine texture. These soils have a slow rate of water transmission.

GROUP D: High runoff potential. Soils having very slow infiltration rates when thoroughly wetted and consisting chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very slow rate of water transmission.

The Warren and Copper Mountain Sub-units are comprised primarily of Group B, C and D soils, having moderate to slow infiltration and water transmission rates. The lower valleys in the Yucca Valley/Joshua Tree areas are dominated by the Group B soils, with Group C soils in the Copper Dry Lake area and Group D soils forming the southern mountainous boundary.

The Emerson Hydrologic Unit is characterized by Group B soils in the lower valley areas along Pipes Wash and Landers. The San Bernardino Mountains on the southwest portion are made up mostly of the high-runoff Group D soils.

The Means Hydrologic Unit is relatively small, with some Group A soils in the southern portion and Group C and D soils dominating the remainder.
The lower Johnson Valley, along Highway 247, is comprised primarily of Group A soils, having low runoff potential and high infiltration and water transmission rates. The upper Johnson Valley is primarily Group C soil with scattered Group D soils. The southern portion of the watershed receives runoff from the mostly Group D soils of the San Bernardino Mountains.

WATERSHED YIELDS

The stormwater runoff available for capture and recharge is not known. Various methods are available for the study of watershed yields. However, the accuracy of a watershed yield analysis is closely related to the availability of data.

Other Studies

The San Bernardino County Transportation/Flood Control Department has conducted preliminary hydrologic studies in the Warren Hydrologic Subunit (B.AO) in the Yucca Valley area. As noted previously, the County is currently preparing an updated master plan of drainage which will study hydrologic conditions in the more populated areas of Division No. 2.
<table>
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<tr>
<th>Location</th>
<th>Oct</th>
<th>Nov</th>
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<th>Jan</th>
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<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
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<td>0.57</td>
<td>0.41</td>
<td>6.43</td>
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</table>
JURISDICTION/LEGAL CONTROL

According to the Local Agency Formation Commission (LAFCO), there are five local special districts within the area (Lopez-Henderson, LAFCO, letter of March 18, 1992). These are three water districts, an airport district, and a hospital district, and are all primarily in the lower elevation valley floor areas. In addition, the County provides water service to two areas in the study area.

There are three main agencies which have responsibilities and authorities in the higher tributary watersheds. These are the USFS, the BLM, and the San Bernardino County Department of Transportation/Flood Control. In general, the USFS administers the lands within the San Bernardino National Forest, located in the higher elevation areas. The County conducts flood control and water conservation programs along the streams and washes outside the National Forest. The BLM administers the federal lands outside the National Forest at the lower elevations and in the desert. One exception is the Rattlesnake Range Allotment, Eastern Unit, Back Country Management Area of the San Bernardino National Forest. This allotment encompasses both National Forest land and public domain land administered by BLM. The entire allotment is administered by the BLM under a Memorandum of Understanding with the USFS.

All three agencies have jurisdiction or responsibilities in two of the three watersheds tributary to the study area, namely: Johnson and Emerson Hydrologic Units, shown on Figure 1 and described in Table 1 (Land Status Map, BLM, 1978). Runoff from the third watershed, Copper 'Mountain, originates largely within the Joshua Tree National Monument located south and southeast of the community of Joshua Tree.

U.S. Forest Service

The administration of lands within the San Bernardino National Forest is directed by federal laws and regulations and guided by the Land and Resource Management Plan for the forest (USFS, 1988). Preparation of the plan was required by the Forest and Rangeland Renewable Resources Planning Act of 1974, as amended by the National Forest Management Act of 1976.
In general, USFS management practices have been established to protect water quality in surface water courses and groundwater, maintain existing and acquire new water rights for USFS uses, assist enhancing additional water production by other entities if available and to keep sediment increases restricted. USFS does not have specific goals identified for their lands within the study area beyond those generally summarized above.

**U. S. Bureau of Land Management**

Similar to the USFS, BLM administration of lands tributary to the study area is guided by a management plan. (BLM, 1980, as amended in September 1991.) Preparation of the management plan for the California Desert Conservation Area was required by Section 601 of the Federal Land Policy and Management Act passed by Congress in 1976. BLM operates in conformance with the following public-land management laws:

- U. S. Mining Laws
- Taylor Grazing Act of 1934
- Wilderness Act of 1964
- Historic Preservation Act of 1966
- U. S. Mineral Leasing Laws
- Mining and Minerals Policy Act of 1973
- Public Rangeland Improvement Act of 1978
- Off-Road Vehicle Management Executive Orders
Although there is not a "water" element in the plan, water does relate to some of the other elements. For example, water is required for cattle as part of the Livestock Grazing Element. The largest grazing area tributary to the study area is the Rattlesnake Canyon Allotment within the Johnson Hydrologic Unit. It covers 29,000 acres south of Johnson Valley Basin and west of Means Valley Basin. BLM proposes to enlarge the allotment eastward to Highway 247. Water is furnished by springs developed by the lessee (Anthony Chavez, BLM, phone call of March 26, 1992). For purposes concerning the MWA's Regional Water Management Plan, this water use is assumed to be negligible.

BLM has proposed creation of a wilderness area in the Bighorn Mountains, part of which would cover the Rattlesnake Canyon Allotment. This would further control water-related activities in the tributary area. Authorizing legislation has recently passed the House of Representatives (Dave Frink, BLM, phone call of March 26, 1992).

San Bernardino County Department of Transportation/Flood Control

In addition to flood control, and of more importance to the water supply of the study area, the Department is assigned the responsibility for water conservation and is authorized to retain and recharge storm flows to replenish groundwater basins. Under contract with a local agency, it can also recharge imported water.

The Department also has the right to condemn property needed for its projects, create benefit zones for assessment purposes (with the approval of the voters), operate and maintain facilities, levy a property tax, and enter into contracts with local, state and federal agencies.

POTENTIAL IMPACTS

The goal of capturing and recharging of stormwater in the tributary areas by the San Bernardino County Department of Transportation/Flood Control would be to reduce the evaporative loss of run-off and increase the replenishment of the groundwater supply.
The current and planned management practices of the USFS and BLM in the tributary watersheds are expected to produce little or no water-related impacts in the study area. However, if the County of San Bernardino implements capture and recharge of run-off programs, modest replenishment of the groundwater supply can be expected. MWA has initiated coordination with the County to establish a memorandum of understanding and an agreement to facilitate work in the tributary watercourses.
MOJAVE WATER AGENCY

Regional Water Management Plan

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TECHNICAL MEMORANDUM
ON
WATER SERVICE ISSUES

May 1993
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TECHNICAL MEMORANDUM
WATER SERVICE ISSUES

INTRODUCTION

The purpose of this Technical Memorandum is to identify water service issues that are unique to the Johnson Valley/Morongo Basin area. Issues identified in this memorandum will be addressed by strategies developed in the following phase of the Regional Water Management Plan.

The water service plan must account for the study area's characteristic water use and financial status and provide for service during times of deficient and surplus supplies. Water service contracts between Mojave Water Agency (MWA) and the purveyors will, of necessity, be influenced by provisions in the MWA contract with the State for State Water Project (SWP) water.

SUMMARY OF FINDINGS

The following were found to be the major water service issues:

1. **Water service is inadequate in some areas.**

   Some areas, such as parts of Johnson Valley, rely on trucked water as the only potable supply. Long term overdraft in the Warren Valley Basin is responsible for growth limitations in areas of Yucca Valley.

2. **Water service contracts need to be tailored to meet the unique needs in each service area.**

   Because groundwater basin overdraft, water quality, basin storage space, and capability for recharge vary within the study area, water service contracts should contain special provisions to meet various local conditions.

3. **Service contracts should provide for fluctuation in the magnitude of imported water supplies.**
The SWP experiences periods of normal, surplus, and deficient water supply. Water use priorities should be set and the Morongo Basin Pipeline and local facilities should be operated to satisfy water needs and bank reserves under these conditions. In addition, the need for SWP supply varies from Agency to Agency.

4. **Water rates can adversely impact users with fixed incomes.**

Since a large percentage of the water users are retired with a modest income, water pricing policies should recognize the ability and willingness of these users to pay for water.

5. **Water conservation is an essential element in the Regional Water Management Plan.**

Because imported water is relatively expensive and local supplies are limited, it is important that effective land use planning and water conservation programs be implemented. Water conservation should be considered on an equal basis with other water management options. Conservation efforts should address the issues identified in the state’s "Memorandum of Understanding Regarding Urban Water Conservation in California."

**EXISTING WATER SERVICE**

Groundwater is the only supply for the study area where essentially all of the use is for municipal and industrial purposes. The area does not have any significant agricultural use. Water connections and production for the major water users are presented in Table 1.
TABLE 1
SUMMARY OF 1991 WATER USE

<table>
<thead>
<tr>
<th>Service Connections</th>
<th>Production, in Acre-feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bighorn-Desert View Water Agency</td>
<td>1,500</td>
</tr>
<tr>
<td>Hi-Desert Water District</td>
<td>8,255</td>
</tr>
<tr>
<td>Joshua Basin Water District</td>
<td>3,440</td>
</tr>
<tr>
<td>San Bernardino Co. CSA 70, W-1</td>
<td>715</td>
</tr>
<tr>
<td>San Bernardino Co. CSA 70, W-4</td>
<td>125</td>
</tr>
<tr>
<td>Institute of Mental Physics</td>
<td>1</td>
</tr>
<tr>
<td>Blue Skies Country Club</td>
<td>1</td>
</tr>
<tr>
<td>16 Individual Property Owners</td>
<td>16</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>14,053</strong></td>
</tr>
</tbody>
</table>

Source: Extractions over 25 AF/year reported by each purveyor to SWRCB.

Forty-nine private wells with production exceeding 25 acre-feet per year were active in 1991 (SWRCB records). Production from smaller wells is not known. MWA is currently conducting a survey of all well producers to determine total groundwater production.

Due to poor quality of groundwater in Johnson Valley, many individual property owners obtain their supply from water trucked into the area. Bighorn-Desert View Water Agency (BDVWA), with a service area covering a minor portion of the southeast end of the valley, sells "bulk" water to trucking services supplying water to the Johnson Valley.
Total bulk water sold by BDVWA for the past five years is as follows:

<table>
<thead>
<tr>
<th>Calendar Year</th>
<th>Sales, in Acre-Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>1987</td>
<td>0.00</td>
</tr>
<tr>
<td>1988</td>
<td>26.20</td>
</tr>
<tr>
<td>1989</td>
<td>79.17</td>
</tr>
<tr>
<td>1990</td>
<td>19.24</td>
</tr>
<tr>
<td>1991</td>
<td>19.27</td>
</tr>
</tbody>
</table>

Imported water from the SWP will be available via the Morongo Basin Pipeline in 1994. Improvement District "M" (IDM) was created to finance the $66.5 million Morongo Basin Pipeline project and has an allotment of SWP water of up to 7,257 acre-feet per year when available. The pipeline will deliver untreated SWP water and provide the opportunity to take advantage of surplus water during average and "wet" years. The management plan will consider how to take advantage of this opportunity.

The Morongo Basin JPA was formed to initiate the planning, design and construction of the Morongo Basin Pipeline. The JPA consists of one representative from MWA, Bighorn-Desert View Water Agency, Hi-Desert Water District (HDWD), Joshua Basin Water District (JBWD), and San Bernardino County CSA 70 W-1 and W-4 systems. Once the pipeline project was approved by the voters and IDM was formed, the JPA selected MWA as the lead agency to manage the pipeline project.

MWA has entered into water allotment and repayment contracts with each participant in the pipeline. Payments for fixed and variable costs of pipeline construction, operation, maintenance and purchasing of SWP water are to be made to MWA by the participants (Agreement for Construction, Operation and Financing of the Morongo Basin Pipeline Project, 1991).

BDVWA recently entered into a 5-year-drought related water service contract with HDWD to supply HDWD with up to 500 acre-feet per year at a cost of $400/AF plus BDVWA's energy cost for groundwater pumping. BDVWA and HDWD also established an agreement for HDWD's production from the Mainstream Well located in Section 24. This agreement resulted from concern over overdrafting the Ames Valley Basin to benefit users outside of the Basin. The agreement allows HDWD to pump 800 acre-feet per year plus 0.5 acre-foot per year for each additional service connection, with all water to be used within the Basin (BDVWD - HDWD agreement dated January 10, 1991). As discussed in the Technical Memorandum on
"Groundwater issues," attention should be given to the safe yield of the Ames Valley Basin and the amount of water extracted by BDVWA and HDWD:

- Safe Yield (DWR No. 118, 1975) 700 AF/year
- BDVWA 1991 Consumptive Use (50 percent) (335 AF/year)
- HDWD 5 year Export Agreement (500 AF/year) (temporary)
- HDWD Mainstream Well (50 percent consumptive use) (400 AF/year) (535 AF/year) (overdraft)

This indicates that the total of water use and agreements exceeds the safe yield of the Ames Valley Basin for the 5-year-term agreement, and subsequently does not allow for future demands in BDVWA.

FUTURE WATER SERVICE ISSUES

Service Contracts

Water service contracts between MWA and purveyors should reflect the policies and water marketing program of MWA while still meeting the unique needs of the retail water agencies. Some provisions which the contract should address are as follows:

- Service during times of water shortage and surplus for the SWP and MWA
- Peaking
- Water pricing with respect to:
  - Point of use
  - Type of use
  - Degree of treatment
  - Reducing groundwater pumping
  - Time of delivery (off-peak, on-peak)
• Priorities in times of shortage
• Shortage because of a lack of MWA facilities.
• Carryover of unused allotment
• Turnouts
• Water quality objectives
• Water demand projections (buildup)
• Conjunctive use with groundwater basins
• Conveyance in Morongo Basin Pipeline of transfer water obtained by water marketing in the state.

Future water service contracts with the major water purveyors must be sensitive to the recent financial impact of the Morongo Basin Pipeline. Significant increases in water rates and property taxes have been reported to be a concern to the fixed income residents in the study area.

Water service contracts between Morongo Basin Pipeline participants could provide for localized water "transfers" and joint participation in regional transmission, treatment and recharge facilities and banking. Groundwater could be transferred from an underutilized basin to an overdrafted basin. Contracts could provide for mutual assistance during shortages.

Supply/Demand Concepts

Policy alternatives concerning meeting demands under various conditions of supply (normal, surplus and shortage) should be established. SWP supply could be delivered to users as needed, either treated or untreated, depending on use. Demands exceeding SWP supply could be met from groundwater. Over utilization of the "cheaper" groundwater supply could be avoided through an appropriate imported water pricing policy and a groundwater pumping assessment. This could provide funds to repay SWP charges, balance demands and water supplies, and avoid increasing the groundwater basin overdraft.

Water supply management scenarios should address normal, surplus, and shortage conditions. Each type of supply is discussed below:
Normal Supply Conditions

The goal to managing the imported water and local water supply is to control groundwater pumping at or below estimated safe or perennial yield, while still providing storage space for conjunctive use with imported water.

Operational issues for direct use of treated SWP water include peaking alternatives. Imported water can be delivered at a constant rate from day to day with peaking of demands supplied by wells. This facilitates the operation of the pipeline and maintains local versatility of each water purveyor. In some cases where groundwater facilities do not exist or are inadequate, users may wish to peak off the Morongo Basin Pipeline.

To avoid construction and operation of treatment plants, imported water could be recharged to the groundwater basins and the earth's natural treatment system would be utilized. It should be noted that it is not known if all basins can be recharged by spreading. Some may require natural recharge by reducing or eliminating pumping and using imported water directly which would require treatment. Overdrafted basins can be relieved and basin production could be increased above historic safe or perennial yield.

Groundwater transfers from underutilized basins to overdrafted basins should be evaluated. Institutional and legal considerations should be investigated.

Surplus Conditions

When surplus water conditions exist locally or on the SWP, the Regional Water Management Plan should include operational scenarios to take advantage of this condition. During surplus conditions, for example, SWP water could be purchased at a lesser cost and "banked" for use at times of shortage.

The Morongo Basin Pipeline will be constructed with a 22 cfs capacity. If surplus imported supply is available, the Morongo Basin Pipeline is designed to deliver peak surplus flows above the allotment of 7,257 acre-feet per year. The excess supply could be delivered and used either directly with reduced groundwater production, or banked for use in shortage years. Surplus water is generally available in "wet" years, only after the State has filled the SWP reservoirs or
cannot use the surplus water available. The availability of this surplus water can be statistically estimated by the State, however, is not guaranteed. However, if the Agency has facilities to take immediate delivery of the large amounts of water, when it is available, the surplus water is very beneficial for banking and utilization of less expensive water.

**Shortage Conditions**

With a shortage in SWP supply, the state contract calls for reduction in deliveries to agriculture before cutting deliveries to municipal and industrial contractors, such as MWA. MWA and water purveyors can implement their own allocation program during shortages. Commonly, domestic use is first priority, followed by irrigation and recharge.

Local groundwater banking of imported water could offset the supply constraints when the SWP system is short of water because of drought, emergency interruption, or lack of facilities.

**Pricing Policies**

Demand has been found, like many other commodities, to be affected by price. Lower costs for water compared to other utility costs are generally found to be of low elasticity. However, with expected higher future water costs relative to other utility costs, the sensitivity of demand to price will likely increase and become more important in pricing decisions. Elasticity is defined as the percentage change in demand divided by the percentage change in price. For example, M & I demand is less sensitive to price than agricultural demand. Winter demands are less elastic than summer demands. Some utilities have established prices to reduce peak demand for the purpose of reducing or deferring capital expenditure, and to provide lower winter rates to encourage seasonal or carryover storage (primarily groundwater banking).

Examination of pricing policy issues requires an examination of various factors which will have a bearing in the shaping of the financing plan. These include the following:

1. Method of financing capital facilities.
2. Mix of revenue sources.
3. Level of water service.
4. Cost of water supply.
5. Cost of water service.
6. Areas of benefit.
7. Cost allocation policy.
10. Types of water use.

The nature and extent of the above factors will affect the amount of costs to be recovered and the selection of a fair and equitable pricing policy. Each of the following pricing policy approaches will be investigated and issues identified for each:

A. "Postage Stamp"—Use of a single uniform price, sometimes referred to as the "Postage Stamp" theory, is in part predicated on the finding that service is generally uniform, the means of provision of the service is widely dispersed, the ability to separate and recover actual costs of service to different levels of users is infeasible, and all areas tend to benefit relatively equally from the service.

B. Cost of Service—This approach in its purest sense assumes that all charges for water service are allocated directly in proportion to the level of service (amount, capacity, distance from source, class of service, and cost of transmission, storage, treatment, distribution, and administration) provided to the customer. It is sometimes referred to as the "Train Ride" theory (it costs more to go further).

C. Water Availability Charge (fixed) Plus Water Use Charge (Variable)—This approach is based on the concept that capital cost plus other fixed costs of water service become sunk costs that provide a direct benefit to the land by making water available and do not vary with the amount of actual use. The water use charge recovers all costs associated with the amount of and actual delivery of water to users. It varies with the on-demand supply costs, power costs of pumping, and other variable costs of service. The water availability charge may take on various forms, such as a Standby Charge, Service Charge, Meter Charge, Acreage Assessment Charge, Facility Capacity Fee, etc. The water use charge is generally a water rate commodity or construction charge in dollars per acre-foot.
D. **M & I and Agricultural Rates**—Separate M & I and agricultural rates may be justified on the basis of supplying supplemental and interruptible water to agriculture at the variable transportation cost of water delivery.

E. **Contract Rates**—Contract rates may be established with specific users of water requiring special service. This approach normally includes the full cost of service plus a reasonable additional amount of revenue dedicated to required reserves, including sinking fund replacement accounts. In some special situations, a large user may need water at a far distant location. The Agency may require the contractor to then pay for the oversizing of the facilities to meet some level of future needs along the pipeline with repayment provisions to the contractor when other users connect to the system.

F. **Proportional Use of Facilities**—This approach charges the capital and delivery cost of water in direct proportion to the cost of providing the facility capacity to the user. This method has been implemented by Morongo Basin Pipeline participants. This is also the method used by the State to recover costs from the State Water Project contractors. Under this method, either the MWA finances the entire facility system and charges a fixed annual cost to system contractors, or MWA establishes a special water facility corporation to serve as the fiduciary for the facility system in which local agencies participate according to their desired turnout capacities and locations. Costs are allocated by capacity rights in each reach by participant. Under this arrangement local agencies hold the capacity rights. This can be an effective vehicle where the MWA act as a financing and administration agency and the local participants have the responsibility of raising funds to make annual payments. Variable costs are paid above this amount in dollars per acre-foot based on metered deliveries.
G. Other Considerations--Especially important in selecting the pricing policy is the role of groundwater management, and whether pumping is controlled either through judicial stipulation or through a legislative management program, or is left uncontrolled. The plan for groundwater management will affect the choice of pricing policy. In addition, other factors which need to be considered are the price-elasticity of demand, the use of penalties in water conservation and demand management, as well as what appears and is perceived politically as a fair and equitable pricing policy. For example, Warren Valley Basin is controlled by the adjudication and the judicial stipulation of limited groundwater pumping.

Pricing policies will be developed by Bookman-Edmonston for the Agency-wide Water Management Plan considering the unique characteristics of the study area.

Demand Management

Water conservation techniques have advanced considerably in the past decade, along with knowledge of their expected water savings. As a result, conservation programs can now more confidently be incorporated into a cost effective water management strategy.

