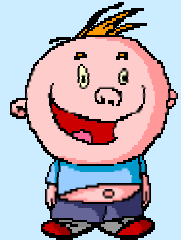


The Marshall Islands Water Resources and the Hydrogen Sulfide (H₂S) test

Presented by:

- Abraham Hicking- **RMIEPA Chief, WQ Monitoring Lab;**
- Amlet Kalemén- **CMI/CRE, WQ Specialist**

**Prepared for ARCSA Conference
Hawaii, Aug. 14 -17, 2007**

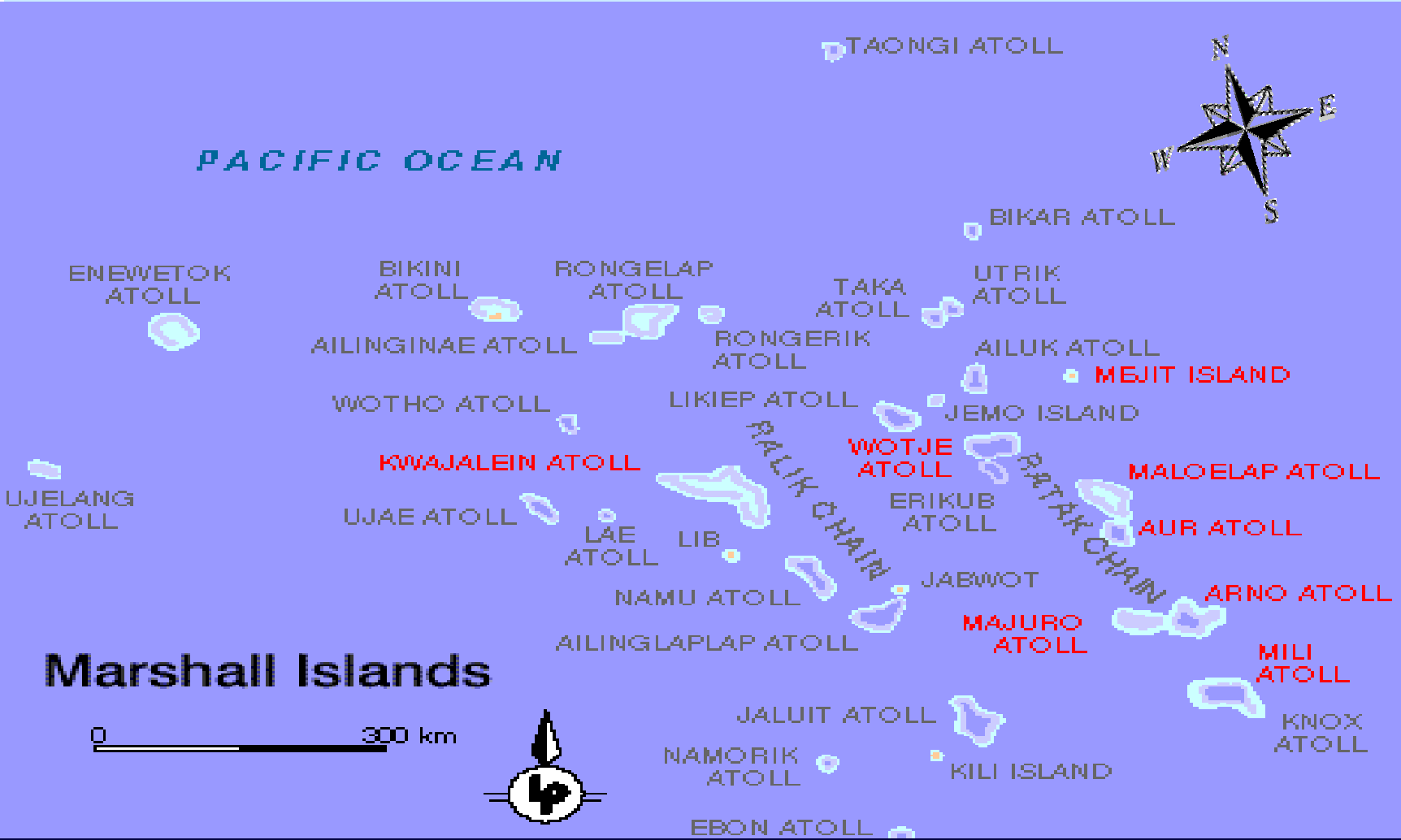


Purpose of Presentation

- **Show briefly what are the main water resources for the Republic of the Marshall Islands (RMI).**
 - How they are operated on atoll islands, especially at the Urban Centers of Majuro Atoll and Ebeye on Kwajalein Atoll and
 - How RMI deal with drought conditions
- **How we set up the Outer Islands Water Quality Monitoring Program using the H₂S test.**



