IMPERIAL IRWMP

INTEGRATED REGIONAL WATER MANAGEMENT PLAN

Appendix N

IID Capital Projects

Appendix N - IID Capital Projects

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N Capital Project Alternatives

This appendix examines the opportunities and challenges of augmenting water supplies through the construction of capital projects. The conceptual projects evaluated in this section are: desalination of brackish water and recycling of municipal wastewater.

The desalted or recycled water would either be used directly by a new water demand (for example, a geothermal power plant), or would be delivered to a current use that would then forego the use of the Colorado River. Under the latter concept, desalted or recycled water produced would be provided to a current user in lieu of the delivery of Colorado River water delivered by IID. The water would be added to IID's overall water supply portfolio since it is a 'new' water supply that would have otherwise not been available. The new water produced could be credited to the regional water portfolio or to an industrial water account managed by IID. Water from the industrial water account could then be apportioned or credited to the new demands by IID. These new water users would pay for the projects and take delivery of raw Colorado River water from IID.

These projects are developed at a reconnaissance or concept level using the available data including site specific data provided by previous studies, communications with local agencies, and aerial photography. Unit cost data includes IID-specific data from the IID Definite Plan and cost curves developed by EPA (EPA 2001) and by Reclamation (Reclamation 2003).

The level of detail included in the definition of each project is intended to allow for identification of technical feasibility, major implementation challenges, approximate costs, and for comparison of the alternatives.

At this point in time, a consensus on the appropriate ranking criteria has not been developed. Thus, projects have not been eliminated unless there is clearly a fatal flaw.

N.1 Desalination of Brackish Water

N.1.1 Purpose and Design Considerations

The purpose of this section is to evaluate opportunities to use brackish groundwater or drain water for MCI uses after desalination. It investigates a broad range of concepts for desalination of brackish water. Each project includes development of a brackish water source, a desalination plant, brine disposal, and conveyance of the product water to customers. Both groundwater and surface water from drains and rivers are evaluated as source water. The desalination plants are assumed to use reverse osmosis (RO) as the treatment process. Brine disposal either in evaporation ponds or by deep well injection in existing wells at geothermal plants or in new wells is examined. Consideration is given to delivering the desalted project water to geothermal power plants, general municipalities, industrial use, or to the IID distribution system.

N.1.1.1 Elements of desalination projects

This section describes the elements that were combined to configure this integrated set of project alternatives and design considerations. Project Scoping Report – Review and Evaluation of Water Management Strategies (June 2009) has a more complete description of the desalination, groundwater development, groundwater banking, and agricultural water management strategies that were used to configure this set of integrated project alternatives.

Source Water

Drainage and River Water

Even after implementation of the IID Definite Plan there will be opportunities to capture drain water before it reaches the New or Alamo River, or to divert water from the New or Alamo River before it reaches the Salton Sea. This would serve to prevent loss of this water and make it subject to management and delivery by IID. River diversions would be more complicated to develop and subject to impacts from flooding. Mitigation for the effects to drain or riparian habitats will likely be required and would be a significant cost component.

Groundwater Well Fields

Groundwater is considered a new source of supply for IID. Groundwater in the East Mesa area and central part of the Imperial Valley is brackish and unacceptable for direct use by MCI sectors without treatment. It is estimated that there is about 0.8 MAF in the shallow aquifer and up to 24 MAF of groundwater storage in the intermediate aquifer and deep aquifer. Of the groundwater in storage about 2 MAF has a low enough TDS to be developed for the desalination plants. The water quality in the deeper aquifer is of poor quality and should not be used for the source water supply.

Desalination of brackish groundwater would remove water currently in storage in the groundwater basin by virtue of the historical losses from the irrigation system delivery canals. Natural recharge is limited and the safe or sustained yield is negligible. Developing the groundwater would deplete groundwater storage over time and recharge projects may be developed to mitigate the groundwater pumping.

In certain locations within the Imperial Valley the groundwater temperatures can range from 180 to 300 degrees Fahrenheit. In order for the hot water to undergo the reverse osmosis process it will need to be cooled to around 100 degrees Fahrenheit. Without cooling, the water would damage the membranes.

The project yield would be based on the annual and total amount of water that is determined permissible for development based on how much water could be removed without causing negative consequences such as land subsidence. Three annual volumes were assumed and tested: 5,000 AFY, 25,000 AFY, and 50,000 AFY. To determine the number of wells needed to supply the desalination plants with enough source water to produce those volumes of product water. A plant efficiency had to be estimated. Factors that affect plant efficiency include TDS, groundwater temperature, and blending volume. With these variables the calculation of the plant efficiency was assumed to range from 70 to 80 percent. To determine the quantity of wells needed a 75 percent operating efficiency was assumed which indicates approximately 66,000 AFY, 33,000 AFY, and 6,000 AFY of source water would be needed to achieve the desired volumes.

Well fields were sized and costs determined to produce these annual amounts. There are six areas that have been selected as potential locations for desalination plants and well fields. These locations were initially selected due to their proximity to KGRA. The desalination plant and well field locations are: South Brawley KGRA – Keystone, East Brawley KGRA, East Mesa, South Salton Sea KGRA, South Salton Sea – East, and the Heber KGRA.

The well fields were designed based on the detailed analysis of groundwater presented in Appendix B. Design assumptions were made based on available data gathered on aquifer characteristics, water quality, water temperature, location of KGRAs, conveyances, and surface water supplies.

Desalination Facilities

Based on the various desalination treatment technologies, RO is recommended for application to projects identified in the IID Plan. RO plants use semi-permeable membranes to separate fresh water from salt water. The brackish water is forced at very high pressures through tightly wrapped membranes to produce fresh water and a brine waste stream. Two concepts were investigated; large central plants and smaller satellite plants. Sitting considerations included:

- Types of available source water supply
- Proximity to the potential demands or markets for the water produced
- Access to power
- Avoidance of environmental constraints
- Land ownership
- Brine disposal

For purposes of comparison, desalination plant facilities were located near the KGRA since geothermal demands are anticipated to be the largest increase in water use over the planning period. The assumed TDS for the delivered water is 650 mg/L.

The evaluation of cost estimates were based on the U.S. Bureau of Reclamation's Desalting Handbook for Planners (Reclamation 2003). Based on this handbook, the most cost effective technology for desalting brackish water is RO. Significant factors affecting the cost of brackish water reverse osmosis plants include:

- The temperature of the source water: The brackish groundwater sources in the Imperial Valley are generally in the range of 180 to 300 degrees, although data is very limited. RO membranes are damaged by water temperatures over 100 degrees. It is feasible – at a cost and with a significant loss of water – to cool water with an initial temperature of 180 degrees with cooling towers. This investigation includes the cost of cooling source water to 100 degrees to avoid damage to the membranes.

- Suspended solids in the source water: Suspended solids need to be filtered out of the source water prior to the RO process. Thus, surface water requires significantly more filtering than groundwater.

- TDS levels of the source water: The TDS level, and the levels of specific ions, impacts the selection of membranes and other details of the design. Also, the TDS level impacts the allowable blending of a source water. The TDS levels used in this investigation are based on limited data. It is likely that actual TDS levels vary enough to significantly affect cost.

- Desired TDS levels in the product water: This investigation has assumed that the product water will have a TDS level of 650 ppm, similar to that of Colorado River water. It is likely that if the IID pursues construction of a desalination plant there will be discussions and negotiations with the end user and a contract will be entered specifying the desired TDS. It is possible that the end user may be willing to pay the added cost of reducing TDS levels below those of the Colorado River.

- Post treatment: If the product water is to be delivered to a municipal and industrial system, then post treatment will be needed to control the corrosiveness of the water. If the product water is delivered to the IID's distribution system, it is likely that blending within the distribution system will solve this issue. Delivery to the distribution system will probably also eliminate the need for regulatory storage.

Conveyance/Use and Market

Alternative uses have been considered including geothermal, agricultural, and other municipal uses. Each will have variable conveyance costs.

If well fields were located adjacent to canals or drains that extend to the desalination plants, the drains could be used to convey source water to the plant instead of more costly piping. Capital project alternatives have been created that outline the use of this approach.

There are two concepts for the use of desalinated water. Desalinated water could be delivered directly to meet the water demands of proposed projects. Desalinated water could also be put into the IID canals, accounted for as new water in the IID portfolio, and then apportioned to proposed new demands for use even if not directly delivered to the point of demand.

Brine Disposal

Desalinated brackish groundwater or drain water may become a viable option, but there are a host of constraints related to brine concentrate management that would need to be overcome. The primary impediment to brackish water desalting is the need for infrastructure that would facilitate, in an environmentally acceptable way, the production of high quality water and the disposal of concentrate discharge. There are many existing facilities, both national and internationally, that have overcome the obstacle and have successfully been permitted.

For purposes of brine management resulting from inland facilities located within Imperial Valley, the major strategies for brine disposal would be limited to four general categories: 1) deep well injection with new wells, 2) deep well injection at existing or proposed power plants by co-locating, 3) evaporation ponds, and 4) salt disposal ponds at the Salton Sea being developed as part of the recovery strategy. These four general categories are further discussed below.

1) Deep Well Injection with New Wells

Typically with the deep well injection method, desalting concentrate is injected into unusable groundwater aquifers through new wells installed in depths that vary from a few hundred feet to several thousand feet. An alternative to drilling new injection wells could involve utilizing existing geothermal wells that are no longer in use. Both alternatives can only occur in areas where large volumes of concentrate can be accepted by the aquifers. Therefore, additional study of the site specific geological and hydrological conditions is needed to determine the suitability of porous aquifers. Also the constituent makeup of the brine concentrate must be compatible with the aquifers and the injection wells.

This method of brine disposal is considered the most cost effective as compared with other systems in practice for land based desalination plants. However, there are drawbacks to this technology. The drawbacks include: 1) selection of suitable well site, 2) costs involved in conditioning the waste brine, 3) possibility of corrosion and subsequent leakage in well casing, 4) seismic activity that could cause damage to the well and subsequently result in groundwater contamination, and 5) uncertainty of well half-life.

Permits for deep well injection are regulated by the U.S. Environmental Protection Agency (EPA) and also mandated by the State in most cases. A National Pollutant Discharge Elimination System (NPDES) permit may be sufficient; however, the Underground Injection Control (UIC) program and State agencies may require additional permitting. For additional discussion on permitting and regulatory constraints refer to Appendix I, Regulatory and Permitting Requirements.

Using aquifers as storage for brine disposal requires the use of aquifers that are too saline to be used for drinking water or agricultural uses. Geothermal energy plants are currently using deep injection wells to dispose of brine from their facilities. To determine the proper location to site an injection well the depth to the saline aquifer needs to be known. The saline aquifer also needs a cap or impermeable layer above it to keep the water pumped for storage from migrating up into the drinking water aquifers.

2) Deep Well Injection with Existing Wells or Proposed Power Plants (co-location)

To determine the general depth within the different KGRA wells, logs from geothermal injection wells were analyzed to determine the depth of the aquifer they are using for storage. Based on six well logs throughout the central Imperial Valley the range for the injection well depths is from about 5,000 feet to 9,000 feet. The depth to the seals placed in the wells to prohibit the upward migration of the stored water ranges from 1,500 feet to 5,000 feet below ground surface. Due to the variability of the seal depths further research will be required to determine the well design and depth needed for the injection well. Depth will vary depending on the location in the Imperial Valley.

When a desalination plant is proposed to serve a small number of geothermal plants there may be opportunities for collaboration between the desalination plant and the geothermal plant. These opportunities may include joint use of facilities such as cooling towers and injection wells, optimization of water quality for the intended use, or more efficient use of power generated by the geothermal plant.

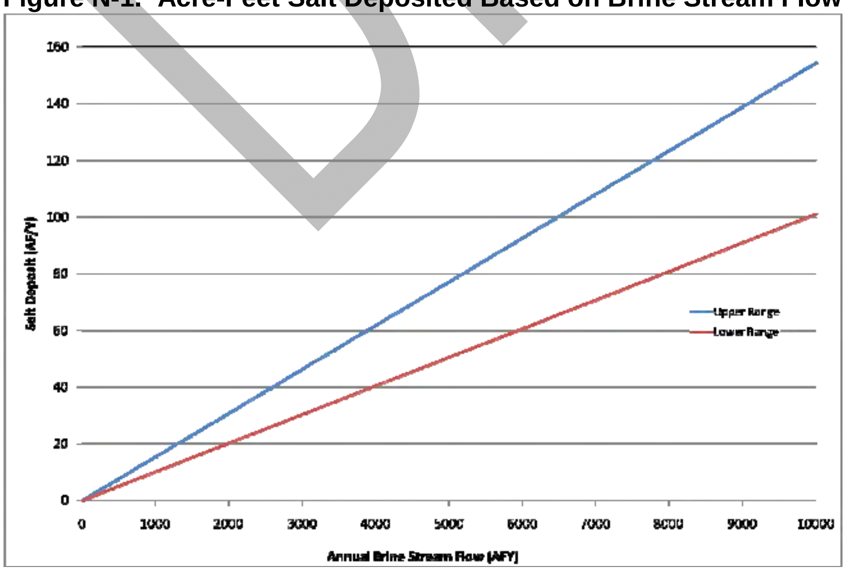
Surface water discharge is the most frequent discharge concentrate disposal method used for brackish water plants. It involves discharging the effluent directly into a larger body of water such as a river or a stream or to a power plant outfall system. The brine concentrate would be mixed with the power plant cooling water within the outfall line prior to the discharge. Power plants typically require substantial flows of cooling water; therefore, providing ample opportunity for mixing and dilution of the concentrate with the cooling water waste stream.

The Clean Water Act (CWA) has mandated the development of standards and regulations for all wastewater discharges to surface water. For desalination, a NPDES permit must be filed. In order to obtain the permit, the brine concentrate must meet water quality standards that apply to the body of water it will discharge to.

3) Evaporation Ponds

Evaporation ponds dispose of reject brine from inland desalination plants by discharging the concentrate to ponds, where it is evaporated to dryness for final disposal in an appropriately designated landfill for non-hazardous waste. It is generally suitable for small inland desalination plants located in arid and semi-arid areas due to high evaporation rates. Evaporation ponds are relatively easy to construct, require low maintenance and little operator attention. In many instances, evaporation ponds are frequently the least costly means of brine disposal, especially in areas with high evaporation rates and low land costs. Figure N-1 illustrates the anticipated quantity of salt generated as a function of volume brine stream. It is expected that 35 acres of land will be required per 1 MGD of capacity. Additional assumptions include approximately 25 to 33 percent brine generated from total product water.

Figure N-1. Acre-Feet Salt Deposited Based on Brine Stream Flow



The principal environmental concern associated with evaporation pond disposal is the potential contamination of underlying potable water aquifers. The ponds generally require an impermeable liner, primarily composed of clay or synthetic materials, to prevent leakage. Double lining is strongly recommended with leakage sensing probes installed between layers of pond lining.

Another concern is the presence of sufficient concentrations of potentially toxic elements in the concentrate that may limit the use of this type of disposal. For example, in the San Joaquin Valley, the presence of selenium in agricultural drainage water generally makes this form of disposal unacceptable. Other waste products, such as cleaning chemicals, produced by desalination plants may be mixed in with the reject brine.

Evaporation ponds do not require permits under the NPDES or UIC program, as long as the responsible party can provide conclusive evidence that no leakage will occur. Therefore, liner installation must be carried out with care since sealing of joints is critical in preventing leakage. Commonly, users of evaporation ponds acquire NPDES permits, rather than prove no leakage is possible.

4) Discharge to the Salton Sea

As part of the Salton Sea Restoration Project, the U.S. Bureau of Reclamation and the Salton Sea Authority conducted the Salton Sea Salinity Control Research Project (Project) at the Salton Sea Test Base from July 2000 until December 2002. The goal of this Project was to further understand the use of evaporation ponds to evaporate Salton Sea water, as well as to understand the issues related to disposing of the salt deposits that likely would be produced from using these systems or any other salt concentrating technology. To date, the Project facilities remain and are comprised of a series of interconnecting evaporation ponds and cells. The possibility of using existing evaporation ponds, co-located by the Salton Sea, exists and should be considered.

Another variation evaluating discharge to the Salton Sea is to directly discharge brine concentrate directly to the Sea. The Salton Sea is a congressionally authorized repository for irrigation drain water from the Imperial and Coachella Valleys, and currently receives about 1.3 million acre-feet (maf) of inflow annually and annually looses about this amount from evaporation. Most of the annual inflow is irrigation drain water with less than eight percent coming from annual precipitation within the basin (Cohen et al. 1999). There are three water quality issues associated with the Salton Sea: salinity, nutrient loading, and selenium.

Approximately four million tons of dissolved salts, 15,000 tons of nutrients (Cohen et al. 1999), and about 9 tons of selenium (Setmire and Schroeder 1998) enter the sea annually. Since its most recent filling in 1905, the Salton Sea has experienced several periods of fluctuating water levels. However, as economic pressures change and the need for domestic water in southern California continues to increase, it appears that a prolonged period of reduced inflow is currently underway. High evaporative loss (5 to 6 feet annually) and reduced inflow in the future has lead to reduced volume and surface area with increasing salinity levels. With the health of the Sea naturally diminishing and transforming more and more to a salt sink, utilizing the sea as a location to receive brine discharge becomes a consideration.

Further discussion on regulatory and permitting requirements associated with each brine disposal method is further discussed and summarized in Appendix I, Permitting and Regulatory Requirements.

Groundwater Recharge and Banking

To mitigate the effects of groundwater pumping in the East Mesa and to store a volume of water during under-run years, groundwater banking and recharge facilities could be used in the East Mesa area. These facilities could be constructed on the old unlined portion of the Coachella Canal or new ponds could be developed and used to recharge or bank water in the aquifer below the east mesa. Appendix B describes the characteristics of the aquifer beneath the East Mesa and the basis of design for the unlined canal recharge facilities.

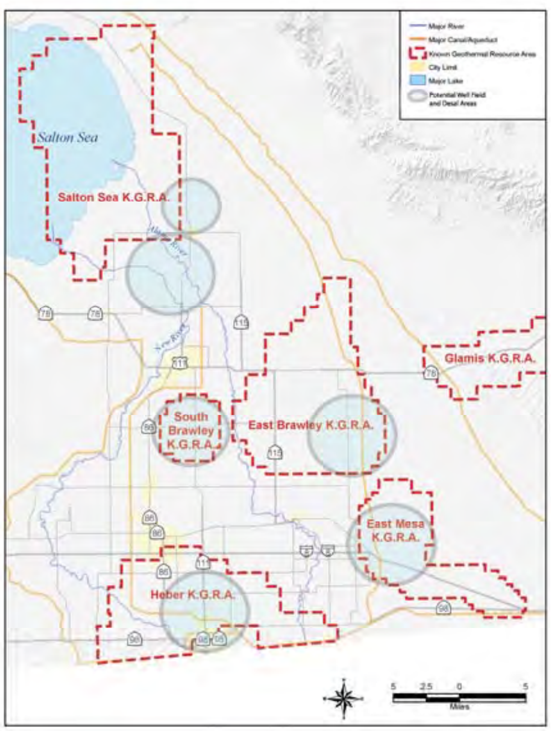
Based on historical data there is a potential for 15,000 to 250,000 AFY of under-run that could be banked by IID. Appendix F, created by NRCE, describes the quantity of water available for IID recharge and groundwater banking efforts.

In the future, banking efforts could also be conducted with CVWD by using banking and recharge facilities provided by CVWD; or new facilities constructed that would involve exchange with CVWD as described in the alternatives discussion below.

N.1.2 Project Alternatives

Table N-1 presents a matrix of project elements that were configured to build varying project alternatives within six different KGRAs. Each area was evaluated for a desalination plant is listed below with the reasons they have been considered (Figure N-2). The formulation of the capital project alternatives tests the relative costs of the major elements within each alternative. An equivalent annual cost of $600 per acre-foot or more or a yield less than 5,000 acre-feet/year is considered a fatal flaw. Details pertaining to aquifer hydraulic characteristics, well field design, water quality, and water temperature are located in Appendix B.

Figure N-2. Study Areas for Potential Capital Project Alternatives. Blue Ovals represent the general locations studied for Desalination Plant feasibility



The Keystone area was chosen for alternatives 1 through 6 because it is planned for future MCI development; agricultural lands are not as productive as other areas; this location would be able to obtain water from a well field, IID drains, or the Alamo River; and it is close to IID irrigation distribution facilities. Treated water could also be used directly for MCI purposes.

The East Brawley KGRA area was selected for alternatives 7 through 10 because it is planned for future geothermal development; this location would be able obtain water from a well field, and it is close to IID irrigation distribution facilities. Treated water could also be used directly for MCI purposes. The well field is located in East

Brawley KGRA which is adjacent to the East Mesa and would benefit from recharge efforts in the East Mesa.

The East Mesa KGRA was selected for alternatives 11 through 13 because of the proximity to geothermal power plants; this location would be able obtain water from a well field. Treated water could also be used for agricultural use.

The South Salton Sea KGRA area was selected for alternatives 14 and 15 because of the proximity to geothermal power plants and would be able to obtain water from the Alamo River. The use of surface water would not impact the groundwater basin therefore would not cause groundwater depletion or subsidence. Treated water could be used for municipal and industrial use.

The South Salton Sea KGRA – East Side area was selected for alternative 16 because of the proximity to geothermal power plants and source water would be obtained from a small well field. Treated water could be used for municipal and industrial use.

The Heber KGRA area was selected for alternative 17 because of the proximity to geothermal power plants and source water would be obtained from a small well field. Treated water could be used for municipal and industrial use.

Table N-1. Alternative Configurations

Design Components "Cost Elements"	Keystone						East Brawley				East Mesa			South Salton Sea		East South Salton	Heber	East Mesa	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Desalination Plant																		Groundwater Blending	Groundwater Blending
1 Central Plant Keystone																			
2 Central Plant East Brawley KGRA Area																			
3 Central Plant South of South Salton Sea KGRA Area																			
4 Central Plant East Mesa KGRA																			
5 Satellite Plant East Mesa KGRA																			
6 Satellite Plant South Salton Sea KGRA Area																			
7 Satellite Heber																			
Yield																			
1 50,000 AFY																			
2 25,000 AFY																			
3 5,000 AFY																			
Source Water																			
Groundwater																			
1 South Salton Sea - Shallow Aquifer - 200 gpm																			
2 South Salton Sea - Intermediate Aquifer - 350 gpm																			
3 Heber - Intermediate Aquifer - 350 gpm																			
4 East Mesa - Intermediate Aquifer - 2,000 gpm																			
5 East Brawley - Intermediate Aquifer - 2,000 gpm																			
a Large well field																			
b Small well field																			
Surface Water																			
6 Drainwater																			
7 New River Water																			
8 Alamo River Water																			
Conveyance																			
Agricultural																			
1 IID Irrigation Systems A: Bryant, Redwood, Rose Canals																			
2 IID Irrigation Systems B: East Highline & Laterals																			
3 IID Irrigation System C:																			
Municipal																			
4 Municipal Distribution																			
Industrial																			
5 Industrial Use (Geothermal)																			
Brine Disposal																			
1 New Well (s)																			
2 Existing Geothermal Cooperators																			
3 Evaporation Ponds																			
Groundwater Recharge																			
1 Coachella Canal																			
2 Percolation Basins																			
3 No Recharge																			
Costs (May 2009 Price Level)																			
Capital Cost	$281,817,834	$282,399,468	$306,357,788	$147,437,743	$372,088,101	$160,695,766	$100,409,542	$100,991,177	$162,175,609	$24,751,185	$111,746,590	$112,318,224	$33,027,263	$158,619,378	$182,975,327	$62,177,056	$55,899,356	$39,501,517	$48,605,551
Annual O&M costs	$13,149,000	$13,158,000	$13,518,000	$15,323,901	$10,232,000	$7,061,000	$6,157,000	$6,166,000	$7,084,000	$1,525,000	$6,327,000	$6,336,000	$1,648,000	$15,491,901	$15,857,901	$1,971,000	$2,476,000	$198,000	$243,000
Equivalent annual capital cost	$16,298,000	$16,331,000	$17,717,000	$8,526,000	$21,518,000	$9,293,000	$5,807,000	$5,840,000	$9,379,000	$1,431,000	$6,462,000	$6,495,000	$1,910,000	$9,173,000	$10,581,000	$3,596,000	$827,000	$2,482,000	$3,054,000
Equivalent annual cost per acre-foot	**$589**	**$590**	**$625**	**$477**	**$1,270**	**$654**	**$479**	**$480**	**$659**	**$591**	**$512**	**$513**	**$712**	**$493**	**$529**	**$1,113**	**$661**	**$99**	**$122**

N.1.2.1 Desal Alternative 1- 50,000 AF Keystone Desalination with Well Field

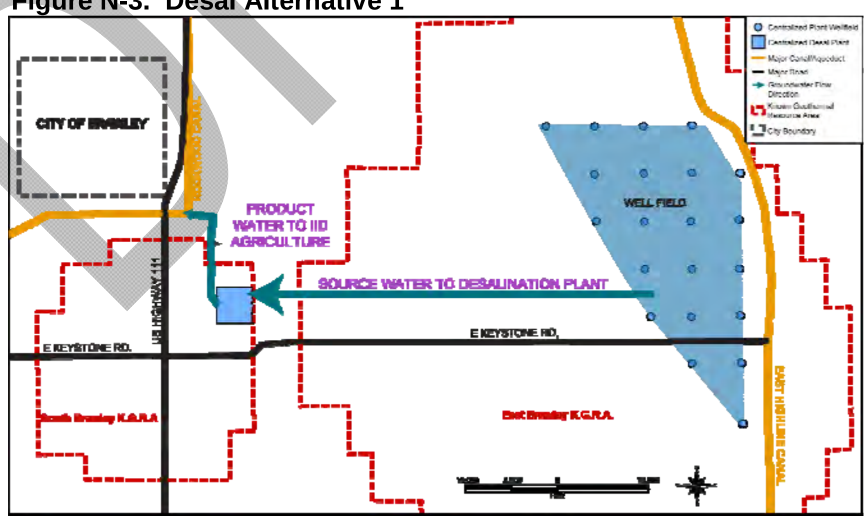
Description

A 50,000 AF Desalination Plant would be located in the South Brawley KGRA. The exact location has not been determined (Figure N-3). The facility was sited to allow for estimation of conveyance costs. The purpose of this alternative is to develop the cost for providing 50,000 AFY of groundwater to a desalination plant without the use of recharge or groundwater banking facilities. The source water would be from a well field located in the East Brawley KGRA and consisting of 21 wells drilled to an average depth of 900 feet, producing 2,000 gpm for a total production capacity of about 42,000 gpm. The wells were located to avoid impacts to habitat and permitting issues related to BLM lands. The wells are connected by pipelines leading to an 11 mile trunk line that will convey the water to the plant; would be sited in existing easements and rights-of-way; and will cross the Alamo River. Total dissolved solids concentration of 1,900 mg/L is assumed. Water temperature from this well configuration is anticipated to be about 170 degrees Fahrenheit. This will necessitate cooling the water prior to treatment to protect membranes and maintain plant efficiency.

The produced water would be conveyed to IID facilities for distribution to agricultural uses. Brine disposal will be through injection of the water to the deeper, highly saline formations beneath the plant using five new injection wells. If geothermal plants were to be co-located in the future, there could be an opportunity to partner on wells that would recover the hot water and inject the brine stream from the Desalination Plant.

