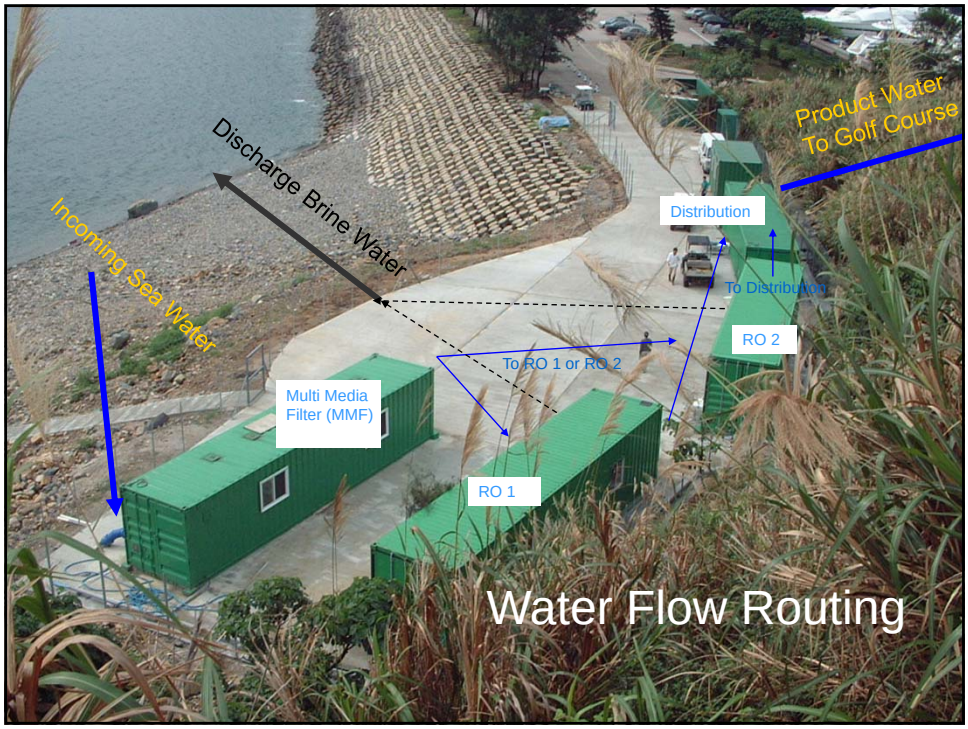
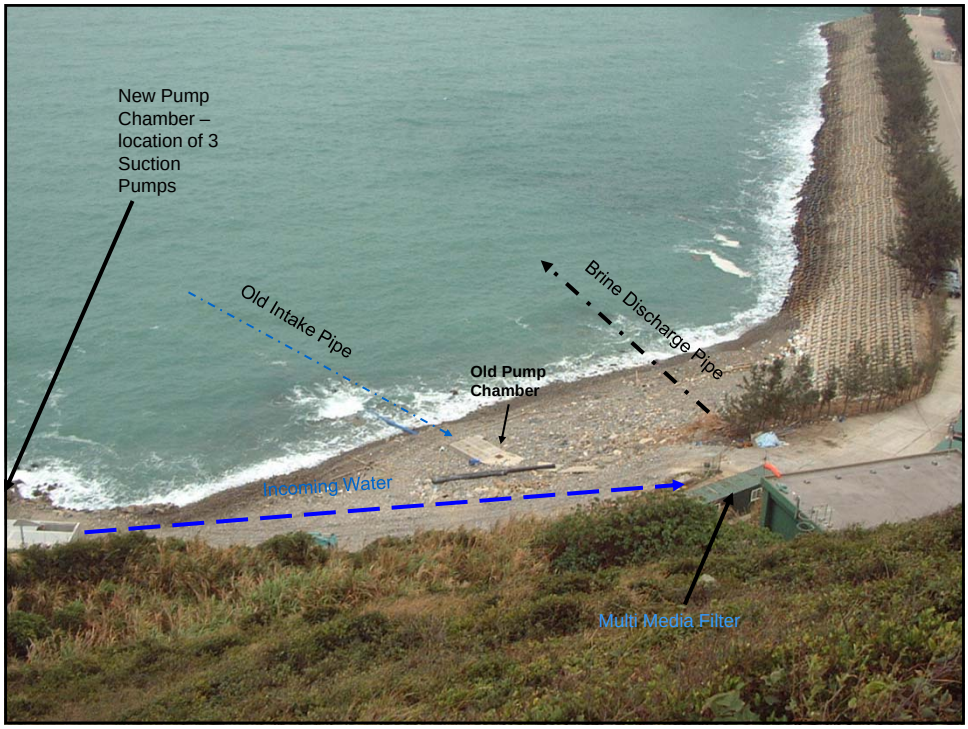

Clearwater Bay's Reverse Osmosis Plant
Spare Parts Container
Distribution Container
RO 2 Container
RO 1 Container
Multi Media Filter Container

