Commission on Water Resource Management

Waimea ʻAnaehoʻomalu Aquifer System Area Updates

2019 update
to Water Resource Protection Plan of the Hawaiʻi Water Plan

I Mana I Ka Wai

DHHL Water Law & Advocacy Training

Department of Hawaiian Home Lands & Ka Huli Ao

May 18, 2019

Presentation Outline

- Introduction & Background
- Updated information
- Proposed amendments to Waimea/ ʻAnaehoʻomalu Aquifer System Area

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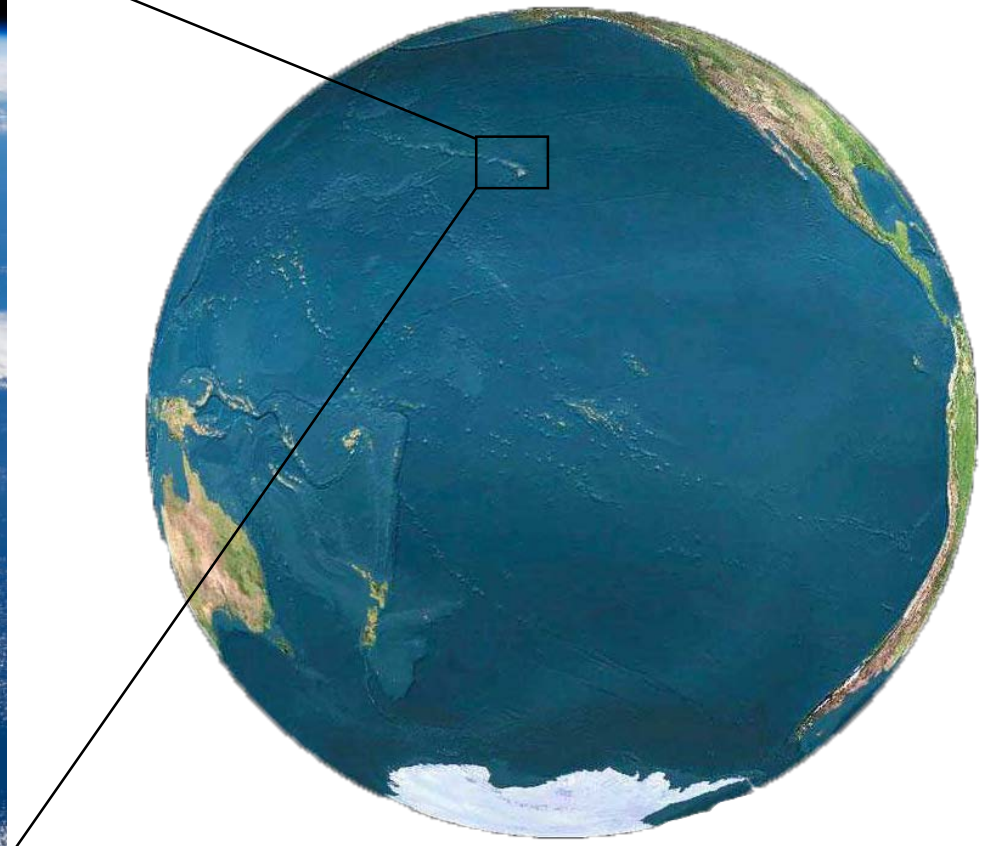
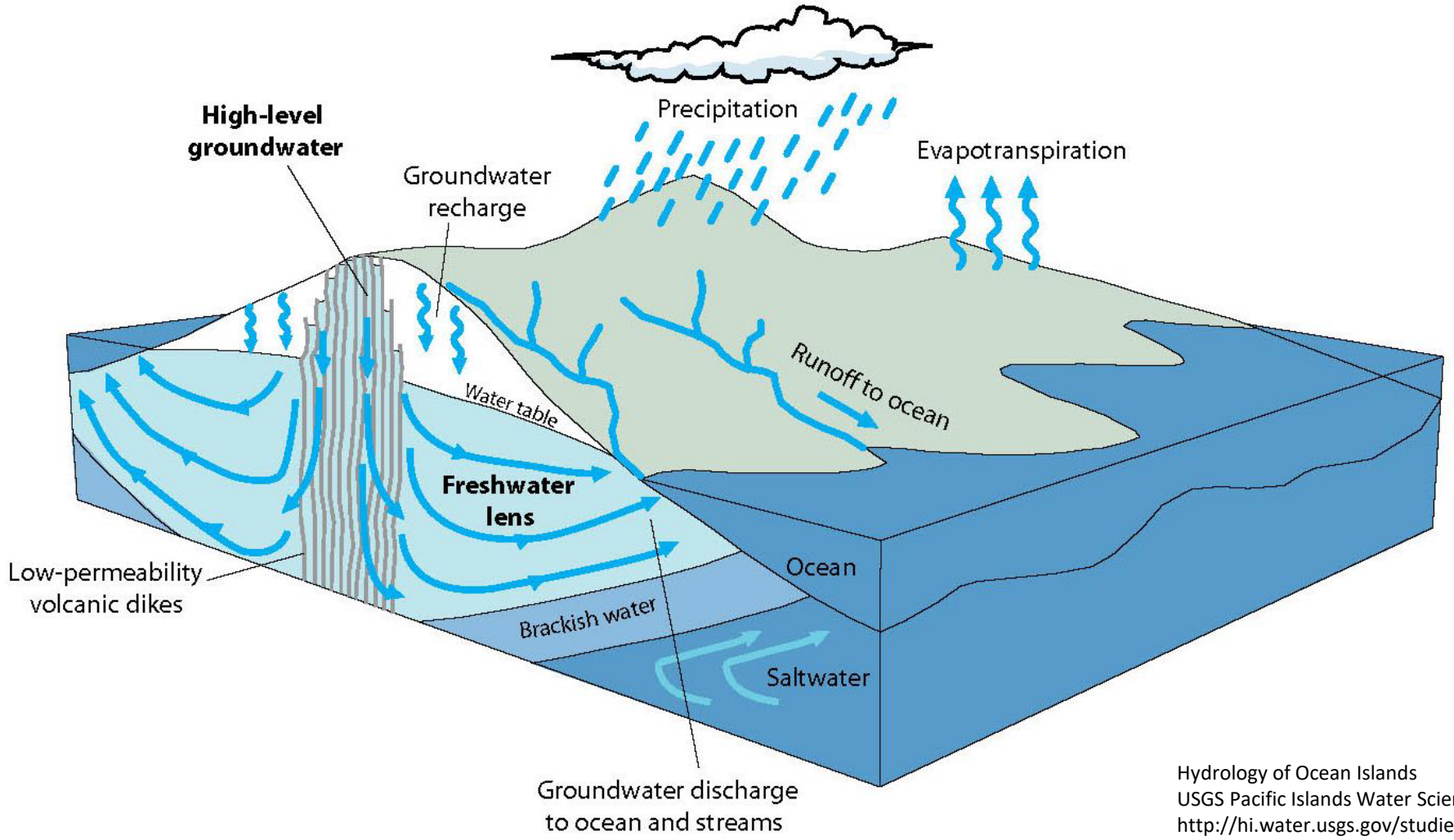
Islands in the Pacific

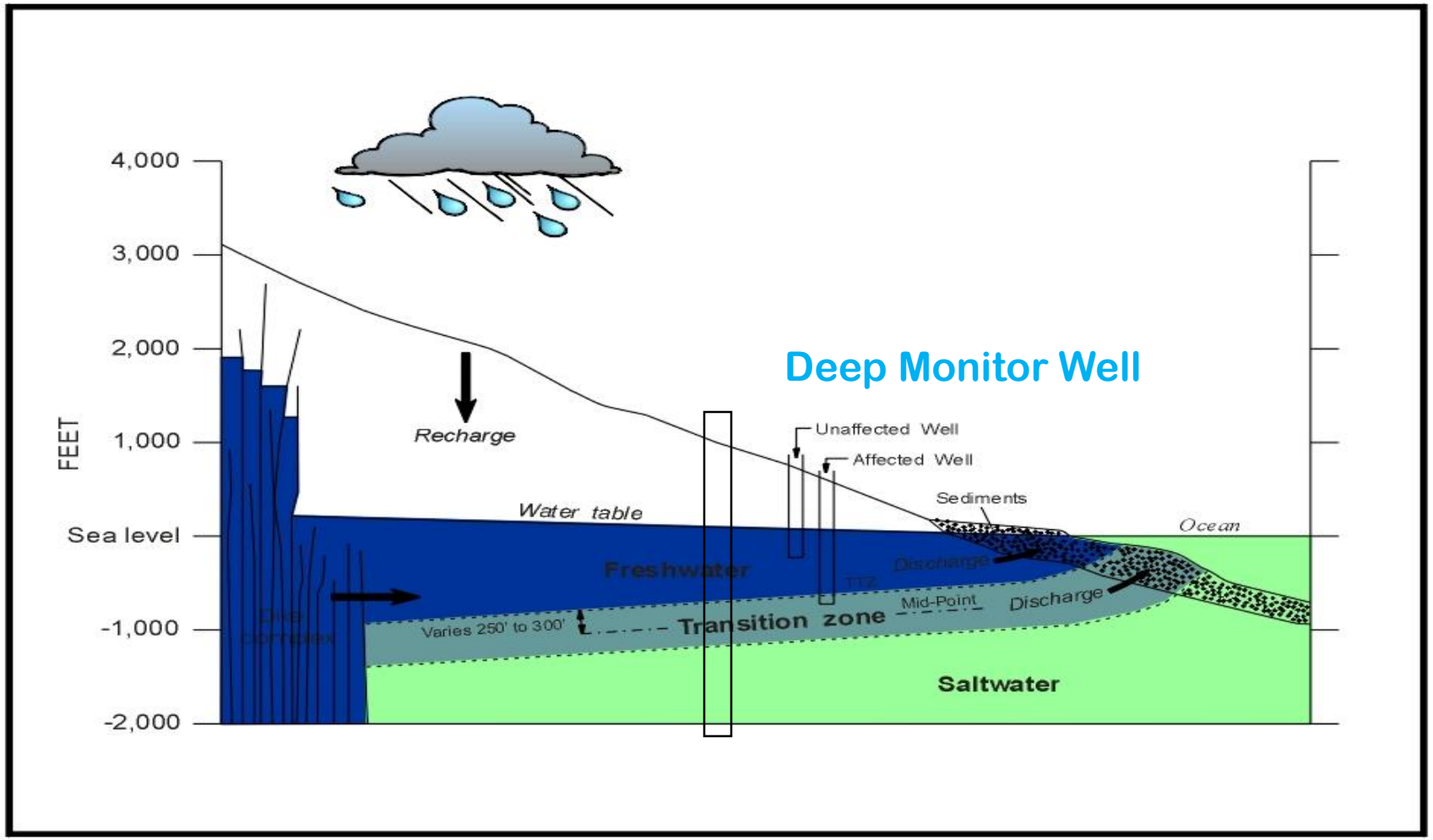


The Water Cycle



Hydrology of Ocean Islands
USGS Pacific Islands Water Science Center
http://hi.water.usgs.gov/studies/GWRP/islhydro.html