This alternative relying solely on groundwater would result in a large groundwater depletion and decline in groundwater levels that could lead to migration of poor quality water and/or land subsidence. Because this was an unacceptable level of impact this was considered a fatal flaw and this project alternative was eliminated from further consideration.

Figure N-3. Desal Alternative 1



Costs

Table N-2. Desal Alternative 1 – 50KAF Keystone Desalination with Well Field (May 2009 price level, 4% real interest rate, 30 year project life)

Direct Capital Costs, May 2009 Price Level	Total
Desal Plant	70,700,000
Source water development, collection and transmission - well water	142,519,509
Recharge Facilities	-
Concentrate Disposal - New Injection Wells	9,000,000
Mitigation Costs (reduced flow from drains)	-
Product Water Distribution	10,968,000
Working capital (2 months of O&M costs per Reclamation, Page D-20)	1,490,000
Direct Capital Costs May 2009 Price Level	$ 234,677,509
Indirect Capital Costs (as percent of direct costs UON)	
Freight and Insurance 5 % of direct capital cost	4,160,000
Owner's direct expense, 10 % of direct capital cost	23,470,000
Construction Overhead, 15 % of direct capital cost	12,470,000
Interest During Construction for half of construction period	7,040,325
Indirect Capital Costs (as percent of direct costs UON)	$ 47,140,325
Capital Cost	$ 281,817,834
Annual O&M costs, May 2009 Price Level	$ 13,149,000
Financial Analysis - cost per acre-foot	
Equivalent annual cost	$ 29,447,000
Product Water, acre-feet	50,000
Equivalent annual cost per acre-foot	**$ 589**
Unacceptable decline in groundwater levels.	**Not Feasible**

N.1.2.2 Desal Alternative 2 - 50,000 AF Keystone Desalination with Well Field and Groundwater Recharge

Description

The purpose of this alternative is to add groundwater recharge and groundwater banking facilities to the East Mesa to minimize the potential negative effects on the groundwater basin and reduce groundwater depletion. It has the same groundwater source elements as discussed in alternative 1. For purpose of the analysis, it was assumed that the old Coachella Canal would be developed to provide for recharge and banking of Colorado River water that is available in years where there is an under-run (Figure N-4). The amount of Colorado River water to be banked was assumed to vary from 15,000 AFY to 250,000 AFY based on the analysis described previously.

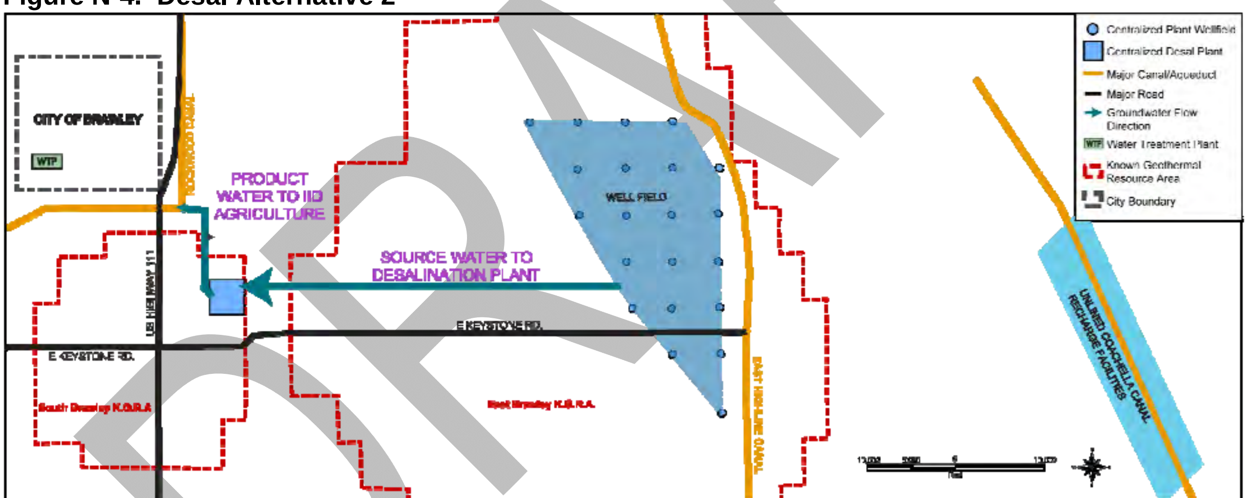
New East Mesa Recharge Ponds. The project goal would be to mitigate for 50,000 AFY of the groundwater impacts but there could still be some depletion of the groundwater basin. The aquifer is currently full and some period of groundwater development may be needed to optimize groundwater recharge operations. IID development, management and operations of local groundwater recharge facilities have multiple benefits and the feasibility of recharge in the East Mesa merits further review. The alternative is technically feasible and will be further compared to other alternatives.

Appendix F describes the potential under-runs that may be available for groundwater recharge and different groundwater banking scenarios.

Variants

A variant on this theme would be to develop dedicated groundwater recharge basins in the East Mesa. This would be constrained due to ownership and management by the Bureau of Land Management (BLM), the existence of sensitive habitats, and ability to obtain easements and rights-of-way. There could be a possibility for land exchange to overcome some of the potential constraints.

Figure N-4. Desal Alternative 2



Costs

Table N-3. Desal Alternative 2 – 50KAF Keystone Desalination with Well Field and Groundwater Recharge (May 2009 price level, 4% real interest rate, 30 year project life)

Direct Capital Costs, May 2009 Price Level		Total
Desal Plant		70,700,000
Source water development, collection and transmission - well water		142,540,389
Recharge Facilities		417,600
Concentrate Disposal - New Injection Wells		9,000,000
Mitigation Costs (reduced flow from drains)		-
Product Water Distribution		10,968,000
Working capital (2 months of O&M costs per Reclamation, Page D-20)		1,490,000
Direct Capital Costs, May 2009 Price Level		$ 235,115,989
Indirect Capital Costs (as percent of direct costs UON)		
Freight and Insurance 5 % of direct capital cost		4,180,000
Owner's direct expense, 10 % of direct capital cost		23,510,000
Construction Overhead, 15 % of direct capital cost		12,540,000
Interest During Construction for half of construction period		7,053,480
Indirect Capital Costs (as percent of direct costs UON)		$ 47,283,480
Capital Cost		$ 282,399,468
Annual O&M costs, May 2009 Price Level		$ 13,158,000
Financial Analysis - cost per acre-foot		
Equivalent annual cost	$	29,489,000
Product Water, acre-feet		50,000
Equivalent annual cost per acre-foot	**$**	**590**

N.1.2.3 Desal Alternative 3 - 50,000 AF Keystone Desalination with Well Field, Groundwater Recharge and MCI Distribution

Description

The purpose of this alternative is to use the same elements as alternative 2 with the addition of delivery of product water to municipal and industrial users (Figure N-5). The water will be conveyed by pipelines leading to the local water treatment plants for distribution to the Keystone development and the City of Brawley.

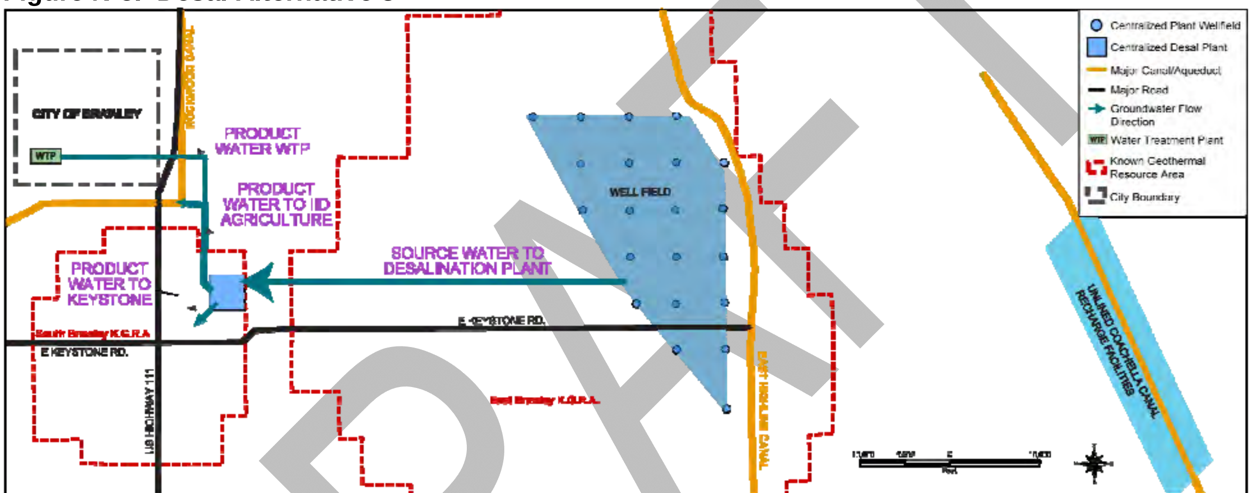
The delivery of the product water to the water treatment plants would require further planning to evaluate the quantity of water that can be accepted by the plants and to determine the quantity of water needed for municipal and industrial use.
Though technically feasible, this project exceeded to $600/AF cost threshold and is infeasible.

Variants

- **New East Mesa Recharge Ponds.** A variant on this theme would be to develop dedicated groundwater recharge basins in the East Mesa.

- **Municipal Water Delivery.** A variant on this alternative would be to supply the cities of Imperial, El Centro and Calexico with product water. This could result in future economies of scale. Additional benefits could be related to increased reliability of MCI supply in the event of catastrophic failure of the All American Canal. Further research would need to be conducted to cost this addition to the alternative and to determine the quantity that would be required for delivery.

Figure N-5. Desal Alternative 3



Costs

Table N-4. Desal Alternative 3 – 50KAF Keystone Desalination with Well Field and Groundwater Recharge and MCI Distribution (May 2009 price level, 4% real interest rate, 30 year project life)

Direct Capital Costs, May 2009 Price Level		Total
Desal Plant		70,700,000
Source water development, collection and transmission - well water		143,404,389
Recharge Facilities		417,600
Concentrate Disposal - New Injection Wells		9,000,000
Mitigation Costs (reduced flow from drains)		-
Product Water Distribution		28,248,000
Working capital (2 months of O&M costs per Reclamation, Page D-20)		1,490,000
Direct Capital Costs, May 2009 Price Level		$ 253,259,989
Indirect Capital Costs (as percent of direct costs UON)		
Freight and Insurance 5 % of direct capital cost		5,040,000
Owner's direct expense, 10 % of direct capital cost		25,330,000
Construction Overhead, 15 % of direct capital cost		15,130,000
Interest During Construction for half of construction period		7,597,800
Indirect Capital Costs (as percent of direct costs UON)		$ 53,097,800
Capital Cost		$ 306,357,788
Annual O&M costs, May 2009 Price Level		$ 13,518,000
Financial Analysis - cost per acre-foot		
Equivalent annual cost	$	31,235,000
Product Water, acre-feet		50,000
Equivalent annual cost per acre-foot	**$**	**625**

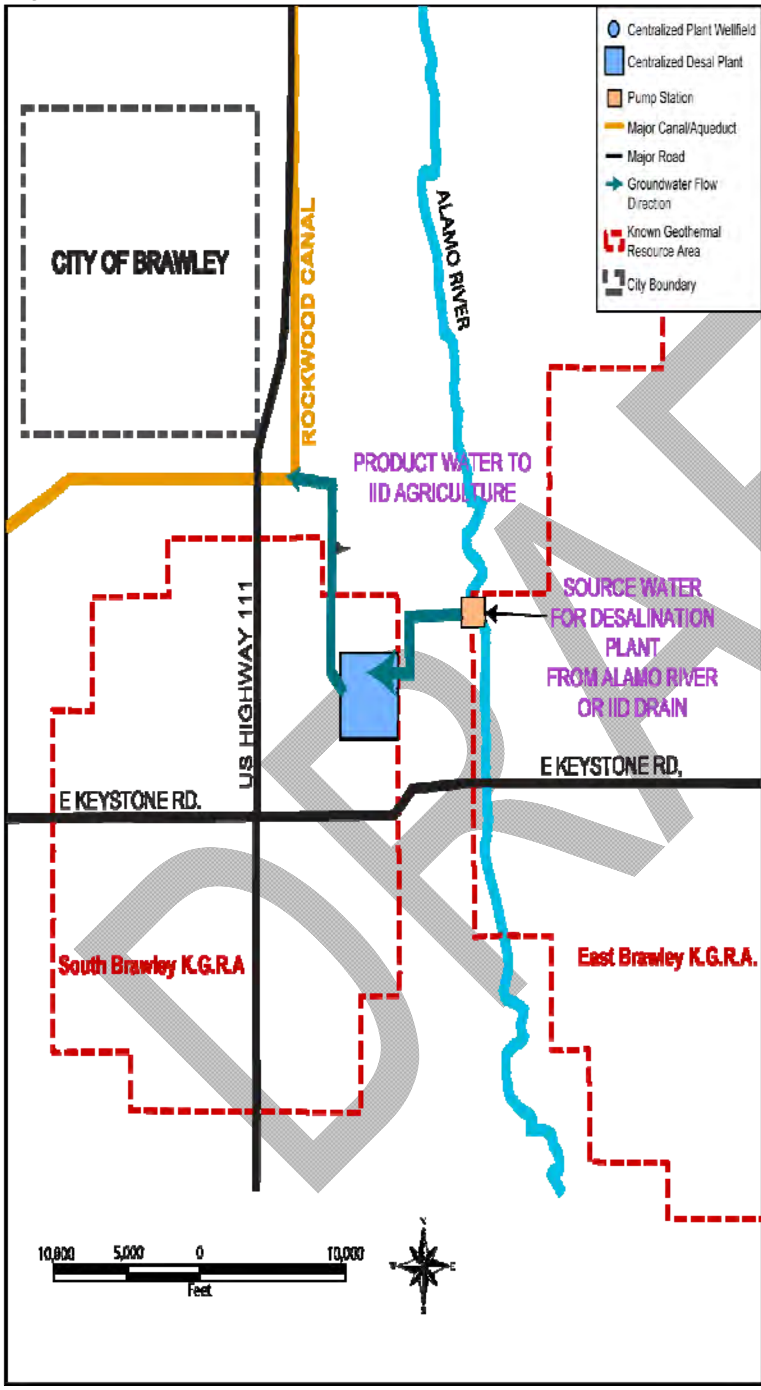
N.1.2.4 Desal Alternative 4- 50,000 AF Keystone Desalination with Alamo River

Description

The purpose of this alternative would be to supply a 50,000 AFY desalination plant with a surface water supply from the Alamo River (Figure N-6). This alternative would not impact the groundwater aquifer. The plant would be located in the South Brawley KGRA and the exact location has not been determined. The facility was sited to allow for estimation of conveyance costs. The source water from the Alamo River would have an assumed TDS of about 3,000 mg/L. Water temperature from the river is anticipated to be about 75 degrees Fahrenheit which will not necessitate cooling the water prior to treatment.

The product water would be conveyed to IID facilities for distribution to agricultural uses. Brine disposal will be through injection of the water to the deeper, highly saline formations beneath the plant using five new injection wells. If geothermal plants were to be co-located in the future, there could be an opportunity to partner on wells that would inject the brine stream from the Desalination Plant.

Figure N-6. Desal Alternative 4



Variants

- **IID Drain Water Capture.** A variant on this alternative would be the use of source water collected from IID drains instead of the Alamo River. Under this concept approximately 60,000 AF would be collected from a canal near the terminus of the Rose, Holtville, and Central drain. Sump pumps would be installed at the Rose and Holtville drains near the Alamo River to control impacts related to loss of drain water. Central drain water would be collected and conveyed down the Mesquite Drain for collection at the Rose Drain sump. This variant may have less regulatory constraints and may be more cost effective as compared to an Alamo River diversion. Further research would be needed to determine if the Alamo River or the IID drains are the best source for the desalination plant source water.

Costs

Table N-5. Desal Alternative 4 – 50KAF Keystone Desalination with Alamo River (May 2009 price level, 4% real interest rate, 30 year project life)

Direct Capital Costs, May 2009 Price Level		Total
Desal Plant		71,450,000
Source water development and transmission - surface water collection		10,356,408
Recharge Facilities		-
Concentrate Disposal - New Injection Wells		9,000,000
Mitigation Costs (reduced flow from drains)		9,980,391
Product Water Distribution		10,968,000
Working capital (2 months of O&M costs per Reclamation, Page D-20)		2,010,000
Direct Capital Costs, May 2009 Price Level		$ 113,764,799
Indirect Capital Costs (as percent of direct costs UON)		
Freight and Insurance 5 % of direct capital cost		4,720,000
Owner's direct expense, 10 % of direct capital cost		11,380,000
Construction Overhead, 15 % of direct capital cost		14,160,000
Interest During Construction for half of construction period		3,412,944
Indirect Capital Costs (as percent of direct costs UON)		$ 33,672,944
Capital Cost		$ 147,437,743
Annual O&M costs, May 2009 Price Level		$ 15,323,901
Financial Analysis - cost per acre-foot		
Equivalent annual cost	$	23,849,901
Product Water, acre-feet		50,000
Equivalent annual cost per acre-foot	**$**	**477**

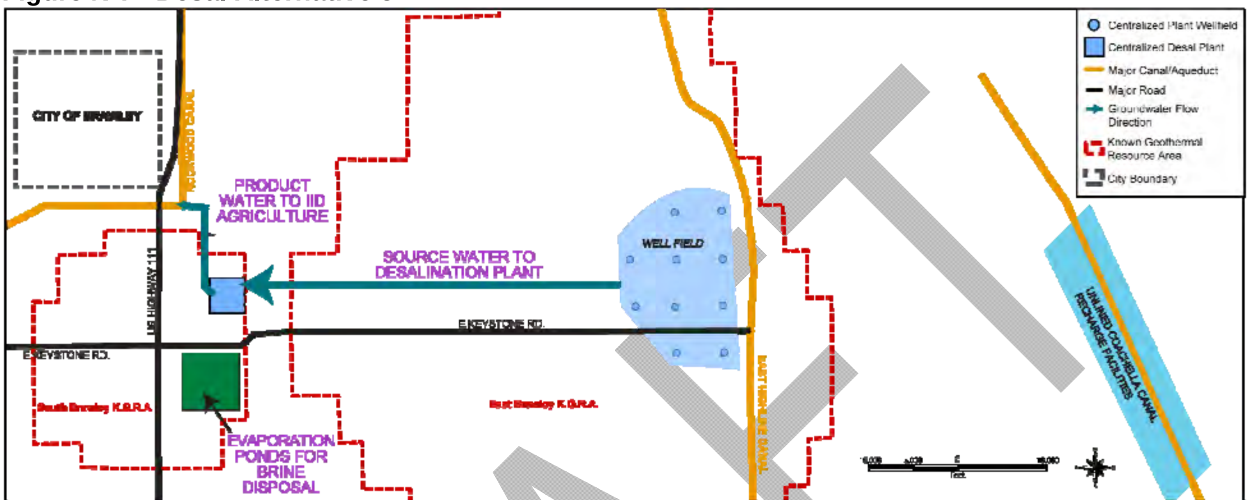
N.1.2.5 Desal Alternative 5 - 25,000 AF Keystone Desalination with Well Field, Groundwater Recharge and Evaporation Ponds

Description

The purpose of alternative 5 is to use the elements from alternative 1 with three changes (Figure N-7). The quantity of wells will be reduced from 21 to 10 to supply 25,000 AFY of product water. Groundwater recharge and banking facilities are included in the East Mesa to minimize the potential negative effects on the groundwater basin and reduce groundwater depletion. For purpose of the analysis, it was assumed that the old Coachella Canal would be developed to provide for recharge and banking of Colorado River water that is available in years where there is an under-run. The amount of Colorado River water to be banked was assumed to vary from 15,000AFY to 250,000 AFY. Appendix F describes the potential under-runs that may be available for groundwater recharge and different groundwater banking scenarios. The third addition is the use of evaporation basins instead of injection wells to dispose of the brine water.

The alternative is not economically feasible due to the cost of the evaporation ponds.

Figure N-7. Desal Alternative 5



Variants

- **New East Mesa Recharge Ponds.** A variant on this theme would be to develop dedicated groundwater recharge basins in the East Mesa.

- **Salton Sea Salt Disposal Ponds.** A variant on the evaporation basins would be to create evaporation basins in conjuncture with the Salton Sea Restoration plan. The brine could be disposed in borrow pits that may be created during the restoration process. This variant will require further research to determine its feasibility and practicality. Using Figure N-1 it is expected that 35 acres of land will be required per 1 MGD of capacity. Further research needs to be conducted to determine the feasibility of this variant.

Costs

Table N-6. Desal Alternative 5 – 25KAF Keystone Desalination with Well Field, Groundwater Recharge and Evaporation (May 2009 price level, 4% real interest rate, 30 year project life)

Direct Capital Costs, May 2009 Price Level		Total
Desal Plant		42,940,000
Source water development, collection and transmission - well water		77,213,197
Recharge Facilities		417,600
Concentrate Disposal - Evaporation ponds, not including land cost		155,710,000
Land Cost for evaporation ponds		5,780,000
Mitigation Costs (reduced flow from drains)		-
Product Water Distribution		8,536,000
Working capital (2 months of O&M costs per Reclamation, Page D-20)		780,000
Direct Capital Costs with Contingency, May 2009 Price Level		$ 291,376,797
Indirect Capital Costs (as percent of direct costs UON)		
Freight and Insurance 5 % of direct capital cost		10,710,000
Owner's direct expense, 10 % of direct capital cost		29,140,000
Construction Overhead, 15 % of direct capital cost		32,120,000
Interest During Construction for half of construction period		8,741,304
Indirect Capital Costs (as percent of direct costs UON)		$ 80,711,304
Capital Cost		$ 372,088,101
Annual O&M costs, May 2009 Price Level		$ 10,232,000
Financial Analysis - cost per acre-foot		
Equivalent annual cost	$	31,750,000
Product Water, acre-feet		25,000
Equivalent annual cost per acre-foot	**$**	**1,270**

N.1.2.6 Desal Alternative 6 - 25,000 AF Keystone Desalination with Well Field

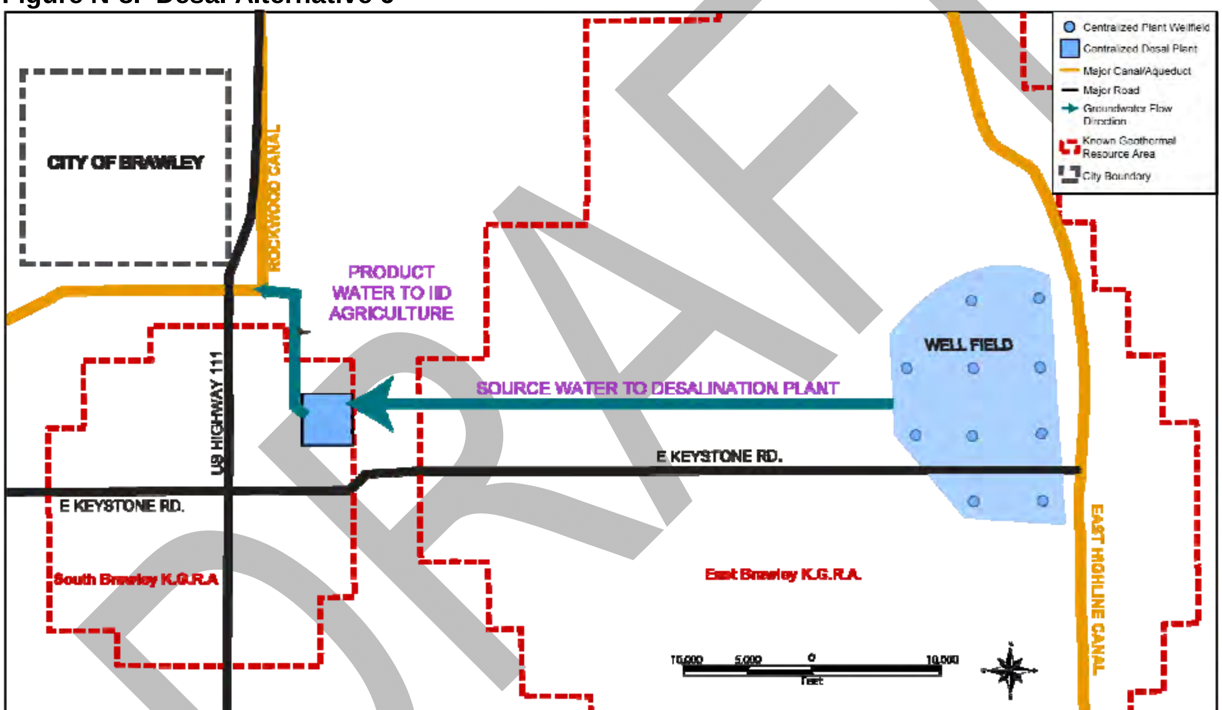
Description

The purpose of this alternative was to use the elements in alternative 1 and compare the feasibility of using a 25,000 AFY desalination plant located in the South Brawley KGRA instead of a 50,000 AFY plant (Figure N-8). The exact location has not been determined. The facility was sited to allow for estimation of conveyance costs. The source water would be from a well field located in the East Brawley KGRA and consisting of 10 wells drilled to an average depth of 900 feet producing 2,000 gpm for a total production capacity of about 21,000 gpm. The project would pump 750,000 AF over the 30-year project life. The wells are connected by pipelines leading to an 11-mile trunk line that will convey the water to the plant; would be sited in existing easements and rights-of-way; and will cross the Alamo River. Total dissolved solids concentration of 1,900 mg/L is assumed. Water temperature from this well configuration is anticipated to be about 170 degrees Fahrenheit. This will necessitate cooling the water prior to treatment to protect membranes and maintain plant efficiency.

The produced water would be conveyed to IID facilities for distribution to agricultural uses. Brine disposal will be through injection of the water to the deeper, highly saline formations beneath the plant using three new injection wells. If geothermal plants were to be co-located in the future, there could be an opportunity to partner on wells that would inject the brine stream from the Desalination Plant.

This project would rely solely on groundwater and would result in groundwater depletion. The project exceeds the $600 per AF threshold and is eliminated from future consideration.

