RECLAMATION

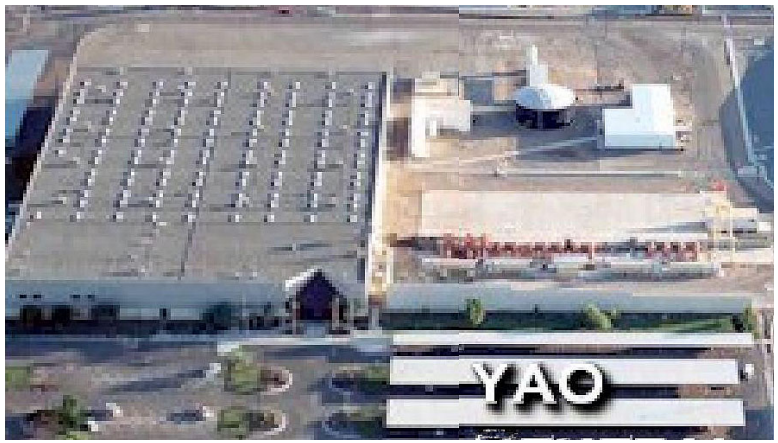
Managing Water in the West

Yuma Desalting Plant

Yuma Readiness Assessment

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

October 2002



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OVERVIEW OF THE ASSESSMENT

Assessment Scope and Approach

SCOPE OF THE STUDY

- **Our assessment was designed to give a complete and current view of what will be required to startup and operate the Yuma Desalting Plant (YDP).**

  The assessment objectives were to:

  - **Update our understanding of expected costs and underlying assumptions for all operating and non-operating modes of the plant.**
  - **Present costs on a delivered price basis for product water - cost per acre-foot.**
  - **Do the work in a way that allows us to update costs as conditions change in the future.**

- **There were several issues that were not within scope of our analysis, including:**

  - **We did not try to determine when or if the plant will operate in the future.**
  - **We did not consider other uses for the plant.**
  - **We did not consider impacts of plant outputs on water obligations.**

STUDY APPROACH

- **The study began in the Spring of 2002.**

- **In order to complete this assessment, we gathered data and information from every available resource, including:**
  - **Past studies**
  - **Bureau of Reclamation staff**
  - **YDP services contractor staff**

- **We also performed several new analyses for identifying and documenting costs and associated work requirements for the plant, including:**
  - **Development of a plant startup plan.**
  - **Development of the YDP Cost Model**
  - **Identification of activities and costs that would be required to resolve outstanding issues related to running the plant again.**

Summary of Key Findings

- As drought conditions persist throughout the west, there is growing concern among staff that the YDP may soon be called upon to operate, and that the plant can be started in time to satisfy expectations of constituents. At the time of the study, many of the activities and issues within the plant were focused things other than improving the preparedness of the plant to run.

- Restarting the plant will require a significant period of time and expenditures. Front-end requirements will cost approximately $26.1 million over a period of 3 to 4 years. Key requirements include:
  - Correcting design deficiencies
  - Purchasing membranes
  - Preparing the equipment to run again
  - Obtaining environmental permits

- Once the plant has been restarted, annually recurring costs for operations and maintenance are estimated to range between $23.5 million and $28.7 million for full plant operations.

- The estimated cost for water from the YDP ranges between $305 per acre-foot and $786 per acre foot, depending on:
  - The level the plant is operated at - 1/3, 2/3, or full capacity.
  - Whether plant product water is blended with MODE water.
  - Actual power costs.
  - Actual process recovery factor attained.
  - Actual on stream factors attained.
  - Number of years the plant actually runs (to amortize the one-time startup costs).

- The timeframe required to start the plant is estimated to be from 24 to 48 months, depending on:
  - The level the plant is operated at - 1/3, 2/3, or full capacity.
  - Timeframe required to obtain environmental permits.
  - Procurement lead times.
  - Funding lead times.
  - Actual time required to complete correction of design deficiencies.

Section 2

BACKGROUND AND CURRENT SITUATION

YDP Historical Perspective

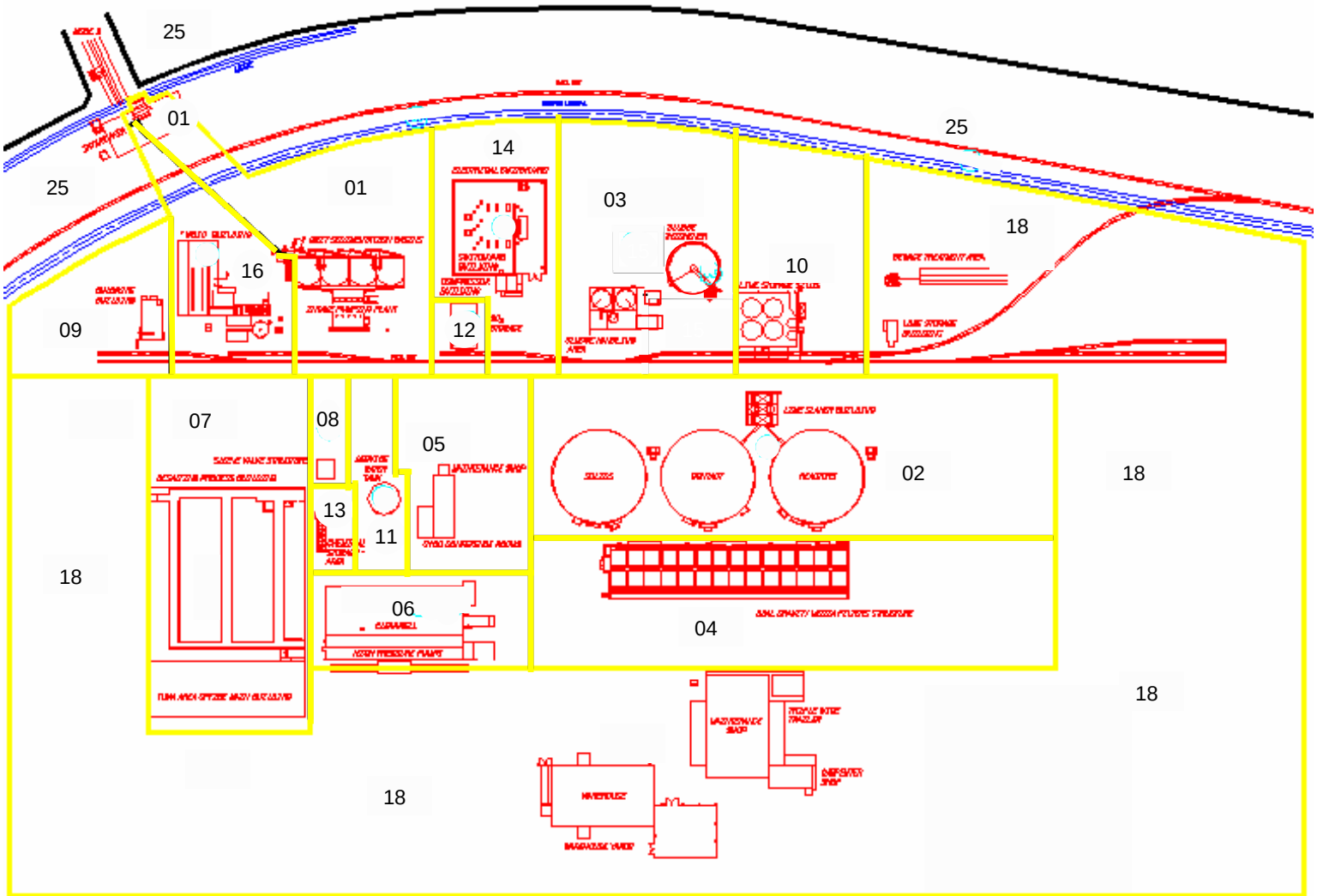
1944	Treaty of 1944 guarantees delivery of 1.5 million acre-feet of Colorado River water to Mexico (did not address water quality)
Nov 1961	Mexico files formal protest regarding water salinity
May 1965	IBWC Minute 218 authorizes MODE construction and use to bypass WMIDD irrigation drainage water to below Morelos dam
Aug 1972	Nixon creates Brownell task force and charges them to find a “permanent” solution
Aug 1973	IBWC Minute 242 defines acceptable salinity differential at the Northerly International Boundary
June 1974	Colorado River Basin Salinity Control Act authorizes actions to control salinity including construction of Desalting Plant
June 1977	Desalting Plant design started
April 1980	Plant construction ground breaking
Dec 1991	Plant shake down testing and operation begins
May 1992	Plant begins production operations at 1/3 capacity
Jan 1993	Plant stops operating as a result of damage from Gila River floods to intake canals and continuation of the “interim period”
Aug 1995	WQIC expansion begins
Jan 1997	WQIC/YAO designated as a National Center for Water Treatment Technologies
Dec 1999	WQIC expansion completed

