Attachment A

Engineering Considerations and Additional Detailed Costs

ENGINEERING CONSIDERATIONS

The appraisal designs of the phase 2 options are intended to improve the biologic habitat in the Salton Sea by improving water quality and maintaining an acceptable water surface elevation at the Sea.

The pump-out/pump-in options pump water from the Salton Sea to various locations. This removes salt-laden water and, thus, reduces the amount of salt and salinity in the Sea. Using other waterways, fresher water is then brought into the Sea. This fresh water raises, or maintains, the water surface elevation of the Sea and decreases the Sea's salinity. While the salinity and water surface elevation depend on the natural inflow and evaporation, they also depend on the quantity and quality of the water brought into the Sea.

WATER IMPORT ASSUMPTIONS

At the onset of this appraisal design, the team and regional personnel assumed that some sources of water could not be used.

Congress stipulated that the design could not use nonflood water from the Colorado River. The Colorado River waters are fully allocated. This includes groundwater that flows into the Colorado River. It also includes boundary groundwater that flows into Mexico and groundwaters that, if tapped, would cause water to flow from Mexico into the United States. It does not include flood waters that sometimes flow into Mexico.

Water Conveyance Design

The pump-in/pump-out preappraisal level designs used only pipelines to convey water. This appraisal level study used all forms of conveyance including pipelines, tunnels, and canals.

Canals generally have lower capital construction cost than pipelines. Their maintenance costs are higher than the pipeline's maintenance costs. Canals must maintain a constant slope. The slope must also be steep enough to meet the required capacity, but flat enough to not create hydraulic problems. There are problems with geologic faults, however. A canal that crosses a fault may drop or rise to an elevation that would render several miles of canal useless. This problem is particularly important where grabens are present, such as in and around the Salton Sea. A pressure pipeline would only need to be repaired at the points of fracture.

Tunnels are more expensive to construct, per linear foot, than either canals or pipelines. They do have some redeeming qualities though. They are not as sinuous as canals and pipelines, which may give better hydraulic properties. Tunnels go through mountains, not over them as pipelines do. This can greatly decrease the number of pumping plants needed to lift the water over the mountains and dramatically reduce the energy requirements. Tunnels are usually much more environmentally acceptable than pipelines and canals.

The design of the water conveyance systems makes use of all three of these conveyance types.

Type of Pipe

The type of pipe is not important at this level of design. It is important that a type of pipe is available that will satisfy design assumptions. This design is based on using steel pipe, usually with a polymer lining. In the size range of this design, this pipe is available in any diameter and easily accommodates the design pressures. In general, designers sized pipe to pressure heads not greater than 500 feet of water. Designers added a pressure head of 100 feet to allow for surges. They designed pumping plants for about 400 feet of head (lift).

Tunnels

Designers studied various schemes of using tunnels at various elevations. This study indicated that very long tunnels might be the optimum choice. This also is environmentally sound. The reader should understand that this economic statement might be true for one route, but totally wrong for another.

Geologists believe that the rock conditions should be good for most of the tunnel reaches. All tunnels will, however, be constructed through active faults. This should not present unusual problems during construction. Operation and maintenance may be more difficult. Minor movements in the grade and alignment in the tunnels will not affect the tunnel operation. Large movements, where the tunnel experiences large offsets, could affect flow rates. If this persists, the tunnel operators may need to unwater the tunnel and hire construction crews to enlarge the changed diameter. This should be the worst case scenario. There is a chance that designers will be able to overcome these obstacles when they know more about the geology in the future.

Canals

Water conveyance routes coming from the east in the vicinity of Yuma, Arizona, use canals. These routes follow the All-American Canal. In general, placing one canal next to another should not affect the environment as much as building a canal across virgin desert. This assumes that the new canal is not constructed through a particular and small environmental hot spot. Tectonic movement may create problems as discussed above.

POWER RECOVERY

The design of water conveyance components includes designs of powerplants used to recover energy.

All of the systems are designed for available power. Designers optimized the pipeline size using powerplant cost weighed against amortized energy production. A majority of the total cost is required for a conveyance system to meet the required tasks. Optimization used only the increased costs of increasing the pipeline size and the cost of the powerplant. The preappraisal generally sized the pipe on a constant velocity of 5 cfs. This appraisal design used this method to size pipes that convey water uphill, but decreased the diameter of the pipes going downhill. Pipe size optimization used these smaller pipe diameters as its basis.

When designing turbines, designers took into consideration that seawater is denser than fresh water. Additionally, all pumps and turbines that use seawater are designed to resist corrosion and scaling.

SALINE WATER CONCERNS

Salt water can cause many problems with water conveyance features. These features include the pipeline, tanks, pumps, inlets, etc. Corrosion is probably the first thing that comes to mind. The ions in the salt water can greatly accelerate corrosion of steel and metallic surfaces.

Scaling is another major concern. The ocean water and Sea water are extremely hard. Hard waters deposit calcium and magnesium on the surfaces in which they come into contact. Pipelines become completely clogged with hardness values much less than is available in Denver.

Other salts will precipitate out of the water and become a problem. Water in the conveyance system will be subjected to both temperature and pressure changes. This must be fully understood before final design. The salts may be abrasive to the linings.

