Guam Groundwater-Availability Study

Technical Working Group Meeting

May 10, 2012

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Outline of Meeting

- **Project goals, products, timeline**
- Well database
- Recharge study final report
- Aquifer properties analysis and numerical modeling
- Future pumping scenarios
- Wrap up and future plans

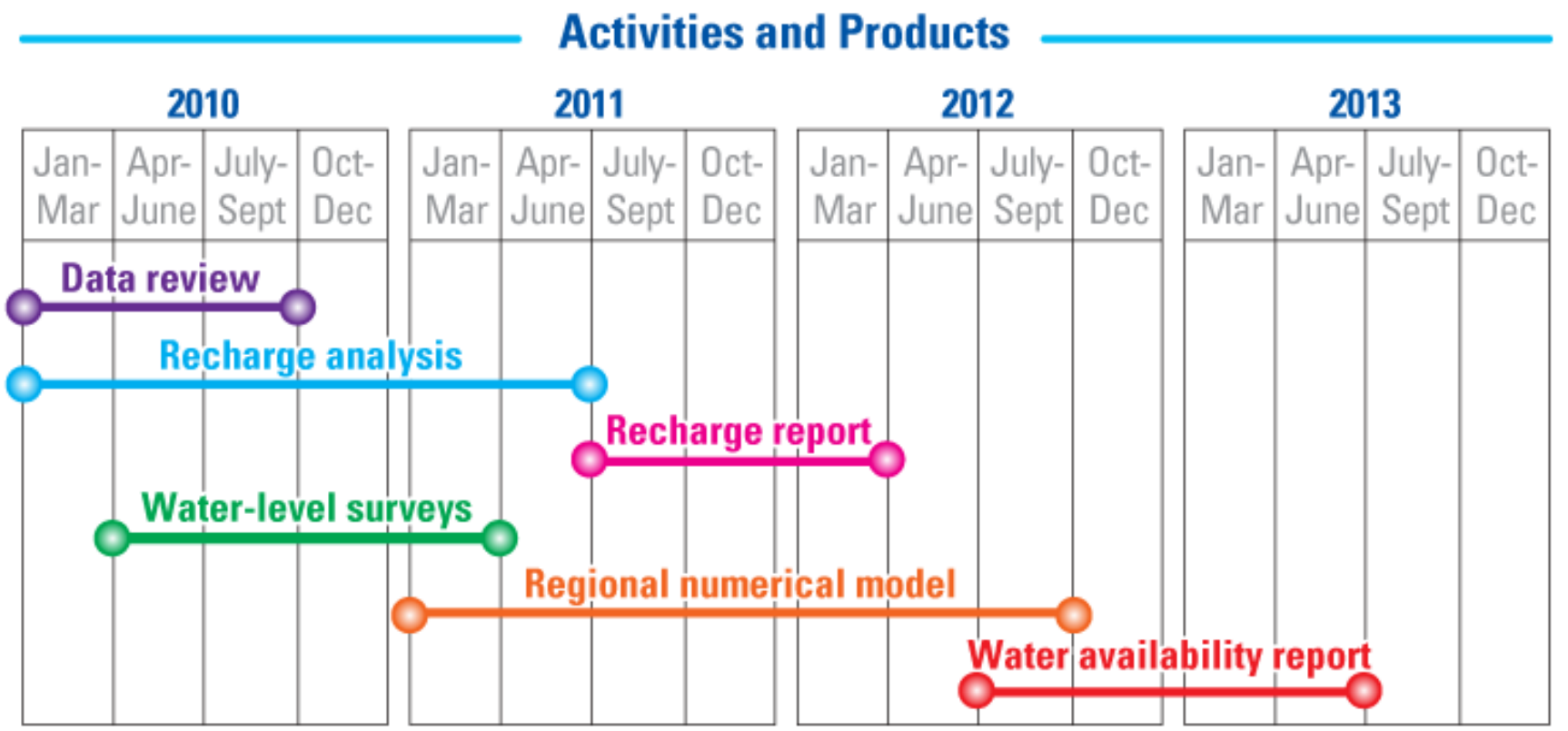
Guam Groundwater-Availability Study Objectives

- Obtain a better understanding of the regional groundwater flow system in northern Guam
- Update estimates of groundwater recharge for the entire island
- Estimate effects of selected withdrawal scenarios within northern Guam, using a numerical groundwater flow and transport model, on water levels and the transition zone between freshwater and saltwater

Guam Groundwater-Availability Study Approach

1. Compile, review, and analyze existing data
2. Collect additional groundwater data in northern Guam
3. Develop daily water budget to estimate groundwater recharge rates
4. Develop numerical groundwater flow and transport model for northern Guam

Timelines



Planned schedule for the various activities and products of the groundwater-availability study of northern Guam.

