APPENDIX A

THE HAWAI‘I LIVESTOCK MARKET

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THE HAWAI'I LIVESTOCK MARKET

Prepared for

The State of Hawai'i Department of Agriculture
Hawai'i Cattlemen's Council

March 2021

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EXECUTIVE SUMMARY

It is the goal of the State of Hawaii, Department of Agriculture (HDOA), in cooperation with the Hawaii Cattlemen's Council (HCC) to evaluate the development of a scalable and replicable livestock handling facility in Hawai'i. The State of Hawaii department of Agriculture and HCC hope to confirm that the livestock facility will aid the sustainability of Hawaii's beef industry, as well as addresses the economic, social, and environmental impacts of a potential facility.

This is one of a series of technical reports to describe and document the existing livestock industry in Hawaii and to assist in meeting the goals and objectives.

The agriculture, forestry, fishing, and hunting industries represent approximately 0.04% of Hawaiʻi's Gross Domestic Product in 2018 (BEA and DBEDT, READ). However, the agriculture sector is still recognized as a cornerstone to achieving the state's sustainability goals. The livestock industry, including cattle ranches and hog farms, is the third largest in the agriculture sector, following seed crop and macadamia nut production.

Despite a minor decline in beef consumption in Hawaiʻi in 2020 and 2021, due to the COVID-19 pandemic, beef consumption is projected to reach its pre-pandemic levels of 91.4 million pounds by 2026. Consumption is eventually expected to increase to 98.2 million pounds by 2036. It is estimated that 91% of the beef consumed in the State of Hawaiʻi is imported, and the industry continues to face many challenges that limit the ability of local beef producers to increase their share of market.

The overall hog industry remains unsystematic and there is less data available around production and distribution. Although there are approximately 400 hog farmers in Hawaiʻi, only about 150 reported sales within the state. Locally produced pork is sold not only at the retail and wholesale level but also directly from the farms, which is known as the grey market. The volume of local pork sales in the gray market is estimated to have surpassed the local pork sales in the commercial market, at more than 80% of estimated sales. The price of locally grown pork is significantly more expensive than imported pork due to higher costs and much smaller economies of scale. Aside from the cost, locally grown pork must also compete with imported pork in terms of taste, quality, and freshness, as well as niche market products of specialty pork cuts. However, experts and chefs agree that locally grown hogs are tastier and provide healthier product.

Challenges:

Capacity: Slaughter facilities have the capacity for slaughtering *many* more cattle than they are currently. Of the seven facilities interviewed by SMS, three only work one or two shifts each week, two work at around 15 percent capacity, one works at 33 percent capacity, and one works at 60 percent capacity.

Processing and Distribution: Current shipping conditions hamper the distribution of beef product from neighbor islands to Oʻahu. Interisland distribution is crucial to the local beef industry because most consumers are located on Oʻahu, while many of the cattle ranches and slaughter facilities are on all other islands. According to interviewees, interisland transportation is expensive and inconsistent at best.

County	% de Facto Population	% of Cattle	% of Slaughterhouses (2019)	% of Pastureland	% of Cattle Export
Honolulu	66%	4%	8%	3%	1%
Hawaiʻi	14%	72%	31%	63%	76%
Maui	14%	14%	23%	21%	13%
Kauaʻi	6%	11%	38%	13%	10%

The table above shows the distribution of population, cattle, slaughterhouse house facilities, pastureland, and cattle exports for 2017 unless otherwise denoted. A significant portion of local beef is exported to external markets.

Pastureland Utilization: Currently only 80 percent of Oʻahu's pastureland is utilized for cattle farming. The land is most commonly left vacant/farmed/conserved by the State and major landholders.

Quality: Consumer preference for local cattle is also low due to quality issues such as gamey flavor, meat toughness and a lack of marbling. This is a result of a variety of factors including such factors quality of cattle stock and inconsistencies in pasture feed.

Cost: Due to Hawaiʻi's higher input costs and much smaller economies of scale, the higher production cost is reflected in significantly higher product pricing for local alternatives.

Recommendations:

- Evaluating and encouraging management of cattle exports thus increasing local beef availability for local consumption could reduce beef imports by up to 33 percent. This would reduce our reliance on imported beef from 91 percent to 61 percent in 2019.

- Encouraging cattle farming on lands owned by Kamehameha School and Department of Land and Natural Resources could help increase utilization rates.

- An increased focus on quality improvement to meet Hawaiʻi resident's standards will be needed to effectively replace imported alternatives by improving cattle genetics, pasture feed stock and slaughter timing.

- To increase industry productivity, a coordinated marketing and production plan is necessary. That will include standardization of Hawaiʻi grass fed beef quality and help ensure continuous and planned demand for ranchers and slaughter operations.

- A coordinated effort to provide marketing and cooperative distribution opportunities to hog farmers will aid in industry expansion.

- A consumer education program and increased distribution and sales coordination will enhance demand, increase formal sales and aid in reducing prices to a level more competitive with imported products.

GOALS AND OBJECTIVES

The State of Hawaiʻi, Department of Agriculture (HDOA), in cooperation with the Hawaiʻi Cattlemen's Council (HCC), have developed the following goals for livestock production and processing for the State.

GOALS

- Create a facility model that enables the sustainability of Hawaiʻi's beef industry, as well as addresses the economic, social, and environmental impacts of a potential facility.

- Create a marketing tool to attract investors for future construction of livestock harvesting facilities in Hawaiʻi.

OBJECTIVES

- Determine the livestock capacity in Hawaiʻi
- Determine the existing and future market potential for Hawaiʻi-grown livestock
- Prepare a feasibility study, master plan, and preliminary design
    - Address socio-economic and environmental conditions
    - Meets regulatory criteria and requirements
    - Replicable and scalable, to the extent practicable
- Explore ownership and sustainable business models
- Quantify economic and social impact of business model options
- Explore and present marketing and branding strategies

BACKGROUND

Livestock production in Hawai‘i has always been a major contributor to the state’s agricultural community. Long before agriculture developed into the industry it is today, some forms of livestock, notably pigs and poultry, played an important role in early Polynesian society in Hawai‘i. Not only were they a source of food, but pigs were involved in religious and ceremonial functions and furnished material for making implements and ornaments. From the time of early importations made by Captain James Cook and George Vancouver during the late 1700’s to the present day, the livestock industry continually expanded in scope and economic importance.

It is generally accepted that approximately 85 to 90 percent of the food we consume in Hawai‘i is imported from the mainland and foreign countries.[1][2][3] The high dependence on food imports, geographic isolation from the rest of the world, and challenges in expanding local production have raised concerns about food security and food sustainability in Hawai‘i. Situated in the center of the Pacific Ocean, Hawai‘i is isolated, and imported food can only be transported via airplane or ship depending on its perishability. In the event of a catastrophic disaster such as a hurricane, tsunami, and/or global pandemic where the airports and harbors may need to temporarily close or reduce activities for safety issues, there is concern that the local food supply is significantly inadequate to support the population in the state.

The State of Hawai‘i, Department of Agriculture (HDOA), in cooperation with the Hawai‘i Cattlemen’s Council (HCC) is interested in (1) identifying opportunities to expand the capacity of livestock handling in Hawai‘i, and (2) assessing the future market potential for Hawai‘i-grown livestock commodities. The objective of this report is to provide an overview of the beef and pork market in Hawai‘i in terms of local consumption, inventory, and the number of operations. Some of the biggest challenges to promoting local production over importing finished beef and pork products include high input cost as well as insufficient local demand and supply, which results in higher consumer prices for locally grown commodities.[4][5]

Expanding local production could contribute to the local economy through creation of jobs, taxes, and support of secondary businesses. Another advantage is the diversification of the local economy. Hawai‘i is a tourism-driven economy and an island state. The 2019 global pandemic has impacted Hawai‘i more significantly than most states in terms of the unemployment rate and food security.[6][7] Expanding local production could reduce our dependence on tourism by diversifying the local economy and putting more resources into alternative industries. It will also contribute to enhancing Hawai‘i’s self-sufficiency and food security by producing more food for residents locally, within the state.

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1 Food Security in Hawai‘i. Kent, 2014.
2 Hawai‘i’s food consumption and supply sources: benchmark estimates and measurement issues. Leung and Loke, 2013
3 Increased food security and food self-sufficiency strategy. State of Hawai‘i DBEDT.
4 Food Security in Hawai‘i. George Kent.
5 The Hawai‘i Beef Industry: Situation and Outlook Update. Cox and Bredhoff, 2003.
6 State Employment and Unemployment – July 2020. U.S. Department of Labor Statistics, Bureau of Labor Statistics.
7 Hawai‘i Foodbank is ready to meet the evolving needs of our communities – during the pandemic and beyond. Hawai‘i Foodbank.

METHODOLOGY

This report utilizes data obtained from multiple sources. These sources include the United States Department of Agriculture (USDA), State of Hawaiʻi Department of Business, Economic Development and Tourism (DBEDT), University of Hawaiʻi at Mānoa College of Tropical Agriculture and Human Resources (CTAHR), and various local businesses such as ranchers, slaughter operations, and grocery wholesalers. Based on our research and consultation with field experts, there are currently no solid estimates of beef and pork supply and consumption for Hawaiʻi. The same is true for imports and exports. While the United States Army Corps of Engineers (USACE) provides imports and exports trend data for Hawaiʻi, it does not provide further breakdowns based on category of meat. Moreover, the substantial decline in meat imports between 2010 and 2015 do not appear to justify the declining local production and growing *de facto*[8] population. After considering all these concerns, we have decided not to employ these data and develop our own import and export estimates.

Due to the unavailability of historical data, our estimates were derived based on a combination of (1) a set of assumptions, (2) previous literature, (3) limited available data on hand, and (4) knowledge collected from field experts. Assumptions made in this report are described as follows:

<u>Assumption 1</u>: The total consumption and total supply of beef and pork in Hawaiʻi are defined as local production plus imports less exports. This assumption is taken from a similar study estimating Hawaiʻi's food consumption and supply sources (Loke and Leung, 2003). Imports and exports data will be inferred using our model and cross-checked with previous literature.

<u>Assumption 2</u>: The per capita beef and pork consumption is assumed to be identical to per capita beef and pork supply. Again, this is an assumption taken from the same study (Loke and Leung, 2003).

<u>Assumption 3</u>: Hawaiʻi's historical per capita beef consumption is assumed to follow a similar pattern as the U.S.'s per capita beef consumption.

<u>Assumption 4</u>: Hawaiʻi's historical per capita pork consumption is assumed to follow a similar pattern as the U.S.'s per capita pork consumption but behaves differently among residents, visitors, and military.

<u>Assumption 5</u>: Total consumption by county is assumed to be proportional to the *de facto* population distribution of each county.

<u>Assumption 6</u>: The breakdowns of meat consumption are assumed to be represented by the available local market distribution.

Based on assumptions (1) through (6), we estimated the total consumption for beef and pork using mathematical modeling. Data is measured and presented either in terms of pounds or heads (of cattle/pork). This report will take into consideration the outbreak of the global pandemic and its related impacts on beef and pork market.

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8 According to the DBEDT, *de facto* population is defined as the number of persons physically present in an area regardless of their military status or usual place of residence. It includes visitors present but excludes residents that are temporarily absent. *De facto population* = resident population + average daily census for visitors + military – residents temporarily absent.

THE BEEF MARKET

CONSUMPTION PER CAPITA, 2001-2036

The beef consumption per capita is measured in retail weight and is defined as the pounds of beef consumed by a person in a region within a year. Unfortunately, there are no available statistics on the per capita beef consumption for Hawai'i. The U.S. beef consumption per capita data was used as a surrogate for the missing Hawai'i data and was taken from the USDA long-term projections to 2029. Consumption statistics from the State of Hawai'i government also use USDA consumption data as a surrogate. The USDA projections were published just prior to the outbreak of the pandemic and therefore did not account for the impacts. We adopted their projections with care and evaluated the short-term impacts on beef per capita consumption.

Figure 1 presents the historical and projected per capita beef consumption for 2001 to 2036. In 2001, the per capita beef consumption was estimated at 66 pounds. It exhibited a decreasing trend through 2014 at 53.9 pounds and then slowly climbed back up to 57.2 pounds in 2019. The per capita beef consumption peaked at 67.5 pounds in 2003.

In 2020, the beef consumption per capita is expected to increase by 0.9 percent from 2019 at 57.7 pounds. While the significant drop in *de facto* population during the pandemic will result in declining overall consumption of beef, the per capita consumption may not necessarily follow suit. Rather, the change in per capita consumption is likely caused by some other exogenous factors. These factors could include (1) the price of beef under tightening supply, (2) temporary beef shortage due to reduced processing capacity due to COVID-19, (3) level of consumer sentiment for social gathering and dining outside during the pandemic, (4) sense for food insecurity, and (5) healthier diet patterns, etc.

The USDA reported that the price of beef rose when U.S. beef production dropped in April 2020, down 20 percent compared to April of 2019.[9] Some reports have suggested that grocery stores did see significant shortages of beef amid the pandemic and that the stocks of meat were depleted.[10] The temporary shortages led to higher prices and the sense of food insecurity drove the surge in demand.

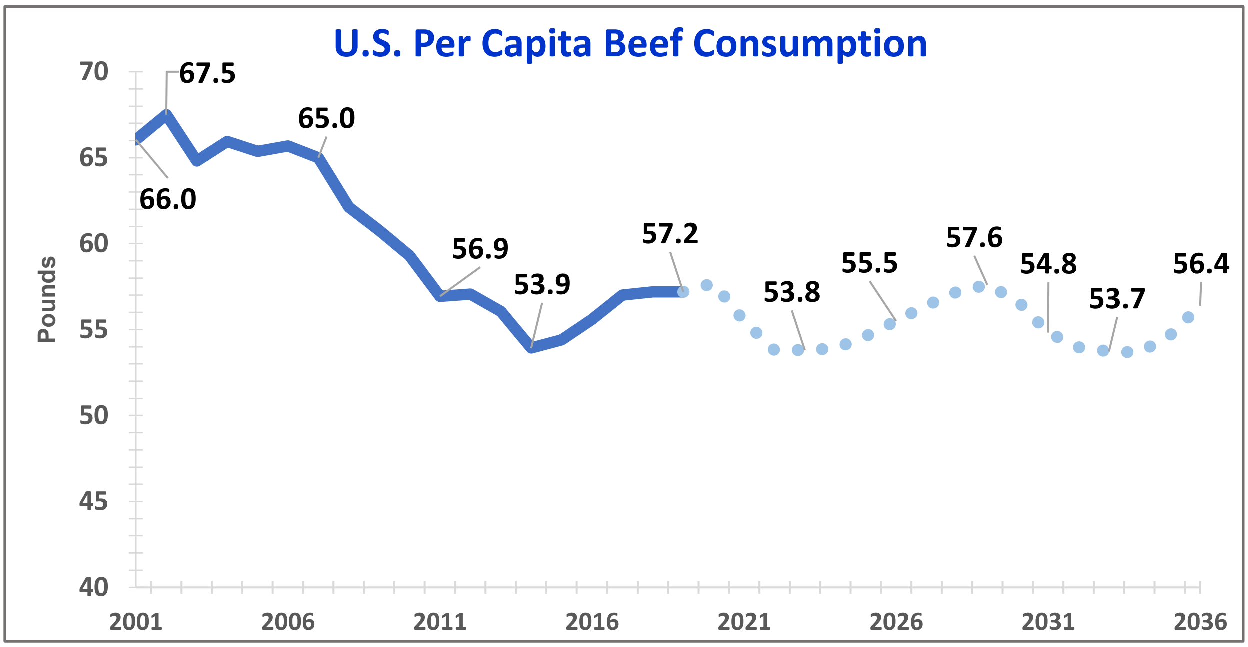
9 Another look at availability and prices of food amid the COVID-19 pandemic. Robert Johansson, 2020. USDA.

10 Meat was once in short supply amid pandemic. Now, it is on sale. The Wall Street Journal.

Now the supply of beef in the U.S. has started to recover as slaughter operations have resumed processing. Production has risen, and lower overall demand is pushing the prices of beef back down according to The Wall Street Journal. On-sale promotions may be additionally attracting people to consume more beef and as a result, the beef consumption per capita might rise slightly in 2020 even though the overall consumption is down due to the significant drop in *de facto* population.

In subsequent years, the per capita beef consumption is projected at around 53.8 to 57.6. The estimates are projected based on historical trends and patterns. One reason for the lower per capita beef consumption could be attributed to the shift of people's meat consumption patterns. The shift from consuming less beef to more chicken was likely because of healthier diet concerns.[11] Another reason could be that the retail price of other meats such as chicken and other poultry are much lower than beef.[12]

Figure 1. Per Capita Beef Consumption in the United States, 2001-2036



Source: USDA NASS; USDA Agricultural Projections to 2029; SMS Projections.

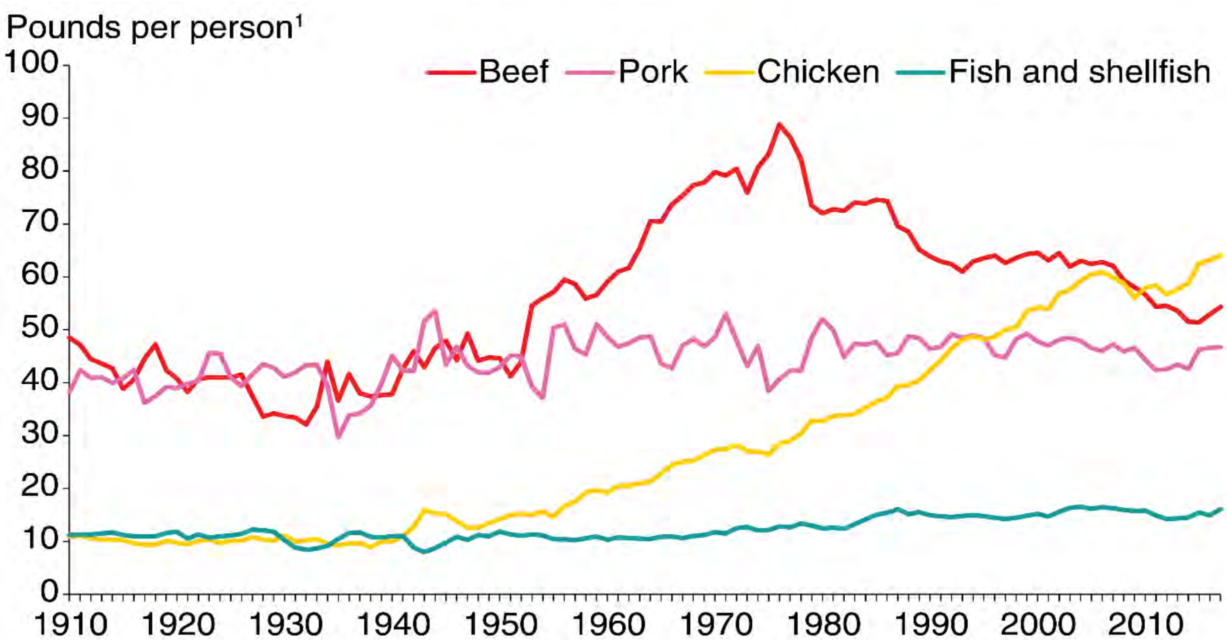
While beef consumption studies agree that the amount of beef average Americans consume has declined steadily since the 1970's, and particularly throughout the past two decades, many cite different reasons for the decline. Figure 2 shows national per capita availability of several animal sources of protein. Although the data is explicitly shown as per capita availability, the USDA indicates that, "the data serve as proxies for actual consumption at the national level". Several studies find that reduced beef consumption can be attributed to environmental concerns and personal health. Others claim the causes to be related to supply and demand.

[11] 2018 will see high meat consumption in the U.S., but the American Diet is Shifting. World Resources Institute.
[12] U.S. per capita availability of red meat, poultry, and seafood on the rise. USDA.

A rigorous study published in the National Center of Biotechnology Information assessed meat reduction behaviors, attitudes, what respondents ate in meatless meals and sociodemographic characteristics through the administration of a web-based survey in April 2015 (Neff et al., 2018). The results showed that the most common reasons for reduction were cost and health; while environment and animal welfare lagged. Consumers' concerns are likely a result of countless studies and articles suggesting lower consumption of red meat may be beneficial to nutrition and the environment. For example, a study published by Finnish scientists in The American Journal of Clinical Nutrition in April 2019 found that "higher ratios of animal to plant protein in diet and higher meat intake were associated with increased mortality risk." (Virtanen et al., 2019) There have been multiple studies since the 1980's reaching similar conclusions.

Alternatively, Daren R. Williams, the senior executive director of communications for National Cattlemen's Beef Association (NCBA), cites stagnation of supply, increase in population, and greater competition from other meats as reasons for declining beef consumption (Fox News Article). The NCBA also makes it clear that a reasonable amount of lean, nutrient dense beef is very important, and eliminating beef consumption entirely may not be best for a balanced diet (NCBA Article).

Figure 2. U.S. Per Capita Availability of Beef, Pork, Chicken, and Fish/Shellfish, 1910-2017



[1]Calculated on the basis of raw and edible meat in boneless, trimmed (edible) weight. Excludes edible offals, bones, viscera, and game from red meat. Includes skin, neck, and giblets from chicken. Excludes use of chicken for commercially prepared pet food.
Source: USDA, Economic Research Service, Food Availability Data.

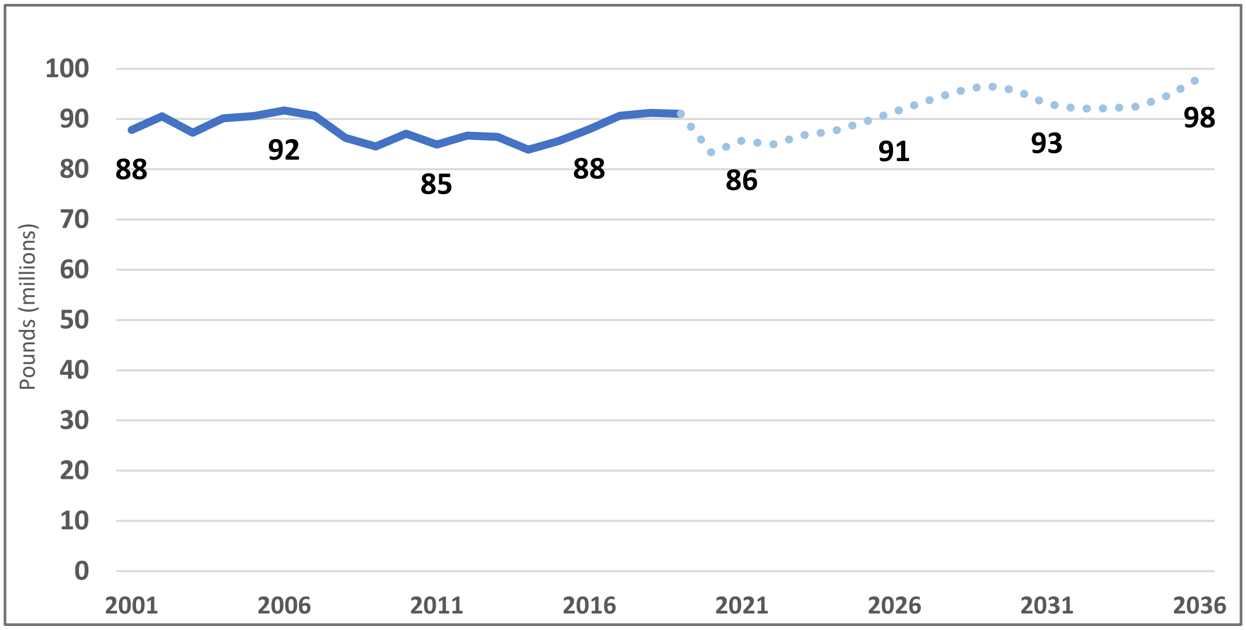
While the reasons for decline are likely some combination of the conclusions reached by independent scientists and the NCBA, all available evidence shows that Hawaiʻi's population would follow similar patterns to the national population in terms of annual beef consumption.

OVERALL CONSUMPTION IN HAWAIʻI, 2001-2036

The overall beef consumption is shown in Figure 3 below. The solid blue line presents the historical consumption estimates from 2001 through 2019. In 2019, it was estimated that people in Hawaiʻi consumed approximately 91.1 million pounds of beef. Compared to 87.8 million pounds of beef in 2001, the beef consumption had increased by 10.6 percent in five years with an average annual growth rate of 0.53 percent. The consumption trend data was estimated using the *de facto* population in Hawaiʻi in conjunction with the U.S. per capita consumption data[13]. A related study conducted by the CTAHR suggests that the beef consumption was projected to be 84.6 and 85.1 million pounds in 2005 and 2010, respectively[14]. Our estimates appear to lie within the reasonable range. As can be seen in Figure 3, the beef consumption has exhibited an increasing trend between 2015 to 2019. The upward trend is a result of growth in *de facto* population and rising per capita beef consumption during the same period.

[13] USDA Long-term Projections, 2015 – 2020. USDA.
[14] The Hawaiʻi Beef Industry: Situation and Outlook Update. Linda J. Cox & Soot Bredhoff (2003). University of Hawaiʻi at Mānoa College of Tropical Agriculture and Human Resources.

Figure 3. Overall Beef Consumption (in pounds) in Hawai‘i, 2001 to 2036



Source: USDA NASS; USDA Agricultural Projections to 2029; DBEDT State Databook 2019; DBEDT Population and Economic Projections for the State of Hawai‘i to 2045; DBEDT Quarterly Tourism Forecast; SMS Estimates; SMS Projections.

In 2020, however, beef consumption is expected to drop abruptly due to the outbreak of the global COVID-19 pandemic. With millions of people contracting COVID-19 worldwide, the global tourism industry has been impacted significantly. Countries and states including Hawai‘i are implementing travel restrictions, disincentivizing or outright banning incoming tourists. According to the DBEDT quarterly tourism forecast, visitor arrivals in Hawai‘i are expected to shrink from 10.4 million in 2019 to 2.9 million in 2020 (-72%). The total visitor days will also decline from 90.9 million days to 30 million days (-67%). The corresponding average daily census for visitors[15] is expected to decrease from 245,733 persons in 2019 to 82,077 persons in 2020 (-66.6%). If we keep the military population and persons who are temporarily absent unchanged, the *de facto* population will likely drop from 1.6 million in 2019 to 1.4 million in 2020. Assuming the beef per capita consumption patterns do not change significantly, the drop in *de facto* population will likely result in declining beef consumption due to a significant reduction of visitors.

The beef consumption is expected to be 83.3 million pounds in 2020, a substantial decrease from 91.1 million pounds in 2019 (-8.5%). The dashed line in Figure 1 presents the projected overall beef consumption for the years 2020 to 2036. The beef consumption is expected to recover slowly as the number of visitors starts to recover in subsequent years. The projected average daily census was calculated from the DBEDT quarterly tourism forecast and the resident population growth was taken from the DBEDT long-range population and economic projection to 2045. The beef consumption is expected to recover to the pre-pandemic levels no earlier than 2026. By 2036, the beef consumption is estimated at around 98.2 million pounds.

[15] Average daily census for visitors is calculated by dividing the total visitor days by 365 and 366 if in leap year.

CONSUMPTION BY COUNTY, 2001-2036

This section reviews the beef consumption by county from 2001 to 2036. As mentioned in the methodology section, there are no existing beef consumption estimates available at the state and county level. A reasonable approach to estimate the county consumption would be to segment the overall consumption proportional to the *de facto* population of each county. This approach assumes similar consumption patterns across all four counties.

Table 1 summarizes the overall beef consumption by county into two parts—historical and projected. Across all four counties, the Honolulu county has the highest overall beef consumption, followed by Hawaiʻi county, Maui county, and Kauaʻi county. Appendix E contains all data for 2001 to 2036.

