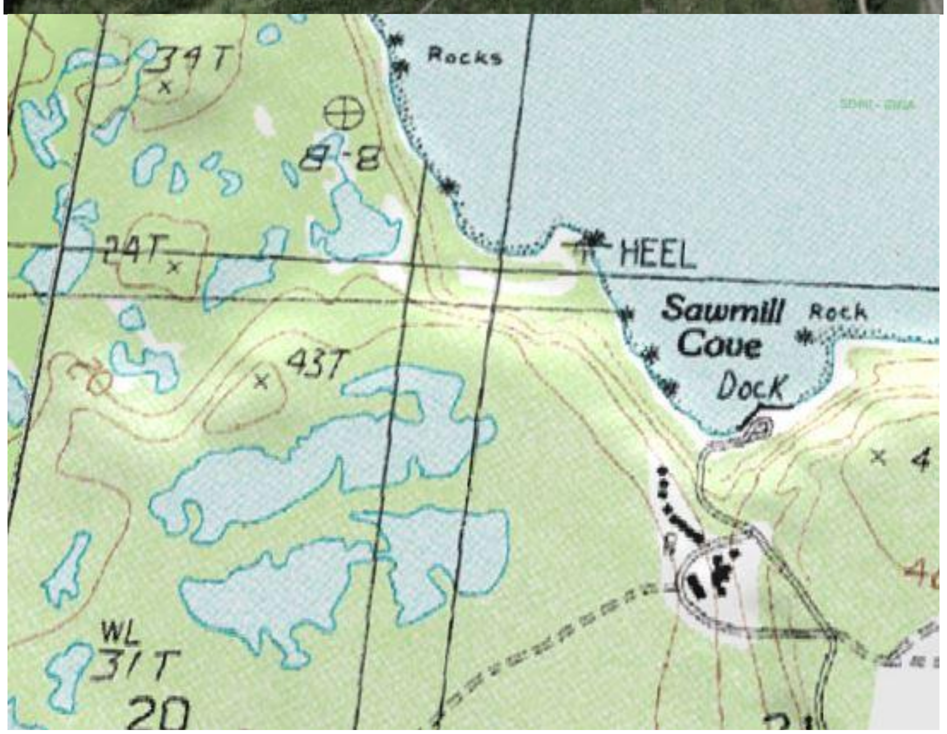
DISCHARGE MEASUREMENTS AND MAPS OF THE SAWMILL COVE SPRINGS
NEAR YAKUTAT, ALASKA



PREPARED FOR THE YAKUTAT REGIONAL AQUACULTURE ASSOCIATION
ALASKA HYDROSCIENCE, OCTOBER 2015.

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1 INTRODUCTION

I have been conducting discharge measurements at an array of springs in Sawmill Cove since April 2014. These measurements were conducted in an effort to evaluate the feasibility of utilizing spring water emerging along the beach at Sawmill Cove for a hatchery facility proposed by the Yakutat Regional Aquaculture Association (YRAA). The following report provides a GPS survey and photo documentation of the measured springs and other key hydrologic features in the Sawmill Cove area. Additional measurements of spring flow collected through September 2015 are also included in the document.

2 SETTING

The study site consists of numerous distributed springs emerging just above tidewater in Sawmill Cove. In addition to the springs two large kettle ponds located just west of Sawmill Cove have been identified as a potential backup or supplemental water supply (Figure 1). At four locations the springs converge into channels suitable for measurement (figures 1 and 2) using conventional surface water measurement techniques. Much of the available spring water in Sawmill Cove has not been measured due to the small size and/or distributed configuration of the discharge. The volume of unmeasured spring water appears noteworthy when compared to the volume of the measured springs. The unmeasured spring water may represent a sizeable percentage of the available water at this site. The approximate location of the unmeasured spring water and measurement locations of the measured springs (labeled A-D) are shown in figures 1 and 2.