Desalt Plant Configuration

- **The desalt plant occupies 40 acres and is divided into 17 distinct process areas.**
  - **Each process area corresponds to unique equipment and functions required during the desalting process.**
  - **The legend below describes each area.**
  - **The map on the next page shows the spatial layout of these areas.**

Number	Area	Number	Area
01	Intake & Grid Sedimentation	10	Lime & Ferric Handling
02	Solid Contact Reactors	11	Service Water
03	Sludge Handling & Disposal	12	Sulfuric Acid
04	Dual Media Filters	13	Membrane Cleaning
05	Ammonia	14	Switchyard
06	Clearwell & HP Pumping	16	WQIC
07	Piping & RO Membranes	18	Sewage & Buffer Areas
08	Energy Recovery	25	Canal & Discharge
09	Chlorine		

Plant Equipment Areas



Key Studies and Conclusions Since 1993

Plant in production operation: May-92 to Jan-93

Jan-93	**Report: Alternatives for Interim Period (Reclamation)**
	Examined alternatives and made recommendations for plant status during interim period
	Interim period will last a few more years Five core alternatives analyzed plus variants of each Recommend alternative: Operate at 1/3 capacity with option for non-federal funding for more capacity
	Shutdown & disassemble: restart in 6 years and $70 million for transition Stand-by: restart in 3 months (if membranes available/viable); no transition cost provided
May-93	**Report: Yuma Desalt Plant (CH2MHill)**
	Focused on recommendations for reducing plant costs in operating modes
	Fifty specific recommendations to reduce operating and maintenance costs by $5.8million/year Mothball status not cost effective if plant will be needed within 4 years Look for other uses for the plant if not required for more than 4 years
	Mothball: restart in 2-3 years and $29 million for transition Stand-by: no restart time frame or transition cost provided
Aug-93	**Letter: Reclamation Commissioner to Colorado River Basin Salinity Control Forum**
	Concern about federal expenditures levels Significant rationale exists for putting plant in ready reserve given current costs and likelihood of running
Apr-94	**Public Reviews of Title I and II Programs**
	Public comment on what should be done with the desalt plant Five possibilities offered: shut down, ready reserve, purchase alt. water, 1/3 operation, full scale operation Strong negative reaction to plant shut down General consensus that Reclamation should further explore near-term and long-term alternatives
Jan-96	**Briefing to Asst Secretary of the Interior (Reclamation study)**
	Reviewed alternatives to operating the desalt plant given a longer interim period
	Interim period expected to last for the foreseeable future Changes in institutional framework may provide opportunities for permanent alternatives to operating plant Four alternatives to running plant reviewed: ready reserve, lease, mothball, abandon Recommendation: maintain plant in ready reserve status
	Mothball: restart in 5 years (2 budget + 3 to start up) and no transition cost provided Ready reserve: restart in 1 year (after funding assumed) and no transition cost provided
Current	**Letter to Congress (Reclamation)**

- **Our review of prior studies of the plant indicated that considerable time has passed since a fresh look at costs had been completed.**
- **Most published estimates relied of work done during the first 3 years following plant shut down.**
- **Past studies did not consider all relevant cost and timing factors such as:**
  - **Operating modes**
  - **Transition costs**
  - **Cost savings from research**
- **The most recent comprehensive study is now 7 years old.**
  - **Plant equipment and membranes have aged 10 years since plant last operated.**
  - **Realistic lead times for funding, permitting, procurement, and operating staffing have never been identified.**

Current Status and Issues

- **As drought conditions persist throughout the west, there is growing concern among staff that the YDP may not be able to start in time to satisfy expectations of constituents.**

