# Heʻeia Snapshot Water Quality Monitoring Day: March 12, 2011.
# Oʻahu, Koʻolaupoko, Heʻeia

## Background

On Saturday March 12, 2011 Hui o Koʻolaupoko (HOK) hosted the second annual Heʻeia Snapshot Water Quality Monitoring Day. HOK is a non-profit community organization whose mission is to: *protect ocean health by restoring the ʻaina, mauka to makai*. The mission is achieved through three programs: 1. Community volunteering and education (e.g. water quality monitoring events), 2. On-the-ground restoration projects and 3. Project effectiveness monitoring (e.g. how effective was the restoration project at improving water quality?).

For this event, HOK staff and volunteers monitored water quality at two locations on the southern side of Kealohi Point, more commonly referred to as Heʻeia State Park: 1. Heʻeia Stream mouth and 2.the ocean tidal flat of Kāneʻohe Bay (see photo 1 below). The main objectives of the event are to engage the community in water quality monitoring, provide background information regarding water quality problems from non-point sources and collect a discrete amount of data to compare spatially during a given timeframe (e.g. snapshot). The parameters monitored for each location included: temperature, turbidity, salinity, dissolved oxygen (D.O.), pH, nitrate, phosphate, coliform and Enterococcus bacteria. Based on the nature of a "snapshot" event, it is difficult to determine definitively the overall health of the locations monitored. To have a greater understanding of water quality in a certain area, samples have to be collected frequently over a longer period of time. The data collected at the snapshot events will be used by HOK to help inform the public about water quality, pique the interest of island residents and provide a forum for education regarding non-point source pollution.

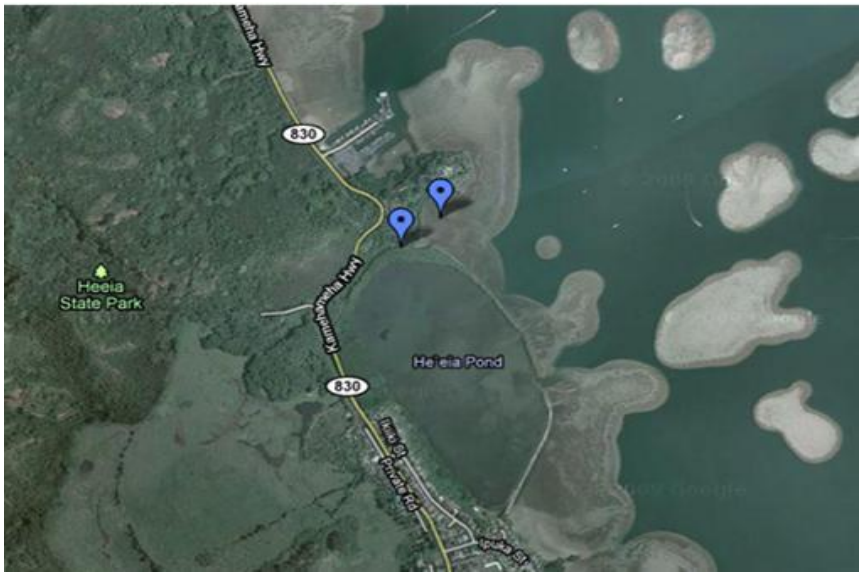



**Photo1:**

He‘eia Stream is on the Environmental Protection Agency’s (EPA) 303d list of impaired waterways. Pollutants in the stream include nitrates and nitrites from residential uses of pesticides and polluted groundwater high in nutrient concentrations from past agricultural practices.[1] Water quality of He‘eia Stream can also be affected by a variety sources including pollution from roads, parking lots, sediment from eroding hill sides and streambanks, and animal waste. Additionally, water quality problems are compounded with the increase of impervious surface (e.g. concrete, roads and roofs) in the urban areas and following periods of rain, pollutants flow across the landscape and enter into stormdrains, streams and ultimately the ocean.

## Protocols

Protocols for each location were similar yet flexible enough to allow all of the various volunteers to participate in the event and utilized different equipment.

Volunteers used *LaMotte Low Cost Water Monitoring Kit* (Kits) to analyze temperature, D.O. p.H. nitrate, phosphate, turbidity and Coliform. In addition to the Kits, a YSI 556 unit was used to gather data for temperature, salinity, p.H and dissolved oxygen from samples collected in a 3-gallon plastic bucket. Volunteers also used a Hach 2100P Turbidimeter for collecting secondary turbidity readings.

Lastly, volunteers collected Enterococcus samples which were placed on ice and processed by HOK staff in the organization’s lab using a method developed by IDEXX Laboratories and approved by the EPA. The 10ml sample water is diluted with 90ml of distilled water (Step 1 in Photo 2 below). Enterolert reagent is added, mixed, and dissolved thoroughly by swirling (Step 2). The solution is then poured into a Quanti-tray 2000 multi-well pack (Step 3) and sealed (Step 4). Filled Quanti-trays are then placed in an incubator at 41°+/- 1°C for 24 hours (Step 5). An ultra violet (UV) lamp is then used to identify the number of fluorescing wells (Step 6). The fluorescing wells are counted and a Most Probable Number (MRN) chart converts the number of wells to an MPN in colony forming units (CFU) of enterococcus per 100ml of water.

