the people of 'Ewa followed the woman back to Kahuku so that she could prove that the board was the same one she had lost. They wrapped a bundle of *ti* or *kī* (*Cordyline terminalis*) leaves and cast them into the pool near the house of the Kahuku woman. Then returning to 'Ewa, they saw the same bundle of *ti* leaves a few days later in Waipahu at the spring. Because of this, the Waipahu spring was called Ka-puka-na-wai-o-Kahuku, which means "Outlet of water from Kahuku."

4.3.2 Stories of the Gods in Waipi'o

There was a cave named Kapuna on Waipi'o Peninsula that was associated with a famous riddle. *No Kapuna ka hale noho ia e ke kai*, or "To Kapuna belongs the house, the sea dwells in it."

> This cave is on the Waipio side and a sea passage separates Waipio and Waikele and Waikele and Honouliuli. The passage is obstructed by three small islands, a middle one and Manana and Laulaunui. These small islands in the middle of the passage to Honouliuli and inside and outside of these small islands is the sea of Kaihuopalaai [Hawaiian name for West Loch] where mullet lived till they whitened with age. (*Ka Loea Kālai'āina*, Oct. 7, 1899, translation in Sterling and Summers 1978:24)

Another famous cave of the area was Keanapua'a, in Hālawa, opposite Waipi'o Peninsula, which means "the pig's cave," so named because Kamapua'a once slept there (Pukui et al. 1974:103). This cave was one of the places that the high king of O'ahu, Kahahana, hid after he had killed the priest Ka'opulupulu, thus angering the high chief of Maui, Kahekili.

In Waipi'o, 'Ewa, 'Ai'ai, the son of the fishing god, Kū'ula, was said to have established a *pōhaku i'a* (fish stone) at Hanapouli and a *ku'ula* (stone god used to attract fish) named Ahu'ena (Manu 1902:127).

4.3.3 Stone Markers on the Trail through Waiawa

Along the coastal trail through 'Ewa described by John Papa 'Ī'ī were several stone markers, called Nāpōhaku-luahine. These are described as old women who were changed into stones:

> The names of these royal stones were Kahoaiai (also the name of an *'ili* in Waiawa), Waiawakalea, Piliaumoa, Kahe'ekuluaikamoku, all chiefesses. Their four servants were Nohoana, Kikaeleke, Piliamo'o, Nohoanakalai. These were the guardians of the trail. (*Ka Loea Kālai'āina,* June 29, 1899, translation in Sterling and Summers 1978:6)

The writer describes the location of the stones:

> Here is how the traveler can locate them. When you leave the bridge of Waiawa, for Honolulu, go up and then down an incline. The hill standing on the seaward side is Nuku-o-ka-manu. The next incline is Waiawa. Go up the ascent till you reach the top and above that, about two chains from the road you will find the stones. (*Ka Loea Kālai'āina,* June 29, 1899, translation in Sterling and Summers 1978:6)

4.3.4 Maihea and the Cultivation of *'Awa* in Waiawa, Waiau, Waimalu, and Hālawa

There were many places in 'Ewa associated with the cultivation of the *'awa*, (Piper methysticum) which was used to make a slightly intoxicating drink. The first *'awa* plant was brought from Kahiki, the Hawaiian ancestral lands, by Oilikukaheana, who planted it in Kauai. His wife discarded the plants, and some were pulled up by a man named Mō'īkehā, who took them to Oahu and planted them at Hālawa:

> *Noho o Moikeha a ulu ua laau nei a nui, no ka pohihihi iaia o ka inoa hele oia ia Ewa, oiai e noho kaawale ana o Ewa me Halawa, aole no hoi e ike wale ia o Halawa, oia ka mea i olelo ia ai: "Ike ole ia aku Halawa la; Aina i ka mole o Ewa la," a plea aku.*
>
> *O ko ia nei hele aku la no ia ia Ewa, o ko Ewa olelo mai la no ia e kii i ua laau nei. O ko ia nei kii aku la no ia ua kolo ke a-a, ko ianei huhuki mai la no ia o ke kumu o ka lau, ku ana imua o Ewa, a olelo aku o Ewa: "E ai mua au i keia laau a i make au, alaila, mai kanu oe aohe waiwai, aka ina aole au e make, alaila, waiwai kaua." I ka ai ana a ua o Ewa, ona iho la ia a po ka la, ala mai la ia a kapa mai la i ka inoa li'i.*
>
> Moikeha waited until the plants grew large, and because he had forgotten the name, he west to Ewa. This was the time when Ewa and Halawa were living separately; Halawa was not available to everyone, hence the saying: "Halawa is not to be seen; 'tis a land at the end of Ewa," etc.
>
> He went to Ewa, and she told him to go and get the plant. So he went for some, and found that the roots had grown large. So he pulled up the plants, roots and leaves, and brought them to Ewa. Ewa said: "Let me first eat of this plant, and should I die, do not plant it for it would be valueless; but should I not die, then we will be rich." When 'Ewa ate it she became drunk and was intoxicated all day. When she awoke she called the plant "awa"; from thence forward this plant was called 'awa, the awa of Kaumaka'eha, the chief. (Fornander 1919:606–609)

The story talks of 'Ewa and Hālawa as if they were two people separated and living apart. Fornander suggests that these sentences refer to a time when Hālawa was not an *ahupua'a* of 'Ewa, but was "apart" and at "end of 'Ewa." After this, Hālawa was one of the noted places for the cultivation of *'awa* (Fornander 1919:610).

4.3.5 The Eel Boy of Pilimo'o in Mānana

The following is the story of the "Eel Boy of Pilimo'o," a pool in Pearl City, Mānana Ahupua'a:

> This pool had an underground tunnel that led to the sea. For a long time there was no danger to the children that came to swim in the pool until a man-eating shark discovered the tunnel and slipped in and out at will.
>
> One day, a boy went to the pool and disappeared. No trace of him was found. His father was so worried that he went to consult a Makaula or prophet. The makaula asked his gods, who told him that it was the will of the gods to change him into a

small eel, so that he could live in the depth of the pool and warn the children of danger.

The father of the boy went to the pool to see if it were so. He sat there for a long time and neither saw nor heard anything. Then the children gathered at the opposite side of the pool from him and began to dive and play.

Suddenly he heard a whistle which sounded so like the whistling of his son when he went home every day after playing. "That sounds very much like my son's whistling," he said to himself. He looked around and saw nothing. The whistling was repeated. Then looking toward a ledge under some hau trees, he noticed the head of an eel. Every now and then it whistled. He drew closer to it and spoke to it, "Can it be that you are my son? How did your human body change to an eel?" The boy replied, "Yes I was once a boy, now I am an eel because the gods have willed it, so that I may save human lives from the wicked sharks of the deep that come here. Go and tell those children to go home. Tell them to listen and if they hear whistling that it is a warning that they are in danger."

The man went as he was told to do. He told them to listen for a shrill whistle every now and then. That was a signal to go away at once.

The eel whistled again so loudly that the children heard him and went away. The father remained to see if a shark would appear. A little while later he saw the dark form of a big shark swim about in the pool.

So it was that ever after, a whistle was a signal of danger.

This is the story of Pilimoo pool. (Namau 1940a, in Sterling and Summers 1978:16–17)

4.3.6 Pearl City Stone in Mānana

The "Pearl City Stone" myth tells of a "supernatural" rock that was located at the site of the Pearl City Mormon Church:

> When the church was built the stone remained undisturbed until some of the Hawaiians began to talk about it and call the attention of the visitors to this "female" rock. True, it was regarded as a sacred rock by the ancients but no one was worried about it in particular except to stare at it in curiosity and think what it must have meant to their ancestors.
>
> Then some of the "higher ups" in the church heard it. These were Hawaiians who looked upon anything that the ancients revered as detrimental to their own faith when brought in such close contact as this. They insisted that it be thrown out to the road side.
>
> Waiwaiole, a man who lived in the neighborhood and knew the legend of this rock was assigned the work of removing it to the roadside. He put it off from week to week as he hoped that his friends would forget about it, but they did not. They became more insistent until he found someone to help him to carry it out. At first he tried to lift it but it would not move until he talked to it. He told it that it

> was unwelcome in the church yard and it would be better for it to be by the roadside. After that, the two men had no trouble in moving it.
>
> Some years later the road was widened where the stone stood and it was blasted. Part of it is gone and a part remains to this day.
>
> Waiwaiole, the man who removed it fell sick and gradually grew worse until he was brought to the Queen's Hospital where he died.
>
> The man who helped him also became sick with a disease that made him look bloated and dark. He became an inmate of the Mino'aka Home until death took him. Waiwaiole's beautiful home was burned down with fire. No one knew what caused it. His widow is still at Pearl City and expects to build a new home ere long. (Naumau 1940b, in Sterling and Summers 1978:17)

4.3.7 Pōhaku Anae in Mānana

The following story describes a famous stone in Pearl City associated with the mullet of Pearl Harbor:

> I saw the beauty and charm of the broken currents at Moanalua and also heard the tooting of the whistle at the turn of Kauwahipouli. I heard it three and four times and asked the person sitting on my left, "What place is this?" Answer—"This is Pearl City." It was here that mullets were bred in the ancient times and that flat stone there was called Mullet Rock or Pōhaku 'Anae. It lies near the beach by Ewa mill. (*Ka Nūpepa Ku'oko'a*, Oct. 2, 1908, translation in Sterling and Summers 1978:53)

4.3.8 The Dog Kū'īlioloa on the Plain of Kaluahole in Waiau

The high chief Kūali'i conquered the Kona and 'Ewa District chiefs in the early eighteenth century, ruling as *mō'ī* of O'ahu from 1720 to 1740 (Cordy 2002:19). According to a source from a Hawaiian language newspaper (*Ka Loea Kālai'āina* 1899f), Kūali'i's father was a chief of the Ko'olau District, but his mother was raised in Waiau in 'Ewa, and Kūali'i himself was born in Waiau, which was noted as a favored place for the Waiau royal high chiefs. The plain of Kalua'ōlohe was the noted residence of the dog Kū'īlioloa, who was also of the royal lineage of Waiau.

> There was a pit where the hairless dog, seen in the olden days, lived. The name of the dog was Ku-ilio-loa and he was hairless. He often met with those who went on the plain at night and he changed his colors from black to brown, to white or to brindle. He showed himself when something was going to happen, such as the death of a ruling chief or other things pertaining to the government such as disagreements and so on. (*Ka Loea Kālai'āina* July 29, 1899, translation in Sterling and Summers 1978:15)

4.3.9 The Kahuawai Bathing Place of Chiefs at Kalauao

Hawaiian language newspapers give us accounts of a bathing place reserved for *ali'i* named Kahuawai in Kalauao. The summary translations for each account below are from Sterling and Summers (1978:13–14):

> Here is another thing. I went to see the diving place of the chiefs where they used to bathe. It is very close to the pump at Kalauao. It is cemented and deep. The name of this pool is Kahuawai. On the eastern side are some taro patches that are somewhat like ponds. They were deep in the olden days and these were the taro patches owned by Kaho, in which he planted all the time. (Apuakehau, *Ka Nūpepa Kū'oko'a* July 18, 1919, translation in Sterling and Summers 1978:13)

> Kahuawai was a noted bathing place since ancient times and was guarded so that any one did not bathe in it except the chiefs. Later it was used by all. Kakuhihewa's daughters and the hero Kalelealuaka (their husband) bathed in this pool. Kaeokulani, the chief of Kauai also bathed here when he came to war here on O'ahu. He was killed at Kukiiahu. Many visitors from Hawaii to Kauai that came to see this pool and it was well known to Ewa's inhabitants. (*Ke Au Hou* 1910, translated in Sterling and Summers 1978:13)

> They went to the taro patches of Aiea, up the plain of Kukiiahu, below the road where Kaeo, chief of Kauai, was killed by Kalanikupule. From there they went along the taro patches on the upper side of Kohokaho, til they came to Kahuewai, a little waterfall. A little way above it was a spring, a place where travelers sat and rested. They went up a little way to a small plain and ascended the low cliff of Waimalu and went along between the taro patches of that land. (*Ka Nūpepa Kū'oko'a,* January 1, 1870, translated in Sterling and Summer 1978:13–14)

4.3.10 Keahiakahoe in Kalauao

Pu'u Keahiakahoe is a peak that divides Kalauao from Hālawa Ahupua'a along the Ko'olau Mountain Range. On the other side of the mountains at this point is the *ahupua'a* of Kāne'ohe. In a condensed *mo'olelo*, Catherine Summers (Sterling and Summers 1978:206) explains that the peak was named for sibling quarrels that took place between two farmers, Kahoe and Kahuanui, living in or near Kāne'ohe, their brother, a fisherman named Pahu, and their sister, Lo'e, who lived on Moku o Lo'e (Coconut Island) in Kāne'ohe Bay. Pahu traveled to his brother's inland taro fields to exchange fish for poi. Kahoe generously gave him all he needed, but Pahu only gave his brother the less desirable bait fish from his catch. Lo'e told Kahoe of their brother's deception, and although Kahoe continued to give his brother vegetables, he let Pahu know that he was aware of his lack of generosity. In time, a famine occurred. People cooked their vegetables in *imu* (earth ovens) at night so their neighbors could not see the smoke and come to ask for part of the food. Kahoe cleverly masked his fire so that the smoke traveled a half a mile inland, seeming to come from the mountain range summit. Pahu could not figure out where the imu was located. As he was gazing at the mountains, Lo'e saw him, and said:

> "So, standing with eyes gazing at Ke-ahi-a-Kahoe (Kahoe's fire.)" Pahu, thinking of his past deeds had nothing to reply. This peak has been called Ke-ahi-a-Kahoe to this day. (Catherine Summers, cited in Sterling and Summers 1978:206)

4.3.11 Pōhaku o Ki'i (Stone of Ki'i) in 'Aiea

There are very few specific *mo'olelo* about the *ahupua'a* of 'Aiea. One story, told by John Ka'imikaua shared a *mo'olelo*, tells of Pōhaku o Ki'i, or the Stone of Ki'i. According to Mr. Ka'imikaua, a beautiful woman of chiefly rank named La'a fell in love with a handsome commoner named Ki'i. Her father, a high chief, forbade the marriage, but would relent if Ki'i could fulfill his wish. The high chief instructed Ki'i to go into the Ko'olau mountains and make a *lei* from the rare white *lehua* (*Metrosideros polymopha*) blossoms. If he returned before sunrise on the third day with the *lei* he could marry La'a. Ki'i gathered the *lehua* blossoms and rushed down to the high chief's home near a sacred bathing pond on the third day. He was within sight of the pond when the first rays of the sun rose over the Ko'olau mountains. He was turned to stone just above the pond, Pohaku o Ki'i. La'a never married. She became the *mo'o wahine* (demi-goddess) of the pond, which was named Waiola'a, or the waters of La'a. She would pull down and drown any commoner who swam in the waters—only male chiefs could use the sacred pond, including Kakuhihewa and Kuali'i, as well as the god Kamapua'a. The last chief to bathe here was David Kalakaua while on his way to Honouliuli. Two palms were planted in historic times to mark the sacred pond, which now mark the entrance to the post office in 'Aiea (paraphrased from Napoka 1994:2).

Pōhaku o Ki'i was moved to the entrance of the 'Aiea post office due to the widening of Moanalua Road in 1994. This final resting place of Pōhaku o Ki'i is near the historic site of Waiola'a pond. Thus, the two lovers Ki'i and La'a have finally been reunited (Aiea High School and Alumni and Community Association 2009).

4.3.12 Keaiwa, the Healers' Heiau in 'Aiea

In ancient times, Keaiwa Heiau in 'Aiea was the site of a medicinal herb garden and training area for traditional healers:

> At the time the Keaiwa heiau at the top of Aiea Heights was discovered in 1951 to be the ruins of an ancient medical center, few Hawaiians knew of its ancient usage.
>
> Eminent anthropologists acknowledged that they had never heard of such centers but were convinced when several Hawaiians independently told of them.
>
> In telling of these centers, Mrs. Mary Kawena Pukui, associate in Hawaiian culture at the Bishop Museum, translated the name Ke-a-iwa as "Incomprehensible."
>
> The thought being that no one could explain the powers of the priests or the herbs used in healing.
>
> She said Ke-a-iwa came from an obsolete word aiwa-iwa which means the mysterious or the incomprehensible.
>
> Further confirmation of the use of Ke-a-iwa has lately been given me by Paul Keliikoa, a Hawaiian living in Aiea.
>
> Mr. Keliikoa has the story from his grandmother Kamoekai.

> In her day Ke-a-iwa was interpreted as "a period of fasting and meditation" and the heiau was so named because novitiates in the art of healing spent long hours in fasting, praying and meditation.
>
> Kamoekai also told her grandson that the very young were taken to Ke-a-iwa to be trained as kahuna lapaau. There they were taught the prayers needed to compound medicines and heal the sick.
>
> They cared for the great herb garden which lay beyond the heiau walls.
>
> After the novice learned his first steps in the art of the kahuna lapaau, he was sent out to other medical centers to learn the advanced art of diagnosis and other treatments.
>
> Mr. Keliikoa's interpretation of the name means a change in the pronunciation. Not Ke-a-iwa, but Ke-ai-wa.
>
> Ke-ai is the Hawaiian word for fasting. (Taylor 1959, reprinted in Sterling and Summers 1978:11–12)

Most early references in the traditional literature are one-line passages that merely mention Hālawa in passing with little attention to detail. People traveled through Hālawa from 'Ewa to Honolulu or vice versa, but most of these travels seem to have taken place inland of the Āliamanu and Salt Lake (Āliapa'akai) craters. Once the trail left the northeast margin of Pearl Harbor, it could have been traversed quickly across the one mile (1.6 km) width of Hālawa Ahupua'a by a traveler heading to Kona District.

A fourteenth century account speaks of the reign of Mā'ili-kūkahi, an *ali'i* who was born at Kūkaniloko in Wahiawā around the fourteenth century (Pukui et al. 1974:113). After consenting to become *mō'ī* at the age of 29, Mā'ili-kūkahi was taken by the chiefs to live at Waikīkī. The story tells that he was probably one of the first chiefs to live there. Up until this time, the chiefs had always lived at Wai'alua and 'Ewa. Under his reign, the land divisions were reorganized and redefined. In reference to the productivity of the land and the population (including at Hālawa) during Mā'ili-kūkahi's reign Kamakau writes:

> In the time of Mā'ili-kūkahi, the land was full of people. From the brow, lae, of Kulihemo to the brow of Maunauna in 'Ewa, from the brow of Maunauna to the brow of Pu'ukea [Pu'u Ku'ua] the land was full of chiefs and people. From Kānewai to Halemano in Wai'alua, from Halemano to Paupali, from Paupali to Hālawa in 'Ewa the land was filled with chiefs and people. (Kamakau 1991a:55)

Oral tradition tells us that Hālawa was the home of Papa, where she lived in the uplands with her parents, Kahakauakoko and Kūkalani'ehu. Papa is known for her generative role as the "earth mother". Together with her husband, Wākea, they were the progenitors of the Hawaiian race. The Hale o Papa Heiau and ritual, which is the female component of the ancient *luakini* ritual, probably takes its name from her. The Hale o Papa was the *heiau* for the female deities. Only chiefesses of the highest ranks were allowed to enter and partake of the specially-dedicated foods. (Valeri 1985:245; 'Ī'ī 1959:39; Kamakau 1992:179, 380)

Mention is made of the travels of Kamapua'a (the famous pig-god) through Hālawa and of the cave, Keanapua'a, where he slept (Kame'eleihiwa 1992:131): "In the name chant for

Kaumuali'i, reference is made to "*ka ea nō mai Hālawa a Honouliuli*" (the whirlwind which blows from Hālawa to Honoulili) (Fornander 1920:475).

In traditional lore, Hālawa was one of several places noted and remembered for its *'awa* (*Piper methysticum*) (Fornander 1916:610). One account tells us that the first *'awa* plant was brought to Hawai'i by Oilikūkaheana from Kahiki (possibly Tahiti) and planted on Kaua'i. He brought it to Hawai'i for use in fishing. The use of *'awa* as an offering to a shark guardian by fishermen is noted in Handy and Handy 1972:192. Mō'īkehā, brought some *'awa* plants with him to O'ahu and planted them at Hālawa. When they grew, he mentioned it to Oilikukaheana who told him the name of these *'awa* plants was called Paholei. Mō'īkehā forgot the name and later, when the plants were much larger, he went to 'Ewa and told her about the plants. 'Ewa sent Mō'īkehā to get some plants. 'Ewa said:

> Let me first eat of this plant, and should I die, do not plant it for it would be valueless; but should I not die, then we will be rich." When 'Ewa ate it she became drunk and was intoxicated all day. When she awoke she called the plant "awa"; from thence forward this plant was called 'awa, the awa of Kaumaka'eha, the chief. (Fornander 1916:608)

On the December 12, 1794 the decisive battle of Kūki'iahu took place at Kalauao (lit. "the multitude of clouds") approximately a mile (1.6 km) northwest of the current Project area. It was there that the O'ahu ruling chief, Kalanikūpule, killed and defeated the invader Ka'eokūlani. It is said that the dead bodies were gathered up and taken to Pa'aiau where they were piled in a great heap. Among the piled-up bodies was Kahulunuika'aumoku, daughter of Kū'ohu, a Kaua'i *kahuna* (priest) who had been slain with Ka'eokūlani. Late at night an owl woke her up by flying over and beating its wings on her head. The owl flew *makai*, and she crawled after it until reaching the sea. She then swam to the other side at 'Aiea where the owl appeared once more and led her up to the mountains in Hālawa valley. There, she took shelter in a cave and fell into an unconscious sleep. The owl flew to a former *kahu* (caretaker) of hers who "knew the country well around Hālawa." This *kahu* brought her food and nursed her back to health. (Kamakau 1992:169–70)

The following *mo'olelo* are accounts regarding people and events that took place in or near Hālawa. These accounts are what have been preserved through the oral and written record of times long past.

4.3.13 Leilono, then entrance to Milu, the Underworld, in Hālawa

Leilono was a supernatural breadfruit tree ('Ulu o Leiwalo) whose branches appeared through a hole or crater in the ground. This hole (also called Leilono) was said to be the entrance whereby wandering spirits could enter the afterworld of Milu (*pō pau 'ole*), the *ao kuewa* or realm of wandering spirits, or the *ao 'aumakua* (ancestral spirit realm). The tree had two branches which were deceiving to look at, one on the east side of the tree and one on the west side. If a spirit climbed onto the west branch, it would wither and break off and he would plunge into the realm of Milu. If a spirit climbed onto the branch on the east, he would be able to see the *'aumākua* realm and receive help from his ancestors. This hole is described as being round and approximately two ft wide, on a piece of *pāhoehoe* lava. Leilono is in the neighboring district of Moanalua. However, very specific boundaries are given for it. Kamakau says it was:

> Close to the rock Kapūkakī and easterly of it ... directly in line with the burial mound of Āliamanu and facing toward the right side of the North Star.... The boundaries of Leilono were Kapapakōlea on the east, [with] a huge caterpillar (*pe 'elua nui*) called Koleana as its eastern watchman, and the pool Napeha on the west, with a *mo 'o* [water spirit, lizard] the watchman there. If the soul was afraid of these watchmen and retreated, it was urged on by the *'aumakua* spirits, then it would go forward again and be guided to the *'aumakua* realm. If a soul coming from the Ālia (Āliapa'akai) side was afraid of the caterpillar, whose head peered over the hill Kapapakōlea, and who blocked the way, it would wander about close to the stream by the harness shop. This was not the government road (*alanui aupuni*) of former times, but was a trail customarily used by "those of Kauhila'ele" [figuratively, the common people; the *la'ele*, old taro leaves, as contrasted with the *liko*, the new and choicer leaves — that is, the chiefs]. It was said that if a wandering soul entered within these boundaries it would die by leaping into the *pō pau 'ole*; but if they were found by helpful *'aumākua* souls, some wandering souls were saved. Those who had no such help perished in the *pō pau 'ole* of Milu. (Kamakau 1991b:48–49).

4.3.14 The Gods in Hālawa

The Hawaiian pig-god, Kamapua'a, made a stop in Hālawa and spent the night in a cave in Hālawa opposite Waipi'o Peninsula at a place now called Hospital Point. He woke and then urinated in the sea, which "is why the fish of Pu'uloa [Pearl Harbor] have such a strong odor." The cave Keanapua'a, which means "the pig's cave" was named for this incident (Sterling and Summer 1978:10). The strong odor of fish only applied to fish caught on the eastern side of Pearl Harbor. In contrast, the fish from the western shore, at Pu'uloa, were renowned for their good fragrance. All the market man had to say was, "these are from Ke Ahi [coastal point in Pu'uloa/Honouliuli] and his supply would vanish in a short time" (Sterling and Summer 1978:44). Fishermen once used Keanapua'a Cave for temporary habitation (Sterling and Summers 1978:59).

The gods Kāne and Kanaloa also came to Hālawa to visit a fisherman named Hanakahi. They built a fishtrap along the shore at Keanapu'a Point in Hālawa, but "found it unsatisfactory." They moved west across East Loch to the southern tip of Waipi'o Peninsula at Po'okala and built a second fishtrap, but also found it unsatisfactory. They then moved to the western shore at Pu'uloa and built the fishtrap called Ka Pakule. They were pleased with this fishtrap, and they stocked it with every kind of fish. They returned to the house of Hanakahi and "told him of the enclosure they built for fish for him, that he and his descendants might be benefited" (Ka Wahi Pana o Ewa, *Ka Loea Kalaiaina* July 8, 1899, translation in Sterling and Summers 19788:43). The "tabu enclosure" was dedicated to Kū'ulakai (a Hawaiian fishing deity) and seems to have had a resident *kahuna* until 1891 (Stokes 1908:211). Pu'uloa was symbolic of the blessing and bounty of the gods and of the successful transactions between men and the gods. In each of these stories, the superiority of the marine resources and ceremonial importance of the western shore at Pearl River mouth at Pu'uloa is contrasted favorably with the less pleasant central section (Waipi'o Peninsula) and the eastern shore (Hālawa).

Section 5 Historical Background

5.1 Pre-Contact to the Mid-Nineteenth Century

5.1.1 Traditional Settlement and Agricultural Patterns

Various Hawaiian legends and early historical accounts indicate that 'Ewa was once widely inhabited by pre-Contact populations, including the Hawaiian *ali'i*. Other attractive subsistence-related features of the district include irrigated lowlands suitable for wetland taro cultivation, as well as the lower forest area of the mountain slopes for the procurement of forest resources. Handy and Handy (1972:429) report:

> The lowlands, bisected by ample streams, were ideal terrain for the cultivation of irrigated taro. The hinterland consisted of deep valleys running far back into the Ko'olau range. Between the valleys were ridges, with steep sides, but a very gradual increase of altitude. The lower part of the valley sides were excellent for the cultivation of yams and bananas. Farther inland grew the 'awa for which the area was famous.

In addition, breadfruit, coconuts, *wauke* (paper mulberry, *Broussonetia papyrifera,* used to make *kapa* for clothing), bananas, and *olonā* (*Touchardia latifoli,* used to make cordage) and other plants were grown in the interior. 'Ewa was known as one of the best areas to grow gourds and was famous for its *māmaki* (*Pipterus* spp.; used to make *kapa* for clothing). It was also famous for a rare taro called the *kāī o 'Ewa*, which was grown in mounds in marshy locations (Handy and Handy 1972:471). The cultivation of this prized and delicious taro led to the saying:

Ua 'ai i ke kāī-koi o 'Ewa. He has eaten the Kāī-koi taro of 'Ewa.

Kāī is O'ahu's best eating taro; one who has eaten it will always like it. Said of a youth of a maiden of 'Ewa, who, like the Kāī taro, is not easily forgotten. (Pukui 1983:305)

The lochs of Pearl Harbor were ideal for the construction of fishponds and fish traps. Forest resources along the slopes of the Wai'anae Range probably acted as a viable subsistence alternative during times of famine and/or low rainfall (Handy 1940:211; Handy and Handy 1972:469–470). The upper valley slopes may have also been a resource for sporadic quarrying of basalt used in the manufacturing of stone tools. At least one probable quarrying site (SIHP site 50-80-12-4322) is present in Makaīwa Gulch at 152 m (500 ft) above mean sea level (Hammatt et al. 1990) in Honouliuli.

5.1.2 Mā'ilikūkahi and the Battle of Kīpapa

The rich resources of Pu'uloa—the fisheries in the lochs, the shoreline fishponds, the numerous springs, and the irrigated lands along the streams—made 'Ewa a prize for competing chiefs. Battles were fought for the 'Ewa lands, sometimes by competing O'ahu chiefs and invading chiefs from other islands.

Mā'ilikūkahi, who was born *ali'i* at the birthing stones of Kūkaniloko (Kamakau 1991a:53), became *mō'ī* of O'ahu between 1520–1540 (Cordy 2002:19). Mā'ilikūkahi was popular during

his reign and was remembered for initiating land reforms, which brought about peace, and for encouraging agricultural production, which brought about prosperity. He also prohibited the chiefs from plundering the *maka'āinana* (commoner), a prohibition that was punishable by death (Kamakau 1991a:55).

Upon consenting to become *mō'ī* at the age of 29, Mā'ilikūkahi was taken to Kapukapuākea Heiau at Pa'ala'akai in Waialua to be consecrated. Soon after becoming king, Mā'ilikūkahi was taken by the chiefs to live at Waikīkī. He was probably one of the first chiefs to live there, as the chiefs had previously always lived at Waialua and 'Ewa. Under his reign, the land divisions were reorganized and redefined (Pukui et al. 1974:113).

In reference to the productivity of the land and the population during Mā'ilikūkahi's reign, Kamakau writes:

> In the time of Mā'ili-kūkahi, the land was full of people. From the brow, *lae*, of Kulihemo to the brow of Maunauna in 'Ewa, from the brow of Maunauna to the brow of Pu'ukea [Pu'u Ku'ua] the land was full of chiefs and people. From Kānewai to Halemano in Waialua, from Halemano to Paupali, from Paupali to Hālawa in 'Ewa the land was filled with chiefs and people. (Kamakau 1991a:55)

Mā'ilikūkahi's peaceful reign was interrupted by an invasion which would change 'Ewa forever. Fornander describes the Battle of Kīpapa (to be paved [with the corpses of the slain]) at Kīpapa Gulch in Waipi'o Ahupua'a by Fornander:

> I have before referred to the expedition by some Hawaii chiefs, *Hilo-a-Lakapu, Hilo-a-Hilo-Kapuhi*, and *Punaluu*, joined by *Luakoa* of Maui, which invaded Oahu during the reign of *Mailikukahi*. It cannot be considered as a war between the two islands, but rather as a raid by some restless and turbulent Hawaii chiefs.... The invading force landed at first at Waikiki, but for reasons not stated in the legend, altered their mind, and proceeded up the Ewa lagoon and marched inland. At Waikakalaua they met *Mailikukahi* with his forces, and a sanguinary battle ensued. The fight continued from there to the Kīpapa gulch. The invaders were thoroughly defeated, and the gulch is said to have been literally paved with the corpses of the slain, and received its name "Kīpapa," from this circumstance. *Punaluu* was slain on the plain which bears his name, the fugitives were pursued as far as Waimano, and the head of *Hilo* was cut off and carried in triumph to Honouliuli, and stuck up at a place still called *Poo-Hilo*. (Fornander 1996:89–90)

5.1.3 The Battle of Kūki'iahu in Kalauao and Refuge in Hālawa

Kahekili and the Maui chiefs retained control of O'ahu until the 1790s. In 1794, Kahekili died at Waikīkī. His heir and son, Kalanikūpule, retained supremacy over Maui and O'ahu, but Kā'eokulani, the half brother of Kahekili, ruled Kaua'i. After fighting against the Hawaiian chief Kamehameha on Hawai'i, Kā'eokulani began sailing his canoe fleet to Kaua'i, but dissension among his followers made him to decide to land on O'ahu and challenge his brother's rule by joining with the Waialua and Wai'anae chiefs. In this battle, Kalanikūpule gained the support of a foreign ship captain named Captain Brown. On the opposing side, Kā'eokulani was aided by a foreign gunner called Mare Amara. Fornander has suggested that the last name is actually the

Hawaiian corruption of the English title "Armourer" (Fornander 1996:241). Four battles were fought in 'Ewa, and in the fourth, the Kaua'i chief was defeated.

The Hawaiian historian Samuel M. Kamakau gives the following account of the battles in 'Ewa fought in 1794, including the last, which was fought in Kalauao:

> A battle was fought on the plains of Pu'unahawele in which some foreigners were killed by Mare Amara. Natives also fell, and Ka-lani-ku-pule was forced to retreat. Some six days later another battle was fought in which Ka-'eo was again victorious. This gain he followed up by approaching further upon 'Ewa, hoping to push on to Waikiki which was at that time the center of government. On December 12, 1794, a great battle was fought on the ground of Ka-lani-manuia between Kalauao and 'Aiea in 'Ewa. The heights of Kuamo'o, Kalauao, and 'Aiea were held by the right wing of Ka-lani-ku-pule's forces commanded by a warrior named Koa-lau-kani; the shore line of Malie [was held] by the left wing under the command of Ka-mohomoho, Ka-lani-ku-pule himself with the main army held the middle ground between 'Aiea and the taro patches; Captain Brown's men were in boats guarding the shoreline. Thus surrounded Ka'eo found his men fighting at close quarters and cut off by Koa-lau-kani between Kalauao and Kuamo'o, he was hemmed in on all sides and compelled to meet the onset, which moved like the ebb and flow of the tide. Shots from guns and cannon, thrusts of the sword and spear fell upon his helpers. Ka'eo with six of his men escaped into a ravine below 'Aiea and might have disappeared there had not the red of his feather cloak been seen from the boats at sea and there shots drew attention to those on land. Hemmed in from above, he was killed fighting bravely. His wives were killed with him, and his chiefs and warriors. This war called Kuki'iahu, was fought from November 16 to December 12, 1794 at Kalauao in 'Ewa. (Kamakau 1992:169)

The battle was given the name of Kūki'iahu as the battle was fought near the former residence (called Kūki'iahu) in Kalauao of the chiefess Kala'imanuia, who ruled O'ahu in the seventeenth century. Kamakau (1992:169–170) states that the dead from the battle were taken to Pā'aiau and piled into a large heap.

Kamakau (1992:169–170) stated that the dead bodies were gathered up and taken to Pā'aiau (an *'ili* and fishpond in Kalauao) where they were piled in a great heap. Among the piled-up bodies was Kahulunuika'aumoku, daughter of Kū'ohu, a Kaua'i *kahuna* who had been slain with Ka'eokūlani. Late at night an owl woke her up by flying over and beating its wings on her head. The owl flew *makai*, and she crawled after it until reaching the sea. She then swam to the other side at 'Aiea where the owl appeared once more and led her up to the mountains in Hālawa valley. There, she took shelter in a cave and fell into an unconscious sleep. The owl flew to a former *kahu* (caretaker) of hers who "knew the country well around Hālawa." This *kahu* brought her food and nursed her back to health. (Kamakau 1992:169–70)

During the construction of the Interstate H-3 Freeway, Mālama o Hālawa protesters used this story as basis for claiming Hālawa's importance to women. They maintained that Hālawa was an important and special healing site for women in times past and that it was also home of the protective *'aumakua*, the *pueo*.

5.1.4 Kamehameha's Conquest of O'ahu

Kalanikāpule was defeated the following year at the battle of Nu'uanu when the Hawaiian chief, Kamehameha, invaded O'ahu and conquered the opposing forces. Kamehameha distributed the O'ahu lands among his favorite followers, which resulted in the displacement of many families: "Land belonging to the old chiefs was given to strange chiefs and that of old residents on the land to their companies of soldiers, leaving the old settled families destitute" (Kamakau 1992:376–377).

The main battle was fought from the Honolulu shore past the forts of Pūowaina (Punchbowl) and into the valley of Nu'uanu. By tradition, one warrior with Kamehameha fought a series of one-man battles from Honolulu to Wai'anae. This individual, Makaioulu, killed a champion of O'ahu in Waikīkī by standing in front his own companion, who threw a spear at the other champion, Makaioulu dodging at the last second so the spear killed his opponent instead. In Kalauao, he met a party of men, and shamed them into fighting him one at a time rather than as a group. He defeated and killed each warrior. He then killed a robber at Kapolei in Honouliuli and two women famed for bone-breaking in Makua in the *moku* of Wai'anae (Fornander 1919:488).

5.1.5 Observations of Early Explorers and Visitors

Captain James Cook landed in the Hawaiian Islands in 1778, and ten years later the first published description of Pearl Harbor appeared. Captain Nathaniel Portlock, observing the coast of Honolulu for Great Britain, recorded the investigation of a "fine, deep bay running well to the northward" around the west point of "King George's Bay" in his journal (Portlock 1789:74). Portlock's description matches the entire crescent-shaped shoreline from Barber's Point to Diamond Head.

Captain George Vancouver made three voyages to the Hawaiian Islands between 1792 and 1794. In 1793, the British captain recorded the name of the harbor opening as "O-poo-ro-ah" and sent several boats across the sand bar to venture into the harbor proper (Vancouver 1798:884). The area known as "Pu'u-loa" was comprised of the eastern bank at the entrance to Pearl River. George Vancouver anchored off the entrance to West Loch in 1793, and the Hawaiians told him of the area at "a little distance from the sea, [where] the soil is rich and all the necessaries of life are abundantly produced" (Vancouver 1798, in Sterling and Summers 1978:36). Mr. Whitbey, one of Vancouver's crew, observed, "from the number of houses within the harbor it should seem to be very populous; but the very few inhabitants who made their appearance were an indication of the contrary" (Vancouver 1798, in Sterling and Summers 1978:36).

Captain Vancouver sailed by Kalaeloa (Barbers Point) in 1792, and recorded his impression of the small coastal village of Kualaka'i and the arid Honouliuli coast.

> The point is low flat land, with a reef round it.... Not far from the S.W. point is a small grove of shabby cocoa-nut trees, and along these shores are a few struggling fishermen's huts. (Vancouver 1798:167)
>
> From the commencement of the high land to the westward of Opooroah [Pu'uloa], was composed of one very barren rocky waste, nearly destitute of verdure, cultivation or inhabitants, with little variation all the way to the west point of the island.... (Vancouver 1798:217)

> This tract of land was of some extent but did not seem to be populous, nor to possess any great degree of fertility; although we were told that at a little distance from the sea, the soil is rich, and all necessaries of life are abundantly produced... (Vancouver 1798:361–363)

During the first decades of the nineteenth century, several western visitors described the 'Ewa landscape near Pearl Harbor. Archibald Campbell, an English sailor, spent some time in Hawai'i between 1809–1810. He had endured a shipwreck off the Island of Sannack on the northwest coast of America. As a result, both his feet became frost-bitten and were amputated. He spent over a year recuperating in the Hawaiian Islands. His narrative is considered noteworthy because it describes life before the missionaries arrived. During part of his stay, he resided with King Kamehameha I, who granted him 60 acres in Waimano Ahupua'a in 1809. Campbell described his land:

> In the month of November the king was pleased to grant me about sixty acres of land, situated upon the Wymummee [traditional Hawaiian name for Pearl River], or Pearl-water, an inlet of the sea about twelve miles to the west of Hanaroora [Honolulu]. I immediately removed thither; and it being Macaheite time [Makahiki], during which canoes are tabooed, I was carried on men's shoulders. We passed by footpaths winding through an extensive and fertile plain, the whole of which is in the highest state of cultivation. Every stream was carefully embanked, to supply water for taro beds. Where there was no water, the land was under crops of yams and sweet potatoes. The roads and numerous houses are shaded by cocoa-nut trees, and the sides of the mountains are covered with wood to a great height. We halted two or three times, and were treated by the natives with the utmost hospitality. My farm, called Wymannoo [Waimano], was upon the east side of the river, four or five miles from its mouth. Fifteen people with their families resided upon it, who cultivated the ground as my servants. There were three houses upon the property; but I found it most agreeable to live with one of my neighbours, and get what I wanted from my own land. This person's name was William Stevenson a native of Borrowstouness. (Campbell 1967:103–104)

Of the Pearl River area, Campbell wrote:

> Wymumme, or Pearl River, lies about seven miles farther to the westward. This inlet extends ten or twelve miles up the country. The entrance is not more than a quarter of a mile wide, and is only navigable for small craft; the depth of water on the bar, at the highest tides, not exceeding seven feet; farther up it is nearly two miles across. There is an isle in it, belonging to Manina, the king's interpreter, in which he keeps a numerous flock of sheep and goats. (Campbell 1967:114) The flat land along shore is highly cultivated; taro root, yams, and sweet potatoes, are the most common crops; but taro forms the chief object of their husbandry, being the principal article of food amongst every class of inhabitants. (Campbell 1967:115)

The botanist, F. J. F. Meyen, visiting in 1831, confirms the abundant vegetation described by Campbell in the vicinity of Pearl Harbor:

> At the mouth of the Pearl River the ground has such a slight elevation, that at high tide the ocean encroaches far into the river, helping to form small lakes which are so deep, that the long boats from the ocean can penetrate far upstream. All around these water basins the land is extraordinarily low but also exceedingly fertile and nowhere else on the whole island of Oahu are such large and continuous stretches of land cultivated. The taro fields, the banana plantations, the plantations of sugar cane are immeasurable. (Meyen 1981:63)

A contrasting picture of 'Ewa is recorded in the missionary William Ellis' description from 1823–1824 of the 'Ewa lands away from the coast:

> The plain of Eva is nearly twenty miles in length, from the Pearl River to Waiarua, and in some parts nine or ten miles across. The soil is fertile, and watered by a number of rivulets, which wind their way along the deep water-courses that intersect its surface, and empty themselves into the sea. Though capable of a high state of improvement, a very small portion of it is enclosed or under any kind of culture, and in travelling across it, scarce a habitation is to be seen. (Ellis 1963:7)

5.2 Mid-Nineteenth Century and The Māhele

In 1845, the Board of Commissioners to Quiet Land Titles, also called the Land Commission, was established "for the investigation and final ascertainment or rejection of all claims of private individuals, whether natives or foreigners, to any landed property" (Chinen 1958:8). This led to the Māhele, the division of lands between the king of Hawai'i, the *ali'i*, and the common people, which introduced the concept of private property into the Hawaiian society. Kamehameha III divided the land into four categories: certain lands to be reserved for the king and the royal house were known as Crown Lands; lands set aside to generate revenue for the government were known as Government Lands; lands claimed by *ali'i* and their *konohiki* (headman of an *ahupua'a* land division under the chief) were called Konohiki Lands; and habitation and agricultural plots claimed by the common people were called *kuleana* (Native land rights) (Chinen 1958:8-15).

In 1848, the crown and the *ali'i* received their land titles, known as LCA. Members of the royal family were awarded entire *ahupua'a*, while high-ranking *ali'i* were awarded entire *'ili*, and lesser *konohiki* were awarded half of an *'ili* (Kame'eleihiwa 1992:269, 279). Title to an *ahupua'a* or *'ili* typically included ownership of the area's fishpond and offshore fishing rights (Devaney et al. 1982:143). The lands awarded as Crown Lands and Konohiki Lands, as well as lands designated as Government Lands, were "subject to the rights of native tenants." The Kuleana Act of 1850 "authorized the Land Commission to award fee simple titles to all native tenants who occupied and improved any portion of Crown, Government, or Konohiki Lands" (Chinen 1958:29). It is through records for LCAs generated during the Māhele that the first specific documentation of life in 'Ewa, as it had evolved up to the mid-nineteenth century, come to light. The LCA parcels adjacent to the proposed tunnels for the current Project area are outlined on two 2005 aerial photographs (Figure 23 and Figure 24), and the numbers of the adjacent LCA parcels are typed in bold in the following LCA award tables for each *ahupua'a*.

5.2.1.1 Honouliuli

In A. D. 1795, seventeen years after Captain James Cook made the first Western contact with the Hawaiian Islands, the great Hawaiian warrior Kamehameha completed his conquest of the island of O'ahu and then went on to consolidate his rule over all of the Hawaiian Islands. He gave the *ahupua'a* of Honouliuli to Kalanimōkū, an early supporter, as part of the *panalā'au*, or conquered lands, with the right to pass the land on to his heirs rather than having it revert to Kamehameha (Kame'eleihiwa 1992:58, 112). Kalanimōkū subsequently gave the *ahupua'a* to his sister, Wahinepi'o.

In 1855 the Land Commission awarded all of the unclaimed lands in Honouliuli, 43,250 acres, to Miriam Ke'ahikuni Kekau'ōnohi (LCA 11218), a granddaughter of Kamehameha I, and the heir of Kalanimōkū, who had been given the land by Kamehameha after the conquest of O'ahu (Indices of Awards 1929; Kame'eleihiwa 1992). Kekau'ōnohi was one of Liholiho's (Kamehameha II's) wives, and after his death, she lived with her half-brother, Luanu'u Kahalai'a, governor of Kaua'i (Kelly 1985:21). Subsequently, Kekau'ōnohi ran away with Queen Ka'ahumanu's stepson, Keli'iahonui, and then became the wife of Chief Levi Ha'alelea. Upon her death on June 2, 1851, all her property was passed on to her husband and his heirs. In 1863, the owners of the *kuleana* lands deeded their lands back to Ha'alelea to pay off debts owed to him (Frierson 1972:12). In 1864, Ha'alelea died, and his second wife, Anadelia Amoe, transferred ownership of the land to her sister's husband John Coney.

During the *Māhele* of 1848, 96 individual claims were made and 72 individual claims in the *ahupua'a* of Honouliuli were registered and awarded by King Kamehameha III to commoners (Tuggle and Tomonari-Tuggle 1997:34). The 72 *kuleana* awards were almost all made adjacent to Honouliuli Gulch, which contained fishponds and irrigated taro fields (Figure 25). The awards ranged in size from 0.1 to 5.5 acres in size. The alternate storage corridor along Fort Weaver Road extends through the middle of this former rich taro land, from Laulaunui Road, south of Old Fort Weaver Road. Fort Weaver Road was constructed over sixteen LCA parcels (including the *ahupua'a* award to Kekau'ōnohi). A total of 16 LCA parcels, including the *ahupua'a* award to Kekau'ōnohi), are adjacent to the wastewater proposed alternate tunnels and facilities in Honouliuli.

This map also indicates that Fort Weaver Road was built over an old church yard and near an old school yard. There are two land applications that make reference to a Catholic Church near the town of Honouliuli. Kaohai, in April of 1850, (LCA 5670B) claimed a house site in the *'ili* of Polapola "adjoining the Catholic Chapel yard." Hilinae (LCA 1720) in November of 1847 made a house lot claim in the *'ili* of Polapola bounded on the west by the Kapalani Church. Little is known about the Kapalani Roman Catholic Church. It is clearly annotated on Monsarrat's 1878 map. Even the name is uncertain, as Kapalani probably means "the Frenchmen's" church. Efforts to start a Catholic Mission in Hawai'i were initially met with hostility until the issuing of an edict of toleration in 1839. The establishment of the Catholic Mission in Hawai'i in May of 1849 initiated an active period of building churches and schools. The Kapalani church (and school house) cited in the Land Court Application of Hilinae in November of 1847 must have been constructed within the previous seven years. Father Raymond Delande was pastor of the Leeward District of the church from 1857 to 1885 and, operating out of Honouliuli, he covered

an area extending as far as Makaha and Waialua. "Up to 1877, he had baptized 600 children and adults, all living along the SW coast of Oahu" (Schoofs 1978:110).

"The Honouliuli church ... had by the 1880s outlived its usefulness and become dilapidated. It was therefore abandoned and replaced by a simple structure close, too close to the mill" [at 'Ewa Village, south of the Project area] (Schoofs 1978:111). However, "in 1891 Honouliuli was still important enough to acquire its own Catholic cemetery" (Schoofs 1978:110). Whether this cemetery or any other Catholic cemetery was on the grounds of the Kapalani Church is unknown. In the late 1920s, Bishop Alencastre exchanged land at Honouliuli with Campbell Estate for land at 'Ewa Village to establish a new church. During a recent inventory survey of former 'Ewa Sugar Plantation lands, west of Fort Weaver Road, several trenches were excavated near the probable location of this church, but no cultural layers, artifacts, or burials were found (O'Hare et al. 2006:75).

5.2.1.2 Hō'ae'ae

The *ahupua'a* of Hō'ae'ae was awarded to Nueku Nāmau'u as Māhele Award 63 (LCA 10474). Nāmau'u was a descendant of Hawai'i Island chieftains and a cousin (or nephew) to Mataio Kekūanao'a, the father of two Hawaiian monarchs, Alexander Liholiho (Kamehameha IV) and Lot Kapuāiwa (Kamehameha V) (Day 1984:69). A total of 23 claims were made and 19 claims were awarded in Hō'ae'ae to commoners. The *kuleana* awards, ranging in size from 0.2 to 2.3 acres in size, were clustered around the floodplain on the north shore of Pearl Harbor's West Loch, along Hō'ae'ae Stream and along a large irrigation ditch. The awardees claimed *kula* lands (for dry land agriculture or pasture), *lo'i* (irrigated terraces) for taro, and house lots. Six LCA parcels in Hō'ae'ae, including portions of the *ahupua'a* award of Hō'ae'ae to Nāmau'u, are adjacent to the wastewater proposed alternate tunnels and facilities.

5.2.1.3 Waikele

In the Māhele, the *ahupua'a* of Waikele was awarded to the *ali'i* Nahuina; he returned it to the government as a commutation fee to pay for the lands he was kept for himself. Much of the most productive agricultural lands were awarded to several *ali'i* as *'ili* awards, such as the 199-acre award of the *'ili* of Auiole to Nāmāhana and Maawe, the 252-acre award for the *'ili* of Koalipea to Nāmakehā, and the 2829-acre award of Pouhala 'Ili to Lūlūhiwalani. In all, 119 claims were made for the *ahupua'a* and 73 of these were awarded. Fifteen LCA parcels in Waikele are adjacent to the wastewater proposed alternate tunnels and facilities. Information in the award records indicates that the *makai* region contained agricultural land used most often for growing taro, pasturelands, abundant fishponds, sand dunes, *auwai*, and *muliwai* (river mouth).

5.2.1.4 Waipi'o

The *ahupua'a* of Waipi'o was awarded to John Papa 'I'ī in the Māhele (LCA 8241) comprising approximately 20,540 acres. In addition four *'ili* were awarded to *ali'i* as *konohiki* awards. Two of the *ali'i* kept all of their lands, and two returned half of their *'ili* awards to the government. 'Ī'ī, who was born in Waipi'o, was a companion to the young Liholiho (Kamehameha II). He was an early Christian convert, a member of the house of nobles during the Kamehameha III reign, and an early chronicler of Hawaiian customs and history (Day 1984:55). In all, a total of 121 claims were made for land in Waipi'o, but only 80 were awarded.

Including the *ahupua'a* award to John Papa 'I'ī, 17 LCA awards in Waipi'o are adjacent to the wastewater proposed alternate tunnels and facilities.