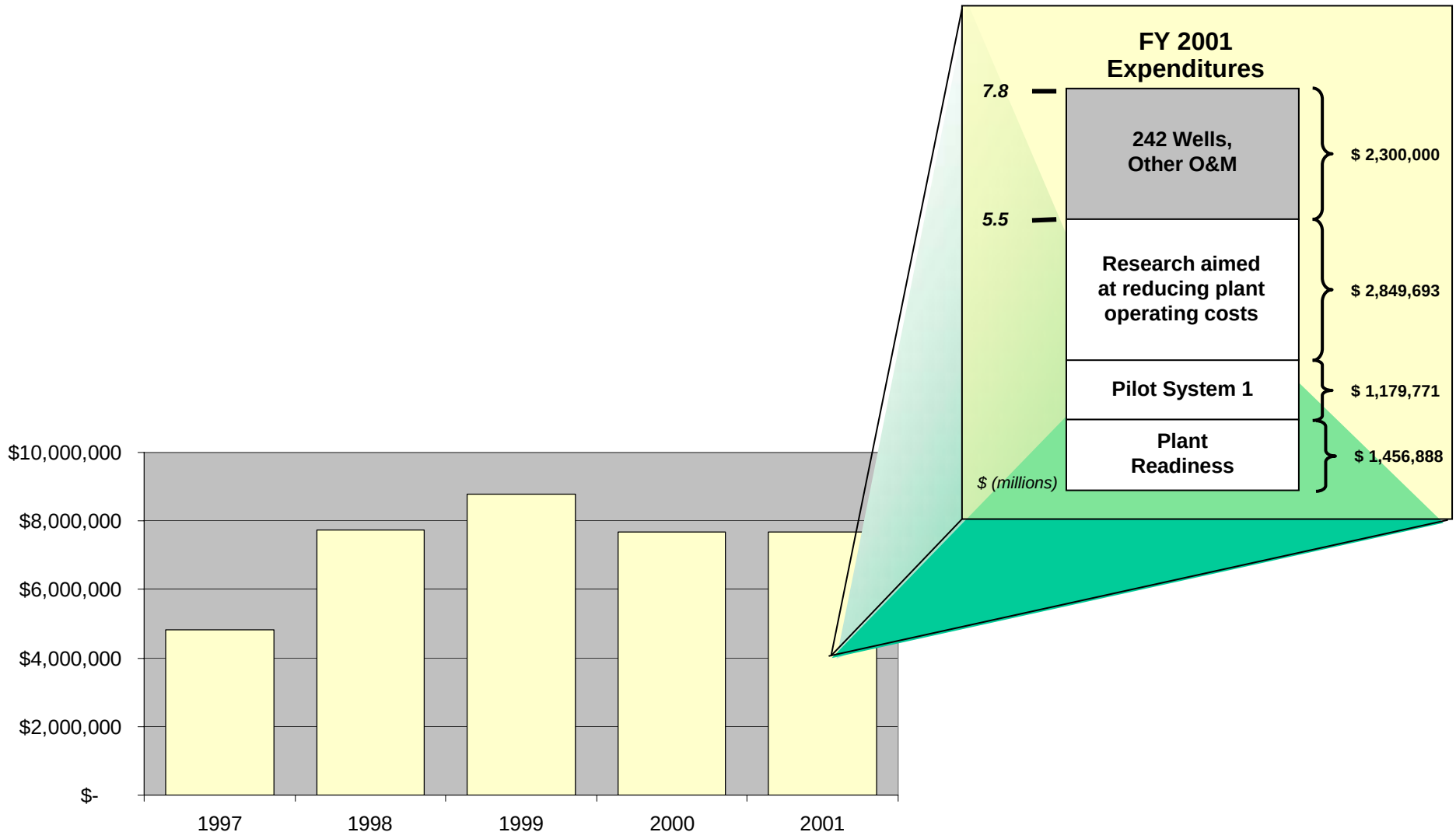
- **At the time of the study, many of the activities and issues within the plant were focused things other than improving the preparedness of the plant to run.**

  - **Due to funding limitations, correction of design deficiencies stopped during the 1996 / 1997 timeframe.**

  - **This year, the operation and maintenance services contractor began working under a new, fixed price contract. Prior to this time, the contract was a cost plus fixed fee contract. Change of contracting approach has caused some contract administration difficulties that are requiring significant amounts of attention to resolve.**

  - **Spending patterns have evolved to the point where the majority of the funds are being spent on activities other than maintaining plant readiness. The next page shows these trends.**
    - **Starting in 1996, correction of design deficiencies ceased and focus shifted toward research. Over time research has grown to nearly $3 million per year.**
      - **The focus of this research has been to develop processes and methods to reduce operating costs, when the plant resumes operations.**
      - **To date, there have been a number of tangible results from the research effort that will reduce future operating costs by more than $1.3 million per year, including: improvement of membrane recovery rates and life spans, reduction of chemical use, and extending membrane storage life.**
    - **Operation of Pilot System 1 requires approximately $1 million each year.**
    - **Currently spending for plant readiness activities is approximately $1.4 million annually.**

Historical Title I Expenditures



Section 3

YDP STARTUP & OPERATING ASSESSMENT

How we assessed YDP startup and operating requirements

- **While the plant has been kept in a "ready reserve" status since it was shut down in the January 1993, operating the plant again will not be a simple matter of "pushing the button" to start equipment. Restarting the plant will require a significant period of time and expenditures. For this reason we divided our cost and schedule analysis into two parts:**
  - **One-time activities and resources required to restart the plant. We call these one-time activities "Transition" requirements.**
  - **Recurring activities and resources required to operate and maintain the plant once it is running. We call these annually recurring activities "Operating" requirements.**

- **Since the plant is designed to be operated in thirds (i.e., 1/3 capacity, 2/3 capacity, or full capacity) our cost and schedule analysis is shown at this level of detail.**

- **Our analysis reflects a comprehensive review of past studies and documentation, extensive reviews and input with Reclamation staff and the current YDP services contractor, Burns and Roe Services Corp., and development of a well-documented production costing model that integrates current best estimates for costs. The following pages show the details of our assessment, including:**
  - **Transition requirements**
  - **Operating requirements**
  - **Integration of these requirements into the YDP cost model**
  - **Timeframe estimates**

A Transition Period will be required to achieve YDP startup

- **In the 1992 / 1993 timeframe, only 1/3 of the plant capacity operated at any one time. This was accomplished by using approximately 2/3 of the equipment in the plant at any single point in time.**
  - **Like many process-based manufacturing plants, many individual components and major sub-systems are designed with some levels of redundancy to allow continuous operation.**
  - **However, since the plant only operated at 1/3 capacity, some equipment was never operated, some redundancies were never addressed or were never completed prior to shutdown.**

- **At the time of its construction, YDP was a state-of-the art facility. It ran for a brief period of time and has never reached full operating capacity.**
  - **The design was based upon scaling up technologies that had never been fully demonstrated on a full production scale.**
  - **All systems throughout the plant were never fully broken in over a sustained period of time.**
  - **At the time of shutdown, in 1993, engineers were still engaged in identifying and resolving design deficiencies. This creates a level of uncertainty about whether additional design problems might be identified, once the plant runs again for some period of time.**

