CPET, Continued Professional Education and Training

Water Globe

THE MIDDLE EAST DESALINATION RESEARCH CENTER

Cost Estimating of SWRO Desalination Plants

Day 3: Desalination Project Costs – Trends, Examples and Interactive Session

June 27, 2013

13:00-13:30

3.3 Cost Estimating Session – Team Assignments

Nikolay Voutchkov, PE, BCEE

Interactive Cost Estimating Session - Outline

1. Form 5 Cost-estimating Teams – up to 7 People per Team.

2. Each Team is Assigned One Project and is Given Power Point Sheet to Fill up

3. Each Team Has One Hour to Develop Cost Estimate which Incorporates:
   - Capital Costs
   - O&M Costs
   - Cost of Water Production

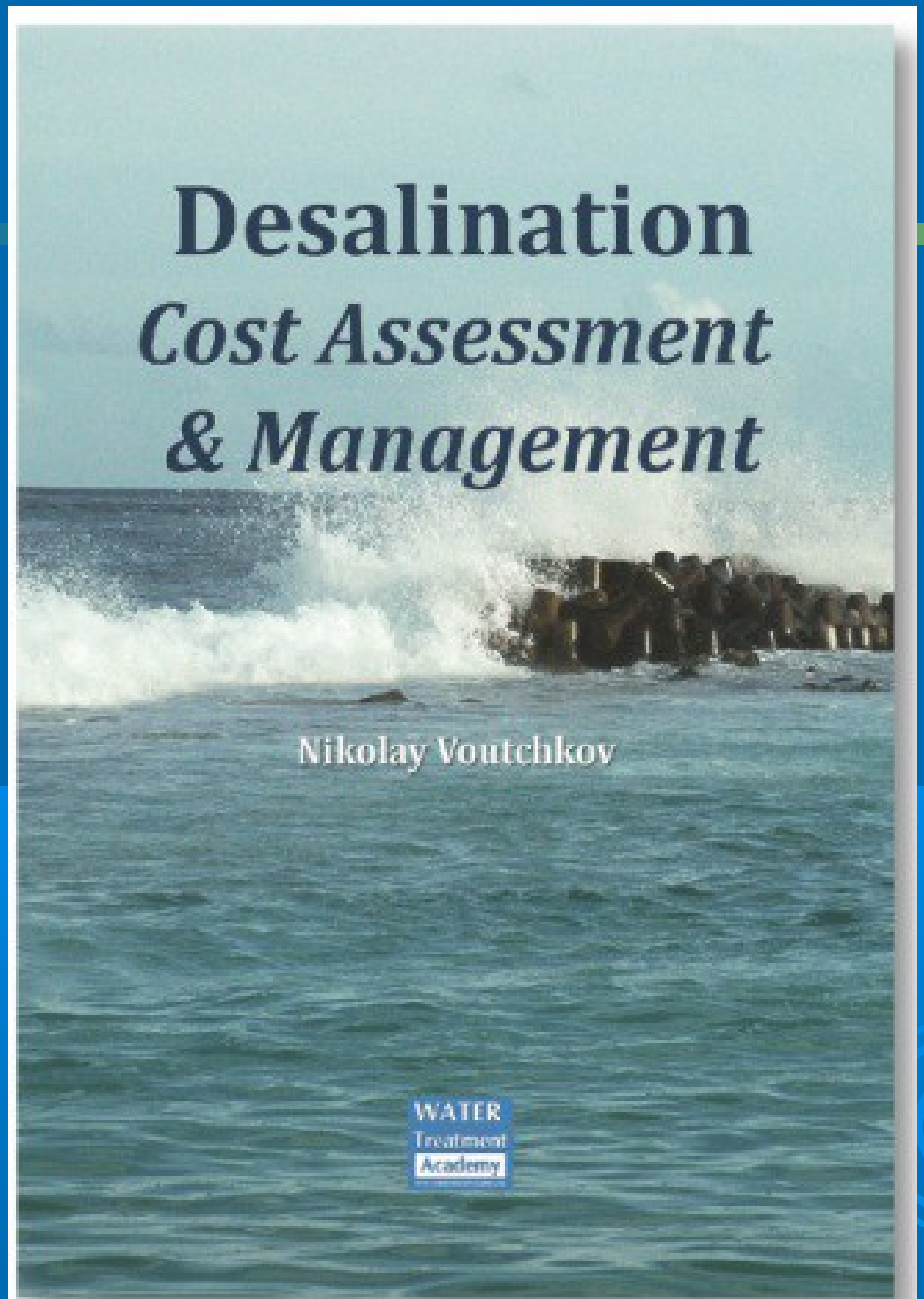
Interactive Cost Estimating Session – Outline (Continued)

