RECLAMATION

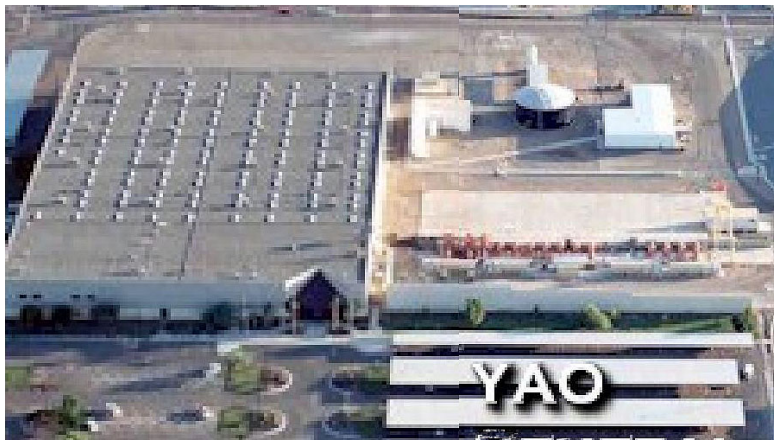
*Managing Water in the West*

## Yuma Desalting Plant

# Readiness Assessment Update

**U.S. Department of the Interior**
**Bureau of Reclamation**
**Yuma Area Office**
**Yuma, Arizona**

**April 2004**

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# Readiness Assessment Update

**April 2004**

***Discussion Draft***
*This draft is intended only for discussion purposes*

*Contact:*
*Charles Haddon*
*770-993-8778*

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Section 1

# EXECUTIVE SUMMARY

# Summary of Key Findings



- **The initial YDP Readiness Assessment was conducted in 2002. Periodic re-examination and updates are prudent because changes occur at the plant over time.**

- **Operational readiness has improved. Focus during the last two years has concentrated on improving overall plant condition, eliminating design deficiencies, and starting the process to resolve environmental compliance issues related to plant operation.**

- **Progress since 2002 is consistent with the current management approach to the plant:**
  - **Improve operational readiness of YDP.**
  - **Allow sustainable funding for pursuit of plant alternatives and other Title I programs.**
  - **Stay within current funding levels until YDP environmental issues are more clearly defined.**

- **YDP remains costly to operate. Estimated costs for start-up and operation have not changed substantially since the original assessment:**
  - **Updated cost estimates reflect a capital requirement of $94 to $108 million over 5 years to reach and sustain full operating capacity.**
  - **$26.9 million in one time start up costs, including the resolution of design deficiencies, completion of the environmental compliance process, purchase of new membranes and completion of plant equipment start-up procedures.**
  - **$23.6 to $28.8 annually to operate and maintain the plant once full capacity operations is reached.**
  - **Per acre-foot production costs range between $307 and $482 at full operating capacity.**

- **Time required to operate the plant at 1/3 capacity or reach full operating capacity has not changed from earlier estimates.**
  - **While tangible progress has been made in improving the readiness of the YDP, completing environmental compliance activities, securing start-up funding, and effecting major contracts (e.g. power, O&M) will still require significant lead time.**
  - **The estimated timeframe needed to complete start-up for 1/3 capacity operations remains at least 24 months. Reaching full capacity operations could require as much as 48 months.**

Section 2

# PLANT READINESS ACTIVITIES AND ISSUES

# Scope of the Assessment Update



- **This analysis was designed to provide an updated view of what is required to startup and operate the Yuma Desalting Plant (YDP). It is an update of a comprehensive assessment conducted in 2002.**
  - **This report is not a stand alone document. A comprehensive perspective of the YDP requires use of both this report and the 2002 Readiness Assessment. This report assumes such perspective.**
  - **The 2002 YDP Readiness Assessment is available on request from the Yuma Area Office of the Bureau of Reclamation.**

- **This update was conducted because changes associated with the plant have occurred in the past 18 months. These changes are contained in Section 2 of this report entitled "Plant Readiness Activities and Issues".**

- **The objectives of this updated analysis were to:**
  - **Update the understanding of expected costs for all operating and non-operating modes of the plant.**
  - **Provide current costs on a delivered price basis for product water - cost per acre-foot.**
  - **Update estimated schedules associated with making the plant operationally ready and bringing it to various levels of operating capacity.**

- **Issues that were not within scope of this analysis, included:**
  - **When or if the plant will operate in the future.**
  - **Alternatives to the YDP.**
  - **Consideration of impacts of plant outputs on water obligations.**