Table 1. Overall Beef Consumption by County in Pounds, 2001 to 2036

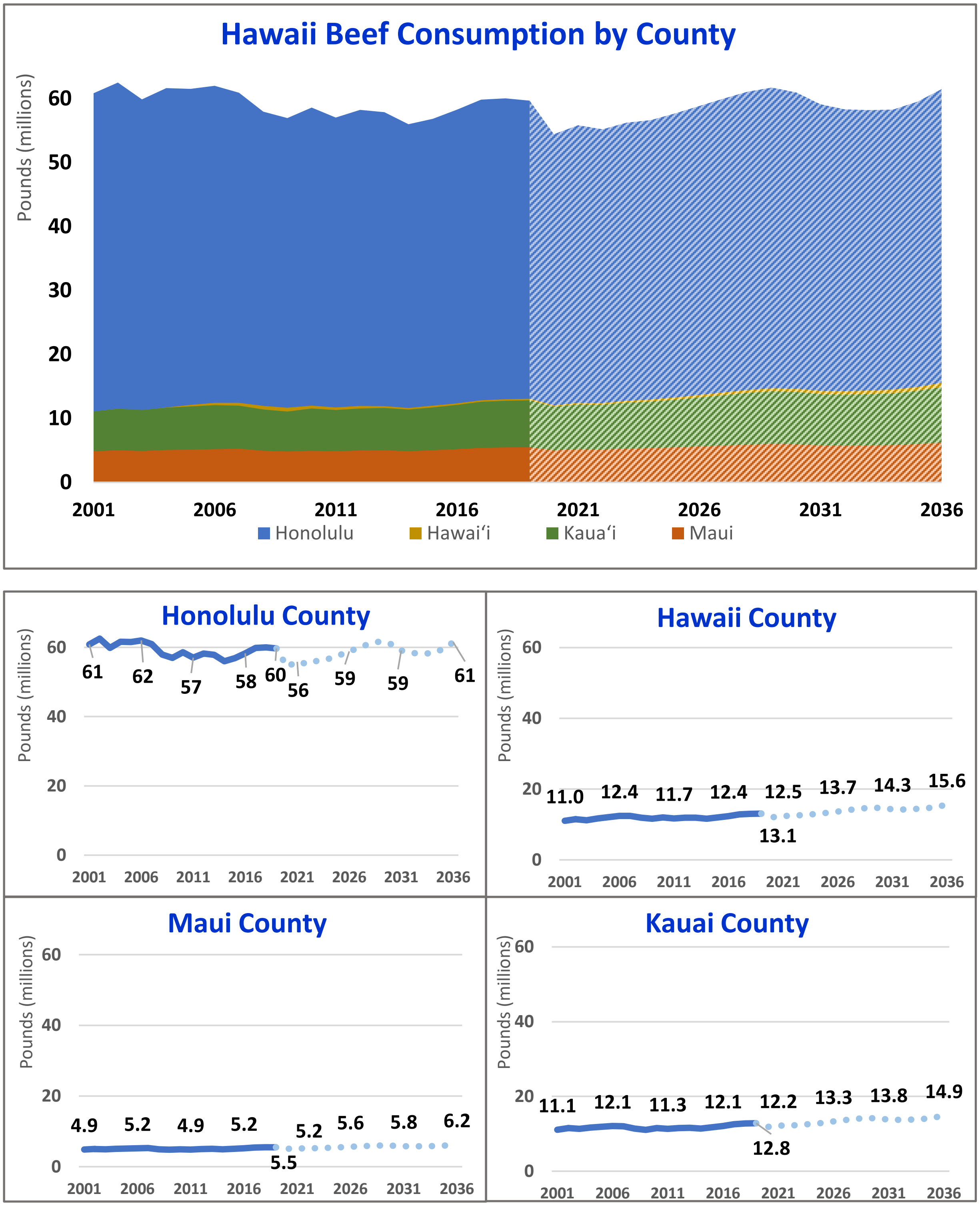
		Honolulu County		Hawaiʻi County		Maui County		Kauaʻi County		State of Hawaiʻi	
	Year	*De facto* Population (Persons)	Beef Consumption (Pounds)	*De facto* Population (Persons)	Beef Consumption (Pounds)	*De facto* Population (Persons)	Beef Consumption (Pounds)	*De facto* Population (Persons)	Beef Consumption (Pounds)	*De facto* Population (Persons)	Beef Consumption (Pounds)
Historical	**2001**	921,418	60,853,346	167,170	11,040,456	167,880	11,087,341	73,518	4,855,329	1,329,986	87,836,471
	2006	944,318	62,023,699	189,379	12,438,592	183,730	12,067,565	78,957	5,185,974	1,396,384	91,715,830
	2011	1,001,509	57,022,384	205,716	11,712,742	198,870	11,322,955	85,195	4,850,702	1,491,290	84,908,783
	2016	1,048,304	58,285,697	222,345	12,362,370	217,922	12,116,439	93,571	5,202,547	1,582,141	87,967,053
Projection	**2021**	1,006,086	55,837,794	224,360	12,452,006	219,930	12,206,141	93,567	5,192,973	1,543,944	85,688,915
	2026	1,060,276	58,845,345	246,446	13,677,751	239,446	13,289,269	101,126	5,612,505	1,647,295	91,424,869
	2031	1,078,175	59,107,654	261,421	14,331,628	251,904	13,809,889	105,724	5,796,024	1,697,271	93,047,719
	2036	1,090,619	61,493,753	276,116	15,568,566	263,878	14,878,567	110,198	6,213,431	1,740,858	98,156,977

Source: USDA Agricultural Projections to 2029; DBEDT State Databook 2019; DBEDT Population and Economic Projections for the State of Hawaiʻi to 2045; SMS Estimates.

The overall beef consumption for Honolulu county was estimated at 60.9 million pounds in 2001 and 59.7 million pounds in 2019, a decrease of 1.9 percent. The slight decrease in consumption was due to the declining population over the past two years. Honolulu county is the most populous county in the state, and it accounts for 60 percent of the *de facto* population of the State. The pandemic is expected to cause a significant drop in *de facto* population in Honolulu County from 1.05 million persons in 2019 to 944,488 persons in 2020. The corresponding beef consumption will likely decline from 59.7 million pounds to 54.4 million pounds. Honolulu beef consumption is not expected to recover to pre-pandemic levels until 2027 at 60 million pounds as the *de facto* population and lower per capita consumption slowly recovers. By 2036, the beef consumption in Honolulu is only expected to reach 61.5 million pounds. The *de facto* population growth rate was taken from the DBEDT long-range population and economic projections to 2045.

The overall beef consumption for Hawaiʻi, Maui, and Kauaʻi counties were estimated at 13.1 million pounds, 12.8 million pounds, and 5.5 million pounds in 2019, respectively. Their overall beef consumption has been increasing steadily since 2001 as the *de facto* population increased. Compared to Honolulu county, the decline in *de facto* population due the pandemic is not as substantial in these three counties. In 2020, the overall beef consumption is estimated at 12 million pounds for Hawaiʻi county, 11.8 million pounds for Maui county, and 5 million pounds for Kauaʻi county. According to the DBEDT's projections, the resident population will continue to increase for all four counties in the future, despite that Honolulu county had declining population for two consecutive years in 2018 and 2019. Visitors are also expected to recover when COVID-19 alleviates and when the global tourism are fully reopened. The population increase and non-decreasing per capita beef consumption will lead to increase in overall beef consumption. Therefore, by 2036, the overall beef consumption is expected to increase to 15.6 million pounds, 14.9 million pounds, and 6.2 million pounds for Hawaiʻi county, Maui county, and Kauaʻi county, respectively. Figure 3 provides the trends of the overall historical and projected beef consumption by county for 2001 to 2036.

Figure 4. Overall Beef Consumption by County in Pounds, 2001 to 2036

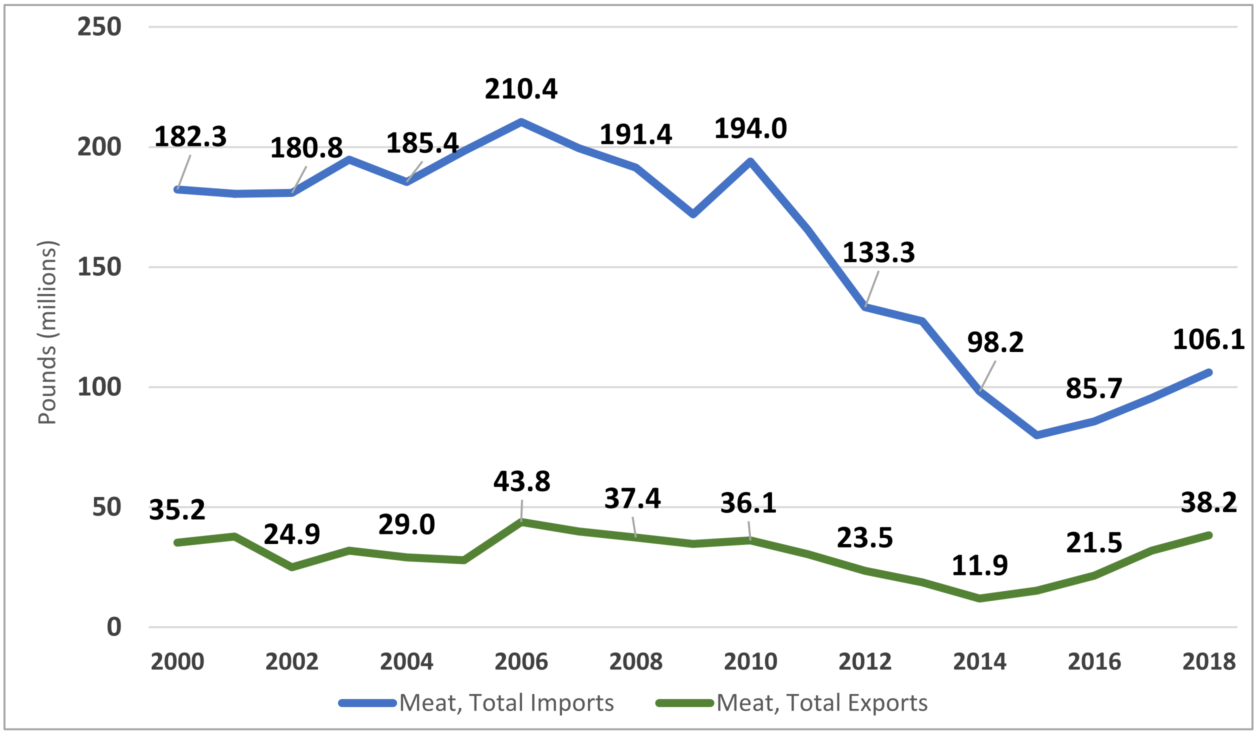


Source: USDA Agricultural Projections to 2029; DBEDT State Databook 2019; DBEDT Population and Economic Projections for the State of Hawai'i to 2045; SMS Estimates.

ANNUAL IMPORTS, 2001-2036

The initial import and export data we acquired from the US Army Corps of Engineers is shown in Figure 5 below. These import and export data represent fresh, frozen, and prepared meat products imported to and exported from Hawai‘i. There are two fundamental concerns regarding these data specifically for this analysis: (1) USACE does not distinguish between types of meats (beef, pork, poultry, etc.), and (2) the substantial decline in import between 2010 and 2015 did not appear to be entirely representative of the supply of meat in Hawai‘i. The U.S. Census, on the other hand, does provide data on imports, but the aggregate total appears to be far lower than what we expected in the local meat market.

Figure 5. Imports and Exports of All Meats, according to USACE, 2000 to 2018



Source: USACE Waterborne Commerce Statistics Center.

The distinct drop in meat import volume after 2011 is the primary concern. According to the data, Hawai‘i's meat imports had dropped by 59 percent between 2010 and 2015. This is not, however, consistent with the knowledge of local retail and wholesale markets consultants as they did not see similar decline in their meat supplies between those years. Inquiries were made to USACE regarding this concern. Unfortunately, no further clarification was available.

Additionally, the USACE does not report different types of meat separately (ex: beef, pork, poultry, etc.). The aggregate import data makes it impossible to identify the volume of import for each type of meat. Although the import data from the U.S. Census is broken down by Harmonized System Code and North American Industry Classification System Code—two systems for classifying trade commodities, the data is inconsistent with other findings. Similar to the USACE data, there is a 53 percent drop in “Meat of Bovine Animals, Boneless” category between 2017 and 2018. Additionally, the figures prior to 2017 are about half of what we expect from our estimates described below.

In a study conducted by UH CTAHR, the researchers utilized import, export, and local production data to estimate Hawai'i's food consumption[16] (see Figure 6 below). Our initial strategy was to borrow the same concept and apply it to the beef consumption. However, from the USACE and Census data, it is understood that this is not possible based on the issues described above. We therefore reversed the equation below and utilized our estimates of total beef consumption to subtract the local production and export obtained from the USDA. It should be noted that the beef export data were measured in monetary unit and required some price per unit conversions prior to being used.

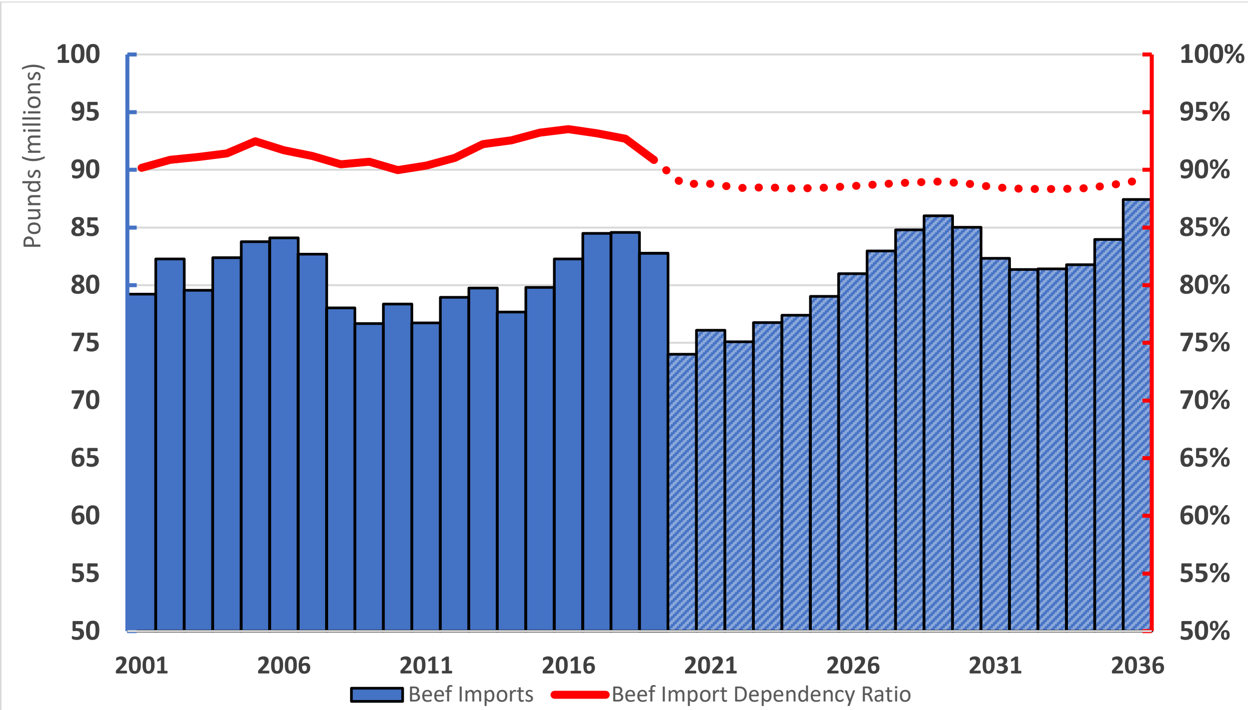
Figure 6. Formula for "Total Food Supply Available in Local Market for Consumption"

Source: "Hawai'i's food consumption and supply sources: benchmark estimates and measurement issues", Loke and Leung, 2013

The data resulting from this analysis are shown below in Figure 7. Beef import dependency ratio (IDR) is the proportion of Hawai'i's consumed beef that is imported. As IDR decreases, beef sustainability and independence increase. Throughout the 21st century, beef IDR has been stable between 90 percent and 95 percent, approximately 5 percent to 10 percent of beef consumed is produced locally. As beef consumption decreases and local slaughter increases through 2020, Hawai'i's dependency on beef imports is expected to decrease to around 88%. As the local cattle companies continue to put effort into increasing local beef production, Hawai'i's beef IDR is expected to stabilize between 85 percent and 90 percent along with the increasing consumption through the next two decades.

[16] Hawai'i's food consumption and supply sources: benchmark estimates and measurement issues. Loke and Leung, 2013.

Figure 7. Estimated Beef Imports, 2001 to 2036

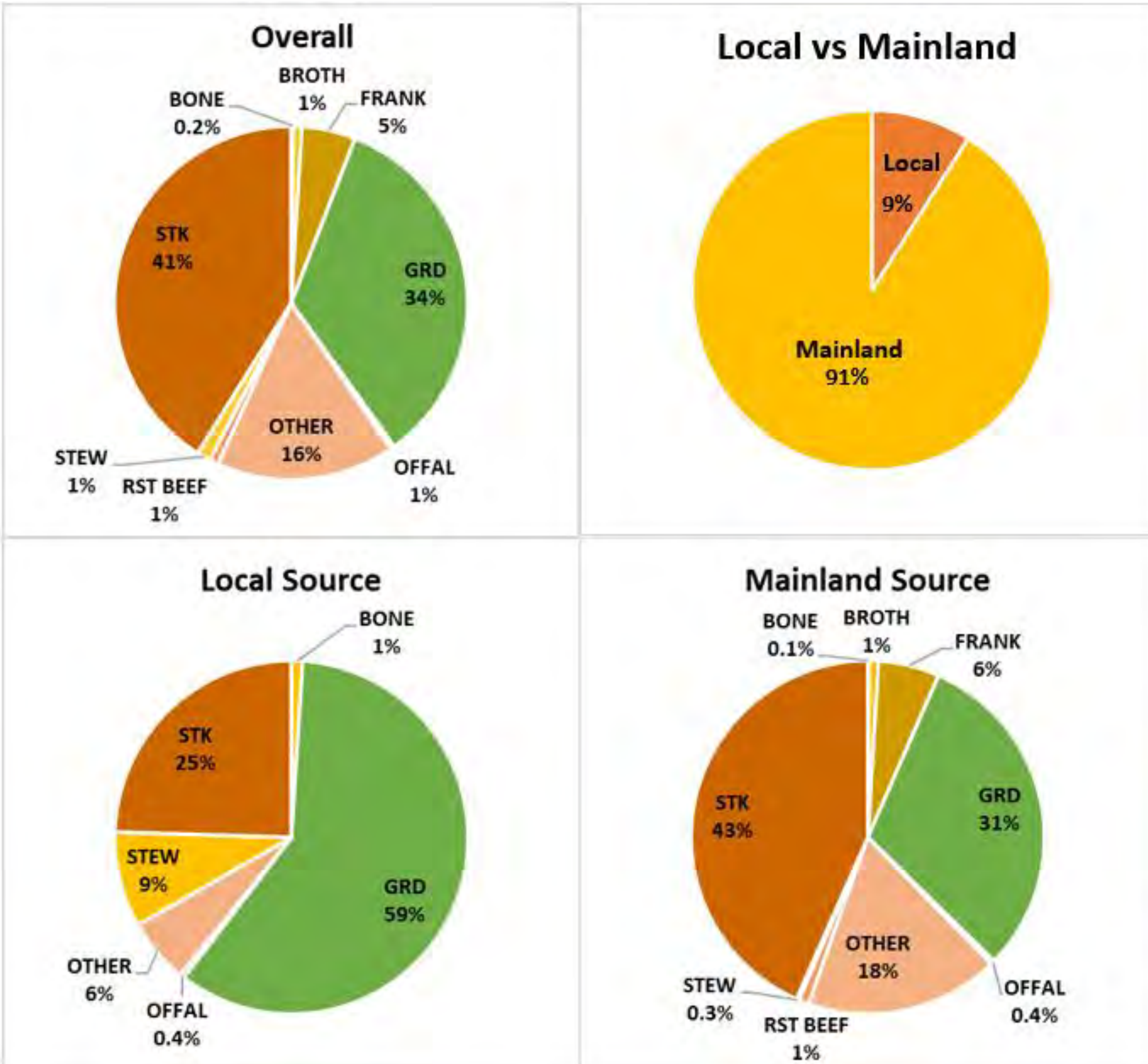


Source: USDA, ERS, FAS, GATS, NASS; SMS Estimates.

CONSUMPTION BY TYPE OF BEEF

This section covers the distribution of different beef cuts consumed. The following data were provided by two distributors who requested confidentiality. Their share in the market is sufficiently large such that SMS believes the distributors' sales distribution by cut is representative of the Hawai'i beef market as a whole. Despite our confidence in the representation of these data, we do not have a market share estimate accurate enough to upscale to the whole market. The consumption estimates found by extrapolating USDA data is within the range resultant from extrapolating using these distributors' market share. Additionally, providing an exact market share of these distributors would break confidentiality agreements.

Figure 8. Cuts of Beef in the Market, Local vs Mainland sources



Source: Local food distributors, USDA, SMS Estimates

The current beef retail market in Hawai'i is dominated by various steak cuts (41%)—such as loin, brisket, and ribs—and ground beef (34%) for various usages including beef patties. Beef franks, broths, stews, offal, bones, and roast beef are all very small portions of Hawai'i's retail beef market. Sixteen percent (16%) of products sold could not be partitioned into the aforementioned categories.

More telling for our local industry, however, are the usages of locally produced beef. A major hurdle the local beef industry is working to overcome is the quality of grass-fed beef. Because of the high cost of importing feed for raising cattle, ninety-four percent (94%) of all locally produced beef is on an all-forage diet. Although raising cattle on natural grass pastures has its advantages, its biggest downfall is the substantial increase in time it takes to grow a cattle to maturity, which results in a beef cut that is more tough than the current market's preference for tender beef cuts. As a result, fifty-nine percent (59%) of the locally produced beef is mixed with more fatty undesirable parts to make ground beef. Tougher meat becomes more tender when boiled or cooked for a longer duration, so at least nine percent (9%) of locally produced beef is sold as stew meat.

The figures for mainland-sourced beef are very similar to the overall figures, as only 9 percent of beef consumed in Hawai'i is produced in Hawai'i. This set of proprietary data is likely more reliant on local production because these particular distributors supply beef and pork to the DOE, who are making efforts to source more and more of their meats locally.

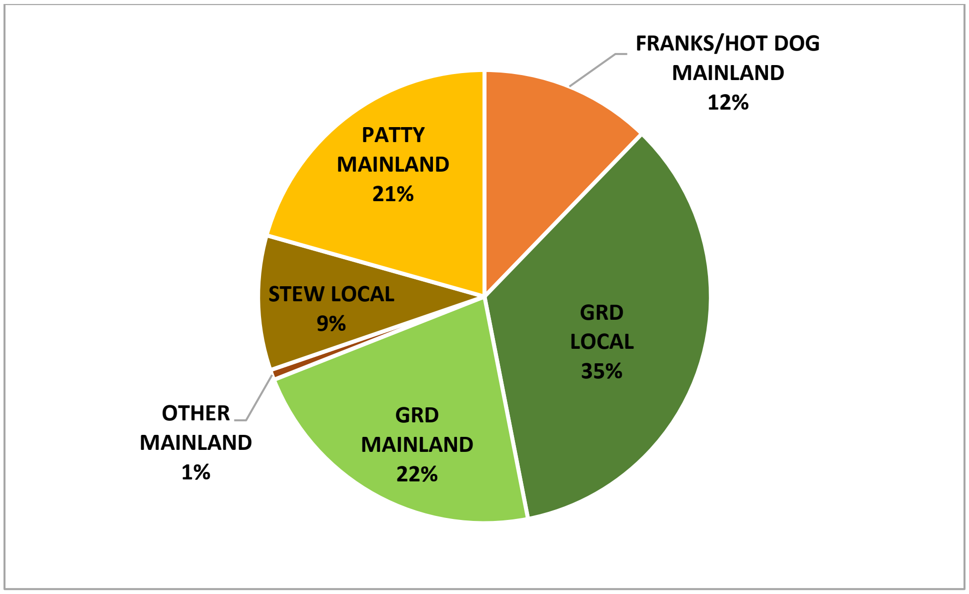
DEPARTMENT OF EDUCATION ANNUAL PURCHASES

This section covers the beef purchasing patterns of the Hawai'i Department of Education. The topics of interest are purchases by type of beef, purchases by production source, and their overall goals to increase the proportion of meat they purchase from local producers.

As shown in Figure 9, the DoE purchased 1.4 million pounds of beef for 5.7 million dollars from our confidential distributors in 2019. Of the beef purchased, 57 percent was ground beef, and more than half of the ground beef was locally sourced.

In the same year, about 815,000 pounds of this beef (45%) was produced locally, and 1,025,000 pounds (55%) was imported from the mainland U.S. As expected, the DoE spent about 25 percent more per pound on locally produced beef than on its mainland counterpart. To quantify, they paid $4.23 per pound of local beef and $3.87 per pound of beef imported from the mainland U.S. Although the local beef is more expensive, it is not necessarily of better quality. As we can see by this analysis, local beef is not used for patties or sausages because as mentioned earlier, it is best used in a dish where flavor and texture are less important, like stews and chilis.

Figure 9. Distribution of Hawai‘i DOE Beef Purchases by Type, 2019



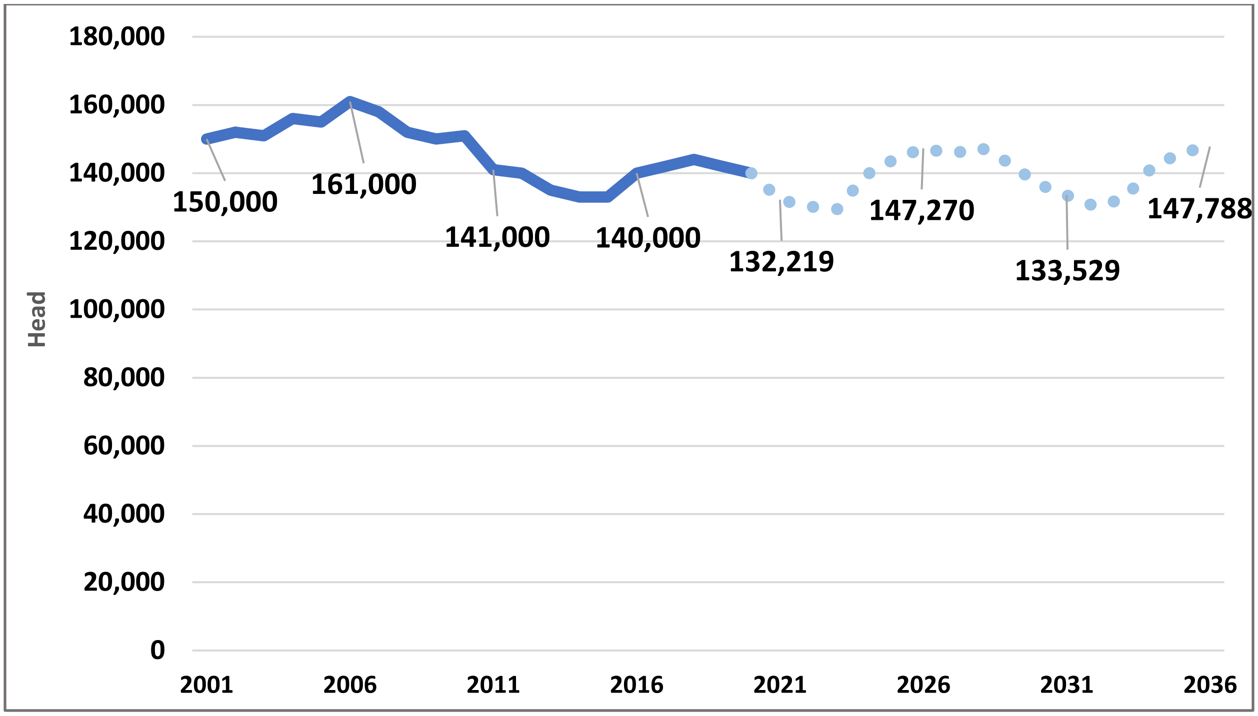
Source: Local food distributors.

In March 2019, with a staff of 45 people, the Kunoa Cattle Company announced a partnership to supply half the beef served in O‘ahu's 168 public schools following a January deal to supply Kaua‘i's 15 public schools with all their beef needs.

CATTLE INVENTORY AND USAGE

Understanding the destinations of our local cattle supply is crucial to understanding the local beef market. Of the 144,000 cattle in Hawai‘i in 2018, 40,683 calves and 232 mature cattle (28% in total) were exported to the mainland, and only 13,600 cattle (9.4%) were slaughtered locally. Since 2001, cattle export and slaughter as a percentage of inventory has remained fairly constant, with variations of up to 3 percent and 1 percent in either direction for export or slaughter, respectively. By this analysis, we find that Hawai‘i exports an average of four times as many cattle as it slaughters.

Figure 10. Inventory of Cattle in Hawai‘i, 2001 to 2036



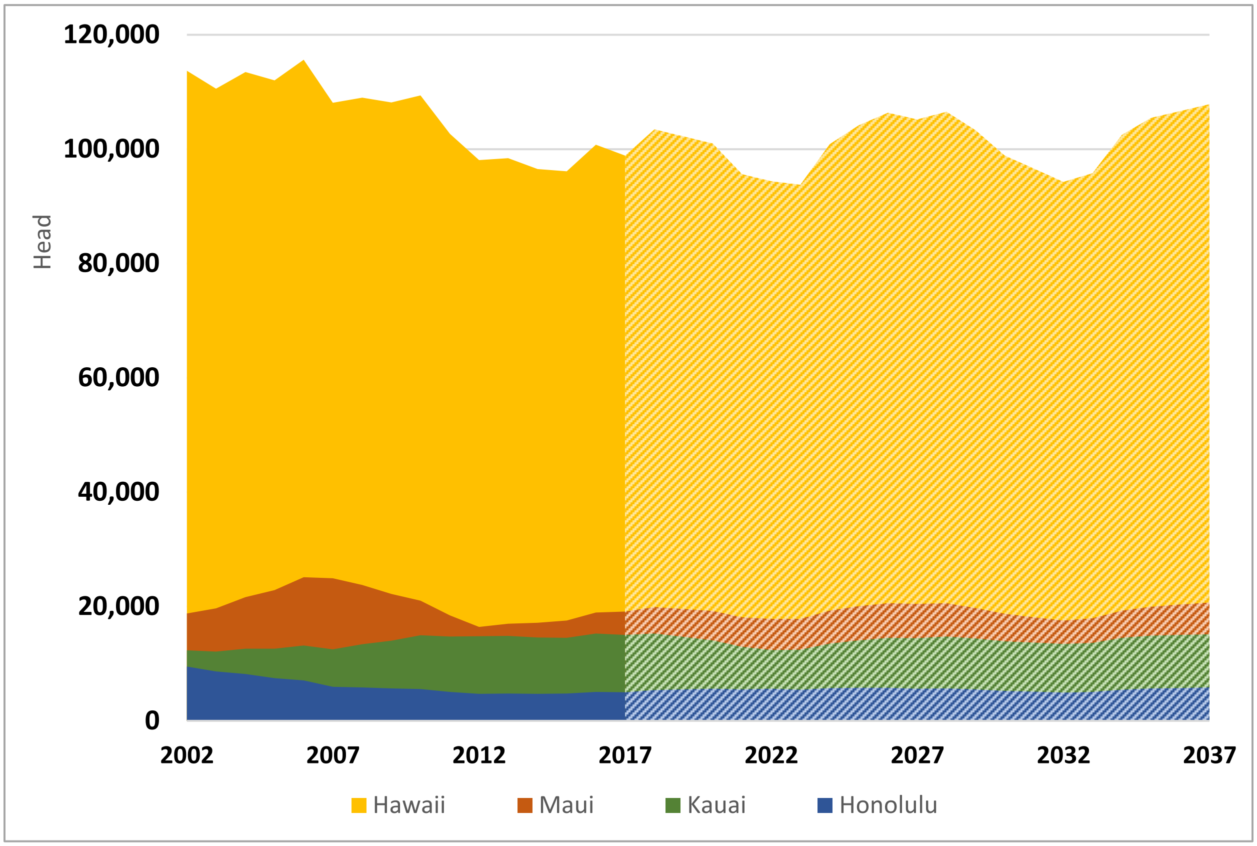
Source: USDA NASS, SMS Estimates.