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Well Database

Wells commented_july 7 2010_0938 - Microsoft Excel

D6 | A-2

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1		Agana (Hag		Yigo			Finegayan	Mangi	Agafa Guma	Andersen			INACTIVE WELLS							
2				GWA			EARTH TECH	NAVY	AIR FORCE	USGS									Avg last 3 yrs - GWA	
3		Sub-Basin uwa database		WERI Tech Report	Latitude	Longitude	Land surface elevation	Well Depth	Solid Casing Length	Screen Length	Hole Diameter (inches)	Casing Diameter (inches)	Date Started Drilling	Date Completed Drilling	Test Pumping Rate (GPM)	Drawdown (ft)	Specific capacity (gpm/ft) pumping rate/drawdown	Depth to volcanic baseme	Chloride data	Water Level data (relative to MSL)
4				Production																
5		Agana	A01	A-1			67.66'	221.0'	70'	150'	11	8	13-Feb-65	20-Nov-65	210	103.49'	210/103.49'		36	18.91'
6		Agana	A02	A-2			118'	172'	110'	60'	11	8	19-Aug-65	8-Oct-65	210	23.23'	210/23.23'		33	106.1' ?
7		Agana	A03	A-3			127.45'	410'	???(390' ho	???	11	8	11-Apr-66	7-Jun-67	273	98'	273/98'		29	105.8'
8		Agana	A04	A-4			140.18'	300'	130'	170'	11	8	28-Jun-66	21-Mar-67	300		300/???		96	134'
9		Agana	A05	A-5			146.7'	332'	323'		11	8	3-Aug-66	18-Feb-69	100 ?	[illegible]	[illegible] ?	340'	33	322' (137.45'?)
10		Agana	A06	A-6			152'	306'	136'	170'/11	11	8	19-Jul-67	9-Sep-67	325				40	142'
11		Agana	A07	A-7			136'	186'	116'	70'	11	8	18-Apr-67	8-May-67	210	35			102	126'
12		Agana	A08	A-8			124'	305'	96'	205'	11	8	26-May-67	20-Jul-68	270				34	109'
13		Agana	A09	A-9			187.15'	240'	237'	70'	11	8	24-Mar-67	23sep??	83	1.2	83/1.2		228	180.5'
14		Agana	A10	A-10			191.01'	215'	171'	45'	11	8	10-May-67	???			???		372	184.5'
15				A-11			178'	375'	125'	205'	11	8	7-Jun-68	23-Jul-68	150	201'	150/201'		3	131'
16		Agana	A12	A-12			138'	390'	103'	225'	11	8	24-Jul-68	29-Aug-68	330		330/		37	108'
17		Agana	A13	A-13			130.8'	418'	205'	120'	11	8	24-Oct-68	10-Dec-68	200		10.5 GPM/FT @ 200 GPM /250GPM/2		512	123'
18		Agana	A14	A-14			208'	260'	220'	40'		8		05/21/73 (date	160		160 GPM/??		341	206'
19		Agana	A15	A-15			197.74'		210'	50'		8		06/13/73 (date	235		235 GPM/13.67'=17.19		168	194.5'
20				A-16																
21		Agana	A17	A-17			196'	235'	195'	40'		8		08/17/73 (date	180		180 GPM/		441	192.75'
22		Agana	A18	A-18			265.5' (205')	250'	227' (210')	40'		8	19-Sep-73	22-Sep-73	135		135 GPM/		391	172' (204')
23		Agana	A19	A-19				165'	135'	20'		8		08/17/73 (date drilled)			120		400	133.3'
24				A-20																
25		Agana	A21	A-21					255'(260' 19feb98 GWA Maint Rec)										413	180.9'
26				A-22																
27		Agana	A23	A-23										5/10/1983 (date	330		330 GPM/?		70	
28		Agana	A25	A-25			59.96'	70.56'	68'	40'		8		4/10/1994 (date	270		270 GPM/11.29'=23.91		89	50.11'
29		Agana	A26	A-26			156.5'	203.5'						05/05/83 (date	50		50 GPM/11.9'=4.20		84	148.5'
30				A-27			150.5'	197.5'												
31		Agana	A28	A-28			246'	242'						05/05/83 (date drilled)						199.6'
32		Agana	A29	A-29			58.93' (54.4')	105'	60'	40'	15	10	18-May-88	19-May-88	275		275gpm/8.59'=32.01gpm/ft		16-18	52.33'

UOG:
A-6 Well Info Layne Internattional

Sheet1 Sheet2

Cell O10 commented by UOG

80%

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Prepared in cooperation with the United States Marine Corps

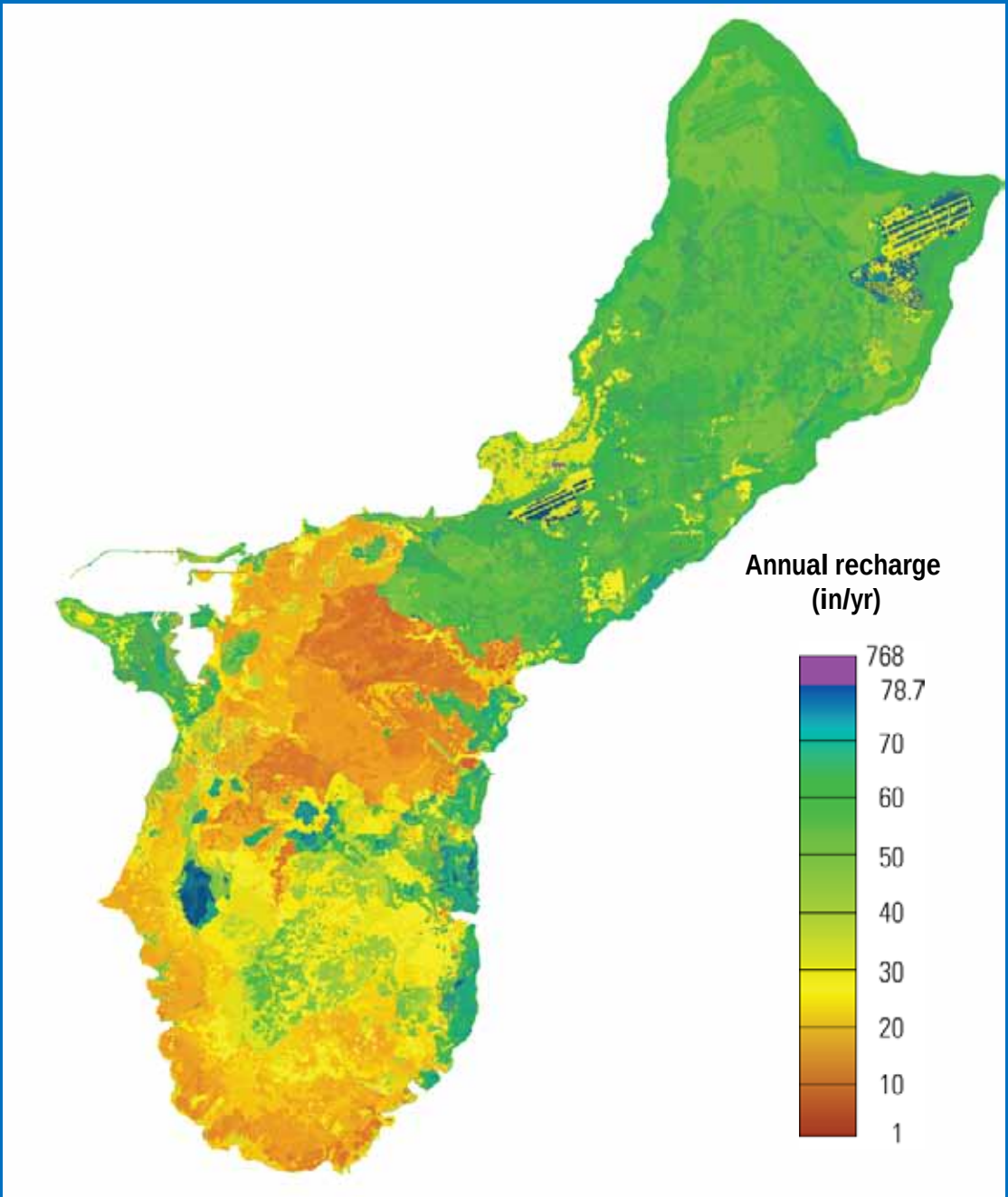
A Water-Budget Model and Estimates of Groundwater Recharge for Guam

Scientific Investigations Report 2012–5028

U.S. Department of the Interior
U.S. Geological Survey

Mean annual recharge distribution

- Limestone areas have highest recharge
- Volcanic areas have lowest recharge
- Storm-drain systems redistribute water