Groundwater Management



CWRM Vision

Flowing streams,

sustainable aquifers,

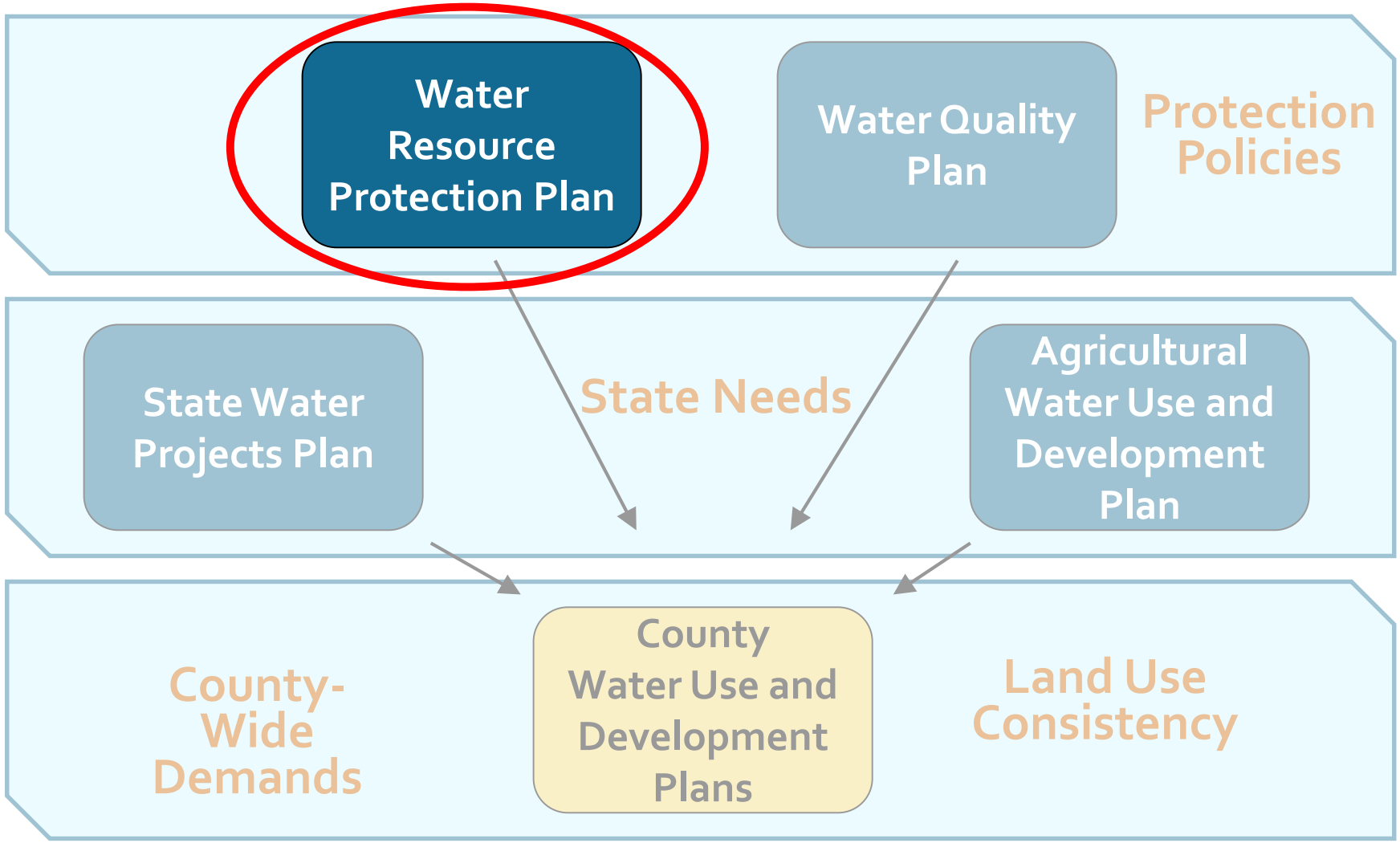
and functioning watersheds

for the use, enjoyment, and benefit of all.

CWRM Mission

To protect and manage
the waters of the State of Hawai‘i
for present and future generations.

Hawai‘i Water Plan



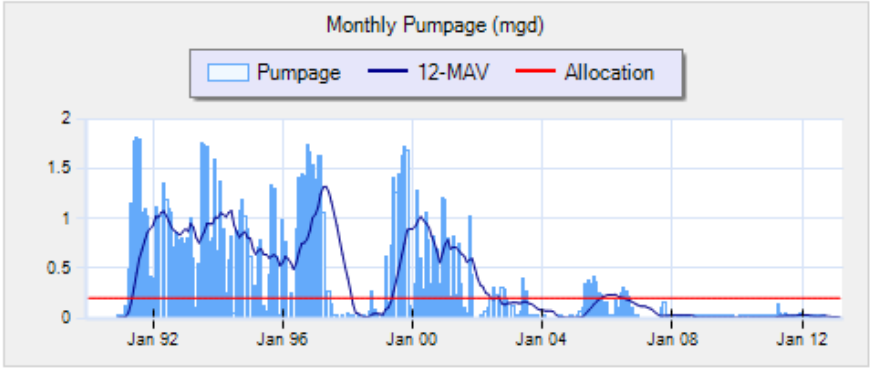
Water Quantity vs. Water Quality

Commission on Water Resource Management

Department of Health, Clean Water Branch

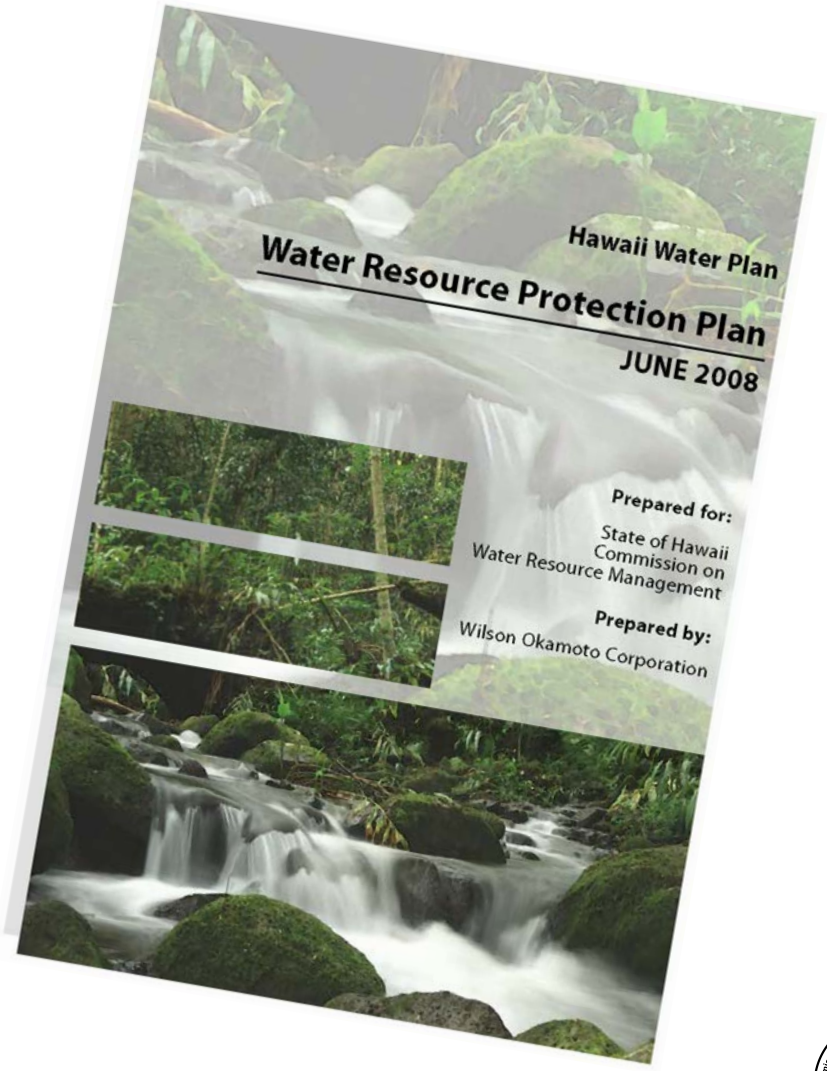
Water Resource Protection Plan

- Nature and occurrence of water
- Hydrologic units and their characteristics
- Existing and contemplated uses of water
- Programs to conserve, augment, regulate and protect the resource



Background/History/Timeline

- Initial adoption: 1990
- First update: 1992
- Most recent update: 2008
- Current draft update: 2019 (July)



Stakeholder Input

Evaluate the 2008 WRPP

- Outstanding actions/goals
- Data gaps
- Completed projects/actions
- New data analysis for RF, ET, Recharge, IFS
- Legal actions

CWRM Input

- Commission actions/decisions
- CWRM staff

Interview Individuals and Small Groups

- Cultural practitioners
- Government agencies
- NGOs
- Large landowners
- Professional hydrologists
- University researchers

Water Workshops

- Hawai‘i Island – Hilo
- Hawai‘i Island - Kona
- Kaua‘i
- Lāna‘i
- Maui
- Moloka‘i
- O‘ahu

Stakeholder Input - Small Group Interviews

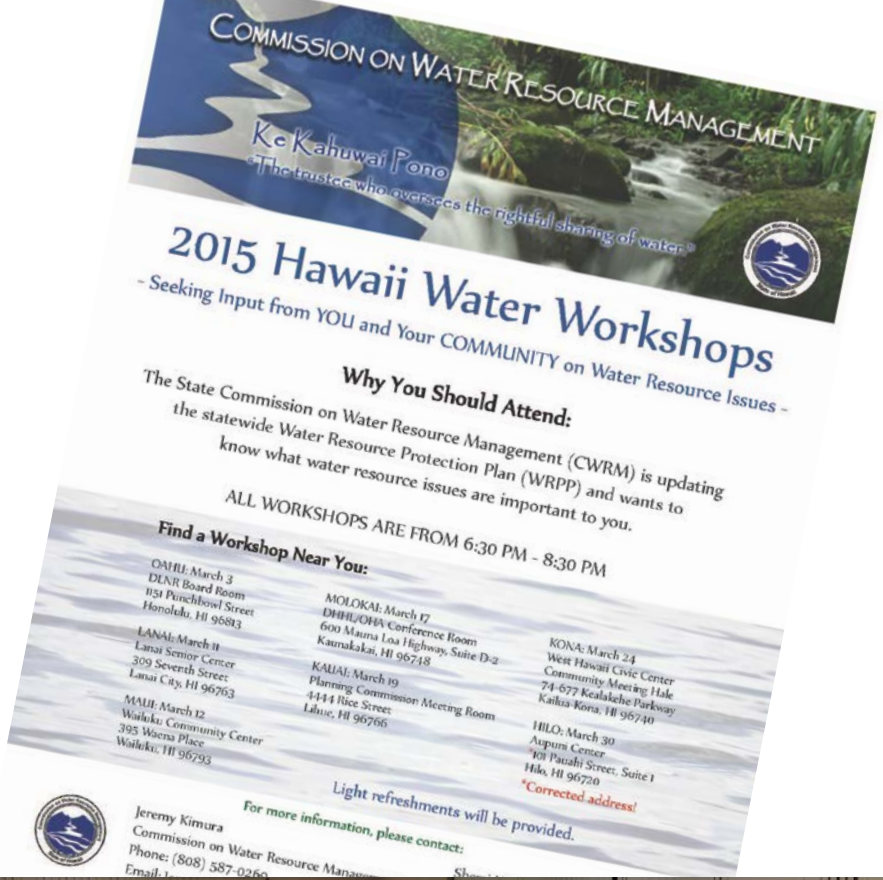
- **Inter-Agency Group**
  - CWRM
  - DLNR Division of Aquatic Resources
  - DLNR Engineering
  - DOA
  - ADC
  - DBEDT Office of Planning
  - DHHL
  - DOH Safe Drinking Water Branch
  - DOH Clean Water Branch
  - DOH Wastewater Branch
  - DOH Environmental Planning Office
  - County DWS
  - NPS
  - USACE
  - USGS

- **Water Professionals Group**
  - Private Sector (5)
  - CWRM
  - County DWS
  - NPS
  - UH Mānoa Water Resource Research Center
  - UH Mānoa Geology & Geophysics
  - UH Mānoa Hawai‘i Institute of Geophysics and Planetology
  - USGS

Stakeholder Input - Individual Interviews

- William S. Richardson School of Law, Ka Huli Ao Center for Excellence in Native Hawaiian Law; Environmental Law Program
- University of Hawai‘i Kamakakuokalani Center for Hawaiian Studies
- Native Hawaiian Legal Corporation
- Office of Hawaiian Affairs
- Department of Hawaiian Home Lands
- Attorney General’s Office
- National Park Service
- DLNR Office of Conservation and Coastal Lands
- Pacific RISA
- Professional Hydrologists