Conservation techniques have been identified in the "Best Management Practice" conservation measures identified in the SWRCB Bay/Delta Proceedings. Conservation techniques include:

- Public and school educational programs.
- Pricing programs.
- Plumbing retrofit.
- User audits.
- Leak detection programs.
- Water restrictions.
- Inverted rate structures.
HDWD has achieved substantial success with its conservation techniques and "Urban Water Management Plan." BDVWA, JBWD and the County water service areas have also adopted ordinances on conservation measures. In addition, all local agencies are encouraged to adopt the State "Memorandum of Understanding regarding Urban Water Conservation in California," September 1991. Managing water demands by type of land use includes restricted uses for new customers, restricted times of use, and contracted agreements for periodic interruptions of service during times of water shortage. The local purveyors should work with the local land planners to best manage the water resources.

Priority for Utilization

Priority utilization policies can be established under which certain classes of land and water use might receive priority to water while other, lower priority classes are interrupted. Such a policy will need to differentiate between drought year shortages and seasonal or emergency shortages of shorter duration. A consideration is access to alternative groundwater pumping during periods of shortage.
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Regional Water Management Plan

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TECHNICAL MEMORANDUM

ON

FINANCIAL ISSUES

May 1993
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TECHNICAL MEMORANDUM
FINANCIAL ISSUES

INTRODUCTION

The purpose of this Technical Memorandum is to identify financial issues that are unique to the characteristics of the Johnson Valley/Morongo Basin area. A financial plan to implement improvements and programs developed in the Regional Water Management Plan must account for the current and projected financial characteristics of the region. Although the population and economic growth of the study area depends on a dependable water supply, any proposed financial encumbrance must address the community's ability to support the cost of facilities and programs.

Information in this memorandum is intended to augment the Agency-wide Water Service Issues Technical Memorandum prepared by Bookman-Edmonston. Issues identified in this memorandum will be addressed by strategies developed in the subsequent phase of the Regional Water Management Plan.

SUMMARY OF FINDINGS

The following were found to be the major issues:

1. **State Water Project Financial Obligations**

   Three general financial obligations exist for delivery of water within the study area:

   a. Payment for allocation of State Water Project (SWP) entitlement under current Mojave Water Agency (MWA) policy for fixed cost of SWP by Ad Valorem taxes.

   b. Future variable SWP cost to purchase SWP water upon completion of the Morongo Basin Pipeline.

   c. Morongo Basin Pipeline capital, operation and maintenance costs.
d. Local distribution system capital, operation and maintenance costs.

2. Improvement District "M"

Due to the financial impact of the Morongo Basin Pipeline (MBP) to Improvement District "M" (IDM), additional financing alternatives impacting water rates and property taxes should be carefully evaluated to determine the impact on the consumer.

3. Morongo Basin Pipeline - Allocation of Debt Service

By Joint Powers Agreement (JPA), 40 percent of the pipeline debt service is derived from property taxes levied in IDM. Sixty percent of debt service is derived from JPA participant’s revenue sources.

GENERAL DESCRIPTION

Sources of capital funds include general obligation bonds, revenue bonds, forms of lease financing such as certificates of participation, lease-back, state and federal grants and loans, and pay-as-you-go financing. Appropriate financing methods to provide local funds and the anticipated terms, structure, costs, and annual payments of the financing will be addressed in the Agency Wide Plan prepared by Bookman-Edmonston.

The state provides loans of up to $5 million for water conservation, groundwater recharge, and water quality projects through a variety of state bond laws. The most recent of these was the Water Conservation Bond Law of 1988 (Proposition 82). Most of the funding for these programs has already been committed, but the state intends to place more bond measures before the voters in the future. Potential federal programs for groundwater projects may be available. The $5 million construction of an upsized portion of the MBP from the California Aqueduct to the Mojave River, will be financed through the 1988 Water Conservation Bonds. MWA is currently working with HDWD to obtain 1988 Bond financing for the extension of the MBP to recharge basins in Warren Valley groundwater basin.
Sources of revenue are required for annual expenses including current water O & M costs, administration, amortization of current debt, operating expenses of the proposed facilities and payment for new debt service. Procedures and authority to establish recommended charges and fees should be outlined in the Plan.

Zones of Benefit and assessments to pay for the variable cost of SWP water and for distribution facilities to deliver water to retail contracting agencies or for groundwater recharge may be applied. The MWA Act 9095, creating the Agency, provides a basis to spread the costs of imported water supplies to beneficiaries by Zones of Benefit assessment. Procedures for formation of Zones of Benefit are specified in the MWA Act and the Board of Directors must make certain findings to establish a Zone of Benefit and levy assessments. The findings must be supported by a technical evaluation. The procedures and possible use of Zones of Benefit will be addressed as a management strategy.

Imported water from the SWP will be delivered by the Morongo Basin Pipeline beginning in 1994. Construction of this pipeline will begin in late 1992 to bring up to 7,257 AF/year of SWP water to the study area. Improvement District "M" (IDM) was created for financing up to $66.5 million Morongo Basin Pipeline project. Forty percent of the cost is to be paid by property taxes, and 60 percent to be paid by the participating water agencies (JPA Agreement for Morongo Basin Pipeline). Due to the voter's passage of Measure "M" to construct the pipeline, property owners and the five participating water agencies within IDM are financially responsible for the construction of this transmission facility.

**Bighorn-Desert View Water Agency**

The BDVWA reports that current groundwater supply meets current demands and that they are financially capable to participate in the construction of the MBP imported water transmission facility and internal distribution facilities to plan for future growth.
Hi-Desert Water District

HDWD serves water to the Township of Yucca Valley, the most concentrated development in the study area. Over the years, the majority of water serving Yucca Valley has been from the overdrafted Warren Valley groundwater basin. The Superior Court adjudication judge is allowing overdrafting of the basin on the condition that additional water supply is available in 1995 to relieve the basin overdraft. However, growth within the Warren Valley Basin is limited to 2 percent until additional water supply is provided to support growth.

HDWD is preparing financial and engineering plans to use imported water in addition to other projects to secure additional sources of supply. The financial impact of importing water supply has been publicly discussed and is considered to be a significant impact to the public.

Joshua Basin Water District

JBWD has estimated that their groundwater supply is in a mild overdraft condition. The District has followed their Engineer’s recommendation to plan for obtaining an additional source of supply by 1995 to balance the overdraft condition.

San Bernardino County CSA 70, W-1 and W-4

The County reports that current supplies meet current demands and that they are financially capable to participate in the construction of the imported water transmission facility to plan for future growth.

FINANCIAL ISSUES UNIQUE TO THE SUBJECT STUDY AREA

Three general financial responsibilities exist within the study area for delivery of water:

1. Repayment of SWP entitlement under current MWA policy.

2. Morongo Basin Pipeline capital, operation and maintenance cost.
3. Local purveyor's distribution system capital, operation and maintenance cost. This includes the future transmission facilities from the MBP to each Agency's system.

The entire area within MWA's boundaries is financially responsible for the cost of participation in the SWP system. IDM, which is only a portion of the study area, is financially responsible for the Morongo Basin Pipeline.

Upon commencement of SWP water delivery, each agency taking delivery shall be responsible, by MWA agreement, for the variable costs associated with the imported water.

**Morongo Basin Pipeline**

IDM was formed by MWA Resolution No. 477-90 and adopted by the Board of Directors on January 26, 1990. Voters within this Improvement District authorized the agency to issue $66.5 million aggregate principal amount of general obligation bonds to finance the acquisition of easements and construction of the Morongo Basin Pipeline project. Table 1 summarizes the allocation of debt service to each participant.

Reach 1 of the MBP, from the California Aqueduct to the Mojave Rivers, was upsized from a 30-inch to a 54-inch diameter to convey SWP water to the Mojave River for recharge. This upsizing will be paid for by the Agency with funds from the 1988 Water Conservation Bonds. This upsizing of the MBP provides a savings to the study area by sharing the cost of operational and maintenance cost for this reach of the pipeline used by others. The study area could also benefit from use of other reaches of the MBP by others in the same manner. To increase the beneficial use of the MBP and to lower the cost of the MBP to the study area, the Agency should investigate use of other reaches by others in the Agency.

Unique issues pertaining to a financial plan are limited to the financial impact of new facilities and programs. Projected increases in water rates and property taxes associated with the Morongo Basin Pipeline must be considered when evaluating additional means of financing other projects.
TABLE 1
MORONGO BASIN PIPELINE MILLION BOND ISSUE
ALLOCATION OF DEBT SERVICE

<table>
<thead>
<tr>
<th>Water Purveyor</th>
<th>Allocation of Debt Service Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Bighorn-Desert View Water Agency</td>
<td>5.4%</td>
</tr>
<tr>
<td>2. a. County Service Area No. 70, Improvement Zone W-1</td>
<td>2.4%</td>
</tr>
<tr>
<td>b. County Service Area No. 70, Improvement Zone W-4</td>
<td>0.6%</td>
</tr>
<tr>
<td>3. Hi-Desert Water District</td>
<td>35.4%</td>
</tr>
<tr>
<td>4. Joshua Basin Water District</td>
<td>16.2%</td>
</tr>
<tr>
<td>5. Levied by Mojave Water Agency in IDM</td>
<td>* 40.0%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

* The debt service costs allocated to the Mojave Water Agency are being derived from property taxes levied in IDM.

Source: Agreement for construction, operation and financing of the Morongo Basin Pipeline Project.
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TECHNICAL MEMORANDUM ON
MONITORING PROGRAMS

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TECHNICAL MEMORANDUM

MONITORING PROGRAMS

INTRODUCTION

The purpose of this Technical Memorandum is to describe existing monitoring programs and to identify areas where monitoring should be expanded. An adequate area-wide monitoring program is essential to measure the performance of management programs.

SUMMARY OF FINDINGS

The following were found to be the major issues regarding monitoring programs within the study area:

1. **Ames Valley Basin**

   A Stipulation for Judgment was issued June 3, 1991, to end three years of litigation between Bighorn-Desert View Water Agency (BDVWA) and Hi-Desert Water District (HDWD) concerning additional groundwater pumping from the Ames Valley Basin to be used by HDWD. The delineation of the "Ames Valley Basin" in this judgment appears to be mostly within the "Means/Ames Valley Basin" as defined herein. Central to the settlement is a groundwater quality and production monitoring program. Groundwater levels are recorded monthly, water quality data reviewed annually and production data is recorded daily for selected wells.

2. **Warren Valley Basin**

   The Warren Valley Basin was adjudicated in 1977, due to an increasing overdraft problem. The court-appointed Watermaster (HDWD) monitors activities affecting the Basin.
3. **Landers Landfill**

A detection monitoring program exists for the County-owned Landers Landfill to monitor the localized contamination to the groundwater basin.

4. **USGS and SWRCB**

Both the USGS and SWRCB collect, compile, and publish data annually on water quality and levels, and reported well extractions greater than 25 acre-feet per year, respectively.

5. **State Department of Health Services (DHS)**

The State DHS monitors water systems with greater than 200 service connections.

6. **County of San Bernardino**

Limited precipitation and stream flow data are available within the study area from the County Department of Transportation/Flood Control.

The County Department of Health Services monitors water systems with less than 200 connections.

7. **Improved and Expanded Monitoring Program**

Mojave Water Agency (MWA) is currently conducting a well production survey of all active wells.

It is important for MWA to maintain and use an Agency-wide data base to develop and monitor water management programs.
EXISTING GROUNDWATER MONITORING PROGRAMS

Means/Ames Valley Basin

Mainstream Well

The HDWD and BDVWA entered into the "Ames Valley Water Basin Agreement" on January 10, 1991, for the purpose of settling litigation between the two agencies regarding extractions from a well located between the boundaries of the two agencies. The well is referred to as the "Mainstream Well" and is located in Section 24, Township 2 North, Range 5 East. The "Ames Valley Basin" is delineated in the judgment and agreement as being mostly within the "Means/Ames Valley Basin" described herein.

The Agreement placed limitations on the use of water from the Mainstream Well and all other wells owned, operated, or controlled by HDWD within the "Ames" Valley Basin. HDWD is limited to pumping 800 acre-feet per year from the Basin, and the water pumped must be used within the Basin. However, the amount of water pumped may be increased by an amount equal to 0.5 acre-feet per year for each new residential water meter installed by HDWD.

The Agreement also established a groundwater monitoring program to "mitigate any potential environmental damage to the hydrologic resources" of the Basin caused by the Mainstream Well or any other production wells. Well monitoring frequencies were established for groundwater levels, groundwater quality, and groundwater production. The program was initiated with 24 wells, including 13 producing and 11 dormant wells, with provisions for adding any new production wells and deleting wells when production is terminated.

Landers Landfill

The Landers Waste Management Facility (Landers Landfill) is located in the Means/Ames Valley Basin. The landfill is owned and operated by San Bernardino County. A detection monitoring program exists to sample and analyze data for compliance with existing waste discharge requirements.
Six monitoring wells constitute the monitoring network. Quarterly monitoring reports are published providing groundwater levels and water-quality findings.

**Warren Valley Basin**

The Warren Valley Basin is currently the sole source of water supply to the Yucca Valley area. The Basin was adjudicated in 1977, due to an increasing overdraft problem. The Superior Court appointed HDWD as Watergate and ordered the Watergate to develop a physical solution to the overdraft problem.

The "Warren Valley Basin Management Plan" (Kennedy/Jenks/Chilton, 1991) recommended the establishment of a groundwater quality monitoring program to record extractions, water levels, water quality and future basin recharge.

**USGS Well Monitoring Data**

The USGS compiles and publishes data annually on selected wells in the study area. The wells are identified by state well number (township/range/section) and latitude and longitude. The data includes groundwater levels and quality. Data printouts are available on request.

**SWRCB Groundwater Extraction Data**

The SWRCB, Division of Water Rights records the amounts of groundwater extractions annually that are filed with the Division by owners of wells which produce 25 acre-feet or more per year. The filing is pursuant to the State Recordation Act which applies to several southern California counties, including San Bernardino County.

**Department of Health Services (DHS)**

Water systems with less than 200 connections must submit water production, consumption, service connections counts, population and number and types of complaints to the County DHS. Water systems with greater than 200 service connection must submit the same data to the State DHS.
EXISTING SURFACE WATER MONITORING PROGRAMS

As discussed in the Technical Memorandum on "Tributary Watershed Issues," precipitation and stream flow data within the study areas is limited.

Precipitation Gages

The study area consists of five drainage subareas. Only four precipitation gages are located within the entire study area: two near Yucca Valley, one near Joshua Tree, and one in Johnson Valley. They are measured and maintained by San Bernardino County. See the "Tributary Watershed Issues" Technical Memorandum for locations.

Stream Flow Stations

Two stream flow stations exist within the study area: one on Yucca Creek near Yucca Valley, and one on Quail Wash south of Joshua Tree. However, the station on Yucca Creek is considered unreliable by the San Bernardino County Transportation/Flood Control Department, who maintains it. The station on Quail Wash is also maintained by San Bernardino County. See the "Tributary Watershed Issues" Technical Memorandum for location.

FUTURE MONITORING PROGRAMS

Although some monitoring programs exist, a comprehensive water resources monitoring program should be developed. This comprehensive program could utilize data generated by expanded and improved existing programs, and include additional data such as water use, well data and imported water deliveries. The program should be managed by MWA and updated annually with input from local, state, and federal agencies.
WELL DATA BASE

MWA has begun a data base to inventory data on all wells in production. It is essential for MWA to maintain and use an Agency-wide data base to develop and monitor water management programs. A program should be implemented whereby data collected by others is forwarded to MWA on a regular basis for entry to the computerized data base. In return, the data would be available to cooperating agencies. In areas outside the jurisdiction of local water agencies, MWA may collect, or arrange for others to collect, the data. This process could occur simultaneously with improving the existing monitoring programs. The following data should be considered for inclusion in the data base:

- Groundwater levels.
- Groundwater quality.
- Well data (location, depth, logs, status, owner, etc.).
- Groundwater extractions.
- Pumping tests to determine aquifer characteristics.
- Precipitation.
- Stream flow.
- Surface water quality.
- Water use.
  - Source
  - Quantity
  - Type
  - Per capita
- Imported water.
  - Deliveries
    - Total
    - By turnout
    - Use
    - Variation with time (peak, off-peak)
- Quality
- Population.
Information from the data base would be useful in the preparation of a groundwater basin study. The data could be used to evaluate groundwater overdraft and subsurface flow under changing conditions. Also, the data base would be invaluable in preparing annual reports on water conditions within MWA and its divisions. Use of some of the data would be controlled by confidentiality, such as individual driller well logs filed with the State Department of Water Resources.
EXHIBIT 5

URBAN WATER CONSERVATION ANNUAL REPORT OUTLINE

I. Executive Summary

II. Implementation Assessment

   Water Suppliers' Report
   Findings
   Comments
   Progress

   Public Advocacy Organizations' Report
   Findings
   Comments
   Progress

III. Survey Results for 199X

   Summary of Survey Responses
   Table __. Per Capita Usage [by region]
   Table __. Status of BMP Implementation [by supplier]
   Table __. Proposed Implementation Schedules

   Interpretation of Survey Responses
   Lack of Data
   Climatic Influences
   Implementation Difficulties

   Evaluation of Results

IV. Trend Analysis

   Comparison with Prior Years
   Table __. Per Capita Usage [by region]

   Projected Conservation
   Table __. Schedule of Implementation
Updated Estimates of Future Savings [by region]

Evaluation of Progress

V. Studies of Best Management Practices

   Assessment of Current BMPs
      Table ___. Evaluation of Effectiveness [by measure and region]

   Assessment of Potential BMPs
      Status of Current Studies
      Proposed Future Studies

   Revision of Lists of Current and Potential BMPs
      Additions and Deletions

   Other Modifications to MOU or Exhibits

VI. Recent Developments

   Legislative Update
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   Case Studies
      Residential Conservation
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      Legal Actions

   National Practices

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VII. Council Committee Activities

VIII. Funding Levels

IX. Staffing Levels

X. Substantiated Findings by Signatory Water Supplier in Support of Use of Exemptions

5-2
MOJAVE WATER AGENCY

Regional Water Management Plan

Johnson Valley / Morongo Basin

PHASE III

TECHNICAL MEMORANDUM

ON

ALTERNATIVE MANAGEMENT STRATEGIES

May 1993
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Preliminary Alternative Management Strategies

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EXECUTIVE SUMMARY

GENERAL

The study area addressed by Boyle is that portion of Mojave Water Agency which generally drains easterly to the Colorado River, extending from Johnson Valley to Yucca Valley as shown in Figure 1. The area lies north and east of the San Bernardino Mountains, generally sloping from the mountains to the desert valleys and playas. Elevations range from over 4,000 feet in the west slopes to about 2,400 feet in the valleys. Intermittent washes extend from the mountains and terminate in dry playas. Communities include Landers, Yucca Valley, Joshua Tree and Pioneertown. Population was about 38,000 in 1990 for the study area, with Yucca Valley being the major population center with 80 percent of the population. Major water purveyors are the Bighorn-Desert View Water Agency (BDVWA), Hi-Desert Water District (HDWD), Joshua Basin Water District (JBWD), and County Service Areas (CSA) 70 W-1 and W-4.

WATER RESOURCES

Groundwater basins in the study area include:

- Means/Ames Valley Basin
- Copper Mountain Valley Basin
- Johnson Valley Basin
- Warren Valley Basin
The study area is currently supplied solely by groundwater. There is a severe overdraft in the Warren Valley Basin, mild overdrafting in the Copper Valley Mountain Basin, and Means/Ames Valley Basin is estimated to be entering an overdraft condition. Additional sources of water are therefore necessary to balance current demands and to provide supply as water use increases. Johnson Valley Basin is not significantly developed now and plans for future development have not been filed with the County of San Bernardino to date. This basin represents a source of supply exceeding present consumptive use, although water quality may require treatment.

Mojave Water Agency (MWA) has a maximum annual entitlement to State Water Project (SWP) water of 50,800 acre feet (AF). By agreement, MWA and the five major water purveyors identified above are constructing the MBP to convey up to 7,257 acre-feet per year (AF/year) of SWP water to the study area to augment the local groundwater supply. MBP has a design capacity of 22 cfs which could potentially deliver approximately 11,000 AF/year if surplus water is available to MWA from the SWP.

MBP is scheduled to be completed in 1994. Initial use of the SWP water will be for recharge to the overdrafted groundwater basins, and could ultimately be treated and delivered as a direct source of supply. The completion of the MBP provides the study area with additional water supply to manage current water use and allow for future growth and development without jeopardizing the existing groundwater supply.

REGIONAL WATER MANAGEMENT PLAN

MWA, recognizing unaddressed water issues and the need for regionally coordinated water management within its area of jurisdiction, is preparing a regional water management plan executed in the following phases:

Phase I - Data Review and Assessment (completed)

Phase II - Issue Identification (completed)

Phase III - Alternative Management Strategies (presented herein)
Phase IV - Supplementary Technical Analysis (if necessary)

Phase V - Regional Water Management Plan

The general goal of the Regional Water Management Plan is to integrate the natural water supply with supply from the State Water Project and implement water management practices to effectively and economically meet future water needs. This will require bringing water supply and demand into hydrological balance, including eventual elimination of groundwater basin overdraft. A chief component of the plan is how best to use the imported SWP supply.