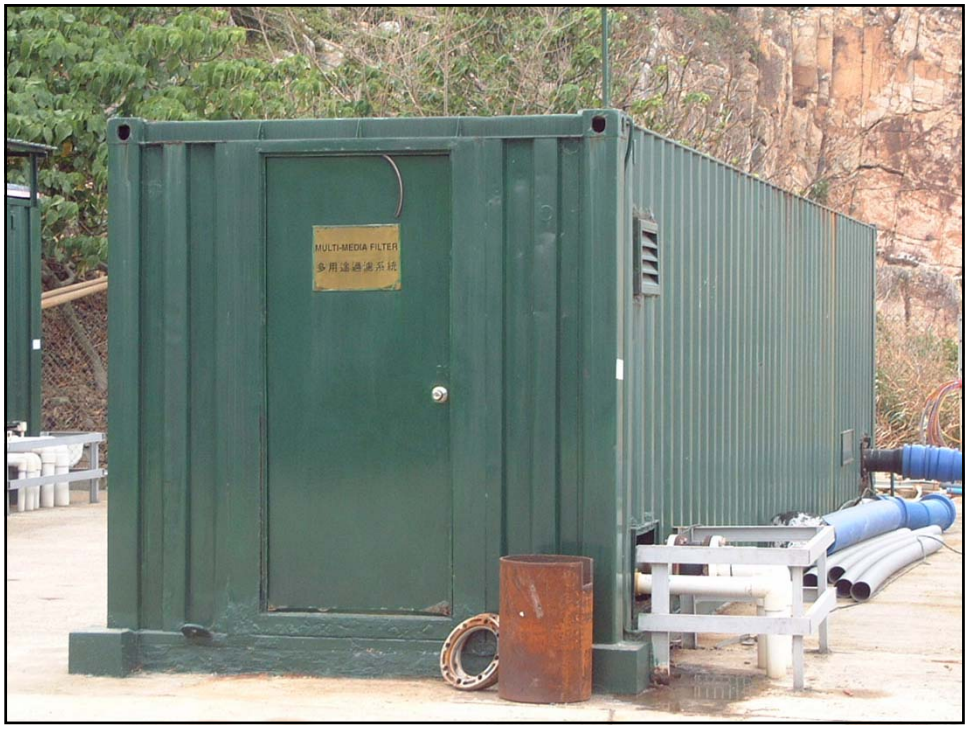

Discharge Brine Water
Incoming Sea Water
Product Water To Golf Course
Distribution
To Distribution
RO 2
To RO 1 or RO 2
Multi Media Filter (MMF)
RO 1
Water Flow Routing


New Pump Chamber – location of 3 Suction Pumps
Old Intake Pipe
Brine Discharge Pipe
Old Pump Chamber
Incoming Water
Multi Media Filter