Marshall Islands

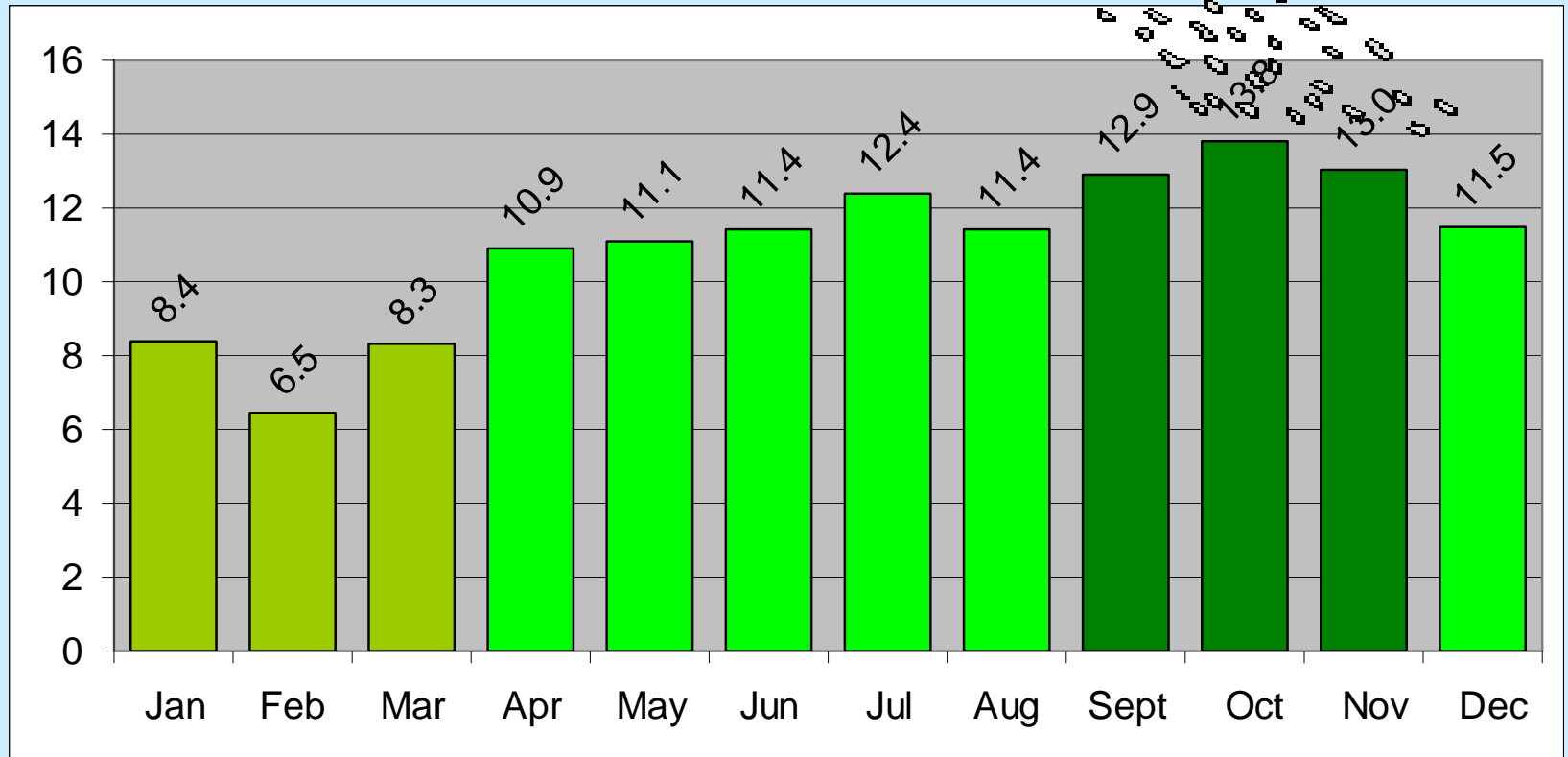


BACKGROUND

- The islands are scattered in an archipelago consisting of two roughly parallel island chains – the western “Ralik” chains (“sunset”) and the eastern “Ratak” chains (“sunrise”).
- These extend about 700 miles north to south (4-14°N Lat) and about 800 miles from east to west (160°to 173° E Long.)
- Total land area of only 70 sq.mi. The sea, on the other hand, including our Exclusive Economic zone covers over 750,000 sq.mi.- a ratio of about 1:10,000 land to sea
- Total population of about 51,000 last census (1999) of which 70% reside in Majuro and Ebeye.