4. Cost Estimates are Developed Based on the Toolbox and Format of Cost Estimating Example presented in Session 3.2

5. Each Team Saves Their Cost Estimate on USB Flash Drive and the Estimates are Loaded on the Main Computer During the Coffee Break

5. Each Team Will Have 15 min After the Break to Present their Cost Estimate.

6. The Team Which Comes Closest to the Actual Project Water Cost Receives a Praise.

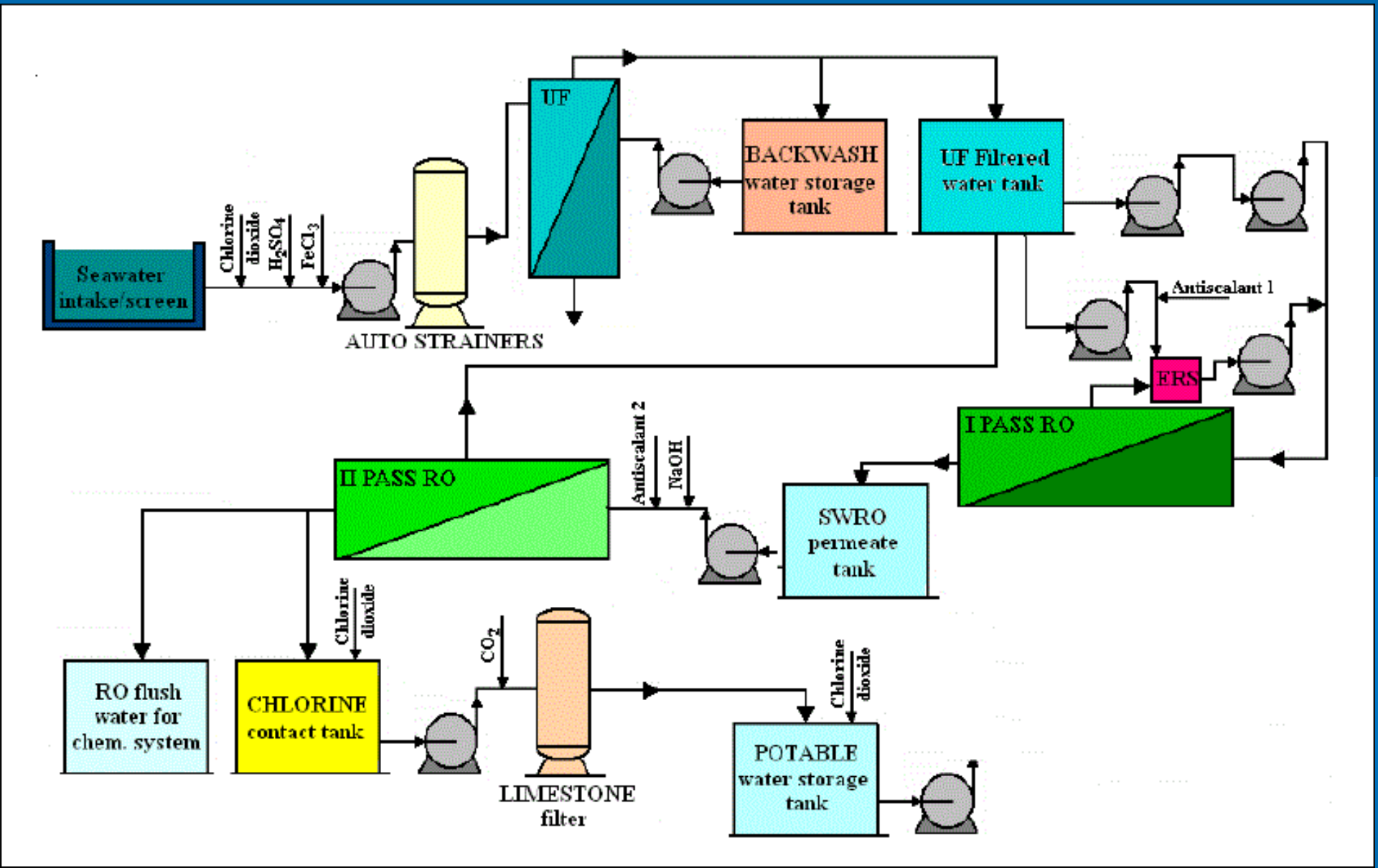

Desalination
Cost Assessment
& Management
Nikolay Voutchkov
WATER
Treatment
Academy

Select One of the Following Projects:

1. 64 MLD Palm Jumeirah SWRO Plant, UAEs – Arabian Gulf
2. 140 MLD Fujairah SWRO Plant, UAE – Arabian Gulf
3. 75.8 MLD Jorf Lasfar SWRO Plant, Morocco – Mediterranean
4. 64 MLD Larnaca SWRO Plant, Cyprus - Mediterranean
5. 150 MLD Shuaibah SWRO Plant, Saudi Arabia – Red Sea