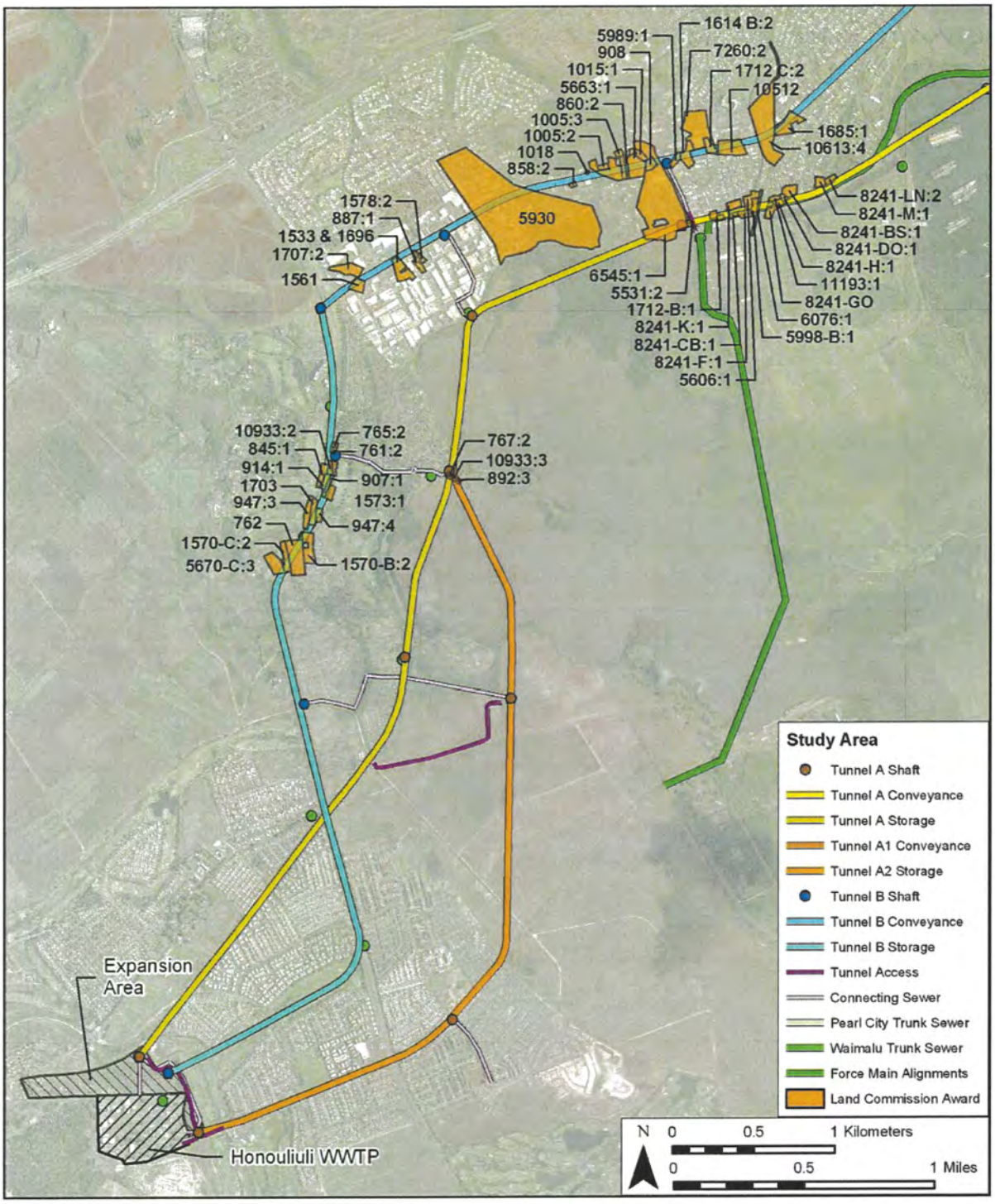

Figure 23. Locations of LCAs adjacent to the wastewater proposed alternate tunnels and facilities in Honouliuli, Hō'ae'ae, Waikele, and Waipi'o (base figure: 2005 U.S. Geological Survey Orthoimagery)

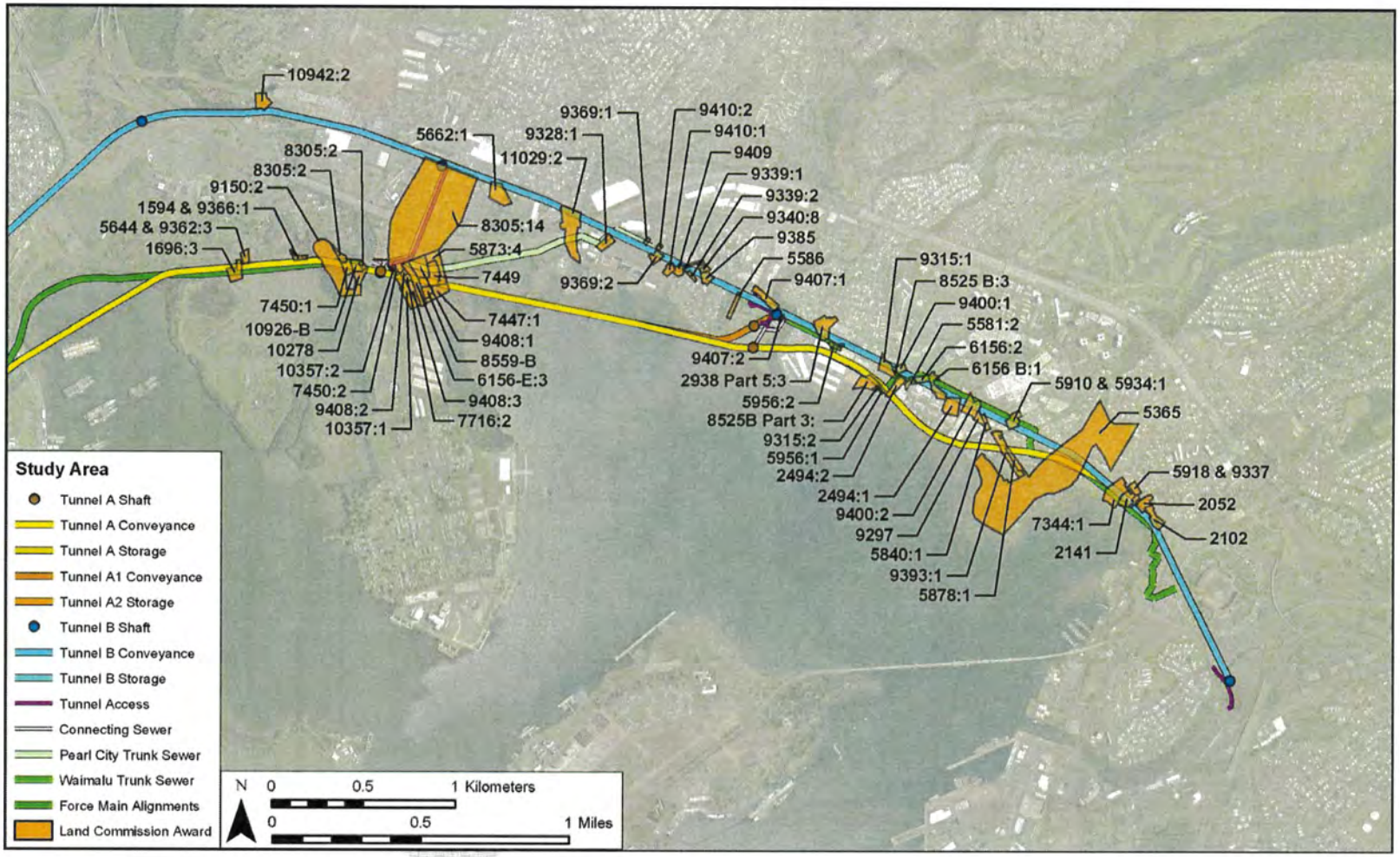

Figure 24. Locations of LCAs adjacent to the wastewater proposed alternate tunnels and facilities in Waiawa, Mānana, Waimano, Waiau, Waimalu, Kalauao, 'Aiea, and Hālawa (base figure: 2005 U.S. Geological Survey Orthoimagery)

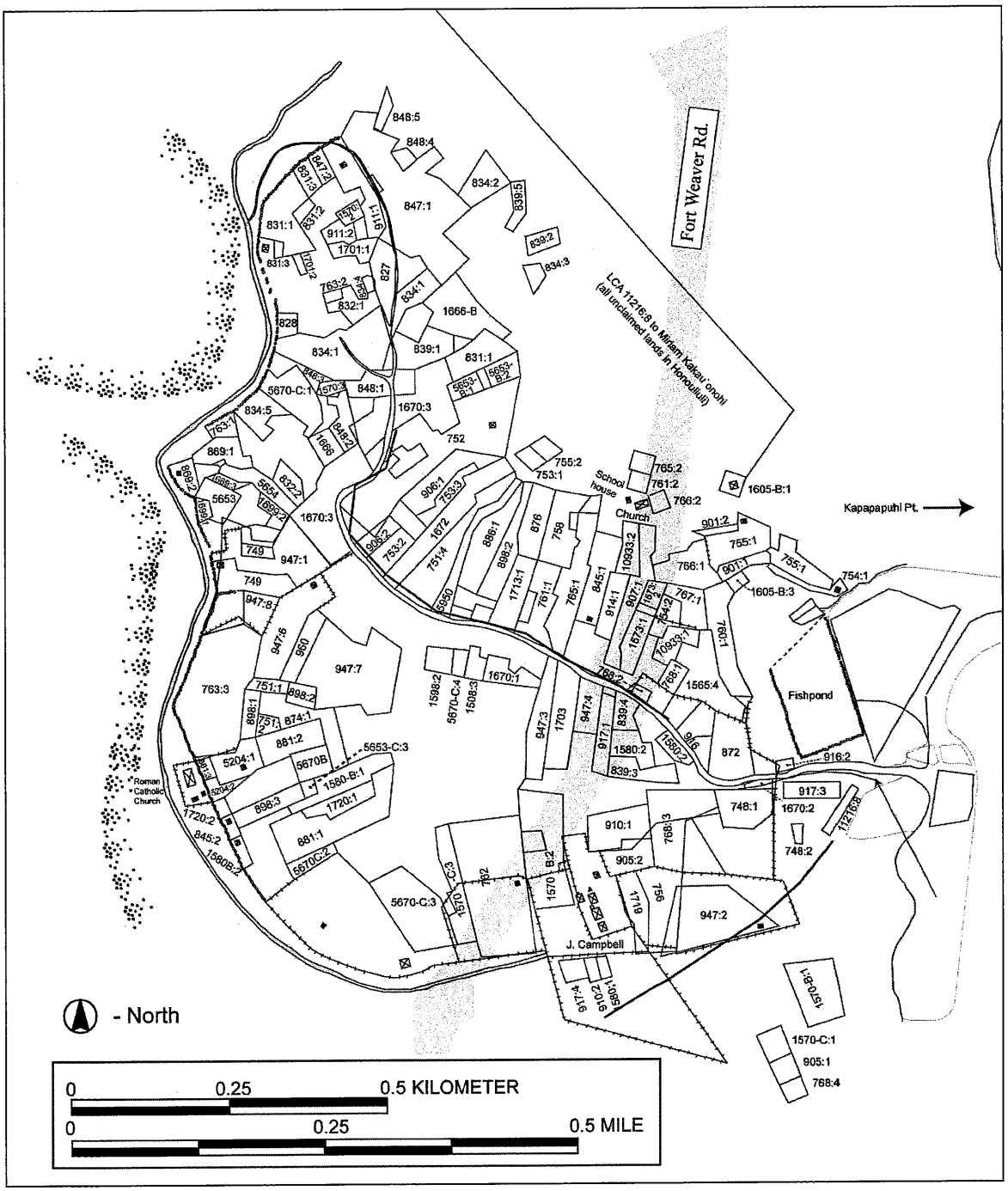

Figure 25. Tracing of 1878 Map of Honouliuli Taro Lands by M. D. Monsarrat; current alignment of Fort Weaver Road in relation to LCA parcels added

The remaining land claims documented in the Land Commission records, a total of 99 (not all of which were awarded), are *kuleana* claims, where the commoners of Waipi'o worked and lived. The majority of awarded land parcels were located in the *makai* portions of Waipi'o, at or just above the Waipi'o Peninsula. Predominant among the claimed land usages in Waipi'o are 312 *lo'i* of various sizes. Wetland taro cultivation was the primary agricultural pursuit within the *ahupua'a* at the mid-nineteenth century, and likely reflects a long history of taro farming. At the coast, four fishponds were claimed.

In the *mauka* reaches of Waipi'o, 53 claims were made for portions of *kula* (pasture land) and 25 for "*okipu*" (forest clearings). The fact that several claims were made in the *mauka* regions suggests that Waipi'o residents had particular locales that they traveled to regularly. This also confirms other accounts, suggesting this area had especially abundant and diverse uplands (Handy and Handy 1972:469–470). *Kula* land is a general term for open fields, pastures, uncultivated fields, or fields for cultivation, and upland (drier), which is distinct from meadow or wetland (Lucas 1995:60). *Kula* lands were often used for opportunistic plantings such as bananas, sugar cane, sweet potatoes, dry land taro, and other crops that did not depend on a consistent source of water. *Okipu* is defined as a forest clearing, a place that was presumably used to gather forest products and medicinal herbs or for pasture (Lucas 1995:82).

In contrast to the well-populated *makai* lands of Waipi'o, the *mauka* regions were often described in nineteenth century accounts as virtually uninhabited. The missionary William Ellis described the interior regions of 'Ewa in 1823–1824:

> The plain of Eva is nearly twenty miles in length, from the Pearl River to Waialua, and in some parts nine or ten miles across. The soil is fertile, and watered by a number of rivulets, which wind their way along the deep water-courses that intersect its surface, and empty themselves into the sea. Though capable of a high state of improvement, a very small portion of it is enclosed or under any kind of culture, and in traveling across it, scarce a habitation is to be seen. (Ellis 1963:7)

Despite Ellis' impressions, there is evidence that during the early nineteenth century, the Waipi'o population was not solely focused on the fertile coast. In an inventory of advances in education during the reign of Kamehameha III (from 1825 to 1854), "schools were built in the mountains and in the crowded settlements. Waipi'o had school houses near the coast and in the uplands" (Kamakau 1992:424). The placement of a school "in the uplands" of Waipi'o suggests that some portion of the *ahupua'a* population had settled there.

During the 1830s, cattle grazing began in the *mauka* regions of Waipi'o (Bishop 1901:87). In 1847, residents of more *makai* land petitioned the Minister of the Interior, John Young, to resolve the problem of stray animals. These stray animals may have been from herds of cattle and goats grazing on Waipi'o's *kula* lands. In addition to damage from stray animals on the lands of Waipi'o, the impact of grazing animals was noted several kilometers away at Pearl Harbor and likely near the present Project area. Stray cattle continued to be a problem until large-scale agriculture was introduced just prior to the beginning of the twentieth century. The occupation of the uplands by cattle denuded the countryside of ground cover, and caused vast quantities of earth to be washed down by storms into the lagoons, shoaling the water for a long distance seaward (Bishop 1901:87).

John Papa 'Ī'ī was placed in the household of Liholiho (Kamehameha II) when he was ten years old; he became Liholiho's personal attendant and also maintained records of life in the Hawaiian Kingdom. He was born in Waipi'o Ahupua'a at the beginning of the nineteenth century; an account of his birth details the establishment of 'Ī'ī's family at Waipi'o after the ascendancy of Kamehameha on O'ahu:

> John Papa 'Ī'ī was born in Kūmelewai, Waipi'o, in 'Ewa, O'ahu , on the third day of August (*Hilinehu* in the Hawaiian calendar) in 1800, on the land of Papa 'Ī'ī, whose namesake he was. Papa ['Ī'ī's uncle] was the owner of the pond of Hanaloa and two other pieces of property, all of which he had received from Kamehameha, as did others who lived on that *ahupua'a*, or land division, after the battle of Nu'uanu. He gave the property to his *kaikuahine*, or cousin, who was the mother of the aforementioned boy. Her names were Wanaoa, Pahulemu, and Kalaikane. ('Ī'ī 1959:20)

'Ī'ī's writings provide glimpses of life within Waipi'o Ahupua'a during 'Ī'ī's lifetime. 'Ī'ī mentions the "family [going] to Kīpapa from Kūmelewai by way of upper Waipi'o to make ditches for the farms" ('Ī'ī 1959:28) and recalls that, during the visit to O'ahu by the Kaua'i chief Kaumuali'i and his entourage, the chief's attendants were provided with gifts: "From Waipi'o in 'Ewa and from some lands of Hawai'i came *tapa* made of *mamaki* bark" ('Ī'ī 1959:83). 'Ī'ī notes how a period of famine was managed in Waipi'o and what resources were available during the famine:

> Here is a wonderful thing about the land of Waipi'o. After a famine had raged in that land, the removal of new crops from the taro patches and gardens was prohibited until all of the people had gathered and the farmers had joined in thanks to the gods. This prohibition was called "*kapu 'ohi'a*" because, while the famine was upon the land, the people had lived on mountain apples [*'ohi'a 'ai*], *ti*, yams, and other upland foods. On the morning of Kane, an offering of taro greens and other things was made to remove the *'ohi'a* prohibition, after which each farmer took of his own crops for the needs of his family. ('Ī'ī 1959:77)

The end of the eighteenth century and beginning of the nineteenth century marked Hawai'i's entry into world trade networks. One of the chief exports at this time was sandalwood (*Santalum* sp.) or *'iliahi*, which was prized in China for its unique fragrance and used in the manufacture of household items, as incense, as perfume, and as medicine (St. John 1947:13). The central plains of 'Ewa supplied the Hawaiian Kingdom with *'iliahi*. One of the first generation missionaries, Sereno Bishop (1901), described his memories of the central O'ahu region in the 1830s:

> Our family made repeated trips to the home of Rev. John S. Emerson at Waialua during those years. There was then no road save a foot path across the generally smooth upland. We forded the streams. Beyond Kīpapa Gulch the upland was dotted with occasional groves of Koa trees. On the high plains the *ti* plant abounded, often so high as to intercept the view. No cattle then existed to destroy its succulent foliage. According to the statements of the natives, a forest formerly covered the whole of the then nearly naked plains. It was burned off by the natives in search of sandalwood, which they detected by its odor burning. (Sterling and Summers 1978:89)

After John Papa 'Ī'ī's death in 1870, his estate—including the Waipi'o lands—was inherited by his daughter Irene 'Ī'ī Brown. Shortly after, small parcels within the *ahupua'a* were sold off (Barrerè 1994:75).

5.2.1.5 Waiawa

During the Māhele land division of Hawai'i in 1848, Waiawa Ahupua'a was awarded to Princess Victoria Kamāmalu (sister of Kamehameha IV and V) as part of LCA 7713. During the second half of the nineteenth century, Waiawa was passed on to successive members of the *ali'i*: Victoria Kamāmalu died in 1866 at the age of twenty-seven. Her entire estate was inherited by her father, Mataio Kekūanao'a died two years later and the estate went to Kekūanao'a's son Lota Kapuāiwa, who by that time reigned as Kamehameha V. Kapuāiwa died intestate in 1872, whereupon Ruta Ke'elikōlani, Kapuāiwa's half-sister, petitioned for and received in 1873 the entire estate. By 1883, Ruta Ke'elikōlani died, leaving all of her estate to her cousin Bernice Pauahi Bishop (Kame'eleihiwa 1992:309–310). The Kamehameha Schools (Bernice Pauahi Bishop Estate) presently retains ownership of most of the *ahupua'a*.

A total of 57 *kuleana* claims were made and 31 were awarded, ranging in size from 0.2 to 3.9 acres in size. One of these was an award to the American Board of Commissioners for Foreign Missions (ABDFM): LCA 387 comprised 4.13 acres in the *makai* portion of Waiawa and included a salt pond, a land strip for the church, and a house lot. Making the application was Artemis Bishop, the Protestant missionary stationed at 'Ewa from 1836–1856. Another claim by a non-Hawaiian was made by William Wallace in LCA 10942, which comprised 3.2 acres including a house lot, 2 *mo'o* (narrow strip of land), and 6 *lo'i*. The remaining 50 claims (for individual *'āpana*) by 29 claimants in Waiawa were for *kuleana*; the claims included: 28 house lots, 176 taro *lo'i*, 20 fishponds, 23 *kula* or pasture, 8 *paukū 'auwai* [length of ditch], and 7 banana *kula*. Modern tax maps show the 31 claims actually awarded all located in the *makai* portion of the *ahupua'a*. While the uplands of Waiawa were probably used for the procurement of resources, we have no evidence anyone actually lived there permanently in traditional Hawaiian times. Five LCA parcels in Waiawa, including the *ahupua'a* award to Victoria Kamāmalu, are adjacent to the wastewater proposed alternate tunnels and facilities.

5.2.1.6 Mānana

Prior to the Māhele, it was documented that Mānana was retained as one of the few O'ahu *'āina* (land holdings) of Ruth Ke'elikōlani, a great-granddaughter of Kamehameha. Ke'elikōlani became one of the largest landholders up to the time of her passing in 1883. Subsequently her heir, Bernice Pauahi Bishop, endowed Kamehameha Schools (Kame'eleihiwa 1992:246).

The productivity of the land of Mānana is indicated in the Māhele records, as a large number of *'ili* were awarded to various *ali'i* for Konohiki Lands. The *'ili* of Kaholona, Kalanihale, Paauau, Weloka, and Keahua were all awarded and retained to members of the *ali'i*, in addition to the large awards of the entire *'ili* of Poupouwela to Victoria Kamāmalu (sister of Kamehameha IV and V) and the entire *'ili* of Mānana Nui to Ruth Ke'elikōani, the great-granddaughter (or great grandniece) of Kamehameha I and half-sister of Kamāmalu.

A total of 48 claims were made for land in the Māhele, and 33 were awarded, including the seven *'ili* awards to the *ali'i*, as shown in Table 20. Ten of these awards in Mānana are adjacent to the wastewater proposed alternate tunnels and facilities.

5.2.1.7 Waimano

The *ahupua'a* of Waimano was awarded to Victoria Kamāmalu during the Māhele as part of LCA 7713. The *'ili* of Kūkona was awarded to John Stevenson (LCA 11029) as a *konohiki* award, but he returned a portion to the government. Only 12 claims were made in Waimano (including the *konohiki* awards) and only nine were awarded (Table 21). LCA 5662 and portions of the awards of Kamāmalu and Stevenson in Waimano are adjacent to the wastewater proposed alternate tunnels and facilities.

5.2.1.8 Waiau

Victoria Kamāmalu (LCA 7713, *'āpana* 35) was awarded almost all of the land in Kumu'ulu, a large *'ili* which seems to include the entire inland section of Waiau from the government road to the Ko'olau Mountains. Originally the *'ili* of Kauhihau, Nāono, Nālima, and Ka'ākauwaihau in Waiau were all awarded to the *ali'i* Puhi as part of LCA 3834, but he returned three of the *'ili* to the government to pay the commutation fees for the Waiau land he kept, which was an 11.94-acre *'ili* of Ka'ākauwaihau (Barrerè 1994:542). Another Māhele award (MA 18) was to the *konohiki* Paewahine, who claimed the *'ili* of Kalua'ōlohe, kept half (3.25 acres; R.P. 4526), and returned the remaining half to the government. The largest claim of 35.7 acres went to Iona (Jonah) Pi'ikoi, a high Kaua'i chief who was a childhood retainer to Liholiho (Kamehameha II). He had first married the Hawaiian chiefess Kekahili, which made him the brother-in-law to the father of the future monarch David Kalākaua. His second wife was the chiefess Kamake'e, with whom he shared LCA 10605. This award included a claim in the *'ili* of Kalua'o'opu in Waiau and large awards in other sections of O'ahu, Kaua'i, and Maui. The remaining land in Waiau became government land. Twenty-three claims by commoners were made for Waiau, and 17 were awarded. Including the Kumu'ulu 'Ili claim to Victoria Kamāmalu, eight LCA parcels in Waiau are adjacent to the wastewater proposed alternate tunnels and facilities.

5.2.1.9 Waimalu

Waimalu was awarded to the *ali'i* Miriam Kekau'ōnohi in the Māhele (LCA 11216). Biographical information on this *ali'i* was discussed in the Honouliuli Māhele section of this report. Fifteen other *'ili* (or half an *'ili*) were awarded to *ali'i* as *konohiki* awards, but only ten were retained. In all, 93 people claimed land in Waimalu, and 63 claims were awarded (Table 23). Including the *ahupua'a* award to Kekau'ōnohi, seven LCA awards in Waimalu are adjacent to the wastewater proposed alternate tunnels and facilities.

5.2.1.10 Kalauao

In the Māhele land division of 1848 and the subsequent Kuleana Act, a total of 36 LCAs were granted within Kalauao Ahupua'a (Table 24). Seven of these were *konohiki* awards to *ali'i*, some of them for half or an entire *'ili*. Virtually all of the *konohiki* and *kuleana* LCAs were located within 500 meters of the coast. The awards ranged from 0.1 to 5.0 acres in size. Ten LCA awards in Kalauao are adjacent to the wastewater proposed alternate tunnels and facilities.

The largest award in Kalauao (LCA 5524; 1603 acres), for half of the *'ili* of Ka'ōnohi, went to Laura Konia, the ninth largest landholder in the Kingdom. She was a daughter of Pā'uli Ka'ōleiokū, reputed *po'olua* (child with "two fathers") son of Kamehameha I and Kalaniōpu'u by Kānekapolei (Kame'eleihiwa 1992:228). Thus, she was either a granddaughter or grandniece of Kamehameha the Great. She was also the mother of Bernice Pauahi Bishop, who inherited the lands at her mother's death.

She received 22 *ahupua'a*-sized lands in the Hawaiian Islands, of which she relinquished 11 back to the Kingdom by way of taxes. She was given the west side of the large *'ili* of Ka'ōnohi (Barrerè 1994:372), which stretched from the coastal trail to the *mauka* boundary of Kalauao at the Ko'olau Mountains. The fact that she retained her Kalauao lands suggests she may have regarded them as particularly good lands.

The second largest landholder at Kalauao was John Meek, an important merchant involved in the early sandalwood trade, who was awarded a long narrow strip of 1300 acres on the east side of Kalauao Ahupua'a (Kuykendall 1967:435). This is presumably the eastern section of the large *'ili* of Ka'ōnohi, although this is not labeled on any available historic map. Little data are supplied in association with Meek's claim, but it appears he resided there from 1824 to 1853. The Native Register account supporting his Kalauao lands claim is given below:

> N.R. 768v3 No. 591, John Meek, Parcel 6
>
> I, Kamehameha III, the King of the Hawaiian Islands, do hereby give a certain parcel of land, bounded as follows: The stream in the middle of Kalauao is the boundary on the west, there also it adjoins the leased land of John Meek. The division between Kalauao and Aiea is the boundary on the east. The highway is the makai boundary and the mountain is the mauka boundary. The length measured from the highway is one hundred and ninety six fathoms. To John Meek and his heirs born under the King of Hawaii and living in these islands. This land shall not be conveyed to a foreigner, nor shall spirit be distilled or vended on said land, but he shall live on it in righteousness under the law of the land. In witness whereof I set my hand in Honolulu on this day.
>
> KAMEHAMEHA III (seal)

The Foreign Testimony account supporting John Meek's Kalauao lands claim is given below:

> F.T. 468v3 No. 591, John Meek, July 11th, 1853, Sec. 6 part 1 Chief Justice Lee, states that he called this day on His Majesty, the King, with the Grant presented by claimant for the land called "Kalauao" and that His Majesty reaffirmed the said grant and stated that it was executed sometime in the year 1839.
>
> John Ii, sworn by the Word of God and stated, ... 3. "There is another (land) at Kalawao in Ewa. Kamehameha had given (land) in the year 1824 and residence was since then to the present time...

Only one other land award at Kalauao was greater than five acres. This land, LCA 5365, was awarded to Colonel William Stevens. His claim follows:

> No. 5365, K.U. Giwini/William Stevens/ February 2, 1848 N.R. 44–45v5 To the Honorable and Esteemed Land Commissioners, Greetings: I, Colonel William

> Stevens, have thought of telling you correctly of my claim for land, in accordance with the law which designated Ministers for the Government and which says for claimants to petition for their land claims. Therefore, I hereby petition for my land claim which was from King Kamehameha III, as follows: Paaiau 'Ili in the Ahupua'a of Kalauao, Ewa, Island of Oahu, described as follows: North, Kauapooli and Keahua, along the Muliwai, south, the edge of the sea of Kapaeli and the edge of the sea of Kapuai, east, Kauapoi and the kula from thence to the far upland of the pali [cliff] of Koolau, south, the edge of the kula of Aiea, north, the edge of the kula of Kalauao. The nature of the kula on the west of Paaiau, is that the people must wade in the sea outside the western boundary of this 'ili. Colonel William Stevens N.T. 428v10 No. 5365, Wm. E. Stevens (he is U.K. Guvini) Wm. Stevens land distribution. Paaiau 'Ili for Kalauao, Ewa, Oahu [Kalauao] True Copy Honolulu, 11 November 1854 A.G. Thurston, Chief Clerk [Award 5365; R.P. 5687; Paaiau Kalauao Ewa; 1 *'āp.*; 62.15 Acs]. (Native Testimony 1847)

William Poomuku Stevens claimed Pā'aiau, an *'ili* of Kalauao, as his Māhele award. Kame'eleihiwa (1992:280) lists Stevens as a mid-level *ali'i*. Of his award, Stevens notes, "The nature of the *kula* on the west of Paaiau is that the people must wade in the sea outside the western boundary of this ili" (Barrerè 1994:554).

Most of these early landowners probably planted taro and other crops along the streams and springs and used the *kula* as pasture. It has already been noted that John Meek used his land in Kalauao as a cattle ranch. In addition, Lincoln McCandless imported Angora goats to Hawai'i in 1898 and put them with some other goats to improve his stock on some land he owned in Kalauao, but "his purpose was foiled by the destruction brought about by dogs, who used to get into the pens at night, as many as 50 goats being killed in one night" (Marques 1906:52).

5.2.1.11 'Aiea

The *ahupua'a* of 'Aiea was initially awarded to Charles Kana'ina, a friend of Kamehameha I and the father of Lunalilo (Kamehameha IV). He returned this land to the Crown. A total of 30 claims were made in 'Aiea, and 20 were awarded (Table 25). All of these were small claims ranged from 0.56 to 2.67 acres in size. Five LCA parcels in 'Aiea are adjacent to the wastewater proposed alternate tunnels and facilities.

5.2.1.12 Hālawa

Sometime after Kamehameha conquered O'ahu in the battle of Nu'uanu in 1795, he gave his most trusted foreign advisors, Isaac Davis and John Young, land as a reward for their loyal service to him. As part of this award, each one received half of the *ahupua'a* of Hālawa. As was the usual custom at the time, the king divided the land among his chiefs, who supported him throughout his conquests of the islands.

Young and Davis were allowed to work the land as long as they lived. But, as was the traditional custom, upon their death the land reverted back to the *ali'i nui* (high chief). This rule held true even for these two most faithful advisors. John Young tried to make his lands inheritable by requesting that his children, and those of Isaac Davis whom he adopted, be

allowed to retain the lands given to him by the king upon his death. Even by the late date of 1834, Kamehameha III refused to honor Young's request. It is interesting to note that even though his request was denied, in the Māhele, John Young's children were allowed to keep lands as *'āina ho'olina* or inherited lands. Lilikalā Kame'eleihiwa notes that in all of the Buke Māhele, these were the only lands given under this designation. (Kame'eleihiwa 1992:60)

Prior to John Young's death in 1835, he attempted to make his lands inheritable by willing Hālawa to his daughter, Grace Kama'iku'i. His will states:

> In behalf of my deceased friend Isaac Davis and for his children as he died without will, the King Kamehameha gave me all the said Isaac Davises [Davis'] lands to take care of them and his children until the children came of age, and now they are come of age so I think it right to leave my last wishes and will that the King, Ka'ahumanu, Adams and Rooke and all the Chiefs will let Isaac Davises children keep their father's lands that King Kamehameha gave to him as a reward for assisting the King in his wars in conquering the islands of Hawai'i, Maui, Molokai, and O'ahu, and which we have an undoubted right to leave to our children, which I hope in God our young king will fulfill the wishes of his honored father. My own lands, I wish my children to enjoy as I have done, likewise my wife. (Claim: #595 F.R. 67–72 V2)

Kekūanaō'a ended up with Davis' Hālawa portion (LCA 7712) at the end of the Māhele and Grace Kama'iku'i Young Rooke (John Young's daughter) retained the John Young portion (LCA 8516-B). Isaac Davis' portion of Hālawa passed from Kekūanaō'a to Ruth Ke'elekōlani and on to Bernice Pauahi Bishop. Upon Ruth's death, her lands become part of the Bishop Estate Trust.

In 1852, Kekūanaō'a wrote a letter to the Minister of Interior requesting that a list of the *kapu* (taboo) fish for Victoria Kamāmalu's lands on O'ahu be published in the newspaper. The *kapu* fish for Hālawa was the *'anae* or full-sized mullet. (Kekūanaō'a August 12, 1852) In 1862, Mataio Kekūanaō'a and Kama'iku'i Rooke (John Young's daughter) leased a portion of *ahupua'a* of Hālawa to a Manuel Paiko of Honolulu for the purpose of cattle ranching. (Boundary Commission 9:174–179) In 1866, Kama'iku'i willed to her sister, Fanny Na'ea, her interest in her portion of Hālawa.

In 1879, Fanny gave her interest of Hālawa to her daughter, Emma Kaleleonālani Na'ea Rooke, Queen of Kamehameha IV, by way of a deed, which stated: "The undivided ½ interest of and in to the *ahupua'a* of Hālawa situate in 'Ewa, Island of Oahu, and more fully described in Royal Patent 6717 to Grace Kamaikui and being the same premises devised to me the said Fanny Young Kaleleonalani by the said Grace Kamikui" (Boundary Commission 59:285).

Fanny died one year later in 1880. A listing of *konohiki* lands on the island of O'ahu reflects the joint tenancy of Hālawa. Both Ruth Ke'elikōlani and Queen Emma are listed as owners. The document also lists the lands on O'ahu that abut the ocean, including the length and whether the land is a lagoon, reef or open sea. The length of the land abutting the sea at Hālawa is 8.52 miles and it is listed as being a reef and a lagoon. (Interior Dept. Letters, Document No. 15). Five years later, Queen Emma died in 1885, leaving no heirs. All of her lands became part of the Queen Emma legacy.

Throughout the years, there seems to have been dispute over the joint tenancy of Hālawa between the families of Kekūanaō'a and Young. In 1888 after a new survey was completed, Sanford B. Dole settled the matter by giving the northern portion of Hālawa to the Bishop Estate and the southern portion to the Queen Emma Trust. From this time on, the boundaries have been distinct and the two portions recognized independently of each other.

Besides the two *konohiki* awards to Kekūanaō'a and Grace Kama'iku'i Young Rooke, 26 commoner lands were claimed in Hālawa and 19 were awarded (Table 26). The *kuleana* awards ranged from 0.16 to 3.9 acres in size. There are no LCA awards in Hālawa adjacent to the wastewater proposed alternate tunnels and facilities.

5.3 Mid-Nineteenth Century to the Present

5.3.1 Early Ranching

5.3.1.1 Ranching in Lower Honouliuli

In 1871, John Coney rented the lands of Honouliuli to James Dowsett and John Meek, who used the land for cattle grazing. In 1877, James Campbell purchased most of Honouliuli Ahupua'a—except the *'ili* of Pu'uloa—for a total of $95,000. He then drove off 32,347 head of cattle belonging to Dowsett, Meek and James Robinson, and constructed a fence around the outer boundary of his property (Bordner and Silva 1983:C-12) (Figure 26). He let the land rest for one year and then began to restock the ranch, so that he had 5,500 head after a few years (Dillingham 1885, cited in Frierson 1972:14).

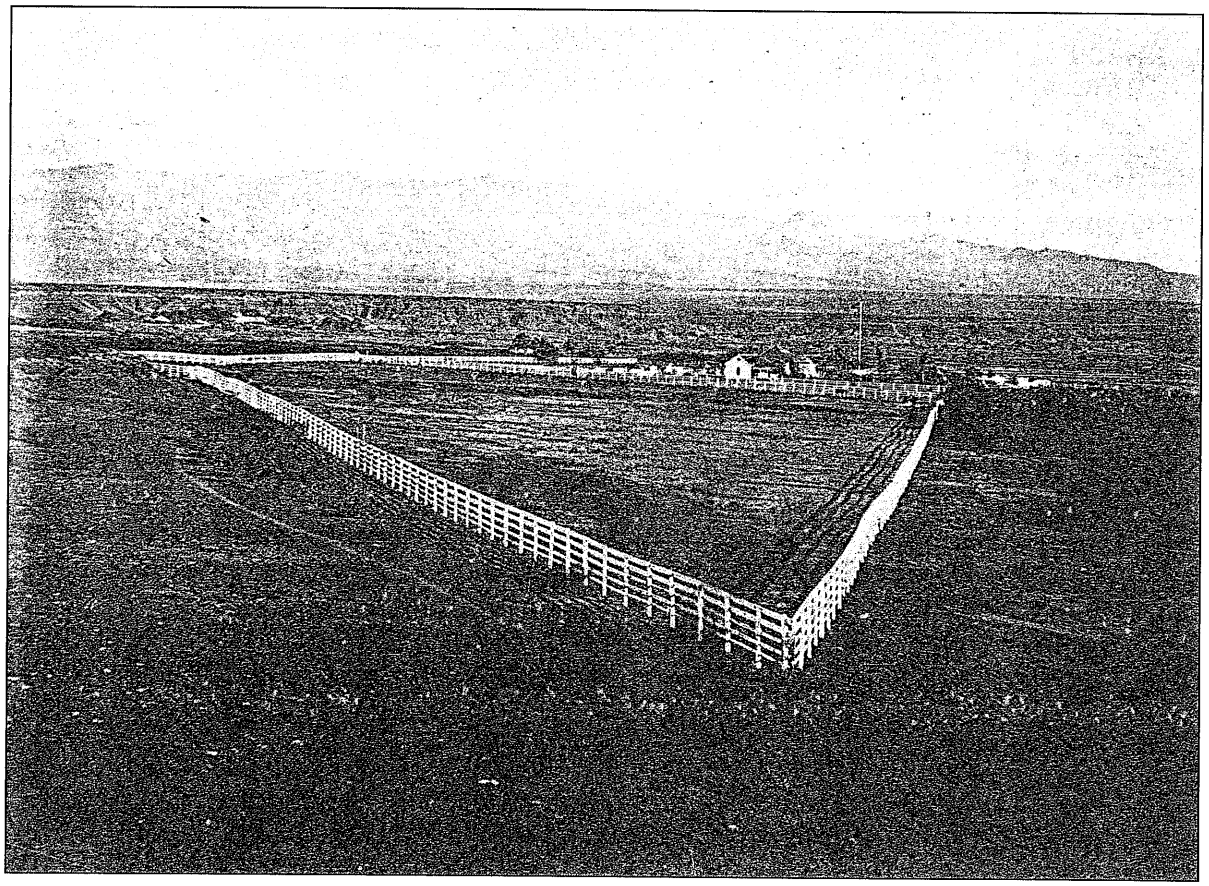

Figure 26. 1880s photograph of James Campbell's residence on the 'Ewa Plain (Hawai'i State Archives)

In 1881, a medical student, touring the island to provide smallpox vaccinations to the population, viewed Campbell's property, called the Honouliuli Ranch:

> I took a ride over the Honouliuli Ranch which is quite romantic. The soil is a deep, reddish loam, up to the highest peaks, and the country is well-grassed. Springs of water abound. The *'ilima*, which grows in endless quantities on the plains of this ranch, is considered excellent for feeding cattle; beside it grows the indigo plant, whose young shoots are also good fodder, of which the cattle are fond. Beneath these grows the manieizie grass, and Spanish clover and native grasses grow in the open; so there is abundant pasturage of various kinds here. As I rode, to the left were towering mountains and gaping gorges; ahead, undulating plains, and to the right, creeks and indentations from the sea. A wide valley of fertile land extends between the Nuuanu Range and the Waianae Mountains and thence to the coast of Waialua. There are many wild goats in this valley, which are left more or less undisturbed because they kill the growth of mimosa bushes, which would otherwise overrun the country and destroy the pasturage for cattle. (Briggs 1926:62–63)

In 1880–81, the Honouliuli ranch was described as:

> Acreage, 43,250, all in pasture, but possessing fertile soils suitable for agriculture; affords grazing for such valuable stock. The length of this estate is no less than 18 miles. It extends to within less than a mile of the sea coast, to the westward of the Pearl River inlet..... There are valuable fisheries attached to this estate.... (Bowser 1880:489)
>
> From Mr. Campbell's veranda, looking eastward, you have one of the most splendid sights imaginable. Below the house there are two lochs, or lagoons, covered with water fowl, and celebrated for their plentiful supply of fish, chiefly mullet.... Besides Mr. Campbell's residence, which is pleasantly situated and surrounded with ornamental and shade trees, there are at Honouliuli two churches and a school house, with a little village of native huts. (Bowser 1880:495)

Most of Campbell's lands in Honouliuli were used exclusively for cattle ranching. At that time, one planter remarked "the country was so dry and full of bottomless cracks and fissures that water would all be lost and irrigation impracticable" (Ewa Plantation Co. 1923:6–7). In 1879, Campbell brought in a well-driller from California to search the 'Ewa plains for water, and the well, drilled to a depth of 240 ft near Campbell's home in 'Ewa, resulted in "a sheet of pure water flowing like a dome of glass from all sides of the well casing" (The Legacy of James Campbell n.d., cited in Pagliaro 1987:3). Following this discovery, plantation developers and ranchers drilled numerous wells in search of the valuable resource.

Between the years of 1861 and 1873, parcels of Waiawa were leased to Valdemar Knudsen for use as grazing lands for live stock. A fifty-year lease and leaseholds were granted to James Robinson in 1868. After James Robinson's death in 1890, his son, Mark P. Robinson, acquired a twenty-five year lease. Overwritten on the lease was the "permission granted to assign the lease to the Oahu Railway and Land Company" (Hawai'i Bureau of Land Conveyances 1915:496). This lease was subleased from Oahu Railway and Land Company to the Oahu Sugar Company for forty-three years on January 1, 1897. It is probable that much of the upper grasslands of Hō'ae'ae, Waikele, Waipi'o and Waiawa were all used for cattle pasture.

5.3.1.2 Ranching in Hālawa

In 1862 Kama'iku'i Rooke and Mataio Kekūanaō'a leased much of Hālawa to a Manuel Paiko, a Portuguese rancher. (Klieger 1995:76) The lease document reads that the boundaries begin at "a small brook which forms the boundary between Hālawa and Moanalua" and continue "along the ridge of the mountain bordered on the north by 'Aiea and Kalauao, and on the west by Ko'olau, to the top of a peak called Aloheo; which forms the boundary between Moanalua and Hālawa." The leased area consisted of approximately 10,000 acres. However, excluded from the lease was the "sea, the lagoons, the fish and all ponds, the enclosed *kalo* lands, all kuleanas awarded by the Land Commission, and so much of the *kula* lands adjoining the pond Ka Waiaho." The lease was taken out for fifteen years with a rent of $500 per year (Boundary Commission 9:174–179). Manuel Paiko took on a business partner, James Dowsett of 'Ulupalakua Ranch fame. By 1870, their herd consisted of 1,400 head (Boundary Commission 29:239). James Dowsett and another partner, J. R. Williams tried unsuccessfully to raise sugar. Due to lack of a railroad to haul cane and the mill burning down three times, they gave up trying

to raise sugar in 1875. Altogether, about 100 acres had been planted in cane (Condé and Best 1973:327).

5.3.2 Rice Cultivation in Former Taro Fields

As the sugar industry throughout the Hawaiian kingdom expanded in the second half of the nineteenth century, the need for increased numbers of field laborers prompted passage of contract labor laws. In 1852 the first Chinese contract laborers arrived in Hawai'i. Contracts were for five years, and pay was three dollars a month plus room and board. Upon completion of their contracts, a number of the immigrants remained in the islands, many becoming merchants or rice farmers. As was happening in other locales, in the 1880s, groups of Chinese began leasing and buying—from the Hawaiians of 'Ewa former taro lands for conversion to rice farming. The taro lands' availability throughout the islands in the late 1800s reflected the declining demand for taro as the native Hawaiian population declined.

The Hawaiian Islands were well-positioned for rice cultivation. A market for rice in California had developed as increasing numbers of Chinese laborers immigrated there since the mid-nineteenth century. Similarly, as Chinese immigration to Hawai'i also accelerated, a domestic market opened. Devaney et al., describes the following:

> Considerable effort has been made to induce the natives to be more industrious to cultivate the soil and particularly to try to [sic] the cultivation of rice.... Foreigners too have begun the culture of rice in this district extensively and it was hoped their example would stimulate the natives to cultivate their own lands, but most of them choose to hire themselves to the foreigners at low wages and put their lands in the hands of the foreigners for a few dollars rather than cultivate or improve it themselves. (Mission Station Report 1862:1, cited in Devaney et al. 1982:49)

Following the completion of their plantation labor contracts, some Chinese immigrants began rice farming, to which they were accustomed in their native land (Figure 27). The availability of former *lo'i* lands throughout the islands in the late 1800s reflected the declining demand for taro as the native Hawaiian population diminished. Chinese rice farmers acquired lands by leasing small plots of land for individual farms, or by forming *hui* (partnerships) with other farmers and acquiring large tracts of land (Coulter and Chun 1937:17–18). During the height of rice cultivation (circa 1880–1920), the industry was dominated by Chinese firms who controlled the growing and milling of rice (Devaney et al. 1982:49).

Figure 27. Waikele Rice Fields below the Oahu Sugar Co. Mill (Hawai'i State Archives)

By 1885, 200 acres in Honouliuli were used for rice and 50 acres were used to grow bananas (article in *Pacific Commercial Advertiser*, August 15, 1885, summarized in Silva 1987:A-12). These rice fields were planted in former taro fields or in undeveloped swamps, such as those near the former Honouliuli Taro lands. The rice fields in 1882 were described by Frank Damon, during a tour of the area.

> Towards evening we reached Honouliuli, where the whole valley is leased to rice planters.... This was one of the largest rice plantations we visited. Sometimes two or three men only, have a few fields which they cultivate for themselves, and we often too came upon houses where there were eight or ten men working their own land. But the larger plantations are owned by merchants in Honolulu, who have a manager acting for them. (Damon 1882:37)

Rice cultivation replaced much of the former taro lands and became widespread in the lowlands surrounding Pearl Harbor. By 1892, approximately 262 acres were under rice cultivation in Waiawa, Mānana, and Waiau, 135 acres in Waimalu, 76 acres in Kalauao and 'Aiea, and 117 acres in Hālawa (Coulter and Chun 1937:21). The ancient taro *lo'i* and *'auwai* were modified and expanded to support rice cultivation:

> The great demand for rice land brought disused taro patches into requisition—especially because water rights attached to them. Such was the desire of the Chinese to use every piece of land to its fullest extent for paddy that they cut away the paths which the Hawaiians had used between taro patches to strips so

> narrow that a man could walk along them only with difficulty.... As the demand for rice continued, it became profitable to bring into use land hitherto unused. The land most easily rendered fit for rice cultivation was swamp or marsh land of which there was a large amount in the islands. Most of such land was at or near sea level-undrained areas at the mouths of streams: lowlands, which could be reclaimed without great expense ... lands hitherto unused became fields of waving grain (Coulter and Chun 1937:11)

The following account describes a visit to the rice fields of 'Aiea, circa 1904:

> On the morning of June 2nd, for instance, our destination was Aiea. At ten minutes past seven we boarded the first passenger train going towards Honolulu. For a distance of eight miles the road skirts the shore and then turns landwards or mauka through rice and sugar plantations, Ewa Mill, Waipahu, Pearl City. We reached Aiea at eleven minutes past eight. Like all rice fields in Hawaii, this one is worked entirely by Chinamen, they alone being able to endure the conditions of location and climate necessary for the cultivation of this cereal. On one side of the railroad track was the broad, muddy inland lake or bay of salt water, Pearl Harbor; on the other side were the terraced plots or fields, flooded to a depth of several inches with water and separated by narrow raised earthen ridges on which the careful Chinaman doubtless succeeded in walking, but which many times proved treacherous to our unsteady feet. A rice plantation, laid out as it generally is on the low flats at the foot of a valley, where mountain streams empty into the sea, is an ideal collecting ground for certain kinds of algae. (Tilden 1905:134)

By the early decades of the twentieth century rice farming in the Hawaiian Islands was in decline, beset by crop diseases and cheaper prices for mainland-grown rice. Commercial agriculture in 'Ewa became dominated by sugar with the development of the three sugar companies of 'Ewa (Nedbalek 1984:13).

5.3.3 Pineapple Cultivation

In the early decades of the twentieth century, lands in the *mauka* portion of the central and eastern sections of 'Ewa were being acquired for pineapple cultivation. There is a record of attempted pineapple irrigation utilizing water from shallow wells in Waiawa Gulch in 1893. Later attempts were made in Waiawa and Honouliuli (Figure 28). James Dole founded the Hawaiian Pineapple Company in 1901. The previous year, Dole had purchased 61 acres of land in Wahiawa for growing pineapple. Prior to 1913, most of the upland plateau areas in Waiawa were planted in pineapple (Goodman and Nees 1991:59) and small plots along gullies. Those not appropriate for sugar cane cultivation, in several 'Ewa *ahupua'a*, were planted in cane. Many of these small plots were cultivated by independent farmers, who sold the crops at markets or to larger companies. In 1901, the Hawaiian Pineapple Company obtained 61 acres in Waiawa through public auction. Initially, most pineapple was shipped to California for packing. In an attempt to speed up processing, save money and produce a fresher product, a cannery was constructed in Waiawa. This cannery was constructed by the Pearl City Fruit Company but became a part of the Hawaiian Pineapple Company operations after the Pearl City Fruit Company went bankrupt. The cannery was in operation from 1905 to 1935.

A 1908 lease from the John 'Ī'ī Estate, Ltd. to Yoshisuke Tanimoto and Kintaro Izumi led to the formation of the Waipi'o Pineapple Company, which cleared and cultivated approximately 223 acres in portions of Kīpapa Gulch. In 1909, the government appropriated the Waipi'o peninsula from the 'Ī'ī estate. The land was valued at $10,000 for purposes of fair compensation (DLNR, Land Record Books 1909:228–235). In 1915, Libby, McNeill & Libby took over Waipi'o Pineapple Company's leases and continued to cultivate pineapple in the area. By the late 1920s, James Dole's Hawaiian Pineapple Company, incorporated in 1901, was cultivating pineapple on thousands of acres leased from the 'Ī'ī estate in the *mauka* area of Waipi'o.

Pineapples were handpicked, graded, boxed, and loaded into trucks before the introduction of machinery into the harvesting process. The introduction of the mechanical field fruit harvester in 1947 eliminated the labor-intensive process of grading, boxing, and loading. The pineapple industry employed both male and female Japanese and Filipino workers in the fields and in the cannery. Camps were set up throughout 'Ewa to be used as housing for the workers and their families (Goodman and Ness 1991:165). In the 1920s, pineapple was abandoned and by 1935, much of the former pineapple lands were planted in sugar cane.

Figure 28. First pineapple plantation in Kunia in Honouliuli ca. 1900 (University of Hawai'i-Mānoa Digital Photograph Collection)

5.3.4 History of the Oahu Railway and Land Company (OR&L)

In 1886, Campbell and B. F. Dillingham put together the "Great Land Colonization Scheme," which was an attempt to sell Honouliuli land to homesteaders (Thrum 1887:74). This homestead idea failed. Two factors for the failure were the lack of water and the distance from 'Ewa to Honolulu. The water problem was solved by the drilling of artesian wells, and Dillingham decided that the area could be used instead for large-scale cultivation (Pagliaro 1987:4). The transportation problem was to be solved by the construction of a railroad, which B. Franklin Dillingham soon began to finance under the company name of the Oahu Railway and Land Company (OR&L).

During the last decade of the nineteenth century, the railroad would reach from Honolulu to Pearl City in 1890, to Wai'anae in 1895, to Waialua Plantation in 1898, and to Kahuku in 1899 (Kuykendall 1967:III, 100). This railroad line eventually ran across the center of the 'Ewa Plain at the lower boundary of the sugar fields (Figure 29). To attract business to his new railroad system, Dillingham subleased all land below 200 ft to William Castle, who in turn sublet the area to the newly-formed Ewa Plantation Company (Frierson 1972:15). Dillingham's Honouliuli lands above 200 ft that were suitable for sugar cane cultivation were sublet to the Oahu Sugar Company). Throughout this time, and continuing into modern times, cattle ranching continued in the area, and Honouliuli Ranch—established by Dillingham was—the "fattening" area for the other ranches (Frierson 1972:15).

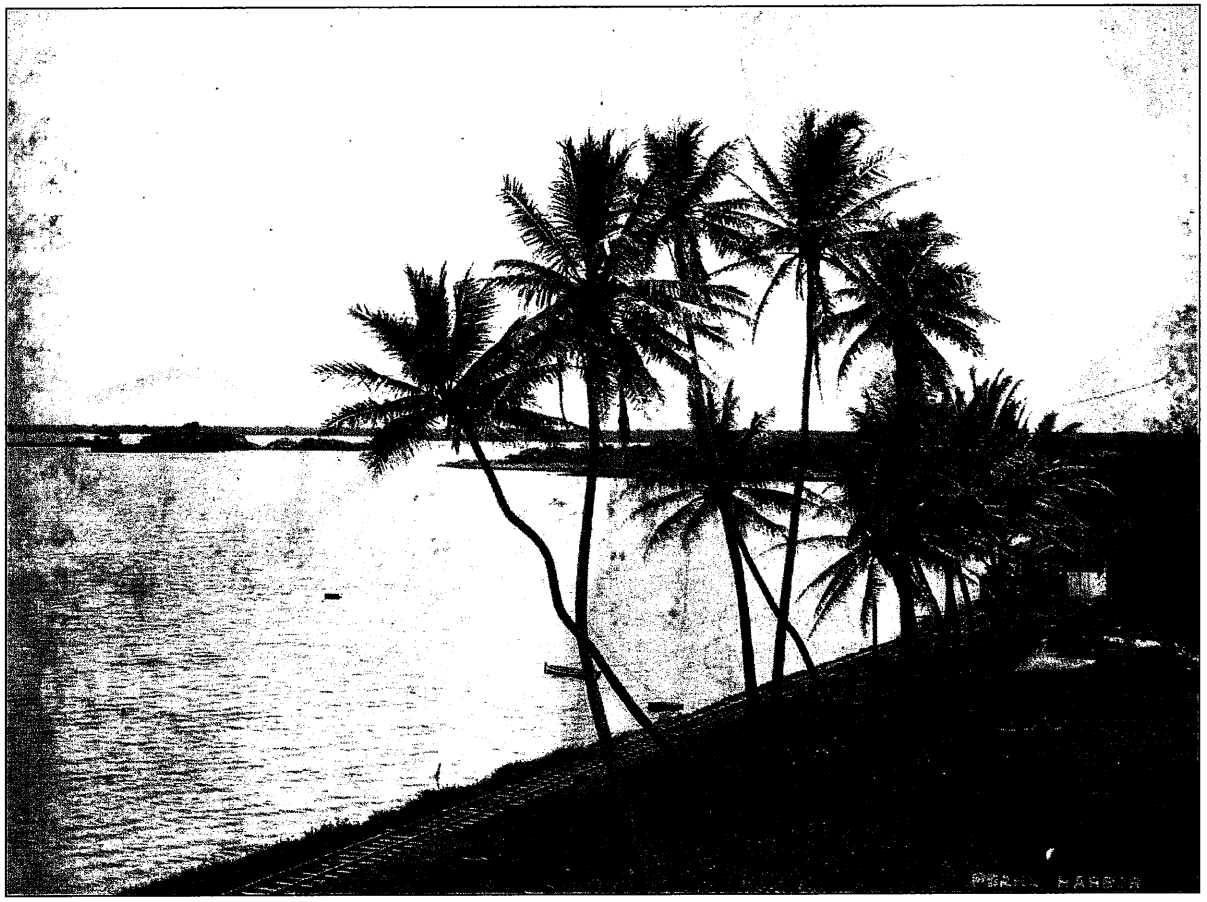

Figure 29. 1890 photograph of Pearl Harbor with OR&L railroad tracks along the coast (Honolulu Advertiser Archives)

Operations at the OR&L began to slow down in the 1920s when electric streetcars were built for public transportation within the city of Honolulu and automobiles began to be used by families for transportation outside the city (Chiddix and Simpson 2004:185). The build-up to World War II turned this decline around as the U.S. military utilized the OR&L lines to transport materials for building defense projects around the island. Historians have noted that one of the most serious mistakes made by the Japanese in their 1941 attack on Pearl Harbor was their decision not to bomb the railway infrastructure. Soon after the attack, the OR&L operated 24 hours a day, transporting war materials and troops from Honolulu to the new and expanded army, naval, and air bases. The huge navy base at Pearl Harbor had its own rail lines that connected to the OR& L rail lines.

In August of 1945, the war ended, and so did OR&L's heyday as a military transport line. Chiddix and Simpson writes:

> She had served her country well and proudly during the war, but operating round-the-clock on what little maintenance could be squeezed in, had taken a prodigious hit on the locomotives and track. Traffic stayed steady for a short time, but soon

> dropped precipitously as soldiers and sailors went home, military posts were shrunk or razed, and civilians could again get tires, gasoline and new cars. (Chiddix and Simpson 2004:257)

There was no choice but to abandon the OR&L main line, and in 1946 Water F. Dillingham, son of B.F. Dillingham, wrote:

> The sudden termination of the war with Japan changed not only the character of our transportation, but cut the freight tonnage to a third and the passenger business to a little above the pre-war level. With the increased cost of labor and material and the shrinkage in freight tonnage and passenger travel, it was definite that the road could not be operated as a common carrier. With no prospect of increased tonnage, and the impossibility of increasing rates against truck competition, your management has applied to the Interstate Commerce for authority to abandon its mainline. (Walter Dillingham, cited in Chiddix and Simpson 2004:257)

After the war, most of the 150+ miles of OR&L track were pried up, locomotives were sold to businesses on the US mainland, and railway cars were scraped. In 1947, the U.S. Navy took over a section of the OR&L track for their own use, to transport bombs, ammunition, and torpedoes from the ammunition magazines at Lualualei, West Loch in Pearl Harbor, and Waikele on OR&L's Wahiawā Branch to Pearl Harbor Naval Base (Treiber 2005:25–26). The track to Waipahu was abandoned in the 1950s, but the line from the magazines in Lualualei to the wharves in West Loch at Pearl Harbor remained open until 1968.

5.3.5 History of the Sugar Plantations of 'Ewa

Although sugar cane was already being grown as far back as the early 1800s, the industry revealed its economic potential in 1879 when the first artesian well was drilled in 'Ewa (Ellis 1995:22). The availability of subsurface water resources enabled greater irrigation possibilities for expanding plantations besides the use of water diversions from the surrounding stream systems. This prompted the drilling of many other wells amongst the Hawaiian Islands, thereby commencing the Hawai'i sugar plantation era. By the early 1900s, the entire main Hawaiian Islands had land devoted to the production of sugar cane.

Agricultural field systems, railroads, and residential areas in 'Ewa were developed by three sugar cane companies: the Ewa Plantation, located largely in the *ahupua'a* of Honouliuli and Hō'ae'ae in the western section of the 'Ewa; the Oahu Sugar Company, extending in the areas upland of the Ewa Plantation in central 'Ewa, including a portion of the uplands of Waiawa; and the Honolulu Plantation Company, with fields extending through Mānana to Hālawa in the eastern section of the 'Ewa.

5.3.5.1 The Ewa Plantation Company

The Ewa Plantation Company was incorporated in 1890 for sugar cane cultivation (Figure 30). The first crop, 2,849 tons of sugar, was harvested in 1892 at the Ewa Plantation. 'Ewa was the first all-artesian plantation, and it gave an impressive demonstration of the part artesian wells were to play in the later history of the Hawaiian sugar industry (Kuykendall 1967:III, 69). As a means to generate soil deposition on the coral plain and increase arable land in the lowlands, the

Ewa Plantation Company installed ditches running from the lower slopes of the mountain range to the lowlands. When the rainy season began, they plowed ground perpendicular to the slope to the lowlands. When the rainy season began, they plowed ground perpendicular to the slope so that soil would be carried down the drainage ditches into the lower coral plain. After a few years, about 373 acres of coral wasteland were reclaimed in this manner (Immisch 1964:3). By the 1920s, Ewa Plantation was generating large profits and was the "richest sugar plantation in the world" (*Paradise of the Pacific,* December 1902:19-22, cited in Kelly 1985:171).