# Assessment Update Approach



- **The update analysis began in January, 2004 and was concluded in April of the same year. Personnel conducting the update were identical to those that performed the 2002 Assessment.**

- **An initial review of the 2002 Assessment and YDP cost model identified key subject areas to ascertain progress or other changes. These included, but were not limited to:**
  - **Design Deficiencies**
  - **On going plant maintenance program**
  - **Environmental compliance**

- **A review of plant related documents and issues since the initial assessment resulted in the identification of the additional areas of focus such as the Plant Retrofitting and Upgrade Study.**

- **The core of the update analysis focused on:**
  - **Confirming the progress of work since 2002.**
  - **Validating assumptions, estimated costs and projected schedules for planned work .**
  - **Identifying and understanding issues at or associated with the plant.**

- **The 2002 Assessment included the development of a comprehensive PC based cost model for the YDP. This analysis did not result in the need for structural changes to the model. Data in the model was updated to reflect the best data currently available.**

# Design Deficiency Status and Outlook



- **By October 2002, seventeen design deficiencies associated with the YDP had been identified. Since the, resolution work has been conducted on fourteen deficiencies resulting in completion or resolution of five (see page 8). Design deficiency resolution work since 2002 has focused on three goals:**
  - **Developing solutions for deficiencies where solutions were unknown (e.g. ammonia system).**
  - **Creating designs and specifications for known fixes (e.g. upgrade plant air system).**
  - **Completing field work where possible (e.g. control block isolation valves and actuators).**
  - **Some field work has not been initiated because the results of the Plant Retrofitting and Upgrade Study may change solutions previously designed for selected deficiencies (see Section 3 of this report).**

- **While the total estimated costs associated with all remaining design deficiencies has decreased from $14.8 million to $14.1 million, the estimates for two deficiencies have increased significantly.**
  - **As deficiency resolution work moves through the project life cycle from scoping and preliminary estimating to design and specification, estimated completion costs are expected to fluctuate.**
  - **Since 2002 estimated resolution costs for six remaining deficiencies have increased and the costs of three others have decreased; three estimates remain materially unchanged.**
  - **Remaining deficiencies with substantially increased resolution estimates include :**
    - **Construct third sludge disposal stage: Additional environmental requirements such as double liners will likely be required for new disposal cells. These requirements were not included in the 2002 estimate.**
    - **Access and repair coating on SCR1: Detailed examination of the SCR in 2003 revealed a complete recoating is required.**

# Known Design Deficiencies

| Deficiency defined in 2002 Assessment | Expended since 2002 Assessment | Est Total Remaining to Resolve | 1/3 Capacity | 2/3 Capacity | Full Capacity | Comments |
|---|---|---|---|---|---|---|
| Replace high pressure RO pumps | - | 4,760,000 | 1,725,000 | 1,500,000 | 1,535,000 | |
| Construct third sludge disposal stage | 6,811 | 4,170,000 | | | 4,170,000 | $1.3M increase: new environmental requirements |
| Replace control block valves and actuators | 109,042 | 1,660,000 | 1,660,000 | | | |
| Repair plant ammonia system | 52,096 | 630,000 | | 630,000 | | $ 430K decrease: developed solution less costly |
| Replace failed segment of ERU reject piping | 84,386 | 670,000 | 670,000 | | | |
| Replace plant SDI equipment | - | 250,000 | | 250,000 | | |
| Replace SDI equipment in WQIC | 8,515 | 270,000 | | 270,000 | | |
| Install MODE II blend system | 50,296 | 220,000 | 220,000 | | | |
| Replace RO discharge valves and actuators | 7,811 | 200,000 | 120,000 | 80,000 | | |
| Upgrade plant air system | 45,441 | 220,000 | 220,000 | | | |
| Install chlorine containment system | - | 250,000 | 250,000 | | | |
| Access and repair coating on SCR1 | 8,908 | 390,000 | | | 390,000 | $ 300K increase: complete recoat required |
| | **$ 373,306** | **$13,690,000** | **$ 4,865,000** | **$ 2,730,000** | **$ 6,095,000** | |

| Deficiencies Resolved | Expended to Resolve | Comments |
|---|---|---|
| **Clearwell pH control system** | 50,091 | Technical study determined system is adequate however, tighter operating parameters are required and Al-Br piping requires closer examination |
| **Install electrochlorination system** | 32,620 | Technical study determined electrochlorination is not presently cost feasible for the production plant. |
| **Plant paving** | 423,217 | Paving completed. |
| **Element storage biocide replacement** | 11,052 | Analysis of elements has concluded biocide replacement is not recommended. |
| **Tecan diluter** | 52,096 | Diluter installation completed. |
| | **$ 569,076** | |

| New Deficiencies | Est Total to Resolve | 1/3 Capacity | 2/3 Capacity | Full Capacity |
|---|---|---|---|---|
| **Upgrade plant chlorination system** | 400,000 | | | 400,000 |