Majuro Average Rainfall

Mean Monthly Rainfall (inches), Majuro Atoll: 1959 to 2001



Source: Ben Graham 2007

WATER SUPPLY SOURCES

AIRPORT RUNWAY



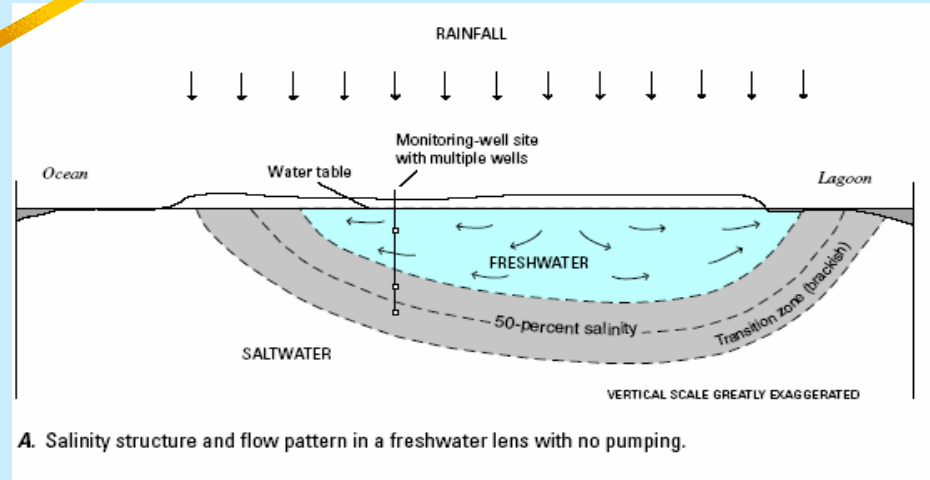
RESERVOIR

Treatment Plant C 16 4:42 PM



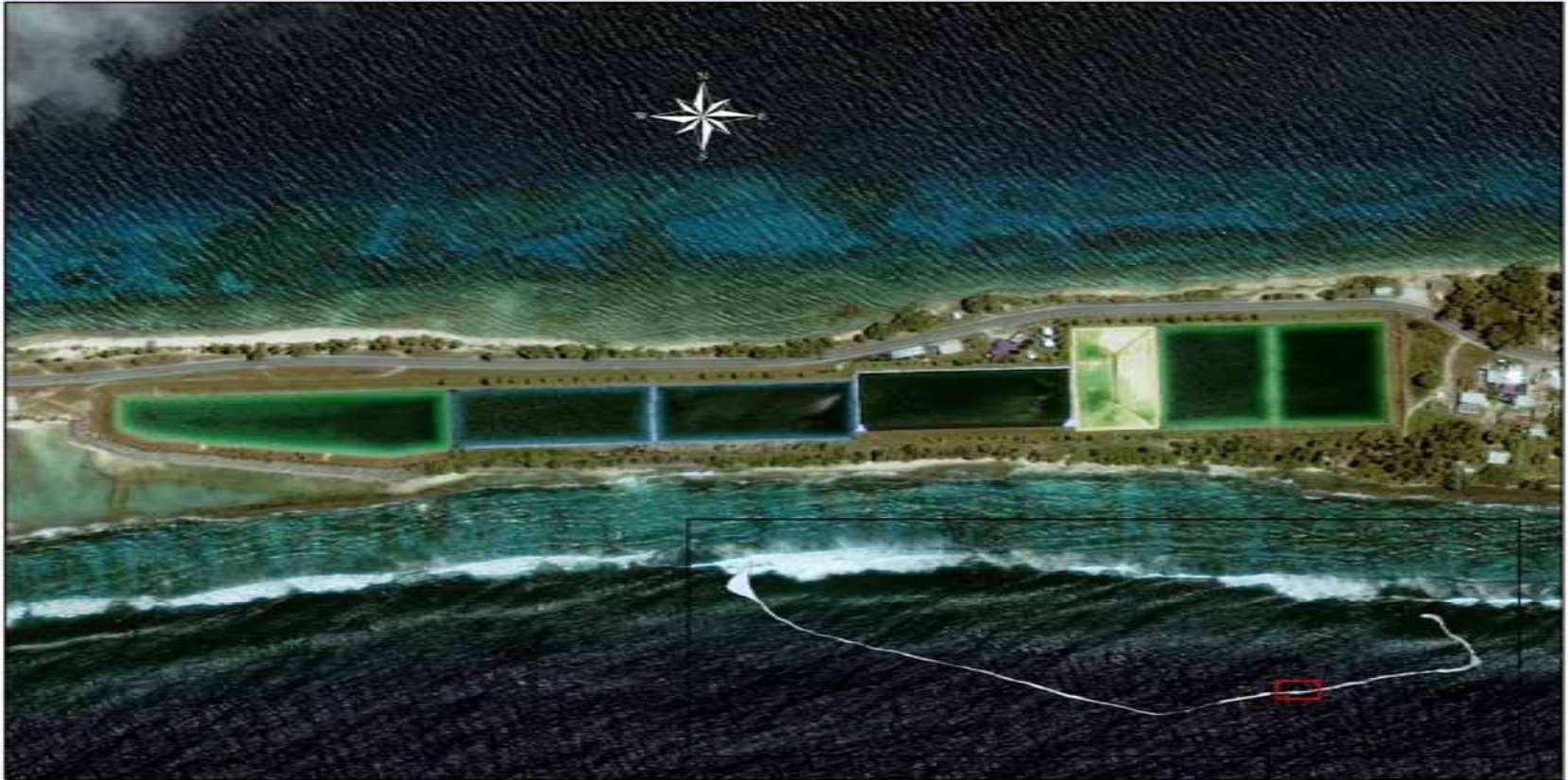
LAURA LENS

~500 million gallons capacity 16 3:34 PM



- The RMI International Airport on Majuro serves as the rainwater catchment with approximately 2-3 million gallons capacity.
- Both rainwater and groundwater (Laura Lens) are pumped into a 38 million gallons capacity reservoirs. This water undergoes sand filtration and chlorination at Treatment Plant C prior to distribution.
- The groundwater from Laura is one of the largest lens in the islands and it's our primary source of drinking water during the drought.