Figure 10 shows the cattle inventory in Hawai‘i since 2001. While the inventory of cattle did not appear to vary significantly in the past 20 years, the figure does not reveal the whole story of the cattle industry in Hawai‘i. A longer series from 1961 to 2020 in the Appendix shows that the inventory of cattle once reached its maximum at 249,000 heads in 1970 has since declined to 140,000 heads in 2020 (-43.8%). The decline was continuous and did not show a clear sign for substantial recovery.

As will be discussed in the later section, the local slaughter exhibited a decreasing trend beginning in the late 1980’s. The decrease in cattle inventory was not a result of increasing local slaughter but an increase in exports of cattle and calves. The Hawai‘i’s cattle industry has shifted from locally grown and slaughtered to exporting cattle and calves and importing beef to support the local consumption. The reasons for the shift include, but are not limited to, the high cost of raising cattle in Hawai‘i due to its geographic location and the inability to sustain a long-term demand for locally grown cattle.

The cattle inventory for 2021 to 2036 is projected based on the trend and patterns of historical data with the perception of ranch owners about the future cattle industry. Overall, the cattle inventory for the next 15 years is expected to exhibit a slightly upward trend. The growth in cattle inventory is likely caused by the increased demand for locally grown beef from the Department of Education in Hawai‘i. In addition, some companies are putting effort into establishing locally grown beef as their own brands sold in stores and restaurant beginning in 2020. Increasing local production of beef implies less export of cattle and calves to the mainland for harvesting, which will increase the cattle inventory over years. The cattle inventory is expected to recover to 144,115 heads (+2.9%) and 147,788 heads (+5.6%) by 2025 and 2030, respectively.

Figure 11. Inventory of Cattle in Hawai'i by County, 2002 to 2036



Source: USDA NASS Census of Agriculture; SMS Estimates.

The USDA NASS Census of Agriculture conducts a census on agriculture and livestock at the state and county level every five years. That includes the inventory count of cattle. Data unavailable between two census years were interpolated assuming a linear relationship.

Figure 11 shows the historical and interpolated cattle inventory for Honolulu county, Hawai'i county, Kaua'i county, and Maui county. Of the four counties, Hawai'i county has consistently had the largest share of cattle inventory. Between 2002 and 2017, Hawai'i county's inventory of cattle were in the range of 98,000 to 114,000 heads. That was equivalent to 71.7 percent to 73.7 percent of the total cattle in the state. Hawai'i county has the largest share of cattle inventory because it has the largest proportion of pastureland in the state (62.9%). Detailed information about the pastureland will be discussed in the later section of this report.

The second largest inventory of cattle can be found in Maui county. It accounted for 12.2 percent to 16.5 percent of total cattle between 2002 and 2017. Maui county also has the second largest proportion of pastureland in the state (21.3%). Kaua'i county had 8 percent to 11 percent of the cattle inventory during the same period and Honolulu county consistently had the smallest share of the cattle inventory, accounting for 3.5 to 6.2 percent of total cattle in the state. This is not surprising since Honolulu is the most urbanized and developed county and its proportion of pastureland is the lowest among all four counties at 3.1%.

Besides Kaua‘i county, the remaining three counties all exhibited a downward trend between 2002 and 2017. The most noticeable decline in the cattle inventory took place between 2006 to 2013. According to the USDA and HDOA, lack of rainfall had led to prolonged drought conditions across the state. Little precipitation had reduced forage and pasture conditions, which in turn, increased the operating costs in feeding and watering cattle. Some ranchers in Hawai‘i county had to haul water to maintain the pastures and supplement feed for their cattle. Majority of the ranchers had faced a decline in the herd due to the persistent drought.

The projections of cattle inventory by counties are shown in the shaded area. Given the availability of pastureland in each county, it is expected that Hawai‘i county and Maui county will continue to dominate the inventory of cattle for the next 20 years. The increase in projected inventory due to the expected decrease in exports of cattle and calves will mostly take place in Hawai‘i county, Maui county, and Kaua‘i county.

CATTLE RANCH OPERATIONS

It is estimated that there are more than 150 operating cow ranchers in Hawai‘i. According to NASS (2017) Census data, almost 24 percent of cows in the state are on small ranches maintaining less than 100 cows each. Appendix B provides a representative list of ranchers by island.

Three ranchers on the Big Island control 60 percent of the cattle raised in Hawai‘i. The largest of the three large ranching operations is Parker Ranch established in 1847. Parker Ranch has 130,000-acres in the Waimea area of the island and raises 10,000 mother cows[17] that are bred twice a year on the Big Island and 26,000 head of cattle, mostly Angus and Charolais. They also have 100,000-acres on the mainland where they send their cows to finish in preparation for sale on the mainland. Following a successful grass-fed beef trial on Hawai‘i Island, Parker Ranch, and Ulupono Initiative announced the launch of the Paniolo Cattle Company, a joint venture aimed at a statewide local beef production in March 2014. Paniolo Cattle Company began with 1,400 head of cattle to be raised at Parker Ranch. This represented the largest commitment of grass-fed beef by a single ranch in the state and increased the supply of grass-fed steers to the beef market by nearly 35 percent. The Paniolo Cattle Company grass-fed beef can be found in island Safeway stores.

The second largest ranch is Ponoholo Ranch located on Kohala Mountain on the Big Island. This 11,000-acre cattle ranch covers three climate zones and stretches from the rainforest at 4,800

[17] The mother cows, also known as brood cows, are retained on the farm for rearing calves rather than slaughtering. A brood cow is grown from a female calf known as heifer.

feet to the ocean. It has the second largest herd of cattle on the island, 6,000 to 8,000, after Parker Ranch. The ranch uses an intensive rotational grazing operation, which helps maximize nutritional opportunities for the cattle and reduces any damage such as erosion and overgrazing to the land. The cattle raised on the Ponoholo Ranch are sent to the mainland in livestock ships after they are weaned from their mothers. They are then trucked to pasture or to feed lots primarily in Texas, on pastures owned by Ponoholo.

The third largest ranch is Kahua Ranch, Ltd., which is home to a herd of cattle with 1,400 to 2,000 mother cows at any given time. Originally a Hereford breed-based herd, today Kahua is primarily Angus influenced with the use of Charolais as a terminal sire crossbred. Kahua Ranch has been breeding cattle for more than 85 years and has produced quality beef. Kahua Ranch is also home to 400 mother sheep or "ewes". A Merino-based flock originating in Niihau with Romney, Corriedale, Dorset, and most recently, Cooper influence. The sheep are used together with the cattle to graze and manage the lands. The meat production is all locally consumed in restaurant and retail sales; the wool is shorn and shipped to the mainland United States for woolen manufacturing.

ʻUlupalakua on Maui has 18,000-acres. Along with being conservationists, the Erdmans operate as a 2,300-head cattle ranch, and have also diversified with elk, lamb, and goat herds, a winery, a country store and grill, horseback rides, and clay shooting.

Sumner Erdman, ʻUlupalakua Ranch president and son of owner Pardee Erdman, has been stepping up the ranch's efforts to improve the genes of their herd in recent years. Though it is a constant work in progress, so far, his efforts have helped produce a cow that can withstand dry years and has an increased weight of 50 lbs.

The exported calves are shipped to a 2,800-acre ranch in Oregon also owned by ʻUlupalakua Ranch. ʻUlupalakua Ranch has 2,300 mother cows. A majority of the remaining calves are shipped to the 2,800-acre, ʻUlupalakua Ranch-owned White Deer Ranch in Crook County, Oregon. Those calves are grown out with other purchased stockers and then custom fed in the Northwest before being sold to a packing operation.

In 2018 a survey was undertaken among 140 ranchers (producers) by Elsevier, Inc. on behalf of the American Registry of Professional Animal Scientists (http://creativecommons.org/licenses/by-nc-nd/3.0/). Forty percent (40%) of recipients completed the survey that includes 56 ranchers representing an estimated 44 percent of cows raised in Hawaiʻi. The ranchers were distributed as follows:

Island of Hawaiʻi	48%
Maui	21%
Kauaʻi	18%
Oʻahu	13%

The study estimated individual ranch herd sizes ranging from 5 to 10,000 cows, with a mean of 588 head and a median of 150 head of cows.

Mean Number of Head Count of Herds by County

Island of Hawai‘i	828 mother cows
Maui	438 mother cows
Kaua‘i	390 mother cows
O‘ahu	136 mother cows

Other facts gained from the study:

- When calves were maintained through a stocker phase, they were sold at 7 to 24 months of age. Cattle finished in the state were sold at an age of 27.5 ± 5.2 months, weighing 1095 ± 114 pounds. These were slaughtered for local consumption.
- Overall, about 94% of all cattle reported to be finished in the state were fed an all-forage diet.
- Use of growth implants or other growth promoting treatments were not reported by responding cattle producers.
- Purchased feed supplements were used by 83% of responding ranches (Table 1). Of these, 84% used minerals (including salt and sulfur), and 23% were molasses-based energy and mineral supplements. Protein supplement purchases were reported by just 2% of responding ranches. Almost all supplementary feeds used by a majority of ranches were purchased within the state from feed stores.
- Annual labor requirements for feeding and managing animals varied widely from 0.5 to 173 person-h/animal with a mean of 19.1 person-h/animal
- Forty percent of the ranches surveyed reported a dressing percentage, a measure of carcass yield, between 50 to 60%, whereas about 17% reported a higher range of 60 to 65%. The national industry dressing percentage at slaughter averages 62% for finished cattle and may range between 40 and 60% for culled cows and bulls (Gill, 1998; NCBA, 2014a).
- Although almost half (47%) of the ranchers used more than one marketing channel, a considerable portion of survey participants in the County of Hawai‘i (43%) marketed directly to distributors or wholesalers compared with 21 and 16% who sold directly to consumers and retailers, respectively.
- Most the ranches (91%) reported shipping their cattle over 80 km to slaughter facilities. This would include those cattle transported over sea or by air to be finished on the mainland.
- A large portion of ranches (39%, n = 38) marketed their beef under a certified grass-fed label, with some ranches indicating more than one certification. Of this number, 20% marketed under the USDA Certified Grass-Fed Beef or the American Grass-Fed Association.

PASTURE CAPACITY AND LOCAL CATTLE GROWTH

This section covers the local cattle raising industry. The data discussed in this section was acquired from the 2012 and 2017 USDA NASS census. For the purposes of this section, a “rancher” is a farm that owns cattle—they do not necessarily sell the cattle.

In 2017, there were 1,218 cattle ranchers in Hawai‘i—847 in Hawai‘i County, 46 in Honolulu County, 193 in Maui County, and 132 in Kaua‘i County. From 2012 to 2017, Hawai‘i County lost 70 ranchers while the other three counties lost a combined 26. Clearly, there is plenty of volatility in Hawaiʻi's cattle industry. Although there are fewer ranchers than before, the combined cattle and calf inventory grew from 134,000 in 2012 to 138,000 in 2017[18].

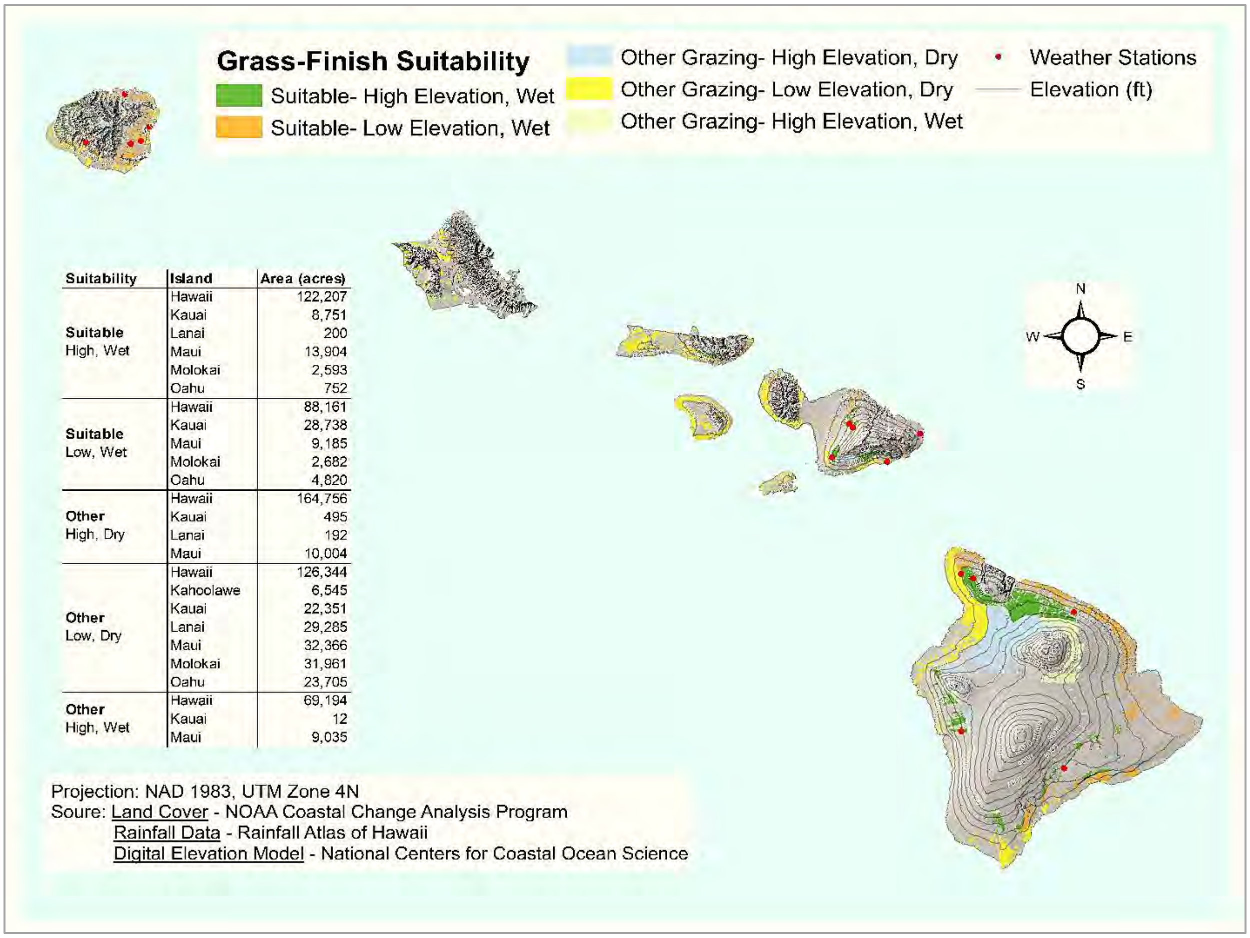
Crucial for understanding the possibility of expanding the local beef industry is knowing the limit of our resources. In a series of studies by UH CTAHR, Fukumoto et al. examine the suitability of Hawaiʻi's geography for forage-finished beef production. Figure 11b shows the five types of pasture suitable for cattle grazing and their areas on each of the islands. In aggregate, there are 808,238 acres throughout the state, or 11.6 percent of the total land area, that may be suitable for grazing[19]. According to the study, although some pastures might require the development of irrigation, application of fertilizers, and/or incorporation of improved varieties of *Leucaena* and other improved forages.

In 2017, the USDA reported 760,686 acres of pastureland in Hawaiʻi—close to the theoretical maximum. This is because ranches throughout the state—Haleakalā Ranch on Maui, for example—use swaths of land that are not identified as appropriate for cattle grazing. This means that there is a higher capacity than what UH CTAHR might show and that not all land deemed viable could be realistically acquired for this use from the various large landowners like Kamehameha Schools and the DLNR. At the same time, maximizing any land for cattle is a difficult balance of "genetics, forage quantity, forage quality, age of animal at slaughter, and climatic conditions". Maintaining this amount of pastureland also requires careful and active herd management by ranchers.

Because of the quality and variety of grasses and legumes that grow in these microbiomes, each type of pasture can accommodate a different number of cattle per acre. Figure 11b presents the geographic clusters and the total number of acres for different types of pasturelands across islands. If we divide the acres of pasturelands by the number of cattle, each cow may take approximately 5 acres of pasturelands. However, indication from the cattle industry suggests that the potential range is around 3 to 4 acres per cow. For the sake of this analysis, we will use these ratios as high and low estimate to calculate the possible cattle capacity in Hawaiʻi.

[18] USDA Census of Agriculture, 2017 State and County Profiles – Hawaiʻi
[19] Fukumoto et al, UH CTAHR, 2015

Figure 11b. Distribution of Hawai‘i Pastureland by Type



Source: University of Hawai‘i, College of Tropical Agriculture and Human Resources

Table 2 summarizes the estimated cattle capacity by islands. We estimate that Hawai‘i can accommodate a range of 202,000 to 269,000 cattle based on the reported acres of pasturelands. Approximately 71 percent of cattle will be on the Island of Hawai‘i. According to the series of studies by UH CTAHR, not all pasturelands are suitable for producing high-quality forage-finished beef. Fukumoto et al. classified pasturelands into suitability zones by elevation and amount of annual rainfall. The suitable pasturelands only account for 18.4 percent of the total pasturelands. We estimate that these suitable pasturelands can produce between 18,000 to 23,000 heads of high-quality forage-finished beef cattle each year. As stated by Fukumoto et al, management of forage and inventory is a very complex science, and if done incorrectly, can lead to less-than-ideal production volume. It should also be noted that there is a possibility in which the capacity can increase. In that circumstance, ranchers will need more resources on water and labor to accommodate for more cattle capacity.

Table 2. Estimated Cattle Capacity by Pasture Type and Island

Island	Pasture Type	Area (acres)	Estimated cattle capacity High estimate	Low estimate
Hawaii	**Suitable** High, Wet	122,207	40,736	30,552
	Suitable Low, Wet	88,161	29,387	22,040
	Other High, Dry	164,756	54,919	41,189
	Other Low, Dry	126,344	42,115	31,586
	Other High, Wet	69,194	23,065	17,299
	Total	**570,662**	**190,221**	**142,666**
Kauai	**Suitable** High, Wet	8,751	2,917	2,188
	Suitable Low, Wet	28,738	9,579	7,185
	Other High, Dry	495	165	124
	Other Low, Dry	22,351	7,450	5,588
	Other High, Wet	12	4	3
	Total	**60,347**	**20,116**	**15,087**
Lanai	**Suitable** High, Wet	200	67	50
	Suitable Low, Wet	0	0	0
	Other High, Dry	192	64	48
	Other Low, Dry	29,285	9,762	7,321
	Other High, Wet	0	0	0
	Total	**29,677**	**9,892**	**7,419**
Maui	**Suitable** High, Wet	13,904	4,635	3,476
	Suitable Low, Wet	9,185	3,062	2,296
	Other High, Dry	10,004	3,335	2,501
	Other Low, Dry	32,366	10,789	8,092
	Other High, Wet	9,035	3,012	2,259
	Total	**74,494**	**24,831**	**18,624**
Molokai	**Suitable** High, Wet	2,593	864	648
	Suitable Low, Wet	2,682	894	671
	Other High, Dry	0	0	0
	Other Low, Dry	31,961	10,654	7,990
	Other High, Wet	0	0	0
	Total	**37,236**	**12,412**	**9,309**
Oahu	**Suitable** High, Wet	752	251	188
	Suitable Low, Wet	4,820	1,607	1,205
	Other High, Dry	0	0	0
	Other Low, Dry	23,705	7,902	5,926
	Other High, Wet	0	0	0
	Total	**29,277**	**9,759**	**7,319**
Kahoolawe	**Suitable** High, Wet	0	0	0
	Suitable Low, Wet	0	0	0
	Other High, Dry	0	0	0
	Other Low, Dry	6,545	2,182	1,636
	Other High, Wet	0	0	0
	Total	**6,545**	**2,182**	**1,636**
State	**Suitable** High, Wet	148,407	49,469	37,102
	Suitable Low, Wet	133,586	44,529	33,397
	Other High, Dry	175,447	58,482	43,862
	Other Low, Dry	272,557	90,852	68,139
	Other High, Wet	78,241	26,080	19,560
	Total	**808,238**	**269,413**	**202,060**

Source: University of Hawaiʻi, College of Tropical Agriculture and Human Resources.
SMS Estimates.

Assuming an average live weight of 1,095 pounds per head and an average dressing percentage of 56 percent[20], which yields 613 pounds per head, Hawai‘i is capable of producing 123.9 to 165.2 million pounds of beef. This is 1.4 to 1.8 times more than Hawai‘i’s total beef consumption in 2019. Assuming maximal efficiency of lands, if we stopped exporting cattle, only 55.1 to 73.5 percent of viable pasturelands needs to be acquired to fulfill Hawai‘i’s beef need. Although we possess the necessary land to raise enough cattle to feed Hawai‘i, there are some other limitations and constrains that may pose challenges to the cattle raising in Hawai‘i.

LIMITATIONS, CONSTRAINS, AND POST-SLAUGHTER ISSUES

In this section, we will discuss some of the major limitations, constrains, and post-slaughter issues that may emerge should the cattle raising expand in Hawai‘i. These issues include the volatility of grazing lands, Hawai‘i ranchers’ cost of production, utilization rate of slaughter facility, limited storage capacity, disposal of inedible parts and waste management, and transportation.

Limitations on Grazing Lands

Hawai‘i certainly possess the necessary land for cattle raising, but the condition of grazing lands is precisely the primary key factor that maintains the sustainability of the industry. The grazing lands are extremely volatile and vulnerable in the sense that, the quality and quantity of forage growth on grazing lands are highly subject to climatic factors such as solar radiation, temperatures, and precipitation[21]. All these climatic factors are uncontrollable by the ranchers. This implies that any short-term climate fluctuations or climate change will significantly influence the forage growth cycle and thereby affecting the forage supply. A study conducted by the Nature Climate Change suggests that areas that are more climatically stable have the highest cattle densities. Nevertheless, it revealed that 49 percent of the total land area that were considered as pasture have experienced increases in precipitation variability between 1901 and 2014[22].

While the variability measure of Hawai‘i’s grazing lands is not available, the study provides a significant implication on cattle raising in Hawai‘i. If Hawai‘i were to shift part of the beef imports to raising and slaughtering cattle locally, then it will need to develop alternative plans in case of any climate fluctuations such as seasonal drought or deluge cycle. One possible plan could be the channeling or improvement of the irrigation and sewage system on the grazing lands. The consequences are that, these investments may incur considerable amount of building and maintenance costs, which will add to the ranchers’ cost of production that is already high. The beef industry in Hawai‘i is especially vulnerable to the condition of grazing lands compared to the mainland. When there is a climate fluctuation, the production and supply of local beef will likely be affected and may cause a shortage if the imports are not readily available.

Issues Faced by Hawai‘i Ranchers

Today, Hawai‘i imports nearly 90 percent of all beef consumed in the state from mainland or international markets. Conversely, Hawai‘i ranchers export about 80 percent of Hawai‘i' cattle to the mainland to be backgrounded, fed out, and slaughtered. There are reasons for this, the main one being a shift away from local feedlot beef production because of rising grain import costs in the 90’s. As the cost of importing grain increased, Hawai‘i beef producers began shipping wean-

[20] Schweihofer et al, Michigan State University Extension, 2013
[21] Fukumoto et al, UH CTAHR, 2015
[22] Sloat et al, “Increasing importance of precipitation variability on global livestock grazing lands”, 2018.

off calves to the mainland which was and remains less expensive. The consequence of the contraction of local finished beef animals was the closing of several slaughter plants across the state due to exports and less demand for the facilities. Few remain operational today. As a result, the “slaughter bottleneck” remains a major challenge to increasing local beef production.

Finishing in Hawaiʻi has become challenging due to limited feed availability, lack of auction markets, limited packing facility capacity, and high costs of production. No commercial feedlots solely finishing cattle on high concentrate diets were reported.

The increase in calves and cattle exports since the late 1980s had also led to the shutdown of the final feeding operation in Hawaiʻi. This is another chain effect of rising grain import costs. Ranchers who retain the feedlot beef production model had to bear the high grain import costs. Recently, the Hawaiʻi Pacific University’s Oceanic Institute (OI) has opened an innovative feed mill in Hilo intending to provide local farmers with cheaper animal feed through the donations of Ulupono Initiative, McInerny Foundation, and support from USDA, HDOA, and DLNR. The local production of corn and dairy allows ranchers to purchase feed and fodder locally without having to pay high costs to import feed from the mainland.

Another bottleneck is the means to finish beef animals. Importing grain into the state for feedlot finishing remains cost prohibitive. Consequently, grass-finish beef production for local slaughter is the only option. Finishing beef on grass; however, requires more pasture acreage and more time than finishing beef on concentrate feeds in a feedlot. If slaughter capacity is the primary limiting factor in the adoption of grass-finish beef production in Hawaiʻi, then pasture space is the next most limiting factor. For the industry to shift from its current model (shipping wean-off calves to the mainland) to retaining and finishing beef animals on grass, it will require reducing the current breeding herd by nearly half in order to provide adequate pasture space of sufficient quality to reach finish within 12-18 (24-30 months of age) months post wean. As mentioned earlier, Hawaiʻi does possess the necessary land to accommodate more cattle, the acquisition of those lands, however, may need to undergo a series of time-consuming and complex legal procedures, regulations, and environmental assessment. Moreover, additional development on those acquired lands may be needed prior to be used.

Adequate Qualified Butchers: There is an apparent shortage of qualified butchers and no local education is available.

Developing industry standards: For the industry to expand the grass-fed beef market in- or out-of-state, the industry needs to develop a program certifying its eating quality. Suggested certification criteria may include shear force, marbling score, and age verification to improve eating satisfaction of grass-fed beef. The certified beef probably can demand a premium price, and the certification program would serve as an effective marketing tool.

Limited Slaughter Operation and Storage Capacity

All slaughter operations are working below capacity, working only one shift per day. A large number are working at less than 30 percent capacity. A variety of reasons were brought forth regarding low-capacity usage.

- Lack of consistent and adequate market demand for locally grown beef. There was consensus among the managers that a more aggressive marketing effort to promote locally grown grass-fed beef is necessary.

- The unique and slightly tougher locally grown grass-fed cattle may also be limiting local demand for local beef.
- Lack adequate storage and processing capacity at slaughterhouse facilities.

Shifting the cattle exports back to retaining and slaughtering locally may overload the capacity of slaughter facilities and storage space rapidly despite they are currently underutilized. While there are no solid estimates on the storage capacity, we have learned that some slaughter facilities are underutilized because there is no sufficient storage space during our interviews with the industry experts. The closure of slaughter plants due to low demand in local slaughtering will squeeze all the operations to the facilities that remain opening. Once the slaughter facilities or storage reach the maximum capacity, the production of beef will be limited and so is the supply.

The beef industry is therefore, actively looking for opportunity to expand the harvest of market cattle[23] and not cull cattle[24]. According to the field expert, if the harvesting capacity is increased, exported cull cattle will most likely be harvested in Hawaiʻi.

Constrains on Disposal of Inedible Parts and Waste Management

The importance of inedible parts' disposal and proper waste management cannot be overstated. The waste disposal associated with manure, bedding, and contaminated runoff may pollute the nearby environment if handled improperly. The State of Hawaiʻi Department of Health (DOH) has set forth a detail guidelines for the livestock waste management[25]. According to the industry experts, the innards of slaughtered cattle are currently disposed by the operations in public landfills. The expansion of local cattle industry also implies a significant increase in the disposal of inedible parts as well as the waste. Whether the current waste management systems at the plants have adequate capacity to handle the amount of waste and ensure a satisfactory level of hygiene remain questionable.

Inter-Island Transportation

Inter-island transportation is a major issue for neighbor island slaughter operations. A majority of the cattle is grown on the Island of Hawaiʻi, yet the majority of consumers are on the Island of Oʻahu. Young Brothers transportation costs exclusively have been high, which limits sufficient return for neighbor island operations. Most recently, Young Brothers instituted rate increases that have made shipping even less viable.

There are also concerns about the reliability of transportation services, both in timing and refrigeration standards.

While there is potential for transporting cattle across islands through air cargo, it is unlikely an efficient and economical solution for ranchers. Commonly, time-sensitive, perishable, or high-value cargo is transported by air. Transporting cattle by air will require higher freight costs than by ship as the transportation time is shorter and the number of cattle that can be shipped each time is significantly limited. This leads to higher input costs borne by ranchers, which in turn, shifts the costs onto the operations of slaughterhouses and local consumers. The availability of planes could also be an issue because ranchers are unlikely to afford to charter a plane strictly for

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23 Market cattle refer to cattle that are under 30 months of age.

24 Cull cattle refer to cattle that are segregated from the rest of the cattle group due to possessing undesirable characteristics, diseases, genetics, or beyond efficient use. They are usually harvested for ground meat.

25 Appendix for Livestock Waste Management, State of Hawaiʻi Department of Health, 2010.

transporting cattle. During the holiday seasons, ranchers might not be able to schedule for shipment when the freight volume is high[26].

LOCAL SLAUGHTER INDUSTRY

Slaughterhouses were initially developed as a necessary service by ranch owners to provide a distribution channel for their ranch-grown livestock. A slaughterhouse on the Big Island has been in operation since the 1800's when the cattle ranch was started as a necessary service. Other slaughterhouse operations started more recently and though slaughterhouses today continue to provide traditional services, many have also developed into marketing and distribution centers of livestock products. Some of the major slaughterhouses purchase livestock products from ranchers and develop their unique retail distribution channels and brand names.

