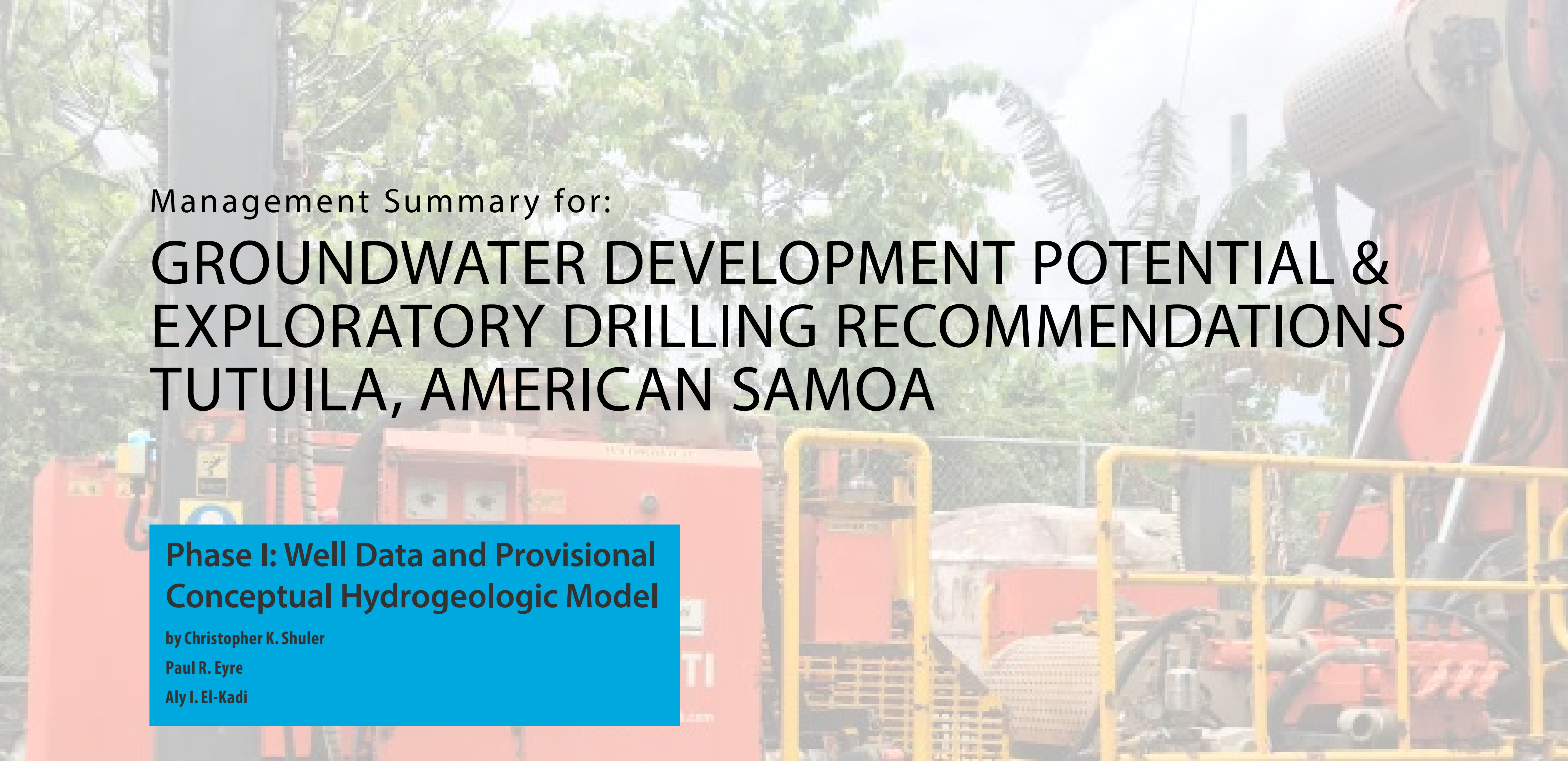

Management Summary for:

GROUNDWATER DEVELOPMENT POTENTIAL & EXPLORATORY DRILLING RECOMMENDATIONS TUTUILA, AMERICAN SAMOA

Phase I: Well Data and Provisional Conceptual Hydrogeologic Model

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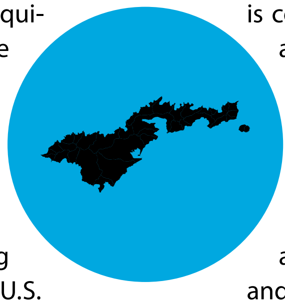
This document synthesizes a WRRC special report of the same title, produced December 2017. The full report contains a comprehensive review of existing hydrological information, suggests hypotheses of groundwater occurrence on Tutuila, and recommends exploratory well drilling locations.

Motivation



On Tutuila, the main island in the Territory of American Samoa, the sustainability of existing drinking water resources is threatened by anthropogenic contamination and by the overuse of limited groundwater reservoirs. Tutuila's most productive aquifers, located in the Tafuna-Leone Plain region, are directly influenced by surface water (ASEPA, 2010). This has led to the longest-standing boil-water notice in U.S. history (ASEPA, 2016). Additionally, a number of smaller aquifers on the island are affected by saltwater intrusion. Development of new groundwater sources with lower contamination potential is a high priority on Tutuila. To accomplish this, new hydrogeological information and updated conceptual hydrogeological models are needed to make scientifically informed groundwater exploration decisions. In this report, existing hydrological information is compiled with recently acquired subsurface datasets to inform three hypotheses of groundwater occurrence on Tutuila. These hypotheses are used to develop and prioritize recommendations for exploration drilling sites targeted at finding new groundwater sources. It should be noted that due to data limitations, the quality and conclusiveness of some information presented herein may be unknown.

Framework

The report presents a framework for recommending locations for exploratory drilling that target new sources of groundwater in both high-level and basal aquifers, including:

- Compilation of existing hydrogeologic knowledge
- Application of geologic principles to estimate subsurface conditions
- Prioritize exploration regions or watersheds based on available data and information

Comprehensive Literature Review

Consolidating all groundwater data

All known groundwater data from journal publications, grey literature, agency files, and original studies were gathered to create a comprehensive list of information relating to groundwater on Tutuila

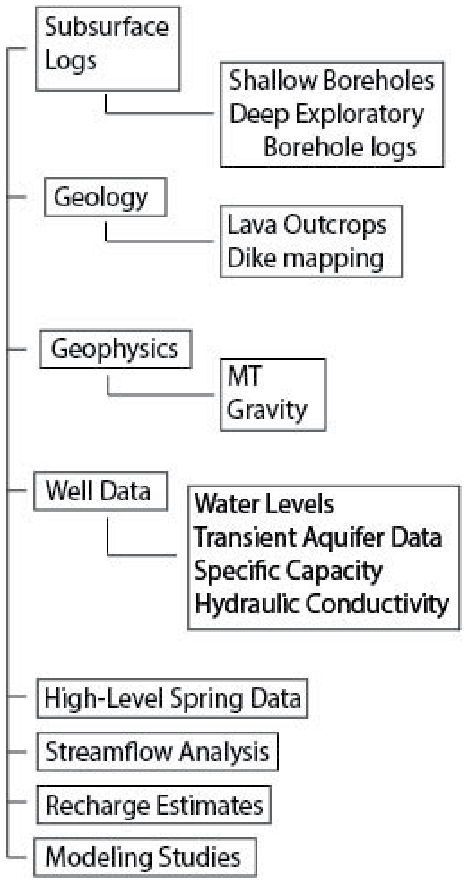


Figure 2: List of Hydrologic and geologic datasets currently available for Tutuila