64 MLD Palm Jumeirah, Dubai
Norit UF System

64 MLD Palm Jumeirah, Dubai
Process Schematic



64 MLD Jumeirah Plant – Key Statistics

Parameter	Value	Parameter	Value
Capacity – m3/d	64,000	Intake – 245.4 MLD Discharge – 181.4 MLD	Intake – Onshore Intake/Onshore Discharge
Date Commissioned	2008	Pretreatment System	Micro screens & UF Pressure Filters
Recovery	40 %	RO System (Hydranautics Membranes)	Conventional RO Design 2 passes/2 stages
Feed TDS, ppt	40 - 44 (42 avg.)	Energy Recovery System	DWEER Pressure Exchangers
Feed Temperature	22 to 36 ºC (28 ºC avg.)	Energy Use	4.1 kWh/m³
Unit Cost of Power	US$0.03/kWh	Post-treatment	Calcite Filters & CO2

64 MLD Palm Jumeirah Schematic

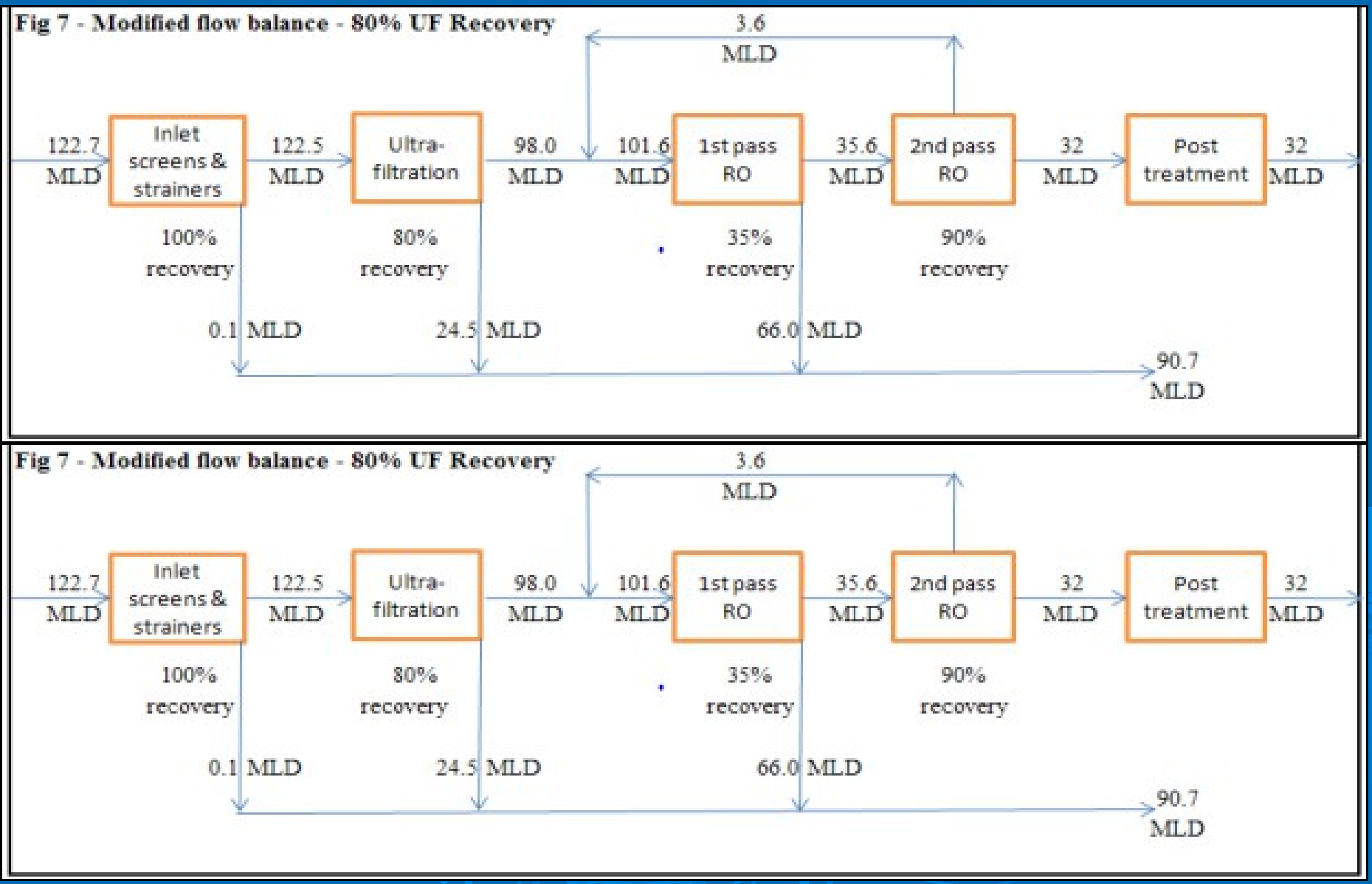


Fig 7 - Modified flow balance - 80% UF Recovery
3.6 MLD
122.7 MLD
Inlet screens & strainers
122.5 MLD
Ultra-filtration
98.0 MLD
101.6 MLD
1st pass RO
35.6 MLD
2nd pass RO
32 MLD
Post treatment
32 MLD
100% recovery
80% recovery
35% recovery
90% recovery
0.1 MLD
24.5 MLD
66.0 MLD
90.7 MLD