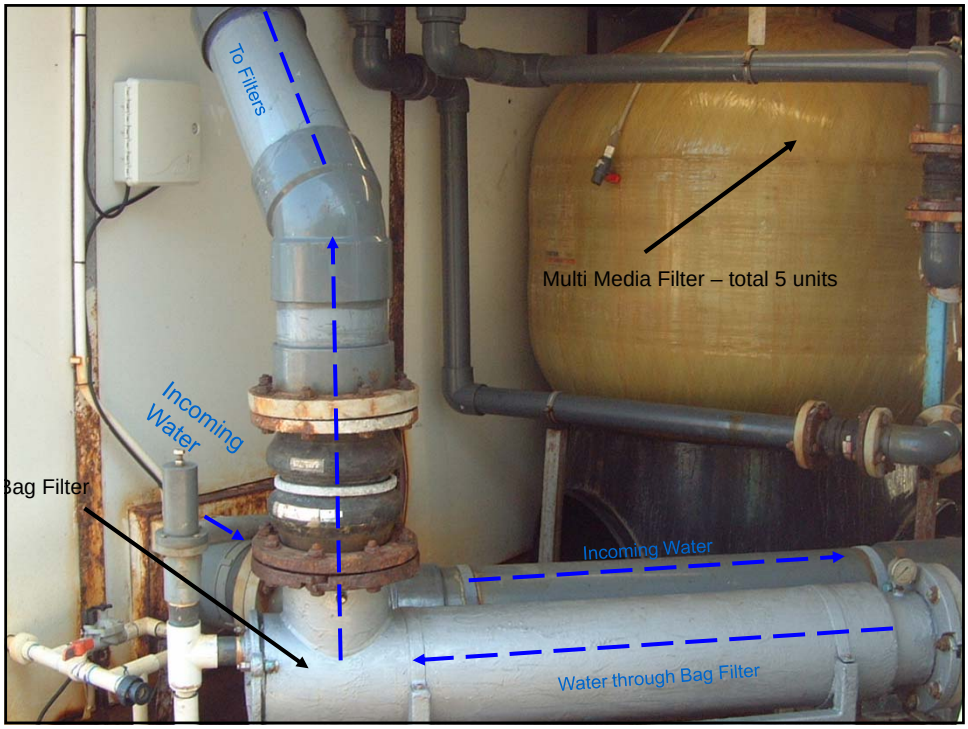

Inlet for Intake Pipe
Intake Chamber

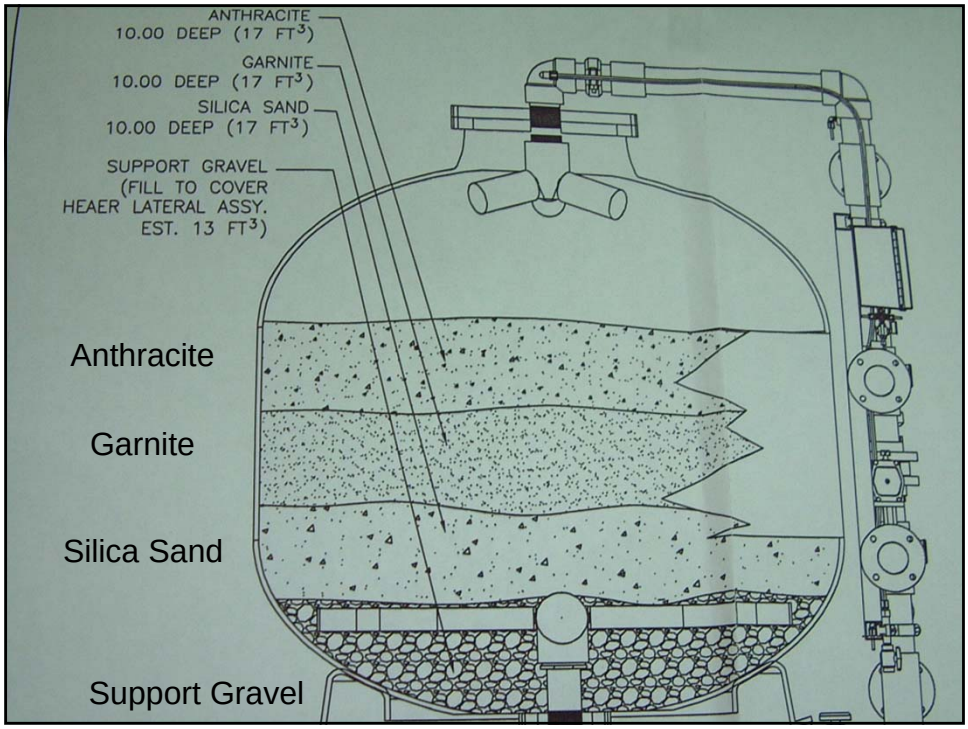
Inside Intake Chamber

Inside Intake Chamber


MULTI-MEDIA FILTER
多用途過濾系統


Multi Media Filter Tank


To Filters
Multi Media Filter – total 5 units
Incoming Water
Bag Filter
Incoming Water
Water through Bag Filter

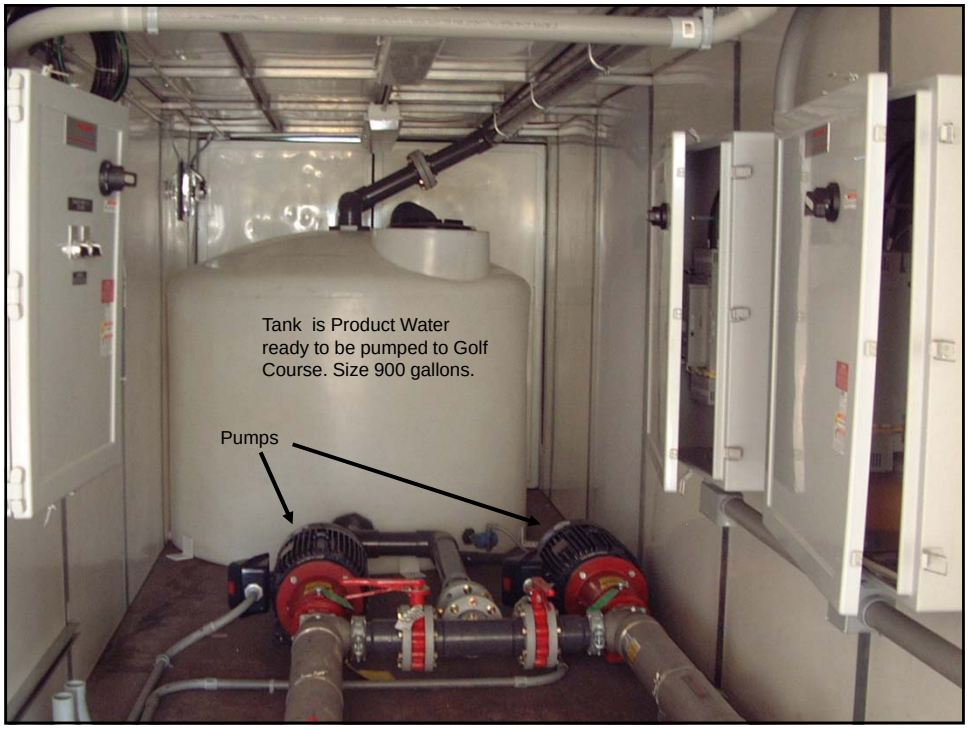

ANTHRACITE
10.00 DEEP (17 FT3)
GARNITE
10.00 DEEP (17 FT3)
SILICA SAND
10.00 DEEP (17 FT3)
SUPPORT GRAVEL
(FILL TO COVER
HEAER LATERAL ASSY.
EST. 13 FT3)
Anthracite
Garnite
Silica Sand
Support Gravel


RO 1


Vessels – Each contains
7 Membranes
Pump
Motor 100 hp


Cartridge
Filters
Turbo Charger


DISTRIBUTION SYSTEM
分流系統


Tank is Product Water ready to be pumped to Golf Course. Size 900 gallons.
Pumps


CIP Tank

Clearwater Bay Golf and Country Club

Water Production of the Plant - Based on 2 RO Plants operating 24 hours day

Recovery Rate	Production (m3) per plant	Production (m3) 2 plants	Production (gallons) 2 plants
40%	650	1,300	344,500
39%	644	1,287	341,055
38%	637	1,274	337,610
37%	631	1,261	334,165
36%	624	1,248	330,720
35%	618	1,235	327,275
34%	611	1,222	323,830
33%	605	1,209	320,385
32%	598	1,196	316,940

Clearwater Bay Golf and Country Club

Capital Cost of the System in 2004

	($HK)	($US)
RO Plant (GE - General Electric - USA) - 1 Multi Media Filters Container - 2 RO Containers - 1 Distribution Container	6,000,000	769,231
Pipeline Works - Piping and Cabling	3,800,000	487,179
Staff, Consultants and Technicians - Project Manager - RO Consultant - Technical Consultants	485,000	62,179
Environmental Monitoring - EPD (Environmental Protection Dept.)	120,000	15,385
Contingency (3%)	330,000	42,308
Total Capital Cost	**10,735,000**	**1,376,282**