**Photo 2:** Step 1 Step 2 Step 3 Step 4


Step 5 Step 6

[1] http://huihawaii.org/data_documents/finalwras_june_2007.pdf

## Results

Overall, results suggest that the different methods of data collection (YSI versus KIT) were fairly accurate when compared to one another and across the two locations. The YSI 556 is more accurate while the Kits are more objective and designed for education. Readings between the stream and ocean sites are also quite similar because of the close proximity of the sites and the outgoing tide.

On the day of the event, participants noted information on local weather conditions which included partly cloudy skies with no rain during the event, but trace amounts of precipitation the night prior to the event (.03-.12 inches [2] of rainfall in neighboring watersheds within the previous 24 hours). Ocean conditions consisted of ripples to small waves and the tide was nearing the end-stage of an outgoing tide (+ .45″ high tide at 9:00 am reaching+ .02″ by the close of the monitoring event at 11:00am[3].) Light trade winds were blowing from a Northern direction. The day of the snapshot event followed the March 11, 2011 Japan earthquakes and the resulting tsunami that affected the entire Pacific Ocean Basin. Tidal fluxes as a result of the tsunami are evident in tidal charts from that day[3] and may have also affected the turbidity of the sampling sites.

**Photo 3**: Looking mauka from the He‘eia ocean sampling site to the mouth of He‘eia Stream

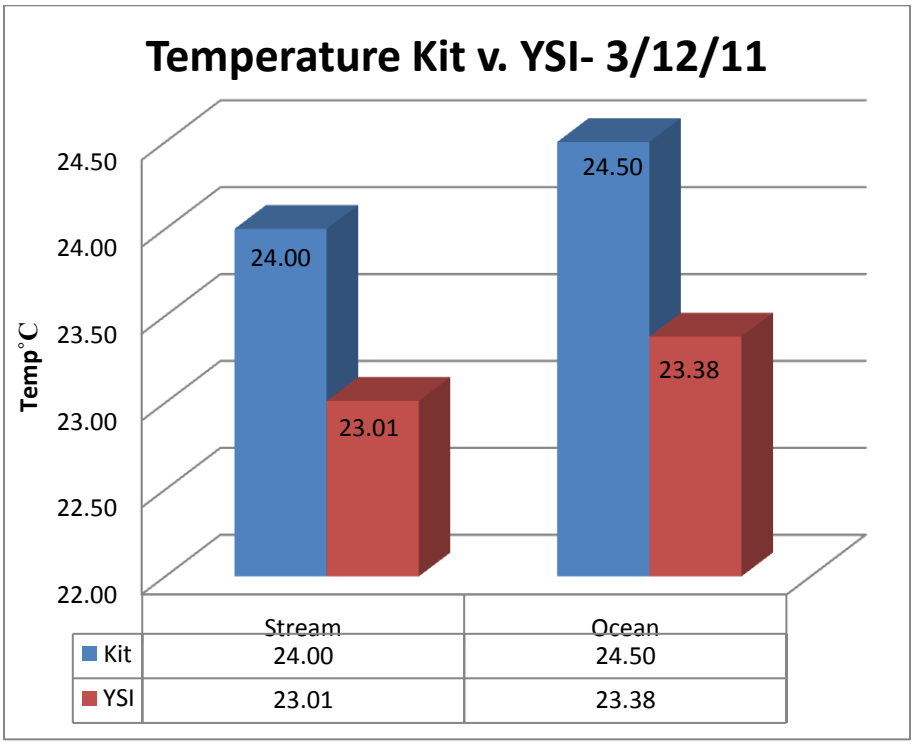
### Temperature

[2] http://www.prh.noaa.gov/hnl/Products/RRAHFO/RRAHFO.1103120800

[3] http://tidesandcurrents.noaa.gov/data_menu.shtml?bdate=20110311&edate=20110313&wl_sensor_hist=W1&relative=&datum=6&unit=1&shift=d&stn=1612480+Mokuoloe%2C+HI&type=Historic+Tide+Data&format=View+Plot

Temperature is very important to water quality. It can affect the amount of dissolved oxygen in the water, the rate of photosynthesis by aquatic plants and the health of aquatic animals. In Hawai'i, we expect to see temperatures from 16 °C to 27 °C.