- **Even if there were no remaining design deficiencies, some time will be required to prepare plant components and systems for operation. The Transition requirements analysis also contains a detailed startup plan showing these activities.**

- **Significant lead times will also be required during the Transition Period to address support activities such as procurement and environmental permitting.**

Transition Requirements:
Resolving known design deficiencies

- **Correction of design deficiencies was halted around the 1996 / 1997 timeframe.**
  - **This timeframe coincided with discontinuing the use of construction funds.**
  - **By the 1996/1997 period, uncertainty arose over whether it was prudent to spend funds to continue to correct equipment deficiencies that were identified during the operating period, when it was not clear when the plant would be called upon again to operate.**
  - **Continuing water surpluses reinforced the attitude that the plant would not run, an attitude that eventually became prevalent among the staff.**
  - **Emphasis shifted to desalt research for reducing future operating costs, as the Water Quality Improvement Center was started.**

- **Prior to restarting each third of the plant, identified design deficiencies relating to that part of the plant will have to be corrected. The table on the next page shows costs for currently identified design deficiencies that will need to be corrected prior to starting each third of the plant.**

- **These individual cost and timeframe estimates were directly used in the development of YDP Plant Cost Model, described later in this section of our report.**

Known Design Deficiencies

Design Deficiencies	Total Est Cost	1/3 Capacity	2/3 Capacity	Full Capacity
Replace high pressure RO pumps	4,762,695	1,725,000	1,500,000	1,537,695
Construct third sludge disposal stage	2,863,421			2,863,421
Replace control block isolation valves and actuators	1,879,888	1,879,888		
Install clearwell pH control system	1,168,819	1,168,819		
Repair plant ammonia system	1,058,922		1,058,922	
Replace failed segment of ERU reject piping	598,405	598,405		
Install electro chlorination system	344,534	344,534		
Complete plant paving	300,000			300,000
Replace element storage biocide system	294,985	294,985		
Replace plant SDI equipment	284,211		284,211	
Replace SDI equipment in WQIC	284,211		284,211	
Install MODE II blend system	223,070	223,070		
Replace high pressure pump discharge valves and actuators	200,000	120,000	80,000	
Upgrade plant air system (compressor addition)	182,095	182,095		
Install chlorine containment system	155,000	155,000		
Access and repair coating on SCR1	90,000			90,000
Replace Tecan diluter	77,175	77,175		
	$ 14,767,431	**$ 6,768,971**	**$ 3,207,344**	**$ 4,791,116**

NOTE: Estimates include all costs for labor, materials, contracts and overheads

Transition Requirements:
Preparing plant components and systems to run again

- **In addition to correction of design deficiencies, the Transition Period will be used to prepare long-dormant plant systems to run again.**
  - **Membranes must be reinstalled.**
  - **Mechanical and electrical equipment, such as valves and pumps must be tested and repaired, as necessary.**
  - **Wear parts such as packing and belts must be reinstalled on equipment.**

- **As part of our assessment, we worked with staff and the service contractor to prepare an actual startup plan for these activities.**

- **A complete listing of the anticipated work activities that will be required for each of the plant equipment areas is listed on the following pages. The lists are segregated by activities required for:**
  - **Transition from current state to 1/3 operation**
  - **Transition from 1/3 operation to 2/3 operation**
  - **Transition from 2/3 operation to full operation**

- **These work activity lists created the underlying basis for preparing cost and timeframe estimates used in the YDP Plant Cost Model.**

Transition activities from current state to 1/3 operation

Area	Sub Area	Transition Activity
1	**MODE Intake 1&2**	Perform MODE II cleanout and panel repairs Repair or replace MODE II bypass radial diversion gates Repair or replace MODE control radial diversion gates Complete development & testing of Allen Bradley PLC software & I/O hrdwr Procure and add missing instrumentation at MODE II outlet (req. by permit) Program MODE II instrumentation in UCOS DCS via Intellusion SCADA Add missing instrumentation at MODE inlet (e.g., level, pH, turbidity) Put in stop logs, bypass intake area, and put WQIC operation on DW8 well Check intake conveyor systems (east & west) Install screens in the west traveling screen & Test both East and West Start up and check out DW-8 well for operation for spray water Remove earth dam, clean out muck, install stop logs & radial gate MODE 2 Check MODE II Diversion valves Check two of the four Intake slide gate system (1&2) Thourghly clean and inspect Intake motor control centers located in DCT Check all modes of operation (manual, automatic, supervisory)
1	**Intake GB 1&2**	Develop program for the Allen Bradley Panel View & Grit Transfer system Test two of the four grit disposal system to sludge handling area (1&2) Test two of the four grit flushing system to grit basins (1&2) Repack pumps, install belts, replace missing piping Replace rubber in cyclone separators Check expansion joint in concrete between GB 2 and GB 3 Check operation of the five intake pumps especially motor loading Determine if grit can be returned to the MODE (Permitting) Check packing, seals, and gaskets and replace if needed Check four grit sedimentation slide gates & control systems (1&2) Flush & inspect intake lines to the grit basin (1&2) Thourghly clean and inspect Intake motor control centers located in DCT Reinstall intake basin analytical instrumentation & test Check all modes of operation (manual, automatic, supervisory)

Transition activities from current state to 1/3 operation

Area	Sub Area	Transition Activity
2	SCR No. 3	Test and align rake Test mixer control and hydraulic systems Test influent, effluent and bypass to drain valves Inspect lime slurry & ferric injection lines, control valves & flow instruments Inspect V/V sampling system and install pH sensors Check out sludge transfer system to area 03 (SCR No. 3) Rechaulk SCR expansion joints Install cathodic protection Check ground settling around SCRs 2 & 3 (about 3 ft around outside) Check out sludge blowdown and flush system for SCR No. 3 Hydro test SCR No. 3 Inspect and test all sump pump in valve pits Thourghly clean and inspect motor control centers located in DCT Check all modes of operation (manual, automatic, supervisory)
3	Sludge	Rebuild sludge holding tank mixer Test cyclone separators, Biomass & Grit handling system Test sludge handling & dewatering system Test truck load out valve & piping systems
4	Filters	Fix expansion joints on inlet weir and check expansion joint on outlet weir Check operation of all valves (35% completion necessary) Take media measurements and clean out filters if necessary Inspect backwash sump and clean out if necessary Check settling in instrument tunnel Repack backwash pumps Test air scour blower & control systems Test and repair filter sampling system in tunnel (28 systems total) Verify functionality of air water separators Inspect and test all sump pump in valve pits Recalibrate 28 filter level xmitters to assure proper backwash procedures Check all modes of operation (manual, automatic, supervisory)