Stakeholder Input – Water Workshops



Stakeholder Input – Water Workshops

Schedule

Draft WRPP
October 2018
Public Hearings
Jan-Feb 2019
WRPP Adoption
July 2019

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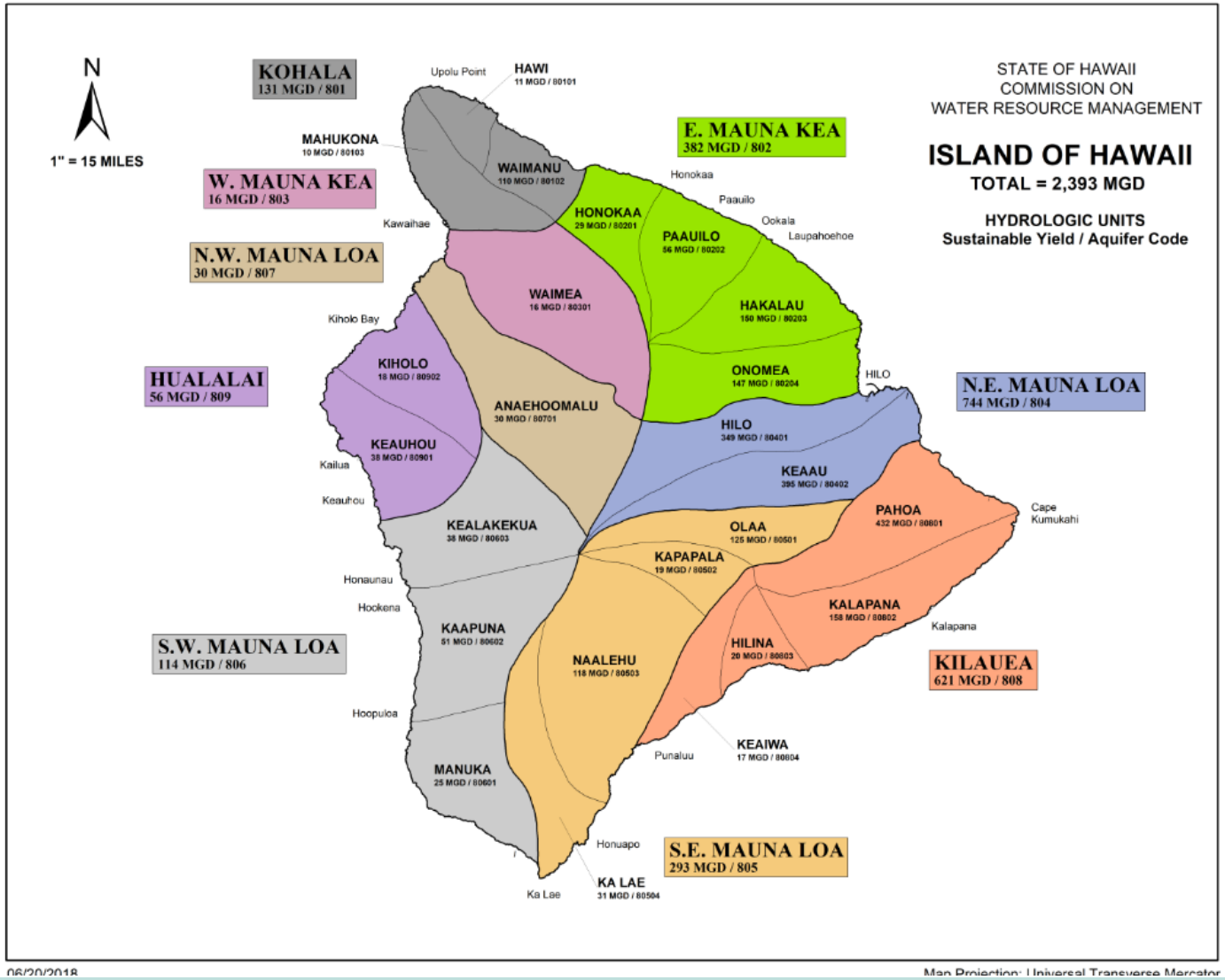
- Introduction & Background
- Updated information
- Proposed amendments to Waimea/ ʻAnaehoʻomalu Aquifer System Area

Groundwater Management

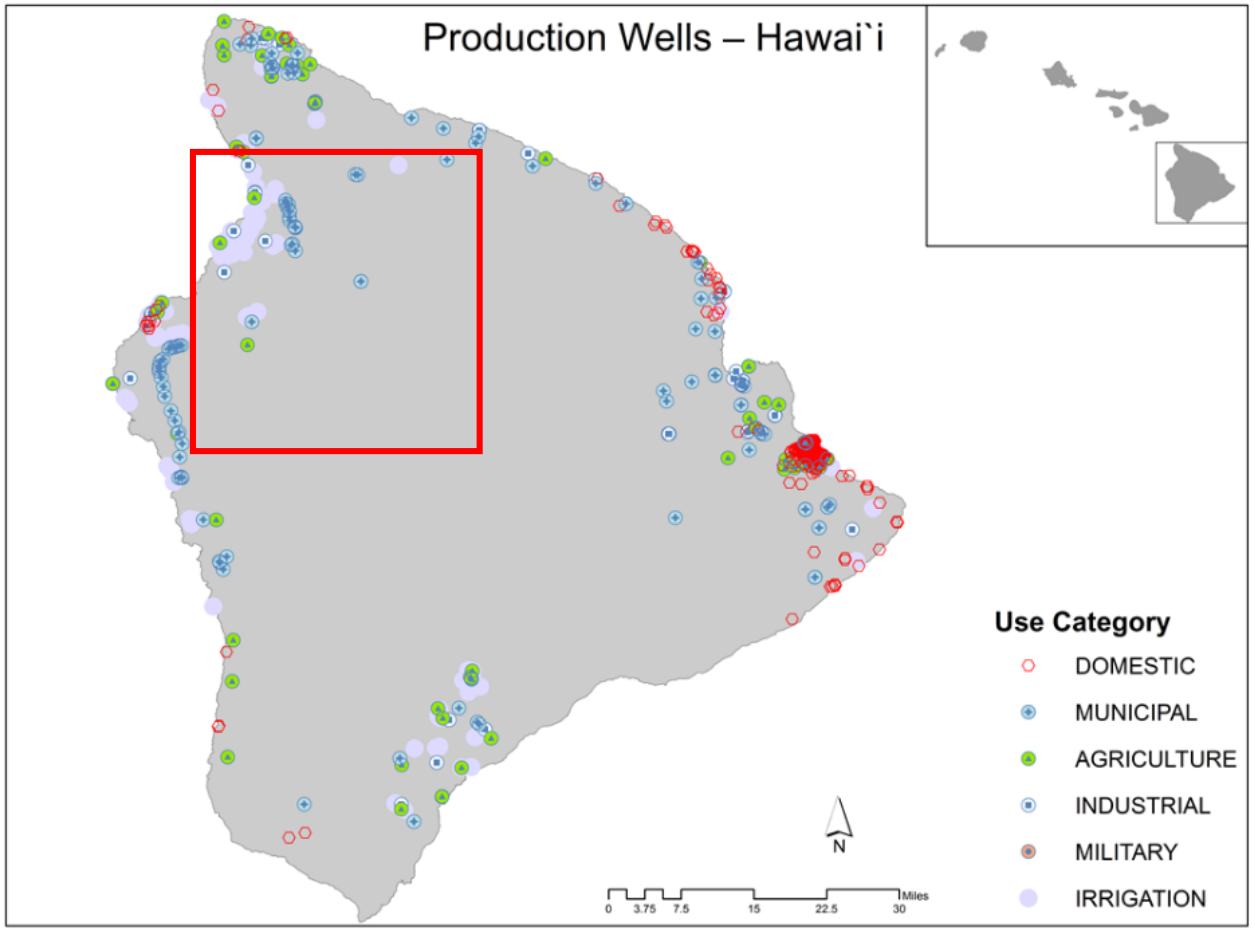
Sustainable limits for each management unit