Chart 1: Temperature




For temperature, all groups agreed that the stream temperature readings from their kits were 24°c (75.2° Fahrenheit) while the YSI read 23.1°c. For ocean samples, Kit readings ranged from 23°c to 24°c while the YSI read 23.38°c. The temperature graph above shows the average temperature at both locations using the two different protocols. When compared to 2010's snapshot data (stream temperature 21.35° & ocean temperature 22.82°), the temperature of the water this year was slightly higher at both locations.

## Salinity

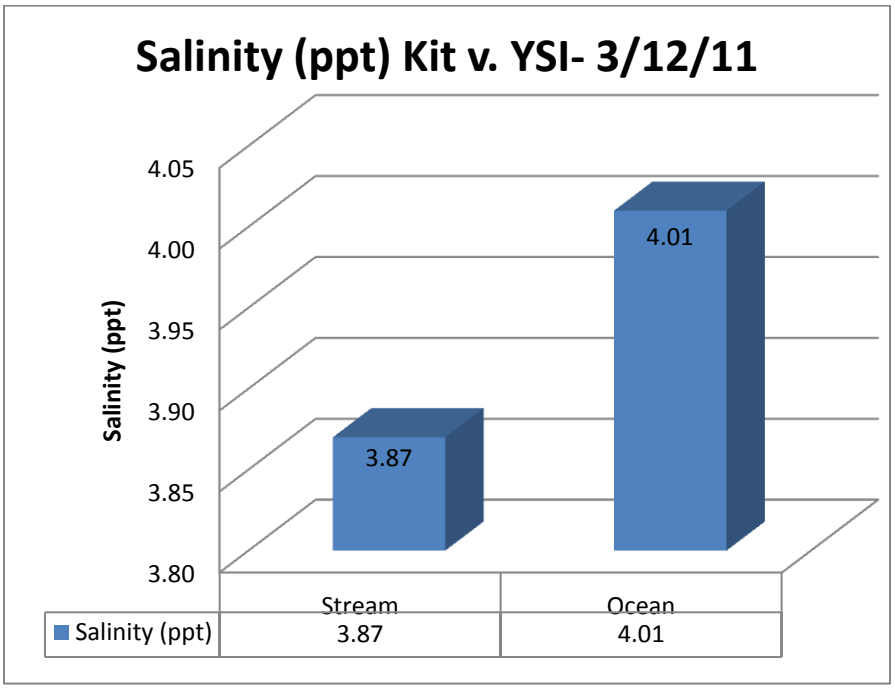
Salinity is the technical term for the saltiness of a water body. It influences the types of animals that can survive in a body of water. Some fish can only live in fresh water or salt water, while others like eels, puffer fish and o'opu spend different parts of their life in the ocean and streams. The salinity of a body of water often changes from location to location, Fresh water usually has a salinity of <0.5 parts per thousand (ppt), where a reading of 0.5ppt-17ppt, would be considered normal for brackish water. The oceans have an average salinity reading of 35 ppt. The standard salinity readings for various environments as can be compared in Table #1 below.

