

SAWEA 2007

Saudi Aramco Project Development

Wastewater Treatment Facilities Jeddah Refinery And Marine Area

December 2007

Facilities Planning Dept.

أرامكو السعودية
Saudi Aramco



OBJECTIVE:

Provide an overview of the complexities of developing a project scope for Upgrading the Industrial and Sanitary Wastewater Treatment Facilities at Jeddah Refinery attributed to:

- Difficult to treat industrial oily wastewater stream requiring multiple studies
- Multiple changes in the future operations of the Jeddah Refinery

PRESENTATION OUTLINE

- Background
- Initial Study – Conventional Biological Treatment
- Second Study – Physical Chemical Treatment
- 1st Revised Operating Scenario for Jeddah Refinery
- Third Study – Membrane Bio-Reactor
- 2nd Revised Operating Scenario for Jeddah Refinery
- Overall summary of the project development

BACKGROUND

General Information

- Environmental Master Plan (EMP) issued by Company in 2001
- EMP indicates that upgrades required for Jeddah Refinery Industrial Wastewater Treatment System and Sanitary Sewage System
- Consultant contracted in 2002 to perform field evaluation and tests and recommend upgrade requirements

BACKGROUND (cont'd)

Location & Existing Facilities

- **Jeddah Refinery:**
 - Located adjacent to the Islamic Port in Jeddah
 - Commissioned in 1982
 - Currently operating at 90,000 barrel crude oil refinery producing gasoline, fuel oil, and asphalt
 - Major process units include crude distillation, vacuum, platformer unit, naphtha hydrotreating, fluid catalytic cracker (FCC)
 - Tank Farm for Crude and Product and Terminal Facilities
 - Provides feedstock/some utilities and treats wastewater from adjacent Luberef Plant

BACKGROUND (cont'd)

Location & Facilities (cont'd)

- **Existing Industrial Wastewater Treatment Facilities, Jeddah Refinery**
 - Located adjacent to the refinery in the Marine Area
 - Holding Basin for incoming wastewater flow conditions
 - API Separators for removal of oil & grease and solids
 - Media Filter for removal of total suspended solids (TSS)
 - All equipment more than 25 years old
 - Treats wastewater from the refinery, tank farm, & Luberef
 - Design wastewater flow 2.66 million gpd (10,000 M³/d)
- **Existing Sanitary Wastewater System**
 - Sewage collected from buildings into holding tanks
 - Sewage removed via vacuum trucks and sent to Saudi Aramco's Al-Rehab Community Center STP
 - Approximate quantity of sewage generated: 12,000 gpd (45 M³/d)



Red Sea

Jeddah Refinery

Tank Farm Area

Marine Area

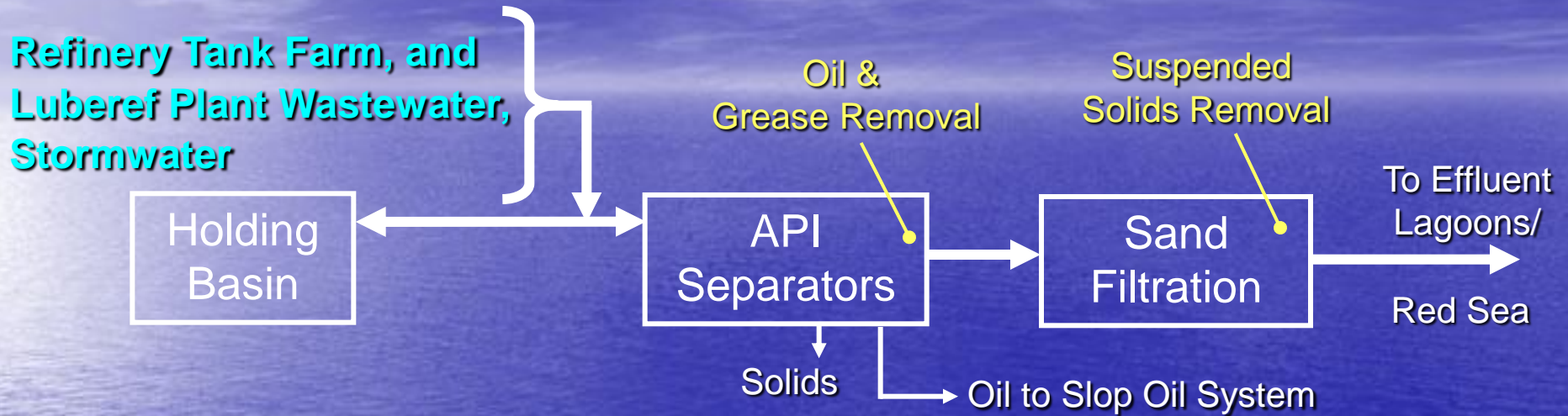
Lagoons

Industrial WWTP

Luberef

Jeddah Refinery & Marine Area

Industrial & Sanitary Wastewater Treatment Existing Flow Scheme – Jeddah Refinery