ALTERNATIVE MANAGEMENT STRATEGIES

The goal of the Alternative Management Strategies, presented herein, is to present alternative scenarios to efficiently manage the available water resources and water use. Strategies directed at increasing natural recharge of all the basins and implementation of interbasin transfers are discussed to best utilize the local water resources. Strategies to utilize the imported SWP water for supply of demands in excess of the local supplies are also discussed.

In addition, demand management, or conservation, is considered on an equal basis with the management of water resources to most efficiently and economically supply water to existing and projected development. Some, or all, of the alternative management strategies described will be incorporated into the Regional Water Management Plan for consideration by the MWA Board of Directors.

DATA ASSESSMENT

Available data was collected and reviewed in Phase I "Data Review and Assessment." Although it was determined that the data base is not complete, it appears sufficient to proceed with development of the Regional Water Management Plan. Due to the severe overdrafting of the Warren Valley Basin and overdrafting in other basins as water use increases, the Plan should be developed at this time to manage the water resources available to the study area. This will allow projects to be evaluated and implemented on a timely basis to supply water demands before a crisis condition prevails which would be adverse to the economic climate of the area.
Over the years, the groundwater basins in the study area have been defined in various configurations, sometimes completely independent of one another. Although references to the basins in these various reports are sometimes conflicting, each study has evaluated the same water bearing geologic formations. Unfortunately, a comprehensive presentation of groundwater basin characteristics has not been provided in any one report. However, good data is available in the existing reports which we feel is sufficient to proceed with the Regional Water Management Plan to begin managing the water resources in the study area.

Hydrologic data is also negligible for the study area. Although some data is available to measure rainfall within the study area and in the adjacent mountains within the tributary watershed of the groundwater basins, additional hydrological data and additional stream gage information are necessary to estimate the amount of storm water recharging the basins.

Monitoring programs are identified herein to provide a means to obtain the necessary information required to implement the Regional Water Management Plan.

PRIORITIZED STRATEGIES

Management strategies developed and compared with other programs to solve water problems are both structural and nonstructural in nature. Structural options involve facilities such as pipelines, storage tanks, treatment plants, recharge projects, wells, and groundwater basins. Nonstructural strategies include pricing policies, water allocation, capital funding, groundwater pumping assessments, and water conservation ordinances. Strategies presented herein are intended to address the issues unique to the Johnson Valley/Morongo Basin study area. Strategies addressing Agency-wide issues are included in the plan prepared by Bookman-Edmonston which will incorporate the planning effort unique to this study area.

The following is a preliminary summary of alternative strategies in order of priority to most economically and efficiently implement the Regional Water Management Plan:
1. Monitoring Program

Expand MWA's existing Well Database to include a detailed procedure to collect groundwater data. Initially, obtain this data from the major water purveyors and other agencies collecting data on groundwater conditions annually. Ultimately, expand the program to implement specific data gathering projects such as monitoring wells in specific areas of interest.

2. Developed Basins

Warren Valley Basin:

Begin recharging the Warren Valley Basin with SWP water upon completion of the MBP. Proceed with plans by HDWD and MWA to extend the MBP and construct recharge basins. There has been roughly a 30,000 AF (Fox & Egan, 1991) loss in storage which now provides immediate opportunities to make beneficial use of imported water deliveries to balance the existing hydrologic conditions of the basin and to ultimately increase water in storage.

Copper Mountain Valley Basin:

Coordinate planning of MBP extension to include transmission of SWP water to Joshua Tree Subbasin for recharge. Construct pipelines and recharge facilities to accept delivery of SWP water upon completion of the MBP.

Means/Ames Valley Basin:

Plan for facilities to recharge SWP water. Coordinate planning with BDWVA and CSA W-1. For Pioneertown Subbasin, coordinate planning of MBP extension with HDWD, JBWD and CSA W-4.
3. **Increase Natural Recharge of Groundwater Basins**

Construct streambed modifications in coordination with the County Flood Control District. Yucca Creek, Quail Wash and tributaries to them are priorities to increase recharge from local run-off in Warren Valley and Copper Mountain Valley Basins, respectively. Streambed projects in the Pipes Wash will benefit the Means/Ames Valley Basin.

4. **Groundwater Investigation**

Conduct a groundwater investigation of the basins to delineate their boundaries and to present a comprehensive description of their characteristics such as natural recharge, safe yield, inflow, outflow, storage capacity and available water in storage. Expand existing MWA/USGS study to include this study area.

5. **Interbasin Transfers**

Investigate the potential to transfer groundwater from Johnson Valley Basin to the areas of overdraft. Investigate the water quality in Johnson Valley Basin to determine if treatment is necessary and, if so, what type of treatment or blending is required to comply to DHS drinking water standards. Wells, transmission mains and possibly treatment facilities would be required to convey the water to areas of demand. Investigate development of wells in the Giant Rock and Coyote Lake Subbasins in the Copper Mountain Valley Basin to provide supply to JBWD.

6. **Conservation**

Begin a program to encourage the local purveyors to implement the following best management practices (BPM):

- Distribution system leak detection, unaccounted-for water evaluation
- Water audits
- Provide water conservation kits
- Provide public information

MWA could provide procedures, instruction and information to the purveyors to facilitate the purveyor's implementation of these BPM's.

7. **Bank SWP Water in the Mojave River Basin**

Continue banking SWP water in the Mojave River Basin on behalf of the study area. MWA extraction wells may be needed to pump banked groundwater for use when needed. Banked water could be extracted and pumped to the study area, or Mojave River agencies could directly utilize the banked groundwater and their SWP water could be delivered to the study area by the MBP.

8. **SWP/Groundwater Recharge and Banking**

In addition to recharge projects discussed in (2) above, planning of these facilities should also include capacity for banking water to compensate for the SWP periods of above-normal and below-normal yield. This banked water would provide supply at times when SWP water is cut back.

9. **MBP Operation**

Initial unused capacity in the MBP could be leased to others. The MBP Agreement allows for excess capacity to be used by participants with reimbursement for the capital, operation and maintenance cost paid to the participant with unused capacity. Other temporary leasing arrangements could be possible with other users outside of the study area.

These and other alternative management strategies are discussed in the following chapters.
GROUNDWATER

Groundwater is the sole source of supply to the study area at this time. Water demands in the populated areas overlying the Means/Ames Valley, Copper Mountain Valley and Warren Valley Basins have increased to the level where pumping of groundwater has created overdrafting in these basins.

With the availability of SWP water delivered by the MBP, the local groundwater basins become an additional asset to manage the supply of imported water. The interruptible nature of the SWP supply can be managed by banking, or storing water in the groundwater basins for use when the imported water supply is reduced due to drought or lack of delivery facilities.

As discussed in the "Groundwater Issues" Technical Memorandum, the groundwater basins in the study area have been described by various reports in differing configurations. In the middle of this controversy is the existence of the Ames Valley Basin, which was not identified in a study prepared by USGS (Lewis, 1972), the most detailed report evaluating all the groundwater basins in the study area. Upon reviewing the USGS report as well as other reports prepared by DWR and consultants since the 1950's, it was determined that the USGS (1972) report is a comprehensive study of the local groundwater supply. USGS (1972) includes evaluation of all the water bearing geologic formations, however refers to each basin and subbasin by different configurations. In general, the "Means Valley Basin" referred to by USGS (1972) with a safe yield of approximately 500 AF/year, mostly includes the "Ames Valley Basin" referred to in some DWR reports with a natural recharge of 700 AF/year. Because the Regional Water Management Plan is not a groundwater study but is intended to provide a plan to manage the water resources in the study area, a safe yield of 600 AF/year for the Means/Ames Valley Basin is assumed herein. Table 1 identifies the local groundwater basins' characteristics assumed for preparation of the Plan. Figures 2 and 3 illustrate the USGS (1972) and DWR (1975) groundwater basins' configuration, respectively.

Management of the groundwater basins includes hydrologically balancing the natural recharge, or safe yield, with consumptive use.
When evaluating and projecting water use demands, estimates are expressed as applied and net. Applied water is that amount of water actually delivered. Net water, or consumptive use, is the applied water less return flow to the groundwater basin. Consumptive use assumed herein is 50 percent of the applied water (DWR, 1981). Table 2 compares the consumptive use in each basin with the estimated safe yield and identifies the associated overdraft conditions as projected through the year 2015.

**TABLE 1**

**DESCRIPTION OF GROUNDWATER BASINS**

<table>
<thead>
<tr>
<th>Basin</th>
<th>Depth Zone (Feet)</th>
<th>Area Sq. Mi.</th>
<th>Storage (AF)</th>
<th>Safe Yield (AF/Year)</th>
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<td>20-220</td>
<td>150</td>
<td>1,200,000</td>
<td>600</td>
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<td>Copper Mountain</td>
<td>20-220</td>
<td>110</td>
<td>830,000</td>
<td>550 (3)</td>
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<tr>
<td>Johnson Valley</td>
<td>20-300</td>
<td>150</td>
<td>1,300,000</td>
<td>2,300 (4)</td>
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<td>Warren Valley</td>
<td>20-220</td>
<td>20</td>
<td>180,000</td>
<td>900 (5)</td>
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</table>

(1) Estimates of total water storage capacity estimates are presented.
(2) Safe yield is assumed to be equal to the estimated natural recharge. Subsurface inflow and outflow is unknown and is not included. Safe yield may be limited for domestic purposes due to poor water quality in some areas.
(3) Krieger & Stewart, 1984
(4) Lewis, 1972; DWR, 1975
(5) Adjudication pumping limitation
# TABLE 2

**PROJECTED CONSUMPTIVE USE AND OVERDRAFT OF DEVELOPED BASINS**

*(ACRE-FEET)*

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<td>-</td>
<td>1,330</td>
<td>940</td>
<td>1,060</td>
<td>1,200</td>
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<td>-Consumptive Use (50%)</td>
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<td>(340)</td>
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<td>550</td>
<td>750</td>
<td>860</td>
<td>1,010</td>
<td>1,180</td>
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<td>500</td>
<td>(250)</td>
<td>(360)</td>
<td>(510)</td>
<td>(680)</td>
<td>(890)</td>
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<td>-Consumptive Use (50%)</td>
<td></td>
<td></td>
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<td>900</td>
<td>2,190</td>
<td>1,080</td>
<td>1,860</td>
<td>2,180</td>
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<td>(1,290)</td>
<td>(180)</td>
<td>(960)</td>
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<td><strong>TOTAL</strong></td>
<td>2,000</td>
<td>2,940</td>
<td>3,270</td>
<td>3,810</td>
<td>4,420</td>
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*(1) Projections are made assuming no action is taken to increase supply or reduce demands. The projections presented here include agreements and transfers of water between BDWQA and HDWD.*

*(2) Production in the Copper Mountain Valley Basin currently consists of extractions from the Joshua Tree Subbasin with an estimated safe yield of 500 AF/year. The overdraft figures estimated here assume all production is from the Joshua Tree Subbasin. This overdraft may be reduced by development of production in other parts of the basin.*

---

**Increase Natural Recharge**

Natural recharge of the basins occurs from storm flow runoff. Occasionally, large storm runoff will flow over parts of the basins and collect in dry lake beds where most is lost to evaporation and therefore lost for domestic use. The infiltration of both normal and large storm flows can be increased by constructing minor modifications to stream beds and creating diversions of water from the main water course.
Streambed modifications, dikes and diversion basins could be constructed to increase recharge of storm flow runoff. MWA should continue negotiating with the County of San Bernardino Flood Control Department to accomplish this effort. Yucca Creek and Quail Wash should be considered the priority efforts to increase recharge in Warren Valley and Copper Mountain Valley basins, followed by Pipes Wash upstream near Pioneertown and upstream of Landers, although the potential quantity of captured water is not known. Studies prepared for the Warren Valley Basin have estimated that these modifications can increase recharge by about 4-5 percent per year. This equates to a total of nearly 100 AF/year for the Means/Ames Valley, Copper Mountain Valley and Warren Valley basins. These improvements often offer an economical means to increase recharge to the basins. Figure 4 identifies the tributary watersheds overlying the groundwater basins and areas to investigate for improvement to increase the recharge of the storm flows.

Interbasin Transfers

Investigation into water transfers from one basin to another could be made, however it is not considered to be a preferred source of supply. With the introduction of imported water as a source of supply, the cost to transfer and even treat groundwater with substandard quality may become cost effective in the future as compared to the future cost of buying, pumping, conveying and treating SWP imported water. SWP water, purchased, pumped and delivered to the study area is estimated to cost approximately $400 AF (Egan, 1992). Once recharged, an additional $50/AF can be assumed to pump the water from the ground, for a total of $450/AF. Treatment cost of high TDS groundwater (about 2000 mg/l) could be in the range of $500-600/AF including pumping and treatment. Pipelines would need to be constructed from either source. For example, Johnson Valley Basin's estimated 2,300 AF/year safe yield is relatively untapped due to poor water quality evidenced by high dissolved solids, sulfates and chlorides. Extraction wells, pipeline and possibly treatment facilities would be needed to utilize water transfers. Legal, institutional and environmental issues can make this study more costly.
Monitoring Program

The Agency's Ordinance No. 8 Well Information Database should be expanded to include a detailed procedure to collect groundwater data. Intervals, amount of time to "rest" wells before taking measurements and time-of-year requirements will provide more dependable results from the monitoring program. Ultimately, specific data gathering projects may be necessary to complete the database, such as drilling and monitoring wells in specific areas of interest. Automatic recording devices could be installed in abandoned wells to record data over about a period of a year without any need for attention.

CONJUNCTIVE USE

Conjunctive use is the combined management of all water resources, including local supply, imported supply and water reuse. To efficiently manage both Agency-wide water resources and resources in the study area, a conjunctive use plan should be developed and implemented.

Groundwater Basin Artificial Recharge

With the completion of the MBP scheduled for 1994, raw SWP water can be delivered to the study area for recharge of the groundwater basins to augment the local water supply. Table 3 identifies each IDM purveyor's allocation of SWP water per the MWA/IDM Participant Agreement.
TABLE 3

IMPORTED WATER ALLOCATION

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<th>Purveyor</th>
<th>AF/Year</th>
<th>Peak Delivery Rate, in CFS</th>
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<tr>
<td>Bighorn-Desert View</td>
<td>653</td>
<td>1.19</td>
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<tr>
<td>County CSA 70 W-1</td>
<td>290</td>
<td>0.53</td>
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<tr>
<td>County CSA 70 W-4</td>
<td>73</td>
<td>0.13</td>
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<tr>
<td>Hi-Desert Water District</td>
<td>4,282</td>
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<td>Joshua Basin Water</td>
<td>1,959</td>
<td>3.35</td>
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<td>District</td>
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<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>7,257</td>
<td>13.26</td>
</tr>
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Source: MWA/Improvement District "M" Participating Agreements

The Warren Valley Basin is the highest priority for recharge of imported water to balance the current extractions and, if possible, to restore groundwater levels. The Warren Valley Basin has experienced a loss of roughly 30,000 AF of storage due to accumulated overdraft conditions (Fox & Egan, 1991). In addition, the Warren Valley Basin could be utilized for seasonal storage by banking excess SWP water when it is available. MWA and HDWD are progressing with plans to extend the MBP for recharge of the Warren Valley Basin and possible future treatment for direct supply to the HDWD distribution system. Figure 5 shows a proposed alignment of extending the MBP. Figure 6 illustrates potential recharge sites in the Warren Valley Basin (CM Engineering, 1991).
MOJAVE WATER AGENCY
REGIONAL WATER MANAGEMENT PLAN
MORONGO BASIN PIPELINE FACILITIES
FIGURE 5
In addition to the Warren Valley Basin, other basins can benefit from recharging SWP water to balance groundwater extractions and water use. Copper Mountain Valley Basin is experiencing overdrafting and planning for utilization of SWP water has begun by JBWD. The proposed extension of the MBP could incorporate capacity requirements for delivery of SWP water to HDWD, JBWD and CSA W-4 service areas. Means/Ames Valley Basin is estimated to be entering an overdraft condition. Planning for recharge of SWP water by BDVWA, HDWD and CSA W-1 should begin to avoid depletion of storage.

Groundwater Banking

Available SWP water is currently being banked in the Mojave River Basin. Once the MBP is completed, banking could be planned for the local basins within IDM. At times of SWP cutbacks, this "banked" water can be extracted to supply demands. However, the basins must be managed so that the amount of banked water does not exceed the basin's ability to capture natural run-off during "wet" years.

Agencies that do not have an immediate need for imported water can benefit from the MBP capacity and bank SWP water now. This banked water could then be used in future years.

Wastewater Reuse

Wastewater reuse, or reclaimed water, is another source of supply for irrigation demands and some industrial uses. A conjunctive use program could incorporate this supply to make benefit of its use. Because the study area is currently entirely on septic systems for disposal of wastewater, the cost to construct and operate a collection system, treatment plant(s) and a dual water system could not be solely justified by the benefit of the additional water supply. However, if other factors (groundwater quality, level of service, etc.) necessitated the construction of facilities, the additional cost to reclaim and deliver recycled water could be investigated and justified as an additional source of supply.
DIRECT USE OF SWP WATER

Treated water can be provided under different alternatives such as a regional treatment plant or individual treatment plants constructed and operated by each retail purveyor. Delivery of raw water to each purveyor is probably the cost effective approach to satisfy immediate conditions, with capability of phasing implementation of treatment at a later date as demands increase.

The following are general strategies identifying the options of locating and operating a treatment plant to serve the study area:

- A regional treatment plant located adjacent to the Mojave River, to allow delivery of raw water to the Mojave River for recharge, treated water to Mojave River Basin purveyors, and treated water to the IDM agencies.

- A regional treatment plant centrally located at the terminus of the MBP would provide treated water to each agency. Facilities to deliver the treated water to each agency would be required.

- Treatment plants to be constructed and operated by each IDM agency to supply their individual needs. Timing of facilities for treatment and facilities for delivery would correspond to the need of each individual agency.

Also, a combination of the options identified above could be implemented by multiple agencies as follows:

- A treatment plant, located adjacent to BDVWA and CSA W-1 systems to serve treated water to those agencies.

- A treatment plant located adjacent to HDWD and JBWD to serve those agencies and CSA W-4.

- A regional treatment plant located at the regulating reservoir site at the terminus of the MBP serving treated water to each agency in the study area.
In each case, the MBP extension is required and additional transmission facilities are necessary. Versatility to serve both raw water and treated water to each agency would provide more flexibility in phasing of facilities and operations. The capability to recharge and bank surplus water when available will add to the supply of SWP water to the study area.

In addition, the impact of the interruptible nature of the SWP supply on operation and financing of individual agency treatment plants should be addressed. If a treatment facility is financed based on revenue from the sale of the treated water, cutbacks of SWP water delivery could severely impact the payback of financing. The interruptions of SWP water delivery will also impact the most economical sizing of a treatment facility. For example, a treatment plant sized for the entire allocation of SWP water could not be economically financed or operated if that full allocation is only available 50 percent of the time.

DEMAND MANAGEMENT

Management of water demand is an integral part of sound water resource management. The Urban Water Conservation Memorandum of Understanding (MOU) was made and entered into by urban water suppliers, public advocacy organizations and other interested groups in California. It is the intent of this MOU that signatory water suppliers develop and implement comprehensive conservation programs and acknowledge water conservation equally with other water management options. As of March 1992, there were approximately 150 signatories to the MOU. These signatories represent purveyors of over 90 percent of water used by urban development.

MWA or the local purveyors could implement specific best management practices (BMP) identified in the Urban Water Conservation Memorandum of Understanding. The following water management strategies could be implemented as part of the Regional Water Management Plan:

- MWA could request an evaluation of unaccounted-for water from each major purveyor’s system, and recommend to purveyors to perform leak detection or other testing to identify sources of lost water. Information and procedures could be supplied to the purveyors to assist their implementation.
- MWA could provide procedures and information to purveyors to perform water audits on large users.

- MWA could offer "conservation kits" including low flow shower heads, toilet bowl dams, etc. to major purveyors for their distribution. A rebate program for toilet replacement with ultra low flush models could be considered.

- Public information and education could be distributed concerning water use by community contact, advertising and instructional assistant at local schools. Brochures could be prepared and provided to the major purveyors for their distribution.

**FACILITIES**

To implement the management strategies of structural nature, new facilities would be needed. The following is a summary of facilities discussed in the preceding sections which would meet management objects.

**Increase Natural Recharge**

To increase the natural storm flow recharge to the groundwater basins, streambed modifications could be constructed. The Warren Valley Basin should receive first priority, followed by Copper Mountain Valley Basin, and then implementation in the remaining basins. MWA is currently negotiating an agreement with the County of San Bernardino Flood Control Department to accomplish this type of work. The following are facilities which could increase the natural recharge. Specific sites are identified for the Warren Valley Basin as shown on Figure 6.

- Streambed bottoms could be graded to scarify the fine, silty deposits which hinder the percolation of water. "Sugar dikes" and ditches could also be constructed. These consist of approximately 1- to 2-foot depressions excavated and 1- to 2-foot dikes constructed across the streambed to concentrate low flows and allow them to percolate. Larger flows will wash out the dikes and allow normal high flow conditions in the channel. Maintenance and reconstruction
after high flows would be necessary (Warren Valley Basin sites 1, 8, 10 and 11 on Figure 6).