Groundwater Management

5000 Wells in State

1,342 Wells on Hawai'i

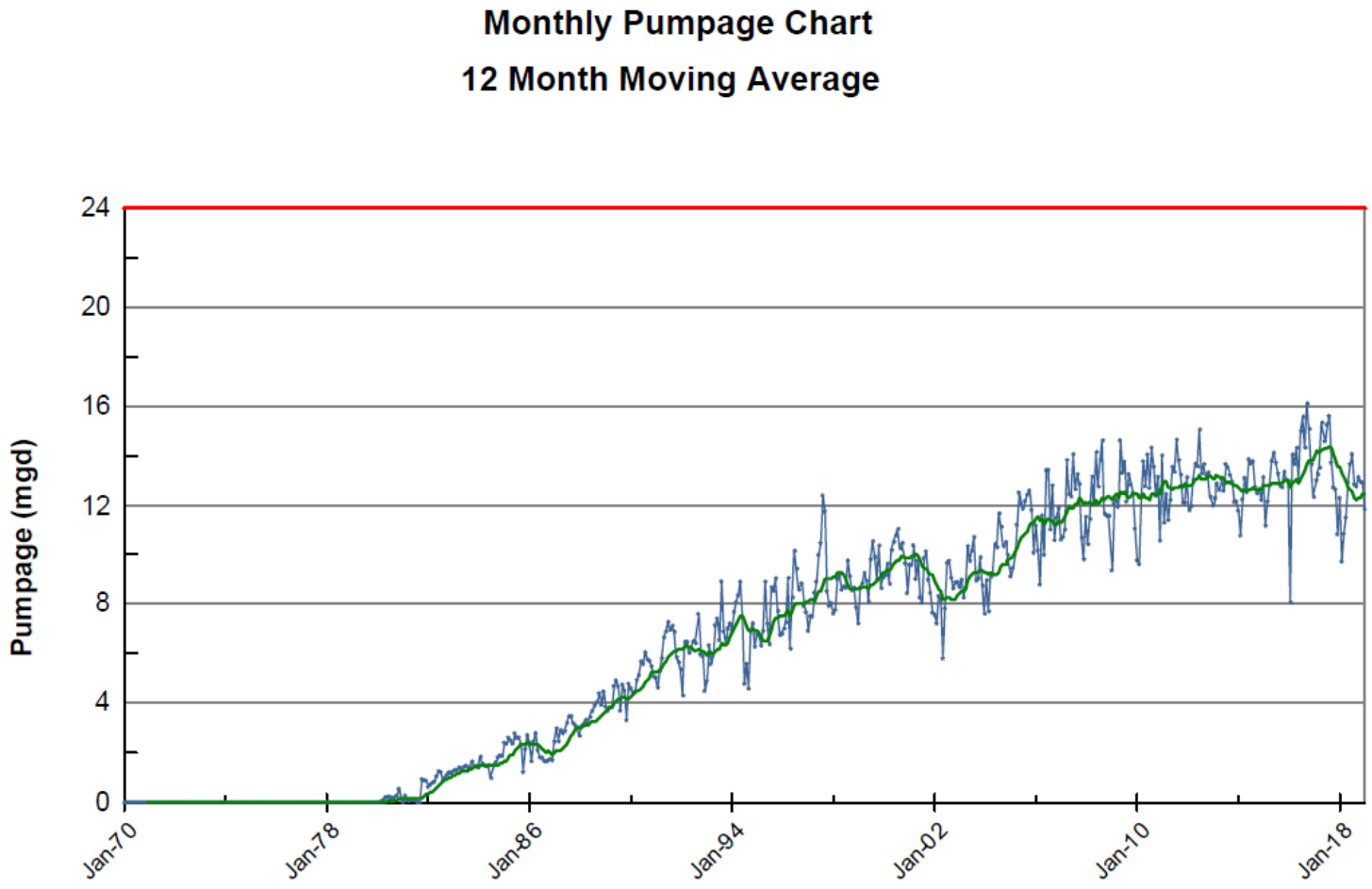


Groundwater Management

79 Wells in Waimea ‘Anaeho‘omalu ASAs

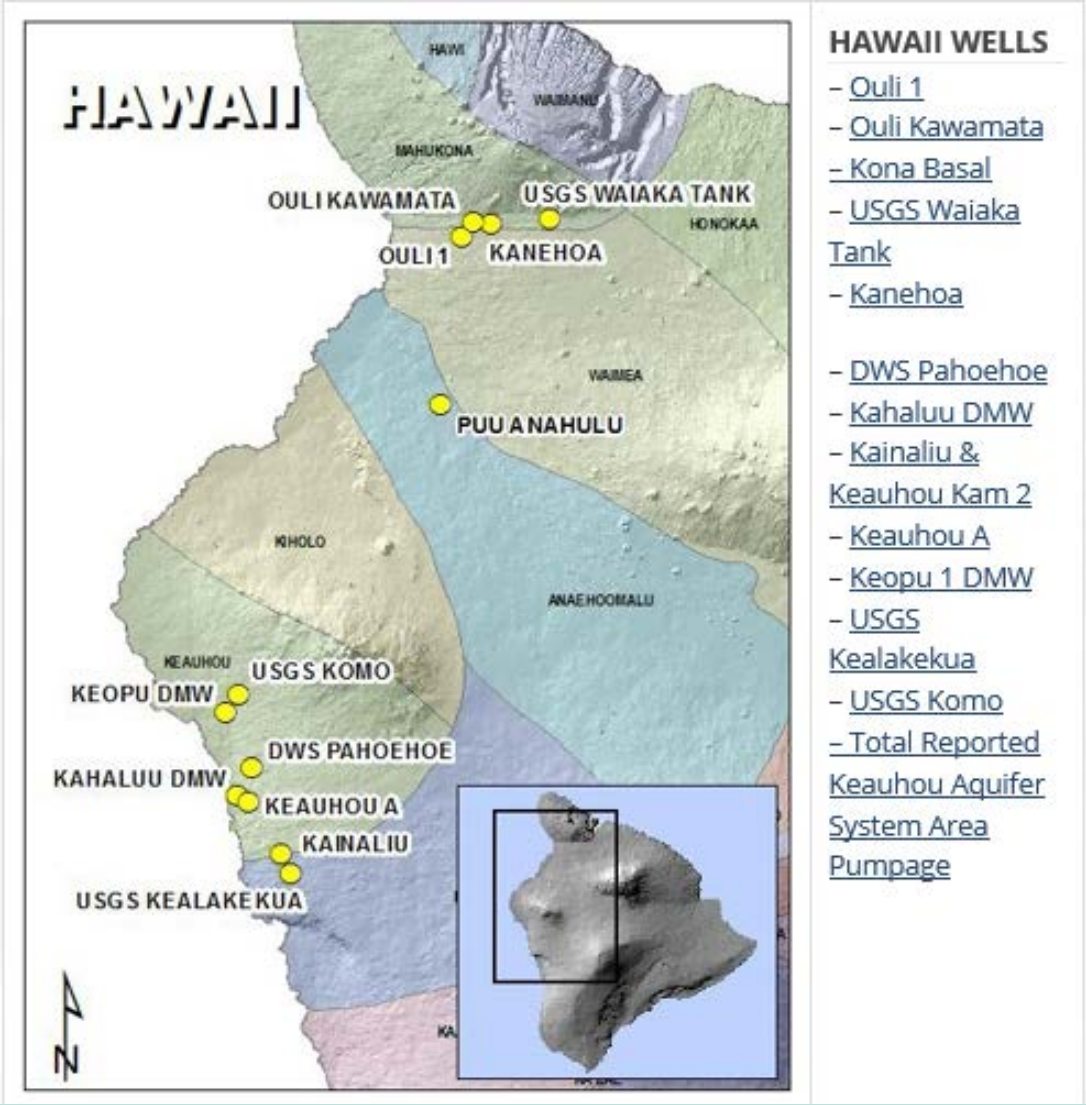
Groundwater Management

79 Wells in Waimea ‘Anaeho‘omalu ASAs



Groundwater Management

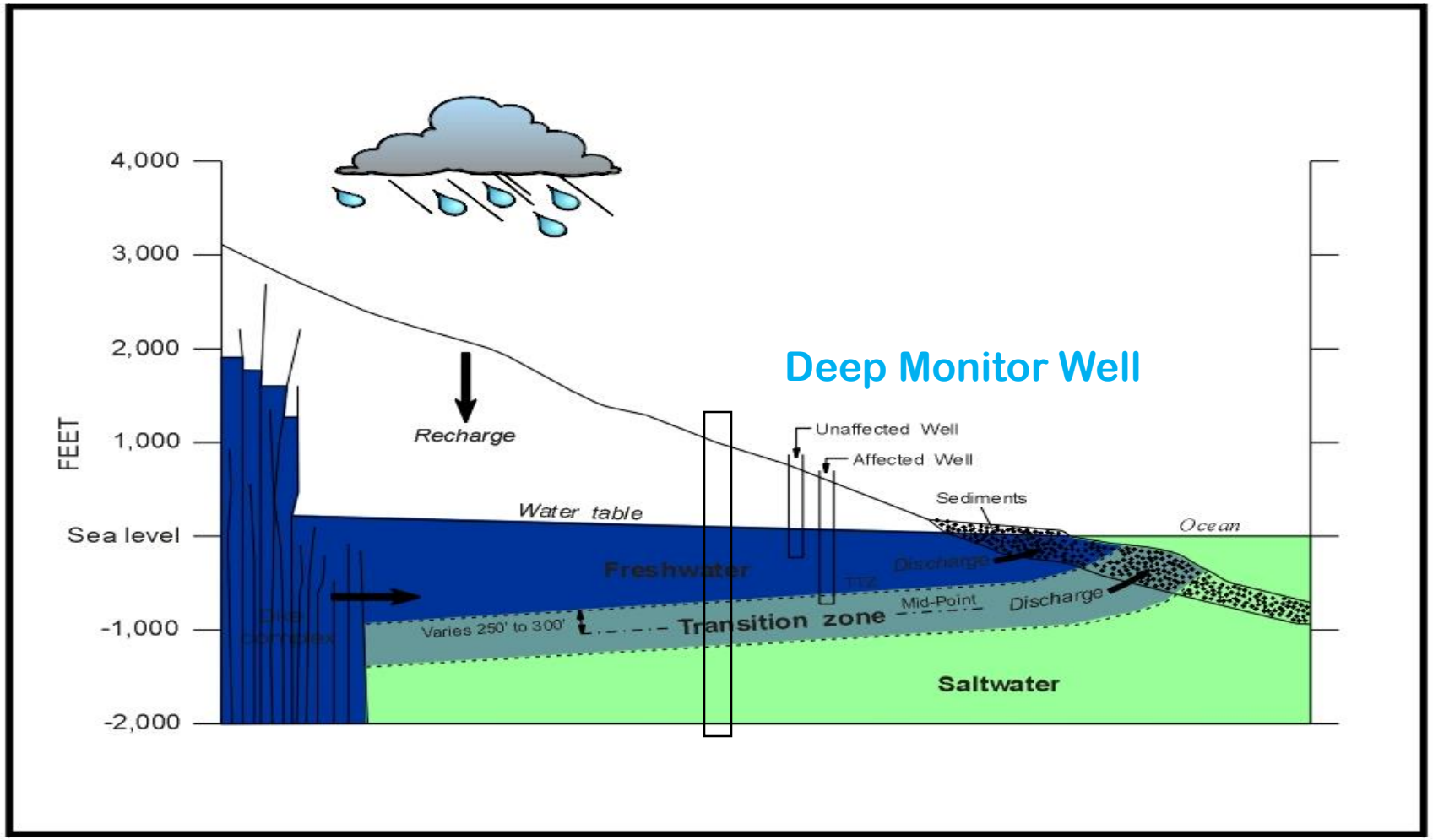
5 Observation Wells in Waimea Region



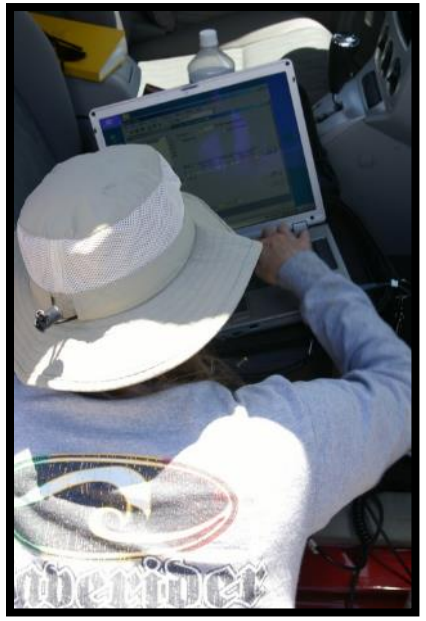
HAWAII WELLS

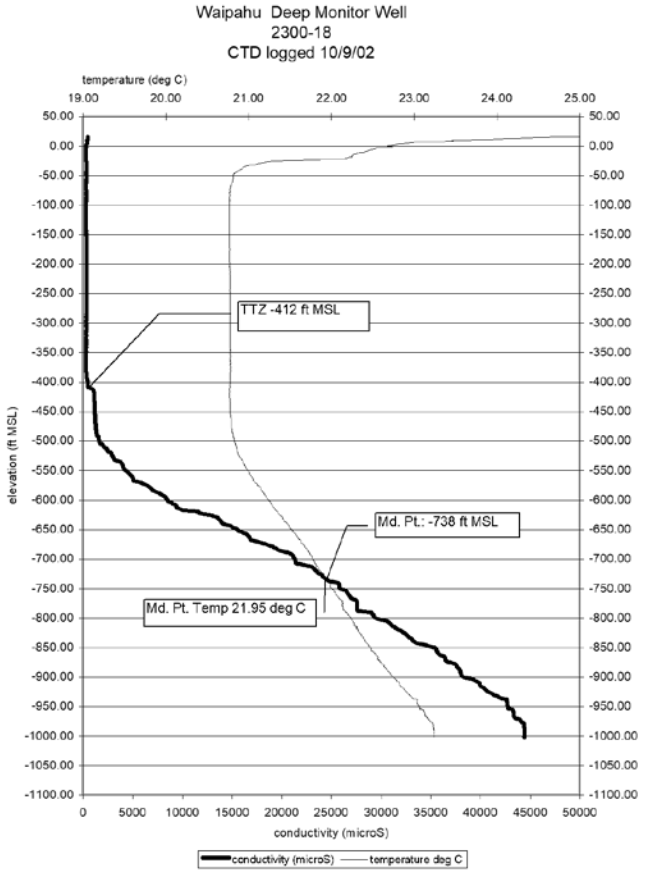
- Ouli 1
- Ouli Kawamata
- Kona Basal
- USGS Waiaka Tank
- Kanehoa
- DWS Pahoehoe
- Kahaluu DMW
- Kainaliu & Keauhou Kam 2
- Keauhou A
- Keopu 1 DMW
- USGS Kealakekua
- USGS Komo
- Total Reported Keauhou Aquifer System Area Pumpage