MAJURO PUBLIC WATER RESERVOIRS



- The six (6) raw water storage tanks that provide potable water for the people residing at the DUD Area - total capacity of 38 million gallons
- One tank is covered and contains the finished water – water that has been sand-filtered and chlorinated and is ready for distribution.

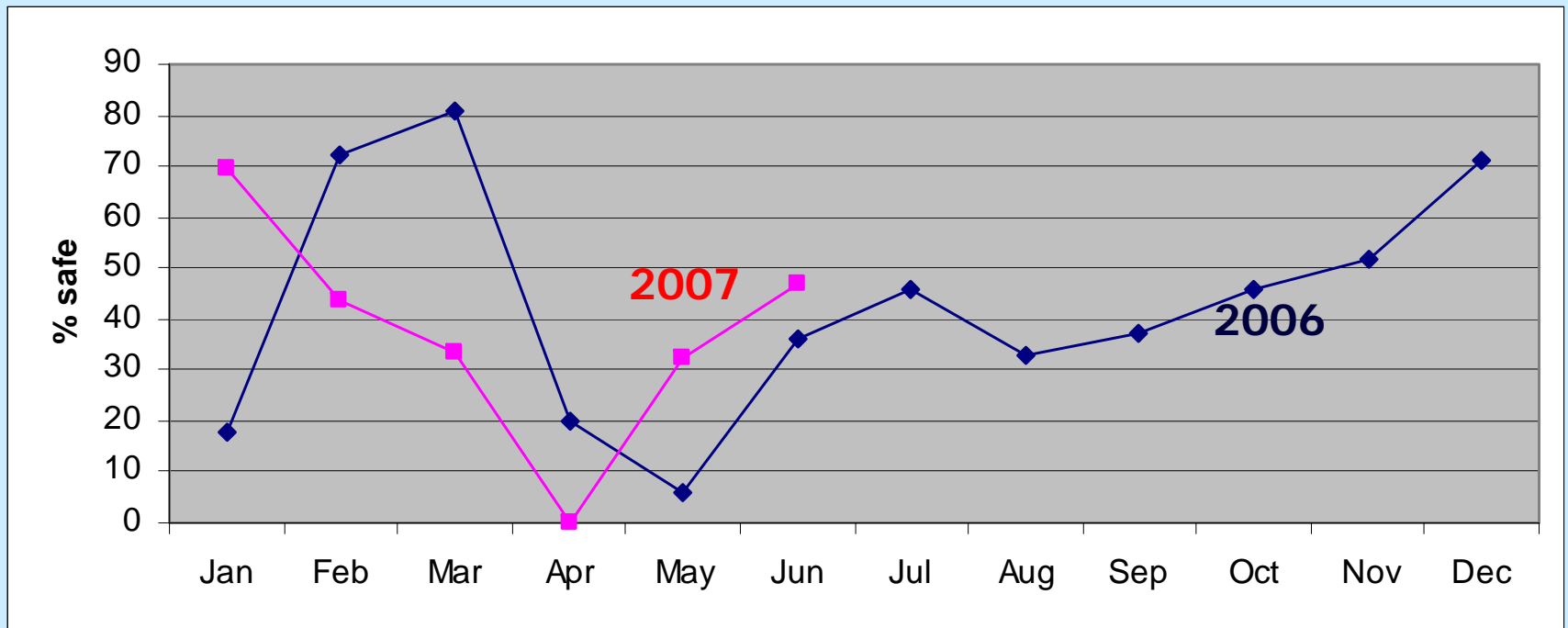
Source: GIS Photo Coastal Dept. RMIEPA



The Majuro Water Treatment Plant C

- The Majuro Public Water supply is operated and managed by the Majuro Water & Sewer Company (MWSC). It delivers about 900,000 gallons per day.
- Water undergoes sand filtration, chlorination and then stored for distribution.
- Water is serviced twice a week – Mondays and Fridays for 6-8 hrs only.
- RMIEPA is responsible for monitoring the quality of the water serviced and water used at public places such as at restaurants, hotels, and apartments.