- Diversion basins could be constructed to divert high flows out of the channel into a basin to allow the water to recharge at this point. These basins also act as detention basins for storm flows and therefore are a benefit to flood control (sites 1, 3, 4, 5 and 9).

- Existing flood control detention basins could be modified to increase their capacity. Inlets and outlets could be modified and depths increased. Fine, silty soil could also be removed from the bottom to increase the rate of recharge (sites 2, 6 and 7).

It is estimated that more than 40 AF/year can be captured from these types of facilities in the Warren Valley Basin (CM Engineering, 1991). This represents about a 4 to 5 percent increase in natural recharge for Warren Valley Basin. For other groundwater basins in the study area, it is anticipated that a similar increase in natural recharge could be experienced with similar facilities.

**Interbasin Transfers**

Interbasin transfers from the Johnson Valley Basin would require new extraction wells, transmission mains, and possibly treatment facilities. Size of wells and transmission mains will depend upon the amount of water to be transferred. Treatment facilities may be required to reduce high dissolved solids, sulfates and chlorides. Blending of groundwater with delivery of SWP water could also be investigated.

**Direct Use of SWP Water**

Treatment plant(s), pumping stations, and transmission mains will be needed to directly use SWP water as a source of supply. The number, size and location of treatment plants must be determined with consideration of the interruptible nature of the SWP.
Groundwater Recharge of SWP

Transmission facilities and recharge basins are necessary to convey SWP water from the terminus of the MBP for groundwater recharge in the local basins. These facilities should be sized to accommodate surplus SWP water when it is available, as well as each agency’s allocation of capacity in the MBP.

The MBP alignment is located through the middle of BDVWA and adjacent to CSA W-1 in the central portion of the study area. Extensions from the MBP to these Agencies require the least amount of transmission main. Locations and size of recharge basins and transmission mains should be investigated.

HDWD has identified a proposed alignment of an extension from the MBP as shown on Figure 5. JBWD is adjacent to this extension and would benefit by participating with HDWD in constructing this proposed facility. CSA W-4 is near the terminus of this extension. CSA W-4 would also benefit from participating in its construction rather than building another pipeline at a later date. The current planning of the MBP extension by MWA and HDWD could consider participation by JBWD and CSA W-4. This proposed alignment would allow delivery of raw SWP water to each agency for recharge and/or treatment.

Figure 6 identifies potential recharge sites for Warren Valley Basins as discussed previously to both recharge SWP water and increase natural recharge of the basins. Recharge areas within Copper Mountain Valley Basin and Means/Ames Valley Basin are illustrated on Figure 4.

FINANCIAL

Funding of future programs and facilities must address the three general financial obligations that exist for delivery of water within the study area in the Agency-wide plan:

a. Payment (for fixed and variable costs) for allocation of SWP entitlement and surplus water.
• Fixed costs paid by property taxes throughout MWA.

• Variable cost paid by user.

b. Morongo Basin Pipeline capital, operation and maintenance costs.

• 40 percent paid by property taxes on Improvement District *M.*

• 60 percent to be paid by each participating Agency.

c. Local treatment and distribution system capital, operation and maintenance costs.

• Paid for by each individual Agency.

The Morongo Basin Pipeline was designed based on a legal agreement between MWA and the participants to provide an annual delivery of SWP water up to 7,257 AF/year.

Reach 1 of the MBP, from the California Aqueduct to the Mojave River, was upsized to 54" diameter to convey SWP water to the Mojave River for recharge. This upsizing will be paid for by the Agency with funds from the 1988 Water Conservation Bonds, and provides a savings to the study area by sharing the operational and maintenance cost for this reach of the pipeline. The study area could also benefit from use of other reaches of the MBP by others in the same manner. To increase the beneficial use of the MBP and to lower the cost of the MBP to the study area, the Agency should investigate use of additional reaches by others in the Agency.

CONCLUSION

The alternative management strategies presented are preliminary and intended to facilitate discussion. This document is not the Regional Water Management Plan.
The strategies presented herein are alternatives, and are intended to represent a selection of strategies from which specific ones will be selected for inclusion in the Regional Plan. In addition, these alternative strategies will be incorporated into the environmental analysis of the Regional Water Management Plan. Preliminary prioritization is presented to indicate the phasing of implementation. As with the alternative strategies, priorities identified herein will also be evaluated with respect to input received from others.
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SUMMARY

This document addresses the unique characteristics of the Morongo Basin area for development of the Regional Water Management Plan. The information presented herein is intended as input to Bookman-Edmonston Engineering’s Agency-wide Plan and is not intended as a "stand alone" product. However, information presented herein is supported by the Issues (Phase II) and Alternative Management Strategies (Phase III) Technical Memorandums previously prepared by Boyle Engineering Corporation.

The format of this document is based on Bookman-Edmonston’s Draft Regional Management Plan dated January 1993. Reference should be made to Bookman-Edmonston’s Draft Plan.
INTRODUCTION

Boyle Engineering Corporation (Boyle) was retained by Mojave Water Agency (MWA) on November 12, 1991 to prepare a Regional Water Management Plan for the study area shown on Figure 1. This Plan is to include a technical evaluation of the physical and economic characteristics associated with the regional planning of water resources available to the study area.

The study area consists of that portion of MWA that generally drains easterly to the Colorado River and includes the Morongo Basin and Johnson Valley tributary areas. In a parallel assignment, MWA has retained Bookman-Edmonston Engineering, Inc. (Bookman-Edmonston) to prepare the plan for that portion of the Agency which flows to the Mojave River.

Boyle’s Scope of Work is to address the unique characteristics associated with the study area. Bookman-Edmonston will be responsible for the assembly of the overall, Agency-wide Plan and will incorporate Boyle’s regional Water Management Plan for the Johnson Valley/Morongo Basin area. Issues that relate to the general policies and management objectives of MWA are to be addressed by Bookman-Edmonston.

The study area is currently supplied solely by groundwater sources. Residential, commercial, industrial and recreational water demands have created overdraft conditions in the Warren Valley Basin and the Joshua Tree Subbasin of the Copper Mountain groundwater basin, the most densely populated areas. Other groundwater basins are projected to be in an overdraft condition with future growth unless another source of water supply is obtained. An additional source of supply to the study area will be the Morongo Basin Pipeline, to be constructed to deliver State Water Project (SWP) water from the California Aqueduct in 1994. Future growth in the area will require management of current groundwater supplies, water use and importation of water from the State Water Project.
WATER SUPPLIES, UTILIZATION AND DEFICIENCIES

WATER SUPPLIES

Groundwater basins in the study area include:

- Means/Ames Valley Basin
- Copper Mountain Valley Basin
- Johnson Valley Basin
- Warren Valley Basin

The study area is currently supplied solely by groundwater. There is a severe overdraft in the Warren Valley Basin, mild overdrafting in the Copper Valley Mountain Basin, and Means/Ames Valley Basin is estimated to be entering an overdraft condition. Additional sources of water are therefore necessary to balance current demands and to provide supply as water use increases. Johnson Valley Basin is not significantly developed now and plans for future development have not been filed with the County of San Bernardino to date. This basin represents a source of supply exceeding present consumptive use, although water quality may require treatment.

Mojave Water Agency (MWA) has a maximum annual entitlement to State Water Project (SWP) water of 50,800 acre feet (AF). By agreement, MWA, Bighorn Desert View Water Agency (BDVWA), High Desert Water District (HDWD), Joshua Basin Water District (JBWD), San Bernardino County Service Areas CSA W-1 and CSA W-4 are constructing the MBP to convey up to 7,257 acre-feet per year (AF/year) of SWP water to the study area to augment the local groundwater supply. MBP has a design capacity of 22 cfs.
MBP is scheduled to be completed in 1994. Initial use of the SWP water will be for recharge to the overdrafted groundwater basins, and could ultimately be treated and delivered as a direct source of supply. The completion of the MBP provides the study area with additional water supply to manage current water use and allow for future growth and development without jeopardizing the existing groundwater supply.

**Local Surface Water Supplies**

*Morongo Basin Precipitation and Stream Flow*

The location of hydrologic, or watershed boundaries of the Morongo Basin are illustrated on Figure 2. The hydrologic areas were defined by DWR as a portion of the Colorado River Basin.

Five drainage areas encompass the bulk of the Morongo Basin: Warren, Copper Mountain, Emerson, Means and Johnson. Two of the areas, Warren and Means, are contained almost completely within MWA. The watershed boundaries of the other three all extend beyond the borders of MWA.

The majority of precipitation data available to the study area is concentrated in the Yucca Valley/Joshua Tree area. There are three precipitation gages and a stream gage on Quail Wash in the Joshua Tree Hydrologic Unit including the Warren and Copper Mountain Subunits. Two other precipitation gages are located near Morongo Valley, but are outside of MWA. The only other rain gage in the study area is located in the Johnson Hydrologic Unit near Melville Lake.

Annual precipitation is highly variable within and adjacent to the Morongo Basin area. Average annual precipitation ranges from nearly 40 inches at Lake Arrowhead to about four inches at Twentynine Palms. Valley floor areas receive an average precipitation of less than eight inches annually.
Thirty two years of hydrologic data indicate that the average precipitation exceeds 0.2 inches per day only 10 days a year. Precipitation less than 0.2 inches per day does not produce significant runoff for recharge purposes. On an annual basis, precipitation less than 8 inches per year is not considered to contribute significantly to basin recharge. Table 1 summarizes average annual precipitation in the study area and at gages located near the study area.
<table>
<thead>
<tr>
<th>Station</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raywoods Flats</td>
<td>1.03</td>
<td>3.65</td>
<td>4.74</td>
<td>5.64</td>
<td>5.10</td>
<td>5.60</td>
<td>2.45</td>
<td>0.84</td>
<td>0.05</td>
<td>0.42</td>
<td>1.05</td>
<td>1.20</td>
<td>31.77</td>
</tr>
<tr>
<td>Big Bear Community Services</td>
<td>0.42</td>
<td>1.48</td>
<td>1.77</td>
<td>2.10</td>
<td>1.94</td>
<td>2.31</td>
<td>0.63</td>
<td>0.47</td>
<td>0.13</td>
<td>0.95</td>
<td>1.02</td>
<td>0.74</td>
<td>13.96</td>
</tr>
<tr>
<td>Morongo Valley</td>
<td>0.24</td>
<td>1.33</td>
<td>1.67</td>
<td>2.20</td>
<td>1.24</td>
<td>1.36</td>
<td>0.39</td>
<td>0.17</td>
<td>0.05</td>
<td>0.20</td>
<td>0.62</td>
<td>0.43</td>
<td>9.90</td>
</tr>
<tr>
<td>Cushenberry Springs</td>
<td>0.30</td>
<td>0.82</td>
<td>0.98</td>
<td>1.14</td>
<td>1.41</td>
<td>1.20</td>
<td>0.46</td>
<td>0.21</td>
<td>0.07</td>
<td>0.50</td>
<td>0.56</td>
<td>0.46</td>
<td>8.11</td>
</tr>
<tr>
<td>Yucca Valley CDF</td>
<td>0.27</td>
<td>0.66</td>
<td>0.073</td>
<td>0.97</td>
<td>1.13</td>
<td>1.03</td>
<td>0.22</td>
<td>0.19</td>
<td>0.01</td>
<td>0.24</td>
<td>0.57</td>
<td>0.41</td>
<td>6.43</td>
</tr>
<tr>
<td>Johnson Valley</td>
<td>0.23</td>
<td>0.28</td>
<td>0.49</td>
<td>0.41</td>
<td>0.39</td>
<td>0.42</td>
<td>0.14</td>
<td>0.16</td>
<td>0.04</td>
<td>0.26</td>
<td>0.47</td>
<td>0.41</td>
<td>3.70</td>
</tr>
<tr>
<td>Twentynine Palms</td>
<td>0.22</td>
<td>0.25</td>
<td>0.33</td>
<td>0.30</td>
<td>0.33</td>
<td>0.28</td>
<td>0.10</td>
<td>0.13</td>
<td>0.01</td>
<td>0.45</td>
<td>0.74</td>
<td>0.42</td>
<td>3.56</td>
</tr>
</tbody>
</table>

Storage Facilities

Storage facilities in the Morongo Basin area consist principally of above-ground tanks owned by the individual water purveyors. There are no reservoirs for the capture of surface runoff. The MBP system includes a 5 million gallon tank at the terminus of the pipeline for regulating purposes.

Wastewater

Wastewater in the Morongo Basin area is currently disposed of through septic tank systems. At the present, the downward percolation of septic tank effluent is a source of groundwater basin replenishment. Significant water quality problems, such as elevated nitrates in the groundwater, from this disposal have not been reported.

Surface Water Quality

Data on the quality of storm runoff is not available for the Morongo Basin area, largely because streams flow for only short periods after storms. Runoff quality is assumed to be similar to other surface flow from the San Bernardino Mountains, probably calcium-bicarbonate in character, low to medium hardness and total dissolved solids.

Tributary Runoff

Typical storms create little runoff to generate significant flows in the local stream courses. The precipitation generally percolates into the ground, evaporates or is used by vegetation. Flows from large storms with intensity and duration capable of creating significant runoff either recharge the groundwater basins through natural streambed percolation or flow to their terminus at dry lakes where the water is lost to evaporation. The amount of this water which flows out of the study area or is lost to evaporation in the dry lakes is not known, but is considered to be relatively small. Dry lakes in the Morongo Basin area are summarized in Table 2.
TABLE 2
PRINCIPAL DRY LAKES WITHIN THE MORONGO BASIN AREA

<table>
<thead>
<tr>
<th>Name</th>
<th>Hydrologic Area</th>
<th>Drainage Area (Sq. Miles)</th>
<th>Dry Lake Area (acres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soggy Lake</td>
<td>Johnson</td>
<td>160</td>
<td>450</td>
</tr>
<tr>
<td>Melville Lake</td>
<td>Johnson</td>
<td>160</td>
<td>850</td>
</tr>
<tr>
<td>Means Lake</td>
<td>Means</td>
<td>50</td>
<td>200</td>
</tr>
<tr>
<td>Emerson Ames/Lake</td>
<td>Emerson</td>
<td>320</td>
<td>2200</td>
</tr>
<tr>
<td>Copper Lake</td>
<td>Copper Mountain</td>
<td>200</td>
<td>3200</td>
</tr>
</tbody>
</table>

Groundwater Supplies

Description of Groundwater Basins

The groundwater basins in the Morongo area are water-bearing formations of unconsolidated sedimentary rock. Many of them are bounded or traversed by faults. Depths of the basins are generally unknown because of the lack of wells reaching bedrock. Test holes near the communities of Yucca Valley and Joshua Tree are over 750-feet deep without reaching bedrock (USGS, Lewis, 1972). Near Twentynine Palms, east of the study area, water-bearing deposits are believed to exceed 1,000 feet in thickness (USGS, Dibblee, 1968). In this area, an exploratory well hit granite at 2,106 feet (USGS, Smith, 1959).

Several dry lakes exist, mostly in the north, and overlie unconsolidated deposits. Although these areas have high groundwater levels, they are not important water sources because they are fine-grained, yield water slowly to wells, and water is typically poor in quality.

Over the years, the groundwater basins in the study area have been defined in various configurations, sometimes completely independent of one another. Although references to the basins in these various reports are sometimes conflicting, each study has evaluated the same water bearing geologic formations. Unfortunately, a comprehensive presentation of the groundwater basins' characteristics has not been provided in any one report. However, the
available data is adequate for preparation of the Regional Water Management Plan.

Figure 3 illustrates the basin boundaries as presented by USGS (Lewis, 1972) and the Ames Valley Basin Water Agreement (1991). The Ames Valley Basin Agreement between BDVWA and HDWD established a legal boundary for a groundwater basin, designated in the agreement as the Ames Valley Basin, to monitor wells in the area to observe the impact of HDWD's pumping of the Mainstream Well. Provisions of the agreement allow HDWD to extract 800 AF/year to be used only over the Ames Valley Basin. Extractions may increase at a rate of 0.5 AF/year per additional connection made. A monitoring program is also implemented to trigger reassessment of allowed pumping if groundwater levels are observed to drop and/or water quality deteriorates.

Groundwater Storage

Two groundwater basins in the Morongo area, Warren Valley and Copper Mountain Valley Basins, have experienced a long term decrease of water in storage due to overdrafting. In the Warren Valley Basin, a loss of approximately 30,000 acre feet of water in storage has been estimated. In the Copper Mountain Basin, the loss of water in storage is within the Joshua Tree Subbasin, may be in the range of 5,000 to 10,000 AF. Table 3 identifies the estimated storage capacity and recoverable groundwater in storage. The total quantity of water that may be withdrawn is estimated to be 50 percent of water in storage. The total amount of water in storage is not available because it is not possible to drain the basin completely by pumping (USGS, 1978).
TABLE 3
ESTIMATED RECOVERABLE GROUNDWATER STORAGE

<table>
<thead>
<tr>
<th>Groundwater Storage Unit</th>
<th>Storage Capacity (Acre-feet)</th>
<th>Recoverable Water in Storage (Acre-feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipes</td>
<td>120,000</td>
<td>60,000</td>
</tr>
<tr>
<td>Pioneertown</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Reche</td>
<td>240,000</td>
<td>120,000</td>
</tr>
<tr>
<td>Giant Rock</td>
<td>180,000</td>
<td>90,000</td>
</tr>
<tr>
<td>Coyote Lake</td>
<td>130,000</td>
<td>65,000</td>
</tr>
<tr>
<td>Joshua Tree</td>
<td>140,000</td>
<td>65,000</td>
</tr>
<tr>
<td>Warren Valley</td>
<td>100,000</td>
<td>35,000</td>
</tr>
<tr>
<td>Johnson Valley</td>
<td>250,000 *</td>
<td>125,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,160,000</strong></td>
<td><strong>555,000</strong></td>
</tr>
</tbody>
</table>

* Excludes Fry and Rattlesnake Valleys.


---

**Safe Yield of Groundwater Basins**

Several definitions of "safe yield" are used, often depending on the method of computation. Among the generally accepted definitions are:

1. The yield equal to the long-term average annual net natural recharge. This definition is used for development of the Plan.

2. The yield equal to the minimum annual recharge.
3. In recent years, the term "perennial yield" has come into common use. It can be defined as the rate at which water can be withdrawn perennially under specific physical conditions (land use, import and export of water and wastewater, well pumping and recharge patterns, and amounts of usable storage available, etc.) without producing an undesirable result such as land subsidence, degradation of water quality, uneconomical pumping lifts, etc.

Table 4 summarizes the assumed safe yield estimates of the groundwater basins in the Morongo Basin area used for preparation of the Plan.

<table>
<thead>
<tr>
<th>Basin</th>
<th>Safe Yield (1) (Af/Year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Means/Ames</td>
<td>600</td>
</tr>
<tr>
<td>Copper Mountain</td>
<td>550 (2)</td>
</tr>
<tr>
<td>Johnson Valley</td>
<td>2,300 (3)</td>
</tr>
<tr>
<td>Warren Valley</td>
<td>900 (4)</td>
</tr>
</tbody>
</table>

(1) Safe yield is assumed to be equal to the estimated natural recharge. Subsurface inflow and outflow is unknown and is not included. Safe yield may be limited for domestic purposes due to poor water quality in some areas.

(3) Lewis, 1972; DWR, 1975.
(4) Adjudication pumping limitation.

Groundwater Quality

The groundwater quality of existing production wells throughout the study area is generally suitable for existing beneficial uses, mostly residential with some commercial, including golf course irrigation. There are localized areas where salinity or individual constituents exceed recommended limits. Fluoride exceeds the recommended 1.4 mg/l in some wells in Means/Ames Valley, Copper Mountain, Warren Valley and Johnson Valley Basins. The upper limit of 500
mg/l for total dissolved solids (TDS) and 250 mg/l for chloride and sulfate are exceeded in some wells in Johnson Valley, Means/Ames Valley and Copper Mountain Valley Basins.

There has not been a trend of declining water quality apparent from available data, however water quality should be monitored to identify any changes.

**State Water Project**

MWA has a maximum annual entitlement of SWP water of 50,800 acre-feet. Under the SWP contract, MWA can obtain surplus and transfer water when available. Requests for entitlement water is subject to contract shortage provisions which were imposed in the 1986-1992 drought. Improvement District "M" (IDM) is allocated up to 7,257 acre-feet per year of SWP water. IDM was formed within MWA Division #2 to establish a funding mechanism to construct facilities to import and pay for water to the study area. The imported water project participants in IDM have entered into an agreement with MWA. Agreement allotment percentages for repayment of project capital and fixed O & M costs and corresponding flow capacities for each participant are presented in Table 5.

**Morongo Basin Pipeline**

In 1991, final design commenced on the Morongo Basin Pipeline, which will convey water from the California Aqueduct to Improvement District "M" as shown on Figure 4. The Morongo Basin Pipeline will extend approximately 70 miles from a new turnout near the Antelope Valley Siphon to a terminal reservoir north of Yucca Valley. The pipeline is sized for a peak delivery rate of 22 cfs. The terminal reservoir will have a capacity of 5 MG and a minimum water surface elevation of 3,500 feet.