Fujairah SWRO Plant, UAE

Fresh Water Production Capacity = 140,000 m^3/d

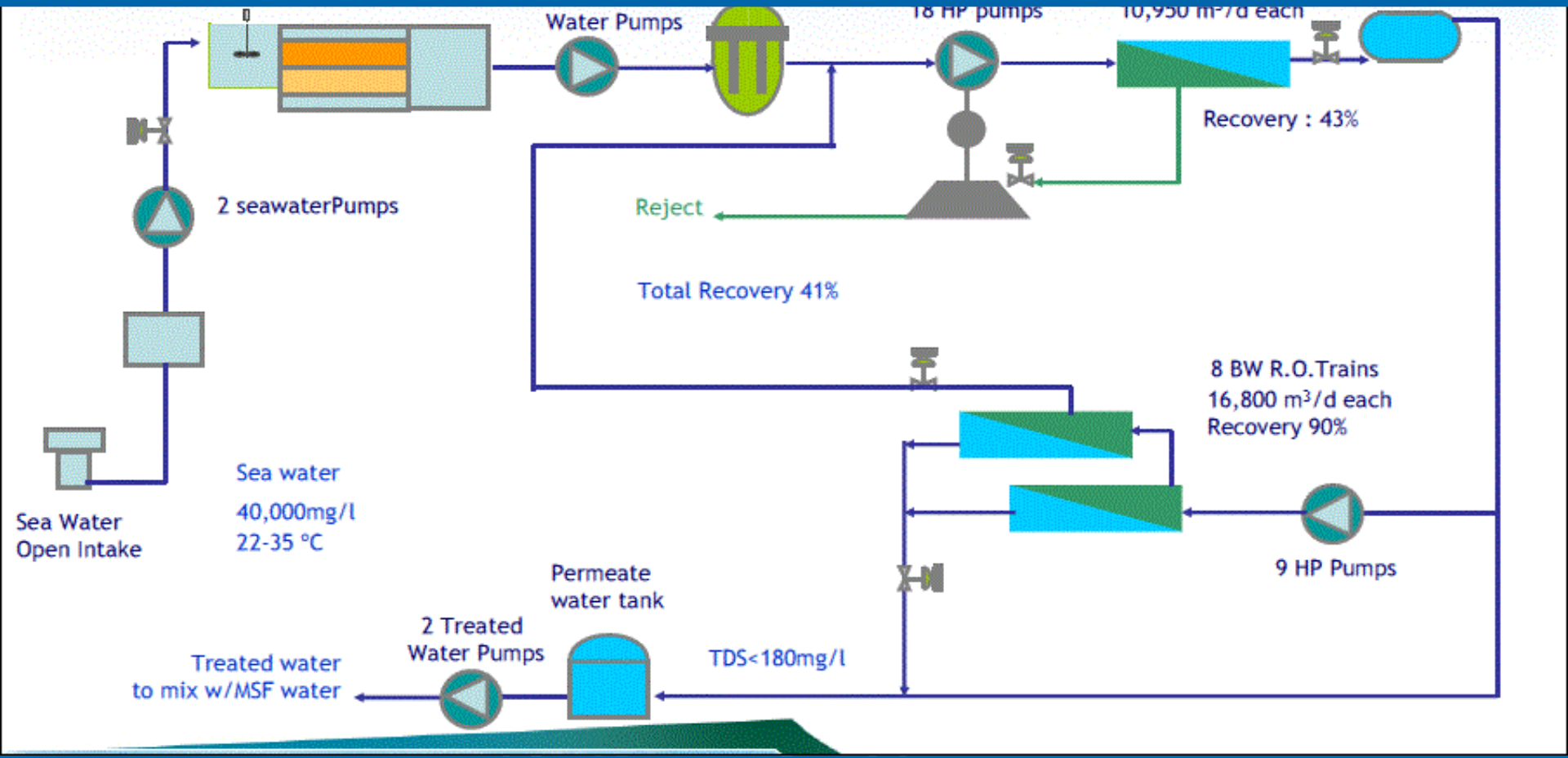
Fujairah – Key Statistics

Parameter	Value	Parameter	Value
Capacity – m3/d	140,000	Intake/Discharge **Intake = 376 MLD** **Discharge = 236 MLD**	1.5 km Offshore Intake/Onshore Discharge
Date Commissioned	2002	Pretreatment System	Dual Media Gravity Filters
Recovery	41 %	RO System (Hydranautics Membranes)	Conventional RO Design 2 passes/2 stages
Feed TDS, ppt	40 - 42 (26 avg.)	Energy Recovery System	Pelton Wheels
Feed Temperature	22 to 36 ºC (28 ºC avg.)	Energy Use	4.5 kWh/m³
		Post-treatment	Lime + CO2