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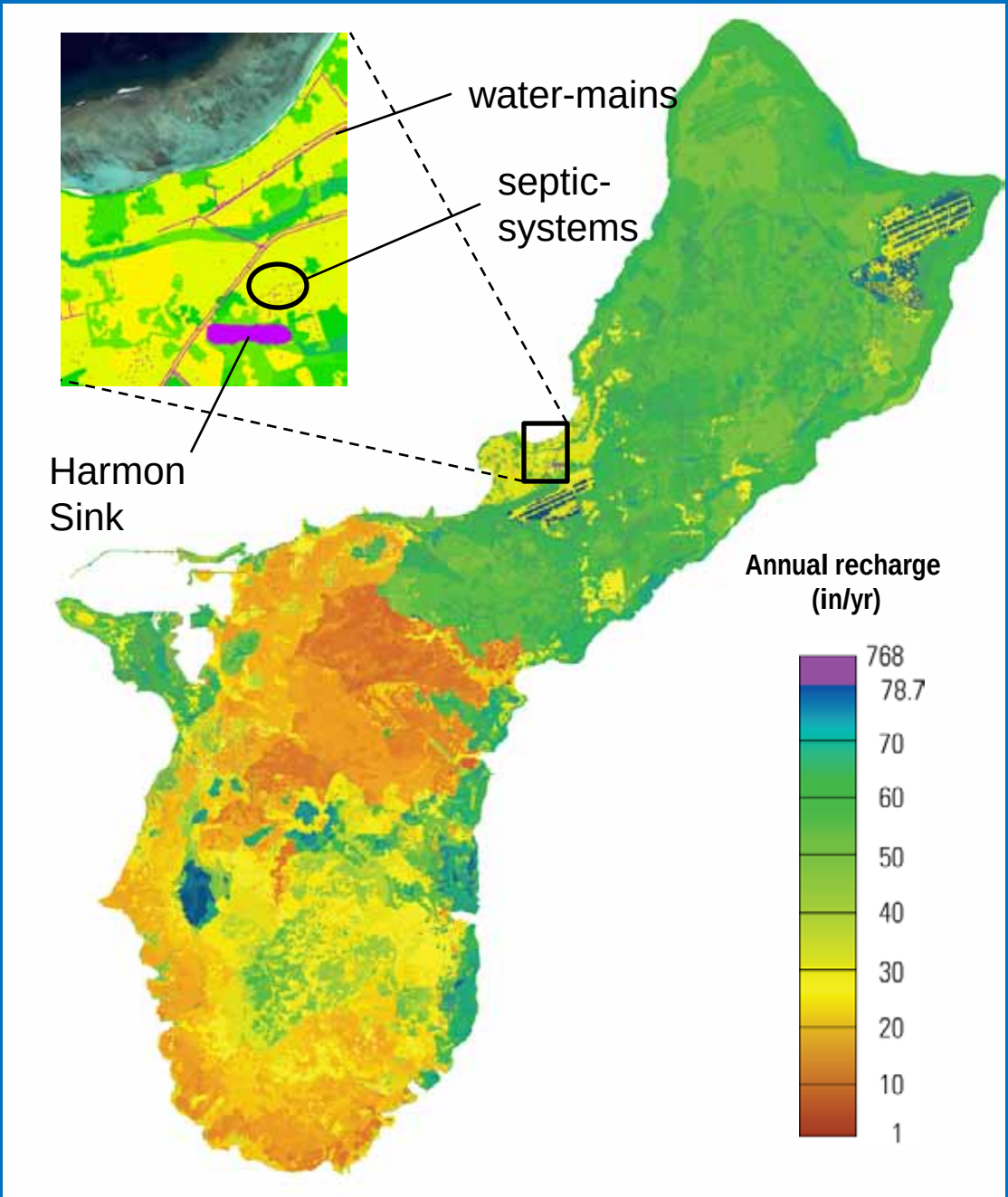
Mean annual recharge distribution

Recharge can be enhanced by

- water-main leakage
- septic-system leaching
- stormwater runoff at Harmon Sink



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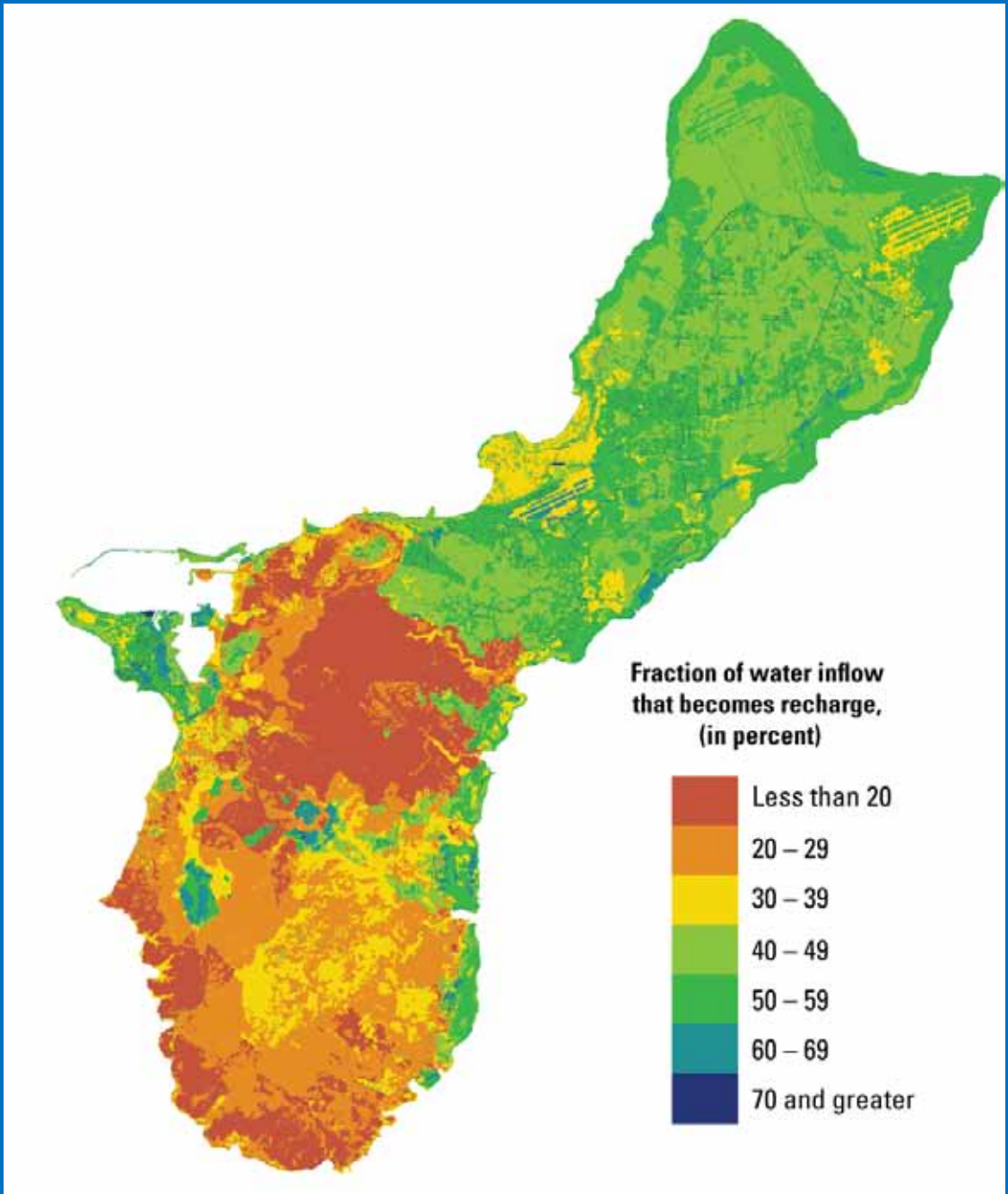
Recharge, percent of water inflow

most limestone areas:
40 to 60%

most volcanic areas:
less than 30%



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Water-Budget Summary

1. Recharge estimated for the northern aquifer subbasins is 32% to 49% greater than recharge estimated by the Northern Guam Lens Study (1982)

2. Recharge is about 40%-60% of water input in limestone areas and less than 30% in volcanic areas

3. Potential land-cover changes incurred during the proposed military buildup likely will not reduce overall recharge to Guam

4. Compared to long-term average recharge, recharge is 34% lower during the lowest 5-year rainfall period

5. Recharge distribution maps will be used in a numerical groundwater model of Guam's freshwater-lens system

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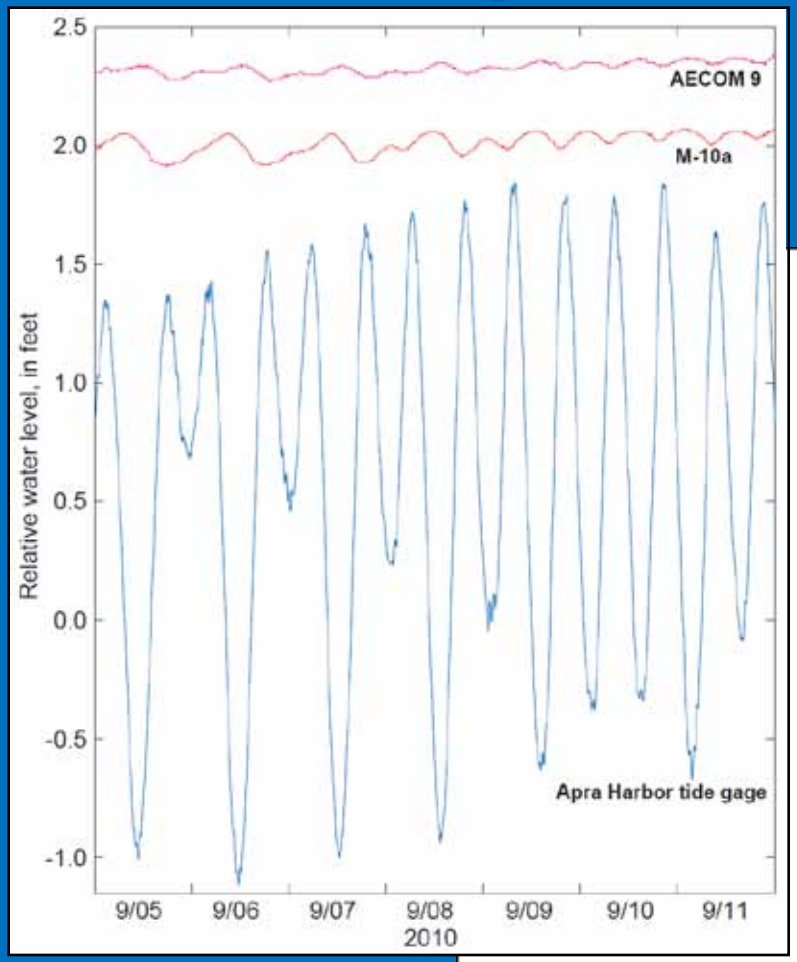
Aquifer Properties of Northern Guam

- Measured water levels in selected areas for several months
- Compiled long-term continuous water levels
- Digitized historic water levels
- Characterized distribution of aquifer properties by analyzing tidal response in wells
- Compared results using numerical model

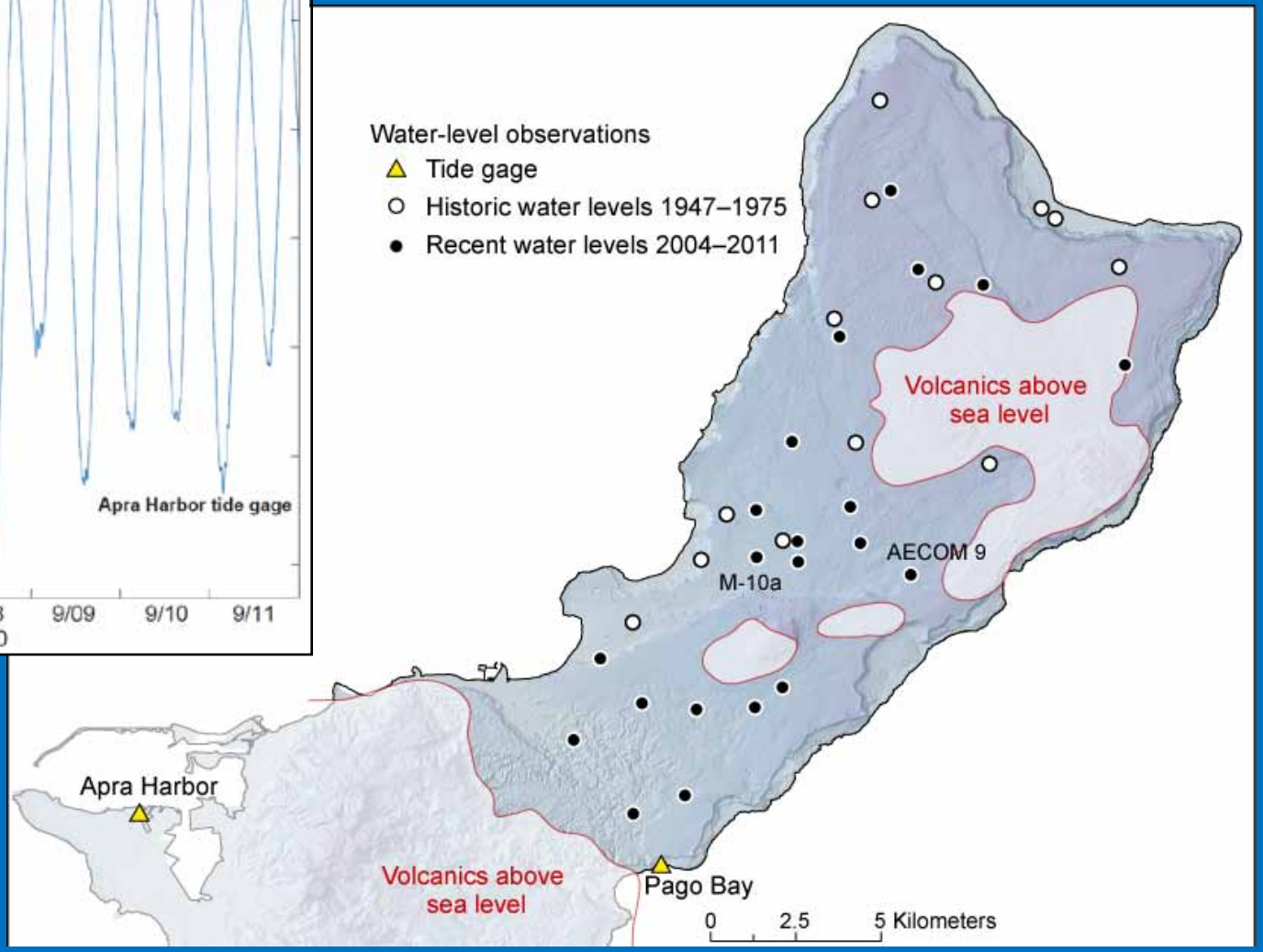
by Kolja Rotzoll, John Jenson, Steve Gingerich, and Aly El-Kadi

Tidal Response in Monitoring Wells



With increasing distance from the coast:

- amplitude decays exponentially
- time lag increases linearly



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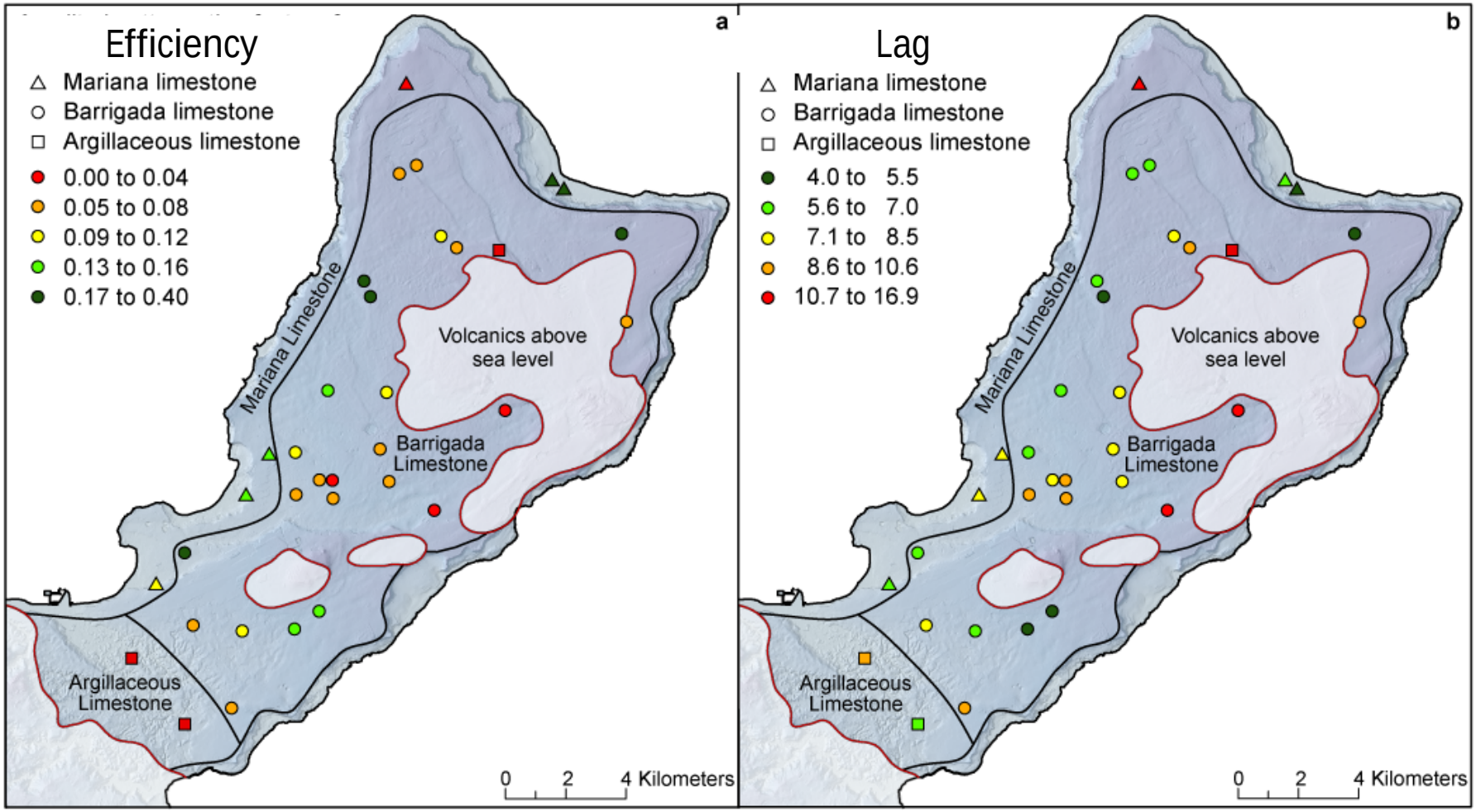
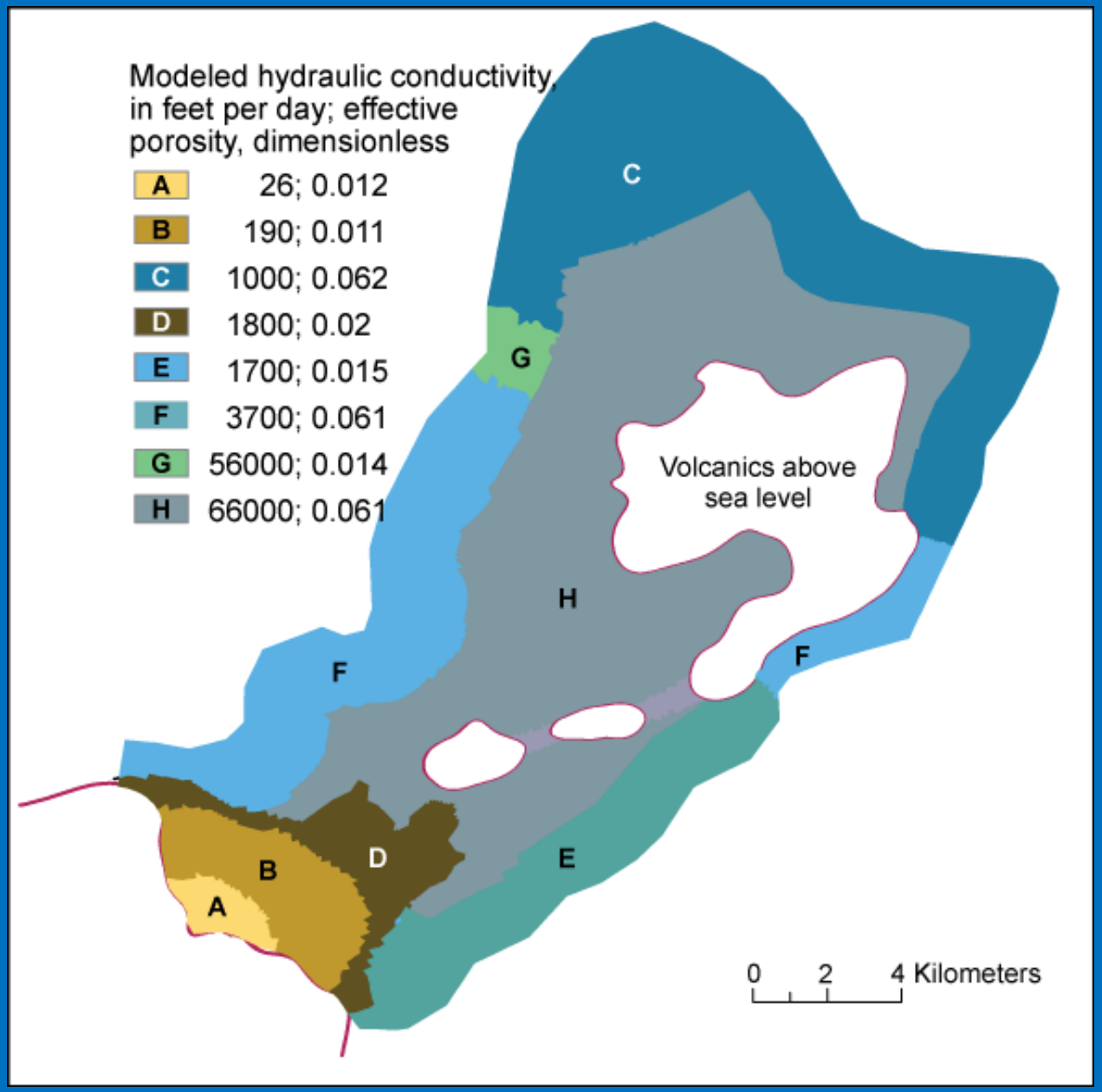
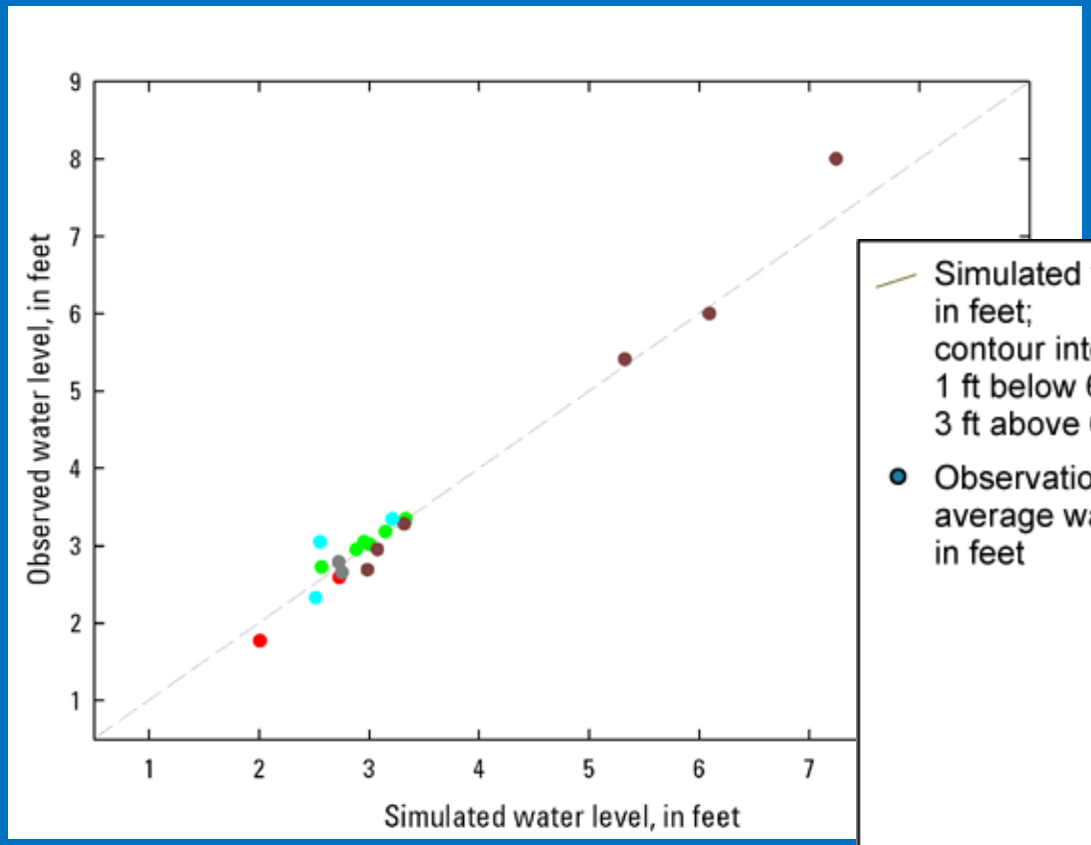
Tidal Efficiency and Lag

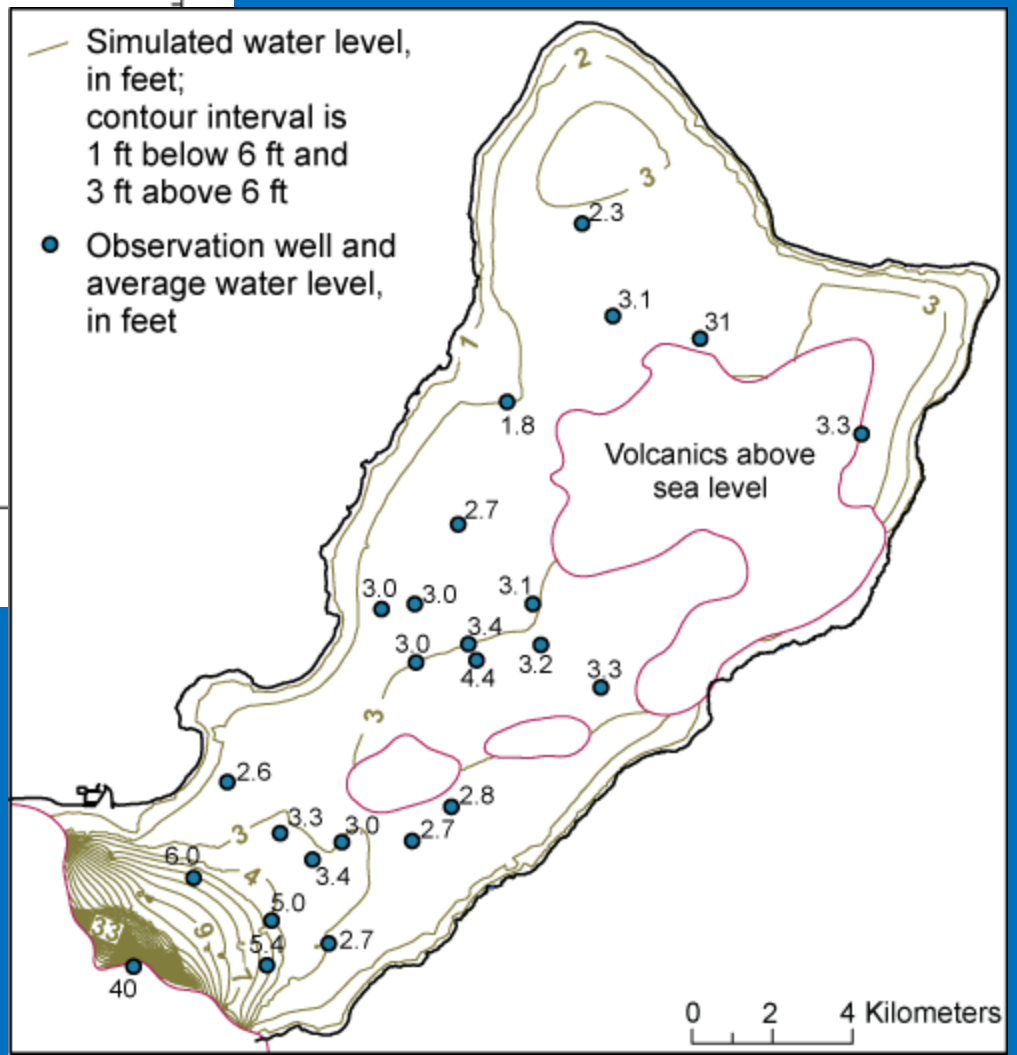


Aquifer properties from numerical model

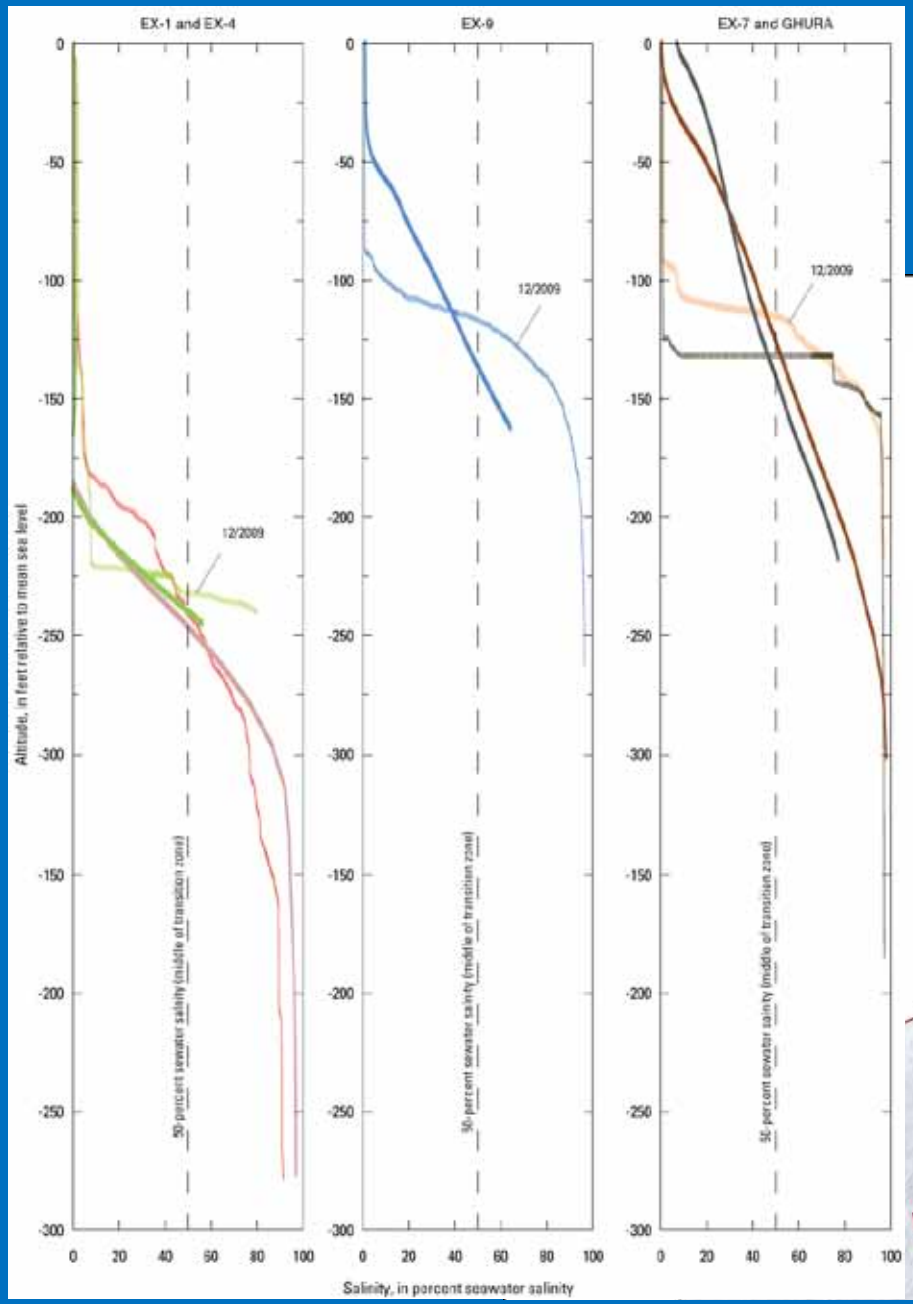


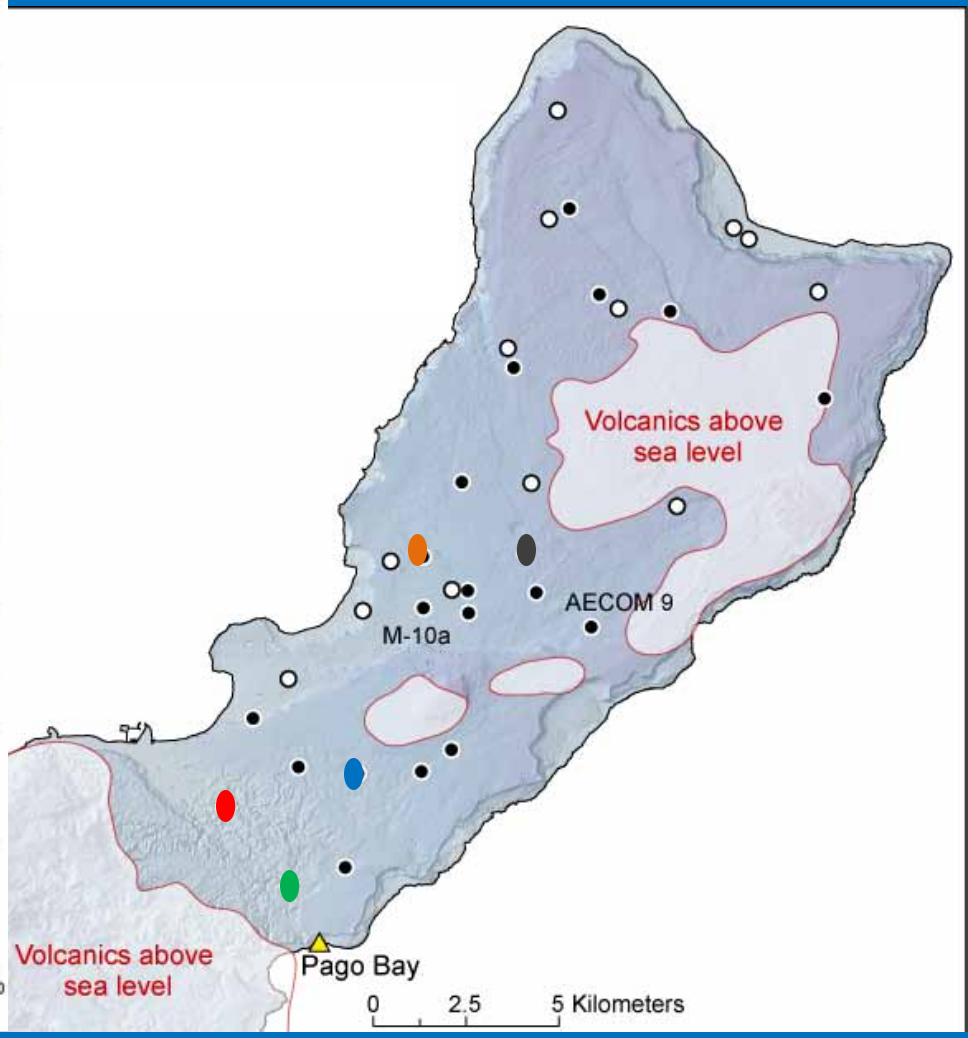
Modeled Water Levels





Modeled Salinity Profiles





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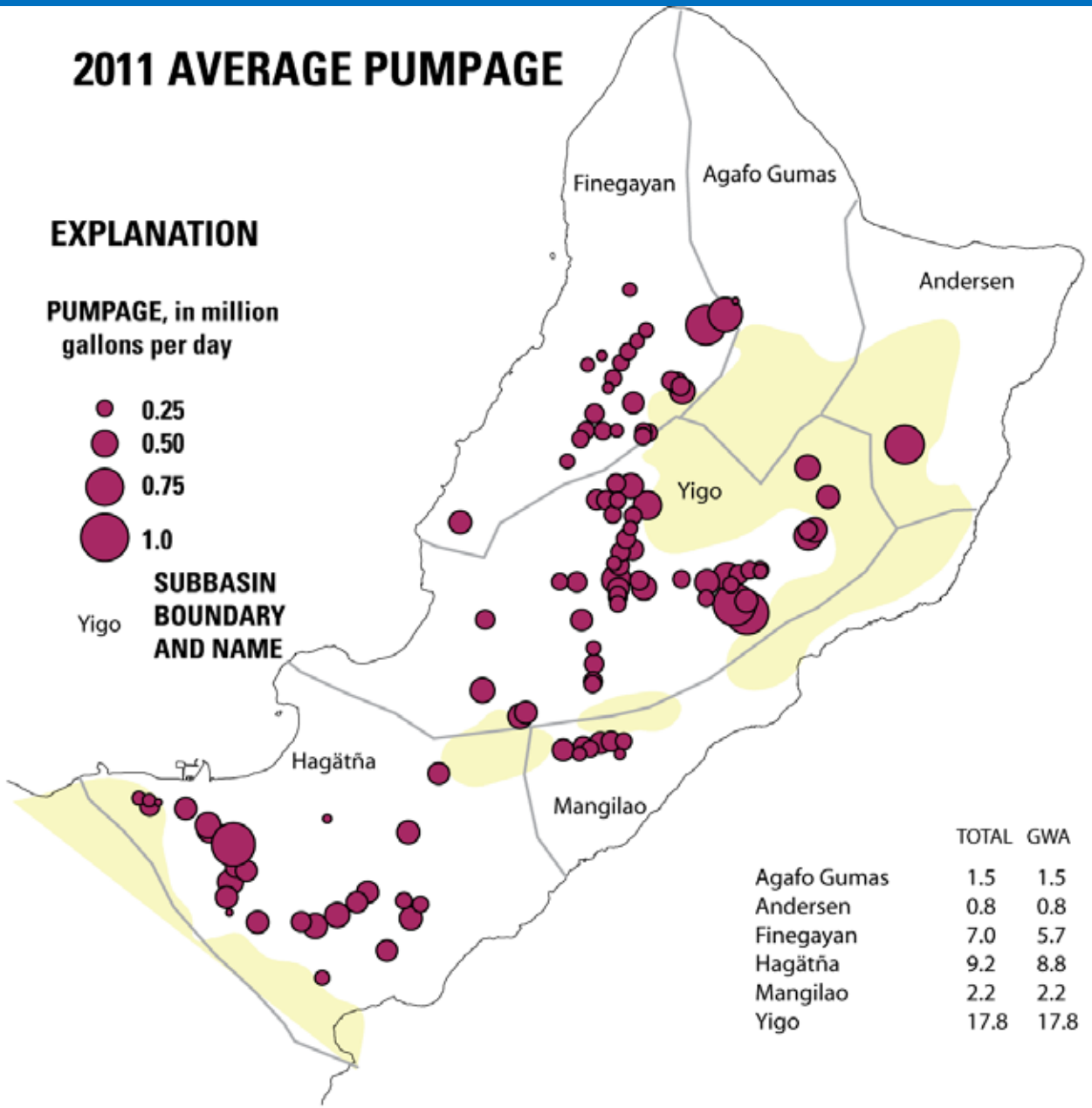
2011 AVERAGE PUMPAGE



	TOTAL	GWA	DOD	OTHER
Agafo Gumas	1.5	1.5	0	0
Andersen	0.8	0.8	0	0
Finegayan	7.0	5.7	1.3	0
Hagätña	9.2	8.8	0.4	0
Mangilao	2.2	2.2	0	0
Yigo	17.8	17.8	0	0

Next Steps

- Publish aquifer properties report
- Finish calibrating numerical groundwater model
- Formulate future pumping scenarios
- Present preliminary findings – September 13, 2012
- Finalize future pumping scenarios
- Present final findings – December 6, 2012
- Publish final report – June 2013