Industrial Wastewater Treatment



Sanitary Wastewater Handling



JRMA - Holding Basin



JRMA - API Separators



JRMA - Sand Filters

INITIAL STUDY (2002)

FINDINGS

- **Major Deficiencies with JR Industrial Wastewater Treatment and Sewage System**
 - API Separators at end of useful life
 - Separator solids difficult to remove
 - Media Filters in constant state of repair and often unavailable
 - Removal of Organic/Inorganic contaminants not possible
 - No onsite sanitary waste treatment facility

INITIAL STUDY (2002)

FINDINGS

- **PME Discharge Limits are not met**

Chemical Constituent	PME Discharge Limits	JR Industrial Wastewater Discharge	
		Max	Avg
pH, units	6 - 9	8.62	8.14
BOD5, mg/l	25		490
COD, mg/l	150		878
TOC	50		199
Phenol, mg/l	0.1	26	23
Oil & Grease, mg/l	8	57	39
Total Suspended Solids, mg/l	15	199	170
Ammonia, mg/l	1	77	69
Cyanide (T/F), mg/l	0.05	0.5/ 0.05	0.3/ 0.05

INITIAL STUDY (Cont'd)

FINDINGS

- **Other Physical Characteristics of Wastewater**
 - Highly Variable Total Dissolved Solids, up to 16,000 ppm
 - Extreme Variability of Wastewater Parameters
 - High Temperatures 30 -50 °C
 - Highly Variable Flow Rate

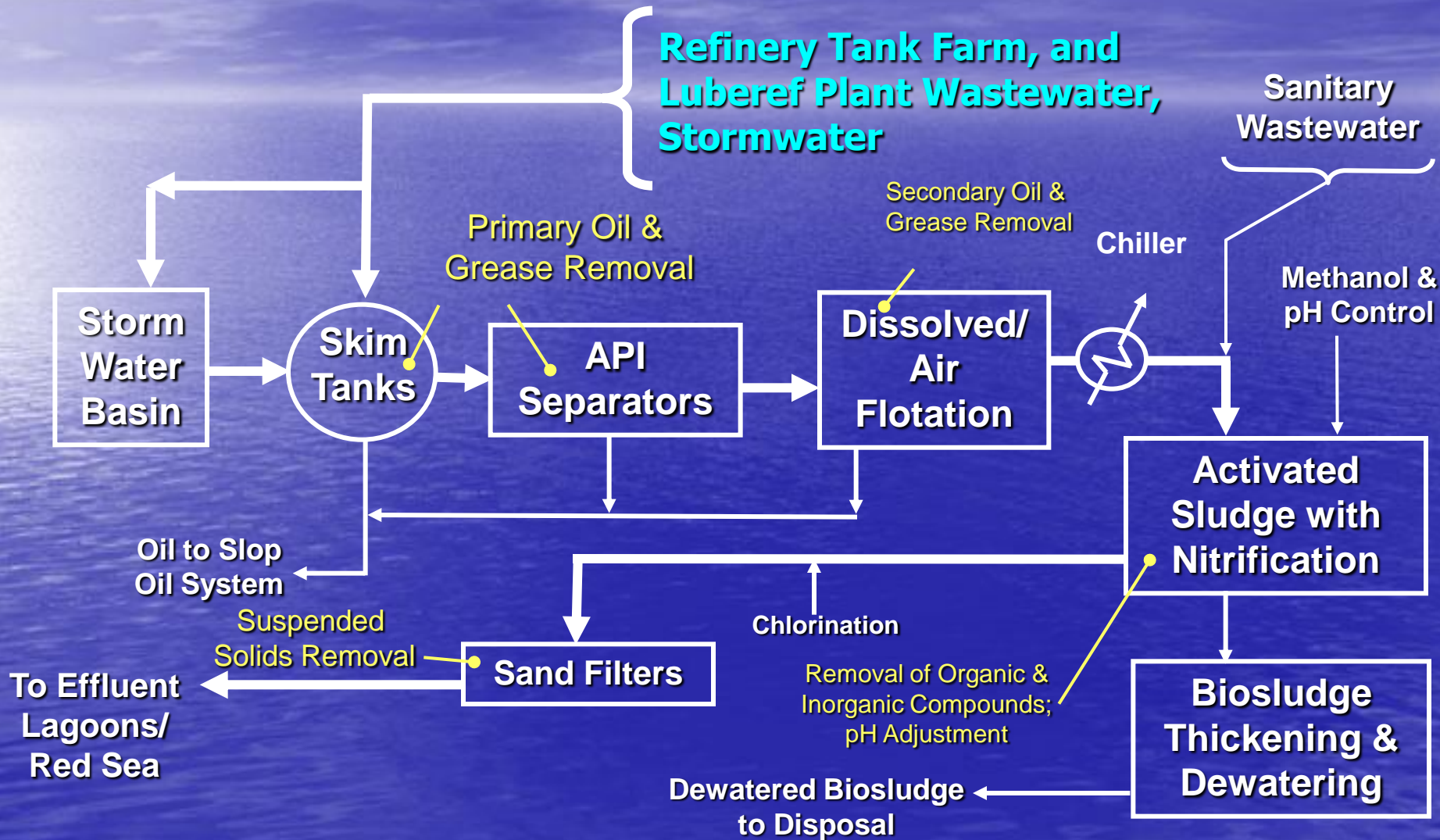
INITIAL STUDY (Cont'd)