Clearwater Bay Golf and Country Club

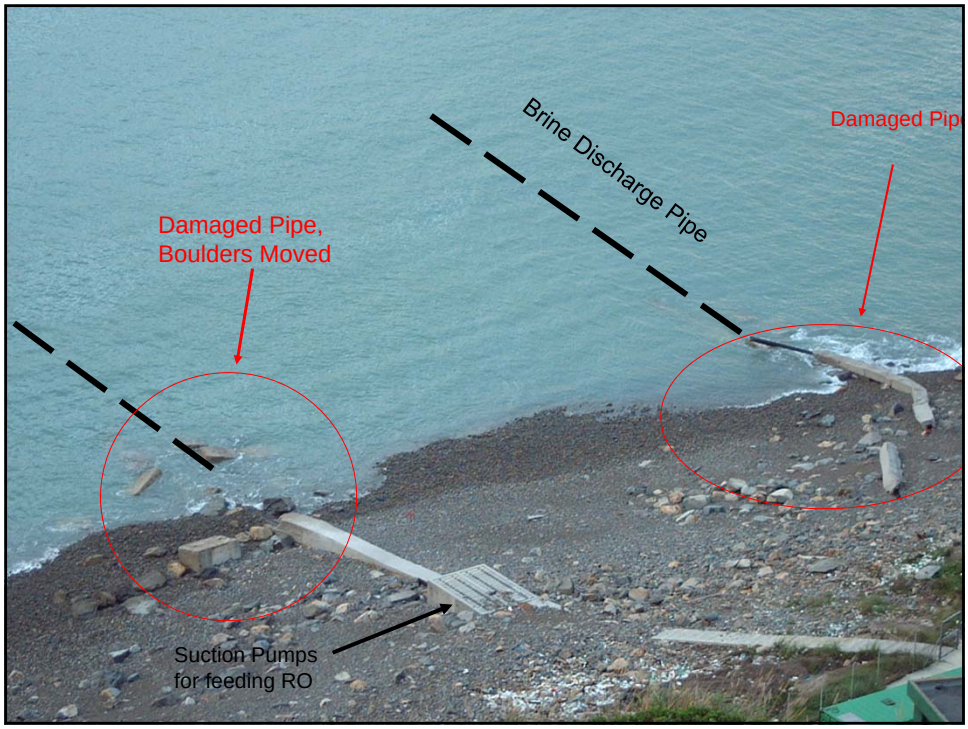
RO Plant Maintenance Expenses by Year

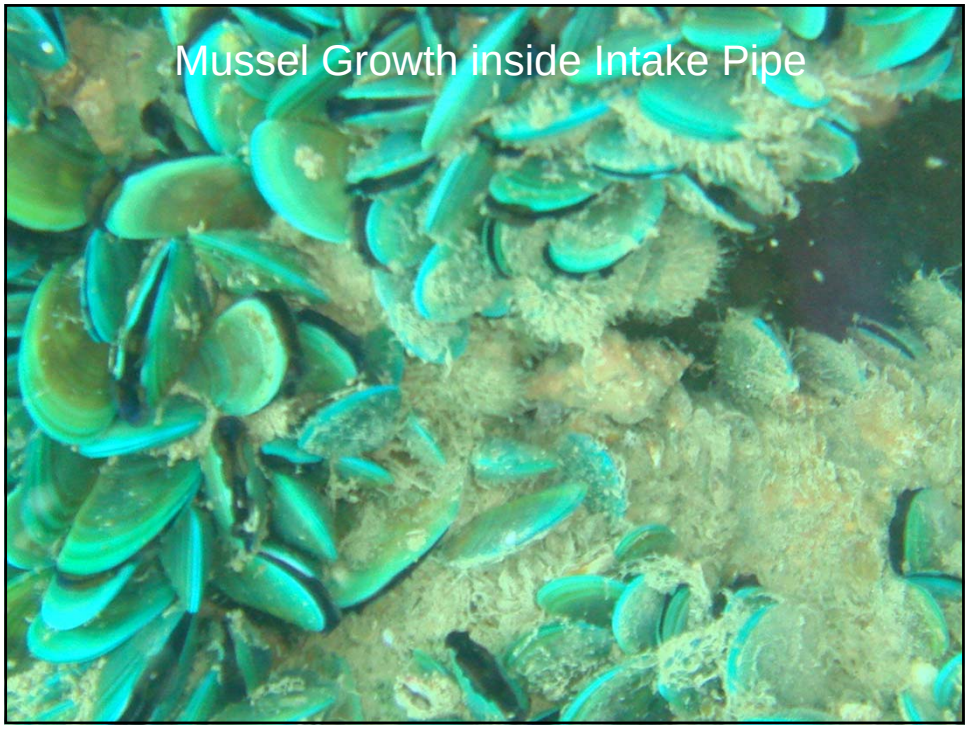
	2007-2008		2009-2010	
	$HK	%	$HK	%
Payroll & Related Expenses	256,710	12%	523,813	22%
Cleaning Supplies	0	0.0%	0	0%
Consultancy Fees	240,052	11%	200,890	8%
Equipment Repairs	820,587	38%	720,945	30%
RO Supplies	6,715	0.3%	119,756	5%
Admin Charges	2,217	0.1%	6,567	0.3%
General Fees	0	0.0%	1,450	0.1%
Electricity	859,638	39%	860,680	35%
Total Expenses	**2,185,919**		**2,434,101**	