Groundwater Management

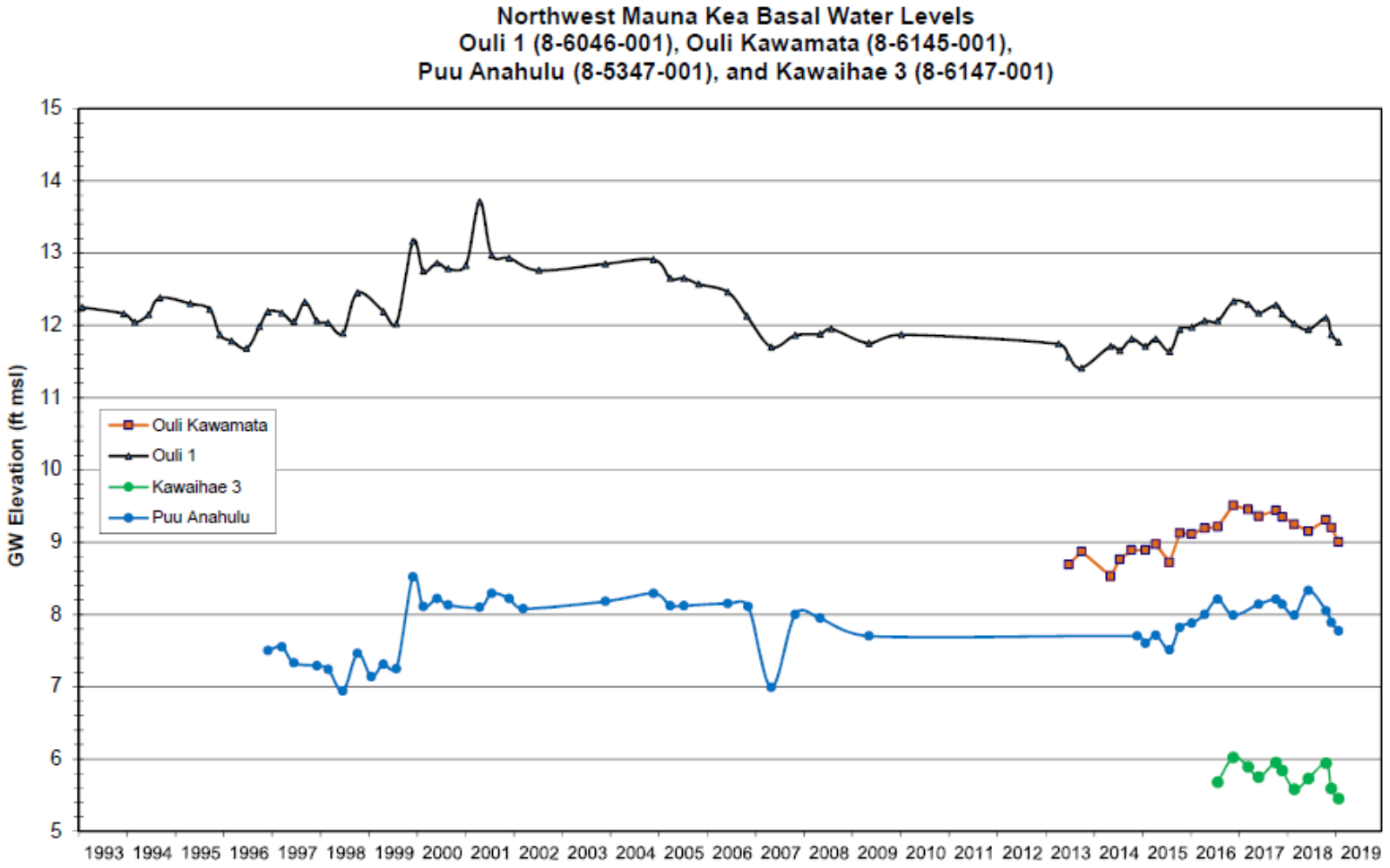


Groundwater Management (data collection)





Groundwater Management



- How does CWRM estimate Sustainable Yields?

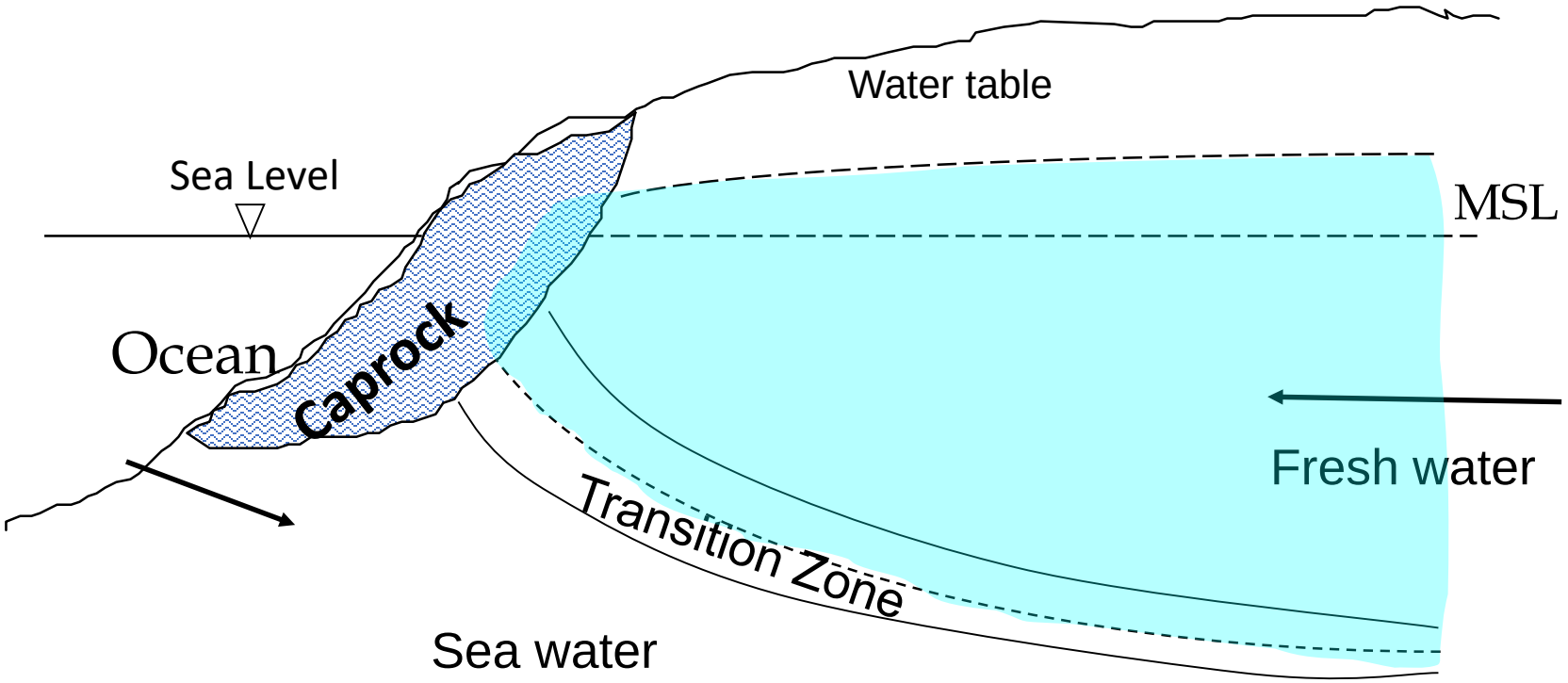
  - Use best public information available
  - ✓ RAM
  - RAM2
  - Numerical Models and other public studies

What is RAM?

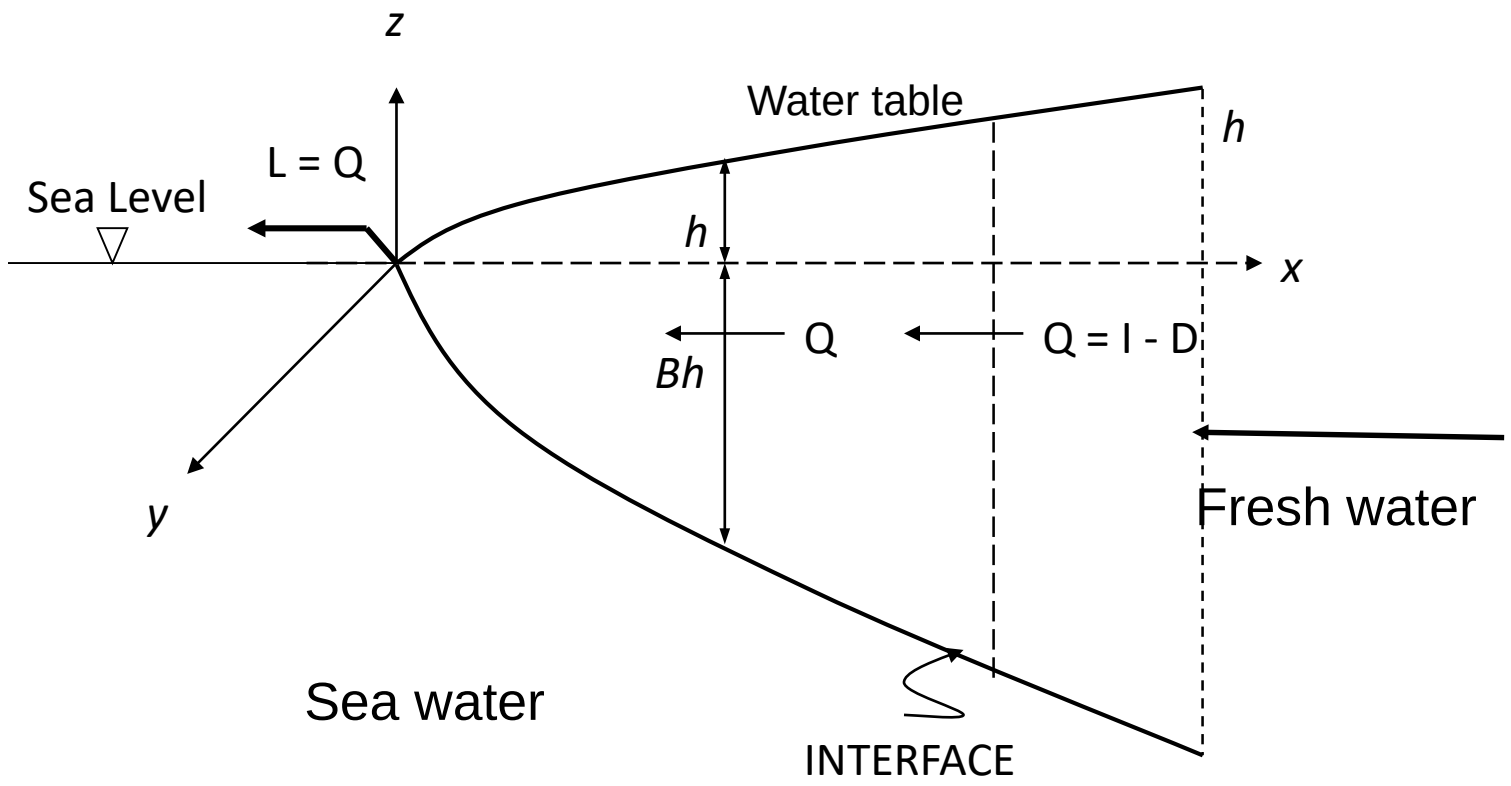
Robust Analytical Model (RAM)

(Mink, J.F. 1981. Determination of Sustainable Yields, in: Groundwater in Hawaii – A Century of Progress, Water Resources Research Center, University of Hawaii)

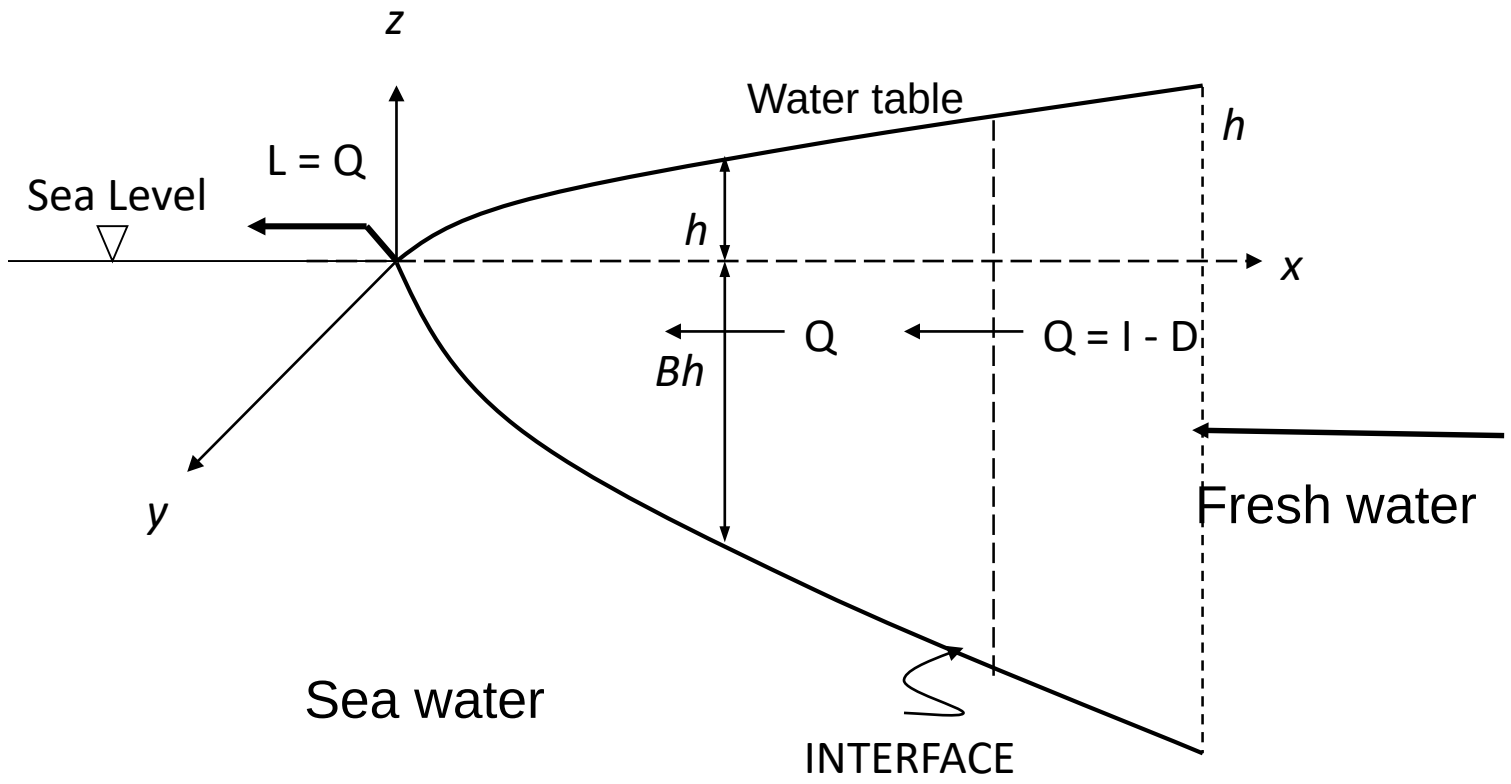
Conceptual RAM Model



Conceptual RAM Model



Conceptual RAM Model



By combining Darcy's Law, conservation of mass, and GH principle - RAM Model:

Solution:

$$h_{i+1} = h_0 \sqrt{\frac{I-D}{D}} \left[\frac{[\sqrt{I-D} + \frac{h_i}{h_0}\sqrt{I}] \cdot \exp\left\{\frac{2\sqrt{(I-D)I}\,(t_{i+1}-t_i)}{V_0}\right\} - \sqrt{I-D} + \frac{h_i}{h_0}\sqrt{I}}{[\sqrt{I-D} + \frac{h_i}{h_0}\sqrt{I}] \cdot \exp\left\{\frac{2\sqrt{(I-D)I}\,(t_{i+1}-t_i)}{V_0}\right\} + \sqrt{I-D} - \frac{h_i}{h_0}\sqrt{I}} \right]$$

John Mink's Robust Analytical Model (RAM)

(Mink, J.F. 1981. Determination of Sustainable Yields, in: Groundwater in Hawaii – A Century of Progress, Water Resources Research Center, University of Hawaii)

$$D = I\{1 - (h/H)^2\}$$

D = allowable draft (i.e. sustainable yield)

I = Recharge

H = original head before pumping (important calibration point)

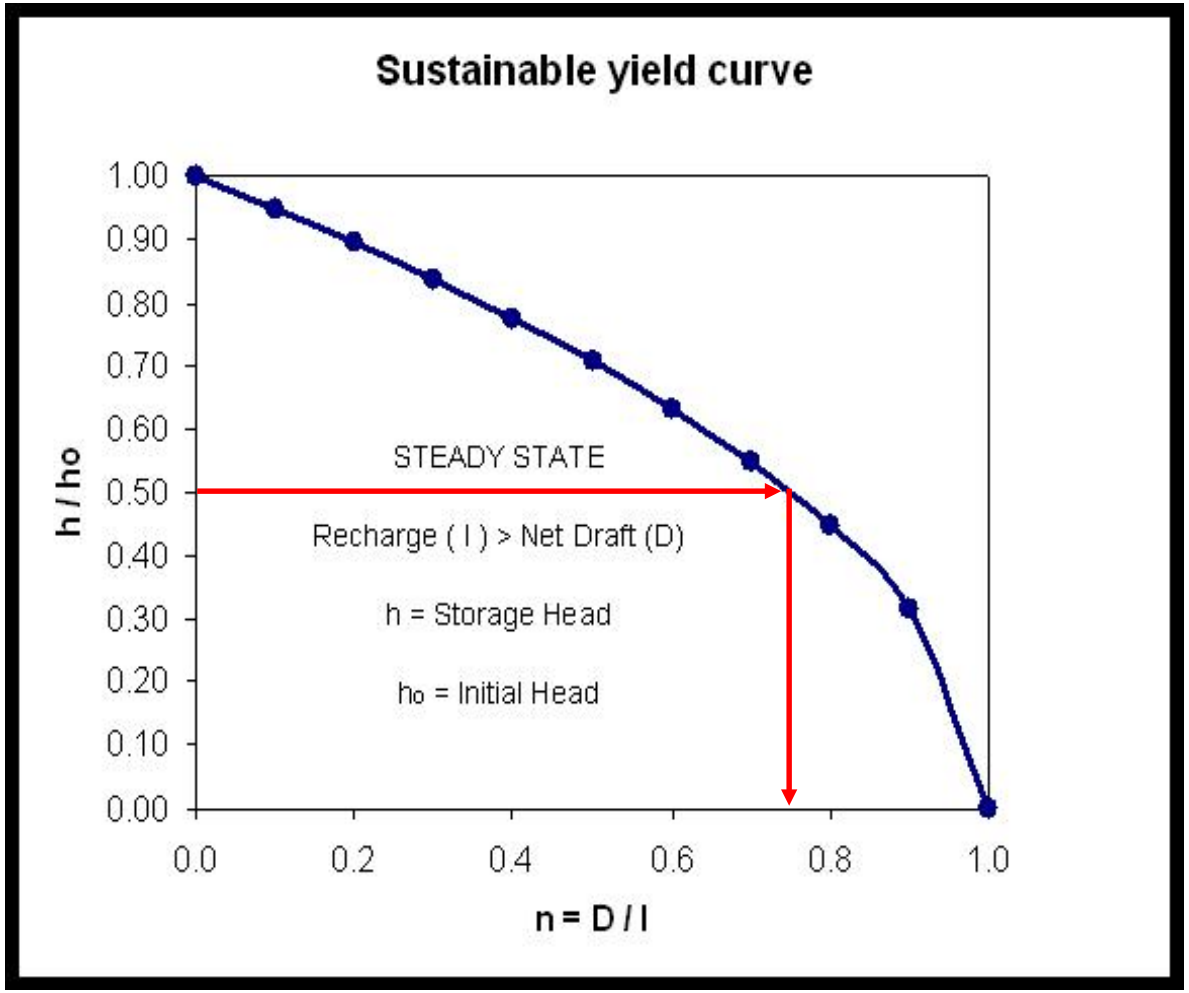
h = equilibrium head

Limitations

- Assumes uniform distribution (optimized) pumpage
- Difficult, if not impossible, to define original & equilibrium head
- Does not directly assess changes in chlorides or water levels at a specific well
- Does not consider GDE impacts directly (2018 issue)

John Mink's Robust Analytical Model (RAM)

(Mink, J.F. 1981. Determination of Sustainable Yields, in: Groundwater in Hawaii – A Century of Progress, Water Resources Research Center, University of Hawaii)



John Mink's Robust Analytical Model (RAM)

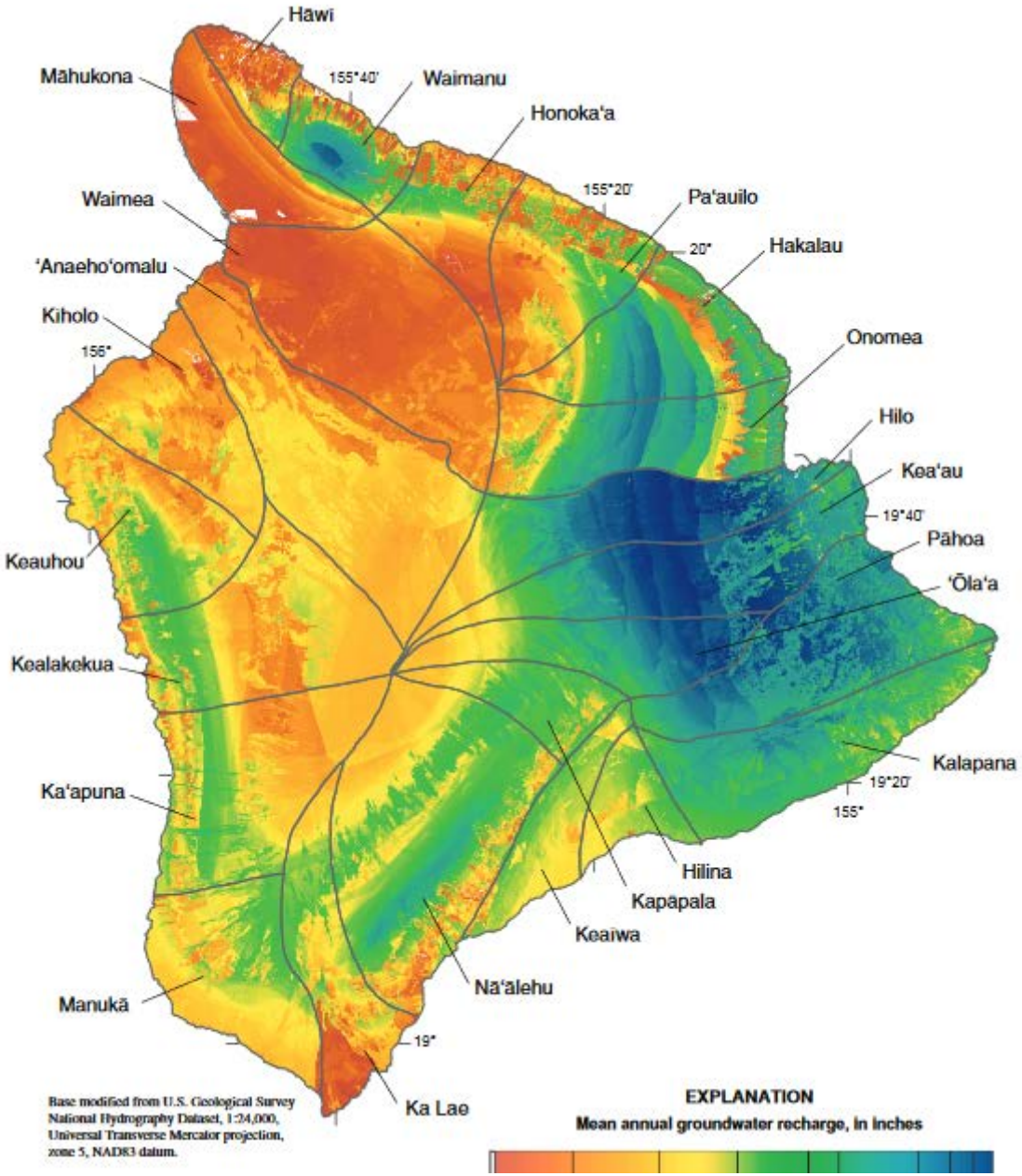
(Mink, J.F. 1981. Determination of Sustainable Yields, in: Groundwater in Hawaii – A Century of Progress, Water Resources Research Center, University of Hawaii)

Table 2. Relationships Between Initial Head and Minimum Equilibrium Head of Hawaii Basal Aquifers, Established by CWRM (1990)

Range of Initial Head, h_0 (ft)	Ratio of Minimum Equilibrium Head and Initial Head, h_e/h_0	
4–10	0.75	44
11–15	0.70	51
16–20	0.65	58
21–25	0.60	64
> 26	0.50	75