3 SURVEY OBJECTIVES

The site was surveyed in order to determine the aerial extent of spring flow emerging along the beach at Sawmill Cove. It was of further interest to determine emergence points and source of discharge for the four springs that have been measured since April of 2014. In addition to the survey of the springs I located and mapped portions of the outlet stream of the northern pond adjacent to Sawmill Cove. If the site is selected for the proposed hatchery it may be of interest to monitor stage and discharge of the ponds as they may provide a supplemental or backup water supply.

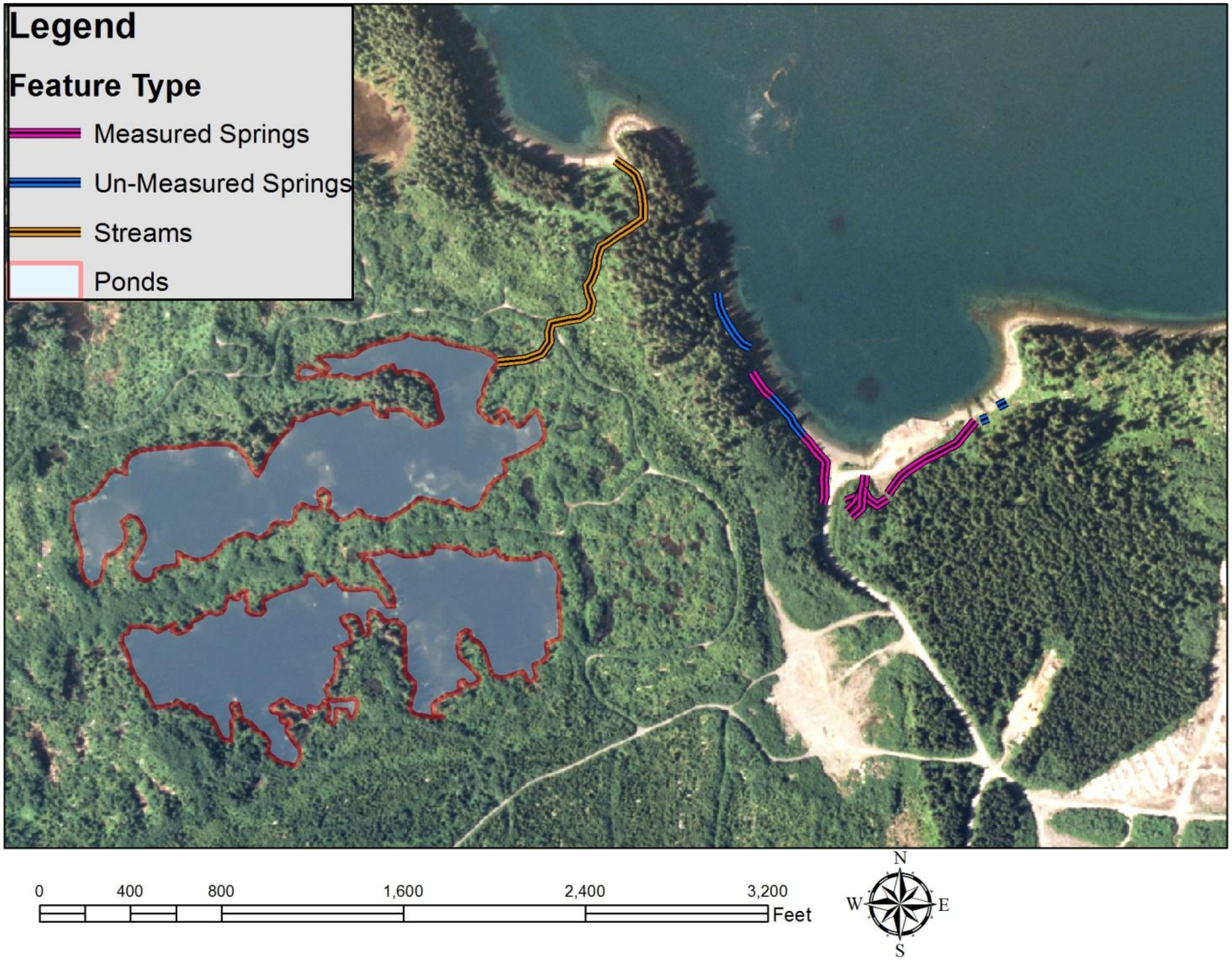

Figure 1. Map of the study area showing Sawmill Cove springs, kettle ponds, and outlet stream to the west.