Figure N-8. Desal Alternative 6



Costs

Table N-7. Desal Alternative 6 – 25KAF Keystone Desalination with Well Field (May 2009 price level, 4% real interest rate, 30 year project life)

Direct Capital Costs, May 2009 Price Level		Total
Desal Plant		42,940,000
Source water development, collection and transmission - well water		77,192,317
Recharge Facilities		-
Concentrate Disposal - New Injection Wells		5,400,000
Mitigation Costs (reduced flow from drains)		-
Product Water Distribution		6,936,000
Working capital (2 months of O&M costs per Reclamation, Page D-20)		780,000
Direct Capital Costs, May 2009 Price Level		$ 133,248,317
Indirect Capital Costs (as percent of direct costs UON)		
Freight and Insurance 5 % of direct capital cost		2,530,000
Owner's direct expense, 10 % of direct capital cost		13,320,000
Construction Overhead, 15 % of direct capital cost		7,600,000
Interest During Construction for half of construction period		3,997,449
Indirect Capital Costs (as percent of direct costs UON)		$ 27,447,449
Capital Cost		$ 160,695,766
Annual O&M costs, May 2009 Price Level		$ 7,061,000
Financial Analysis - cost per acre-foot		
Equivalent annual cost	$	16,354,000
Product Water, acre-feet		25,000
Equivalent annual cost per acre-foot	**$**	**654**

N.1.2.7 Desal Alternative N - 25,000 AF East Brawley Desalination with Well Field

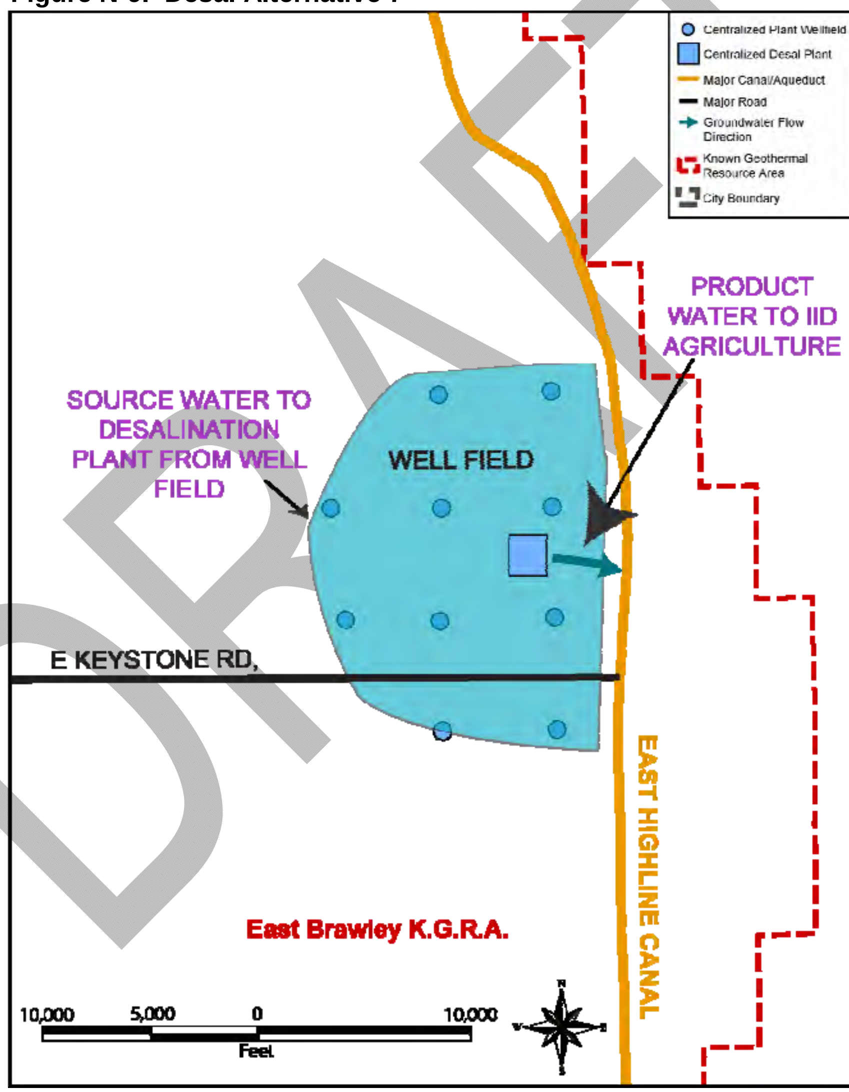
Description

The purpose of this alternative is to determine the feasibility of a 25,000 AFY desalination plant located in the East Brawley KGRA using groundwater without recharge or groundwater banking facilities (Figure N-9). The exact location has not been determined. The facility was sited to allow for estimation of conveyance costs. The source water would be from a well field located in the East Brawley KGRA and consisting of 10 wells drilled to an average depth of 900 feet producing 2,000 gpm for a total production capacity of about 21,000 gpm. The wells are connected by pipelines to convey the water to the plant; would be sited in existing easements and rights-of-way. Total dissolved solids concentration of 1,900 mg/L is assumed. Water temperature from this well configuration is anticipated to be about 170 degrees Fahrenheit. This will necessitate cooling the water prior to treatment to protect membranes and maintain plant efficiency.

The produced water would be conveyed to IID facilities for distribution for agricultural uses. Brine disposal will be through injection of the water to the deeper, highly saline formations beneath the plant using three new injection wells. If geothermal plants were to be co-located in the future, there could be an opportunity to partner on wells that would recover the hot water and inject the brine stream from the Desalination Plant.

This project would rely solely on groundwater and would result in large groundwater depletion.

Figure N-9. Desal Alternative 7



Costs

Table N-8. Desal Alternative 7 – 25KAF East Brawley Desalination with Well Field (May 2009 price level, 4% real interest rate, 30 year project life)

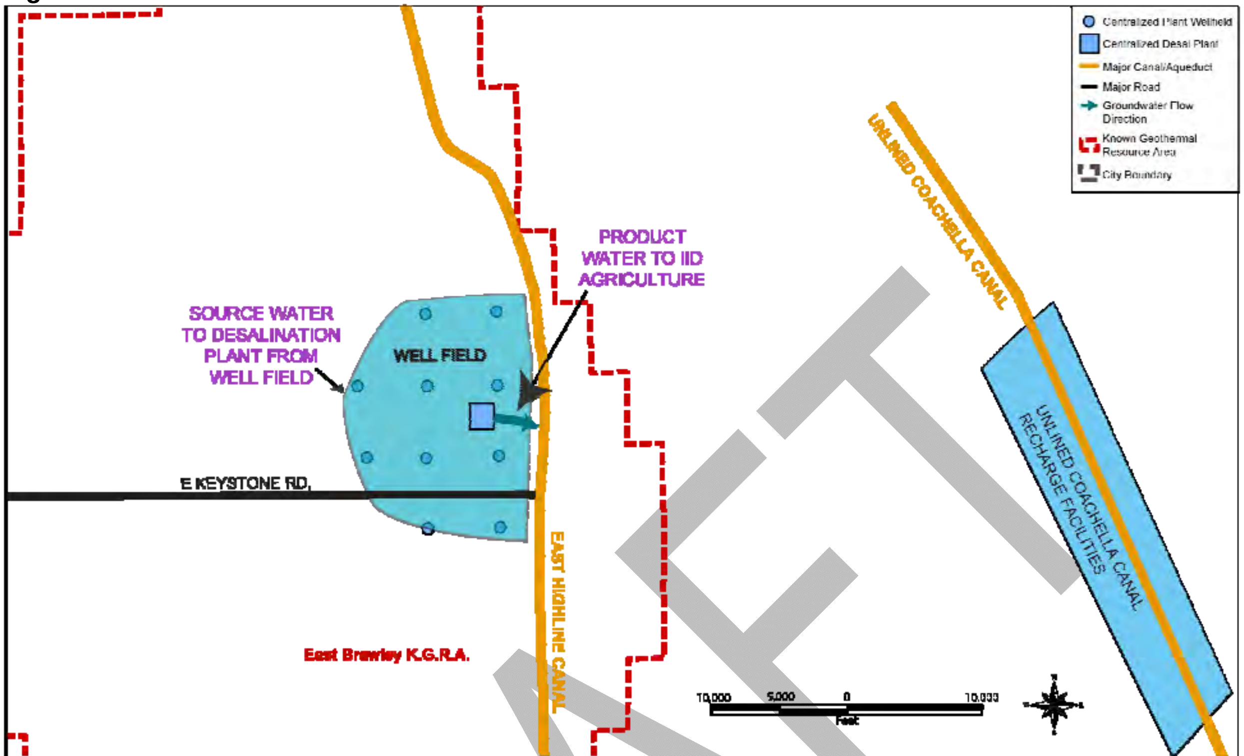
Direct Capital Costs, May 2009 Price Level		Total
Desal Plant		42,940,000
Source water development, collection and transmission - well water		31,635,517
Recharge Facilities		-
Concentrate Disposal - New Injection Wells		5,400,000
Mitigation Costs (reduced flow from drains)		-
Product Water Distribution		312,000
Working capital (2 months of O&M costs per Reclamation, Page D-20)		780,000
Direct Capital Costs, May 2009 Price Level		$ 81,067,517
Indirect Capital Costs (as percent of direct costs UON)		
Freight and Insurance 5 % of direct capital cost		2,200,000
Owner's direct expense, 10 % of direct capital cost		8,110,000
Construction Overhead, 15 % of direct capital cost		6,600,000
Interest During Construction for half of construction period		2,432,025
Indirect Capital Costs (as percent of direct costs UON)		$ 19,342,025
Capital Cost		$ 100,409,542
Annual O&M costs, May 2009 Price Level		$ 6,157,000
Financial Analysis - cost per acre-foot		
Equivalent annual cost	$	11,964,000
Product Water, acre-feet		25,000
Equivalent annual cost per acre-foot	**$**	**479**

N.1.2.8 Desal Alternative 8 - 25,000 AF East Brawley Desalination with Well Field and Groundwater Recharge

Description

The purpose of this alternative is to use the elements from alternative 7 and add groundwater recharge facilities in the East Mesa to mitigate groundwater pumping effects (Figure N-10). For purpose of the analysis, it was assumed that the old Coachella Canal would be developed to provide for recharge and banking of Colorado River water that is available in years where there is an under-run. The amount of Colorado River water to be banked was assumed to vary from 15,000 AFY to 250,000 AFY based on the analysis described previously. Appendix F describes the potential under-runs that may be available for groundwater recharge and different groundwater banking scenarios.

Figure N-10. Desal Alternative 8



This project would mitigate for most of the groundwater impacts but could result in some groundwater depletion of the groundwater basin. The aquifer is currently full and some period of groundwater development may be needed to optimize groundwater recharge operations. IID development, management, and operations of local groundwater recharge facilities have multiple benefits and the feasibility of recharge in the East Mesa merits further review.

Variants

East Mesa Recharge Facilities. A variant on this theme would be to develop dedicated groundwater recharge basins in the East Mesa. This would be constrained due to ownership and management by the BLM, the existence of sensitive habitats, and ability to obtain easements and rights-of-way. There could be a possibility for land exchange to overcome some of the potential constraints.

Costs

Table N-9. Desal Alternative 8 – 25KAF East Brawley Desalination with Well Field and Groundwater Recharge (May 2009 price level, 4% real interest rate, 30 year project life)

Direct Capital Costs, May 2009 Price Level		Total
Desal Plant		42,940,000
Source water development, collection and transmission - well water		31,656,397
Recharge Facilities		417,600
Concentrate Disposal - New Injection Wells		5,400,000
Mitigation Costs (reduced flow from drains)		-
Product Water Distribution		312,000
Working capital (2 months of O&M costs per Reclamation, Page D-20)		780,000
Direct Capital Costs, May 2009 Price Level		$ 81,505,997
Indirect Capital Costs (as percent of direct costs UON)		
Freight and Insurance 5 % of direct capital cost		2,220,000
Owner's direct expense, 10 % of direct capital cost		8,150,000
Construction Overhead, 15 % of direct capital cost		6,670,000
Interest During Construction for half of construction period		2,445,180
Indirect Capital Costs (as percent of direct costs UON)		$ 19,485,180
Capital Cost		$ 100,991,177
Annual O&M costs, May 2009 Price Level		$ 6,166,000
Financial Analysis - cost per acre-foot		
Equivalent annual cost	$	12,006,000
Product Water, acre-feet		25,000
Equivalent annual cost per acre-foot	**$**	**480**

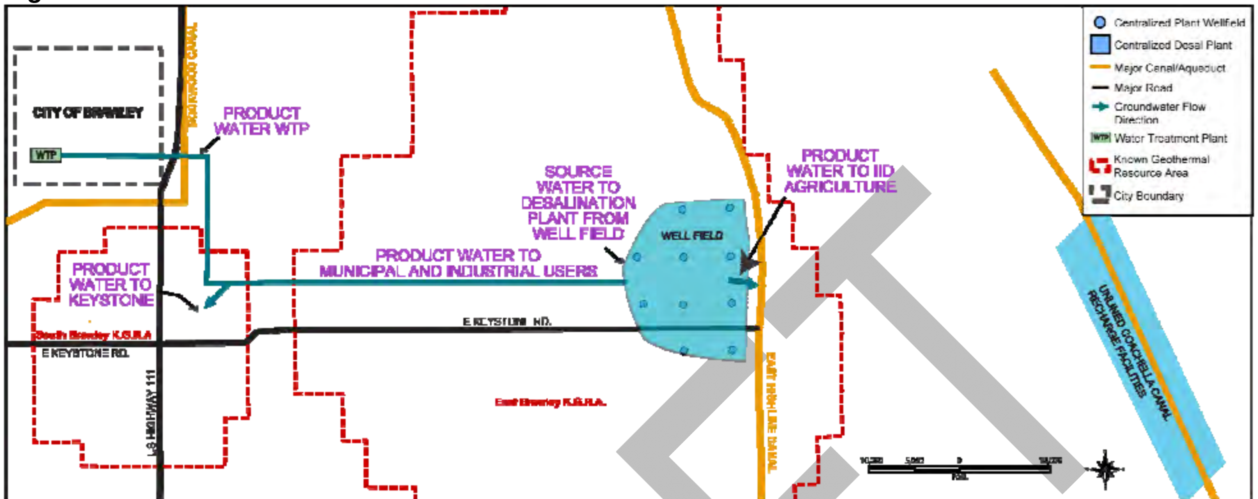
N.1.2.9 Desal Alternative 9 - 25,000 AF East Brawley Desalination with Well Field, Groundwater Recharge and MCI Distribution

Description

The purpose of this alternative is to use all the elements in alternative 8 and add a product water delivery pipeline from East Brawley to the Keystone area and the City of Brawley for municipal and industrial use (Figure N-11). The product water will be delivered through approximately 19 miles of pipeline to the Keystone area and the City of Brawley water treatment plant. This source of water would also provide benefits as a contingency to catastrophic failure of the Coachella Canal and the All American Canal.

The delivery of the product water to the water treatment plants would require further planning to evaluate the quantity of water that can be accepted by the treatment plants and be supplied for municipal and industrial use. The alternative is technically feasible and will be further compared to other alternatives.

Figure N-11. Desal Alternative 9



Costs

Table N-10. Desal Alternative 9 – 25KAF East Brawley Desalination with Well Field and Groundwater Recharge and MCI Distribution (May 2009 price level, 4% real interest rate, 30 year project life)

Direct Capital Costs, May 2009 Price Level		Total
Desal Plant		42,940,000
Source water development, collection and transmission - well water		33,862,797
Recharge Facilities		417,600
Concentrate Disposal - New Injection Wells		5,400,000
Mitigation Costs (reduced flow from drains)		-
Product Water Distribution		44,440,000
Working capital (2 months of O&M costs per Reclamation, Page D-20)		780,000
Direct Capital Costs, May 2009 Price Level		$ 127,840,397
Indirect Capital Costs (as percent of direct costs UON)		
Freight and Insurance 5 % of direct capital cost		4,430,000
Owner's direct expense, 10 % of direct capital cost		12,780,000
Construction Overhead, 15 % of direct capital cost		13,290,000
Interest During Construction for half of construction period		3,835,212
Indirect Capital Costs (as percent of direct costs UON)		$ 34,335,212
Capital Cost		$ 162,175,609
Annual O&M costs, May 2009 Price Level		$ 7,084,000
Financial Analysis - cost per acre-foot		
Equivalent annual cost	$	16,463,000
Product Water, acre-feet		25,000
Equivalent annual cost per acre-foot	**$**	**659**

N.1.2.10 Desal Alternative 10 - 5,000 AF East Brawley Desalination with Well Field

Description

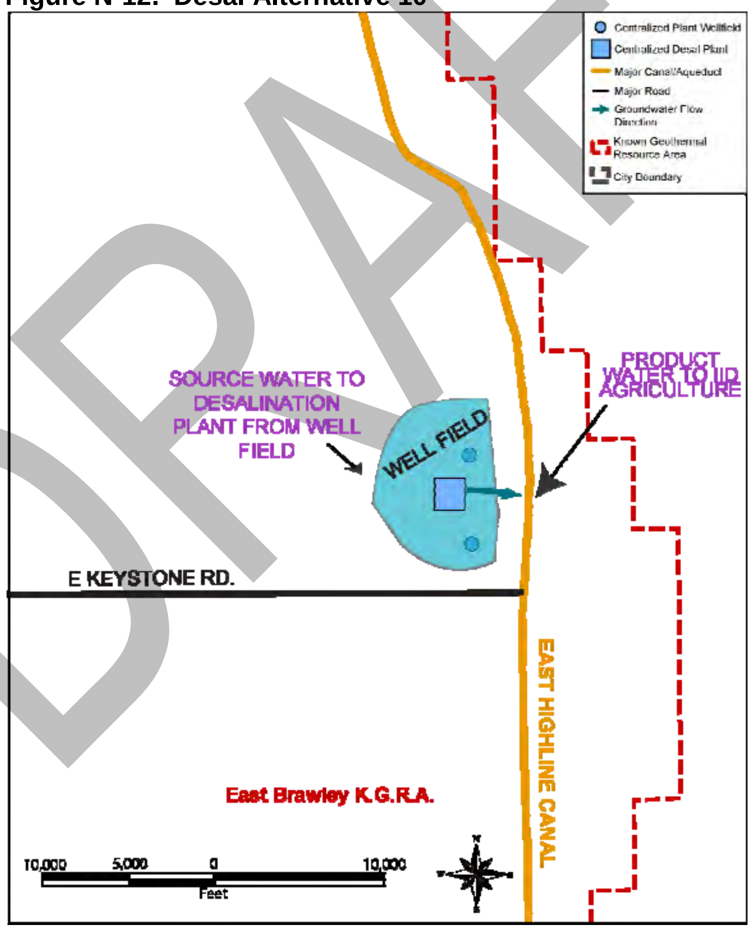
The purpose of this alternative is to determine the feasibility of a 5,000 AFY desalination plant supplied by groundwater located in the East Brawley KGRA (Figure N-12). The exact location has not been determined. The facility was sited to allow for estimation of conveyance costs. The source water would be from a well field located in the East Brawley KGRA and consisting of two wells drilled to an average depth of 900 feet producing 2,000 gpm for a total production capacity of about 4,100 gpm. The wells are connected by pipelines which will convey the water to the plant; would be sited in existing easements and rights-of-way. Total dissolved solids concentration of 1,900 mg/L is assumed. Water temperature from this well configuration is

anticipated to be about 170 degrees Fahrenheit. This will necessitate cooling the water prior to treatment to protect membranes and maintain plant efficiency.

The product water would be conveyed to IID facilities for distribution to agricultural uses. Brine disposal will be through injection of the water to the deeper, highly saline formations beneath the plant using one new injection well. If geothermal plants were to be co-located in the future, there could be an opportunity to partner on wells that would recover the hot water and inject the brine stream from the Desalination Plant.

This project would rely solely on groundwater and may result in a groundwater depletion and decline in groundwater level that could lead to migration of poor quality water or land subsidence. Further research of the aquifer characteristics should be conducted to determine the sustainability of using groundwater without mitigation through recharge facilities. The alternative is technically feasible and will be further compared to other alternatives.

Figure N-12. Desal Alternative 10



Costs

Table N-11. Desal Alternative 10 – 5KAF East Brawley Desalination with Well Field (May 2009 price level, 4% real interest rate, 30 year project life)

Direct Capital Costs, May 2009 Price Level		Total
Desal Plant		13,960,000
Source water development, collection and transmission - well water		4,792,448
Recharge Facilities		-
Concentrate Disposal - Using Geothermal Operators Injection Wells		-
Mitigation Costs (reduced flow from drains)		-
Product Water Distribution		388,800
Working capital (2 months of O&M costs per Reclamation, Page D-20)		190,000
Direct Capital Costs, May 2009 Price Level		$ 19,331,248
Indirect Capital Costs (as percent of direct costs UON)		
Freight and Insurance 5 % of direct capital cost		730,000
Owner's direct expense, 10 % of direct capital cost		1,930,000
Construction Overhead, 15 % of direct capital cost		2,180,000
Interest During Construction for half of construction period		579,937
Indirect Capital Costs (as percent of direct costs UON)		$ 5,419,937
Capital Cost		$ 24,751,185
Annual O&M costs, May 2009 Price Level		$ 1,525,000
Financial Analysis - cost per acre-foot		
Equivalent annual cost	$	2,956,000
Product Water, acre-feet		5,000
Equivalent annual cost per acre-foot	**$**	**591**

N.1.2.11 Desal Alternative 11 - 25,000 AF East Mesa Desalination with Well Field

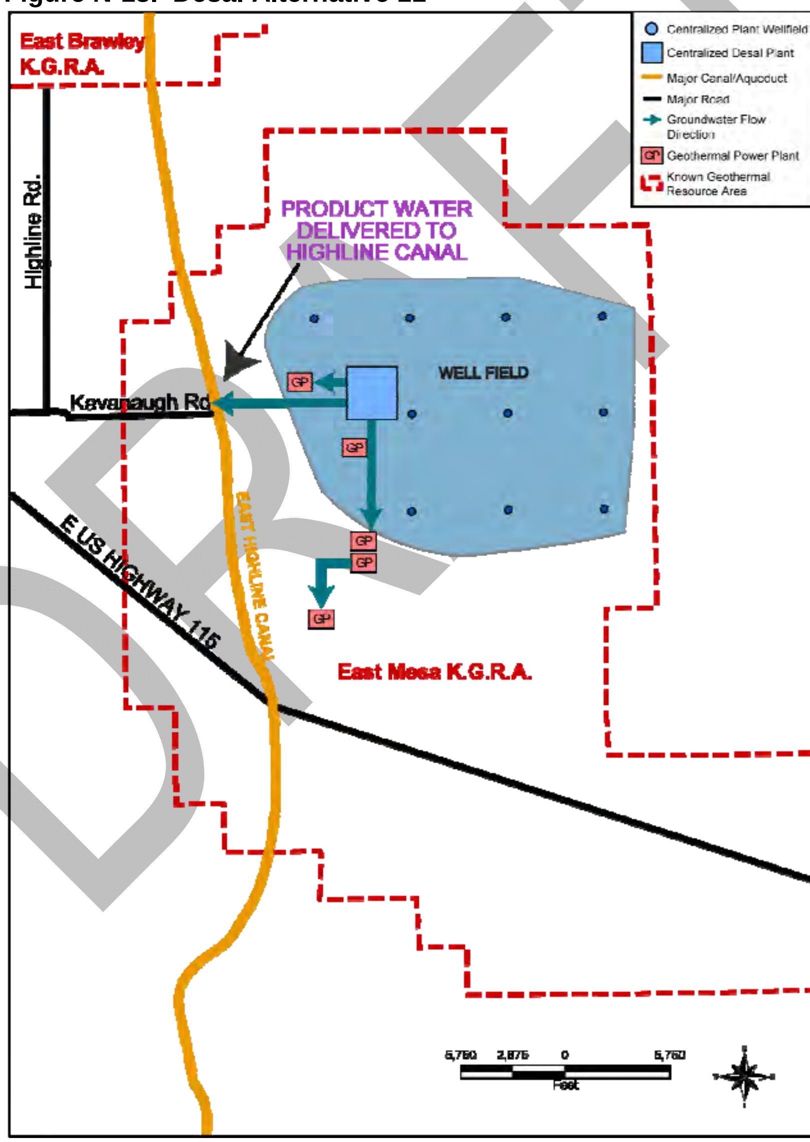
Description

The purpose of this alternative is to determine the feasibility of a 25,000 AFY desalination plant located in the East Mesa KGRA using groundwater without recharge or groundwater banking facilities (Figure N-13). The exact location has not been determined. The facility was sited to allow for estimation of conveyance costs. The source water would be from a well field located in the East Mesa KGRA and consisting of 10 wells drilled to an average depth of 900 feet producing 2,000 gpm for a total production capacity of about 21,000 gpm. The wells are connected by pipelines leading to one-mile long trunk line that will convey the water to the plant; would be sited in existing easements and rights-of-way. Total dissolved solids concentration of 1,900 mg/L is assumed. Water temperature from this well configuration is anticipated to be about 170 degrees Fahrenheit. This will necessitate cooling the water prior to treatment to protect membranes and maintain plant efficiency.

The product water would be conveyed to the geothermal plants and IID facilities for distribution to agricultural uses. Brine disposal will be through injection of the water to the deeper, highly saline formations beneath the plant using three new injection wells.   If geothermal plants were to be co-located in the future, there could be an opportunity to partner on wells that would recover the hot water and inject the brine stream from the Desalination Plant.

This project would rely solely on groundwater and would result in large groundwater depletion.

Figure N-13. Desal Alternative 11



Costs

Table N-12. Desal Alternative 11 – 25KAF East Mesa Desalination with Well Field (May 2009 price level, 4% real interest rate, 30 year project life)

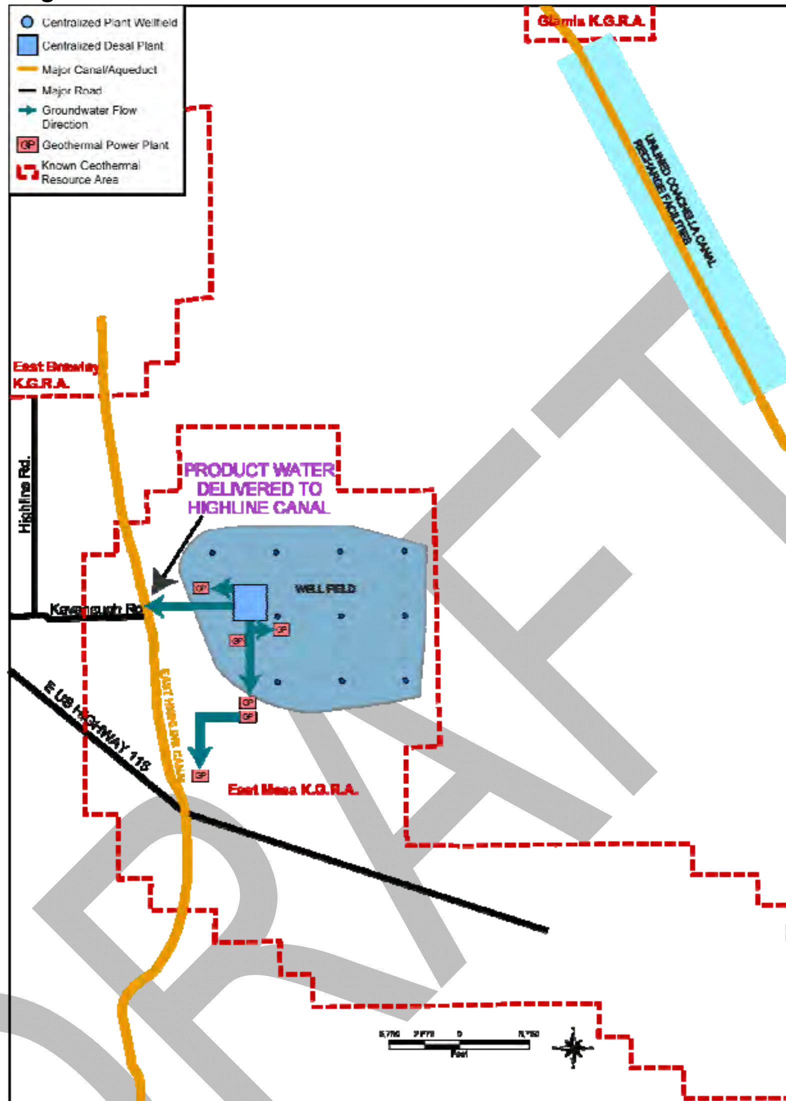
Direct Capital Costs, May 2009 Price Level		Total
Desal Plant		42,940,000
Source water development, collection and transmission - well water		27,026,002
Recharge Facilities		-
Concentrate Disposal - New Injection Wells		5,400,000
Mitigation Costs (reduced flow from drains)		-
Product Water Distribution		12,753,600
Working capital (2 months of O&M costs per Reclamation, Page D-20)		780,000
Direct Capital Costs, May 2009 Price Level		$ 88,899,602
Indirect Capital Costs (as percent of direct costs UON)		
Freight and Insurance 5 % of direct capital cost		2,820,000
Owner's direct expense, 10 % of direct capital cost		8,890,000
Construction Overhead, 15 % of direct capital cost		8,470,000
Interest During Construction for half of construction period		2,666,988
Indirect Capital Costs (as percent of direct costs UON)		$ 22,846,988
Capital Cost		$ 111,746,590
Annual O&M costs, May 2009 Price Level		$ 6,327,000
Financial Analysis - cost per acre-foot		
Equivalent annual cost	$	12,789,000
Product Water, acre-feet		25,000
Equivalent annual cost per acre-foot	**$**	**512**

N.1.2.12 Desal Alternative 12 - 25,000 AF East Mesa Desalination with Well Field and Groundwater Recharge

Description

The purpose of this alternative is to utilize the same elements as alternative 11 with the exception that groundwater recharge and banking facilities are included in the East Mesa to minimize the potential negative effects on the groundwater basin and reduce groundwater depletion (Figure N-14). For purpose of the analysis, it was assumed that the old Coachella Canal would be developed to provide for recharge and banking of Colorado River water that is available in years where there is an under-run. The amount of Colorado River water to be banked was assumed to vary from 15,000 AFY to 250,000 AFY. Appendix F describes the potential under-runs that may be available for groundwater recharge and different groundwater banking scenarios.