Treatment Alternatives

- **Industrial Wastewater Treatment**
 - Conventional Biological Treatment
 - Physical Chemical Treatment (Steam Stripping)
- **Sanitary Wastewater Treatment**
 - Conventional Biological Treatment

INITIAL STUDY (Cont'd)

Recommended Industrial Wastewater Treatment Scheme – Conventional Biological Treatment



INITIAL STUDY (Cont'd)

Issues with Recommended Biological Treatment

Advantages

- Most commonly used process for "normal" industrial oily wastewater streams
- Can be also used to treat sanitary waste

Disadvantages

- Difficult to sustain biomass due to high swings in wastewater concentrations, TDS, and temperature
- Requires complex operations (as currently experienced at Rabigh Refinery)
- Not supported by EPD

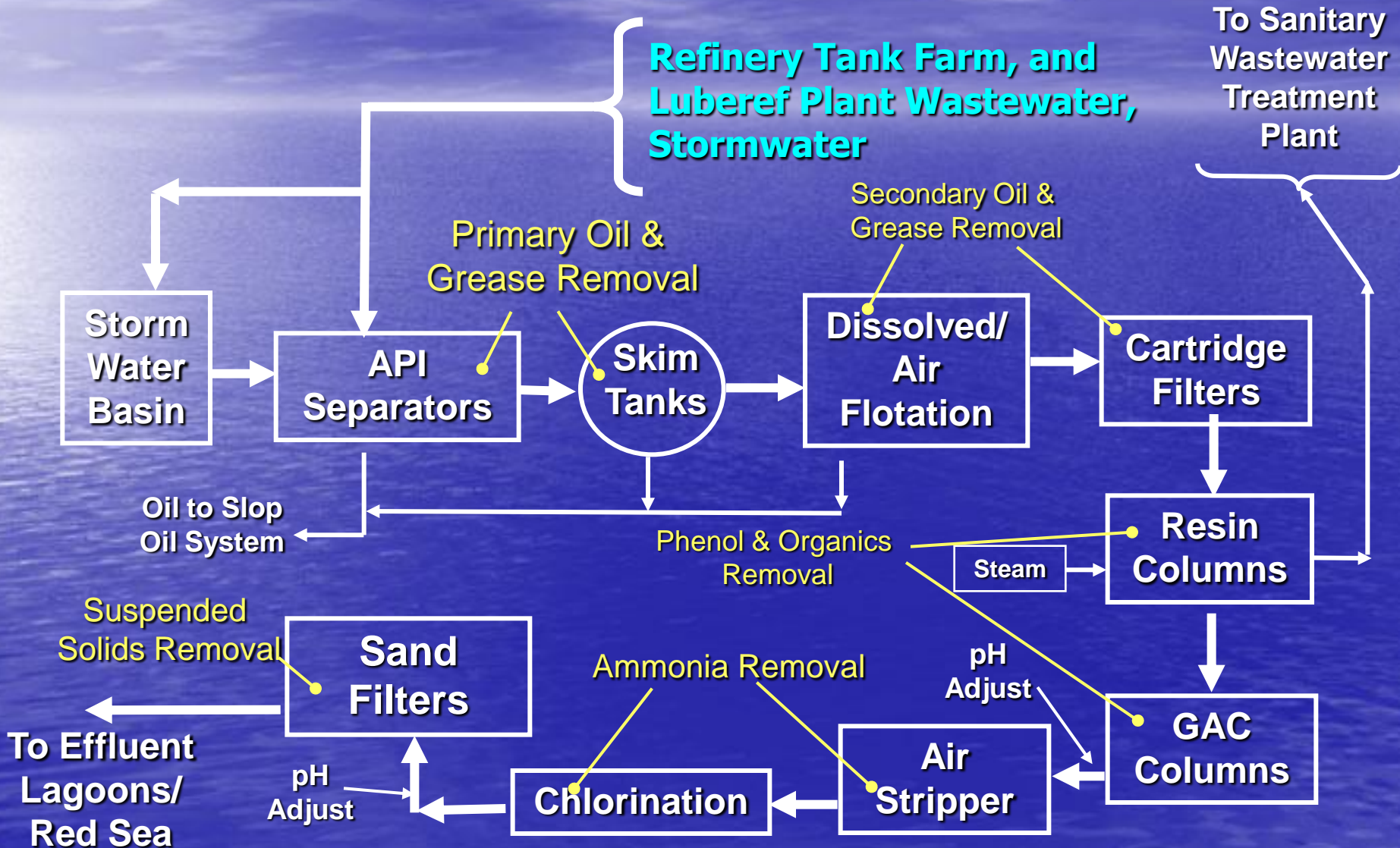
SECOND STUDY (2003)