Most of these problems can be rendered harmless. Corrosion, scaling, and abrasion will not harm some polymer coatings. These coatings are quite expensive, and designers included the costs for them into the cost estimate.

ADDITIONAL DETAILED COSTS

Costs included in this report are comparative costs. They should only be used to compare relative differences in costs among the alternatives.

The costs shown as construction field costs were based on estimated quantities. Minor items were handled by adding a percentage (15 percent) of the overall cost. The total construction field cost also includes contingencies of 25 percent.

The costs do not include the expense of purchasing water to be delivered to the Salton Sea. A cost may be charged for water other than ocean water. Pumping plant costs (capital and OM&R) were determined using computer programs and equations developed for planning estimates. Program input included head (pressure), discharge flow, and other factors.

The alternative designs assumed the presence of electrical transmission lines and energy prices typical of the local area. These are current energy costs and not marginal energy costs. The average rate used was $0.05 per kilowatthour (50 mils).

Operation, maintenance, and replacement costs include those for operating and maintaining the pumping plants and replacing components as required. OM&R costs do not include energy costs.

Appraisal Level Estimates

Conveyance system	Item	Construction cost estimate ($M)	OM&R ($M/yr)	Cost energy ($M/yr)
	Common Action			
Flood flows from Imperial Dam to Alamo River	0	0	0	0
	Phase I Alternative Components			
Concentration ponds	South dike	195	0.53	0.00
	North dike	200	0.57	0.00
	Water conveyance	5	0.10	0.12
	Total	400	1.20	0.12
EES Phase I				
Bombay Beach (150,000 ac-ft/yr)				
	EES modules	198	8.41	0.00
	Move power lines	8		
	Salt disposal	79	0.28	0.00
	Total	285	8.69	3.00
Salton Sea Test Site (150,000 ac-ft/yr)				
	EES modules	198	8.41	3.00
	Salt disposal	211	0.74	0.00
	Total	409	9.15	3.00
Salton Sea Test Site (250,000 ac-ft/yr)				
	EES modules	330	14.01	5.00
	Salt disposal	210	0.74	0.00
	Total	540	14.75	5.00
Concentration ponds and EES (100,000 ac-ft/yr)	South dike	195	0.53	0.00
	North dike	200	0.57	0.00
	Water conveyance	5	0.10	0.12
	EES modules	132	5.60	2.00
	Salt disposal	169	0.56	0.00
	Total	701	7.36	2.12

Appraisal Level Estimates

Conveyance system	Item	Construction cost estimate ($M)	OM&R ($M/yr)	Cost energy ($M/yr)
	Phase II Alternative Components			
Salton Sea to Golfo de Santa Clara		1150	1.25	15.00
Salton Sea to San Felipe		1500	1.70	17.32
San Diego to Salton Sea	San Diego to tunnel	700	21.24	28.20
	Tunnel	370	0.05	0.00
	Tunnel to Salton Sea	150	0.96	-21.60
	Total	1220	22.24	6.60
San Bernardino to Salton Sea		220	1.27	-3.00
San Diego—Salton Sea two-way	San Diego to tunnel	1,600	22.01	9.25
	Tunnel	450	0.05	0.00
	Tunnel to Salton Sea	780	2.93	6.65
	Total	2,830	24.99	15.90
Salton Sea to Oceanside	Salton Sea to tunnel	400	2.10	31.14
	Tunnel	500	0.06	0.00
	Tunnel to Oceanside	240	0.87	-15.70
	Total	1,140	3.03	15.44
Yuma to Alamo River		73	0.70	-2.30
EES Phase II				
Bombay Beach (100,000 ac-ft/yr)	EES modules	132	5.60	2.00
	Move power lines	8		
	Salt disposal	64	0.22	0.00
	Total	204	5.82	2.00
Salton Sea Test Base (150,000 ac-ft/yr)	EES modules	198	8.41	3.00
	Salt disposal	258	0.90	0.00
	Total	456	9.31	3.00

Appraisal Level Estimates

Conveyance system	Item	Construction cost estimate ($M)	OM&R ($M/yr)	Cost energy ($M/yr)
OR				
Salton Sea Test Base (150,000 ac-ft/yr)	EES modules	198	8.41	3.00
(In-Sea disposal pond constructed elsewhere)	Salt disposal	169	0.56	0.00
	Total	367	8.97	3.00
	Total	660	15.14	5.00
(In-Sea disposal pond constructed elsewhere)	Total	571	14.79	5.00
EES Phase II				
Bombay Beach (150,000 ac-ft/yr)	EES modules	198	8.41	3.00
	Salt disposal	99	0.35	0.00
Salton Sea Test Base (100,000 ac-ft/yr)	EES modules	132	5.60	2.00
	Salt disposal	181	0.63	0.00
	Total	313	6.23	2.00
	Total	610	14.99	5.00
Salton Sea to Palen Lake				
Salton Sea to Palen Lake (w/o EES) (250,000 ac-ft/yr)	Waterways	500	2.70	19.00
	Palen Lake Dike	300	0.55	0.00
	Total	800	3.23	19.00
Salton Sea to Palen Lake (w/EES) (250,000 ac-ft/yr)	Waterways	190	1.47	12.00
	Palen Lake Dike	67	0.12	0.00
	EES (Modules Only)	330	14.01	5.00
	Move power lines	8	0.00	0.00
	Total	595	15.60	17.00