Figure N-14. Desal Alternative 12



This project would mitigate for most of the groundwater impacts, but would still result in some groundwater storage depletion of the groundwater basin. The aquifer is currently full and some period of groundwater development may be needed to optimize groundwater recharge operations. IID development, management, and operations of local groundwater recharge facilities have multiple benefits and the feasibility of recharge in the East Mesa merits further review. The alternative is technically feasible and will be further compared to other alternatives.

Variants

East Mesa Recharge Facilities: A variant on this theme would be to develop dedicated groundwater recharge basins in the East Mesa. This would be constrained due to ownership and management by the BLM, the existence of sensitive habitats, and ability to obtain easements and rights-of-way. There could be possibility for land exchange to overcome some of the potential constraints.

Costs

Table N-13. Desal Alternative 12 – 25KAF East Mesa Desalination with Well Field and Groundwater Recharge May 2009 price level, 4% real interest rate, 30 year project life)

Direct Capital Costs, May 2009 Price Level		Total
Desal Plant		42,940,000
Source water development, collection, transmission and recharge - well water		27,046,882
Recharge Facilities		417,600
Concentrate Disposal - New Injection Wells		5,400,000
Mitigation Costs (reduced flow from drains)		-
Product Water Distribution		12,753,600
Working capital (2 months of O&M costs per Reclamation, Page D-20)		780,000
Direct Capital Costs, May 2009 Price Level		$ 89,338,082
Indirect Capital Costs (as percent of direct costs UON)		
Freight and Insurance 5 % of direct capital cost		2,840,000
Owner's direct expense, 10 % of direct capital cost		8,930,000
Construction Overhead, 15 % of direct capital cost		8,530,000
Interest During Construction for half of construction period		2,680,142
Indirect Capital Costs (as percent of direct costs UON)		$ 22,980,142
Capital Cost		$ 112,318,224
Annual O&M costs, May 2009 Price Level		$ 6,336,000
Financial Analysis - cost per acre-foot		
Equivalent annual cost	$	12,831,000
Product Water, acre-feet		25,000
Equivalent annual cost per acre-foot	**$**	**513**

N.1.2.13 Desal Alternative 13 - 5,000 AF East Mesa Desalination with Well Field

Description

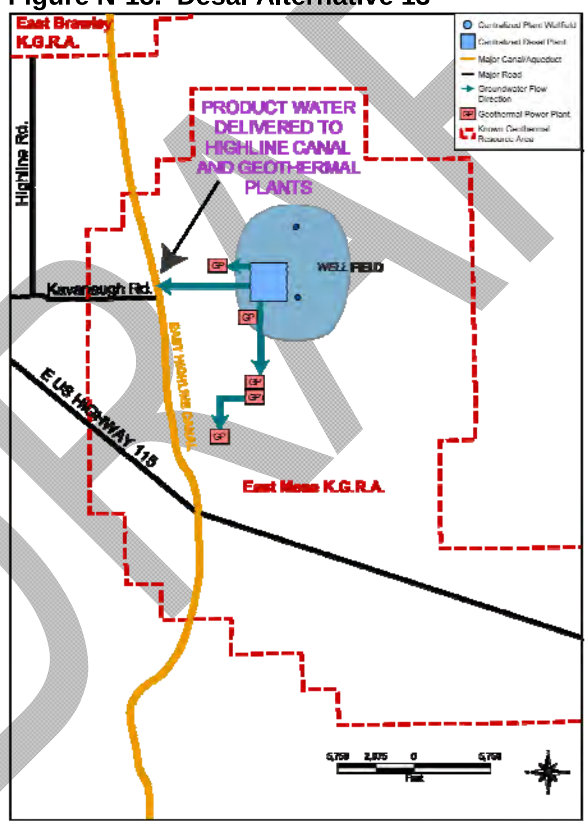
The purpose of this alternative is to reduce the desalination plant from 25,000 AFY to a 5,000 AFY desalination plant located in the East Mesa KGRA and to evaluate and compare small plants if they were to be developed to serve individual geothermal facilities (Figure N-15); for example, if plants were required to develop independent water supplies in lieu of Colorado River Water. The exact location has not been determined. The facility was sited to allow for estimation of conveyance costs. The source water would be from a well field located in the East Mesa KGRA and consisting of two wells drilled to an average depth of 900 feet producing 2,000 gpm for a total production capacity of about 4,100 gpm. The wells are connected by pipelines leading to a one-mile trunk line which will convey the water to a plant. Total dissolved solids concentration of 1,900 mg/L is assumed. Water temperature from this well configuration is

anticipated to be about 170 degrees Fahrenheit. This will necessitate cooling the water prior to treatment to protect membranes and maintain plant efficiency.

The produced water would be conveyed to geothermal plants for industrial use. Brine disposal will be through injection of the water to the deeper, highly saline formations beneath the plant using one new injection well. If geothermal plants were to be co-located in the future, there could be an opportunity to partner on cooling and injection wells that would recover the hot water and inject the brine stream from the desalination plant.

This project would rely solely on groundwater and may result in groundwater depletion and decline in groundwater level which could lead to migration of poor quality water or land subsidence. Further research of the aquifer characteristics should be conducted to determine the sustainability of using groundwater without mitigation through recharge facilities. The alternative is technically feasible and will be further compared to other alternatives.

Figure N-15. Desal Alternative 13



Note: No specific recommendation is made for connecting a specific existing or proposed geothermal plant

Costs

Table N-14. Desal Alternative 13 – 5KAF East Mesa Desalination with Well Field (May 2009 price level, 4% real interest rate, 30 year project life)

Direct Capital Costs, May 2009 Price Level		Total
Desal Plant		13,960,000
Source water development, collection and transmission - well water		4,976,912
Recharge Facilities		-
Concentrate Disposal - New Injection Wells		1,800,000
Mitigation Costs (reduced flow from drains)		-
Product Water Distribution		4,924,800
Working capital (2 months of O&M costs per Reclamation, Page D-20)		190,000
Direct Capital Cost, May 2009 Price Level		$ 25,851,712
Indirect Capital Costs (as percent of direct costs UON)		
Freight and Insurance 5 % of direct capital cost		950,000
Owner's direct expense, 10 % of direct capital cost		2,590,000
Construction Overhead, 15 % of direct capital cost		2,860,000
Interest During Construction for half of construction period		775,551
Indirect Capital Costs (as percent of direct costs UON)		$ 7,175,551
Capital Cost		$ 33,027,263
Annual O&M costs, May 2009 Price Level		$ 1,648,000
Financial Analysis - cost per acre-foot		
Equivalent annual cost	$	3,558,000
Product Water, acre-feet		5,000
Equivalent annual cost per acre-foot	**$**	**712**

N.1.2.14 Desal Alternative 14 - 50,000 AF South Salton Sea Desalination with Alamo River Water and Industrial Distribution

Description

The purpose of this alternative is to provide 50,000 AFY of water from the Alamo River to the desalination plant located in the South Salton Sea KGRA (Figure N-16). The exact location has not been determined. The facility was sited to allow for estimation of conveyance costs. The source water would be from the Alamo River with an assumed TDS of about 3,000 mg/L. Water temperature from the river or drains is anticipated to be about 75 degrees Fahrenheit, which will not necessitate cooling the water prior to treatment, but would require filtration.

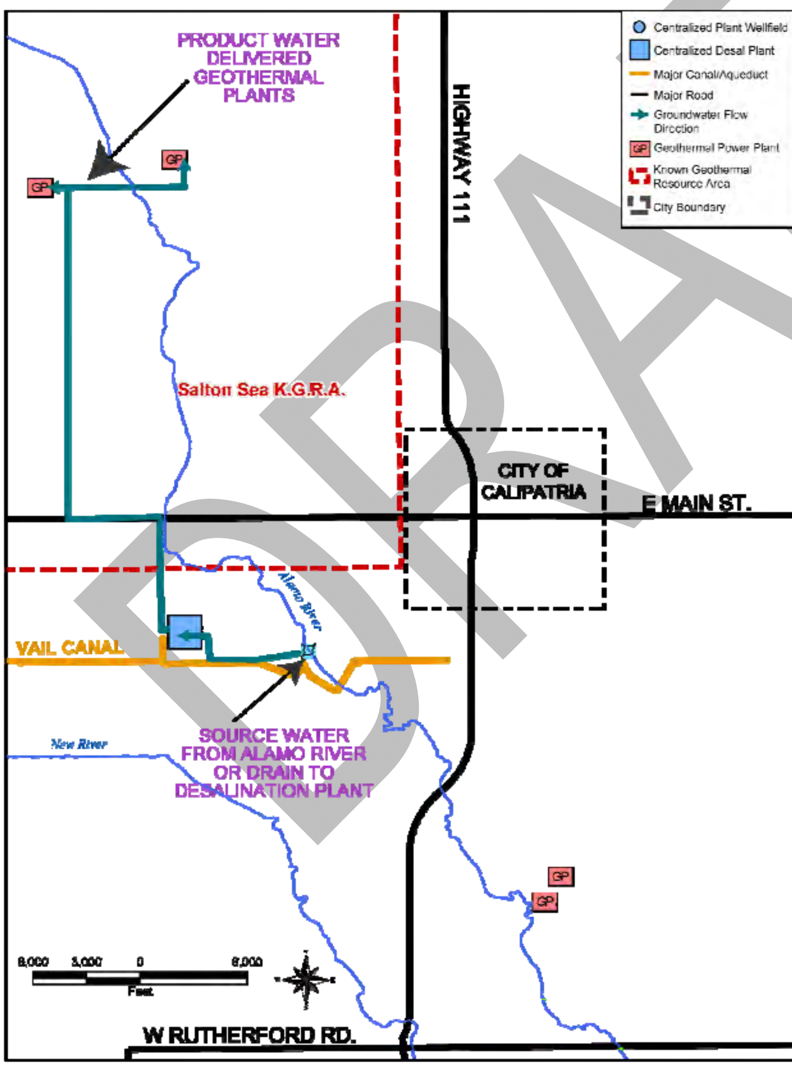
The produced water will be conveyed to geothermal plant operators in the South Salton Sea KGRA for industrial use. Brine disposal will be through injection of the water to the deeper, highly saline formations beneath the plant using five new injection wells. If geothermal plants were to be co-located in the future, there could be an opportunity to partner on wells that would recover the hot water and inject the brine stream from the Desalination Plant.

The lack of a well field and recharge facilities will also decrease the capital and operations and maintenance costs. The alternative is technically feasible and will be further compared to other alternatives.

Variants

Drain Water. A variant on this alternative would be the use of source water collected from IID drains instead of the Alamo River. Further research would be needed to determine if the Alamo River or the IID drains are the best source for the desalination plant.

Figure N-16. Desal Alternative 14



Salton Sea Salt Disposal Ponds. A variant on the evaporation basins would be to create evaporation basins in conjuncture with the Salton Sea Restoration plan. The brine could be disposed in borrow pits that may be created during the restoration process. This variant will require further research to determine its feasibility and practicality. Figure N-1 illustrates the anticipated quantity of salt generated as a function of volume brine stream. It is expected that 35 acres of land will be required per 1 MGD of capacity. The dried salts will need to be disposed off-site and further research needs to be conducted to determine the feasibility of this variant.

Costs

Table N-15. Desal Alternative 14 – 50KAF South Salton Sea Desalination with Alamo River Water and Industrial Distribution (May 2009 price level, 4% real interest rate, 30 year project life)

Direct Capital Costs, May 2009 Price Level		Total
Desal Plant		89,560,000
Source water development and transmission - surface water collection		9,414,240
Recharge Facilities		-
Concentrate Disposal - New Injection Wells		9,000,000
Mitigation Costs (reduced flow from drains)		9,980,391
Product Water Distribution		2,073,600
Working capital (2 months of O&M costs per Reclamation, Page D-20)		2,010,000
Direct Capital Costs, May 2009 Price Level		$ 122,038,231
Indirect Capital Costs (as percent of direct costs UON)		
Freight and Insurance 5 % of direct capital cost		5,180,000
Owner's direct expense, 10 % of direct capital cost		12,200,000
Construction Overhead, 15 % of direct capital cost		15,540,000
Interest During Construction for half of construction period		3,661,147
Indirect Capital Costs (as percent of direct costs UON)		$ 36,581,147
Capital Cost		$ 158,619,378
Annual O&M costs, May 2009 Price Level		$ 15,491,901
Financial Analysis - cost per acre-foot		
Equivalent annual cost	$	24,664,901
Product Water, acre-feet		50,000
Equivalent annual cost per acre-foot	**$**	**493**

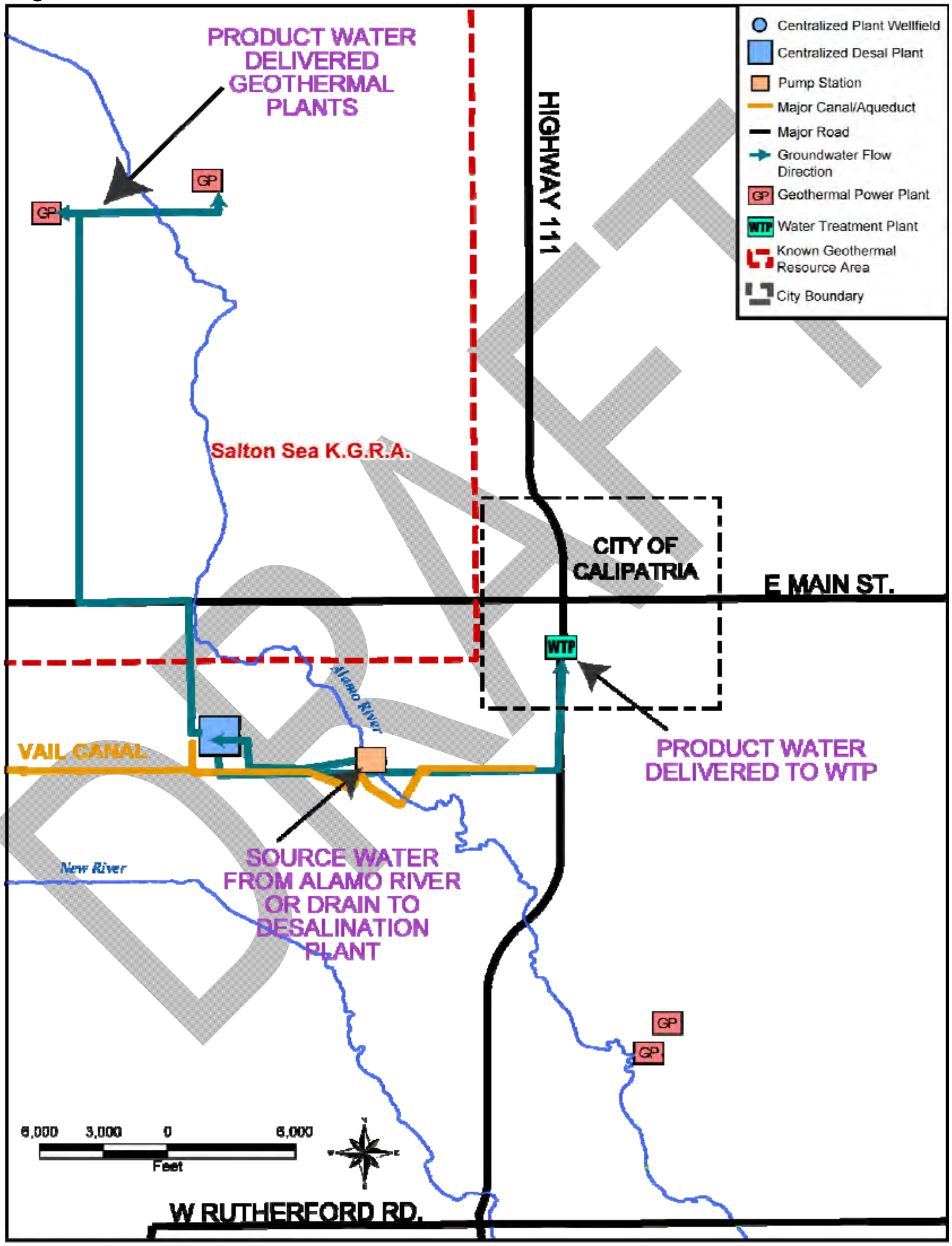
N.1.2.15 Desal Alternative 15 - 50,000 AF South Salton Sea Desalination with Alamo River Water and MCI Distribution

Description

The purpose of this alternative is to use the same elements presented in alternative 14 and add distribution to the Calipatria water treatment plant for municipal use (Figure N-17). The alternative is technically feasible and will be further compared to other alternatives.

A variant on this alternative would be the use of source water collected from IID drains instead of the Alamo River. Further research would be needed to determine if the Alamo River or the IID drains are the best source for the desalination plant.

Figure N-17. Desal Alternative 15



Costs

Table N-16. Desal Alternative 15 – 50KAF South Salton Sea Desalination with Alamo River Water and MCI Distribution (May 2009 price level, 4% real interest rate, 30 year project life)

Direct Capital Costs, May 2009 Price Level		Total
Desal Plant		89,560,000
Source water development and transmission - surface water collection		10,292,000
Recharge Facilities		-
Concentrate Disposal - New Injection Wells		9,000,000
Mitigation Costs (reduced flow from drains)		9,980,391
Product Water Distribution		19,628,800
Working capital (2 months of O&M costs per Reclamation, Page D-20)		2,010,000
Direct Capital Costs, May 2009 Price Level		$ 140,471,191
Indirect Capital Costs (as percent of direct costs UON)		
Freight and Insurance 5 % of direct capital cost		6,060,000
Owner's direct expense, 10 % of direct capital cost		14,050,000
Construction Overhead, 15 % of direct capital cost		18,180,000
Interest During Construction for half of construction period		4,214,136
Indirect Capital Costs (as percent of direct costs UON)		$ 42,504,136
Capital Cost		$ 182,975,327
Annual O&M costs, May 2009 Price Level		$ 15,857,901
Financial Analysis - cost per acre-foot		
Equivalent annual cost	$	26,438,901
Product Water, acre-feet		50,000
Equivalent annual cost per acre-foot	**$**	**529**

N.1.2.16 Desal Alternative 16 - 5,000 AF South Salton Sea – East Desalination with Well Field

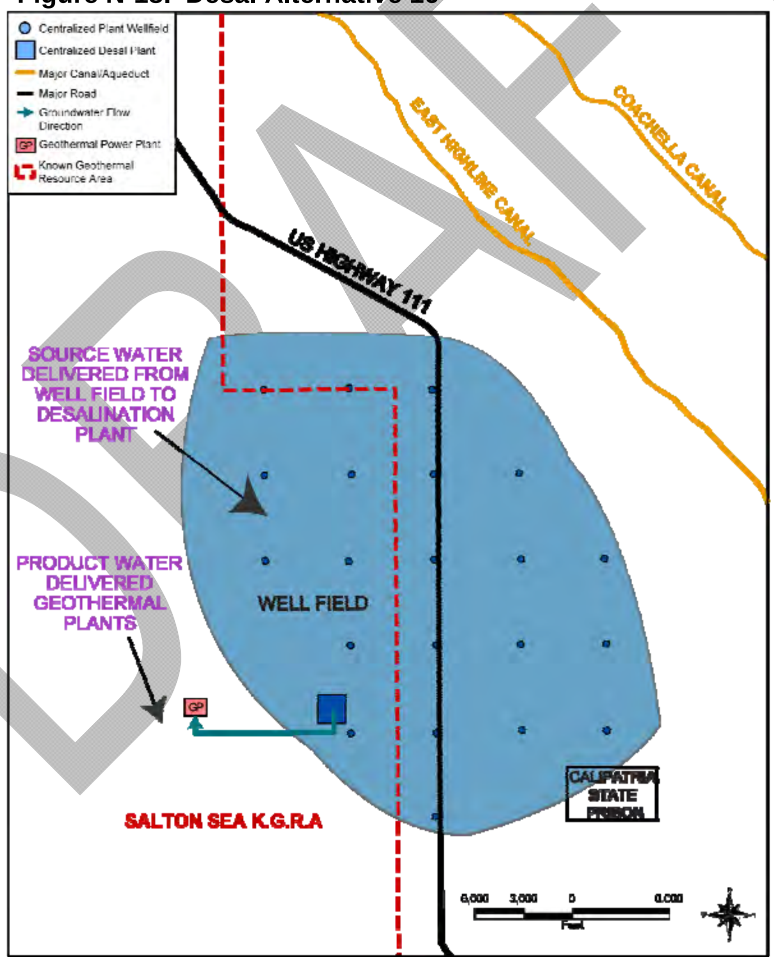
Description

The purpose of this alternative is to provide a 5,000 AFY desalination plant located in the East Side of the South Salton Sea KGRA for industrial use (Figure N-18). The exact location has not been determined. The facility was sited to allow for estimation of conveyance costs. This alternative would also allow for comparison of smaller plants if such plants were to be developed to serve the water needs of individual geothermal plants. The source water would be from a well field located in the East Side of the South Salton Sea KGRA in the shallow aquifer and consisting of 21 wells drilled to an average depth of 300 feet producing 200 gpm for a total production capacity of about 4,100 gpm. The wells are connected by pipelines leading the water to the plant; would be sited in existing easements and rights-of-way. Total dissolved solids concentration of 1,500 mg/L is assumed. Water temperature from this well configuration is anticipated to be about 94 degrees Fahrenheit. This may necessitate cooling the water prior to treatment to protect membranes and maintain plant efficiency.

The produced water would be conveyed to geothermal plants for industrial use. Brine disposal will be through injection of the water to the deeper, highly saline formations beneath the plant using one new injection well. If geothermal plants were to be co-located in the future, there could be an opportunity to partner on wells that would recover the hot water and inject the brine stream from the Desalination Plant.

This project would rely solely on groundwater and may result in groundwater depletion. Further research of the aquifer characteristics should be conducted to determine the sustainability of using groundwater without mitigation through recharge facilities. The alternative is technically feasible and will be further compared to other alternatives.

Figure N-18. Desal Alternative 16



Costs

Table N-17. Desal Alternative 16 – 5KAF South Salton Sea – East Desalination with Well Field (May 2009 price level, 4% real interest rate, 30 year project life)

Direct Capital Costs, May 2009 Price Level		Total
Desal Plant		12,260,000
Source water development, collection and transmission - well water		34,489,425
Recharge Facilities		-
Concentrate Disposal - New Injection Wells		1,800,000
Mitigation Costs (reduced flow from drains)		-
Product Water Distribution		3,481,600
Working capital (2 months of O&M costs per Reclamation, Page D-20)		170,000
Direct Capital Costs, May 2009 Price Level	$	52,201,025
Indirect Capital Costs (as percent of direct costs UON)		
Freight and Insurance 5 % of direct capital cost		800,000
Owner's direct expense, 10 % of direct capital cost		5,220,000
Construction Overhead, 15 % of direct capital cost		2,390,000
Interest During Construction for half of construction period		1,566,031
Indirect Capital Costs (as percent of direct costs UON)	$	9,976,031
Capital Cost	$	62,177,056
Annual O&M costs, May 2009 Price Level	$	1,971,000
Financial Analysis - cost per acre-foot		
Equivalent annual cost	$	5,567,000
Product Water, acre-feet		5,000
Equivalent annual cost per acre-foot	**$**	**1,113**

N.1.2.17 Desal Alternative 17 - 5,000 AF Heber Desalination with Well Field

Description

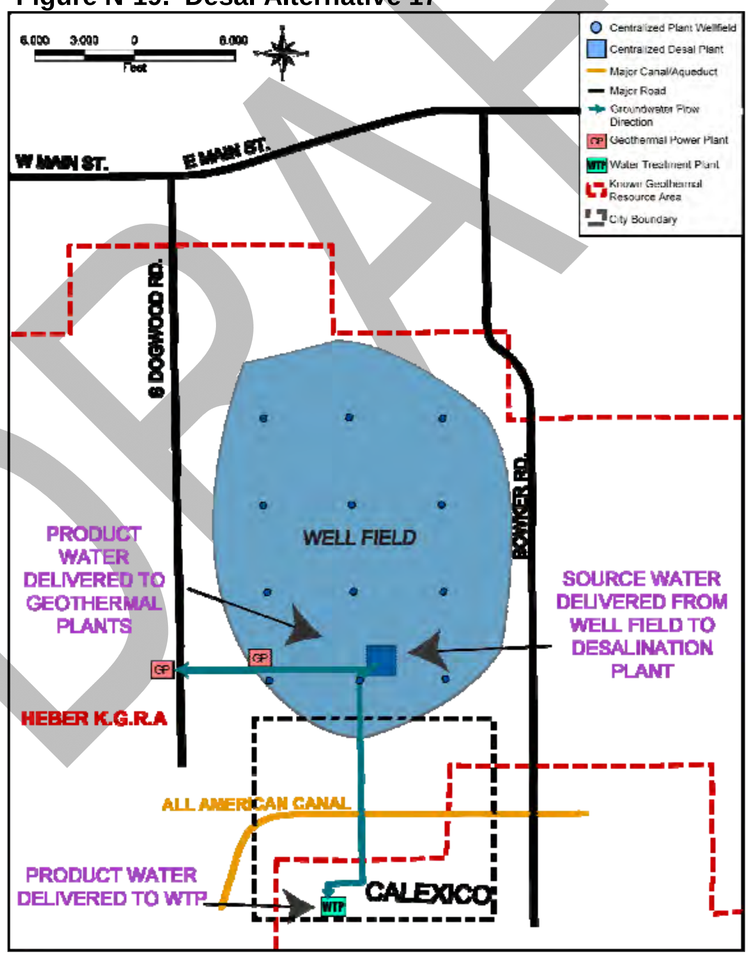
The purpose of this alternative is to provide a 5,000 AFY desalination plant located in the Heber KGRA using groundwater and not using groundwater recharge or banking (Figure N-19). The exact location has not been determined. The facility was sited to allow for estimation of conveyance costs and to allow conveyance of product water to be used by geothermal plants in this area. The source water would be from a well field located in the Heber KGRA and consisting of two wells drilled to an average depth of 1,500 feet producing 350 gpm for a total production capacity of about 4,100 gpm. The wells are connected by pipelines leading to the plant; would be sited in existing easements and rights-of-way. Total dissolved solids concentration of 1,500 mg/L is assumed. Water temperature from this well configuration is

anticipated to be about 300 degrees Fahrenheit. This will necessitate cooling the water prior to treatment to protect membranes and maintain plant efficiency.