Background Information

- EPD – Identify Simpler Treatment Process
- R&DC – Recommended resins for treatment via polymeric adsorption of contaminants
- Consultant – Contracted to perform bench testing & field pilot tests
- Physical Chemical Treatment – Proposed scheme developed

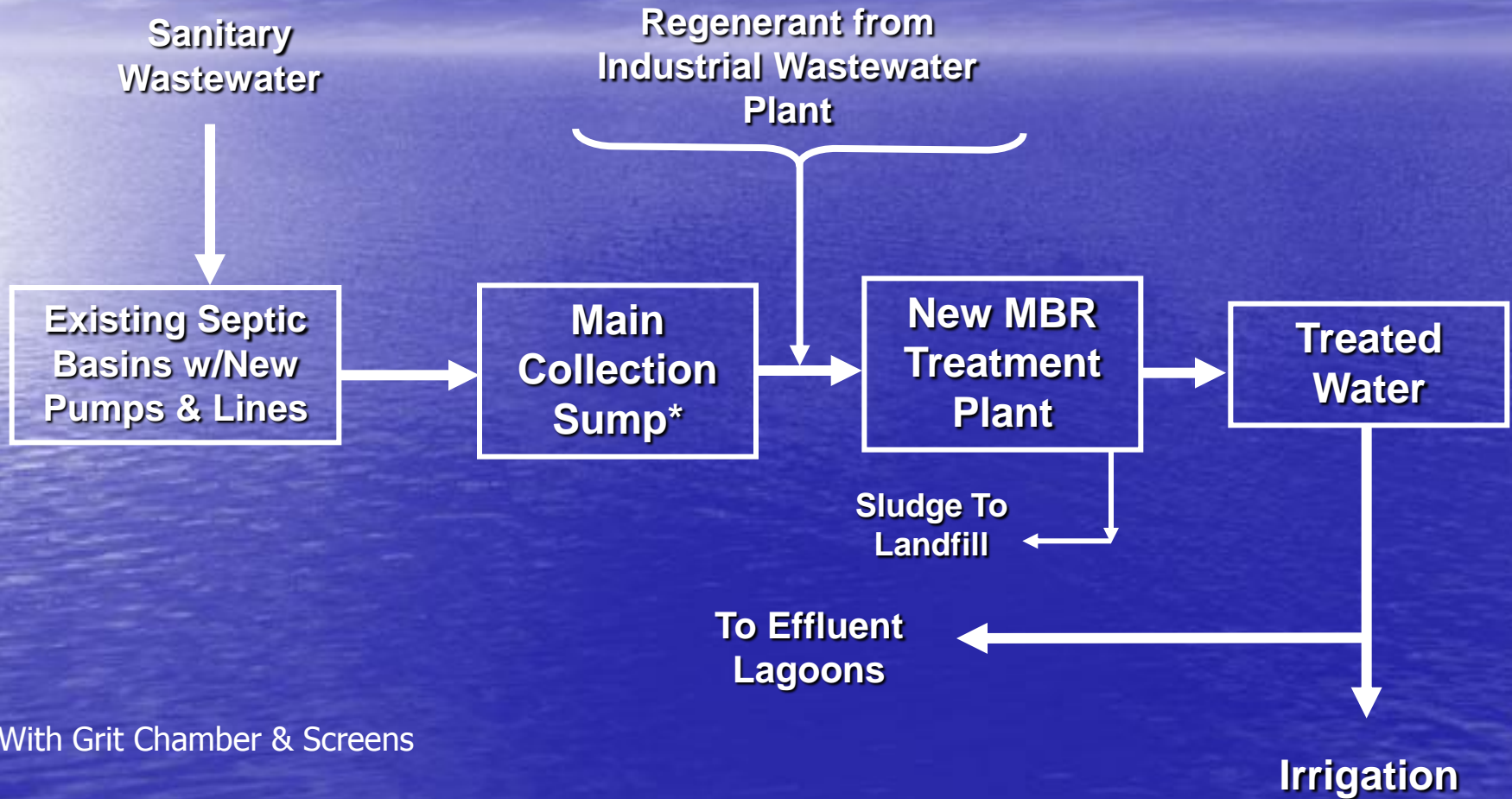
Second Study (Cont'd)

Recommended Physical Chemical Treatment – Resin Adsorption



Second Study (Cont'd)

Recommended Sanitary Wastewater Treatment Scheme – Membrane Bio-Reactor (MBR)



*With Grit Chamber & Screens

Second Study (Cont'd)

Physical Chemical Treatment - Resin Adsorption

- **Advantages**

- Simple unit operations
- High tolerance to swings in effluent conditions
- Easy to restart after shutdown

- **Disadvantages**

- High steam requirements
- Frequent replacement of GAC (Regeneration possible)
- Requires separate sanitary wastewater treatment plant

1st Revised Operating Scenario for Jeddah Refinery (2004)