# Design Deficiency Status and Outlook



- **A new design deficiency has been identified, since the original assessment. The plant chlorination system requires an upgrade in order for the plant to operate at full capacity during peak seasonal temperature extremes.**
  - **This deficiency was identified during technical analysis focused on determining the feasibility of electrochlorination (on-site chlorine generation).**
  - **A preliminary estimate for upgrading the plant chlorination system is $400,000.**

- **The YDP ran for approximately six months at just 1/3 capacity before its shutdown in 1993. At that time engineers were still engaged in identifying and resolving design deficiencies. Continued focus on increasing the plant's operational readiness may result in the identification of additional design deficiencies.**

# Plant Maintenance Program



- **The YDP plant maintenance program has improved since the original Readiness Assessment.**
  - **Additional preventative maintenance work orders (PMs) are being performed. If required repairs result, these are scheduled and either performed immediately or placed in a prioritized backlog.**
  - **This backlog totaled over 6,000 maintenance hours in mid 2002. Since then it was decreased to as low as 2,800 hours. Presently the maintenance backlog for the production plant is approximately 3,500 hours.**
  - **Visual inspection confirms an overall increase in the general condition of the production plant.**

- **Spending on plant readiness has increased.**
  - **During fiscal year 2001 approximately $1,457,000 was expended in order to maintain the dormant production plant. Such maintenance primarily consisted of executing PMs or repair activities designed to ensure the plant's condition did not deteriorate.**
  - **During fiscal year 2002 plant readiness expenditures totaled about $2,085,657 – an increase of 43%. During fiscal year 2003 such expenditures totaled approximately $2,955,346 – double the 2001 expenditure level. These increases were driven by more numerous and broader work orders (both preventative and repair) as well stepped up planning and the implementation of more quality assurance and control activities.**

- **More effective planning and focus has been implemented.**
  - **A long term Resource Plan, a local activity based planning, accounting and management program has significantly increased management's ability to allocate and account for resources focused on the plant or other Area Office responsibilities.**

# Plant Maintenance Program



- **On site plant surveillance and monitoring activities have increased and continue to be improved.**
  - **In 2002, plant quality assurance and control activities were limited to part-time responsibilities spread among multiple personnel who had little inspection experience. Since then, professional inspectors have been utilized to oversee preventative and corrective maintenance activities on the plant.**
  - **In addition, the Yuma Area Office is in the process of implementing a comprehensive and formal QA/QC program specifically for the production plant and Water Quality Improvement Center. The program is closely aligned with those in use at other process plants and will add another 2000 hours of plant condition monitoring resource.**

- **Presently many hands-on work activities for the YDP are performed by a single contractor. That contract includes supporting other activities within the Area Office such as water treatment research and miscellaneous facilities support.**
  - **During 2003 Reclamation issued new solicitations that separated the scope of the current contract into five separate contracts to address issues such as:**
    - **Eliminate the historic dilution of efforts and results amongst varied activities in the contract, a key contributor to pre 2002 declines in plant readiness.**
    - **Enhance visibility and accountability for major activities on site such as plant readiness and water treatment research.**
    - **And, most importantly to create additional flexibility to redistribute contract resources to more rapidly respond to changes in Government needs.**
  - **The multi contract solicitations were halted in late 2003 as a result of successful protests from the incumbent contractor.**

# Future Investment Requirements



- **The YDP will also require future investments, in addition to the resolution of design deficiencies. While some ongoing reinvestment for repair and replacement of equipment that wears out as the plant ages is anticipated by the cost model, there are two currently identified issues that may require significant early investment:**

  - **A22 Pipeline Cathodic Protection**
    - **A 22 mile underground pipeline conveys water treatment sludge from the YDP to 67 lined surface ponds for storage, evaporation and disposal. The sludge is primarily composed of calcium carbonate.**
    - **This pipeline has been in continuous service since the 1980's. Routine examination and maintenance disclosed some of the pipeline's cathodic protection has failed.**
    - **Subsequent testing and analysis indicate the replacement of multiple anode ground beds and test stations is required. The preliminary repair estimate is approximately $440,000 of which about $30,000 has already been expended.**