The product water would be conveyed to the Calexico water treatment plant for municipal distribution and also conveyed to geothermal operators for industrial use. Brine disposal will be through injection of the water to the deeper, highly saline formations beneath the plant using injection wells currently in operation by the geothermal purveyors. If geothermal plants were to be co-located in the future, there could be an opportunity to partner on wells that would recover the hot water and inject the brine stream from the Desalination Plant.

This project would rely solely on groundwater and may result in further groundwater depletion. Further investigation on aquifer characteristics should be conducted to determine the sustainability of using groundwater. The alternative is technically feasible and will be further compared to other alternatives.

Figure N-19. Desal Alternative 17



Costs

Table N-18. Desal Alternative 17 – 5KAF Heber Desalination with Well Field (May 2009 price level, 4% real interest rate, 30 year project life)

Direct Capital Costs, May 2009 Price Level		Total
Desal Plant		11,750,000
Source water development, collection and transmission - well water		63,103,716
Recharge Facilities		-
Concentrate Disposal - Using Geothermal Operators Injection Wells		Not Included
Mitigation Costs (reduced flow from drains)		-
Product Water Distribution		5,577,600
Working capital (2 months of O&M costs per Reclamation, Page D-20)		170,000
Direct Capital Costs, May 2009 Price Level		$ 81,601,316
Indirect Capital Costs (as percent of direct costs UON)		
Freight and Insurance 5 % of direct capital cost		920,000
Owner's direct expense, 10 % of direct capital cost		8,160,000
Construction Overhead, 15 % of direct capital cost		2,770,000
Interest During Construction for half of construction period		2,448,039
Indirect Capital Costs (as percent of direct costs UON)		$ 14,298,039
Capital Cost		$ 95,899,356
Annual O&M costs, May 2009 Price Level		$ 2,476,000
Financial Analysis - cost per acre-foot		
Equivalent annual cost	$	3,303,000
Product Water, acre-feet		5,000
Equivalent annual cost per acre-foot	**$**	**661**

N.1.2.18 Groundwater Blending Alternative 18 - 25,000 AF East Mesa with Well Field pumping to All-American Canal

Description

The purpose of this alternative is to utilize groundwater in the East Mesa area based on proximity of the well field to the All-American Canal (AAC). It is estimated that 35 cfs (25,000 AFY) of groundwater will be produced with a TDS of between 1,500 and 3,000 mg/L. The groundwater will be pumped into the AAC and would be blended to have a resultant TDS of about 780 mg/L assuming median flows of 3,975 cfs and a canal water TDS of 753 mg/L with groundwater TDS of 3,000 mg/L. Please see Figure 2 in Appendix M for the resultant water quality with the All-American Canal with respect to groundwater pumping flow.

The designed supply of 25,000 AFY for the well field may not be the actual yield of water that can be supplied for irrigation. Depending on the TDS of the groundwater the resultant TDS in the canal may approach a level that will require over irrigation of the land to compensate for a higher TDS. If the TDS of the groundwater were 2,000 mg/L the net increase of the water supply with 25,000 acre-feet pumped would be about 17,000 acre-feet. A groundwater TDS of 3,000 mg/L with 25,000 acre-feet pumped would result in an actual net supply of 10,000 acre-feet (Davids Engineering, Inc., 2009). To determine the actual TDS of the groundwater in the location chosen for a well field a pumping test should be performed to determine the aquifer characteristics and water quality samples should be collected during the pumping and analyzed for TDS. This analysis will allow a greater understanding of the final blended TDS that will be supplied for irrigation.

Recharge and banking facilities are not included in the East Mesa to mitigate for the groundwater pumping. This project would not mitigate for the groundwater impacts and would result in some groundwater storage depletion from groundwater basin.

The alternative is technically feasible and will be further compared to other alternatives.

Costs

Table N-18 a. Groundwater Blending Alternative 18 – 25KAF East Mesa with Well Field pumping to All-American Canal (May 2009 price level, 4% real interest rate, 30 year project life)

Direct Capital Costs, May 2009 Price Level	Total
Source water development, collection and transmission - well water	24,599,532
Highway and Canal Crossings (allowance)	360,000
Electric Power Installed - Well Field	8,000,000
Product Water Distribution	24,000
Land Costs for 640 acres	416,000
Direct Capital Costs, May 2009 Price Level	$ 33,399,532
Indirect Capital Costs (as percent of direct costs UON)	
Freight and Insurance 5 % of direct capital cost	440,000
Owner's direct expense, 10 % of direct capital cost	3,340,000
Construction Overhead, 15 % of direct capital cost	1,320,000
Interest During Construction for half of construction period	1,001,986
Indirect Capital Costs (as percent of direct costs UON)	$ 6,101,986
Capital Cost	$ 39,501,517
Annual O&M costs, May 2009 Price Level	$ 198,000
Financial Analysis - cost per acre-foot	
Equivalent annual cost	$ 2,482,000
Product Water, acre-feet	25,000
Equivalent annual cost per acre-foot	**$ 99**

N.1.2.19 Groundwater Blending Alternative 19 - 25,000 AF East Mesa with Well Field pumping to All-American Canal – With Percolation Basins Supplied by Coachella Canal

Description

The purpose of this alternative is to add 200 acres of percolation basins to alternative to mitigate for the production of 25,000 AFY. The source of water for groundwater banking is from under-run years. The recharge water will be supplied by a turnout from the Coachella Canal and the recharge quantity will be approximately 30,000 acre-feet during years of overrun and assuming a 5,000 acre-feet loss of the percolated water about 25,000 acre-feet will be banked.

The total amount of water that can be percolated through the percolation basins will be able to exceed the take amount of 25,000 AFY from the aquifer. During years of overrun up to 60,000 AFY of lower TDS canal water could be percolated and may result in the lowering of the TDS within the aquifer in the East Mesa. This lowering of TDS may allow for better quality groundwater to be produced by the wells in years of under-run which would result in a greater actual yield of water that can be supplied for irrigation.

Further review and refinement of this alternative will be based on the evaluation of actual field conditions. Viable properties in the East Mesa will need to be located and negotiations with BLM will be necessary to secure the easements and rights of way for the well sites and the percolation basins. Due to these uncertainties a 30-percent contingency has been added to the source water development, collection and transmission line item for the project costs as well as to the acquisition price of the land.

The alternative is technically feasible and will be further compared to other alternatives.

Variants

Instead of using the Coachella Canal to supply the percolation basins the All American Canal could be used. Depending on the quality of the source water a SCADA system could be installed to monitor a reservoir that would be used to pre-blend the water for the canal. This type of monitoring would allow better management of the TDS during periods of low flow in the canal.

Costs

Table N-18 b. Groundwater Blending Alternative 19 – 25KAF East Mesa with Well Field pumping to All-American Canal – With Percolation Basins Supplied by Coachella Canal (May 2009 price level, 4% real interest rate, 30 year project life)

Direct Capital Costs	Total
Source water development, collection and transmission - well water	$ 26,725,187
Highway and Canal Crossings (allowance)	360,000
Electric Power Installed - Well Field	8,000,000
Product Water Distribution	24,000
Land Costs for 640 acres	416,000
Percolation Basins	5,033,600
Working capital (2 months of O&M costs per Reclamation, Page D-20)	-
Direct Capital Costs, May 2009 Price Level	$ 40,558,787
Indirect Capital Costs (as percent of direct costs UON)	
Freight and Insurance 5 % of direct capital cost	690,000
Owner's direct expense, 10 % of direct capital cost	4,060,000
Construction Overhead, 15 % of direct capital cost	2,080,000
Interest During Construction for half of construction period	1,216,764
Indirect Capital Costs (as percent of direct costs UON)	$ 8,046,764
Capital Cost	$ 48,605,551
Annual O&M costs, May 2009 Price Level	$ 243,000
Financial Analysis - cost per acre-foot	
Equivalent annual cost	$ 3,054,000
Product Water, acre-feet	25,000
Equivalent annual cost per acre-foot	**$ 122**

N.1.2.20 Next Steps/Additional Information Required

This investigation has been done at a concept level based on available information. Decisions to eliminate these alternatives should consider the following assumptions. If these alternatives are further evaluated, additional examination of these limitations should be made.

- Further field work and original data collection should be conducted to determine if pumping of groundwater will result in unacceptable levels of groundwater depletion and have potentially negative effects on the aquifers beneath the different KGRAs. A test well should be drilled, water quality samples obtained, and an aquifer test should be conducted to assess the aquifer characteristics for each potential well field location. A temperature log should be completed on each test borehole to determine if the water temperature for the source water requires cooling prior to desalination. TDS levels and the levels of specific ions should be established.

- If these alternatives pass additional screening further feasibility studies of recharge in the East Mesa should be conducted, including meeting with the BLM; scoping further field and pre-design studies; evaluating input; and taking operational scenarios (alternatives 2, 5, 8, and 12).

- Determine the quantity of water municipalities and geothermal plant operators can use for alternatives 3, 9, and 13. Also, determine the appropriate water quality parameters for the finished water.

- Determine the point-of-take for source water, whether the Alamo River or the drains for alternative 4, 15, and 16. The river diversion or drain diversion will need to be engineered and an analysis performed to determine the most efficient method of providing the source water.

- Research the potential to use borrow pits created from the Salton Sea restoration for evaporation ponds and phasing projects to be sequenced with efforts to restore the Salton Sea. Using Figure N-1, it is expected that 35 acres of land will be required per 1 MGD of capacity.

N.2 Banking of Inadvertent Under-runs

N.2.1 Purpose and Design Considerations

Imperial Irrigation District (IID) has a fixed annual consumptive use allocation from the Colorado River based on the Quantification Settlement Agreement (QSA) and the United States Bureau of Reclamation (USBR) Colorado River Decree accounting. Most of IID's demands are based on agricultural irrigation which tends to vary from year to year.

On an annual basis this results in overruns (diversions in excess of consumptive use right) or under-runs (diversions that are less than consumptive use rights). These inadvertent overruns must be paid back by extraordinary water conservation in future years. Under- runs are lost every year and do not carry over unless there is groundwater storage space that can be used. USBR has developed the Inadvertent Overrun and Payback Policy (IOPP) that provides accounting for overruns and manner of payback.

Surface water is typically stored underground by spreading the water in shallow basins overlying an aquifer which has capacity to absorb the water and which will keep the water where it can later be recovered by pumping. The soil between the shallow basins and the aquifer must allow the water to flow through to the aquifer. Layers of clay or fault lines may prevent the water from reaching the aquifer. As the stored water will blend with the water already in the aquifer, the quality of both water supplies must meet a variety of water quality standards. Resultant water quality will be a mix of the two water types.

The physical characteristics of the aquifer must be such that the stored water will be retained within the aquifer and available for recovery when needed. Adequate wells and conveyance are needed for the recovery.

Establishing a viable water banking program – especially if the program is physically located outside the district whose water is being stored – requires developing a number of contractual agreements and institutional relationships. These may address use of facilities for conveying the water, ownership of the water while in storage, use of facilities to recover the water, and limitations on the recovery of the water to protect other users of the aquifer.

Practical solutions for challenges created by the seasonal availability of water for storage, water quality issues, costs of conveyance, and seasonal demand for water may involve exchanges of water between water agencies. These exchanges also create development of contractual agreements and institutional relationships.

N.2.2 Project Alternative - Water Banking Alternative 1 – Coachella Valley Groundwater Storage Project The proposed project is based on a preliminary memorandum provided by Imperial Irrigation District.

Description

Water Banking Alternative 1 proposes storing inadvertent overruns by them via the Coachella Canal to spreading grounds located in the East Coachella Valley. Recovery of the water would be accomplished by exchange. Agricultural users overlying the aquifer where the water was stored would pump the water for their use. IID would receive their Colorado River entitlement in exchange.

The physical facilities would consist of a canal turnout and pump station, 5 miles of power transmission lines and a 500-acre spreading grounds. The spreading grounds would include a stilling basin for desilting and clarification, a geo-biologic treatment basin, and a series of tiered spreading basins covering 292 acres. Maximum recharge capacity is estimated at slightly over 100,000 acres per year (150 cfs).

The anticipated yield of this alternative varies depending on a variety of assumptions including, the management of overruns, available initial storage, aquifer losses and total storage capacity. Based on an analyses prepared by Natural Resources Consulting Engineers (NRCE 2009), the yield may vary between 19,000 AFY and 55,000 AFY. For purposes of this analysis, a yield of 50,000 AFY has been used.

Implementation is anticipated to require on the order of 5 to 8 years. Preliminary planning efforts (studies, land acquisition, negotiations, draft environmental) are anticipated to require 1.5 to 2 years); completion of environmental documentation and approvals, another 2.25 to 3 years; design and bidding, 1.5 to 2 years; and construction would take 1 to 1.5 years.

Cost

The capital cost of Water Banking Alternative 1 is $ 99.2 million. The alternative would deliver 50,000 AFY at a cost of approximately $ 266 per acre foot. Table N-19 presents the cost of developing this alternative.

Table N-19. Water Banking Alternative 1 IID East Coachella Valley Recharge/Storage

(May 2009 price level, 4% real interest rate, 30 year project life)

Capital Cost		
Design	$	7,950,000
Ground Acquisition/Grading and Construction		81,000,000
Offsite Infrastructure		1,250,000
Contingency		9,000,000
Capital Cost	$	99,200,000
O&M Cost		
Recharge facility O&M Costs	$	2,916,000
Annual Land Lease		128,000
Wheeling-Water Delivery to Site [1]		1,500,000
Energy Cost for Withdrawal Pumping [2]		3,000,000
Total O&M Costs	$	7,544,000
Financial Analysis (4%, 30 years)		
Equivalent Annual Capital Cost		$5,736,746
O&M		7,544,000
Equivalent Annual Cost		$13,280,746
Yield (AFY)		50,000
Equivalent Annual Cost per acre-foot		$266

Notes

[1] Subject to negotiations with land owner.

[2] Subject to negotiation with Coachella Valley Water District

N.3 Recycling of Municipal Wastewater

N.3.1 Purpose and Design Considerations

The purpose of this section is to evaluate opportunities to recycle municipal wastewater. It investigates a broad range of concepts for recycling ranging from irrigation of crops with secondary treatment, to municipal and industrial use with tertiary treatment. Each alternative includes treatment costs, distribution system costs, and an analysis of potential customers. Four existing plants (Brawley, El Centro, Calexico, and Imperial) and a proposed regional plant are investigated. The cost of additional treatment processes at existing plants and the cost of the proposed regional plants are based on an EPA study (EPA 2001). The alternatives address two different concepts for use: either direct delivery to specific customers or delivery to the IID distribution system where it would be blended with Colorado River water.

Figure N-20 shows the locations of existing wastewater treatment plants and of the proposed regional plant.

Figure N-20. Overview of Wastewater Treatment Plants in IID

N.3.1.1 Availability of and use of wastewater treatment plant effluent

Effluent from the publicly owned wastewater treatment plants is currently discharged to surface drainage, either IID drains or the Alamo or New Rivers. None of it is recycled. Briefly, the cost of water from IID has been so low, and the supply so reliable, that it has been clear to the wastewater agencies that recycling plant effluent would be far more expensive than use of water purchased from IID. But, discussions have started between wastewater plant operators and potential industrial customers.

Additionally, implementing any recycled water programs has been limited due to the concerns about removing inflows from the Salton Sea. Treated wastewater from facilities within IID ultimately discharges to the Salton Sea. The flows help support habitats on the New and Alamos Rivers. The Salton Sea depends on such inflows for several reasons. The inflows help to reduce the effect of evaporation, which causes the salinity levels in the sea to concentrate by providing a constant source of new water. The Sea also serves as a critical link to the Pacific Flyway for bird migration. Also, due to the QSA transfer agreements, flows into the Salton Sea will be reduced. Further reduction could occur because the flows from Mexico may be diminished as Mexicali implements their own reclaimed water program.[1]

State law says that: "The owner of a waste water treatment plant operated, for the purpose of treating wastes from a sanitary sewer system, holds the exclusive right to the treated waste water as against anyone who has supplied the water discharged into the waste water collection and treatment system, including a person using water under a water service contract, unless otherwise provided by agreement."[2] This implies that unless IID has a contract with any of the entities treating and disposing of wastewater that stipulates otherwise, that the wastewater entity has the exclusive right to treat, sell and convey the water to other entities. The wastewater treatment entity needs approval from the RWQCB to ensure consistency with the Water Quality Control Plan and that the new uses of water have appropriate permits or waste discharge requirements.

The approval of the SWRCB would also be required prior to making any change in the point of discharge, place of use, or purpose of use of treated wastewater since all of the wastewater treatment plants currently operate under NPDES permits and discharge wastewater to either the New or Alamo Rivers or IID drains, and reuse of treated wastewater would likely diminish flows to these watercourses. It is not believed that there are any existing water rights or diverters that would be affected or have claim to wastewater flows, but there could be public trust issues and any impacts and effects from any change in use and recycling would need to be evaluated pursuant to CEQA. If impacts are identified as result of the proposed reuse of wastewater, these would need to be mitigated. Without further analysis it cannot be determined what such impacts and mitigation costs may be. The local lead agency proposing the projects would need scope the analysis to consider the effects in such a way that the analysis would support the RWQCB and SWRCB when they make their determination as responsible agencies. IID does not currently have requirements, policies, or permitting standards related to reuse of wastewater within the IID boundaries.

Table N-20 reviews the wastewater plants within the IID service area. Following that table is a more in-depth review of the largest wastewater plant and the plans of their operators.

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[1] Salton Sea Authority Plan for Multi-Purpose Project July 2006 Draft for Board Review
[2] Water Code, Division 2, Part 2, Chapter 1, Article 1.5, 1210-1212

Table N-20. Wastewater Treatment Plants, Imperial County

Discharge sources	Current Conditions				Anticipated Capital Improvements
	Plant Capacity [AFY]	Average Flow [AFY]	Treatment Level	Discharge to (Discharge point/End of Drainage Path)	
City of Brawley WWTP	6,608 (5.9 MGD) [1]	4,481 (4.0 MGD) [1]	Secondary (with impending improvements) [1]	New River [+] / Salton Sea	$25 to $30 million within next three years. Improvements will provide Secondary treatment. [1]
City of Calexico Municipal WWTP	4,816 (4.3 MGD) [2]	3,024 to 3,249 (2.7 to 2.9 MGD) [2]	Secondary with disinfection	New River / Salton Sea [+]	Current plant is 40 years old. Have completed designs for an 8.5 MGD, advanced secondary plant. Economy has stopped the project. Project may be re-scoped. Will take 2 to 3 years to construct. [2]
Calipatria WWTP	1,938 (1.73 MGD) [1]	840 (0.75 MGD) [1]	Primary [1]	"G" Drain / Alamo River [+] (to Salton Sea)	Starting preliminary plans to upgrade to secondary treatment. Capacity is adequate – the prison is the main source of flow and it has significantly reduced flows. [1]
El Centro Municipal WWTP	8,960 (8 MGD) [3]	4,033 (3.6 MGD) [3]	Secondary with disinfection [3]	Central Main Drain / Salton Sea via Alamo River [+]	Repairs to collection systems are anticipated over next five years. Little work to the plant. [3]
Gateway of the Americas WWTP	224 (0.2 MGD) [4]	205 (0.18 MGD) [^]	Secondary with disinfection [4]		No active plans. Ultimate plant intended as 1.5 MGD with daily flows of 1.0 to 1.1 MGD. [4]
Heber PUD WWTP	907 (0.81 MGD) [5]	560 (0.5 MGD) [5]	Primary [5]		Completed design for an upgrade to 1.2 MGD and secondary treatment at a cost of $12.5 million. Project is unfunded. [5]
City of Holtville Municipal WWTP	952 (0.85 MGD) [6]	672 to 728 (0.6 to 0.65 MGD) [6]	Secondary with disinfection [6]	Pear Drain/Alamo River [^] (to Salton Sea)	Evaluating process upgrades to achieve regulatory compliance (still secondary). And expansion initially to 1.2 MGD, ultimately 1.8 MGD. [6]
City of Imperial Water Pollution Control Plant	2,689 (2.4 MGD) [7]	1,568 to 1,792 (1.4 to 1.6 MGD) [7]	Secondary with disinfection [7]	Dolson Drain / Salton Sea via Alamo River [+]	May be replaced by "Keystone" plant north of the city. [7]
City of Imperial proposed Keystone/Mesquite Lake WWRP	-----	-----	-----	-----	Ultimately 15 MGD, initially 5 MGD. Will at some point replace Imperial's existing plant. $40 million for the initial 5 MGD plant. $30 million to include only the equipment for 2.5 MGD capacity (and the structures for a full 5 MGD). Cost wise, for full build out of initial 5 MGD. [8]
Niland WWTP	560 (0.5 MGD) [9]	196 to 202 (0.175 to 0.18 MGD) [9]	Primary [9]		Various repairs are needed. Funding is a challenge. No increase in size or change in process is envisioned. [9]
Seeley County WWTP	224 (0.2 MGD) [10]	112 to 168 (0.1 to 0.15 MGD) [10]	Secondary with disinfection [10]	New River [+] / Salton Sea	
Westmorland WWTP	560 (0.5 MGD) [11]	246 (0.22 MGD) [11]	Primary [11]	Trifolium Drain No. 6 / Salton Sea via New River [+]	If a proposed annexation, adding maybe 400 homes occurs, an increase in plant size would be needed. But, no plans today. [11]

Totals	**28,438**	**15,937 to 16,282**			

Personal Communications:

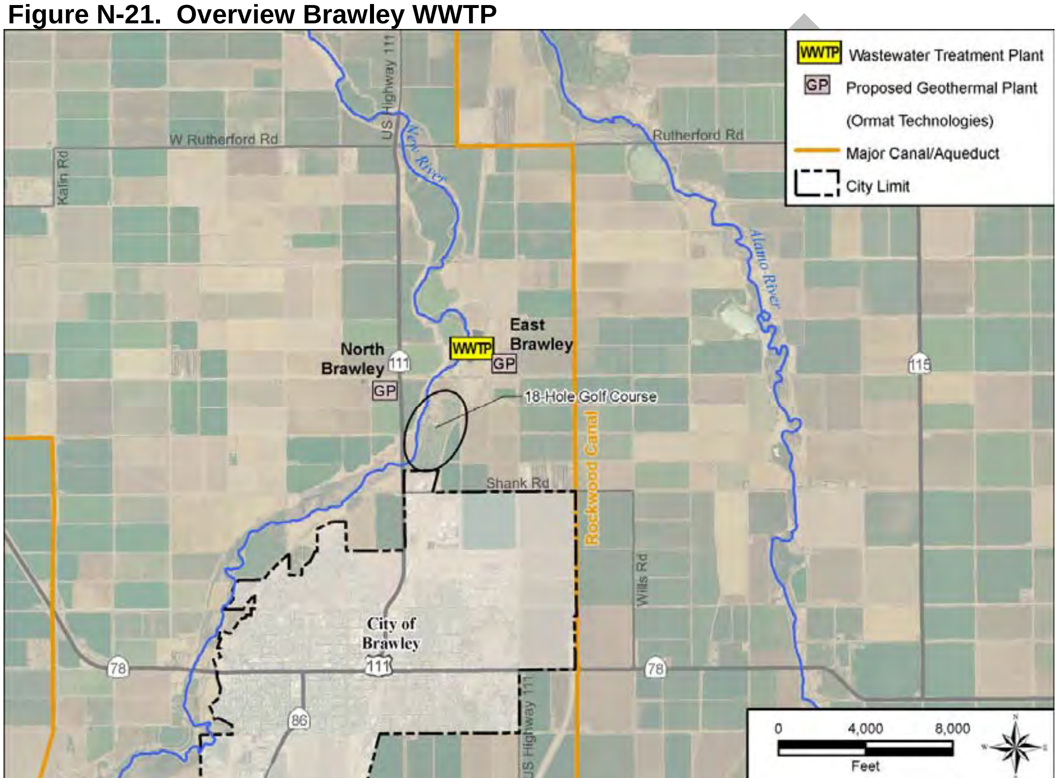
[1] Ruben Mireles, Brawley WWTP Operations Division Manager and Calipatria WWTP Chief Operator. June 16, 2009
[2] Arturo Estrada, Caliexico Municipal WWTP Chief Operator. June 17, 2009
[3] Randy Hines, El Centro WWTP Supervisor, June 15 and June 18, 2009
[4] Ed Delgado, County Administrative Analyst. June 28,2009; June 23, 2009; June 24, 2009
[5] Graciela Lopez Heber PUD Finance Manager. June 17, 2009
[6] Frank Cornejo. Hotville Municipal WWTP, Waterworks Supervisor. June 23, 2009.
[9] James Strang. Niland WWTP Lead Operator. June 23, 2009
[N] Jackie Loper, City of Imperial Water Pollution Control Plant Maintenance Supervisor. June 19, 2009
[8] Brian Knoll, Albert Well Associates. June 29, 2009
[10] Hector Orozco. Seeley County WWTP Chief Operator. June 24, 2009
[11] Lucas Agatep. Westmorland WWTP Chief Operator. June 18, 2009

+ From NPDES Permit
^ From Service Area Plan
Note: Date of information varies from NPDES permits and Service Area Plans.

Brawley Wastewater Treatment Plant

The City of Brawley Wastewater Treatment Plant is located on Best Road on the east side of the Alamo River (Figure N-21). It is one mile north of the developed portion of Brawley and 2.5 miles north by north-east of the center of Brawley. The plant is adjacent to farmed lands. It is within 1.5 miles of two proposed geothermal plants. A golf course is located 0.5 miles to the south.