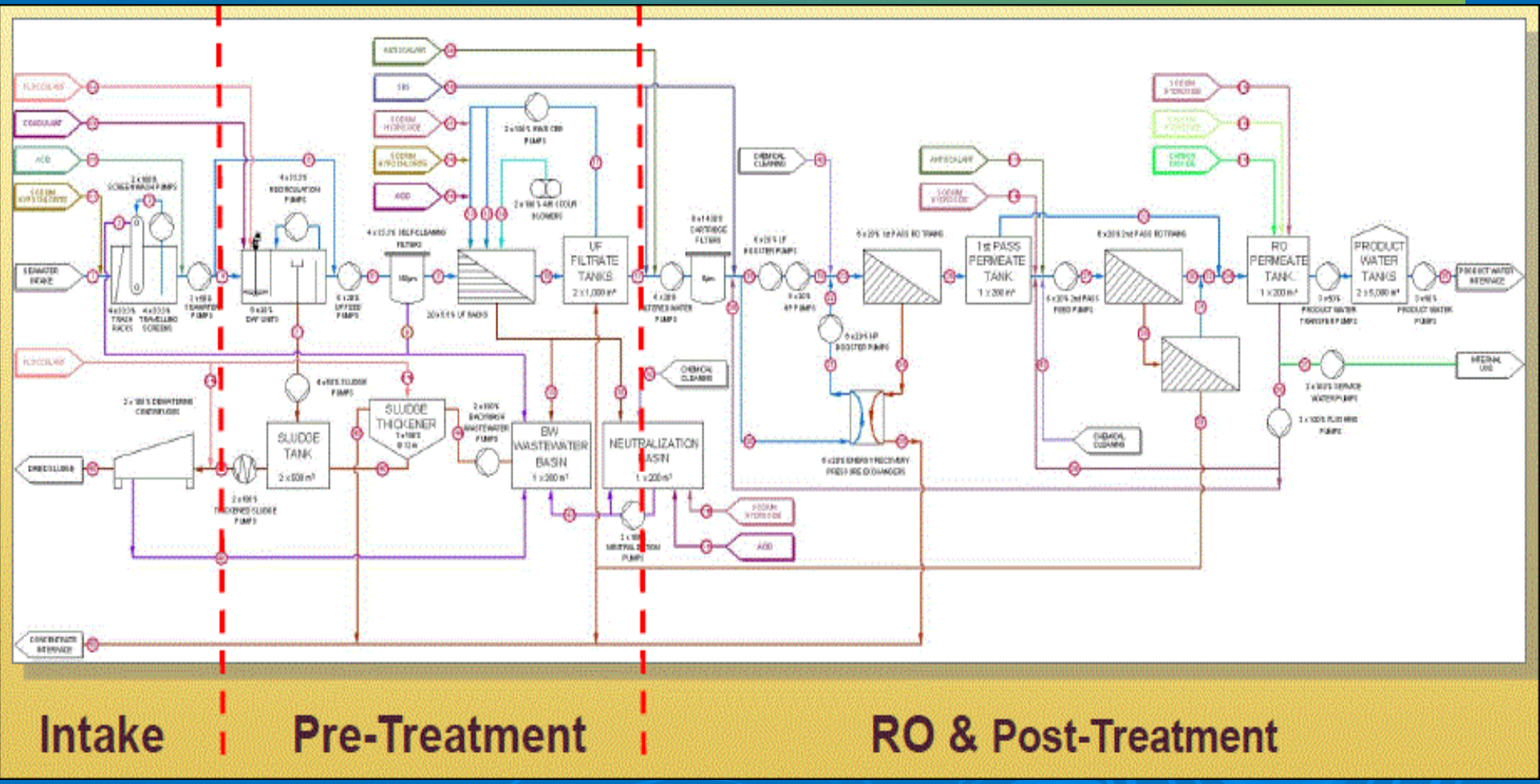
Fujairah Intake System – 1.5 km Offshore