Transition activities from current state to 1/3 operation

Area	Sub Area	Transition Activity
5	**Ammonia**	Install piping on injection pumps Test current (temporary) ammonia control system Check all modes of operation (manual, automatic, supervisory)
6	**Clearwell**	Check coating and expansion joint Install missing instrumentation Fix conduit Check all modes of operation (manual, automatic, supervisory)
6	**Ammonia**	Evaluate placement of a permanent ammonia injection system Re-evaluate modification requested by Process Safety Team
6	**Pumps (5 minimum)**	Reinstall stages removed from pump 8 Install crossover valves Clean all MCC switchgear Evaluate HWS ERU electrical and hydraulic control systems (Pump 15) Resolve drainage problem to this area (applicable when it rains) Test new watt transducers and I/O equipment Check all modes of operation (manual, automatic, supervisory)
7	**Membrane Batching**	Check entire membrane batching and cooling system Add electric actuator to tank feed valve
7	**Piping HWS**	Hydro test all Hydranautics (HWS) aluminum bronze piping Repair all leaks Replace failed Hydranautics and Fluid Systems reject line Remove blind on Hydranautics feed line HYDRO test & repair 316 SS pitting leaks on control blocks Replace defective & missing panel meters on HWS control block cabinets

Transition activities from current state to 1/3 operation

Area	Sub Area	Transition Activity
7	RO HWS	Check out all control block valves and instrumentation Replace valve disks on Hydranautics (HWS) valves Hydro test RO Service Water flush piping & control system Hydro test RO cleaning pipe & control system Check out all newly installed product and reject flow meters Evaluate o-rings and replace as necessary Rehydrate, size, load Hydranautics mbrns 15 cntrl blcks, 5040 elements Inspect and test all sump pump in valve pits
8	Sleeve	Remove blind from Hydranautics sleeve valve Open & Inspect Hydranautics sleeve valve for debris Test Hydranautics sleeve valve inlet and outlet valves Check all modes of operation (manual, automatic, supervisory)
9	Chlorine	Check evaporators, chlorinators, control, rupture disk, alarms Re-evaluate modification requested by Process Safety Team Install chlorine evaporator vent lines Make rail spur available Get rail car mover operational Repair or replace load cells for chlorine car scale Need pigtail for tank Check all modes of operation (manual, automatic, supervisory)
10	Ferric	Check out dilution tank in silo 1 Check out transfer pumps (may require rebuilding) Check out hose pumps (hoses may require replacement) Test Railcar unloading system Replace missing parts and valves Check out automatic batch, dilution and flush system Check all modes of operation (manual, automatic, supervisory)

Transition activities from current state to 1/3 operation

Area	Sub Area	Transition Activity
10	**Lime Silos 3&4**	Test east & west lime unloading systems, blowers, VFDs and instruments Test all transfer systems, blower, VFD's & instrumentation for silos (3&4) Check status of silo level sensor replacement Replace lime slaker ratio controllers with PLC or sequence controllers Install belts and packing for feeders and blowers for silos Check out operation of diverter valves Replace bag filters on silos and use bins Replace rubber boots on silos and use bins Repack slakers and check operation Replace level sensors in the slurry tanks and clean out tanks Get sewage ejection 2 and bathroom operational Get lab operational Install motors, belts, and packing for lime slurry pumps. Test Check out slaker grit vibrating screens and grit wash (3&4) Inspect and test all sump pump in valve pits Check all modes of operation (manual, automatic, supervisory)
12	**Acid**	Hydro test all acid injection lines Check out metering pumps for SCR No. 3 effluent Check out metering pumps for Clearwell inlet Check out metering pumps for RO membrane cleaning Check out metering pumps for RO service water flush Install pH probes Repair and program PP trench detection system Relocate 64 sump alarms Check all modes of operation (manual, automatic, supervisory)
13	**Membrane Cleaning**	Check entire membrane cleaning and chemical handling system Test membrane cleaning cooling tower & chem. inj.. System Test membrane cleaning chiller, condenser & heat exchanger system
All	**UCOS**	Install UCOS plant wide (Universal Control & Operating System)

Transition activities from 1/3 operation to 2/3 operation

Area	Sub Area	Transition Activity
1	MODE Intake 1&2	Check two of the four Intake slide gate system (3&4) Check all modes of operation (manual, automatic, supervisory)
1	Intake GB 3&4	Develop program for the Allen Bradley Panel View & Grit Transfer system Test remaining two of four grit disposal systems to sludge handling area Test remaining grit flushing system to grit basins (3&4) Repack pumps, install belts, replace missing piping Check packing, seals, and gaskets and replace if needed Check grit sedimentation slide gates & control systems (3&4) Flush & inspect intake lines to the grit basin (3&4) Check all modes of operation (manual, automatic, supervisory)
2	SCR No. 2	Test and align rake Test mixer control and hydraulic systems Test influent, effluent and bypass to drain valves Inspect lime slurry & ferric injection lines, control valves & flow instruments Inspect V/V sampling system and install pH sensors Check out sludge transfer system to area 03 (SCR No. 1&2) Rechaulk SCR expansion joints Install cathodic protection Check out sludge blowdown and flush system Hydro test SCR No. 2 Inspect and test all sump pump in valve pits Check all modes of operation (manual, automatic, supervisory)
4	Filters	Fix expansion joints on inlet weir and check expansion joint on outlet weir Check operation of all valves (70% completion necessary) Take media measurements and clean out filters if necessary Test & repair remaining filter sampling system in tunnel (28 systems total) Recalibrate filter level transmitters to assure proper backwash procedures Check all modes of operation (manual, automatic, supervisory)