Table 1: Average Salinity between Bodies of Water

| Fresh Water | Brackish Water | Salt Water |
|---|---|---|

| | | |
|---|---|---|
| <0.5 ppt | 0.5 ppt -17ppt | >17ppt |

Chart 2: Salinity



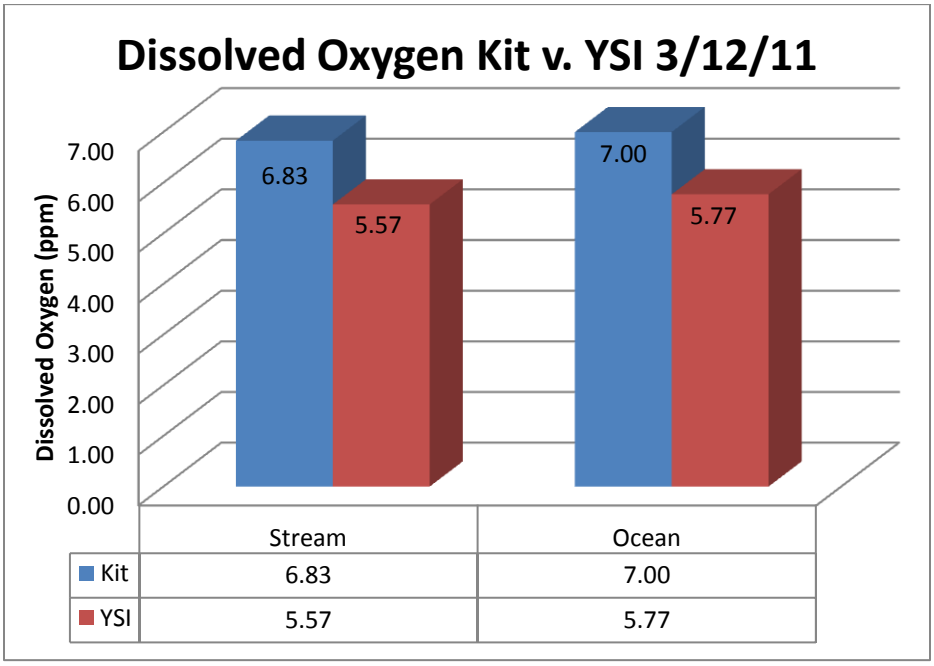

Salinity was measured at all locations using only the YSI *556* as there is no method to test for salinity with the Kits. Salinity of He'eia Stream measured 3.87 ppt (parts per thousand) and the ocean at 4.01 ppt. 2010 data shows salinity readings of 17-18 ppt. The difference can most likely be attributed to a variation in weather prior to the 2 events; the 2010 event followed a period of minimal rainfall, whereas the 2011event had a total of approximately 5 inches of rainfall in 11 days prior to the event. The 2011 event was also held during the end stages of an outgoing tide which resulted in an influx of fresh water exiting He'eia Stream towards the ocean sampling site. These combined weather factors could contribute to the He'eia sampling sites yielding results expected of a brackish water environment. Salinity readings at both sites would have presumably been higher if the tide had been incoming.

**Photo 4**: Looking makai from the mouth of He'eia Stream

## Dissolved Oxygen

Just as humans need to breathe oxygen to survive, so do all aquatic species. Cold water often contains more dissolved oxygen than warm water and dissolved oxygen (D.O.) levels can change depending on the time of day. In Hawai‘i, we expect to see D.O. levels between 5 and 10 parts per million (ppm).

Chart 3: Dissolved Oxygen

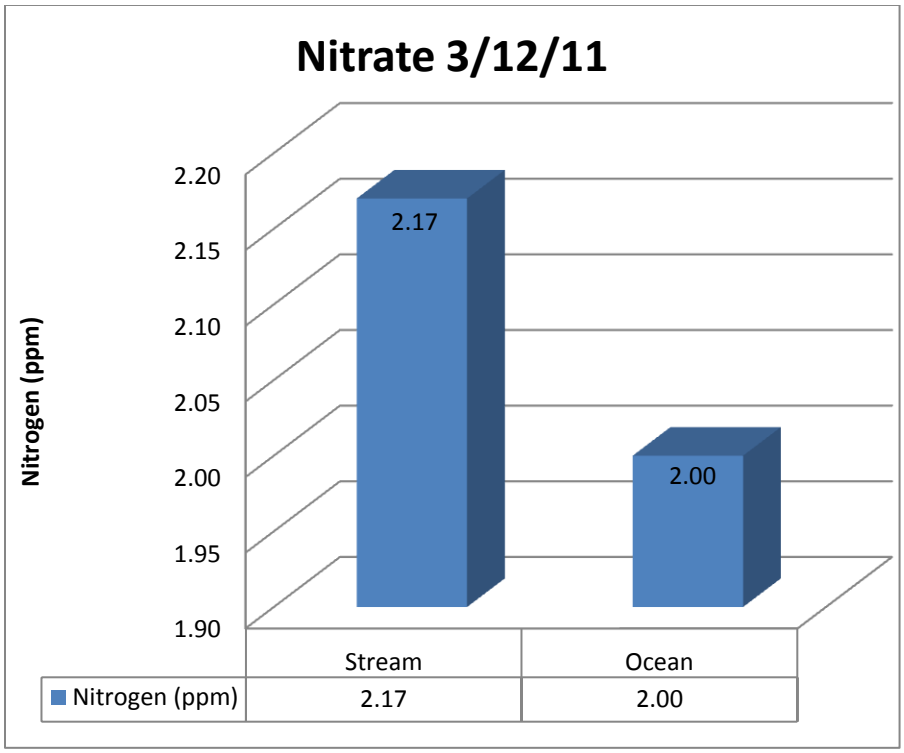



The amount of dissolved oxygen recorded at both sampling locations on March 12, 2011 falls within the acceptable parameters set by the State and is consistent with other nearshore/beach environments Hui o Ko’olaupoko has monitored in the past. The average D.O. readings from He‘eia in 2010 were 8.68 mg/L for ocean samples and 6.63 mg/L for stream samples.

## Nitrate

Nitrate is a nutrient needed by all aquatic plants and animals to build protein. Nitrates are released in to the environment by the excretions of living animals and the decomposition of dead plants & animals. Excessive amounts of nutrients such as Nitrates and increase plant & bacterial growth/decay which decrease the amount of oxygen available in the water. Fertilizers, agricultural runoff and sewage can contribute to high levels of nitrate in the water. A result of 5 ppm or less is considered fair to good.