There will be two turnouts along the Morongo Basin Pipeline. One, for BDVWA and one for CSA W-1. Turnouts will be provided at the terminal reservoir for HDWD and JBWD.
<table>
<thead>
<tr>
<th>Purveyor</th>
<th>Repayment Allotment Percent</th>
<th>Maximum AF/YR</th>
<th>Peak Delivery Rate, in CFS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bighorn-Desert View Water Agency</td>
<td>5.4</td>
<td>653</td>
<td>1.19</td>
</tr>
<tr>
<td>County CSA 70 W-1</td>
<td>2.4</td>
<td>290</td>
<td>0.53</td>
</tr>
<tr>
<td>County CSA W-4</td>
<td>0.6</td>
<td>73</td>
<td>0.13</td>
</tr>
<tr>
<td>Hi-Desert Water District</td>
<td>35.4</td>
<td>4,282</td>
<td>7.83</td>
</tr>
<tr>
<td>Joshua Basin Water District</td>
<td>16.2</td>
<td>1,959</td>
<td>3.35</td>
</tr>
<tr>
<td>Property Taxes</td>
<td>40.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>100</strong></td>
<td><strong>7,257</strong></td>
<td><strong>13.26</strong></td>
</tr>
</tbody>
</table>

Source: MWA/Improvement District "M" Participant Agreements

WATER UTILIZATION

Water use in the Morongo area is primarily for domestic use with some commercial and industrial uses. There is no significant agricultural use in the Morongo Basin.
Population

Population in the Morongo Basin area has grown from about 3,000 in the 1950's to nearly 40,000 in 1991. Estimates of future population were developed from Southern California Association of Governments (SCAG) projections. Growth of population is projected to increase to approximately 83,000 in 2015.

Urban Use

Per capita water use experienced in 1991 was 130 gallons per capita per day (GPCPD) based on applied water. Consumptive use, estimated to be 50 percent of applied, was approximately 65 GPCPD in 1991. Table 6 identifies the projected water use and population for the Morongo Basin area through the year 2015.
### TABLE 6

**PROJECTED WATER USE, POPULATION**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Means/Ames Valley</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1)</td>
<td>2.50</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-Production Demand</td>
<td>694</td>
<td>2,150</td>
<td>(4) 1,870</td>
<td>2,110</td>
<td>2,390</td>
<td>2,700</td>
</tr>
<tr>
<td>-Consumptive Use (50%)</td>
<td>- (2)</td>
<td>1,330</td>
<td>(4) 940</td>
<td>1,060</td>
<td>1,200</td>
<td>1,350</td>
</tr>
<tr>
<td>-Population</td>
<td>4,700</td>
<td>5,200</td>
<td>5,900</td>
<td>6,700</td>
<td>7,600</td>
<td>8,600</td>
</tr>
<tr>
<td><strong>Copper Mtn. Valley</strong></td>
<td>3.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-Production Demand</td>
<td>1,509</td>
<td>1,720</td>
<td>2,020</td>
<td>2,360</td>
<td>2,780</td>
<td>3,260</td>
</tr>
<tr>
<td>-Consumptive Use (50%)</td>
<td>750</td>
<td>860</td>
<td>1,010</td>
<td>1,180</td>
<td>1,390</td>
<td>1,630</td>
</tr>
<tr>
<td>-Population</td>
<td>10,200</td>
<td>11,500</td>
<td>13,300</td>
<td>15,400</td>
<td>17,900</td>
<td>20,800</td>
</tr>
<tr>
<td><strong>Warren Valley Basin</strong></td>
<td>3.25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-Production Demand</td>
<td>3,582</td>
<td>2,660</td>
<td>(4) 3,710</td>
<td>4,350</td>
<td>5,110</td>
<td>5,890</td>
</tr>
<tr>
<td>-Consumptive Use (50%)</td>
<td>2,190</td>
<td>1,080</td>
<td>(4) 1,860</td>
<td>2,180</td>
<td>2,550</td>
<td>3,000</td>
</tr>
<tr>
<td>-Population</td>
<td>24,300</td>
<td>27,700</td>
<td>32,700</td>
<td>38,500</td>
<td>45,300</td>
<td>53,300</td>
</tr>
<tr>
<td><strong>Johnson Valley Basin</strong></td>
<td>(3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-Population</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-Production Demand</td>
<td>5,785</td>
<td>6,530</td>
<td>7,600</td>
<td>8,820</td>
<td>10,280</td>
<td>11,950</td>
</tr>
<tr>
<td>-Consumptive Use</td>
<td>2,940</td>
<td>3,270</td>
<td>3,810</td>
<td>4,420</td>
<td>5,140</td>
<td>5,980</td>
</tr>
<tr>
<td>-Population</td>
<td>39,200</td>
<td>44,400</td>
<td>51,900</td>
<td>60,600</td>
<td>70,800</td>
<td>82,700</td>
</tr>
</tbody>
</table>

(1) Means/Ames Valley Basin 1991 extractions and assumed growth rates:

- 438 AF (BDWFA) @ 2.25%
- 208 AF (CSA 70 W-1) @ 3.00%
- 24 AF (HDWD) @ 3.25%
- 24 AF (CSA 70 W-4) @ 2.00%
- 694 AF @ 2.53%

(2) The consumptive use in Means/Ames Valley Basin for 1991 is negligible, if not a surplus, due to return flows of water produced in Warren Valley Basin and applied over the Means/Ames Valley Basin. Warren Valley Basin’s consumptive use is in excess of 50 percent due to the “export” of this flow applied over Means/Ames Valley Basin. It is assumed that 300 AF/year produced from Warren Valley Basin will have a consumptive use component of 100 percent due to its use outside of the basin (600 AF/year based on the “Ames Valley Basin Agreement”).

(3) Although there was no reported production in the Johnson Valley Basin in 1991, some use is known to exist, however, it is considered negligible for this study. Scattered population exists within Johnson Valley which has not been quantified.

(4) Accounts for the 500 AF/year emergency drought supply from BDWFA to HDWD and the start-up of the Mainstream Well in Means/Ames Basin which will reduce production in Warren Valley Basin by 800 AF/year and increase production in Means/Ames Valley Basin by the same amount.
DEFICIENCIES IN WATER SUPPLIES

Currently, groundwater is the sole source of supply to the Morongo Basin area. When water use exceeds the water supply, overdrafting occurs in the groundwater basins. Presently, overdrafting is being experienced in the Warren Valley Basin and the Joshua Tree Subbasin of the Copper Mountain Valley Basin. Table 7 illustrates the projected consumptive use and associated deficiency of groundwater supply to meet water use. However, with the completion of the Morongo Basin Pipeline to convey imported water, the combined management of the local groundwater supply and the State Project imported water supply is estimated to meet the needs of the study area through 2015.
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Means/Ames Valley</td>
<td>600</td>
<td>-</td>
<td>1,330</td>
<td>940</td>
<td>1,060</td>
<td>1,200</td>
<td>1,350</td>
</tr>
<tr>
<td>-Consumptive Use (50%)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-Surplus (overdraft)</td>
<td></td>
<td></td>
<td>(730)</td>
<td>(340)</td>
<td>(460)</td>
<td>(600)</td>
<td>(750)</td>
</tr>
<tr>
<td>Copper Mtn. Valley</td>
<td>550</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Joshua Tree Subbasin</td>
<td>500</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-Consumptive Use (50%)</td>
<td></td>
<td>750</td>
<td>860</td>
<td>1,010</td>
<td>1,180</td>
<td>1,390</td>
<td>1,630</td>
</tr>
<tr>
<td>-Surplus (overdraft)</td>
<td>(250)</td>
<td>(360)</td>
<td>(510)</td>
<td>(680)</td>
<td>(890)</td>
<td>(1,130)</td>
<td></td>
</tr>
<tr>
<td>Warren Valley Basin</td>
<td>900</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>-Consumptive Use (50%)</td>
<td></td>
<td>2,190</td>
<td>1,080</td>
<td>1,860</td>
<td>2,180</td>
<td>2,550</td>
<td>3,000</td>
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<tr>
<td>-Surplus (overdraft)</td>
<td>(1,290)</td>
<td>(180)</td>
<td>(960)</td>
<td>(1,280)</td>
<td>(1,650)</td>
<td>(2,100)</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>2,000</td>
<td>(2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>-Consumptive Use</td>
<td>2,940</td>
<td></td>
<td>3,270</td>
<td>3,810</td>
<td>4,420</td>
<td>5,140</td>
<td>5,980</td>
</tr>
<tr>
<td>-Surplus (overdraft)</td>
<td>(1,540)</td>
<td>(1,270)</td>
<td>(1,810)</td>
<td>(2,420)</td>
<td>(3,140)</td>
<td>(3,980)</td>
<td></td>
</tr>
</tbody>
</table>

(1) Projections are made assuming no action is taken to increase supply or reduce demands. The projections presented here include agreements and transfers of water between BDVWA and HDWD.

(2) Production in the Copper Mountain Valley Basin currently consists of extractions from the Joshua Tree Subbasin with an estimated safe yield of 500 AF/year. The overdraft figures estimated here assume all production is from the Joshua Tree Subbasin. This overdraft may be reduced by development of production in other parts of the basin.
ADJUDICATION OF WATER RIGHTS

The Warren Valley groundwater basin was adjudicated in 1977 due to overdrafting. In the adjudication judgment, Hi Desert Water District was appointed the Watermaster to manage the groundwater basin to eliminate the overdraft conditions. Currently, cumulative pumping from the Warren Valley Basin is limited to 900 AF/year by the Judgement.
POTENTIAL ADDITIONAL WATER SUPPLIES

MAXIMIZING LOCAL WATER SUPPLIES

With the introduction of imported water to the Morongo Basin area, local water supplies must be maximized to provide a cost effective water supply to the consumer.

Increase Natural Recharge

Studies performed for the Warren Valley basin have indicated that an additional 4 percent of the estimated safe yield of that groundwater basin could be obtained by increasing the natural recharge of storm flows with streambed modifications and detention basins. However, this effort consisted of streambed modifications in approximately five locations to capture an average of about 30 AF/year.

Because storm flow data are not available for the significant washes in the Morongo Basin, a firm estimate of increased natural recharge, or increase of supply, cannot be made. However, if it is assumed that a 4 percent increase in natural recharge could be generated by these types of streambed modifications throughout the study area. This would increase the supply from the Copper Mountain Valley, Means/Ames Valley, and Warren Valley Basins of approximately 80 AF/year. The level of effort to accomplish this amount of increased recharge would be considerable and not considered cost effective on its own merits. However, coupled with alternatives to artificially recharge State Project water in the streambeds, it may provide a side benefit.

Groundwater Basin Evaluation

To maximize the management of the local groundwater supply, a groundwater evaluation is needed to provide comprehensive estimates of the groundwater basin characteristics such as estimated recharge, inflow, outflow, storage capacity and available water in storage.
Groundwater Transfers

Transferring water from one groundwater basin to be used in another is a groundwater interbasin transfer.

The estimated safe yield of the Johnson Valley basin is 2,300 AF/year. However, poor water quality exists in most areas ranging from high total dissolved solids in the northern portion to high fluorides in the southeasterly portion of the basin. Water production is minor.

A possible method to utilize a portion of Johnson Valley basin’s safe yield would be to blend inferior quality groundwater with State Project water in the Morongo Basin Pipeline. Possibly 500 AF/year, depending on blending requirements and impact to other users, could be utilized to maximize the use of the MBP, help stabilize the SWP supply and utilize this inexpensive source of water.

Investigation of legal, institutional and physical constraints would be required prior to implementation to determine the impact, if any, on existing water producers in the vicinity. In addition, detailed investigations of well sites and groundwater quality must be performed to confirm the feasibility of this alternative. Although constraints may initially make this alternative unattractive, it could be included in the Plan for consideration in subsequent phases due to the potential significant, low cost supply.

MAXIMIZING SWP SUPPLY

Conjunctive use programs could be implemented in the Morongo Basin area to stabilize the supply from the State Water Project.

Recharge Potential

Local groundwater basins, primarily the Warren Valley Basin, Joshua Tree Subbasin and the Means/Ames Valley Basin, provide opportunities to store SWP water, when available, for use during future cutbacks. It is estimated that the Warren Valley basin has experienced an overdraft of 30,000 acre feet. Overdraft has also occurred in the
Joshua Tree Subbasin, reducing groundwater storage on the order of 5,000 to 10,000 acre feet.

A study was performed by USGS (1978) evaluating the potential recharge and banking of SWP water in the Johnson Valley groundwater basin. This study offered preliminary conclusions as to sites of recharge basins and extraction wells in the southeastern portion of the basin. Due to groundwater quality, this alternative does not appear to be optimistic at this time and will not be considered in the Plan.

**Recharge and Distribution Facilities**

Figure 5 illustrates distribution facilities from the Morongo Basin Pipeline to potential recharge sites in the Warren Valley Basin, Joshua Tree Subbasin, Means/Ames Valley Basin and Johnson Valley Basin. These facilities would be sized to accommodate surplus State Project supply when available. Figures 6 and 7 illustrate two types of typical recharge basins. Recharge of SWP water directly into existing streambeds may also be considered to reduce the capital, operation and maintenance cost, although further investigation is required to determine its feasibility.

The Means/Ames Valley Basin is projected to be entering an overdraft condition due to pumping by BDVWA, HDWD and CSA W-1. To facilitate the management of this groundwater basin, an agreement between the three water purveyors should be established to control and account for pumping and recharge activities.

In addition to the availability of SWP water, physical constraints to recharge SWP water include a peak MBP capacity of 22 cfs and limited storage capacity of the groundwater basins. Planning of recharge facilities should include further evaluation of storage capacity, infiltration rates, and selection and sizing of site and facilities.

**SWP Water Treatment**

Figure 8 illustrates the SWP water treatment plant alternatives. These alternatives range from a Regional Treatment Plant to individual facilities constructed by each agency. Planning of facility design and financing should account for the interruptible nature of the SWP supply.
ASSUMED CRITERIA

- PERCOLATION RATE = 2 FEET/DAY = 1 CFS/ACRE
- ALLOW ONE HALF TO LIE FALLOW
- TOTAL LAND REQUIREMENTS = WETTED LAND \times 1.25
- DEPTH OF WATER = 3 TO 4 FEET
- DEPTH OF BASIN = 8 FEET
ASSUMED CRITERIA

- PERCOLATION RATE = 2' PER DAY
  = 1 CFS PER ACRE
- ALLOW ONE HALF TO LIE FALLOW
- TOTAL LAND REQUIREMENTS = WETTED ACRES x 1.25
- LEVEE - 3 FEET
- WATER FLOW VELOCITY THROUGH LEVEE SYSTEM
  = MAX. 3 ft/sec. (DEPENDING ON SOIL LEVEE/BANK STABILIZATION)
- DEPTH OF WATER = 1 TO 2 FEET
- DEPTH OF BASIN = APPROXIMATELY 8 FEET

NOTE:
MOVEMENT OF WATER REDUCES
THE BUILD-UP OF ALGAE GROWTH
WHICH MAINTAINS PERCOLATION RATE.
Water Banking

Water banking could be performed by the local purveyors in the Morongo area groundwater basins. Figure 9 shows an illustration of banking State Project water for use at a later time. The local purveyors could use the groundwater storage capacity to bank imported water when it becomes available and withdraw this banked water at times of cutbacks. Purveyors can also take advantage of the available seasonal supply in winter months for use during the summer months.

MWA could also bank imported water locally as a part of an agency wide program to increase the supply from the SWP. An agreement with the participants of the Morongo Basin Pipeline for use of the pipeline would be required.
ASSUMED CONJUNCTIVE USE CRITERIA

- Recharge SWP water into groundwater basins
- Consumptive use must not be greater than the net natural recharge plus SWP water recharged
- Avoid long-term overdraft
- Recharge & bank additional SWP water (seasonal and/or wet years) in addition to water recharge required to balance extractions
- Extract banked water during summer months or times of cutbacks on the SWP system

MOJAVE WATER AGENCY
REGIONAL WATER MANAGEMENT PLAN
CONJUNCTIVE USE AND BANKING
FIGURE 9
DEMAND REDUCTION

WATER CONSERVATION

See Bookman Edmonston's discussion.

WATER ALLOCATION

The Morongo Basin Pipeline (MBP) agreement allocates up to 7,257 AF/year of SWP water to the project participants in the Morongo area when MWA's total SWP entitlement is available. This allocation and maximum peak supply deliveries are subject to reduction per the MBP agreement, which is consistent with the State Water Supply Contract.

Allocation of the 7,257 AF/year supply between MBP participants is the basis for financial responsibility of constructing, operating and maintaining the MBP. If a participant has unused MBP capacity or SWP allotment in any one year, MWA will, at the request of the participant, transfer the unused supply at a cost at least equal to the participant's fixed, variable and any directly related costs associated with the capacity of facilities to be credited to that participant. MBP participants will have the first option to take delivery of the unused allotment or MBP capacity.

WATER PRICING

The MBP agreement provides that MWA shall fix charges to the MBP participants to produce revenues to MWA equal to the amounts of fixed and variable cost of transporting SWP water from the California Aqueduct to the Morongo Basin area.
WATER SERVICE RESPONSIBILITIES

MORONGO BASIN PIPELINE

For the Morongo basin area, the water service responsibilities of MWA and the MBP participants are identified in the MBP agreement. In summary, the participants each own capacity in the facilities, and therefore collectively own the MBP project. Upon completion of construction, MWA may contract with any public agency or private company for the operation and maintenance of the project or any specific reach thereof.

MWA BANKING

As part of this Regional Water Management Plan, MWA may consider the possibility of purchasing and banking SWP water in the Morongo area as a part of a conjunctive use program. MWA could also bank water in the Mojave River Basin on behalf of the Morongo area. At times of SWP cutbacks, 1) users over the Mojave River Basin would extract and use this banked water, and an equal amount of their SWP water allocation would be delivered to the Morongo area via the MBP, and/or 2) extractions from the Mojave River Basin by MWA could be delivered to the Morongo area via the MBP.
REGIONAL WATER MANAGEMENT PLAN ELEMENTS

ELEMENTS ELIMINATION OF GROUNDWATER OVERDRAFT

For the Morongo Basin area, groundwater overdraft can be eliminated by efficient use of SWP water allocated to IDM upon the completion of the Morongo Basin Pipeline. Supply can be further supplemented by more efficient use of local supplies. The program elements to eliminate existing and future overdraft are summarized as follows:

1. **Artificial Recharge**: Artificial recharge of SWP water to hydrologically balance the groundwater basins will eliminate overdraft and become the basis of conjunctive use programs to maximize the supply from the SWP. Local water purveyors would be responsible for construction of additional extraction wells when necessary to meet demands. For the Means/Ames Valley Basin, an agreement between BDVWA, HDWD and CSA W-1 would facilitate management of the groundwater basin, control overdraft and effectively recharge and bank SWP water. Because multiple agencies are pumping from the same basin, this agreement would act as the basis for the groundwater basin management. Otherwise, it appears an over-draft condition may be created if production, recharge and banking is not managed in an agreed plan by each agency.

2. **Monitoring Program**: Due to minimal geologic and hydrologic data, a monitoring program is necessary to maximize the use of local supplies. MWA's existing Well Monitoring Program could be expanded.

3. **Groundwater Evaluation**: A groundwater evaluation should be performed to better define the local groundwater basin characteristics such as safe yield, inflow, outflow, recharge, storage capacity, and water in storage. Current USGS studies being prepared for MWA and USMC Twentynine Palms may be expanded to include the Morongo Basin area. Better definition will maximize the management of the local supply.

4. **Conservation**: Conservation has been effective in the Morongo Basin area, however increased effort will benefit the effort to reduce groundwater overdraft.
5. **SWP Water Treatment:** Treatment and direct delivery of SWP water would be vulnerable to interruptions in deliveries and require additional capital, operation and maintenance expenditures. Although a regional treatment plant concept does not appear to be feasible, individual purveyors may benefit from constructing and operating individual treatment facilities.

6. **Conjunctive Use/Banking:** A conjunctive use and banking program will maximize the SWP supply. This program could be implemented by MWA and/or the local purveyors.

An effective conjunctive use program will initially recharge the SWP water. Later, if treatment plants become feasible, the program will allow for recharge of excess SWP water not treated.

**STRUCTURAL PLAN ELEMENTS**

**Water Conveyance and Distribution Facilities**

Upon completion of the Morongo Basin Pipeline to convey SWP water from the California Aqueduct to the Morongo Basin area, distribution facilities should be planned to coincide with the earliest possible delivery of SWP water and maximize the use of the MBP. The following are facilities which would be needed:

1. **HDWD extend the MBP and construct recharge basins in the Warren Valley groundwater basin.**

2. **Element 1 plus participation by JBWD in the MBP extension and construction of recharge basins in the Joshua Tree Subbasin of the Copper Mountain Valley groundwater basin.**

3. **Construct distribution facilities and recharge basins in the Means/Ames Valley groundwater basin.**
4. Construct a distribution pipeline from HDWD's existing system to Pioneertown to convey treated water to CSA W-4 in exchange for W-4 SWP allotment.

5. Construct extraction wells in the Johnson Valley groundwater basin to transfer water, blended with SWP water, via the MBP to others.

6. Construct individual treatment facilities for direct use of SWP water by purveyors.

**Monitoring Facilities**

1. Install 4" rain gages (if old gage is inadequate) and evaporation pans at the existing San Bernardino County Department of Transportation/Flood Control climate sites located in Yucca Valley, Johnson Valley, Twentynine Palms county yard, and Morongo Valley.

2. Install 4" precipitation gages at new sites in Landers and west of Rim Rock (toward Baldwin Lake) to improve precipitation input.