Figure N-21. Overview Brawley WWTP



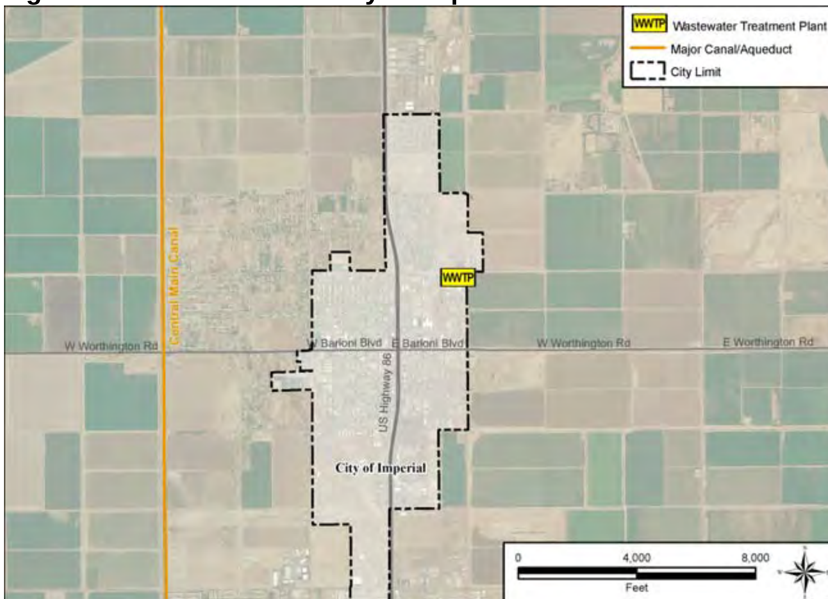
The plant capacity is 5.9 MGD with an average flow of 4.0 MGD. While the plant currently provides primary treatment, it is expected that construction will start in the near future to provide secondary treatment with disinfection.

There have been discussions between the City of Brawley and Ormat Technologies to provide effluent (with additional treatment) to Ormat for use in cooling towers. In addition, Ormat has investigated the costs of such treatment. Consideration has also been given to delivering recycled water to the golf course located just south of the plant, to Caltrans, and to a proposed ethanol plant.

City of Imperial Water Pollution Control Plant

The City of Imperial Water Pollution Control Plant has a capacity of 2.4 MGD and currently treats 1.5 MGD (Figure N-22). The city has taken a leading role in the planning for future development north of Imperial and south of Brawley. Part of the planning for the "Keystone Planning Area" is a proposed Keystone Regional Water Reclamation Facility. This proposed facility would include tertiary treatment and provisions for delivery of recycled water.

Figure N-22. Overview of City of Imperial Water Pollution Control Plant



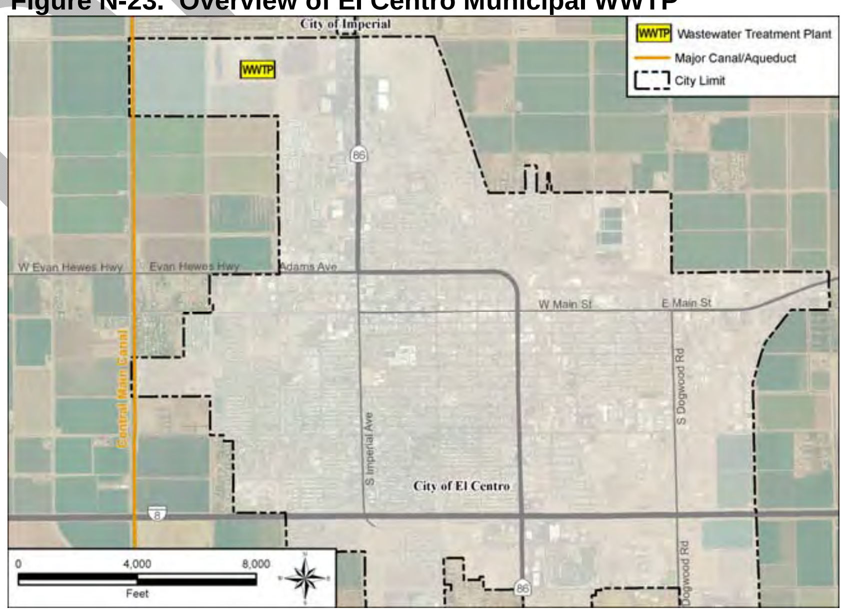
El Centro Municipal Wastewater Treatment Plant

The El Centro Municipal Wastewater Treatment Plant has a capacity of 8 MGD and an average flow of 3.6 MGD (Figure N-23). The plant provides secondary treatment with disinfection. The plant has compliance issues with selenium levels.

There has been interest expressed in delivery of recycled water to power plants or irrigation.

At present, no money has been committed for future capital projects at the plant.

Figure N-23. Overview of El Centro Municipal WWTP

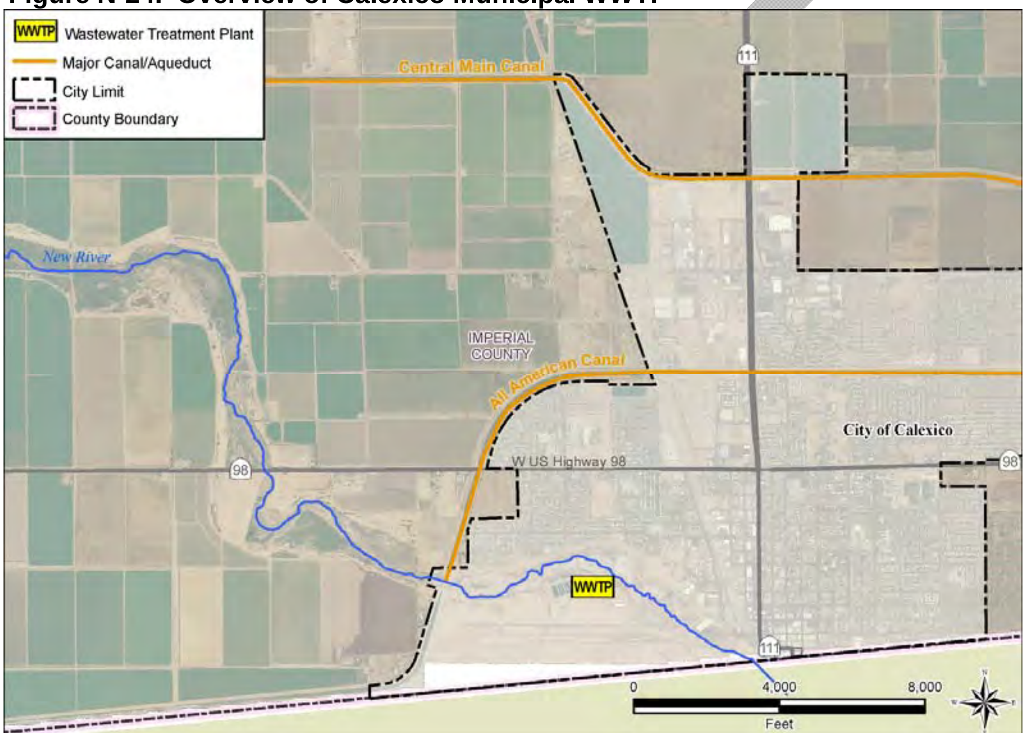


Calexico Municipal Wastewater Treatment Plant

The Calixico Wastewater Treatment Plant has a capacity of 4.3 MGD and an average flow of 2.7 to 2.9 MGD (Figure N-24). The plant provides secondary treatment with disinfection.

The majority of the process equipment at the plant is 40 years old. There are completed designs to upgrade the plant to advanced secondary treatment and a capacity of 8.5 MGD. Implementation of these plans has been slowed by the recession.

Figure N-24. Overview of Calexico Municipal WWTP



N.3.1.2 Project Elements

The following subsection discusses the project elements that will then be combined into a series of Project Alternatives. Initially, it focuses on the markets for recycled water and the cost of conveying water to those markets. It then addresses improvements to the treatment plants.

Unit costs have been developed by a number of methods, depending on the available data. Where appropriate unit costs are available from IID's Definite Plan (Unit Cost Summary for Imperial Irrigation District System Conservation Projects), those costs have been used with a contingency factor of 30 percent. Generally, data is available from this source for storage and conveyance facilities. The cost of upgrading treatment facilities has been developed from an EPA survey (EPA, 2001). All costs have been updated to May 2009 price levels.

Markets for Recycled Water and Conveyance Costs

Four broad markets are being considered for recycled water use in this evaluation: (1) adjacent agriculture, (2) local municipal and industrial uses, (3) industrial use at power plants, and (4) the IID distribution system. Table N-21 provides guidance on the accepted uses of recycled water and will be referred to later in this section.

Table N-21. Demand Sectors and Examples of Minimum Treatment Levels for Specific Uses to Protect Public Health[3]

Types of Use	*Treatment Level*		
	Disinfected Tertiary	*Disinfected Secondary*	*Undisinfected Secondary*
Urban Uses and Landscape Irrigation			
Fire protection	☑		
Toilet & urinal flushing	☑		
Irrigation of parks, schoolyards, residential landscaping	☑		
Irrigation of cemeteries, highway landscaping		☑	
Irrigation of nurseries		☑	
Landscape impoundment	☑	☑*	
Agricultural Irrigation			
Pasture for milk animals		☑	
Fodder and fiber crops			☑
Orchards (no contact between fruit and recycled water)			☑
Vineyards (no contact between fruit and recycled water)			☑
Non-food bearing trees			☑
Food crops eaten after processing		☑	
Food crops eaten raw	☑		
Commercial/Industrial			
Cooling & air conditioning - w/cooling towers	☑	☑*	
Structural fire fighting	☑		
Commercial car washes	☑		
Commercial laundries	☑		
Artificial snow making	☑		
Soil compaction, concrete mixing		☑	
Environmental and Other Uses			
Recreational ponds with body contact (swimming)	☑		
Wildlife habitat/wetland		☑	
Aquaculture	☑	☑*	
Groundwater Recharge			
Seawater intrusion barrier	☑*		
Replenishment of potable aquifers	☑*		

**Restrictions may apply*

[3] DWR Water Facts No. 23 – Water Recycling, October 2004

Agriculture near the WWTP

A common use of wastewater effluent is on crops adjacent to the treatment plant. Often, land disposal and application to crops is used as part of the treatment and disposal of treated effluent. In the southern portion of the San Joaquin Valley, this is the typical method of handling effluent. The majority of crops – with the exception of food crops eaten raw – can be grown with secondary effluent or disinfected secondary effluent. The majority of existing wastewater treatment plants within IID's service area provides secondary or disinfected secondary treatment.

A challenge with using recycled water for irrigation is that while the supply of recycled water is constant through the year, irrigation demand peaks during the summer. One is given a choice between building a distribution system large enough to use all available recycled water in the winter and supplementing the supply with other water in the summer; or building a smaller system that can meet summer demand and has excess supply in the winter. With the smaller system, there is recycled water in the winter that cannot be used.

The IID Definite Plan uses 5.25 feet/acre as the average water use within IID. If Colorado River diversions are used to proportion this amount to each month, approximately 5 percent, or 0.25 feet is used per month from December through February. Were the goal to apply 500 acre-feet of recycled water in one year, a distribution system would have to deliver to a quarter-section of cultivated land.[4] Additional water – presumably canal water delivered by IID – would be required from March through October to keep the land in production.

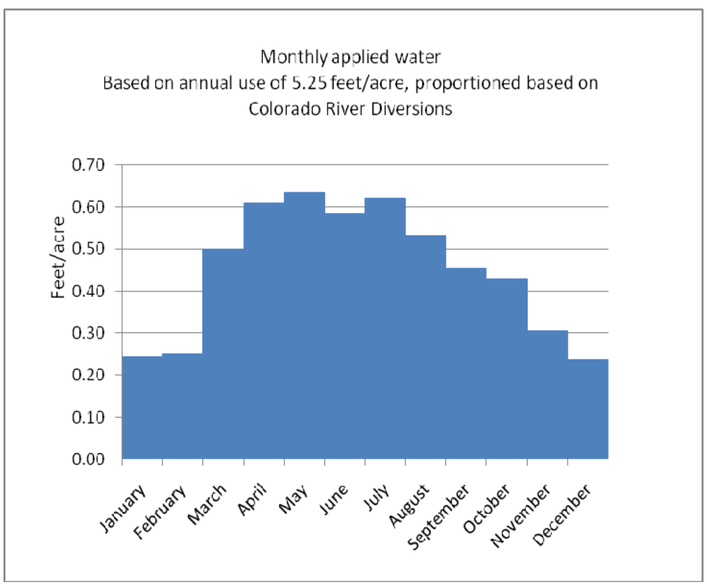
Design Basis

As discussed above and for planning purposes, the service area for each plant will include a quarter section (160 acres) for every 500 AFY of available recycled water (current average flow). The service areas were selected based on inspection of aerial photography. In one case (Brawley WWTP), some deliveries will be made to a short canal that it appears can be isolated from the remainder of the IID system – Spruce Lateral 5.

Pressure pipelines to the agriculture will be sized to flow at five feet per second. Costs will be based on the IID Definite Plan costs for PVC pipe with a 30 percent contingency.

Note that all areas served by recycled water will also need regular access to canal water as the service areas are sized based on winter demands –

Figure N-25. Monthly Applied Water



[4] 0.25 ft/acre/month * 12 months/year * 160 acres/quarter section ≈ 500 acre-feet/quarter section/year

significantly lower than summer demands.

Local Municipal and Industrial Use
Many communities in southern California have developed programs for direct use of recycled water for municipal and industrial purposes. The recycled water service area is typically served by dual piping. One system provides potable water for use inside residences and the majority of inside use at commercial facilities. The second system distributes recycled water predominately for irrigation and for some industrial uses.

While in some situations, a number of large, consistent customers are located close together provide a ready market, there is generally a significant challenge developing the customer base and constructing a distribution system large enough to use the available recycled water.

Serving recycled water to municipal and industrial customers would require tertiary treatment of wastewater.

Design Basis

Without a market survey of an area (including review of water sales to identify the potential market followed by discussions with potential users) it is extremely difficult to determine the market for recycled water in an area. Such a survey is beyond the scope of this investigation. For purposes of this study the following assumptions have been made:

- Deliveries are assumed to be for landscape irrigation. Annual deliveries are assumed to be 5.25 per acre (the same as IID's average agricultural deliveries). The extent of recycled systems will be limited to areas where the recycled supply can meet peak monthly demand. Thus, in non-peak months, there will be wastewater plant effluent that cannot be used as recycled water. Over the course of a year, the excess supply is 29 percent of total supply.[5]

- Tertiary treatment will be required for municipal and industrial use.

- One-day's storage will be provided at each plant to regulate flows. Conveyance has been sized with a peaking factor of four. This is equivalent to allowing all deliveries to be made in a six hour period. A relatively high peaking factor has been selected to allow irrigation to be done during the night reducing the likelihood of human contract. The pressure at the delivery point is assumed to be 80 pounds to allow pressurizing of sprinkler systems.

- Cost for use of recycled wastewater are typically higher when constructed to serve already developed metropolitan areas. Ideally, advanced planning for dual plumbing

[5] Some systems have been developed which combine various water sources into a non-potable system. Yucaipa Valley Water District has developed a non-potable system combining wastewater plant effluent, untreated surface water and backwash water from their water treatment plant.

of new developments at the General or Specific plan stage of the land development process is preferred and costs can be incorporated into the community design.

Industrial /Geothermal Market

This investigation has been initiated predominately by interest in developing additional geothermal power plants in Imperial County. Table N-22 shows the historic use of IID water at existing geothermal plants.

Table N-22. Historic Water Use at Geothermal Plants

Plant	Average Annual Deliveries by IID to Geothermal Plants (1997 – 2008) Acre-feet/year
Heber 1	1156
Heber 2	3663
Ormesa 11	1993
Ormesa 1	1655
Ormesa 1E	923
Ormesa 1H	1040
Leathers	1354
Elmore	1910
Vulcan	164
Del Ranch	948
Salton Sea 5	1120
Salton Sea 3 & 4	399
Salton Sea 1 & 2	10

Recent investigations for Ormat Technologies

Recently Brawley and Ormat Technologies have been investigating opportunities for the use of effluent from the Brawly WWTP at Ormat facilities. The design basis for serving the Industrial/Geothermal Market will be based on work recently done for the City of Brawley and for Ormat Technologies.

The Brawley WWTP is to be reconstructed in the immediate future should anticipated funding be available. The design is complete and proposed improvements will provide secondary treatment with disinfection.

Ormat has had additional studies done to determine what additional treatment (beyond the proposed improvements) would be needed to provide water quality satisfactory for their use and deliver to their plant. Based on these investigations, additional treatment to remove organics would be required. Filters, including Dynasand filters, and MBR (Membrane Bioreactors) were evaluated. Cost would be from $129 to $308/AF for the additional treatment. The investigation found that no salt removal would be needed as Ormat injects cooling water.   Ormat is seeking 8 MGD, and Brawley WWTP can provide only 4 MGD. The report is draft and no additional information was made available.

> ***Recycled water use for industrial customers in the West Basin area of Los Angeles County***
>
> The recycled systems constructed for industrial customers in the service area of West Basin Municipal Water District are worth noting. The source water for this system is tertiary effluent from the City of Los Angeles Hyperion Wastewater Treatment System and it serves a number of industrial customers – typically oil refineries. Each of the customers has an agreement with West Basin defining the quality of water that will be delivered to them. West Basin provides desalted water (RO systems) to match the specifications of the customer.

Design Basis

This investigation assumed that recycled water delivered to power plants would have been tertiary treated and that no desalting would be required. The assumptions were consistent with those made for other municipal and industrial users.

IID Distribution System

Delivering recycled water to the canal system – if water quality concerns can be solved simplifies a number of challenges:

- If there are enough users downstream, the market for the recycled water is assured.
- As the recycled water supply and the surface water supply are blended, the delivery area can be large enough to provide a market for all the recycled water.
- Negligible storage at the WWTP may be needed.
- Distribution pipelines are minimized.

A concern with delivery to IID's distribution system is the use of the system to deliver raw water to municipal water treatment plants. Table N-23 shows the canals currently used for delivery to water treatment plants.

Table N-23. Summary of the Canals that Provide Water to the Water Treatment Plants in IID

Community within Imperial County	Canals that Supply the Water Treatment Plants
Brawley	Mansfield and Central Main Canals
Calexico	Date and Dahlia Lateral #1 Canals
Calipatria	C West Lateral Gate #38
El Centro	Date and Dahlia Lateral #1 Canals
Heber	Dogwood Canal Gate #37
Holtville	Pear Canal
Imperial	Newside and Dahlia Canals
Niland	C West Lateral Gate #38
Seeley	Elder Canal
Westmorland	Westmorland Canal

Note: Information from the service area plans for Holtville (October 2006), Brawley (February 2007), Calipatria (November 2004), and Westmorland (March 2005); Information about the source of the water for the water treatment plants for Calexico (March 2007), El Centro (March 2006), and Imperial (December 2005) was found in the UWMP for that city.

Design Basis

The conveyance systems from the wastewater treatment plants to IIDs distribution system are sized without peaking and with a residual head of 25 psi at the canal.

Treatment upgrades and storage requirements

Determining the cost of treatment upgrades at a wastewater treatment plant for a reconnaissance level investigation presents significant challenges. For purposes of this study data developed for a national EPA study has been used (EPA 2001). That study developed costs for constructing wastewater treatment plants with various levels of treatment. For purposes of this investigation the cost of upgrading an existing treatment plant from secondary treatment to "advanced treatment with nutrient removal" was used. The EPA study states that the data it provides is the best that is available, but suggests that it is likely to provide a high costs. Significantly improving the accuracy of these estimates would require working with each plant operator to develop conceptual designs for required improvements which is beyond the scope of this investigation.

Where storage is needed to regulate delivery of recycled water, storage for one day's flow has been included at the wastewater plant. The storage cost is estimated assuming the reservoir will have earth berm side walls, 15-foot depth of water, be lined with a geotextile and have a floating cover. The storage can be located at the plant and at an elevation allowing delivery from the process trains without pumping. Costs will be based on the IID Definite Plan unit costs and include a 30 percent contingency. Costs would rise if additional lands are needed to be acquired for storage.

Mitigation

Any recycling project removes water from IID drains, the New River or the Alamo River; and, ultimately, from the Salton Sea. The QSA requires mitigation for the environmental impact of removing this water from the drains. This investigation presumes that the same mitigation cost would be required of a recycling project. Calculations of the mitigation cost were provided by IID and are based on USFWS and CDFG negotiated mitigation requirements (Wilcox, 2009).

The cost of mitigation cost includes a capital cost of $183.12 per acre foot of transferred water and an operation and maintenance (O&M) cost of $73.68 per acre foot.

N.3.2 Project Alternatives

Six recycled water alternatives have been laid out to bracket the possibilities for recycling. Table N-24 summarizes the elements of these alternatives. The cost information in the table will be discussed later in this section.

Alternatives 1, 2, and 3 use the four largest wastewater treatment plants within IID's service area (Brawley, Calexico, El Centro, and Imperial) as the supply source. These plants produce 80 percent of all wastewater effluent within IID's service area. The alternatives differ in the market that would receive the recycled water and the source of wastewater. These two factors then govern the level of treatment and the needed distribution system.

Alternatives 4, 5, and 6 presume the construction of a new wastewater treatment plant. The purpose was to evaluate a larger centralized plant and investigate the potential to realize economies of scale. The alternatives vary in how large an area wastewater would be collected from and in the market that would receive the recycled water.

These alternatives can also be divided by their potential customers. Alternatives 1, 2, 4, and 5 all look to develop distribution systems serving specific customers with recycled water. Alternatives 3 and 6 deliver recycled water to the IID distribution system for use by all IID customers located downstream of that delivery point.

Table N-24. Recycled Water Alternatives

Design Components, "Cost Elements"	Configuration Alternatives					
	Existing plants (independently)			Central Plant - Keystone		
	1	2	3	4	5	6
Treatment Plant Location(s) and Treatment Level						
1 Brawley, Imperial, El Centro, and Calexico (Independently): Secondary with Disinfection						
2 Brawley, Imperial, El Centro, and Calexico (Independently): Tertiary with Disinfection						
3 Central Plant - Keystone: Tertiary with Disinfection - 7.5 MGD						
4 Central Plant - Keystone: Tertiary with Disinfection - 15 MGD						
Source Water						
1 Brawley						
2 Imperial						
3 El Centro						
4 Calexico						
5 Keystone/New Development Area						
Conveyance						
1 Surrounding Ag.						
2 Local Service Area Demand						
3 Industrial - Geothermal Plant (Brawley WWTP Only[3])						
4 Into Central Canal						
Project Cost (May 2009 Price Level, 4 percent real interest rate, 30-year project life)						
Capital Cost	$18,779,688	$140,568,145	$90,531,216	$51,323,359	$20,818,710	102,374,854
Annual O&M Cost	$ 486,671	$ 2,567,145	$,992,257	$ 1,438,723	$ 829,853	$ 2,280,145
Equivalent Annual Cost	$1,572,702	$10,726,215	$7,498,347	$ 4,406,758	$ 2,033,801	$ 8,200,493
Yield (AF)	13,331	11,674	13,331	4,696	6,611	16,808
Equivalent Annual Cost per AF	**$ 118**	**$ 919**	**$ 562**	**$ 938**	**$ 308**	**$ 488**

N.3.2.1 Recycled Water Alternative 1 –Disinfected Secondary Effluent from Existing Wastewater Treatment Plants applied to adjacent agriculture

Description

Recycled Water Alternative 1 proposes delivering the effluent for agricultural use in the vicinity of each plant. These plants currently produce disinfected secondary effluent and no additional treatment would be needed for application to most crops (An exception is vegetables, eaten raw).

Improvements to each plant would include installation of storage for one day's flow. A pump station would be installed at the plant to allow delivery. New conveyance systems – Pump stations and pipelines – would deliver the recycled water from each plant to adjacent farms.

Table N-25 shows the amount of agricultural land each plant would serve based on the analysis presented in Section N.2.1.2.

Table N-25. Recycled Water Alternative 1 – Potentially Served Agricultural Area

Wastewater Treatment Plants	Average Effluent Flow [AFY]	Potentially served agricultural area at 5.25 af/acre
City of Brawley WWTP	4,481	9 quarter sections
City of Calexico Municipal WWTP	3,024 to 3,249 (use 3,137)	6 quarter sections
El Centro Municipal WWTP	4,033	8 quarter sections
City of Imperial Water Pollution Control Plant	1,568 to 1,792 (use 1640)	3 quarter sections

Each of these plants is discussed separately below.

Modifications to the Brawley WWTP would require construction of storage equal to an average days flow and conveyance to Spruce Lateral 5. Recycled water would be delivered to crops both from the pipeline and from Spruce Lateral 5 (Figure N-26). This distribution system assumes that a portion of the lateral could be isolated from the remainder of IID's system to assure that deliveries of recycled water would be only to limited acreage. Were this concept of using Spruce Lateral 5 not to work, then additional conveyance facilities would need to be constructed.[6]

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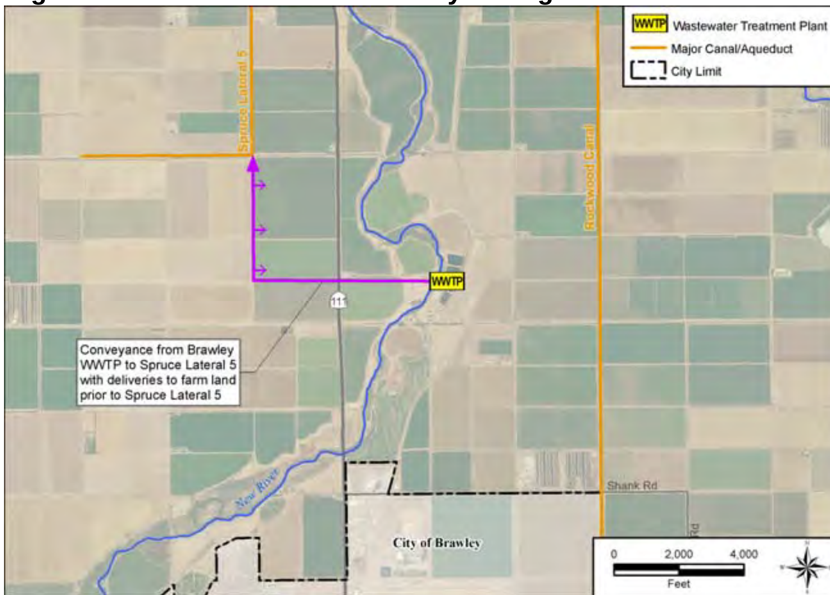
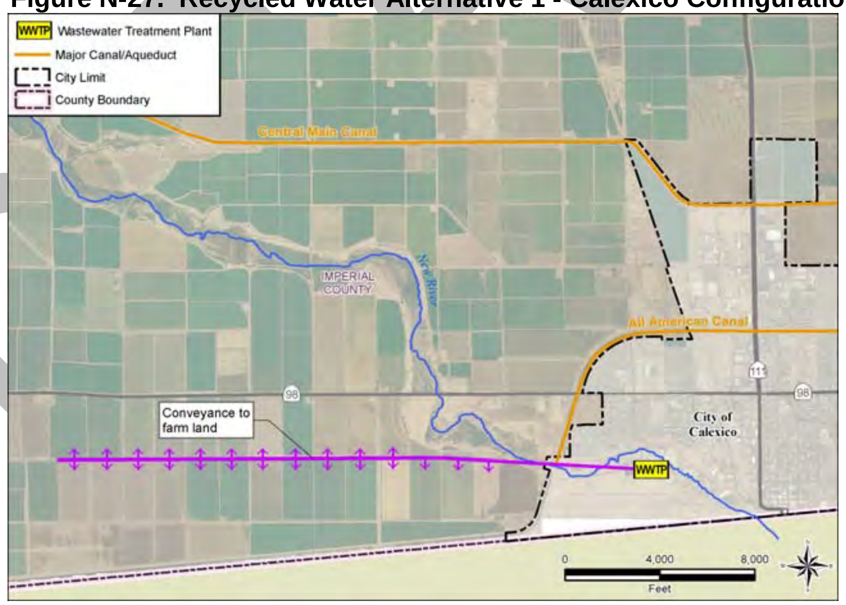
[6] The City of Brawley's web site indicates that the feasibility of serving recycled water to the golf course is currently being examined.