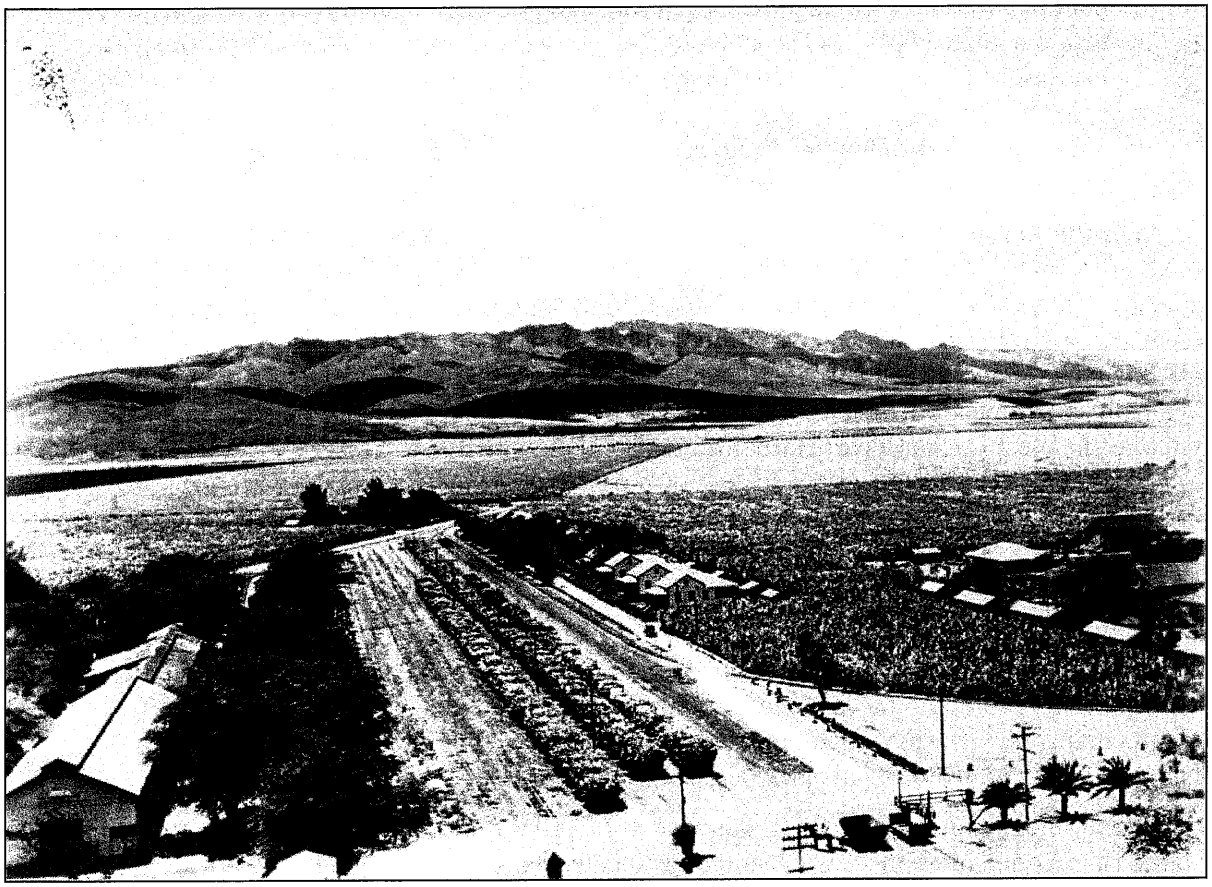

Figure 30. Ewa Plantation Co. sugar cane fields, Filipino Camp area, ca. 1925 (University of Hawai'i at Mānoa Digital Photograph Collection)

During the twentieth century, the Ewa Plantation would continue to grow and, by the 1930s, would encompass much of the eastern half of Honouliuli Ahupua'a. This growth impelled the creation of plantation villages to house the growing immigrant labor force working the fields. After the outbreak of World War II, which siphoned off much of the plantation's manpower, along with the changeover to almost complete reliance on mechanical harvesting in 1938, there was little need for the large multi-racial (Japanese, Chinese, Okinawan, Korean, Portuguese, Spanish, Hawaiian, Filipino, European) labor force that had characterized most of the early history of the plantation. The Oahu Sugar Company took control over the Ewa Plantation lands in 1970 and continued operations until 1995, when they decided to shut down sugar cane production in the combined plantation areas (Dorrance and Morgan 2000:45, 50).

5.3.5.2 The Oahu Sugar Co. and the Waiahole Ditch

In 1889, Benjamin Dillingham organized the Oahu Railway and Land (OR&L) Company. The railroad connected the outlying areas of O'ahu to Honolulu. By 1890, the railroad reached from Honolulu to Pearl City and continued on to Waianae in 1895, to Waialua Plantation in 1898, and to Kahuku in 1899 (Kuykendall 1967:100).

In 1897, B. F. Dillingham established the Oahu Sugar Company (OSC) on 12,000 acres leased from the estates of John Papa 'Ī'ī, Bishop, and Robinson. The Oahu Sugar Co. had over 900 field workers, composed of 44 Hawaiians, 473 Japanese, 399 Chinese, and 57 Portuguese. The first sugar crop was harvested in 1899, ushering in the sugar plantation era in Waipahu (Ohira 1997).

Prior to commercial sugar cultivation, these lands were described as being "of near desert proportion until water was supplied from drilled artesian wells and the Waiahole Water project" (Condé and Best 1973:313). Dillingham had successfully promoted the Ewa Plantation Company in 1890; the sprawling sugar company was just south of and adjacent to the OSC. Artesian wells had converted those arid Eva lands into a thriving plantation, and Dillingham recognized the same potential in the northern area.

Water to irrigate the upper cane fields was initially pumped to levels of 500 ft by some of the "largest steam pumps ever manufactured" (Dorrance and Morgan 2000:49). The expense of pumping water to the high elevations of the plantation led to the proposal to transport water from the windward side of the Ko'olau Mountains. The Waiahole Water Company was formally incorporated in 1913 and was originally a subsidiary of the Oahu Sugar Company. The Waiahole Ditch was designed by engineer Jorgen Jorgensen, with recommendations by engineer J.B. Lippencott and assisted by W.A. Wall. The original system, when completed, included 27 tunnels connecting with 37 stream intakes on the north side of the Ko'olau, with the main bore through Waiāhole Valley, then connecting it to the 14 tunnels on the southern side of the Ko'olau at Waiawa, and thence by ditch westward to Honouliuli, covering a total of 13.6 kilometers (Condé and Best 1973:37). Upon its completion in 1916, the Waiahole Ditch was 21.9 miles long (35 kilometers) and cost $2.3 million. The 32 million gallons of daily water enabled the O'ahu Sugar Company to grow to "some 20 square miles ... ranging in elevation from 10 ft at the Waipio Peninsula ... to 700 ft at the Waiahole Ditch" (Condé and Best 1973:313). The ditch system, with some modifications is still in use. It is included on the state inventory of archaeological sites as Site no. 50-80-09-2268.

This ditch complex first passed through Hō'ae'ae, bringing much needed water to the area. Kluegel describes the area:

> West of Waikakalaua Gulch, through Hoaeae and to the upper boundary of Oahu Plantation in Honouliuli, the conduit consists of 12,650 feet of cement-lined ditches, and three redwood pipes 5 feet in diameter, having an aggregate length of 2,830 feet. (Kluegel 1917:96)
>
> The Waiahole Water Co. has taken over from the Oahu Sugar Co. the Ahrens Ditch in Waiawa, the Kipapa Ditch, the Waikakalaua Ditch in Waipio, and the Hoaeae Ditch. Two redwood pipes having a total length of 1,223 feet have been laid across two gulches on the line of Hoaeae Ditch, cutting out 21/4 miles of ditch. The water delivered by the Waiahole System is chiefly used on newly planted cane on land above the lift of the pumps. (Kluegel 1917:107)

5.3.5.3 The Honolulu Sugar Plantation

The eastern section of 'Ewa was largely developed by the Honolulu Plantation Company. Commercial sugar cane cultivation began in Waimalu and Hālawa in the 1850s, on the estate of Mr. J.R. Williams (Condé and Best 1973:327). The plantation was first known as the Honolulu Sugar Company. In 1900, along with a change in ownership, the name of the company was changed to the Honolulu Plantation Company. The plantation's mill and refinery were located in 'Aiea, with the plantation's fields stretching across the plains and foothills *mauka* of Pearl Harbor (Figure 31). The expanse of the Honolulu Plantation Company lands seems to extend from 'Aiea westward as far as Mānana and Waiawa Streams. Additionally, several land sections lay southeast of Pearl Harbor where the present Honolulu International Airport and Hickam Air Force Base are located. In 1914, the company harvested 19,000 tons of sugar. It was taken over by the Oahu Sugar Company in 1947 (Condé and Best 1973:313).

The increased productivity of the sugar cane industry relied heavily on transporting the raw product from the field to the mills, including the 'Aiea sugar mill, as well as then taking the processed sugar to port for loading onto ships (or to storage facilities). Railway lines, which were established in the Honolulu Plantation Company fields by OR&L in 1901, provided a means to transport material, workers, and goods in an adequate amount of time. By 1910, the network of railways circumnavigated the plantation with over 36 miles of main railroad, utilizing four locomotives and 500 cane cars. This transportation system greatly enhanced the plantation's product output and economic growth, having taken in 900 tons of raw sugar per week and producing 1100 tons of processed sugar daily (Condé and Best 1973:328).

Despite its economic promise and gains, gradual land condemnation of Honolulu Plantation lands by the government caused declines in production and removal of rail lines. Continued pressure by the U.S. military proved to be too much. Large shares of Honolulu Plantation land were gradually turned over to the government for military use. In 1907, a sizeable portion was used for the expansion of the U.S. Naval Facilities at Pearl Harbor. In 1935, all of the Pu'uloa lands (approximately 15 percent of the plantation) were handed over for the construction of Hickam Air Field. The plantation lands were given up during World War II and post-war urbanization brought an end to the Honolulu Plantation Company in 1947. The plantation equipment and remaining land were sold to the neighboring Oahu Sugar Company, and the mill

was dismantled and shipped to the Philippines. However, the refinery continued to operate, producing a liquid sugar product for canners and bottlers until the Hawai'i bottlers switched to corn syrup. The operation shut down in 1996. The refinery building is now the site of the Hawai'i Agriculture Research Center (Dorrance and Morgan 2000:50).

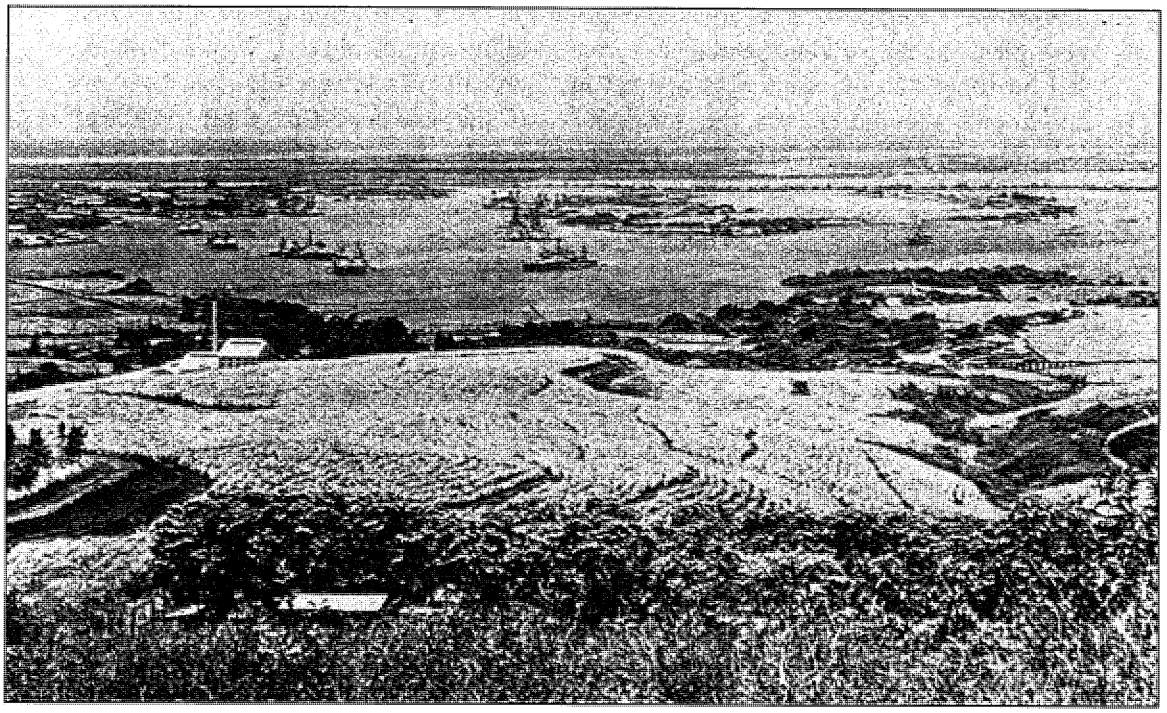

Figure 31. Photograph of Pearl Harbor in 1932 with the 'Aiea Sugar Mill in the foreground (Hawai'i State Archives, reprinted in Scott 1968:822)

5.3.6 The Military Development of 'Ewa

5.3.6.1 Early Evaluations of Pearl Harbor

In 1891, Russian explorer Otto Von Kotzebue tried to observe Pearl River, but his group could not obtain a canoe. What he was told led him to speculate on the possible importance of Pearl Harbor to the future:

> In the mouth of this river are several islands; it is so deep, that the greatest ship of the line can lie at anchor a few fathoms from the shore; and so broad, that a hundred vessels can conveniently find room in it. The entrance into the Pearl Rivers is in the same situation as the harbor of Hana-rura; but the windings between the reefs are, however, said to render a passage more difficult. If this place were in the hands of the Europeans, they would certainly employ means to make this harbour the finest in the world. (Kotzebue 1821:338–348)

The early missionary, Levi Chamberlain, took an outrigger canoe trip to Pearl River and noted the difficulty of access for larger ships:

> Kawaa took passage in our canoe to go down the harbor to a place where oysters are abundant to give orders to his people to gather a mess. The sail down the harbor was delightful.... The passage down the creek for a number of miles was very pleasant till we got down near the reef and our course altered. We then could sail no longer as the wind was against us. The sail was lowered the mast taken down and secured across the outrigger and the rowers plied their paddles. (Chamberlain 1822–1849, reprinted in Sterling and Summers 1978:51)

The first foreign attempt to survey Pearl Harbor was made in 1840 during the U.S. Exploring Expedition, led by Charles Wilkes. Wilkes describes the area:

> In this district is a large inlet of the sea, into which the river Ewa empties; at the entrance of this inlet is the village of Laeloa (at Kalaeloa Pont): the shore is known by the name of Pearl River or harbour, from the circumstance that the pearl oyster is found here; and it is the only place in these islands where it occurs.
>
> The inlet has somewhat the appearance of a lagoon that has been partly filled up by alluvial deposits. At the request of the king, we made a survey of it: the depth of water at its mouth was found to be only fifteen feet; but after passing this coral bar, which is four hundred feet wide, the depth of water becomes ample for large ships, and the basin is sufficiently extensive to accommodate any number of vessels. If the water upon the bar should be deepened, which I doubt not can be effected, it would afford the best and most capacious harbour in the Pacific. (Wilkes 1970:79)

Although Wilkes was impressed by the harbor, he was not at this time thinking of how this survey could benefit the American government in the future. In fact, Wilkes (1970:79) concluded, "As yet there is no necessity for such an operation, for the port of Honolulu is sufficient for all the present wants of the islands, and the trade that frequents them."

The low impression of Wilkes for the use of Pearl Harbor had changed in less than 30 years. The U.S. Navy had tried to make a coaling station on Midway Island in 1869 by blasting through the coral reef to make a harbor, but the plan failed. In 1873, General Schofield presented a confidential report to the U.S Secretary of war, recommending that Pearl Harbor should be available to the U.S. Navy. Schofield wrote:

> In case it should become the policy of the Government of the United States to obtain the possession of this harbor for naval purposes, jurisdiction over all the waters of Pearl River with the adjacent shores to the distance of 4 miles from any anchorage should be ceded to the United States by the Hawaiian Government....
>
> The cession of Pearl River could probably be obtained by the United States in consideration of the repeal of the duty of Sandwich Island sugar. Indeed, the sugar –planters are so anxious for a reciprocity treaty, or so anxious rather for free trade in sugar with the United States, that many of them openly proclaim themselves in favor of annexation of these islands of the United States. (Sen. Ex. Docs, 52nd Cong. 2nd Sess. No. 77, pp. 150–154, reproduced in Judd 1971:Appendix 3)

5.3.6.2 The U.S. Military and the Development of Pearl Harbor

The reciprocity treaty was concluded in 1876 with the provision that Hawai'i would not "lease or relinquish sovereignty to another country or any harbor, etc." In 1887, the treaty was renewed and amended and allowed the United States the "exclusive right to enter the harbor of Pearl River, in the Island of Oahu, at to establish and to maintain there a coaling and repair station for the use of vessels of the United States" (Judd 1971:128).

The most dramatic change affecting both the use of Pearl Harbor and the growth of the sugar industry in Hawai'i occurred July 7, 1898. Following years of diplomatic pressure from delegates to Washington, the Congress of the United States approved a joint resolution of annexation that established the Republic of Hawai'i as a Territory of the United States. On April 30, 1900, President William McKinley signed the Organic Act for the Territory of Hawai'i, which provided a government whose leaders were appointed by the United States and otherwise defined the political structure and powers of the newly established government (U.S. Department of the Interior 1900).

The U.S. Navy began a preliminary dredging program for Pearl Harbor in 1901, which created a 30-foot deep entrance channel measuring 200 ft wide and 3,085 ft long. In 1908, money was appropriated for five miles of entrance channel dredged to an additional 35 ft down (Downes 1953) (Figure 32). Money for the funding of the construction of dry docks and other support facilities was also approved in 1908. In 1909, the government appropriated the entire Waipi'o peninsula from the 'Ī'ī estate for the Pearl Harbor Naval Station and Shipyard. Additional dredging to deepen and widen the channel was conducted in the 1920s. In 1931, the Navy built an ammunition depot at West Loch on a 213-acre parcel that it had bought from the Campbell Estate. Construction of a new depot in Lualualei Valley and at West Loch Harbor began in 1931.

In the early 1930s, the U.S. Navy leased 700 acres of the Campbell Estate to build 'Ewa Field in Honouliuli, a base with a mooring mast for Navy dirigibles. Although the mast was completed, the program was abandoned before the *Akron*, the designated airship for the mast, was built. In 1937, 18 miles of roads were built in the coastal Honouliuli area, and in 1939 to 1940 the U.S. bought 3,500 acres of land in this area (Landrum et al 1997:62–67), to build several other military camps and installations, including Barbers Point Naval Air Station, at the site of the old mooring mast.

Figure 32. Dredging in Pearl Harbor ca. 1908 (Hawai'i State Archives)

In the 1930s an Army Air Corps airfield was established to the west of Rodgers Airport. The Hickam Air Force Base web site offers the following brief history of this military base's early development:

> In 1934, the Army Air Corps saw the need for another airfield in Hawaii and assigned the Quartermaster Corps the job of constructing a modern airdrome from tangled brush and sugar cane fields adjacent to Pearl Harbor on the island of Oahu. The site consisted of 2,200 acres of ancient coral reef, covered by a thin layer of soil, located between Oahu's Waianae and Koolau mountain ranges, with the Pearl Harbor channel and naval reservation marking its western and northern boundaries, John Rodgers Airport to the east, and Fort Kamehameha on the south. The new airfield was dedicated May 31, 1935 and named in honor of Lt. Col. Horace Meek Hickam, a distinguished aviation pioneer killed Nov. 5, 1934, at Fort Crockett in Galveston, Texas.
>
> Hickam AFB now consists of 2,850 acres of land and facilities valued at more than $444 million. (Hickam Air Force Base 2010)

5.3.6.3 World War II and the Military in 'Ewa

By 1941, Pacific Naval Air Bases expenditures for new construction at Pearl Harbor were in the hundreds of millions of dollars (Figure 33). The Japanese attack on Pearl Harbor, December 7, 1941, damaged or destroyed much of the new construction. Reconstruction was instituted to

double the Pearl Harbor's war capacity. Military planners approved a new ammunition depot in the mountainside of Waipahu, a large new hospital in 'Aiea, and thousands of additional changes to the Navy Yard to accommodate the new aircraft carrier task forces (Woodbury 1946:342–343). During World War II, the military used the sugar cane rail system to "haul large quantities of ammunition" (Condé and Best 1973:315).

Figure 33. October 1941 photograph of Hickam Air Force Station, in center; Ford Island on left; southern ends of Mānana and Waipi'o Peninsulas in foreground (Photograph with National Register of Historic Places Nomination form, U.S. National Archives)

By 1943, over 24,000 people were working at Pearl Harbor. Navy Housing Areas 1 and 2 and Civilian Housing Area 3 had grown large enough to be considered separate cities. Barracks and temporary housing for workers filled every available piece of land for miles between Pearl Harbor and the outskirts of Honolulu. A ring of huge barrage balloons was set up for the protection of the once-quiet waters of Wai-momi, which had since become one of the greatest Navy bases in the world (Downes 1953).

Before the war, the main Pearl Harbor Naval yard was sufficient for a staging and storage area for the Pacific fleet, but after the Japanese attack and the beginning of World War II, additional areas were needed for supply depots and warehouses. The government procured additional land after the beginning of World War II to expand the functionality of the military bases. The Navy took all of the coastline area in eastern 'Ewa District from the coast inland of the OR&L railroad

tracks (Ching 1996:24). Waipi'o Point, Waiawa Gulch, Pearl City (Mānana) Peninsula, Iroquois Point in Hālawa, and small areas in Honouliuli and Hō'ae'ae were taken over as supply depots and storage areas. The OR&L railroad had built a spur from the coast to Wahiawa in 1905, to haul cane and pineapples down to the coast and later to haul men and supplies from Pearl Harbor to Schofield Barracks in Wahiawa through Waikakalaua Gulch in Waikele. During the war, the military built a "secret railroad" from the railroad terminus at Waikakalaua Gulch to join the OR&L railroad coming around Ka'ena Point at Hale'iwa, thus providing a short cut from Pearl Harbor to Army facilities at Kahuku on the north shore of O'ahu (Kneiss 1957:11–12). By 1944, the Navy had claimed close to 2,400 acres of land in the Pearl Harbor and Pearl City areas within Mānana, Waiawa, and Hālawa for use as military staging areas in the war effort (Allen 1999:234).

There were four main portions of Waiawa that were used by the military—the Pearl City Peninsula *makai* of Kamehameha Highway, a storage area along Waiawa Stream *mauka* of the highway, a diesel drum storage area at 'Ewa Junction, and a military reservation in upland Waiawa used for communications and training (Allen 1999:234). The military reservation in Waiawa was 650 acres consisting of both gulch and plateau lands. From 1941 to 1945, the reservation was used as a training area for tanks and personnel and as an artillery impact area. The area was also used for the storage of munitions and supplies. The primary structure built by the military was a communications center. This center consists of four buildings and a tunnel system. The communications center is currently being used by the State of Hawai'i as a minimum security prison (Waiawa Correctional Facility).

On the Pearl City Peninsula in Mānana, three large warehouses were built for a storage area. Other sections of the peninsula, including the Waiawa portion, were used for supply depot warehouses and spare part distribution centers. One of these was the U.S. Navy Mānana Supply Center, now known as the U.S. Navy Mānana Storage Area. A 25-acre portion of the former Supply Center on the Waiawa side of Mānana Peninsula was set aside in 1972 as a portion of the Pearl Harbor National Wildlife Refuge. This refuge for endangered wetland water birds was set up in the former area of Loko Kuhialoko and Loko Mo'o. A non-contiguous section of the U.S. Navy Mānana Storage Area was located *mauka* of Kamehameha Highway. It began as an aviation supply depot on the border between Waiawa and Mānana. The Navy built 50 wood-frame structures and spaced open-storage areas along the banks of Waiawa Stream for two miles (Allen 1999:238).

The Ewa Junction Fuel Drumming Facility was built on a 44-acre site in 1943 as a fuel drumming and transportation terminal at the site of the old OR&L railroad junction. Thus, it had railroad lines to the Pearl Harbor Shipyard and Hickam Air Field to the east, to Barbers Point Naval Air Station and other bases in Waianae to the west, and to Schofield Barracks and Wheeler Air Field Base to the north. The facilities consist of two 585,000-gallon fuel storage tanks, a fuel drumming building, and associated piping. The site has been inactive since the 1970s (Allen 1999).

Following World War II, much of the lower lands of Waiawa and Mānana remained part of the Naval Reservation and were used mainly as housing for military families and also sites for military warehousing. To this day, much of the Pearl City peninsula remains in the custody of the

U.S. Navy; however, in the late 1990s, much of the rest of the previous Pearl City regions were released to the State for public use (Allen 1999:239).

A supply depot for fuel drums was also set up along the coast called the Waiau Drum Storage. This site is actually in Waimalu Ahupua'a. It was built on land that the U.S. Navy purchased from the OR&L in 1942, and it was used to clean and store empty fuel drums. Between 1943 and 1963, waste oils were destroyed at the site (Dega and O'Rourke 2003:15). In 1963, the U.S. Navy gave the land to the City and County of Honolulu on which the Neal Blaisdell Park now located.

The peninsula on the west side of 'Aiea Bay is used for military housing. It currently consists of 140 single-unit, single story homes, most of which were built in 1960. Upper 'Aiea, adjacent to the western border of Kalauao, was used as a base for the 'Aiea Anti-Aircraft Battery during World War II. 'Aiea Heights developed into a residential area in the 1930s, and the former battery area was converted into Nāpuanani Park (Dega and O'Rourke 2003:16).

5.3.7 Residential and Commercial Development in 'Ewa

Three topographic maps show the extensive changes in commercial and residential development in the twentieth century. On a 1919 map U. S. War Department map (Figure 34), the proposed Honouliuli/ Waipahu/ Pearl City Wastewater Facilities Project area crosses mainly through undeveloped sugar cane fields, crossed only by the OR&L railroad and its stations, and the numerous railroad track sections of the Ewa Plantation Co., the Oahu Sugar Co., and the Honolulu Sugar Co., which extended from the inland fields to the sugar mills.

On the 1953 to 1954 topographic map (Figure 35), the criss-cross of railroad tracks is missing, replaced by numerous roads and dense residential neighborhoods at 'Ewa Villages, Waipahu, Pearl City, and 'Aiea. Many areas are blocked off for military installations and housing, such as the Makalapa Crater Naval Reservation in Hālawa, and the Naval Reservation sections at McGrew Point on 'Aiea Bay, on Pearl City (Mānana) Peninsula, along Middle Loch coast through Waiawa and Mānana, on Waipi'o Peninsula, and on the shores of West Loch in Honouliuli. On the 1998 topographic map, many of these naval reservation lands have shrunk, replaced by golf courses, large shopping complexes, and new neighborhoods that extend inland along the 'Ewa ridgelines.

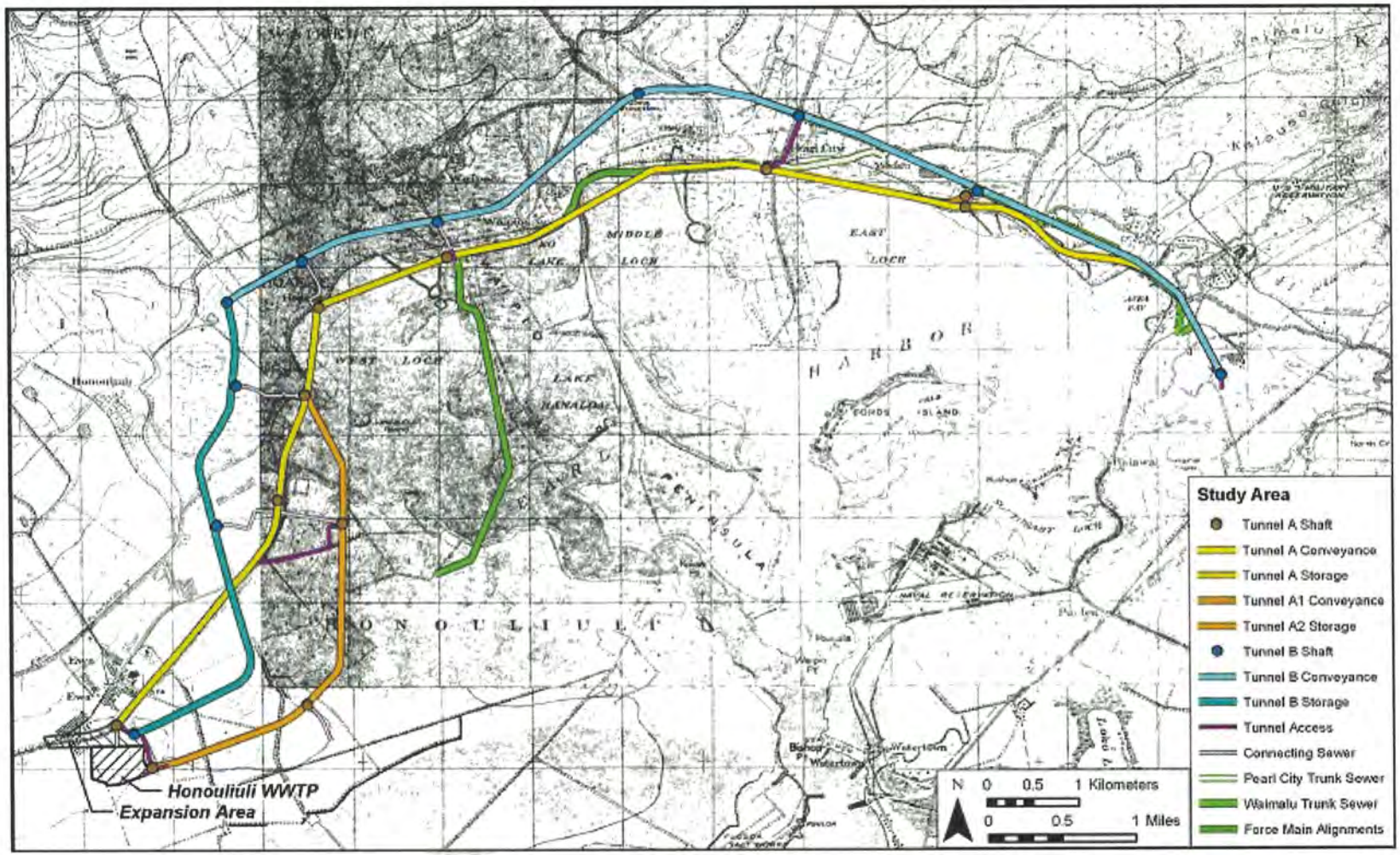

Figure 34. 1919 U.S. War Department Fire Control Map (portions of Pearl Harbor, Barbers Point, Nanakuli, and Honolulu Quadrangles, showing Project area through sugar cane fields and scattered settlements

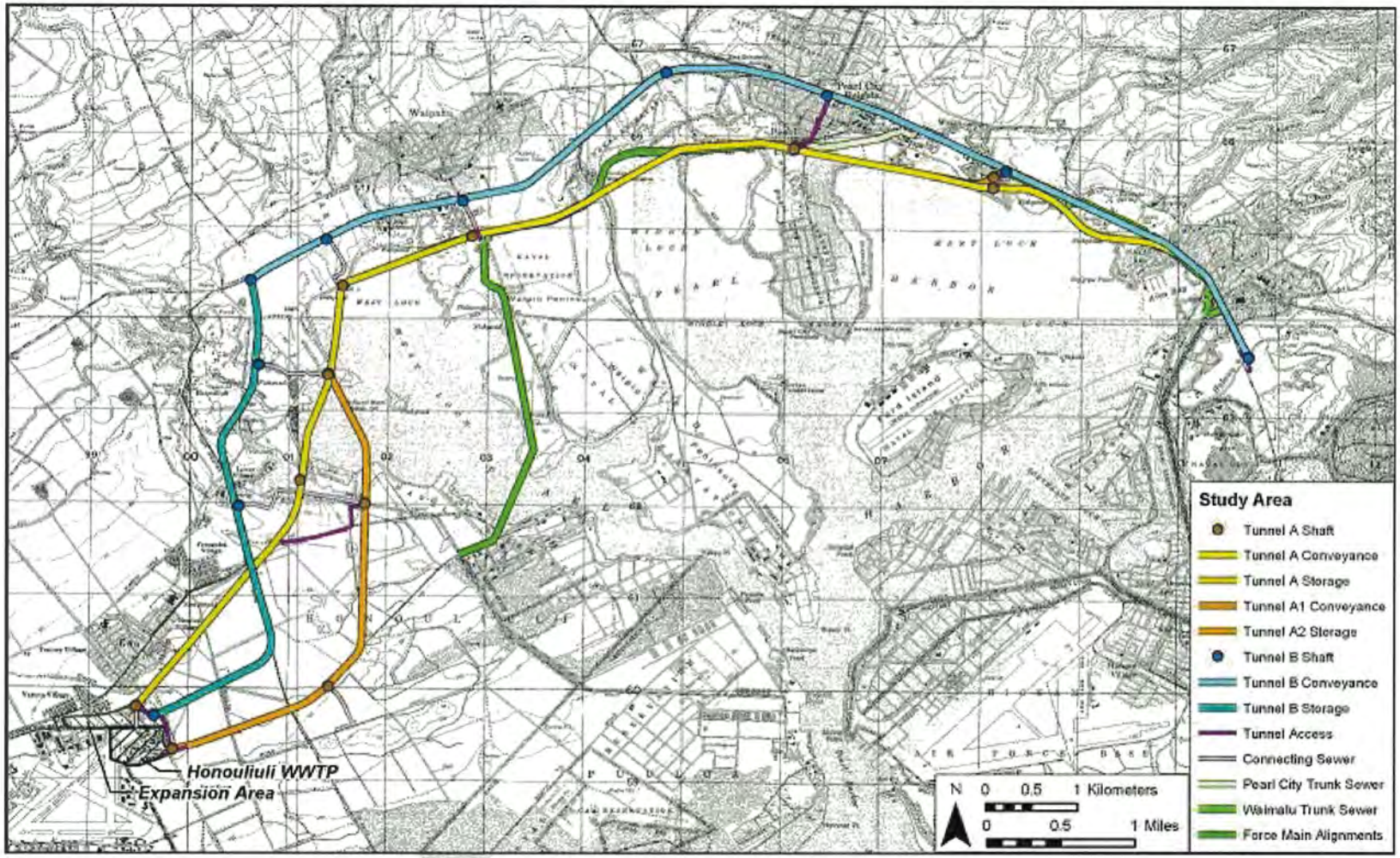

Figure 35. 1953–1954 U. S. Army Mapping Service topographic map (portions of Waipahu, 'Ewa, Schofield Barracks, and Pu'uloa Quadrangles), showing Project area

Section 6 Community Consultation

Throughout the course of this assessment, an effort was made to contact and consult with Hawaiian cultural organizations, government agencies, and individuals who might have knowledge of and/or concerns about traditional cultural practices specifically related to the Project area. This effort was made by letter, email, telephone and in person contact. The initial outreach effort was started in November 2010. Community consultation was completed in February 2011. In the majority of cases, letters along with a map and an aerial photograph of the Project area were mailed with the following text:

> At the request of AECOM and the City and County of Honolulu (CCH), Cultural Surveys Hawai'i Inc. (CSH) is conducting a Cultural Impact Assessment (CIA) for the proposed Honouliuli/Waipahu/Pearl City Wastewater Facilities Project, Multiple Ahupua'a, 'Ewa District, O'ahu Island, Multiple TMK. This study will be an update to the *West Mamala Bay Facilities Plan (2001)* for the Honouliuli Sewershed. The Honouliuli Sewershed encompasses the areas from which current wastewater flows into the Honouliuli Wastewater Treatment Plant (Honouliuli WWTP) including Hālawa, 'Aiea, Pearl City, Waipi'o, Waikele, Waipahu, 'Ewa, Kapolei and Mililani.
>
> The CCH is conducting a planning and engineering study for improvements to the Honouliuli/Waipahu/Pearl City Wastewater Facilities that is aimed at minimizing sanitary sewer overflows, to comply with regulatory mandates from the State of Hawaii, Department of Health (DOH), and the United States Environmental Protection Agency (EPA) and to meet the future needs for wastewater management. The study will cover potential future flows up to the year 2030.
>
> Alternatives being considered include but are not limited to:
>
> - Increased capacity and/or additional gravity sewers.
> - Peak flow storage tanks at Hālawa, Waimalu and/or Pearl City pump stations.
> - Increased capacity and/or additional pump station force mains for the Pearl City and/or Waipahu pump stations.
> - Pump station modification, capacity expansion, and/or relocation of the Pearl City pump station and capacity expansion or a second Waipahu pump station.
> - Deep tunnel conveyance and storage system to minimize or replace pump stations and provide peak flow storage.
> - Modification, upgrade and/or expansion of the Honouliuli WWTP.
>
> We are seeking your input on any of the following aspects of this study:
>
> - **General history and present and past land use of the project area.**

- **Knowledge of cultural sites- for example, historic sites, archaeological sites, and burials.**
- **Knowledge of traditional gathering practices in the project area, both past and ongoing.**
- **Cultural associations of the project area, such as legends and traditional uses.**
- **Referrals of *kūpuna* or elders and *kama'āina* who might be willing to share their cultural knowledge of the project area and the surrounding *ahupua'a* lands.**
- **Any other cultural concerns the community might have related to Hawaiian cultural practices within or in the vicinity of the project area.**

6.1 Community Consultation Effort

Several attempts were made by mail, email and telephone to contact individuals, organizations, and agencies apposite to the subject CIA. The summary of consultations is presented in Table 3 below.

Table 3. Results of Community Consultation

Name	Affiliation, Background	Comments
Alaka'i, Robert	Cultural Practitioner, Nā Koa member	CSH sent community outreach letter and figures on November 13, 2010 and December 23, 2010
Alegado, Dean	Filipino Community Center member, Waipahu *kama'āina*	CSH sent community outreach letter and figures on November 13, 2010 and December 23, 2010
Amaral, Annelle	'Ahahui Sivila Hawai'i O Kapolei Hawaiian Civic Club	CSH sent community outreach letter and figures on November 13, 2010 and December 23, 2010
Bise, Tony	'Ewa Federal Credit Union; Historian	CSH sent community outreach letter and figures on November 13, 2010 and December 23, 2010
Brown, Kenneth F.	Cultural Descendent	CSH sent community outreach letter and figures on November 13, 2010 and December 23, 2010

Name	Affiliation, Background	Comments
Cayan, Coochie	SHPD	CSH sent community outreach letter and figures on November 13, 2010. See SHPD response below in Figure 35
Ching, Arlene	Branch Mgr, 'Aiea Public Library	CSH sent community outreach letter and figures on November 13, 2010 and December 23, 2010
Ching, Lavaina	'Aiea *kama'āina*	CSH sent community outreach letter and figures on November 13, 2010 and December 23, 2010
Clark, Melvin Kauwila	Cultural Historian, Hawaiian healing, ceremonies	CSH sent community outreach letter and figures on November 13, 2010 and December 23, 2010
Eaton, Arlene	*Kupuna* (elder), Hale O Na'auao, Iroquois Elementary School	CSH sent community outreach letter and figures on November 13, 2010. See complete interview in Section 7 below
Fujita, Mitsuko	*Kama'āina* of 'Aiea and Manana; Family historian and researcher	CSH sent community outreach letter and figures on November 13, 2010 and December 23, 2010
Higa, Jeffrey	Assistant executive director of Plantation Village	CSH sent community outreach letter and figures on November 13, 2010 and December 23, 2010
Holt, Ruth	King Kamehameha Hawaiian Civic Club	CSH sent community outreach letter and figures on November 13, 2010 and December 23, 2010
Ka'eliwai, George	Hawaiian Civic Club of 'Ewa	CSH sent community outreach letter and figures on November 13, 2010 and December 23, 2010
Kalahiki, Mel	*Kupuna,* former Kīpapa Gulch worker	CSH sent community outreach letter and figures on November 13, 2010. See complete interview in Section 7 below
Kamahele, Momi	Hawaiian Studies Department, Leeward Community College	CSH sent community outreach letter and figures on November 13, 2010 and December 23, 2010

Name	Affiliation, Background	Comments
Kamelamela, Jonah	'Aiea *kama'āina*	CSH sent community outreach letter and figures on November 13, 2010 and December 23, 2010
Kāne, Shad	'Ahahui Sivila Hawai'i O Kapolei Hawaiian Civic Club	CSH sent community outreach letter and figures on November 13, 2010. See complete interview in Section 7 below
Kawamura, Kauro and Dorothy	'Aiea *kama'āina*	CSH sent community outreach letter and figures on November 13, 2010 and December 23, 2010
Keala, Jane	'Ahahui Sivila Hawai'iO Kapolei HCC	CSH sent community outreach letter and figures on November 13, 2010 and December 23, 2010
Kekina, Mabel	'Aiea *kupuna*	CSH sent community outreach letter and figures on November 13, 2010 and December 23, 2010
Keko'olani, Terri	Community Activist	CSH sent community outreach letter and figures on November 13, 2010 and December 23, 2010
Khan, Leimomi Khan	President of the Association of Hwn Civic Clubs	CSH sent community outreach letter and figures on November 13, 2010 and December 23, 2010
Lee, Chew Hoy	'Aiea *kama'āina*	CSH sent community outreach letter and figures on November 13, 2010 and December 23, 2010
Lee, Richard	'Aiea *kama'āina*	CSH sent community outreach letter and figures on November 13, 2010 and December 23, 2010
Lenchanko, Tom	Kūkaniloko Birthstones Caretaker; Wahiawā Hawaiian Civic Club	CSH sent community outreach letter and figures on November 13, 2010 and December 23, 2010
Loo, Clifford	Pearl Harbor Hawaiian Civic Club	CSH sent community outreach letter and figures on November 13, 2010 and December 23, 2010

Name	Affiliation, Background	Comments
Marzan, Marques	Bishop Museum	CSH sent community outreach letter and figures on November 13, 2010 and December 23, 2010
Matanane, Eric	Nā Koa member	CSH sent community outreach letter and figures on November 13, 2010 and December 23, 2010
Mckeague, Kawika	OIBC Chairperson	CSH sent community outreach letter and figures on November 13, 2010 and December 23, 2010
McKenzie, Nova-Jean	Pearl City *kama'āina*	CSH sent community outreach letter and figures on November 13, 2010 and December 23, 2010
Nahulu-Mahelona, Moani	Hawaiian Studies Department, Kapolei HS	CSH sent community outreach letter and figures on November 13, 2010 and December 23, 2010
Nāmu'o, Clyde	Administrator, OHA	CSH sent community outreach letter and figures on November 13, 2010. See OHA response below in Figure 36
Nicholson, Dorinda	Pearl City *kupuna*	CSH sent community outreach letter and figures on November 13, 2010 and December 23, 2010
Nunes, Keoni	Oral Traditions, *Kalaikakau* (tattoo)	CSH sent community outreach letter and figures on November 13, 2010 and December 23, 2010
Oba, Ron	*Kupuna*, author-historian, wrote *Journey to Aiea Town*	CSH sent community outreach letter and figures on November 13, 2010 and December 23, 2010
Pena, Uluwehi	'Aiea *kama'āina*	CSH sent community outreach letter and figures on November 13, 2010 and December 23, 2010
Philpotts, Douglas 'McD'	Makakilo *kama'āina*	CSH sent community outreach letter and figures on November 13, 2010 and December 23, 2010

Name	Affiliation, Background	Comments
Sanders, Moana	Pearl Harbor Hawaiian Civic Club	CSH sent community outreach letter and figures on November 13, 2010 and December 23, 2010
Shirai, Thomas	Kawaihāpai *'ohana* (family)	CSH sent community outreach letter and figures on November 13, 2010 and December 23, 2010
Slater, Lovey	Pearl City *kama'āina*;	CSH sent community outreach letter and figures on November 13, 2010 and December 23, 2010
Stagner, Ishmael	Author of book on *hula*, genealogist (brother of Dorinda Nicholson) works at Alu Like	CSH sent community outreach letter and figures on November 13, 2010. See complete interview in Section 7 below
Tiffany, Nettie	*Kahu* for Lanikūhonua	CSH sent community outreach letter and figures on November 13, 2010 and December 23, 2010
Young, Tin Hu and Helen	OEQC recommended cultural contact	CSH sent community outreach letter and figures on November 13, 2010. See complete interview in Section 7 below

6.2 State Historic Preservation Division

The SHPD stated the following in writing to CSH regarding the proposed Project in a letter dated December 30, 2010 (Figure 35): SHPD is concerned about the following but not limited to cultural practices and/or issues (1) the impact on access (including but not limited to trails) and gathering for cultural resources in the various *ahupua'a*; (2) impact of all ground moving activities which may disturb burials and/or other archaeological resources that may not be currently visible and/or known; (3) impact on other locally-known historic or significant sites in the various *ahupua'a*; (4) Kupuna Arlene Eaton, Ms. Garnet Clark, Ms. Momi Kanahele and Kawika McKeague should be contacted for their *mana'o* (thoughts, ideas) regarding the various *ahupua'a*.

6.3 Office of Hawaiian Affairs

The OHA stated the following in writing to CSH regarding the proposed Project in a letter dated December 13, 2010 (Figure 36): (1) Kawika McKeague, Shad Kāne and the Pearl Harbor

Hawaiian Civic Club should be contacted for their *mana'o*; (2) various neighborhood boards in the Project may be appropriate forums to seek input on the CIA.

NEIL ABERCROMBIE
GOVERNOR OF HAWAII

WILLIAM J. AILA, JR.
INTERIM CHAIRPERSON,
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

GUY H. KAULUKUKUI
FIRST DEPUTY

WILLIAM M. TAM
INTERIM DEPUTY DIRECTOR - WATER

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

December 30, 2010

Mr. Brian Kawika Cruz
Cultural Surveys Hawaii
P.O. Box 1114
Kailua, Hawaii 96734

Log No. 2010.4014
Doc.No.1012PC009
Culture

Dear Brian Cruz:

Subject: HONOULIULI 35: Cultural Impact Assessment (CIA) for the proposed Honouliuli/Waipahu/Pearl City Wastewater Facilities Project, Multiple Ahupua'a, 'Ewa District, O'ahu Island. Multiple TMK.

Mahalo for the opportunity to comment on the above proposed project and to refer folks who may have knowledge of impacts on cultural resources and/or practices in the general area. As you know, all previous archaeological and CIA reports will be helpful in your research to carefully document impacts.

The SHPD is concerned about the following but not limited to cultural practices and/or issues:

- Impact on access (including but not limited to trails) and gathering for cultural resources in the various ahupua'a.
- Impact of all ground moving activities which may disturb burials and/or other archaeological resources that may not be currently visible and/or known.
- Impact on other locally-known historic or significant sites in the various ahupua'a.

Some folks you may want to consult with include the following:

- Kawika McKeague — OIBC Chairman & 'Ewa District Rep. — mckeague@hawaii.rr.com
- Kupuna Arline Eaton — Hoakalei Cultural Foundation — www.hoakaleifoundation.org
- Ms. Garnet Clark — Native Hawaiian — gclark@hawaii.edu
- Ms. Momi Kanahele — Leeward Community College/ Hawaiian Studies Educator

This project will impact multiple ahupua'a and various places where folks live and practice cultural activities. It would be a benefit to have a public talk story within each ahupua'a for comments from the general public and/or special interest groups.

Any questions, please call me directly at 808.692.8025 or via email at Phyllis.L.Cayan@hawaii.gov.

Sincerely,

Phyllis Coochie Cayan

Phyllis Coochie Cayan
SHPD History and Culture Branch Chief

Figure 35. SHPD response letter dated December 30, 2010

PHONE (808) 594-1888

FAX (808) 594-1865

STATE OF HAWAI'I
OFFICE OF HAWAIIAN AFFAIRS
711 KAPI'OLANI BOULEVARD, SUITE 500
HONOLULU, HAWAI'I 96813

HRD10/4035B

December 13, 2010

Brian Kawika Cruz, Researcher
Cultural Surveys Hawai'i, Inc.
P.O. Box 1114
Kailua, Hawai'i 96734

Re: **Pre- Cultural Impact Assessment Consultation**
Honouliuli Wastewater Treatment Plant Project
Island of O'ahu

Aloha e Brian Cruz,

The Office of Hawaiian Affairs is in receipt of your November 9, 2010 request for comments ahead of a cultural impact assessment (CIA) for improvements to the Honouliuli Wastewater Treatment Plant (project) proposed by the City and County of Honolulu.

The project is intended to ensure facilities are in compliance with State of Hawai'i-Department of Health and United States Environmental Protection Agency requirements up to the year 2030. A wide range of improvements are proposed for facilities serving a geographic area extending from Hālawa through 'Aiea, Pearl City, Waipi'o, Waikele, Waipahu, 'Ewa, Kapolei and Mililani.

OHA recommends consultation with the following individuals who may be willing to share their thoughts with you: Kawika McKeague, Shad Kane, those involved with makahiki observances at Puuloa and members of the Pearl Harbor Hawaiian Civic Club. The various neighborhood boards in the project area may be appropriate forums to seek input on the CIA.

Thank you for initiating consultation at this early stage and we look forward to reviewing to reviewing the CIA and providing additional comments at that time. Should you have any questions, please contact Keola Lindsey at 594-0244 or keolal@oha.org.

'O wau iho nō me ka 'oia'i'o,

Clyde W. Nāmu'o
Chief Executive Officer

Figure 36. OHA response letter dated December 13, 2010

Section 7 Interviews

Kama'āina and *kūpuna* with knowledge of the proposed Project and study area participated in semi-structured interviews for this CIA. CSH conducted interviews from November 2010 to February 2011. CSH attempted to contact 44 individuals for this draft CIA report; of those, seven responded and five participated in formal interviews. CSH initiated the interviews with questions from the following six broad categories: *wahi pana* and *mo'olelo*, agriculture and gathering practices, freshwater and marine resources, trails, cultural and historic properties, and burials. Participants' biographical backgrounds, comments, and concerns about the proposed development and Project area and environs are presented below.

7.1 Acknowledgements

The authors and researchers of this report extend our deep appreciation to everyone who took time to speak and share their *mana'o* with CSH whether in interviews or brief consultations. We request that if these interviews are used in future documents, the words of contributors are reproduced accurately and not in any way altered, and that if large excerpts from interviews are used, report preparers obtain the express written consent of the interviewee/s.

7.2 Shad Kane

CSH interviewed Shad Kāne on January 3, 2011 at his home in Kapolei. Selections from the interview reveal Mr. Kāne's generational ties to the peninsula of Pu'uloa, highlight the buried cultural landscape—the ancient use of the land—of 'Ewa, tell the *mo'olelo* of the Battle of Kūki'iahu, and explain the significance of the *mauka-makai* relationship in 'Ewa. Mr. Kāne paints an image of how the ancient Hawaiians might have viewed their world.

7.2.1 Family Background

Mr. Kāne was born on the Pearl City peninsula in Mānana in 1945. Just prior to his first birthday and after the Navy took control of the peninsula at the start of the Pacific theater of World War II, his parents, Hattie and Tazoni Crowningberg Kāne, moved to Wahiawā where he grew up. Mr. Kāne attended Kamehameha Schools. After enlisting in the Navy and attending the University of Hawai'i, Mr. Kāne worked for the Honolulu Police Department for 34 years. He retired in 2000 and since, has become involved in several initiatives to preserve Hawaiian historical and cultural sites. He is a member of the Royal Order of Kamehameha, the O'ahu Council of Hawaiian Civic Clubs, Nā Koa 'O Pālehua, and the Ahahui Sivila O Hawai'i O Kapolei Hawaiian Civic Club. He is also the 'Ewa representative on the OIBC and a Native Hawaiian representative on the Native American Advisory Group to the Advisory Council of Historic Preservation in Washington, D.C.

As a young adult, Mr. Kāne first became interested in his Hawaiian cultural heritage. Yet, his parents were part of a generation of Hawaiians that was struggling to survive. In this period of time, many Hawaiians did not share their knowledge of Hawaiian cultural traditions and language with their children. After Mr. Kāne graduated from high school, his mother shared several *mo'olelo* with him of her life on the peninsula of Pu'uloa prior to World War II. Mr.

Kāne's family lived on Laniwai Street, which was not far from where his mother worked as a hula dancer for Pan American. Pā'au'au, a fishpond, was also located nearby. Mr. Kāne recalls with fondness that he sang the Pā'au'au Waltz as a student at Kamehameha Schools.

7.2.2 Agriculture, Fishing and Gathering

Mr. Kāne's mother also spoke to him of *lo'i kalo*, although Mr. Kāne cannot say with certainty that these *lo'i kalo* were on the peninsula. Family photographs of *lo'i kalo* from this time period could be from the surrounding area. The region's agricultural base also included watercress farms and rice fields. In addition, Mr. Kāne's father fished, hunted for crabs, collected oysters and clams, and gathered *limu* in the waters of Pu'uloa in the specific area of Pōhaku O Kāne on the peninsula. Growing up, Mr. Kāne recollects how he and his father fished at the mouths of rivers that flowed into the ocean, such as Waimea Bay. While he has photographs of many of the fishing areas, most of these rivers no longer flow.

7.2.3 Cultural Landscape of 'Ewa

Mr. Kāne discusses the dramatic alterations to the land within the *moku* of 'Ewa. Most significantly, the land of Pu'uloa, which connects to all 13 *ahupua'a* in 'Ewa, has been filled in through a growing partnership between business interests and federal agencies. However, the cultural landscape—the ancient use of the land for such activities as fishing, gathering, collecting medicinal plants, and worshipping—remains intact underground:

> There are a lot of interesting things regarding all of Pu'uloa. Much of this area in 'Ewa Moku has been altered a lot. Compared to other places it is has been altered significantly by, and grew out of, a partnership between business interests, land owners and federal agencies. We've seen this history in other places, like Manifest Destiny, moving and expanding land ownership. The federal agency provided security for the business interests, and ultimately to provide for the expansion of large numbers of people. In these Hawaiian Islands, it happened more in 'Ewa more than anywhere else. Twenty-five percent of all lands belong to federal agencies, such as the Department of Defense [DOD]. Much of that is on O'ahu, and much of that is in 'Ewa. Think of all the military bases. I'm not trying to be judgmental—I'm just trying to share what I've learned over the years. I don't blame the children of today for the decisions their parents made. It is a different time and we have to move on.
>
> 'Ewa is critical. It is at the very nature of that partnership, of agriculture and the support of federal agencies, and the erosion of our Hawaiian culture. The nature of agriculture is to bulldoze. An archaeologist's job is to find things [that] are identifiable and draw conclusions from something that can be seen. You can't do that if you can't see anything. It is a challenge.
>
> The ancient Hawaiian resources, due to the very nature of the alteration in the region, have not been removed. It has all been filled in. In other words, the cultural landscape within all of 'Ewa is still there. It is just buried. The stuff that was on the high ground, where they planted sugar cane and pineapple is gone.

> Within the valleys, the low-lying areas, the wetlands adjacent to Pearl Harbor, from 'Ewa Beach to 'Aiea, much of that cultural landscape—the cultural layer—is still in place. The Navy and the DOD are beginning to understand the importance of preservation and our history. They are realizing it is not just a history of the DOD within Pearl Harbor; it is a history of all the many cultures that live here. No better place than 'Ewa because there is a lot here. These guys, Tin Hu Young, the Colburns, and Don Francisco de Paula Marin, were a big part of this history. They were from other places, making it a very colorful place that tries to integrate many histories into one.
>
> When you see Pearl Harbor, you see nothing Hawaiian. But in reality, that Hawaiian cultural history is still there. Much of what was on the surface is no longer there. But the cultural landscape is still beneath it. The Navy simply filled in everything. Much of Pearl Harbor was fishponds and salt ponds. All of those are still there, they are just filled up. I am constantly saying that this is part of a traditional cultural landscape, but the Navy disagrees with me. The Navy doesn't see anything. To show that the traditional cultural landscape still exists, I have to speak about the ancient Hawaiian land use, and not in terms of physical structures. We are talking about land that was used for specific purposes by Native Hawaiians. We can talk about it in terms of gathering resources, fishing. We can talk about in terms of a place to gather salt. We can speak of it in terms of a place of worship and pray. We can speak of it in terms of a place to gather medicinal plants. A traditional cultural landscape is that. It is land that was used for a specific cultural purpose. If you speak of it in that respect the Navy must understand that it is a traditional cultural landscape. This is a challenge in 'Ewa, more so than anywhere else. If you go anywhere else, you'll see something above the ground and exposed. You go to 'Ewa, it is not exposed. It's underground.

Mr. Kāne is not aware of any visible evidence of such an ancient cultural landscape in the *ahupua'a* of Waiawa, Waiau or Kalauao. However, he suggests that there would have been other structures similar to Keaīwa Heiau in the mountainous region of 'Aiea. In particular, he read about a large *heiau* on a ridge at the intersection of the Mānana and Waiawa Rivers. This area was never cleared for agriculture, yet the area remains heavily forested, which has prevented Mr. Kāne from locating it on horseback. In addition, Mr. Kāne asserts that the ancient canoes are still near the shores of Pu'uloa. He suggests that over time sediment and mud from the rivers flowing into Pu'uloa have buried the canoes that were once left abandoned on the shores, and in doing so, the deposits preserved the organic materials in anaerobic conditions. To visualize what the ancient cultural landscape would have looked like, Mr. Kāne suggests looking today at Sumida Watercress Farm:

> The best place to get an idea of what it might have looked like is through Sumida Farms. If you see the way the way they have the little grass hut sitting on the high ground between two irrigated areas, is how I picture all that land. I'm not saying that is exactly what it looked like, but it should give us a sense of what that whole area looked like in terms of irrigated *lo'i kalo* or fishponds, and it should also give us a sense of how people lived on the lowlands. My understanding is that there

would not have been a lot of people living on the wetlands. The only people living there would have been the people farming. In an area such as this, the lowland wetland area was used for agricultural purposes; lands from 'Aiea to Mānana to Waipahu. Most of the people would be living in the high grounds, such Kalauao right where McGrew Point is, or Kūki'iahu. If you go to McGrew Point and turn and look *mauka*, that ridge is Kūki'iahu. People would have lived in such places as that, the high grounds. If you read *Sites of O'ahu*, that is where the *heiau* were, and the people would have lived there. From an archaeological perspective, the habitation and trash sites would be on the high ground. The sad part today is where much of the disturbance has taken place. The low ground is buried. I am sharing this so we get a picture, a blurred picture of what it might have been like.