SY=%Recharge

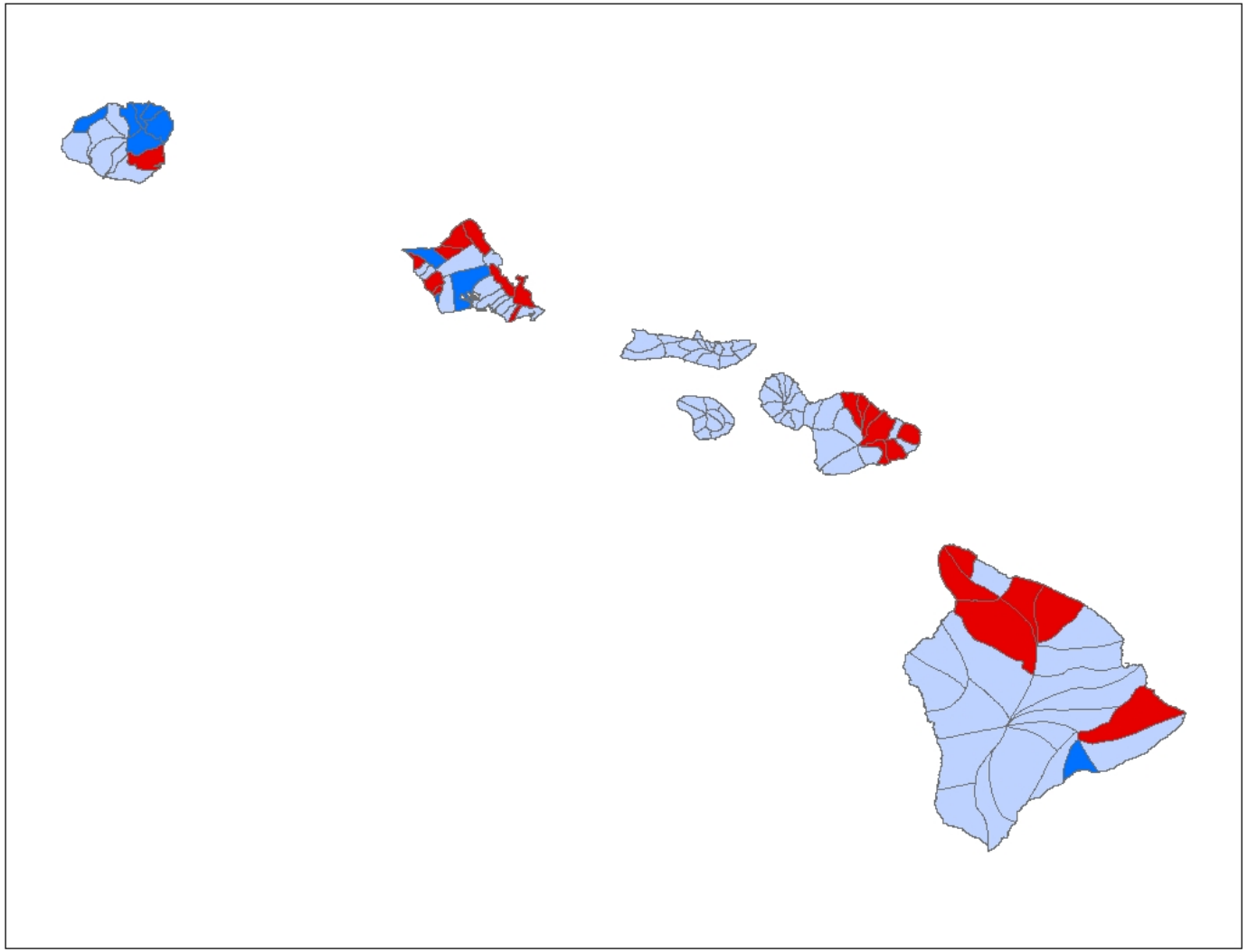
2011 USGS Hawai'i Recharge Updates



2019 WRPP Big Island SY

Aquifer Sector	Aquifer System	RAM SY - 1990 (mgd)	D/I = 1990 pg B-3	1990 Recharge	Revised Recharge	Revised Recharge SY	USGS 2011 Revised Recharge Baseline	USGS 2011 Revised Recharge Baseline SY	2008 SY Range	Proposed 2014 SY Range
Hawaii										
Kohala	Hawi	27	0.44	62	29.9/65.4	13-29	21.09	9	13 - 29	9 - 29
Kohala	Waimanu	110	0.75	147	~	~	153.09	115	110	110 - 115
Kohala	Mahukona	17	0.44	38	~	~	23.22	10	17	10 - 17
E. Mauna Kea	Honokaa	31	0.44	71	~	~	63.33	28	31	28 - 31
E. Mauna Kea	Paauilo	60	0.44	136	~	~	120.86	53	60	53 - 60
E. Mauna Kea	Hakalau	150	0.44	341	~	~	364.81	161	150	150 - 161
E. Mauna Kea	Onomea	147	0.44	335	~	~	417.08	184	147	147 - 184
W. Mauna Kea	Waimea	24	0.44	54	~	~	35.62	16	24	16 - 24
NE. Mauna Loa	Hilo	347	0.44	793	~	~	815.16	359	349	349 - 359
NE. Mauna Loa	Keaau	393	0.44	898	~	~	914.71	402	395	395 - 402
SE. Mauna Loa	Olaa	124	0.44	284	~	~	454.01	200	125	125 - 200
SE. Mauna Loa	Kapapala	19	0.44	44	~	~	116.81	51	19	19 - 51
SE. Mauna Loa	Naalehu	117	0.44	268	~	~	476.19	210	118	118 - 210
SE. Mauna Loa	Ka Lae	31	0.44	71	~	~	106.61	47	31	31 - 47
SW. Mauna Loa	Manuka	42	0.44	96	56	25	160.11	70	25 - 42	25 - 70
SW. Mauna Loa	Kaapuna	50	0.44	115	133	58	197.47	87	51 - 58	51 - 87
SW. Mauna Loa	Kealakekua	38	0.44	86	87	38	179.58	79	38	38 - 79
NW. Mauna Loa	Anaehoomalu	30	0.44	69	~	~	181.69	80	30	30 - 80
Kilauea	Pahoa	435	0.44	994	~	~	910.93	401	437	401 - 437
Kilauea	Kalapana	157	0.44	359	~	~	487.76	215	158	158 - 215
Kilauea	Hilina	9	0.44	20	~	~	72.95	32	9	9 - 32
Kilauea	Keaiwa	17	0.44	39	~	~	93.61	41	17	17 - 41
Hualalai	Keauhou	38	0.44	87	86	38	151.62	67	38	38 - 67
Hualalai	Kiholo	18	0.44	42	~	~	76.19	34	18	18 - 34

Sustainable Yield Updates



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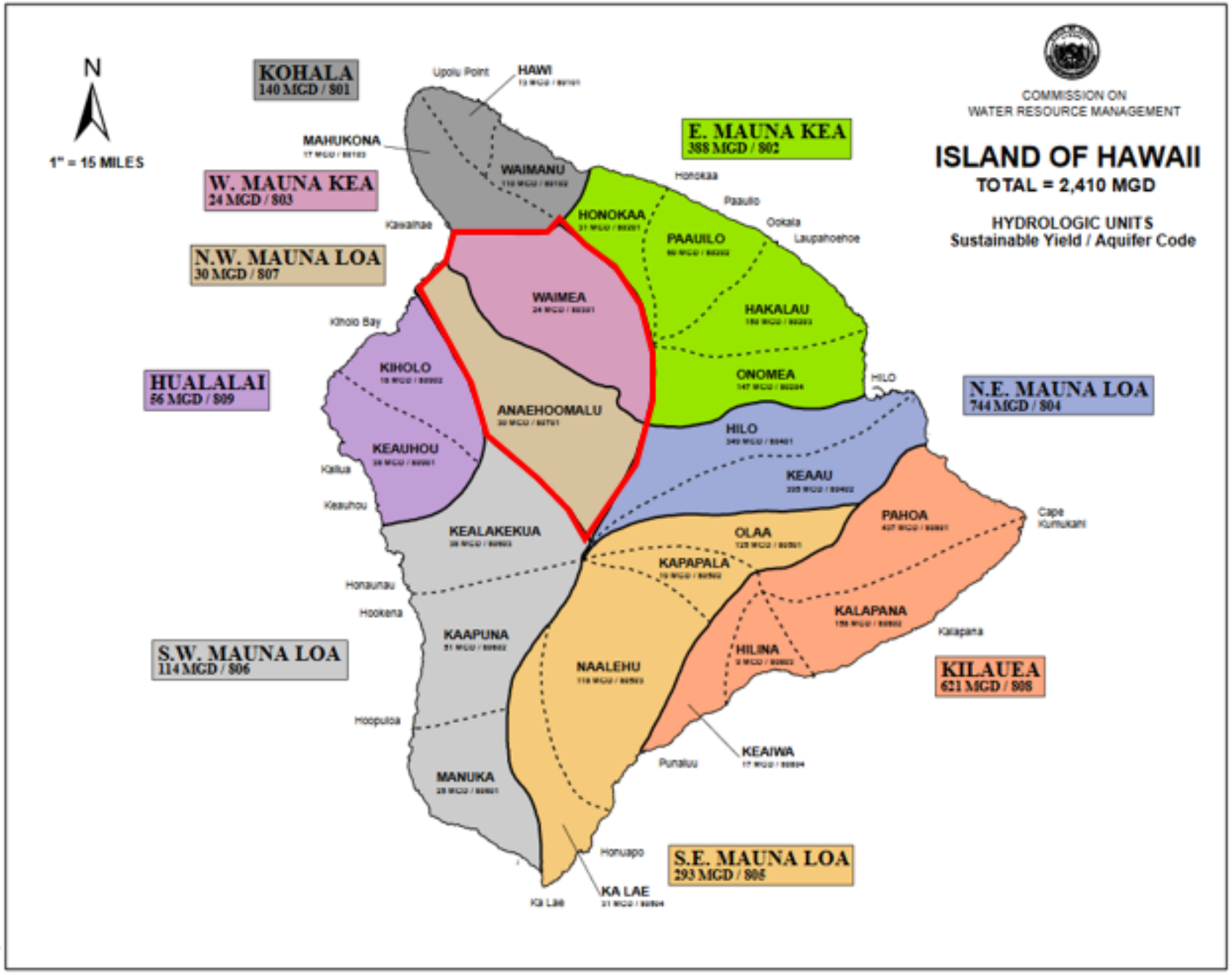
Aquifer System Areas

- Waimea
- ʻAnaehoʻomalu



2019 WRPP Sustainable Yields

	mgd
Waimea	16 (reduced from 24)
‘Anaeho‘omalu	30 (unchanged from 1990)

2019 WRPP Sustainable Yields

	Recharge % of all inputs
Waimea	11.4
‘Anaeho‘omalu	53.7

2019 WRPP Sustainable Yields

	Recharge % of all inputs
• Waimea, Hāwī, Mahukona	11
• Honoka‘a, Pa‘auilo, Hakalau	22-28
• Remainder Big Isle	44-70