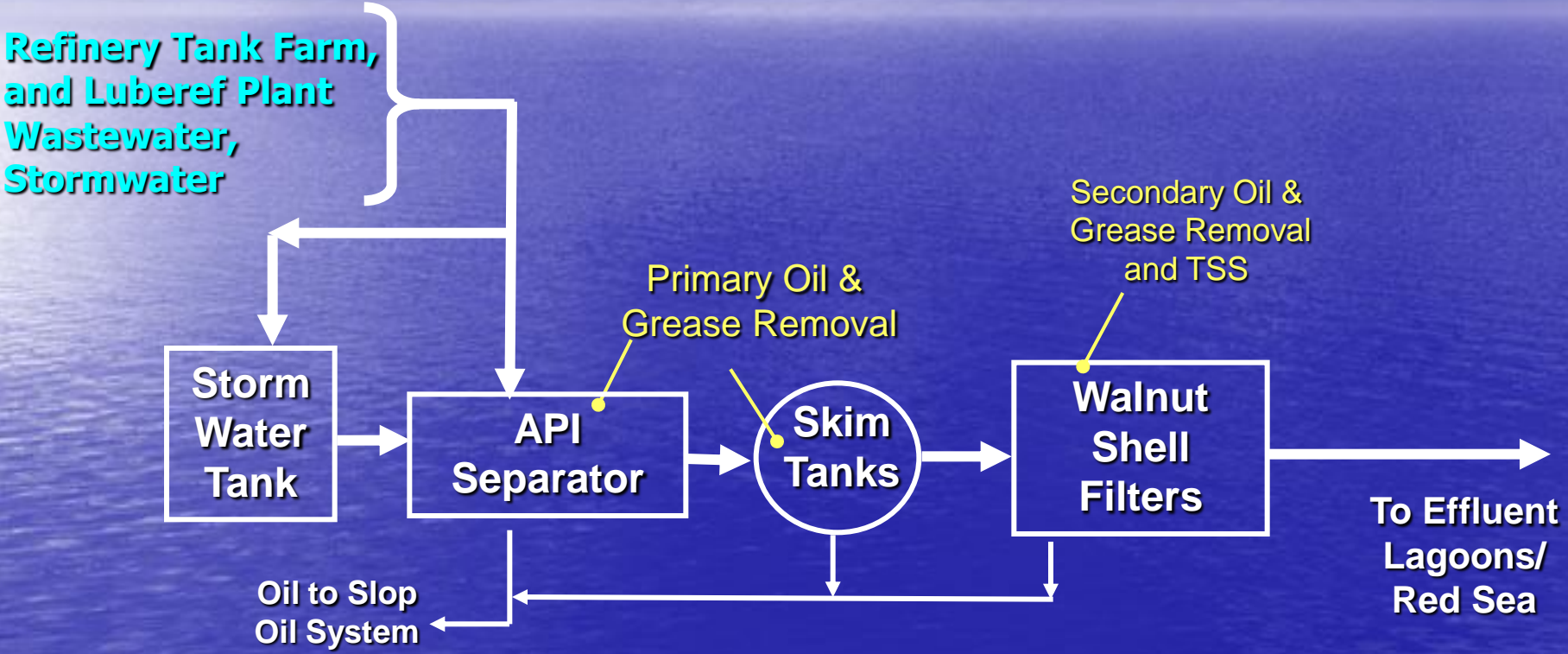
- New Rabigh Refinery/Petrochemical Complex – may affect future operation of Jeddah Refinery
- Jeddah Refinery – partial or complete shutdown of process units; study being performed by Facilities Planning Dept. (FPD)
- Industrial Wastewater Treatment Plant (IWTP) for Jeddah Refinery – capacity & treatment scheme could vary with process units remaining in operation
- Two - Phase Implementation of IWTP at Jeddah Refinery
- Phase 1 – install equipment for removal of oil & grease and total dissolve solids from the industrial wastewater to meet PME regulations
- Phase 2 – based on FPD study results and management recommendations, install remaining equipment for removal of all other contaminants from the industrial wastewater and provide onsite sanitary sewage to meet PME regulations

1st Revised Operating Scenario for Jeddah Refinery

- **Phase 1 Industrial Wastewater Treatment Facilities**
 - Design Capacity: flexibility to allow for any changes in the operation of Jeddah Refinery
 - Project Proposal Engineering: commenced on August 2004
 - Detailed Engineering: commenced on December 2005
 - Construction: currently under
 - Plant Start Up: July 2008

1st Revised Operating Scenario for Jeddah Refinery (Cont'd)

Phase 1 Industrial Wastewater Treatment Facilities



1st Revised Operating Scenario for Jeddah Refinery

- **FPD Study Results for Future Operations of Jeddah Refinery Released in Early 2005**
 - Based on study recommendations and management decision in May 2005, Jeddah Refinery process units to be shutdown in 2010
 - Jeddah Refinery Tank Farm (including marine area) and Luberef to remain in operation
 - Proceed with implementation of Phase 2 Wastewater Treatment Facilities