There are 13 slaughter facilities in Hawai'i. They are distributed as follows by island:

Slaughterhouses by Island	
Island	Number of operations
O'ahu	1
Maui	2
Hawai'i Island	4
Kaua'i	5
Molokai	1

This chart is based on the personal interviews conducted by SMS. Not all facilities were interviewed. The slaughterhouses that were interviewed include:

Island	Operation	Year Built
Kaua'i	Makaweli Meat Company	1988
Kaua'i	Andrades Slaughterhouse and Cattle Company	1900
Maui	Maui Cattle Co.	2002
Molokai	Molokai Livestock Cooperative	2006
Hawai'i Island	Mobile Slaughterhouse- Hawai'i Island Meat Cooperative	2014
Hawai'i Island	Hawai'i Beef Producers	1985
O'ahu	Hawai'i Meats	2004

Compared to the distribution of ranches, the distribution of the operations is not ideal. The O'ahu facility is large and is currently underutilized due to lack of large ranches on the island. The Big Island has one large and two smaller facilities that are also underutilized, not due to lack of adequate livestock, but due to lack of storage capacity at the slaughter facilities.

SMS professionals undertook in-depth personal interviews with the owners/managers of the top nine slaughterhouse operations in Hawai'i. The interviews were with facilities on all islands, including the smaller islands such as Molokai. The introductory e-mail and survey utilized can be reviewed as Appendix A.

All Hawai'i-based slaughterhouses are USDA Certified. Only one slaughterhouse located on the Island of Hawai'i is BRC (British Retail Consortium) and OSHA certified. An additional slaughterhouse on O'ahu is currently in the process of undergoing BRC certification.

[26] Wyatt Bechtel, Shipping Cattle to the Mainland.

The number of livestock animals slaughtered in Hawai‘i is small.

Estimates provided by 9 operations			Estimated total slaughter in the whole market
	Monthly	Annual	Annual
Cows	1,036	12,432	13,813
Calves	0	-	-
Bulls	0	-	-
Hogs	151	1,812	2,013
Deer	2	24	27
Sheep	25	300	333
Lamb	4	50	56

To maintain operations confidentiality, SMS cannot report the slaughter data by operation. However, the range of cows slaughtered as an example ranges from 12 cows per annum to 5,280 cows per annum. Same applies to all other animals.

There is a Big Island slaughterhouse that slaughters for only three ranchers.

Maui Cattle Company slaughterhouse on Maui is owned by Mahi Pono Haleakala Ranch, Ulupalakua Ranch, Nobriga Ranch, Kaupo Ranch, and Hana Ranch, and is exclusively utilized in slaughtering their livestock.

LOCALLY SLAUGHTERED, 2001-2036

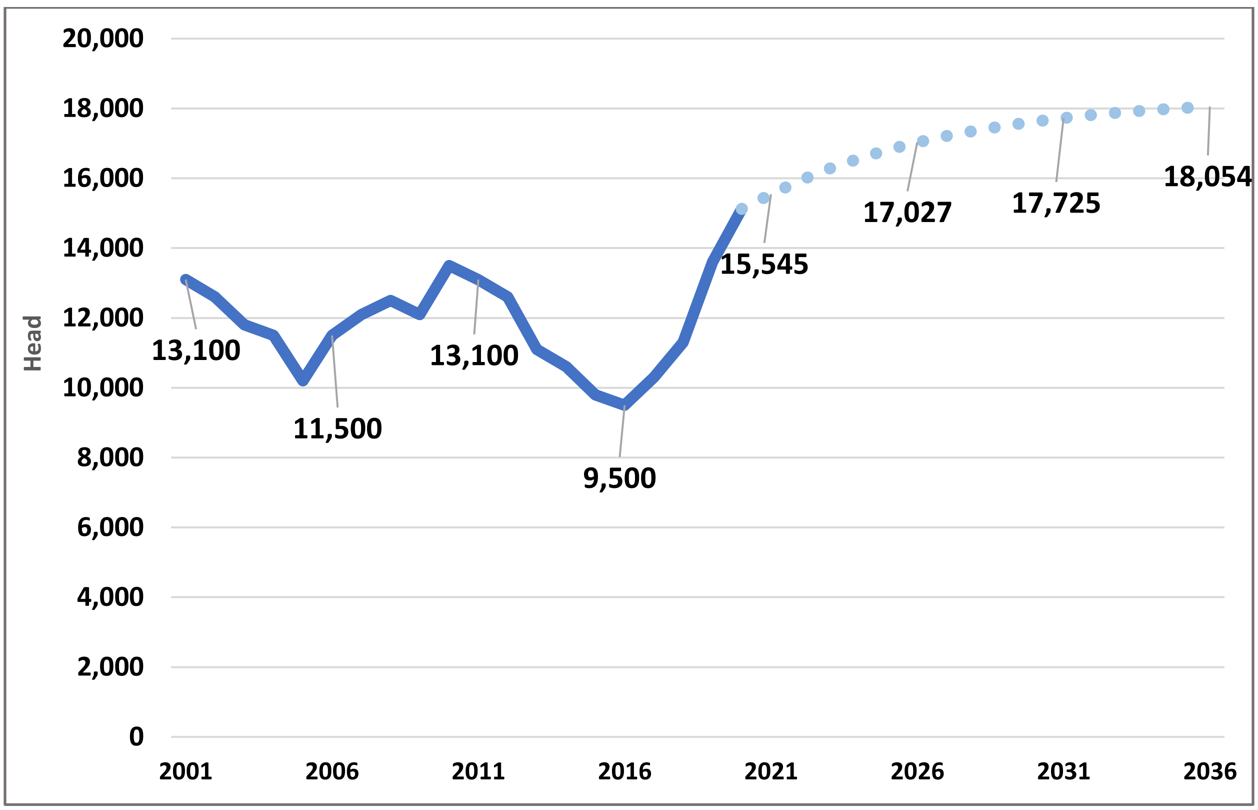
Although slaughterhouses are currently underutilized due to the reasons described above, Hawai‘i does slaughter thousands of cattle annually to support the local beef market. According to the USDA, the slaughter operation can be divided into three types: (1) commercial slaughter, (2) on-farm slaughter for home consumption, and (3) non-federally inspected farm slaughter. Based on the USDA’s definitions,

(1) Commercial slaughter includes slaughter in federally inspected (FI) plants in compliance with USDA standards,

(2) On-farm slaughter for home consumption includes animals slaughtered on farms for home consumption. It excludes custom slaughter for farmers at commercial establishments but includes mobile slaughtering on farms, and

(3) Non-federally inspected (NFI) farm slaughter includes slaughter in plants that are compliant with individual state standards.

Figure 12. Number of Cattle (Heads) Slaughtered Locally in Hawai‘i, 2001 to 2036



Source: USDA NASS, SMS Estimates.

The total number of cattle slaughtered in Hawai'i can be estimated by adding together (1), (2), and (3). The Federal Meat Inspection Act (FMIA) requires that all meat sold commercially must be inspected and passed the inspection in order to label as safe and wholesome.[27] The USDA, however, does not provide any data for the non-federally inspected farm slaughter. As such, we only consider federally inspected slaughter in this section. Our estimates for cattle slaughter will only be based on commercial slaughter and on-farm slaughter for home consumption.

Figure 12 shows the historical trend for the number of cattle slaughtered in Hawai'i from 2001 to 2019. According to the USDA, approximately 13,600 cattle[28] were slaughtered in 2019. Compared to 13,100 cattle in 2001, Hawai'i slaughtered only 3.8 percent more cattle in 2019. Of the 13,600 cattle that were slaughtered, 13,400 cattle (98.5%) belonged to commercial slaughter. The remaining 200 (1.5%) were slaughtered on-farm for home consumption. Since 2001, the number of cattle slaughtered has lied within the range of 9,500 to 13,600, which happened in 2016 and 2019, respectively.

While the trend in Figure 12 does not show much volatility, a further examination on a longer series shows a consistent decline in local cattle slaughter since around 1970. The additional figure with a longer series is available in the Appendix. In 1971, the number of locally slaughtered cattle was as high as 65,600 heads. Four decades later, it dropped significantly to 13,100 (-94.7%). The Hawai'i's cattle industry had shifted from local sales to mainland exports. According to Melrose and Delparte (2003), the shift began in the late 1980's and it was a result of shipping economics, transportation costs and the high price of grain.[29] The calves were exported to the mainland for finishing and sale because it cost more to ship the grain to Hawai'i for raising the calves than to ship them to the mainland. The high market demand in the mainland which led to higher cattle prices also incentivized local ranchers to export for more profitability.

When the local slaughter declined, the local production could no longer support the local demand, and Hawai'i consumers had to rely more on imported beef. Because the slaughterhouses currently only slaughter cattle at approximately 20.7 percent of what they used to process, the slaughterhouses are considered underutilized. It would be beneficial to help grow the local industry if more ranchers could process cattle locally rather than shipping calves to the mainland for harvesting.[30]

Figure 12 also provides the projections for number of cattle slaughtering from 2020 to 2036. Many Hawai'i ranchers are striving to expand the Hawai'i's homegrown beef supply in the local market. With more investment in the Honolulu slaughterhouse and the recent acquisition by Mahi Pono for capacity expansion[31], the number of cattle slaughtering will likely increase substantially. In 2025, the number of cattle slaughtering is expected to increase to about 16,812 heads, or 23 percent from 2019. In 2036, the cattle slaughtering is projected to reach 18,054 heads, an increase of 32.7 percent from 2019.

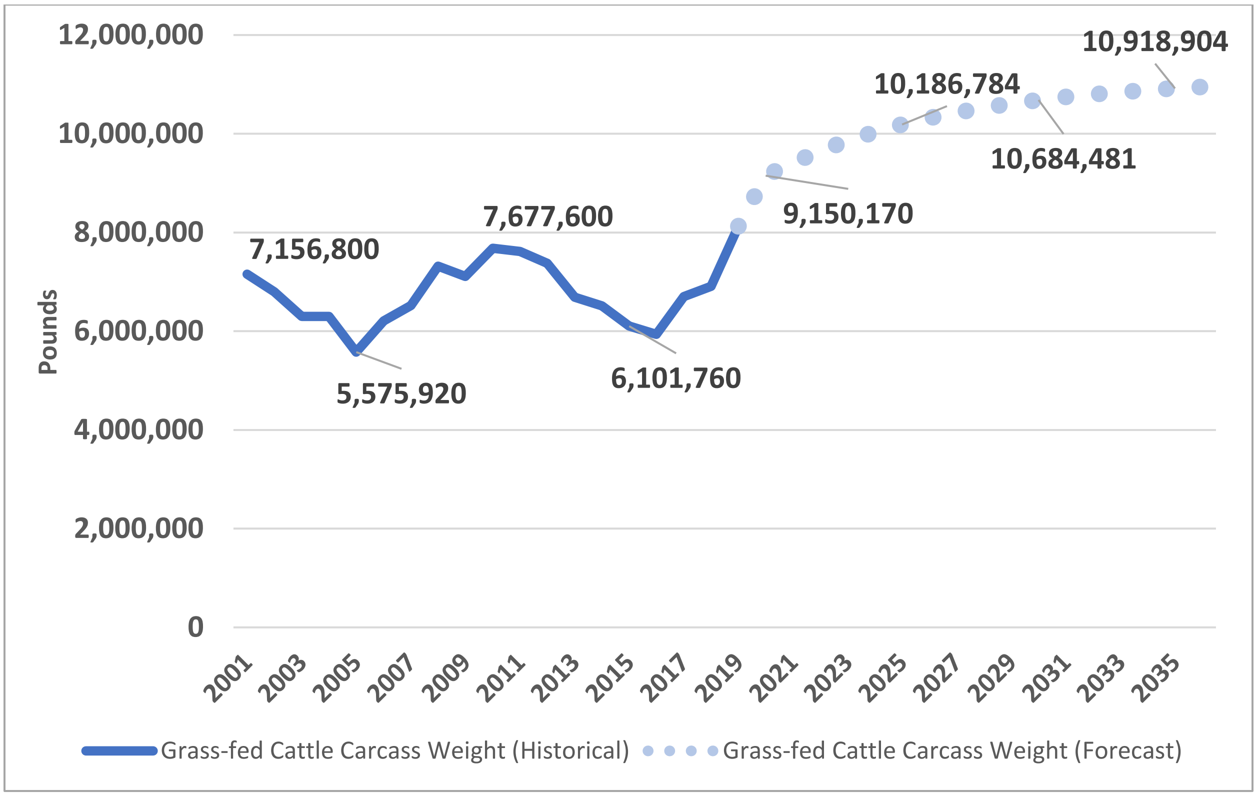
While the increased capacity of the slaughterhouses cannot process all cattle from Hawai'i's ranchers and most of the calves may still need to be shipped to the mainland for finishing, Farias estimated that the exports of calves can be reduced from 95 percent to around 90 to 92 percent. This will keep some of the cattle from leaving Hawai'i when the calves mature, and those cattle will eventually be slaughtered and consumed in Hawai'i's beef market. It should be noted that the

27 USDA Summary of Federal Inspection Requirements for Meat Products, Food Safety and Inspection Service.
28 Cattle were greater than or equal to 500 lbs.
29 Melrose and Delparte, Baseline Study for Food Self-Sufficiency in Hawai'i County. 2012.
30 Local Beef Production to Grow with New Company Meats. West Hawai'i Today.
31 Mahi Pono Acquires Slaughterhouse, Investments are being made to expand capacity. The Maui News.

forecast does not eliminate the current export of calves in the future and will coexist with calves to the mainland. The calves export operations will continue, although the number of head exported will be influenced by the number of cattle raised for local harvesting. The actual number will vary with each ranch and will be the rancher's decision.

Figure 13 provides the total beef produced in Hawai'i in carcass weight. Carcass weight refers to the weight of the cattle after slaughtered and the removal of the head, hide, intestinal tract, and internal organ[32]. The carcass weight of a grass-fed cattle is approximately 56 percent of its live weight. Because the carcass weight is a factor of the live weight, Figure 13 exhibits a similar curve as in Figure 12.

Figure 13. Total Beef Produced in Hawai'i, Carcass Weight, 2001 to 2036



Source: USDA NASS, SMS Estimates.

32 Understanding Beef Carcass Reports. University of Georgia Extension.

USAGE OF COW HIDES AND INNARDS

There is no adequate market for the cow hides produced in Hawaiʻi. All hides are disposed at landfills as are all other non-usable byproducts such as stomachs, intestines, etc. Though Hawaiʻi has a diversified ethnic population, the slaughter operations managers stated that there is no adequate demand for specific byproducts to make the marketing of such items possible.

CATTLE EXPORT

As previously documented, a large number of cattle are exported to the mainland. Ninety-five percent (95%) of calves are shipped to the mainland.

The Elsevier, Inc. survey data gathered estimates that a quarter of the calves produced are finished and marketed for beef within the state, with the remainder transported to the mainland for finishing. This is similar to the export data reported. On average, the calf weaning age was reported as 7.6 ± 1.3 months and ranged from 4 to 11 months. This average weaning age was similar to the 7.7 months reported for the mainland western United States (Asem-Hiablie et al., 2017). At weaning, calves weighed on average 486 ± 81 lbs. with a range from 224 to 649 lbs.

One of the ranchers explained the financial benefit of exporting a calf to the mainland in the following manner. Exporting a calf under 400 lbs. to the mainland provides the operation with more income than it takes to grow a cow to maturity in Hawaiʻi over a three-year period. The cost of land used alone makes it a much less attractive option economically.

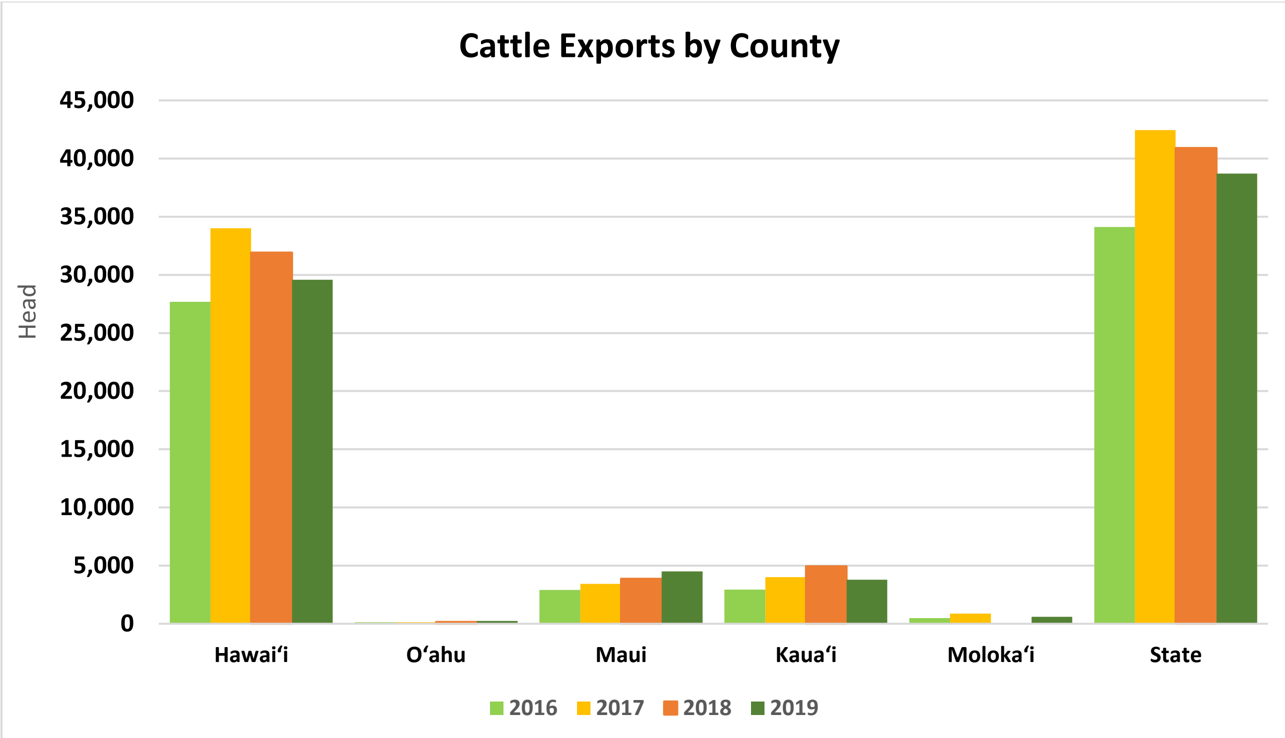
The larger farmers market/ship their cattle directly to ranches on the mainland. The smaller ranchers market their cattle to the mainland through 5 Gate Buyers or consolidators. The price per pound received is low and is greatly affected by cost of shipping.

Bobby Farias, who helped establish Kunoa Cattle Co. in 2014, recently left that company and has formed Hawaiʻi Meats in partnership with Frank and Belinda Vandersloot, owners of Riverbend Ranch in Idaho. The Riverbend Ranch is recognized as in every segment of the industry from commercial cow-calf to high-end steak houses. As part of the deal, Hawaiʻi Meats acquired the slaughterhouse and a Kauaʻi cattle operation with about 2,500 animals that had been part of Kunoa, according to Farias. Recent volume at the Hawaiʻi Meat Company slaughterhouse was up to about 120 animals a week, but Farias said the facility was being operated only three days a week and that he wanted to invest more in labor and physical capacity of the processing plant so that more local ranchers can stop shipping calves to the mainland for harvesting.

It is the long-term plan of the new partnership to improve local herds genetics and pasture feed and thus improve the quality of locally grown grass-fed beef and increase local beef sustainability.

Cattle exports have shrunk by about 7,000 head since 2006. In the same timeframe, inventory has been reduced by about 20,000 head, and slaughter has increased by about 3,000 or 4,000 head.

Figure 14. Cattle Exports by County, 2016-2019



Source: State of Hawai'i DOA

If we were to instead keep and raise the exported calves to maturity and slaughter them locally, we would produce an additional 28.4 million pounds of edible beef, which would account for 30 percent of the total beef consumed locally. This would reduce our reliance on imported beef significantly.

BEEF QUALITY

The "Grass-Fed Beef" label indicates meat that is produced by feeding forages from start to finish without any grain supplementation. Also, "animals must have continuous access to pasture during the growing season" for a grass-fed marketing claim (USDA-AMS 2007).

When speaking of the quality of beef, the first impression that comes into the consumers' minds is usually the palatability, flavor, tenderness, texture, marbling, or breeding, etc. These attributes are the intrinsic values of the product. In the study "Hawai'i Grass-fed Beef Quality Standards", the researcher had suggested that besides the intrinsic values, the consumers are also looking for extrinsic values when making their purchase decisions. Extrinsic attributes may include the followings:

- how the cattle are raised,
- whether the cattle have received antibiotics or growth hormones,
- whether the cattle are Hawai'i-grown, or
- whether the cattle are sustainably raised or humanely raised.

These extrinsic value labels add value to the consumers' confidence when purchasing beef. Researchers even observed a consumer willingness to pay a premium on grass-fed beef based on health benefits[33,34].

Intrinsic Values of Beef

Since all Hawaiʻi grown cows are grass fed, the beef tends to be tougher and, in many cases, has a more gamey flavor. Many healthful aspects of grass-fed beef have been identified, including lower total fat content and higher content of omega-3 fatty acids. The healthy nutritional profile of grass-fed beef, along with the perception that grass-finishing promotes animal well-being and environmental sustainability, has probably contributed to the increase in the demand for grass-fed beef. Despite these perceptions, some studies have reported that palatability of grass-fed beef is inconsistent, often leading to consumer dissatisfaction with this product (Van Elswyk and McNeill 2014).

Some of the slaughter operations have experienced the consumer's resistance to the local grass-fed beef. As an example, the Molokaʻi Livestock Cooperative markets their prime cuts on Molokaʻi as Molokaʻi Grass-Fed Beef and demand for the product is low, and not growing.

To improve quality, the University of Hawaiʻi analysis recommends selling the cows at no more than 24 months and with a frame score no larger than 5, preferably 4. However, consumers are used to large steaks that come off animals that are much larger, at three years old with a 7-frame score, but this beef is much too tough. There is a need to inform consumers that smaller is better.

As a result, a majority of the slaughtered grass-fed beef cows are marketed as ground beef in Hawaiʻi. The result is lower profits, and the ground beef product does not provide significant or long-term brand enhancement.

University of Hawaiʻi CTAHR's grass-fed beef research program and extension efforts to communicate research results with ranchers and other stakeholders appear to have helped improve the tenderness of Hawaiʻi grass-fed beef. Younger slaughter age appears to be an important factor in improving the tenderness of grass-fed beef. Significant improvement in marbling score was also noted, but it appears that marbling, beyond a certain level, is not an important factor influencing the tenderness of grass-fed beef.

A Kauaʻi Island consumer study undertaken in 2005 concluded:

- Beef is bought most often per week compared to other proteins (~50% total)
- Taste preference drives purchasing over cost, health benefits, or other factors (>42% total)
- At home, steaks were cooked most often compared to other types of beef (>60%)
- Tenderness and secondarily flavor rank as lead factors in steak eating quality

Results of the study also show that incorporation of an improved Leucaena leucocephala, cv. "Wondergraze", into a tropical pastoral rotational grazing system significantly enhanced average daily gains, shortened days to harvest, and improved carcass traits as compared to guinea grass pastures. "Wondergraze" is a variant of Leucaena leucocephala, known as "Haole Koa" in Hawaiʻi, bred by the University of Hawaiʻi in collaboration with the University of Queensland, Australia with the specific purpose of improving sustainable beef production. The improvement in animal growth

33 Hawaiʻi Grass-fed Beef Quality Standards, Hawaiʻi Cattlemen's Council, 2020.
34 Mccluskey J et al., U.S. Grass-Fed Beef: Marketing Health Benefits, February 2005.

and carcass traits is likely due to the enhanced nutritional quality of the grass-legume forage mixture.

One of the major ranch and slaughterhouse operators is putting their resources into four areas to improve Hawaiʻi-grown grass-fed beef:

- Improved genetics of livestock by importing some of the higher quality heifers from the mainland
- Improving the pastures to include Leucaena leucocephala
- Developing strong brand names for local grown grass-fed beef
- Improving the eating quality and be able to provide a more consistent product to consumers are the keys to drive the local demand and sustainability to the beef industry.

Extrinsic Values of Beef

Although the extrinsic attributes listed above do not necessarily contribute to the eating quality, the labels add value to the consumers in terms of additional warranty. By including the labels to show how the cattle are raised or whether the cattle have received antibiotics or growth hormones, the consumers can feel safer and more informed of what they are consuming. Moreover, they can easily differentiate whether the beef products are locally grown or imported from elsewhere. According to the "Hawaiʻi Grass-fed Beef Quality Standards" study, most of the Hawaiʻi ranchers are already incorporating these extrinsic attributes into their production. The more consumers feel confident and safe when buying and eating beef with these extrinsic labels, the higher the possibility that the local demand can be built up, which will, in turn, bring sustainability to the local beef industry and diversity to the State.

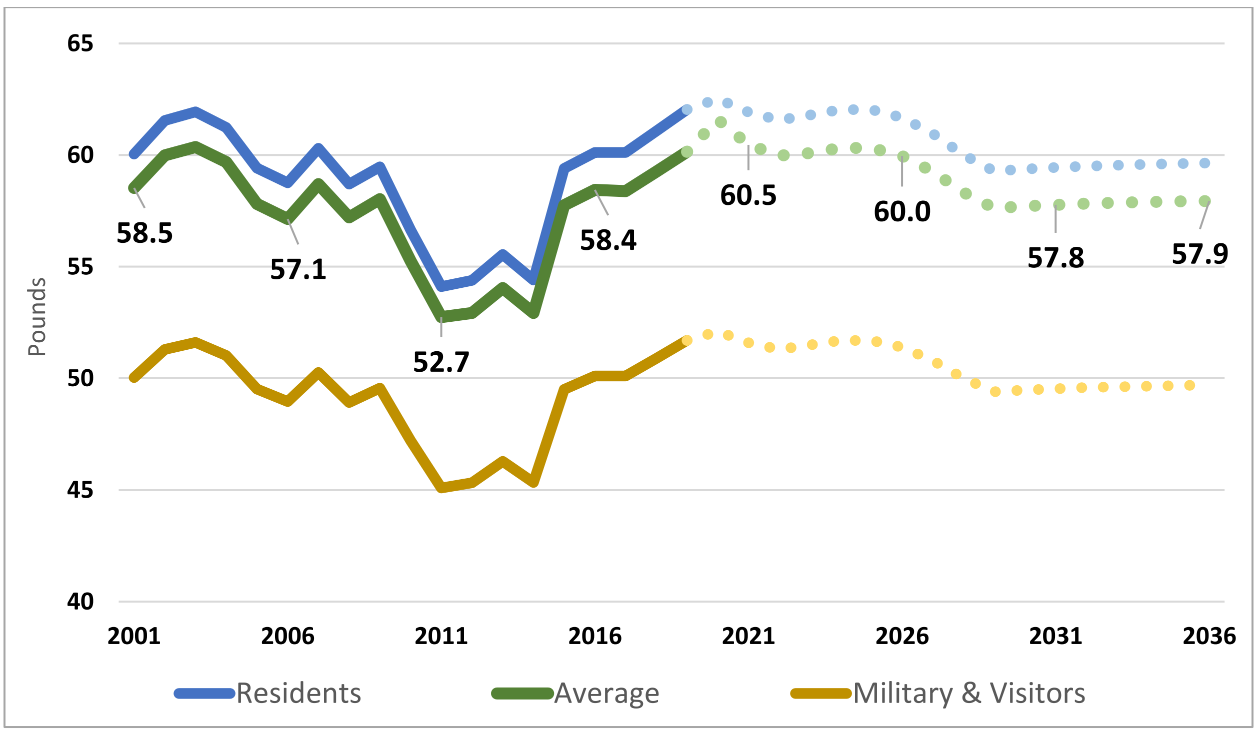
THE PORK MARKET

CONSUMPTION PER CAPITA, 2001-2036

Much like beef consumption, there is no accurate data for the State of Hawaiʻi regarding pork consumption. We used the U.S. per capita pork consumption again, as a surrogate. We do not, however, assume the same consumption for the entire population. According to several consulting experts, Hawaiʻi residents consume 20 percent more pork on average than visitors and military due to differences in culture and cuisine. Hawaiian and East Asian cuisine traditionally uses more pork than the standard American cuisine. While this is a very general assumption to make, the resulting consumption estimates are within range of other academic estimates. As will be discussed in "Local Hog Industry" below, a significant portion of this extra pork consumed by locals is not tracked or federally inspected due to farm-to-table sales.

Figure 15 below presents the per capita consumption of Hawaiʻi military, visitors, and residents. Due to resident-majority population in Hawaiʻi, the per capita pork consumption of the *de facto* population varies between 16 and 18 percent higher than the national per capita consumption. In 2020, it is estimated that the average military member or visitor will consume 52.1 pounds of pork, while the average Hawaiʻi resident will consume an estimated 62.5 pounds of pork—giving an average per capita consumption of 61.6 lbs. This is a slight increase from 58.5 pounds in 2001, and it is estimated to decrease slightly to 57.9 pounds in 2036**.** It is important to note that while overall pork consumption drops in 2020, per capita consumption peaks in 2020 due to the pandemic dramatically decreasing the proportion of visitors.