Bacteria Quality of the Majuro Public Water Supply 2006-07



Source: RMIEPA WQ Lab, 2007



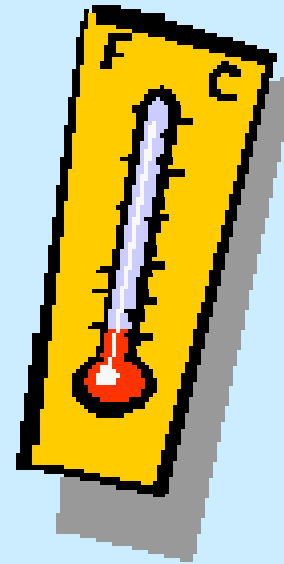
EBEYE PUBLIC WATER SUPPLY

- Ebeye Public Water Supply is provided by three RO units – a total of 150,000gpd but undergoes chlorination before distribution.
- Due to lack of pressurized water, illegal tapping is a common practice among water consumers.
- Like Majuro, water is rationed an hour or two a day and the problem can be exacerbated by lack of power on the island.
- Alternate source of potable water is from Kwajalein, Kwajalein where the US military installation base is located.

RMI's Water Situation- Drought

Recent MI Journal News Headlines:

- "Stand By For Some Weird, Wild Weather"
(Journal December 8, 2006)
- "It's Time To Pray For Rain"
(January 12, 2007)
- "Reservoir Levels Getting Low"
(January 19, 2007)
- "RMI on Drought Alert"
(February 23, 2007)
- "Water Situation Really Bad"
(March 2, 2007)



It's time to pray for rain

In the first nine days of January, less than half an inch of rain fell. In the same nine days, MWH's airport reservoir level fell from about 25 million gallons of water to just 10 million.

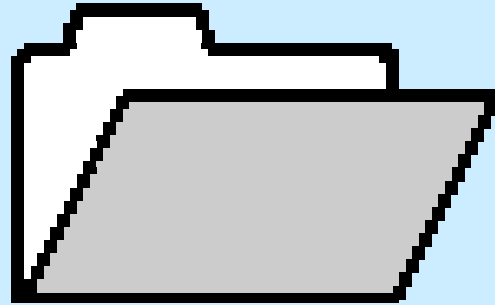
The .34 inches of rain so far in January is closer to March weather, and puts the Marshall on track for one of its driest periods since the big El Niño drought of 1998 when virtually no rain fell between January and June.

Although this year's El Niño is not predicted to be as strong as '98, a drought is still expected. Even the 104.76 inches of rain for 2006 was far below the 2000-2004 average of 131 inches.

It is best prepared for water rationing and pray for rain.

RMI responses to Drought Conditions -2007

- The National Disaster Management Task Force has to declare a State of Disaster/Emergency in order to access the Emergency relief fund - Feb. 2007.
- The Task Force, comprised of all Government Secretaries, Head of Departments and the Chair – Chief Secretary, formulated the declaration and approved/signed by the Cabinet/President.
- Only Majuro and the Northern Islands were declared State of Disaster due to lack of potable drinking water.

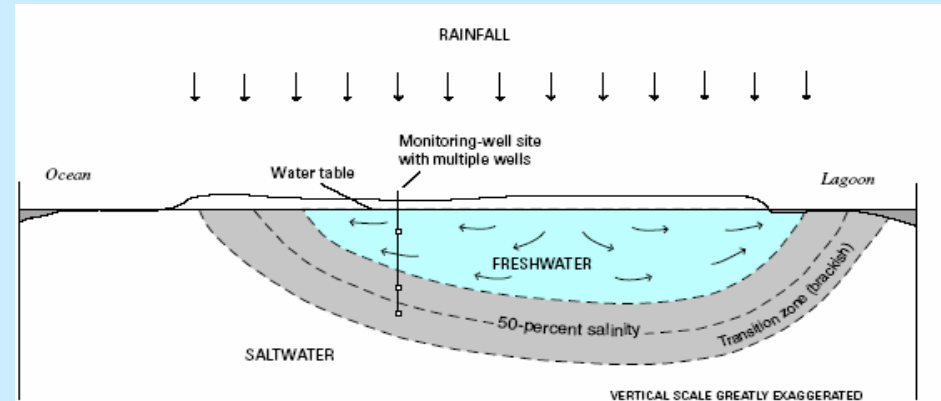


Activities For Outer Islands

- Deployment of the first available RMI government vessel to dispatch water supplies to the mostly affected atolls in the north (3 atolls) declared as having no drinking water on the island.
- One Officer from the MWSC, RMIEPA and the Internal Affairs Offices joined the crew to assist in water delivery and to advise people to boil water thoroughly 1-5 minutes before use.
- RMIEPA investigated groundwater that can be used for human consumption – test for conductivity, total dissolved solids (TDS) and nitrates.
- Submit data gathered to the Office of Disaster and to the Task Force.

Drought Condition on Majuro

- MWSC supplies rationed water **every other Mondays for 2-4 hours only.**
- To supplement availability of potable water, MWSC installed and operated smaller Reverse Osmosis (RO) Units at three major sites on the island – 2 with 2000 gpd capacity and 1 with 6000 gpd capacity.
- These RO units provided the residence of Majuro with daily potable water during the drought.