7.2.4 Mo'olelo of the Battle of Kūki'iahu

Mr. Kāne draws from the writings of Samuel Kamakau and John Papa 'I'ī to explain the Battle of Kūki'iahu in the *ahupua'a* of Kalauao:

> At that time Kalanikūpule was *mō'ī* of the island of O'ahu and Moloka'i. At that time, the island of O'ahu was already Kalanikapule; Kahekili already passes away. Kalanikapule was *mō'ī* in 1784. Between 1784 and 1794 the island of O'ahu was under control of Kalanikapule. During that same period, the *mō'ī* of Kaua'i and Moloka'i was Kaeokulani. He was struggling with his men. He had to have the respect of the men. They set the direction of what you were going to do. If your men were with you, you could do what you want to do. If your men were not with you, there is nothing you can do. Kaeokulani was having a hard time with his men, apparently they were not happy. They were trying to get back to Kaua'i but didn't make it. Kaeokulani tried to appease his men by finding battles over here. He didn't need to fight but he figured a few small battles would get his men under control again. This was the Battle of Kūki'iahu between the forces of the Kaeokulani and Kalanikapule. This was the first time a British Ship, the *H.M.S. Jackal*, under the command of Captain Brown entered the waters of Pu'uloa. How did they get those ships in there? The draft on those ships...pretty heavy ships that sit low in the water. The question is how he got them in. Up to that point I was always of the understanding that there was no way to get in. It was dredged, but for large canoes—not for ships. My thinking is that it was only around 10 to 15 feet at the entrance of Pearl Harbor. Those three-masted ships would have needed more clearance. Brown was able to get his two ships into the harbor and out safely. It is an interesting part of that battle, because they got into the area by 'Aiea. His part, his role in the battle between Kaeokulani and Kalanikapule that decided the outcome. Kaeokulani was wearing his red cape, and you can't miss a red cape! Brown provided cannon support for the ground forces of Kalanikapule. It served as a decisive defeat of Kaeokulani and a victory for Kalanikapule. Kaeokulani, his wife and his army all died in this battle. Their bodies were buried where they fell and that of Kaeokulani was taken and sacrificed.

7.2.5 Mauka and Makai Waters and the Mana of Moku'ume'ume

Mr. Kāne notes that ancient Hawaiians perceived their world in terms of relationships. According to Mr. Kāne, one of the most elementary relationships is the *mauka-makai* relationship. From a Hawaiian perspective, the shoreline out to the ocean is connected to the tallest mountain peak within an *ahupua'a*. Mr. Kāne elaborates on how the ancient Hawaiians would have viewed the fresh water mountain streams of 'Ewa flowing into Pu'uloa, mixing with the ocean water and depositing sediments, and building, over a long period of time, Moku'ume'ume:

> Why 'Ewa? Freshwater. What makes 'Ewa really unique is the wetlands. All 13 *ahupua'a* center on Pu'uloa. If you consider the geographical area of Pu'uloa, it is the only place in all the Hawaiian Islands where all 13 *ahupua'a*, from the mountain to the sea, have water that all comes here, Pu'uloa.
>
> If you read the *mo'olelo* associated with this region, the two gods that play a big part are Kāne and Kanaloa. Why? It is the relationship and marriage between freshwater and salt water. Here, in Pu'uloa, is the mixing. If you can understand that, you can understand everything that happened on the low ground and on the high ground. It is the relationship between the mountains to the sea, and the path that the fresh water follows. Every one of these high grounds, all of that freshwater went in one direction; all ended up in Pearl Harbor.
>
> In trying to understand the symbolic meaning of a name with respect to the place, consider the name Moku'ume'ume. It is a perfect place for such an understanding. We are talking about the relationship between Kāne and Kanaloa, salt water and fresh water. We're also talking about the *mauka-makai* relationship—water travels from the top of the mountains to the ocean. Hawaiians' world was full of those relationships. We're just talking about two here. The name Moku'ume'ume comes from an understanding that you have 13 *ahupua'a* with the waters of Kāne all coming to a particular area. In the Hawaiian belief, when fresh water brushes up, the island was formed through sediment. Think of the waters of Kāne, sacred waters of Kāne. All of the water from these 13 *ahupua'a* brushes up against an island. This symbolic brushing of fresh water gives the island spiritual significance and *mana* (supernatural or divine power). Moku'ume'ume is a place of spiritual *mana*. The water is a life-giving force that provides life to that island. This is an example of how a name manifests the significance of the surrounding region. Moku'ume'ume is not one island; Moku'ume'ume is the whole region, and the island is in the very center. *'Ume'ume* [to draw, pull, attract] in Hawaiian, I think, is pushing and pulling. It's the action of the fresh water and the tides, pushing and pulling, that builds the island from a Hawaiian cultural perspective.
>
> *Mana* is real in Hawaiian culture. *Mana* permeated all aspects of ancient Hawaiian life. It played a big part in their daily lives, but also a part in their sculptures and the way they designed. Look at the *hoaka* [crescent]. The crescent is a symbol that is on the back of the chief's *'ahu* [cape]. It replicates itself in everything. Every *mahiole* [feather helmet] has a *mahina* [crescent shape of

moon], the *mana* carried within the person. In other words, his *po'o* [head] is the receptacle. Think of the *hoaka* symbol, it is a receptacle of the spiritual power of the bearer, the person who carries it. This spiritual power can be seen in people today. In ancient Hawai'i, they realized that certain individuals had different levels of spiritual power. You can take that away from somebody. Today, President Obama is a person who has plenty of *mana*. Because he was able to do what he did, from a Hawaiian perspective, this guy has plenty of spiritual power. But it manifests itself in what has become of him. We all possess it. Some of us nurture it and some of us ignore it. Some of us have different levels of it. So it depends, from a Hawaiian perspective. You can take *mana* from someone else. And you take it by discrediting them. You destroy him in a certain way, and now you have that *mana*. Although I am giving examples, it is much broader than what I am sharing. For example, different shapes in the geography gave different places different power, which is why they built certain structures in certain places. Mountain tops are very powerful places—places close to the gods.

We are talking about the water of Kāne, the freshwater, and the water of Kanaloa, the salt water. We are talking about the relationship between the mountains and the sea, about the heavenly place. In the Hawaiian cultural perspective, it is the brushing of the waters against a specific place that gives it the spiritual power. In the case of Moku'ume'ume, this *mana* builds the island. Their perspective was real world. What you see and what you observe. You see an island growing.

The name Moku'ume'ume has two stories. The missionaries associated pushing and pulling with sexual activity. One of the stories that came out of the monarchy period was that the name Moku'ume'ume was a place where they used to have sexual games. But there wasn't any such thing as a sexual game. Since there are so few physical things around, we rely on traditions. Finding a story in its purist form without missionary thoughts being inserted is hard.

The challenge today is get people to have an understanding of the Hawaiians' worldview. It is totally different from how we see things today. I should really say all indigenous peoples' view of the world, which is that people were part of the natural world and that the gods were manifested in the natural world. They made this idea part of the naming process. It is very significant. I always try to reflect on how they might have seen things. When reading Kamakau and others, who are part of the missionary era, I try to see the purity of their thoughts. To see things today through their eyes is hard. So the role fresh water played in this whole region, the relationship between Kāne and fresh water and Kanaloa and salt water, and how it manifests itself in the name of this place and everything associated with it.

7.2.6 Mo'olelo of 'Ōlohe O Lua at the 'Ewa-Wai'anae Gate

Mr. Kāne shares a *mo'olelo* of the *'ōlohe o lua* (skilled practitioners of a type of dangerous hand-to-hand fighting) practitioners at the gateway between the *moku* of 'Ewa and Wai'anae to

illustrate how the use of the term *'ōlohe* has changed through time, and, in doing, so, highlights the significance of the *moku* divisions:

> Pukaua is where Honokai Hale is today, just Makakilo and Ko'olina Resort. The high ground, Pukaua, was associated with Hawaiian warriors, the *lua* [a type of dangerous hand-to-hand fighting in which the, fighters broke bones, dislocated bones at the joints, and inflicted severe pain by pressing on nerve centers] practitioners. The stories that came out during the missionary period used the name *'ōlohe*, as if they were robbers. In the mid-1800s, a lot of visitors traveled from Honolulu to Wai'anae. They bought nice pieces of land in the Pearl City peninsula, and that was their summer retreat. Some tourists were getting robbed along Farrington Highway, which was a trail then. They used the name *'ōlohe*, but it was referred to as a robber. The ancient stories of Pukaua used *'ōlohe*, but with a different meaning. It references a *lua* practitioner. These training areas were for the guardians of security. They provided security at the borders. When you leave one district, there would be *'ōlohe o lua* practitioners. They were like the National Guard; not full-time soldiers. Their *kuleana* was the borders. I can use Wai'anae as an example. The Wai'anae mountain is a wall. Stories with *'ōlohe* associated with Pukaua, the eastern gate to Wai'anae. Other areas of *'ōlohe* were Mākua-Ka'ena Point—the western gate. Mākua were the guardians to Wai'anae from the western gate. The eastern gate was Kolekole Pass at Schofield Barracks. If you left your *moku* you left your home. If you go over the Ko'olau I am in a foreign land. Everybody knew each other. It was the same if you went from one *moku* to another.

7.2.7 Recommendations

Mr. Kāne was asked about his concerns for the proposed Honouliuli/Waipahu/Pearl City Wastewater Facilities Project and the potential impacts it may have on Hawaiian culture:

> I've had an opportunity to review the proposed expansion and conveyance lines within 'Ewa Moku. It is also my understanding the nature of the design and the depth of the transmission lines is to minimize impact to the surface cultural and burial layers. The likelihood of inadvertent burials at the points of deep excavation should be of a low probability. However it is also important to understand that there is never a certainty regarding burials. Your Project should have no effect to the cultural layer within the footprint of the proposed expansion and conveyance lines.

7.3 Arlene Eaton

CSH interviewed Arlene Wainaha Ku'uleialoha Nakihei Rayleen Brede Eaton (Figure 36) on February 22, 2011, near her home at the Iroquois Point Elementary School. Selections from this and previous CSH interviews (Cruz and Hammatt 2008; Vogeler et al. 2009) reveal a window into the traditional Hawaiian past on the western shores of Pu'uloa.

7.3.1 Family Background

Kupuna Eaton's maternal grandfather, grandmother, and several uncles had previously left Kohala on canoes in search of better places to live. While her uncles settled on Moloka'i and Maui, her grandparents discovered a coastal site at Ke'ahi on the western side of the entrance to Pearl Harbor in the *ahupua'a* of Pu'uloa within the *moku* of 'Ewa on the *mokupuni* (island) of O'ahu. Her *hāpai* (pregnant) mother, Mekia Nakihei Kawena'ole of Lāna'i, had been attending a *lū'au* (feast) in Ke'ahi when her contractions started. Kupuna Eaton, now 82 years of age, was born in Kapālama on November 11, 1927. William Eli Brede, Jr. and Jenny Kalehua adopted her as their *keiki hānai* (foster child) and took her to their residence at 1508 Kalihi Road. However, excessive asthmatic coughing at her new home tempted her family to restore the infant to the coastal waters of Pu'uloa. On her second day of life, she moved in with her *tūtū* at Ke'ahi and has continued to live in the area all her life.

Kupuna Eaton grew up in a traditional Hawaiian household. As her grandfather did not speak English, Kupuna Eaton grew up only speaking Hawaiian until she started school. After the military took possession of her family's land after World War II, she moved to nearby Kupaka, now known as 'Ewa Beach, and worked for 40 years with the telephone company until she became a *kupuna* with the Iroquois Point Elementary School. She is currently involved in several initiatives to preserve Hawaiian language and culture. She is a member of the Royal Order of Kamehameha, Hale o Nā Ali'i, the Hawaiian Civic Club of 'Ewa Pu'uloa, State president of the Business and Professional Women's Organization in 'Ewa, and founder of the Hoakalei Cultural Foundation.

7.3.2 Agriculture and Gathering

Kupuna Eaton lived with her *tūtū* in a grass shack on the coast at the entrance to the harbor of Pu'uloa. Only two other families lived in the area, one of which had a young boy, Mekia, who was her playmate and life-long friend. These two children played in the ocean and helped their families catch fish, gather *limu*, and gather salt. The area Ke'ahi was known as the "house of the *limu*" for its variety and abundance of *limu*. Each family had specific gathering rights for *limu*, such as *limu 'ele'ele* (see Appendix B for common and scientific plant and animal names mentioned by community participants). She also gathered *pipipi* (a variant spelling of *pipi*) for eating and for her grandmother to use the beautiful shells for making necklaces as gifts.

The area contained numerous salt pans. The Parish family, one of her neighbors, owned much of the land surrounding Kupuna Eaton's residence, which was passed on to her grandparents from Liholiho. They collected salt and operated a cattle ranch. Kupuna Eaton recalls that her first taste of meat came from the Parish's cattle. She preserved the dried cow meat, as well as fish, with the natural salt deposits, and also presented the salt as gifts to *haole* (foreigner).

Kupuna Eaton's *tūtū papa* (grandfather) gathered black feathers from the *'ō'ō* (black honey eater) and dark red feathers from the *'i'iwi* (scarlet Hawaiian honey creeper)—two special birds during the time of the *ali'i*. She never killed these birds for their feathers, but either caged the birds to pluck their feathers or patiently searched the land until she found solitary feathers that had fallen off the birds. She taught the young Kupuna Eaton how to sew these small feathers into belts of colorful patterns for gifts. She attached the feathers to a muslin base in a series of very closely spaced strips. She recalls the fortitude and patience required to sew these decorative

patterns. Sewing for half a day resulted in a single strip of feathers about 1.5 inches wide. To complete one belt took several years of diligent work. She shows several perfectly preserved decorative feather belts that she made in her childhood in the 1930s (Figure 37).

Kupuna Eaton remembers that her *tūtū papa*, a *lawai'a* (fisherman), built a two-man canoe and paddled it with her to Duke Kahanamoku's residence in Kou (Waikīkī) and into the lochs of Pu'uloa to trade their fish, *limu*, *pipipi*, salt, and bird feathers for other food items. She also walked as far as the lighthouse on Kalaeloa (Barber's Point) to share their food. Her family exchanged their marine resources for taro and *poi* from the vast *lo'i kalo* of the *mauka* regions of Pu'uloa.

7.3.3 Freshwater and Marine Resources

The 'Ewa side of Pu'uloa contains freshwater springs and *loko wai* (fresh water ponds) but no rivers. The growth of *limu* on the coast signaled the presence of small sources of brackish water to Kupuna Eaton. As a young girl, she gathered water that seeped out of the ground with gourds, boiled the water, and then buried the containers deep in the sand so that the underground movement of ocean water would keep the water cold. In addition, the area contained some coconut trees and the fallen coconuts offered sweet juice.

Kupuna Eaton especially enjoyed catching *he'e* (squid). Rather than using the traditional cowry shell-baited octopus lure, she lured the *he'e* by shaking a cowry shell with her hand. She allowed the octopus' tentacles to wrap around her arms. Once the body was within her grasp, she quickly and deftly ripped out its single pincer to avoid harm. She still has scars on her hands to show her mistakes of avoiding the sharp teeth. Sometimes she would catch a *he'e* with each arm and walk ashore with their tentacles wrapped around her arms while continuing to gather *limu*. Rather than being frightened, she enjoyed the massages she received from the *he'e*. On shore a touch of salt released the grasp of the *he'e*.

Kupuna Eaton shares a story from her childhood that centers on the *ae'o* (Hawaiian stilt bird) of the wetlands:

> My grandparents would punish me, but their way of punishing me was not hitting me at all. They would say to me, "You're not to go in the *kai*." Of course, even one day is like the end of the world. Maybe one week I couldn't go into the water. And it's only 25 to 30 minutes away from the water. So the next best place is to go into the *loko wai*, where the wetlands are. I called my friend to go over there. But he's *kolohe* [mischievious]. He teases the *ae'o* stilt birds. He can go because he has short hair and he teases them and runs. But when I turn around to run, I have braids and the *ae'o* would grab my hair.

7.3.4 Wahi Pana of Hoakalei

Kupuna Eaton noted that a woman named Hi'iaka swam in a pond in Honouliuli Ahupua'a and saw her reflection. Her response to the splendor of her reflected image, "Hoakalei" (lei reflection), served to name the pond.

7.3.5 World War II

On the morning of December 7, 1941, Kupuna Eaton and her family watched the start of the attack on Pearl Harbor. They moved to a coral cove near their house and observed the ensuing battle:

> When World War II broke out, we were out fishing early in the morning. You know, you could hear the planes. I said to my grandfather, "I wonder what's going on?" So he went to look outside because we used to take care of the ranch outside. All the *paniolo* [cowboys] outside were talking. I wasn't supposed to be listening, but I could hear my grandfather say to them to take care of the animals then go in the cave. There were different caves. I was in one with my grandfather and my *tūtū* was in another cave with the men. We were watching the thing that was going on. It was only later we found out what was happening. We didn't have a *ka'a* [car].

As the war progressed, the military escorted Kupuna Eaton to her school in Kalihi. She soon discovered that her Japanese friend, Fusae, was not attending school. She (Fusae) and her family had been placed in a detention camp. Kupuna Eaton's father walked near the camp to obtain fresh water from an artesian well and spoke to the Japanese prisoners with his daughter by his side:

> I ran up to her and then she came to me. Even when I talk about it now... I asked her, "Fusae, what are you doing here?" And we hugged each other. Then I realized that my dad told me that we were at war with the Japanese. I always thought [she] was Hawaiian because she's like me. But my Daddy said they put her in with her mother and the rest of them. The Japanese stuck them over in the prison. I don't how he did it, but my dad got them out. But she had changed, wasn't so close to me anymore.

7.3.6 Ka'ōnohi and Kalauao

Kupuna Eaton distinguishes between Ka'ōnohi and Kalauao. She describes Kalauao as the name of a stream and Ka'ōnohi as the name of a chief from Moloka'i who first dredged the waters of Pu'uloa.

7.3.7 Mo'olelo of Ka'ahupāhau and 'Aumākua of Pu'uloa

Kupuna Eaton recalls a *mo'olelo* about Ka'ahupāhau, the shark goddess of Pu'uloa. According to the legend, she and her brother entered a cave while playing, and a shark took them and transformed them into sharks. Their parents called out to them from the shore, and one day saw two small sharks—their children. Kupuna Eaton shares a gripping story of riding the sharks of Pu'uloa. While paddling, her grandfather talked and chanted to the sharks in Hawaiian. As they became more docile and approached the canoe, he ventured to ride them. One time he brought his granddaughter, the young Kupuna Eaton, with him. She recalls that the roughness of the shark's skin enabled her to ride the shark:

> I've ridden that thing. My *tūtū* used to ride that, the shark. When I tell them, people don't believe me. I feel close to Ka'ahu Pahau. My *tūtū* would get on the sharks, on the back. It is not easy riding those sharks, you can get cut with the skin. There were certain ones that would come up, and he would call them, hit the side of the canoe, feed them, talk to them in Hawaiian, and pretty soon he would jump over and ride away. They understand what he was saying. I never tried on my own for the simple reason that you cannot just do it if you don't know the *oli*, and it must be done right. As time went on I did get to know the *oli*, but by that time, it was like God saying, it is not your time. So I stopped.

7.3.8 Mo'olelo of Hāpu'u Tree Fern

In a previous CSH interview, Kupuna Eaton shared a *mo 'olelo* of the *hāpu 'u* (Figure 38) tree fern:

> My *mo 'opuna* (grandchild) called me. She teaches and is going to graduate from UH this year. Her brother Makana needed a story about *hāpu 'u* for a project.
>
> "Why didn't you go library?"
>
> "We looked, nothing."
>
> I gave her a story about my *Tūtū* when she was young about *hāpu 'u*. This boy took it down and took it to *kula* [school] and he got an A+. People don't understand that this area we had all this *hāpu 'u*. We had all these different kinds of plants that people never thought of. They think it's too dry. My *Tūtū* was born and raised here. She never left this area. Not even to go on a canoe or anywhere else. She stayed here. I remember her telling me, it was raining. The wetlands were a forest. She had gone to get *kalo* [taro]. Then it started pouring. She saw the *hāpu 'u*. She imagined it to be big enough for her to get under but she realized "*Auwē* [oh no]! I can't go under here, the rain will come through!" It was too rainy for her to get home and the only thing there was the *hāpu 'u*. Pretty soon she *oli* [chant] and *kāhea* [to call out] and asked for a place she could go under. One *hāpu 'u* opened its branches and another one opened over the little one and it covered right over her just like an umbrella. It rained and she sat under there. It was all *pau* [finished]; she was ready to go home. She went like that [motions hugging the *hāpu 'u*]. When she got home, my great grandmother said to her, "How come you not wet?" She said, "I gotta tell you something!" She said the story all over again. She said she'd never forget.
>
> I told my *mo 'opuna* he could add anything he wanted but don't exaggerate but what I said was the truth. It's such a small little thing, but imagine what had been in the forest. (Cruz and Hammatt 2008)

Figure 36. Arlene Eaton (CSH April 12, 2010)

Figure 37. Kupuna Eaton's hand-sewn decorative belt of *'i'iwi* and *'ō'ō* feathers from the 1930s (CSH April 12, 2010)

Figure 38. Hāpu'u Tree fern (*Cibotium Splendens*)

7.4 Ishmael Stagner

CSH interviewed Ishmael Stagner, *kama'āina* of 'Aiea and Pearl City and author of books about Hawaiian genealogy and hula on February 1, 2011, at the CSH office in Waimānalo. Selections from this interview and a previous interview conducted by CSH on March 22, 2010, (Genz et al. 2010) reveal Mr. Stagner's generational ties to the peninsula of Pu'uloa. Mr. Stagner highlights the importance of maintaining the integrity of the 'Ewa watershed, and also describes in detail the life of the sugar plantation era.

7.4.1 Family Background

Dr. Stagner, now 72 years old, was born to Ishmael Worth Stagner, Sr. and Pansy Akona Ka'ula in Wahiawa in 1939. He was raised in Pearl City where his family had a home since 1935 until they moved to Hālawa Heights in 'Aiea in 1950. In his youth prior to entering Kamehameha Schools, Dr. Stagner learned about the history and culture of Pu'uloa, O'ahu, and the other Hawaiian Islands through several *kūpuna*, including Sarah Nakoa, who was a writer of cultural traditions for KS, and Alice Kamokila Campbell.

7.4.2 'Ewa Watershed

The single most important feature of 'Ewa, according to Dr. Stagner, is its watershed. This fact is highlighted by the naming of the *ahupua'a* with the term *wai*, including Waiawa, Waiao, Waikele, and Waipahu. Mirroring the *ahupua'a* boundaries, water flows from the Ko'olau mountains down to the waters of Pu'uloa throughout a network of streams and an underwater system of tunnels. These contribute heavily to the Hālawa Aquifer, which now supplies the majority of the drinking water for the island of O'ahu.

Sugar cane was grown on the lands of Pu'uloa *mauka* of the present-day Kamehameha Highway. The upland streams were channeled to nourish the sugar cane. In 1957, the O'ahu Sugar Company began to clear the upper sugar fields in Mānana, severely disturbing the ground cover. Harsh rains in 1958 caused severe flooding, as there was no more upland vegetation to absorb the overflowing streams and excessive rainfall. Fast water flowing down Waiawa Stream caused the drowning of several people in Pearl City.

Makai of the present-day Kamehameha Highway was a floodplain that had formerly been dense with taro fields and rice paddies, and eventually watercress ponds. Dr. Stagner highlights the fact that each region had its own special variety of taro. With over 300 kinds of taro throughout the Islands, the freshwater taro of Pu'uloa was particularly productive. The Pu'uloa variety yielded four crops each year, enough to supply taro for one-third of the island of O'ahu. There were freshwater aquifer springs all over the region and *mo'o 'aumakua* guarded these tunnels of water.

The waters flowing down the streams and up through the aquifers eventually entered Pu'uloa. *Loko i'a* once occupied the intersection of land and sea. Small fish would enter these nutrient-rich waters, feed, and become too big to escape through the narrow channels. Hawaiians used to catch and feast on these fish.

Prior to Dillingham's dredging at the beginning of the twentieth century and the Navy's later occupation of Pearl Harbor, the channel to Pearl Harbor was narrow, and this restricted the movement of ocean water into the freshwater basin. Dr. Stagner's earliest recollections of his childhood life on the peninsula center on swimming and paddling canoes in the mostly fresh water. In fact, several people that grew up swimming in the Pu'uloa went on to compete in the Olympics. Dr. Stagner explains that one of the residents of the Pearl City peninsula, Clarence "Buster" Crabbe, won the 1928 Olympics by swimming faster than Johnny Weissmuller and Duke Kahanamoku. In addition, Dr. Stagner is aware of chants that describe how Queen Lili'uōkalani and King Kalākaua swam in Pu'uloa. In his youth he also hunted crabs and harvested clams in the *wai momi*, or the "pearl waters," that was a rich resource of pearls. According to Dr. Stagner, these waters were guarded by the shark *'aumakua* Ka'ahupāhau.

In a previous interview (Golin et al. 2007), Dr. Stagner depicts how the waters of Pu'uloa envelop Moku'ume'ume, the "island of attraction/strife," now commonly referred to as Ford Island. The term *'ume 'ume* refers to a partner-swapping game played by *maka'āinana*. Couples who were childless would go to the island and play the game during the full moon—switching possibly infertile partners for potentially fertile ones in hopes of becoming pregnant.

7.4.3 World War II

Dr. Stagner was only two and a half years old at the time of the attack on Pearl Harbor on December 7, 1941. Years later as a young child, Dr. Stagner began to stutter and the family physician hypnotized him to determine whether his stuttering was psychological in nature. Indeed, Dr. Stagner had experienced and remembered a traumatic event. The hypnosis brought him back to the morning of December 7, 1941, and the young Dr. Stagner recalled dramatic images of the battle that had ensued, especially the sights of the torpedo planes, which had to fly very low and slow to drop their heavy loads. The military had blocked the only road leaving the peninsula, so Dr. Stagner and his family could not leave until later in the afternoon. That evening, they were placed in the social hall of the Waipahu Sugar Mill.

7.4.4 Sugar Plantation and Baseball

"The plantations were the fabric of life until the 1960s," according to Dr. Stagner. In particular, he draws out a connection between the growth of American baseball and the sugar plantations on O'ahu. He states that "One of the things I don't think anybody understands is that without the plantation system in Hawai'i, we would never had American baseball as we know it today." In 1849, Alexander Cartwright, who is credited with inventing the modern game of baseball, came to Honolulu en route to California to search for gold. Mr. Cartwright stayed on O'ahu to start several businesses and served as the fire chief on Honolulu. Significantly, he also introduced baseball to the sugar plantation communities, which gave the workers something to do so as to not fight amongst themselves. Competitive leagues quickly formed along ethnic lines, with Hawaiian, Japanese, Filipino, Chinese, Portuguese, and *haole* teams. Dr. Stagner did not work in the plantations himself, but he played for the Rural Redsocks in Pearl City and became envious of the workers' growing collective enthusiasm for baseball. Each plantation camp constructed its own baseball field, which became one of the central arenas for social interaction. Island-wide games were held, and several local plantation teams integrated their ethnicities to strive toward the championship game. Each plantation community, such as the 'Aiea Sugar Mill, recruited their nine best players to form a strong multiethnic team. A strong interest in baseball arose from these plantation teams, such that the best leagues today on O'ahu are descendents from the former plantation communities in the 'Ewa plain. Dr. Stagner makes another connection between the plantation baseball and the Japanese internment camps of World War II:

> What makes this even more interesting is when we had World War II and we sent our island Japanese over to internment camps, one of the ways they were allowed to recreate was by playing baseball in the camps. Later on, many of them joined the military. They are still playing baseball and become forces of occupation in Japan. So there were Japanese-Americans playing baseball in Japan, and they recruit Japanese players. Now you have an entire generation of Japanese playing the American major leagues who are the direct descendents of those Japanese who

went over as American soldiers whose grandparents played baseball for the Hawai'i plantations.

7.4.5 Mo'olelo of Po'o Hilo

Dr. Stagner shared several *mo'olelo*, including a description of night marchers. The district is famous for night marchers, Dr. Stagner commented, referring to the belief that following the lunar calendar, on certain nights (the nights of the gods—Kū, Akua, Lono, Kāne and Kanaloa) a procession of ghosts known as *huaka'i pō* or *pō kāne* (night marchers) can be seen and heard as they travel to familiar places they once frequented when they were alive. Long before the mass deaths from the epidemic of the influenza epidemic of the 1920s, and the WWII attack on Pearl Harbor, a major battle fought in the 1500s led to legions of night marchers in the Pearl Harbor region. He told the story of Po'o Hilo (Hilo's Head) about a chief, who came from Maui to conquer O'ahu. A resistant force awaited the chief at East Loch and overcame his forces, decapitating the chief's head and urinating on the head of their adversary. Hilo's head was placed on a staff for all to see as a cautionary message to any potential conquerors. The area remained untouched until the 1700s when Kamehameha came and took over Pearl Harbor.

7.4.6 Mo'olelo of Ma'ilikukahi

Dr. Stagner also shares the story of the sixteenth century chief Ma'ilikūkahi from the 'Ewa plain. He decides to develop O'ahu into seven self-sustaining *moku* along with the smaller *ahupua'a* subdivisions. The idea was that anyone coming to O'ahu to invade would be defeated because the armies from each *moku* could defend the entire island. Dr. Stagner clarifies that the armies mainly defended their water. Dr. Stagner stresses that O'ahu has the greatest amount of underwater reserves of all the Hawaiian Islands.

7.4.7 Cultural Properties

In his youth, Dr. Stagner hiked in the *mauka* regions in 'Ewa with his Boy Scout troop, and discovered several petroglyphs and *heiau*. Dr. Stagner explained that there had been an influenza epidemic in the 1920s and many Hawaiians were buried in the area that was abandoned and eventually taken over by the 'Aiea Sugar Mill. Many of the plantation workers moved rocks, not knowing the cultural significance of the rocks that could have been associated with Hawaiian burials or other cultural sites.

7.4.8 Concerns and Recommendations

Dr. Stagner's main concern is the management of the 'Ewa watershed. The *kūpuna* from his youth told him that the upland regions must be conserved in order to prevent excessive runoff and lowland flooding. Historically, surplus water was channeled toward the 'Ewa plain. Dr. Stagner advocates protecting agricultural and conservation lands of Waiawa in particular, as they are the most vulnerable to future development. In other regions in 'Ewa, there are already documented cases of lowland flooding during times of heavy rains due to inadequate drainage of the water. Dr. Stagner draws upon the historic flood of 1958, which occurred after the sugar cane was cleared, to highlight that the disturbed ground cover prevented adequate absorption of the overflowing streams and excessive rainfall. Similarly, recent floods in the more developed

regions, such as the Palisades, have occurred due to heavy urbanization with inadequate drainage. Hence, the *mauka* regions of Waiawa and neighboring *ahupua'a* must not be developed and the highland streams must be regularly cleared and maintained to prevent future lowland flooding.

7.5 Tin Hu Young and Helen Kealiiwahineulawenaokola He'eia Colburn

CSH met with Tin Hu Young and his wife, Helen Kealiiwahineulawenaokola He'eia Colburn (Figure 39), on January 26, 2011, at their home in Waiawa near the shores of Pu'uloa. In addition, CSH previously interviewed Mr. Young at the Kawaiaha'o Church on January 6, 2010 (Genz et al. 2010). Selections from these two interview transcripts reveal Mr. Young's generational ties to the area and the deep history of Waiawa and the waters of Pu'uloa.

7.5.1 Family Background

Mr. Young was born in 1927 and has lived his entire life in Waiawa near the shores of Pu'uloa. Mr. Young traces his family background through two distinct ancestral lines of descent—his mother's Hawaiian and Portuguese ancestry and his father's Chinese ancestry. Mr. Young's Chinese background has been chronicled for 24 generations by tracing the generations from father to son. Two generations ago within this familial timeline, Mr. Young's grandfather, Young See Hop, migrated to Hawai'i from China. Despite this deep family history, Mr. Young calls attention to his Hawaiian heritage.

Mr. Young's mother was Elizabeth Kahiku Johnson. She was the daughter of Pedro Manini Johnson (born about 1871 and died May 28, 1925) and Pa'ahana (born about 1860 and died 1927). Pedro Johnson—Mr. Young's maternal grandfather—worked as a cowboy with the O'ahu Railway and Land Company for his brother—Mr. Young's granduncle—Johnny Johnson, who was a ranch foreman for the Dillingham family. Another brother, Enoka Johnson (born May 3, 1857) served as secretary to Prince Jonah Kūhiō Kalanianaole. Their parents were Ambrose Johnson (born about 1832) and La'amaikahiki Wahine (born about 1834), who was born in Mānoa Valley.

The La'amaikahiki family traces their lineage to the first settlers that landed on the shores of Pu'uloa. Today, Mr. Young continues to reside at this location at the mouth of the Waiawa River, which is also referred to as the Pearl River. Mr. Young elaborates on the connections between La'amaikahiki and Kamehameha, and the family's land at the mouth of the Pearl River:

> The interesting thing about all this is on my mom's father's side, my grandfather's mom was La'amaikahiki Wahine. And her family actually lived at the mouth of the Waiawa River here, right here in Pearl Harbor, Pu'uloa.
>
> Well here, this land here belonged to my side of the family, through the La'amaikahiki. As you know, he was one of the earlier settlers in Hawai'i. La'amaikahiki, that is where he landed. One of his four wives is from here. That's us, our family. The original migration, right here at the mouth of the river. That's also the area where the Colburns settled, the descendents of Don Francisco Marin.

> My great-grandmother, La'amaikahiki Wahine, was born in Mānoa Valley in about 1834 where Queen Ka'ahumanu resided. Queen Ka'ahumanu had died two years earlier. So La'amaikahiki Wahine's father, Timoteo La'amaikahiki was considered like a *kaukau ali'i* [class of chiefs of lesser rank than the high chief]. *Kaukau ali'i* was the ones you captured. That side of the family lived at the mouth of the Waiawa River and that's the area where the Colburn family occupied. John Colburn, who was the Secretary of Interior for Queen Lili'uokalani, resided nearby. That particular spot was next to Pāu'au'au, a sacred pond. Our family originally lived there and Kūkaniloko [on the Big Island], where the sacred *heiau* was located. So when Kamehameha invaded our lands of the family we became subjects of Kamehameha. The family really dispersed and went into hiding. Then Kamehameha died in 1819. Next, the missionaries came over after we went underground. We ended up supporting the missionaries through Ka'ahumanu. She was the one that got the Hawaiian chiefs and herself to give up lands in Mānoa so that the missionaries could establish themselves in Hawai'i. Through her, she did the same thing, Ka'ahumanu did the same thing in Lāhainā for Lahainaluna High School.

Mr. Young continues to describe his family connections to Queen Ka'ahumanu, the arrival of the missionaries, and the founding of the Kawaiaha'o Church:

> Part of my *'ohana* was Thomas Hopu that landed with the missionaries in Kawaiaha'o, was told that the royal entourage was in Kailua-Kona probably where the Hulihe'e Palace is now in Kona, might have been around the King Kamehameha Hotel in Kona. He went there to get an audience with the Queen Mother, or Queen Ka'ahumanu, of course you know the story of Queen Ka'ahumanu. She was just one of the wives of Kamehameha, but she was beautiful and strongest at that time. Although she couldn't have children, she ended up taking care of Kamehameha's two sons, Liholiho and Kauikeaouli. So, you know Hawaiians sometimes have this knack for, there's this place for you in society. Look at Ka'ahumanu, she was the favorite of Kamehameha, was kept *kapu* at a young age at 13 on for Kamehameha to become his wife, yet he was smart enough to marry actually the enemies' side, the highest ranking wahine [woman] to have his children. Of course he wanted them to be born at Kūkaniloko so they have this extra *mana*, from this special spot, but somehow they were never born there at Kūkaniloko. There is a lot of history connected here. When my Hawaiian side was dispersed and went into hiding somehow, they came out hiding when Kamehameha died and came under the protection of Ka'ahumanu. And that was Timoteo La'amaikahiki, he's even listed as one of the early people who joined the Kawaiaha'o Church. Of course at the top of that list was Ka'ahumanu herself. She died in 1832 and Timoteo officially joined the church two years later. After that time it was just *kaukau ali'i*, whatever she said and wanted him to do, he did it.
>
> See when the missionaries landed at Kawaihae [Big Island] and went to see that Queen Ka'ahumanu was there with the Queen Mother and other royalty, they

went there to get permission for the missionaries to go to Honolulu to start preaching the gospel of Jesus Christ. Of course, they are from the Calvinist line, they were Protestants. At that time, there Protestants of many different sects. So John Calvin out of England went to Holland but couldn't settle there and ended up coming in to Plymouth Rock, so those people there were the ones who started America. A lot of people don't realize these same families that started America at Plymouth Rock were part of the same family that came over to Hawai'i to spread the gospel of Jesus Christ. So we really have deep ties to way back. When they sent Thomas Hopu to Kawaihae to get the attention of the queen, he was taking a chance. They could have killed him. Who was he, right? But he did get to speak to Ka'ahumanu but she didn't know what they were up to. Ka'ahumanu was a beautiful woman. In ancient Hawai'i, big was beautiful and she was big. But not only that, she was strong too. She could surf, very athletic. She was beautiful not only physically but mentally too. She knew what to do. She was very skeptical about the missionaries. So she told them you can stay on the Big Island for one year, to see what you guys are up to. So when she got to learn about the gospel and Jesus Christ and so forth, she really, pardon the expression, saw the light. 'Cause you got to remember at that time the wars of Kamehameha was over, the place was in chaos. The people's *heiau* was desecrated. The people needed a new religion. And the funny thing was their *kahuna* were told they would get one way ahead before the missionaries came. Then Hiram Bingham landed with all these young missionaries who had to get married before they came on this trip because they had to be serious about spreading the gospel of Jesus Christ. So prior to that, during the wars of Kamehameha, Henry Opukaia had lost his mother and father during the wars of Kamehameha so his uncle was one of the *kāhuna* of the *heiau* and he was just a teenager and he had asked his uncle if he could start a new life somewhere else. So he somehow got onboard an American vessel that probably went to China and ended up in Boston. Thomas Hopu came from this area too. This land, in the back here, where we live right now, is part of that Hau'upu land. See, his name was really from the Hau'upu family, but the missionaries wrote it HOOPOO cause they didn't know the correct pronunciation, but it really Hau'upu and that ended up Hopu.

Mr. Young describes his wife's family's connections to Kamehameha:

Of course in the past that whole area was taken over by Kamehameha, you know, and also amazingly by my wife's side through the Marin family. Don Francisco Marin was originally a Spanish trained cadet in the Navy and ended up in Hawai'i with a ship of his own, and he became allied with Kamehameha since he had such good knowledge of warfare and especially how to use firearms. The key to all that was keeping the gun powder dry and of course the Hawaiian way with grass huts and thatch roofs wasn't good enough to store gun powder, so he had men who were expert in masonry. In a way, he and his son eventually even had a decision in using the type of material that would be used in constructing Kawaiaha'o Church, using coral as the base material to construct a large building. When they

used sailing vessels, it wasn't practical to ship bricks here to Hawai'i and even lumber was costly, you couldn't do that too much.

Going back to the Spanish Don Francisco Marin that my wife is related to, his eldest child was Maria Cruz and Mr. Marin was a very good family man that kept very good records of his children. Of course, he was a Catholic. His first daughter Maria Cruz married a ship's captain by the name of Maughan, sounded like that pirateer Morgan, but it is actually spelled MAUGHAN, that kind of Maughan. They had two children, a boy and a girl, I forgot what the boy's name was, the girl's was Elizabeth. She married a Colburn, and that is where the Colburn side comes in, my wife is a Colburn. Of course when Don Francisco Marin was allied with Kamehameha at the time Kamehameha was consolidating the islands into one kingdom, Kamehameha assigned Don Marin all this area of Pu'uloa, Pearl Harbor, Waiawa, Waikele, Mānana, Kalauao, all the way to Hālawa. All this area here.

7.5.2 Marine and Freshwater Resources

Mr. Young speaks of the intense productivity of the marine and freshwater resources in and near Pu'uloa:

Before that if you read excerpts from Kamakau and other writers, this particular area here, La'amaikahiki was from Tahiti and had a Tahiti connection, so the people of this area would always thank our patron saint, wahine from Tahiti, for their wealth. In fact this was a breadbasket in the ancient times. It had fish, crab, oysters, clam, it had everything. It was a rich area to live, you would never starve. I can remember my mom saying when she got the place on the Big Island she noticed how harsh the people had to live there with the lava flows and no running streams. They had to plant dryland taro. Over here they had wetland taro, which was *'ono* [delicious]. It's like that the good tasting *poi* going to Hanalei, fresh water.

Of course at that time Hawaiians had developed pearls in Pearl Harbor, what was growing naturally. The Hawaiian pearl was a source of income and although the pearls weren't as well cultivated they were colorful and a little smaller though.

But, the real wealth of this place here, Pu'uloa, was because, this whole area that surrounds Pearl Harbor, they are called like Waipahu, Waikele, Waiawa, Waiau, tells you that the source of water here is great. Everything pours into Pearl Harbor. According to old Hawaiian legends and stories, in reality Hawaiians considered *waiwai* [wealth], water is wealth, not oil, not gold, not silver, but water was the wealth of our place here, in Waiawa. Although Waiwa might refer to the water, the *'awa* that's growing up in the mountains. And with the water source, Waipahu might be related to the pounding of the water like the drum, you know, so that's the wealth here, the water.

In a previously recorded interview, Mr. Young elaborates on the meaning of Waiawa, the cultural salience of *'awa*, and the imagery of flowing water that the *'awa* roots evoke for him:

> In fact, the name 'Waiawa' means water and *'awa*. You know the meaning of *'awa*? *'Awa* is that kava kava root that you drink, Hawaiians call it *'awa*. I kind of didn't like the idea they called it 'bitter water.' Because *'awa* is a little bitter when you drink it, so Waiawa—Waiawa Valley was an area known in the ancient days of harvesting *'awa* root. It was a ceremonial drink that they had. Of course in the old days only the royalty used that root, until later on, and then the commoners would use it. Then you could sell it in the market and go buy it, like other things. So, Waiawa was a source of that. But, I like to think that the meaning of 'bitter water' for the name Waiawa, to me, could come from—because the area is the farther lot, the bottom on the lowland, *mauka* of Pearl Harbor. And when I used to watch the water, the rivulets would come twisting and turning like little *'awa* roots, twisted. If you ever harvest that *'awa* root, you got to see, it's like a big root coral. It's all tangled into each other. And it reminds me, when it flooded down in the lowland, all these little rivulets, twisting and turning, like the *'awa* root. But it's just my romantic—it's just because I live there. I don't want them to say, Eh you live in bitter water? But, we do have good drinking water if you drill a well at the proper depth. All these little *'āpana* [land section], like Waiawa, Waikele, Waiau, Mānana, Hālawa, Kalauao—you know, they all have spring water, some natural. But if you dig too deep, you hit the salty water. And if you dig too shallow, you don't get enough pressure. They like to dig their well deeper to get more pressure, but when you do that, you let more salt get into your water system. But there's good water there.

In a previous interview, Mr. Young detailed the significance of the waters of Pu'uloa to the ancient history of the settling of O'ahu:

> The reason why we chose that title for Arlene Ching's, *The Pathway to Mānana, the Pathway to Pearl City*, was the fact that in the ancient days when the Hawaiians settled on O'ahu, one of the pathways was through Pu'uloa, Pearl Harbor. That was the perfect place for the canoes to come in. And later on, the sailing vessels came in, and then that lead to the Pearl Harbor we know today.
>
> Pearl City proper, where Lehua Avenue runs down to the peninsula, in the very old days that wasn't considered a very good place to live. Why? 'Cause there was no springs around there. They wanted to live in this kind of area like Waiawa with all the springs. Even up to today, all these houses up here *makai* of the Gardens have their own wells. They still relying on the old springs.
>
> Prior to the taro patches, most of this land all the way from Waipahu High School down to the peninsula where the Colburns lived, was actually a giant fishpond, two fishponds in one.

Mr. Young reminisces about fishing for mullet as a child. In doing so, he explains the ecology of mullet, which involves traveling from the ocean through the brackish waters of Pu'uloa and upstream to the spring-fed taro patches:

> You needed the ocean to flush the harbor out. We had a lot of fish like the mullet that were accustomed to the salty and brackish water. You have to have the mix of brackish water. Pearl Harbor was ideal. When we were kids it was almost the same as when I read some of the readings by Kamakau. He would say Pearl Harbor and this area was so rich that when the mullets went upstream, it wouldn't be just one school, but [saying rapidly] school after school after school after school, like that. Then as a young boy [saying slowly] school after school after school. In other words, in the ancient days was constant, but when I was a kid not that constant, started to diminish. Today, lucky to ever see a school of mullet, right here in this river.
>
> What we do when we kids, after school run down to the bridge, so much mullet going by all you have to do is jerk up and have a fish. Just jerk it, forget bait. That's how good it was. In those days the river was clear. You don't have these sewer lines. The mullet would come upstream when it was clear and come up to these areas cleared off. If this stream from this land went to this bridge, the mullet would come all the way up through the lock through west lock through the stream and into your little taro patch. And breed, even if no taro just swampy land, it was still okay 'cause the water was coming from the stream. Then breed and go back out again, a constant replenishment of your fish. Guess what, the crabs get good eat. And when we were kids it was common to go out and get a gunny sack full of crabs. In the old days if you had one of these little streams running through your property, the guys at the top couldn't put all this crap or stop it, has to let it down so your taro patch gets filled and the water goes back to Pearl Harbor.

7.5.3 Pearl City

> Of course, when I grew in this area, like I told you originally, I was born in the peninsula area, the area bounded by Lanakile, Lehua Avenue today, in that particular area in 1927. I grew up there and when the war broke out, we didn't move out right away until the Navy bought up all the property and moved downtown to the Makiki area. My mom also got property on the other islands, away from the target area, you know Pearl Harbor during the war. In fact from our place you could see the Oklahoma from where we lived. It wasn't too far from, right across the street in our area there, was where Mr. Fuller, who was a good friend of FDR, Franklin Delano Roosevelt, so I think they were classmates at one time, knew each other well. He came down to Pearl City in 1934 and I can remember when we were young children we had to go out and gather flowers so when the President went by we sprinkle them on the road, garlands. And I remember Mr. Fuller down in Pearl City not too far from where we lived, and where Mrs. Guigni lived, and she was asked by Mr. Fuller to decorate his house to give it a Hawaiian feeling to make President Roosevelt welcome, so that's what

> they did. Mrs. Guigni's son, Henry, became sergeant-of-arms of the United States Congress. Of course he, for years he worked with Senator Inouye and we were childhood friends, good neighbors. We really enjoyed living down at the peninsula area, it was like a miniature suburb when I was a kid. A lot of the kids there, their families worked for the military or worked at Pearl Harbor, or other military installation on O'ahu. My dad was a plumber, a pipe fitter really. He worked on the Navy ships, the Navy yard. My oldest brother also worked in the machine shop in the boat division.

7.5.4 World War II

Mr. Young describes how his life on the peninsula of Waiawa changed with World War II:

> Prior to the war, somehow when we were kids there, we could ride the ferry from the peninsula to Ford Island. All the kids that lived there could do that with their fishing poles at the coal docks and all these other facilities they had there at Ford Island. That was prior to the war. When the war broke out, it was very strict, couldn't do that. By that time we still had our place on the peninsula but my mom wanted to get away from the target area so we lived on Kewalo Street in Makiki, from there I went to Kamehameha School. But we still had our home on the peninsula, when the Navy bought everybody out, we had to go. But I remember when we got home after the December 7 bombing; there was so much shrapnel in our yard. We were so close to the battle site. Soon after the bombing, the military set up a camp at the Pearl City Tavern. They also had these big search lights set up at Pearl City Tavern looking for enemy aircrafts.

7.5.5 Agriculture

Mr. Young has seen tremendous land use changes in Waiawa. He notes that before he was born, the land *mauka* of Kamehameha Highway was heavily forested, but then it shifted to grazing land during his childhood and later to sugar cane. Farther *makai*, the lowland regions were used primarily for taro and rice cultivation. Mr. Young describes the cultivation of taro and rice on his family's land near Pu'uloa and the growing of sugar cane farther *mauka*:

> Yeah, right behind me [is Hā'upu land]. Yeah, and my cousin and aunt used to reside there. That part of the family resides now in San Diego. My family and I on this side, my dad and I have always taken care of this property. This is a flood zone, a flood zone area. When I was a kid, all this area was lowland for taro patches, all this area here. And later on when rice became profitable it was rice. And up on the hill was all sugar cane where Leeward College is.

Mr. Young describes an interesting connection between his wife's family, who operated the sugar mill, and his father's family, who grew the rice:

> When I was a child it just switched over from taro to rice. My grandfather was actually was a rice grower, on my Chinese side. He was a rice grower in this particular area. My dad married my mom, who was from here, so they had a lot of

> property to grow rice. My wife's side, the Colburns, owned the mill and my grandfather would lease it to thrash the rice. In those days, they had water buffalos all over to cultivate the rice. The family joke is I had to marry a Colburn to get our land back [laughs]. But that's just a joke.

Mr. Young describes how the area around Pearl Harbor had an abundance of food:

> This area around the Pearl Harbor was known as our "bread basket" of food. As a kid here, you could never starve. You could fish off the eighteenth bridge and catch mullet using bread as bait. You could dig up clams enough to stuff a bag in no time. On the land we had bananas, papayas and taro. When Wai'anae had famines, they would come to Pearl Harbor and raid our food and take it back to Wai'anae. Our place was known to be stocked with food.

7.5.6 Mo'olelo of the 'Aumākua of Pu'uloa

Mr. Young shared a *mo'olelo* about the *'aumākua* of Pu'uloa—the *manō* (shark) and *pueo* (owl)—and in doing so, reemphasizes the intense productivity of Waiawa and surrounding lands of Pu'uloa:

> Pu'uloa was the home of the shark, that's our *'aumakua*. We have two, the shark and owl, *pueo*. The interesting thing about this when I went to school at Chaplain College in New York after the war, my engineering teacher, Dean Canon, was a young engineer at Pearl Harbor building Drydock 1. At that time the local people were saying they better make a dedication or *lū'au* to celebrate that 'cause where they are digging is the home of the shark god. The moment they open the doors to the drydock, it collapsed. Number 1 drydock. When they went to rebuild it they found a huge cave with a whole skeleton with a shark.
>
> This area was like a breadbasket in the old days. Our *'aumakua* used to warn our people here in this area of the raiders, like Wai'anae, Nānākuli, when they had a drought or hard time, they would come over on the canoes and raid the Pearl Harbor area and raid our people. Our people knew what was going on. The owl warned us, but we knew that these people over there needed food, so we would all lay low, we didn't fight them, we let them have it because we had so much here, and we might be *'ohana*. That is the story I heard from my parents. The older stories that came through chants and *mele* were about this area being so fruitful.

7.5.7 Mele of Pa'ahana and the Pā'au'au Waltz

Mr. Young and his wife mention two songs that connect directly to their family—*Pa'ahana*, and the *Pā'au'au Waltz*. The *Pā'au'au Waltz* was composed by John U. Iosepa for the Colburn family, who lived next to the sacred pond Pā'au'au on the peninsula of Pu'uloa. Mr. Young briefly outlines the *mo'olelo* of Pa'ahana, his maternal grandmother. His maternal grandfather, Pedro Manini Johnson, found Pa'ahana in the Ko'olau mountains, and this moment was captured in an enduring song. Although Mr. Young and his wife could not recall the lyrics of the song in

full, its importance to the history of their families warrants reproducing it from Elbert and Mahoe's (1970) *Nā Mele O Hawai'i Nei*:

He inoa keia no Pa'ahana	This is a name song for Pa'ahana
Kaikamahine noho kuahiwi	The girl who lived in the hills
Mele he inoa no Pa'ahana	Namesong for Pa'ahana
Na'u i noho aku ia wao kele	I lived in the rain forests in
Ia uka 'iu'iu Wahiawa	The distant uplands of Wahiawa
Mele he inoa no Pa'ahana	Namesong for Pa'ahana
'Opae 'oeha'a o ke kahawai	Clawed shrimps of the streams and
'O ka hua o ke kuawa ka'u 'ai ia	Guava fruits my food
Mele he inoa no Pa'ahana	Namesong for Pa'ahana
Mai kuhi mai 'oe ka makuahine	Don't think about the mother
A he pono keia e noho nei	I live here and am glad
Mele he inoa no Pa'ahana	Namesong for Pa'ahana
'O kahi mu'umu'u pili i ka 'ili	A single mu'umu'u clings to my skin
'O ka lau la'i ko'u kapa ia	My blankets are ti leaves
Mele he inoa no Pa'ahana	Namesong for Pa'ahana
Pilali kukui kau la'au	Kukui gum on the trees
Lau o ke pili ko'u hale ia	And pili grass my home
Mele he inoa no Pa'ahana	Namesong for Pa'ahana
I hume iho au ma ka puhaka	I bind my loins
I nalo iho ho'i kahi hilahila	And hide my private parts
Mele he inoa no Pa'ahana	Namesong for Pa'ahana
I ho'i iho ho'i au e pe'e	I came and hid but was
'Ike 'e 'ia mai e ka 'enemi	Seen by the enemy
Mele he inoa no Pa'ahana	Namesong for Pa'ahana
Lawa 'ia aku au a i Manana	I was taken to Manana
Maka'ika'i 'ia e ka malihini	And visited by strangers
Mele he inoa no Pa'ahana	Namesong for Pa'ahana
Ha'ina 'ia mai ana ka puana	Tell the refrain
He mele he inoa no Pa'ahana	A song, a name for Pa'ahana
Mele he inoa no Pa'ahana	Namesong for Pa'ahana

7.5.8 Cultural Properties

When asked specifically about cultural properties in Waiawa and surrounding areas, Mr. Young describes Pā'au'au, a sacred pond on the peninsula that has been filled in, and he talks of a *heiau* near the waters of Pu'uloa:

> The only thing up *mauka* there [on the hill by Leeward College] are stone formations that look like they came from somewhere else, maybe a *heiau*. Of course this hill here was an old *heiau* where the housing is, right up here where you park the cars at Leeward College. I think there was an ancient *heiau* there. My grandmother was buried there, right next to the surveyor's bench mark. That's where the first church was built in this area.

7.5.9 Historical Development

Mr. Young's home is surrounded by land leased from Kamehameha Schools. Mr. Young describes the history of development of this land:

> The family always lived up higher, 'cause this was all flood land. This lower part was all flooded. The best part was to live up. You know when you went through the back of the subdivision, all these old houses, all of that used to be the primary area where you used to live. That was land. All back of us that were all taro land. The only time you can fill in the land is with the Army Corp of Engineers *kuleana*. Any land that is in the flood zone or that is a swamp land or land near a river is under their control.
>
> We've always been filling in little by little. You could only do that if you lived on the land. When I was a kid, all the land was swamp, taro or rice paddies, all low land. From Waipahu High School all the way to Pearl Harbor all the way to 'Aiea all the land was like that. From here going up to Leeward College, there is 21 connections for sewer. What does that tell you? When we were kids, as soon as they put the sewer line in, that place was going to go, because humans take over. One generation thinks different from the next. That's how it develops. They didn't have to put 21 connections in the swampland, which means there is a future there for housing. That's what happened to all these places.

7.5.10 Concerns and Recommendations

Mr. Young and Mrs. Colburn were asked about concerns for the proposed Honouliuli/Waipahu/Pearl City Wastewater Facilities Project and the potential impacts it may have on Hawaiian culture:

> Our main concerns for this Project are flooding in the area and sewer backup. If they build the pump stations and its facilities here along the shoreline from Honouliuli to Hālawa, when we have one of those big storms like we've had this winter, flooding may cause the pump stations to overflow into the surrounding areas and into Pearl Harbor. It has happened before. We recommend that the flood control system for the Pearl City/Waiawa area be addressed and updated to prevent flooding in the lower plains of this area, which may cause a failure in the new proposed sewer system.

Figure 39. Tin Hu Young and Helen Kealiiwahineulawenaokola He'eia Colburn (CSH January 6, 2010)

7.6 Mel Kalahiki

CSH interviewed Mel Kalahiki on February 22, 2011 at his home in Kāne'ohe. He was also interviewed in 2008, 2009 and 2010. Mr. Kalahiki, now 85 years old, was born on June 25, 1925 to Kamaka Kalahiki of Kahalu'u and Elisabeth Akau of Kohala. He worked within the Council of Hawaiian Organizations to establish legislation that formed OHA. Mr. Kalahiki also formed 'Ahahui Mālama o Kaniakapūpū to help preserve the summer home of Kamehameha III in Nu'uanu on the island of O'ahu.

7.6.1 Family Background

Tracing his lineage to Kamehameha, Mr. Kalahiki carries a deep responsibility to "carry on Kamehameha's wishes," including the preservation and perpetuation of Kamehameha's knowledge and accomplishments. In 1995, Mr. Kalahiki conceptualized and organized a bicentennial commemoration of the 1795 battle of Nu'uanu. The Council of Chiefs of Pu'ukoholā Heiau led about 1000 people on the general path of the battle, starting at Kapi'olani Park and Waikīkī Beach to symbolically commemorate the arrival of the canoes, and then up Nu'uanu Valley to reach the precipice of the Nu'uanu Pali.