Chart 4: Nitrogen



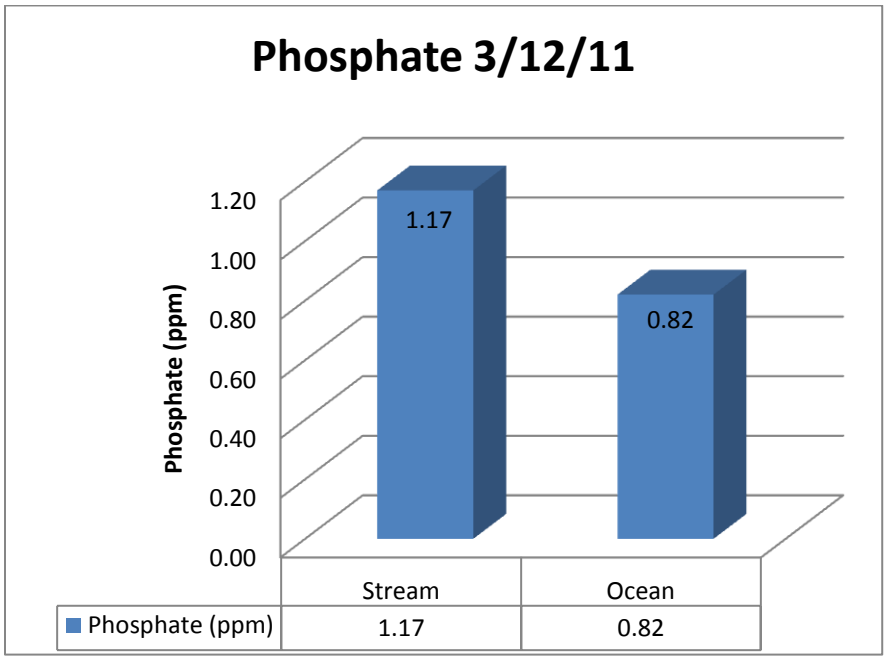

No Nitrate data was taken at the 2010 He'eia Snapshot Water Quality Monitoring Day. However, when compared to results from Kailua and Waimānalo Bays in September 2010 and Kualoa Beach Park in February 2011 (results ranging from 0 to 3ppm) and the State of Hawai'i standards, the results for the March 2011 sampling event at both He'eia monitoring locations fall within the acceptable range and mirror baseline data from other locations throughout Ko'olaupoko.

**Photo 5**: The contents of a LaMotte Low Cost Water Monitoring Kit displayed prior to testing.

## Phosphate

Phosphate is a nutrient needed for plant and animal growth and is also a fundamental element in metabolic reactions. High levels of phosphates can lead to overgrowth of plants, increased bacterial activity and decreased oxygen levels. Phosphates come from sources including human & animal waste, industrial pollution and agricultural runoff. A result of 1 to 2 ppm is considered excellent to good.

Chart 5: Phosphate




No phosphate data was taken at the 2010 He'eia Snapshot Water Quality Monitoring Day. When compared to results from Kailua and Waimānalo Bays in September 2010 (results ranging from 0 to1ppm), Kualoa Beach Park in February 2011 (results ranging from 1.10 to 4ppm) and the State of Hawai'i standards, the results for the March 2011 sampling event at both He'eia monitoring locations fall within the acceptable and common range.

## p.H.

pH is a measurement of acidity of a solution. The pH scale ranges from 0 (very acidic) to 14 (very basic) and 7 is considered neutral. The pH of saltwater plays an important role in the Earth's carbon cycle. The pH of natural water bodies is usually between 6.5 and 8.2. pH can be affected by industrial waste and agricultural runoff. Most aquatic organisms are adapted to a specific pH level and may die if the pH of the water changes even slightly. Figure 1 below helps illustrate pH of everyday items.