  - **Aluminum Bronze Piping**
    - **Aluminum bronze (Al-Br) pipes, pumps, and valves are installed extensively throughout the YDP. During plant operations in May 1992 through January 1993 an atypical number of failures of these components occurred. Analysis and experimentation since 2000 have confirmed the plant's design operating pH is corrosive to aluminum bronze.**
    - **Four existing design deficiencies are directly associated with Al-Br. Resolutions to these deficiencies have been developed and address all Al-Br pumps and values, but only a small portion of the plant's Al-Br piping (the ERU reject piping).**
    - **The majority of plant's Al-Br piping is not presently characterized a design deficiency. When the analysis of options associated with this piping is completed this characterization may change.**

# Environmental Compliance



- **The two major environmental issues associated potential YDP operations are National Environmental Policy Act (NEPA) compliance and National Pollutant Discharge Elimination System (NPDES) permitting.**

- **Any action that Reclamation takes to address salinity and water flows will need to be in compliance with NEPA. The original Environmental Impact Statement (EIS) for the Colorado River Basin Control Act, Title I was completed in 1975.**
  - **This EIS was prepared in the infancy of NEPA compliance. Requirements have changed and case law is now available.**
  - **Since 1975 there have been substantial changes to some social and environmental conditions including the expansion of the Cienega wetlands resulting from bypass flows.**
  - **Other options besides operating the YDP have been proposed to meet salinity and delivery requirements.**

- **Reclamation recognizes successful NEPA compliance requires sound definition of:**
  - **Project purpose and scope**
  - **Types and ranges of alternatives**
  - **Other issues (e.g. applicability of Endangered Species Act)**

- **Recently Reclamation completed a preliminary draft of a "bounding analysis" defining and discussing these requirements with respect to potential plant operations. Further internal revision and decision making are expected to conclude in 2004.**

# Environmental Compliance



- **If the YDP operates, additional NPDES permitting is required.**
  - **In 1999, Reclamation filed for such a permit with United States Environmental Protection Agency (EPA). In 2003, EPA transferred primacy to write and enforce NPDES permits to Arizona, specifically to the Arizona Department of Environmental Quality (ADEQ).**

- **Recent developments have further delayed receipt of an NPDES permit.**
  - **In late December 2003 the ADEQ informed Reclamation that ADEQ's consultation with the Arizona Attorney General's office about YDP permit application had raised legal and regulatory concerns.**
  - **Concerns center on exemptions in the Clean Water Act for return flows from irrigated agriculture and the validity of applying such exemptions to water from ground water wells used by Reclamation and irrigations districts throughout Arizona.**

- **While these concerns have broad implications for Reclamation and Arizona irrigation districts, potential impacts at YDP would include additional monitoring of plant product water after it is blended with bypass channel water, but before discharge to the Colorado River.**

- **Reclamation anticipates receipt of the NPDES permit in 2004, though its requirements are uncertain as are the operational implications of those requirements.**

Section 3

# RESEARCH AND DEVELOPMENT

- **At the time of its construction, the YDP was a state-of-the art facility. Its design is based on scaling up technologies that to this day have not been demonstrated on the full production scale of the YDP.**
  - **The world's operating largest reverse osmosis (RO) plant is in Hail, Saudi Arabia. It began operating in 1996 and has a capacity of approximately 29% of the YDP. The largest operating RO plant is the U.S. in Tampa Bay, Florida is presently operating at 21% of the YDP's capacity.**
  - **Nevertheless, membrane technology and other aspects reverse osmosis desalination have evolved in the past twenty years.**