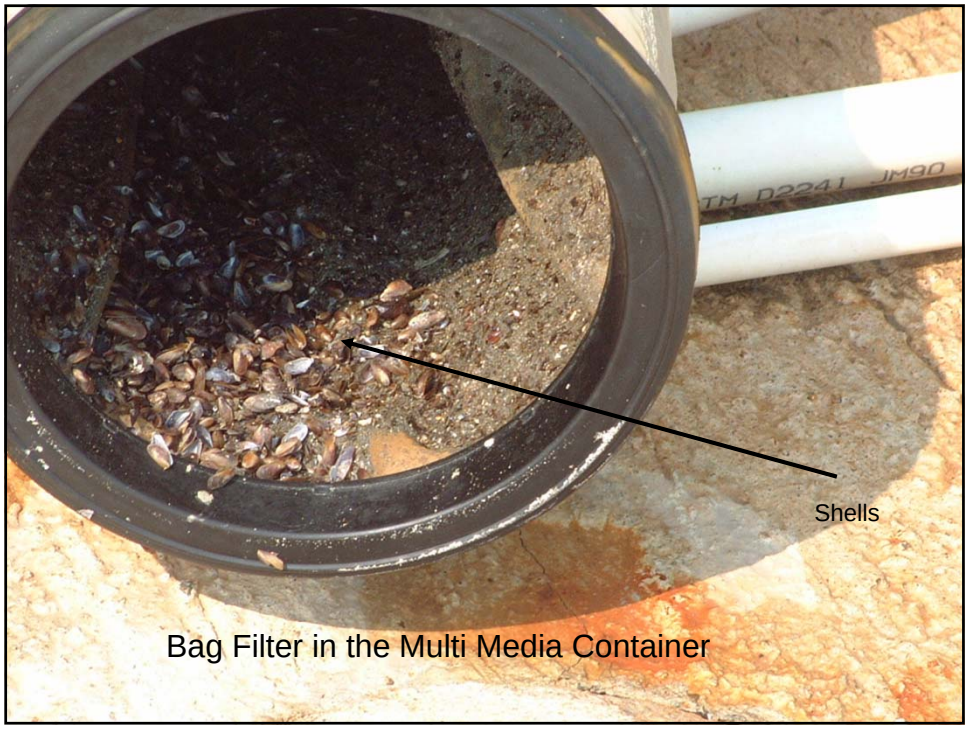
Major Issues with the RO Plant

- Typhoons.
- Marine Growth in the Intake Pipe.
- Corrosion of Distribution and Irrigation Pipes.


Typhoon Damage


Brine Discharge Pipe
Damaged Pipe,
Boulders Moved
Suction Pumps
for feeding RO


Mussel Growth inside Intake Pipe


Shells
Bag Filter in the Multi Media Container

Intake Grill – 4 months with marine growth

Clearwater Bay Golf and Country Club

		RO Water Sample Test Result					Soil Test Result		
		Water Transfer Route from Permeate to Sprinkle							
	Unit of measure	**Permeate**	**Pond 1**	**Pond 2**	**Sprinkler**	**Guideline**	**Sample Grn 2**	**Desired**	**Guideline**
CEC							5.4		Ok
Zinc	ppm						15	3-8	Very High
Copper	ppm						16	1-3	Very High
Sulfur	ppm						16	6-16	Ok
Sulfate (SO4)	ppm	4	7	13	10	Low			
Manganese (Mn)	ppm	0.01	0.01	0.01	0.01	Low	12	18-52	Very Low
Total Disolved Salts (TDS)	ppm	450	425	411	375	Low			
Chloride	ppm	206	155	119	119	Med-High			
Sodium Absorption Ratio (SAR)	meq/l	17.4	10.03	5.08	6.75	Med-High	2.5	<3	Ok
pH	----	6.7	7.7	8.3	7.3	Medium	6.1		Ok
Electrical Conductivity (Ecw)	mmhos/com	0.73	0.58	0.49	0.49	Medium	1.3	<3	Ok
Total Soluble Salts (TSS)	ppm	467	371	314	314	Medium	0.24	.44-1.4	Low
Sodium	meq/l	142	105	81	86	High	73	9	High
Hardness	----	12.6	20.7	48.1	30.7	Very Low			
Bicarbonates	ppm	7	7	12	10	Very Low			
Carbonates	ppm	0	0	0	0	Very Low			
Nitrates (NO3)	ppm	0.34	0.2	0.36	0.86	Very Low	15	<15	Ok
Phosphate (PO4)	ppm	0.4	0.01	0.01	0.01	Very Low			
Potassium (K)	ppm	6	6	6	6	Very Low	47	103	Low
Magnesium (Mg)	ppm	3	2	5	2	Very Low	54	79	Low
Calcium (Ca)	ppm	0.1	5	11	9	Very Low	658	663	Little Low
Iron (Fe)	ppm	0.01	0.01	0.1	0.01	Very Low	67	8-52	High
Boron (B)	ppm	1.2	0.8	0.6	0.6	Very Low	1	1-3	Ok

Note:		Colder Months	Warmer Months
Feed Water Salinity	ppm	35,000-38,000	27,000-35,000
Brine Water Salinity	ppm	50,000-55,000	37,000-50,000

Clearwater Bay Golf and Country Club

Environmental Protection Department (EPD) Requirements

Samples taken from 3 Sampling Points
- Seawater Intake
- Brine Discharge on RO 1 and RO 2

1. Weekly - Water Samples tested for the Following
   - Salinity
   - TDS (Total Dissolved Solids)
   - pH
   - Temperature

2. Monthly - Water Samples Tested for the following
   - Arsenic
   - Barium
   - Cadmium
   - Iron
   - Mercury
   - Selenium
   - Vanadium
   - Zinc
   - Cyanide
   - TSS (Total Suspended Solids)

3. Monthly - Water Samples tested for the following from Multi Media Filter discharge
   - TSS

4. Every 6 months - Water Samples tested for the following from Brine Discharge site at Ocean
   - Salinity
   - TDS (Total Dissolved Solids)

Introduction

Reverse Osmosis

What is Reverse Osmosis?