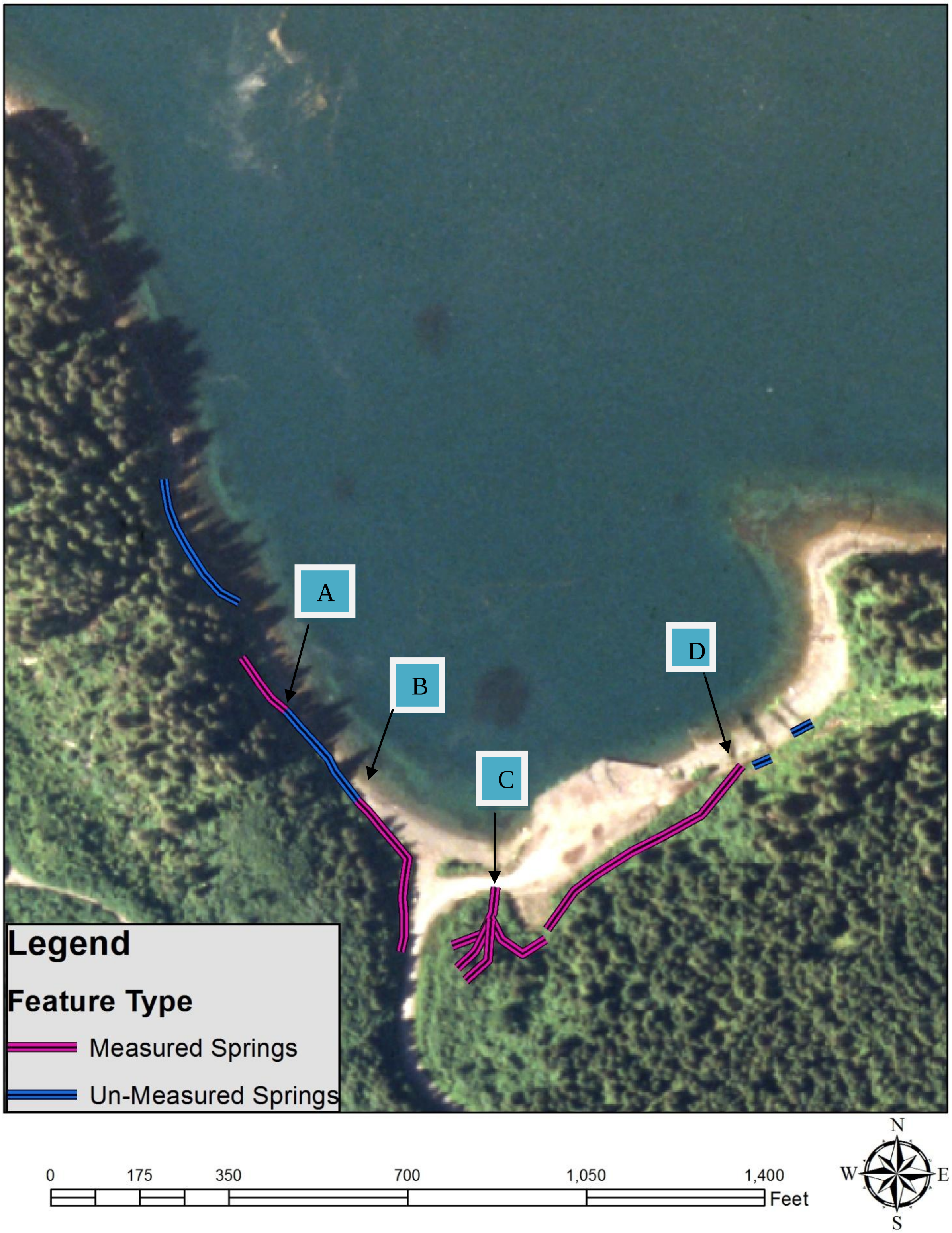

Figure 2. Map showing Sawmill Cove spring measurement locations and the location of unmeasured springs in the region.