Figure N-26. Alternative 1 - Brawley Configuration



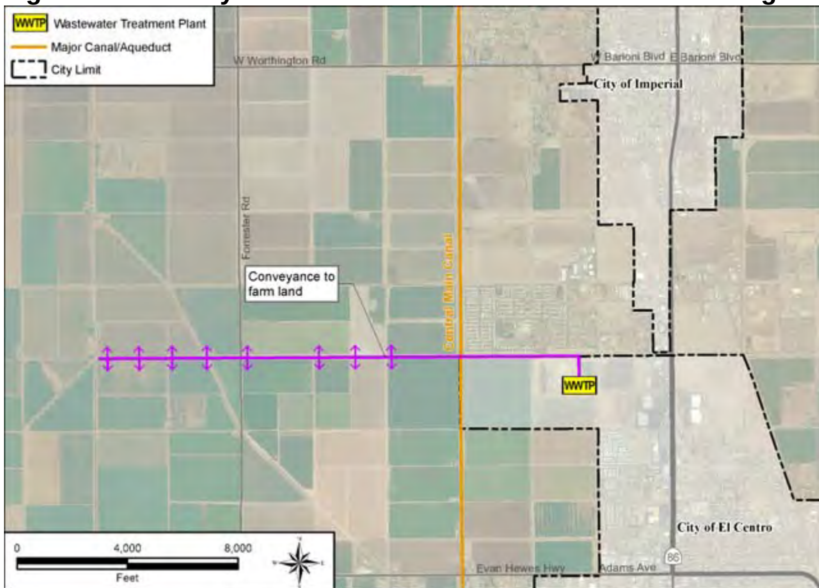
Modifications to the Calexico WWTP would include the construction of storage equal to an average day's flow and construction of a conveyance system including four miles of pipelines delivering recycled water to the west of the plant and of the All American Canal (Figure N-27).

Figure N-27. Recycled Water Alternative 1 - Calexico Configuration



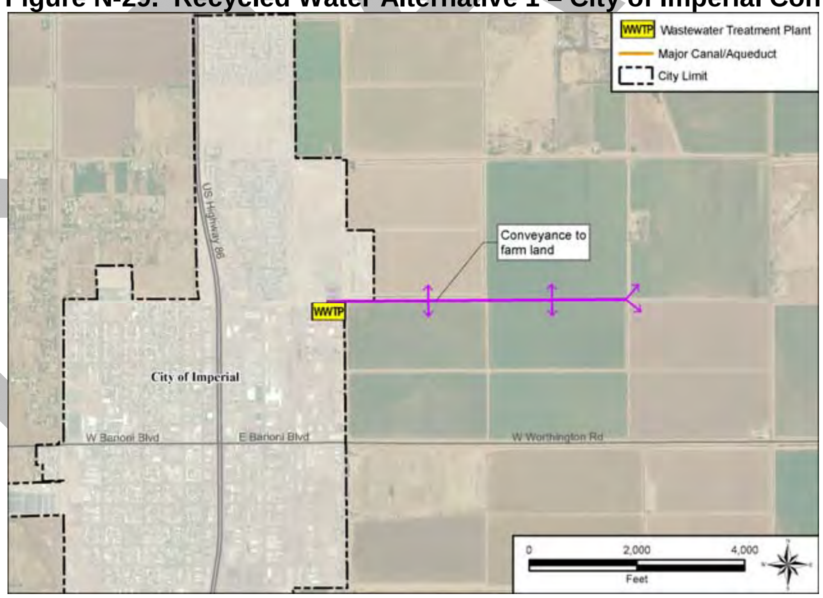
Modifications to the El Centro WWTP would include construction of storage equal to an average days flow and construction of a conveyance system including 4.5 miles of pipelines to the west (Figure N-28). Inspection of aerial photography indicates that this area is close to existing urbanized areas. Were these areas to develop, the recycled water would have to be delivered elsewhere.

Figure N-28. Recycled Water Alternative 1 – El Centro Configuration



Modifications to the City of Imperial Water Pollution Control Plant would include construction of storage equal to an average days flow and construction of a conveyance system including one mile of pipeline (Figure N-29).

Figure N-29. Recycled Water Alternative 1 – City of Imperial Configuration



Recycled Water Alternative 1 would produce 13,331 AFY yield. It is technically feasible and the cost, at $118 per AF, within the cost limits developed for this investigation. It will be carried forward for further investigation.

Cost

The capital cost of Recycled Water Alternative 1 would be on the order of $18,800,000. The alternative would deliver 13,300 AFY at a cost of approximately $ 118 per acre foot (May 2009 price level, 4 percent real interest rate, 30 year project life). Approximately half of this cost is mitigation costs. On-farm costs to facilitate use of recycled water have not been addressed in this calculation. Table N-26 presents the cost of developing these systems.

Table N-26. Recycled Water Alternative 1 Disinfected Secondary Effluent from Existing WWTP applied to adjacent agriculture (May 2009 price level, 4 percent real interest rate, 30 year project life

	Total
Recycled Facilities (Storage & Conveyance) at Brawley WWTP	
Capital Cost	
Storage (4.0 MG, 12.3 af)	$ 1,267,578
Pumping Facilities, 2@100 hp incl standby	287,040
Pipelines (conveyance to Spruce Lateral 5)	2,543,112
Irrigation Turnouts	576,122
Check Structures	78,000
Mitigation Costs (reduced drain flows)	820,561
On-Farm costs, if any	not included
Capital Cost	$ 5,572,413
O&M Costs	
O&M Costs	168,052
Financial Analysis (4%, 30 years)	
Equivalent Annual Cost	$ 490,305
Yield (AFY)	4,481
Equivalent Annual Cost per acre-foot	$164
Recycled Facilities (Storage & Conveyance) at Calexico WWTP	
Capital Cost	
Storage (2.8 MG, 8.6 af)	$ 891,072
Pumping Facilities, 2 @ 100 hp incl standby	266,240
Pipelines (conveyance to west for 4.5 miles)	3,442,982
Irrigation Turnouts	1,456,775
Mitigation Costs (reduced drain flows)	574,447
On-Farm costs, if any	not included
Capital Cost	$ 6,631,517
O&M Costs	
O&M Costs	119,521
Financial Analysis (4%, 30 years)	
Equivalent Annual Cost	$ 503,023
Yield (AFY)	3,137
Equivalent Annual Cost per acre-foot	$160

Recycled Facilities (Storage & Conveyance) at El Centro WWTP

Capital Cost	
Storage (3.6 MGD, 11.1 af)	$ 1,021,176
Pumping Facilities, 100 hp + standby	234,806
Pipelines (conveyance to west for 4.5 miles)	2,065,789
Irrigation Turnouts	374,400
Mitigation Costs (reduced drain flows)	738,523
On-Farm costs, if any	not included
Capital Cost	$4,434,694
O&M Costs	
O&M Costs	151,981
Financial Analysis (4%, 30 years)	
Equivalent Annual Cost	$408,440
Yield (AFY)	4,033
Equivalent Annual Cost per acre-foot	$156

Recycled Facilities (Storage & Conveyance) at Imperial WWTP

Capital Cost	
Storage (1.5 MG, 4.6 af)	$ 652,626
Pumping Facilities, 20 hp + standby	178,152
Pipelines (conveyance to east for 1 mile)	815,443
Irrigation Turnouts	187,200
Mitigation Costs (reduced drain flows)	307,642
On-Farm costs, if any	not included
Capital Cost	$ 2,141,063
O&M Costs	
O&M Costs	47,117
Financial Analysis (4%, 30 years)	
Equivalent Annual Cost	$262,847
Yield (AFY)	1,680
Equivalent Annual Cost per acre-foot	$102

Recycled Water Alternative 1 - Summary Costs

Capital Cost	$ 18,779,688
O&M Costs	486,671
Equivalent Annual Cost	1,572,702
Yield (AFY)	13,331
Equivalent Annual Cost per acre-foot	$ 118

N.3.2.2 Recycled Water Alternative 2 – Upgrade Existing Plants to Tertiary and deliver effluent to a local market

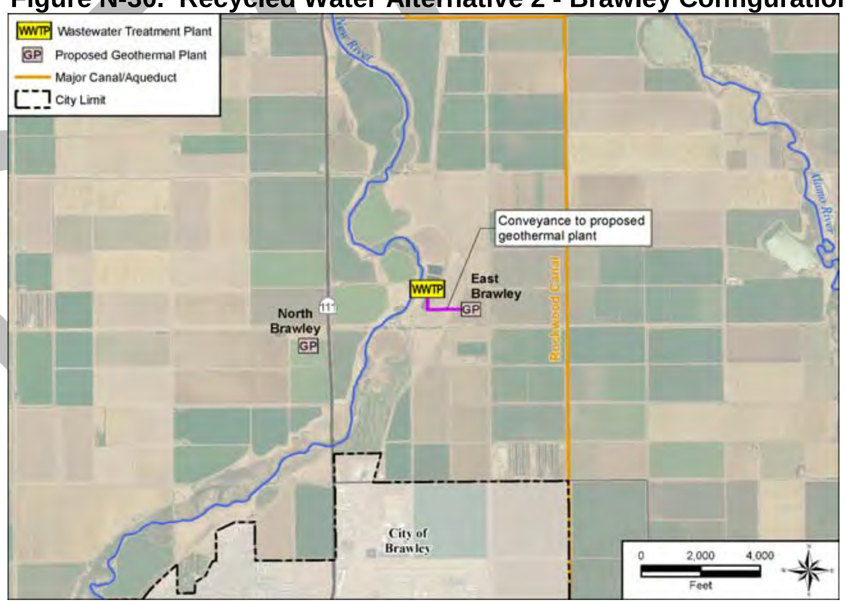
Description

Recycled Water Alternative 2 proposes upgrading the four largest plants from secondary to tertiary treatment and delivering their effluent to municipal and industrial use in the adjacent communities. This alternative presents a number of challenges. The cost of upgrading the treatment process is high. Identifying the customers who would receive the water is required. If the customers are existing MCI customers, this alternative would require constructing new distribution systems through established communities and require modifications of the customer’s on-site plumbing systems. If the customers are in future developments, then, with appropriate regulation, the required infrastructure (dual plumbing) could be established when the area developed. In the absence of known major industrial customers, the size of the service areas of this alternative would be limited by a wastewater plants ability to meet the summer peak demand for irrigation. Thus, during the winter, there would be effluent that cannot be marketed.

Each of these plants is discussed separately below.

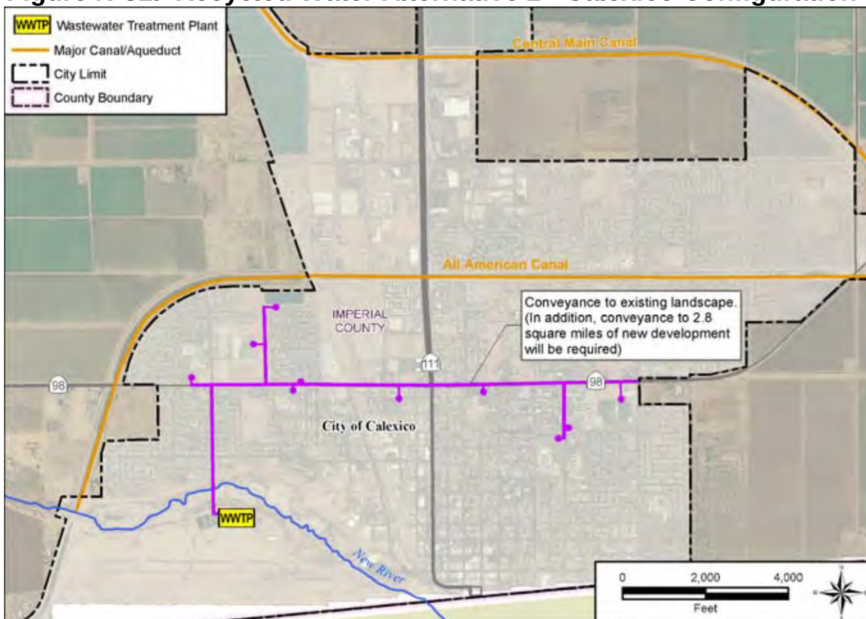
The Brawley WWTP is located close to two proposed geothermal power plants. The proposed East Brawley plant is one-half mile to the southeast and the proposed West Brawley plant is one mile to the southwest. This alternative delivers the entire flow of the Brawley WWTP to the East Brawley plant (Figure N-30).

Figure N-30. Recycled Water Alternative 2 - Brawley Configuration



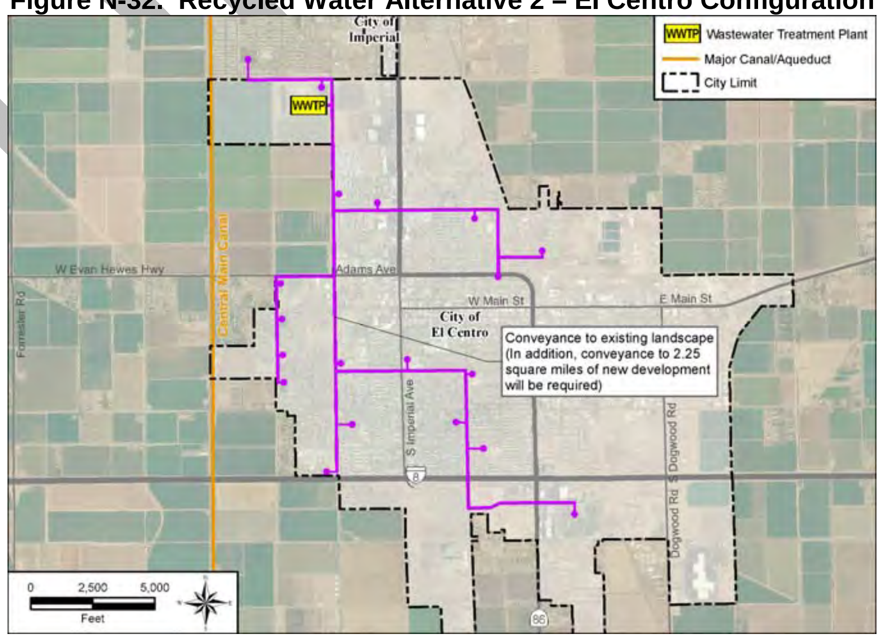
The Calexico WWTP could potentially serve approximately 422 acres of irrigated landscape (0.62ft/month irrigation required in the peak month) (Figure N-31). Inspection of aerial photographs indicates that there may be 44 acres of large irrigated areas within two miles of the plant (10 sites from 2 to 8 acres each). It would take roughly 3.0 miles of pipe to serve these areas. The remaining 378 acres to be served could be new development spread over a total area of 2.4 square miles. Approximately 2,200 AFY of recycled water would be served by this system.

Figure N-31. Recycled Water Alternative 2 - Calexico Configuration



The El Centro WWTP could potentially serve approximately 542 acres of irrigated landscape (0.62ft/month irrigation required in the peak month) (Figure N-32). Inspection of aerial photographs indicates that there may be 100 acres of large irrigated areas within two miles of the plant (Six sites with 6 acres to 40 acres of irrigated landscape). It would take roughly 4.5 miles of pipe to serve these areas. The remaining 442 acres to be served could be new development spread over a total area of approximately 2.8 square miles. Approximately 2,200 AFY of recycled water would be served by this system.

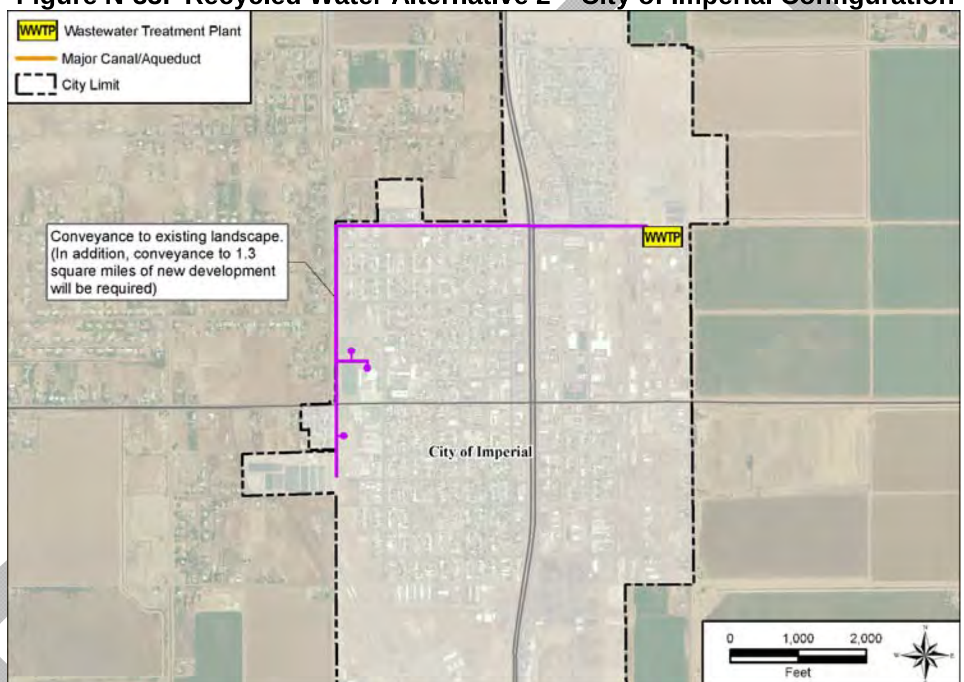
Figure N-32. Recycled Water Alternative 2 – El Centro Configuration



The City of Imperial Water Pollution Control Plant could potentially serve approximately 226 acres of irrigated landscape (0.62ft/month irrigation required in the peak month) (Figure N-33). Inspection of aerial photographs indicates that there may be 19 acres of large irrigated areas within one mile of the plant. It would take roughly 1.25 miles of pipe to serve these areas. The remaining 207 acres to be served could be new development spread over a total area of approximately 1.3 square miles. Approximately 1,200 AFY of recycled water would be served by this system.

Recycled Water Alternative 2 would produce 11,674 AFY yield. While it is technically feasible, the cost, at $919 per AF, is beyond the cost limits developed for this investigation. It will not be carried forward for further investigation.

Figure N-33. Recycled Water Alternative 2 – City of Imperial Configuration



Cost

The capital cost of Recycled Water Alternative 2 would be on the order of $141 million Approximately half of that cost is for an increased level of treatment. The alternative would deliver 11,674 AFY at a cost of approximately $919 per acre foot (May 2009 price level, 4 percent real interest rate, 30-year project life). Approximately 60 percent of the capital cost is for treatment. Significant amounts (not included in this estimate) would also be needed to connect irrigation uses in large areas of future developments. Costs included by the users of the recycled water to facilitate use of recycled water have not been addressed in this calculation. Table N-27 presents the cost of developing these systems.

The costs per acre-foot for three of the plants are similar – Imperial, El Centro, and Calexico. The cost per acre-foot for the Brawley WWTP is significantly lower ($448) than the others as all deliveries are to the proposed geothermal power plant one-half mile away rather than to a number of irrigation users. Distribution costs are lower and (due to the constant demand of the plant) all available effluent is used.

A previous analysis prepared for Ormat Technologies by another firm, found a much lower cost ranging from: $129/acre-foot to $308/acre-foot as opposed to $448/acre-foot.   While the source of the difference cannot be determined, it is probable that the firm which prepared the previous analysis had more specific knowledge of treatment requirements. It is unlikely that the previous analysis included mitigation costs.

Table N-27. Recycled Water Alternative 2 – Tertiary Treatment applied to local market (May 2009 price level, 4% real interest rate, 30 year project life)

Recycled Facilities (Storage & Conveyance) at Brawley WWTP	
Capital Cost	
Tertiary Treatment (4.0 MGD)	$ 24,326,976
Storage (4.0 MG, 12.3 af)	1,267,578
Pumping Facilities, 3 @ 40 hp incl standby (deliver to Ormat)	270,348
Pipelines to Ormat Technologies	119,180
Mitigation Costs (reduced drain flows)	820,561
On-site costs	not included
Capital Cost	$ 26,804,643
O&M Costs	
O&M Costs	$ 638,824
Financial Analysis (4%, 30 years)	
Equivalent Annual Cost	$2,188,939
Yield (AFY)	4,481
Equivalent Annual Cost per acre-foot	$488
Recycled Facilities (Storage & Conveyance) at Calexico WWTP	
Capital Cost	
Tertiary Treatment (2.8 MGD)	$ 18,837,421
Storage (2.8 MG, 8.6 af)	891,072
Pumping Facilities, 4 @ 100 hp including standby	565,344
Pipelines (2.4 square miles of new dev)	17,417,867
Pipelines (existing development)	2,816,986
Mitigation Costs (reduced drain flows)	574,447
On-site costs	not included
Capital Cost	$ 40,528,689
O&M Costs	
O&M Costs	680,129
Financial Analysis (4%, 30 years)	
Equivalent Annual Cost	$3,023,907
Water delivered (acre-feet/year)	3,137
Equivalent Annual Cost per acre-foot	$964

Recycled Facilities (Storage & Conveyance) at El Centro WWTP

Capital Cost	
Tertiary Treatment (3.6 MGD)	$ 22,557,748
Storage (3.6 MGD, 11.1 af)	1,021,176
Pumping Facilities, 4 each @ 200 hp, incl standby, VFDs	1,186,380
Pipelines (2.25 square miles of new dev)	16,329,250
Pipelines (Serving exist development)	7,708,656
Mitigation Costs (reduced drain flows)	524,351
On-Site costs	not included
Capital Cost	$ 49,327,562
O&M Costs	
O&M Costs	719,616
Financial Analysis (4%, 30 years)	
Equivalent Annual Cost	$3,572,234
Yield (AFY)	2,863
Equivalent Annual Cost per acre-foot	$1,248

Recycled Facilities (Storage & Conveyance) at Imperial WWTP

Capital Cost	
Tertiary Treatment (1.5 MGD)	$ 12,030,992
Storage (1.5 MGD, 4.6 af)	627,525
Pumping Facilities, 4 @ 40 hp including standby	304,512
Pipelines serving existing development	1,291,118
Pipelines (1.3 square miles of new dev)	9,434,678
Mitigation Costs (reduced drain flows)	218,426
On-site costs	not included
Capital Cost	$ 23,907,251
O&M Costs	
O&M Costs	558,576
Financial Analysis (4%, 30 years)	
Equivalent Annual Cost	$1,941,135
Yield (AFY)	1,193
Equivalent Annual Cost per acre-foot	$1,627

Recycled Water Alternative 2 - Summary Costs

Capital Cost	$ 140,568,145
O&M Costs	2,597,145
Equivalent Annual Cost	$ 10,726,215
Yield (AFY)	11,674
Equivalent Annual Cost per acre-foot	**$ 919**

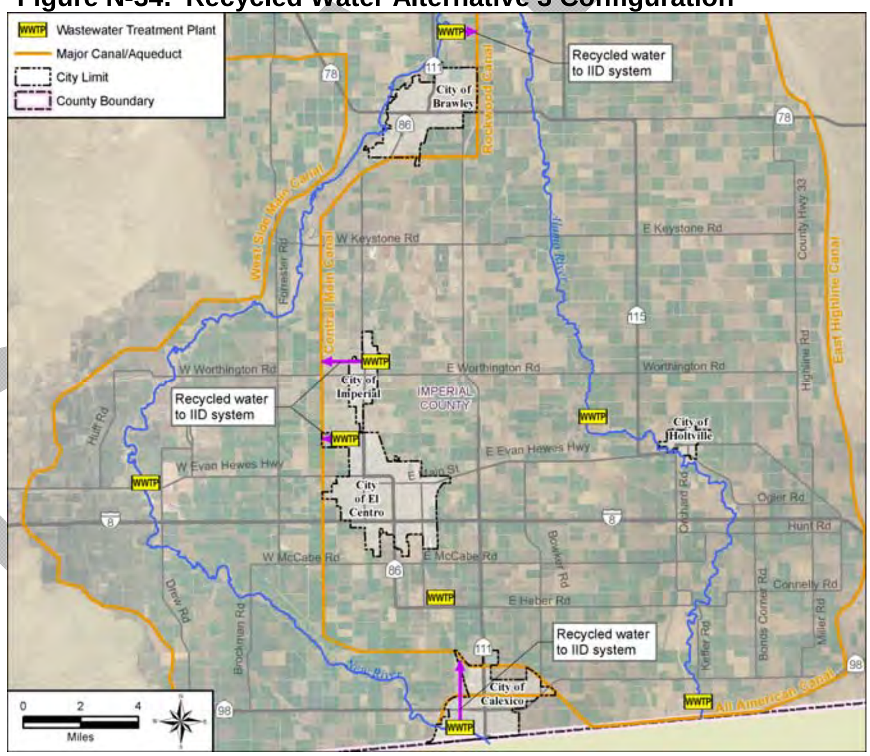
N.3.2.3 Recycled Water Alternative 3 – Upgrade existing plants to tertiary and deliver effluent to IID canal system

Description

Recycled Water Alternative 3 (like Recycled Water Alternative 2) proposes upgrading the four largest plants from secondary to tertiary treatment, but the deliveries would be made to IID's canal system rather than developing separate distribution systems for deliveries from each plant (Figure N-34). The purpose of this analysis was to test the reduction in cost from elimination of the dual plumbing system and distribution in already developed areas. This alternative presumes that the institutional and regulatory issues associated with delivering tertiary treated water to a raw water system can be solved. If they can be, then the challenges of developing a market for recycled water and the purple pipe distribution system to deliver that water is solved.

As deliveries from the treatment plants are made to IID's distribution system, those deliveries can most likely be regulated by the distribution system – both on a daily and on a seasonal basis. Thus, no storage would be needed at the treatment plant and all effluent can be used.

Figure N-34. Recycled Water Alternative 3 Configuration



Recycled Water Alternative 3 would produce 13,331 AFY yield. It is technically feasible and the cost, at $562 per AF, is within the cost limits developed for this investigation. It will be carried forward for further investigation.

Cost

Table N-28 presents the cost of developing this alternative.