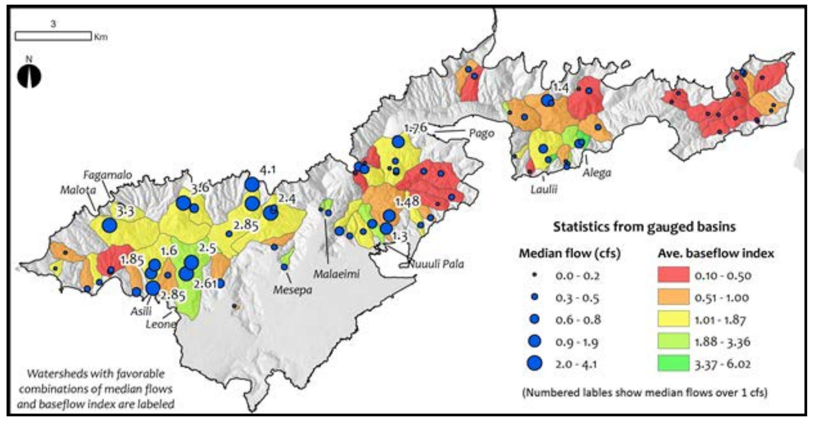


Figure 1: Summary of low-flow streamflow characteristics for Tutuila, data from Wong, (1996).

Review of Existing Data

Summary of major findings from hydrologic and geologic data

Geological logs and examination of outcrops show that Tutuila's geologic structure is complex and heterogeneous. This is supported by examination of existing well performance through aquifer tests and water level observations, which show ranges of specific capacity, transmissivity and hydraulic conductivity that span over three to four orders of magnitude on the island. The primary generalization that can be made is the younger Tafuna-Leone Plain Region displays higher K values and a thinner freshwater lens, than the older portion of the island. Existing geophysical datasets are not resolved enough to reveal small scale structures, but do support the regional generalization made above. Available recharge estimates indicate the eastern region of the island receives significantly lower amounts of recharge than the western region. The existence of persistent high-level groundwater is indicated by the occurrence of perennial streams and springs, with δ2H & δ18O signatures matching average annual groundwater and high (> 80 dpm/L) 222Rn concentrations. While there are a number of locations on Tutuila where springs with exceptional flow rates occur, most documented springs are small. Variation in baseflow between different watersheds (Fig 1) can indicate aquifer parameters, and streamflow analysis shows a number of basins in Western Tutuila with more substantial aquifers that contribute a larger proportion of water to the stream.

Key Datasets

Aquifer Test Data

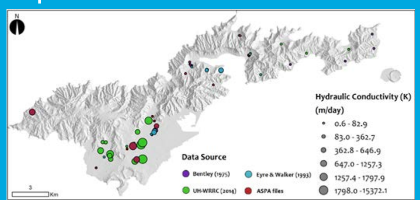


Figure 3: e.g. distribution and magnitude of hydraulic conductivity values from all known wells on Tutuila.

Borehole Data

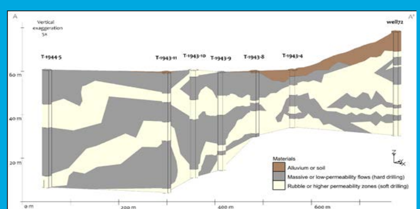


Figure 4: e.g. Interpretation of driller's logs from closely spaced wells on the Tafuna-Leone delta.

Geologic & Geophysical Data

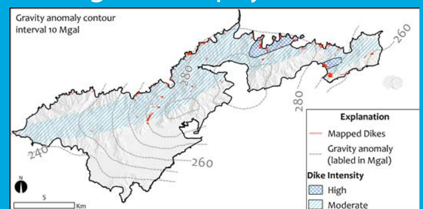


Figure 5: e.g. gravity measurements and dike mapping data from surface/ subsurface geologic studies