Figure 15. Pork Consumption Per Capita (in pounds) in Hawaiʻi, 2001 to 2036

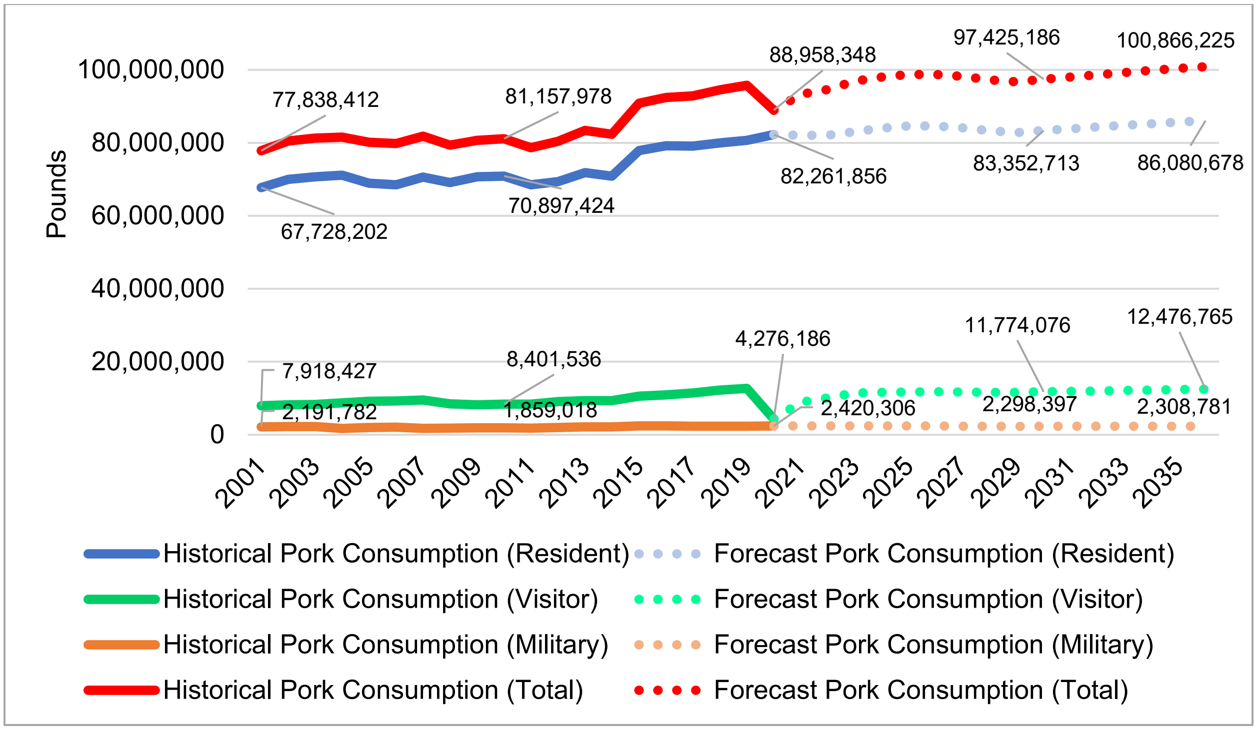


Source: USDA Agricultural Projections to 2029; DBEDT State Databook 2019; DBEDT Population and Economic Projections for the State of Hawaiʻi to 2045.

OVERALL HAWAIʻI CONSUMPTION, 2001-2036

The overall pork consumption is shown in Figure 16 below. In 2019, it is estimated that people in Hawaiʻi consumed approximately 95.8 million pounds of pork. Compared to 77.8 million pounds of pork in 2001, the pork consumption had increased by 23 percent in 18 years with an average annual growth rate of 1.2 percent. The consumption trend data was estimated using the military, visitor average daily census, and resident populations in Hawaiʻi in conjunction with the U.S. per capita consumption data[35]. The projected average daily census was calculated from the DBEDT quarterly tourism forecast and the resident population growth was taken from the DBEDT long-range population and economic projection to 2045. As was discussed in the previous section, Hawaiʻi residents consume about 20 percent more pork than non-residents.

Figure 16. Overall Pork Consumption (in pounds) in Hawaiʻi, 2001 to 2036



Source: USDA Agricultural Projections to 2029; DBEDT State Databook 2019; DBEDT Population and Economic Projections for the State of Hawaiʻi to 2045; SMS Estimates.

The 10.4 percent increase from 2014 to 2015 is a result of the 9 percent recovery of per capita consumption from its dip from 2011 to 2014 in conjunction with the fact that population has been rising at an average annual rate of 1.2 percent since 2001.

In 2020, however, the pork consumption is expected to drop abruptly due to the outbreak of global pandemic. As discussed with beef consumption, the decrease in tourism due to the COVID-19 pandemic will likely result in a decrease in pork consumption. Because the missing visitors eat less pork than residents on average, pork consumption only drops 7.1 percent—less than the 8.5 percent decrease in beef consumption.

[35] USDA Long-term Projections, 2015 – 2020. USDA.

Pork consumption is expected to be 89.0 million pounds in 2020, a substantial decrease from 95.8 million pounds in 2019 (-7.1%). The dashed line in Figure 17 presents the projected overall pork consumption for the years 2020 to 2036. The pork consumption is expected to recover quickly as the number of visitors start to recover in subsequent years. The pork consumption is expected to recover to the pre-pandemic level as soon as 2023. By 2036, the pork consumption is estimated at around 101 million pounds.

CONSUMPTION BY COUNTY, 2001-2036

This section reviews the pork consumption by county for 2001 to 2036. As mentioned in the methodology section, there are no established pork consumption estimates available at the state and county level. A reasonable approach to estimate the county consumption would be to segment the overall consumption proportional to the *de facto* population of each county. This approach assumes similar consumption patterns across all four counties.

Table 3 summarizes the overall pork consumption by county into two parts—historical and projection. Across all four counties, the Honolulu county had the highest overall pork consumption, followed by Hawai‘i county, Maui county, then Kaua‘i county between 2015 to 2019.

Table 3. Overall Pork Consumption by County in Pounds, 2001 to 2036

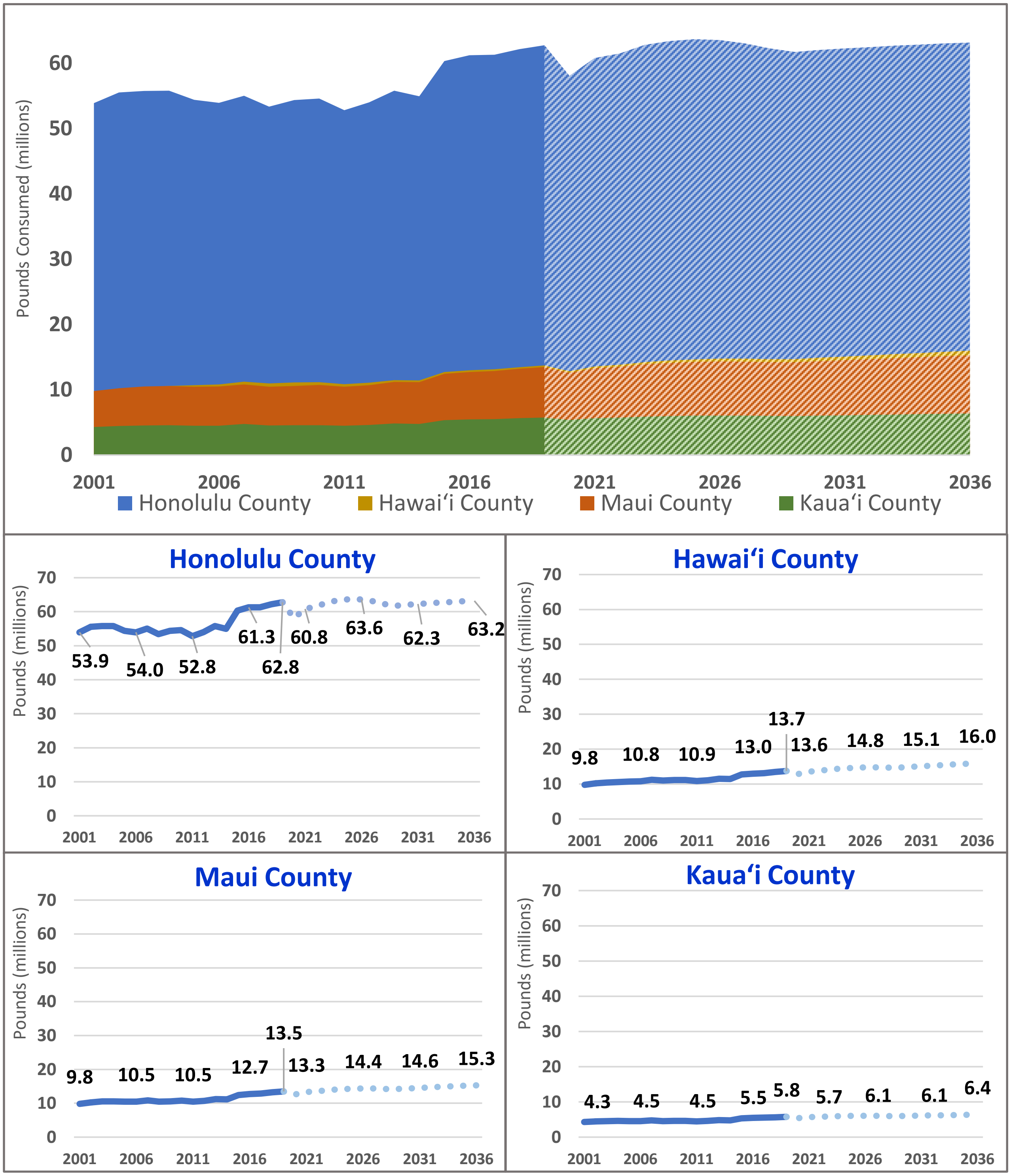
		Honolulu County		Hawai‘i County		Maui County		Kaua‘i County		State of Hawai‘i	
	Year	*De facto* Population (Persons)	Pork Consumption (Pounds)	*De facto* Population (Persons)	Pork Consumption (Pounds)	*De facto* Population (Persons)	Pork Consumption (Pounds)	*De facto* Population (Persons)	Pork Consumption (Pounds)	*De facto* Population (Persons)	Pork Consumption (Pounds)
Historical	**2001**	921,418	53,926,663	167,170	9,783,767	167,880	9,825,315	73,518	4,302,667	1,329,986	77,838,412
	2006	944,318	53,951,017	189,379	10,819,649	183,730	10,496,914	78,957	4,510,994	1,396,384	79,778,574
	2011	1,001,509	52,822,457	205,716	10,850,052	198,870	10,488,974	85,195	4,493,429	1,491,290	78,654,912
	2016	1,048,304	61,262,966	222,345	12,993,847	217,922	12,735,354	93,571	5,468,296	1,582,141	92,460,463
Projection	**2021**	1,006,086	60,824,474	224,360	13,564,052	219,930	13,296,229	93,567	5,656,739	1,543,944	93,341,494
	2026	1,060,276	63,576,100	246,446	14,777,346	239,446	14,357,633	101,126	6,063,712	1,647,295	98,774,790
	2031	1,078,175	62,286,827	261,421	15,102,471	251,904	14,552,669	105,724	6,107,770	1,697,271	98,052,396
	2036	1,090,619	63,191,053	276,116	15,998,277	263,878	15,289,233	110,198	6,384,929	1,740,858	100,866,225

Source: USDA Agricultural Projections to 2029; DBEDT State Databook 2019; DBEDT Population and Economic Projections for the State of Hawai‘i to 2045; SMS Estimates.

The overall pork consumption for Honolulu county was estimated at 60.4 million pounds in 2015 and 62.7 million pounds in 2019, an increase of 4 percent. The increasing consumption mostly followed the trend of de facto population. Honolulu county is the most populous county in the state, and it accounts for 60 percent of the *de facto* population of the State. The pandemic is expected to lead to a significant drop in *de facto* population in Honolulu County from 1.05 million persons in 2019 to 944,488 persons in 2020. The corresponding pork consumption will also decline, from 62.8 million pounds to 58.1 million pounds. By 2026, it is expected to climb back to 63.6 million pounds as the *de facto* population slowly recovers. The *de facto* population growth rate was taken from the DBEDT long-range population and economic projections to 2045.

The share of *de facto* population in Hawaiʻi county, Maui county, and Kauaʻi county are not as much as Honolulu county. Their overall pork consumption was estimated at 13.7 million pounds, 13.5 million pounds, and 5.8 million pounds in 2019, respectively. Their overall beef consumption was estimated to have increased between 2015 and 2019 as the *de facto* population increased. Compared to Honolulu county, the decline in *de facto* population due the pandemic is not as substantial in these three counties. In 2020, the overall pork consumption is estimated at 12.8 million pounds for Hawaiʻi county, 12.6 million pounds for Maui county, and 5.8 million pounds for Maui county. By 2026, their overall beef consumption is expected to increase to 14.8 million pounds, 14.4 million pounds, and 6.1 million pounds for Hawaiʻi county, Maui county, and Kauaʻi county, respectively. Figure 17 provides the trends of the overall historical and projected pork consumption by county for 2015 to 2026 in graphical form.

Figure 17: Overall Pork Consumption by County in Pounds, 2001 to 2036



Source: USDA Agricultural Projections to 2029; DBEDT State Databook 2019; DBEDT Population and Economic Projections for the State of Hawaiʻi to 2045; SMS Estimates.

Although the ratios of consumption between islands is likely proportional to the ratios of their populations, their sources of pork are likely not proportional. Honolulu appears to source a lower percentage of its pork from the smaller farm-to-table “Grey Market” farms.

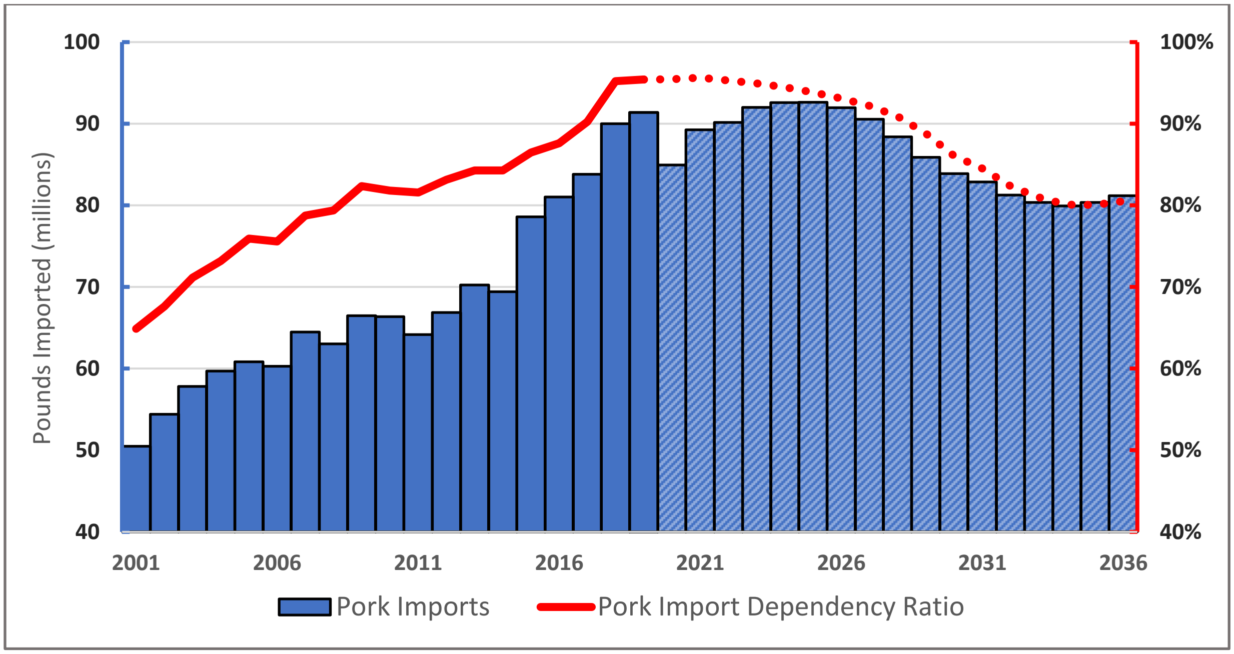
ANNUAL IMPORTS LBS., 2001-2036

In determining the consumption of pork in Hawaiʻi, SMS heavily cited a University of Hawaiʻi study that examines food availability across all types of food in Hawaiʻi (Loke and Leung, 2013). Following the study’s exact methods is not viable for the purposes of this study, as U.S. Army Corps of Engineers import data is provided only for general meats, not pork specifically. Once determining consumption through other methods described in “Consumption per Capita” and “Overall Hawaiʻi Consumption”, SMS decided it best to calculate pork imports by reversing the methods used by Loke and Leung. A formula given for the total food supply available for consumption can be easily manipulated to determine that **imports** are **equivalent** to **exports plus consumption less production**. This simple formula entirely accounts for the supply and usage of pork in Hawaiʻi.

Export data is from the USDA “U.S. agricultural exports, State detail by commodity” dataset. Data was provided as monetary value in USD ($) and were converted to pounds using the average conversion factor given from local confidential distributors and wholesalers. These figures have little impact on the resulting imports because pork exports were only $73,258, or 30,343 pounds, in 2019. Consumption and production data used to calculate imports are described in their respective sections of this report.

In addition to pork imports in pounds, Figure 18 shows the import dependency ratio (IDR) over time. The IDR is the proportion of pork consumed locally that is not produced locally. The lower the IDR, the more sustainable Hawaiʻi’s pork consumption is.

Figure 18. Estimated Pork Imports, 2001-2036



Source: USDA Economic Research Service; USDA Foreign Agricultural Service, Global Agricultural Trade System; SMS Estimates.

Over a period of 10 years, annual pork imports see an increase of 20 percent, going from 79.2 million pounds in 2010 to 95.2 pounds in 2019. This is much larger than the 6 percent increase beef imports saw over the same timeframe. This jump in pork imports can be partially explained by the considerable de facto population increase and the number of hogs slaughtered in Hawai‘i decreasing by 67 percent over the same period, as described later. Between 2020 and 2021, annual imports decrease by 2 percent, following similar trends caused by the COVID-19 pandemic. Hawai‘i’s pork import dependency is likely to decrease into the next decade given the strong efforts by Akamai and other parties to substantially increase local pork production.

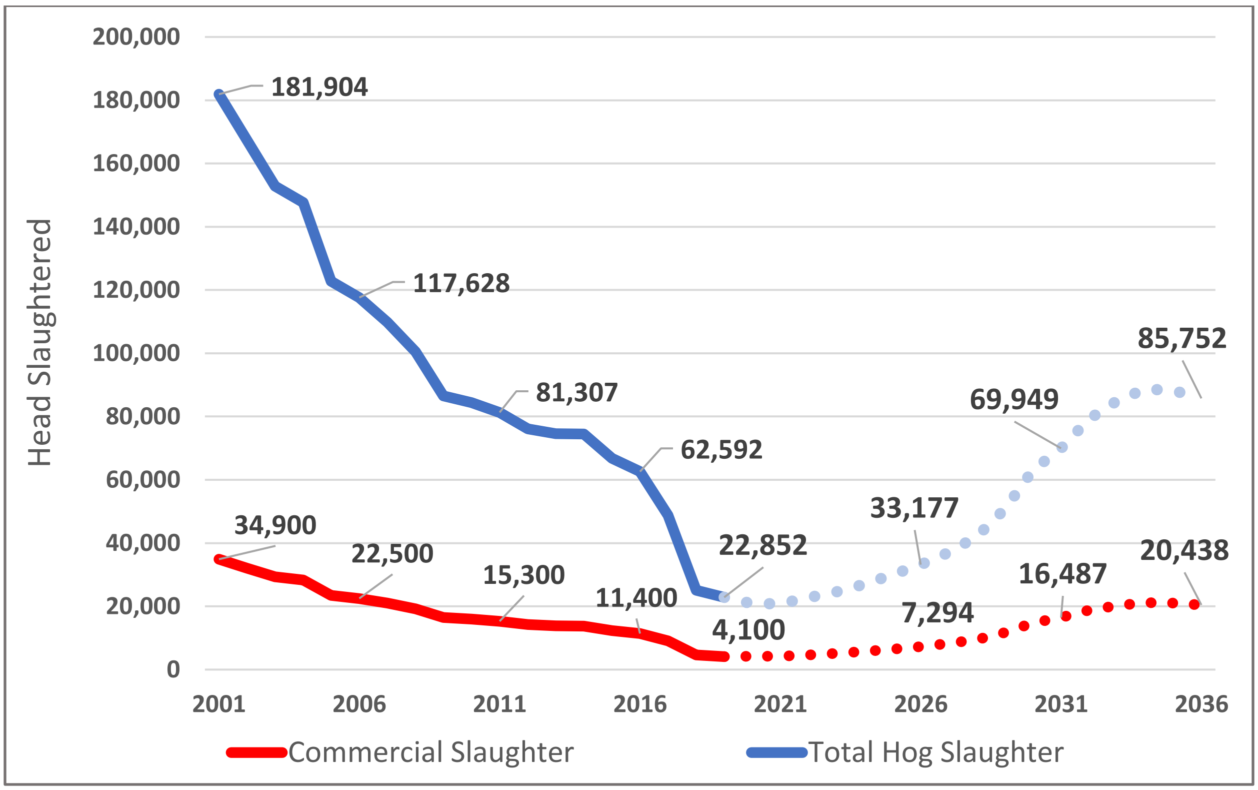
LOCALLY SLAUGHTERED, 2001-2036

The slaughter of hogs consists of (1) commercial slaughter, (2) on-farm slaughter for home consumption, and (3) the farm-to-table slaughter, also known as the “grey market”. As in the case with cattle, all beef sold in the commercial market must pass the federal inspection from the USDA. The farm-to-table slaughter, however, does not directly associate with the commercial market and thus is not required to be federally inspected by the USDA. There is no established number of hogs slaughtered in Hawai‘i’s grey market and only a rough estimate can be inferred by local producers. In our analysis, we have adopted an estimate of 80 percent of locally produced pork are sourced from the grey market. With no other grey market related sources available, this estimate would be our best and most reliable estimate from Hawai‘i’s local producers.

Based on the USDA Census data, the number of pig farms in Hawai‘i has been decreasing in the past four decades. In 1978, there were about 399 pig farms. In 2017, 39 years later, only 155 pig farms remained operating (-61.2%). The disappearance of local pig farms could largely be attributed to the inability to compete with the big agricultural producers on the mainland[36]. Unlike the big agricultural competitors whose pork can be sold at an extremely low price, the local pig farmers must sell their pork at a much higher price due to the high input costs of feeding in Hawai‘i.

This implies that the consumers will have to pay a higher price for locally produced pork. The sustainability of locally produced pork will depend upon consumer support and willingness to pay. If the quality and taste of locally produced pork are indifferent from imported pork, more consumers may likely favor imported pork than locally produced pork due to cheaper prices. This may result in the disappearance of more pig farms and shrinkage in the local slaughter of hogs.

Figure 19. Number of Total Hogs (Heads) Slaughtered in Hawai‘i, 2001 to 2036



Source: USDA NASS, SMS Estimates

Figure 19 presents the estimated total number of hogs slaughtered locally in Hawai‘i since 2001. The total also includes the estimated number of hogs slaughtered in the grey market. Our estimates for the grey market were assumed to follow the trend of commercial slaughter in the absence of historical data. As can be seen in Figure 19, the total number of hogs have been

36 Saving Hawai‘i’s Pig Farms. Honolulu Civil Beat.

declining substantially since 2001. A longer series suggests that the decline began in 1988.[37] This appears to be consistent with the disappearance of many pig farms in Hawaiʻi.

According to the Swine Task Force Report prepared by the DOA, CTAHR, and the Hawaiʻi Farm Bureau Federation, local producers lost market share to the cheaper imported pork due to consumers' inability to differentiate between local and imported pork. Oʻahu's only USDA-certified hog and cattle slaughter facility, which was built with the intent of handling both cattle and hog, was difficult to keep operating because of the decline in cattle slaughter due to exporting. The hog farmers and pork customers had to carry the cost of operating the facility. On Maui, the decline in the number of hogs also led to fewer days of operations. The high costs of building slaughter facilities, purchasing grain-based feed, transportation, land, labor, and waste management coupled with the decline in cattle slaughter appeared to be the major causes of the decline in hog slaughter for the past few decades.

The projections for local production of pork are expected to increase gradually in the next two decades. Although the pandemic has driven down the demand for local pork from dine-in restaurants, Oʻahu's pig farm bounced back in sales in the wake of people scaring shutdown of the meat processing facilities in the mainland.[38] This provided an opportunity for more consumers to try the local fresh pork. On the other hand, the expected increase in local cattle slaughter will share the cost of operating the slaughterhouse, which will lower the cost of hog slaughter and likely keep the slaughterhouse operating.

According to Erin Borror, an economist with the U.S. Meat Export Federation, "the success of small farm all came from carving a niche and branding the pork as a higher value product for the customers."[39] A similar market also exists in Japan where people are willing to pay higher prices for Kobe beef or Kurobuta pork despite the massively cheaper beef imported from the U.S. If Hawaiʻi's locally produced pork can also effectively rebrand and promote itself as a higher value product and ensure better quality, it is believed that there is a strong market demand for local fresh pork in Hawaiʻi. When the demand for local fresh pork increases, local slaughter (supply) will need to increase to keep up with the demand. By 2030, it is projected that the local slaughter of hogs will climb back to 63,000 heads. And by 2036, the local slaughter of hogs is expected to reach 86,000 heads.

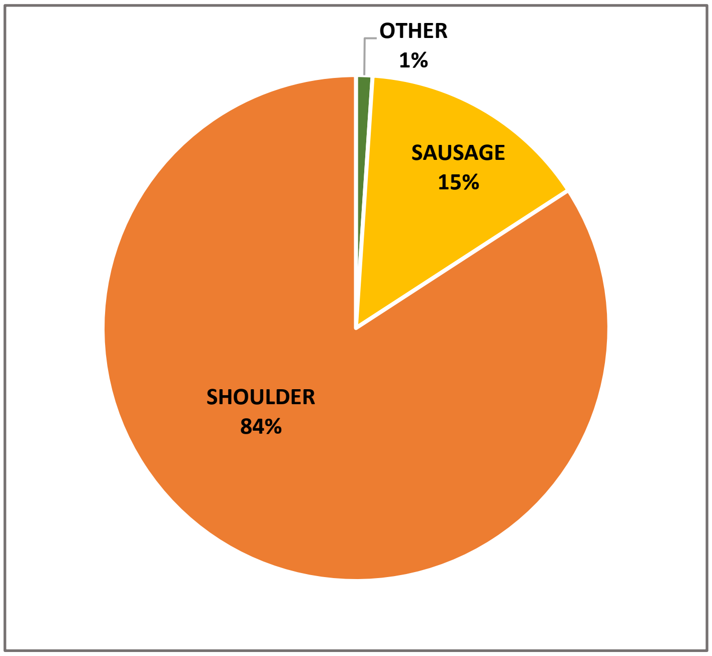
DEPARTMENT OF EDUCATION ANNUAL PURCHASES

This section covers the pork purchasing patterns of the Hawaiʻi Department of Education. The topics of interest are purchases by type of pork, purchases by production source, and their overall goals to increase the proportion of meat they purchase from local producers.

The DoE purchased 702,000 pounds of pork for 1.6 million dollars in 2019. None of this pork was sourced locally. As shown in Figure 20, most of the purchased pork (by weight) is from a cut of shoulder, or butt, used for stews, about 15 percent is used in sausage patties and links, and one percent is an assortment of products like pork gravy.

[37] The USDA provides commercial slaughter data for hogs as far back as 1963 but the data series for on-farm slaughter for home consumption did not start until 1988.
[38] Oʻahu pig farm bouncing back after pandemic slashed its pork sales. Hawaiʻi News Now.
[39] Saving Hawaiʻi's Pig Farms. Honolulu Civil Beat.

Figure 20. Distribution of Hawai‘i DOE Pork Purchases by Type, 2019



Source: Local food distributors.

LOCAL HOG INDUSTRY

The first pigs were brought to the Hawaiian Islands by Polynesians as early as the fourth century A.D. Skeletal remains of pigs and recorded traditional knowledge sources indicate that pua‘a (the Polynesian pig) was a much smaller animal than the feral pigs of today. Captain Cook brought English pigs on his first voyage to Hawai‘i in 1778. Swine production in Hawai‘i reached its peak in 1945, when a population of more than 90,000 head was attained. The trend has been downward since then.