Figure 1: pH table

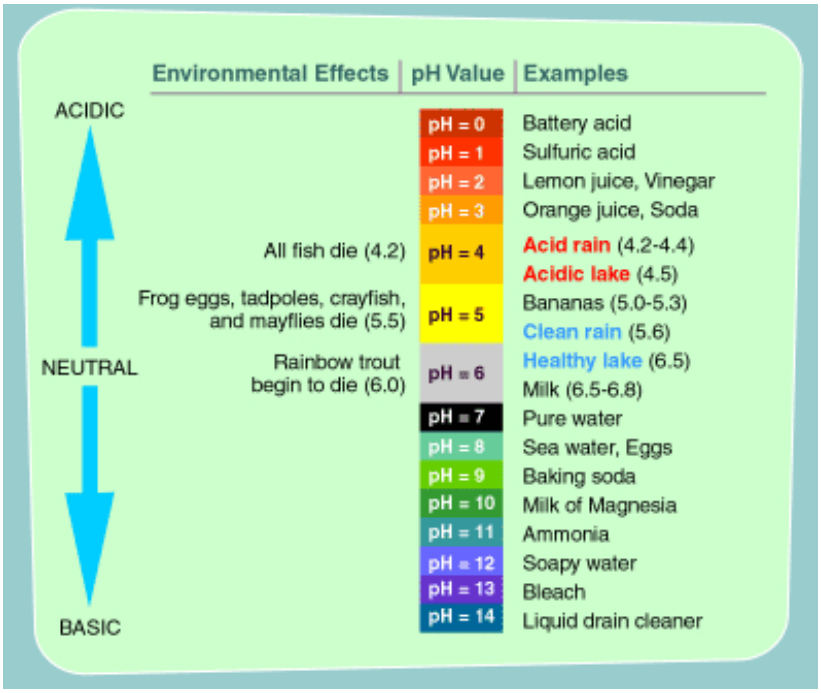
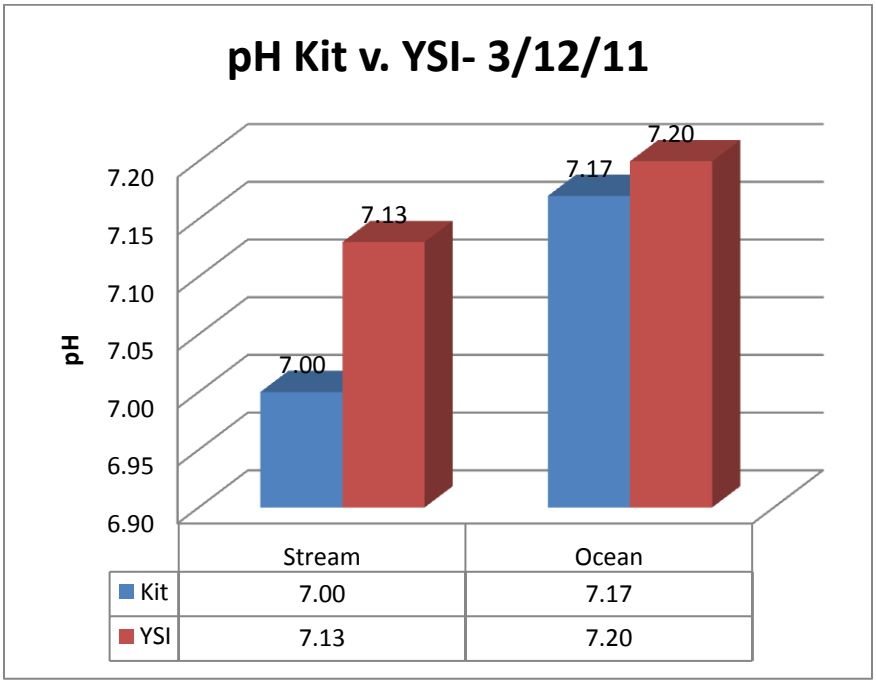



Chart 6: pH

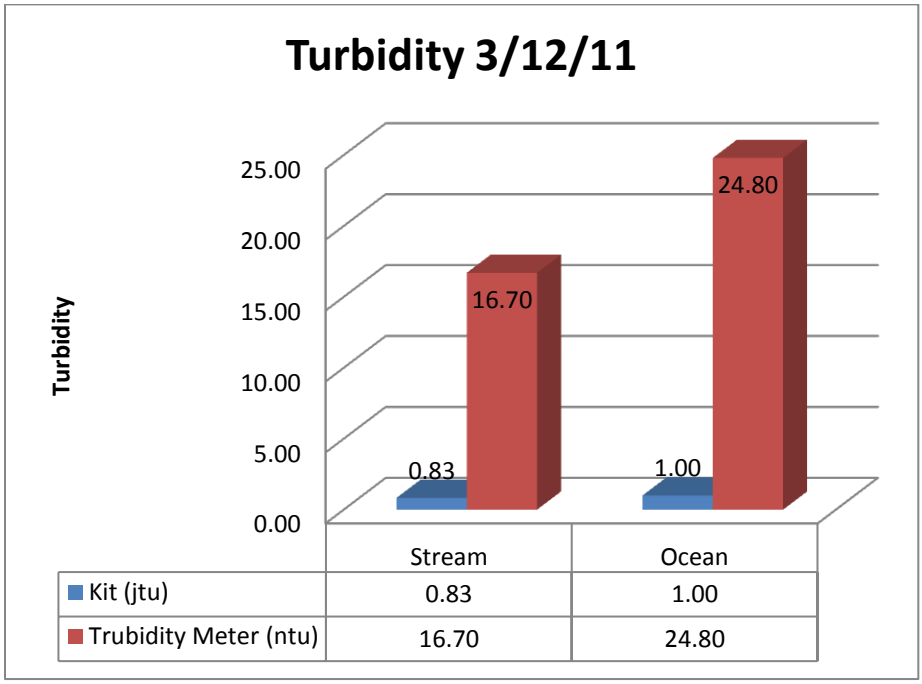



For pH, data from this event is very consistent with other monitoring efforts throughout Koʻolaupoko in 2011 and 2010. The data in Chart 6 is an average of the data collected from the groups at the March 12, 2011 Heʻeia Snapshot Day. The State of Hawaiʻi standard for pH in streams is 5.5 – 8.0 and 8.1 for the ocean. The Heʻeia data collected in 2011 and the previous year's sampling event, fall within the State standards.