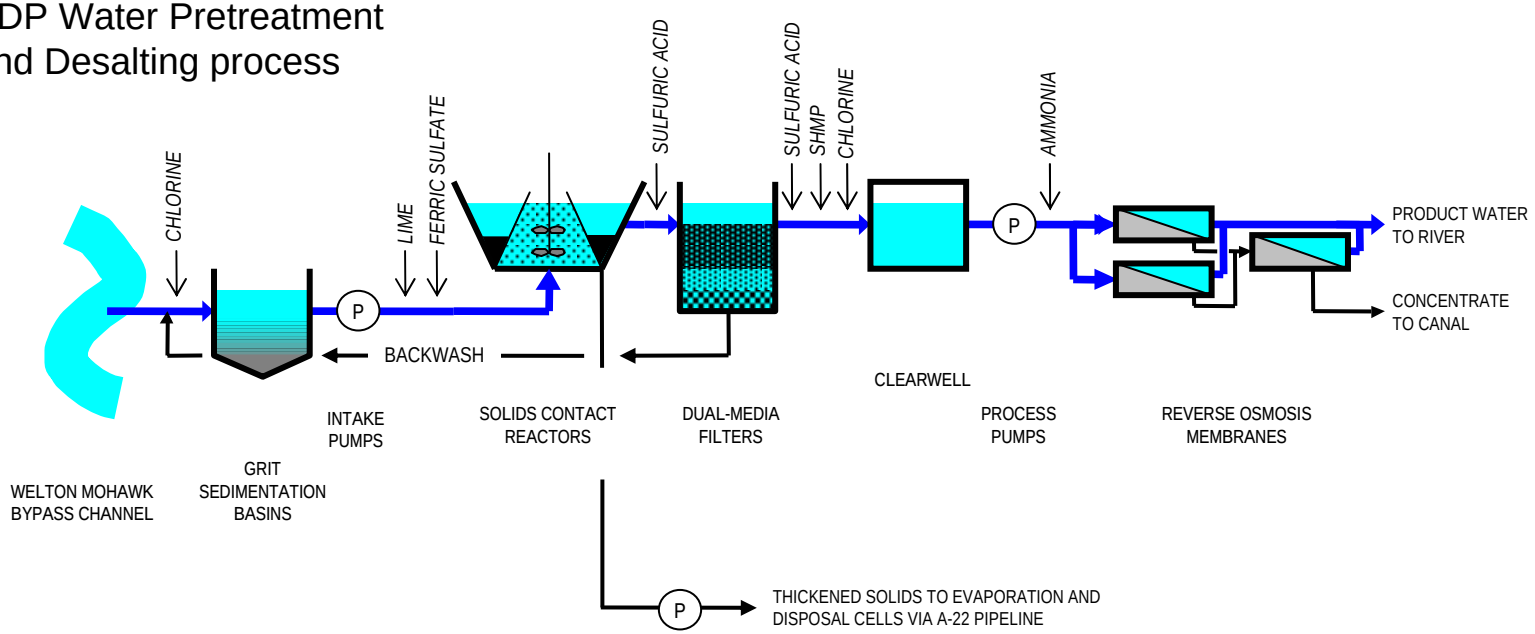
- **Each desalination plant is one-of-a-kind. Whether a plant utilizes reverse osmosis like the YDP or flash distillation like most plants in the middle east where power is inexpensive, each plant is uniquely designed for its feed water.**
  - **The YDP was designed to treat water from the Welton Mohawk valley. 25 miles of open conveyance to the YDP results in the delivery of exceptionally poor quality feed water laden with biologic growth and silt.**
  - **As a result, when compared to many other reverse osmosis plants, the YDP has an atypically large amount of plant infrastructure and operating costs associated with the pretreatment of water before it enters the reverse osmosis process (see page 17) .**

- **Reclamation's YDP Retrofitting and Upgrade Study is focusing on both advances in water pretreatment and reverse osmosis desalination.**
  - **The study is analyzing 20 different configurations of new technology, including micro and ultra filtration, low pressure operations, advanced membranes, and alternative chemicals.**
  - **Participants in the study include world-class desalination experts.**

# Plant Retrofitting and Upgrade Study



YDP Water Pretreatment and Desalting process




Pretreatment

***48 % of operating and maintenance costs***

Reverse Osmosis

***52 % of O&M costs***

**Sample retrofitting technologies under Study**

**Microfiltration**
**Ultrafiltration**
**Slow sand filtration**

**Low pressure operations**
**Alternative membranes**
**Modified product recovery**

# Plant Retrofitting and Upgrade Study



- **The study consists of two phases:**
  - **Modeling, technical analysis and short term bench scale testing.**
  - **Pilot scale testing.**

- **Phase I, modeling and technical analysis, has been progress for over a year.**
  - **The goal of Phase I is to identify a short-list of configurations which are promising.**
  - **Based on modeling and bench testing, configurations will be identified that create acceptable quality product water and are less costly to operate and maintain than the YDP's current configuration.**

- **In Phase II, short-listed configurations would then undergo longer-term pilot scale testing at the Water Quality Improvement Center.**