3. Install stream gages in Yucca Creek, Quail Wash (if old gage is inadequate) and Pipes Wash.

4. Monitor producing wells. Utilize non-producing wells or drill monitoring wells in areas where producing wells do not exist.

**COSTS**

Table 8 summarizes the capital, operation and maintenance costs for each of the Distribution Facilities. The basis and break down of costs for each element is presented in the Appendix.

The cost estimates presented herein are order-of-magnitude estimates for comparison purposes only and have been completed prior to any engineering design. Such estimates should be viewed as having an accuracy of plus or minus 30 to 40 percent.
<table>
<thead>
<tr>
<th>Alternative Number</th>
<th>Description</th>
<th>Supply AF/Year</th>
<th>Capital Cost</th>
<th>Annual O &amp; M Cost</th>
<th>Purchase of Water (a) $/AF</th>
<th>Capital Recovery (b) $/AF</th>
<th>Total Cost of O &amp; M $/AF</th>
<th>Total Cost of Supply $/AF</th>
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</thead>
<tbody>
<tr>
<td>(1)</td>
<td>Construct MBP extension, recharge basins in Warren Valley Basin (15 cfs)</td>
<td>4,355</td>
<td>$9,500,000</td>
<td>$44,000</td>
<td>$411</td>
<td>$206</td>
<td>$10</td>
<td>$627</td>
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<tr>
<td>(2)</td>
<td>Construct extension from Alt (1) to Joshua Tree, recharge basins in Joshua Tree Subbasin (10 cfs)</td>
<td>1,959</td>
<td>2,800,000</td>
<td>20,000</td>
<td>411</td>
<td>135</td>
<td>10</td>
<td>556</td>
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<tr>
<td>(3)</td>
<td>Construct Distribution and recharge facilities in Means/Ames Basin (10 cfs)</td>
<td>943</td>
<td>2,200,000</td>
<td>9,400</td>
<td>411</td>
<td>220</td>
<td>10</td>
<td>641</td>
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<tr>
<td>(4)</td>
<td>Construct potable distribution line from HDWD’s system to Pioneertown, CSA W-4</td>
<td>73</td>
<td>820,000</td>
<td>23,000</td>
<td>500</td>
<td>1,060</td>
<td>309</td>
<td>1,870</td>
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<tr>
<td>(5)</td>
<td>Construct extraction wells in Johnson Valley Basin, transfer/blend via MBP</td>
<td>500</td>
<td>400,000</td>
<td>89,000</td>
<td>0</td>
<td>76</td>
<td>178</td>
<td>253</td>
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<tr>
<td>(6)</td>
<td>Construct individual treatment plants for direct use of SWP water (Assume supply = 1/2 SWP water allocation)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Individual Agency Treatment Plants</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- BDVWA (1 mgd)</td>
<td>330</td>
<td>1,300,000</td>
<td>23,000</td>
<td>411</td>
<td>372</td>
<td>70</td>
<td>853</td>
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<tr>
<td></td>
<td>- CSA W-1 (0.2 mgd)</td>
<td>145</td>
<td>600,000</td>
<td>32,000</td>
<td>411</td>
<td>391</td>
<td>220</td>
<td>1,022</td>
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<td></td>
<td>- HDWD (1 mgd)</td>
<td>2,140</td>
<td>2,300,000</td>
<td>240,000</td>
<td>411</td>
<td>101</td>
<td>112</td>
<td>624</td>
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<tr>
<td></td>
<td>- JBWD (0.5 mgd)</td>
<td>980</td>
<td>1,300,000</td>
<td>120,000</td>
<td>411</td>
<td>125</td>
<td>118</td>
<td>654</td>
</tr>
<tr>
<td></td>
<td>Multi-Agency Treatment Plants</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Regional Treatment Plant (3 mgd)</td>
<td>3,630</td>
<td>9,400,000</td>
<td>510,000</td>
<td>411</td>
<td>244</td>
<td>141</td>
<td>796</td>
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<tr>
<td></td>
<td>- HDWD and JBWD Treatment Plant (1.5 mgd)</td>
<td>3,120</td>
<td>3,600,000</td>
<td>350,000</td>
<td>411</td>
<td>109</td>
<td>112</td>
<td>632</td>
</tr>
</tbody>
</table>

(a) The cost of purchasing and transporting SWP water has been estimated to be $411/AF (Egan, 1992).
(b) 20 years, 7%/year, A/P = .0944
FINANCING ALTERNATIVES

Financial issues for the Morongo Basin area were supplied to Bookman-Edmonston for incorporation into its development of financing alternatives for the Regional Water Management Plan.
RECOMMENDED REGIONAL WATER MANAGEMENT PLAN

As stated in Bookman-Edmonston's Draft Plan dated January 1993, the Regional Water Management Plan will have the following broad objectives:

- Eliminate overdraft of groundwater basins.
- Meet future water demands.
- Provide maximum flexibility in managing both quantity and quality of local and imported water supplies.

The following presents the recommended phasing of the Regional Water Management Plan elements unique to the Morongo Basin study area.

PHASE 1

A. Recharge groundwater basins to bring them into hydrologic balance.

- Construct distribution and recharge facilities in Warren Valley Basin, Joshua Tree Subbasin of the Copper Mountain Valley Basin and the Means/Ames Valley Basin.
- In addition to hydrologically balancing the overdrafted basins, begin restoration of groundwater levels and water in storage with additional SWP water when available.

B. Establish an effective monitoring program in the Morongo Basin area to provide necessary information to efficiently manage water resources.

- Install hydrologic equipment at existing and new sites.
- Establish a data gathering procedure to increase the dependability of data received from others.

- Establish specific wells in critical locations to monitor groundwater conditions.

C. Implement an Agency-wide water conservation plan.

**PHASE II**

A. Define the basins' characteristics to better manage the groundwater supply and future conjunctive use programs.

B. Establish a conjunctive use and banking program with SWP water in the local and Mojave River groundwater basins.

C. Investigate and implement, if feasible, groundwater interbasin transfers from the Johnson Valley groundwater basin. Groundwater to be blended and transported with SWP water in the Morongo Basin Pipeline.

D. Construct a distribution pipeline from HDWD’s system to deliver potable water to Pioneertown, CSA W-4.

**PHASE III**

A. MWA coordinate with individual agency to construct water treatment plants as necessary to treat SWP water.
APPENDIX
BASIS FOR COST ESTIMATING

ENR CCI = 6,349\(^{(1)}\)

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit Cost</th>
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</thead>
<tbody>
<tr>
<td>1. Recharge Basins - Grading</td>
<td>$4.00/C.Y.</td>
</tr>
<tr>
<td>2. Pipelines</td>
<td></td>
</tr>
<tr>
<td>6&quot;</td>
<td>$35/L.F.</td>
</tr>
<tr>
<td>8&quot;</td>
<td>$40/L.F.</td>
</tr>
<tr>
<td>12&quot;</td>
<td>$50/L.F.</td>
</tr>
<tr>
<td>16&quot;</td>
<td>$65/L.F.</td>
</tr>
<tr>
<td>18&quot;</td>
<td>$70/L.F.</td>
</tr>
<tr>
<td>20&quot;</td>
<td>$75/L.F.</td>
</tr>
<tr>
<td>24&quot;</td>
<td>$85/L.F.</td>
</tr>
<tr>
<td>27&quot;</td>
<td>$95/L.F.</td>
</tr>
<tr>
<td>30&quot;</td>
<td>$105/L.F.</td>
</tr>
<tr>
<td>3. Wells, equipped</td>
<td>$250,000 each</td>
</tr>
<tr>
<td>4. Property Cost</td>
<td>$15,000/acre</td>
</tr>
<tr>
<td>(included in Recharge Basins' Cost only)</td>
<td></td>
</tr>
<tr>
<td>5. Operating Cost</td>
<td></td>
</tr>
<tr>
<td>- Water Treatment</td>
<td>$70/AF</td>
</tr>
<tr>
<td>- Recharge</td>
<td>$10/AF</td>
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<tr>
<td>- Power Cost</td>
<td>$0.10/Kwh</td>
</tr>
<tr>
<td>6. Technical, legal, Administration, contingencies</td>
<td>35%</td>
</tr>
</tbody>
</table>

## RECHARGE FACILITIES
### ESTIMATED COST

1. **Warren Valley Basin - 15 cfs**
   - Pipeline
     - 30" 31,700 L.F. @ $105/L.F. = $3,328,500
     - 24" 27,500 L.F. @ $95/L.F. = 2,612,500
   - Recharge Basins - 8 feet deep
     - 15 AC 193,600 C.Y. @ $4/C.Y. = $ 774,000
   - Property Costs
     - 19 AC @ $15,000/AC = 285,000
   - Subtotal $7,000,000
   - Technical, legal, administration, contingencies @ 35%
     - Total 2,500,000
     - Total 9,500,000

2. **Joshua Tree Subbasin - 10 cfs**
   - Pipeline
     - 20" 18,000 L.F. @ $75/L.F. = $1,350,000
   - Recharge Basin - 8 feet deep
     - 10 AC 129,066 C.Y. @ $4/C.Y. = 516,000
   - Property Cost
     - 13 AC @ $15,000/AC = 195,000
   - Subtotal $2,061,000
   - Technical, legal, administration, contingencies @ 35%
     - Total 739,000
     - Total 2,800,000 *

3. **Means/Ames Basin - 10 cfs**
   - Pipeline
     - 24" 11,100 L.F. @ $85/L.F. = $ 944,000
   - Recharge Basins - 8 feet deep
     - 10 AC 129,066 C.Y. @ $4/C.Y. = 516,000
   - Property Costs
     - 13 AC @ $15,000/AC = 195,000
   - Subtotal $1,655,000
   - Technical, legal, administration, contingencies @ 35%
     - Total 545,000
     - Total 2,200,000

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*Cost of the 30" MBP extension from the regulating reservoir to Twentynine Palms Highway is not included (included in 1) above.*
# WATER TREATMENT PLANTS

## ESTIMATED COST

### INDIVIDUAL AGENCY WTP's

1. **BHDVWA**
   - 8-inch pipeline 2,600 L.F. @ $40/L.F. = $104,000
   - 0.5 MGD Treatment Plant = 830,000
   - Subtotal $934,000
   - Technical, legal, administration, contingencies @ 35% $366,000
   - Total $1,300,000

2. **CSA W -1**
   - 0.2 MGD Treatment Plant = $380,000
   - Pump Station - 10 hp. = 60,000
   - Subtotal $440,000
   - Technical, legal, administration, contingencies @ 35% $160,000
   - Total $600,000

3. **HDWD**
   - 1.0 MGD Treatment Plant = $1,510,000
   - Pump Station - 50 hp = 170,000
   - Subtotal 1,680,000
   - Technical, legal, administration, contingencies @ 35% $620,000
   - Total $2,300,000

4. **JBWD**
   - 0.5 MGD Treatment Plant = $830,000
   - Pump Station - 25 hp = 100,000
   - Subtotal 930,000
   - Technical, legal, administration, contingencies @ 35% $370,000
   - Total $1,300,000

5. **CSA W-4 (Pioneertown) 100 gpm**
   - 6-inch pipeline 16,000 L.F. @ $35/L.F. = $560,000
   - Pump station - 7.5 HP = 50,000
   - Subtotal 610,000
   - Technical, legal, administration, contingencies @ 35% $210,000
   - Total $820,000
WATER TREATMENT PLANTS

ESTIMATED COST

(Continued)

MULTI-AGENCY WTP’s

1. Regional WTP (All Agencies)

   8” Pipeline  16,900 L.F. @ $40/L.F. = $676,000
   12” Pipeline 39,100 L.F. @ $50/L.F. = 1,955,000

   Subtotal $2,631,000

   3.0 MGD @ $1.5 million/MGD = $4,000,000
   Pump Station - 150 hp = 300,000

   Subtotal $6,931,000

   Technical, legal, administration, contingencies @ 35% 2,469,000

   Total $9,400,000

2. HDWD & JBWD

   8” Pipeline  9,000 L.F. @ $40/L.F. = $360,000

   1.5 MGD @ $1.5 million/MGD = 2,100,000

   Pump Station - 75 hp = 200,000

   Subtotal 2,660,000

   Technical, legal, administration, contingencies @ 35% 940,000

   Total $3,600,000
WATER TREATMENT PLANT COSTS

SOURCE: AWWA Water Treatment
Design and Construction Committee
November 1982


Bighorn Desert View Water Agency

- Water Production 1987-1991
- Water Consumption 1987-1991
- Water system map
- Old DVWD Sphere of Influence map
- Legal agency boundaries
- Water sale contract to HDWD
- Ames Basin Monitoring Program
- Bighorn-HDWD lawsuit settlement
- Landers landfill - misc. info
- Rasmussen Geological Reports
- Capital improvement budgets - 1990-1996
- MWA G.O. Bond Sales Report


*California Department of Water Resources*, *California Groundwater*, 1975.


-----  *South Lahontan and Northern Colorado Desert Land Use Survey*, 1990.


-----  *Bulletin No. 119-12 Feasibility of Serving the Mojave Water Agency From the State Water Project*, December 1965.


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----- *Supplemental Water Delivery Management* (letter), Hi-Desert Water District, October 9, 1991.


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- Production 1987-91
- Consumption 1987-91


General Plan for Water Supply & Distribution, Joshua Basin County Water District, June 1972 (see Feb 1984 updated plan).


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MEMORANDUM OF UNDERSTANDING REGARDING

URBAN WATER CONSERVATION IN CALIFORNIA

September 1991
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EXHIBITS


2. EXHIBIT 2: California Urban Water Conservation Council

3. EXHIBIT 3: Principles to Guide the Performance of BMP Economic (Cost-Effectiveness) Analyses

4. EXHIBIT 4: Form of Letter to State Water Resources Control Board

5. EXHIBIT 5: Urban Water Conservation Annual Report Outline
MEMORANDUM OF UNDERSTANDING REGARDING URBAN WATER CONSERVATION IN CALIFORNIA

This MEMORANDUM OF UNDERSTANDING REGARDING URBAN WATER CONSERVATION IN CALIFORNIA ("MOU") is made and entered into on the dates set forth below among the undersigned parties ("signatories"). The signatories represent urban water suppliers, public advocacy organizations and other interested groups as defined in Section 1 of this MOU.

RECITALS

A. The signatories to this MOU recognize that California's economy, quality of life and environment depend in large part upon the water resources of the State. The signatories also recognize the need to provide reliable urban water supplies and to protect the environment. Increasing demands for urban, agricultural and environmental water uses call for conservation and the elimination of waste as important elements in the overall management of water resources. Many organizations and groups in California have an interest in urban water conservation, and this MOU is intended to gain much needed consensus on a complex issue.

B. The urban water conservation practices included in this MOU (referred to as "Best Management Practices" or "BMPs") are intended to reduce long-term urban demands from what they would have been without implementation of these practices and are in addition to programs which may be instituted during occasional water supply shortages.

C. The combination of BMPs and urban growth, unless properly accounted for in water management planning, could make reductions in urban demands during short-term emergencies such as droughts or earthquakes more difficult to achieve. However, notwithstanding such difficulties, the signatory water suppliers will carry out the urban water conservation BMP process as described in this MOU.

D. The signatories recognize that means other than urban water conservation may be needed to provide long-term reliability for urban water suppliers and long-term protection of the environment. However, the signatories may have differing views on what additional measures might be appropriate to provide for these needs. Accordingly, this MOU is not intended to address these issues.

E. A major benefit of this MOU is to conserve water which could be used for the protection of streams, wetlands and estuaries and/or urban water supply reliability. This MOU leaves to other forums the issue of how conserved water will be used.
F. It is the intent of this MOU that individual signatory water suppliers (1) develop comprehensive conservation BMP programs using sound economic criteria and (2) consider water conservation on an equal basis with other water management options.

G. It is recognized that present urban water use throughout the State varies according to many factors including, but not limited to, climate, types of housing and landscaping, amounts and kinds of commercial, industrial and recreational development, and the extent to which conservation measures have already been implemented. It is further recognized that many of the BMPs identified in Exhibit 1 to this MOU have already been implemented in some areas and that even with broader employment of BMPs, future urban water use will continue to vary from area to area. Therefore, this MOU is not intended to establish uniform per capita water use allotments throughout the urban areas of the State. This MOU is also not intended to limit the amount or types of conservation a water supplier can pursue or to limit a water supplier's more rapid implementation of BMPs.

H. It is recognized that projections of future water demand should include estimates of anticipated demand reductions due to changes in the real price of water.

TERMS
SECTION 1
DEFINITIONS

For purposes of this MOU, the following definitions apply:

1.1 Best Management Practices. A Best Management Practice ("BMP") means a policy, program, practice, rule, regulation or ordinance or the use of devices, equipment or facilities which meets either of the following criteria:

(a) An established and generally accepted practice among water suppliers that results in more efficient use or conservation of water;

(b) A practice for which sufficient data are available from existing water conservation projects to indicate that significant conservation or conservation related benefits can be achieved; that the practice is technically and economically reasonable and not environmentally or socially unacceptable; and that the practice is not otherwise unreasonable for most water suppliers to carry out.
Although the term "Best Management Practices" has been used in various statutes and regulations, the definitions and interpretations of that term in those statutes and regulations do not apply to this MOU. The term "Best Management Practices" or "BMPs" has an independent and special meaning in this MOU and is to be applied for purposes of this MOU only as defined above.

1.2 Implementation. "Implementation" means achieving and maintaining the staffing, funding, and in general, the priority levels necessary to achieve the level of activity called for in the descriptions of the various BMPs and to satisfy the commitment by the signatories to use good faith efforts to optimize savings from implementing BMPs as described in Section 4.4 of this MOU. Section B of Exhibit 1 to this MOU establishes the schedule for initial implementation of BMPs.

1.3 Signatory Groups. For purposes of this MOU, signatories will be divided into three groups as follows:

(a) Group 1 will consist of water suppliers. A "water supplier" is defined as any entity, including a city, which delivers or supplies water for urban use at the wholesale or retail level.

(b) Group 2 will consist of public advocacy organizations. A "public advocacy organization" is defined as a non profit organization:

(i) whose primary function is not the representation of trade, industrial, or utility entities, and

(ii) whose prime mission is the protection of the environment or who has a clear interest in advancing the BMP process.

(c) Group 3 will consist of other interested groups. "Other interested groups" is defined as any other group which does not fall into one of the two groups above.

1.4 California Urban Water Conservation Council. The California Urban Water Conservation Council or "Council" will have responsibility for monitoring the implementation of this MOU and will be comprised of signatories to this MOU grouped according to the definitions in Section 1.3 above. The duties of the Council are set forth in Section 6 and in Exhibit 2 to this MOU.
SECTION 2

PURPOSES

2.1 This MOU has two primary purposes: (1) to expedite implementation of reasonable water conservation measures in urban areas; and (2) pursuant to Section 5 of this MOU, to establish assumptions for use in calculating estimates of reliable future water conservation savings resulting from proven and reasonable conservation measures. Estimates of reliable savings are the water conservation savings which can be achieved with a high degree of confidence in a given service area. The signatories have agreed upon the initial assumptions to be used in calculating estimates of reliable savings. These assumptions are included in Exhibit 1 to this MOU. It is probable that average savings achieved by water suppliers will exceed the estimates of reliable savings.

SECTION 3

LIMITS TO APPLICABILITY OF MOU

3.1 Relationship Between Water Suppliers. No rights, obligations or authorities between wholesale suppliers, retail agencies, cities or other water suppliers are created or expanded by this MOU. Moreover, wholesale water suppliers are not obligated to implement BMPs at the retail customer level except within their own retail service area, if any.

3.2 Agriculture. This MOU is intended to apply only to the delivery of water for domestic, municipal and industrial uses. This MOU is not intended to apply directly or indirectly to the use of water for irrigated agriculture.

3.3 Reclamation. The signatory water suppliers support the reclamation and reuse of wastewater wherever technically and economically reasonable and not environmentally or socially unacceptable, and agree to prepare feasibility studies on water reclamation for their respective service areas. However, this MOU does not apply to that aspect of water management, except where the use of reclaimed water may otherwise qualify as a BMP as defined above.
3.4 **Land Use Planning.** This MOU does not deal with the question of growth management. However, each signatory water supplier will inform all relevant land planning agencies at least annually of the impacts that planning decisions involving projected growth would have upon the reliability of its water supplies for the water supplier’s service area and other areas being considered for annexation.

3.5 **Use of Conserved Water.** A major benefit of this MOU is to conserve water which could be used for the protection of streams, wetlands and estuaries and/or urban water supply reliability. This MOU leaves to other forums the issue of how conserved water will be used.

**SECTION 4**

**IMPLEMENTATION OF BEST MANAGEMENT PRACTICES**

4.1 **The Best Management Practices List, Schedule of Implementation and Assumptions.** Exhibit 1 to this MOU contains:

(a) In Section A: A list identifying those practices which the signatories believe presently meet the definition of a BMP as set forth in Section 1.1 of this MOU.

(b) In Section B: A schedule for implementing the BMPs to be followed by signatory water suppliers unless exempted under Section 4.5 of this MOU or an alternative schedule is prepared pursuant to Section 4.6 of this MOU.