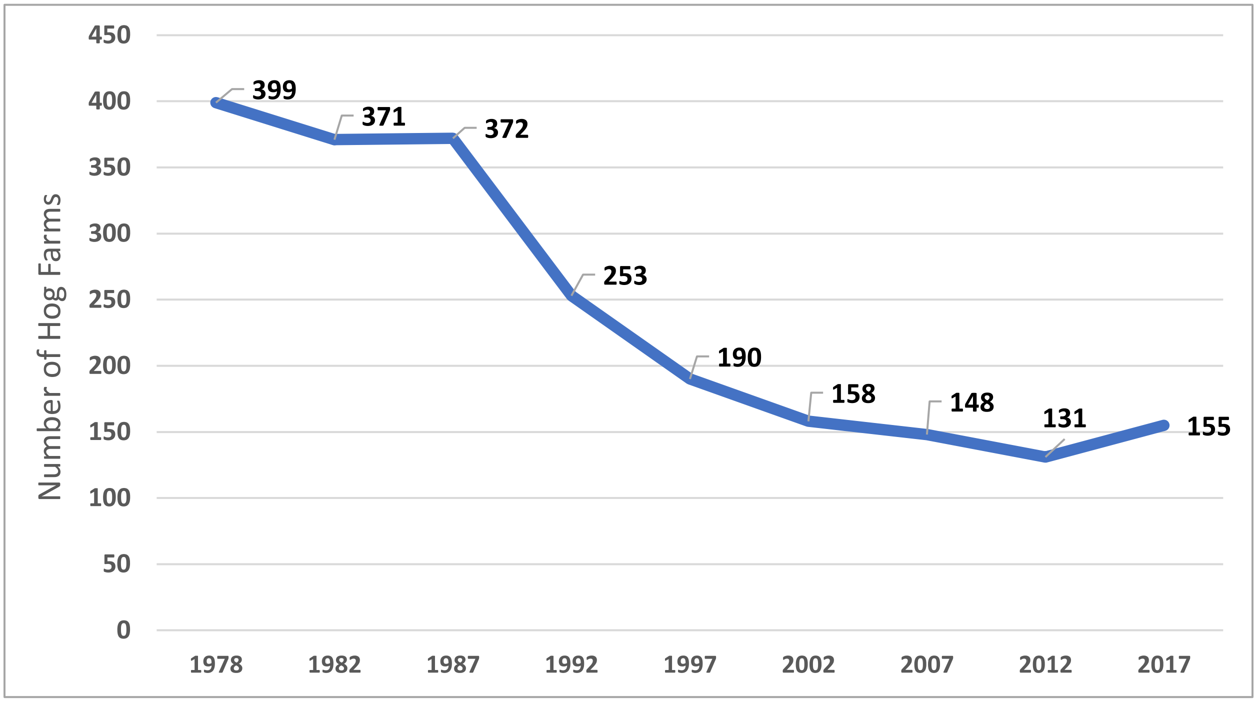
Domesticated pua‘a carried strong cultural value in traditional Hawai‘i. Aside from being an important possession and food source, an oral tradition describes the adventures of Kamapua‘a (the pig child), a powerful demi-god who ranged over the islands and into the sea. Even the name of the traditional land management system, ahupua’a, refers directly to the pua‘a and highlights the animal’s importance among the variety of resources that were collected and offered during the annual makahiki tributes.

In contrast, current feral pigs are largely derived from animals introduced after western contact. Cook, for example, brought European pigs during his first voyage to Hawai‘i, and many other introductions of European and Asian swine followed. Over time, the Polynesian pua‘a interbred with and were mostly displaced by these larger animals.

Swine production has cultural as well as economic importance in Hawaiʻi. Pigs play a vital role in Hawaiʻi's diverse cultures, as well as in the Pacific Islands, Asia, and even mainland America. Pork dishes such as the ever-popular kalua pig and laulau, Chinese char siu, Filipino adobo, and Portuguese sausage are just some of the delicious foods that make up Hawaiʻi's unique blend of culture and cuisine.

Unlike the cattle producer market, the hog market is fragmented. As reflected in the following chart, USDA estimated the number of pig farms in Hawaiʻi who report *pig sales* at 155 farms in 2017. Based on discussions with experts at University of Hawaiʻi's CTAHR and some of the pig farmers in Hawaiʻi, the number of pig farms with reported sales has not changed much in the past three years. The number of pig farms reported by USDA is understated. It is SMS's estimate that there are approximately 400 plus pig farms in Hawaiʻi based on conversations with market experts. Most of the pig farms are small, with less than 30 pigs a farm.

Figure 21. Number of Pig Farms with Sales, 1978-2017



Source: USDA Census of Agriculture

Most pig farms are family run operations. University of Hawaiʻi pig experts as well as local slaughterhouse operators estimate that 80 percent to 90 percent of local pigs are purchased by local residents directly from local pig farms and slaughtered for immediate consumption. An example of the issues faced by hog farmers is Hawaiʻi's David Souza (Waianae Pig Farm). He sells only two pigs a week slaughtered by the Hawaiʻi Meat Company slaughterhouse to Tamura's. The other 90 percent of his revenue is achieved through other, more direct distribution channels.

Some of the larger farms present in Hawaiʻi are:

- Jay's Hog Farm in Waiʻanae, 480 sows
- David Wong in Waiʻanae, 800 sows
- Kaneshiro Farms in Koloa, Kauaʻi 100 sows
- Two Lady Farmers in Waianae, Oʻahu

As reported by the Honolulu Civil Beat in 2018 pig "farmers develop relationships with high-end chefs and ensure their pork has a reputation for quality. They can also depend on customers from immigrant or Native Hawaiian communities who prefer to buy whole pigs straight from the farm and slaughter them themselves on-site. Especially during holidays, many pig farmers can't keep up with the demand." This means of distribution is viable for pig farmers because most Hawaiʻi pork is of very high quality, according to field experts. Most hogs in Hawaiʻi are fed rich and dense food waste, which create a more desirable lean cut.

To expand the industry, farmers recognize the need to expand their reach and better control their production and distribution. A group of 27 Big Island farms have the "Akamai Working Group" to endeavor to build a slaughterhouse including production and processing facility to market their products jointly. They recognize that one of the key dilemmas facing them are transportation costs to reach the majority of Hawaiʻi consumers on the Island of Oʻahu. They plan to increase the numbers of pigs managed on their farms from a current population of 4,500 to 7,000.

LOCAL SLAUGHTER INDUSTRY

This section covers the local hog raising industry. The data discussed in this section were acquired from the 2012 and 2017 USDA NASS census. For the purposes of this section, a "farm" is a farm that owns hogs—they do not necessarily sell the hogs or pork.

In 2017, there were 226 hog farmers in Hawaiʻi—93 in Hawaiʻi County, 28 in Honolulu County, 80 in Maui County, and 25 in Kauaʻi County. From 2012 to 2017, Hawaiʻi County gained 23, Honolulu County lost 32, and the remaining counties gained a combined 4 for an overall loss of 5 farmers.

ISSUES FACING THE INDUSTRY

Following issues were identified through interviews and literature review. These issues are not listed in order of priority.

- Retail prices are higher for local pork compared to prices for imported pork—$0.15 a pound for imports vs. $3.00 a pound for local pork
- Local pork, being fresher, tends to have greater shrinkage on the counter than imported pork
- Quality of pork from large producers is good, that from small operators is less desirable
- The supply and types of cuts available are uncertain at times
- Transportation costs of shipping pork from neighbor island to Oʻahu is unaffordable

THE SHEEP MARKET IN HAWAIʻI

Little data is available about the sheep market in Hawaiʻi. Following are the sheep farms listed in the Hawaiʻi Sheep and Goat Association:

- ʻĀhualoa Hog Farm, Ahualoa
- Aloha ʻAina Tropicals, Laupāhoehoe, lamb
- ʻAina Pono Livestock, Hilo, goat, lamb and mutton
- Double D Ranch, Laupāhoehoe
- Kahua Ranch, North Kohala, lamb
- Kalopi Ranch, Waimea, goats, and sheep
- Kapua Gulch Farms, Kapaʻau, lamb and mutton
- Kapapala Ranch, Pahala
- Kuahiwi Ranch, Nāʻālehu
- Maluhia Farm, Hamakua, lamb and mutton
- Michael Tomich, Kona
- Paʻahana Livestock, Waimea, goat
- Primal Cuts, North Kohala
- Thema Black, Kona and Waimea
- Waiakea Uka Ranch, Waimea, lamb, and mutton

SMS made an effort to contact the owners of some of the sheep farms, but they were reluctant to provide data. The Executive Director of the Association has no data available on the market or production in Hawaiʻi. Only limited information about sheep slaughter was provided by the slaughterhouse operations. There was discussion that a plurality of goats and sheep raised on Hawaiʻi farms are slaughtered at the farms and sold directly to consumers. This means the 1,200 slaughtered sheep reported by the USDA in 2019 is likely far lower than reality.

A development opportunity for the struggling sheep farmers in Hawaiʻi is “agrivoltaics”, an already existing and expanding practice where the same land is utilized for both agriculture and renewable energy generation. Sheep are the ideal candidate livestock for solar because of their smaller size and daily grazing habits. This idea, developed in the 1980’s, is sustainable and efficient, and it reduces operating costs for both the farmer and the energy developer. It gives farmers who own the land a new source of income, and it provides solar developers a cheaper solution to the problem of vegetation management. Solar grazing, a subset of agrivoltaics in which livestock graze under photovoltaic solar panels, is the ideal segment of agrivoltaics in Hawaiʻi because of its limited space and high average amount of sunlight per year.

There is plenty of room for expansion of this practice in Hawaiʻi. According to the USDA, the average American consumed 1.1 pounds of lamb or mutton in 2017. Assuming the average Hawaiian resident consumes the same amount, there is opportunity to produce 1.7 million pounds of edible meat, or almost 20,000 head of sheep, in 2021.

DEER AND ELKS

Some studies on axis deer in Hawai'i disagree as to the population sizes currently on Moloka'i, Lāna'i, and Maui. According to Kia Hawai'i, there are as many as 70,000, 30,000, and 50,000 deer on Moloka'i, Lāna'i, and Maui, respectively. Local officials and residents say this is far too many because they trample crops and endanger drivers. They want to reduce the population to healthy levels to increase safety and keep some around for food and those who want to hunt for sport. Hunting parties looking to get deer slaughtered in a slaughterhouse must include a USDA agent to permit the deer to be slaughtered in the approved USDA facility. This is common practice across the islands. This is an industry trying to shrink, not grow their inventory and it will likely remain small.

While it is small, Hawai'i's venison industry is not non-existent. Currently, Hawai'i Meat Company on O'ahu sells approximately 30,000 lbs. of Maui venison a month. The only comments gathered by SMS from local industry professionals is that a slaughterhouse on Moloka'i may slaughter one deer every two weeks for local community sale.

APPENDIX

APPENDIX A. INTRODUCTORY E-MAIL AND SURVEY

Interviewer Name: ______________	Local Livestock Producer Questionnaire July, 2020	Date: ______________
Time: ______________		Processor Name: ______________

Hi, my name is ______________ and I am with SMS Research & Marketing Services, Inc., a Honolulu based research company. SMS has been retained by the State of Hawai'i Department of Agriculture to undertake this confidential survey among Hawai'i livestock producers. The purpose of this study is to more clearly understand the needs and opportunities available to local processors. This study is a component of a broad study of the livestock market opportunities in Hawai'i. All the answers that you will be providing are CONFIDENTIAL. SMS will only report aggregated data. We are providing a confidentiality agreement signed by SMS guaranteeing confidentiality.

Q2 Can you please tell us a little about the history of your operation?

____

Q4 How long has your operation been in business?

- < 10 years .... O
- 10-25 years .... O
- 26-50 years .... O
- 51+ years .... O

What livestock breeds do you grow? How many heads of each breed do you have?

	Yes, grow	Number of heads
Cows		
Calves		
Bulls		
Hogs		
Deer		
Sheep		
Lamb		
Other: (Specify)______________		

Where do you market each of the breeds you grow? (FOR EACH RESPONSE ASK) How many heads does that represent?   When exporting out of state, are animals live, processed, and if processed are they packaged?

		Export		
	Process locally	Live	Processed	Packaged
Cows				
Calves				
Bulls				
Hogs				
Deer				
Sheep				

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Lamb				
Other: (Specify)________________				

How do you market your calves? Number of head to each market?

	Yes	Number of head
Local grass-finished market		
Breeding stock		
Conventional feed lot - Sell at weaning		
Conventional feed lot - Retain ownership		

Are you interested in increasing the number of animals you grow/breed?

Yes
No

How much would you ideally like to increase the number of animals?___%

Q7 Are you interested in increasing the number of animals you market locally?

Yes..O
No..O

Q8 What percentage of your total herd would you ideally target for the local market?

< 10%..O
11-25%..O
26-50%..O
51-75%..O
76-100%..O

Q9 What barriers prevent you from growing more livestock locally? Select all that apply.

Limited acreage .... O
Limited access to locally available forages/
  hay/feedstuffs .... O
High cost of imported forages/hay/feedstuffs....... O
Limited markets .... O
Food safety .... O
Inconsistent quality .... O
Potential for drought .... O
Lower return on investment................................ O
Access to processor .... O
Other: ______________________________ ...... O
Nothing. I market all of my cattle locally.
  (If you choose this response, do not select
  any other option.).. O

Q10 (PROBE MORE ABOUT PROCESSOR) Do you have any issues with availability of local processing services? (PROBE)____________________

Q11 Do you participate in any local-branded beef or other livestock programs?

Yes.. O
No .... O

Q12 Can you describe these programs?____

Q13 Do you believe there is variability in the quality of local beef products?

Yes.. O
No .... O

Q14 How important do you think it is to establish a standardized method for local beef products?

Not important... O
Somewhat important.. O
Very important... O

Q15

Q19 What are your future plans relative to the next five years in terms of production levels? Select all that apply.

Keep animal numbers stable; no change .... O
Increase herd numbers....................................... O
Decrease herd numbers .... O
Retire / Get out of business................................. O

Q20 Are there any additional thoughts you have on creating a standard for local, grass-finished beef?

Q21 Thank you for your response!

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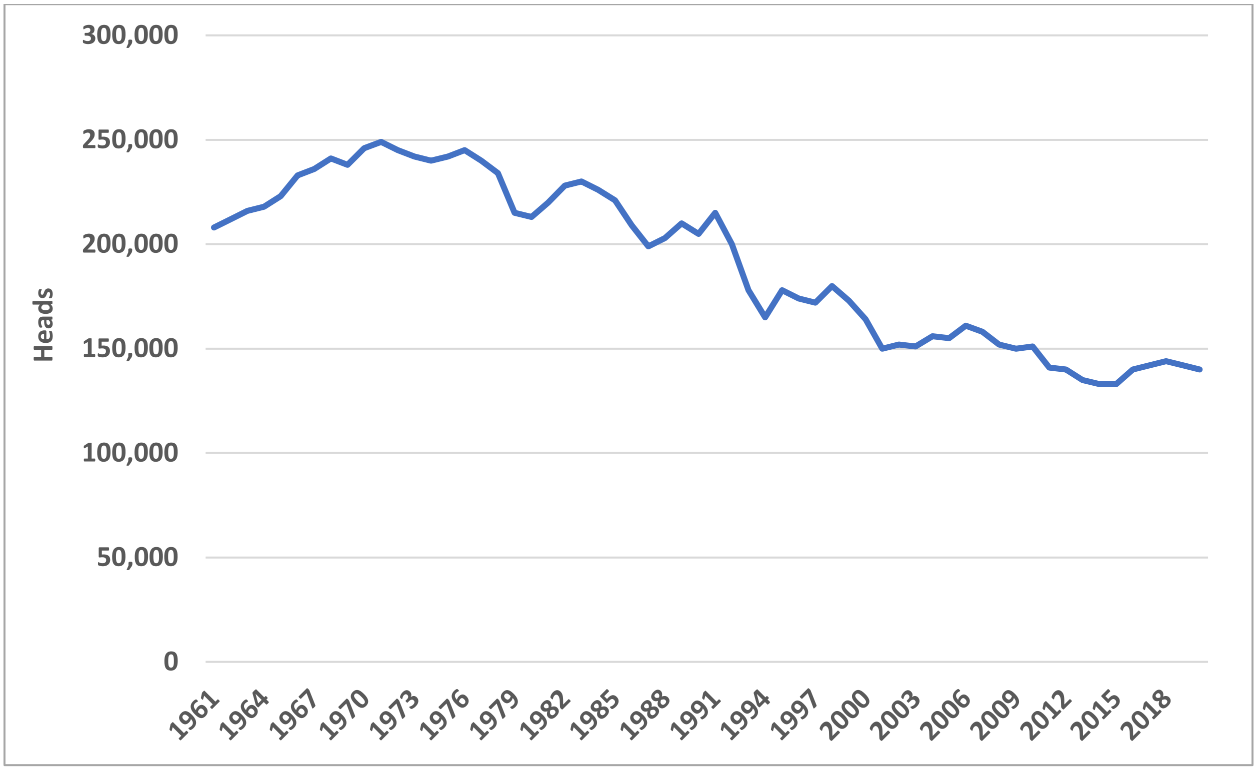
APPENDIX B. LIST OF RANCHERS BY ISLAND

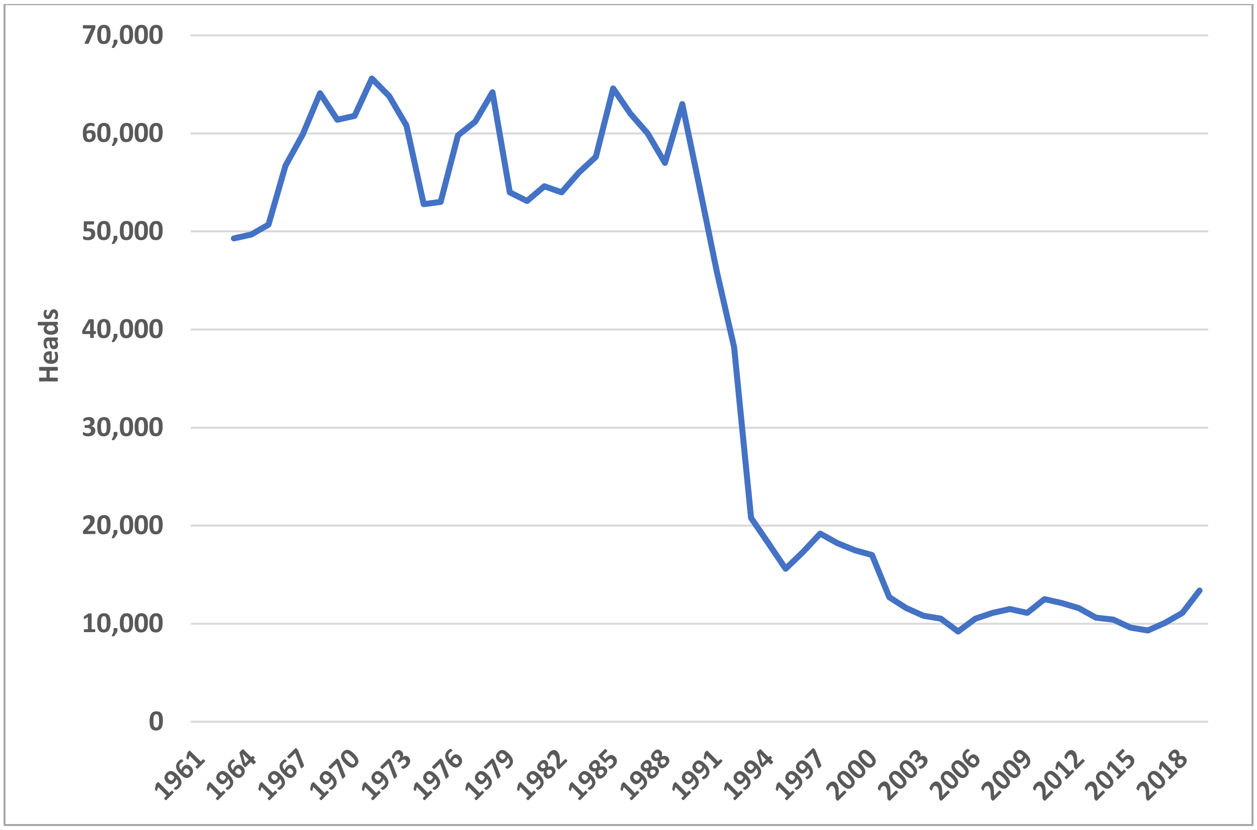
Ranch Business Name	Island	Ranch Business Name	Island
Kealia Ranch	Hawai‘i	Louis Ranch 44	Kaua‘i
Kelonukai Ranch LLC	Hawai‘i	Princeville Ranch	Kaua‘i
EzEz Ranch	Hawai‘i	Walking A Ranch	Kaua‘i
Wung Ranch	Hawai‘i	Circle 5	Kaua‘i
Azevedo Farm	Hawai‘i	Kaua‘i Livestock Producer's	Kaua‘i
McCandless Land & Cattle Co	Hawai‘i	RKL Ranch LLC	Kaua‘i
RJ Ranch	Hawai‘i	Farias Cattle Company	Kaua‘i
Nie Ranch	Hawai‘i	G E Farms Inc	Kaua‘i
F Ranch LLC	Hawai‘i	Makaweli Ranch	Kaua‘i
Paniolo Cattle Company LLC	Hawai‘i	Reis Ohana Ranch	Kaua‘i
Parker Ranch Inc	Hawai‘i	Kaua‘i Cattle Inc	Kaua‘i
Kipukaohelo Ranch	Hawai‘i	Jurassic Kahili Ranch LLC	Kaua‘i
Rim Ranch	Hawai‘i	Halaulani Ranch	Kaua‘i
Pu‘uwa‘awa‘a Ranch	Hawai‘i	Vasconcelles Ranch	Kaua‘i
Hale Kea Farms	Hawai‘i	W Brun Cattle Co	Kaua‘i
Kūka‘iau Ranch LLC	Hawai‘i	DL Akita Ranch	Kaua‘i
Ponoholo Ranch Ltd	Hawai‘i	Mauna Ikena Ranch	Kaua‘i
Daleico Ranch	Hawai‘i	Aakukui Ranch	Kaua‘i
Palani Ranch Co Inc	Hawai‘i	Medeiros Farms Inc	Kaua‘i
Palika Ranch	Hawai‘i	Grove Farm Company Inc	Kaua‘i
Wall Ranch Inc	Hawai‘i		
Mahealani Ranch	Hawai‘i		
SC Ranch	Hawai‘i		
Hawai‘i Beef Producers Inc	Hawai‘i		
KK Ranch	Hawai‘i		
Pu‘unai Ranch & Nursery	Hawai‘i		
Pu‘uwai Ranch	Hawai‘i		
Kapapala Ranch	Hawai‘i		
KHK Ranch LLC	Hawai‘i		
Hoku Nui Farms LLC	Maui	Griffith Livestock	O‘ahu
Diamond B Ranch LLC	Maui	Ponoholo Ranch Ltd	O‘ahu
Haleakala Ranch	Maui	Kualoa Ranch Hawai‘i	O‘ahu
Molokai Ranch	Maui	DB Cattle	O‘ahu
Kaonoulu Ranch LLLP	Maui	4-J Livestock Co	O‘ahu
Na‘alae Beef Company	Maui	Mililani Mauka Ranch	O‘ahu
Thompson Ranch	Maui	Barbed S Ranch	O‘ahu
Ulupalakua Ranch Inc	Maui	Latigo Ranches LLC	O‘ahu
Kaupo Ranch Ltd	Maui	Rocker G Livestock	O‘ahu
Circle L Ranch LLC	Maui	Kapualei Ranch	O‘ahu

APPENDIX C. HISTORICAL CATTLE INVENTORY, 1961 TO 2020



Source: USDA NASS.

APPENDIX D. HISTORICAL CATTLE SLAUGHTERED, 1963 TO 2019



Source: USDA NASS.

APPENDIX E. BEEF CONSUMPTION BY COUNTY, FULL DATA, 2001 TO 2036

		Honolulu County		Hawai'i County		Maui County		Kaua'i County		State of Hawai'i	
	Year	*De facto* Population (Persons)	Beef Consumption (Pounds)	*De facto* Population (Persons)	Beef Consumption (Pounds)	*De facto* Population (Persons)	Beef Consumption (Pounds)	*De facto* Population (Persons)	Beef Consumption (Pounds)	*De facto* Population (Persons)	Beef Consumption (Pounds)
	2001	921,418	60,853,346	167,170	11,040,456	167,880	11,087,341	73,518	4,855,329	1,329,986	87,836,471
	2002	926,101	62,512,601	170,318	11,496,638	170,832	11,531,305	74,256	5,012,345	1,341,507	90,552,889
	2003	923,749	59,872,422	173,159	11,223,220	174,508	11,310,663	75,484	4,892,438	1,346,899	87,298,744
	2004	935,041	61,653,687	177,409	11,697,783	177,336	11,692,977	76,996	5,076,874	1,366,782	90,121,321
	2005	941,266	61,529,100	185,058	12,096,990	181,502	11,864,494	78,062	5,102,796	1,385,888	90,593,380
	2006	944,318	62,023,699	189,379	12,438,592	183,730	12,067,565	78,957	5,185,974	1,396,384	91,715,830
	2007	937,467	60,933,529	191,392	12,440,134	184,730	12,007,088	81,029	5,266,740	1,394,618	90,647,491
	2008	932,842	57,960,431	192,218	11,943,096	183,419	11,396,422	79,409	4,933,909	1,387,888	86,233,859
	2009	937,468	56,971,677	191,936	11,664,285	182,446	11,087,596	79,168	4,811,173	1,391,017	84,534,731
Historical	**2010**	988,367	58,610,037	202,412	12,003,006	194,730	11,547,464	83,186	4,932,919	1,468,695	87,093,425
	2011	1,001,509	57,022,384	205,716	11,712,742	198,870	11,322,955	85,195	4,850,702	1,491,290	84,908,783
	2012	1,020,778	58,244,400	209,495	11,953,524	202,532	11,556,235	87,281	4,980,173	1,520,086	86,734,332
	2013	1,032,428	57,880,091	212,685	11,923,587	207,486	11,632,091	89,574	5,021,731	1,542,173	86,457,499
	2014	1,038,245	55,993,808	215,934	11,645,571	211,290	11,395,123	90,388	4,874,753	1,555,857	83,909,254
	2015	1,045,153	56,856,338	220,521	11,996,331	215,419	11,718,768	92,505	5,032,266	1,573,597	85,603,702
	2016	1,048,304	58,285,697	222,345	12,362,370	217,922	12,116,439	93,571	5,202,547	1,582,141	87,967,053
	2017	1,050,210	59,861,985	225,151	12,833,596	220,790	12,585,005	94,613	5,392,942	1,590,764	90,673,528
	2018	1,049,445	60,028,269	227,362	13,005,130	223,074	12,759,809	95,407	5,457,252	1,595,288	91,250,461
	2019	1,043,661	59,697,424	228,448	13,067,226	224,251	12,827,157	95,730	5,475,738	1,592,090	91,067,548
	2020	943,499	54,439,865	208,616	12,037,163	204,883	11,821,758	87,302	5,037,332	1,444,300	83,336,119
	2021	1,006,086	55,837,794	224,360	12,452,006	219,930	12,206,141	93,567	5,192,973	1,543,944	85,688,915
	2022	1,025,792	55,187,595	230,681	12,410,615	225,710	12,143,189	95,878	5,158,261	1,578,061	84,899,660
	2023	1,045,509	56,248,401	237,060	12,753,848	231,535	12,456,605	98,205	5,283,437	1,612,310	86,742,291
	2024	1,051,147	56,656,803	240,278	12,950,977	234,266	12,626,935	99,217	5,347,785	1,624,907	87,582,498
	2025	1,056,197	57,668,379	243,364	13,287,686	236,868	12,932,994	100,174	5,469,489	1,636,603	89,358,546
	2026	1,060,276	58,845,345	246,446	13,677,751	239,446	13,289,269	101,126	5,612,505	1,647,295	91,424,869
	2027	1,064,106	60,015,579	249,374	14,064,702	241,902	13,643,288	102,035	5,754,754	1,657,480	93,481,856
Projection	**2028**	1,067,939	61,086,120	252,401	14,437,318	244,427	13,981,201	102,964	5,889,550	1,667,794	95,397,798
	2029	1,071,693	61,729,495	255,442	14,713,438	246,956	14,224,648	103,893	5,984,242	1,678,025	96,654,264
	2030	1,075,487	60,958,612	258,526	14,653,250	249,517	14,142,648	104,833	5,941,941	1,688,363	95,696,455
	2031	1,078,175	59,107,654	261,421	14,331,628	251,904	13,809,889	105,724	5,796,024	1,697,271	93,047,719
	2032	1,080,869	58,333,474	264,349	14,266,668	254,314	13,725,087	106,623	5,754,366	1,706,226	92,083,343
	2033	1,083,560	58,215,490	267,307	14,361,381	256,744	13,793,886	107,529	5,777,120	1,715,210	92,151,629
	2034	1,086,266	58,294,570	270,301	14,505,699	259,200	13,909,995	108,443	5,819,613	1,724,257	92,532,392
	2035	1,088,984	59,505,260	273,329	14,935,468	261,680	14,298,979	109,366	5,976,054	1,733,359	94,715,763
	2036	1,090,619	61,493,753	276,116	15,568,566	263,878	14,878,567	110,198	6,213,431	1,740,858	98,156,977

Source: USDA Agricultural Projections to 2029; DBEDT State Databook 2019; DBEDT Population and Economic Projections for the State of Hawai'i to 2045; SMS Estimates.