4 Observations

4.1 Spring A

Spring A (figure 2) emerges from the ground approximately 140 feet north west of the measurement location at an elevation 8-10 feet above the beach terrace. It accumulates discharge from a series of tributary springs emerging from the hillside. On average, spring A accumulates the largest discharge contribution of the measured springs, with discharges ranging from 197 to 485 gpm (table 1). At high flows some spring discharge will not be measurable as flow overflows the confined channel both east and west of the measurement location.

Figure 3. Photo of spring A flowing east across the beach terrace upstream of the measurement location (discharge 485 gpm).

4.2 Spring B

At the time of the survey spring B emerged from the hill side adjacent to the road approximately 300 feet upstream from the measurement location. It accumulated additional discharge from two small springs as it flowed toward the measurement location. Spring B discharges less water than the other measured springs and measured discharges have ranged from 13 to 211 gpm (table 1). Measurements of Spring B may include surface water runoff and associated sediment loading from the road during periods of high flow as the upstream reach flows through a ditch adjacent to the road.

Figure 4. Spring B at the measurement location just upstream of tide water (discharge 121 gpm).

4.3 Spring C

Spring C emerges from the hill side at several locations upstream from the measurement site and generally flows northward before all tributaries converge at the measurement site. The upstream extent of surface water discharge was found approximately 180 feet upstream of the measurement location. Discharges in Spring C have ranged from 72 to 305 gpm (table 1). Spring C contributes less discharge than all of the other measured springs with the exception of spring B.

Figure 5. Photograph of spring C taken at the discharge measurement location immediately upstream of the road (discharge 265 gpm).

4.4 Spring D

The upstream extent of spring D emerges from the hill side about 500 feet to the south west of the measurement location, which is immediately adjacent to the road. It flows east and north accumulating discharge from numerous springs emerging from the hillside including one large tributary spring that converges immediately above the measurement location. Discharges in spring D have been measured from 157 to 570 gpm. Despite having the largest measured flow volume (570 gpm) Spring D has the second greatest mean discharge of all the measured springs. Most of the springs contributing to spring D appear to emerge from the ground at an elevation approximately 20 feet above the road elevation.


Figure 6. Photograph of spring D at the measurement location (discharge 471 gpm).

Figure 7. Tributary springs to Spring A emerging from the hillside upstream from the measurement location.

4.5 Unmeasured springs

There were additional springs identified that did not converge into defined channels and could not be measured using conventional measurement equipment. Surface flow was visible in the springs located between springs A and B (figures 1 and 2) during all site visits, although this array of springs could not be measured I would estimate discharge from these springs nearly equivalent to discharge from spring C. Surface flow was also visible at the springs east of spring D during site visits. Springs to the north west of spring A were first identified during the February 2015 site visit and again when mapped in April of 2015 and both times appeared to provide a sizeable discharge relative to the measured springs. Collectively the discharge from the array of springs located to the north and west of spring A could equal or exceed the discharge of spring A. While the combined discharge of the unmeasured springs remains unknown it likely represents an important discharge component of your project if the discharge can be effectively utilized.

Figure 8. Northwest extent of unmeasured springs at Sawmill Cove showing a 5 foot ruler and note pad for scale.

Figure 9. Spring emerging from hill slope between springs A and B.

4.6 4.6 Pond Outlet Stream

During the April 2015 survey I hiked the beach to the north west of Sawmill Cove to determine if additional water sources could be identified in the vicinity of Sawmill Cove. In addition to the unmeasured springs I mapped a small stream discharging to Yakutat Bay just north and west of Sawmill Cove. The following day I identified the upstream source of the stream as the northern pond adjacent to Sawmill Cove (see figure 1). This small stream may be draining one or both of the ponds adjacent to Sawmill Cove and could provide a significant water source for the proposed project. Although these two ponds are located adjacent to one another they may not both drain through the outlet stream identified in figure 1. My initial survey suggests that natural drainage patterns may have been modified in this region and it's possible that the southern pond drains to the south west. It may also be possible that the ponds are hydrologically connected but have more than one discharge point depending on water levels.