(c) In Section C: Assumptions for use in developing estimates of reliable savings from the implementation of BMPs. Estimates of reliable savings are the water conservation savings which can be achieved with a high degree of confidence in a given service area. The estimate of reliable savings for each BMP depends upon the nature of the BMP and upon the amount of data available to evaluate potential savings. For some BMPs (e.g., public information) estimates of reliable savings may never be generated. For others, additional data may lead to significant changes in the estimate of reliable savings. It is probable that average savings achieved by water suppliers will exceed the estimates of reliable savings.
In Section D: A list of "Potential Best Management Practices" ("PBMPs"). PBMPs are possible conservation practices which have not been promoted to the BMP list.

4.2 Initial BMPs, PBMPs, Schedules, and Estimates of Reliable Savings. The initial position of conservation practices on the BMP and PBMP lists, the initial schedule of implementation and study for the BMP list, the initial schedule of study for the PBMP list, and the initial estimates of reliable savings represent compromises by the signatories to move the process forward both for purposes of the present Bay/Delta proceedings as defined in Section 5 and to promote water conservation generally. The signatories agree that as more and better data are collected in the future, the lists, the schedules, and the estimates of reliable savings will be refined and revised based upon the most objective criteria available. However, the signatories agree that the measures included as initial BMPs in Section A of Exhibit 1 are economically justified on a statewide basis.

4.3 Future Revision of BMPs, PBMPs, Schedules, and Estimates of Reliable Savings. After the beginning of the initial term of the MOU as provided in Section 7.1, the California Urban Water Conservation Council ("Council") will, pursuant to Section 6 of this MOU and Exhibit 2, alter the composition of the BMP and PBMP lists, redefine individual BMPs, alter the schedules of implementation, and update the assumptions of reliable savings as more data becomes available. This dynamic BMP assessment process includes the following specific commitments:

(a) The assumptions of reliable savings will be updated at least every 3 years.

(b) The economic reasonableness of a BMP or PBMP will be assessed by the Council using the economic principles in Sections 3 and 4 of Exhibit 3.

(c) A BMP will be removed from the BMP list if, after review of data developed during implementation, the Council determines that the BMP cannot be made economically reasonable or determines that the BMP otherwise fails to conform to the definition of BMPs in Section 1.1.

(d) A PBMP will be moved to the BMP list and assigned a schedule of implementation if, after review of data developed during research, and/or demonstration projects, the Council determines that the PBMP is economically reasonable and otherwise conforms to the definition of BMPs in Section 1.1.
4.4 Good Faith Effort. While specific BMPs and results may differ because of varying local conditions among the areas served by the signatory water suppliers, a good faith effort to implement BMPs will be required of all signatory water suppliers. The following are included within the meaning of "good faith effort to implement BMPs":

(a) The proactive use by a signatory water supplier of legal authorities and administrative prerogatives available to the water supplier as necessary and reasonable for the implementation of BMPs.

(b) Where implementation of a particular BMP is not within the legal authority of a signatory water supplier, encouraging timely implementation of the BMP by other entities that have the legal authority to carry out the BMP within that water supplier's service area pursuant to existing legal authority. This encouragement may include, but is not limited to, financial incentives as appropriate.

(c) Cooperating with and encouraging cooperation between other water suppliers and other relevant entities whenever possible and within existing legal authority to promote the implementation of BMPs.

(d) Optimizing savings from implementing BMPs.

(e) For each signatory water supplier and all signatory public advocacy organizations, encouraging the removal of institutional barriers to the implementation of BMPs within that water supplier's service area. Examples of good faith efforts to remove institutional barriers include formal presentations and/or written requests to entities requesting approval of, or amendment to, local ordinances, administrative policies or legislation which will promote BMP implementation.

4.5 Exemptions. A signatory water supplier will be exempt from the implementation of specific BMPs for as long as the supplier annually substantiates that based upon then prevailing local conditions, one or more of the following findings applies:

(a) A full cost-benefit analysis, performed in accordance with the principles set forth in Exhibit 3, demonstrates that either the program (i) is not cost-effective overall when total program benefits and costs are considered; OR (ii) is not cost-effective to the individual water supplier even after the water supplier has made a good faith effort to share costs with other program beneficiaries.
(b) Adequate funds are not and cannot reasonably be made available from sources accessible to the water supplier including funds from other entities. However, this exemption cannot be used if a new, less cost-effective water management option would be implemented instead of the BMP for which the water supplier is seeking this exemption.

(c) Implementation of the BMP is (i) not within the legal authority of the water supplier; and (ii) the water supplier has made a good faith effort to work with other entities that have the legal authority to carry out the BMP; and (iii) the water supplier has made a good faith effort to work with other relevant entities to encourage the removal of institutional barriers to the implementation of BMPs within its service area.

4.6 Schedule of Implementation. The schedule of implementation for BMPs is set forth in Section B of Exhibit 1 to this MOU. However, it is recognized by the signatories that deviations from this schedule by water suppliers may be necessary. Therefore, a water supplier may modify, to the minimum extent necessary, the schedule for implementation of BMPs if the water supplier substantiates one or more of the following findings:

(a) That after a good faith effort to implement the BMP within the time prescribed, implementation is not feasible pursuant to the schedule. However, implementation of this BMP is still required as soon as feasible within the initial term of this MOU as defined in Section 7.1.

(b) That implementation of one or more BMPs prior to other BMPs will have a more positive effect on conservation or water supplies than will adherence to the schedule.

(c) That implementation of one or more Potential BMPs or other conservation measures prior to one or more BMPs will have a more positive effect on conservation or water supplies than will adherence to the schedule.
SECTION 5

BAY/DELTA PROCEEDINGS

5.1 Use of MOU for Bay/Delta Proceedings. The BMPs, the estimates of reliable savings and the processes established by this MOU are agreed to by the signatories for purposes of the present proceedings on the San Francisco Bay/Sacramento-San Joaquin Delta Estuary ("Bay/Delta") and in order to move the water conservation process forward. "Present Bay/Delta proceedings" is intended to mean those Bay/Delta proceedings presently underway and those conducted until a final water rights decision is reached by the State Water Resources Control Board ("State Board"). The willingness of the signatories to enter into this MOU for purposes of the present Bay/Delta proceedings in no way limits the signatories' ability to propose different conservation practices, different estimates of savings, or different processes in a forum other than the present Bay/Delta proceedings, or for non-urban water suppliers or for other water management issues. By signing this MOU, public advocacy organization signatories are not agreeing to use the initial assumptions of reliable conservation savings in proceedings other than the present Bay/Delta proceedings. The signatories may present other assumptions of reliable conservation savings for non-signatory water suppliers in the present Bay/Delta proceedings, provided that such assumptions could not have adverse impacts upon the water supplies of any signatory water supplier. Furthermore, the signatories retain the right to advocate any particular level of protection for the Bay/Delta Estuary, including levels of freshwater flows, and do not necessarily agree on population projections for California. This MOU is not intended to address any authority or obligation of the State Board to establish freshwater flow protections or set water quality objectives for the Estuary, or to address any authority of the Environmental Protection Agency.

5.2 Recommendations for Bay/Delta Proceedings. The signatories will make the following recommendations to the State Board in conjunction with the present Bay/Delta proceedings and to the EPA to the extent the EPA concerns itself with the proceedings:

(a) That for purposes of the present Bay/Delta proceedings, implementation of the BMP process set forth in this MOU represents a sufficient long-term water conservation program by the signatory water suppliers, recognizing that additional programs may be required during occasional water supply shortages;

(b) That for purposes of the present Bay/Delta proceedings only, the State Board and EPA should base their estimates of future urban water conservation savings on the implementation of all of the BMPs included in Section A of Exhibit 1 to this MOU for the entire service area of
the signatory water suppliers and only on those BMPs, except for (i) the conservation potential for water supplied by urban agencies for agricultural purposes, or (ii) in cases where higher levels of conservation have been mandated;

(c) That for the purposes of the present Bay/Delta proceedings, the State Board and EPA should make their estimates of future urban water conservation savings by employing the reliable savings assumptions associated with those BMPs set forth in Section C of Exhibit 1 to this MOU;

(d) That the State Board should include a policy statement in the water rights phase of the Bay/Delta proceedings supporting the BMP process described in this MOU and that the BMP process should be considered in any documents prepared by the State Board pursuant to the California Environmental Quality Act as part of the present Bay/Delta proceedings.

5.3 Letter to State Board. Within 30 days of signing this MOU, each signatory will jointly or individually convey the principles set forth in Sections 5.1 and 5.2 above by sending a letter to the State Board, copied to the EPA, in the form attached to this MOU as Exhibit 4.

5.4 Withdrawal from MOU. If during the present Bay/Delta proceedings, the State Board or EPA uses future urban water conservation savings that are inconsistent with the use of BMPs as provided in this MOU, any signatory shall have the right to withdraw from the MOU by providing written notice to the Council as described in Section 7.4(a)(i) below.

SECTION 6

CALIFORNIA URBAN WATER CONSERVATION COUNCIL

6.1 Organization. The California Urban Water Conservation Council ("Council") will be comprised of all signatories to this MOU grouped according to the definition in Section 1. The signatories agree to the necessary organization and duties of the Council as specified in Exhibit 2 to this MOU. Within 30 days of the effective date of this MOU, the Council will hold its first meeting.
6.2 **Annual Reports.** The signatory water suppliers will submit standardized reports annually to the Council providing sufficient information to inform the Council on the progress being made towards implementing the BMP process. The Council will also make annual reports to the State Board. An outline for the Council's annual report to the State Board is attached as Exhibit 5 to this MOU.

**SECTION 7**

**GENERAL PROVISIONS**

7.1 **Initial Term of MOU.** The initial term of this MOU shall be for a period of 10 years. This initial term shall commence on September 1, 1991.

7.2 **Signatories.** Signatories shall consist of three groups: water suppliers, public advocacy organizations and other interested groups, arranged according to the definition in Section 1.3. Such arrangement will be made by a Council membership committee comprised of three representatives from the water suppliers' group and three representatives from the public advocacy organizations' group.

7.3 **Renewal of MOU.** The MOU shall be automatically renewed after the initial term of 10 years on an annual basis as to all signatories unless a signatory withdraws as described below in Section 7.4.

7.4 **Withdrawal from MOU.** Signatories to the MOU may withdraw from the MOU in three separate ways as described in sections (a), (b) and (c) below.

(a) **Withdrawal prior to expiration of initial term.** Before the expiration of the initial term of 10 years, a signatory may withdraw by providing written notice to the Council declaring its intent to withdraw. This written notice must include a substantiated finding that one of the two provisions (i) or (ii) below applies:

(i) During the present Bay/Delta proceedings, the State Board or EPA used future urban water conservation savings that are inconsistent with the use of BMPs as provided in this MOU; OR

(ii) After a period of 5 years from the commencement of the initial term of the MOU:
(A) Specific signatory water suppliers representing more than 10 percent of the population included within the combined service areas of the signatory water suppliers have failed to act in good faith pursuant to Section 4.4 of the MOU; and

(B) The signatory wishing to withdraw has attached findings to its past two annual reports to the Council beginning no earlier than the fourth annual report identifying these same signatory water suppliers and giving evidence based upon the information required to be submitted in the annual reports to the Council to support the allegations of failure to act in good faith; and

(C) The State Board has failed to require conservation efforts by the specific water suppliers adequate to satisfy the requirements of this MOU; and

(D) Discussions between the signatory wishing to withdraw and the specific signatories named have failed to satisfy the objections of the signatory wishing to withdraw.

After a signatory declares an intent to withdraw under Section 7.4(a), the MOU shall remain in effect as to that signatory for 180 days.

(b) **Withdrawal after expiration of initial term.** After the initial term of 10 years, any signatory may declare its intent to withdraw from the MOU unconditionally by providing written notice to the Council. After a signatory has declared its intent to withdraw as provided in this section, the MOU will remain in effect as to that signatory for 180 days.

(c) **Immediate withdrawal.** Any signatory who does not sign a modification to the MOU requiring a 2/3 vote as described in Exhibit 2 of this MOU may withdraw from the MOU by providing written notice to the Council. The withdrawing signatory's duties under this MOU will be terminated effective immediately upon providing such written notice.

If a signatory withdraws from the MOU under any of the above methods, the MOU shall remain in effect as to all other signatories.

7.5 **Additional Parties.** Additional parties may sign the MOU after September 1, 1991 by providing written notice to and upon approval by the Council. Additional parties
will be assigned by the Council to one of the three signatory groups defined in Section 1.3 before entry into the Council. All additional signatory water suppliers shall be subject to the schedule of implementation provided in Exhibit 1.

7.6 **Legal Authority.** Nothing in this MOU is intended to give any signatory, agency, entity or organization expansion of any existing authority. No organization formed pursuant to this MOU has authority beyond that specified in this MOU.

7.7 **Non-Contractual Agreement.** This MOU is intended to embody general principles agreed upon between and among the signatories and is not intended to create contractual relationships, rights, obligations, duties or remedies in a court of law between or among the signatories.

7.8 **Modifications.** The signatories agree that this writing constitutes the entire understanding between and among the signatories. The general manager, chief executive officer or executive director of each signatory or their designee shall have the authority to vote on any modifications to this MOU and its exhibits. Any modifications to the MOU itself and to its exhibits shall be made by the Council as described in Exhibit 2.
SECTION A. BEST MANAGEMENT PRACTICES

This section contains those Best Management Practices ("BMPs") that signatory water suppliers commit to implementing. Suppliers' water needs estimates will be adjusted to reflect estimates of reliable savings from this category of BMPs. For some BMPs, no estimate of savings is made.

It is recognized by all parties that a single implementation method for a BMP would not be appropriate for all water suppliers. In fact, it is likely that as the process moves forward, water suppliers will find new implementation methods even more effective than those described. Any implementation method used should be at least as effective as the methods described below.

1. INTERIOR AND EXTERIOR WATER AUDITS AND INCENTIVE PROGRAMS FOR SINGLE FAMILY RESIDENTIAL, MULTI-FAMILY RESIDENTIAL, AND GOVERNMENTAL/INSTITUTIONAL CUSTOMERS.

Implementation methods shall be at least as effective as identifying the top 20% of water users in each sector, directly contacting them (e.g., by mail and/or telephone) and offering the service on a repeating cycle; providing incentives sufficient to achieve customer implementation (e.g., free showerheads, hose end sprinkler timers, adjustment to high water use bills, if customers implement water conservation measures, etc.). This could be a cooperative program among organizations that would benefit from its implementation.

2. PLUMBING, NEW AND RETROFIT.

a. ENFORCEMENT OF WATER CONSERVING PLUMBING FIXTURE STANDARDS INCLUDING REQUIREMENT FOR ULTRA LOW FLUSH ("ULF") TOILETS IN ALL NEW CONSTRUCTION BEGINNING JANUARY 1, 1992.
Implementation methods shall be at least as effective as contacting the local building departments and providing information to the inspectors; and contacting major developers and plumbing supply outlets to inform them of the requirement.

b. SUPPORT OF STATE AND FEDERAL LEGISLATION PROHIBITING SALE OF TOILETS USING MORE THAN 1.6 GALLONS PER FLUSH.

c. PLUMBING RETROFIT.

Implementation methods shall be at least as effective as delivering retrofit kits including high quality low-flow showerheads to pre-1980 homes that do not have them and toilet displacement devices or other devices to reduce flush volume for each home that does not already have ULF toilets; offering to install the devices; and following up at least three times.

3. DISTRIBUTION SYSTEM WATER AUDITS, LEAK DETECTION AND REPAIR.

Implementation methods shall be at least as effective as at least once every three years completing a water audit of the water supplier's distribution system using methodology such as that described in the American Water Works Association's "Manual of Water Supply Practices, Water Audits and Leak Detection;" advising customers whenever it appears possible that leaks exist on the customers' side of the meter; and performing distribution system leak detection and repair whenever the audit reveals that it would be cost effective.

4. METERING WITH COMMODITY RATES FOR ALL NEW CONNECTIONS AND RETROFIT OF EXISTING CONNECTIONS.

Implementation methods shall be requiring meters for all new connections and billing by volume of use; and establishing a program for retrofitting any existing unmetered connections and billing by volume of use; for example, through a requirement that all connections be retrofitted at or within six months of resale of the property or retrofitted by neighborhood.

5. LARGE LANDSCAPE WATER AUDITS AND INCENTIVES.

Implementation methods shall be at least as effective as identifying all irrigators of large (at least 3 acres) landscapes (e.g., golf courses, green belts, common areas, multi-family housing landscapes, schools, business parks,
cemeteries, parks and publicly owned landscapes on or adjacent to road rights-of-way); contacting them directly (by mail and/or telephone); offering landscape audits using methodology such as that described in the Landscape Water Management Handbook prepared for the California Department of Water Resources; and cost-effective incentives sufficient to achieve customer implementation; providing follow-up audits at least once every five years; and providing multi-lingual training and information necessary for implementation.

6. LANDSCAPE WATER CONSERVATION REQUIREMENTS FOR NEW AND EXISTING COMMERCIAL, INDUSTRIAL, INSTITUTIONAL, GOVERNMENTAL, AND MULTI-FAMILY DEVELOPMENTS.

Implementation methods shall be enacting and implementing landscape water conservation ordinances, or if the supplier does not have the authority to enact ordinances, cooperating with cities, counties and the green industry in the service area to develop and implement landscape water conservation ordinances pursuant to the "Water Conservation in Landscaping Act" ("Act") (California Government Code §§ 65590 et seq.). The ordinance shall be at least as effective as the Model Water Efficient Landscape Ordinance being developed by the Department of Water Resources. A study of the effectiveness of this BMP will be initiated within two years of the date local agencies must adopt ordinances under the Act.

7. PUBLIC INFORMATION.

Implementation methods shall be at least as effective as ongoing programs promoting water conservation and conservation related benefits including providing speakers to community groups and the media; using paid and public service advertising; using bill inserts; providing information on customers’ bills showing use in gallons per day for the last billing period compared to the same period the year before; providing public information to promote other water conservation practices; and coordinating with other governmental agencies, industry groups and public interest groups.

8. SCHOOL EDUCATION.

Implementation methods shall be at least as effective as ongoing programs promoting water conservation and conservation related benefits including working with the school districts in the water supplier’s service area to provide educational materials and instructional assistance.
9. COMMERCIAL AND INDUSTRIAL WATER CONSERVATION.

Implementation methods shall be at least as effective as identifying and contacting the top 10% of the industrial and commercial customers directly (by mail and/or telephone); offering audits and incentives sufficient to achieve customer implementation; and providing follow-up audits at least once every five years if necessary.

10. NEW COMMERCIAL AND INDUSTRIAL WATER USE REVIEW.

Implementation methods shall be at least as effective as assuring the review of proposed water uses for new commercial and industrial water service and making recommendations for improved water use efficiency before completion of the building permit process.

11. CONSERVATION PRICING.

Implementation methods shall be at least as effective as eliminating nonconserving pricing and adopting conserving pricing. For signatories supplying both water and sewer service, this BMP applies to pricing of both water and sewer service. Signatories that supply water but not sewer service shall make good faith efforts to work with sewer agencies so that those sewer agencies adopt conservation pricing for sewer service.

Nonconserving pricing provides no incentives to customers to reduce use. Such pricing is characterized by one or more of the following components:

a. Rates in which the unit price decreases as the quantity used increases (declining block rates);

b. Rates that involve charging customers a fixed amount per billing cycle regardless of the quantity used;

c. Pricing in which the typical bill is determined by high fixed charges and low commodity charges.

Conservation pricing provides incentives to customers to reduce average or peak use, or both. Such pricing includes:

a. Rates designed to recover the cost of providing service; and

b. Billing for water and sewer service based on metered water use.
Conservation pricing is also characterized by one or more of the following components:

- **c.** Rates in which the unit rate is constant regardless of the quantity used (uniform rates) or increases as the quantity used increases (increasing block rates);

- **d.** Seasonal rates or excess-use surcharges to reduce peak demands during summer months;

- **e.** Rates based upon the long-run marginal cost or the cost of adding the next unit of capacity to the system;

- **f.** Lifeline rates.

12. **LANDSCAPE WATER CONSERVATION FOR NEW AND EXISTING SINGLE FAMILY HOMES.**

Implementation methods shall be at least as effective as providing guidelines, information and incentives for installation of more efficient landscapes and water saving practices (e.g., encouraging local nurseries to promote sales and use of low water using plants, providing landscape water conservation materials in new home owner packets and water bills, sponsoring demonstration gardens); and enacting and implementing landscape water conservation ordinances or, if the supplier does not have the authority to enact ordinances, cooperating with cities, counties, and the green industry in the service area to develop and implement landscape water conservation ordinances pursuant to the "Water Conservation in Landscaping Act" ("Act") (California Government Code §§ 65590 et seq.). The ordinance shall be at least as effective as the Model Water Efficient Landscape Ordinance being developed by the Department of Water Resources.

13. **WATER WASTE PROHIBITION.**

Implementation methods shall be enacting and enforcing measures prohibiting gutter flooding, sales of automatic (self-regenerating) water softeners, single pass cooling systems in new connections, nonrecirculating systems in all new conveyor car wash and commercial laundry systems, and nonrecycling decorative water fountains.
14. **WATER CONSERVATION COORDINATOR.**

Implementation methods shall be at least as effective as designating a water conservation coordinator responsible for preparing the conservation plan, managing its implementation, and evaluating the results. For very small water suppliers, this might be a part-time responsibility. For larger suppliers this would be a full-time responsibility with additional staff as appropriate. This work should be coordinated with the supplier's operations and planning staff.