A. Salinity structure and flow pattern in a freshwater lens with no pumping.



Lessons Learned/Problems encountered

- No appropriate containers to fill or a transport to deliver water to individual homes.
 - People have to collect water using plastic gallons or 3-5 gallons buckets and hand carry back to the homes which may cover several hundreds yards or even a mile away from the ship.
- When water supplies are out, the ship desalination machine is used to re-fill the bladders or fill individual containers
- Re-direct the ship to visit Kwajalein Atoll (a military base) to have their water bladders refilled with potable water



The Outer Islands Community-Based WQ Monitoring Program using the H₂S test

SET OF OBJECTIVES:

1. To establish an Outer Island Community –Based Water Quality Monitoring Program.
 - Develop baseline data on bacterial quality of all drinking water sources using the H₂S test.
2. Train Representatives from each atoll on:
 - how to perform the H₂S test,
 - how to conduct a sanitary survey on rainwater tanks and wells
 - How to perform other environmental monitoring-such as hazardous wastes
3. To increase the number of safe drinking water sources from the current 20% to about 50% by the end of the year, 2005.



Objectives (cont'd)

4. To help reduce incidences of water borne illness in the Outer Islands.
5. To survey household for availability of toilet facilities and include the report in the water testing data.
6. To meet or comply with the national, regional (SOPAC) and international (MDG/WHO) strategic action plan on water related issues



Funds for the Outer Islands Water Quality Monitoring using the H2S



Outer Island Community Awareness

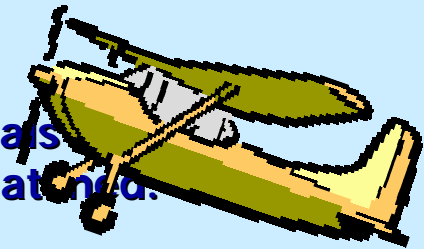


Outer Island Local Policeman

Source – WHO, RMIEPA & the CMI/CRE Matching Fund

2000-2003:WHO/SOPAC initiated both the training and the purchase of the H2S test reagents and tubes

RMIEPA submitted 3 proposals with an amount to be matched.



- First Match (2003) : \$20,000
- Second (2004-2005) : \$30,000
- Third Match (2006-2007) : \$20,000

Ex. of Break down (2003)

Personnel	11.78%
Travel	44.96%
<i>Equipment</i>	4.06%
Others	39.18%

THE H₂S Test Costs



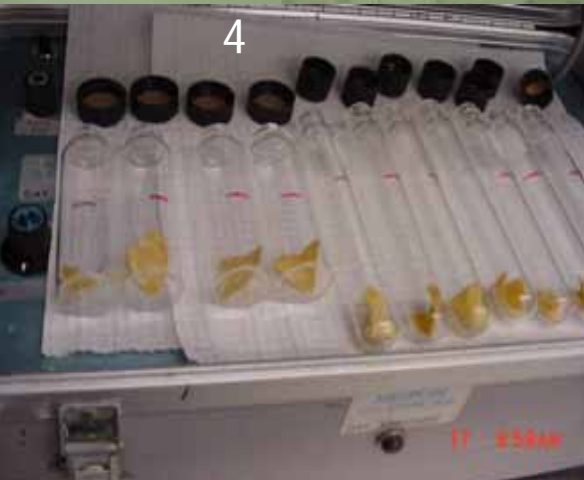
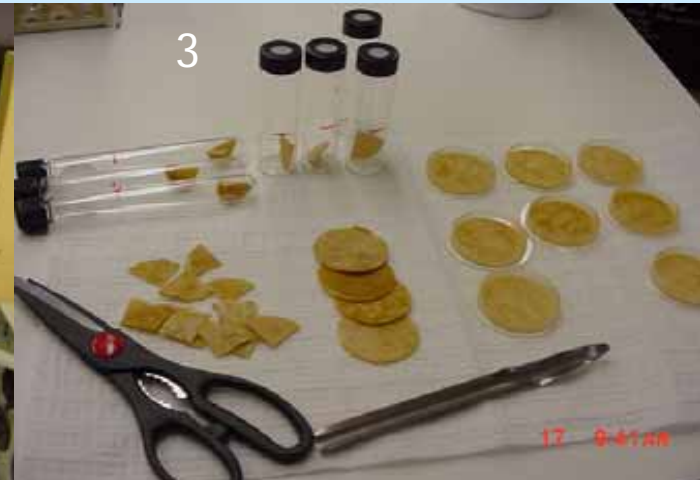
Cost of tube/vial	\$0.52
Cost of H ₂ S media (20ml)	\$0.13
Total cost for H₂S	\$0.65

Cost of 1 Test strip 5-1	\$0.21
Cost of Nitrate test	\$0.53
Chlorine Test	\$0.42

Total cost of tests	\$1.81
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Preparing the H₂S (strip) test



Sterilizing using UV Light

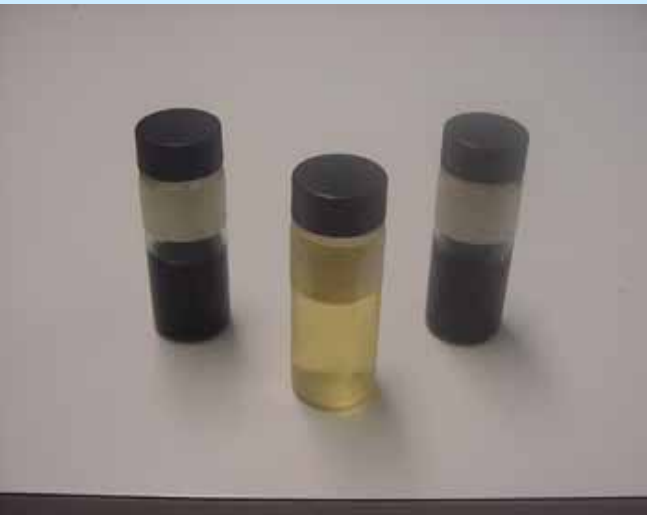
Boiling using Steamer – Outer Islands.