As a child in the early 1930s, Mr. Kalahiki spent several years at Kawaihae living with his grandfather, William Paul Mahi-nauli Akau, at the foot of Pu'ukohalā Heiau (which Kamehameha built between 1790 to 1791) on the Big Island, so his memories and ties to the *heiau* are very strong. He understood then the legacy of Kamehameha—when he saw Pu'ukohalā Heiau, he "saw things through the eyes of Kamehameha," as the structure of the *heiau* had become "the essence of Hawaiian wisdom."

7.6.2 World War II

When Pearl Harbor was attacked in 1941, Mr. Kalahiki, a high school student at the time, left school to work for the United States Engineering Department (U.S.E.D.) based at Fort Shafter in Kalihi, O'ahu. During his tenure with U.S.E.D., he participated in the excavation project for the military bunkers in Kīpapa Gulch in 1942:

> I remember working in Kīpapa Gulch after the war; it was during the "Blackout" period. I was a truck driver and I was getting $1.50 an hour and that was big bucks. One of my uncles was working on the docks and he was getting $1.00 an hour and I used to brag about my $1.50. There was only one way to get in Kīpapa and that was Kamehameha Highway. We were working right on the bridge in the gulch. The engineers would stick dynamite in these holes and they would blast them off and I would back my truck in there and they would load the muck into my truck. I would take the muck a short ways away to unload and then go back for more. As I remember each of the bunkers were 25 yards in and about 10 feet wide by 10 feet high. None of the bunkers connected together because if one blew up, they didn't want the others to be affected.

The military bunkers Mr. Kalahiki is referring to are still present today in Kīpapa Gulch. There are over 30 bunkers approximately 100 meters apart along the sides of Kīpapa Gulch. These bunkers are sealed shut with metal brackets welded to the doors to keep people out. When

asked about the sealed doors to the bunkers and its possible contents, Mr. Kalahiki shared this story:

> When I was working in the Kīpapa area excavation, I had been there for about a year and a half. My coworker, his name was Jim Albertini, and I were standing on the bridge over Kīpapa stream and we were watching the military load and unload equipment in the bunkers. As we watched them from above, we saw what we believed was an Atomic bomb. Jim had heard rumors circulating in the area that the atomic bomb was being stored in the bunkers that we built. I was convinced that what we were seeing was an atomic bomb. Of course by now, the talks around the job site was all about the Atomic bomb in the bunker. Everyone believed on our job site was a serious weapon stuffed in the bunker we built. The sad part about this whole thing was that when we bomb Japan and we heard about all the people that died, we felt bad for the people who had lost their lives. It was as if we were a part of the bombing because we had it stored in our bunkers. It was a real uneasy feeling.

7.6.3 Concerns and Recommendations

Mr. Kalahiki was asked about his concerns for the proposed Honouliuli/Waipahu/Pearl City Wastewater Facilities Project and the potential impacts it may have on Hawaiian culture:

> I am concerned for the water tables as the boring machines dig the underground tunnels. I do not believe they will harm any Hawaiian cultural sites during this Project but in the event there is a cultural find, please contact the appropriate organizations and individuals representing that area.

Section 8 Cultural Landscape

8.1 Overview

Discussions of specific aspects of traditional Hawaiian culture as they may relate to the Project area are presented below. This section examines cultural resources and practices identified within or in proximity to the subject Project area in the broader context of the encompassing Honouliuli, Hō'ae'ae, Waikele, Waipi'o, Waiawa, Mānana, and Hālawa Ahupua'a landscape. Excerpts from interview sessions from past and the present cultural studies are incorporated throughout this section where applicable.

8.2 Wahi Pana and Mo'olelo

The western most *ahupua'a* in the 'Ewa District is Honouliuli. Honouliuli means "dark water," "dark bay," or "blue harbor" and was named for the waters of Pearl Harbor (Jarrett 1930:22), which marks the eastern boundary of the *ahupua'a*. The Hawaiians called Pearl Harbor, Pu'uloa (*lit.* long hill). Another explanation for the names comes from the "Legend of Lepeamoa," the chicken-girl of Pālama. In this legend, Honouliuli is the name of the husband of the chiefess Kapālama and grandfather of Lepeamoa. The land district Honouliuli was named for the grandfather of Lepeamoa (Westervelt 1923:164–184).

It seems likely the boundaries of the western-most *ahupua'a* of 'Ewa were often contested with Wai'anae people. The 'Ewa people could cite divine sanction that the dividing point between Wai'anae and 'Ewa was between two hills at Pili o Kahe:

> The ancient Hawaiians said the hill on the 'Ewa side was the male and the hill on the Wai'anae side was female. The stone was found on the Waianae side hill and the place is known as Pili o Kahe [Pili=cling to, Kahe=flow]. The name refers, therefore, to the female or Waianae side hill. And that is where the boundary between the two districts runs. (Sterling and Summers 1978:1)

Mr. Shad Kāne shares a *mo'olelo* of the *'ōlohe o lua* (skilled practitioners of a type of dangerous hand-to-hand fighting) practitioners at the gateway between the *moku* of 'Ewa and Wai'anae to illustrate how the use of the term *'ōlohe* has changed through time, and, in doing, so, highlights the significance of the *moku* divisions:

> Pukaua is where Honokai Hale is today, just Makakilo and Ko'olina Resort. The high ground, Pukaua, was associated with Hawaiian warriors, the *lua* practitioners. The stories that came out during the missionary period used the name 'ōlohe, as if they were robbers. In the mid-1800s, a lot of visitors traveled from Honolulu to Wai'anae. They bought nice pieces of land in the Pearl City peninsula, and that was their summer retreat. Some tourists were getting robbed along Farrington Highway, which was a trail then. They used the name *'ōlohe*, but it was referred to as a robber. The ancient stories of Pukaua used *'ōlohe*, but with a different meaning. It references a *lua* practitioner. These training areas were for the guardians of security. They provided security at the borders. When you leave one district, there would be *'ōlohe o lua* practitioners. They were like the National

> Guard; not full-time soldiers. Their *kuleana* was the borders. I can use Wai'anae as an example. The Wai'anae mountain is a wall. Stories with *'ōlohe* associated with Pukaua, the eastern gate to Wai'anae. Other areas of *'ōlohe* were Mākua-Ka'ena Point—the western gate. Mākua were the guardians to Wai'anae from the western gate. The eastern gate was Kolekole Pass at Schofield Barracks. If you left your *moku* you left your home. If you go over the Ko'olau I am in a foreign land. Everybody knew each other. It was the same if you went from one *moku* to another.

8.3 Traditional Settlement and Agricultural Patterns

Various Hawaiian legends and early historical accounts indicate that 'Ewa was once widely inhabited by pre-Contact populations, including the Hawaiian *ali'i.* This would be attributable for the most part to the plentiful marine and estuarine resources available at the coast, along which several sites interpreted as permanent habitations and fishing shrines have been located. Other attractive subsistence-related features of the district include irrigated lowlands suitable for wetland taro cultivation, as well as the lower forest area of the mountain slopes for the procurement of forest resources. Handy and Handy (1972:429) report on 'Ewa:

> The lowlands, bisected by ample streams, were ideal terrain for the cultivation of irrigated taro. The hinterland consisted of deep valleys running far back into the Ko'olau range. Between the valleys were ridges, with steep sides, but a very gradual increase of altitude. The lower part of the valley sides were excellent for the cultivation of yams and bananas. Farther inland grew the 'awa for which the area was famous.

In addition, breadfruit, coconuts, *wauke* (paper mulberry, *Broussonetia papyrifera,* used to make *kapa* for clothing), bananas, and *olonā* (*Touchardia latifoli*, used to make cordage) and other plants were grown in the interior. 'Ewa was known as one of the best areas to grow gourds and was famous for its *māmaki* (*Pipterus* spp.; used to make *kapa* for clothing). It was also famous for a rare taro called the *kāī o 'Ewa*, which was grown in mounds in marshy locations (Handy and Handy 1972:471).

Mr. Young has seen tremendous land use changes in Waiawa. He notes that before he was born, the land *mauka* of Kamehameha Highway was heavily forested, but then it shifted to grazing land during his childhood and later to sugar cane. Farther *makai*, the lowland regions were used primarily for taro and rice cultivation. Mr. Young describes the cultivation of taro and rice on his family's land near Pu'uloa and the growing of sugar cane farther *mauka*:

> Yeah, right behind me [is Hā'upu land]. Yeah, and my cousin and aunt used to reside there. That part of the family resides now in San Diego. My family and I on this side, my dad and I have always taken care of this property. This is a flood zone, a flood zone area. When I was a kid, all this area was lowland for taro patches, all this area here. And later on when rice became profitable it was rice. And up on the hill was all sugar cane where Leeward College is.

Mr. Young describes an interesting connection between his wife's family, who operated the sugar mill, and his father's family, who grew the rice:

> When I was a child it just switched over from taro to rice. My grandfather was actually was a rice grower, on my Chinese side. He was a rice grower in this particular area. My dad married my mom, who was from here, so they had a lot of property to grow rice. My wife's side, the Colburns, owned the mill and my grandfather would lease it to thrash the rice. In those days they had water buffalos all over, to cultivate the rice. The family joke is I had to marry a Colburn to get our land back [laughs]. But that's just a joke.

Mr. Young describes how the area around Pearl Harbor had an abundance of food:

> This area around the Pearl Harbor was known as our "bread basket" of food. As a kid here, you could never starve. You could fish off the eighteenth bridge and catch mullet using bread as bait. You could dig up clams enough to stuff a bag in no time. On the land we had bananas, papayas and taro. When Wai'anae had famines, they would come to Pearl Harbor and raid our food and take it back to Wai'anae. Our place was known to be stocked with food.

8.4 Marine and Freshwater Gathering and Cultivation

The fact that there were so many fishponds in 'Ewa, more than any other district on O'ahu, indicates that agricultural and aquacultural intensification was a direct link to the chiefs who resided there and to the increasing needs of the population.

There were several *loko* (fishponds) in Waipi'o; two of the largest were **Loko 'Ēo** ("a filled container") and **Loko Hanaloa** ("long bay"). **Loko Pā'au'au** was a large fishpond located on the western coast of the Mānana Peninsula. Pukui et al. (1974:173) translate *pā'au'au* as "bath enclosure." **Pā'au'au** was also the name of the *'ili* surrounding the pond, and the name of the home of John F. Colburn, an early resident who had a home near the pond.

Loko Welokā, a large fishpond with a small island in the center, was located in Waimano, along the eastern shore of the Mānana Peninsula. The word *welokā* is translated as "thrashing, smiting, as a fishtail" (Pukui and Elbert 1986:355), which may also be a reference to the shark demigoddess associated with Waimano. Two other large fishponds were **Loko Kūkona**, and **Loko Luakaha'ole** which were located along the northern coast of Pearl Harbor. **Loko Pa'akea**, a large fishpond in **Waimalu** along the Pearl Harbor coast was said to have been built by the chiefess, Kalaimanuia (McAllister 1933:103–104). The word *pa'akea* is translated as "coral bed, limestone" (Pukui et al. 1974:173).,

Hālawa had numerous fishponds (from south to north). **Loko Waiaho**, also known as **Queen Emma's Pond** and **Loko Ke'oki**, were both located near the mouth of the Pearl River near the nineteenth century village called Watertown. **Papiolua** was opposite the tip of Waipi'o Peninsula. **Loko A Mano** (Amana), **Loko Pōhaku**, **Ola Loko**, **Wailolokai** and **Wailolowai** were all inland of Kūāhua Island, in the bay now called the South East Loch, while **Loko Kūnana** and **Loko Muliwai** were between the east side of the island and the Hālawa shore.

Loko Kahakupōhaku and **Kealipaia** were near the northeastern corner of the East Loch of Pearl Harbor.

Kupuna Eaton shared her enjoyment of catching *he'e* in Pu'uloa. Rather than using the traditional cowry shell-baited octopus lure, she lured the *he'e* by shaking a cowry shell with her hand. She allowed the octopus' tentacles to wrap around her arms. Once the body was within her grasp, she quickly and deftly ripped out its single pincer to avoid harm. She still has scars on her hands to show her mistakes of avoiding the sharp teeth. Sometimes she would catch a *he'e* with each arm and walk ashore with their tentacles wrapped around her arms while continuing to gather *limu*. Rather than being frightened, she enjoyed the massages she received from the *he'e*. On shore a touch of salt released the grasp of the *he'e*.

Kupuna Eaton shares a story from her childhood that centers on the *ae'o* of the wetlands:

> My grandparents would punish me, but their way of punishing me was not hitting me at all. They would say to me, "You're not to go in the *kai*." Of course, even one day is like the end of the world. Maybe one week I couldn't go into the water. And it's only 25 to 30 minutes away from the water. So the next best place is to go into the loko wai, where the wetlands are. I called my friend to go over there. But he's kolohe [mischievious]. He teases the *ae'o* stilt birds. He can go because he has short hair and he teases them and runs. But when I turn around to run, I have braids and the *ae'o* would grab my hair.

8.5 Burials

The caves of Pu'uloa, located on the western portions of Pearl Harbor, were sometimes also used as burial caves. In 1849, Keali'iahonui, son of Kaua'i's last king, Kaumuali'i, died. He had once been married to the chiefess Kekau'ōnohi, who had stayed with him until 1849. She wanted to bury her ex-husband at sea.

> It seems that by Kekauonohi's orders, the coffin containing her late husband's remains was removed to Puuloa, Ewa, with the view of having it afterwards taken out to sea and there sunk. It was temporarily deposited in a cavern in the coral limestone back of Puuloa, which has long been used for a burial place, and has lately been closed up. (Alexander 1907:27)

After some initial objections by the niece of Keali'iahonui, the body was removed from the outer coffin, the rest was sunk, and the coffin was later buried somewhere in Pu'uloa.

Section 9 Summary and Recommendations

At the request of AECOM and the City and County of Honolulu (CCH), CSH is conducting a CIA for the proposed Honouliuli/Waipahu/Pearl City Wastewater Facilities Project, Honouliuli, Pu'uloa, Hō'ae'ae, Waikele, Waipi'o, Waiawa, Manana, Waimano, Waiau, Waimalu, Kalauao, 'Aiea, and Hālawa Ahupua'a, 'Ewa District, O'ahu Island, TMK [1] 9-1, 9-2, 9-3, 9-4, 9-6, 9-7,9-8, 9-9 (Various Plats and Parcels). This study will be an update to the *West Mamala Bay Facilities Plan (2001)* for the Honouliuli Sewershed. The Honouliuli Sewershed encompasses the areas from which current wastewater flows into the Honouliuli Wastewater Treatment Plant (Honouliuli WWTP) including Hālawa, 'Aiea, Pearl City, Waipi'o, Waikele, Waipahu, 'Ewa, Kapolei and Mililani.

The CCH is conducting a planning and engineering study for improvements to the Honouliuli/Waipahu/Pearl City Wastewater Facilities that is aimed at minimizing sanitary sewer overflows, to comply with regulatory mandates from the State of Hawaii, Department of Health (DOH), and the United States Environmental Protection Agency (EPA) and to meet the future needs for wastewater management.

9.1 Results of Background Research

Background research of the Project area indicates:

1. The Project area traverses through 12 of the 13 *ahupua'a* located in the 'Ewa District. They are (from west to east) Honouliuli, Hō'ae'ae, Waikele, Waipi'o, Waiawa, Mānana, Waimano, Waiau, Waimalu, Kalauao, 'Aiea, and Hālawa. Pu'uloa Ahupua'a, located on the western portion of the Pearl Harbor entryway, is the only *ahupua'a* in the 'Ewa District that is not located in the Project area.
2. The 'Ewa District had more fishponds than any other district on O'ahu, indicating that agricultural and aquacultural intensification was a direct link to the chiefs who resided there and to the increasing needs of the population. The Project area transects at least nine former fishponds.
3. According to an account in the Hawaiian newspaper *Ka Loea Kālai'āina* (June 10, 1899), several of the fishponds in the Pu'uloa area were made by the brother gods, Kāne and Kanaloa. A fisherman living in Pu'uloa, named Hanakahi, prayed to unknown gods, until one day two men came to his house. They revealed to him that they were the gods to whom he should pray. Kāne and Kanaloa then built fishponds at Ke'anapua'a, but were not satisfied. Then they built the fishpond, Kepo'okala, but were still not satisfied. Finally they made the pond Kapākule, which they stocked with all manner of fish. They gifted all of these fishponds to Hanakahi and his descendants (Handy and Handy 1972:473; Ka Loea Kālai'āina, July 8, 1899).
4. 'Ewa was famous for the many limestone caves, also known as the "Caves of Honouliuli," formed in the uplifted coral, called the "Ewa Karst." This Pleistocene limestone outcrop, where not covered by alluvium or stockpiled material, has characteristic dissolution "pit caves" (Mylroie and Carew 1995), which are nearly universally, but erroneously, referred to as "sink holes" (Halliday 2005).

5. A famous cave of Hālawa was Keanapua'a, opposite Waipi'o Peninsula, which means "the pig's cave," so named because Kamapua'a once slept there (Pukui et al. 1974:103). This cave was one of the places that the high king of O'ahu, Kahahana, hid after he had killed the priest Ka'opulupulu, thus angering the high chief of Maui, Kahekili.
6. Oral tradition tells of Hālawa as the home of Papa, where she lived in the uplands with her parents, Kahakauakoko and Kūkalani'ehu. Papa is known for her generative role as the "earth mother". Together with her husband, Wākea, they are the progenitors of the Hawaiian race.
7. The *heiau* of Keaīwa in 'Aiea was the site of a medicinal herb garden and training area for traditional healers.
8. In 1852, the first Chinese contract laborers arrived in the Hawaiian Islands. Contracts were for five years, and pay was $3 a month plus room and board. Upon completion of their contracts, a number of the immigrants remained in the islands, many becoming merchants or rice farmers.
9. The eastern section of 'Ewa was largely developed by the Honolulu Plantation Company. Commercial sugar cane cultivation began in Waimalu and Hālawa in the 1850s, on the estate of Mr. J.R. Williams (Condé and Best 1973:327). The plantation was first known as the Honolulu Sugar Company.
10. In 1897, B. F. Dillingham established the Oahu Sugar Company on 12,000 acres leased from the estates of John Papa 'Ī'ī, Bishop, and Robinson. The Oahu Sugar Co. had over 900 field workers, composed of 44 Hawaiians, 473 Japanese, 399 Chinese, and 57 Portuguese. The first sugar crop was harvested in 1899, ushering in the sugar plantation era in Waipahu (Ohira 1997).
11. The U.S. Navy began a preliminary dredging program for Pearl Harbor in 1901, which created a 30-foot deep entrance channel measuring 200 ft wide and 3,085 ft long. In 1908, money was appropriated for five miles of entrance channel dredged to an additional 35 ft down (Downes 1953).
12. In 1909, the government appropriated the entire Waipi'o peninsula from the 'Ī'ī Estate for the Pearl Harbor Naval Station and Shipyard. Additional dredging to deepen and widen the channel was conducted in the 1920s.

9.2 Results of Community Consultation

CSH attempted to contact 44 community members (government agency or community organization representatives, or individuals such as residents and cultural practitioners) for this draft CIA report; of those, seven responded and five participated in formal interviews for more in-depth contributions to the CIA. Presented below are salient themes and concerns that emerged from participants' interviews regarding the proposed Project:

1. Mr. Tin Hu Young describes the area of Pearl Harbor during his youth as a "bread basket" of food. He recalls an abundance of mullet, clams, bananas, taro and other varieties of food in his neighborhood for subsistence.

2. Mr. Kāne's mother tells of *lo'i kalo* in the Waipi'o Peninsula area. His father gathered oysters, clams, crab and *limu* from the waters of Pearl Harbor.
3. Mr. Young states that after the December 7, 1941 bombing of Pearl Harbor, the U.S. military set up a camp at the Pearl City Tavern bar on Farrington Highway in Pearl City, which included searchlights looking for enemy airplanes.
4. In his youth, Dr. Stagner hiked the *mauka* regions in 'Ewa with his Boy Scout troop and discovered several petroglyphs and *heiau*. Dr. Stagner explained that there had been an influenza epidemic in the 1920s and many Hawaiians were buried in the *mauka* area, which was abandoned and eventually taken over by the 'Aiea Sugar Mill. Many of the plantation workers moved rocks, not knowing the cultural significance of the rocks that could have been associated with Hawaiian burials or other cultural sites.
5. Dr. Stagner believes 'Ewa's most important feature is its watershed. This fact is highlighted by the naming of the *ahupua'a* with the term *wai* (fresh water of any kind), including Waiawa, Waiau, Waikele, and Waipahu. Mirroring the *ahupua'a* boundaries, water flows from the Ko'olau mountains down to the waters of Pu'uloa throughout a network of streams and an underwater system of tunnels. These contribute heavily to the Hālawa Aquifer, which now supplies the majority of the drinking water for the island of O'ahu.
6. Dr. Stagner's main concern is the management of the 'Ewa watershed. The *kūpuna* from his youth told him that the upland regions must be conserved to prevent excessive runoff and lowland flooding. Historically, surplus water was channeled toward the 'Ewa plain. Dr. Stagner advocates protecting agricultural and conservation lands of Waiawa in particular, as they are the most vulnerable to future development.
7. Mr. Kāne states that the cultural layer of 'Ewa still exists today, however, buried or filled in by the Navy and the Department of Defense.
8. Mr. Kalahiki is concerned that the water tables below surface of the Project area may be adversely impacted during the boring/excavating phase of construction.
9. Mr. Young is concerned that potential future flooding in the lowland areas of 'Ewa may cause the proposed Project's sewer system to backup and spill into Pearl Harbor.
10. Mr. Kāne feels that the likelihood of inadvertent burials at the points of deep excavation is low and that the cultural layers will not be disturbed during construction phases of this Project.

9.3 Cultural Impacts and Recommendations

Based on information gathered from the community consultation effort as well as archaeological and archival research presented in this report, the evidence indicates that the proposed Project may have minimal impact on potential burials and other cultural sites within the Project area due to underground tunneling and boring at debths below known cultural sites.

However, concerns raised by community participants include protection of water tables in the area and possible sewer backups due to flooding the lower areas of 'Ewa. A good faith effort to address the following recommendations would help mitigate potentially adverse effects the proposed Project may have on Hawaiian cultural practices, beliefs and resources in and near the Project area:

1. The Project may have a direct impact on as-yet undiscovered burials located in subsurface contexts along the Project area corridor. CSH recommends that personnel involved in development activities in the Project area should be informed of the possibility of inadvertent cultural finds, including human remains. Should cultural and/or burial sites be identified during ground disturbance, all work should immediately cease, and the appropriate agencies notified pursuant to applicable law.
2. CSH recommends that, in the event of discoveries of *iwi kūpuna* during Project construction activities, recognized cultural and lineal descendants should be notified and consulted on matters of burial treatment.
3. Hydrological studies should be conducted prior to excavation/underground boring begins to prevent damage to aquifers and water tables in the proposed Project area.
4. Flooding concerns should be addressed in the lower areas of the 'Ewa District to prevent sewer backups of the proposed Project's new sewer system.
5. Archaeological monitoring should be conducted during ground-disturbance activities that affect layers likely to contain burials and/or cultural layers.

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Appendix A Glossary of Hawaiian Words

To highlight the various and complex meanings of Hawaiian words, the complete translations from Pukui and Elbert (1986) are used unless otherwise noted. In some cases, alternate translations may resonate stronger with Hawaiians today; these are placed prior to the Pukui and Elbert (1986) translations and marked with "(common)."

Diacritical markings used in the Hawaiian words are the 'okina and the kahakō. The *'okina*, or glottal stop, is only found between two vowels or at the beginning of a word that starts with a vowel. A break in speech is created between the sounds of the two vowels. The pronunciation of the *'okina* is similar to saying "oh-oh." The *'okina* is written as a backwards apostrophe. The *kahakō* is only found above a vowel. It stresses or elongates a vowel sound from one beat to two beats. The *kahakō* is written as a line above a vowel.

Hawaiian Word	English Translation
ahupua'a	Land division usually extending from the uplands to the sea, so called because the boundary was marked by a heap (*ahu*) of stones surmounted by an image of a pig (*pua'a*), or because a pig or other tribute was laid on the altar as tax to the chief.
ali'i	Chief, chiefess, officer, ruler, monarch, peer, headman, noble, aristocrat, king, queen, commander.
'aumakua	Family of personal gods, deified ancestors who might assume the shape of sharks, owls, hawks...etc. A symbiotic relationship existed; mortals did not harm or eat *'aumakua*, and *'aumakua* warned and reprimanded mortals in dreams, visions, and calls.
'auwai	Ditch, canal
haole	Foreigner, white person (common).
hāpai	Pregnant.
hau	Beach Hibiscus.
heiau	Place of worship, shrine; some *heiau* were elaborately constructed stone platforms, others simple earth terraces. Many are preserved today.
hoaka	Crescent.
'ili	Land section, next in importance to *ahupua'a* and usually a

	subdivision of an *ahupua'a.*
iwi kūpuna	Ancestral bone remains (common).
kahuna	Priest, sorcerer, magician, wizard, minister, expert in any profession. *Kāhuna*—plural of *kahuna. Kahuna nui* – high priest.
kama'āina	Native-born, one born in a place, host; native plant; acquainted, familiar, Lit., land child.
kapu	Taboo, prohibition; special privilege or exemption from ordinary taboo; sacredness; prohibited, forbidden; sacred, holy, consecrated; no trespassing, keep out.
kolohe	Mischievous, naughty.
konohiki	Headman of an *ahupua'a* land division under the chief.
kuleana	Native land rights (common), right, privilege, concern, responsibility, title, business, property, estate, portion, jurisdiction, authority, liability, interest, claim, ownership, tenure, affair, province.
kupuna	Elder (common), grandparent, ancestor, relative or close friend of the grandparent's generation, grandaunt, granduncle. *Kūpuna*—plural of *kupuna.*
lawai'a	Fisherman.
limu	Seaweed.
lo'i	Irrigated terrace, especially for taro, but also for rice; paddy.
loko i'a	Fishpond.
lua	A type of dangerous hand-to-hand fighting in which the, fighters broke bones, dislocated bones at the joints, and inflicted severe pain by pressing on nerve centers.
lū'au	Hawaiian feast (common), young taro tops.
makai	Seaward, towards the sea (common).
maka'āinana	Commoner.
makana	Gift, present.

mana	Supernatural or divine power.
mana'o	Thoughts, ideas, beliefs, opinions, theories.
manō	Shark.
mauka	Towards the mountain, inland.
mele	Song, anthem, or chant of any kind; poem, poetry; to sing, chant.
mō'ī	King, island wide chief (common).
moku	District, island, islet, section.
mokupuni	Island.
mo'o	Water spirit, lizard (common).
mo'olelo	Story, tale, myth, history, tradition, literature, legend, journal, log, yarn, fable, essay, chronicle, record, article; minutes, as of a meeting. (From *mo'o 'ōlelo*, succession of talk; all stories were oral, not written).
mo'opuna	Grandchild.
muliwai	River mouth.
nā	Plural definite article. *Nā lani*, the chiefs.
'ohana	Family.
'ōlelo no'eau	Proverb, wise saying, traditional saying.
'ōlohe	Skilled, especially in lua fighting.
oli	Chant that was not danced to, especially with prolonged phrases chanted in one breath, often with a trill at the end of each phrase; to chant thus.
pōhaku	Rock, stone.
po'o	Head.
pueo	Owl.
pule	Prayer.

tūtū	Granny, grandma, grandpa; granduncle, grandaunt; any relative or close friend of grandparent's generation.
'ume 'ume	To draw, pull or attract.
wahi pana	Storied place (common). Legendary place.

Appendix B Common and Scientific Names for Plants and Animals Mentioned by Community Participants

Common Names		Possible Scientific Names		Source
Hawaiian	Other	Genus	Species	
ae 'o	Hawaiian stilt bird	*Himantopus*	*mexicanus*	Pukui and Elbert 1986
'anae	mullet	*Mugil*	*cephalus*	Pukui and Elbert 1986
'awa	kava	*Piper*	*methysticum*	Wagner et al. 1999
hāpu'u	tree fern	*Cibotium*	spp.*	Wagner et al. 1999
he'e	octopus, squid	multiple families and species		
i'iwi	scarlett Hawaiian honey creeper	*Vestiaria*	*coccinea*	Pukui and Elbert 1986
kalo	taro	*Colocasia esculenta*	*esculenta*	Wagner et al. 1999
limu 'ele'ele	seaweed, algae	*Entermorpha*	*prolifera*	Abbott and Williamson 1974
manō	shark	multiple families and species		
'ō'ō	black honey eater	*Moho*	*nobilis*	Pukui and Elbert 1986

Common Names		Possible Scientific Names		Source
Hawaiian	Other	Genus	Species	
pueo	short-eared owl	*Asio*	*flammeus sandwichensis*	Pukui and Elbert 1986
pipipi	pearl oyster	*Pinctada*	*radiata* and other species from family Pteriidae	Pukui and Elbert 1986

Appendix C Authorization and Release Form

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AUTHORIZATION AND RELEASE FORM

Cultural Surveys Hawai'i (CSH) appreciates the generosity of the *kūpuna* and *kama'āina* who are sharing their knowledge of cultural and historic properties, and experiences of past and present cultural practices for the proposed Honouliuli/Waipahu/Pearl City Wastewater Facilities Project, Multiple Ahupua'a, 'Ewa District, O'ahu Island, Multiple TMK.

We understand our responsibility in respecting the wishes and concerns of the interviewees participating in our study. Here are the procedures we promise to follow:

1. The interview will not be tape-recorded without your knowledge and explicit permission.
2. If recorded, you will have the opportunity to review the written transcript of our interview with you. At that time you may make any additions, deletions or corrections you wish.
3. If recorded, you will be given a copy of the interview notes for your records.
4. You will be given a copy of this release form for your records.
5. You will be given any photographs taken of you during the interview.

For your protection, we need your written confirmation that:

1. You consent to the use of the complete transcript and/or interview quotes for reports on cultural sites and practices, historic documentation, and/or academic purposes.
2. You agree that the interview shall be made available to the public.
3. If a photograph is taken during the interview, you consent to the photograph being included in any report/s or publication/s generated by this cultural study.

I, _____, agree to the procedures outlined above and, by my
(Please print your name here)
signature, give my consent and release for this interview to be used as specified.

_____
(Signature)

_____
(Date)

Appendix D
Air Quality Analysis, Technical Memorandum, AECOM, November 2014

AECOM Water

Submitted to:
City and County of Honolulu
Department of Environmental Services
1001 Uluohia Street Suite 308
Kapolei, Hawaii 96707

Prepared by:
AECOM
1001 Bishop Street, Suite 1600
Honolulu, Hawaii 96813

Honouliuli/Waipahu/Pearl City Wastewater Facilities Plan

Air Quality Analysis

Technical Memorandum-*Final*
November 2014

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List of Acronyms

AS	activated sludge
BTU	British thermal units
CAA	Clean Air Act
CCH	City and County of Honolulu
cfm	cubic feet per minute
CH_4	methane
CHP	combined heat and power
CO	carbon monoxide
DBEDT	Hawaii Department of Business, Economic Development, and Tourism
DOH	Department of Health, State of Hawaii
EPA	Environmental Protection Agency, United States
GHG	greenhouse gas
HAPS	hazardous air pollutants
H_2S	hydrogen sulfide
HWBOCP	Honouliuli Wastewater Basin Odor Control Project
HWRF	Honouliuli Water Recycling Facility
kW	kilowatt
mgd	million gallons per day
NAAQS	National Ambient Air Quality Standards
NO_2	nitrogen dioxide
NO_x	nitrogen oxides
N_2O	nitrous oxide
NSPS	new source performance standards
NSR	new source review
O_3	ozone
O&M	operation and maintenance
Pb	lead
PM	particulate matter
ppm	parts per million
ppmV	parts per million by volume
PSD	prevention of significant deterioration
ROG	reactive organic gases
SC	solids contact
SO_2	sulfur dioxide
TPY	tons per year
TF	Trickling Filter
WWTP	wastewater treatment plant

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Executive Summary

An air quality analysis was conducted to evaluate the potential for impact as a result of the proposed upgrade and expansion of the existing Honouliuli Wastewater Treatment Plant (WWTP) to provide secondary treatment and accommodate projected wastewater flows, as well as the potential relocation of non-process facilities that support island-wide WWTPs and wastewater pump stations that are currently located at Sand Island WWTP to the Honouliuli WWTP site. This project is part of the Honouliuli/ Waipahu/Pearl City Wastewater Facilities Plan (Honouliuli Fac Plan) that is currently being prepared by the City and County of Honolulu (CCH) Department of Environmental Services (ENV). This analysis was conducted as part of an Environmental Impact Statement in accordance with the Hawaii Environmental Quality Control Act, codified as Chapter 341, Hawaii Revised Statutes (HRS) and Chapter 343, HRS, Environmental Impact Statement Law. The EPA is the federal agency that develops and enforces the regulations that help govern air quality on a national level and provides guidance at the state level. Air quality impacts are typically evaluated against the National Ambient Air Quality Standards (NAAQS), which were established as part of the 1970 federal Clean Air Act (CAA) in 1970 to protect the public health.

Since the facility expansion as incorporated in the Honouliuli Fac Plan would involve construction and operational activities that have potential air quality impacts, this assessment includes impact evaluation of:

- Construction activities focusing on the usage of equipment during varying phases
- Operation activities focusing on the addition of new stationary and mobile sources
- Odor effects identifying the change from existing to the proposed condition.

Under the full build plan condition,

- Construction duration could last 72, 108, or 144 months depending on the selection of contracts. Since the scale of project remains the same, the usage of equipment during varying phases would be greater under short-duration schedule as compared to longer construction period, resulting in greater short-term air quality impacts. However, the equipment to be utilized remains typical for infrastructure development projects in urban areas. Given the spreading of the construction activity over the years, hot spot air quality concerns associated with concentrated equipment operations would be limited and mobile, therefore construction impacts are anticipated to be less than significant.

- Operation of the plant under future proposed condition would involve installation of new standby generators to provide expanded emergency power supply from existing 3.8 MW to 12.55 MW causing a potential short-term increase in combustion source emissions on an annual basis. However, given their emergency usage purposes, potential air quality impacts would be short in duration unlikely causing significant air quality impacts. If these generators would also provide power shaving purposes during peak loading condition, greater air quality impacts would occur. The future CAA air permitting process would further ensure compliance with the NAAQS as a result of increasing stationary source operational emissions on site. Therefore, the proposed project would unlikely result in significant air quality impacts.

- Odor releasing points at the facility would increase in the secondary treatment area in comparison to the existing condition. The affected residences would likely include those located close to Renton Road and around the Coral Creek Golf Course. However, with consideration of the on-going and future odor control measures to be implemented at the facility's major odor generating sources, adverse ambient odor impacts would likely be reduced. The future ambient odor monitoring plan to be implemented would ensure the measured hydrogen sulfide concentration levels would be below the Hawaii ambient standard.

As a result, no significant air quality impacts are anticipated as a result of the proposed project. Therefore, no construction and operational air quality mitigation measures are required.

1 Introduction

1.1 Project Description

The City and County of Honolulu (CCH) Department of Environmental Services is in the process of developing the Honouliuli/Waipahu/Pearl City Wastewater Facilities Plan (Honouliuli Fac Plan) for the Honouliuli sewer basin. The intent of the Honouliuli Fac Plan is to define necessary improvements to the collection and treatment facilities to meet future flow demands and permit compliance.

The 2010 Consent Decree (Civil Number (No.) 94-00765 DAE-KSC) is an agreement between CCH, the State of Hawaii Department of Health (DOH), and the United States Environmental Protection Agency (EPA) that requires CCH to meet certain requirements with respect to its wastewater collection system and wastewater treatment plants (WWTPs). The 2010 Consent Decree mandates that the Honouliuli and Sand Island WWTPs be upgraded to secondary treatment facilities by 2024 and 2035, respectively.

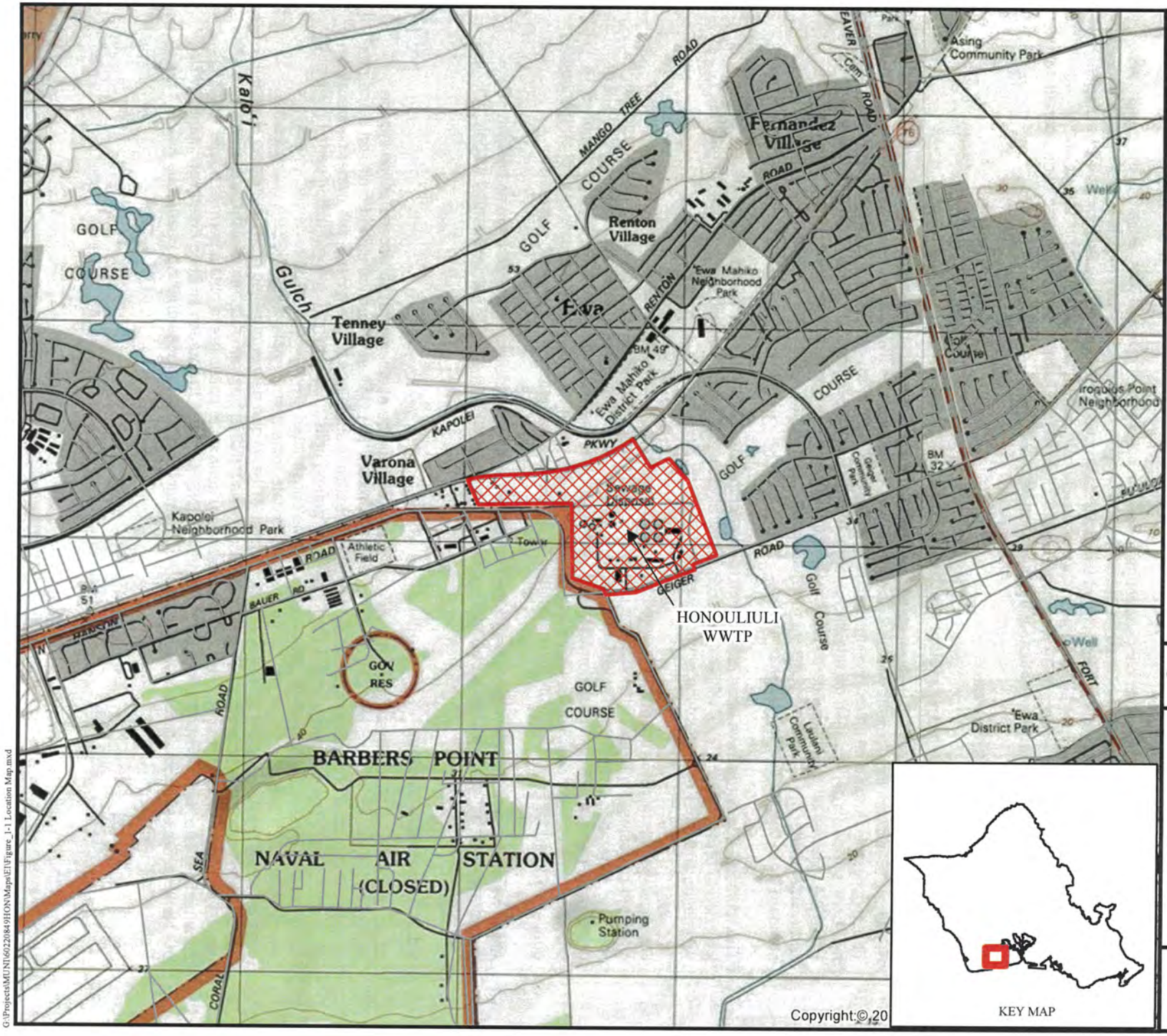
The WWTP was originally built in 1978 as a primary plant and became fully operational in 1984. The Honouliuli WWTP is the second-largest WWTP on Oahu, and has undergone numerous expansions and upgrades due to growth within the service area and additional treatment needs. The average daily flow to the WWTP was approximately 25.8 million gallons per day (mgd) in 2012. The rated design capacity is 38 mgd with one unit out of service and 51 mgd with all units in service according to the *Honouliuli WWTP Facility-Wide Operations Manual* (O&M Manual) (Fukunaga and Associates, Inc. and HDR Engineering, Inc., 2011). The WWTP provides primary treatment to all flow received. Approximately 13 mgd undergoes further secondary treatment. A portion of the secondary effluent is treated for water reuse at the CCH Board of Water Supply Honouliuli Water Recycling Facility (HWRF). The solids stream has a rated design capacity of solids generated from 42 mgd of primary treatment and 26 mgd of secondary treatment according to the *O&M Manual*.

In addition to the regulatory requirements established for secondary treatment, it is anticipated that there will be a future increased demand for reclaimed water from the HWRF. The *Ewa Non-Potable Water Master Plan* projected future non-potable maximum daily demand to be 24.6 mgd beyond 2015. Planning for the existing secondary treatment system began in 1990 as a first step toward reclamation of effluent for reuse through irrigation. The existing secondary treatment system was constructed in 1996, specifically for water reclamation purposes.

In 2011, CCH acquired 48.4 acres of land abutting the north and east boundaries of the existing Honouliuli WWTP to provide sufficient space for treatment and associated facilities to comply with the 2010 Consent Decree mandates. The Honouliuli WWTP site area is currently 100.5 acres.

The study area includes the existing Honouliuli WWTP located at 91-1000 Geiger Road and expansion property to the north and east, adjacent to the Coral Creek Golf Course. The Honouliuli WWTP project site is identified on **Figure 1-1**.

The proposed project assessed in this analysis concerns the upgrade and expansion of the Honouliuli WWTP to provide secondary treatment and accommodate projected wastewater flows, as well as addresses the potential location of non-process facilities to accommodate current needs that are not adequately met, future needs that will arise from upgrading Honouliuli and Sand Island WWTFs to secondary treatment, and other treatment and collection system support facilities that may currently be decentralized. Additional improvements at the Honouliuli WWTP are proposed for the following existing facilities: Central Laboratory, Ocean Team Facilities, Administration Building, Operations Building, Leeward Region Maintenance, Central Shops, Warehouse, truck wash, process Supervisory Control and Data Acquisition, septage receiving station, odor control, grounds keeping, janitorial service and security, and Honouliuli Water Recycling Facility.



City and County of Honolulu

HONOULIULI/ WAIPAHU/ PEARL CITY WASTEWATER FACILITIES PLAN

Legend

- Honouliuli WWTP
- Street

0 2,000 Feet

1 inch = 2,000 feet

FIGURE 1-1

PROJECT LOCATION MAP

December 2014

AECOM
1001 BISHOP ST, STE 1600
HONOLULU, HAWAII 96813

G:\Projects\MUNI\60220849\HON\Maps\EI\Figure_1-1 Location Map.mxd

2 Air Quality Regulatory Settings

Air quality is defined by ambient air concentrations of specific pollutants of concern with respect to the health and welfare of the general public. Air quality can be affected by air pollutants produced by mobile sources, such as vehicular traffic, aircraft, or non-road equipment used for construction activities; and by fixed or immobile facilities, referred to as "stationary sources." Stationary sources can include combustion and industrial stacks and exhaust vents. Potential air quality effects in the vicinity of the WWTP would occur from both construction and operational activities associated with implementation of the proposed improvements.

2.1 Definition of Resource

2.1.1 National and Hawaiian Ambient Air Quality Standards

As required by the Clean Air Act, federal standards have been established to maintain ambient air quality. The regulatory framework includes the National Ambient Air Quality Standards (NAAQS) for six major air pollutants. These pollutants, known as criteria pollutants, are: particulate matter (PM_{10} and $PM_{2.5}$), sulfur dioxide (SO_2), hydrogen sulfide (H_2S), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3) and lead (Pb) as shown in Table 2-1. Hawaii air quality standards are similar to the national standards, although the Hawaii standards for carbon monoxide and nitrogen dioxide are more stringent than the national standards. In addition, Hawaii has a standard for hydrogen sulfide (Table 2-1).

The "primary" standards have been established to protect the public health. The "secondary" standards are intended to protect the nation's welfare and account for air pollutant effects on soil, water, visibility, materials, vegetation and other aspects of the general welfare.

Hydrogen sulfide (H_2S) is the primary compound in wastewater collection and treatment systems that causes odor and corrosion. Problems with odor and corrosion are attributed to high wastewater sulfide levels and the resulting generation of hydrogen sulfide. As shown in Table 2-1, Hawaii has an ambient air standard for H_2S of 0.025 parts per million by volume (ppmV) in any 1-hour period at the property line of a facility. This standard provides a measure of odor impacts from a wastewater treatment plant. Presently there is no federal ambient air quality standard for H_2S. The DOH also regulates emissions discharged from odor control systems.

Areas where concentration levels are below the NAAQS for a criteria pollutant are designated as being in "attainment." Areas where a criteria pollutant level equals or exceeds the NAAQS are designated as being in "nonattainment."

2.1.2 Stationary Sources

Stationary sources of air emissions at the various sites that could be affected by the proposed action include combustion turbines, boilers, generators, flares, and fuel tanks. The CAA set permit rules and emission standards for pollution sources of certain sizes. An air permit application is submitted by the prospective owner or operator of an emitting source in order to obtain approval of the source construction permit. A construction permit generally specifies a time period within which the source must be constructed. Permits should be reviewed for any modifications to the site or the air emissions sources to determine permit applicability. USEPA oversees the programs that grant stationary source operating permits (Title V) and new or modified major stationary source construction and operation permits. The New Source Review (NSR) program requires new major stationary sources or major modification of existing major stationary sources of pollutants to obtain permits before initiating construction. The New Source Performance Standards (NSPS) apply to sources emitting criteria pollutants, while the National Emission Standards for Hazardous Air Pollutants apply to sources emitting Hazardous Air Pollutants (HAPs).

Table 2-1. Hawaiian and National Ambient Air Quality Standards (NAAQS)

Pollutant		Primary/ Secondary[1]	Averaging Time	National Standard	Hawaii Standard	Form
Carbon Monoxide (CO)		Primary	8-hour	9 ppm	4.4 ppm	Not to be exceeded more than once per year
			1-hour	35 ppm	9 ppm	
Lead (Pb)		Primary and secondary	Rolling 3-month average	0.15 $\mu g/m^3$[2]	0.15 $\mu g/m^3$ (calendar quarter)	Not to be exceeded
Nitrogen Dioxide (NO_2)		Primary	1-hour	100 ppb	None	98th percentile, averaged over 3 years
		Primary and secondary	Annual	53 ppb[3]	0.04 ppb	Annual mean
Ozone (O_3)		Primary and secondary	8-hour	0.075 ppm[4]	0.08 ppm	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years
Particle Pollution	$PM_{2.5}$	Primary	Annual	12 $\mu g/m^3$	None	Annual mean, averaged over 3 years
		Secondary	Annual	15 $\mu g/m^3$	None	Annual mean, averaged over 3 years
		Primary and secondary	24-hour	35 $\mu g/m^3$	None	98th percentile, averaged over 3 years
	PM_{10}	Primary and secondary	24-hour	150 $\mu g/m^3$	150 $\mu g/m^3$	Not to be exceeded more than once per year on average over 3 years
		None	Annual	None	50 $\mu g/m^3$	Annual average
Sulfur Dioxide (SO_2)		Primary	1-hour	0.075 ppm[5]	None	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		Secondary	3-hour	0.5 ppm	0.5 ppm	Not to be exceeded more than once per year
		None	24-hour	None	0.14 ppm	24-hour average
		None	Annual	None	0.03 ppm	Annual average
Hydrogen Sulfide (H_2S)		None	1-hour	None	0.025 ppm	1-hour average

Notes:
(1) Primary standards set limits to protect public health, including the health of "sensitive" populations such as asthmatics, children and the elderly and secondary standards set limits to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings.
(2) Final rule signed October 15, 2008. The 1978 lead standard (1.5 µg/m3 as a quarterly average) remains in effect until one year after an area is designated for the 2008 standard, except that in areas designated nonattainment for the 1978 standard, the 1978 standard remains in effect until implementation plans to attain or maintain the 2008 standard are approved.
(3) The official level of the annual NO_2 standard is 0.053 ppm, equal to 53 ppb, which is shown here for the purpose of clearer comparison to the 1-hour standard.
(4) Final rule signed March 12, 2008. The 1997 ozone standard (0.08 ppm, annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years) and related implementation rules remain in place. In 1997, EPA revoked the 1-hour ozone standard (0.12 ppm, not to be exceeded more than once per year) in all areas, although some areas have continued obligations under that standard ("anti-backsliding"). The 1-hour ozone standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is less than or equal to 1.
(5) Final rule signed June 2, 2010. The 1971 annual and 24-hour SO_2 standards were revoked in the same rulemaking. However, these standards remain in effect until one year after an area is designated for the 2010 standard, except in areas designated nonattainment for the 1971 standards, where the 1971 standards remain in effect until implementation plans to attain or maintain the 2010 standard are approved.
Sources: http://www.epa.gov/air/criteria.html and http://health.hawaii.gov/cab/files/2013/05/naaqs_jan_2013.pdf.

HAPs, also known as toxic air pollutants, are chemicals that can cause adverse effects to human health or the environment. The CAAA directed USEPA to set standards for all major sources of air toxics. USEPA established a list of 187 HAPs that includes substances that cause cancer, neurological, respiratory, and reproductive effects. The Title V major source thresholds for pollutant emissions that are applicable to Hawaii are:

- 100 tons per year (TPY) for any criteria pollutant
- 25 TPY total HAPs
- 10 TPY for any one HAP

USEPA also established Prevention of Significant Deterioration (PSD) regulations to ensure that air quality in attainment areas does not significantly deteriorate as a result of construction and operation of major stationary sources, and to allow future industrial growth to occur. A typical major PSD source is classified as anything with the potential to emit 250 TPY of any regulated pollutant in an attainment area. However, for several types of major source operations, including fossil fuel–fired steam electric plants of more than 250 million British Thermal Units (Btu) per hour heat input, 100 TPY is the major PSD source threshold.

Since Hawaii is in an attainment area, major new sources or major modifications to existing major sources must meet the PSD requirements.

The DOH has adopted the USEPA-established stationary source regulations discussed previously and acts as the administrator to enforce stationary source air pollution control regulations in Hawaii (DOH, Title 11, Chapter 60.1, Air Pollution Control). DOH grants an air permit to applicable facilities for not only federal enforceable major sources but also non-major sources in the state.

2.1.3 Mobile Sources

Typical mobile sources include on-road and non-road vehicles, and construction equipment. The emissions from these mobile sources are regulated under the CAA Title II that establishes emission standards that manufacturers must achieve. Therefore, unlike stationary sources, no permitting requirements exist for operating mobile sources.

2.2 Criteria Pollutants and Hydrogen Sulfide Health Effects

The sources of criteria pollutants and hydrogen sulfide, their effects on human health and the nation's welfare, and their final deposition in the atmosphere vary considerably. A brief description of each criteria pollutant and hydrogen sulfide is given below.

Ozone. O_3, a colorless toxic gas, enters the blood stream and interferes with the transfer of oxygen, depriving sensitive tissues in the heart and brain of oxygen. O_3 also damages vegetation by inhibiting their growth. Although O_3 is not directly emitted, it forms in the atmosphere through a chemical reaction between reactive organic gases (ROG) and nitrogen oxides (NO_x), which are emitted from industrial sources and from automobiles. Substantial O_3 formations generally require a stable atmosphere with strong sunlight.

Particulate Matter. Particulate pollution is composed of solid particles or liquid droplets that are small enough to remain suspended in the air. In general, particulate pollution can include dust, soot, and smoke; these can be irritating but usually are not poisonous.

Particulate pollution also can include bits of solid or liquid substances that can be highly toxic. Of particular concern are those particles that are smaller than, or equal to, 10 microns (PM_{10}) and 2.5 microns ($PM_{2.5}$) in size.

PM_{10}. PM_{10} refers to particulate matter less than 10 microns in diameter, about one/seventh the thickness of a human hair. Major sources of PM_{10} include motor vehicles; wood burning stoves and fireplaces; dust from construction, landfills, and agriculture; wildfires and brush/waste burning; industrial sources; windblown dust from open lands; and atmospheric chemical and photochemical reactions. Suspended particulates produce haze and reduce visibility. Additionally, PM_{10} poses a greater health risk than larger- sized particles. When inhaled, these tiny particles can penetrate the human respiratory system's natural defenses and damage the respiratory tract.

PM_{10} can increase the number and severity of asthma attacks, cause or aggravate bronchitis and other lung diseases, and reduce the body's ability to fight infections.

$PM_{2.5}$. A small portion of particulate matter is the product of fuel combustion processes. In the case of $PM_{2.5}$, the combustion of fossil fuels accounts for a significant portion of this pollutant. The main health effect of airborne particulate matter is on the respiratory system. $PM_{2.5}$ refers to particulates that are 2.5 microns or less in diameter, roughly 1/28th the diameter of a human hair. $PM_{2.5}$ results from fuel combustion (from motor vehicles, power generation, and industrial facilities), residential fireplaces, and wood stoves. In addition, $PM_{2.5}$ can be formed in the atmosphere from gases such as sulfur dioxide, nitrogen oxides, and volatile organic compounds. Like PM_{10}, $PM_{2.5}$ can penetrate the human respiratory system's natural defenses and damage the respiratory tract when inhaled. Whereas, particles 2.5 to 10 microns in diameter tend to collect in the upper portion of the respiratory system, particles 2.5 microns or less are so tiny that they can penetrate deeper into the lungs and damage lung tissues.

Carbon Monoxide. CO, a colorless gas, interferes with the transfer of oxygen to the brain. CO is emitted almost exclusively from the incomplete combustion of fossil fuels. Prolonged exposure to high levels of CO can cause headaches, drowsiness, loss of equilibrium, or heart disease. CO concentrations can vary greatly over relatively short distances. Relatively high concentrations of CO are typically found near congested intersections, along heavily used roadways carrying slow-moving traffic, and in areas where atmospheric dispersion is inhibited by urban "street canyon" conditions. Consequently, CO concentrations must be predicted on a localized, or microscale, basis.

Nitrogen Dioxide. NO_2, a brownish gas, irritates the lungs. It can cause breathing difficulties at high concentrations. Like O_3, NO_2 is not directly emitted, but is formed through a reaction between nitric oxide (NO) and atmospheric oxygen. NO and NO_2 are collectively referred to as nitrogen oxides (NO_x) and are major contributors to ozone formation. NO_2 also contributes to the formation of PM_{10}, small liquid and solid particles that are less than 10 microns in diameter (see discussion of PM_{10} above). At atmospheric concentration, NO_2 is only potentially irritating. In high concentrations, the result is a brownish-red cast to the atmosphere and reduced visibility. There is some indication of a relationship between NO_2 and chronic pulmonary fibrosis. Some increase in bronchitis in children (two and three years old) has also been observed at concentrations below 0.3 parts per million (ppm).

Lead. Pb is a stable element that persists and accumulates both in the environment and in animals. Its principal effects in humans are on the blood-forming, nervous, and renal systems. Lead levels in the urban environment from mobile sources have significantly decreased due to the federally mandated switch to lead-free gasoline.

Sulfur Dioxide. SO_2 is a product of high-sulfur fuel combustion. The main sources of SO_2 are coal and oil used in power stations, industry and for domestic heating. Industrial chemical manufacturing is another source of SO_2. SO_2 is an irritant gas that attacks the throat and lungs. It can cause acute respiratory symptoms and diminished ventilator function in children. SO_2 can also yellow plant leaves and erode iron and steel.

Hydrogen Sulfide. H_2S is a colorless gas that is soluble in liquids such as water. It has a distinctive odor of rotten eggs. It can be formed under conditions of deficient oxygen, in the presence of organic material and sulfate. Most of the atmospheric hydrogen sulfide has natural origins. In areas of natural occurrence, such as such as in geothermal areas and sulfur springs the unpleasant smell of H_2S can be a nuisance. At concentrations of 20 ppm or higher it can cause eye irritation and beginning at concentrations of 50 ppm or higher it can also cause respiratory tract irritation. The H_2S concentration level is commonly used as a measure of potential odor impact for a wastewater treatment plant.

2.3 Climate Change and Greenhouse Gases

Climate change is an important national and global concern. While the earth has gone through many natural changes in climate in its history, there is general agreement that the earth's climate is currently changing at an accelerated rate and will continue to do so for the foreseeable future. Anthropogenic (human-caused) greenhouse gas (GHG) emissions contribute to this rapid change. Carbon dioxide (CO_2) makes up the largest component of these GHG emissions. Other prominent transportation GHGs include methane (CH_4) and nitrous oxide (N_2O).

Many GHGs occur naturally. Water vapor is the most abundant GHG and makes up approximately two thirds of the natural greenhouse effect. However, the burning of fossil fuels and other human activities are adding to the concentration of GHGs in the atmosphere. Many GHGs remain in the atmosphere for time periods ranging from decades to centuries. GHGs trap heat in the earth's atmosphere. Because atmospheric concentration of GHGs continues to climb, our planet will continue to experience climate-related phenomena. For example, warmer global temperatures can cause changes in precipitation and sea levels.