Transition activities from 1/3 operation to 2/3 operation

Area	Sub Area	Transition Activity
6	**Pumps (9 minimum)**	Evaluate ERU electrical and hydraulic control systems (Pump 16&17) Test new watt transducers and I/O equipment Check all modes of operation (manual, automatic, supervisory)
7	**Piping FSD**	HYDRO test & repair 31SS pitting leaks on fluid systems (FSD) cntrl blcks Replace defective & missing panel meters on FSD control block cabinets
7	**RO FSD**	Check out all FSD control block valves and instrumentation Replace valve disks on fluid systems (FSD) valves Hydro test RO Service Water flush piping & control system Hydro test RO cleaning pipe & control system Check out all newly installed product and reject flow meters Evaluate o-rings and replace as necessary Deliver & load 25 fluid systems control blocks (2400 elements) Inspect and test all sump pump in valve pits
8	**Sleeve**	Open & Inspect Fluid Systems sleeve valve for debris Test Fluid Systems sleeve valve inlet and outlet valves Check all modes of operation (manual, automatic, supervisory)
10	**Lime Silos 1&2**	Test all transfer systems, blower, VFD's, & instrumentation for silos (1&2) Check status of silo level sensor replacement Replace lime slaker ratio controllers with PLC or sequence controllers Install belts and packing for feeders and blowers for silos Check out operation of diverter valves Replace bag filters on silos and use bins Replace rubber boots on silos and use bins Repack slakers and check operation (1&2) Replace level sensors in the slurry tanks and clean out tanks Install motors, belts, and packing for lime slurry pumps. Test Check out slaker grit vibrating screens and grit wash Check all modes of operation (manual, automatic, supervisory)

Transition activities from 1/3 operation to 2/3 operation

Area	Sub Area	Transition Activity
12	**Acid**	Check out metering pumps for SCR No. 2 effluent Install pH probes Check all modes of operation (manual, automatic, supervisory)
All	**UCOS**	Ongoing installation of UCOS plant wide

Transition activities from 2/3 operation to full operation

Area	Sub Area	Transition Activity
2	**SCR No. 1**	Test and align rake Test mixer control and hydraulic systems Test influent, effluent and bypass to drain valves Inspect lime slurry & ferric injection lines, control valves & flow instruments Inspect V/V sampling system and install pH sensors Rechaulk SCR expansion joints Install cathodic protection Check out sludge blowdown and flush system Hydro test SCR No. 1 Inspect and test all sump pump in valve pits Check all modes of operation (manual, automatic, supervisory)
4	**Filters**	Fix expansion joints on inlet weir and check expansion joint on outlet weir Check operation of all valves (100% completion necessary) Take media measurements and clean out filters if necessary Test & repair remaining filter sampling system in tunnel (28 systems total) Recalibrate filter level transmitters to assure proper backwash procedures Check all modes of operation (manual, automatic, supervisory)
6	**Pumps (12 minimum)**	Test new watt transducers and I/O equipment Check all modes of operation (manual, automatic, supervisory)
7	**RO** **FSD**	Evaluate o-rings and replace as necessary Deliver & load 20 fluid systems control blocks (1920 elements)

Transition activities from 2/3 operation to full operation

Area	Sub Area	Transition Activity
12	**Acid**	Check out metering pumps for SCR No. 1 effluent Install pH probes Check all modes of operation (manual, automatic, supervisory)
All	**UCOS**	Ongoing installation of UCOS plant wide

Transition Requirements:
Support activities for startup and operations

- **While not significant from a cost standpoint, there are a number of key activities that will be required during the Transition Period to support transition and operating requirements. These support activities typically require long lead times to accomplish. They include:**
  - **Procurement of materials and equipment, including contracts for:**
    - **Membranes**
    - **Chemicals**
    - **Materials needed to correct design deficiencies**
  - **Procurement of power to operate the plant.**
  - **Procurement of a new services contract for operating and maintaining the plant. The current contract only covers activities to keep the plant in ready reserve status.**
  - **Obtaining funding to actually operate the plant. Funding levels for operations would be many times the amount currently appropriated for ready reserve.**
  - **Obtaining environmental permits. Since the time the plant last operated, the nature and focus of environmental oversight has changed considerably. Known issues that would have to be addressed include:**
    - **Updating environmental compliance**
    - **Obtaining a discharge permit**

- **Costs for these support activities are embedded in the major components shown in the YDP Plant Cost Model.**

- **Timeframe estimates for completing these activities are shown separately, since they will require significant lead times.**

Understanding and estimating operating requirements

- **The plant is designed to operate in thirds: 1/3 capacity, 2/3 capacity, full capacity. Regardless of the level of operation, key operating and maintenance requirements recur during each year of plant operation. Major cost components include:**
  - **Labor**
    - **Bureau staff**
    - **Maintenance and operation (M&O) contractor staff**
  - **Membrane replacement cost (membranes are consumed over a 3 year life)**
  - **Equipment renewal and replacement cost**
  - **Power cost**
  - **Chemicals cost**

- **Developing cost estimates for each of these components entailed defining requirements at a detailed level for staffing levels, chemical and power use, and actual equipment utilization estimates.**

- **Ultimately, operating costs are going depend on knowing several key factors which can vary, depending on plant performance and external market factors. Issues considered in arriving at these estimates are discussed on the following two pages. Key variables include:**
  - **Cost of power - determined by contract negotiations prior to plant startup**
  - **Process recovery factor attained - a measure of membrane efficiency; range 73% to 85%**
  - **On stream factors attained - the % of time the plant operates; range between 75% to 100%**

Estimating operating costs: Operating capabilities have never been fully demonstrated

- **Like many process-based manufacturing plants, many individual components and major sub-systems are designed with some levels of redundancy to allow continuous operation.**
  - **However, since the plant only operated at 1/3 capacity, some redundancies were never addressed or were never completed prior to shutdown of the facility.**
  - **All systems throughout the plant were never fully broken-in over a sustained period of time.**
  - **At the time of shutdown, in 1993, engineers were still engaged in identifying and resolving design deficiencies.**

- **Uncertainty about unknown design problems and reduced levels of redundancy lead us to concerns about the level of on-stream factor the plant can operate at over time.**
  - **Higher on-stream factor estimates when plant is operated at 1/3 capacity (high level of redundancy) than when plant is operated at full capacity (lower levels of redundancy).**
  - **On-stream factor estimates range between 75% and 100%, depending on the level of plant operation.**

- **Uncertainty about unknown design problems and lack of actual operating experience caused uncertainty in estimating renewal and replacement costs.**
  - **Costs for industrial facilities typically allow for a certain amount of funds to repair or replace major components as they wear out during plant operations.**
  - **Since the plant has not fully operated, and only then for a short period of time, it was difficult to estimate the appropriate level of funds for renewal and replacement. We estimated 1% to 2% of plant equipment cost for this factor.**

Estimating operating costs : Operating capabilities have never been fully demonstrated