Reverse Osmosis (RO) is a membrane process used to remove salts from water.

Why is Reverse Osmosis Used?

RO is used to provide alternate water supplies for areas where potable water is limited and/or purified water is required.

Where is Reverse Osmosis is used?

It is used world-wide in the following Markets:

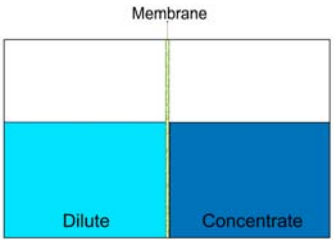
Golf Courses, Food, Beverage, Semi-Conductor, Resorts, Municipalities, Power, Industry, Construction, Ships, Pharmaceutical, Wastewater Reuse

What is Osmosis?

Osmosis

Osmotic flow is the spontaneous flow of water from a pure water solution to the higher salinity solution.

Osmotic pressure is the pressure that must be applied to the saline solution to prevent osmotic flow of water.



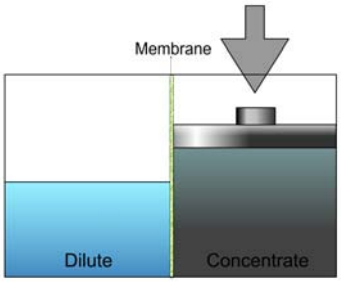
Osmosis

What is Reverse Osmosis?

Reverse Osmosis

Reverse Osmosis is the reversal of flow by pushing water from the high salinity solution to pure water solution through membrane.

The pressure applied (P) must be in excess of the osmotic pressure



Reverse Osmosis

Reverse Osmosis

There are three major types of Reverse Osmosis in terms of function:

- Seawater Reverse Osmosis (SWRO)
- Brackish Water Reverse Osmosis (BWRO)
- Nanofiltration for membrane softening (NF)

Depending on the type of removal required there are different membranes.

Reverse Osmosis

- Seawater Reverse Osmosis (SWRO)

Salt Concentration: 10,000 - 50,000 mg/l TDS
Membrane Feed Pressure: 800-1400 psi
Sources: Surface Waters or Beach Wells

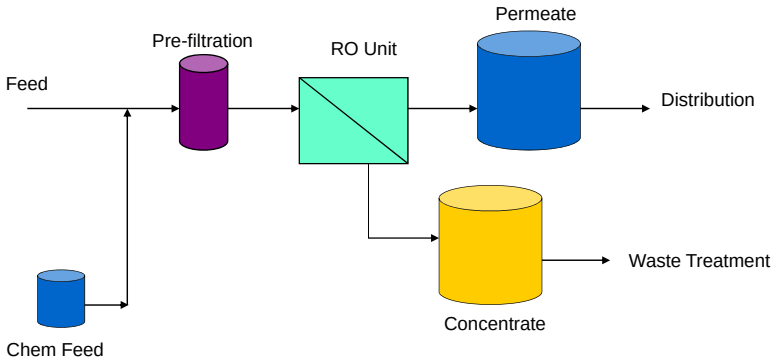
- Brackish Water Reverse Osmosis (BWRO)

Salt Concentration: 500 - 5,000 mg/l TDS
Membrane Feed Pressure: 100-600 psi
Sources: Recycling, Groundwater, Surface Water, Industrial Water

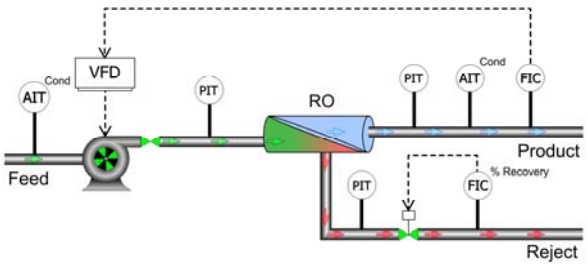
- Nanofiltration (NF) / Membrane Softening

Salt Concentration: 100 - 500 mg/l TDS
Membrane Feed Pressure: 50-300 psi
Sources: Boiler Feedwater, Potable or Ultrapure applications

Process Flow Diagram - RO



RO Flow Diagram



RO Membranes

Standard sizes for membranes:
8” diameter x 40” long
4” diameter x 40” long

Reverse Osmosis Membranes

There are two physical types of Membrane:

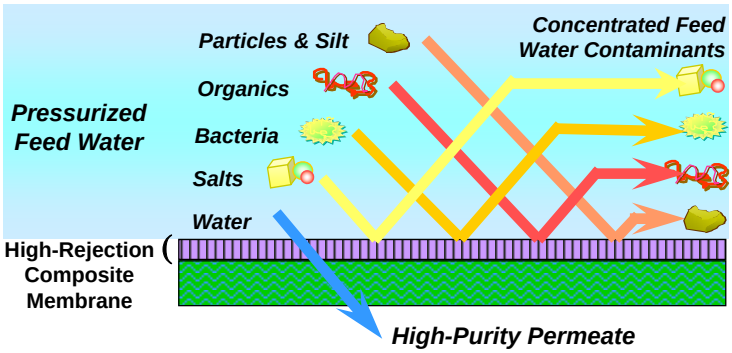
- Hollow Fiber Membranes – No longer used
- Spiral Wound Membranes - Common today.