To date, no national standards have been established regarding GHGs, nor has EPA established criteria or thresholds for ambient GHG emissions pursuant to its authority to establish motor vehicle emission standards for CO_2 under the Clean Air Act. However, there is a considerable body of scientific literature addressing the sources of GHG emissions and their adverse effects on climate, including reports from the Intergovernmental Panel on Climate Change, the US National Academy of Sciences, EPA, and other federal agencies. GHGs are different from other air pollutants evaluated in federal environmental reviews because their impacts are not localized or regional due to their rapid dispersion into the global atmosphere, which is characteristic of these gases. The affected environment for CO_2 and other GHG emissions is the entire planet. In addition, from a quantitative perspective, global climate change is the cumulative result of numerous and varied emissions sources (in terms of both absolute numbers and types), each of which makes a relatively small addition to global atmospheric GHG concentrations. In contrast to broad scale actions such as actions involving an entire industry sector or very large geographic areas, it is difficult to isolate and understand the GHG emissions impacts for a particular infrastructure project. Furthermore, presently there is no scientific methodology for attributing specific climatological changes to a particular infrastructure project's emissions.

Although there are currently no greenhouse gas (GHG) emission limits for CCH WWTPs, in 2007 the Hawaii State Legislature passed Act 234, "Global Warming Solutions Act" which was signed into law by the governor. Act 234 required the Hawaii Department of Business, Economic Development, and Tourism (DBEDT) and DOH to update their Inventory of Greenhouse Gas Emissions Estimates for 1990 by December 31, 2008. The *Hawaii Greenhouse Gas Inventory: 1990 and 2007* was completed on time in December 2008 by ICF International for DBEDT. Act 234 also requires a reduction in the amount of GHG emissions in Hawaii to levels at or below 1990 levels by 2020.

3 Existing Air Quality Conditions

3.1 Climate

Regional and local climate together with the amount and type of human activity generally dictate the air quality of a given location. The climate of the project area is very much affected by its leeward and coastal situation. Winds are predominantly trade winds from the east northeast except for occasional periods when Kona storms (seasonal cyclones) may generate strong winds from the south or when the trade winds are weak and land breeze-sea breeze circulations may develop. Wind speeds typically vary between about 5 and 15 miles per hour providing relatively good ventilation much of the time. Temperatures in leeward areas of Oahu are generally very moderate with average daily temperatures ranging from about 70°F to 84°F. The extreme minimum temperature recorded at Honolulu Airport is 54°F, while the extreme maximum temperature is 95°F. This area of Oahu is one of the drier locations in the state with rainfall often highly variable from one year to the next. Monthly rainfall has been measured to vary from as little as a trace to as much as 10 inches. Average annual rainfall amounts to about 20 to 30 inches with summer months being the driest.

3.2 Current Air Quality

Based on air quality data collected and published by the EPA and DOH, the State of Hawaii complies with the standards of the CAA, including the NAAQS and State Ambient Air Quality Standards. The air in Hawaii is clean and low in pollutants, and the area where the project is located is in attainment of all air quality standards. Consistent trade winds also contribute to the clean air in Hawaii.

The present good air quality of the project area can be represented based on ambient air quality monitoring data in the state. Collected at the closest monitoring station 3.6 miles east of the project site as provided in **Table 3-1**. Both national and Hawaii ambient air quality standards are currently being met.

Table 3-1. 2013 Monitored Ambient Air Quality Conditions

Pollutant	Location	Units	Averaging Period	Concentration	NAAQS
CO	2052 Lauwiliwili Street, Honolulu, HI	ppm	8-hour	1	9
			1-hour	1	35
Lead (Pb)	2052 Lauwiliwili Street, Honolulu, HI	µg/m3	3 - month Avg	-	0.15
			24-hour	0.001	-
SO_2	2052 Lauwiliwili Street, Honolulu, HI	$\mu g/m^3$	1-hour	16	75
			3-hour	-	1300
			24-hour	5	140
PM10	2052 Lauwiliwili Street, Honolulu, HI	ug/m3	24-hour	39	150
$PM_{2.5}$	2052 Lauwiliwili Street, Honolulu, HI	$\mu g/m^3$	Annual	3	15
			24-hour	10	35
NO_2	2052 Lauwiliwili Street, Honolulu, HI	$\mu g/m^3$	1-hour	23	100
			Annual	-	53
Ozone	2052 Lauwiliwili Street, Honolulu, HI	ppm	8-hour	0.051	0.075

Notes:
CO and Pb levels are the first-highest.
SO_2 levels are the 99-percenrile for 1-hour average and highest for 24-hour average.
$PM_{2.5}$ 24-hour level is the 98th percentile level.
NO_2 1-hour level the 98th percentile.
Ozone 8-hour average level is the 4th highest-daily value.

3.3 Existing Facility Air Permit

The Honouliuli WWTP is minor source for criteria pollutants and HAPs and is operating under a noncovered source permit (No. 0215-020N) issued by the DOH, and therefore not subject to CAA Title V permitting. Various plant stationary sources emitting criteria pollutants, H_2S, and HAPs that are covered by this permit include:

- Cleaver Brooks boiler – 2.5 million Btu/hour heat input, 60 horsepower.
- Various tanks and odor control systems.
- Flares.

With respect to the H_2S emission concentration from the outlet stacks, the following limits were established in the permit for the following odor control systems:

- 2.0 parts per million by volume (ppmv) for the Central Odor Control System;
- 3.0 ppmv for the Headworks Odor Control System;
- 1.0 ppmv for the Secondary Odor Control System;
- 3.0 ppmv for the Biofilter Odor Control System; and
- 3.0 ppmv for the Chemical Scrubber Odor Control System.

3.4 Odor Control System

The Honouliuli WWTP has six separate odor control systems that collect and treat foul air consisting of:

- Preliminary Odor Control System – collects and treats foul air from the influent sewers, influent screens, and influent pump station wet well. This foul air is conveyed to two activated carbon scrubbers, which are run in parallel. The total capacity of the activated carbon scrubbers is 7,000 cubic feet per minute (cfm).
- Primary Odor Control System – collects and treats foul air from the aerated grit chambers, preaeration tanks, and primary clarifier weirs. This system consists of two-stage treatment that includes two catalytic scrubbers that have been converted into caustic scrubbers, followed by five dual-bed activated carbon scrubbers. The total capacity of the system is 24,000 cfm.
- Secondary Odor Control System – collects and treats foul air from the secondary treatment processes including the biotower pump station and trickling filter/solids contact (TF/SC) process. Like the primary odor control system, the Secondary Odor Control System consists of a two-stage treatment system that includes two catalytic scrubbers that have been converted into caustic scrubbers, followed by five dual-bed activated carbon scrubbers. The total capacity of the secondary odor control system is 25,000 cfm.
- Primary Sludge Odor Control System – consists of a four-cell stone media biofilter system that collects and treats foul air from the gravity thickeners and sludge blend tanks. The total capacity of the Primary Sludge Odor Control System is 16,400 cfm.
- Secondary Sludge Odor Control System – consists of an activated carbon system with two units that collect and treat foul air from the gravity belt thickeners. The capacity of the Secondary Sludge Odor Control System is 3,000 cfm.
- Solids Dewatering Odor Control System – consists of a multistage chemical unit that collects and treats foul air from the centrifuge dewatering building. The Solids Dewatering Odor Control System has a treatment capacity of 22,000 cfm.

The existing wastewater pumping stations and force mains generally are not significant sources of air pollution emissions or nuisance odor issues (AECOM, 2010). Odorous emissions may occasionally occur with outgassing leaks from the conveyance system and/or from wastewater upset or overflow situations. Odor Control System Permit No. 0215-02-N limits the H_2S concentrations at each individual odor control system outlet. Detailed Honouliuli Wastewater Basin Odor Control Project (HWBOCP) performance monitoring results from each of the existing odor control systems are provided in the Odor Control Strategy (AECOM, April 2013) and summarized in

Table 3-2. Ongoing monitoring is conducted at 13 fence line monitoring locations along the original property line and at the outlet stacks of each odor control system to meet permit requirements.

Table 3-2. HWBOCP Performance Monitoring

Odor Control System	Location of Monitoring	Test Duration (days)	Average Removal Efficiency	Average Inlet H_2S (ppmV)	Peak Inlet H_2S (ppmV)	Average outlet H_2S (ppmV)	Peak outlet H_2S (ppmV)
Preliminary	Influent Junction Box	12	n/a	86	213	n/a	n/a
	IPS Wetwell	12	n/a	21	46	n/a	n/a
	GAC 1	8	n/a *	26	134	n/a *	>2.0*
	GAC 2	8	n/a *	13	65	n/a *	>2.0*
Primary	Caustic Scrubber	8	98%	59	154	2 **	11**
	GAC 1	8	99%	2	11	0.024	0.049
Secondary	Caustic Scrubber	7	>99%	1	3	0.01	0.12
	GAC 1	7	75%	0.02	0.11	0.005	0.015
Primary Sludge	Biofilter	7	>99%	33	55	0.00	0.04
Secondary Sludge	GAC 1	8	98%	0.04	0.27	0.001	0.004
Solids Dewatering	Chemical Scrubber 1 ***	10	<70%	<1	3	0.31	0.58
	Chemical Scrubber 2 ***	10	85%	1	1	0.15	0.31

*A reading of >2.0 is over scale for the low range Odalogs, which indicates an unknown value that is greater than 2 ppmV.

**A low range logger was used for the Primary Caustic Scrubber outlet. H2S concentration was too high for the logger type. At nearly the same location, a standard logger was used for the Primary GAC 1 inlet. Therefore, the Primary GAC 1 inlet results are also used for the Primary Caustic Scrubber outlet.

***Water only, chemicals are not presently used in these units.

Source: Honouliuli Wastewater Basin Odor Control Project (HWBOCP), 2013

It should be noted that odor complaints may occur even when the Hawaii standard of 0.025 ppm for H_2S is met because people's odor thresholds are variable and range from about 0.001 to 0.02 ppm for detection of H_2S. Also, the Hawaii standard for hydrogen sulfide relates to 1-hour averaging periods, while odor can typically be detected by individuals when concentrations are present for only a few seconds to a few minutes. Due to the nature of atmospheric dispersion, concentrations averaged over a few minutes will be higher than concentrations averaged over 1 hour.

The existing Honouliuli WWTP odor control systems are presently being evaluated under a separate CCH project entitled *Honouliuli Wastewater Basin Odor Control*. The purpose of this on-going project is to identify deficiencies in the odor control systems at the Honouliuli WWTP; identify odor sources from within the Honouliuli Wastewater Basin; and provide recommendations for effective and economical improvements to address current odor control needs. Results of the HWBOCP will be incorporated as a baseline for development of recommendations to control odors from future wastewater treatment process that are being addressed under the Honouliuli WWTP Facility Plan and Conceptual Design (AECOM, April 2013).

4 Construction Impacts

4.1 Sources of Emissions

The major potential short-term air quality impact of the project will occur from the emission of fugitive dust during construction operations. During construction phases, emissions from engine exhausts will also occur both from on-site construction equipment and from vehicles used by construction workers and from trucks traveling to and from the project construction sites. Increased vehicular emissions due to disruption of traffic by construction equipment and/or commuting construction workers can be alleviated by moving equipment and personnel to the site during off-peak traffic hours.

4.2 Construction Impacts

Three action alternatives are considered for secondary treatment upgrades and modifications to the Honouliuli WWTP to meet future flow and water quality requirements as well as the No Action Alternative. In addition, four primary alternatives and the No Action Alternative for site layouts are also evaluated in the DEIS. However, construction air quality impacts from the site layout alternatives are considered to be the same and therefore analyses of the different site layouts were not performed.

4.2.1 On-site Equipment Impacts

The proposed upgrades to the Honouliuli Wastewater Treatment Plant will require a variety of heavy construction equipment to implement. Generally, for heavy construction such as that proposed for the Honouliuli WWTP, construction equipment will include a variety of cranes (ranging from smaller tire-mount units for unloading of delivered materials, to large crawler cranes for lifting in place and setting large pieces of equipment and structural steel), earthmoving equipment, hydraulic rams, concrete delivery trucks and pumpers, and a variety of gasoline- and pneumatically-powered hand tools.

Because the scope of the proposed program is well-defined in terms of what is to be constructed, the primary variable in determining equipment needs is the construction phasing. The contracting approaches considered call for the letting of one, two or four separate construction contract packages, with the latter two options corresponding to a two-phase approach to the construction. Different phases of construction would not overlap under any of the proposed approaches, although the total length of active construction differs with the alternatives. The shortest duration alternative is the single-phase/single-contract approach, which would result in peak construction equipment. Accordingly, for purposes of this estimate, the single-phase/single-contract approach is considered the primary option; other alternatives would generate less intense scheduling.

A detailed construction and equipment schedule would be developed by the contractor(s). However, it is possible to estimate the approximate needs and schedule for large equipment based on the currently-available project descriptions. The work proposed is heavy civil work, and while not defined in the *Facilities Plan*, it is assumed that significant effort will be ultimately expended in foundation work. This will likely include installation of piles at key support locations. Significant concreting operations occur as part of both the foundation construction and superstructure construction. In parallel, structural steel work will likely be a significant phase of work for most major scope items. Finally, equipment installation will occur at the various process structures.

Based on the construction conceptual plan and past construction project experience, equipment requirements for these various demolition and construction stages would likely include:

- A combination of backhoes, bulldozers, cranes, compressors, pile drivers, dump trucks, etc. as necessary, during heavy earth-moving/foundation demolition and construction phases over the first 48-month period.
- Concrete pump and mix trucks, compressors, certain hand-held pieces of equipment such as slab smoothing, etc. over the first 48-month duration.

- Cranes, compressors, and some hand-held equipment during the building/facility erection phases between Month 12 and Month 72.
- Cranes, forklifts, compressors, etc., during final equipment installation stage between Month 48 and Month 70.

Alternate phasing (e.g., the two- or four-contract approaches) would have similar equipment requirements over a longer duration (108 months for the 2-contract option, 144 months for the 4-contract option). The extension in schedule would be driven more by inefficiencies inherent in subdividing the work, such as multiple mobilizations and demobilizations, as opposed to duplicative work. Since the scale of project remains the same, the usage of equipment under varied scenarios would differ with worse short-term air quality impacts under the compressed construction schedule. However, given the spreading of the construction activity over the years, hot spot air quality concerns associated with concentrated equipment operations would be limited. Moreover these construction equipment are typical of routine infrastructure development projects in urban areas, short-term emissions from the small number of construction equipment would be inconsequential compared to the regional emissions, factoring in the substantially greater number of unrelated on-road vehicles and associated emissions that constitute the majority of baseline mobile emissions. Therefore construction equipment operational impacts are anticipated to be less than significant.

4.2.2 On-road Vehicle Impacts

According to the worst-case construction year, 2021, trip generation, it is anticipated that 185 construction workers would arrive to the site during the AM peak hour and 185 construction workers would exit the site during the PM peak, in addition to 8 total trips (4 entering and 4 exiting) generated by cement trucks during each of the AM and PM peak hours of traffic.

Based on the level of service comparison between Future Year 2021 (with project) and Base Year 2021 (without project), the majority of traffic congestion at analyzed affected intersections would continue operating at similar levels of service with or without construction activities. Therefore, the on-road mobile source air quality impacts would be temporary and comparable to the 2021 baseline condition causing no significant impacts.

4.3 Best Management Practices

Short-term impacts to air quality would result from the demolition of old facilities and construction of the secondary treatment upgrades and modifications. Regardless of the alternative, there would be temporary impacts to air quality due to fugitive dust during construction, exhaust emissions from stationary and mobile construction equipment, from the disruption of traffic, and from workers' vehicles that may also affect air quality during the period of construction.

The best management practices to control construction emissions would be implemented in accordance with state air pollution control regulations which require that there be no visible fugitive dust emissions at the property line.

Fugitive dust emissions can be controlled to a large extent by watering of active work areas, using wind screens, keeping adjacent paved roads clean, and by covering of open-bodied trucks. Other dust control measures could include limiting the area that can be disturbed at any given time and/or mulching or chemically stabilizing inactive areas that have been worked. Dirt-hauling trucks should be covered when traveling on roadways to prevent loss of dirt. A routine road cleaning and/or tire washing program can also help to reduce fugitive dust emissions that may occur as a result of trucks tracking dirt onto paved roadways in the project area. Paving and landscaping of project areas early in the construction schedule would also reduce dust emissions.

Monitoring dust at the project boundaries during periods of construction could be considered as a means to evaluate the effectiveness of the project dust control program and to adjust the program if necessary. Localized effects of exhaust emissions can be reduced by using newer construction equipment, reducing truck on-site idling time, and moving construction materials and workers to and from the project sites during off-peak traffic hours.

5 Operation Impacts

Potential operational impacts with the implementation of the proposed project would include an upgrade on the standby power capacity, possible introduction of a new energy saving combined and heat (CHP) system by burning currently flared digested gas, and increase in mobile source operation. This section discusses the evaluation of potential operational air quality including odor impacts from the proposed plant expansion.

5.1 Stationary Source Impacts

5.1.1 Standby Power Upgrade

The WWTP standby power system provides power to the WWTP when the utility feed is interrupted.

The existing configuration of standby power has a total of 4 diesel generators with a capacity of 1.25 MW, 1 MW, 0.65 MW and 0.9 MW, respectively.

Under the improvement plan, it is recommended that three smaller existing generators that are still in good shape would continue to provide power to the current load and a central 10 MW diesel powered medium voltage generator plant would provide standby power to the new loads. Given their emergency use, these generators are exempt from obtaining air permit.

The emissions standards for diesel generators are governed by the EPA as well as any state requirements. Standby/emergency generators above 2 MW are currently required to meet the EPA Tier 2 emissions requirements. To meet this requirement, the generator must be used as a standby/emergency generator which limits its operation to only during a utility outage and for some testing purposes for a maximum of 500 hours per year. However, at the time when these generators are installed, the emissions control requirement could be more stringent since the installation of these generators may not occur until 2021. Table 5-1 summarizes the net increase in potential annual standby generator emissions assuming each generator has a potential to operate for a maximum of 500 hours per year.

Table 5-1. Emergency Diesel Generator Emissions

Generator Power (kW)	Annual Hours	Diesel Generator Annual Emissions (TPY)							
		VOC	NOx	CO	PM_{10}	$PM_{2.5}$	SOx	HAPs	CO_2e
Existing									
3,800	500	0.90	30.57	7.01	0.44	0.43	0.02	0.04	1344
Future									
12,550	500	2.89	98.56	22.59	1.46	1.41	0.05	0.13	4441
Net Increase Under the Improvement Plan		**2.0**	**68.0**	**15.6**	**1.0**	**1.0**	**0.03**	**0.1**	**3096**

Notes
1. USEPA AP-42 emission factors for large diesel engines
2. Uncontrolled NOx emission factor
3. VOC emissions use TOC (as CH_4) emission factor
4. ULSD 15 ppm (0.0015%)

However, given their emergency usage purposes, potential air quality impacts would be short in duration unlikely causing significant air quality impacts. If these generators would be used for peak power shaving purposes as compared to emergency use, they would have to comply with more stringent emissions requirement, i.e., EPA Tier 4 requirements involving treatment of exhaust emissions and greater air quality impacts would occur. Under this circumstance, the future CAA air permitting process would ensure the compliance of the NAAQS as a result of increasing stationary source operational emissions on site when a final design plan is available. Therefore, the proposed project would be unlikely to result in significant air quality impacts.

5.1.2 New Combined Heat and Power Facility

A combined heat and power (CHP) facility may be incorporated at Honouliuli WWTP to make beneficial use of digester biogas. The most common CHP systems for medium size wastewater treatment plants are reciprocating engines or microturbines. If a CHP facility is incorporated at Honouliuli WWTP, it would need to be permitted according to state and federal air regulations. Since this facility would be a new stationary source and the emissions at Honouliuli WWTP would increase resulting in adverse air quality impacts on the local level. However, because the feasibility of constructing such facility is still under evaluation and has no design specifics, the potential air emissions from the facility cannot be reasonably estimated. If the CHP facility option is elected in the future, the CHP facility would need to be considered for future air permitting in conjunction with the biosolids disposal process during the design stage. During the air permitting process, it is anticipated that a separate air quality impact modeling analysis would be conducted to address potential air quality impact significance from the CHP facility.

5.2 Mobile Source Impacts

With an anticipated 55 peak hour vehicles entering the project site under the future operational condition, the on-road traffic induced air quality impacts are anticipated to be minimal.

Based on the level of service comparison between Future Year 2030 and Baseline Year 2030 conditions, the congestions at each affected intersection will operate at similar levels of service with minimal impacts. Therefore, the mobile source air quality impacts under the plant improvement plan would not be significant.

5.3 Odor Impacts

The operation of the Honouliuli WWTP generates odors under current conditions (No Action Alternative) and would also generate odors under all upgrade options. The Honouliuli Wastewater Basin Odor Control Project evaluated and recommended improvements to the odor control systems at the Honouliuli WWTP to be incorporated into upgrades to the facilities Under the proposed project, the existing Preliminary and Primary Odor Control Systems would be replaced with a combined new treatment system and no upgrades would be required for the existing Secondary Odor Control System, Primary Sludge Odor Control System, Secondary Sludge Odor Control System, and Dewatering Odor Control System. These improvements would consider future needs and allow for expansion of the system, as needed.

The proposed project recommends replacing the existing Primary Odor Control System with biofilters. In addition, odor control will be provided to the new treatment facilities with biofilters. The odor control improvements can be centralized or decentralized. In addition to the biofilters, grit covers, primary clarifier covers, and primary effluent channel covers are recommended for odor containment. These project activities and upgrades for components are common to each of the secondary treatment options. Under the No Action Alternative, there would be no upgrades to the current system.

Covers keep foul odors contained within the headspace of process units. By ventilating the headspace, odorous air can be exhausted and treated. Several proposed new process units would be covered or enclosed to contain foul air for the Phase 1 Secondary Treatment Improvements Odor Control System as described in the Odor Control Strategy *Technical Memorandum 12.G* (AECOM, 2013).

All three of the secondary treatment alternatives would result in improvements in the long-term air quality of the project area in terms of the nuisance odor that could occur from sewer overflows. The improvements would also

likely result in a reduced number of incidents of offsite odor near the plant as compared to the No Action Alternative.

Therefore, compounded with the improvements on existing Primary Odor Control System and the proposed secondary treatment alternative, the odor impacts under the proposed plant improvement plan would be unlikely significant. The ambient odor monitoring program to be implemented after the completion of the project would demonstrate the compliance of the DOH ambient odor standard in terms of H_2S concentration levels.

5.4 Conclusion

After construction activities are completed, the potential long-term air quality impacts to the project area would be unlikely significant although there is a potential to increase on-site stationary and mobile source emissions due to an increase in operational capacity. However, the possibility of nuisance odor from the sewer system would likely be reduced by the upgrade odor control system causing lower nuisance odor downwind of the Honouliuli WWTP. The compliance of all applicable ambient standards including odor in terms of ambient H_2S concentration levels would be further demonstrated 1) during the final design stage of the project when the air permit is modified for applicable criteria pollutants and 2) after the completion of construction with an ambient monitoring program for odor.

Although the proposed project is not expected to cause or promote population growth or any associated secondary air quality impacts, population growth in the project area is expected to occur at an annual rate of about 1.2 percent through the year 2030. Despite the expected population growth, it appears likely that the overall good cumulative air quality of the project area would be maintained. Higher levels of emission control, both from industrial sources (including Honouliuli WWTP) and from motor vehicles, would likely largely offset the potentially higher emissions from a larger population.

Similar to the criteria pollutants, it is anticipated that an increase in the GHG would occur associated with the WWTP expansion project. However, such an increase would be further evaluated during the final design stage when each improvement element is well defined and such emissions can be reasonably forecasted. Given its global effects, such a typical infrastructure development project in an urban area would unlikely cause any meaningful global warming effects.

Appendix E
Noise Study, Ebisu & Associates, January 2015

Y. Ebisu & Associates
Acoustical and Electronic Engineers

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Honolulu, Hawaii 96816
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YEA Job #52.029
January 5, 2015

AECOM
1001 Bishop Street, Suite 1600
Honolulu, Hawaii 96813

Attention: Mr. Lambert Yamashita, P.E.

Subject: Final Results of Noise Study for the Proposed Honouliuli Wastewater Treatment Plant (WWTP) Development

Dear Mr. Yamashita:

I am providing this letter report to present our findings regarding potential noise impacts associated with the proposed Honouliuli Wastewater Treatment Plant (WWTP) Development. We have reviewed the draft Traffic Impact Assessment Report (TIAR dated 10/27/14) and the Phase II development plan of future facilities at the Honouliuli WWTP, and have completed our noise measurements of existing conditions at the plant. We have also completed our modeling of existing and future traffic noise levels, and have completed our noise modeling of future plant facilities.

Existing Background Noise Levels. Daytime and nighttime noise measurements were obtained at or near the boundary lines of the Honouliuli WWTP to determine if the facility is in compliance with State Department of Health (DOH) noise limits. Because the facility is located on lands which are zoned I-2 and AG-1, the applicable DOH noise limit for noise emissions from WWTP equipment at or beyond the WWTP property boundaries is 70 dBA, for both daytime and nighttime periods.

Figure 1 and Table 1 depict the noise measurements at or near the property boundary lines which were obtained on October 22 and 23, 2014. The measured sound levels at the various locations during the daytime and nighttime are also shown in the figure and table. In Figure 1, the measured L10 values (or levels exceeded 10 percent of the time) are shown, since this is the metric used by the State DOH. The nighttime measurements were used to determine if the steady noise levels from the facility exceeded the 70 dBA DOH noise limit, and it was clear that the facility is in full compliance with the 70 dBA DOH noise limit. The daytime noise measurement results were typically controlled by non-plant noise sources, such as motor vehicle traffic and aircraft. The daytime noise measurement results also confirmed the conclusion that the Honouliuli WWTP is currently in compliance with the 70 dBA DOH noise limit.

At measurement Locations B and C, the dominant noise source during the night was an audible low frequency source which appeared to be originating from beyond the

WWTP toward the east. At all other measurement locations, the steady (L50) nighttime background noise levels were less than 50 dBA, indicating that the Honouliuli WWTP noise sources were well below the 70 dBA limit along the property lines of the WWTP. At Locations F and G, where the closest residences are located, measured steady (L50) background noise levels at night were less than 41 dBA.

During the daytime, motor vehicle traffic and aircraft noise become the dominant noise sources along the Honouliuli WWTP's property lines. Measured daytime background noise levels (L10) along the Honouliuli WWTP's property lines ranged from 52 to 71 dBA, and were influenced by off-site noise sources rather than by WWTP noise sources.

Close-in noise measurements of five of the louder noise sources at the existing Honouliuli WWTP were also obtained to confirm that their noise levels could not exceed the 70 dBA DOH limit at the facility's property boundaries when operating singly or together. These noise sources are shown in Figure 2, and were the: Dewatering Building Centrifuge; Influent Pump Station; Blower Building #1 (Primary); BioTower Pump Station Booster Fan; and Caustic Scrubber Odor Control Blower. These five noise sources should remain at their present general locations through 2030, but may increase in noise levels due to increases in their future capacity. The measured existing noise levels of these five sources were: 63 dBA at 50 feet from the Centrifuge; 73 dBA at 25 feet from the Influent Pump Station; 65 dBA at 50 feet from the Blower Building #1; 67 dBA at 25 feet from the Booster Fan; and 75 dBA at 25 feet from the Odor Control Blower. Using these measured noise levels, the calculated combined noise levels from these five noise sources ranged from 31 to 48 dBA along the facility's property boundaries. The results of these calculations at the various noise measurement locations at or near the facility's boundaries are shown in Table 2. The calculated noise levels shown in Table 2 for the existing WWTP's noise sources are very low, and consistent with the conclusion that the noise levels from existing plant sources do not exceed the 70 dBA DOH noise limit. At the closest residences (Locations F and G), calculated noise levels from existing plant equipment were less than 35 dBA, and well below the nighttime average (or Leq) noise levels of 39 to 47 dBA measured at those two locations.

Existing Road Traffic Noise Levels. Table 3 and Figure 3 present the results and locations of traffic noise level measurements which were performed on December 2, 2014. We have reviewed the existing and forecasted traffic volumes from the project's draft TIAR and utilized that data and the results of the traffic noise measurements to develop our conclusions regarding potential traffic noise impacts associated with the project. Table 4 presents the calculated hourly average [or Leq(h)] traffic noise levels at 50, 75, and 100 feet setback distances from the roadways' centerlines in the immediate environs of the project during the pm peak traffic hour. The Federal Highway

Administration Traffic Noise Model (TNM Version 2.5) was used to calculate existing and future traffic noise levels using the Loose Soil ground feature. The Hawaii State Department of Transportation considers traffic noise levels less than 66 Leq to be acceptable for noise sensitive land uses. This criteria level was exceeded at 50 feet from the centerlines of Geiger Road and Roosevelt Avenue.

The U.S. Department of Housing and Urban Development (HUD) uses the Day-Night Average Sound Level (or DNL) descriptor in evaluating acceptable noise levels at noise sensitive locations. The DNL descriptor incorporates a 24-hour average of daytime and nighttime noise levels, with the nighttime noise levels increased by 10 decibels (or dB) prior to computing the 24-hour average. A noise level of 65 DNL is considered to be acceptable for noise sensitive uses by HUD. For the Honouliuli WWTP project, the traffic noise levels in DNL may be estimated by adding 1 unit to the peak hour Leq, so a traffic noise level of 66 Leq during the pm peak hour will result in a 67 DNL value, or 2 DNL units above the HUD noise standard. For the roadways evaluated in this noise study, traffic volumes and hourly traffic noise levels were highest during the pm peak hour.

Table 5 presents the existing setback distances to the 65, 70, and 75 DNL traffic noise contour lines for unobstructed line-of-sight conditions along the roadways in the immediate environs of the project. As indicated in Table 5, setback distances in the order of 68 to 70 feet from the centerlines of Geiger Road and Roosevelt Avenue are required to not exceed the HUD 65 DNL noise standard.

Future Road Traffic Noise Levels. Table 6 presents the calculated hourly average [or Leq(h)] traffic noise levels at 50, 75, and 100 feet setback distances from the roadways' centerlines in the immediate environs of the project by year 2030 with the implementation of the proposed project. Table 5 depicts the forecasted setback distances to the 65, 70, and 75 DNL traffic noise contours by 2030 with the implementation of the project. Exceedances of the 66 Leq and 65 DNL acceptability thresholds are expected to continue along Geiger Road and Roosevelt Avenue.

Table 7 presents the calculated increases in traffic noise by year 2030 due to both non-project and project related roadway traffic. By 2030, traffic noise level increases attributable to project traffic should be less than 1.0 dB at all roadways in the project environs, except along the section of Renton Road between Kapolei Parkway and proposed WWTP entrance road, hereinafter referred to as "Honouliuli Driveway 5 (DW5)". The estimated increases in future traffic noise levels along this section of Renton Road are 0.9 dB due to non-project traffic and 2.0 dB due to project traffic. Because existing traffic volumes along this section of roadway are relatively low (approximately 343 vehicles per hour), and because this area is currently undeveloped within 50 feet of the roadway's centerline, these increases in future traffic noise levels

are not expected to result in exceedances of traffic noise level criteria along this roadway section.

Along Renton Road west of project entrance road DW5 where existing residences are located, future traffic noise level increases associated with the project are not expected to occur. Also, along Roosevelt Avenue in the vicinity of Philippine Sea, future traffic noise level increases associated with project traffic are anticipated to be less than 0.2 dB by year 2030.

Along Geiger Road and Roosevelt Avenue where existing traffic noise levels currently exceed the 66 Leq and 65 DNL noise impact thresholds, future increases in traffic noise levels due to project traffic are lower than the increases associated with non-project traffic, and are predicted to be less than 0.8 Leq or DNL. These increases are not considered to be significant, and will probably not be perceivable over the 16 year period between 2014 and 2030.

Future Plant Noise Sources. Estimates of future plant noise levels for the Phase II Development were made by modeling the source levels of the plant equipment expected to be operating through the Phase II Development as described in the Honouliuli WWTP Conceptual Design Report Item 12.0 dated November 2014. Figure 4 depicts the locations of the future noise sources which were included in the noise modeling, and Table 8 presents the assumed noise levels of these sources at 50 feet distance. Special sound attenuation measures such as enclosures, the addition of silencers or mufflers or acoustical louvers, the use of sound absorptive interior finishes, or the use of sound rated doors were not included in the noise modeling assumptions. Although outdoor air conditioning units were not included in the November 2014 Conceptual Design Report, 30 ton air cooled air conditioning units were arbitrarily located at the administration, lab, and maintenance buildings as shown in Table 8 and Figure 4. The large emergency generators in the Main Electrical Building were not included in the noise modeling because of their intermittent operation during testing or emergencies, and because they will probably be sound attenuated separately so as to not exceed the DOH noise limit of 70 dBA at the property boundaries of the WWTP during their operation. The noise levels of other WWTP noise sources should not affect the generators' allowable noise limit along the mauka property line.

Table 9 presents the results of the calculations of predicted plant noise levels at the perimeter Locations A through J of the WWTP without special sound attenuation treatments applied to the various noise sources. The results in Table 9 were controlled by the dominant noise sources located in Building #033I, the Blower Building, and Building #201F. The utilization of special sound attenuation treatments to all noise sources (except for the emergency generators) will probably not be required to comply with the 70 dBA DOH noise limit along the property boundaries of the WWTP.

Construction Noise Impacts. Audible construction noise will probably be unavoidable during the entire project construction period. The total time period for construction of the project is not known. It is expected that actual construction work will performed in phases and be moving from one location on the project site to another during that period. Actual length of exposure to construction noise at any receptor location will probably be less than the total construction period for the entire project. Figure 5 depicts the range of noise levels of various types of construction equipment when measured at 50 feet distance from the equipment.

Typical levels of exterior noise from construction activity (excluding pile driving activity) at various distances from the job sites are shown in Figure 6. Figure 6 is useful for predicting exterior noise levels at short distances from the work when visual line of sight exists between the construction equipment and the receptor. Direct line-of-sight distances from the construction equipment to existing residential buildings will range from 250 feet to 500+ feet, with corresponding average noise levels of 71 to 64 dBA (plus or minus 5 dBA). For receptors along a cross-street, the construction noise level vs. distance curve of Figure 6 should be reduced by approximately 8 dBA when the work is occurring at the intersection with the cross street, and should be reduced by 15 dBA when work is occurring at least 100 feet from the intersection (and the visual line-of-sight is blocked by intervening buildings). Typical levels of construction noise inside naturally ventilated and air conditioned structures are approximately 10 and 20 dB less, respectively, than the levels shown in Figure 6.

Noise sensitive residences who are predicted to experience the highest noise levels during construction activities are located along Philippine Sea and along Renton Road near Philippine Sea when work occurs at the northwest corner of the WWTP. Predicted construction noise levels at these residences during the site preparation phase of the work in this area ranged from 71 to 62 dBA (plus or minus 5 dBA). The highest noise levels during construction are expected to occur at the Coral Creek Golf Course during infrastructure improvements along the east boundary of the WWTP. Across the golf course to the east, the closest residences should experience construction noise levels of 65 dBA or less (plus or minus 5 dBA). Adverse impacts from construction noise are not expected to be in the "public health and welfare" category due to the temporary nature of the work, and due to the administrative controls available for regulation of construction noise. Instead, these impacts will probably be limited to the temporary degradation of the quality of the acoustic environment in the immediate vicinity of the project site.

The State DOH, regulates noise associated with construction activities so as to minimize risks of adverse impacts to public health and welfare. The DOH would utilize a construction noise permit system for all construction activities on the project site. Typically, noise from construction activities can be expected to exceed the allowable

noise limits for stationary equipment which are not associated with construction activities. Therefore, the DOH's administrative rules for construction activities include nighttime, Sunday, and holiday curfews, so as to limit noisy construction activities to the normal workday periods. Additional curfew periods are typically used for pile driving or other rock or pavement breaking equipment.

Mitigation of construction noise to inaudible levels will not be practical in all cases due to the intensity of construction noise sources (80 to 90+ dB at 50 feet distance), and due to the exterior nature of the work (excavation, grading, trenching, concrete pouring, hammering, etc.). The use of properly muffled construction equipment should be required at the various job sites. The incorporation of State DOH construction noise limits and curfew times, which are applicable throughout the State of Hawaii, is another noise mitigation measure which is normally applied to construction activities. Figure 7 depicts the normally permitted hours of construction. Noisy construction activities are not allowed on Sundays and holidays, during the early morning, and during the late evening and nighttime periods under the DOH permit procedures.

The project's draft TIAR investigated the potential traffic during year 2021, which is expected to be the peak year of construction. The predicted increases in traffic noise levels attributable to project related traffic during 2021 were also evaluated, and it was concluded that these increases would not exceed 1 dB along Renton Road between Kapolei Parkway and the proposed WWTP site entrance road DW5. Along all other roadways in the immediate environs of the project, increases in traffic noise levels associated with project traffic were expected to be less than 0.5 dB. Risks of adverse traffic noise impacts during the peak year of project construction were considered to be very low.

Summary and Recommendations. Traffic noise impacts resulting from the proposed development of the Honouliuli WWTP are not expected at noise sensitive receptors within the immediate environs of the facility. Increases in project related traffic noise levels of less than 1 dB between 2014 and 2030 will be difficult to perceive or accurately measure. At locations well beyond the immediate project environs, these project related traffic noise level increases should be even smaller due to the greater percentage contribution of non-project traffic to total traffic noise levels as distances from the WWTP increase.

The noise levels from existing and future WWTP noise sources should not cause compliance problems with the 70 dBA DOH limit during the daytime or nighttime periods. However, there are existing residences who are relatively close to the WWTP property lines at the west end of the WWTP, and a continuous sound level of 70 dBA (which is equivalent to 76 DNL) at these residences would not be compatible with

residential or other noise sensitive uses. The proposed development plan appears to be cognizant of this, and has located the quieter administrative and non-processing facilities at the west end of the WWTP. Risks of complaints from neighboring residents have been minimized by the proposed future configuration of the WWTP.

As the new facilities and equipment are added to the WWTP, it is recommended that sound attenuation treatments be considered for the louder noise sources listed in Table 8. These sound attenuation treatments will probably involve containment of the noise emissions using enclosures or the building envelope, the addition of absorptive interior ceiling and wall panels, the addition of duct silencers or mufflers, or the addition of mechanical ventilation or acoustical louvers. Acoustical treatments of these louder noise sources will reduce their contributions to the total plant noise levels at the various plant boundary locations listed in Table 9, and will minimize the areas where risks of hearing loss to WWTP employees need to considered in hearing conservation programs. Near existing and any future residences to the WWTP, whenever feasible, attempts should be made to minimize the increases in preexisting background noise levels when new facilities and equipment are added to the WWTP. Doing so should minimize risks of noise complaints from neighboring residents or any other noise sensitive uses near the WWTP.

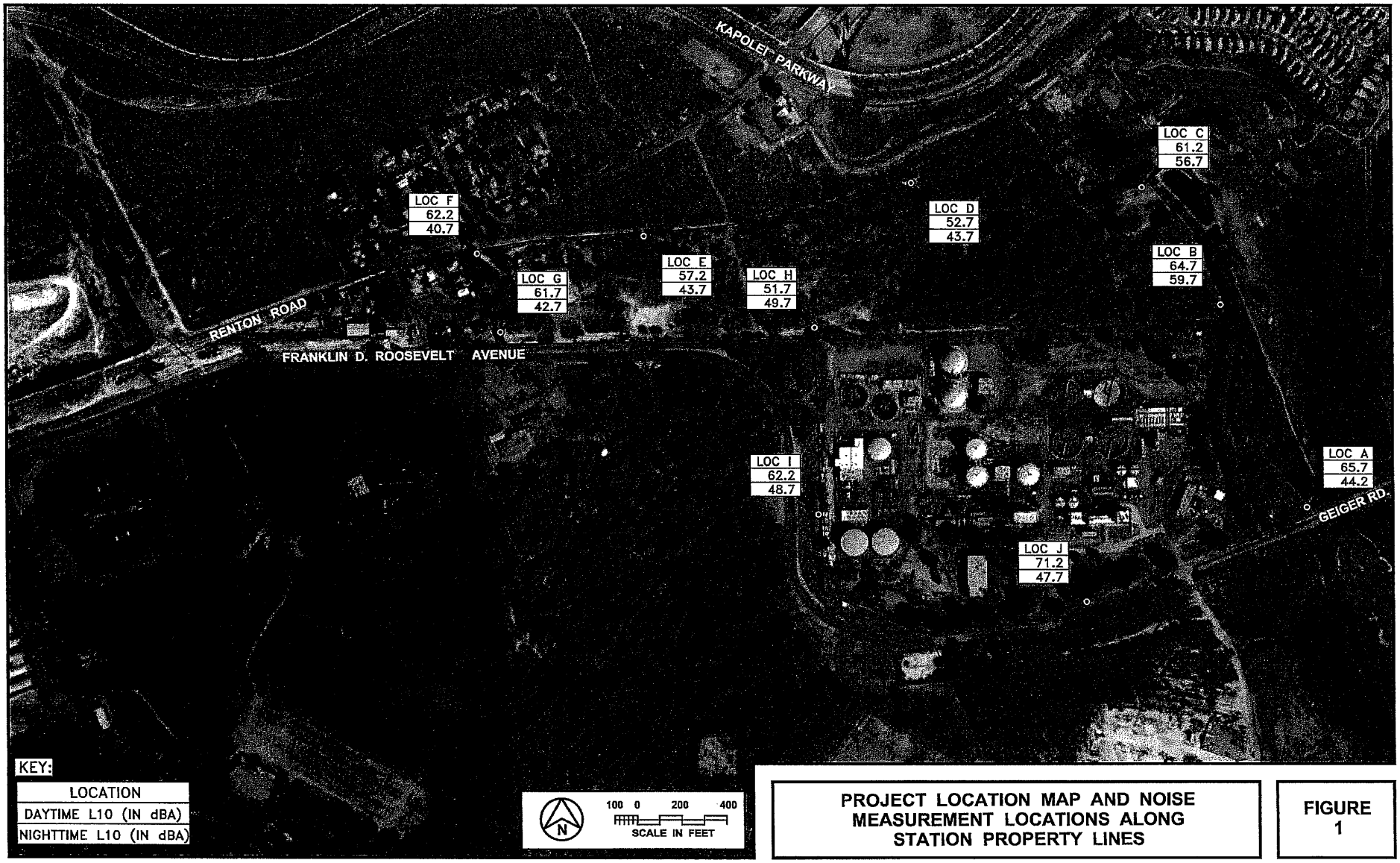
Sound attenuation treatment to the emergency generators in Building #201E will probably be mandatory to comply with the 70 dBA DOH limit along the mauka boundary of the WWTP. The use of a concrete and/or masonry building envelope, the addition of interior acoustical ceiling and wall panels, the inclusion of radiator discharge and fresh air duct silencers, the use of sound rated exterior doors, and the use of high attenuation exhaust silencers will all be required at this building. These methods of quieting emergency generator facilities have been used in the past and are not considered to be extraordinary.

Based on the above evaluations, it was concluded that risks of adverse noise impacts from the proposed Honouliuli WWTP development are very low, and that sound attenuation measures are not required but may be applied as deemed feasible as the improvements and additions occur at the WWTP.

Sincerely,

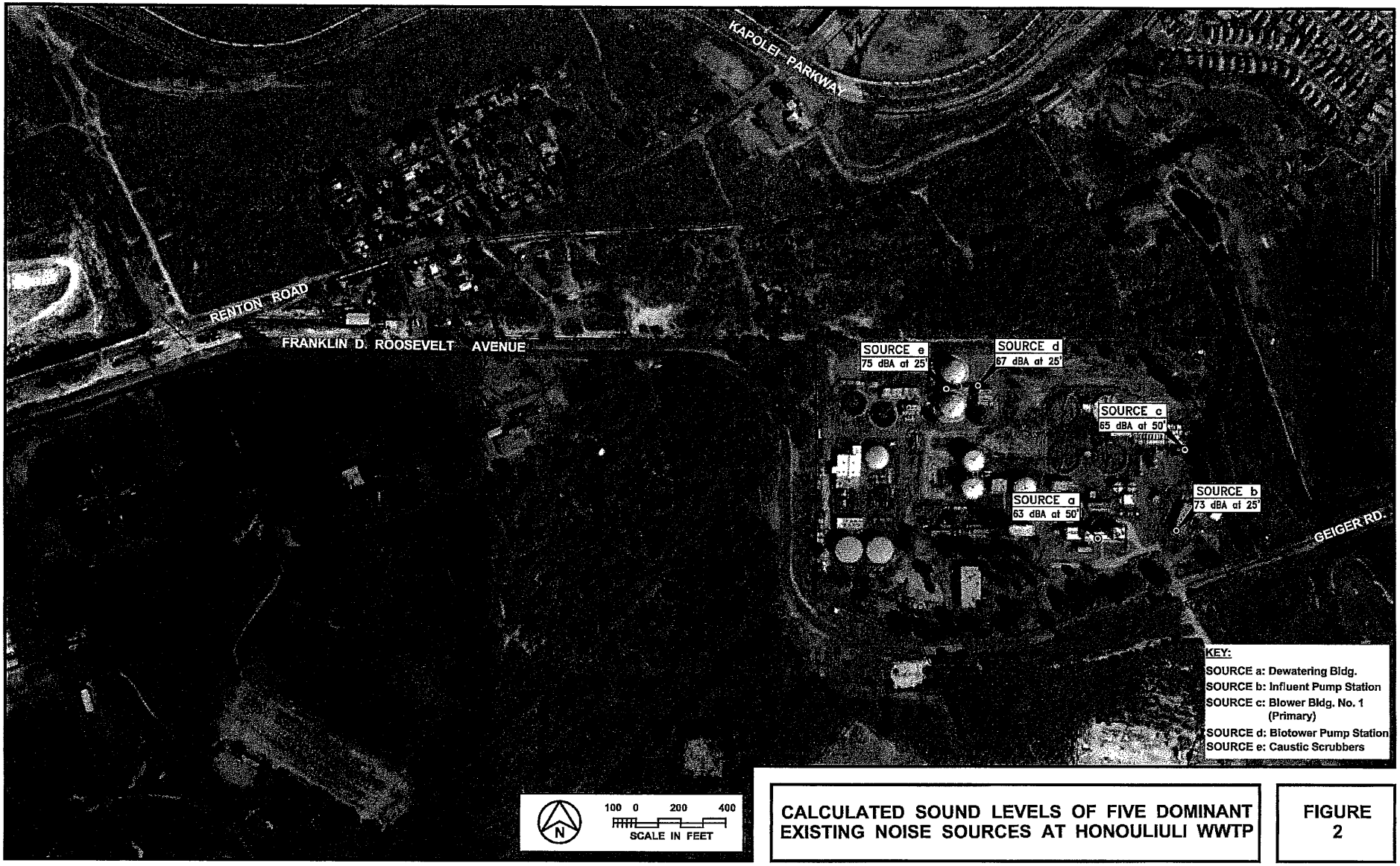
Yoichi Ebisu, P.E.

encl.



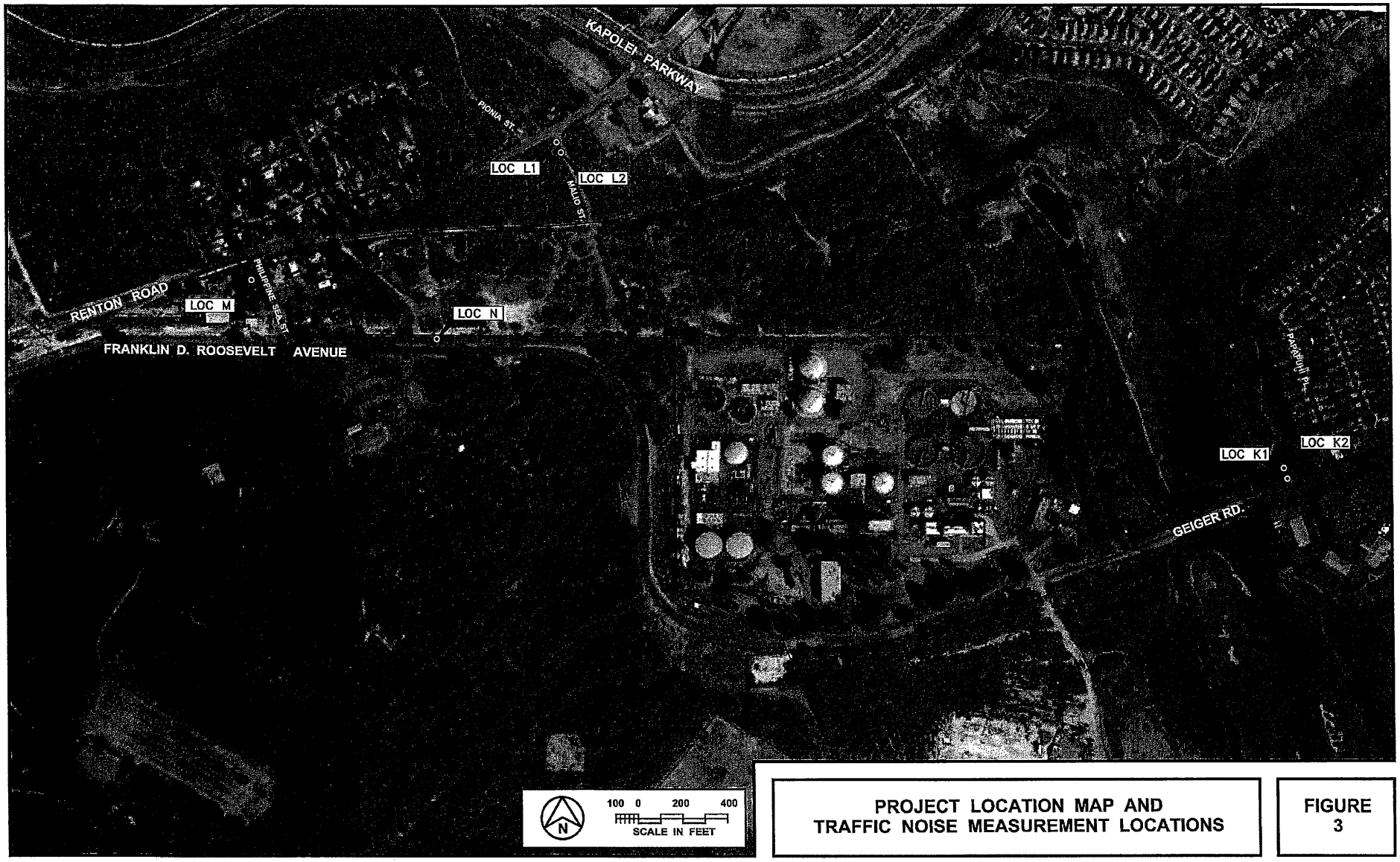
PROJECT LOCATION MAP AND NOISE MEASUREMENT LOCATIONS ALONG STATION PROPERTY LINES

FIGURE 1



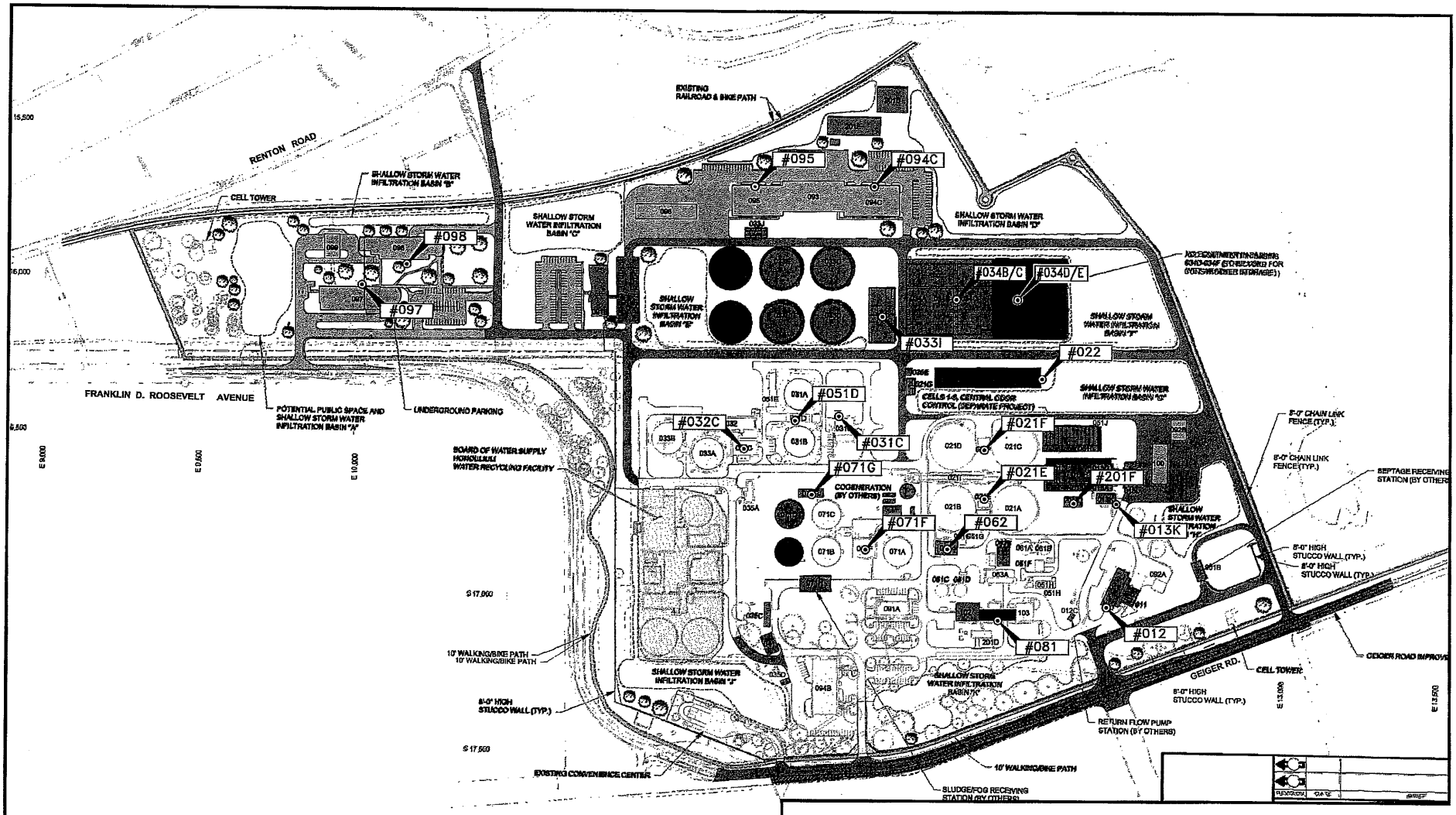
CALCULATED SOUND LEVELS OF FIVE DOMINANT EXISTING NOISE SOURCES AT HONOULIULI WWTP