- **If the Plant Retrofitting and Upgrade Study can determine a less costly YDP configuration that could be implemented through retrofit, the current plans associated with some design deficiencies would likely require modification.**
  - **For example, the single most expensive design deficiency is the replacement of high pressure reverse osmosis pumps (about $4.8 million). If low pressure operations proves viable, less expensive low pressure pumps could be used.**
  - **However, like the high pressure pumps the low pressure alternatives will still require custom design and fabrication. Low pressure operations would also significantly reduce aluminum-bronze piping corrosion issues.**

- **Early study results are mixed and inconclusive.**
  - **Modeling has demonstrated that some technology configurations may significantly reduce plant operating costs. However, in early bench scale testing these configurations have not worked successfully with bypass channel water.**
  - **Since this is research and development, speculation should be avoided about which alternatives, if any, will prove effective at pre-treating and desalinating bypass channel water and do so at a lower cost than the YDP's present configuration.**
  - **The reference above to low pressure operations is only intended to demonstrate the connection between some design deficiencies and the Retrofitting and Upgrade Study that is in progress.**

Section 4

# UPDATED COSTS AND SCHEDULE ESTIMATES

# Structure of the YDP Plant Cost Model



- **During the 2002 YDP Readiness Assessment a PC based model was developed to tie together detailed estimates for all plant start-up and operating requirements (e.g. power, chemicals, membranes, Bureau staffing, contracts, design deficiencies, etc).**
  - **The model was designed to be updated, over time, as underlying costs change and estimates improve.**
  - **All assumptions and data sources underlying estimates are documented within the model.**

- **Structure of the model**
  - **Costs are estimated for each plant operating state:**
    - **1/3 operation**
    - **2/3 operation**
    - **Full operation**
  - **Costs for each operating state are broken down into two categories:**
    - **Annual recurring costs for ongoing operation, maintenance, and investment costs for that operating state.**
    - **One-time transition costs for moving from the previous operating state to the new operating state**

- **A least cost estimate and highest cost estimate were created because of uncertainties in estimating key component costs including power, process recovery efficiency, on stream factor and the amortization period for start-up costs.**
  - **Key assumptions and summary costs are shown on the next two pages for each of these YDP Plant Cost Model runs.**

# Least Cost Estimate: *2004 Assessment Update*
# Transition and Operating Cost Summary

HJA CONSULTING
Haddon Jackson Associates, Inc.

*YDP Readiness Assessment Update*

**Assumptions:**

| | | On Stream Factor | |
|---|---|---|---|
| Power Cost (per MWH) | $ 32 | 1/3 capacity | 100% |
| Process Recovery Factor | 85% | 2/3 capacity | 95% |
| Years to Amortize Startup Costs | 10 | 3/3 capacity | 80% |

| | *1/3 Capacity* | *2/3 Capacity* | *3/3 Capacity* |
|---|---|---|---|
| ***Annual Recurring Costs*** | | | |
| Labor (Bureau staff & contract) | 4,307,732 | 4,879,846 | 5,134,751 |
| Equipment Replacement | 2,251,620 | 2,376,710 | 2,501,800 |
| Membrane Replacement | 1,002,750 | 2,138,750 | 3,047,550 |
| Power | 2,290,135 | 4,170,598 | 5,000,985 |
| Chemicals | 3,043,977 | 6,229,769 | 7,867,088 |
| | **12,896,214** | **19,795,673** | **23,552,174** |
| Product Water (acre feet) | 29,125 | 59,702 | 75,418 |
| Cost per acre foot | 443 | 332 | 312 |
| ***One Time Transition Costs*** | | | |
| Design Deficiencies (in process, new, resolved) | 5,807,382 | 8,537,382 | 15,032,382 |
| Plant start-up | 1,162,852 | 1,678,078 | 2,194,617 |
| Membranes | 3,008,250 | 6,416,250 | 9,142,650 |
| | 9,978,484 | 16,631,710 | 26,369,649 |
| Annual Amortized Cost (10 years) | **997,848** | **1,663,171** | **2,636,965** |
| Product Water (acre feet) | 29,125 | 59,702 | 75,418 |
| Cost per acre foot | 34 | 28 | 35 |
| ***Total Annualized Cost*** | **13,894,062** | **21,458,844** | **26,189,139** |
| Product Water (acre feet) | 29,125 | 59,702 | 75,418 |
| Cost per acre foot | **477** | **359** | **347** |

# Highest Cost Estimate: *2004 Assessment Update*
# Transition and Operating Cost Summary

HJA CONSULTING
Haddon Jackson Associates, Inc.