APPENDIX F. PORK CONSUMPTION BY COUNTY, FULL DATA, 2001 TO 2036

		Honolulu County		Hawai'i County		Maui County		Kaua'i County		State of Hawai'i	
	Year	*De facto* Population (Persons)	Pork Consumption (Pounds)	*De facto* Population (Persons)	Pork Consumption (Pounds)	*De facto* Population (Persons)	Pork Consumption (Pounds)	*De facto* Population (Persons)	Pork Consumption (Pounds)	*De facto* Population (Persons)	Pork Consumption (Pounds)
	2001	921,418	53,926,663	167,170	9,783,767	167,880	9,825,315	73,518	4,302,667	1,329,986	77,838,412
	2002	926,101	55,553,232	170,318	10,216,747	170,832	10,247,554	74,256	4,454,334	1,341,507	80,471,867
	2003	923,749	55,757,757	173,159	10,451,917	174,508	10,533,350	75,484	4,556,211	1,346,899	81,299,236
	2004	935,041	55,815,998	177,409	10,590,176	177,336	10,585,825	76,996	4,596,170	1,366,782	81,588,169
	2005	941,266	54,410,436	185,058	10,697,418	181,502	10,491,821	78,062	4,512,424	1,385,888	80,112,099
	2006	944,318	53,951,017	189,379	10,819,649	183,730	10,496,914	78,957	4,510,994	1,396,384	79,778,574
	2007	937,467	55,022,431	191,392	11,233,329	184,730	10,842,293	81,029	4,755,819	1,394,618	81,853,872
	2008	932,842	53,370,067	192,218	10,997,224	183,419	10,493,846	79,409	4,543,152	1,387,888	79,404,289
	2009	937,468	54,395,642	191,936	11,136,872	182,446	10,586,259	79,168	4,593,630	1,391,017	80,712,404
Historical	**2010**	988,367	54,615,742	202,412	11,184,997	194,730	10,760,500	83,186	4,596,739	1,468,695	81,157,978
	2011	1,001,509	52,822,457	205,716	10,850,052	198,870	10,488,974	85,195	4,493,429	1,491,290	78,654,912
	2012	1,020,778	54,025,110	209,495	11,087,597	202,532	10,719,088	87,281	4,619,404	1,520,086	80,451,200
	2013	1,032,428	55,802,550	212,685	11,495,603	207,486	11,214,570	89,574	4,841,481	1,542,173	83,354,204
	2014	1,038,245	54,948,491	215,934	11,428,167	211,290	11,182,394	90,388	4,783,749	1,555,857	82,342,800
	2015	1,045,153	60,358,488	220,521	12,735,262	215,419	12,440,603	92,505	5,342,235	1,573,597	90,876,588
	2016	1,048,304	61,262,966	222,345	12,993,847	217,922	12,735,354	93,571	5,468,296	1,582,141	92,460,463
	2017	1,050,210	61,314,715	225,151	13,145,041	220,790	12,890,417	94,613	5,523,818	1,590,764	92,873,993
	2018	1,049,445	62,187,382	227,362	13,472,902	223,074	13,218,758	95,407	5,653,540	1,595,288	94,532,582
	2019	1,043,661	62,776,189	228,448	13,741,140	224,251	13,488,690	95,730	5,758,138	1,592,090	95,764,158
	2020	943,499	58,112,623	208,616	12,849,244	204,883	12,619,306	87,302	5,377,173	1,444,300	88,958,348
	2021	1,006,086	60,824,474	224,360	13,564,052	219,930	13,296,229	93,567	5,656,739	1,543,944	93,341,494
	2022	1,025,792	61,519,946	230,681	13,834,637	225,710	13,536,526	95,878	5,750,132	1,578,061	94,641,241
	2023	1,045,509	62,817,253	237,060	14,243,280	231,535	13,911,324	98,205	5,900,452	1,612,310	96,872,308
	2024	1,051,147	63,400,980	240,278	14,492,604	234,266	14,129,990	99,217	5,984,362	1,624,907	98,007,934
	2025	1,056,197	63,704,377	243,364	14,678,474	236,868	14,286,656	100,174	6,041,966	1,636,603	98,711,472
	2026	1,060,276	63,576,100	246,446	14,777,346	239,446	14,357,633	101,126	6,063,712	1,647,295	98,774,790
	2027	1,064,106	63,057,385	249,374	14,777,552	241,902	14,334,779	102,035	6,046,425	1,657,480	98,219,853
Projection	**2028**	1,067,939	62,284,482	252,401	14,720,543	244,427	14,255,478	102,964	6,005,089	1,667,794	97,269,272
	2029	1,071,693	61,749,752	255,442	14,718,266	246,956	14,229,315	103,893	5,986,206	1,678,025	96,685,981
	2030	1,075,487	62,059,813	258,526	14,917,957	249,517	14,398,131	104,833	6,049,281	1,688,363	97,425,186
	2031	1,078,175	62,286,827	261,421	15,102,471	251,904	14,552,669	105,724	6,107,770	1,697,271	98,052,396
	2032	1,080,869	62,499,228	264,349	15,285,490	254,314	14,705,233	106,623	6,165,301	1,706,226	98,659,267
	2033	1,083,560	62,699,344	267,307	15,467,518	256,744	14,856,314	107,529	6,222,083	1,715,210	99,249,300
	2034	1,086,266	62,890,755	270,301	15,649,388	259,200	15,006,717	108,443	6,278,455	1,724,257	99,828,028
	2035	1,088,984	63,075,104	273,329	15,831,478	261,680	15,156,805	109,366	6,334,570	1,733,359	100,397,959
	2036	1,090,619	63,191,053	276,116	15,998,277	263,878	15,289,233	110,198	6,384,929	1,740,858	100,866,225

Source: USDA Agricultural Projections to 2029; DBEDT State Databook 2019; DBEDT Population and Economic Projections for the State of Hawai'i to 2045; SMS Estimates.

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APPENDIX B

WASTE AND WASTEWATER ALTERNATIVES

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STATEWIDE SCALABLE AND REPLICABLE LIVESTOCK HARVESTING FACILITY

INTERIM REPORT
WASTE AND WASTEWATER TREATMENT ALTERNATIVES

For

Hawai‘i Department of Agriculture

Agricultural Resource Management Division

EKNA Services, Inc.

September 2022

Contents

APPENDIX

1.0 INTRODUCTION

Over the last several decades, the disposal of waste and wastewater has been a significant roadblock in the development of the livestock industry, and agriculture in general. The number of environmental rules and regulations have increased since the 1970s and compliance has proven to be burdensome to the industry. During our discussions with harvesting facility operators, some have expressed concerns about the future disposal of solid waste and wastewater.

One of the goals for this project was to:

- Create a facility model that enables the sustainability of Hawaiʻi's beef industry, as well as addresses the economic, social and environmental impacts of a potential facility.

The objectives which are targeted by this interim report to meet this goal are as follows.

- Prepare a feasibility study, master plan and preliminary design.
    - Address socioeconomic and environmental conditions.
    - Meets regulatory criteria and requirements.
    - Replicable and scalable, to the extent practicable.

To a lesser extent the following objectives are touched upon.

- Explore ownership and sustainable business models.
- Quantify economic and social impact of business model options.

Therefore, as part of this planning effort, various alternatives were contemplated for use with the livestock harvesting facility. These alternatives include a range of conventional and non-conventional processes for the disposal of waste and wastewater.

2.0 DESCRIPTION OF WASTE AND WASTEWATER

Approximately 58 percent (58%) of live animal weight is considered inedible and in the form of solid, semi-solid or liquid materials. Certain materials such as hides can be used in other industries for by-products if sufficient quantities are available. However, given the limited number of animals harvested and lack of an in-state by-product processing facilities for these materials, other than rendering, processing of these materials was not considered feasible at this time. Unfortunately, for this study, these materials will be considered as waste. This waste is required to be disposed of appropriately to avoid consequences such as the spread of pathogens and odor, and in compliance with county, state and federal rules and regulations.

Solid waste from the livestock harvesting facility includes hides, offal, paunch, bones, fat, other inedible, manure, etc. These solids are separated during the harvesting process and/or removed from the liquid wastewater stream. Wastewater from the harvesting process includes water for washdown of the animals, animal handling, facility and equipment wash down, and water used during the harvesting process.

Human waste and wastewater will be accommodated with a separate system, which would be commercially available at the site selected. The system options are typically: 1) a connection to a sanitary sewer collection system to a wastewater treatment plant, or 2) disposal to an on-site septic tank and leach/evapotranspiration field system. Therefore, human waste and wastewater are not evaluated or considered in this interim report. This disposal system will be a facility requirement and designed to meet state and county rules and regulations at the selected site.

2.1 LIVESTOCK HARVESTING FACILITY WASTEWATER CHARACTERIZATION

In meat processing, water is used primarily for live animal holdings, washing after killing, hide or hair removal, washing after evisceration, and for cleaning and sanitizing of equipment and facilities. Meat processing wastes includes blood not collected, viscera, soft tissue, bone, urine and feces, soil from hides and hooves, and products used for cleaning and disinfection (detergents and sanitizing agents).

Significant treatment is required for livestock harvesting facilities due to high organic and nutrient content. Wastewater from these facilities has high concentrations of biochemical oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), nitrogen and phosphorus when compared to domestic wastewaters.[1] The typical wastewater composition from a livestock harvesting facility shown in Table 1.

Table 1
Wastewater Characteristics of Livestock Harvesting Effluent

Compound/Nutrient	Raw Effluent, ppm (mg/L)	After Screening, ppm (mg/L)
Biological Oxygen Demand (BOD)	4,448 (4,440)	2,424 (2,420)
Chemical Oxygen Demand (COD)	6,490 (6,478)	3569 (3,563)
Suspended Solids (SS)	4,040 (4,033)	1,010 (1,008)
Total Nitrogen	331 (330)	182 (182)
Total Phosphorus	61 (61)	34 (34)
Oil & Grease	1,714 (1,711)	429 (428)

Source: Food and Livestock Planning, Inc.

Note: Effluent does not include blood from the sticking process

[1] EPA, *Technical Development Document for the Final Effluent Limitations Guidelines and Standards for the Meat and Poultry Products Point Source Category (40 CFR 432),* 2004, 6-2.

The volume of wastewater produced among different processing plants varies greatly. Generated processing wastewater can range from 160 to 1,755 gallons per 1,000 pounds of live weight (LW). Table 2 presents the 2002 Environmental Protection Agency (EPA) *Development Document for the Proposed Effluent Limitations Guidelines and Standards for the Meat and Poultry Products Industry Point Source Category*, which provided a general guideline for estimating processing wastewaters.

Table 2
2002 EPA Wastewater Volumes Produced by Meat Facilities
(Beef Production)

	Process Wastewater Generated (gallons per 1,000 lbs. of Animal Unit)	
	First Processing[a]	**Further Processing[b]**
Small Facilities	348	672
Non-small Facilities	323	555

[a] Production unit for processing is 1,000 lbs. of live weight (LW). These numbers include facilities that may also generate wastewater from cutting operations.
[b] Production unit for further processing operations is 1,000 lbs. of finished product.
Data source: Meat and Poultry Products (MPP) detailed surveys.

Based on these guidelines, the weighted estimate is approximately 600 gals/AU of processing wastewater generated for the entire process. This estimate will be used for preliminary wastewater treatment design and sizing.

2.1.1 Consideration of Separate Waste Streams

The waste and wastewater from the stock pen and harvesting and fabrication areas of the facility have different characteristics. Blood, fat, urine, and feces are the primary sources of high BOD levels in livestock harvesting facilities. Separating the various streams of waste sources should be considered during the facility design to evaluate waste and wastewater disposal methodology.

2.1.1.1 Stock Pen Area Waste

The stock pen area waste consists of soil, and manure and other manure should be separated and disposed as solid waste while separated wash water from the stock pen can be stored in a separate tank and used for land applications or irrigation. Manure can be removed by using a screen and will lower the effluent's BOD concentration. The reduction of wash from the stock pen can reduce the pretreatment and primary treatment facilities. The estimated BOD concentrations[2] from cattle and pig manure are 27,000 ppm and 37,000 ppm, respectively.

[2] American Society of Agricultural Engineers, 1999.

2.1.1.2 Harvesting Operations

The amount of blood in the processing wastewater significantly increases the concentration of BOD and nitrogen. Therefore, during the harvesting process, blood is typically collected and recovered separately. If not separated, blood from beef cattle has a reported BOD of approximately 156,781 ppm (156,500 mg/L) with an average of 32.5 pounds of blood produced per 1,000 pounds live weight.[3]

2.2 HAWAI‘I STATE DEPARTMENT OF HEALTH GUIDELINES FOR LIVESTOCK HARVESTING FACILITY WASTE MANAGEMENT

The Hawai‘i Department of Health (HDOH) Guidelines for Livestock Harvesting Facility Waste Management[4] provide guidance for treatment system location and on-site treatment design.

- Treatment and storage facilities for animal wastes should provide a minimum buffer distance of 1,000 feet from public drinking water resources, and 50 feet from surface water resources and/or state waters.
- Livestock waste products should not be applied to land within 50 feet of public drinking water resources and/or 50 feet from surface water resources.
- Surface drainage should be diverted around the livestock production area.
- Livestock facilities should not be located, if at all possible, over critical water aquifers and sources of drinking water.
- All open-surface impoundment such as lagoons shall be designed to contain all wastewater, manure, clean water, sludge accumulation, net surface rainfall including runoff and the direct precipitation of a 25-year 24-hour rainfall event.
- Livestock waste lagoon shall be lined with a synthetic liner if the facility is located:
    - Within 1,000 feet from a public drinking water resource;
    - Withing 50 feet from surface water resources and/or state waters;
    - Over critical water aquifers and sources of drinking water.
- Waste Storage Structures
    - Waste storage structures designed to receive contaminated runoff or designed for overflow during a catastrophic or chronic rainfall precipitation event should be provided with an overflow spillway and flow contour to provide the best overflow discharge location, flow direction, and outfall area having the least public and environmental impact.

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[3] EPA, *Technical Development Document for the Final Effluent Limitations Guidelines and Standards for the Meat and Poultry Products Point Source Category (40 CFR 432),* 2004, 6-4.

[4] University of Hawai‘i-Mānoa, Cooperative Extension Service, College of Tropical Agriculture and Human Resources, *Guidelines for Livestock Waste Management*, 2010.

- Impervious Soil Surfaces
    - Rainfall diversion drainage and overflow discharge contours subject to scouring should be provided with solid erosion and sediment control measures. Soil surfaces serving the confined feeding operation or the waste system collection, transfer conduit treatment, or storage foundation for process generated waste containing drainable liquids should be of materials impervious to liquids infiltration. The following conditions shall be met when using in-situ soil, borrowed clay or clay/bentonite mixtures:
        - Minimum thickness shall be two feet (2 ft.);
        - Placement and compaction shall be done in lifts not to exceed 6 inches in compacted thickness;
        - Liquid discharge velocity shall be $1x10^{-7}$ cm/sec) or less;
        - Construction and compaction shall be carried out to reduce void spaces and allow the soil to support the loadings imposed by the waste disposal operation with settling.

3.0 OFF-SITE DISPOSAL ALTERNATIVES

The use of off-site disposal alternatives for waste and wastewater is currently available in certain areas of the state. Typically, the use of off-site disposal facilities is relatively inexpensive when compared to on-site disposal facilities. The lower cost is due to the cost sharing of capital improvement and operational costs by a larger group of customers. The off-site facilities must be operated in compliance with local, state, and federal rules and regulations.

The major costs for the livestock facility operator for off-site disposal are processing fees, construction, and operation of on-site storage of waste before transfer and transferring of waste and/or wastewater to the off-site treatment/disposal facility. Typically, waste and wastewater are transmitted to the off-site facility by trucks and/or pipelines. As the disposal of solid waste and wastewater is a key hurdle in operating a livestock harvesting facility, it would be advantageous to have the availability of off-site disposal as a significant site evaluation criteria.

Major off-site disposal alternatives include:

- Solid waste disposal sites (landfill or composting sites);
- Wastewater treatment facilities;
- Anaerobic digesters (which may be associated with other facilities); and
- Rendering plants or other facilities, which can reuse livestock waste.

3.1 SOLID WASTE FACILITIES

An estimate for the quantity of solid waste from a livestock harvesting operation is about 25% (25 percent) of the live weight and depends on the efficiency of the facility. Off-site solid waste facilities are also known as landfills and/or composting facilities. These facilities are typically operated by the government and regulated by the Hawaii Department of Health. Currently, some landfills allow the disposal of livestock harvesting waste. However, this alternative may not be available in the future, if there are future changes to statutes, ordinances, and policies.

Most composting facilities do not allow for the disposal of animal waste due to bacteriological and other contamination concerns. Composting of animal waste requires an additional handling system to address sterilization, odor, insects, etc. In the City and County of Honolulu, the available options for the disposal of animal waste are through rendering or landfill.

3.2 WASTEWATER TREATMENT FACILITIES

Municipal wastewater treatment systems are typically owned by government agencies and located in urban or high population density areas of the state. The wastewater system consists of a network of collection sewers, pump stations and treatment plants. In Hawaiʻi, wastewater treatment plants (WWTP) discharge effluent into salt and/or freshwater bodies of water. The quality of the discharge from a WWTP is determined by the level of treatment at the plant. Typical treatment includes odor control, screening, primary, secondary, tertiary, biosolids handling, disinfection and sludge treatment. Higher levels of treatment will allow for the effluent to be recycled and typically annotated as R-3, R-2 and R-1.[5]

Each wastewater treatment system will have different rules and regulations as to the acceptance of livestock harvesting facility wastewater into their system. Based on City and County of Honolulu requirements and the high nutrient load from the livestock harvesting facility, an on-site pretreatment system will be required prior to discharge into the city's wastewater treatment systems. A pretreatment system will be required to improve the quality of the wastewater to a level acceptable to city requirements. Additional information can be found in Appendix A.

3.3 ANAEROBIC DIGESTERS

Some wastewater treatment systems and other facilities may have anaerobic digesters as part of their operation. An anaerobic digester is typically an in-vessel system that allows for the natural breakdown of organic material without oxygen (anaerobic). The system is used for the conversion of animal manure, food scraps, fats, oils and greases; industrial organic residue; and biosolids

[5] State of Hawaiʻi, Administrative Rules 11-62-26. The use of recycled water is determined by the level of treatment. R-3 has limited reuse potential and R-1 is the highest reuse potential. The classifications are: R-3 water is considered *Undisinfected Secondary Recycled Water*; R-2 water is *Disinfected Secondary-23 Recycled Water;* and R-1 water is *Significant Reduction in Viral and Bacterial Pathogens*.

(sewage sludge). If one is available to the facility, the feasibility of disposal into this system should be explored.

3.4 RENDERING FACILITIES

Solid waste can be transported to a rendering facility, and one located in Kapolei, O‘ahu. The facility will take all solid waste and blood, with the possible exception of hides.[6] The owner/operator of the livestock harvesting facility should contact the rendering company directly to discuss rates and terms. Neighbor island facilities will need to ship the waste via Young Brothers to O‘ahu if the rendering facility is to be used. The Kapolei rendering facility produces various by-products such as biodiesel and fertilizer from their input waste stream.[7]

3.5 OTHER FACILITIES

Other off-site facilities may take solid waste for pet food, fish food, or other uses such as pharmaceutical and cosmetics. In the past, there have been informal inquires by companies which promote these types of products. Unfortunately, the study could not verify the existence of these types of industries in Hawaii. In the future, these industries may be available in Hawaii or as an export commodity. In addition, if pet food were to be produced from the harvesting facilities, the food safety regulations could be stringent and require upgrades to the facilities.

4.0 ON-SITE WASTE AND WASTEWATER TREATMENT ALTERNATIVES

The onsite treatment of solid waste and wastewater would require the construction of on-site facilities and operation of those facilities by the facility operator. These facilities add to the cost of construction and operation, and relatively more costly than off-site disposal and treatment. The need for on-site waste and wastewater alternatives is based on the fact that most non-urbanized areas in the state do not have convenient access to a wastewater treatment system.

Conventional wastewater alternatives are further discussed in Appendix A. Conventional and non-conventional alternatives presented for consideration include the following:

- Pretreatment
    - Screening,
    - Grease interceptor;
    - Dissolved Air Flotation, and
    - Filtration;

[6] The shipment of hides to China is a possibility, but it requires shipment to a broker in the continental United States prior to shipment to China. Therefore, this option was deemed infeasible.

[7] Personal communication June 2021 with Baker Commodities and EKNA Services, Inc.

- Conventional Treatments
    - Septic tank,
    - Aerated lagoon,
    - Membrane bioreactor,
    - Moving bed biofilm reactor,
    - Seepage pit,
    - Evapotranspiration,
    - Leach field, and
    - Sludge Drying bed; and

- Non-conventional Treatments
    - Incineration,
    - Anaerobic digester,
    - Constructed wetland,
    - Composting,
    - Hydrolysis and
    - Alkaline Hydrolysis.

4.1 SOLID WASTE DISPOSAL

The on-site treatment of solid waste (offal, blood, hides, sludge, etc.) is limited. The following alternatives are considered: anaerobic digester (explained in the previous section), sludge drying bed, alkaline hydrolysis, composting, and incineration.

4.1.1 Sludge Drying Beds

Sludge drying beds are commonly used facility for sludge dewatering in the United States. The drying bed is a shallow tank divided into multiple rectangular cells. The beds are constructed with layers of sand (9 to 15 inches) over graded gravel (8 to 18 inches), with subsurface drains to divert water away from the beds. The drying of sludge can be divided into two different stages: drainage and evaporation. Once dried, the sludge is removed and disposed of. The drained water or effluent can be recycled back into the wastewater stream for further processing.

4.1.2 Alkaline Hydrolysis

This application is used in the cremation industry for humans and animal carcasses, and is also known as biocremation, resomation, flameless cremation or water cremation. The system uses an alkaline solution, water pressure and high temperatures (150°F to 300°F) to decrease the decomposition time of flesh and bones. There are approximately 18 states that have approved alkaline hydrolysis for human cremation. As of 2004, there were reportedly approximately 30 to 40 alkaline hydrolysis units in the United States. At that time, the largest unit was owned and operated by USDA and had a capacity of 7,000 pounds. The benefits of this system, especially in an urbanized area, is the reduction of public nuisance concerns such as odor. The systems are commercially available, and the following are links to two companies as a sample of services and products available. There are probably other sites and companies that provide these and other services and equipment.

- [Alkaline Hydrolysis for Pets and Farm Animals | Aquamation International (aquamationindustries.com)]
- [Applications - BioLiquidator]

Waste products include: 1) a residue that is approximately 2 percent (2%) of the input body weight; and 2) liquid effluent. The residue can be used as a soil amendment. The disposal of the liquid effluent could be allowed into a sanitary sewer system depending on the sewer system requirements or to an on-site wastewater facility. The hydrolysis unit can be operated by one individual, and in 2003, the estimated cost of operation was $0.16 per pound ($320/ton), including labor and sanitary sewer disposal fees. USDA reports the capital cost of a mobile trailer is $1.2 million in 2003 dollars. The mobile trailer has the capacity to digest 4,000 pounds of carcasses in eight (8) hours. According to USDA, the alkaline hydrolysis process destroys all pathogens listed as index organisms by the State and Territorial Association on Alternative Treatment Technologies (STAATT I and STAAT II). The process has been approved for the treatment of infectious wastes in various states. A carcass disposal service by the livestock harvesting facility owner/operator may be an additional revenue source for the operator.

4.1.3 Composting

Composting is the decomposing of waste using a biological method, typically by microorganisms and/or insects. Composting of animal waste for smaller livestock harvesting facilities is utilized to treat their solid waste products at several sites on the continental United States. As composting will include animal waste, there are only two methods that are recommended: 1) passive aerated windrow and 2) in-vessel composting. For this project, only the passive aerated windrow method will be considered. Either method will require the solid waste to be sent through a large grinder to decrease the time of composting. If the solid waste is not ground, the composting of the solid waste may take years.

Composting needs to include materials such as plant material from on and off-site, and blood, bones and manure. The mix of input material will provide carbon and moisture in the windrows and improve the quality of the compost. The compost pile needs to be turned regularly and must reach a minimum temperature of 140°F. If the proper temperature and conditions are met with adequate turning (rotation), composting should be completed within 10 to 12 weeks. A private composting facility in the continental United States does not rotate the compost and states the composting takes six (6) to eight (8) months. This facility composts all solid waste from the facility, including hides and bones. This facility also incorporates community green waste to mix in with the solid animal waste.

Compost windrows must be protected from rainfall to avoid runoff issues during rainy periods, either with temporary covering or a permanent structure. In addition, odor and insect controls will be required if the facility is located close to other occupied lands. As composting does not require a permanent structure, the largest cost for a Hawaiʻi facility will be land acquisition. Assuming proper operation and turning, the land size for a 20 hd/day facility operating two days a week is about an acre. For the 70 hd/day facility the land area is approximately 2.5 acres. A detailed analysis is provided in Appendix B.

4.1.4 Incineration

Incineration is a viable option for disposal of solid waste, only if the incineration system does not require costly air quality filtration, permitting and monitoring. Therefore, it is proposed that an oven method be used to sterilize and partially decompose the solid waste. For this project, the recommend method involves the use of hydro-electrolysis to provide the energy for the system.

In this process, electrolysis converts water to hydrogen gas and oxygen gas by using direct current (DC) and two electrodes. The gas is stored in containers for future use. The water would be an output from the constructed wetland and will need filtering and disinfection prior to entering electrolysis machine.

Hydrogen will be used as an energy source for a hydrogen-fueled oven to cook the solid waste. Stored oxygen would be used to aerate the bio-lagoon, thus increasing the dissolved oxygen content. The increase in dissolved oxygen content enhances the pond's ability to process BOD.

4.2 ON-SITE WASTEWATER TREATMENT

An onsite wastewater treatment system will require capital and operating costs and may require additional staff. Depending on the complexity of the wastewater treatment, additional training or expertise may be required of staff. In addition, an on-site wastewater treatment adds to the overall responsibility and liability of the livestock harvesting facility. Detailed information on conventional wastewater treatment systems is presented in Appendix A.

4.2.1 Wastewater Disposal Systems Location Considerations

There are various rules and regulations that may determine the location, type, design, characteristics and construction of wells, surface ponds, seepage pits, leach fields, etc. The Hawaiʻi rules and regulations are administered by the Hawaii Department of Health (HDOH) and found in Hawaiʻi Administrative Rules Title 11 Chapter 62. The various county water supply organizations have zones or similar requiring approval for the location of cesspools, septic tanks, and individual anaerobic treatment units, wastewater treatment facilities and stabilization ponds. This approval is to ensure the system will not contaminate groundwater resources used or expected to be used for domestic water supplies.

The HDOH administers the Underground Injection Control program (UIC) which serves to protect the quality of Hawai‘i’s underground sources of drinking water from injection well activities. Hawai‘i Administrative Rules, Title 11, Chapter 23 provide conditions governing the location, construction and operation of injection wells. Pursuant to Hawai‘i Administrative Rules, Title 11, Chapter 23 Section 06, wastewater from a livestock harvesting facility disposed through a seepage pit would be classified as a Class V[8], and no wells are permitted to be constructed if fluids can flow into an underground source of drinking water. Any new injection well shall be sited in an area that extends at least one-quarter mile from any part of a drinking water source.

UIC maps for each island can be found on the state of HDOH Safe Drinking Water Branch website. These maps show the “UIC line”, which is the boundary between non-drinking water aquifers and underground sources of drinking water. Restrictions on injection wells vary, depending on whether the area is inland (mauka) or seaward (makai) of the UIC line.

Areas that are located oceanside (makai) of the UIC line are:

- Underlying aquifer not considered a drinking water source;
- Wider variety of wells allowed;
- Injection wells need UIC permit or permit exemption; and
- Permit limitations are imposed.

Areas located toward the mountain (mauka) of the UIC line:

- Underlying aquifer considered a drinking water source;
- Limited types of injection wells allowed;
- Injection wells need UIC permit or permit exemption; and
- Permit limitations are imposed and requirements are more stringent.

4.2.2 On-site Wastewater Treatment and Alternatives

Conventional wastewater treatment typically has three (3) major treatment categories: (1) pretreatment (removal of floating and settleable solids); (2) primary treatment (removal of most organic matter) and (3) secondary treatment (removal of nitrogen, phosphorus and/or suspended solids).[9] Additional treatment methods are required to further disinfect,

[8] The Environmental Protection Agency Class V – Injection of Non-Hazardous Fluids into or Above Underground Sources of Drinking Water.

[9] EPA, *Technical Development Document for the Final Effluent Limitations Guidelines and Standards for the Meat and Poultry Products Point Source Category (40 CFR 432),* 2004, 8-1.

increase water quality and purity of the effluent, and/or to meet various effluent quality requirements.

4.2.2.1 Flow Equalization Tanks or Ponds

Livestock harvesting facilities have a variation of wastewater flows throughout each day and throughout the week. A significant difference in flow occurs between processing and cleanup periods when compared to no workdays. To avoid the necessity of sizing subsequent treatment units to handle peak flows and loads, in-line flow equalization tanks are sometimes used. Equalization facilities consist of a holding tank and pumping equipment designed to reduce the fluctuations of waste streams.

4.2.2.2 Pretreatment

Pretreatment involves removal of floating and settleable solids. Typical unit processes used for pre-treatment are screening, catch basins and grease interceptors, dissolved air flotation (DAF) and flow equalization. Pretreatment can significantly reduce the suspended solids and BOD in the effluent prior to biological treatment. It should be noted that pretreatment will most likely be required for off-site disposal into a wastewater treatment system.

Screening

Screening is typically the first and most inexpensive form of pretreatment. Screening reduces the concentration of particulate matter and soft tissue and separates debris from wastewater. The removal of these solids reduces the damage or interference to downstream equipment and reduces BOD and COD loading in the effluent. There are several types of screens used in wastewater treatment, including static or stationary, rotary drum, brushed and vibrating.

Catch Basin/Grease Interceptor

Catch basins and grease interceptors are used to separate grease and finely suspended solids from wastewater by the process of gravity separation. The basic setup employs a minimum turbulence flow-through tank where solids heavier than water sink to the bottom, and the grease and fine solids rise to the surface. The unit is equipped with a skimmer to remove the grease and scum from the top of the water and a scraper to remove sludge at the bottom of the tank. Typically, catch basins and grease interceptors are rectangular and relatively shallow with a typical detention time of 30 to 40 minutes. Tanks are typically constructed of concrete or steel.

Steel tanks will have additional maintenance due to wear from abrasion and corrosion, although steel tanks have the advantage of being semi-portable and more easily modified for future expansion or changes. For a small livestock harvesting facility, a septic tank or catch basin to remove fine particles from the wastewater stream would be the most economical choice as these systems have no moving parts and no electrical equipment; therefore, maintenance costs will be minimal.

Dissolved Air Flotation (DAF)

A dissolved air flotation (DAF) unit is designed to remove grease and fine solids but has the ability to remove very small or light particles more completely and in a shorter amount of time. Air is blown into the water to generate fine bubbles, where small, suspended matter in the water adheres to the air bubbles and floats to the water surface scum layer. Flocculation and coagulation treatment chemicals are often added to the effluent prior to the DAF to improve the performance.

The DAF is capable of removing 95% of suspended solids, fats, oil and grease from the wastewater stream, with a retention time of 10 to 20 minutes. The DAF will require a trained technician and adds to the operational cost of the livestock harvesting facility. The DAF will require a continuous flow therefore a storage or equalization tank/pond will be required.