- **Since the plant last operated, research projects have demonstrated that techniques can be used to increase membrane recovery rates.**
  - **At the time the plant last operated, membrane recovery rates (the percentage of product water to total input water) averaged 73%.**
  - **Research performed at the WQIC has demonstrated that membrane recovery rates as high as 85% are achievable.**
    - **The key to achieving higher rates is increasing operating pressures within the plant.**
    - **Higher recovery rates will increase use of some chemicals.**
  - **Actual recovery rates achieved will depend on operating and hydraulic conditions, once the plant is operating.**

- **The cost of power is uncertain because there is no currently identified source or contract for providing power to the plant. Since this is a continuous process industrial facility, high load factor power will be required. The range of estimates included in our analysis reflects current long term (3 to 5 year duration) market-based contracts for this type of power requirement.**

Development and structure of the YDP Plant Cost Model

- **A cost and staffing model was developed to tie together the cost and staffing estimates for the cost components for each transition and operating requirement.**
  - **The model was designed to be updated, over time, as underlying costs change or cost estimates improve.**
  - **All assumptions underlying estimates are documented within the model.**

- **Structure of the model:**
  - **Costs are estimated for each plant operating state:**
    - **Current state (caretaker / ready reserve)**
    - **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**
  - **Cost estimates for the activities required within each category were estimated at the major cost component level (labor, materials, power, etc.)**

- **A least cost estimate and highest cost estimate were created because of uncertainties in estimating key component costs, discussed on the prior pages. Key assumptions and summary costs are shown on the next two pages for each of these YDP Plant Cost Model runs.**

Least Cost Estimate:
Transition and Operating Cost Summary

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%

	Ready Reserve	1/3 Capacity	2/3 Capacity	3/3 Capacity
Annual Recurring Costs				
Labor (Bureau staff & contract)	1,088,044	4,252,937	4,815,979	5,061,317
Equipment Replacement	77,261	2,251,620	2,376,710	2,501,800
Membrane Replacement	141,700	1,002,750	2,138,750	3,047,550
Power	140,418	2,290,135	4,170,598	5,000,985
Chemicals	9,465	3,043,977	6,229,769	7,867,088
	1,456,888	**12,841,419**	**19,731,806**	**23,478,740**
Product Water (acre feet)		29,125	59,702	75,418
Cost per acre foot		441	331	311
One Time Transition Costs				
Design Deficiencies	n/a	6,768,971	9,976,315	14,767,431
Plant start-up	n/a	1,160,629	1,678,078	2,194,617
Membranes	n/a	3,008,250	6,416,250	9,142,650
	n/a	10,937,850	18,070,643	26,104,698
Annual Amortized Cost (10 years)		**1,093,785**	**1,807,064**	**2,610,470**
Product Water (acre feet)		29,125	59,702	75,418
Cost per acre foot		38	30	35
Total Annualized Cost	**1,456,888**	**13,935,204**	**21,538,870**	**26,089,210**
Product Water (acre feet)		29,125	59,702	75,418
Cost per acre foot		**478**	**361**	**346**

Highest Cost Estimate:
Transition and Operating Cost Summary

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%

	Ready Reserve	1/3 Capacity	2/3 Capacity	3/3 Capacity
Annual Recurring Costs				
Labor (Bureau staff & contract)	1,088,044	4,252,937	4,815,979	5,061,317
Equipment Replacement	77,261	4,503,240	4,753,420	5,003,600
Membrane Replacement	141,700	1,002,750	2,138,750	3,047,550
Power	147,086	4,236,679	7,788,375	9,265,908
Chemicals	9,465	2,485,270	5,070,443	6,336,007
	1,463,556	**16,480,876**	**24,566,967**	**28,714,382**
Product Water (acre feet)		23,762	48,575	60,722
Cost per acre foot		694	506	473
One Time Transition Costs				
Design Deficiencies	n/a	6,768,971	9,976,315	14,767,431
Plant start-up	n/a	1,162,852	1,678,078	2,194,617
Membranes	n/a	3,008,250	6,416,250	9,142,650
	n/a	10,940,073	18,070,643	26,104,698
Annual Amortized Cost (5 years)		**2,188,015**	**3,614,129**	**5,220,940**
Product Water (acre feet)		23,762	48,575	60,722
Cost per acre foot		92	74	86
Total Annualized Cost	**1,463,556**	**18,668,891**	**28,181,096**	**33,935,322**
Product Water (acre feet)		23,762	48,575	60,722
Cost per acre foot		**786**	**580**	**559**

Estimating plant startup timeframes

- **Timeframe estimates, while activity based, ultimately boil down to allowing time for taking risk into account. The next page shows the known risks and unknown risks that we identified and took into account in preparing our timeframe estimates.**

- **Given the list of design deficiencies that have yet to be corrected and other required permitting and procurement activities, the transition time required to make the plant ready for start-up is 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.**
    - **Plant equipment is made operable i.e., deficiencies and corrective maintenance are completed.**
    - **New or updated permits are acquired.**
    - **Power contracts are procured.**

  - **Given our risk assessment, we estimate the timeframe needed to complete all transition activities will require between 24 to 30 months to begin operating the first 1/3 of the plant.**

  - **A Gantt chart showing our complete timeframe estimate for starting all three parts of the plant follows the page detailing our assessment of risks.**

The length of time required for transition depends on both known and unknown elements