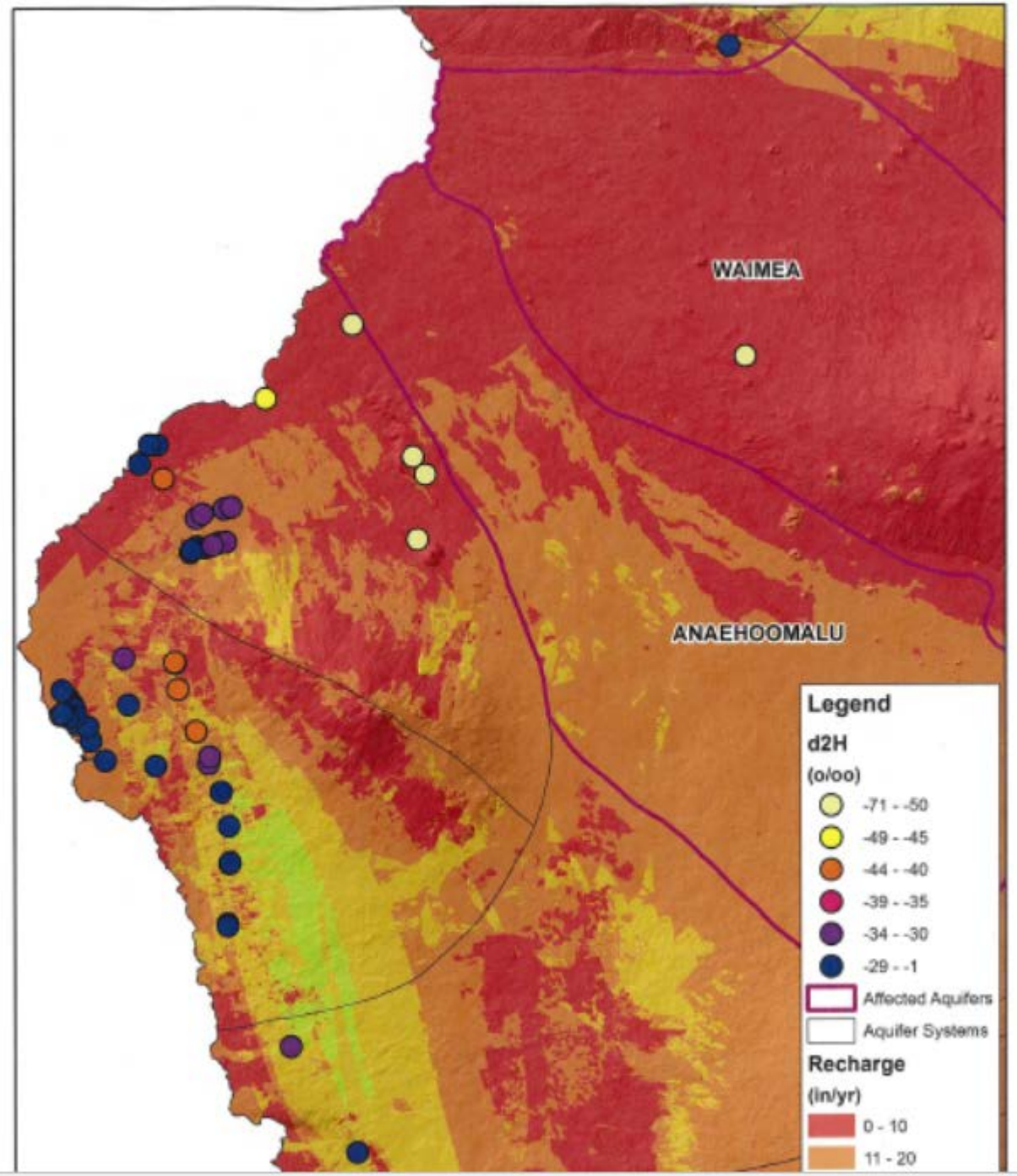
2019 WRPP Sustainable Yields

Missing inputs

Losing Streams into Waimea ASA	mgd
• Waikoloa	5
• Keanuimano	4
• Hauani	1

2019 Isotope Analysis

(rainfall elevation origin)



Boundary Geophysical Analysis

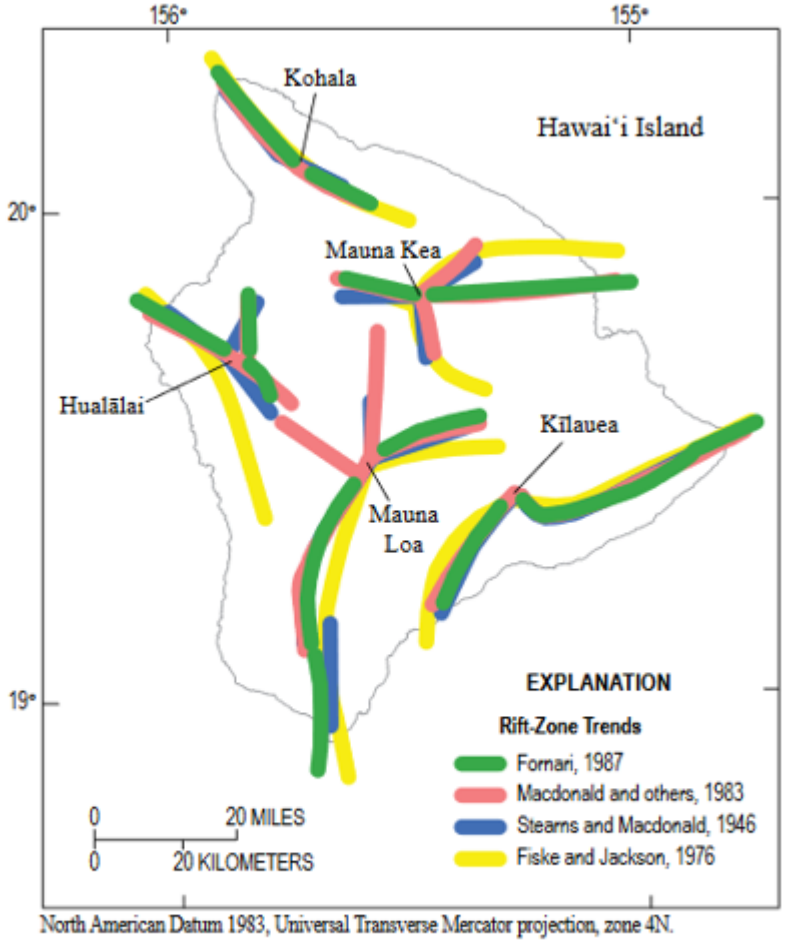


Figure 45. Interpretations of rift-zone trends on Hawai'i Island.

Figure 3 USGS Rift Zone Map (from 1946 to 1987 Studies)

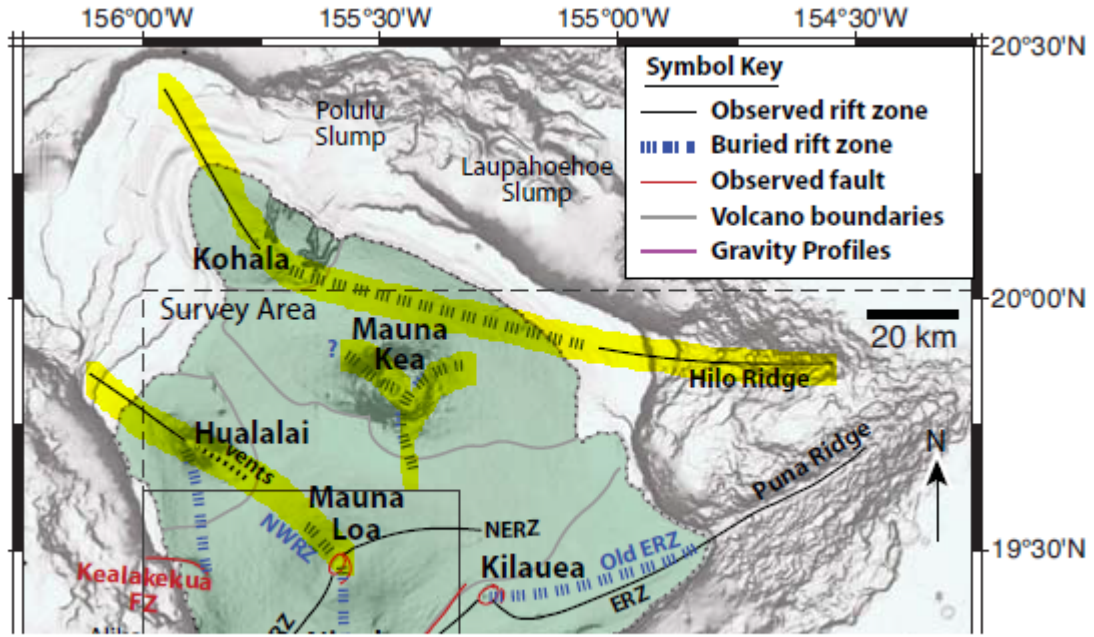
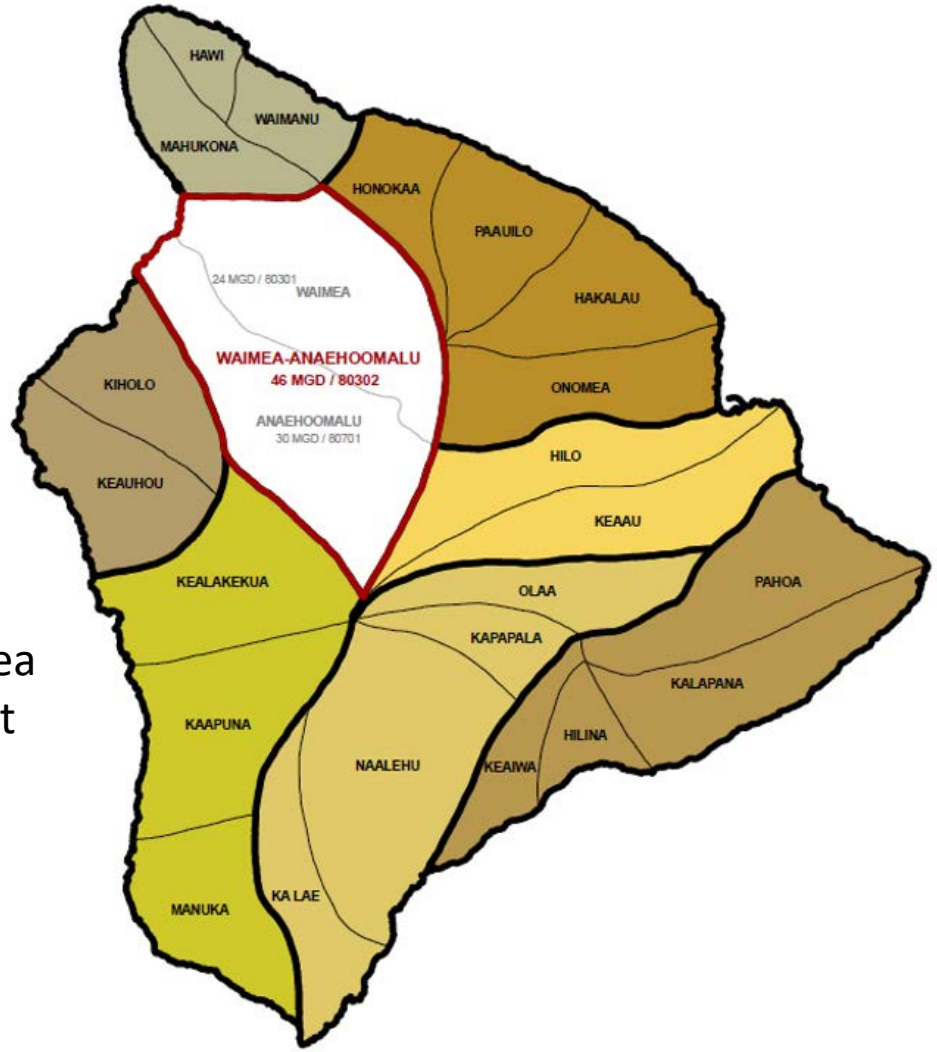


Figure 4 Section from 2010 Morgan Rift Zone Map

Proposed amendment to 2019 WRPP

- Maintains minimum range of latest recharge/sustainable yields
- Appears more consistent with observed hydrogeologic data
- Simple management change to address perceived threat to Waimea from drastic lowering of SY without changing USGS analysis



Proposed amendment to 2019 WRPP

Schedule (subject to change)

- June - brief Commission in Waimea/ʻAnaehoʻomalu boundary change
- June 28 - Public Hearing Notice of WRPP amendment for W/A change
- July - Commission decision on entire final draft of 2019 WRPP
- September 26 – Public Hearing in Waimea
- October 28 – deadline for written comments on W/A amendment
- November 19 – Commission action on W/A amendment

For more information:

WRPP Update Website

http://dlnr.hawaii.gov/cwrm/planning/hiwaterplan/wrpp/

Reservations of Ground Water for Department of Hawaiian Home Lands

Island	Aquifer System Area	Proposed Reservation Amounts (million gallons per day)
Kauaʻi	Wailua	0.708
	Anahola	1.470
	Kekaha	0.336
	Makaweli	0.405
Lanaʻi	Leeward	0.067
Maui	Honokōwai	0.770
	Kamaʻole	2.547
	Keʻanae	0.003
	Kawaipapa	0.118
	Lualaʻiula	0.063
Hawaiʻi	Hawi	0.148
	Māhukona	3.014
	Honokaʻa	0.396
	Hakalau	0.083
	Onomea	0.250
	Hilo	0.492
	Keaʻau	1.336
	ʻŌlaʻa	0.025
	Nāʻālehu	0.185
	Pāhoa	0.660