Reverse Osmosis Membranes

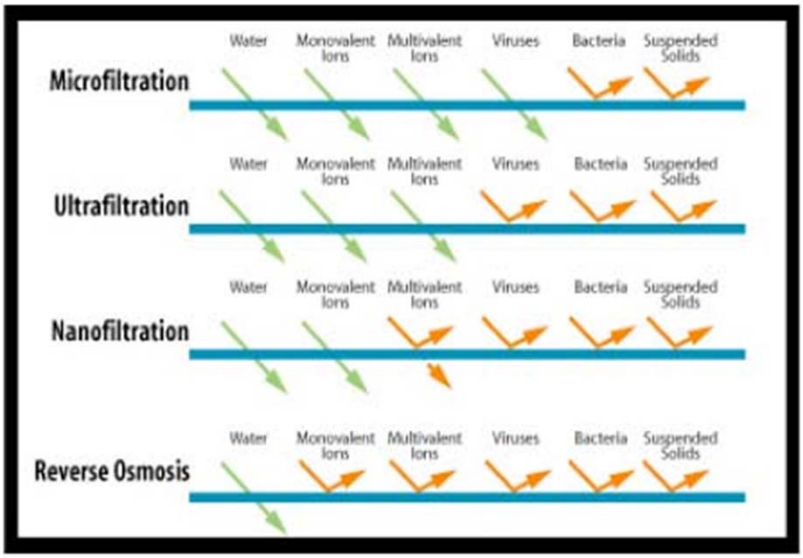
Two most common membrane materials used:

- Cellulose Acetate – Developed in 1959 – 1st membrane for RO systems.
- Thin Film Composite/Polyamide Membranes – Developed in 1970 by FilmTec Corp. – most common membrane used today.

Membranes and What They Reject

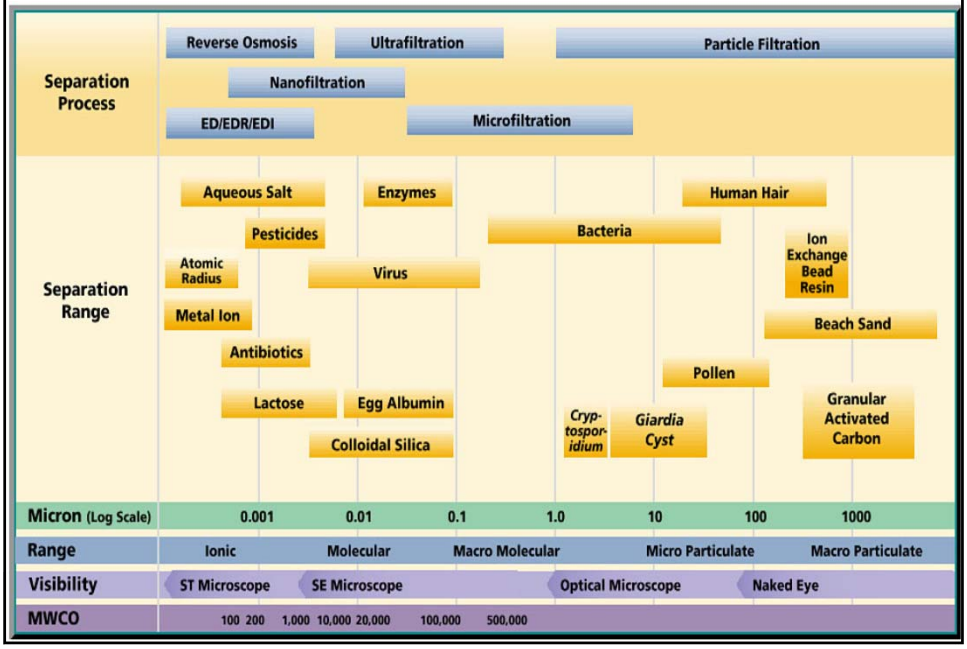


Using high rejection composite membranes, reverse osmosis has been able to remove salts and other particulates.



Membrane Process Characteristics

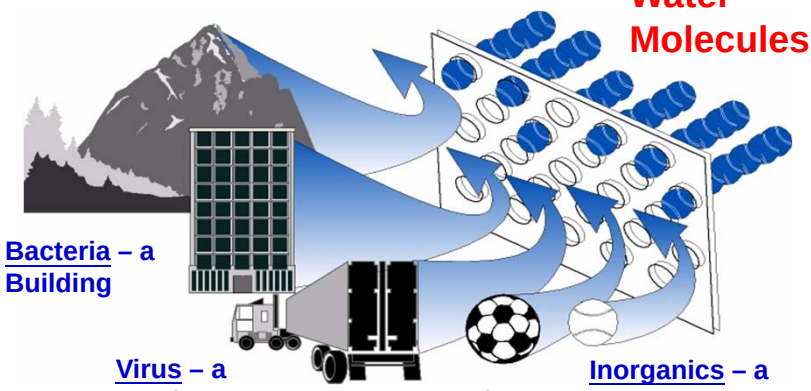
Membrane Separation Breakdown



An RO Membrane is like a Microscopic Strainer that allows Water Molecules to pass through