*YDP Readiness Assessment Update*

**Assumptions:**

| | | On Stream Factor | |
|---|---|---|---|
| Power Cost (per MWH) | $ 64 | 1/3 capacity | 95% |
| Process Recovery Factor | 73% | 2/3 capacity | 90% |
| Years to Amortize Startup Costs | 5 | 3/3 capacity | 75% |

| | *1/3 Capacity* | *2/3 Capacity* | *3/3 Capacity* |
|---|---|---|---|
| ***Annual Recurring Costs*** | | | |
| Labor (Bureau staff & contract) | 4,307,732 | 4,879,846 | 5,134,751 |
| Equipment Replacement | 4,503,240 | 4,753,420 | 5,003,600 |
| Membrane Replacement | 1,002,750 | 2,138,750 | 3,047,550 |
| Power | 4,236,679 | 7,788,375 | 9,265,908 |
| Chemicals | 2,485,270 | 5,070,443 | 6,336,007 |
| | **16,535,671** | **24,630,834** | **28,787,816** |
| Product Water (acre feet) | 23,762 | 48,575 | 60,722 |
| Cost per acre foot | 696 | 507 | 474 |
| ***One Time Transition Costs*** | | | |
| Design Deficiencies (in process, new, resolved) | 5,807,382 | 8,537,382 | 15,032,382 |
| Plant start-up | 1,162,852 | 1,678,078 | 2,194,617 |
| Membranes | 3,008,250 | 6,416,250 | 9,142,650 |
| | 9,978,484 | 16,631,710 | 26,369,649 |
| Annual Amortized Cost (5 years) | **1,995,697** | **3,326,342** | **5,273,930** |
| Product Water (acre feet) | 23,762 | 48,575 | 60,722 |
| Cost per acre foot | 84 | 68 | 87 |
| ***Total Annualized Cost*** | **18,531,368** | **27,957,176** | **34,061,746** |
| Product Water (acre feet) | 23,762 | 48,575 | 60,722 |
| Cost per acre foot | **780** | **576** | **561** |

# Range of Yuma Desalting Plant Costs



## Least Cost Estimate

| ASSUMPTIONS | 1/3 Capacity | 2/3 Capacity | 3/3 Capacity |
|---|---|---|---|
| Power Cost (per MWH) | $ 32 | $ 32 | $ 32 |
| Process Recovery Factor | 85% | 85% | 85% |
| Years to Amortize Startup Costs | 10 | 10 | 10 |
| On Stream Factor | 100% | 95% | 80% |
| Annual Recurring Cost | $ 12,896,214 | $ 19,795,673 | $ 23,552,174 |
| Amortized One Time Transition Cost | $ 997,848 | $ 1,663,171 | $ 2,636,965 |
| Total Annualized Cost | $ 13,894,062 | $ 21,458,844 | $ 26,189,139 |
| **Product Water (acre-feet)** | **29,125** | **59,702** | **75,418** |
| **Cost per acre foot** | **$ 477** | **$ 359** | **$ 347** |
| **Estimated Reduction On River Salinity (ppm)** | **10** | **23** | **28** |
| Blend Water (acre-feet) | 3,333 | 6,667 | 10,000 |
| Total of Product and Blended Water (acre-feet) | 32,458 | 66,369 | 85,418 |
| Cost per acre foot | $ 428 | $ 323 | $ 307 |
| Estimated Reduction On River Salinity (ppm) | 7 | 12 | 13 |

## Highest Cost Estimate

| ASSUMPTIONS | 1/3 Capacity | 2/3 Capacity | 3/3 Capacity |
|---|---|---|---|
| Power Cost (per MWH) | $ 64 | $ 64 | $ 64 |
| Process Recovery Factor | 73% | 73% | 73% |
| Years to Amortize Startup Costs | 5 | 5 | 5 |
| On Stream Factor | 95% | 90% | 75% |
| Annual Recurring Cost | $ 16,535,671 | $ 24,630,834 | $ 28,787,816 |
| Amortized One Time Transition Cost | $ 1,995,697 | $ 3,326,342 | $ 5,273,930 |
| Total Annualized Cost | $ 18,531,368 | $ 27,957,176 | $ 34,061,746 |
| **Product Water (acre-feet)** | **23,762** | **48,575** | **60,722** |
| **Cost per acre foot** | **$ 780** | **$ 576** | **$ 561** |
| **Estimated Reduction On River Salinity (ppm)** | **5** | **11** | **14** |
| Blend Water (acre-feet) | 3,333 | 6,667 | 10,000 |
| Total of Product and Blended Water (acre-feet) | 27,095 | 55,242 | 70,722 |
| Cost per acre foot | $ 684 | $ 506 | $ 482 |
| Estimated Reduction On River Salinity (ppm) | 1 | 1 | 0 |