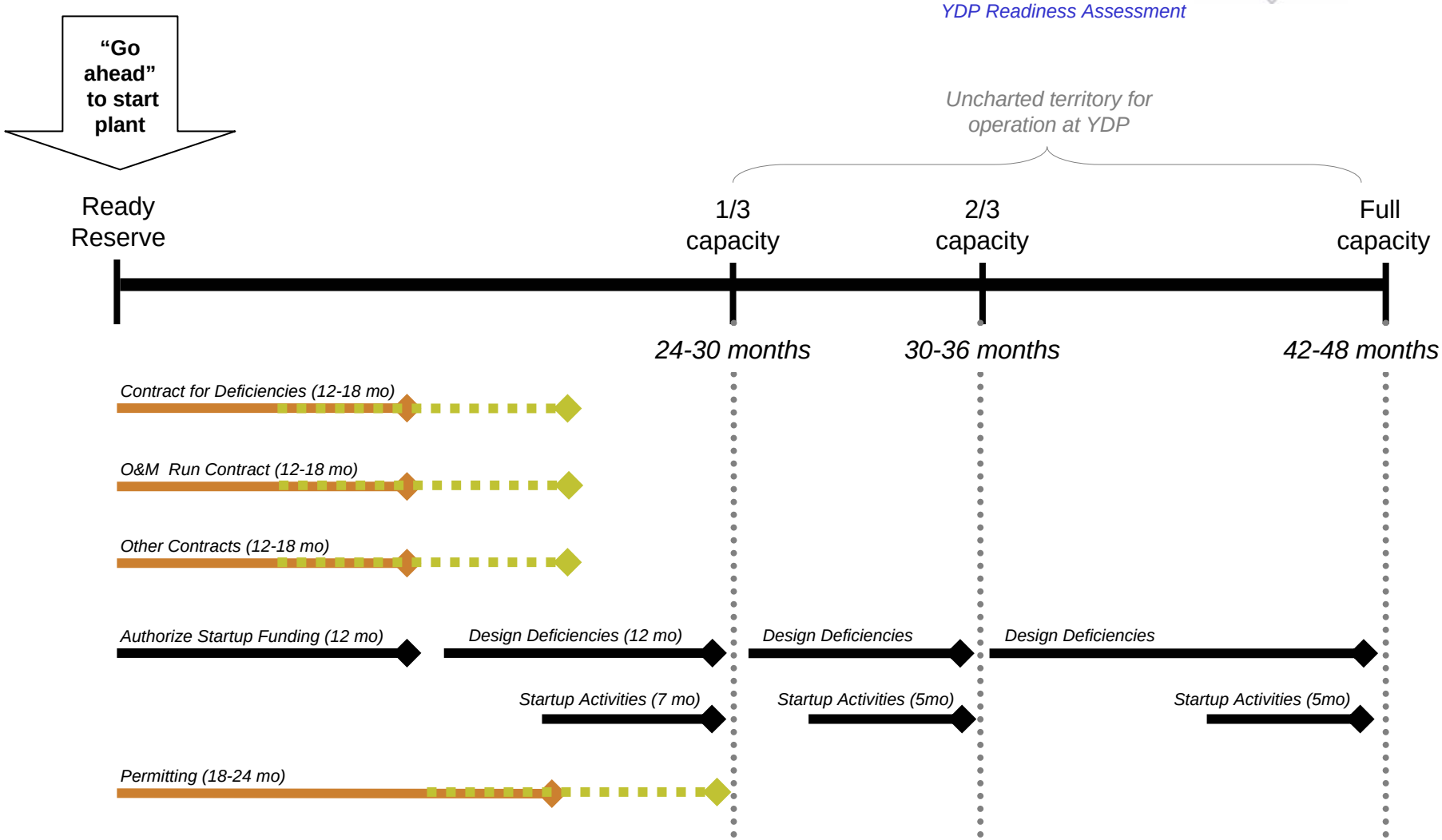
Known Risks

- Funding lead time requirements
- Contracting lead time requirements
  - O&M run contract
  - Chemical contracts
  - Contract for correction of deficiencies
  - Contract for power
- Lead time for reinstating environmental permits required to run plant
- Scope and time frame requirements for correcting design deficiencies in 1st third of the plant

Unknown Risks

- This is a state-of-the art facility that never reached full operating capacity.
  - The plant was only operated at 1/3 capacity. Some systems and components were never operated.
  - The design was based upon scaling up technologies that had never been fully demonstrated on a full production scale
  - All systems throughout the plant were never fully broken in over a sustained period of time.
  - At the time of shutdown, engineering was still engaged in identifying and resolving design deficiencies.
- Scope and time frame requirements for correcting design deficiencies in 2nd and 3rd parts of the plant.
  - Ultimate resolution of aluminum / bronze piping throughout the plant (Possibilities include: change pH of water, install cathodic protection, replace, patch & repair?)
  - Redundancies never incorporated into the design to allow last third of the plant to operate cost effectively.

Estimated Transition Timeframe



Section 4

KEY FINDINGS AND CONCLUSIONS

Key Findings and Conclusions

- **The estimated annualized cost for restarting and operating the YDP will range between $305 per acre-foot and $786 per acre foot, depending on:**
  - **The level the plant is operated at - 1/3, 2/3, or full capacity.**
  - **Whether plant product water is blended with MODE water.**
  - **Actual power costs.**
  - **Actual process recovery factor attained - 73% to 85%.**
  - **Actual on stream factors attained - range between 75% to 100%.**
  - **Number of years the plant actually runs (to amortize the one-time startup costs).**

- **The table on the next page summarizes how costs vary for this range of possible operating scenarios.**

- **The table also shows that the incremental impact on river salinity at the Northerly International Boundary from operating the plant is between 0 ppm and 28 ppm, depending on:**
  - **The level the plant is operated at - 1/3, 2/3, or full capacity.**
  - **Whether plant product water is blended with MODE water.**
  - **Whether there is low flow or high flow conditions in the river.**

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	$ 12,841,419	$ 19,731,806	$ 23,478,740
Amortized One Time Transition Cost	$ 1,093,785	$ 1,807,064	$ 2,610,470
Total Annualized Cost	$ 13,935,204	$ 21,538,870	$ 26,089,210
Product Water (acre-feet)	**29,125**	**59,702**	**75,418**
Cost per acre foot	**$ 478**	**$ 361**	**$ 346**
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	$ 429	$ 325	$ 305
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	$ 16,480,876	$ 24,566,967	$ 28,714,382
Amortized One Time Transition Cost	$ 2,188,015	$ 3,614,129	$ 5,220,940
Total Annualized Cost	$ 18,668,891	$ 28,181,096	$ 33,935,322
Product Water (acre-feet)	**23,762**	**48,575**	**60,722**
Cost per acre foot	**$ 786**	**$ 580**	**$ 559**
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	$ 689	$ 510	$ 480
Estimated Reduction On River Salinity (ppm)	1	1	0

Key Findings and Conclusions

- **The timeframe required to start the plant is estimated to require from 24 to 48 months, depending on:**
  - **The level the plant is operated at - 1/3, 2/3, or full capacity.**
  - **Timeframe required to obtain environmental permits.**
  - **Procurement lead times.**
  - **Funding lead times.**
  - **Actual time required to complete correction of design deficiencies.**

- **The cost and schedule estimates resulting from our assessment vary significantly from earlier studies and estimates prepared by others. Differences in estimates can be attributed to failure of earlier estimates to take into account factors such as:**
  - **New information since earlier studies.**
  - **Transition cost to correct design deficiencies.**
  - **Transition activities and costs to prepare plant components to run again.**
  - **Membrane replacement costs.**
  - **Realistic costs for power.**
  - **Realistic estimates for plant recovery and on-stream factors.**
  - **Lead times required for environmental permitting, procurement, and obtaining funding.**