Table N-28. Recycled Water Alternative 3 – Tertiary Treated Water into the Central Main Canal (May 2009 price level, 4% real interest rate, 30 year project life)

Recycled Facilities (Storage & Conveyance) at Brawley WWTP	
Capital Cost	
Tertiary Treatment (4.0 MGD)	$ 24,326,976
Pumping Facilities, 3 @ 30 including standby	480,480
Pipelines (conveyance to Rockwood Canal)	1,441,326
Turnout to canal	23,400
Mitigation Costs (reduced drain flows)	820,561
Capital Cost	$ 27,092,743
O&M Costs	
O&M Costs	625,459
Financial Analysis (4%, 30 years)	
Equivalent Annual Cost	$2,192,235
Yield (AFY)	4,481
Equivalent Annual Cost per acre-foot	$489

Recycled Facilities (Storage & Conveyance) at Calexico WWTP	
Capital Cost	
Tertiary Treatment (2.8 MGD)	18,837,421
Pumping Facilities, 3 @ 30 including standby	480,480
Pipelines (2.5 miles to Central Main Canal)	3,011,237
Turnout to canal	23,400
Mitigation Costs (reduced drain flows)	574,447
Capital Cost	$ 22,926,985
O&M Costs	
O&M Costs	593,462
Financial Analysis (4%, 30 years)	
Equivalent Annual Cost	$1,919,332
Yield (AFY)	3,137
Equivalent Annual Cost per acre-foot	$612

Recycled Facilities (Storage & Conveyance) at El Centro WWTP

Capital Cost	
Tertiary Treatment (3.6 MGD)	$ 23,553,391
Pumping Facilities (3 @ 40 hp)	493,116
Pipelines (3.0 miles to Central main Canal)	3,098,684
Turnout to canal	23,400
Mitigation Costs (reduced drain flows)	738,523
Capital Cost	$ 27,907,114
O&M Costs	
O&M Costs	715,509
Financial Analysis (4%, 30 years)	
Equivalent Annual Cost	$2,329,380
Water delivered	4,033
Equivalent Annual Cost per acre-foot	$578

Recycled Facilities (Storage & Conveyance) at Imperial WWTP

Capital Cost	
Tertiary Treatment (1.5 MGD)	10,302,585
Pumping Facilities, 2@ 30 hp incl standby	409,188
Pipelines (conveyance to Central Main Canal)	1,561,560
Turnout to canal	23,400
Mitigation Costs (reduced drain flows)	307,642
Capital Cost	12,604,374
O&M Costs	
O&M Costs	328,489
Financial Analysis (4%, 30 years)	
Equivalent Annual Cost	$1,057,401
Yield (AFY)	1,680
Equivalent Annual Cost per acre-foot	$629

Recycled Water Alternative 3 - Summary Costs

Capital Cost	$ 90,531,216
O&M Costs	2,992,257
Equivalent Annual Cost	7,498,347
Yield (AFY)	13,331
Equivalent Annual Cost per acre-foot	**$ 562**

N.3.2.4 Recycled Water Alternative 4 – Regional plant serving tertiary water locally

Description

Recycled Water Alternative 4 proposes construction of a new, regional wastewater treatment plant located between the cities of Imperial and Brawley, in the Keystone Planning Area (Figure N-35). At this time, a design exists for a 5 MGD Keystone Regional Water Reclamation Facility. The expected ultimate treatment capacity needed for all proposed new development in the Keystone Planning Area is 15 MGD, and the proposed plant can be expanded to that size. The plant is proposed to provide tertiary treatment with the intent of delivering the treated effluent to a recycled water system serving new development located between the two cities.

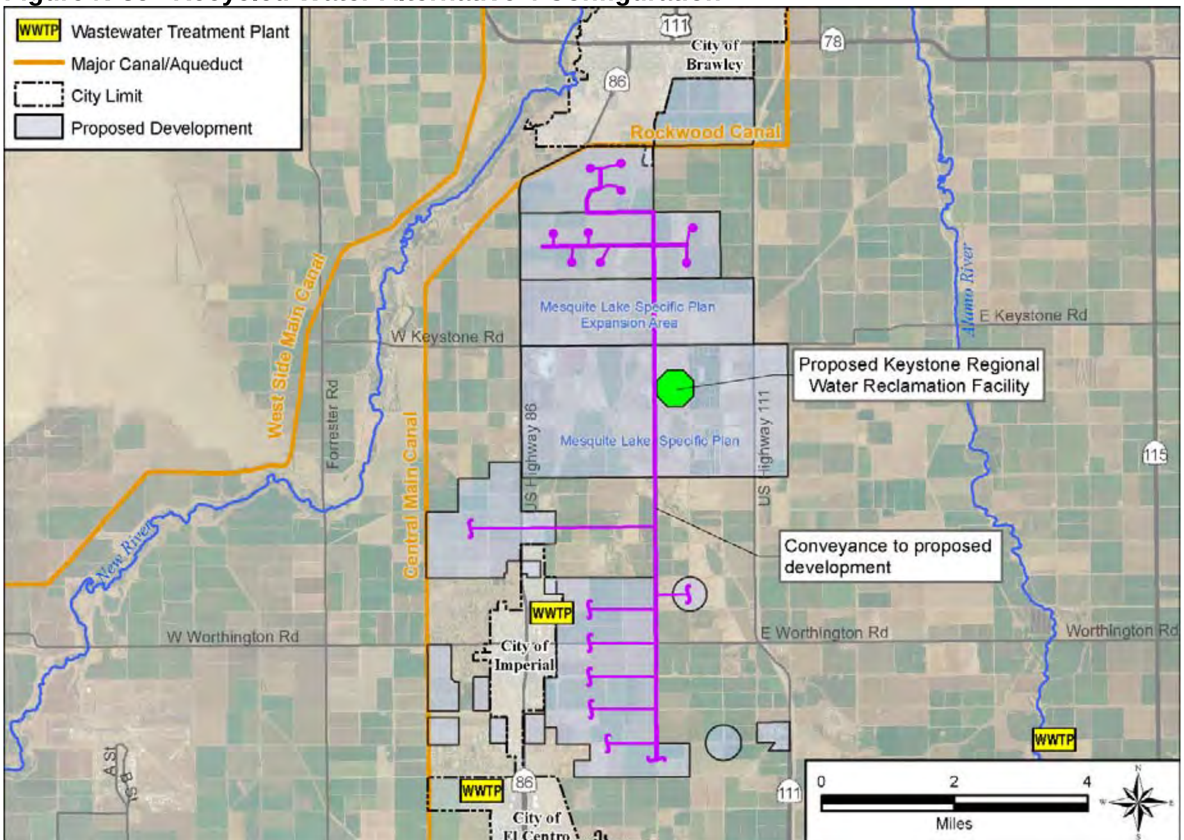
This investigation assumes that the treatment plant would be constructed to meet future needs for wastewater treatment. If the effluent were not intended to be recycled, then the plant would be built to provide secondary treatment. Thus, only the increment treatment from secondary to tertiary is included in this investigation.

This alternative assumes construction of a 7.5 MGD tertiary treatment plant with an average effluent flow of 5.9 MGD. The size plant was selected based on the brief market analysis for recycled water that follows.

The Mesquite Lake Specific Plan Area, surrounding the proposed plant, is 5,100 acres zoned for industry with railway access (IVEDC, 2007). Under the presumption that industrial use would consist of warehousing, distribution and food processing, it appears that there would be few customers for significant amounts of recycled water here. More distant from the proposed plant are a number of proposed subdivisions including Rancho Los Lagos Specific Plan and the 101 Ranch Specific Plan located south of Brawley; Barioni Lakes located north of the City of Imperial; and a number of developments located east of Imperial (Imperial County, 2009). These proposed developments may be markets for recycled water. Rancho Los Lagos is proposed to include a golf course, other parks and schools (say 220 acres out of 1,200 acres). Barioni Lakes includes 95 acres of park land including recreational lakes and 82 acres of schools out of 1,100 total acres. An “Imperial Regional Sports park” is proposed for the southeast corner of Neckel Road and Dogwood Road, approximately two miles east of the City of Imperial. This park may be 160 acres. These developments and the developments on the east side of Imperial may eventually contain enough landscaping to provide a market for a recycled water treatment plant producing 5.9 MGD. Due to the varying irrigation demands through the year, the actual amount of recycled water used would average less than 5.9 MGD.

Recycled Water Alternative 4 would produce 4,696 AFY yield. While it is technically feasible and the cost, at $938 per AF, it is beyond the cost limits developed for this investigation. It will not be carried forward for further investigation.

Figure N-35. Recycled Water Alternative 4 Configuration



Cost

Table N-29 gives a more detailed cost estimate.

Table N-29. Recycled Water Alternative 4 – Keystone Regional Water Reclamation Plant delivering to future MCI customers (May 2009 price level, 4% real interest rate, 30 year project life)

Recycled Facilities (Storage & Conveyance) at Keystone Regional Water Reclamation Facility		
Capital Cost	$	15,729,759
Tertiary Treatment (7.5MGD. Cost over secondary)		
Storage (One day's flow)		1,162,672
Pumping Facilities, 6 @ 200 including standby		2,030,652
Recycled Water Pipelines		32,400,276
Turnout to canal		-
Mitigation Costs (for reduced drain flows)		-
On-site costs		not included
Capital Cost	$	51,323,358
O&M Costs		
O&M Costs	$	1,438,723
Financial Analysis (4%, 30 years)		
Equivalent Annual Cost		$4,406,758
Yield (AFY)		4,696
Equivalent Annual Cost per acre-foot		**$938**

N.3.2.5 Recycled Water Alternative 5 – Regional Plant serving tertiary water to IID canal

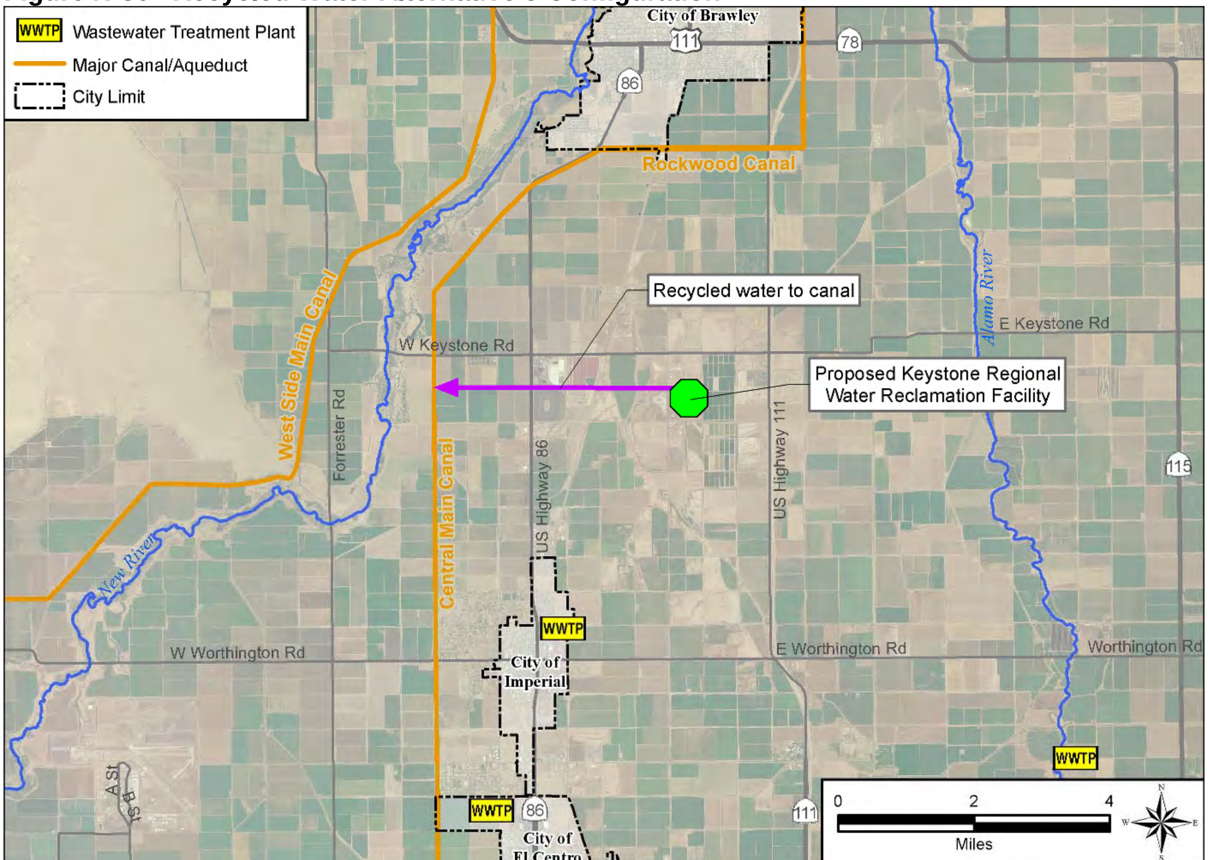
Description

Recycled Water Alternative 5 proposes construction of a new, regional wastewater treatment plant located between the cities of Imperial and Brawley, in the Keystone Planning Area (Figure N-36). The proposed plant would be identical to the one proposed in Recycled Water Alternative 4: a 7.5 MGD tertiary treatment plant with an average effluent flow of 5.9 MGD.

This alternative would require construction of sewer force mains and lift stations to direct flow from the four existing plants to the new Keystone Regional Plant. However, this alternative presumes delivery of the plant effluent to IID's distribution system at the Central Canal located 3.5 miles west of the proposed plant. Because the delivery is to IID's distribution system, all of the plant effluent can be recycled (Alternative 4 was limited by a need to meet the peak summer demand in its market area).

Recycled Water Alternative 5 would yield 6,611 AFY. It is technically feasible and the cost, at $308 per AF, is within the cost limits developed for this investigation. It will be carried forward for further investigation.

Figure N-36. Recycled Water Alternative 5 Configuration



Cost

Recycled Water Alternative 5 has an estimated capital cost of $21 million. This capital cost is dominated by the treatment costs. Recycled Water Alternative 4's extensive recycled conveyance system is not needed. The system would deliver 6,600 acre-feet of recycled water per year at an equivalent annual cost of $308 per acre-foot. Table N-30 gives a more detailed cost estimate.

Table N-30. Recycled Water Alternative 5 – Keystone Regional Water Reclamation Plant delivering to Central Canal (May 2009 price level, 4% real interest rate, 30 year project life)

Capital Cost		
Tertiary Treatment (7.5MGD. Cost over secondary)	$	15,729,759
Pumping Facilities for recycled system, 3 @ 100 including standby		447,470
Pipeline to Canal		4,566,482
Turnout to canal		75,000
Mitigation Costs (reduced drain flows)		-
Capital Cost	$	20,818,710
O&M Costs		
O&M Costs	$	829,853
Financial Analysis (4%, 30 years)		
Equivalent Annual Capital Cost		$1,203,948
O&M		829,853
Equivalent Annual Cost		$2,033,801
Yield (AFY)		6,611
Equivalent Annual Cost per acre-foot		$308

N.3.2.6 Recycled Water Alternative 6 – Regional Plant serving tertiary water to local service area and IID canal

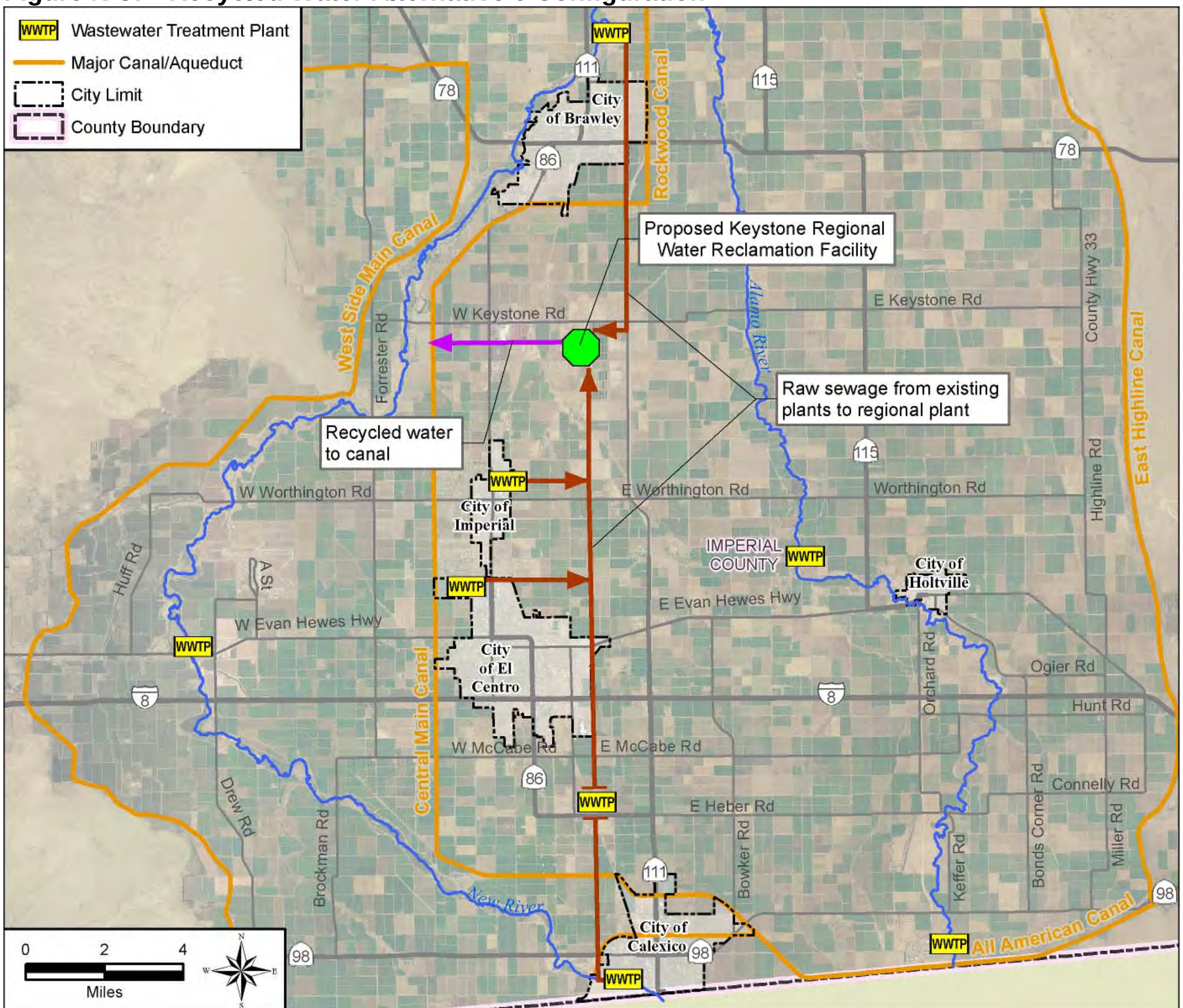
Description

Recycled Water Alternative 6 proposes the replacement of the existing wastewater treatment plants in Brawley, Imperial, El Centro and Calexico with a new regional plant that would serve these cities and serve future needs in the Keystone Planning Area (Figure N-37). The proposed plant would be twice the plant proposed in Recycled Water Alternatives 4 and 5: a 15 MGD tertiary treatment plant. Current average flows at the four existing plants are 11.9 MGD. For this investigation we have presumed that the plants average flow would equal the maximum flow.

Like Recycled Water Alternative 5, assumes all of the plants effluent would be delivered to IID's distribution system at the Central Canal located 3.5 miles west of the proposed plant.

Recycled Water Alternative 6 would yield 16,808 AFY. It is technically feasible and the cost, at $4,888 per AF, is within the cost limits developed for this investigation. It will be carried forward for further investigation.

Figure N-37. Recycled Water Alternative 6 Configuration



Cost

Recycled Water Alternative 6 has an estimated capital cost of $102 million. This capital cost is dominated by the cost of force mains to deliver raw sewage from the existing plants to the regional plant. Recycled Water Alternative 4's extensive recycled conveyance system is not needed. The system would deliver 16,800 AFY of recycled water at an equivalent annual cost of $488 per acre-foot. Table N-31 gives a more detailed cost estimate.

Table N-31. Recycled Water Alternative 6 – Keystone Regional Water Reclamation Plant delivering to Central Canal (May 2009 price level, 4% real interest rate, 30-year project life)

Capital Cost		
Tertiary Treatment (15MGD. Cost over secondary)	$	24,841,252
Sewer Lift Station, Brawley to Keystone, 4 @ 300 hp incl standby		1,298,700
Sewer Lift Station, Imperial to Keystone, 3 @ 40 hp incl standby		518,388
Sewer Lift Station, El Centro to Keystone, 3 @ 40 hp incl standby		518,388
Sewer Lift Station, Calexico to Keystone, 6 @ 200 hp incl standby		1,469,052
Pumping Facilities for recycled system, 3 @ 100 including standby		664,279
Force Main, Brawley to Keystone		22,228,982
Force Main, Calexico, Cl Centro & Imperial to Keystone		42,146,454
Pipeline to Canal		5,517,832
Turnout to canal		93,600
Mitigation Costs (reduced drain flows)		3,077,927
Capital Cost	$	102,374,854
O&M Costs		
O&M Costs	$	2,280,145
Financial Analysis (4%, 30 years)		
Equivalent Annual Cost		$8,200,493
Yield (AFY)		16,808
Equivalent Annual Cost per acre-foot		**$488**

N.3.2.7 Other Projects

In addition to the project alternatives presented and evaluated above there are a number of other opportunities that could be considered in the area. Potential projects include those that may have been identified on an informal level by cities or power plant owners as well as some opportunities that may not have been considered and were outside the scope of this report; such as grey water.

Existing Plants

While no plants within IID currently have any land disposal or reuse, increased emphasis by the RWQCB, along with the UWMP requirements and increasing limitations to IID supplies, may make recycled water a cost effective alternative. Interviews with the wastewater treatment plant operators or representatives indicate that several plants have been approached with ideas or have begun internal discussions of potential recycled water projects.

A number of plants, including the City of Calexico Municipal WWTP, the City of El Centro Municipal WWTP, and City of Holtville Municipal WTTP, mentioned consideration of crop or surrounding area irrigation, some possibly at current treatment levels. Specifically, a study evaluating the tie in of a CHP facility to the Gateway of the Americas WWTP included consideration for using reclaimed water for the irrigation at the CHP facility. Additionally, the City of Brawley's website specifically indicates that the feasibility of using recycled water on a golf course south of the Brawley WWTP is being evaluated.

Several plants have also had interest expressed by various industrial water consumers. As included in the alternatives consideration discussion, the City of Brawley is negotiating with Ormat Nevada, Inc. Ormat approached the city for reclaimed use for cooling tower purposes at a new/expanded plant. The preliminary design report on reclaimed water structures has been started. The Heber PUD WWTP is also in discussion with Ormat regarding use of reclaimed water. Additionally, the City of Brawley has had Caltrans and an ethanol plant planned nearby expressed some interest in the use of recycled water. The Calipatria WWTP indicated they also had discussion with an ethanol plant at one point. Modern ethanol plants have refined water treatment techniques to enable recycling of water to boilers and these treatment techniques typically also enable the plants to use lower quality water such as sewage treatment plant effluents. A potential solar farm has also contacted at least two of the area plants, the Westmorland WWTP and the Seeley County WWTP.

In the interviews all of the plants operators or representatives spoken with could identify a potential market for recycled water from their plant even if the options were not actively being pursued or discussed. Most indicated that they expected more recycled water in the area eventually, some anticipate it in the near future. There appears to be increased focus on recycled water opportunities with increased emphasis by the RWQCB, along with the UWMP requirements and increasing limitations to IID supplies. As an example, Niland WWTP indicated that when the Region Board last visited they recommended evaluating reuse opportunities.

Geothermal Plants

There are also several geothermal plants in the area that are treating cooling water and disposing with NPDES permits. These plants may have opportunities to provide a cost effective source of recycled water supply. One plant, the IID's El Centro Generating Station, has a NPDES permit and a RWQCB order to install RO to treat up to 1,200 AFY.

Grey water

Grey water is household wastewater from sinks, showers, and washer machines, which can be reused for watering plants and flushing toilets. A simple example of reuse of grey water is a homeowner using water from his washing machine or shower for irrigation or to flush a toilet. Depending on the systems used, grey water systems could recycle water without building public infrastructure.

"Scalper" plants

The construction of small recycling plants located in the upper portion of a wastewater service area can have some advantages over recycling at a larger, central wastewater plant. There may be a location that balances the supply of sewage with the demand for recycled water. With the proper location, the cost of the recycled water distribution system is controlled. Also, the new plant may allow downsizing sewer trunk lines or defer their replacement. This is somewhat similar to Recycled Water Alternative 2.

N.3.2.8 Next steps

This investigation has developed conceptual level alternatives based on limited information. Based on this data the cost of recycled water may vary from $170/acre-feet for secondary recycled water delivered to farm land to a thousand dollars for tertiary water delivered to municipal and industrial users. But, this has been a conceptual analysis with a great deal of uncertainty. Decisions to eliminate or further evaluate these alternatives should consider the following assumptions and limitation on the analysis. They should also be considered in the scoping of additional investigations.

There has been limited discussion with the operators of the wastewater plants and none with the potential customers:

- The use of recycled water often presents water quality challenges for the customers. With these projects in particular, salt levels may be a concern. As a rule of thumb, wastewater treatment plant effluent has 300 ppm more TDS than the treated water used in the plants service area. Without desalting, effluent in the IID area may be in the range of 1,000 ppm TDS. This level will affect agricultural and other uses of the recycled water and create costs for those users. High organics are also a concern for customers (See the earlier discussion of Ormat Technologies investigations of reusing effluent from the Brawley WWTP).

- Users may face challenges with the perceptions created by use of recycled water. The agency implementing the recycled water system and the potential users will have to work together to achieve a successful program. Agreements with growers to take the water would be needed. The acceptability of deliveries secondary treated wastewater to even a limited reach of canal (Recycled Water Alternative 1, Brawley WWTP, Recycled Water Alternatives 3,5, and 6) needs to be further examined. Use of recycled water on farmland may require IID acquiring the farm land and then leasing it with restrictions.

- There may be additional markets that have not been identified, which substantially reduce the alternatives costs. An example might be a proposed geothermal plant in the South Brawley KGRA that could receive recycled water from the regional plant proposed in Recycled Water Alternatives 4, 5, and 6. Little is known about Ormat Technologies concepts and analysis for using effluent from the Brawly WWTP.

- The proposed markets for an alternative may not exist. For example, the arrangement of facilities at a park or at a school may make use of recycled water unfeasible.

- Alternatives delivering recycled water to municipal and industrial customers (Recycled Water Alternatives 2 and 4) would require the cooperation of the relevant land use entities.

- In light of increased interest in conservation, the supply and quality of plant effluent available for recycling may reduce in the future. Conservation may reduce the market for recycled water. Conservation may increase TDS levels in effluent.

Delivering recycled water to IID's Distribution System may not be acceptable:

- Recycled Water Alternatives 3, 5, and 6 propose delivering tertiary-treated recycled water to IID's Distribution System. This may not be acceptable for regulatory reasons, water quality reasons or to the users of water delivered from the system.

The estimates of the cost of additional treatment are based on generic data:

- Cost estimates for upgrading treatment to tertiary are based on generic curves that may not be applicable to these cases.

- This investigation assumed that the market for recycled water would be present immediately upon completion of the development of the supply and the conveyance system. Experience on many existing recycled water projects indicates that this typically is not the case. This concern is particularly true for Recycled Water Alternatives 4, 5, and 6, which envision development of a new plant to provide wastewater treatment for future development and deliver recycled water to future development (Recycled Water Alternative 6 serves the recycled water to existing development).

- Other water management strategies impact the feasibility of recycled water. Urban conservation reduces the amount of sewage and increases the TDS levels in that sewage. Urban conservation can also reduce the market for recycled water.

The feasibility of abandoning local wastewater treatment plants for a regional plant has not been evaluated with the owners of those plants

- It is known that the City of Imperial is interested in abandoning their plant because of land use considerations.

- Brawley is about to make a major investment in their wastewater treatment plant. It may not be acceptable to abandon a new plant.

Equity issues have not been addressed in this investigation

- Who should pay for a project and on what basis has not been addressed. Do new users pay the cost of new water? Do all stakeholders in IID's supply pay proportionally to their water use? Do municipal and industrial users pay the cost of on-site conversions?

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