Treatment Processes

Fujairah Seawater Desalination Plant
140,000 m³/d



75.8 MLD Jorf Lasfar, Morocco



75.8 MLD Jorf Lasfar SWRO Plant– Key Statistics

Parameter	Value	Parameter	Value
Capacity – m3/d	75,800	Intake/Discharge **Intake = 203 MLD** **Discharge = 127.2 MLD**	Onshore Intake & Onshore Discharge
Date Commissioned	2013	Pretreatment System	DAF + UF
Recovery	41 %	RO System (Hydranautics Membranes)	Conventional RO Design 2 passes/2 stages
Feed TDS, ppt	36 - 40 (38 avg.)	Energy Recovery System	ERI Pressure Exchangers
Feed Temperature	24 to 34 ºC (30 ºC avg.)	Energy Use	3.8 kWh/m³
Unit Cost of Power	US$0.04/kWh	Post treatment	Lime + CO2

75.8 MLD Jorf Lasfar, Morocco – Onshore Intake – Recovery 43 %

SEAWATER INTAKE

– Type of Intake	Open (existing cooling seawater channel)	
– Screening System		
• Trash Racks	4 x 33.3% / 30 mm	Phase III
• Travelling Screens	4 x 33.3% / 3 mm	Phase III
– Seawater Intake Pumps	3 x 50% (Phase I)	

75.8 MLD Jorf Lasfar, Morocco – Product Water – Partial Second Pass

PRODUCT WATER

– Use of Product Water	Process & Drinking
– Chlorides	< 200 mg/l
– Boron	< 1 mg/l
– LSI	+0.1 - +0.5

75.8 MLD Jorf Lasfar, Morocco – Pretreatment –DAF + UF

- **PRE-TREATMENT**
  - DAF System
    - In service **only** during **Harmful Algae Blooms** and/or **high level of hydrocarbons**
    - No. of lines — 6 x 20%
    - Coagulation — Static mixer - $FeCl_3$
    - Flocculation — 2 stages - Coagulant Aid
    - Flotation Cells equipped with sludge surface scrappers
    - Recycling system

75.8 MLD Jorf Lasfar, Morocco – Pretreatment –DAF + UF

PRE-TREATMENT

- UF System
  - Required UF Permeate Quality

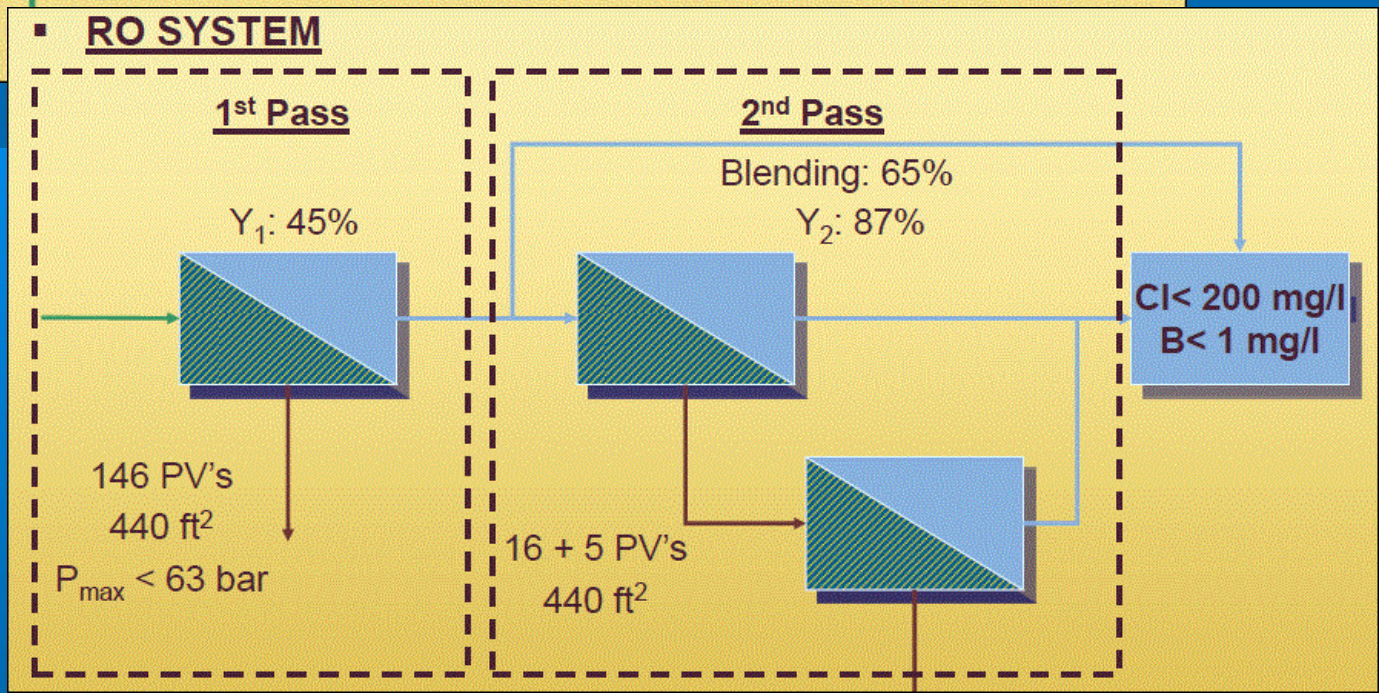
– TSS	Undetectable
– Turbidity	< 1 NTU (100% of time)
– SDI	< 2.5 (95% of time)
	< 3 (100% of time)