FIGURE 2



PROJECT LOCATION MAP AND TRAFFIC NOISE MEASUREMENT LOCATIONS

FIGURE 3



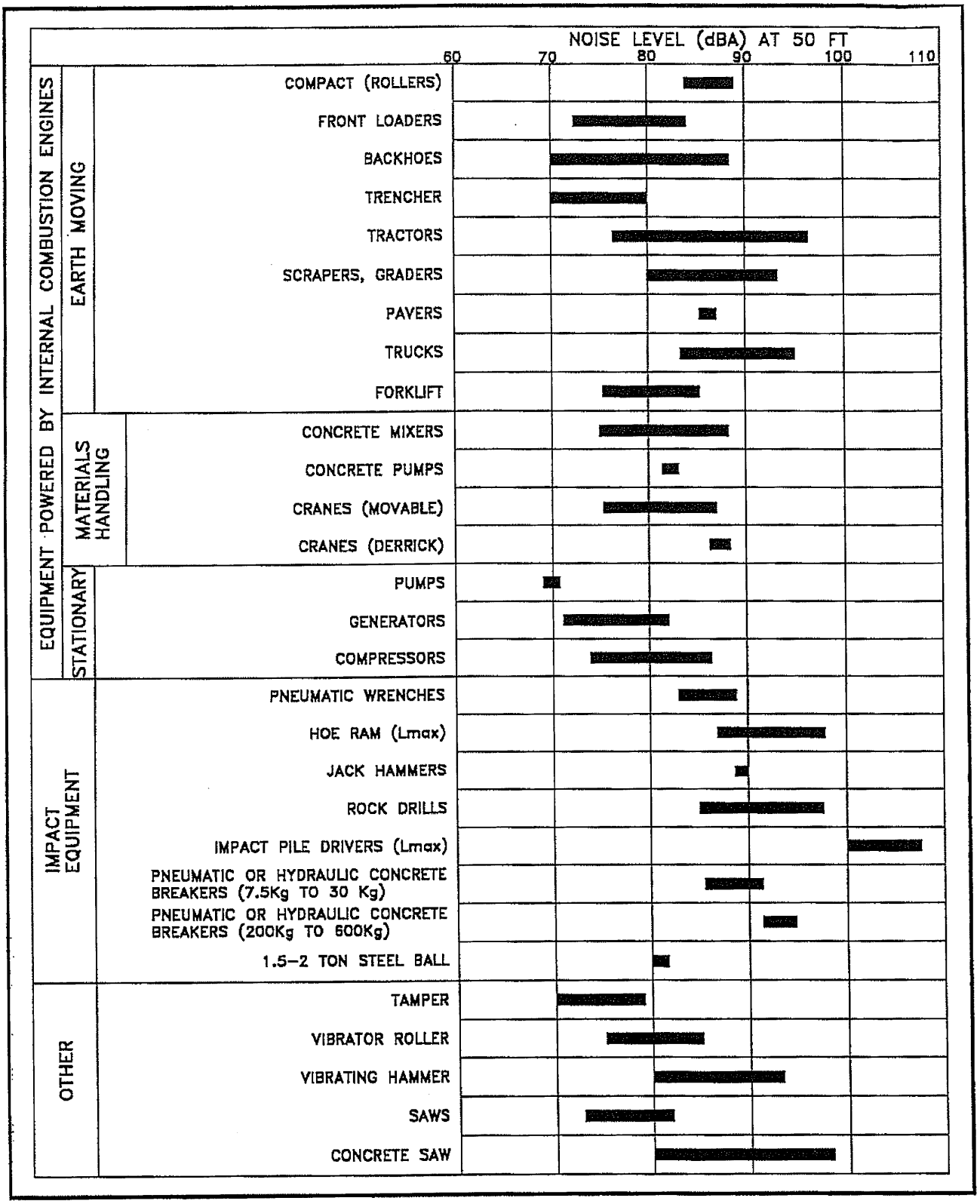
N

75 0 150 300

SCALE IN FEET

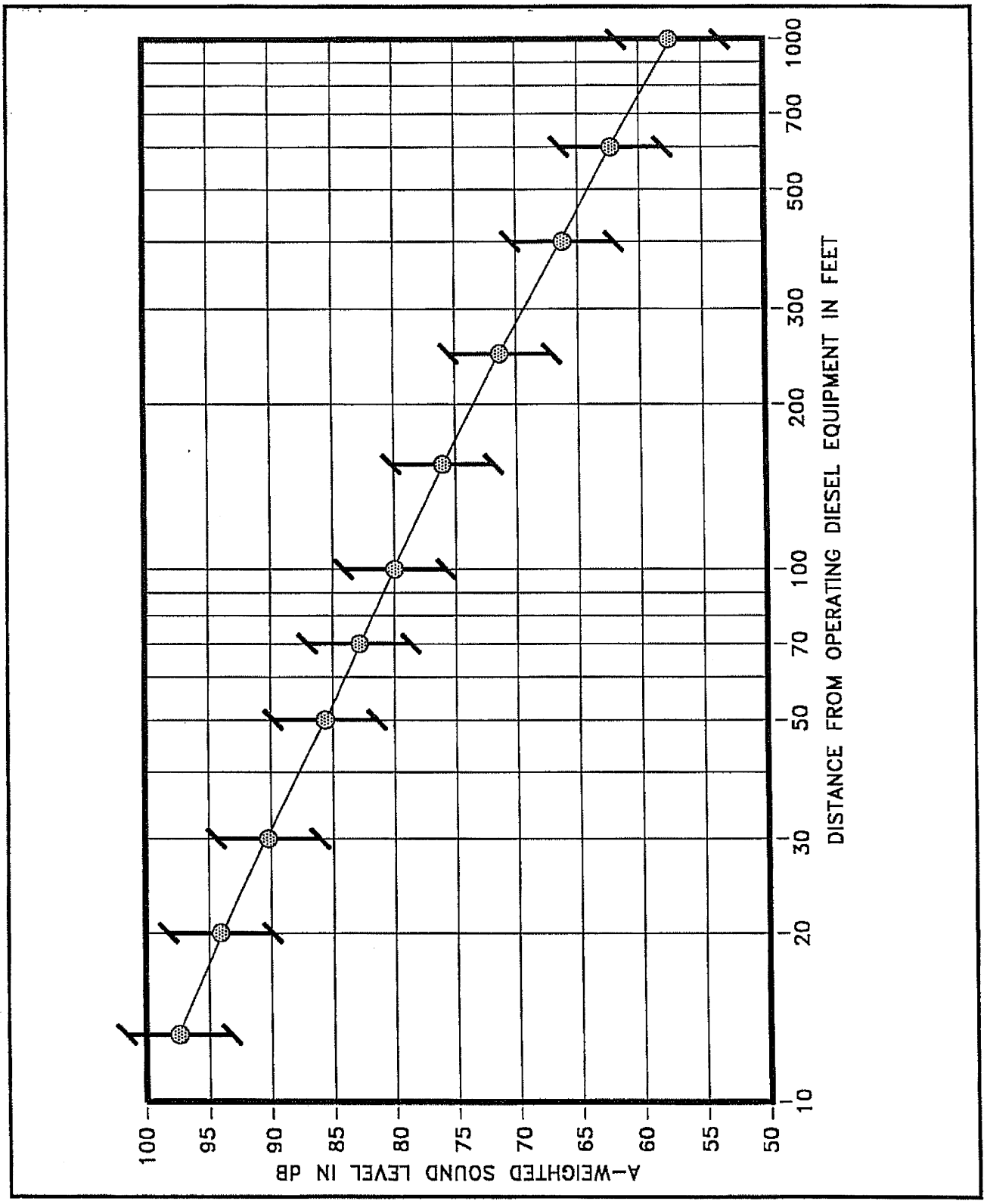
LOCATIONS OF FUTURE (PHASE 2) MODELED NOISE SOURCES

FIGURE 4



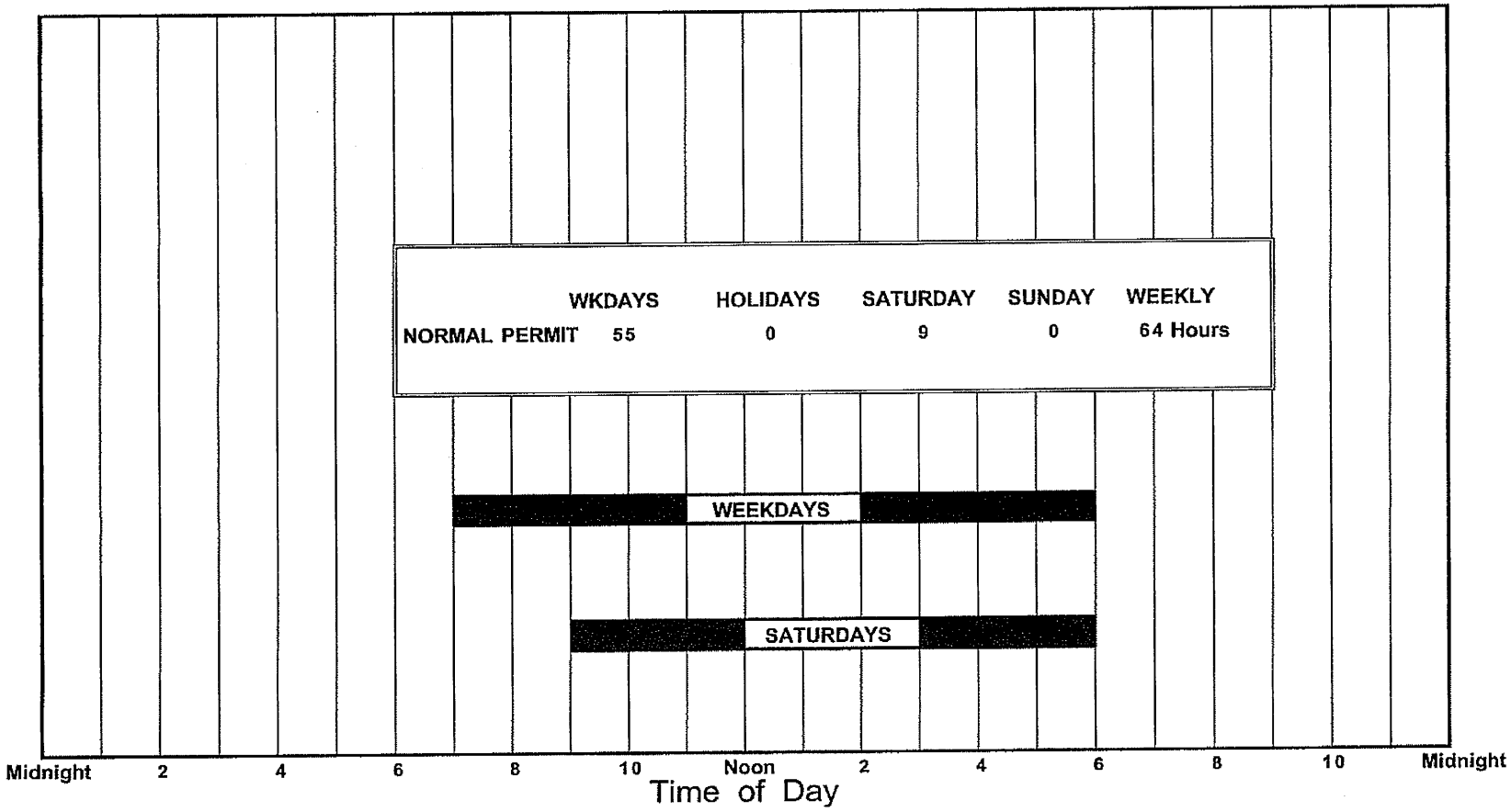
RANGES OF CONSTRUCTION EQUIPMENT NOISE LEVELS

FIGURE 5



ANTICIPATED RANGE OF CONSTRUCTION NOISE LEVELS VS. DISTANCE

FIGURE 6



AVAILABLE WORK HOURS UNDER DOH PERMIT PROCEDURES FOR CONSTRUCTION NOISE

FIGURE 7

TABLE 1
SUMMARY OF MEASURED BACKGROUND NOISE LEVELS AT VARIOUS LOCATIONS

PROJECT: HONOULIULI WWTP FUTURE DEVELOPMENT
DATE: October 22-23, 2014

Date	Start Time	End Time	Leq	Lmax	Lmin	L1	L10	L50	L90	L99	Event Description
Location	"A"										
Oct 22	1343	1358	61.7	76.9	42.3	70.2	65.7	58.2	45.7	43.2	
Oct 23	0243	0303	43.1	50.7	40.7	45.7	44.2	43.2	42.2	41.2	
Location	"B"										
Oct 22	1014	1029	62.5	81.6	44.4	75.7	64.7	48.7	45.7	45.2	50 dBA Transformer Hum.
Oct 22	2242	2257	56.6	68.9	42.7	60.7	59.7	57.2	44.2	43.2	57 dBA Low Freq. Noise
Location	"C"										
Oct 22	1040	1055	56.1	73.2	42.6	66.7	61.2	47.2	44.2	43.2	
Oct 22	2306	2321	52.0	57.3	36.4	57.2	56.7	48.7	40.7	37.2	Intermittent Low Freq. Noise
Location	"D"										
Oct 22	1108	1123	53.1	72.5	42.4	66.2	52.7	46.7	44.7	43.7	
Oct 22	2341	2356	40.8	50.5	35.6	46.7	43.7	39.2	37.2	36.2	
Location	"E"										
Oct 22	1136	1151	53.4	68.4	41.6	64.2	57.2	47.2	44.2	42.7	
Oct 23	0015	0030	42.3	50.8	39.6	46.2	43.7	41.7	40.7	40.2	
Location	"F"										
Oct 22	1200	1215	58.0	71.4	42.5	67.2	62.2	53.2	47.7	44.2	
Oct 23	0043	0100	39.3	55.3	34.7	44.7	40.7	39.2	36.2	35.2	
Location	"G"										
Oct 22	1224	1239	59.5	74.9	40.6	71.7	61.7	53.7	47.2	42.7	
Oct 23	0109	0128	47.3	77.1	37.9	54.2	42.7	40.7	39.2	38.7	
Location	"H"										
Oct 22	1259	1315	50.7	68.5	44.3	63.2	51.7	47.2	45.7	45.2	
Oct 23	0138	0153	49.0	54.0	46.9	50.7	49.7	49.2	48.2	47.7	
Location	"I"										
Oct 22	1417	1432	60.5	83.3	47.2	71.7	62.2	56.2	50.7	48.2	
Oct 23	0330	0352	47.8	51.9	46.1	49.7	48.7	47.7	47.2	46.7	
Location	"J"										
Oct 22	1444	1559	67.6	81.8	46.1	76.7	71.2	64.7	52.7	47.2	
Oct 23	0206	0223	46.5	53.5	44.2	48.7	47.7	46.2	45.2	44.7	

Notes:

a. Leq = Average A-Weighted Sound Level (in dBA)
b. Lmax = Maximum A-Weighted Sound Level (in dBA)
c. Lmin = Minimum A-Weighted Sound Level (in dBA)
d. L50 = A-Weighted Sound Level (in dBA) which was exceeded 50 percent of the time.

TABLE 2
PREDICTED VS. MEASURED EXISTING PLANT NOISE LEVELS

PERIMETER LOCATION	MEASURED EXISTING DAYTIME LAEQ (dBA)	MEASURED EXISTING NIGHTTIME LAEQ (dBA)	CALCULATED PLANT NOISE LAEQ (dBA)
A	61.7	43.1	46.0
B	62.5	56.6	45.0
C	56.1	52.0	41.4
D	53.1	40.8	42.9
E	53.4	42.3	36.8
F	58.0	39.3	30.8
G	59.5	47.3	33.3
H	50.7	49.0	46.2
I	60.5	47.8	43.8
J	67.6	46.5	48.4

TABLE 3

TRAFFIC AND BACKGROUND NOISE MEASUREMENT RESULTS

LOCATION	Time of Day (HRS)	Ave. Speed (MPH)	Hourly Traffic Volume -------- AUTO	M.TRUCK	H.TRUCK	Measured Leq (dB)	Predicted Leq (dB)
K1. 50 FT from the center-line of Geiger Rd. (12/2/14)	0720 TO 0820	38	707	15	38	67.1	65.5
K2. 100 FT from the center-line of Geiger Rd. (12/2/14)	0720 TO 0820	38	707	15	38	58.9	60.3
K1. 50 FT from the center-line of Geiger Rd. (12/2/14)	1440 TO 1540	35	750	15	30	66.7	64.4
K2. 100 FT from the center line of Geiger Rd. (12/2/14)	1440 TO 1540	35	750	15	30	57.2	59.4
L1. 50 FT from the center-line of Renton Rd. (12/2/14)	0845 TO 0945	36	101	6	8	57.6	57.5
L2. 100 FT from the center-line of Renton Rd. (12/2/14)	0845 TO 0945	36	101	6	8	54.3	52.8

TABLE 3 (CONTINUED)

TRAFFIC AND BACKGROUND NOISE MEASUREMENT RESULTS

LOCATION	Time of Day (HRS)	Ave. Speed (MPH)	Hourly Traffic Volume -------- AUTO	M.TRUCK	H.TRUCK	Measured Leq (dB)	Predicted Leq (dB)
L1. 50 FT from the center-line of Renton Rd. (12/2/14)	1600 TO 1700	34	290	6	4	58.8	58.8
L2. 100 FT from the center-line of Renton Rd. (12/2/14)	1600 TO 1700	34	290	6	4	54.1	53.5
M. 50 FT from the center-line of Philippine Sea St (12/2/14)	1046 TO 1146	25	118	3	12	58.1	56.7
N. 50 FT from the center-line of Franklin D Roosevelt Ave. (12/2/14	1207 TO 1307	35	507	7	26	63.1	63.0

TABLE 4

EXISTING (CY 2014) TRAFFIC VOLUMES AND NOISE LEVELS ALONG ROADWAYS IN PROJECT AREA (PM PEAK HOUR)

LOCATION	SPEED (MPH)	TOTAL VPH	****** VOLUMES (VPH) ******** AUTOS	M TRUCKS	H TRUCKS	50' Leq	75' Leq	100' Leq
Geiger Rd. Between Kapolei Pkwy. and DW3	38	1,031	965	21	45	66.6	63.5	61.5
Geiger Rd. Between DW3 and DW2	38	1,002	938	20	44	66.4	63.4	61.3
Geiger Rd. Between DW2 and DW1	38	998	934	20	44	66.4	63.3	61.3
Geiger Rd. Between DW1 and ECRC	38	985	922	20	43	66.3	63.3	61.3
Geiger Rd. Between ECRC and Essex	38	985	922	20	43	66.3	63.3	61.3
Roosevelt Ave. Between Essex and DW4	35	968	909	15	44	65.5	62.5	60.5
Roosevelt Ave. Between DW4 and Philippine Sea	35	968	909	15	44	65.5	62.5	60.5
Roosevelt Ave. W. of Philippine Sea	35	1,209	1,137	18	54	66.4	63.4	61.4
Philippine Sea N. of Roosevelt Ave.	25	326	290	7	29	60.5	57.5	55.4
Philippine Sea S. of Renton Rd.	25	337	299	8	30	60.6	57.6	55.6
Renton Rd. Between Kapolei Pkwy. and DW5	34	343	317	12	14	61.1	58.1	56.0
Renton Rd. Between DW5 and Philippine Sea	34	343	317	12	14	61.1	58.1	56.0
Renton Rd. W. of Philippine Sea	34	13	12	0	1	46.9	44.2	42.6

TABLE 5

EXISTING AND CY 2030 DISTANCES TO 65, 70, AND 75 DNL CONTOURS

STREET SECTION	65 DNL SETBACK (FT)		70 DNL SETBACK (FT)		75 DNL SETBACK (FT)	
	EXISTING	CY 2030	EXISTING	CY 2030	EXISTING	CY 2030
Geiger Rd. Between Kapolei Pkwy. and DW3	70	87	37	44	19	23
Geiger Rd. Between DW3 and DW2	69	83	35	43	18	23
Geiger Rd. Between DW2 and DW1	68	81	36	42	19	22
Geiger Rd. Between DW1 and ECRC	68	79	35	41	18	21
Geiger Rd. Between ECRC and Essex	68	79	35	41	18	21
Roosevelt Ave. Between Essex and DW4	61	71	31	36	16	18
Roosevelt Ave. Between DW4 and Philippine Sea	61	69	31	35	16	18
Roosevelt Ave. W. of Philippine Sea	69	79	35	40	18	20
Philippine Sea N. of Roosevelt Ave.	31	35	16	18	< 12	< 12
Philippine Sea S. of Renton Rd.	32	35	16	18	< 12	< 12
Renton Rd. Between Kapolei Pkwy. and DW5	34	50	17	25	< 12	13
Renton Rd. Between DW5 and Philippine Sea	34	35	17	18	< 12	< 12
Renton Rd. W. of Philippine Sea	< 12	< 12	< 12	< 12	< 12	< 12

Notes:

(1) All setback distances are from the roadways' centerlines.
(2) See Tables 4 and 6 for traffic volume, speed, and mix assumptions.
(3) Setback distances are for ground level receptors.
(4) "Loose Soil" conditions assumed along all roadways.

TABLE 6

FUTURE (CY 2030) TRAFFIC VOLUMES AND NOISE LEVELS ALONG ROADWAYS IN PROJECT AREA (AM OR PM PEAK HOUR, BUILD)

LOCATION	SPEED (MPH)	TOTAL VPH	****** VOLUMES (VPH) ******** AUTOS	M TRUCKS	H TRUCKS	50' Leq	75' Leq	100' Leq
Geiger Rd. Between Kapolei Pkwy. and DW3	38	1,485	1,390	30	65	68.1	65.1	63.0
Geiger Rd. Between DW3 and DW2	38	1,398	1,309	28	61	67.9	64.8	62.8
Geiger Rd. Between DW2 and DW1	38	1,330	1,244	27	59	67.7	64.6	62.6
Geiger Rd. Between DW1 and ECRC	38	1,280	1,198	26	56	67.5	64.4	62.4
Geiger Rd. Between ECRC and Essex	38	1,280	1,198	26	56	67.5	64.4	62.4
Roosevelt Ave. Between Essex and DW4	35	1,263	1,187	19	57	66.6	63.6	61.6
Roosevelt Ave. Between DW4 and Philippine Sea	35	1,213	1,140	18	55	66.4	63.4	61.4
Roosevelt Ave. W. of Philippine Sea	35	1,520	1,429	23	68	67.4	64.4	62.4
Philippine Sea N. of Roosevelt Ave.	25	390	346	9	35	61.3	58.3	56.3
Philippine Sea S. of Renton Rd.	25	405	360	9	36	61.4	58.4	56.4
Renton Rd. Between Kapolei Pkwy. and DW5	34	715	660	26	29	64.0	61.0	59.0
Renton Rd. Between DW5 and Philippine Sea	34	398	368	14	16	61.4	58.4	56.4
Renton Rd. W. of Philippine Sea	34	25	23	1	1	49.1	46.3	44.5

TABLE 7

CALCULATIONS OF PROJECT AND NON-PROJECT TRAFFIC NOISE CONTRIBUTIONS (CY 2030) (PEAK HOUR LEQ OR DNL)

STREET SECTION	NOISE LEVEL INCREASE DUE TO: NON-PROJECT TRAFFIC	PROJECT TRAFFIC
Geiger Rd. Between Kapolei Pkwy. and DW3	0.9	0.7
Geiger Rd. Between DW3 and DW2	0.8	0.6
Geiger Rd. Between DW2 and DW1	0.9	0.4
Geiger Rd. Between DW1 and ECRC	0.9	0.2
Geiger Rd. Between ECRC and Essex	0.9	0.2
Roosevelt Ave. Between Essex and DW4	0.8	0.3
Roosevelt Ave. Between DW4 and Philippine Sea	0.8	0.1
Roosevelt Ave. W. of Philippine Sea	0.9	0.1
Philippine Sea N. of Roosevelt Ave.	0.8	0.0
Philippine Sea S. of Renton Rd.	0.8	0.0
Renton Rd. Between Kapolei Pkwy. and DW5	0.9	2.0
Renton Rd. Between DW5 and Philippine Sea	0.9	-0.6
Renton Rd. W. of Philippine Sea	2.1	0.0

TABLE 8
ASSUMED FUTURE SOURCE NOISE LEVELS

FUTURE NOISE SOURCE	BLDG. LOCATION	SOUND LEVEL AT 50' (dBA)
Solids Dewatering	#081	69.6
Influent Pump Station	#012	61.5
Blower Building No. 1	#013K	79.3
BioTower Pump Station	#031C	62.0
Caustic Scrubbers (Sec.)	#051D	64.5
Grit Building	#201F	74.5
Primary Sludge Pump Station 1	#021E	63.8
Primary Sludge Pump Station 2	#021F	63.8
Mixed Liquor Recirculation Pump 1	#034 B/C	65.8
Mixed Liquor Recirculation Pump 2	#034 D/E	65.8
Aeration Blowers	#033I	89.4
RAS Pumps	#033I	70.6
WAS Pumps	#033I	60.6
Digester Control Building 1	#071F	62.8
Digester Control Building 2	#071G	62.8
Admin. Building 30T AC Unit	#097	59.2
Lab. Building 30T AC Unit	#098	59.2
Central Shops 30T AC Unit	#095	59.2
Maintenance Building 30T AC Unit	#094C	59.2
4 Roof Exhaust Fans (BPS)	#031C	40.7
Roof Exhaust Fan (BLW Bldg. 2)	#032C	37.0
Roof Exhaust Fan (BLW Bldg. 3)	#032C	37.0
Roof Exhaust Fan (BLW Bldg. 4)	#032C	37.0
Roof Exhaust Fan (BLW Bdlg. 5)	#032C	37.0
4 Roof Exhaust Fans (Sec. Thick.)	#062	40.0
Wet Weather Pumps	#022	64.8

TABLE 9
EXISTING AND FUTURE PLANT NOISE LEVELS

PERIMETER LOCATION	MEASURED EXISTING NIGHTTIME LAEQ (dBA) *	CALCULATED EXISTING PLANT NOISE LAEQ (dBA) *	CALCULATED FUTURE PLANT NOISE LAEQ (dBA) *
A	43.1	46.0	59.6
B	56.6	45.0	63.6
C	52.0	41.0	64.3
D	40.8	43.0	65.8
E	42.3	37.0	57.2
F	39.3	31.0	51.4
G	47.3	33.0	53.0
H	49.0	46.0	63.4
I	47.8	44.0	59.7
J	46.5	49.0	60.4

Note:

* Existing Noise Levels are from Table 2.

Appendix F

Traffic Impact Analysis Report (TIAR), Austin Tsutsumi & Associates, Inc. (ATA), November 2014

TRAFFIC IMPACT ANALYSIS REPORT
HONOULIULI WASTEWATER TREATMENT PLANT
KAPOLEI, O'AHU, HAWAI'I

DRAFT FINAL

November 25, 2014

Prepared for:

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TRAFFIC IMPACT ANALYSIS REPORT
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November 25, 2014

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APPENDICES

AUSTIN, TSUTSUMI & ASSOCIATES, INC. CIVIL ENGINEERS • SURVEYORS
CONTINUING THE ENGINEERING PRACTICE FOUNDED BY H. A. R. AUSTIN IN 1934

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TRAFFIC IMPACT ANALYSIS REPORT
HONOULIULI WASTEWATER TREATMENT PLANT
Kapolei, Oahu, Hawai'i

1. INTRODUCTION

This report documents the findings of a traffic study conducted by Austin, Tsutsumi & Associates, Inc. (ATA) to evaluate the potential traffic impacts resulting from the proposed improvements to the Honouliuli Wastewater Treatment Plant (hereinafter referred to as the "Project").

1.1 Location

The Project is located in Kapolei on the island of Oahu on a parcel of land more specifically identified as TMK: 9-1-069:003 and 9-1-013:007. The Project site is bound to the south by Geiger Road with Roosevelt Ave to the west, Renton Road to the north, and Coral Creek Golf Course to the east. Figure 1 shows the Project location.

1.2 Project Description

The Project proposes to upgrade and expand the facility, which will include the potential relocation of non-process facilities currently located at the Sand Island Wastewater Treatment Plant to the Project site. This TIAR will analyze two benchmark years; Year 2021, which corresponds to the peak year of construction for the Project and Year 2030, which corresponds to the build-out of the Project.

Figure 2 shows the Project site plan.

1.3 Study Methodology

This study will address the following:

1. Existing traffic operations at key locations within the study area.
2. Traffic projections for Base Years 2021 and 2030 without the Project including traffic generated by a defacto growth rate as well as traffic generated by other known developments in the vicinity of the Project.

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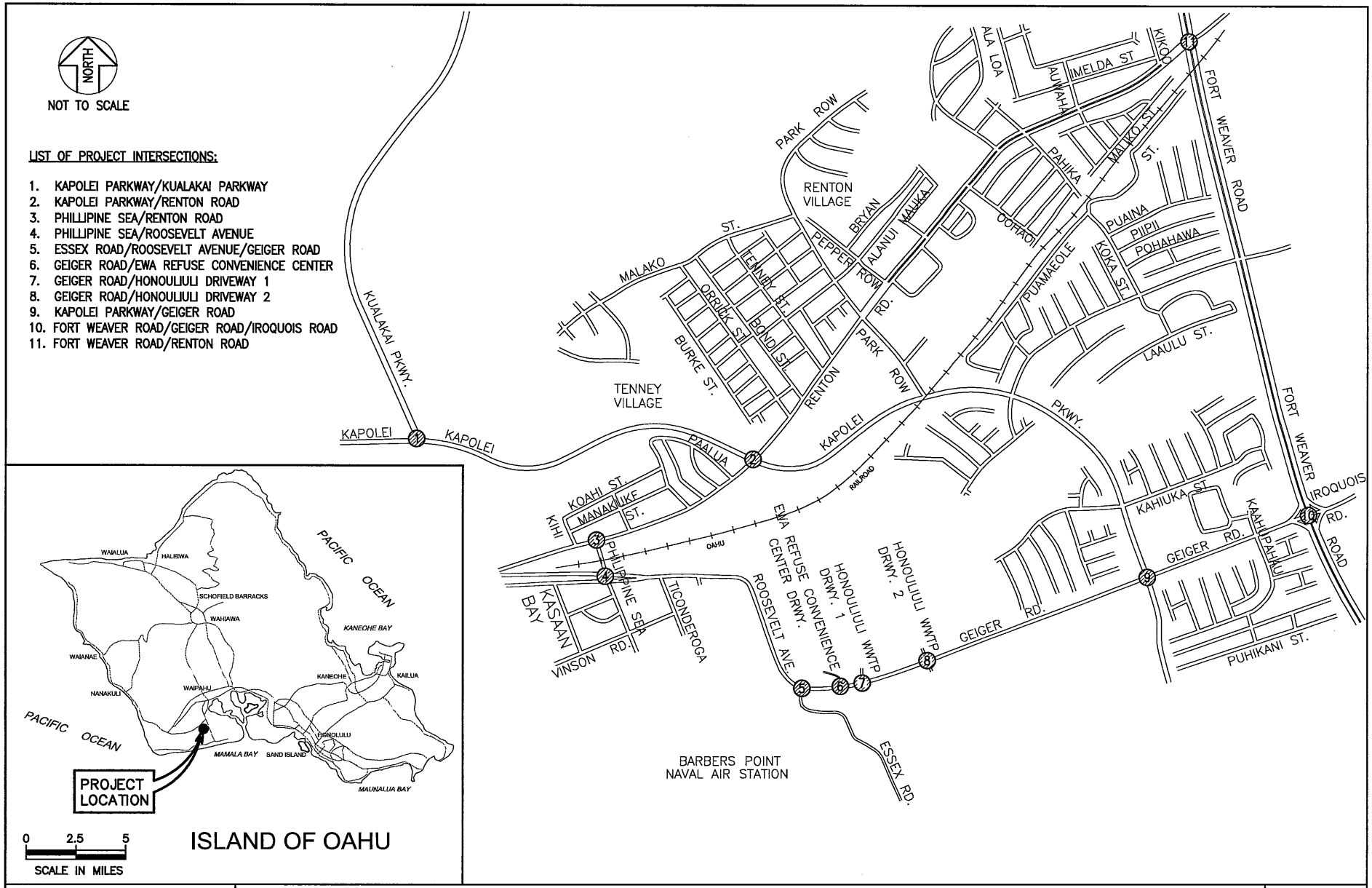
3. Trip generation and assignment for the proposed Project.
4. Traffic projections for Years 2021 and 2030 with the Project conditions, which include Base Years 2021 and 2030 traffic volumes in addition to traffic volumes generated by the Project.
5. Recommendations for roadway improvements or other traffic mitigative measures, as appropriate, to reduce or eliminate the adverse impacts resulting from traffic generated by the Project.
6. This TIAR is prepared according to accepted industry practices. Selection and application of analysis methods are appropriate.

1.4 Analysis Methodology

Level of Service (LOS) is a qualitative measure used to describe the conditions of traffic flow at intersections, with values ranging from free-flow conditions at LOS A to congested conditions at LOS F. The Highway Capacity Manual – Special Report 209 (HCM), dated 2010, includes methods for calculating volume to capacity ratios, delays, and corresponding Levels of Service that were utilized in this study. LOS definitions for signalized and unsignalized intersections are provided in Appendix B.

Analyses for the study intersections were performed using the traffic analysis software Synchro, which is able to prepare reports based on the methodologies described in the HCM. These reports contain control delay results as based on intersection lane geometry, signal timing, and hourly traffic volumes. Based on the vehicular delay at each intersection, a LOS is assigned to each approach and intersection movement as a qualitative measure of performance. These results, as confirmed or refined by field observations, constitute the technical analysis that will form the basis of the recommendations outlined in this report.



HONOULIULI WASTEWATER TREATMENT PLANT TIAR

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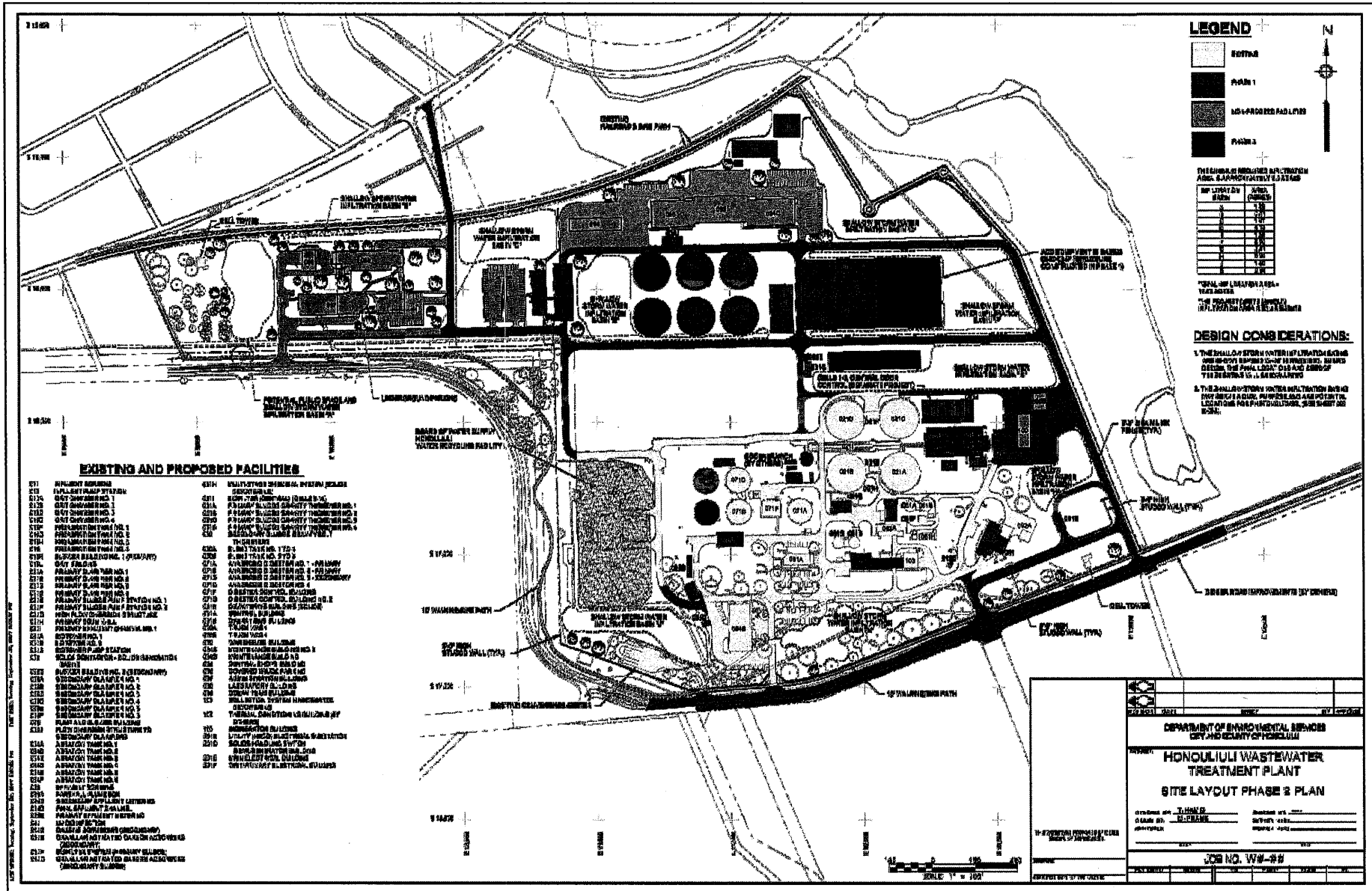
FIGURE 1

PROJECT LOCATION



HONOULIULI WASTEWATER TREATMENT PLANT TIAR

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FIGURE 2

PROJECT SITE PLAN

2. EXISTING CONDITIONS

2.1 Roadway System

The following are brief descriptions of the existing roadways in the vicinity of the Project:

Kualakai Parkway is generally a north-south, two-way, four-lane, divided arterial roadway. This roadway begins to the north as a full diamond interchange with the H-1 Freeway and ends to the south at a T-intersection with Kapolei Parkway. The posted speed limit along Kualakai Parkway is 35 miles per hour (mph).

Renton Road is generally an east-west, two-way, collector roadway that begins at Kihi Street to the west as a two-lane, undivided roadway and extends to the east becoming a four-lane, divided roadway terminating in Asing Park. The posted speed limit along Renton Road is 25 mph.

Kapolei Parkway is generally an east-west, two-way, six-lane, divided arterial roadway in the vicinity of the Project. This roadway begins in the west near the Kapolei Target Store and extends east until it crosses Renton Road and turns to the south. Kapolei Parkway continues past its intersection with Papipi Road as Hailipo Street. The posted speed limit along this roadway in the vicinity of the Project is 30 mph.

Roosevelt Avenue is generally an east-west, two-way, two-lane, undivided collector roadway in the vicinity of the Project. This roadway begins in the west near its intersection with Boxer Road and extends east until it terminates at its intersection with Essex Road and continues as Geiger Road. The posted speed limit along this roadway is 25 mph.

Phillipine Sea is generally a north-south, two-way, two-lane, undivided restricted private local roadway. This roadway begins to the north at a T-intersection with Renton Road and terminates to the south at its intersection with Vinson Road. The posted speed limit is 15 mph.

Geiger Road is generally an east-west, two-lane, undivided two-way collector roadway in the vicinity of the Project. This roadway begins in the west where Roosevelt Ave becomes Geiger Road at the intersection with Essex Road and terminates to the east where Geiger Road becomes Iroquois Road at its intersection with Fort Weaver Road. The posted speed limit in the vicinity of the project is 30 mph.

Fort Weaver Road is generally a north-south, two-way, six-lane, divided arterial roadway in the vicinity of the Project. This roadway begins to the north at the H-1 Freeway interchange, and terminates in the south at its intersection with Popoi Place near Ewa Beach Park. The posted speed limit in the vicinity of the Project is 35 mph.

Essex Road is generally a north-south, two-way, two-lane, undivided private local roadway that primarily serves to provide access to Barbers Point Golf Course. This roadway begins in the north at a T-intersection with Geiger Road, becomes a restricted roadway to the south of Barbers Point Golf Course, and terminates to the south at White Plains Beach Park. The posted speed limit along this roadway is 10 mph.

Ewa Refuse Convenience Center Driveway is approximately 450 feet east of the Geiger Road/Essex Road intersection and provides access to the refuse center.

Honouliuli Driveway 1 is the westernmost Project driveway along Geiger Road and provides direct access to the Honouliuli WWTP.

Honouliuli Driveway 2 is the easternmost Project driveway along Geiger Road and provides direct access to the Honouliuli WWTP.

2.2 Existing Traffic Volumes

Due to their proximity to the Project, the following intersections and Project access driveways were studied:

- Kualakai Parkway/Kapolei Parkway
- Renton Road/Phillipine Sea
- Roosevelt Avenue/Phillipine Sea
- Fort Weaver Road/Geiger Road/Iroquois Road
- Geiger Road/Kapolei Parkway
- Renton Road/Kapolei Parkway
- Renton Road/Fort Weaver Road
- Roosevelt Avenue/Geiger Road/Essex Road
- Geiger Road/Ewa Refuse Convenience Center Driveway
- Geiger Road/Honouliuli Driveway 1
- Geiger Road/Honouliuli Driveway 2

The weekday morning (AM) and afternoon (PM) peak hour turning movement data utilized in this report was collected on Wednesday, September 3, 2014. Based on this traffic count data, the weekday AM peak hour of traffic was determined to be from 7:00 AM to 8:00 AM and the PM peak hour of traffic was determined to be from 4:00 PM to 5:00 PM. The traffic count data is provided in Appendix A.

2.3 Existing Intersection Analysis

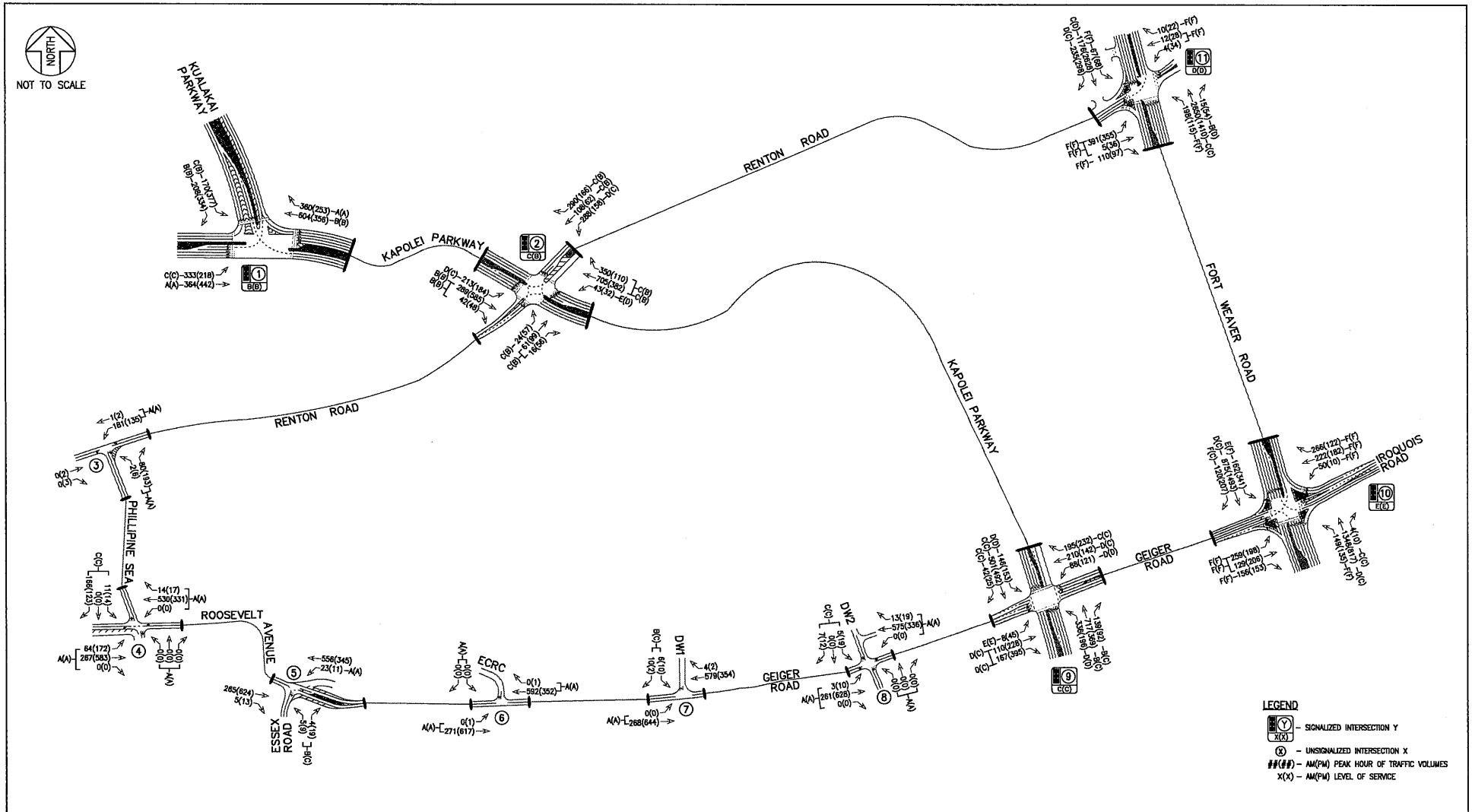
At all signalized study intersections, with the exception of Fort Weaver Road intersections, most vehicles typically cleared each intersection within one signal cycle without any heavy queuing or congestion. All study intersections operate at LOS D or better with adequate capacity except for the following intersections:

Kapolei Parkway/Renton Road
All movements of this intersection currently operate at LOS D or better during the AM and PM peak hours of traffic with the exception of the northbound left-turn movement, which operates at LOS E during the AM peak hour of traffic. Although the northbound left-turn movement operates at LOS E during the AM peak hour of traffic, adequate capacity is provided.

Kapolei Parkway/Geiger Road
The eastbound left-turn movement operates at LOS E(E) during the AM(PM) peak hours, but is generally low volume movements of only 8(45) vehicles, respectively. All remaining movements of this intersection operate at LOS D or better during the AM and PM peak hour of traffic.

Fort Weaver Road/Geiger Road/Iroquois Road & Fort Weaver Road/Renton Road
The majority of movements at these intersections currently operate at LOS E/F conditions during the AM and PM peak hours of traffic mainly due to long delays as a result of requisite long cycle lengths (approximately 4 minutes long). These two intersections also provide split-phase signal operation on the side streets and long pedestrian crossing times across Fort Weaver Road, which contribute to the long delays. During the AM peak hour, the northbound traffic is generally heavier, while during the PM peak hour, traffic is heavier in the southbound direction.

Existing traffic volumes, lane configuration and movement LOS are illustrated in Figure 3. Table 1 shows the existing delay, volume to capacity (v/c) ratio, and LOS for the study intersections, with the full LOS summary table provided in Appendix C.



HONOULIULI WASTEWATER TREATMENT PLAN TIAR

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FIGURE 3

EXISTING LANE CONFIGURATION, VOLUME, AND LOS

T.1: Existing Intersection Level of Service Summary

Intersection	Existing Conditions					
	AM			PM		
	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS
1: Kapolei Pkwy & Kualakai Pkwy						
EB LT	21.8	0.66	C	21.9	0.64	C
EB TH	3.7	0.12	A	5.8	0.18	A
EB RT	-	-	-	-	-	-
WB LT	-	-	-	-	-	-
WB TH	12.3	0.36	B	12.8	0.26	B
WB RT	7.9	0.28	A	6.3	0.19	A
NB LT	-	-	-	-	-	-
NB TH	-	-	-	-	-	-
NB RT	-	-	-	-	-	-
SB LT	21.3	0.41	C	16.9	0.55	B
SB TH	-	-	-	-	-	-
SB RT	14.4	0.28	B	12.6	0.40	B
Overall	12.5	-	B	12.2	-	B
2: Kapolei Pkwy & Renton Rd						
EB LT	26.5	0.07	C	17.5	0.14	B
EB TH/RT	23.9	0.14	C	17.1	0.31	B
WB LT	36.6	0.73	D	22.1	0.46	C
WB TH	24.4	0.21	C	16.0	0.13	B
WB RT	24.1	0.17	C	15.7	0.08	B
NB LT	62.9	0.77	E	40.7	0.66	D
NB TH	25.3	0.60	C	17.0	0.34	B
NB TH/RT	25.9	0.61	C	17.2	0.35	B
SB LT	45.2	0.85	D	28.5	0.77	C
SB TH	13.9	0.14	B	12.5	0.34	B
SB TH/RT	14.0	0.14	B	12.7	0.34	B
Overall	27.9	-	C	17.5	-	B
3: Phillipine Sea & Renton Rd						
EB TH/RT	-	-	-	-	-	-
WB LT/TH	7.5	0.12	A	7.5	0.09	A
NB LT/RT	8.7	0.08	A	9.3	0.21	A
4: Phillipine Sea & Roosevelt Ave						
EB LT/TH/RT	8.9	0.07	A	8.6	0.16	A
WB LT/TH/RT	0.0	-	A	0.0	-	A
NB LT/TH/RT	0.0	-	A	0.0	-	A
SB LT/TH/RT	18.0	0.41	C	18.0	0.35	C
5: Essex Rd & Roosevelt Ave/Geiger Rd						
EB TH/RT	-	-	-	-	-	-
WB LT	7.9	0.02	A	9.0	0.01	A
WB TH	-	-	-	-	-	-
NB LT/RT	14.4	0.03	B	16.3	0.09	C
6: Geiger Rd & Ewa Refuse Convenience Center						
EB LT/TH/RT	0.0	-	A	8.1	0.00	A
WB LT/TH/RT	7.9	0.01	A	8.9	0.00	A
NB LT/TH/RT	11.8	0.04	B	12.9	0.01	B
SB LT/TH/RT	0.0	-	A	0.0	-	A
7: Geiger Rd & Honouliuli Drwy 1						
EB LT/TH	0.0	-	A	0.0	-	A
WB TH/RT	-	-	-	-	-	-
SB LT/RT	14.6	0.04	B	19.2	0.05	C
8: Geiger Rd & Honouliuli Drwy 2						
EB LT/TH/RT	8.8	0.00	A	8.1	0.01	A
WB LT/TH/RT	0.0	-	A	0.0	-	A
NB LT/TH/RT	0.0	-	A	0.0	-	A
SB LT/TH/RT	15.8	0.04	C	20.4	0.13	C
9: Kapolei Pkwy & Geiger Rd						
EB LT	67.8	0.56	E	56.4	0.78	E
EB TH	35.2	0.35	D	30.5	0.63	C
EB TH/RT	35.2	0.36	D	31.1	0.66	C
EB RT	-	-	-	-	-	-
WB LT	46.9	0.77	D	42.2	0.78	D
WB TH	35.6	0.73	D	23.7	0.32	C
WB RT	29.4	0.15	C	22.4	0.14	C
NB LT	36.3	0.88	D	38.5	0.81	D
NB TH	18.2	0.53	B	23.3	0.41	C
NB RT	14.6	0.10	B	20.7	0.04	C
SB LT	42.2	0.79	D	40.1	0.79	D
SB TH	24.5	0.52	C	26.7	0.60	C
SB RT	20.5	0.01	C	22.1	0.01	C
Overall	27.9	-	C	30.3	-	C

Note:
* = over-capacity, v/c > 1

T.1: Existing Intersection Level of Service Summary (continued)

Intersection	Existing Conditions					
	AM			PM		
	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS
10: Ft Weaver Rd & Geiger Rd/Iroquois Rd						
EB LT	107.0	0.65	F	106.7	0.65	F
EB LT/TH	101.9	0.63	F	102.5	0.65	F
EB RT	97.2	0.39	F	99.1	0.48	F
WB LT	85.3	0.18	F	90.3	0.05	F
WB TH	105.2	0.75	F	116.8	0.78	F
WB RT	85.2	0.19	F	90.4	0.06	F
NB LT	111.0	0.61	F	111.1	0.59	F
NB TH	35.9	0.53	D	33.2	0.33	C
NB RT	26.0	0.00	C	28.2	0.01	C
SB LT	77.0	0.63	E	119.0	0.80	F
SB TH	50.1	0.34	D	29.3	0.54	C
SB RT	141.5	0.08	F	32.3	0.17	C
Overall	65.2	0.60	E	57.8	0.64	E
11: Ft Weaver Rd & Renton Rd						
EB LT	111.0	0.79	F	112.4	0.79	F
EB LT/TH	109.3	0.77	F	111.6	0.79	F
EB RT	86.5	0.16	F	86.3	0.09	F
WB LT/TH	118.6	0.34	F	121.2	0.63	F
WB RT	111.6	0.01	F	104.5	0.02	F
NB LT	120.7	0.81	F	100.3	0.70	F
NB TH	21.8	0.87	C	28.7	0.48	C
NB RT	14.9	0.01	B	40.0	0.05	D
SB LT	123.1	0.58	F	111.9	0.59	F
SB TH	31.3	0.44	C	54.6	0.95	D
SB RT	45.8	0.17	D	34.6	0.21	C
Overall	39.8	0.84	D	53.9	0.88	D

Note:
* = over-capacity, v/c > 1

3. BASE YEAR WITHOUT PROJECT SCENARIOS

The year 2021 was selected as the base year to reflect the anticipated peak year of construction activity, which was assumed to occur during Phase 1 construction of the Honouliuli WWTP.

3.1 Defacto Growth Rate

The Oahu Regional Transportation Plan 2035 (ORTP) was prepared in 2011, and serves as the basis for future traffic projections of future conditions throughout this TIAR. The ORTP uses existing data from 2007 as its baseline before assigning land uses and socioeconomic data to Traffic Analysis Zones (TAZ's) to generate and assign traffic across the roadway network. Although island wide projects are accounted for in the ORTP, the economic environment and housing demand would be the main driver for the pace of development to occur.

The ORTP Model takes into account island wide projects and generates and distributes the generated trips throughout the roadway network. The growth rates derived from 2007 and 2035 traffic projections were applied linearly to existing 2014 traffic volume to determine year 2021 and 2030 Base Year conditions. In some cases, growth rates were derived from a comparison of the existing collected 2014 traffic counts and 2035 model traffic projections. With the inclusion of other known developments shown below, some growth rates were adjusted to account for the manual inclusion of trips on the roadway network. Calculated defacto growth rates ranging from 0.5-3.5 percent were used to generate Base Year 2021 and 2030 traffic projections.

3.2 Other Known Developments

The surrounding projects traffic studies – University of Hawaii at West Oahu (UHWO), Ka Makana Alii, Ho'opili and East Kapolei developments – were used to determine turning movement volumes at various study intersection and were reconciled with the ORTP, which does not provide individual turning movement volumes. Other projects' trip contributions to the background traffic were assumed to be implicit to the ORTP.

- UHWO – This project is currently located adjacent and to the west of Kualakai Parkway and south of Farrington Highway. The UHWO currently provides an enrollment for approximately 2,400. Future expansion of the UHWO campus anticipates 7,600 enrollment with residential dwelling units and Village Mixed-Use (VMX) space. This project was assumed to be completed by Year 2021.
- Ka Makana Alii – This project is proposed to be located adjacent and to the south of the Kualakai Parkway/Kapolei Parkway intersection. Ka Makana Alii is a planned shopping center, consisting of approximately 1.4 million square feet (SF) of retail commercial space. This project was assumed to be completed by Year 2021.
- Hoopili –This project is located north of the Project, to the east of Kualakai Parkway and west of Fort Weaver Road. Upon full build-out, Hoopili will include 2,300 single family dwelling units, 9,520 multi-family dwelling units, over 3 million SF of commercial/retail space, over 800,000 SF of industrial space, over 70 acres of parks, approximately 200 acres of a commercial farm, three elementary schools, one middle school, and one high school. Only a percentage of traffic was assumed to be completed, for the Base Year 2021 and Base Year 2030 scenarios, since the full build-out is anticipated to occur by Year 2035.

- East Kapolei II – This project is proposed to be located adjacent and to the west of Kualakai Parkway and will consist of approximately 2,100 dwelling units. This project was assumed to be completed by Year 2021.

3.3 Base Year 2021 Analysis

It is anticipated that by year 2021, traffic will have increased significantly over existing conditions due to the continuing development of the Ewa-Kapolei region.

Upon build-out of the Ka Makana Alii Shopping Center, one of the proposed accesses to the shopping center is anticipated to be provided as a new south leg extension from the existing Kapolei Parkway/Kualakai Parkway intersection, ultimately providing a 4-legged intersection. This improvement was triggered by the Ka Makana Alii TIAR, identified on the STIP and assumed to be a joint effort implemented by Ka Makana Alii and HDOT. The following proposed lane configuration is anticipated to be constructed for the Kapolei Parkway/Kualakai Parkway intersection by Base Year 2021:

Kapolei Parkway/Kualakai Parkway

1. Northbound Approach
   a. Provide a new approach that includes one left-turn lane, one through lane and one shared through/right-turn lane.

2. Southbound Approach
   a. Provide two through lanes.

3. Eastbound Approach
   a. Convert three through lanes to two through lanes and one shared through/right-turn lane.

4. Westbound Approach
   a. Provide two new left-turn lanes.

With the improvements at the intersection the low volume northbound left-turn movement is projected to operate at LOS F during the AM peak hour with only 5 vehicles anticipated to make the left-turn onto Kapolei Parkway. During the PM peak hour, all left-turn movements will operate at LOS E conditions. All LOS E/F movements are provided with adequate capacity with a v/c ratio under 1.0.

Kapolei Parkway/Renton Road
This intersection is forecast to operate similar to existing conditions during the AM and PM peak hours of traffic. However, the southbound left-turn movement will worsen to LOS E during the AM peak hour of traffic and the northbound left-turn movement will worsen to LOS E during the PM peak hour of traffic.

Kapolei Parkway/Geiger Road
The intersection is anticipated to operate overall at LOS D during the AM and PM peak hours of traffic. Due to increased traffic, all left-turn movements are anticipated to operate at LOS E during both peak hours, with the low volume eastbound left-turn movement of 10 vehicles,

operating at LOS F. All LOS E/F movements are provided with adequate capacity with a v/c ratio under 1.0.

Fort Weaver Road/Geiger Road/Iroquois Road & Fort Weaver Road/Renton Road
Similar to Existing conditions, the intersections along Fort Weaver Road through the Ewa region will continue to experience LOS F at some movements. However, this is generally ascribed to requisite long traffic signal cycle lengths, split phase operation and generally long crosswalk lengths across Fort Weaver Road. Further widening of Fort Weaver Road is not prescribed by the ORTP 2035, and is generally considered infeasible due to insufficient ROW.

All unsignalized study intersections will continue operating at LOS D or better during the AM and PM peak hours of traffic.

Figure 4 illustrates the forecast traffic volumes, lane configuration and movement LOS for Base Year 2021 conditions. Table 2 shows the Existing and Base Year 2021 LOS at the study intersections, with the full LOS summary table provided in Appendix C.