# Changes in Estimated Costs Since Last Assessment



- **The total estimated annualized cost of YDP product water has not changed significantly since the 2002 Readiness Assessment.**
  - **Presently, the estimated cost for water from the YDP ranges between $307 per acre-foot and $780 per acre foot. This range is determined by the actual market cost of power, variability in the efficiency of the membranes, reliability of the plant, and the level of capacity at which it is operated.**
  - **This range was $305 to $786 per acre-foot in 2002.**

- **Most of the cost elements for operating the YDP have not significantly changed. Those that did change are Bureau labor, contract labor and design deficiencies.**
  - **Labor: Updated costs reflect about a 6% increase in the cost of government and contract labor since 2002.**
  - **Design Deficiencies: The total estimated cost to resolve remaining deficiencies has decreased 7.3%.**

- **The net result of these changes, on a per acre-foot of product water basis is different for the least and highest cost estimates. This is a result of different amounts of water produced by the YDP in the least and highest cost estimates.**
  - **For example, in both the least and highest cost estimates design deficiency resolution costs to bring the plant to one-third capacity operations total $5,807,382. This results in a $4 per acre-foot reduction in transition costs since 2002 for the least cost estimate at one-third capacity operation. This results in a $8 per acre-foot reduction in transition costs for the highest cost estimate.**
  - **The highest cost estimate assumes about 20% less water is produced by the plant as a result of a lower Process Recovery Factor and lower On Stream Factors. Hence cost increases or decreases always have a greater impact on the highest cost estimate, on a product water per acre-foot basis.**

# Estimating Plant Startup Timeframes



- **Timeframe estimates, while activity based, ultimately boil down to allowing time for taking risk into account. Known risks and unknown risks described in the 2002 Readiness Assessment were taken into account in reviewing timeframe estimates.**

- **Given the list of design deficiencies that remain and required permitting and contract activities, the transition time required to make the plant ready for start-up remains significant.**

- **Start-up estimates developed during our analysis anticipate that operational preparations would require 7 months…provided that first:**
  - **Funds are available.**
  - **Procurements for materials and contractor labor could be completed.**
  - **Design deficiencies are resolved.**
  - **New or updated permits are acquired.**
  - **Power and other major contracts are in place.**

- **Given our risk assessment, we estimate the timeframe needed to complete all transition activities remains at least 24 months to begin operating the first 1/3 of the plant.**

- **While tangible progress has been made in improving the readiness of the YDP this has not significantly impacted uncertainty associated with completing environmental compliance activities, securing start-up funding, or effecting major contracts (e.g. power, O&M).**

# Cash Flow Requirements for Plant Start-up and Operation



| Fiscal Year | FY 1 | FY 2 | FY 3 | FY 4 | FY 5 |
|---|---|---|---|---|---|
| ***$ in millions*** | | | **1/3 capacity** | **2/3 capacity** | **Full capacity** |
| *Plant Readiness* | $ 4.4 | $ 3.5 | $ 2.7 | | |
| *Environmental Process/Permitting* | $ 0.7 | $ 0.9 | | | |
| *Environmental Mitigation/Litigation* | unknown | unknown | unknown | unknown | unknown |
| *Design Deficiencies* | $ 2.4 | $ 2.4 | $ 2.7 | $ 6.6 | |
| *Start-up Activities* | $ 0.6 | $ 0.6 | $ 0.5 | $ 0.5 | |
| *Membranes* | | $ 3.0 | $ 3.0 | $ 3.0 | |
| *Plant Operations & Maintenance* | | | $ 12.9 to $ 16.5 | $ 19.8 to $ 24.6 | $ 23.6 to $ 28.8 |

| ***Total capital requirement by year*** | | | | | | ***Grand Total*** |
|---|---|---|---|---|---|---|
| ***Est. Minimum*** | $ 8.1 | $ 10.4 | $ 21.8 | $ 29.9 | $ 23.6 | **$ 93.8** |
| ***Est. Maximum*** | $ 8.1 | $ 10.4 | $ 25.4 | $ 34.7 | $ 28.8 | **$ 107.4** |