Sampling

Where H₂S can be used

Rainwater tanks

Groundwater



Public Water

Bottled Waters

Coastal waters



Water Supplies in The Outer Islands

- There are no surface water in the Islands, except rainwater and groundwater.
- No reticulated water supply system exists in the Outer Islands – self reliant on individual rainwater tanks and wells.
- Rainwater tanks systems are poorly constructed and no maintenance nor ever cleaned.
- The government helped the people provide potable plastic tanks (1500 gals.) but some houses are so poorly constructed that the tanks is hardly filled with rain.



Typical groundwater or wells in the Outer Islands

- Most groundwater are also poorly constructed and are susceptible to surface contamination.
- No hand pumps available therefore people resort to using quarts or buckets to bail water out of the well.
- Most wells are used for household (laundry and bath) and others used for cooking and drinking.
- Contamination are mostly bacterial in nature.
- Wells that contain $>10\text{mg/L}$ Nitrates (nitrogen) are identified and advised owners not to use it for human consumption, esp. pregnant mothers.

Sharing the Test Results





Training and Workshops

- We carry out the training as stated in our objectives so that the islanders can perform their own water quality monitoring using the H₂S and to be able to perform other environmental monitoring.
- Where possible, we invite doctors to talk about water borne diseases and their impact on people's health, especially the young and the elderly, or attend to invited speakers like Dr. Patrisha during her visit to Majuro.
- Distribute pamphlets, brochures on what RMIEPA does and how to treat water with bleach.



Achievements



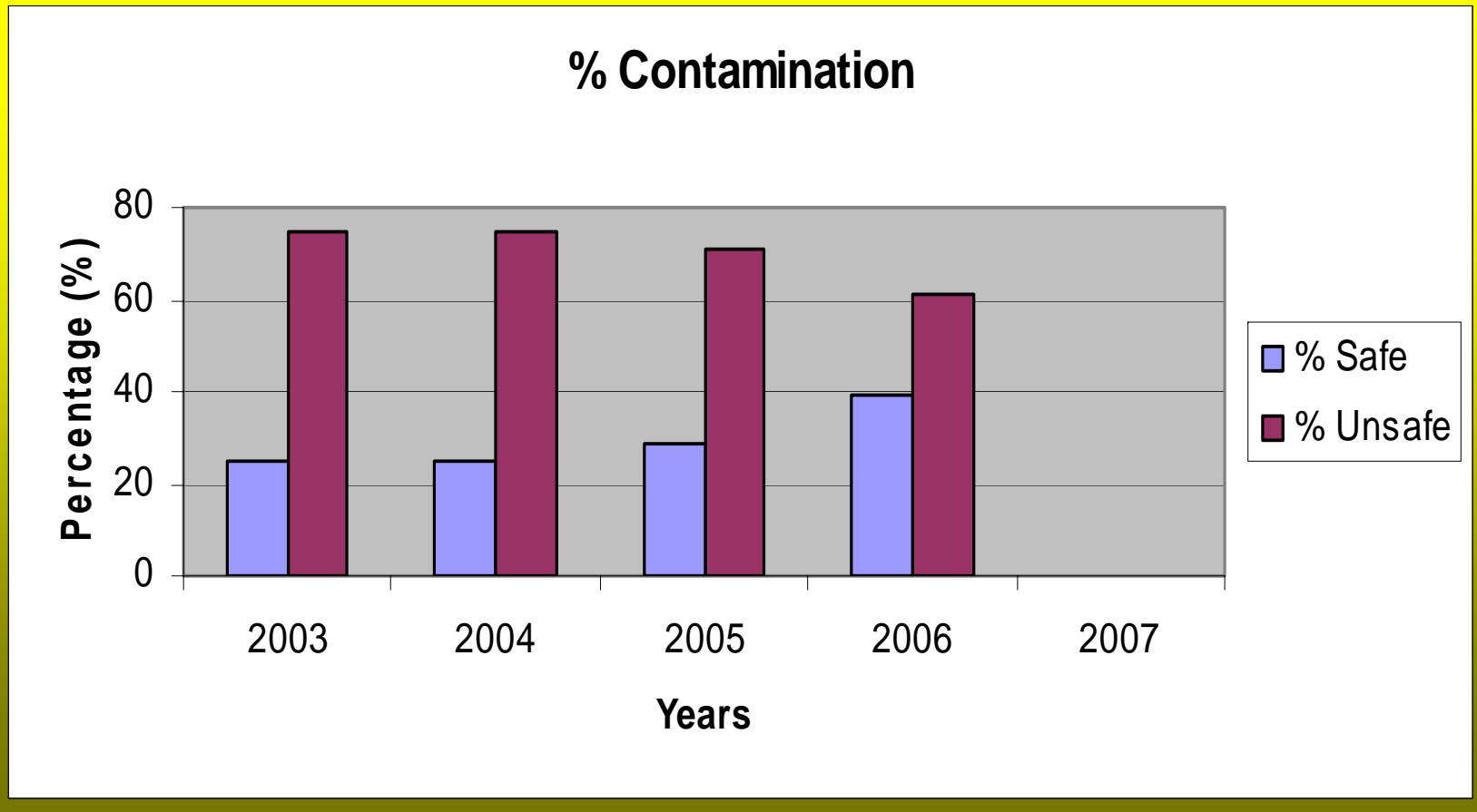
Achievements: Outer Islands Water Quality & Sanitation