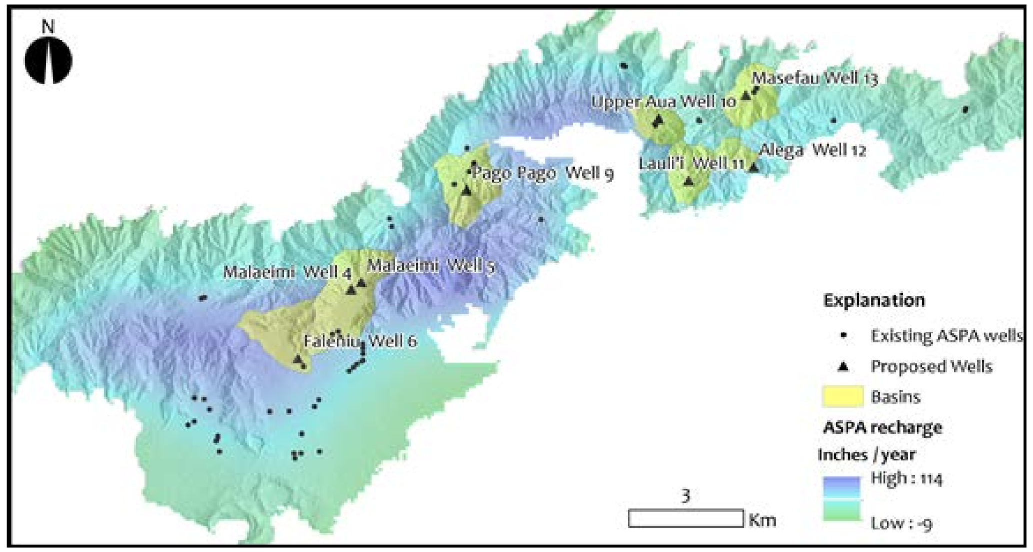


Figure 6: Location of proposed ASPA production well drilling sites, existing production wells, and recharge basins that new wells will utilize

Prioritization of Existing Drilling Sites

As of 2018, the American Samoa Power Authority is working towards new well development in eight new locations throughout Tutuila. To assist these efforts, the information compiled throughout the full report was applied to rank each existing well development site in terms of their potential to yield sufficient quantities of high-quality water, and their value in terms of hydrogeological exploration. Basins with planned production wells were assessed using the available data from existing or historical production well characteristics. Most planned locations are within about 300 m from existing data points, except for those in Malaeimi Valley, which represent locations with high-exploratory value. A relative recharge/pumpage assessment for each basin was estimated from the recharge map documented in Walters (2013), and is given as the ratio of the calculated recharge within the basin over the amount of water currently extracted by existing wells in the basin. The predicted development potential of each of the eight sites are also ranked on three assessment criteria: (1) likelihood to yield sufficient quantities of water as assessed by specific capacity and local water levels in existing wells, as well as hydrogeologic properties of the region; (2) current stress on the local aquifer as assessed by Cl- levels, and chronic drawdowns in nearby wells; and (3) exploratory value regarding the number of nearby wells with existing aquifer information.

This information is intended to facilitate decision making during the well drilling process, and to inform the process of setting pump rates.

Table 1: Summary of well data, aquifer characteristics, and available recharge quantities in existing wells located near proposed wells.

Well Name	Nearby Wells	Average Distance to Nearby Wells (m)	Average Cl^- of Nearby Wells (mg/L)	Average Static Water Level in Nearby Wells (m)	Average Drawdown in Nearby Wells (m)	Average Specific Capacity in Nearby Wells (gpm/m)	Estimated Recharge Currently Used (%)	Exploratory Value	Hydrogeologic Unit	Rank
Faleniu Well 6	85	268	55	1.3	0.2	1,244	9	Medium	Tafuna lavas	1
Alega Well 12	none	–	–	–	–	–	0	High	Pago Shield	2
Laulii Well 11	None (2 historical)	192	25	6.4	8.5	8	0	High	Pago Shield	3
Malaeimi Well 5	89, 67 (1, 2, 3 offline)	1,489	50	2.9	6.0	39	12	Low	Taputapu or alluvial fill	4
Malaeimi Well 4	89, 67 (1, 2, 3 offline)	1,232	50	2.9	6.0	39	12	Low	Taputapu or alluvial fill	5
Masefau Well 13	242, 241	277	58	4.8	3.3	10	6	Medium	Pago Shield	6
Pago Pago Well 9	183, 165, 107, 105, 163	648	255	5.7	20.2	12	48	Low	Pago Shield	7
Upper Aua Well 10	99, 97	142	916	-0.8	15.3	10	40	Low	Pago Shield	8

Recommended New Groundwater Exploration Sites

Based on the conceptual model of groundwater occurrence presented in this report and on experience with existing well performance on Tutuila, the authors recommend three strategies for developing new groundwater supplies: (1) targeting thicker or more elevated portions of basal/semi-perched water reservoirs contained in the Taputapu Shield or low-dike intensity regions of the Pago Shield with angled drilling; (2) targeting larger pockets of high-level groundwater, in locations indicated by large downgradient springs or streams having high baseflow indices with inclined or traditional wells; and (3) exploring the perched or high-level groundwater reservoir at Aoloau, both within the cinder unit and below it as well.