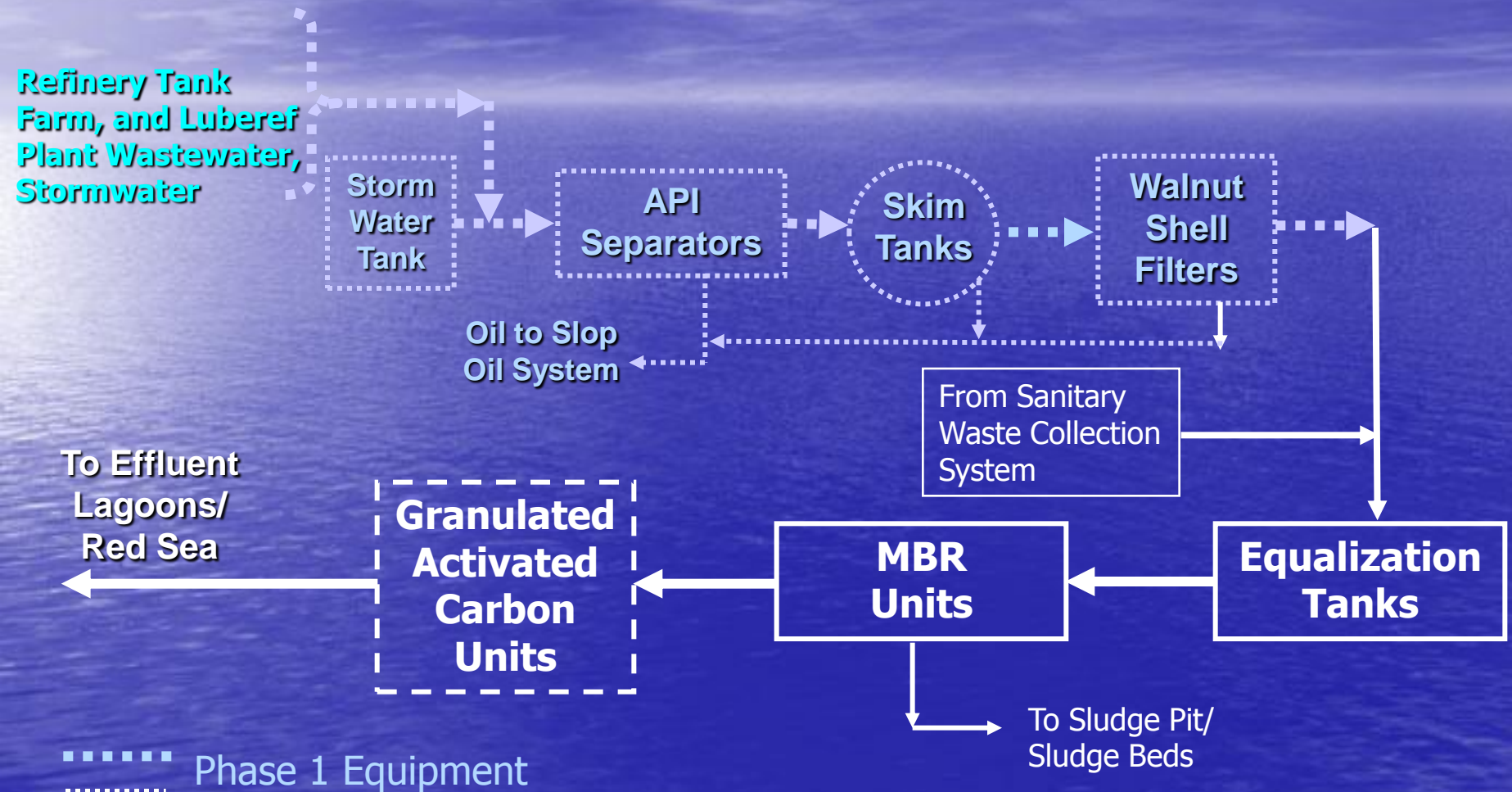
Third Study (2005)

Phase II Industrial Wastewater Treatment Facilities

- **Shutdown of Jeddah Refinery**
 - expect lower concentrations of phenols and ammonia in wastewater
 - cooler wastewater temperatures
 - wastewater flowrate reduced by 33%
- **Membrane Bio-Reactor (MBR)**
 - EPD recommends the evaluating the use of an MBR in lieu of physical chemical treatment for industrial wastewater and sanitary sewage at Jeddah Refinery
 - Consultant contracted to perform bench testing and conducts pilot plant evaluation
 - Test Results indicate MBR viable & economical process