5 DISCHARGE MEASUREMENTS

Spring discharge measurements were repeated from April, 2014 through September 2015 at the four locations shown in Figure 2. The measurements were made as near as possible to tidewater in all cases, such that at large portion of the surface water available was measured. Discharge measurements were taken with a top setting wading rod and a pygmy meter with velocities measured as a 40 second (or more) average. The discharge measurements and statistical summary are shown in table 1.

Table 1. Discharge measurements taken at four locations in Sawmill Cove from April 2014 through September 2015.

Date	Spring A (gal/min)	Spring B (gal/min)	Spring C (gal/min)	Spring D (gal/min)	Total (gal/min)
4/27/2014	215	18	108	nd	>341
5/23/2014	242	13	72	157	485
8/12/2014	197	13	99	162	471
9/26/2014	440	148	287	444	1320
10/16/2014	467	211	305	570	1553
11/6/2014	422	139	269	373	1203
1/3/2015	346	76	166	247	835
2/15/2015	382	99	180	278	938
4/22/2015	485	121	265	471	1342
4/24/2015	480	135	260	440	1315
6/24/2015	251	36	94	224	606
7/24/2015	233	31	76	193	534
9/11/2015	314	72	171	269	826
Mean	344	86	181	319	952
Minimum	197	13	72	157	471
Maximum	485	211	305	570	1553

To determine lower limits of spring discharge it would be necessary to conduct measurements during low-flow or drought conditions. Low-flow conditions tend to be rare and may only occur for a short period every year or even less frequently. Despite the low rate of occurrence of low-flow conditions, these conditions can be expected periodically and will limit water availability to the proposed project. Accurately defining low-flow conditions at the springs by direct measurement will take several years of monitoring with particular attention to low-flow measurements.

6 DISCUSSION

Measurements of spring discharges at the Sawmill Cove site continue to suggest that discharge from the springs alone may be insufficient to supply a continuous discharge of 800 gpm. Five of the thirteen discharge measurements conducted were less than 800 gal/min, although the discharge measurement taken on April 27, 2014 did not include discharge from spring D. None of the discharge measurements included the distributed spring flow emerging along the beach (figure 2). This unmeasured discharge could provide a substantial increase in water availability if it could be utilized. It is also of importance to note that four of the five measurements less than 800 gal/min occurred during April, May, June, and July. These are months that would not require water for hatchery operations.

The potential to utilize water from the kettle ponds (table 1 and figure 3) as a backup or supplemental water supply was briefly examined in a previous memorandum to YRAA and may be feasible. The amount of storage available will depend on the depth of the ponds. If you choose to select this alternative it would be advisable to conduct bathymetric surveys of the ponds to calculate their actual storage capacity. I would further suggest mapping drainage paths of the ponds, monitoring pond water levels, ice thickness, water chemistry, and temperature profiles. There is a possibility that the ponds and springs share a hydrologic connection and that reducing water levels in the ponds might also reduce surface flow from the springs. Monitoring pond water levels and discharge might provide evidence of a hydrologic link between the spring discharge and the ponds and improve estimates of discharge available from the ponds.

Discharge measurements suggest that spring flows typically exceed 400 gpm. Although the springs have not been measured under extreme low-flow conditions they should provide an adequate water source to begin incubation of 10,000,000 chum eggs, which would require a discharge of just 200 gpm. It is likely that including discharge from unmeasured springs (if feasible) would provide a continuous discharge exceeding 400 gpm, perhaps more. If these sources could be supplemented with water from the kettle ponds or an additional source, such as an additional groundwater source, the amount of water available may approach the YRAA goal of 800 gpm.

The calculations and estimates in this report were generated to provide approximations of potential discharge from the springs measured in Sawmill Cove using the best available information. These estimates assume that the spring water can be effectively captured and routed to the proposed hatchery facility. It may also be possible the amount of groundwater available for capture and use in the proposed facility will exceed the measured/modeled discharges. The feasibility of effectively collecting the spring discharge for hatchery operations is beyond the scope of this report.