Kalaeloa Saltwater Desalination Facility

Workplan Preliminary Results

Presented to Hawaii Water Works Association

October 15, 2025

Board of Water Supply
KA ʻOIHANA WAI

WSP

INTERA

Presentation Contents

- Sequence and Thanks
- Background and Why?
- Geology and Hydrogeology
- Data Gaps
- Workplan
  - Well 15 Repair
  - Geophysical Logging
  - Aquifer Testing
  - Water Level Analysis
  - Tracers and Water Quality
- Preliminary Conclusions

INTERA

Sequence

Start Date	End Date	Activity
2001	2004	Wells 13, 14 and 15 Drilled
Dec 2023	Jan 2024	Water Level Study
April 2024	August 2024	Well Integrity Investigation
Nov 2024	March 2025	Obtain, fabricate and ship parts & materials for Well 15 repair (Alberta, California, Texas)
2/19/2025	2/27/2025	Well 15 Bailing
4/7/2025	4/27/2025	Well 15 Liner Installation and Grouting
4/26/2025		Begin water level monitoring
5/23/2025	5/23/2025	Geophysical Survey
5/27/2025	5/27/2025	Offshore Sampling
6/2/2025	6/2/2025	Begin site mob for aquifer test
7/7/2025	7/18/2025	Well 15 testing
7/28/2025	8/5/2025	Well 14 testing
8/11/2025	8/22/2025	Well 13 testing
	8/31/2025	End water level monitoring

INTERA

Many Organizations Contributed to the Workplan

BWS Team

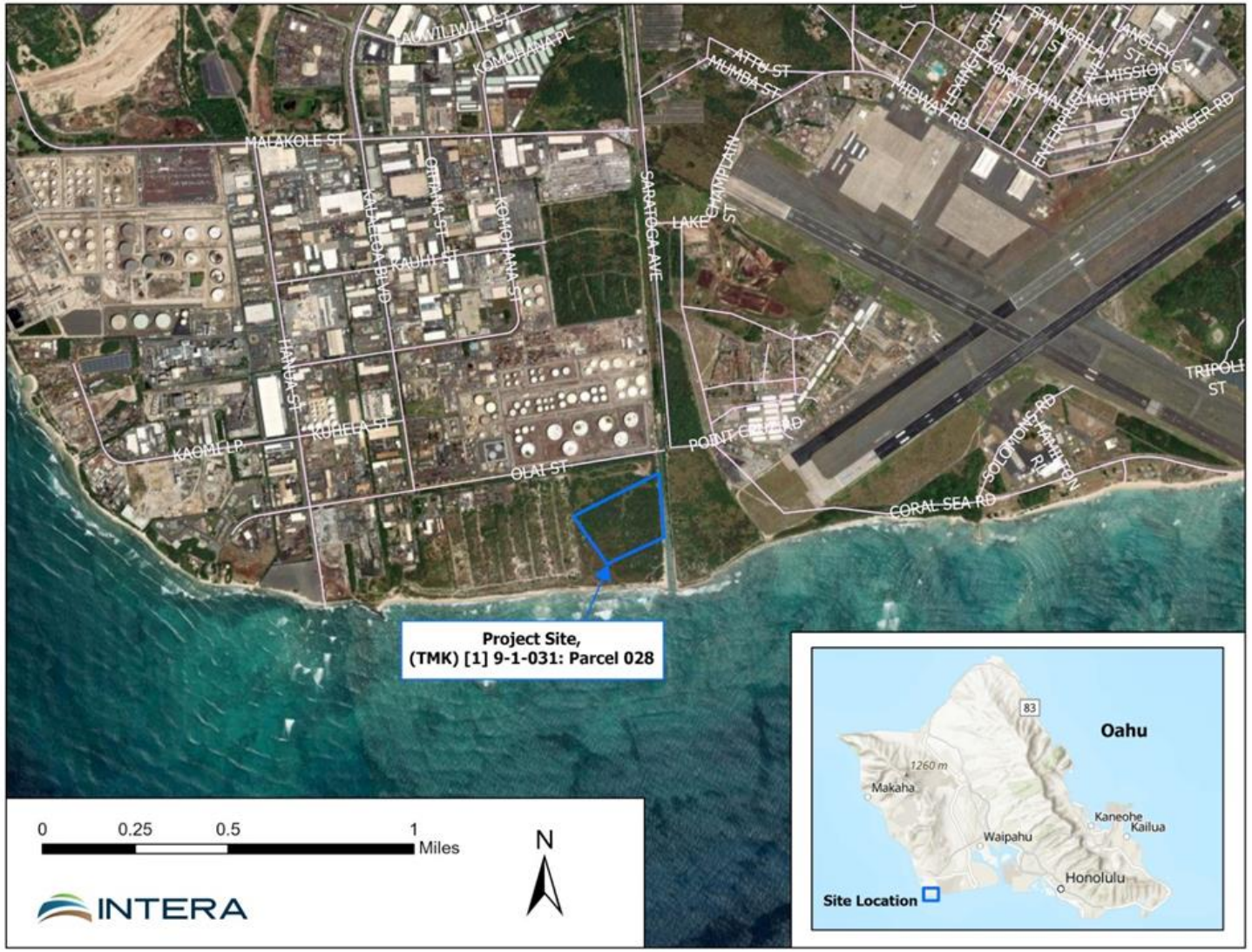
- Honolulu Board of Water Supply
- Kalaeloa Desalco (KD)
- WSP
- Carollo
- The Limtiaco Consulting Group

Workplan Execution Team

- COLOG (CO) –well assessment
- Independent Pipe (CA) and TAM International (TX)
- Alpha Drilling – well repair and bailing
- ReconPetro (TX) – downhole geophysics
- Precision Drilling Services – aquifer testing
- Prior Vision – site security
- Eurofins, FQ Labs, University of Hawaii, ICA, University of Utah – lab services

INTERA

KSDF Project Site



- ‘Ewa Plain and Caprock
- Adjacent to Campbell Industrial Park

INTERA

Goal of Pilot Study

- The Board of Water Supply (BWS) and the Department of Health (DOH) want to ensure that high-quality water is delivered to the public.
- DOH and BWS want more information about the possibility of contamination of the deep basalt drinking water wells from surface activities and Caprock injection disposal.

- BWS initiated an extensive workplan to test the following hypothesis or premise:

Sufficient hydraulic separation exists between the Caprock aquifer and the Volcanic aquifer to protect the supply source wells from harmful migration of surface and near-surface contaminants.

The preliminary results support this hypothesis.

INTERA

Hypothesis Testing

Hypothesis were formulated for each testing program to help maintain objectivity.

For example, during the Aquifer Test we pumped the Basalt wells and monitored the Caprock wells to help test this hypothesis:

- **Sufficient hydraulic separation exists between the caprock aquifer and the production zone in the volcanic aquifer.**
- Possible outcome: No measurable water level change in Caprock wells.
  - Result: No indication of hydraulic connection
- Possible Outcome: Water levels in a Caprock well show a response to pumping in the Basalt aquifer.
  - Result: hydraulic connection

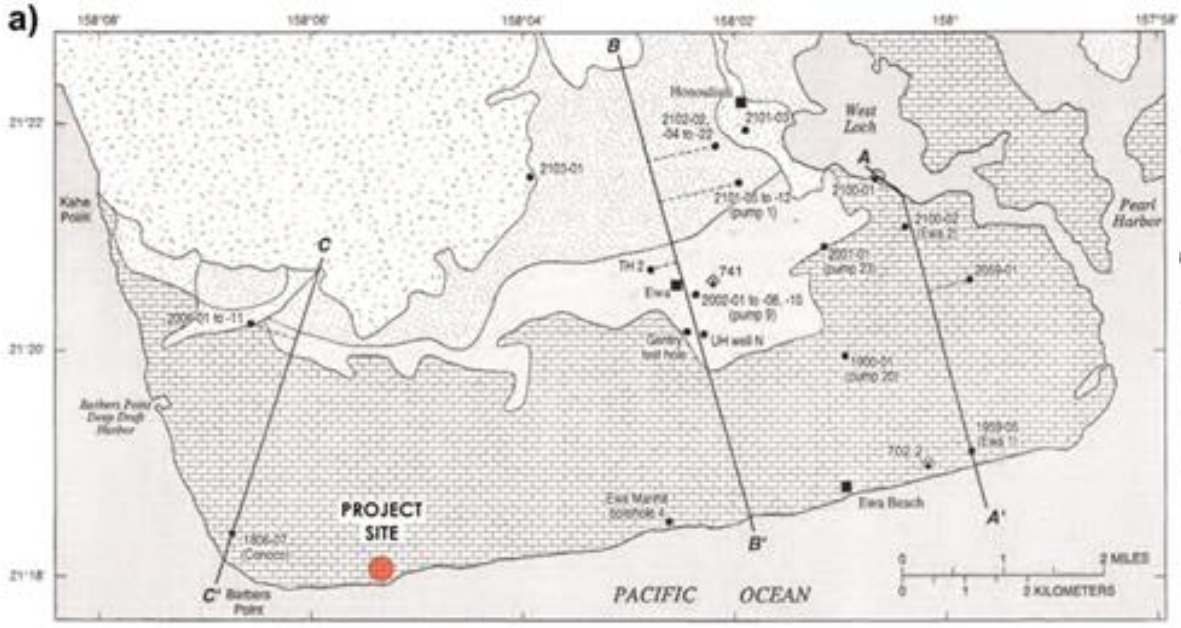
INTERA

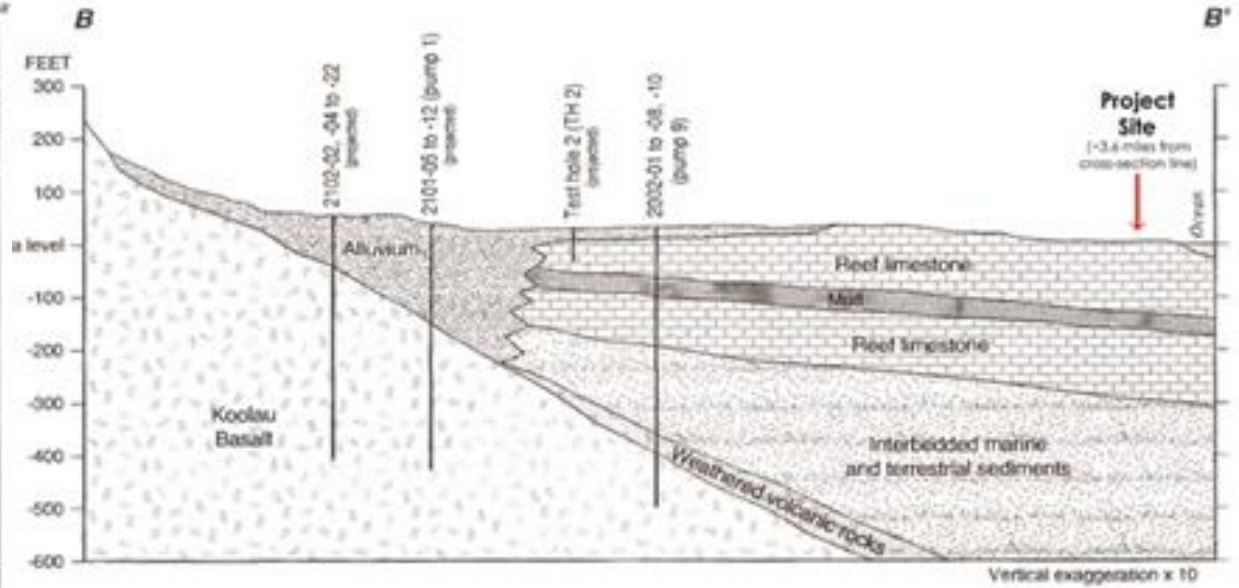
Existing Kalaeloa Wells

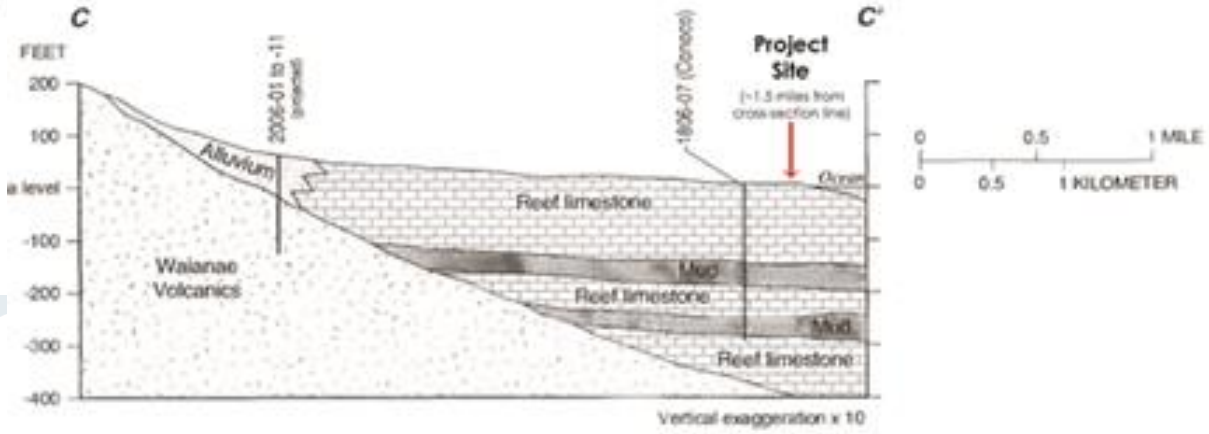
Well Number	Well Name	Depth (ft bgs)	Open Casing Formation
3-1805-013	Well 13	1,600	Wai‘anae Volcanics
3-1805-014	Well 14	300	Lower and upper Caprock
3-1805-015	Well 15	1,556	Wai‘anae Volcanics
n/a	MW1	17	Upper Caprock Aquifer
n/a	MW2	17	Upper Caprock Aquifer

INTERA

Regional Geology







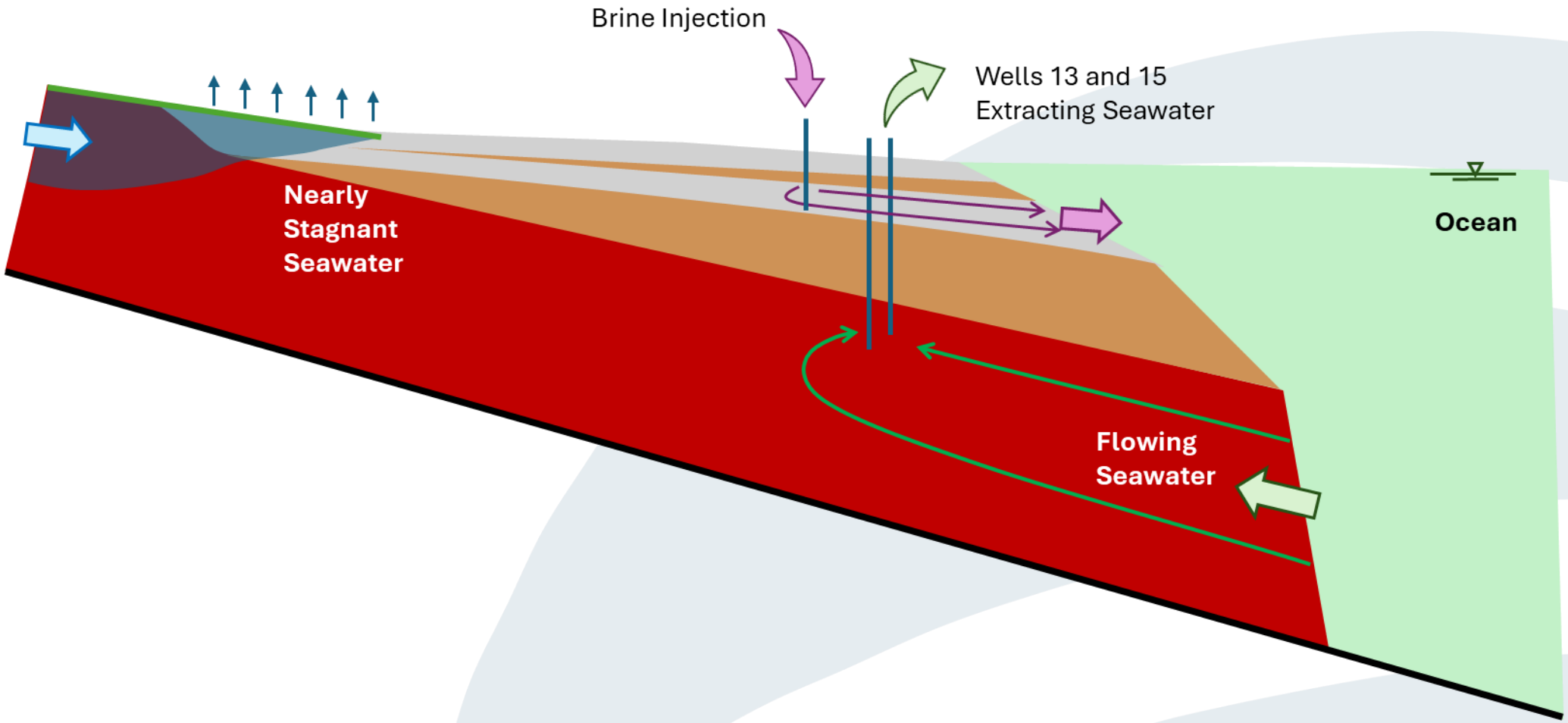
EXPLANATION

- RECENT ALLUVIUM
- ALLUVIUM OVERLYING BASALT
- ALLUVIUM OVERLYING LIMESTONE
- CORALLINE LIMESTONE
- 1/4 MILES EXCLUSION ZONE AROUND THE PROPOSED PRODUCTION WELLS AT KSDF
- KOOLAU BASALT
- WAIANAE VOLCANICS
- B—B' LINE OF SECTION
- 2103-01 WELL AND NUMBER
- 741 RAIN GAGE AND STATE KEY NUMBER

Modified from: **Figure 2.** Geology of the coastal plain in the Ewa area, Oahu, Hawaii (modified from George A.L. Yuen and Associates, Inc., 1989). In USGS OFR 96-442 (Oki et al., 1996)

INTERA

Conceptual Flow System



Data Gaps

- Limited information on site specific geology
  - Good regional information
  - No geologic logs of Wells 13, 14, 15
  - No deep site-specific information
- Limited water level data collected during the early 2000s testing
- Limited information on aquifer interaction
  - No monitoring of caprock during early 2000s testing of the basalt wells
- No tracer information
- Limited water quality information

We needed more information. How do we fill these gaps?

INTERA

Workplan

- Initial water level study (2023-24)
- Wells 15 & 13 integrity investigation
- Repair Well 15

<u>Lines of Evidence:</u>

- Geophysical logging
- Aquifer testing of Wells 13, 14 & 15 (water levels & pumping)
- Natural tracers
- Water quality & contaminant sampling

Well 15 repair finished April 27

Workplan: 4/26 to 8/31/25

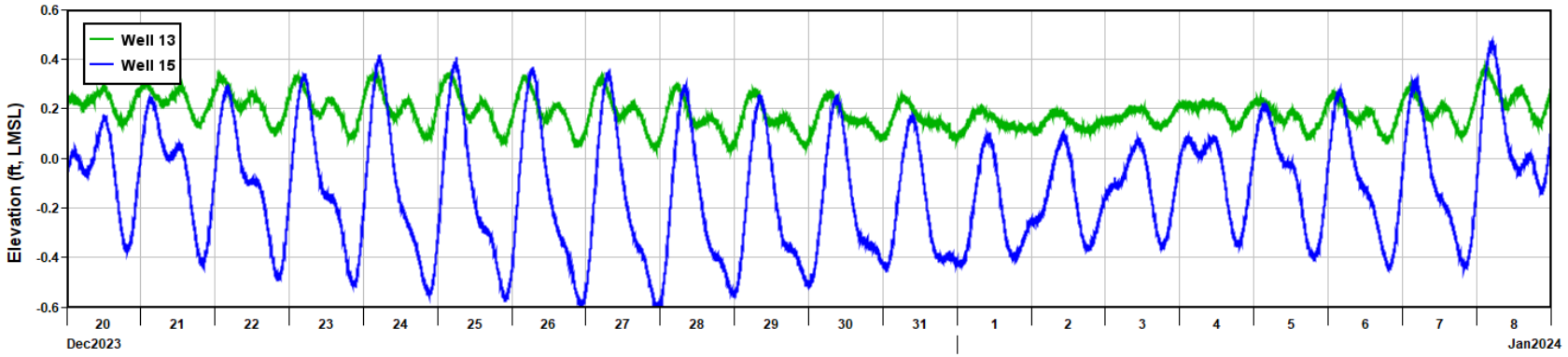
INTERA

Workplan Events

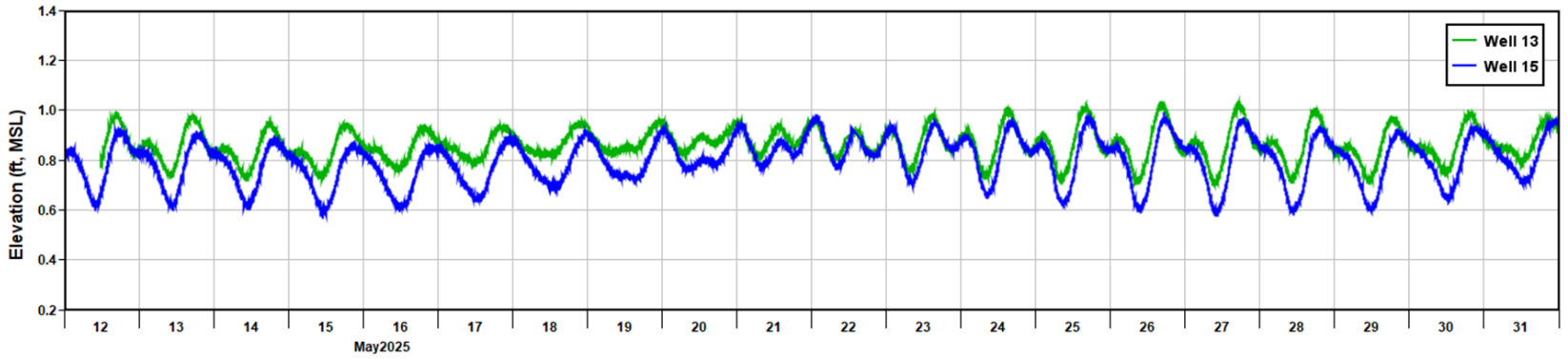
Start Date	End Date	Activity
2/19/2025	2/27/2025	Well 15 Bailing
4/7/2025	4/27/2025	Well 15 Liner Installation and Grouting
4/26/2025		Begin water level monitoring
5/23/2025	5/23/2025	Geophysical Survey
5/27/2025	5/27/2025	Offshore Sampling
6/2/2025	6/2/2025	Begin site mob
7/7/2025	7/18/2025	Well 15 testing
7/28/2025	8/5/2025	Well 14 testing
8/11/2025	8/22/2025	Well 13 testing
	8/31/2025	End water level monitoring

Well 15 Investigation & Repair – Necessary before Workplan

January 2024, prior to repair



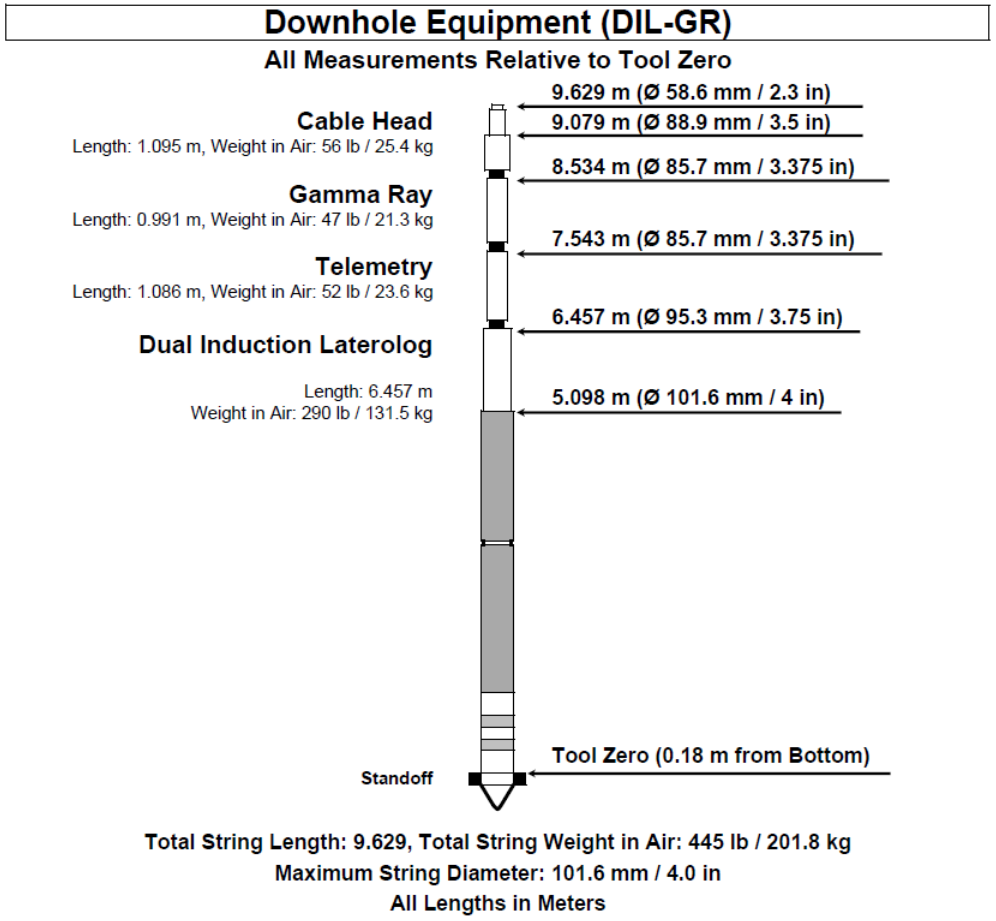
May 2025, after repair



INTERA

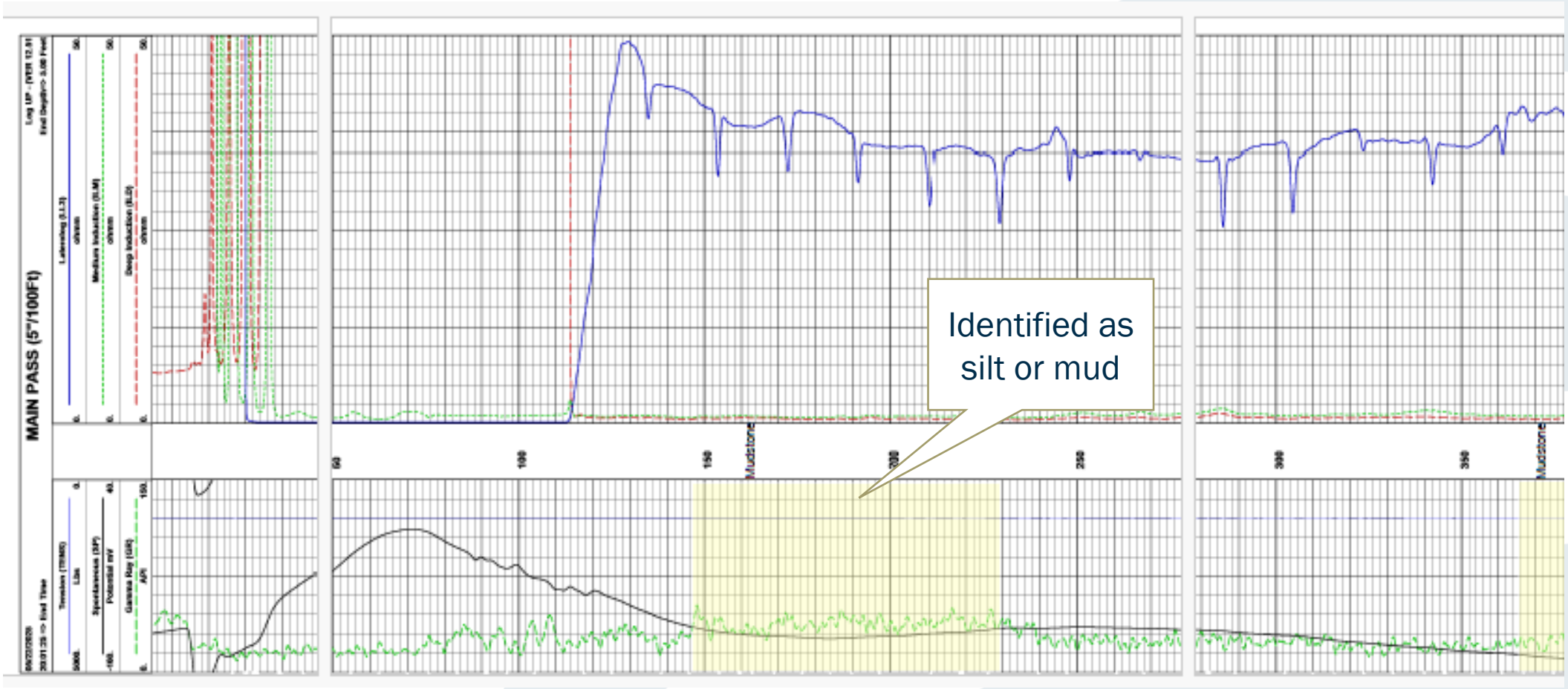
Geophysical Logging – Obtain Geologic Information

- Most methodologies are limited to 15” boreholes
- Large diameter wells (18” to 26”) required petroleum industry technology – RECONPetro (TX)
- Resistivity with Dual Induction
  - Induced electromagnetic field – determine electrical resistivity of the formation & fluid
  - Indicates silts, clays, muds
- Gamma
  - Measures gamma ray emissions from the formation
  - Used to differentiate silts/clays/muds from sandstone/carbonates
- We found that both methods are useful for delineating low permeability zones



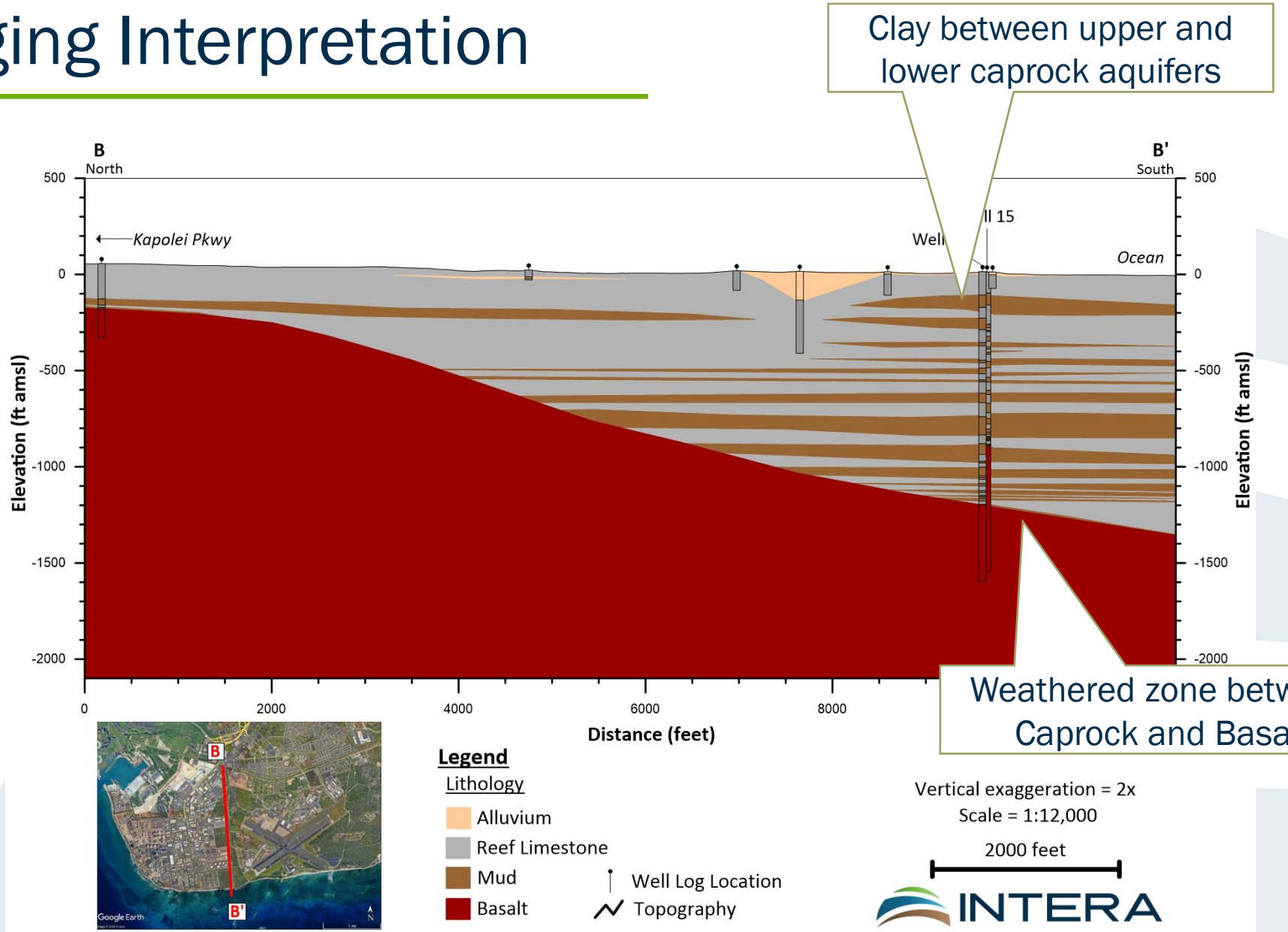
Geophysical Logging Raw Data

- Logged to the bottom of each well (3500 vertical ft of logs)
- Located silts and muds in the log



Geophysical Logging Interpretation

- The results were similar to the UGSS regional geologic model.
  - Mud boundary between upper and lower Caprock
  - Layers of silts muds and clays
  - Weathered zone between Caprock and Basalt
- Preliminary results indicate the presence of aquitards



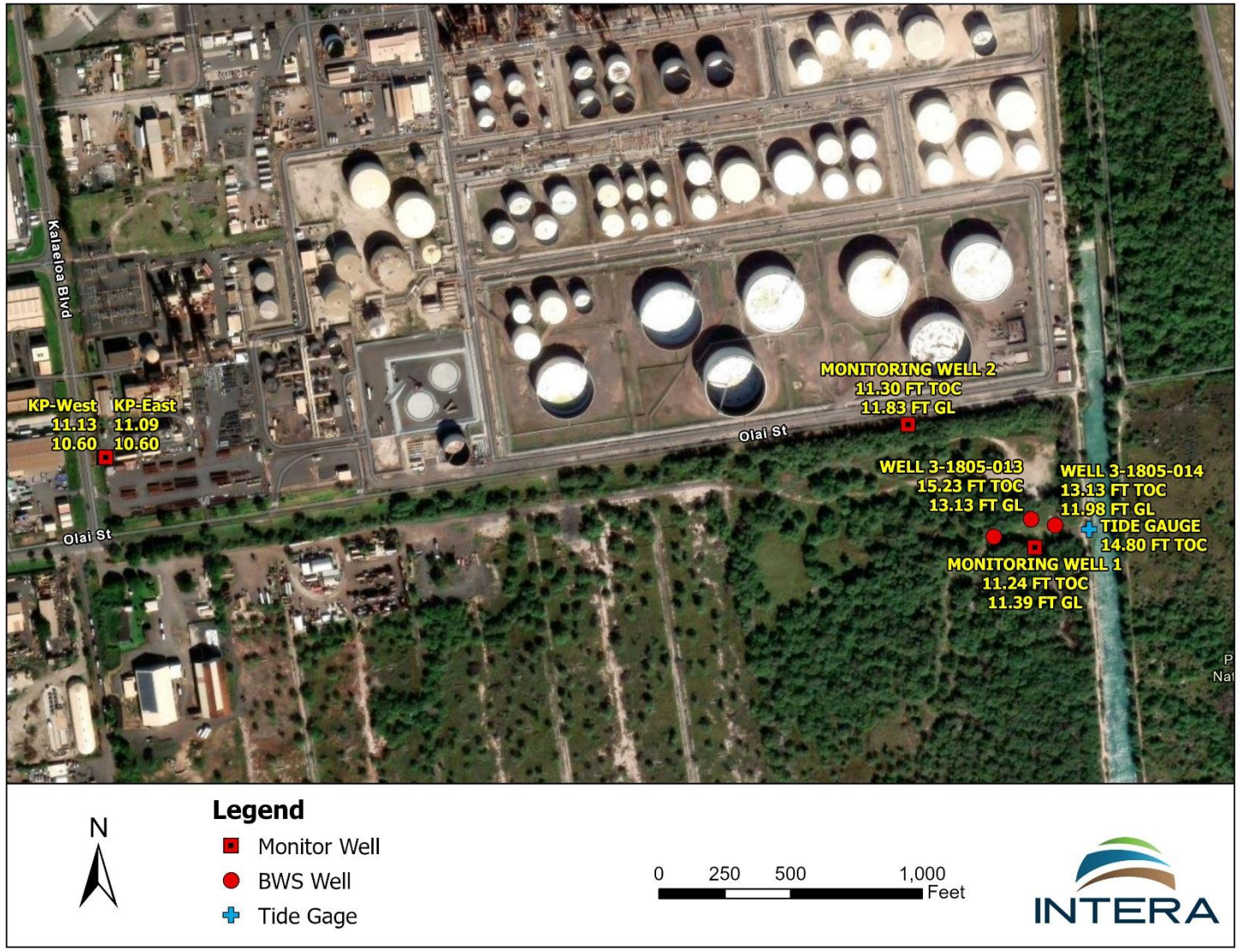
Aquifer Testing (pumping and monitoring WL responses)

- Does sufficient hydraulic separation exist between the caprock and basalt aquifers?
- Preliminary results show no hydraulic connection

Well	Step – Drawdown Test				30 hr Cycle Test GPM	120-hr Constant Rate Test GPM
	GPM					
	Step 1	Step 2	Step 3	Step 4		
Well 13	1550	1988	2485	3210	2770	2800
Well 14	1000	1690	2200	3000	n/a	2500
Well 15	2224	2711	3301	3685	3300	3250

INTERA

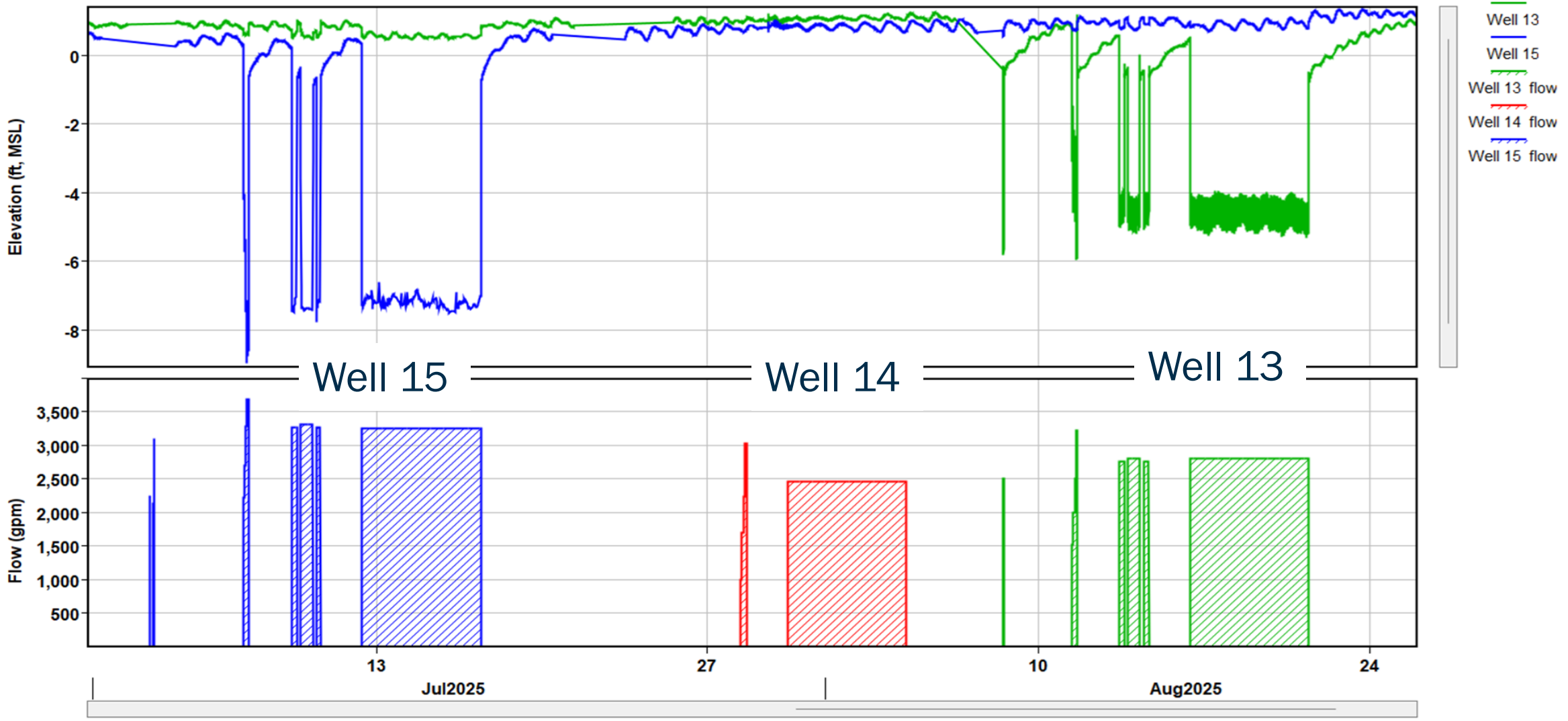
Monitoring – wells and other sites



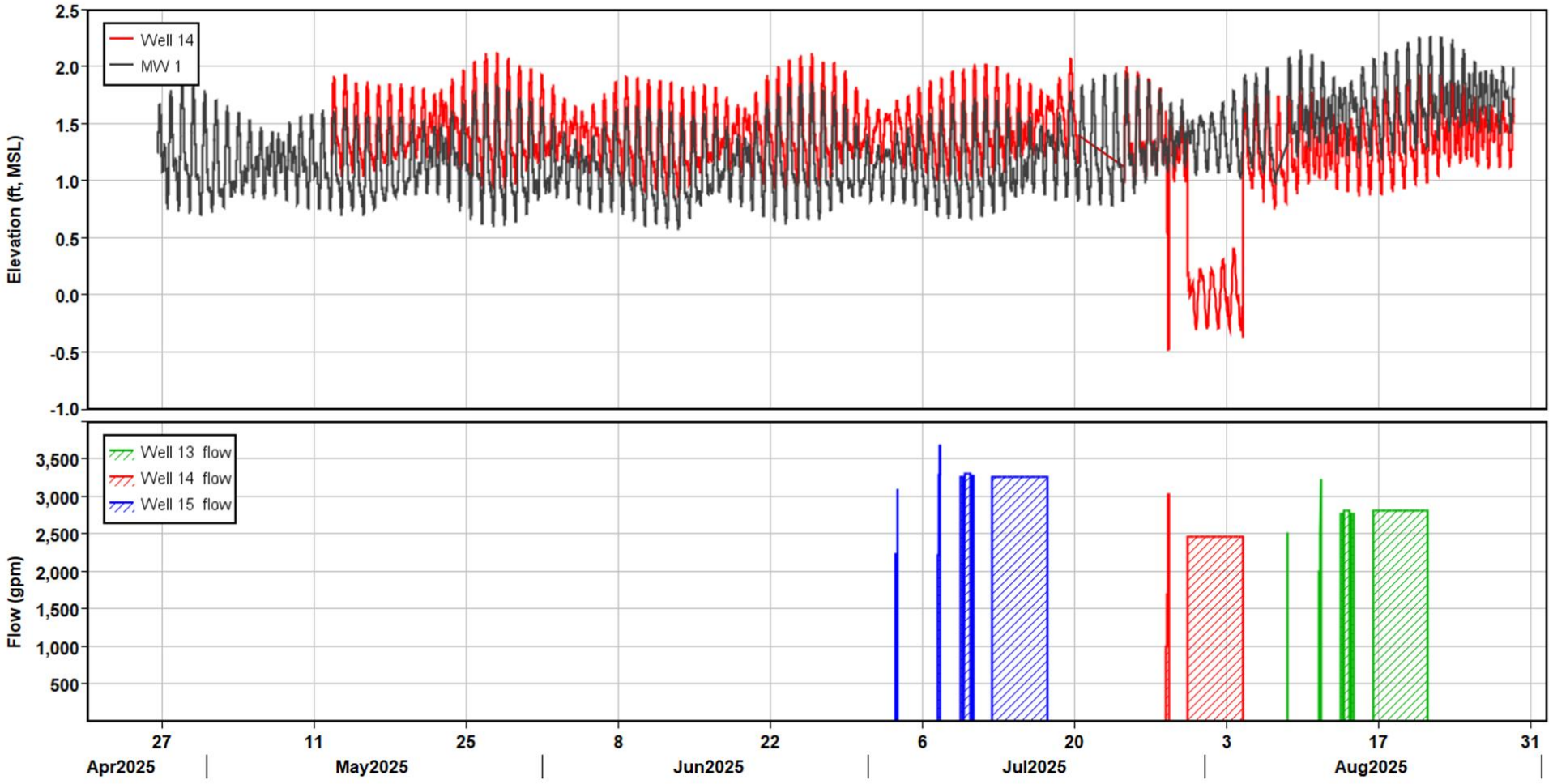
- Three production wells
- Five onsite monitor wells (including production wells)
- Two offsite wells (nested)
- Onsite tide gage
- Onsite barometer
- Honolulu tide gage

INTERA

Aquifer (pump) Testing



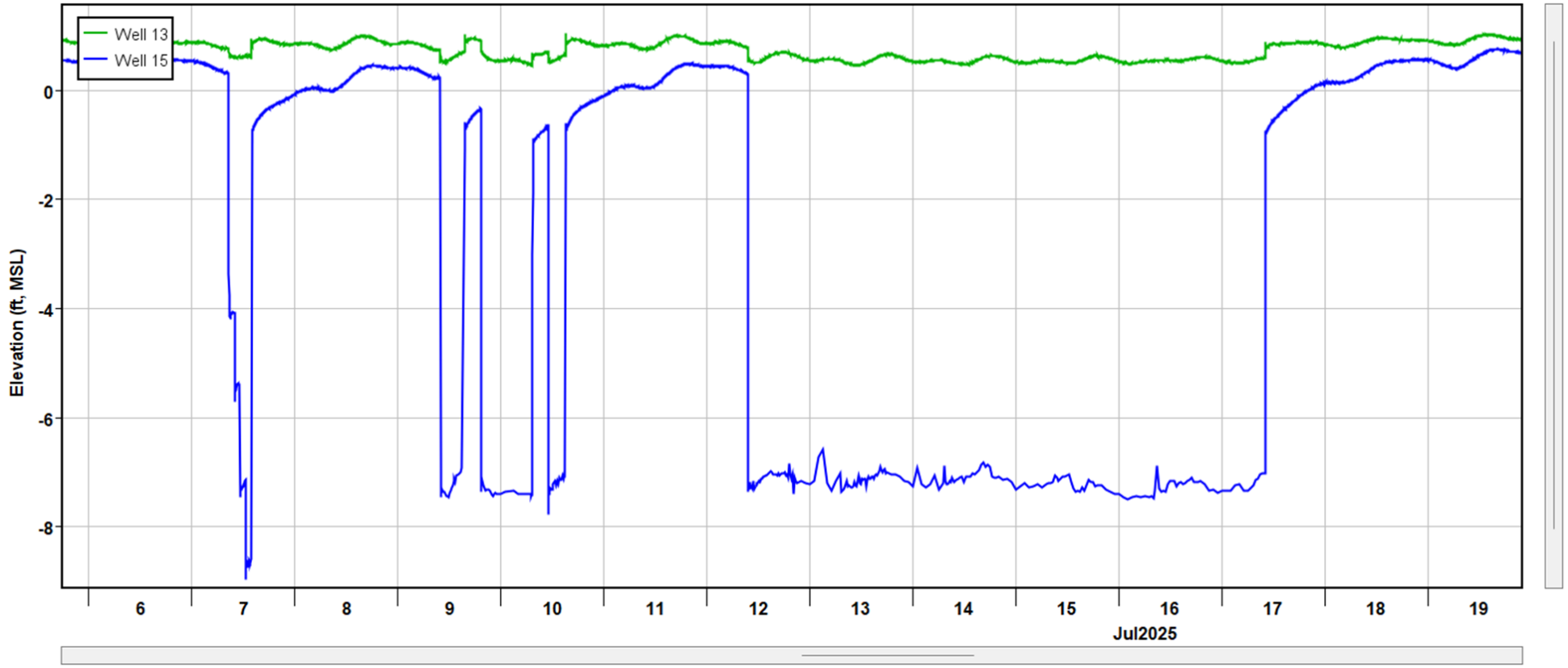
Aquifer Testing – Hard to see small water level changes



- It is difficult to discern small water level changes in the raw water levels
- tides
- sea level changes

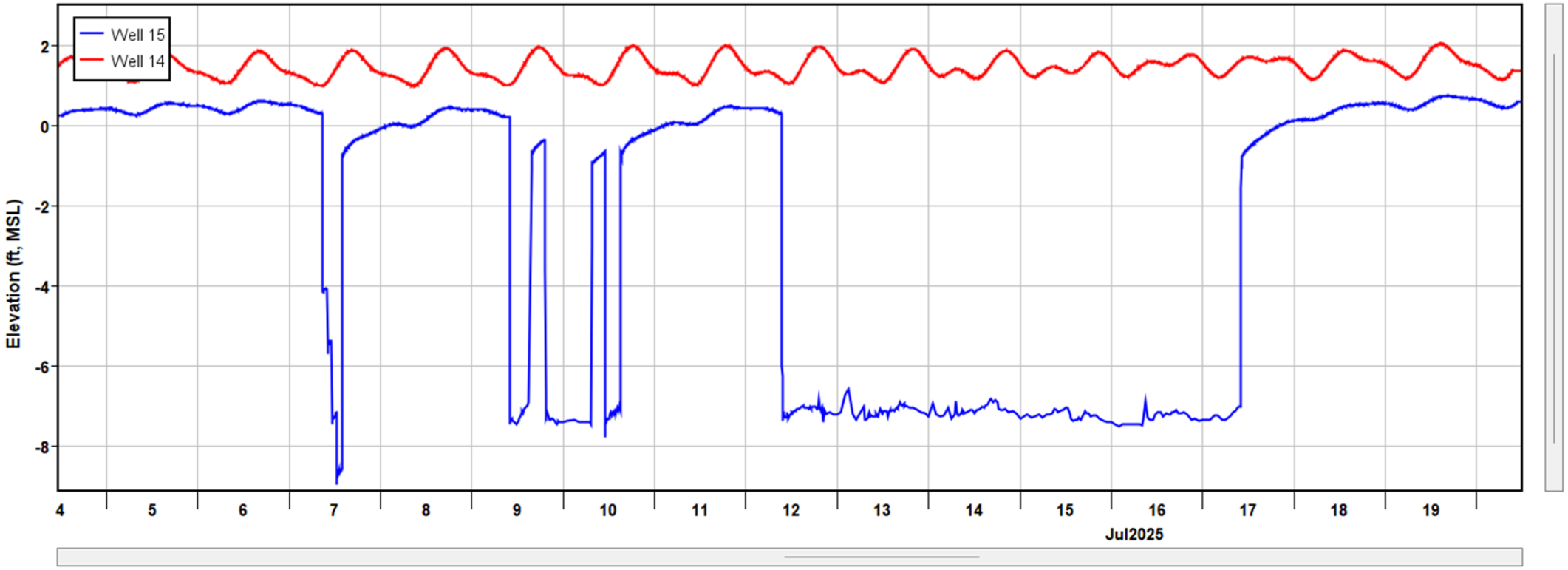
Well 15 pumping Well 13 monitoring (Basalt-Basalt)

- 150 feet horizontal separation
- As expected, some drawdown in Well 13 while pumping well 15
- Preliminary – more time series analysis necessary



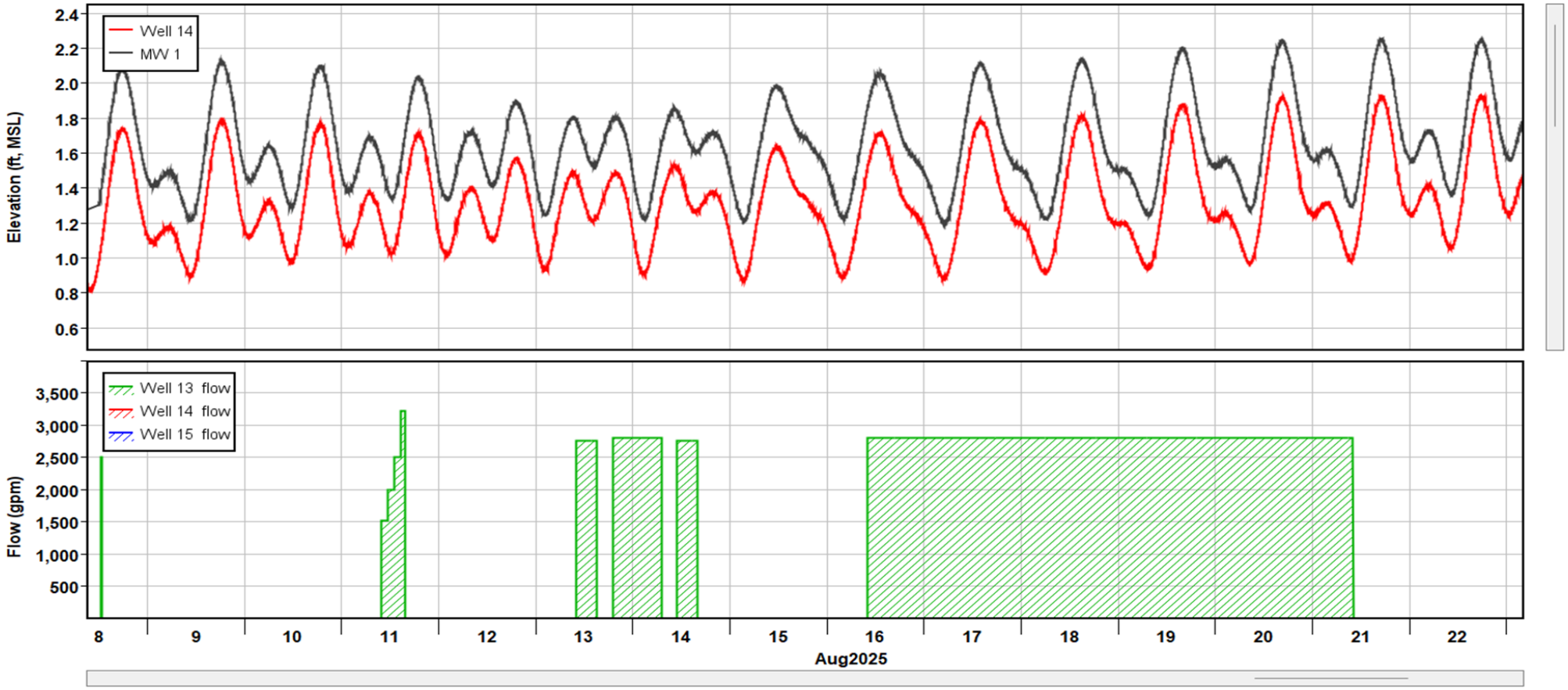
Well 15 pumping Well 14 monitoring (Basalt-Caprock)

- 220 feet horizontal separation and 800 feet vertical separation
- No perceptible drawdown in Well 14 from Well 15 pumpage
- Preliminary – more time series analysis necessary



Caprock Well Response to Well 13 Pumping

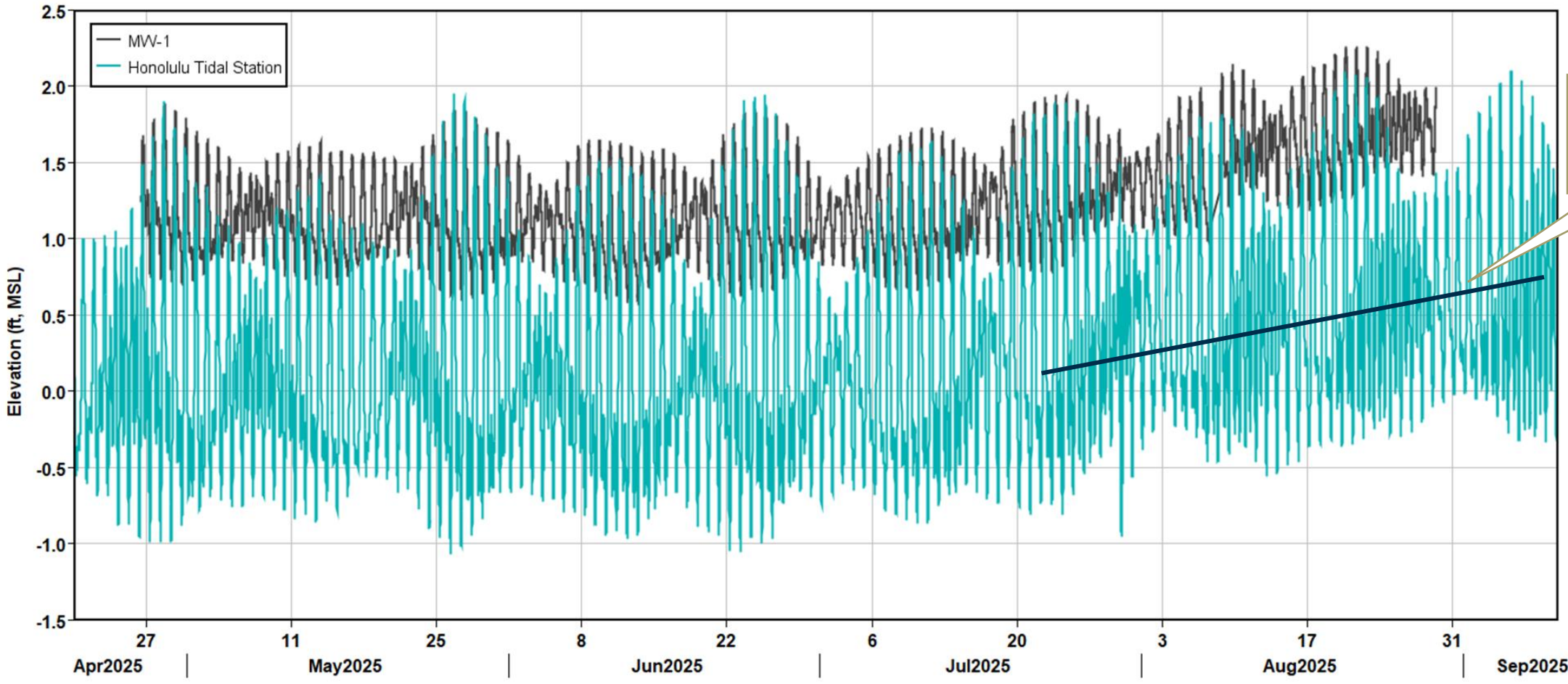
- 100 feet horizontal, 1100 feet vertical separation (MW1-Well 13)
- No perceptible drawdown in Wells 14 and MW1 from Well 13 pumping
- Preliminary – more time series analysis necessary



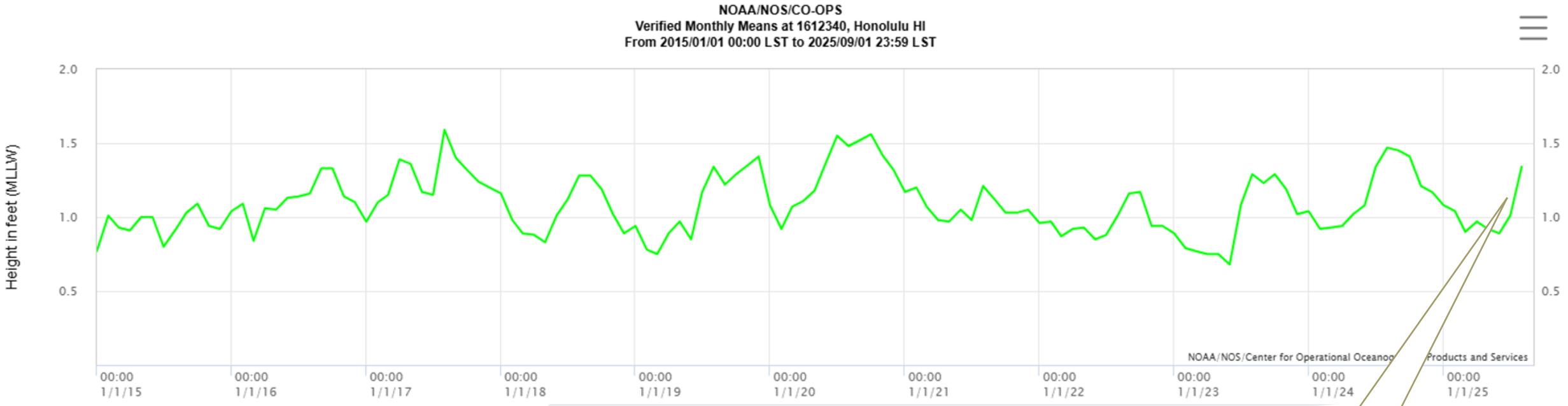
INTERA

Time Series Analysis - Tidal and Sea Level Signal

Tidal signal obscures the aquifer response to pumping



Periodic Sea Level Changes



Aquifer Test

Time Series Analysis

Problem: Water level data is too chaotic to effectively see relatively small (hundredths of a foot) drawdowns

- PASTAS is an open-source Python package to analyze hydro(geo)logical time series.
- Uses transfer function noise (TFN) modeling, which attempts to translate one or more input series to an output series using a statistical model.
- Must know the stresses on the system. What causes water level change?
- Can be customized to individual time series.
- **Can be used to quantify the impacts of different stresses - We want to see any small water level changes due to pumping**

INTERA

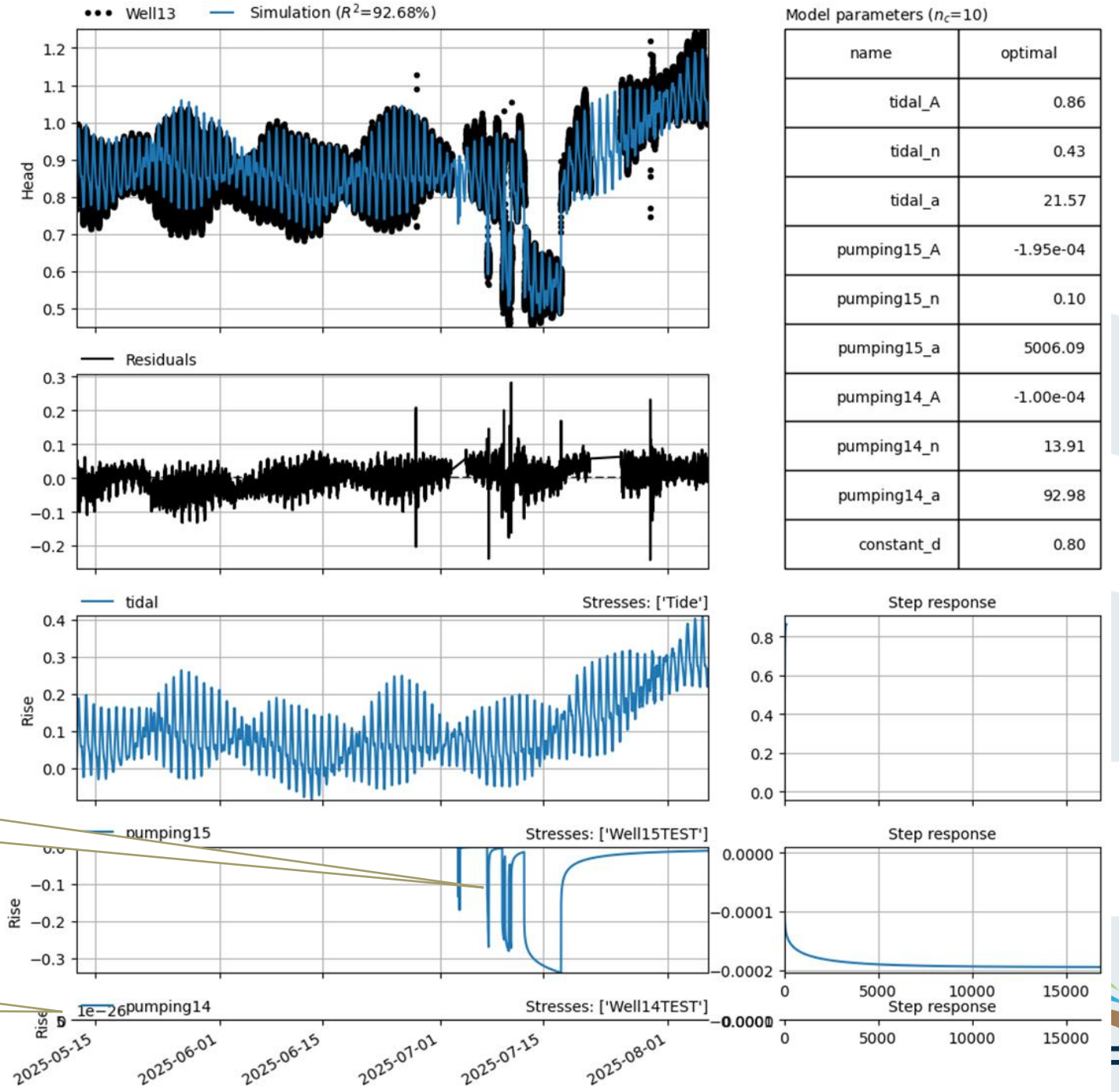
Time Series Analysis – Stresses

- PASTAS is used to analyze factors that affect water levels (Stresses)
- Expected Stresses
  - Precipitation – No. Minimal rainfall during the testing period
  - Barometric pressure changes – No. Tested and found to be not a significant driver
  - Pumpage – Yes
  - Tides – Yes
- Unexpected Stresses
  - Earthquake and Tsunami of July 29 – Yes but probably cannot be removed with PASTAS
  - Seasonal sea level changes possibly due to thermal expansion - Yes and results are still under analysis

INTERA

Time Series Analysis

- Model output
- Observation in Wells 13
- Pumping Well 15 and 14



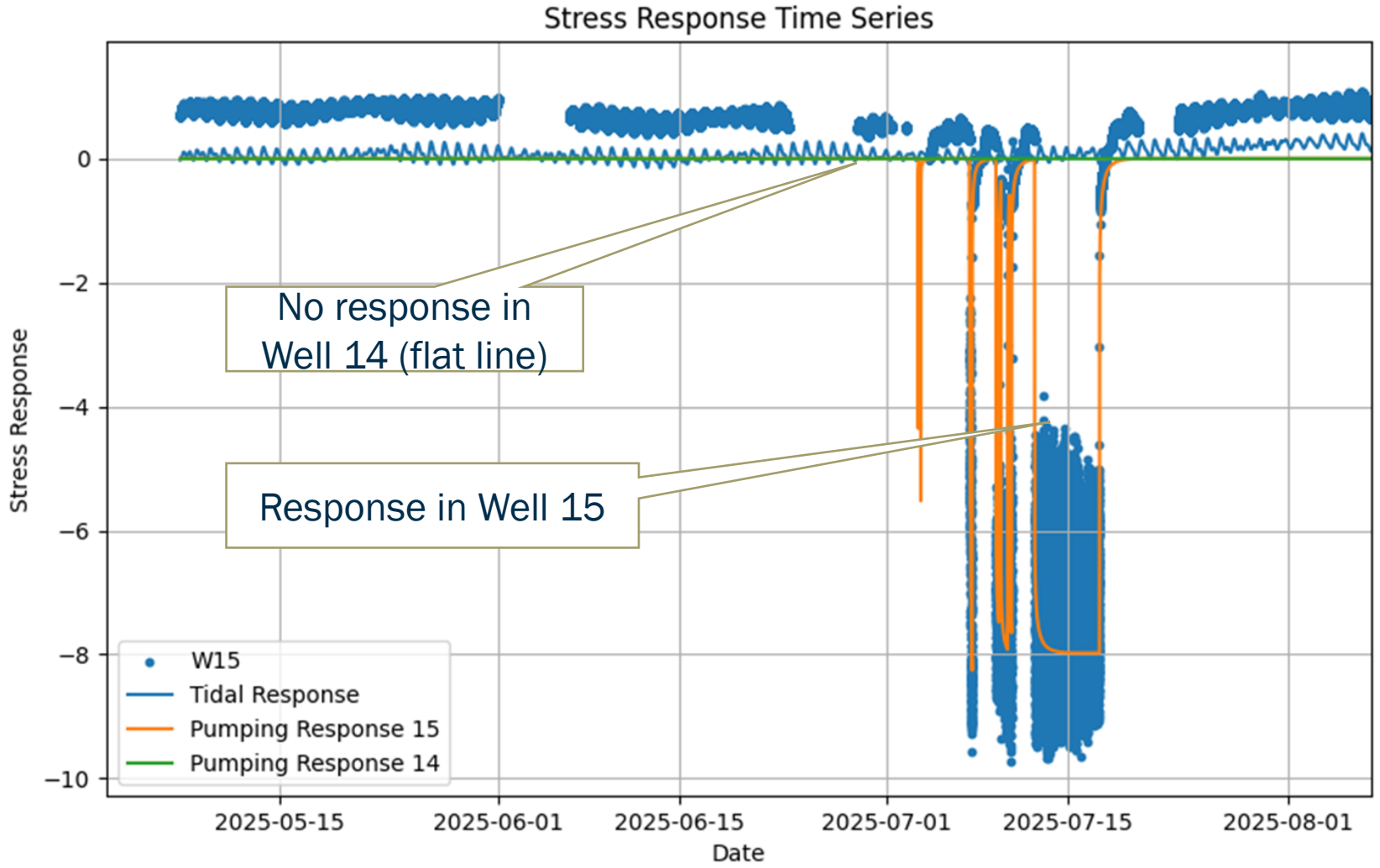
Model parameters (n_c=10)

name	optimal
tidal_A	0.86
tidal_n	0.43
tidal_a	21.57
pumping15_A	-1.95e-04
pumping15_n	0.10
pumping15_a	5006.09
pumping14_A	-1.00e-04
pumping14_n	13.91
pumping14_a	92.98
constant_d	0.80

Drawdown in Well 13 from pumping well 15

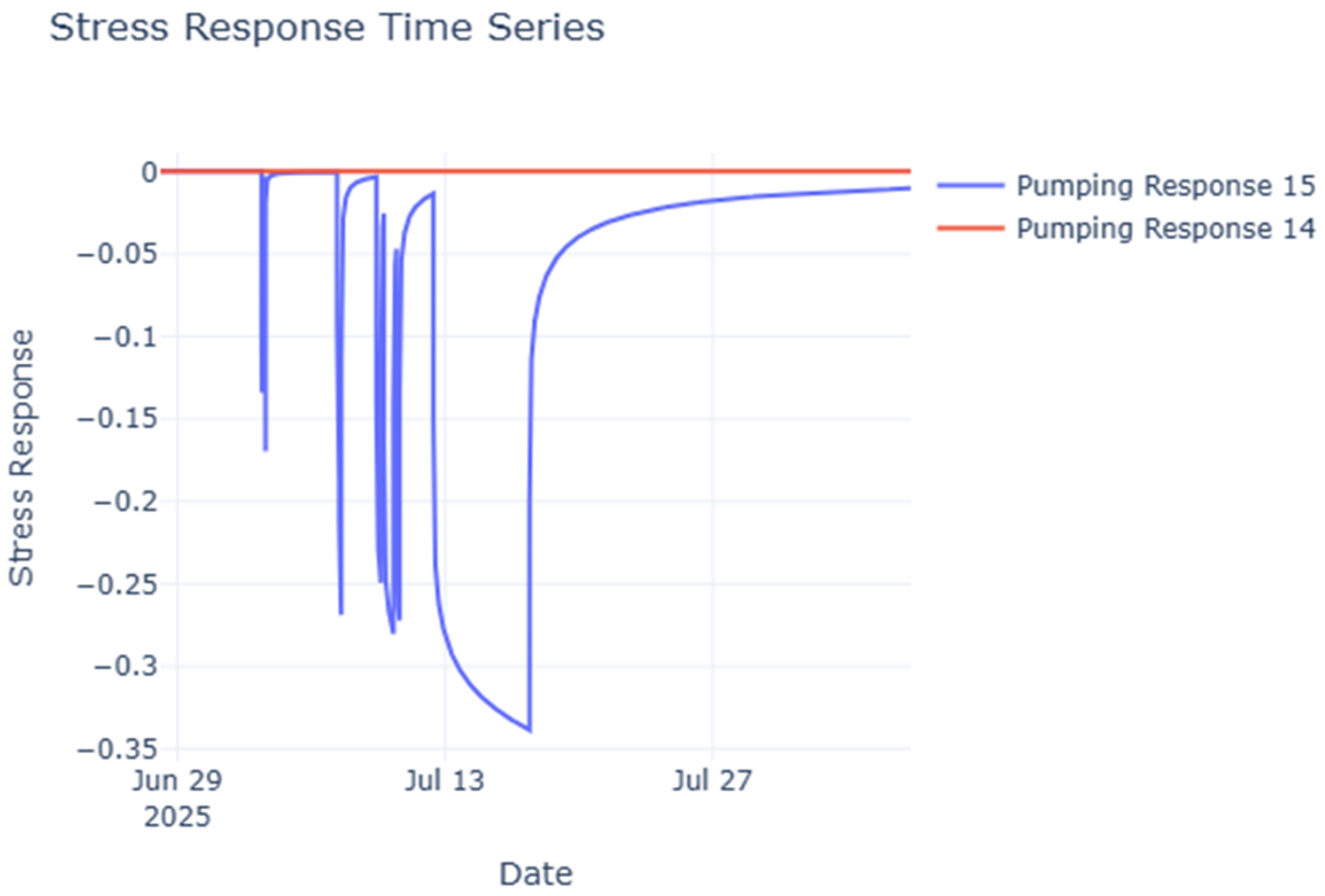
No drawdown in Well 13 from pumping well 14

Well 15 Pumping (orange) and Well 14 response (green)



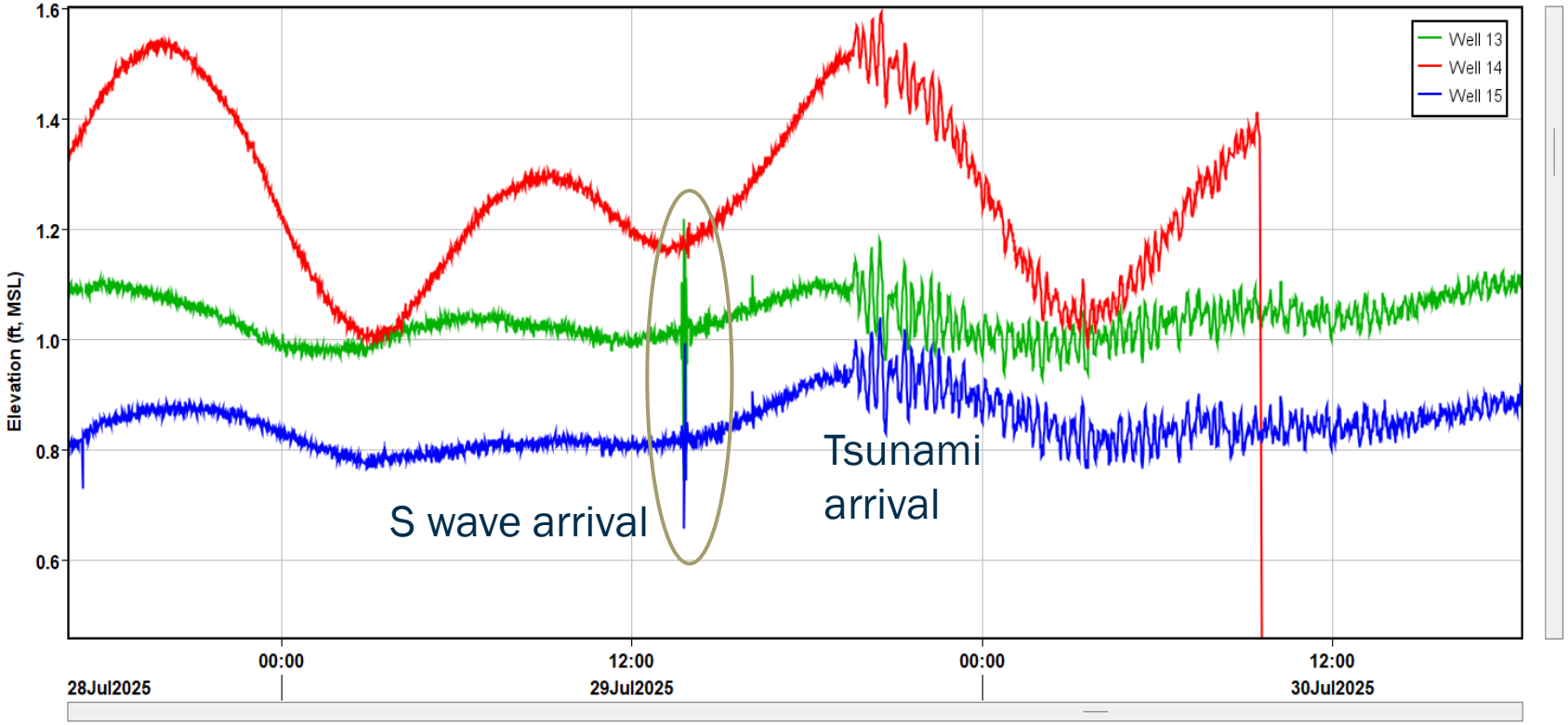
Stress Response Time Series

- Only shows the response to pumpage stress
- Blue line is drawdown in Well 14 from pumping in Well 13
- Red line is drawdown in Well 13 from pumping in Well 15.
- **Analysis so far supports hypothesis of no measurable hydraulic connection**



July 29, 2025 Kamchatka Earthquake

- Two arrivals S (EQ) wave and Tsunami
- S (secondary shear) wave arrival 15 minutes after the EQ.
- Tsunami arrived about 8 hours after the EQ
- S wave arrival only observed in the Basalt. No S in the Caprock
- Indicates confined conditions in Basalt



Water Quality and Tracers

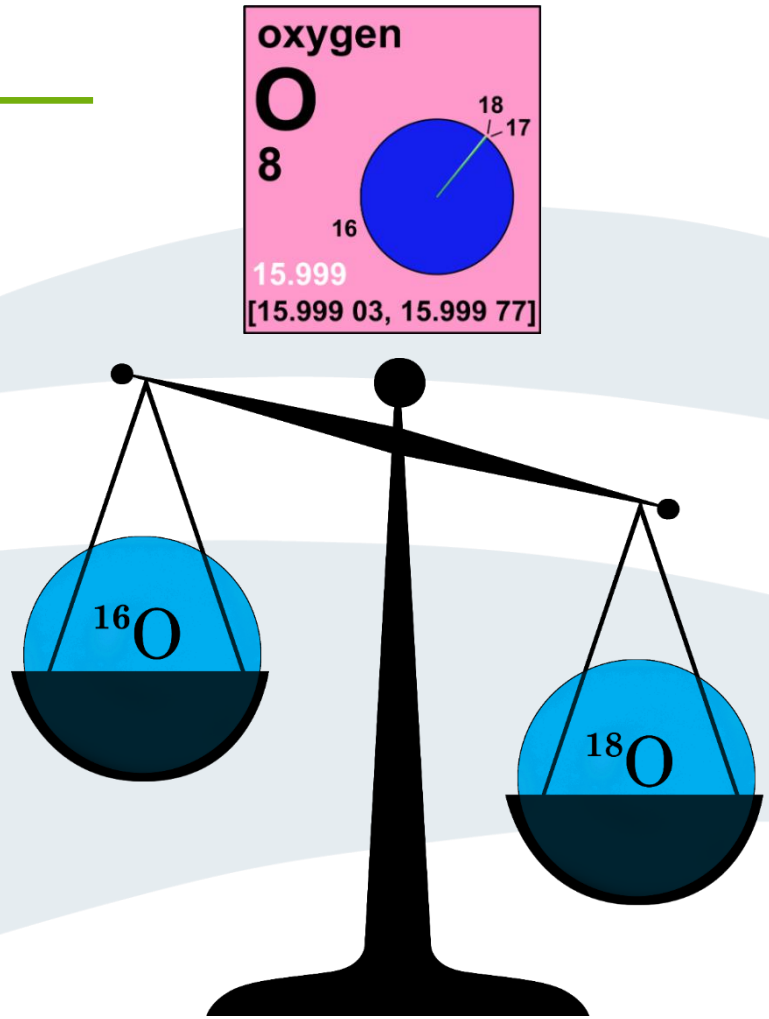
- Sampled pumping wells at the beginning (step) and ending (long) of testing.
- Sampled MW1, MW2, nearshore ocean and offshore ~400’ ocean during or immediately before pumping
- Broad suite of anthropogenic contaminants of concern
- Groundwater Tracers: Stable isotopes, carbon-14, noble gasses, CFCs, tritium, other radioactive isotopes.
- Most of the results are still in review or not completed but we have preliminary stable isotopes – ^{18}O and ^{2}H (deuterium)

A tracer can find provide information about groundwater age, water sources and mixing, recharge and chemical reactions.

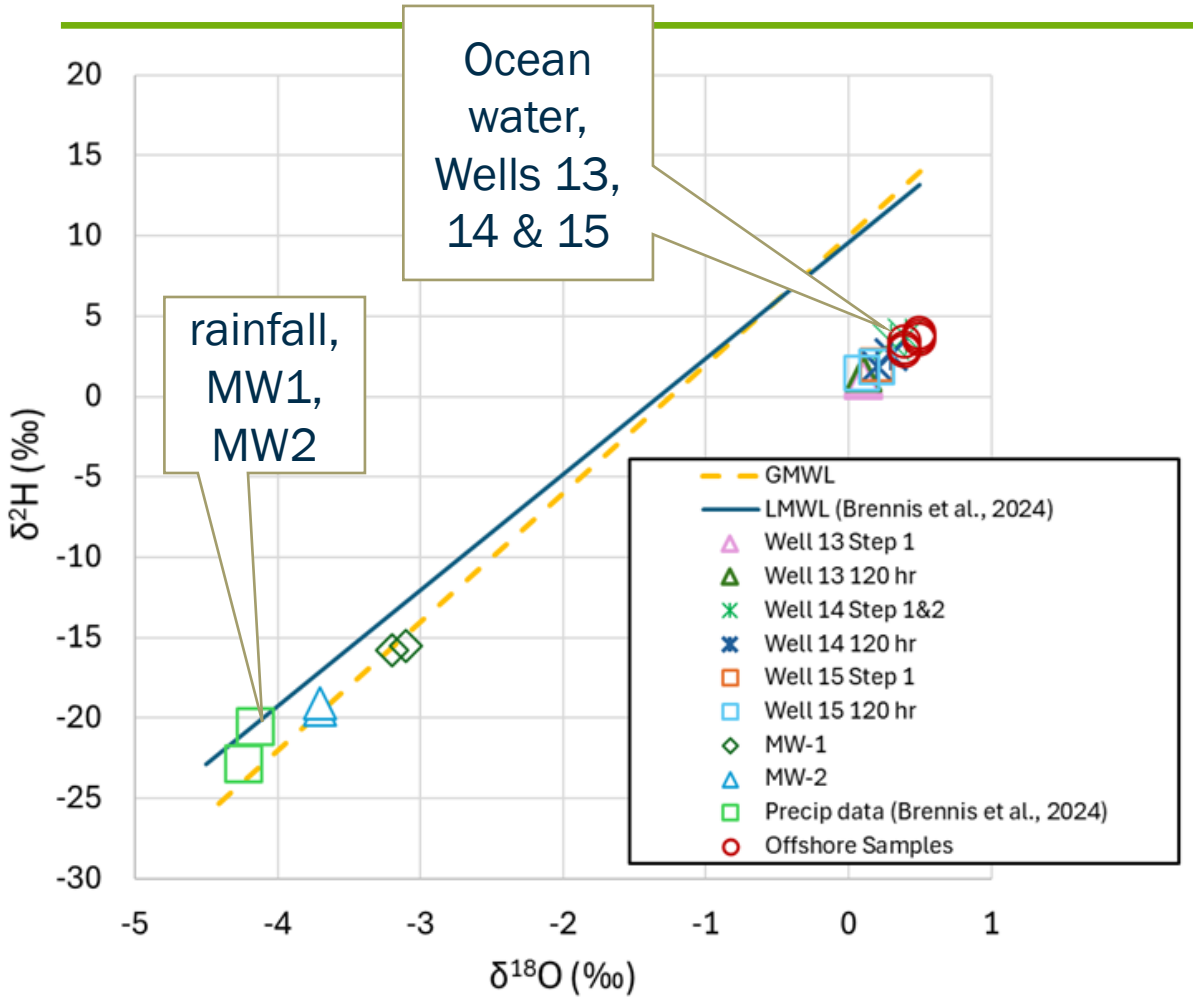
INTERA

Tracers Stable Isotopes

- Hydrogen: $^{2}H/^{1}H$
- Oxygen: $^{18}O/^{16}O$
- “Heavy” isotopes like ^{2}H & ^{18}O have more neutrons and “light” isotopes have fewer neutrons
- Mass fractionation occurs when one isotope is preferred during a chemical or physical process
- For example, the concentration of ^{18}O changes during a phase change – evaporation or condensation.



^{18}O and ^{2}H Stable Isotopes

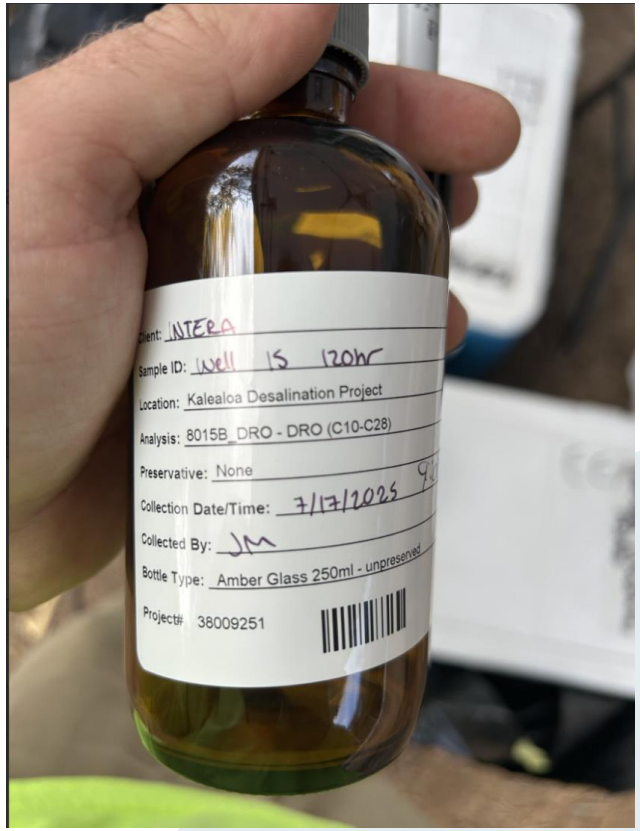


- Tool to better understand sources of groundwater recharge
- MW1 and 2 (upper caprock)– similar to local precipitation
- Well 14 (upper and lower caprock) – similar to basalt and seawater
- Wells 13 & 15 (basalt) similar to seawater

Preliminary conclusion: The upper caprock recharge is separate from the basalt aquifer. Pending analysis of remaining tracers.

Water Quality and Tracers

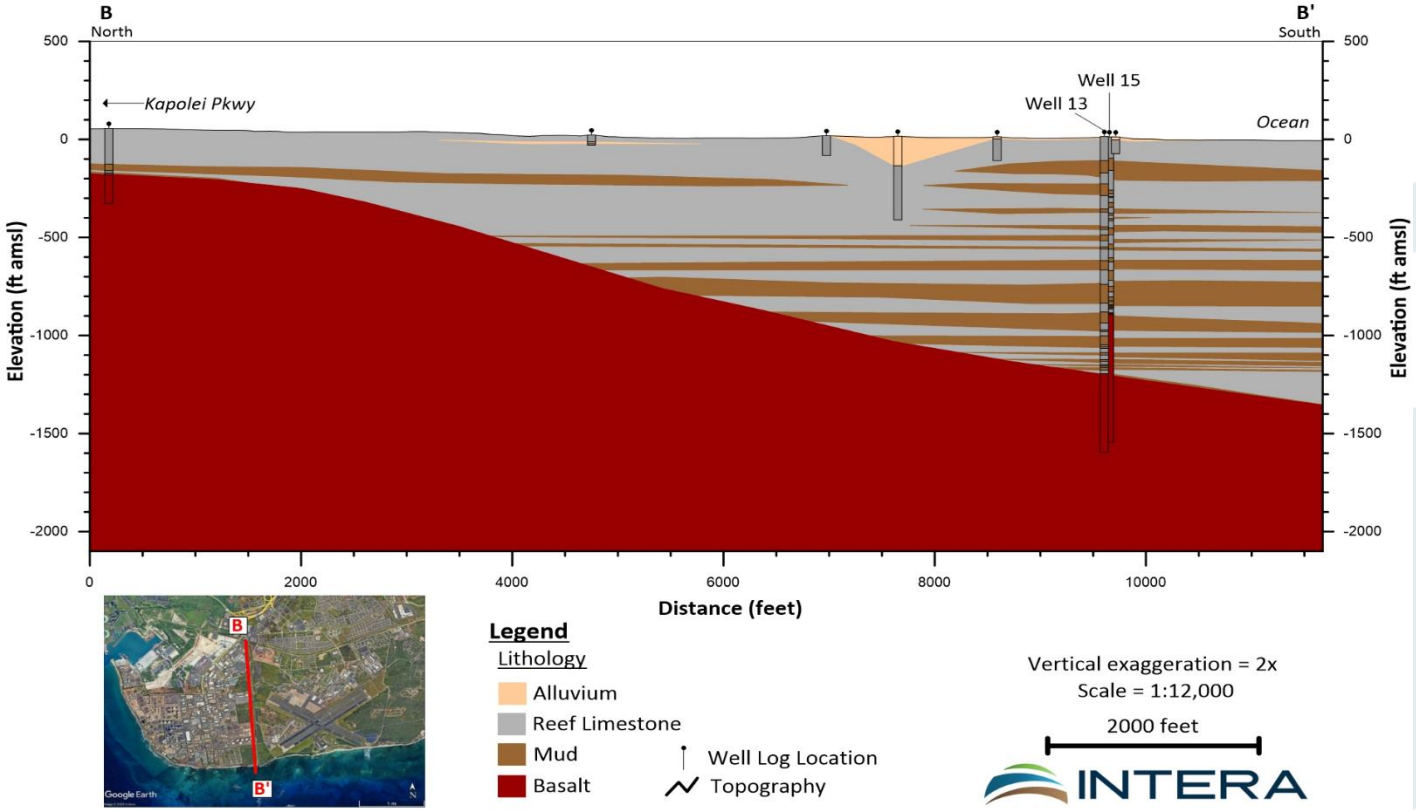
- Data still coming in from the labs (Eurofins, FQ Labs, University of Hawaii, ICA, University of Utah)
- Our data and analysis are incomplete therefore no preliminary conclusions



- TDS
- Major Cations/Anions
- Total Kjeldahl Nitrogen
- Nitrate
- Salinity
- Alkalinity
- Dissolved Silica
- Dissolved Metals
- VOCs/SVOCs
- BOD/COD/TOC
- TPH – G, D, O
- Oil & Grease
- Orthophosphate
- Organochlorine Pesticides
- PCBs
- Hexavalent Chromium
- 1,4-dioxane
- Ethylene dibromide
- PFAS
- Ethylene glycol
- Stable Isotopes
- Tritium
- Noble Gases
- Carbon 14
- CFCs/SF6
- Gross alpha & Beta
- Combined Radium
- Strontium-90
- Uranium

INTERA

Preliminary Conclusions



- Geophysical evidence indicates confining layers in the Caprock
- Aquifer test and water level analysis do not show hydraulic connection
- Stable isotope data indicate separate recharge for the upper Caprock and the deeper Caprock and Basalt aquifers

INTERA

Mahalo

Questions?