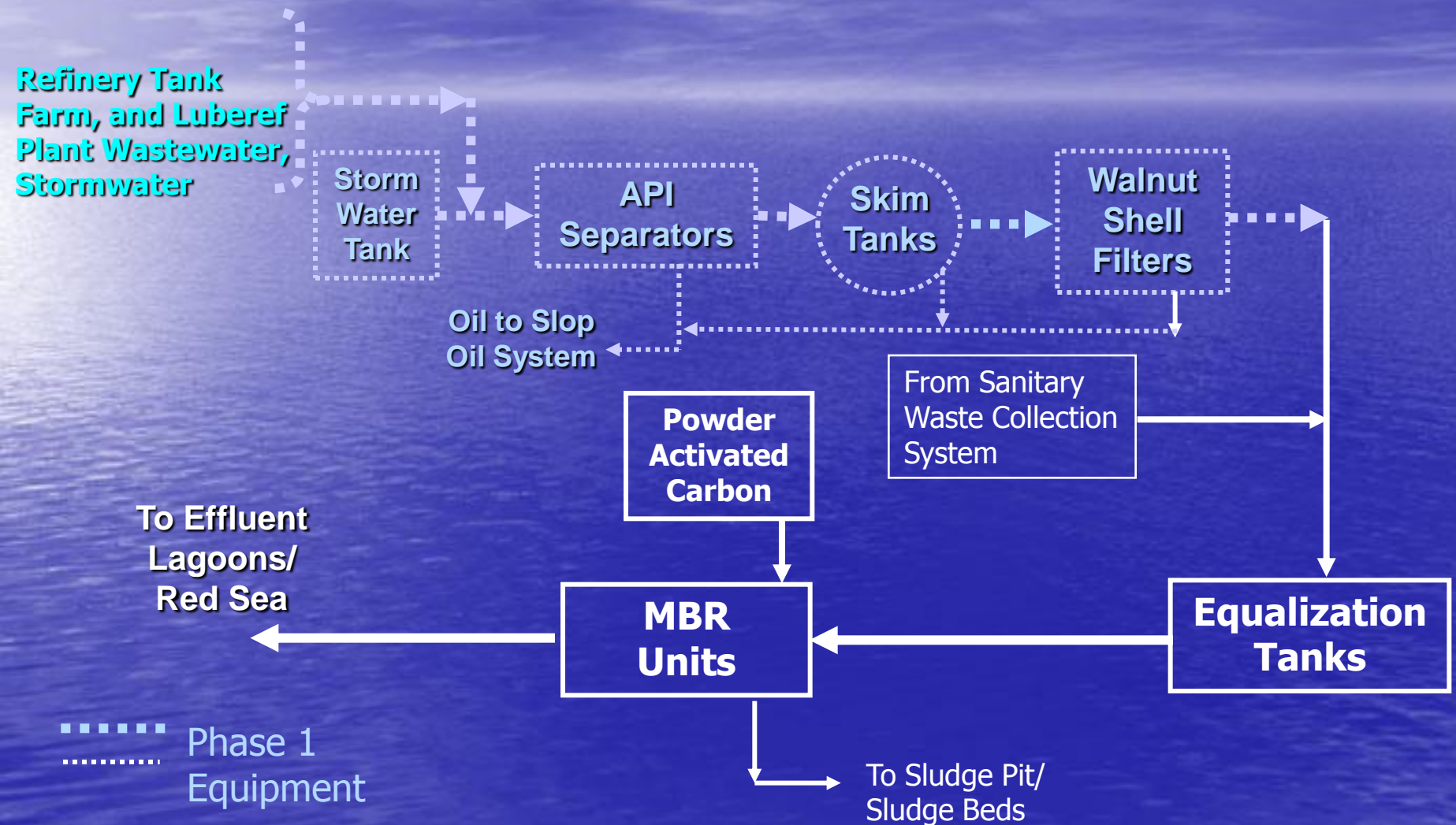
Third Study

Phase 2 Industrial Wastewater Treatment Facilities (Base)



Third Study

Phase 2 Industrial Wastewater Treatment Facilities (Alternate)



2nd Revised Operating Scenario for Jeddah Refinery (2007)