Protozoa – a Mountain

Water Molecules



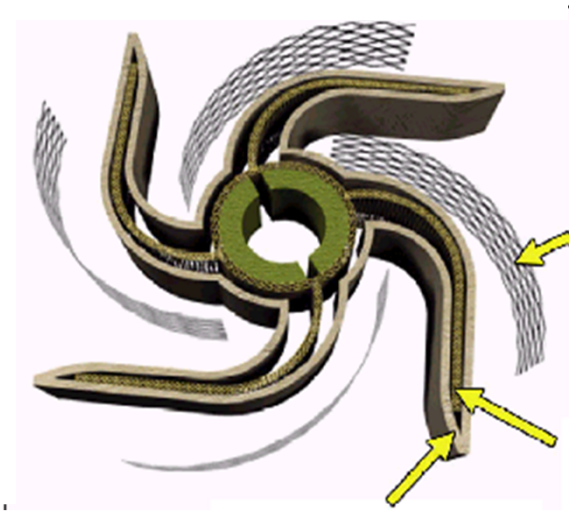
Bacteria – a Building

Virus – a Truck

Organics – a Soccer Ball

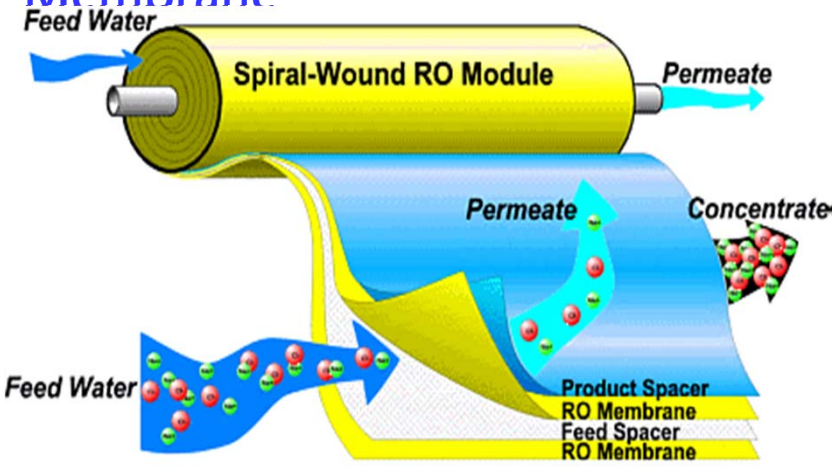
Inorganics – a Baseball

Membrane Arrangement
Membrane Element

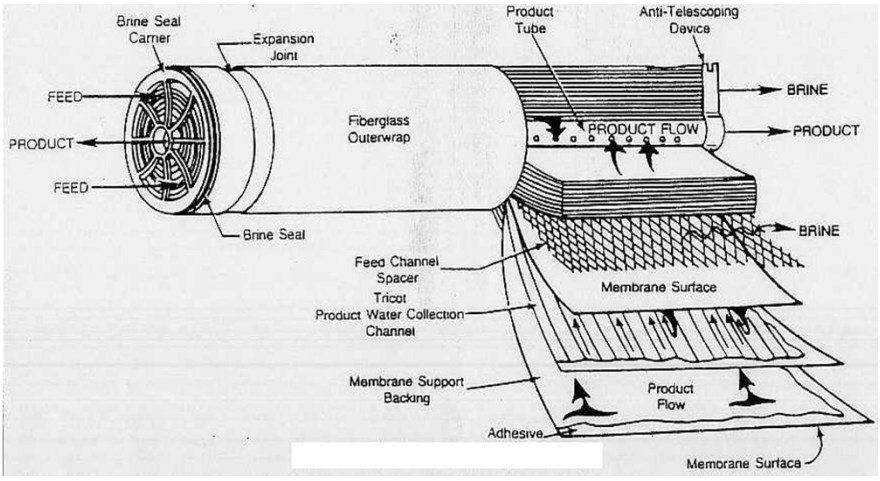


Membrane leaf

Reverse Osmosis Spiral Wound Membrane

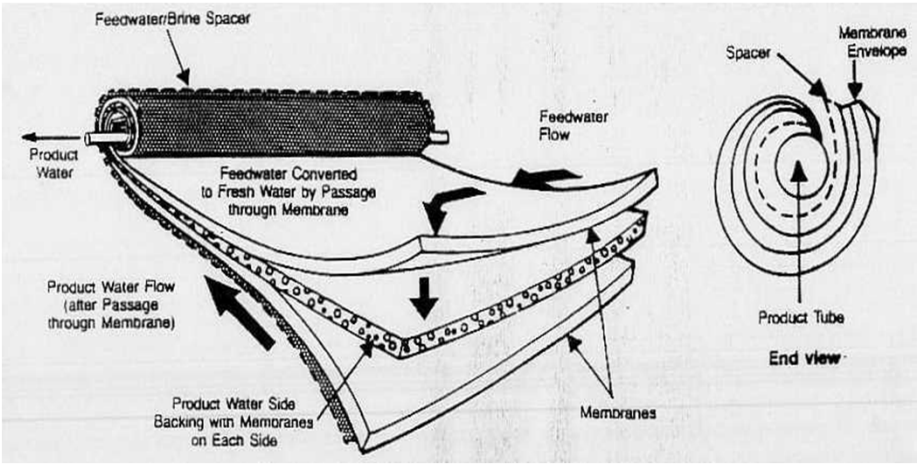


Spiral Wound Membranes



Spiral Wound Construction

Spiral Wound Membranes



Spiral Wound Construction

Summary - Membrane

- Several membrane sheets are rolled together - Thin Film Composite/Polyamide Membranes
- Permeate is collected in the center
- Concentrate proceeds to other elements for water production
- Water flows between flat sheets of membrane under pressure.
- Pure water passes through membranes.

That' s All Folks – Thank You – LIG

How Every Workplace Can Save Water!