	RATAK CHAIN	Total Tanks Tested			Percentage		Sanitation Facility	
Item No	Atoll/Island	Total No. Tested	Total No. Safe	Total No. Unsafe	% Safe	% Unsafe	Have Toilets	No Toilets
1	Milli	98	21	77	21	79	30	31
2	MEJIT	100	42	58	42	58		
3	AUR	136	25	111	18	82		
4	LIKIEP	131	45	86	34	66		
5	MALOELAP	244	45	199	18	82	40	59
6	AILUK	284	207	77	73	27	34	30
7	UTRIK	113	31	82	27	73	20	
8	RONGRONG	59	6	53	10	90		
9	WOTJE	24	3	21	13	87		
	Total	1189	425	764	36	64	124	120

Achievements cont'd

	RALIK CHAIN	Total Tanks tested			Percentage		Households visited	
Item No	ATOLL/ISLAND	Tested	No. Safe	No. Unsafe	%Safe	% Unsafe	Have	No Toilets
							Toilets	
1	EBON	191	26	165	14	86	20	19
2	NAMU	88	28	60	32	68	15	73
3	KILLI	108	15	93	14	86		
4	JABOT	29	6	23	21	79	10	18
5	JALUIT	154	35	119	23	77	30	7
6	NAMDRIK	172	53	119	31	69	49	30
7	AILINGLAPLAP	137	31	106	23	77		
8	UJAE	98	18	80	18	83	39	14
9	WOTHO	12	4	8	33	67	35	73
10	MEJATO	19	8	11	42	56		
11	LIB	13	4	9	31	69		
	Total	992	222	770	22	78	198	234

OUTER ISLANDS H2S TEST RESULTS

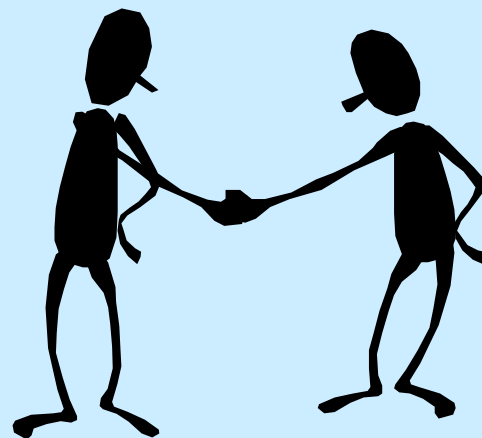


Conclusions

- Since both Public Water Supplies on Majuro and Ebeye not serviced 24 hours, it cannot be guaranteed to produce 100% coliform free water.
- People have to rely on best hygienic practice to protect themselves from drinking contaminated water sources.
 - Boil water 1-5 minutes before use
 - Treat water with Bleach: 3 drops per gallon of water or 1 cup of bleach to 1000 gallon of water
 - Use other means of purifying water sources – install filters, distills, or UV or RO units.
- Improved rainwater catchments systems for Outer Islands;
 - Regular tank cleaning, sanitizing practices and personal hygiene practices.
- Better/improved construction of groundwater to protect from contamination from surface runoffs, and to install pumps properly that can control extraction of water to maintain the quality and depletion of groundwater sources.
- We need more community involvement in implementing best hygienic practices for the homes, schools and at public places.
 - Community-based activities such as water testing, proper food handling, hand-washing practices and other community hygiene promotions should be encouraged at all levels...
- Need water quality awareness materials to be translated into local language so they can be used in the Outer Islands Water Quality awareness programs.

ACKNOWLEDGEMENT

- We would like to thank and acknowledge the following individuals and agencies/departments for their support to get us to attend this very important meeting:
 - **Dr. Patrisha Macomber** and sponsors of the ARCSA, 2007.
 - **Mrs. Diane M. Debrum**, CMI/CRE
 - **Dr. Warmsley, John**; (HHS/OPHS)
 - **Mr. John Bungitak**, General Manager RMIEPA



Thank you