## Turbidity

Turbidity is a measure of the clarity of water. Murky/cloudy water is caused by the presence of silt, clay, organic/inorganic matter and microscopic organisms. Turbidity is often the result of land-based sources of erosion and urban runoff or algal blooms and sediments that have been churned up by waves and wind.

Chart 7: Turbidity




Turbidity averaged .92 JTU when using the Kits (based on a total of five samples) and 20.75 NTU with the Turbidmeter, see Chart #7 [Both JTU(Jackson Turbidity Unit) and NTU (Nephelometric Turbidity Unit) are roughly equivalent].

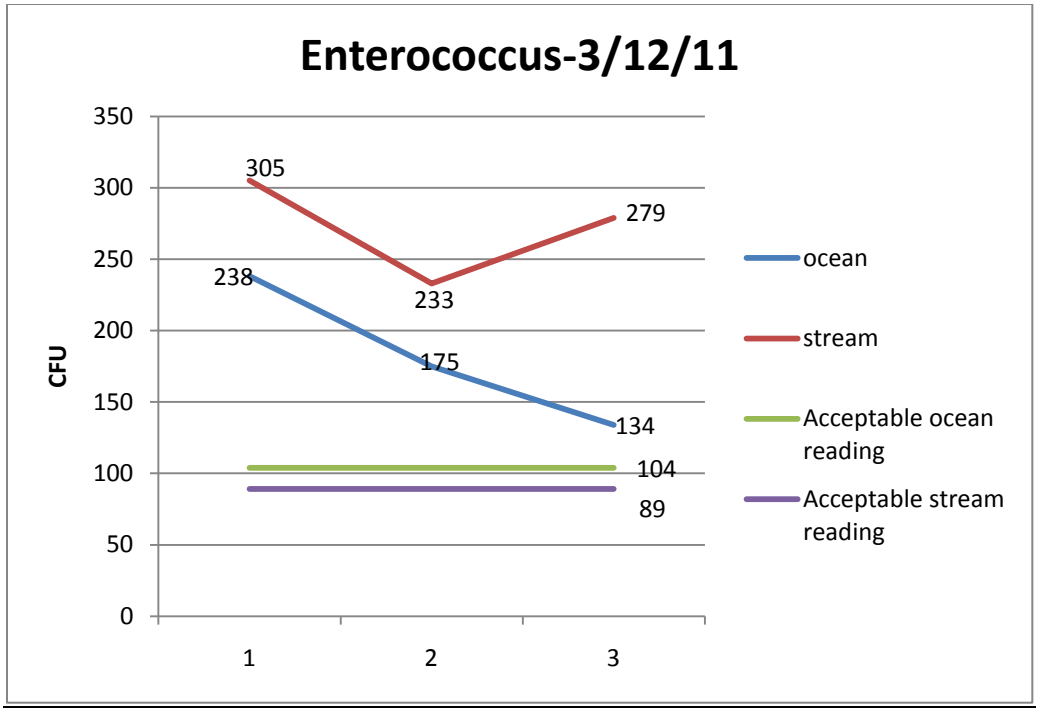
The State of Hawai‘i turbidity criteria for in Kāne‘ohe Bay is 0.4 NTU and 2.0 NTU for streams. The data collected on March 12, 2011 notes levels higher than the criteria; however, the effects of the Japan tsunami on Hawai‘i’s oceans could have created choppy ocean conditions which stirred up sediment resulting in higher than normal turbidity levels for this sampling location. Turbidity results from the 2010 He‘eia sampling event showed an average reading of 6.22NTUs.

The two tools used to measure turbidity, the LaMotte kits and the Turbidmeter, use two different units to measure turbidity. The Kits are much more objective and not as accurate as the digital Tubidimeters. The Tubidimeter measures turbidity in NTUs while the Secchi disk method used in the kits records turbidity in JTUs. Higher turbidity is often attributed to weather conditions such as wind stirring sediment in shallow areas of nearshore ocean environments, rainfall moving pollutants and erosion into the streams, tidal fluxes mixing sediments and even human collection errors. Samples collected too close to the stream bed or ocean bottom can suck in additional sediments not originally suspended in the water column or stirred up by the collector’s footsteps. This human error may be one reason why turbidity readings vary so greatly.

## Enterococcus

Enterococcus is a bacteria found in the intestines of all warm blooded animals. Enterococcus bacteria can originate from both human and animal (mammals such as cats, dogs, mongoose, etc.) sources. When it is found in a water body, it indicates the potential presence of fecal matter in the water. This test does not distinguish the source of bacteria. Nevertheless, bacteria can come from human impacts on surrounding communities, antiquated sewer systems and runoff which includes animal waste.