● **Future Operation of Jeddah Refinery**

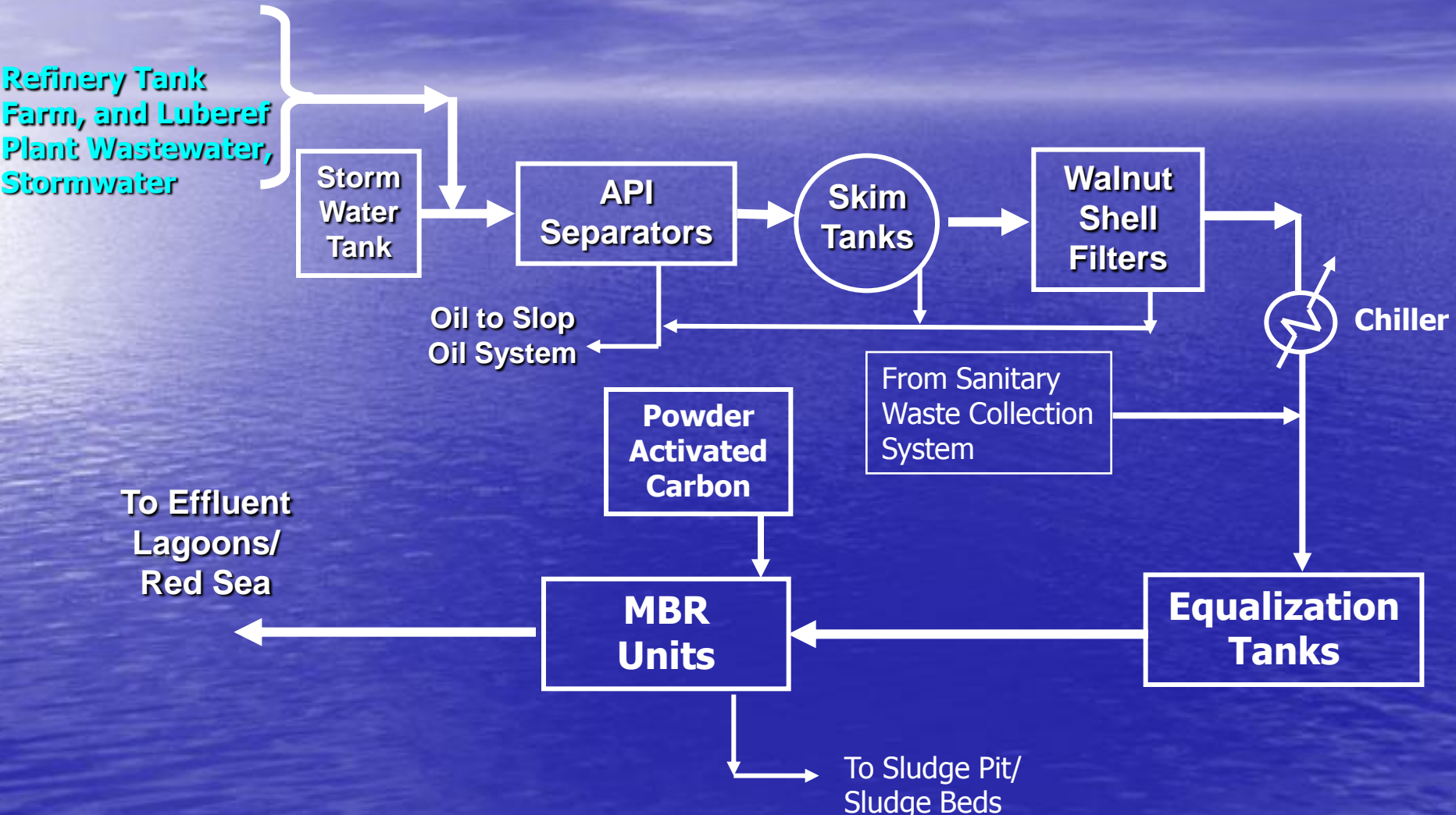
- In lieu of shutting down the Jeddah Refinery process units, the JR is to continue to run as a topping refinery until 2014 for the production of fuel oil and asphalt only
- Jeddah Refinery Tank Farm (including marine area) and Luberef to remain in operation

● **Impact on Phase 1 & 2 Wastewater Treatment Facilities**

- Phase 1 Facilities: none, except install 2nd API Separator in Phase 2
- Phase 2 Facilities: re-size equipment to handle 33% more flow & provide wastewater cooling
 - **Project Proposal: commenced on September 2007**
 - **Plant Start-Up: March 2011**

Currently Proposed Facilities

Phase 1 & 2 Industrial & Sanitary Wastewater Treatment Facilities



Design Capacity: ~ 2MM gpd (7900 M3/d)

PROJECT DEVELOPMENT SUMMARY

JEDDAH REFINERY WASTEWATER TREATMENT FACILITIES

- Pre-2001: Company conducts survey of all major plants and facilities for environmental compliance
- 2001: Company issues Environmental Master Plan
- 2002: Initial Study for Jeddah Refinery with conventional biological treatment recommended
- 2003: EPD recommends physical chemical treatment to facilitate operations (2nd Study)
- 2004: Future continued operations of Jeddah Refinery under study
- 2004: Implementation of JR WWTP in two phases; Phase I treatment for oil & grease and TSS only; Phase I engineering commences
- 2005: Management decision to discontinue operation of process refining units at Jeddah Refinery (1st Operational Change)

PROJECT DEVELOPMENT SUMMARY (Cont'd)

JEDDAH REFINERY WASTEWATER TREATMENT FACILITIES

- 2005: EPD recommends MBR for treatment of industrial wastewater & sanitary sewage (3rd Study)
- 2006: Evaluation of MBR treatment indicates viability
- 2007: In lieu of shutting down the Jeddah Refinery process units, the JR is to continue to run as topping refinery until 2014 (2nd Operational Change)
- 2007: Commence with engineering of Phase 2 wastewater treatment facilities
- 2008: 3rd Operational Change?????
- 2008: Startup of Phase 1
- 2011: Startup of Phase 2

A serene background image featuring a clear blue sky with wispy white clouds at the top. Below the sky is a vast, calm blue ocean. A bright sun is positioned on the left side of the horizon, creating a shimmering reflection on the water's surface. The overall color palette is dominated by various shades of blue, from deep cerulean to light sky blue.

Thank you