Basal Groundwater in Pleistocene Shields

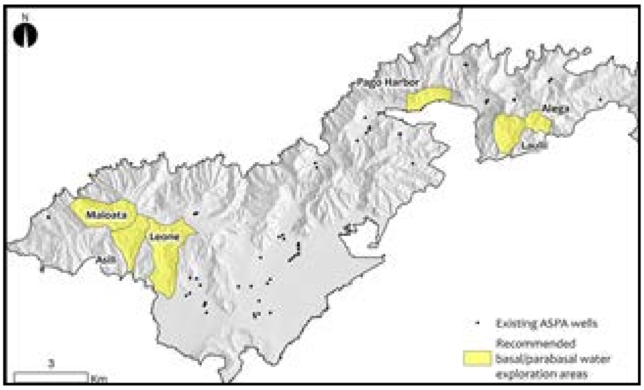


Figure 6: Locations of recommended basal aquifer exploration areas.

Basal/semi-perched groundwater refers to water within or connected to the lens shaped freshwater body that floats on saltwater within saturated rock. The height of the freshwater table is primarily controlled by the hydraulic conductivity (K) of the geologic formation and the area's recharge rate. Reommended exploration areas are prioritized based on hydrologic data, existing well data, and accessible distance from the coast. Although specific drilling sites are not defined, in all areas, site preference should be given to locations as far inland as possible.

High-Level Groundwater

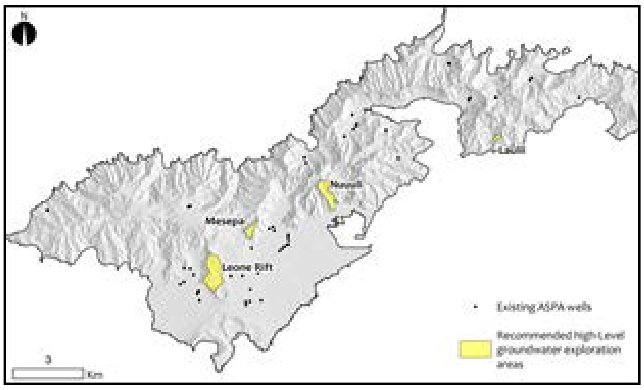


Figure 7: Locations of recommended high-level aquifer exploration areas.

High-level water refers to groundwater that is contained in zones of permeable material, which are bordered by adjacent low-permeability geologic features, such as dikes, perching horizons, or faults. If properly oriented, these structures can support pockets of freshwater at elevations that are discontinuous from the basal water system. Since high-level groundwater is separated from underlying saltwater, it is not at risk of salinization. Potential of disruption to village water systems and aquatic habitats should be fully assessed prior to development of these sources. It is also recommended that field investigations of these areas be conducted prior to development to constrain exact spring locations, flow rates, and elevations.

Table 1: Examples of hydrologic datasets compiled to assess recommended groundwater exploration areas, specifically for hihg-level aquifers

Hydrologic Parameters	WATERSHED			
	Laulii	Nuuului	Mesepa	Leone Rift
Area (km²)	0.08	0.49	0.19	0.87
Normalized recharge (Mgal/d/km²)[a]	1.0	1.9	1.8	1.4
Geologic formation	Pago Shield	Pago Shield	Pago Shield	Leone pyroclastics
Estimated *K* (m/d)	1–9	1–9	1–9	86–837
Baseflow index (ft³/sec/mi²)	5.6	3.36	2.29	1[b]
Median stream discharge (ft³/sec)	0.32	0.6	0.23	0.03[b]
Recommended priority	1	2	3	4

[a] Normalized recharge based on ASPA (2013) data.
[b] Streamflow characteristics for Sigaloa drainage area (western side of unit), is not necessarily representative of all drainage areas from unit.

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