Chart 8: Enterococcus




Enterococcus bacteria samples were collected at the same location as the other parameters. One-time Enterococcus sampling events should not exceed 89 CFU (Colony Forming Units) for inland streams and recreational waters and 104 CFU for ocean water less than 300 meters from shore. For the ocean water at He‘eia, a total of total three samples were taken, all exceeding the State standard. Three samples were also taken from He‘eia Stream which also all exceeded the State standard (see Chart #8). Past data collected by HOK in March 2010 at He‘eia State Park shows Enterococcus levels over the State limit in both He‘eia Stream (210 CFU) and the ocean (115.5 CFU). Enterococcus data can often vary dramatically therefore, common protocol requires that 5 samples be collected over a period of 30 days in order to establish reliable baseline data. More data needs to be collected on a regular basis to determine long-term trends for this site.

## Coliform

Lastly, Coliform testing at the He‘eia Stream and Ocean sites showed positive results (Coliform detected) in all samples, see photo 6 below. Results are either positive (> 20 Coliform colonies per 100 mL) or negative (< 20 Coliform colonies per 100 mL). Coliform bacteria are naturally present in the environment and human digestive tract. Their presence in water can serve as an indicator of sewage or fecal contamination. Federal and State monitoring protocols call for using Enterococcus sampling (rather than Coliform testing) as it is more accurate

and results are completed in twenty-four hours (rather than 48 hours for Coliform) for quicker response time if there is a water quality violation. However, Coliform testing is a great educational tool because it is inexpensive and very easy to perform.

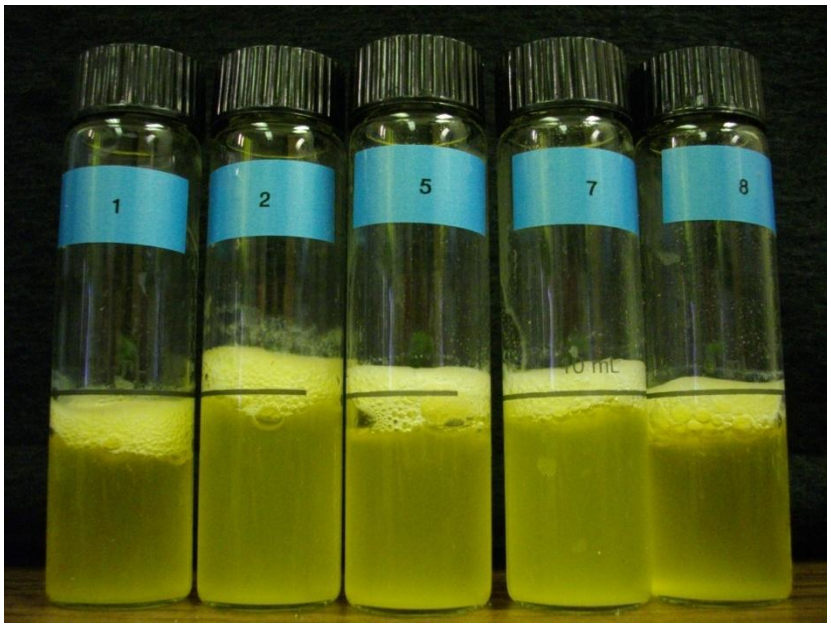



**Photo 6**: Positive Coliform results from 3/12/2011 He‘eia Snapshot

**He‘eia Coliform Results**

Positive results have the following:

- ✓ Cloudy liquid gel
- ✓ Gel rises to surface
- ✓ Turns yellow with many gas bubbles

Negative results have the following:

- – Clean liquid gel
- – Gel remains at bottom of tube
- – Turns red or yellow with no gas bubbles

## Summary

Overall, the data collected on March 12, 2011 are consistent with past data collected by HOK at He‘eia State Park and throughout Ko‘olaupoko. However, for this particular “snapshot” in time our tests note higher than normal turbidity, enterococcus and Coliform levels. The high turbidity can most likely be attributed to erratic tides due to the tsunami the day prior to the event. High enterococcus and Coliform levels may be due to leaky septic system in the area, animal contamination or rainfall prior to the sampling event. Rainfall often acts as a broom, sweeping many land-based pollutants into streams and nearshore areas. More data needs to be collected, particularly for enterococcus to establish good baseline data and see changes over time. HOK consistently seeks funds (private, state and federal) to continue monitoring water quality and works as closely as possible with the State of Hawai‘i to share data. For future snapshot monitoring days, volunteers will be invited again to participate and learn about local water quality.

## Acknowledgements

HOK would like to thank all of the volunteers who participated in the second Snapshot Water Quality Monitoring Day at He‘eia State Park on March 12, 2011.Mahalo also to Surfrider Foundation, O‘ahu Chapter for the use of the IDEXX machine to process enterococcus samples and to the Castle Foundation for their continued support.

MAHALO NUI LOA