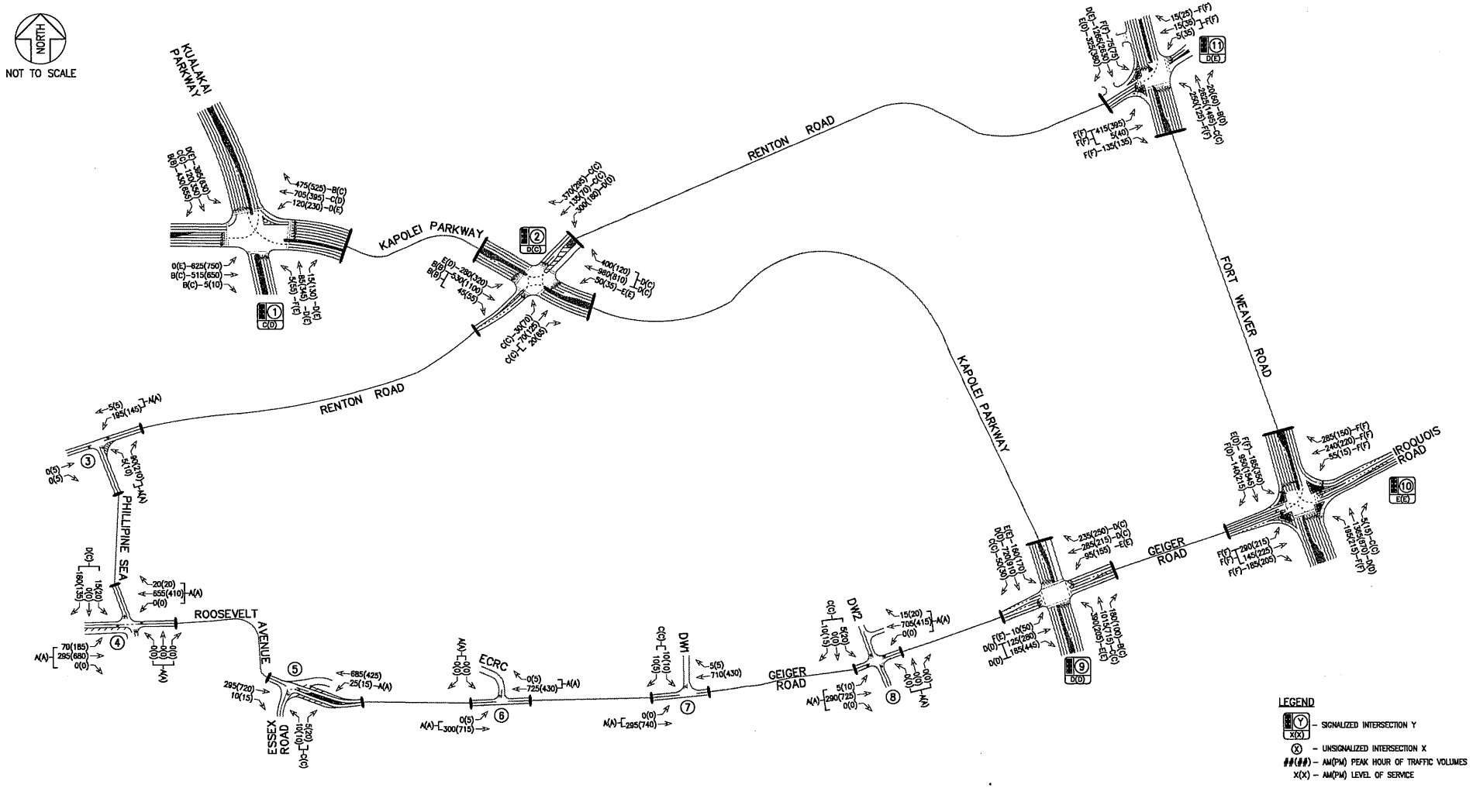

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FIGURE 4

BASE YEAR 2021 LANE CONFIGURATION, VOLUME, AND LOS

Table 2: Existing and Base Year 2021 (no mit) Intersection Level of Service Summary

Intersection	Existing Conditions						BY 2021 (No Mit)					
	AM			PM			AM			PM		
	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS
1: Kapolei Pkwy & Kualakai Pkwy												
EB LT	21.8	0.66	C	21.9	0.64	C	37.0	0.84	D	57.4	0.91	E
EB TH	3.7	0.12	A	5.8	0.18	A	16.7	0.24	B	31.4	0.38	C
EB RT	-	-	-	-	-	-	16.8	0.24	B	31.6	0.38	C
WB LT	-	-	-	-	-	-	46.1	0.61	D	62.6	0.78	E
WB TH	12.3	0.36	B	12.8	0.26	B	30.3	0.56	C	47.2	0.44	D
WB RT	7.9	0.28	A	6.3	0.19	A	19.8	0.44	B	28.3	0.45	C
NB LT	-	-	-	-	-	-	88.5	0.54	F	76.5	0.77	E
NB TH	-	-	-	-	-	-	41.3	0.29	D	56.2	0.71	E
NB TH/RT							41.2	0.29	D	56.2	0.71	E
SB LT	21.3	0.41	C	16.9	0.55	B	42.8	0.82	D	63.2	0.91	E
SB TH	-	-	-	-	-	-	28.7	0.15	C	33.4	0.33	C
SB RT	14.4	0.28	B	12.6	0.40	B	14.7	0.21	B	13.3	0.27	B
Overall	12.5	-	B	12.2	-	B	29.1	-	C	44.4	-	D
2: Kapolei Pkwy & Renton Rd												
EB LT	26.5	0.07	C	17.5	0.14	B	34.8	0.10	C	26.8	0.19	C
EB TH/RT	23.9	0.14	C	17.1	0.31	B	30.1	0.16	C	26.1	0.37	C
WB LT	36.6	0.73	D	22.1	0.46	C	49.2	0.78	D	36.3	0.61	D
WB TH	24.4	0.21	C	16.0	0.13	B	31.2	0.25	C	24.0	0.14	C
WB RT	24.1	0.17	C	15.7	0.08	B	30.5	0.19	C	23.9	0.13	C
NB LT	62.9	0.77	E	40.7	0.66	D	73.2	0.77	E	67.6	0.79	E
NB TH	25.3	0.60	C	17.0	0.34	B	40.2	0.82	D	28.5	0.65	C
NB TH/RT	25.9	0.61	C	17.2	0.35	B	44.6	0.82	D	29.3	0.65	C
SB LT	45.2	0.85	D	28.5	0.77	C	60.7	0.90	E	51.9	0.90	D
SB TH	13.9	0.14	B	12.5	0.34	B	17.1	0.24	B	16.0	0.49	B
SB TH/RT	14.0	0.14	B	12.7	0.34	B	17.2	0.24	B	16.2	0.49	B
Overall	27.9	-	C	17.5	-	B	38.7	-	D	26.8	-	C
3: Phillipine Sea & Renton Rd												
EB TH/RT	-	-	-	-	-	-	-	-	-	-	-	-
WB LT/TH	7.5	0.12	A	7.5	0.09	A	7.6	0.13	A	7.5	0.09	A
NB LT/RT	8.7	0.08	A	9.3	0.21	A	9.0	0.10	A	9.3	0.21	A
4: Phillipine Sea & Roosevelt Ave												
EB LT/TH/RT	8.9	0.07	A	8.6	0.16	A	9.5	0.09	A	8.6	0.16	A
WB LT/TH/RT	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A
NB LT/TH/RT	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A
SB LT/TH/RT	18.0	0.41	C	18.0	0.35	C	26.6	0.57	D	18.0	0.35	C
5: Essex Rd & Roosevelt Ave/Geiger Rd												
EB TH/RT	-	-	-	-	-	-	-	-	-	-	-	-
WB LT	7.9	0.02	A	9.0	0.01	A	8.0	0.02	A	9.0	0.01	A
WB TH	-	-	-	-	-	-	-	-	-	-	-	-
NB LT/RT	14.4	0.03	B	16.3	0.09	C	18.2	0.06	C	16.3	0.09	C
6: Geiger Rd & Ewa Refuse Convenience Center												
EB LT/TH/RT	0.0	-	A	8.1	0.00	A	0.0	-	A	8.1	0.00	A
WB LT/TH/RT	7.9	0.01	A	8.9	0.00	A	0.0	-	A	8.9	0.00	A
NB LT/TH/RT	11.8	0.04	B	12.9	0.01	B	0.0	-	A	12.9	0.01	B
SB LT/TH/RT	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A
7: Geiger Rd & Honouliuli Drwy 1												
EB LT/TH	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A
WB TH/RT	-	-	-	-	-	-	-	-	-	-	-	-
SB LT/RT	14.6	0.04	B	19.2	0.05	C	18.1	0.07	C	19.2	0.05	C
8: Geiger Rd & Honouliuli Drwy 2												
EB LT/TH/RT	8.8	0.00	A	8.1	0.01	A	9.3	0.01	A	8.1	0.01	A
WB LT/TH/RT	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A
NB LT/TH/RT	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A
SB LT/TH/RT	15.8	0.04	C	20.4	0.13	C	18.1	0.06	C	20.4	0.13	C
9: Kapolei Pkwy & Geiger Rd												
EB LT	67.8	0.56	E	56.4	0.78	E	87.1	0.61	F	73.6	0.77	E
EB TH	35.2	0.35	D	30.5	0.63	C	47.1	0.31	D	46.5	0.75	D
EB TH/RT	35.2	0.36	D	31.1	0.66	C	47.2	0.32	D	47.5	0.77	D
EB RT	-	-	-	-	-	-	-	-	-	-	-	-
WB LT	46.9	0.77	D	42.2	0.78	D	67.9	0.80	E	71.9	0.86	E
WB TH	35.6	0.73	D	23.7	0.32	C	52.3	0.84	D	34.7	0.42	C
WB RT	29.4	0.15	C	22.4	0.14	C	39.5	0.13	D	31.3	0.13	C
NB LT	36.3	0.88	D	38.5	0.81	D	61.5	0.93	E	65.7	0.88	E
NB TH	18.2	0.53	B	23.3	0.41	C	24.5	0.66	C	35.0	0.64	C
NB RT	14.6	0.10	B	20.7	0.04	C	17.7	0.14	B	27.0	0.06	C
SB LT	42.2	0.79	D	40.1	0.79	D	66.6	0.86	E	62.0	0.86	E
SB TH	24.5	0.52	C	26.7	0.60	C	35.1	0.67	D	46.1	0.87	D
SB RT	20.5	0.01	C	22.1	0.01	C	26.8	0.02	C	28.3	0.02	C
Overall	27.9	-	C	30.3	-	C	39.5	-	D	46.3	-	D

Note:
* = over-capacity, v/c > 1

Table 2: Existing and Base Year 2021 (no mit) Intersection Level of Service Summary (continued)

Intersection	Existing Conditions						BY 2021 (No Mit)					
	AM			PM			AM			PM		
	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS
10: Ft Weaver Rd & Geiger Rd/Iroquois Rd												
EB LT	107.0	0.65	F	106.7	0.65	F	107.2	0.68	F	104.6	0.65	F
EB LT/TH	101.9	0.63	F	102.5	0.65	F	101.8	0.66	F	100.0	0.65	F
EB RT	97.2	0.39	F	99.1	0.48	F	102.9	0.61	F	106.7	0.68	F
WB LT	85.3	0.18	F	90.3	0.05	F	85.0	0.19	F	86.7	0.06	F
WB TH	105.2	0.75	F	116.8	0.78	F	109.3	0.80	F	117.9	0.83	F
WB RT	85.2	0.19	F	90.4	0.06	F	85.4	0.23	F	87.5	0.12	F
NB LT	111.0	0.61	F	111.1	0.59	F	110.9	0.67	F	110.8	0.69	F
NB TH	35.9	0.53	D	33.2	0.33	C	39.0	0.56	D	38.6	0.38	D
NB RT	26.0	0.00	C	28.2	0.01	C	28.0	0.00	C	32.3	0.01	C
SB LT	77.0	0.63	E	119.0	0.80	F	82.7	0.67	F	123.1	0.80	F
SB TH	50.1	0.34	D	29.3	0.54	C	56.6	0.39	E	37.2	0.62	D
SB RT	141.5	0.08	F	32.3	0.17	C	215.0	0.10	F	36.0	0.20	D
Overall	65.2	0.60	E	57.8	0.64	E	72.6	0.63	E	64.4	0.70	E
11: Ft Weaver Rd & Renton Rd												
EB LT	111.0	0.79	F	112.4	0.79	F	113.0	0.81	F	114.2	0.83	F
EB LT/TH	109.3	0.77	F	111.6	0.79	F	110.8	0.80	F	112.8	0.82	F
EB RT	86.5	0.16	F	86.3	0.09	F	87.6	0.27	F	87.2	0.26	F
WB LT/TH	118.6	0.34	F	121.2	0.63	F	118.9	0.39	F	122.3	0.66	F
WB RT	111.6	0.01	F	104.5	0.02	F	111.2	0.01	F	103.4	0.02	F
NB LT	120.7	0.81	F	100.3	0.70	F	124.9	0.85	F	100.3	0.74	F
NB TH	21.8	0.87	C	28.7	0.48	C	22.4	0.87	C	32.0	0.53	C
NB RT	14.9	0.01	B	40.0	0.05	D	15.4	0.02	B	41.3	0.05	D
SB LT	123.1	0.58	F	111.9	0.59	F	126.9	0.66	F	113.6	0.62	F
SB TH	31.3	0.44	C	54.6	0.95	D	37.2	0.51	D	64.5	0.99	E
SB RT	45.8	0.17	D	34.6	0.21	C	56.2	0.23	E	40.3	0.27	D
Overall	39.8	0.84	D	53.9	0.88	D	44.3	0.85	D	60.5	0.90	E

Note:
* = over-capacity, v/c > 1

3.4 Base Year 2030 Analysis

The year 2030 was selected as the base year to reflect the anticipated build-out of the Honouliuli WWTP. By year 2030, traffic will continue to increase due to the continuing development of the Ewa-Kapolei region. Based on a LOS comparison between Base Year 2021 and Base Year 2030, the majority of individual movements that are projected to operate at LOS E/F for Base Year 2021 conditions will continue operating at similar levels of service for Base Year 2030 conditions during the AM and PM peak hours of traffic except for the following:

Kapolei Parkway/Kualakai Parkway

The low volume northbound left-turn movement will operate at LOS F during the PM peak hour. All LOS E/F movements will continue to be provided with adequate capacity with a v/c ratio under 1.0.

Kapolei Parkway/Renton Road
During the AM peak hour, the northbound approach will worsen to LOS E conditions, with the mainline through movement along Kapolei Parkway nearing its capacity. In addition, the westbound and southbound left-turn movements will operate at LOS E during the PM peak hour of traffic. In order to mitigate the deficiencies of the intersection, dual southbound left-turn lanes were recommended to accommodate the relatively high 275(320) southbound left-turn vehicles during the AM(PM) peak hours.

With the dual southbound left-turn lanes, all movements at the intersection are forecast to operate similar to Base Year 2021 conditions.

Phillipine Sea/Roosevelt Avenue
The southbound shared left/through/right-turn lane is anticipated to worsen from LOS D to LOS E. With a low 15(20) vehicles making the southbound left-turn movement, the heavier southbound right-turn movement should not be heavily impacted. Based on existing observations, the southbound queues did extend beyond four vehicles, with the majority of queues typically consisting of only one vehicle.

Kapolei Parkway/Geiger Road
During the AM peak hour, the westbound and southbound left-turn movements will worsen to LOS F. In addition, northbound left-turn movement will worsen to LOS F at overcapacity conditions. During the PM peak hour, the westbound left-turn movement will worsen to LOS F, and the southbound through movement along Kapolei Parkway will operate near capacity. In order to mitigate the deficiencies of the intersection, dual northbound left-turn lanes were recommended to accommodate the high 470(215) northbound left-turn vehicles during the AM(PM) peak hours. Also, the eastbound approach along Geiger Road was restriped from one left-turn, one through and one shared through/right to one left-turn, one through and one right-turn.

With the dual northbound left-turn lanes and eastbound restriping, all movements are forecast to operate similar to Base Year 2021 conditions.

Fort Weaver Road/Geiger Road/Iroquois Road & Fort Weaver Road/Renton Road
The intersections along Fort Weaver Road through the Ewa region will experience LOS F and over-capacity conditions at some movements. However, this is generally ascribed to requisite

long traffic signal cycle lengths, split phase operation and generally long crosswalk lengths across Fort Weaver Road. Further widening of Fort Weaver Road is not prescribed by the ORTP 2035, and is generally considered infeasible due to insufficient ROW.

Figure 5 illustrates the forecast traffic volumes, lane configuration and movement LOS for Base Year 2030 conditions. Table 3 shows the Base Year 2021 and Base Year 2030 LOS at the study intersections, with the full LOS summary table provided in Appendix C.

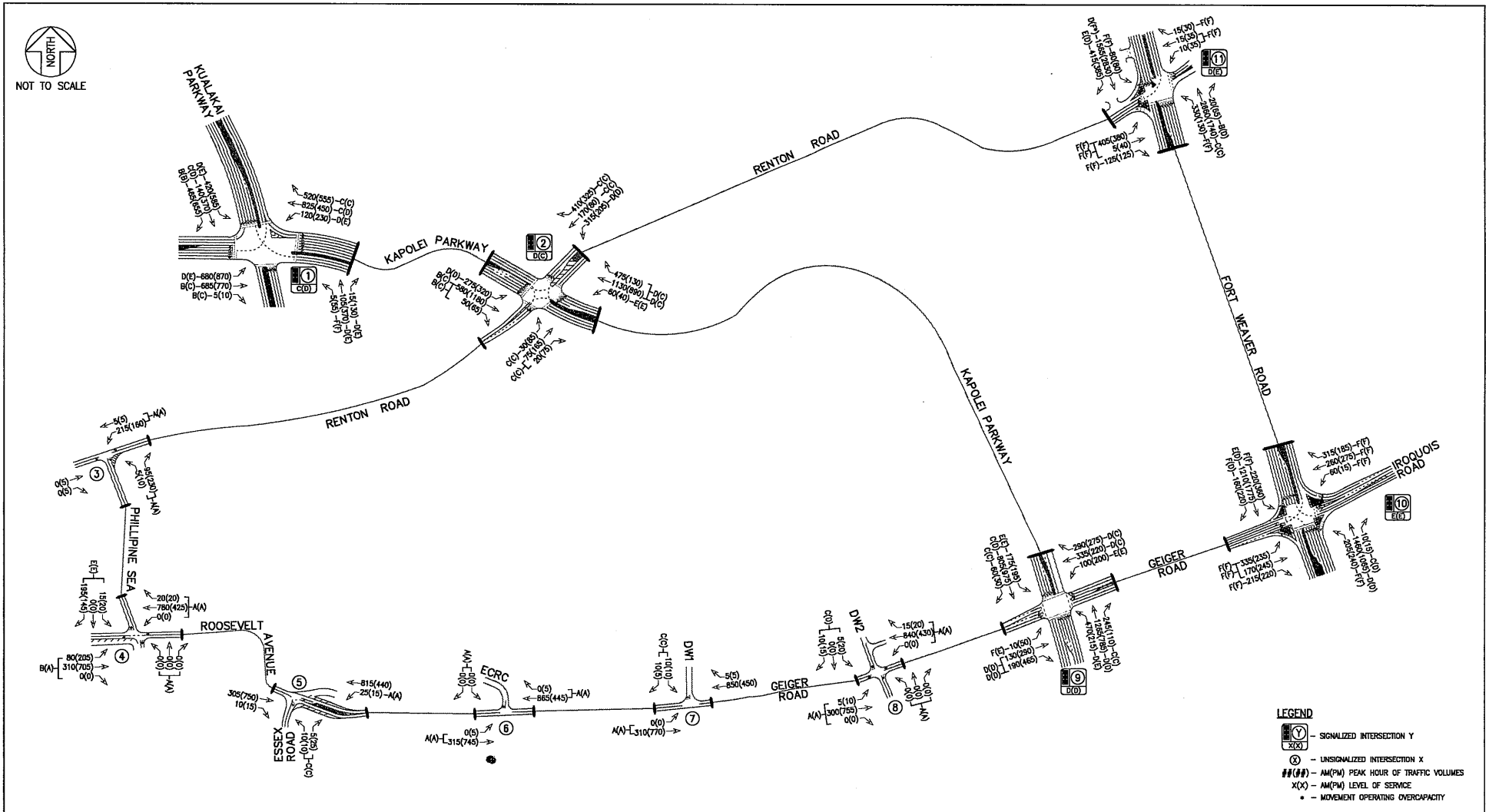

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FIGURE 5

BASE YEAR 2030 WITH MITIGATION LANE CONFIGURATION, VOLUME, AND LOS

Table 3: Base Year 2021 (no mit), Base Year 2030 (no mit) and Base Year 2030 (with mit) Intersection Level of Service Summary

Intersection	BY 2021 (No Mit)						BY 2030 (No Mit)						BY 2030 WITH MITIGATION					
	AM			PM			AM			PM			AM			PM		
	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS
1: Kapolei Pkwy & Kualakai Pkwy																		
EB LT	37.0	0.84	D	57.4	0.91	E	41.3	0.86	D	59.7	0.92	E						
EB TH	16.7	0.24	B	31.4	0.38	C	18.1	0.32	B	31.5	0.40	C						
EB RT	16.8	0.24	B	31.6	0.38	C	18.2	0.32	B	31.6	0.40	C						
WB LT	46.1	0.61	D	62.6	0.78	E	50.5	0.63	D	70.7	0.80	E						
WB TH	30.3	0.56	C	47.2	0.44	D	34.6	0.67	C	53.4	0.49	D						
WB RT	19.8	0.44	B	28.3	0.45	C	22.0	0.48	C	34.1	0.50	C						
NB LT	88.5	0.54	F	76.5	0.77	E	93.3	0.54	F	84.9	0.77	F						
NB TH	41.3	0.29	D	56.2	0.71	E	44.8	0.33	D	65.3	0.77	E						
NB TH/RT	41.2	0.29	D	56.2	0.71	E	44.7	0.34	D	65.3	0.78	E						
SB LT	42.8	0.82	D	63.2	0.91	E	48.9	0.84	D	76.1	0.93	E						
SB TH	28.7	0.15	C	33.4	0.33	C	30.6	0.17	C	40.6	0.37	D						
SB RT	14.7	0.21	B	13.3	0.27	B	14.8	0.23	B	13.8	0.26	B						
Overall	29.1	-	C	44.4	-	D	31.8	-	C	49.4	-	D						
2: Kapolei Pkwy & Renton Rd																		
EB LT	34.8	0.10	C	26.8	0.19	C	37.1	0.11	D	31.5	0.23	C	31.3	0.10	C	24.4	0.20	C
EB TH/RT	30.1	0.16	C	26.1	0.37	C	30.7	0.17	C	31.0	0.45	C	26.0	0.16	C	24.0	0.40	C
WB LT	49.2	0.78	D	36.3	0.61	D	53.9	0.81	D	56.0	0.77	E	42.8	0.77	D	36.1	0.64	D
WB TH	31.2	0.25	C	24.0	0.14	C	32.5	0.31	C	27.6	0.15	C	27.5	0.30	C	21.4	0.13	C
WB RT	30.5	0.19	C	23.9	0.13	C	33.1	0.35	C	27.7	0.16	C	26.9	0.24	C	21.6	0.16	C
NB LT	73.2	0.77	E	67.6	0.79	E	73.5	0.77	E	73.9	0.78	E	65.3	0.77	E	67.0	0.78	E
NB TH	40.2	0.82	D	28.5	0.65	C	59.5	0.97	E	34.3	0.67	C	36.3	0.86	D	28.6	0.64	C
NB TH/RT	44.6	0.82	D	29.3	0.65	C	71.3	0.97	E	35.7	0.68	C	42.0	0.86	D	29.8	0.65	C
SB LT	60.7	0.90	E	51.9	0.90	D	65.0	0.90	E	66.4	0.92	E	50.8	0.78	D	43.1	0.77	D
SB TH	17.1	0.24	B	16.0	0.49	B	19.2	0.27	B	19.1	0.52	B	18.7	0.28	B	21.4	0.60	C
SB TH/RT	17.2	0.24	B	16.2	0.49	B	19.3	0.27	B	19.3	0.52	B	18.8	0.29	B	21.7	0.60	C
Overall	38.7	-	D	26.8	-	C	50.1	-	D	33.1	-	C	35.1	-	D	27.6	-	C
3: Phillipine Sea & Renton Rd																		
EB TH/RT	-	-	-	-	-	-	-	-	-	-	-	-						
WB LT/TH	7.6	0.13	A	7.5	0.09	A	7.6	0.15	A	7.5	0.11	A						
NB LT/RT	9.0	0.10	A	9.3	0.21	A	9.0	0.11	A	9.6	0.25	A						
4: Phillipine Sea & Roosevelt Ave																		
EB LT/TH/RT	9.5	0.09	A	8.6	0.16	A	10.2	0.11	B	9.2	0.21	A						
WB LT/TH/RT	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A						
NB LT/TH/RT	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A						
SB LT/TH/RT	26.6	0.57	D	18.0	0.35	C	43.8	0.74	E	41.9	0.67	E						
5: Essex Rd & Roosevelt Ave/Geiger Rd																		
EB TH/RT	-	-	-	-	-	-	-	-	-	-	-	-						
WB LT	8.0	0.02	A	9.0	0.01	A	8.0	0.02	A	9.6	0.02	A						
WB TH	-	-	-	-	-	-	-	-	-	-	-	-						
NB LT/RT	18.2	0.06	C	16.3	0.09	C	21.2	0.07	C	20.1	0.14	C						
6: Geiger Rd & Ewa Refuse Convenience Center																		
EB LT/TH/RT	0.0	-	A	8.1	0.00	A	0.0	-	A	8.4	0.01	A						
WB LT/TH/RT	0.0	-	A	8.9	0.00	A	0.0	-	A	0.0	-	A						
NB LT/TH/RT	0.0	-	A	12.9	0.01	B	0.0	-	A	0.0	-	A						
SB LT/TH/RT	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A						
7: Geiger Rd & Honouliuli Drwy 1																		
EB LT/TH	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A						
WB TH/RT	-	-	-	-	-	-	-	-	-	-	-	-						
SB LT/RT	18.1	0.07	C	19.2	0.05	C	21.7	0.09	C	22.4	0.07	C						
8: Geiger Rd & Honouliuli Drwy 2																		
EB LT/TH/RT	9.3	0.01	A	8.1	0.01	A	9.9	0.01	A	8.4	0.01	A						
WB LT/TH/RT	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A						
NB LT/TH/RT	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A						
SB LT/TH/RT	18.1	0.06	C	20.4	0.13	C	21.6	0.07	C	27.5	0.19	D						
9: Kapolei Pkwy & Geiger Rd																		
EB LT	87.1	0.61	F	73.6	0.77	E	99.4	0.62	F	77.6	0.77	E	83.7	0.60	F	74.6	0.77	E
EB TH	47.1	0.31	D	46.5	0.75	D	52.5	0.28	D	52.4	0.81	D	44.1	0.46	D	53.2	0.82	D
EB TH/RT	47.2	0.32	D	47.5	0.77	D	52.5	0.29	D	54.2	0.83	D	-	-	-	-	-	-
EB RT	-	-	-	-	-	-	-	-	-	-	-	-	40.5	0.09	D	48.3	0.70	D
WB LT	67.9	0.80	E	71.9	0.86	E	86.9	0.83	F	87.3	0.90	F	67.9	0.81	E	67.9	0.88	E
WB TH	52.3	0.84	D	34.7	0.42	C	68.2	0.89	E	35.4	0.41	D	50.0	0.85	D	34.7	0.42	C
WB RT	39.5	0.13	D	31.3	0.13	C	44.9	0.23	D	32.2	0.15	C	35.2	0.16	D	31.5	0.16	C
NB LT	61.5	0.93	E	65.7	0.88	E	97.9	1.03	F*	73.4	0.89	E	53.2	0.86	D	59.4	0.77	E
NB TH	24.5	0.66	C	35.0	0.64	C	34.4	0.81	C	41.7	0.74	D	39.2	0.91	D	40.0	0.75	D
NB RT	17.7	0.14	B	27.0	0.06	C	21.6	0.23	C	30.2	0.06	C	21.1	0.24	C	28.9	0.05	C
SB LT	66.6	0.86	E	62.0	0.86	E	86.3	0.89	F	70.9	0.88	E	70.5	0.87	E	61.4	0.87	E
SB TH	35.1	0.67	D	46.1	0.87	D	46.2	0.78	D	61.6	0.96	E	30.5	0.66	C	37.9	0.80	D
SB RT	26.8	0.02	C	28.3	0.02	C	32.8	0.03	C	30.9	0.02	C	22.4	0.03	C	24.5	0.02	C
Overall	39.5	-	D	46.3	-	D	53.3	-	D	55.9	-	E	41.9	-	D	45.2	-	D

Note:
* = over-capacity, v/c > 1

Table 3: Base Year 2021 (no mit), Base Year 2030 (no mit) and Base Year 2030 (with mit) Intersection Level of Service Summary (continued)

Intersection	BY 2021 (No Mit)						BY 2030 (No Mit)						BY 2030 WITH MITIGATION					
	AM			PM			AM			PM			AM			PM		
	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS
10: Ft Weaver Rd & Geiger Rd/Iroquois Rd																		
EB LT	107.2	0.68	F	104.6	0.65	F	108.7	0.73	F	103.8	0.67	F						
EB LT/TH	101.8	0.66	F	100.0	0.65	F	101.9	0.71	F	99.8	0.67	F						
EB RT	102.9	0.61	F	106.7	0.68	F	106.8	0.70	F	107.7	0.72	F						
WB LT	85.0	0.19	F	86.7	0.06	F	84.0	0.20	F	81.4	0.05	F						
WB TH	109.3	0.80	F	117.9	0.83	F	112.4	0.83	F	121.1	0.89	F						
WB RT	85.4	0.23	F	87.5	0.12	F	85.1	0.28	F	83.7	0.19	F						
NB LT	110.9	0.67	F	110.8	0.69	F	110.8	0.68	F	110.4	0.72	F						
NB TH	39.0	0.56	D	38.6	0.38	D	44.8	0.62	D	46.8	0.50	D						
NB RT	28.0	0.00	C	32.3	0.01	C	31.1	0.01	C	36.8	0.01	D						
SB LT	82.7	0.67	F	123.1	0.80	F	97.7	0.73	F	125.8	0.81	F						
SB TH	56.6	0.39	E	37.2	0.62	D	63.7	0.52	E	47.4	0.78	D						
SB RT	215.0	0.10	F	36.0	0.20	D	130.3	0.13	F	38.8	0.22	D						
Overall	72.6	0.63	E	64.4	0.70	E	74.6	0.69	E	69.5	0.80	E						
11: Ft Weaver Rd & Renton Rd																		
EB LT	113.0	0.81	F	114.2	0.83	F	113.1	0.81	F	113.6	0.81	F						
EB LT/TH	110.8	0.80	F	112.8	0.82	F	111.5	0.79	F	113.3	0.81	F						
EB RT	87.6	0.27	F	87.2	0.26	F	87.5	0.22	F	87.2	0.22	F						
WB LT/TH	118.9	0.39	F	122.3	0.66	F	119.6	0.46	F	122.3	0.66	F						
WB RT	111.2	0.01	F	103.4	0.02	F	110.5	0.01	F	103.5	0.02	F						
NB LT	124.9	0.85	F	100.3	0.74	F	126.8	0.90	F	98.8	0.75	F						
NB TH	22.4	0.87	C	32.0	0.53	C	23.0	0.88	C	34.6	0.61	C						
NB RT	15.4	0.02	B	41.3	0.05	D	15.5	0.02	B	40.8	0.06	D						
SB LT	126.9	0.66	F	113.6	0.62	F	127.5	0.68	F	115.2	0.64	F						
SB TH	37.2	0.51	D	64.5	0.99	E	48.5	0.69	D	86.0	1.06	F*						
SB RT	56.2	0.23	E	40.3	0.27	D	63.5	0.29	E	38.6	0.27	D						
Overall	44.3	0.85	D	60.5	0.90	E	49.1	0.87	D	70.4	0.95	E						

Note:
* = over-capacity, v/c > 1

4. FUTURE YEAR WITH PROJECT SCENARIOS

4.1 Future Year 2021 Trip Generation

Future year 2021 trip generation is the anticipated peak year of construction activity, which was assumed to occur during Phase 1 construction of the Honouliuli WWTP. A Technical Memorandum provided by AECOM, dated September 18, 2014, shown in Appendix E, was used to estimate the number of vehicular trips generated by construction activity for the Future Year 2021 scenario. It was estimated that the Project would generate 185 construction workers to/from the site, with the assumption of 1 vehicle trip per construction worker. Therefore, 185 construction workers would arrive to the site during the AM peak hour and 185 construction workers would exit the site during the PM peak hour. This was assumed to be a relatively conservative estimate, since carpooling would likely occur, with some workers traveling outside the studied peak hours of traffic.

In addition to the 185 construction workers, 8 total trips (4 entering and 4 exiting) were assumed to be generated by cement trucks during each of the AM and PM peak hours of traffic. This was also a conservative estimate, since it is likely that these trucks would probably avoid peak hours of traffic.

Trips generated for the peak year of construction, 2021 are shown below in Table 4.

Table 4: Future Year 2021 Project Generated Traffic

Independent Variable	AM Peak Hour			PM Peak Hour		
	Enter	Exit	Total	Enter	Exit	Total
Construction Worker Trips	185	0	185	0	185	185
Concrete Truck Trips	4	4	8	4	4	8
TOTAL	189	4	193	4	189	193

4.2 Trip Distribution/Assignment

Trip distribution is based on existing traffic flow patterns throughout the study area. Future Year 2021 Project trips were assigned to all existing driveways in addition to three (3) new proposed accesses; one access along Roosevelt Avenue, one access along Geiger Road and one access along Renton Road. The first access is proposed to be located approximately 600 feet east of the existing Geiger Road/Driveway 2 intersection and will hereinafter be referred to as "Honouliuli Driveway 3". The second access is proposed to be located approximately 600 feet east of the existing Roosevelt Avenue/Phillipine Sea intersection and will hereinafter be referred to as "Honouliuli Driveway 4". The third access is proposed to be located along Renton Road adjacent to the Mailo Street intersection. The new access is proposed near Mailo Street. For purposes of this study, this new access along Renton Road will hereinafter be referred to as "Honouliuli Driveway 5".

4.3 Future Year 2021 Analysis

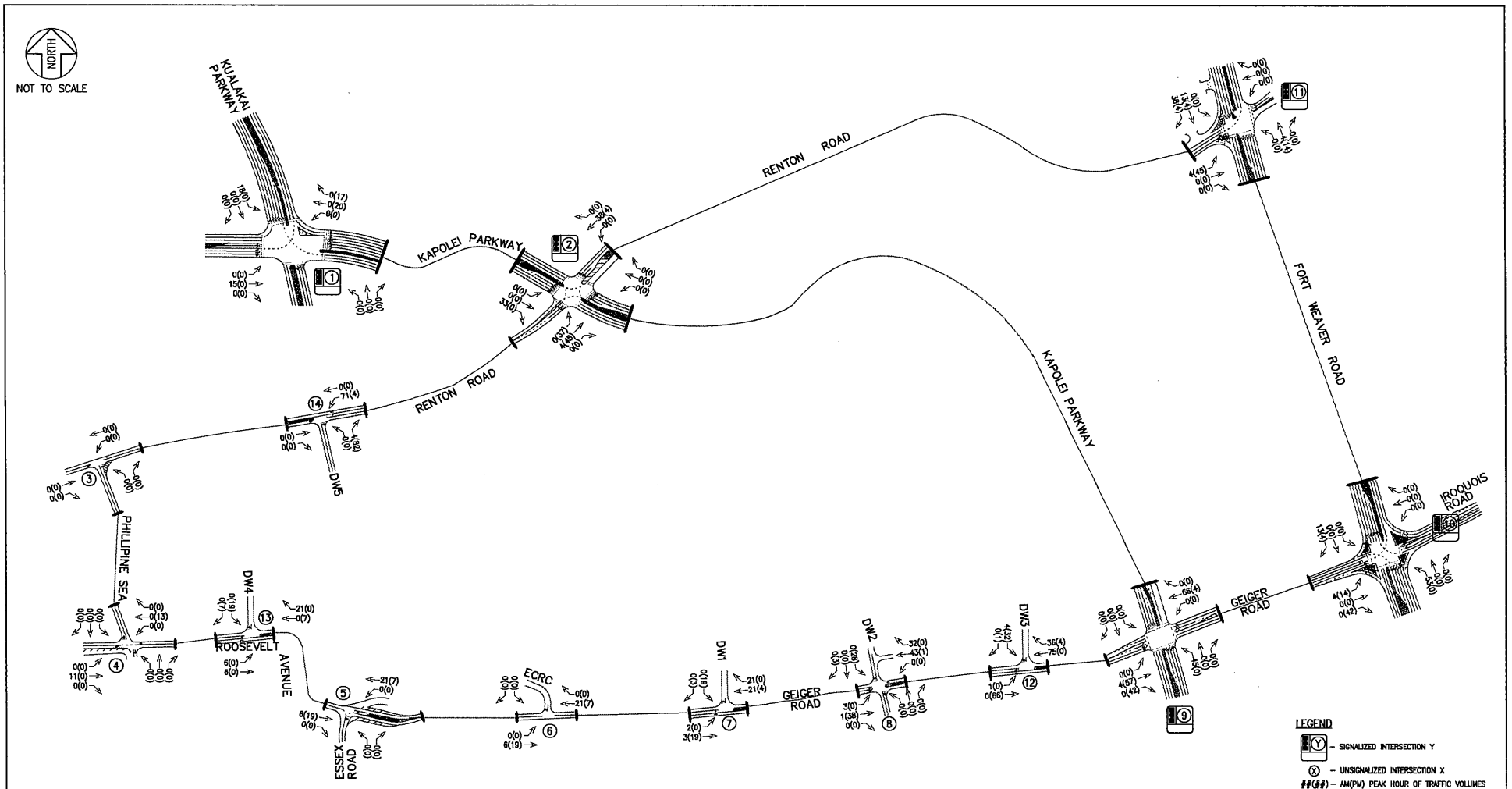
Based on a LOS comparison between Future Year 2021 and Base Year 2021, the majority of individual movements that are projected to operate at LOS E/F for Base Year 2021 conditions will continue operating at similar levels of service for Future Year 2021 conditions during the AM and PM peak hours of traffic except for the following:

Fort Weaver Road/Geiger Road/Iroquois Road & Fort Weaver Road/Renton Road
The intersections along Fort Weaver Road through the Ewa region will experience LOS F and over-capacity conditions at some movements. However, this is generally ascribed to requisite long traffic signal cycle lengths, split phase operation and generally long crosswalk lengths across Fort Weaver Road. Further widening of Fort Weaver Road is not prescribed by the ORTP 2035, and is generally considered infeasible due to insufficient ROW.

Honouliuli Driveways along Geiger Road, Roosevelt Avenue and Renton Road
At the Geiger Road/Honouliuli Driveway 2, the southbound shared left/through/right-turn lane is anticipated to operate at LOS E during the PM peak hour. The southbound left-turn movement currently operates with 20 vehicles and queues were not observed to extend beyond a couple vehicles long. An additional 30 left-turn vehicles generated by construction worker trips should have minimal impacts to the queues along the southbound approach. All movements at the three new Project driveway intersections will operate adequately at LOS D or better during the AM and PM peak hours of traffic.

Although entering traffic volumes at the Project driveways are anticipated to operate with adequate LOS, A Policy on Geometric Design of Highways and Streets, prepared by American Association of State Highway and Transportation Officials (AASHTO), (hereinafter referred to as the "AASHTO Green Book") provides guidance on implementation of left-turn lanes. In the AASHTO Green Book, page 9-131, it suggests that "left-turning traffic should be removed from the through lanes, whenever practical....Ideally, left-turn lanes should be provided at driveways and street intersections along major arterial and collector roads, wherever left-turns are permitted." Therefore, eastbound left-turn lanes are recommended along Geiger Road and Roosevelt Avenue at its intersection with Honouliuli Driveway 1, 2, 3 and 4 and a westbound left-turn lane is recommended at the Renton Road/Driveway 5 intersection. Based on AASHTO guidance, due to relatively low projected left-turn volume along Geiger Road and Roosevelt Avenue, the left-turn lanes entering the Honouliuli Driveways should provide for a minimum storage of at least 50 feet, while the Renton Road/Driveway 5 intersection should provide a minimum of at least 125 feet of storage.

Figure 6 illustrates the Project Generated Traffic Volumes for Year 2021. Figure 7 illustrates the forecast traffic volumes, lane configuration, and LOS for Future Year 2021 conditions. Table 5 summarizes the delay, V/C, and LOS at the study intersections for Base Year 2021 and Future Year 2021 conditions. The full LOS summary table is provided in Appendix C.



HONOULIULI WASTEWATER TREATMENT PLAN TIAR

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FIGURE 6

YEAR 2021 PROJECT ONLY VOLUMES

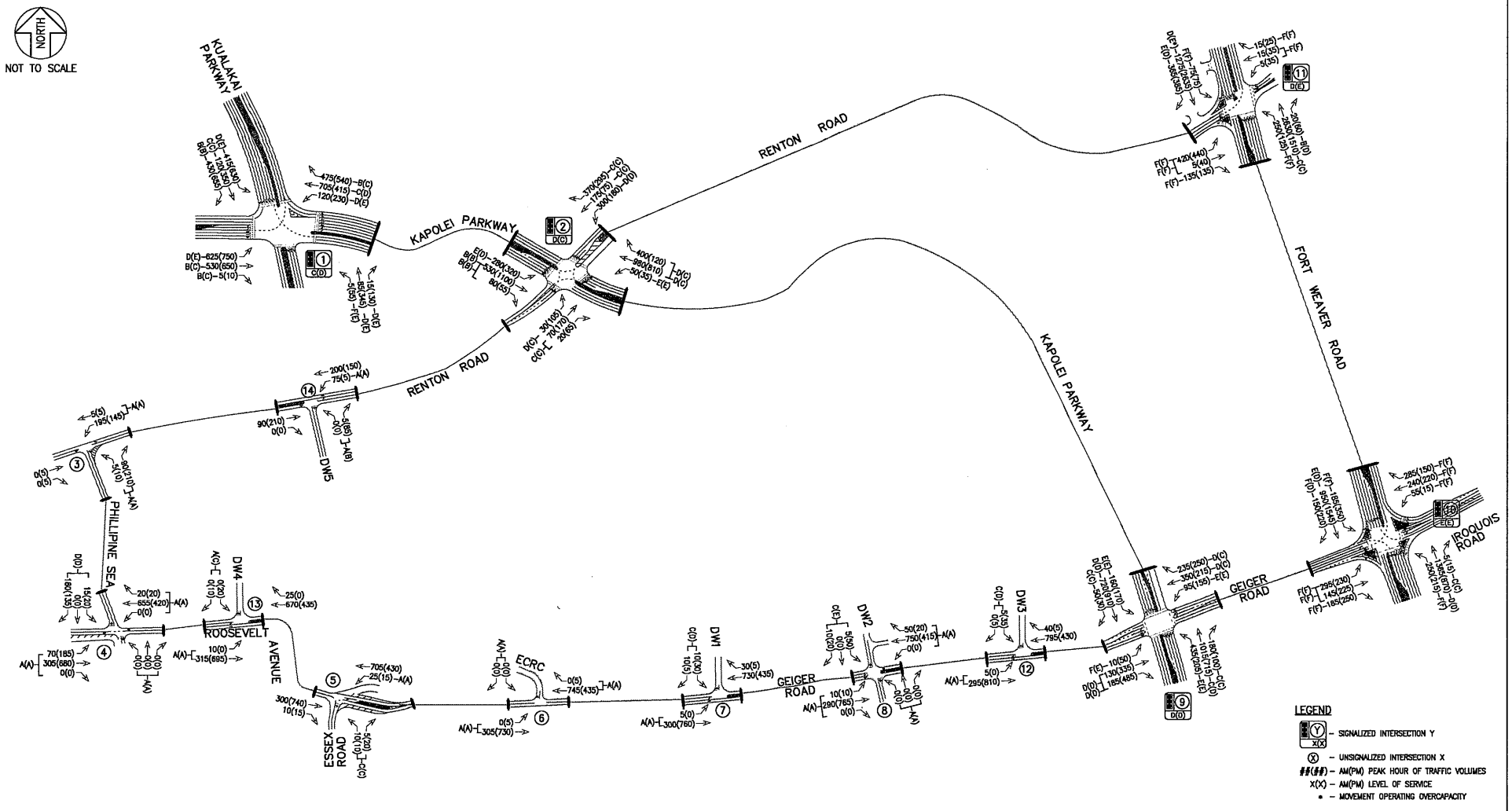

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FIGURE 7

FUTURE YEAR 2021 LANE CONFIGURATION, VOLUME, AND LOS

Table 5: Base Year 2021 (no mit) and Future Year 2021 (no mit) Intersection Level of Service Summary

Intersection	BY 2021 (No Mit)						FY 2021 (No Mit)						FY 2021 (With Mit)					
	AM			PM			AM			PM			AM			PM		
	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS
1: Kapolei Pkwy & Kualakai Pkwy																		
EB LT	37.0	0.84	D	57.4	0.91	E	37.4	0.84	D	58.1	0.91	E						
EB TH	16.7	0.24	B	31.4	0.38	C	17.1	0.25	B	31.3	0.38	C						
EB RT	16.8	0.24	B	31.6	0.38	C	17.2	0.25	B	31.4	0.38	C						
WB LT	46.1	0.61	D	62.6	0.78	E	46.6	0.61	D	63.1	0.78	E						
WB TH	30.3	0.56	C	47.2	0.44	D	30.8	0.57	C	47.4	0.45	D						
WB RT	19.8	0.44	B	28.3	0.45	C	19.7	0.44	B	28.4	0.46	C						
NB LT	88.5	0.54	F	76.5	0.77	E	89.1	0.54	F	77.0	0.77	E						
NB TH	41.3	0.29	D	56.2	0.71	E	41.7	0.29	D	57.0	0.72	E						
NB TH/RT	41.2	0.29	D	56.2	0.71	E	41.7	0.29	D	57.0	0.72	E						
SB LT	42.8	0.82	D	63.2	0.91	E	43.8	0.82	D	64.0	0.91	E						
SB TH	28.7	0.15	C	33.4	0.33	C	28.5	0.15	C	33.9	0.33	C						
SB RT	14.7	0.21	B	13.3	0.27	B	14.6	0.21	B	13.6	0.27	B						
Overall	29.1	-	C	44.4	-	D	29.5	-	C	44.8	-	D						
2: Kapolei Pkwy & Renton Rd																		
EB LT	34.8	0.10	C	26.8	0.19	C	36.7	0.10	D	27.8	0.26	C						
EB TH/RT	30.1	0.16	C	26.1	0.37	C	30.2	0.16	C	26.9	0.42	C						
WB LT	49.2	0.78	D	36.3	0.61	D	49.2	0.78	D	38.9	0.61	D						
WB TH	31.2	0.25	C	24.0	0.14	C	32.1	0.33	C	23.9	0.14	C						
WB RT	30.5	0.19	C	23.9	0.13	C	30.5	0.19	C	23.9	0.13	C						
NB LT	73.2	0.77	E	67.6	0.79	E	73.4	0.77	E	72.2	0.79	E						
NB TH	40.2	0.82	D	28.5	0.65	C	40.4	0.83	D	34.8	0.70	C						
NB TH/RT	44.6	0.82	D	29.3	0.65	C	44.9	0.83	D	36.9	0.71	C						
SB LT	60.7	0.90	E	51.9	0.90	D	61.0	0.90	E	44.8	0.89	D						
SB TH	17.1	0.24	B	16.0	0.49	B	17.3	0.25	B	18.9	0.51	B						
SB TH/RT	17.2	0.24	B	16.2	0.49	B	17.4	0.25	B	19.2	0.51	B						
Overall	38.7	-	D	26.8	-	C	38.7	-	D	29.5	-	C						
3: Phillipine Sea & Renton Rd																		
EB TH/RT	-	-	-	-	-	-	-	-	-	-	-	-						
WB LT/TH	7.6	0.13	A	7.5	0.09	A	7.6	0.13	A	7.5	0.10	A						
NB LT/RT	9.0	0.10	A	9.3	0.21	A	9.0	0.10	A	9.5	0.23	A						
4: Phillipine Sea & Roosevelt Ave																		
EB LT/TH/RT	9.5	0.09	A	8.6	0.16	A	9.5	0.09	A	9.1	0.19	A						
WB LT/TH/RT	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A						
NB LT/TH/RT	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A						
SB LT/TH/RT	26.6	0.57	D	18.0	0.35	C	26.7	0.57	D	34.4	0.59	D						
5: Essex Rd & Roosevelt Ave/Geiger Rd																		
EB TH/RT	-	-	-	-	-	-	-	-	-	-	-	-						
WB LT	8.0	0.02	A	9.0	0.01	A	8.0	0.02	A	9.5	0.02	A						
WB TH	-	-	-	-	-	-	-	-	-	-	-	-						
NB LT/RT	18.2	0.06	C	16.3	0.09	C	18.8	0.06	C	20.2	0.12	C						
6: Geiger Rd & Ewa Refuse Convenience Center																		
EB LT/TH/RT	0.0	-	A	8.1	0.00	A	0.0	-	A	8.3	0.01	A						
WB LT/TH/RT	0.0	-	A	8.9	0.00	A	0.0	-	A	0.0	-	A						
NB LT/TH/RT	0.0	-	A	12.9	0.01	B	0.0	-	A	0.0	-	A						
SB LT/TH/RT	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A						
7: Geiger Rd & Honouliuli Drwy 1																		
EB LT	-	-	-	-	-	-	-	-	-	-	-	-	9.5	0.0	A	0.0	-	A
EB LT/TH	0.0	-	A	0.0	-	A	9.5	0.01	A	0.0	-	A	-	-	-	-	-	-
WB TH/RT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SB LT/RT	18.1	0.07	C	19.2	0.05	C	19.1	0.08	C	27.6	0.19	D	19.0	0.1	C	27.6	0.2	D
8: Geiger Rd & Honouliuli Drwy 2																		
EB LT	-	-	-	-	-	-	-	-	-	-	-	-	9.7	0.01	A	8.3	0.01	A
EB LT/TH/RT	9.3	0.01	A	8.1	0.01	A	9.7	0.01	A	8.3	0.01	A	-	-	-	-	-	-
WB LT/TH/RT	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A
NB LT/TH/RT	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A
SB LT/TH/RT	18.1	0.06	C	20.4	0.13	C	19.8	0.06	C	41.9	0.45	E	19.8	0.06	C	41.6	0.44	E
9: Kapolei Pkwy & Geiger Rd																		
EB LT	87.1	0.61	F	73.6	0.77	E	90.5	0.61	F	76.7	0.77	E						
EB TH	47.1	0.31	D	46.5	0.75	D	44.9	0.25	D	50.2	0.81	D						
EB TH/RT	47.2	0.32	D	47.5	0.77	D	45.0	0.26	D	53.8	0.85	D						
EB RT	-	-	-	-	-	-	-	-	-	-	-	-						
WB LT	67.9	0.80	E	71.9	0.86	E	67.8	0.80	E	77.3	0.86	E						
WB TH	52.3	0.84	D	34.7	0.42	C	54.1	0.86	D	33.9	0.39	C						
WB RT	39.5	0.13	D	31.3	0.13	C	38.5	0.21	D	30.9	0.14	C						
NB LT	61.5	0.93	E	65.7	0.88	E	67.7	0.94	E	70.7	0.89	E						
NB TH	24.5	0.66	C	35.0	0.64	C	29.2	0.70	C	38.5	0.67	D						
NB RT	17.7	0.14	B	27.0	0.06	C	20.7	0.15	C	29.5	0.06	C						
SB LT	66.6	0.86	E	62.0	0.86	E	67.8	0.86	E	66.1	0.86	E						
SB TH	35.1	0.67	D	46.1	0.87	D	45.7	0.80	D	53.2	0.91	D						
SB RT	26.8	0.02	C	28.3	0.02	C	32.8	0.03	C	30.9	0.02	C						
Overall	39.5	-	D	46.3	-	D	45.2	-	D	51.0	-	D						

Note:
* = over-capacity, v/c > 1

Table 5: Base Year 2021 (no mit), Future Year 2021 (no mit), and Future Year 2021 (with mit) Intersection Level of Service Summary (continued)

Intersection	BY 2021 (No Mit)						FY 2021 (No Mit)						FY 2021 (With Mit)					
	AM			PM			AM			PM			AM			PM		
	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS
10: Ft Weaver Rd & Geiger Rd/Iroquois Rd																		
EB LT	107.2	0.68	F	104.6	0.65	F	107.4	0.68	F	99.7	0.62	F						
EB LT/TH	101.8	0.66	F	100.0	0.65	F	101.4	0.66	F	96.7	0.62	F						
EB RT	102.9	0.61	F	106.7	0.68	F	102.4	0.60	F	114.6	0.80	F						
WB LT	85.0	0.19	F	86.7	0.06	F	85.3	0.19	F	87.6	0.06	F						
WB TH	109.3	0.80	F	117.9	0.83	F	110.1	0.80	F	122.6	0.85	F						
WB RT	85.4	0.23	F	87.5	0.12	F	85.6	0.23	F	88.5	0.12	F						
NB LT	110.9	0.67	F	110.8	0.69	F	112.9	0.75	F	110.8	0.69	F						
NB TH	39.0	0.56	D	38.6	0.38	D	39.1	0.56	D	39.9	0.39	D						
NB RT	28.0	0.00	C	32.3	0.01	C	28.1	0.0	C	33.3	0.01	C						
SB LT	82.7	0.67	F	123.1	0.80	F	82.7	0.67	F	123.7	0.80	F						
SB TH	56.6	0.39	E	37.2	0.62	D	59.5	0.40	E	39.0	0.63	D						
SB RT	215.0	0.10	F	36.0	0.20	D	236.8	0.10	F	37.9	0.20	D						
Overall	72.6	0.63	E	64.4	0.70	E	75.2	0.65	E	66.3	0.73	E						
11: Ft Weaver Rd & Renton Rd																		
EB LT	113.0	0.81	F	114.2	0.83	F	111.3	0.81	F	112.9	0.84	F						
EB LT/TH	110.8	0.80	F	112.8	0.82	F	109.2	0.79	F	113.6	0.84	F						
EB RT	87.6	0.27	F	87.2	0.26	F	86.9	0.26	F	84.5	0.25	F						
WB LT/TH	118.9	0.39	F	122.3	0.66	F	118.9	0.39	F	122.3	0.66	F						
WB RT	111.2	0.01	F	103.4	0.02	F	111.2	0.01	F	103.4	0.02	F						
NB LT	124.9	0.85	F	100.3	0.74	F	125.7	0.85	F	100.5	0.74	F						
NB TH	22.4	0.87	C	32.0	0.53	C	22.8	0.87	C	33.7	0.54	C						
NB RT	15.4	0.02	B	41.3	0.05	D	15.6	0.02	B	44.2	0.05	D						
SB LT	126.9	0.66	F	113.6	0.62	F	128.3	0.67	F	113.8	0.62	F						
SB TH	37.2	0.51	D	64.5	0.99	E	37.8	0.52	D	73.1	1.01	E*						
SB RT	56.2	0.23	E	40.3	0.27	D	58.3	0.26	E	42.4	0.27	D						
Overall	44.3	0.85	D	60.5	0.90	E	44.8	0.86	D	65.5	0.92	E						
12: Geiger Rd & Honoulili Drwy 3																		
EB LT							-	-	-	-	-	-	9.8	0.01	A	0.0	-	A
EB LT/TH							9.8	0.01	A	0.0	-	A	-	-	-	-	-	-
WB TH/RT							-	-	-	-	-	-	-	-	-	-	-	-
SB LT/RT							23.8	0.03	C	30.9	0.24	D	23.7	0.03	C	30.9	0.24	D
13: Roosevelt Ave & Honoulili Drwy 4																		
EB LT							-	-	-	-	-	-	9.3	0.01	A	0.0	-	A
EB LT/TH							9.3	0.01	A	0.0	-	A	-	-	-	-	-	-
WB TH/RT							-	-	-	-	-	-	-	-	-	-	-	-
SB LT/RT							0.0	-	A	21.3	0.13	C	0.0	-	A	21.3	0.13	C
14: Honoulili Drwy 5 & Renton Rd																		
EB TH/RT							-	-	-	-	-	-	-	-	-	-	-	-
WB LT							7.5	0.06	A	7.7	0.00	A	7.5	0.06	A	7.7	0.00	A
WB TH							-	-	-	-	-	-	-	-	-	-	-	-
NB LT/RT							8.8	0.01	A	10.0	0.11	B	8.8	0.01	A	10.0	0.11	B

Note:
* = over-capacity, v/c > 1