15. **FINANCIAL INCENTIVES.**

Implementation methods shall be at least as effective as:

a. Offering financial incentives to facilitate implementation of conservation programs. Initial recommendations for such incentives will be developed by the Council within two years of the initial signing of the MOU, including incentives to improve the efficiency of landscape water use; and

b. Financial incentives offered by wholesale water suppliers to their customers to achieve conservation.

16. **ULTRA LOW FLUSH TOILET REPLACEMENT.**

Water suppliers agree to implement programs for replacement of existing high-water-using toilets with ultra-low-flush toilets (1.6 gallons or less) in residential, commercial, and industrial buildings. Such programs will be at least as effective as offering rebates of up to $100 for each replacement that would not have occurred without the rebate, or requiring replacement at the time of resale, or requiring replacement at the time of change of service. This level of implementation will be reviewed by the Council after development of the assumptions included in the following two paragraphs using the economic principles included in paragraphs 3 and 4 of Exhibit 3.

a. **Assumptions for determining estimates of reliable savings from installation of ultra-low-flush toilets in both existing and new residential, commercial, and industrial structures will be recommended by the Council to the State Water Resources Control Board (“State Board”) by December 31, 1991 for use in the present Bay/Delta proceedings.**
b. Should the Council not agree on the above assumptions, a panel will be formed by December 31, 1991 to develop such assumptions. The panel shall consist of one member appointed from the signatory public advocacy group; one member appointed from the signatory water supplier group; and one member mutually agreed to by the two appointed members. The assumptions to be used for this BMP will be determined by a majority vote of the panel by February 15, 1992 using the criteria for determining estimates of reliable savings included in this MOU. The decision of the panel will be adopted by the Council and forwarded to the State Board by March 1, 1992.
SECTION B. IMPLEMENTATION SCHEDULES

Best Management Practices will be implemented by signatory water suppliers according to the schedule set forth below. "Implementation" means achieving and maintaining the staffing, funding, and in general, the priority levels necessary to achieve the level of activity called for in the descriptions of the various BMPs and to satisfy the commitment by the signatories to use good faith efforts to optimize savings from implementing BMPs as described in section 4.4 of the MOU. BMPs will be implemented at a level of effort projected to achieve at least the coverages specified in Section C of this Exhibit within the initial ten year term of the MOU.

This schedule sets forth the latest dates by which implementation of BMPs will be underway. It is recognized that some signatories are already implementing some BMPs, and that this schedule does not prohibit signatories from implementing BMPs sooner than required.

The following BMPs will be implemented by the end of the first year of the initial term (numbers correspond to those in the list set forth in Section A above):

2a. ENFORCEMENT OF WATER CONSERVING PLUMBING FIXTURE STANDARDS INCLUDING REQUIREMENT FOR ULTRA LOW FLUSH TOILETS IN ALL NEW CONSTRUCTION BEGINNING JANUARY 1, 1992.

2b. SUPPORT OF STATE AND FEDERAL LEGISLATION PROHIBITING SALE OF TOILETS USING MORE THAN 1.6 GALLONS PER FLUSH.

3. DISTRIBUTION SYSTEM WATER AUDITS. (LEAK DETECTION AND REPAIR to be implemented by end of second year.)

7. PUBLIC INFORMATION.

8. SCHOOL EDUCATION.

13. WATER WASTE PROHIBITION.

14. WATER CONSERVATION COORDINATOR.

The following BMPs will be implemented by the end of the second year of the initial term:

2c. PLUMBING RETROFIT.
3. LEAK DETECTION AND REPAIR. (DISTRIBUTION SYSTEM WATER AUDITS to be implemented by end of first year.)

4. METERING WITH COMMODITY RATES FOR ALL NEW CONNECTIONS AND RETROFIT OF EXISTING CONNECTIONS.

6. LANDSCAPE WATER CONSERVATION REQUIREMENTS FOR NEW AND EXISTING COMMERCIAL, INDUSTRIAL, INSTITUTIONAL, GOVERNMENTAL, AND MULTI-FAMILY DEVELOPMENTS.

11. CONSERVATION PRICING. (All components except billing for sewer service based on metered water use.)

12. LANDSCAPE WATER CONSERVATION FOR NEW AND EXISTING SINGLE FAMILY HOMES.

16. ULTRA LOW FLUSH TOILET REPLACEMENT.

The following BMPs will be implemented by the end of the third year of the initial term:

1. INTERIOR AND EXTERIOR WATER AUDITS AND INCENTIVE PROGRAMS FOR SINGLE FAMILY RESIDENTIAL, MULTI-FAMILY RESIDENTIAL, AND GOVERNMENTAL/INSTITUTIONAL CUSTOMERS.

5. LARGE LANDSCAPE WATER AUDITS AND INCENTIVES.

9. COMMERCIAL AND INDUSTRIAL WATER CONSERVATION.

10. NEW COMMERCIAL AND INDUSTRIAL WATER USE REVIEW.

11. CONSERVATION PRICING. (Billing for sewer service based on metered water use.)

15. FINANCIAL INCENTIVES.
SECTION C: ASSUMPTIONS FOR ESTIMATING RELIABLE SAVINGS FROM BEST MANAGEMENT PRACTICES

<table>
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<tr>
<th>Best Management Practice</th>
<th>Estimated Water Savings</th>
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<tr>
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<td>Pre-1980 Construction</td>
<td>Post-1980 Construction</td>
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<tr>
<td>1. Interior and Exterior Water Audits and Incentive Programs for Single Family Residential, Multi-family Residential and Governmental/Institutional Customers</td>
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<tr>
<td><strong>Single Family and Multi-family</strong></td>
<td></td>
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<tr>
<td>Reduction factors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low-flow showerhead</td>
<td>7.2 gcd</td>
<td>2.9 gcd</td>
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<tr>
<td>Toilet retrofit*</td>
<td>1.3 gcd</td>
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</tr>
<tr>
<td>Leak repair</td>
<td>0.5 gcd</td>
<td>0.5 gcd</td>
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<td>Landscape audit, percent outdoor use</td>
<td>10%</td>
<td>10%</td>
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<tr>
<td><strong>Coverage factor</strong></td>
<td></td>
<td></td>
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<tr>
<td>Target, top percent of users</td>
<td>20%</td>
<td>20%</td>
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<tr>
<td>Accept audit</td>
<td>20%</td>
<td>20%</td>
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<tr>
<td><strong>Governmental/Institutional</strong></td>
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<tr>
<td>Reduction Factors</td>
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<td>Interior retrofit, percent indoor use</td>
<td>5%</td>
<td>0</td>
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<td>Landscape audit, percent outdoor use</td>
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<td>10%</td>
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<tr>
<td><strong>Coverage Factor</strong></td>
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<tr>
<td>Target, top percent of users</td>
<td>20%</td>
<td>20%</td>
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<tr>
<td>Accept audit</td>
<td>70%</td>
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2. Plumbing, New and Retrofit


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<th>Reduction factor</th>
<th>Coverage factor</th>
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<tbody>
<tr>
<td>All new homes and buildings built after January 1992</td>
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b. Support state and federal legislation prohibiting sale of toilets using more than 1.6 gallons per flush

<table>
<thead>
<tr>
<th>Reduction factor</th>
<th>Coverage factor</th>
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<tbody>
<tr>
<td></td>
<td>NQ</td>
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c. Plumbing Retrofit

**Single family canvass**

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<thead>
<tr>
<th>Reduction factors</th>
<th>Coverage factor</th>
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<tbody>
<tr>
<td>Toilet retrofit*</td>
<td>1.3 gcd</td>
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<tr>
<td>Low-flow showerhead</td>
<td>7.2 gcd</td>
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<table>
<thead>
<tr>
<th>Coverage factor</th>
<th>Installation Rate</th>
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<tbody>
<tr>
<td>Installation Rate</td>
<td>75%</td>
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**Multi-family owner contact**

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<tr>
<th>Reduction factors</th>
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<tr>
<td>Toilet retrofit</td>
<td>1.3 gcd</td>
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<tr>
<td>Low-flow showerhead</td>
<td>7.2 gcd</td>
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<table>
<thead>
<tr>
<th>Coverage factor</th>
<th>Installation rate</th>
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<tr>
<td>Installation rate</td>
<td>80%</td>
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<tr>
<td></td>
<td>Distribution System Water Audits, Leak Detection and Repair</td>
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<td>-----------------------------------------------------------</td>
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<tr>
<td></td>
<td>Reduction factor</td>
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<tr>
<td></td>
<td>Lower unaccounted for water to no more than percent total use</td>
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<tr>
<td></td>
<td>(All other utilities remain at current levels)</td>
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<td></td>
<td>Coverage factor</td>
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<tr>
<td></td>
<td>Total number of utilities participating in audits</td>
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<td></td>
<td>Utilities participating in leak detection and repair</td>
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<td>4.</td>
<td>Metering with Commodity Rates for All New Connections and Retrofit of Existing Connections</td>
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<tr>
<td></td>
<td>Reduction factor</td>
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<tr>
<td></td>
<td>Unmetered portion of utility, percent of applied water</td>
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<td></td>
<td>Coverage factor</td>
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<td></td>
<td>Unmetered customers</td>
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<td>5.</td>
<td>Large Landscape Water Audits and Incentives</td>
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<tr>
<td></td>
<td>Reduction factor</td>
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<tr>
<td></td>
<td>Landscape audit for multi-family, commercial, industrial, institutional, and public users, with 3 acres of landscaping or more, percent of irrigation water use</td>
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<td>Coverage factor</td>
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<td>Applies to all sites three acres or more</td>
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<tr>
<td></td>
<td>Landscape Water Conservation Requirements for New and Existing Commercial, Industrial, Institutional, Governmental, and Multi-family Developments</td>
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<tr>
<td></td>
<td>Reduction factor</td>
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<td></td>
<td>Reduced landscape water use, percent of new irrigation use</td>
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<td>Coverage factor</td>
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<td></td>
<td>All new landscape areas</td>
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<td>7.</td>
<td>Public Information</td>
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<td>8.</td>
<td>School Education</td>
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<td>NQ</td>
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<td>9.</td>
<td>Commercial and Industrial Water Conservation</td>
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<tr>
<td></td>
<td>Commercial water reduction results from Best Management Practices such as Interior and Landscape Water Audits, Plumbing Codes, and Other Factors but exclude Ultra Low Flush Toilet Replacement. Estimated reduction in gallons per employee per day in year 2000 use occurring over the period 1980-2000.</td>
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<td>12%</td>
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<td>15%</td>
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<td>10.</td>
<td>New Commercial and Industrial Water Use Review</td>
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<td>11.</td>
<td>Conservation Pricing</td>
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<td>12.</td>
<td>Landscape Water Conservation for New and Existing Single Family Homes</td>
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<td>13.</td>
<td>Water Waste Prohibition</td>
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<td>14.</td>
<td>Water Conservation Coordinator</td>
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<td>15.</td>
<td>Financial Incentives</td>
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<tr>
<td>16.</td>
<td>Ultra Low Flush Toilet Replacement Programs</td>
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</tbody>
</table>
NOTES AND DEFINITION OF TERMS

a  five year life (toilet retrofit)

b  refer to paragraphs (a) and (b) of Best Management Practice No. 16

c  includes savings accounted for in other Best Management Practices

gcd  = gallons per capita per day

Reduction factor = unit water savings

Coverage factor = installation and/or compliance rate

Low flow showerhead = 2.5 gallons per minute maximum flow

Ultra low flush toilet = 1.6 gallons per flush maximum

Unaccounted for water = authorized (unmetered uses), leakage and meter error

Outdoor use = summer - winter use, on an average annual basis

Irrigation use = water used solely for irrigating, excluding cooling water use

Target = customers offered an incentive or audit

N/A = not applicable

NQ = not quantified at this time

1-15
SECTION D. POTENTIAL BEST MANAGEMENT PRACTICES

This Section contains Potential Best Management Practices ("PBMPs") that will be studied. Where appropriate, demonstration projects will be carried out to determine if the practices meet the criteria to be designated as BMPs. Within one year of the initial signing of this MOU, the Council will develop and adopt a schedule for studies of these PBMPs.

1. RATE STRUCTURES AND OTHER ECONOMIC INCENTIVES AND DISINCENTIVES TO ENCOURAGE WATER CONSERVATION. This is the top priority PBMP to be studied. Such studies should include seasonal rates; increasing block rates; connection fee discounts; grant or loan programs to help finance conservation projects; financial incentives to change landscapes; variable hookup fees tied to landscaping; and interruptible water service to large industrial, commercial or public customers. Studies on this PBMP will be initiated within 12 months from the initial signing of the MOU. At least one of these studies will include a pilot project on incentives to encourage landscape water conservation.

2. EFFICIENCY STANDARDS FOR WATER USING APPLIANCES AND IRRIGATION DEVICES.

3. REPLACEMENT OF EXISTING WATER USING APPLIANCES (EXCEPT TOILETS AND SHOWERHEADS WHOSE REPLACEMENTS ARE INCORPORATED AS BEST MANAGEMENT PRACTICES) AND IRRIGATION DEVICES.

4. RETROFIT OF EXISTING CAR WASHES.

5. GRAYWATER USE.

6. DISTRIBUTION SYSTEM PRESSURE REGULATION.

7. WATER SUPPLIER BILLING RECORDS BROKEN DOWN BY CUSTOMER CLASS (E.G., RESIDENTIAL, COMMERCIAL, INDUSTRIAL).

8. SWIMMING POOL AND SPA CONSERVATION INCLUDING COVERS TO REDUCE EVAPORATION.

9. RESTRICTIONS OR PROHIBITIONS ON DEVICES THAT USE EVAPORATION TO COOL EXTERIOR SPACES.

10. POINT-OF-USE WATER HEATERS, RECIRCULATING HOT WATER SYSTEMS AND HOT WATER PIPE INSULATION.

11. EFFICIENCY STANDARDS FOR NEW INDUSTRIAL AND COMMERCIAL PROCESSES.
EXHIBIT 2

CALIFORNIA URBAN WATER CONSERVATION COUNCIL

1. The California Urban Water Conservation Council (the "Council") will be comprised of a representative of each of the signatories to the MOU.

2. The Council will be housed by California Urban Water Agencies ("CUWA"). The Council will act independently of CUWA on all technical and policy issues. CUWA will be responsible for the initial funding and ensuring that the Council's administrative and general office needs are met. CUWA will retain the right to withdraw from this relationship at any time upon 180 days written notice to the Council. The Council recognizes that its funding requirements may exceed what CUWA is prepared to contribute and that alternative funding may be needed.

3. The Council's responsibilities and authorities include:

   (a) Recommending study methodologies for Best Management Practices ("BMPs"), including procedures for assessing the effectiveness and reliability of urban water conservation measures.

   (b) Developing guidelines including discount rate to be used by all signatories in computing BMP benefits and costs pursuant to Exhibit 3.

   (c) Reviewing and modifying the economic principles set forth in Exhibit 3.

   (d) Collecting and summarizing information on implementation of BMPs and Potential Best Management Practices ("PBMPs").

   (e) Adopting or modifying BMPs and PBMPs lists.

   (f) Adopting or modifying reliable water conservation savings data for BMPs.

   (g) Adopting or modifying the schedules of implementation for existing and new BMPs.

   (h) Adopting or modifying the schedules for research and demonstration projects for BMPs and PBMPs.

   (i) Coordinating and/or making recommendations regarding BMPs study and demonstration projects.

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(j) Accepting or denying requests for additional parties to join the MOU and assigning additional parties to one of the three signatory groups as described in Section 1.3 of the MOU.

(k) Reviewing and modifying report formats.

(l) Making annual reports to the State Water Resources Control Board and the Council Members on the above items based on the format described in Exhibit 5.

(m) Within two years of the initial signing of this MOU, developing and implementing procedures and a funding mechanism for independent evaluation of the MOU process at the Council and signatory levels.

(n) Undertaking such additional responsibilities as the Members may agree upon.

4. The Council will make formal reports to the State Water Resources Control Board and to the governing bodies of all Council Members. Such reports shall include a formal annual written report. Other reports such as status reports and periodic updates may be prepared as deemed appropriate by the Council. Any Member of the Council will be entitled to review draft reports and comment on all reports. Such comments shall be included in any final report at the Member's request.

5. It is anticipated that the Council will develop a committee structure, which will include a Membership Committee as described in Section 7.2 of the MOU. A Steering Committee and one or more technical committees may also be needed.

6. For purposes of the Council, signatories will be divided into three groups: water suppliers ("Group 1"), public advocacy organizations ("Group 2") and other interested groups ("Group 3") as those terms are defined in Section 1 of the MOU. Members of Groups 1 and 2 shall be members of the Council and shall possess all voting rights. Members of Group 3 shall not have voting rights, but shall act in an advisory capacity to the Council.

7. Decisions by the Council to undertake additional responsibilities; to modify the MOU itself; or to modify Exhibits 2 or 3 require the following:

(a) The Council will provide notice to all signatories giving the text of the proposed action or modification at least 60 days in advance of the vote by the Council.

(b) To pass the action or modification, there must be a vote in favor of the action or modification by at least 2/3 of the members of Group 1 voting.
including votes made in person or in writing, and a vote in favor of the action or modification by at least 2/3 of the members of Group 2 voting, including votes made in person or in writing.

8. All other modifications and Council actions shall be undertaken as follows: There must be a vote in favor of the modification or action by a simple majority of the members of Group 1 voting, including votes made in person or in writing, and a vote in favor of the modification or action by a simple majority of the members of Group 2 voting, including votes made in person or in writing.
EXHIBIT 3

PRINCIPLES TO GUIDE THE PERFORMANCE OF BMP ECONOMIC (COST-EFFECTIVENESS) ANALYSES

1. The total cost-effectiveness of a conservation measure will be measured by comparing the present value of the benefits of the measure listed in paragraph 3 below to the present value of the costs listed in paragraph 4. The measure will be cost-effective if the present value of the benefits exceeds the present value of the costs.

2. The cost-effectiveness of a conservation measure to the water supplier will be measured by comparing the present value of the benefits described in paragraph 5 to the present value of the costs described in paragraph 6. The measure will be cost-effective if the present value of the benefits exceeds the present value of the costs.

3. Total benefits exclude financial incentives received by water suppliers or by retail customers. These benefits include:
   
   (a) avoided capital costs of production, transport, storage, treatment, wastewater treatment and distribution capacity
   
   (b) avoided operating costs, including but not limited to, energy and labor
   
   (c) environmental benefits and avoided environmental costs
   
   (d) avoided costs to other water suppliers, including those associated with making surplus water available to other suppliers
   
   (e) benefits to retail customers, including benefits to customers of other suppliers associated with making surplus water available to these suppliers

4. Total program costs are those costs associated with the planning, design, and implementation of the particular BMP, excluding financial incentives paid either to other water suppliers or to retail customers. These costs include:
   
   (a) capital expenditures for equipment or conservation devices
   
   (b) operating expenses for staff or contractors to plan, design, or implement the program
   
   (c) costs to other water suppliers

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5. Program benefits to the water supplier include:

(a) costs avoided by the water supplier of constructing production, transport, storage, treatment, distribution capacity, and wastewater treatment facilities, if any.

(b) operating costs avoided by the water supplier, including but not limited to, energy and labor associated with the water deliveries that no longer must be made.

(c) avoided costs of water purchases by the water supplier

(d) environmental benefits and avoided environmental costs

(e) revenues from other entities, including but not limited to revenue from the sale of water made available by the conservation measure and financial incentives received from other entities.

6. Program costs to the water supplier include:

(a) capital expenditures incurred by the water supplier for equipment or conservation devices

(b) financial incentives to other water suppliers or retail customers

(c) operating expenses for staff or contractors to plan, design, or implement the program

(d) costs to the environment

7. The California Urban Water Conservation Council ("Council") will be responsible for developing guidelines that will be used by all water suppliers in computing BMP benefits and costs. These guidelines will include, but will not be limited to, the following issues:

(a) analytical frameworks

(b) avoided environmental costs

(c) other impacts on the supply system that may be common to many water suppliers

(d) time horizons and discount rates

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EXHIBIT 4

[Date]

W. Don Maughan, Chairman, and Members
State Water Resources Control Board
901 "P" Street
Sacramento, California 95801

Subject: Bay/Delta Proceedings:
Urban Water Conservation

Dear Chairman Maughan and Members:

We are pleased to forward to you a copy of a "Memorandum of Understanding Regarding Urban Water Conservation in California" recently entered into by many urban water suppliers, public advocacy organizations, and other interested groups.

This Memorandum of Understanding was developed over a period of many months of fact-gathering and intensive negotiations. It commits the signatory water suppliers to good faith implementation of a program of water conservation which embodies a series of "Best Management Practices" for California's urban areas. It also commits all of the signatories to an ongoing, structured process of data collection through which other conservation measures, not yet in general use, can be evaluated as to whether they should be added to the list of Best Management Practices. Finally, it commits all signatories to recommending to this Board that the Best Management Practices identified in this Memorandum of Understanding be taken as the benchmark for estimating reliable savings for urban areas which utilize waters affected by the Bay/Delta proceedings. An important part of this program is the signatories' recognition of the need to provide long-term reliability for urban water suppliers and long-term protection of the environment.

To carry out these commitments, please be advised that each of the signatories has endorsed making the following recommendations to this Board: