Appendix D

Water Supply Study
Planned Expansion of University of the Nations
Kona, Hawai‘i
Tom Nance Water Resource Engineering
February 2020

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MEMORANDUM

To: Jeff Overton and Paul Matsuda – Group 70 International, Inc.

From: Tom Nance

Subject: Water Supply for the Planned Expansion of University of Nations – Kona in the Land Use Commission (LUC) Petition Area

Introduction

As I understand it, the Hawaii County Department of Water Supply (HDWS) has indicated that a new source of supply will need to be developed in order to supply the LUC petition area for the planned expansion of the University of Nations-Kona (UNK). The portion of the planned expansion in the LUC petition area is on two adjacent parcels identified as TMKs 7-5-010:085 and 7-5-017:006. These two parcels are shown on Figure 1 and the concept plan for the proposed expansion on these parcels is illustrated on Figure 2.

Required Supply for the Expansion

Table 1 prepared by G70 provides an estimate of the UNK's required water supply for the planned expansion in the petition area. The projected ultimate supply required is 256,400 gallons per day (GPD), expressed as an average day demand. If the new source is dedicated to HDWS, it must be able to deliver the maximum day supply (defined as 1.5 times average) in a 24-hour pumping day. Further, one third of the source capacity would be reserved to HDWS with the remaining two thirds for UNK. These criteria mean that the new source needs to have a capacity of not less than 400 gallons per minute (GPM). Since most HDWS well pumping capacities are in the range of 700 to 1400 GPM, this suggests that a partner for UNK in the development of a new source of supply would be appropriate to consider.

Identified Alternatives for New Source Development

Three potential new source alternatives have been identified. In order from the most to the least promising, they are: a new well and related infrastructure on TMK 7-5-003:023, a property owned by Mr. Richard Wheelock who is actively seeking a partner for well development on his property; a new well TMK 8-1-002:058 in South Kona, a 5-acre property owned by UNK under the name Ahualani, Inc.; and an entirely onsite system. The first two of these systems would be as additions to the HDWS system. The third alternative would be a private, stand alone system. Each is described in the sections following.

Well Development on TMK 7-5-003:023, the Wheelock Property

In 2001, the Keopu Deep Monitor Well (State No. 3858-001) was completed. In a completely unexpected result, extremely fresh artesian water was encountered about 400 feet below sea level, lying beneath the basal lens and saline water below the basal lens. In 2017, a second monitor well was developed about 60 feet away from the first and completed to isolate the artesian water from the overlying brackish and saline water. Once isolated in this manner, the static water level stood at 28 feet above sea level and, somewhat surprisingly, varied significantly with the ocean tide (Figure 3). Pump tests were run, including a 48-hour constant rate test at an average of 820 GPM. The drawdown was essentially constant and recovery was very rapid (Figure 4). It is important to note that there was no evidence in the drawdown or recovery of a boundary effect. Such an effect might have occurred if the water body tapped by the well was of modest areal extent. The pumped water salinity was constant and comparable to the HDWS wells which draw high-level groundwater from locations above Mamalahoa Highway (Figure 5 and Table 2). Specific conductance was about 140 µS/cm and chlorides were less than five (5) MG/L. Further, isotope analysis confirmed that the artesian water at depth below sea level was the same as the high-level groundwater pumped by the inland HDWS wells (Dr. Donald Thomas, UH Hilo, personal communication). The pump test demonstrated that a variable source of drinking water from the artesian water at depth could be developed at this location.

On Figure 6, the location of the two Keopu monitor wells and the location of a potential well on the Wheelock property are shown. Although the areal extent of the developable artesian water at depth is not known, the distance to a well on the Wheelock property is modest enough (about 1200 feet) to warrant drilling an exploratory well and, if successful, completing it as a production well of 700 GPM capacity. The advantages of this location in comparison on to the two other alternatives subsequently discussed are significant: with modest infrastructure improvements, the well water could be delivered directly downslope into HDWS' 20-inch transmission main in Queen Kaahumanu Highway; and the pumping lift (i.e. required electrical power) would be about half the requirement of HDWS' high-level wells above Mamalahoa Highway.

Well Development TMK 8-1-002:058 Along Mamalahoa Highway Near Konawaena High School

TMK 8-1-002:058 is owned by UNK through its subsidiary company, Ahualani, Inc. Its location is shown on Figure 7 in relationship to three wells which surround the property and draw extremely fresh high-level groundwater (existing Well Nos. 3054-001, 3155-002, and 3155-003 on Figure 7). Results of these wells and the Time Domain Electromagnetic geophysical survey results done directly downslope suggest that it is almost certain that a well on the subject property would also encounter the very fresh high-level groundwater. However, there are a number of factors for the development of a well at this location that make it a far more expensive proposition than a well on the Wheelock property:

- The well would need to be drilled to greater depth than a well on the Wheelock property;
- The pumping lift required to deliver water to the nearest HDWS storage tank would be more than twice as great than the pumping lift of a well on the Wheelock property;
- To provide adequate contact time for chlorine injected at the well head, a separate transmission pipeline to the HDWS tank would be required; and

- Substantial upgrades of transmission capacity within the HDWS system would be required in Mamalahoa Highway and elsewhere to enable water from the new well to be effectively used in the portion of the HDWS system serving the UNK project site.

Development of a Private Stand-Alone Water System on the University of Nations - Kona Site

Groundwater everywhere beneath the UNK project site occurs as a thin brackish basal lens underlain by saline groundwater of seawater salinity. This groundwater would have to be treated by reverse osmosis (RO) filtration for drinking water use. At this location and in order to have essentially no impact on the basal groundwater and its discharge into the marine environment, such a system would need to consist of the following:

- Two supply wells, each configured to draw saline groundwater from beneath the basal lens and with each providing 100 percent of the required capacity so that 100 percent back up capacity would be available in the event of a pump failure.
- The RO filtration plant must be capable of producing the maximum day supply of up to 384,600 GPD in a 24-hour operating day. Based on results a prototype RO plant the Honolulu Board of Water Supply (HBWS) ran at the makai end of Campbell Industrial Park in Ewa, Oahu, only about 40 percent of the saline groundwater fed into the plant will be the product water of potable quality. The remaining 60 percent will be a hypersaline concentrate for disposal.
- The RO recovery rate means each of the two supply wells will need to be of 670 GPM capacity. Also based on the HBWS prototype results, a pressure on the order of 900 PSI to the RO filters will be necessary.
- Two disposal wells for the RO concentrate will be necessary, each of at least 400 GPM capacity to provide 100 percent back up capacity. These wells will need to be substantially deeper than the supply wells to prevent recirculation of the RO concentrate back to the supply wells.
- The RO product water would be delivered to an onsite storage tank. Delivery to customers from the onsite storage tank would be by an on-demand booster pump station.
- Based on the number of customers served, the system would be regulated by the State Department of Health (DOH) and would need to be operated and maintained by a technically competent staff acceptable to DOH, very likely by contract to a qualified private company.

All elements of the system described above are actually possible to construct. However, initial costs would be substantially greater than the alternative of a well and related infrastructure on the Wheelock property and the operating cost would be far greater than the price of water from the HDWS system.

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Concluding Comments

By far the best alternative is to jointly develop a well on the Wheelock property. This well would be in the Keauhou Aquifer System, for which there has been considerable scrutiny regarding the possibility that pumpage of potable wells may adversely impact the flowrate and salinity of the brackish basal lens in the nearshore area. Such an impact would not be the case for a well on the Wheelock for the following two reasons:

- The well would draw fresh water from 400 to 600 feet below sea level. This body of water is hydrologically isolated from the overlying saline groundwater and brackish basal groundwater. Based on the piezometric head level and measured tidal response, water drawn by the well would otherwise discharge at great depth and distance offshore without ever coming in contact with the basal groundwater.
- I have in the past and continue to monitor the potential impact the pumpage of HDWS' inland potable wells is having on the nominally downgradient basal lens. The monitoring is at two fortuitously located basal wells directly downgradient of the HDWS wells. Monitoring consists of water level recording and salinity profiling. The HDWS pumpage began in 1994 (26 years ago) and has varied between four (4) and six (6) MGD for the last 15 years. To date, no impact on the basal groundwater has been identified by the monitoring that I have undertaken.

Attachments

ec: Greg Fukumitsu and Todd Yonamine – TNWRE Inc.

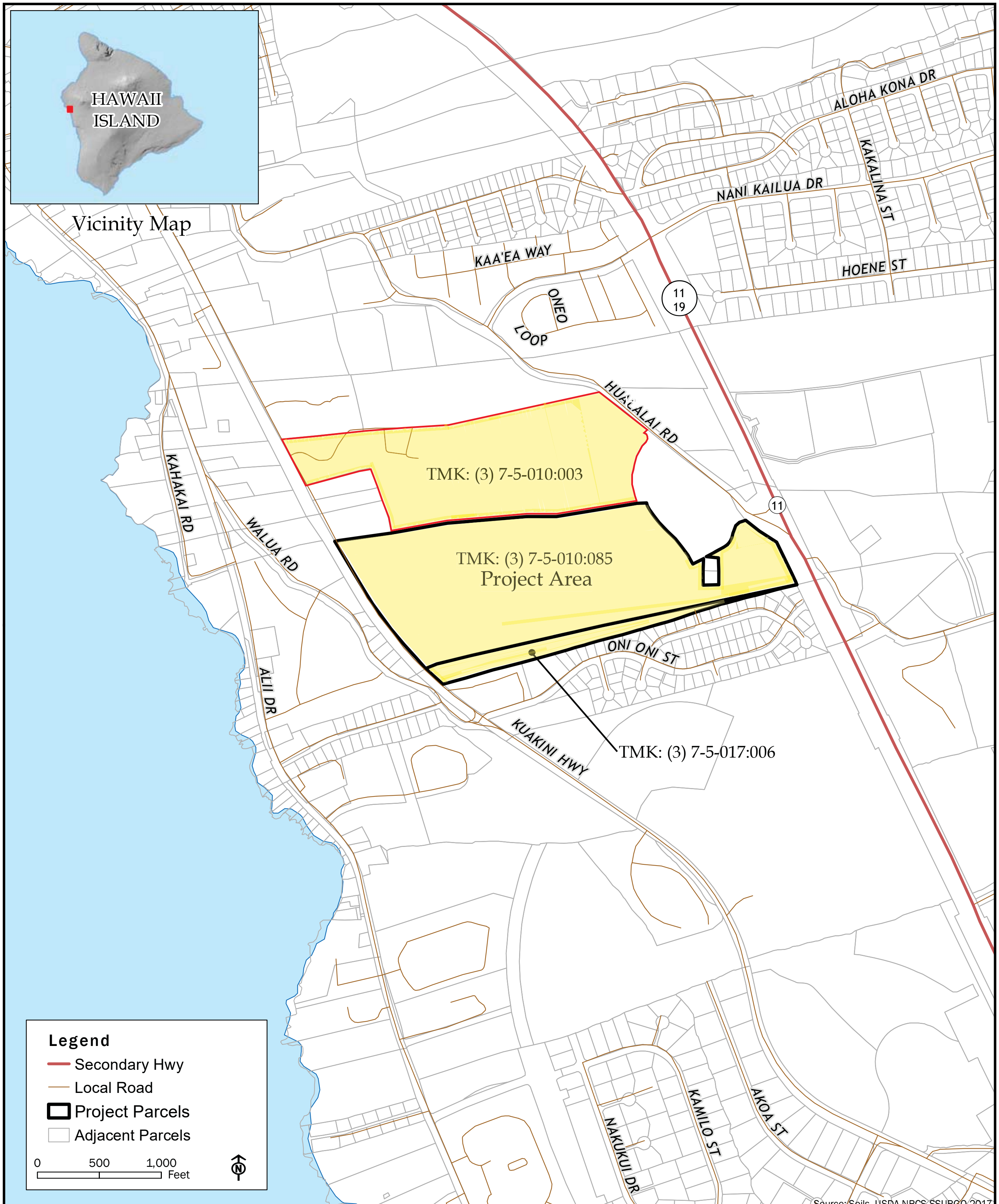

Figure 1: Location Map

219061-01

University of the Nations Campus Expansion

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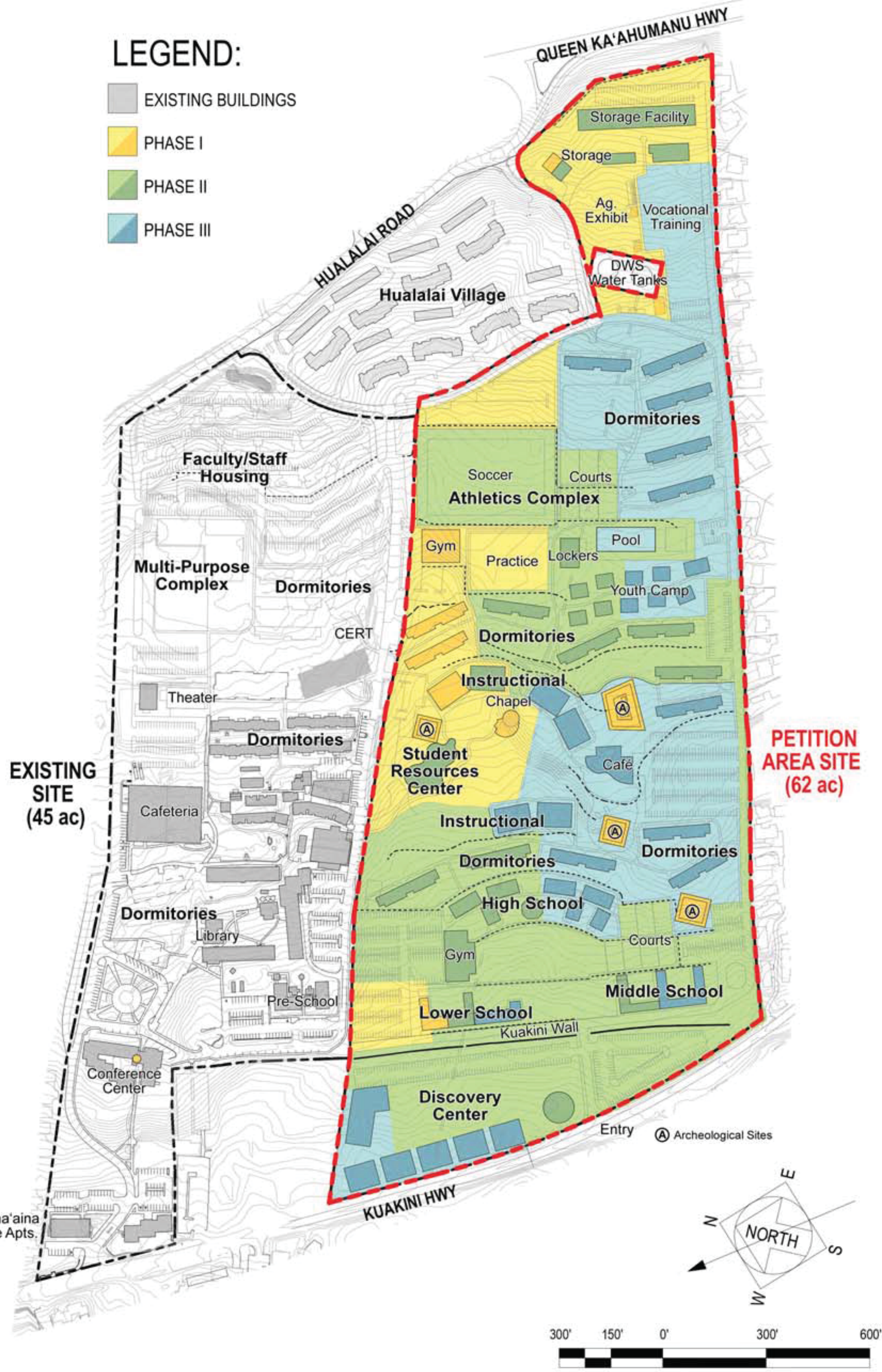

Figure 2

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CONCEPT MASTER PLAN
UNIVERSITY OF THE NATIONS - KONA

Feb 2020

Table 1: Projected Water Demand **2/25/2020**

	Phase 1 Population (persons)	Phase 2 Population (persons)	Phase 3 Population (persons)	Average Daily Demand [1] (gal/person/day)	Phase 1 Water Demand (GPD)	Phase 2 Water Demand (GPD)	Phase 3 Water Demand (GPD)
P-12 Students (FTE)	500	750	1,000	60	30,000	45,000	60,000
University Students (FTE)	130	345	940	60	7,800	20,700	56,400
TOTAL	630	1,095	1,940	SUBTOTAL	37,800	65,700	116,400
P-12 and University Students (Dorming)	200	1,100	1,400	100	20,000	110,000	140,000
				TOTAL	57,800	175,700	256,400
				WATER UNITS	145	439	641

[1] Average Daily Demand value taken from DWS Water System Standards

Table 1

Figure 3. Tidal Response in the Keopu 2 Monitor Well from March 9 to 12, 2018

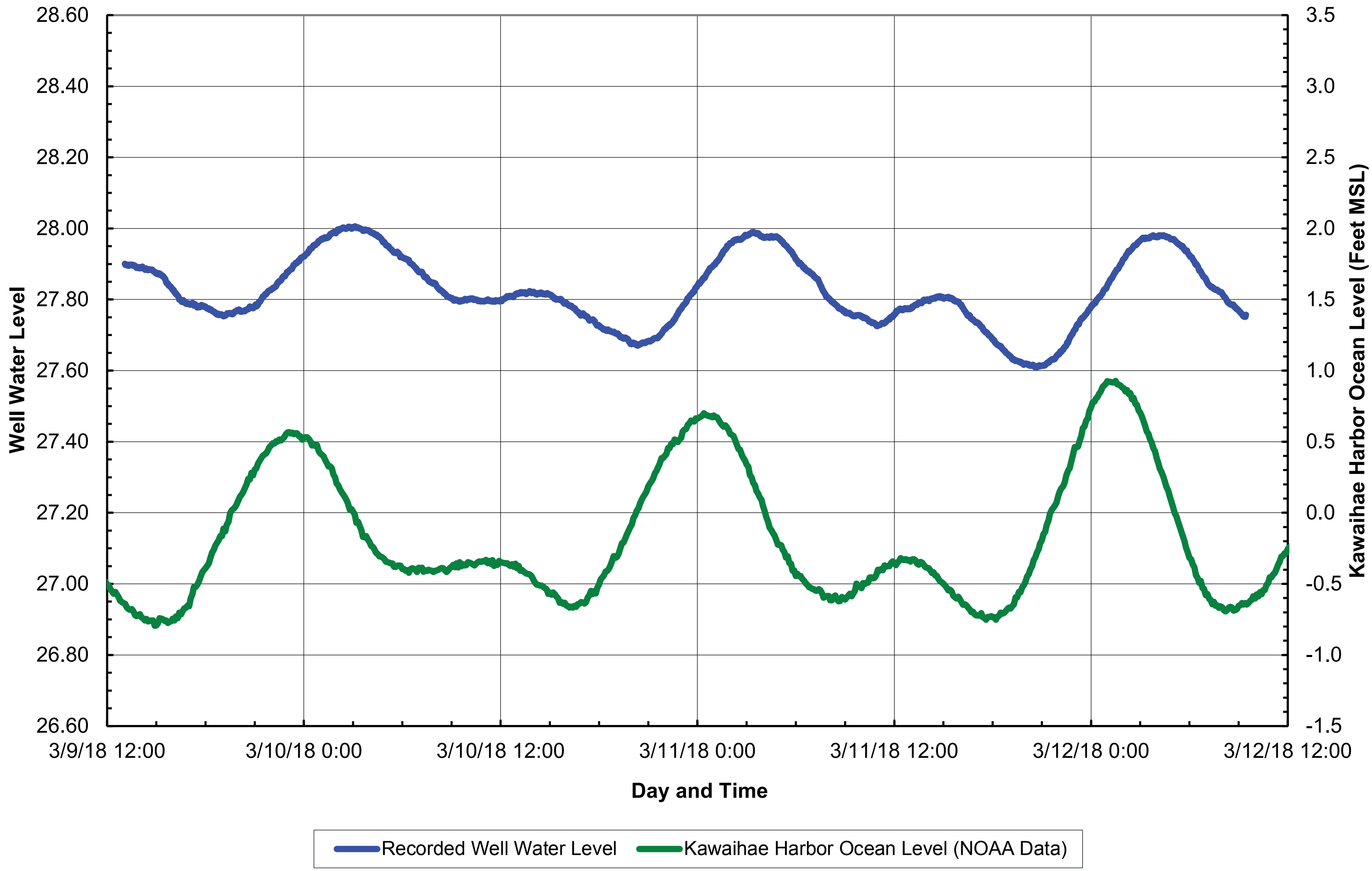


Figure 4. Pumping Rate and Recorded Water Level Response During the 48 Hour Constant Rate Test on March 12 to 14, 2018

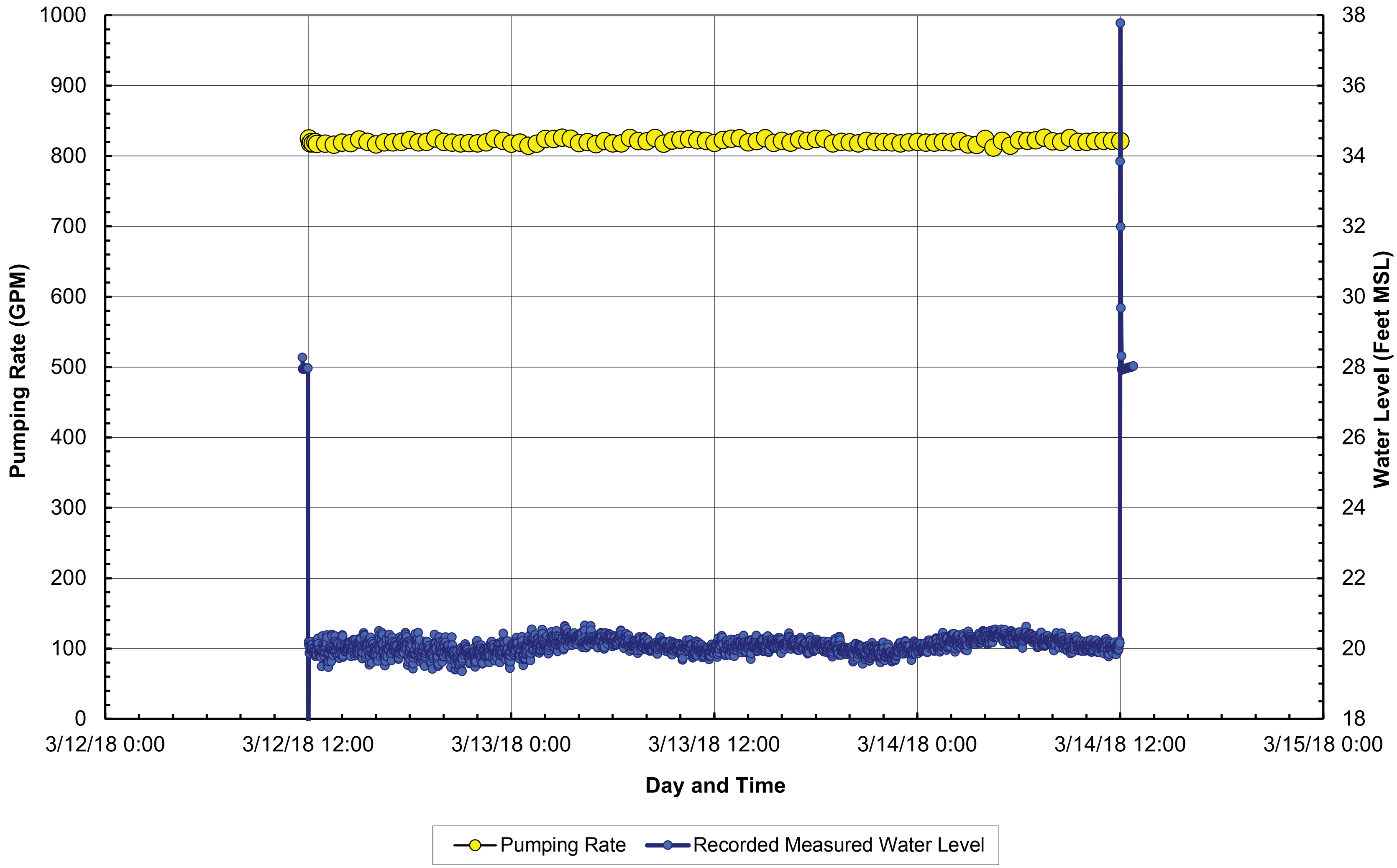


Figure 5. Pumped Water Specific Conductance During the Step Drawdown and Constant Rate Pump Tests on March 12 to 14, 2018

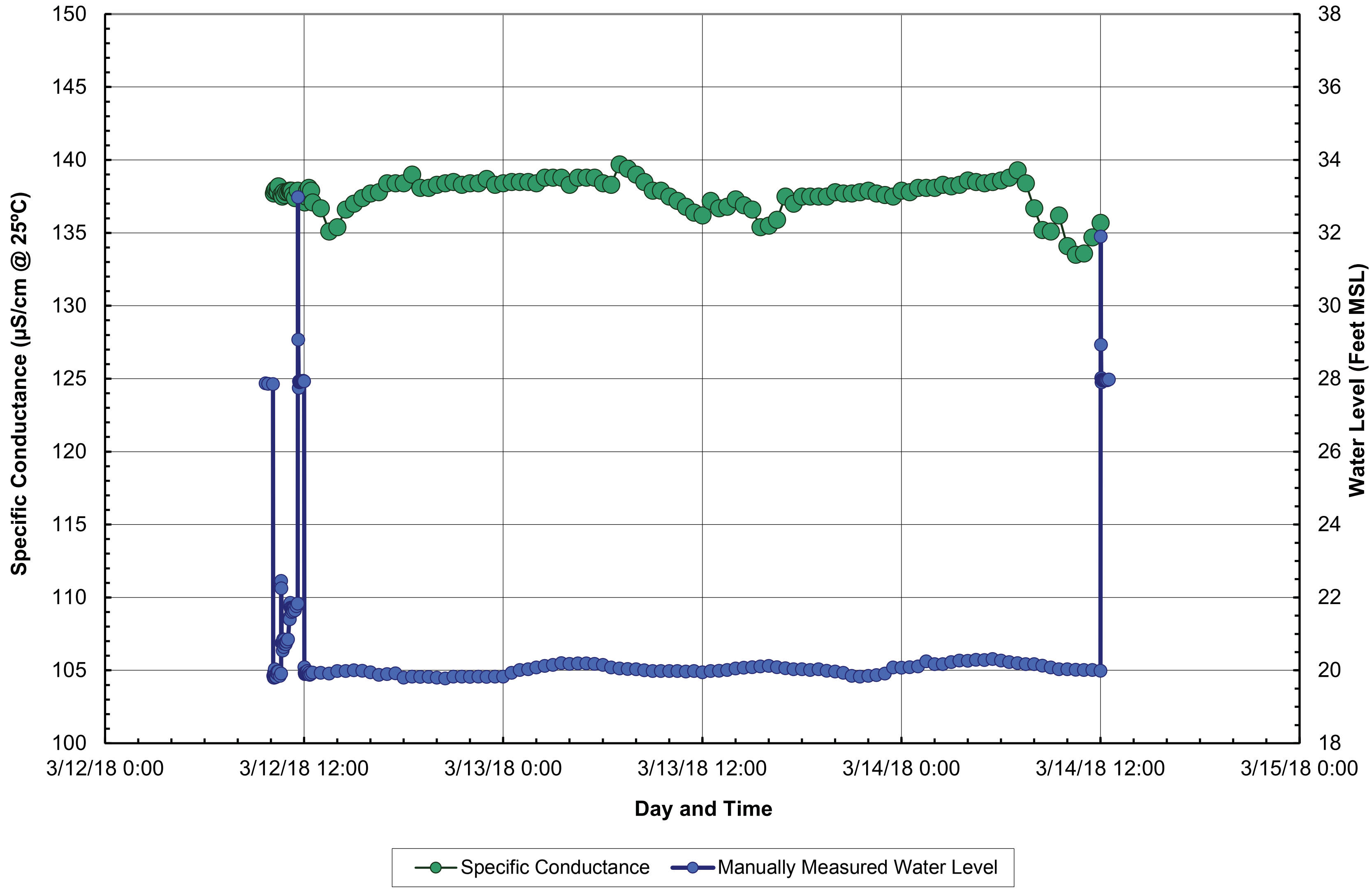
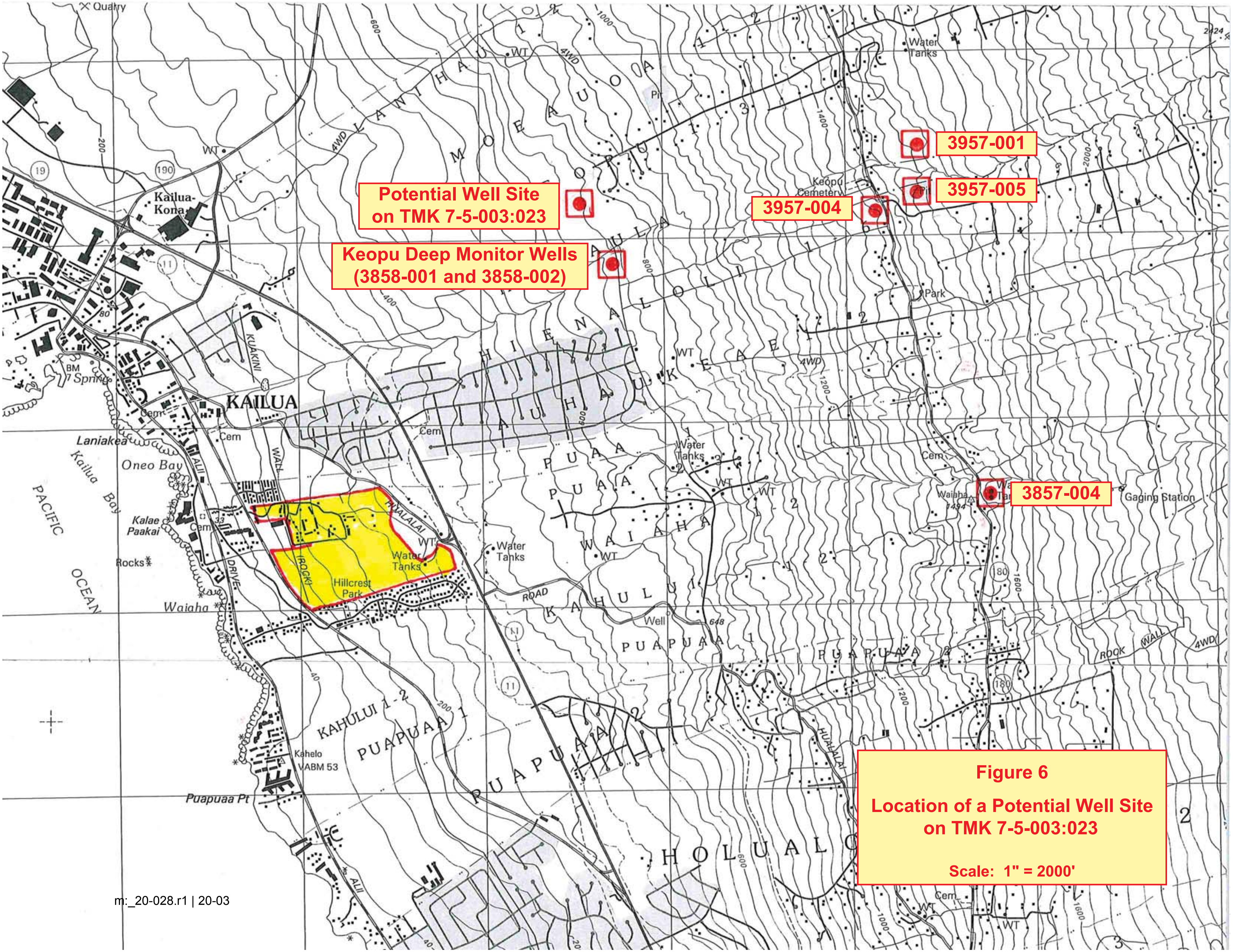


Table 2

Specific Conductance and Chlorides of Samples Collected
During the Step-Drawdown and Constant Rate Pump Tests
of the Keopu 2 Monitor Well

Pump Test	Sample		Specific Conductance (µS/cm @ 25° C.)	Chlorides (MG/L)
	Day	Time		
Step Drawdown	03/12/18	10:12	143.2	4.5
		10:37	140.6	4.5
		11:07	139.9	4.0
		11:37	139.9	4.0
Constant Rate	03/12/18	12:05	140.0	4.1
		18:00	138.8	3.2
	03/13/18	00:00	139.3	3.5
		06:00	139.1	3.4
		12:00	140.0	4.1
		18:00	139.0	3.3
	03/14/18	00:00	139.0	3.3
		06:00	139.1	3.4
		12:00	139.2	3.5

Notes:
1. Specific conductance was measured in the TNWRE office using a HACH Sension 5 meter calibrated with a 447 µS/cm standard.
2. Chlorides determined by mercuric nitrate titration in the TNWRE office.