75.8 LD Jorf Lasfar Plant – RO System

RO SYSTEM

- Permeate composition limiting parameters:
  - Cl < 200 mg/l
  - B < 1 mg/l
- 5 years AMLT

Double Pass Configuration
(2nd partial pass required from 17°C)



75.8 MLD Jorf Lasfar Plant – RO System (Continued)

- **RO SYSTEM**
  - Cartridge Filters
    - Security Filtration 8 x 14.3% (5 µm)
  - RO Trains
    - 6 x 20% Production units (HPP + ERS + RO Racks 1st & 2nd pass) of 15,300 m^3/d each
    - 6 x 20% High Pressure Pumps
    - 6 x 20% Energy Recovery Systems (pressure exchangers)

75.8 MLD Jorf Lasfar Plant – Post Treatment

POST-TREATMENT

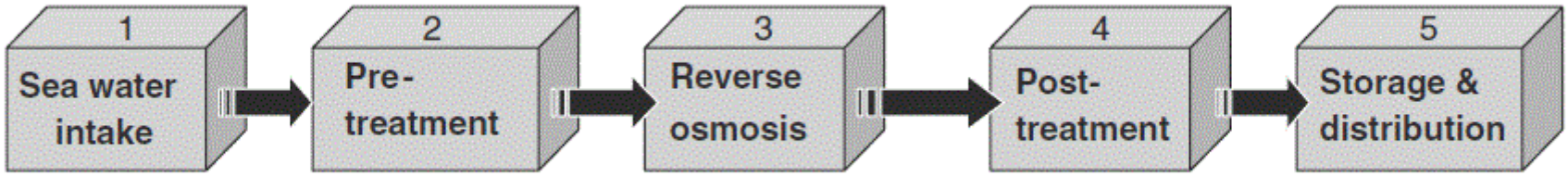
- Remineralization
  - CO_2 dosing
  - Lime dosing
- Product Water Pumping Station
  - 2 x 5,000 m^3 Product Water Tanks
  - 3 x 50% Product Water Pumps to OCP and ONEP reservoirs

64 MLD Larnaca SWRO Plant - Cyprus

64 MLD Laranca SWRO Plant– Key Statistics

Parameter	Value	Parameter	Value
Capacity – m3/d	64,000	Intake/Discharge **Intake = 164 MLD** **Discharge = 100 MLD**	Offshore HDPE Intake – 80 MLD/1.1 km Offshore HDPE Pipe Discharge – 1.5 km
Date Commissioned	2008 (expanded)	Pretreatment System	Single-stage gravity media filters
Recovery	43 %	RO System (Hydranautics Membranes)	RO Design Partial Second Pass
Feed TDS, ppt	36 - 41 (38 avg.)	Energy Recovery System	Pelton Wheels
Feed Temperature	20 to 32 ºC (28 ºC avg.)	Energy Use	4.42 kWh/m³
Unit Cost of Power	US$0.09/kWh	Post-treatment	Calcite Contactors & CO2