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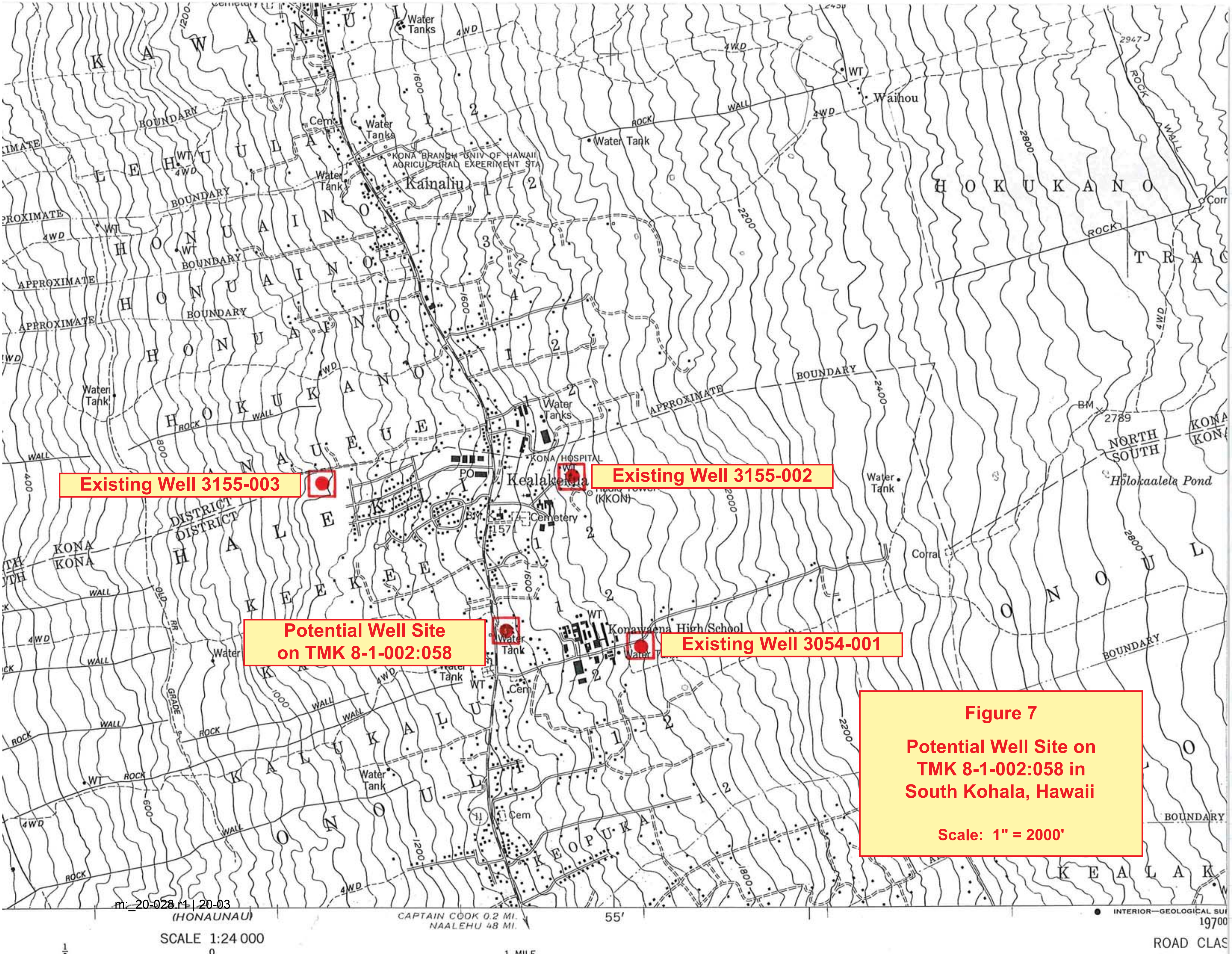
Existing Well 3155-003
Existing Well 3155-002
Potential Well Site
on TMK 8-1-002:058
Existing Well 3054-001
Figure 7
Potential Well Site on
TMK 8-1-002:058 in
South Kohala, Hawaii
Scale: 1" = 2000'
Kealakekua
Kainaliu
Waihou
Konawaena High School
KONA HOSPITAL
Cemetery
Holokaalele Pond
Corral
(KKON)
KONA BRANCH UNIV OF HAWAII AGRICULTURAL EXPERIMENT STA
NORTH KONA
SOUTH KONA
CAPTAIN COOK 0.2 MI.
NAALEHU 48 MI.
(HONAUNAU)
55′
SCALE 1:24 000
ROAD CLAS
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