64 MLD Larnaca SWRO Plant - Treatment Schematic



- Intake pipe
- Screens
- Pumping station

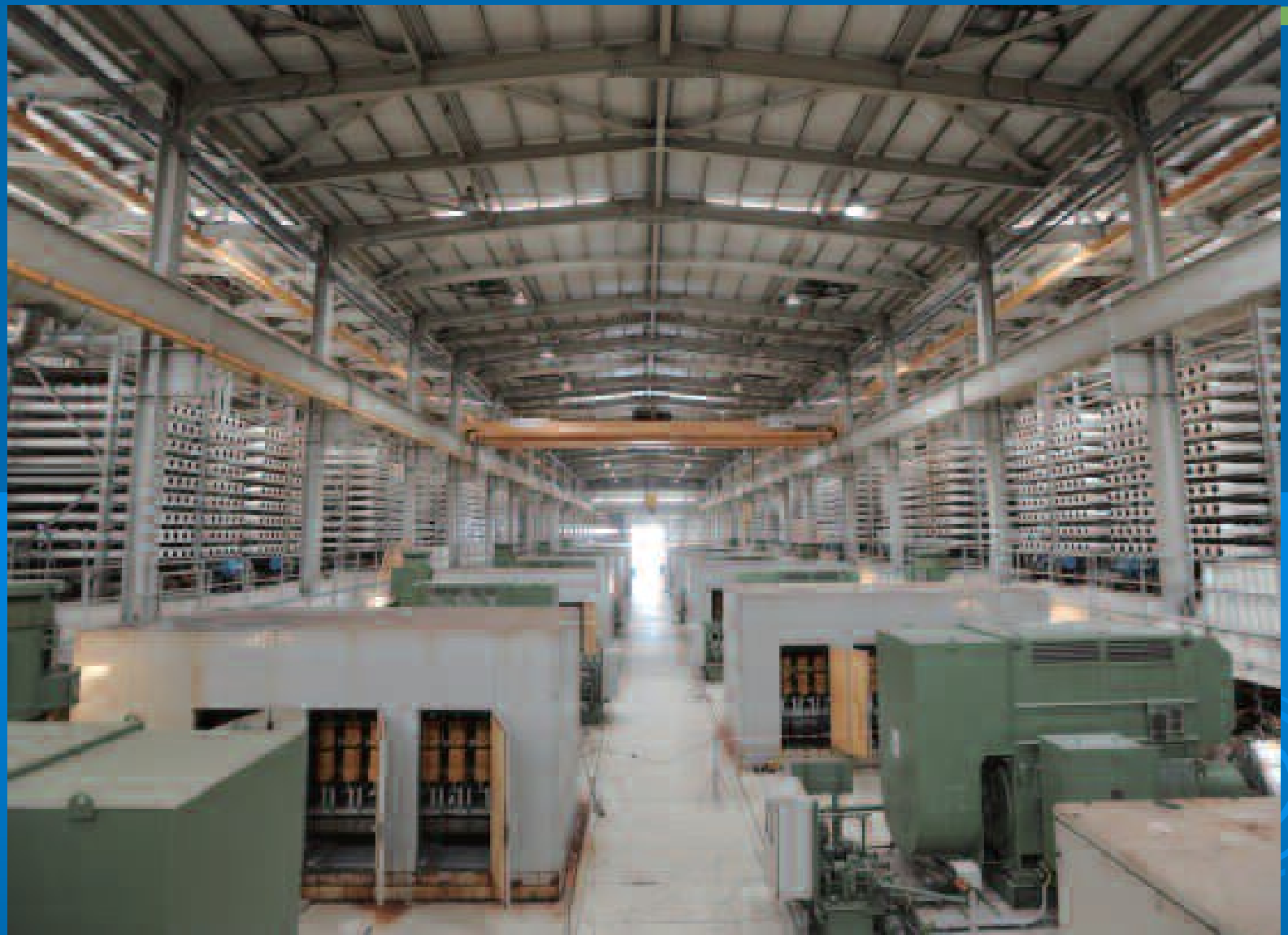
- Coagulation / flocculation
- Dual media filtration
- Booster pump
- Micro filtration

- High pressure pumps
- Membrane trains (1st & 2nd stage)
- Energy recovery
- Antiscalant dosing

- Chemical dosing
- Limestone reactors

- Product tank
- Chlorination
- Pumping station (13 km)

150 MLD Shuaibah SRWO Project S. Arabia – Red Sea



150 MLD Shuaibah SWRO Plant– Key Statistics

Parameter	Value	Parameter	Value
Capacity – m3/d	150.000	Intake/Discharge	Onshore Intake – 389 MLD Onshore Discharge
Date Commissioned	2008 (expanded)	Pretreatment System	Single-stage pressure granular media filters
Recovery	40 %	RO System (Hydranautics Membranes)	RO Design Full Second Pass
Feed TDS, ppt	44 - 46 (44.46 avg.)	Energy Recovery System	ERI Pressure Exchangers
Feed Temperature	25 to 35 ºC (30 ºC avg.)	Energy Use	4.8 kWh/m³
Unit Cost of Power	US$0.03/kWh	Post-treatment	Limestone Contactors & CO2

150 MLD Shuaibah SWRO Plant

Design Parameters

- Seawater Temp. 25~35 ℃

  TDS 44,460 ppm
- Feed flow rate 389,000 m3/day
- Permeate flow 150,000 m3/day (33 MIGD)
- Permeate TDS 45 ppm
- Pretreatment

  Coagulant + Dual Media Filtration (Pressure)
- Number trains

  1st pass 10 / 2nd pass 10
- Conversion rate

  1st pass 41.5% / 2nd pass 90 %

150 MLD Shuaibah Pretreatment System

SHUAIBAH SWRO - DMF

Design Parameters

- Number of DMF : 31 Op + 1 St
- Design Flow per Filter : 520 m3/h
- Diameter of Filter : 4.5 m
- Length of Filter : 12.5m
- Chemical Dosing for Coagulation
  Ferric Chloride + H2SO4
- SDI Value :
  SDI < 4 : 95%, SDI < 5 : 100%
- Max NTU : less than 1
- Media Depth :
  Sand : 0.45 – 0.55mm, Depth : 305mm
  Anthracite : 1.0 – 1.1mm, Depth : 1092mm


Questions?