4.2.2.3 Biological Treatment

The objective of primary treatment is to reduce the BOD through the removal of organic matter using microorganisms to biologically remove contaminants from the wastewater. wastewater treatment processes can be aerobic or anaerobic. Common systems used for biological treatment of wastewater include natural treatment systems like waste stabilization ponds and constructed wetlands, or mechanical treatment systems like activated sludge systems, extended aeration, oxidation ditches and sequencing batch reactors.

Anaerobic Treatment

Anaerobic wastewater treatment processes use organisms that function in the absence of molecular oxygen as the mechanism for reducing organic matter and BOD. The anaerobic processes convert organic contaminants to a biofuel gas consisting of carbon dioxide and methane gas. This treatment process uses less energy than mechanical aeration processes. Anaerobic lagoons are a common treating process for livestock facility wastewater, although the anaerobic lagoon alone will not be able to treat the wastewater to acceptable BOD levels for discharge. When land availability is an issue, alternative mechanical anaerobic processes such as anaerobic contact (AC), up-flow anaerobic sludge blanket (UASB) and anaerobic filter (AF) processes can be used.

Aerobic Treatment

The primary objective of aerobic wastewater treatment processes is transforming soluble and colloidal organic compounds into microbial biomass, with subsequent removal of biomass by settling or mechanical separation as the primary mechanism for removal of organic matter and BOD. Microorganisms involved in the aerobic treatment process require free dissolved oxygen to reduce biomass in the wastewater. Aerobic wastewater treatment processes convert contaminants to carbon dioxide, water, additional microorganisms, and other end products. Advantages of using aerobic wastewater treatment processes include low odor production, fast biological growth rate, no elevated operation temperature requirements, and quick adjustments to temperature and loading rate changes. Operating costs for aerobic systems are higher than the costs of anaerobic systems due to maintenance, management, and energy requirements of artificial oxygenation. Aerobic wastewater treatment processes can be broadly divided into suspended and attached-growth processes. Aerobic lagoons and various forms of the activated-sludge process — such as conventional, extended aeration, oxidation ditches and sequencing batch reactors — are examples of suspended-growth processes; trickling filters and rotating biological contactors are examples of attached-growth processes.

4.2.2.4 Mechanical Wastewater Treatment Alternatives for Small Livestock Harvesting Facility

Mechanical treatment systems are a viable option for the treatment of wastewater if offsite wastewater systems are not available. Federal, state, and local rules and regulations will dictate the level of processing required for the effluent prior to discharge into the receiving water body or location. Two system for small livestock facilities are presented below and in Appendix A: 1) membrane bioreactor, and 2) a moving bed biofilm reactor. These facilities will increase the capital improvement cost of the facility and required trained operators.

Membrane Bioreactor

Membrane bioreactors uses a combines membrane filtration and biological treatment to remove sludge and produces an effluent that meets the minimal requirements for discharge. However, depending on the receiving water or location, further treatment may be required. The use of a membrane bioreactor will require pretreatment and an aerobic treatment to remove most of the suspended solids and sludge. The initial capital cost of a membrane bioreactor is in the range of \$0.74 million to \$1.4 million in 2021 dollars.

Moving Bed Biofilm Reactor
A moving bed biofilm reactor biologically has been used to treat industrial and municipal wastewaters. The system uses a media (biofilm) which ‘collects’ bacteria. Once attached to the media, the bacteria treat the elements in the wastewater in a natural process. A screening system will be required to remove the larger solids and an equalization tank/pond will be required to stabilize the flow into the system. A clarifier or DAF would be recommended as a post-treatment to collect sludge prior to the discharge of the effluent.

As the BOD and nutrient loading from the livestock harvesting facility is heavy, pretreatment of the effluent may be required and depends on the capacity of the moving bed biofilm reactor design. The moving bed biofilm reactor has a compact footprint, and some systems are modular to allow for expansion. A trained operator will be required for this system. The initial capital cost for an MBBR is between \$0.9 million to \$1.1 million in 2021 dollars.

4.2.2.5 Conventional On-Site Treated Effluent Disposal Alternatives

Conventional on-site treated effluent disposal alternatives, include the leach field, seepage pit, and evapotranspiration pond. These systems are described in more detail in Appendix A.

Seepage Pit and Leach Field
Both the leach field and seepage pit collect treated effluent in a subsurface space. A leach field will further reduce contaminants and impurities in the effluent. This collection method allows the treated effluent to percolate into the surrounding soil. These systems are sized based on the flow rate of the discharge and may be large for large flow rates. The size and effectiveness of these system are dependent on the percolation rate of the surrounding soil.

These systems are low maintenance systems and require minimal operational intervention. These systems require treated effluent to enter the soil and potentially affect groundwater, therefore there are location restrictions for these systems. The seepage pit is also regulated as an injection well and is regulated by the HDOH UIC program. If the systems are located near the coast or has the potential to reach the ocean, then a Clean Water Act permit will be required.

Evapotranspiration Pond System

In locations where subsurface disposal of treated effluent is not allowed (within No Pass Zones or above the UIC line), a surface disposal system if used. The evapotranspiration pond, as the name implies, uses evaporation and plant transpiration to eliminate the liquid discharge. The pond is lined to prevent percolation into the surrounding soil, and filled with tiles, gravel, sand to provide a storage area. Plants are used to improve transpiration of the system.

The system is a low maintenance system and relatively more expensive than a leach field or seepage pit system. In addition, adequate storage volume will be required to store rainfall in the pond.

4.2.2.6 Natural Wastewater Treatment System Alternatives

Natural wastewater treatment systems are biological treatments that use minimal energy for the treatment and management of municipal and industrial wastewaters. These systems typically rely on natural factors to treat wastewater. Plants can be incorporated into these wastewater treatment systems to help with nutrient removal. These systems allow wastewater to be treated in a passive manner, and typically have less maintenance and require less expertise to operate. Utilizing these natural biological processes are effective and economical. Common natural wastewater treatment systems are waste stabilization ponds and constructed wetlands. As these are open pond systems, additional storage capacity will be required to store rainfall and eliminate runoff.

Waste Stabilization Ponds

The main benefits of using a wastewater treatment pond system are that the energy requirements to run the system are relatively low and operation and maintenance (O&M) are relatively uncomplicated when compared to mechanical treatment options. Treatment ponds are designed to enhance the growth of natural ecosystems that are either anaerobic, aerobic, or facultative (combination of anaerobic and aerobic).

Anaerobic Ponds

An anaerobic pond is a deep impoundment, essentially free of Dissolved Oxygen (DO) with sufficient volume to permit sedimentation of settleable solids, to digest retained sludge and to anaerobically reduce some of the soluble organic substrate. Anaerobic ponds are not aerated, heated, or mixed. This type of pond is typically used for pretreatment of high-strength industrial wastewaters or municipal wastewaters. Typical BOD loading for an anaerobic pond is 200 to 500 lbs./acre/day.

The depth of an anaerobic pond is typically 8 to 15 feet deep. At such depths, the effects of oxygen diffusion from the surface are minimized, allowing anaerobic conditions to dominate. Approximately 50-85% (50-85 percent) BOD conversion can be expected, and sludge removal is infrequently needed. Typically, an anaerobic pond system will have longer detention times than other wastewater treatment pond designs. Detention times are typically between 20 to 50 days.

Although anaerobic ponds are effective at treating high-strength organic waste, they normally are not designed to produce effluent that can be discharged due to a high level of anaerobic byproducts remaining. A secondary pond with aerobic treatment is typically used to further treat the wastewater to acceptable limits.

Anaerobic ponds can emit unpleasant odors, which may be an issue depending on the facility location. A common practice is to recirculate water from facultative or aerated pond sections to provide a thin aerobic layer at the surface, which prevents odors from escaping into the air. The combination of gasses generated by anaerobic wastewater treatment processes are commonly referred to as biogas, and it can be released directly to the atmosphere, collected, flared, or used as a boiler fuel. A cover can be provided to trap and collect the biogas produced in the process, but this is not a common practice.[10]

Aerobic Ponds

Aerobic ponds are large, shallow basins that use algae in combination with other microorganisms to treat the wastewater. Typically, they are up to 1.5 to 5 feet deep, and are designed to optimize the production of algal biomass as a mechanism for nutrient removal. In aerobic ponds, oxygen is supplied by a combination of natural surface aeration and photosynthesis.

[10] Metcalf & Eddy, Inc., *Wastewater Engineering: Collection, Treatment, Disposal*, 1972

Oxygen released by the algae during photosynthesis is used by the non-photosynthetic microorganisms present in the aerobic degradation of organic matter, while the nutrients and carbon dioxide released by the non-photosynthetic microorganisms are used by the algae.

Aerobic ponds can produce a stable effluent with short detention times, typically as short as 2 to 6 days. Shallow depths allow penetration of ultraviolet (UV) light that may reduce pathogens. Without supplemental aeration, dissolved oxygen concentrations vary from supersaturation due to photosynthesis during daylight hours to values at or approaching zero at night. Mechanical mixing may be required to prevent algae from settling and producing an anaerobic bottom layer in the pond. Effluent will have high suspended solids due to algae production and will require a polishing or settling pond as the final cell.

Facultative Ponds

Facultative ponds are usually 3 to 8 feet deep or deeper, with an aerobic layer overlying an anaerobic layer. These pond systems should have a detention time from 5 to 50 days, depending on the nutrient loading and level of treatment required. The aerobic treatment processes in the upper layer provide odor control and nutrient and BOD removal. The anaerobic fermentation process occurs in the lower depths and includes sludge digestion, denitrification, and some BOD removal.

Facultative ponds may be modified by the addition of mechanical aeration to increase dissolved oxygen content and facilitate the reduction of BOD. Facultative lagoons are moderately effective in removing settleable solids, BOD, pathogens, fecal coliform, and ammonia. They are easy to operate and require little energy, especially if the system is designed to operate with gravity flow. Settled sludges and inert material require periodic removal in shallow facultative ponds. Suspended solid concentration may increase due to algae production.

Aerated Ponds

Aerated lagoons are earthen basins used in place of concrete or steel tanks for suspended growth biological treatment of wastewater. Aerated lagoons are typically about 8 to 15 feet deep and require mechanical or diffused air systems for aeration and mixing. Typically, aerated ponds will have shorter retention times than anaerobic and facultative ponds.

Aerated ponds will require less land than facultative ponds and the process is reliable and relatively easy to operate. Aerated lagoons are more complex and will require additional maintenance and operational costs than the treatment lagoons due to the use of mechanical aeration equipment. Aerated lagoons are not as effective as facultative ponds in removing ammonia nitrogen or phosphorus, unless designed for nitrification. In addition, sludge removal is more frequent when using aerated ponds than facultative ponds.

Constructed Wetlands

The use of an anaerobic, aerobic, or facultative pond as described above reduces the BOD and suspended solids to a lower level. However, secondary treatment is usually required, especially for a livestock harvesting facility, to remove suspended or dissolved substances to reduce BOD, nutrient concentrations and suspended solid concentrations for the discharge of the final effluent. In current systems, a constructed wetland system is implemented and is designed to mirror the natural wetland process.

Generally, the wetland is of a rectangular-shaped basin, which is lined with natural soil and other materials such as clay or a synthetic liner, to make the wetland impervious and to store wastewater. The filter bed can be made up of various medium as long as the material doesn't corrode from the wastewater, typically gravel and/or sand. There is also an inlet and outlet, made up of piping to allow for wastewater to flow in and out of the wetland. Vegetation is used in the wetland to remove nitrates and phosphorus and decrease BOD levels.[11]

Wetlands are usually more cost-effective than conventional wastewater treatments and have lower operation and maintenance costs, as well. The routine operation and maintenance requirements are similar to those of a facultative lagoon. Another benefit of using wetlands as a wastewater treatment system is that wetlands can be designed to handle fluctuating water levels.[12] There is also a reduction in odor from the wastewater with wetlands compared to conventional wastewater treatment systems.

[11] EPA, *Constructed Wetlands Treatment of Municipal Wastewaters,* 1999, 97-99, 66-67.
[12] EPA, *A Handbook of Constructed Wetlands,* 1990, 17.

Subsurface Flow Constructed Wetland

A subsurface flow constructed wetland (SSFCW) is a type of wetland used in secondary treatment to eliminate nitrates and phosphorus, as well as remaining BOD or suspended solids concentrations from the pretreatment or primary treatment system. The wastewater level is below the top of the gravel bed, which not only minimizes exposure to people and the surrounding environment, but also more efficient in the removal of nutrients when compared to surface flow wetlands.

A SSFCW usually consists of a gravel bed, soil, inlet and outlet structures, and vegetation. The medium used for the gravel bed varies as well as the gravel size, but the importance of the gravel bed is to filter wastewater, support vegetation in the wetland, and serve as a growing medium for bacteria.[13]

A constructed inlet and outlet draining system must be installed in the wetland to allow for the effluent flow. The type of vegetation used in wetlands varies on location, temperature, and the surrounding environment. A disadvantage of using a SSFCW is the potential for plugging. Plugging would occur due to high concentrations of solids, therefore a pretreatment system must be implemented prior to the constructed wetland to reduce the solids loading. Another disadvantage is the requirement is adequate land area for the wetland.[14]

Surface Flow Constructed Wetland

A surface flow constructed wetland, or free water surface system (FWS), is designed so that the water enters at the wetland surface. Vegetation in the wetland grows freely without the presence of a gravel bed. This allows for most of the removal of nutrients to be completed by the microbial flora within the wetland.

Some benefits to using surface flow wetlands are their low cost compared to subsurface systems, ease of management and maintenance, and efficiency to treat high strength effluent.[15] Surface flow constructed wetlands are usually used to treat large volumes of wastewater. However, phosphorus removal is typically very minimal and there is always a small

[13] Savannah River Site, *Review of Constructed Subsurface Flow vs. Surface Flow Wetlands,* 2004, 14.
[14] EPA, *Wastewater Technology Fact Sheet Wetlands: Subsurface Flow,* 2000, 4.
[15] Salman Zafar, Bioenergy Consult, *Biogas from Slaughterhouse Wastes,* 2020.

amount of organic matter in the effluent from dead plant materials. Surface flow constructed wetlands require adequate land area.[16]

4.2.2.7 Aquatic and Terrestrial Plants for Nitrogen and Phosphorus Removal

Both aquatic and terrestrial plants provide an effective way of decreasing phosphorus and nitrogen levels within wastewater. Plants can be incorporated into both the lagoon design and wetland design. Plants play an important role in wetland and lagoon systems because they remove contaminants, provide oxygen, increase the substrate porosity and infiltration rates, and are also aesthetically pleasing.[17] Three plant types are identified: 1) floating aquatic plants, 2) emergent aquatic macrophytes, and 3) terrestrial plants.

The use of plants will require more maintenance to remove plant material. The plant material would be used to supplement an on-site composting facility to provide increase composting efficiency and quality. Floating aquatic plants will increase debris levels due to dead plant tissue and could lead to clogging. The live and dead plant material will be a benefit to a facility proposing a compost facility. The plant will serve as a source of carbon and other nutrients which will be necessary to breakdown the proteins, bone, and other solid waste. Table 3 provides examples of plant material that can be used in the pond and constructed wetland.

Table 3
Examples of Plants for Pond and Wetland Treatment

Types of Plants	Native Plants	Non-native Plants
Floating Aquatic Plants	‘Ae‘ae	Duckweed, water hyacinth
Emergent Aquatic Macrophytes	Pu‘uka“a,‘ahu‘awa, makaloa, mha‘akai, neke fern	Cattail, bulrush, giant reed, canna lily, arrowhead, green arum
Terrestrial Plants	‘Uki, ‘uki‘uki	Alemangrass, paragrass, floralta limprograss, bermudagrass

[16] EPA, *Constructed Wetlands Treatment of Municipal Wastewaters,*1999, 97-99, 66-67.
[17] MDPI Sustainability, *Aquatic Macrophytes in Constructed Wetlands: A Fight against Water Pollution,* 2020, 6.

Floating Aquatic Plant (FAP) System

A floating aquatic plant (FAP) system uses floating aquatic plants such as duckweed or water hyacinths to remove nitrogen, phosphorus and metals from the wastewater. Microbes attach to the plant roots to reduce BOD load, nitrify ammonium, and denitrify NO_3 to nitrogen gas.

Usually, FAP systems have lower reaction rates, higher construction, and operating costs, and are more susceptible to plant pests and pathogens. FAP systems are not recommended in areas with cold temperatures.[18] In a FAP system, the aquatic plants form a dense vegetative covering on the surface of the water, therefore maintenance is required to control the amount of water surface covered by the plants. Adequate open surface area is required to allow for adequate algal populations growth and to provide oxygen transfer at the air/water interface.

4.2.4.2 Emergent Aquatic Macrophytes

Emergent aquatic macrophytes are plants that have their roots submerged in shallow water but have their vegetative parts above the surface of the water. These plants are thought to be the most productive of all aquatic macrophytes because their roots are in the sediment submerged beneath the water, while their leaves are exposed to the air and sunlight allowing for the process of photosynthesis to take place. These types of plants are efficient in removing phosphorus and nitrogen through uptake of their roots and evapotranspiration through their leaves.

4.2.4.3 Terrestrial Plant System

Terrestrial plants can be planted around the edges of the wastewater lagoon or within a subsurface flow wetland. Terrestrial plants need to have roots systems which can tolerate moist to wet soil conditions. Most terrestrial plants cannot be fully submerged for extended periods. Studies have shown that terrestrial plants have the potential to reduce phosphorus levels. The referenced study shows a reduction from an average of 14.1 ppm (14.1 mg/l) to an average of 0.73 ppm (0.73 mg/l). [19]

[18] Natural Resources Conservation Service, *Environmental Engineering National Engineering Handbook Chapter 3 Constructed Wetlands,* 2009, 3-4.
[19] Ecological Engineering, *Use of Aquatic and Terrestrial Plants for Removing Phosphorus from Dairy Wastewaters,* 1995, 371-390.

4.3. EXAMPLE: VOLUME ANALYSIS FOR A NATURAL POND SYSTEM

This example shows the flow and pond volumes for the two livestock harvesting concepts presented for beef processing: 20 AU/day, and 70 AU/day. The wastewater flow is based on a wastewater load of 600 gallons per AU (gal/AU) for slaughter and fabrication. As processing and fabrication may or may not occur on the same day, the example averages the load over a week. A process schematic for this example is shown in Exhibit 1 and the sample computations are shown in Appendix C.

Table 4 provides a summary of initial effluent flow and storage volumes for the partially mixed aerated pond system and constructed wetlands. The final effluent is discharged into a leach field. The size of the leach field is not included at this time and will be determined based on site-specific soil types and location of the facility.

Table 4
Estimated Volume of Facultative Pond and Constructed Wetlands

Concept	Days for Slaughter per Week	Average Daily Flow (gpd)	Mixed Aerated Pond (cubic feet)	Constructed Wetlands (cubic feet)
20 AU/day facility	2	3,429	16,960	1,658
	5	8,571	42,394	4,145
70 AU/day facility	2	12,000	59,354	5,803
	5	30,000	148,385	21,760

5.0 MOVING FORWARD

As stated earlier in the document, the alternatives available to the livestock facility will be dependent on the site selected. As the waste and wastewater disposal is a significant stumbling block for such a facility and possibly a significant capital cost, the availablity of inexpenisve alterantives should be included into the selection critieria.

Therefore, from a cost perspective, and not necessarily considered sustainable by some, the use of an off-site public waste and wastewater system would be the preferred choice. That being said, an on-site pretreatment and/or primary treatment system will be necessary to reduce the BOD, TSS and nutirent loading to meet the accepting wastewater system's requirements.

As waste and wastewater disposal in smaller communities may become an issue beyond 2050, one potental option is a public-private funded wastewater system for the livestock harvesting facility and the community (government). In this scenario, the livestock operator and the government proportionally fund the initial construciton fo the new wastewater treatment facility and the government funds the operatoin and maintenance of the facility.

If an on-site waste disposal system is required, composting and alkaline hydrolysis or a combination should be considered. If an on-site wastewater system is required, the MBBR and/or natural pond sytem should be considered. The factors for consideration will include but may not be limited to: capital costs, operaiton and maintenance costs, land availabiltiy and cost, and secondary benefits.

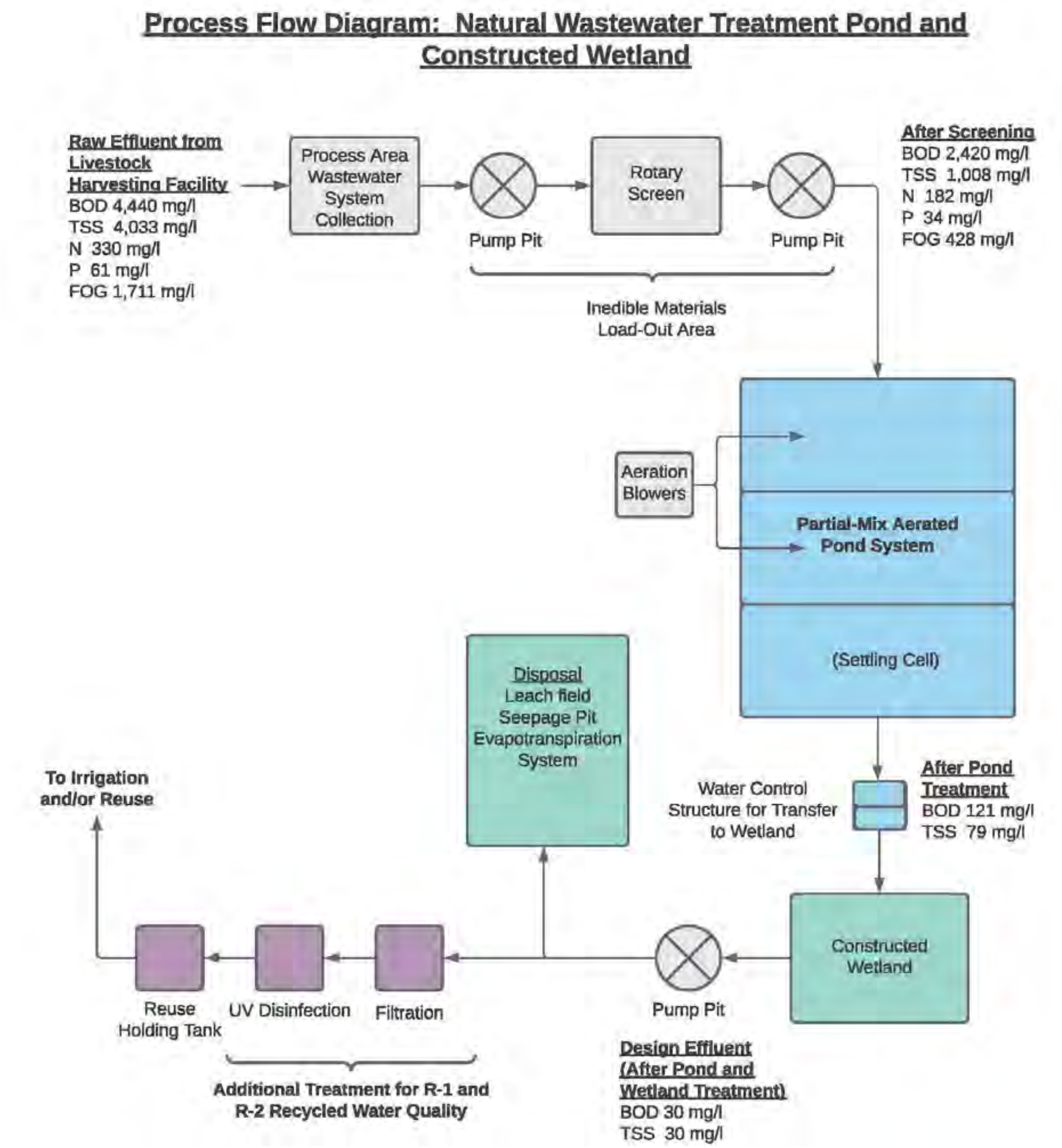

Exhibit 1. Example of a Facultative Pond and Constructed Wetland System

6.0 REFERENCES

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APPENDIX A

LIVESTOCK HARVESTING WASTEWATER ALTERNATIVES STUDY

Prepared by: Community Planning and Engineering, Inc.

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List of Acronyms

ATU	Aerobic Treatment Unit
BMPs	Best Management Practices
BOD	Biological Oxygen Demand
BWS	Board of Water Supply
CCH	City and County of Honolulu
CIU	Categorical Industrial User
DAF	Dissolved Air Flotation System
DEM-WWD	Department of Environmental Management – Wastewater Division (Hawaii County)
DO	Dissolved Oxygen
DOH	Department of Health
DPW	Department of Public Works (Kauai)
ENV	Department of Environmental Services (Honolulu)

EPA	U.S. Environmental Protection Agency
ET	Evapotranspiration
EQ	Equalization Tank
FOG	Fat, Oil and Grease
HAR	Hawaii Administrative Rules
MBBR	Moving Bed Biofilm Reactor
MBR	Membrane Bioreactor
MLSS	Mixed Liquor Suspended Solid
NTU	Nephelometric Turbidity Unit
O&M	Operations and Management
SIC	Standard Industrial Classification
SIU	Standard Industrial User
SRT	Solid Retention Time
TSS	Total Suspended Solids
WWTP	Wastewater Treatment Plant
UIC	Underground Injection Control

B. Introduction

Livestock harvesting facilities face challenges with wastewater produced from the slaughter and processing meat. According to the US Environmental Protection Agency (EPA), 348 gallons of wastewater are produced per 1,000 pounds of production unit during the first processing of livestock, and 672 gallons of wastewater are produced per 1,000 pounds on second processing. Livestock harvesting facilities not only generate a large amount of wastewater, but the facility wastewater is also more concentrated than domestic wastewater. Raw effluent from livestock harvesting facilities contain an average biological oxygen demand (BOD) of 4,440 mg/L and total suspended solids (TSS) of 4,033 mg/L, which is about ten times the concentration of domestic wastewater. Municipal wastewater contains an average BOD of 400 mg/L and TSS of 389 mg/L at a high strength level. (***Reference:*** *Metcalf & Eddy*[1].)

Wastewater treatment processes for livestock harvesting facilities begins when solid and liquid wastes are separated within the processing plant. Following this step, wastewater can proceed to primary treatment, secondary treatment, and finally to disposal. Wastewater must be treated to an acceptable level whether discharging into a municipal sewer system or disposing on-site. After consulting with the City and County of Honolulu (CCH) Department of Environmental Services (ENV), the quality of wastewater discharged to municipal sewer system is determined on a case-by-case basis depending on the end receiving Wastewater Treatment Plant (WWTP). A pretreatment system is recommended to address the high strength of wastewater before discharging into the sewer. The sewer service charges for an industrial user are subject to nonresidential strength surcharges which can either be calculated from measured effluent levels or applied from the Standard Industrial Classification (SIC) Code. When wastewater flow exceeds 25,000 gpd, the user is identified as a Significant Industrial User (SIU) and additional monitoring and reporting are required. The on-site wastewater treatment systems are regulated based on Hawaii Administrative Rules (HAR) 11-62, Subchapter 2.

Considering the high waste loading of TSS, oil, and grease in the raw wastewater, a primary treatment process before the biological treatment phase is necessary to reduce the waste loads and help relieve stress on treatment components. Three primary treatment processes for TSS, oil and grease removal are wastewater screening system, dissolved air flotation system (DAF) and gravity clarification (i.e., grease interceptor). The biological treatment methods, or secondary treatment processes investigated under this report include an aerated treatment unit (ATU), aerated lagoon, membrane bioreactor (MBR), and moving bed biofilm reactor (MBBR). Each of these treatment processes are characterized by their operational complexity and cost. The selected treatment technologies will depend on site characteristics and liquid disposal options. The liquid disposal alternatives include disposing to a leach field, seepage pit, evapotranspiration system, reusing the wastewater, and disposing to the municipal collection system. Each alternative will be discussed along with their technical and operational feasibility. In addition, the legal feasibility will be discussed for each disposal alternatives.

[1] Wastewater Engineering Treatment and Resource Recovery, Metcalf & Eddy, AECOM, Fifth edition.

The sizing of each treatment method is determined by the wastewater flow which relates to the production of meat in different scenarios. Table 1 shows estimated wastewater generated in the livestock harvesting facility based on the number of days of operation and number of cattle slaughtered per day. Table 2 shows the estimated wastewater constituent levels of raw wastewater before and after screening.

Table 1. Estimated Wastewater Generated per Slaughterhouse Activity.

Scenario	Number of Cattle Slaughtered	Number of Days for Slaughter	Number of Days for Processing Beef	Amount of Wastewater Generated	Amount of Wastewater Generated
	heads/day	**days/week**	**days/week**	**gal/week**	**gal/day**
1	20	2	2	22,952	3,279
2	20	5	5	57,379	8,197
3	70	2	2	80,331	11,476
4	70	5	5	200,827	28,690

Notes: 1) Data provided by EKNA Services, Inc.

Table 2. Estimated Slaughterhouse Wastewater Composition

	Raw Wastewater	Wastewater After Screening
	mg/L	**mg/L**
Biological Oxygen Demand (BOD)	4,440	2,420
Chemical Oxygen Demand (COD)	6,478	3,563
Total Suspended Solids (TSS)	4,033	1,008
Total Nitrogen	330	182
Total Phosphorus	61	34
Oil and Grease	1,711	428

Notes: 1) Source – Food and Livestock Planning, Inc.

2) Effluent does not include blood from the stickling process.

C. Regulations

Livestock harvesting facilities must comply with wastewater disposal regulations imposed by DOH, respective County codes, and EPA.

For regulations not covered under DOH, ENV, Hawaii County Environmental Management (DEM-WWD), Maui County Environmental Management, and Kauai County Department of Public Works (DPW), guidelines set by EPA for livestock harvesting facility must be followed.

Regulations for wastewater disposal may vary depending on counties and specific location of the planned facility. Because the location for the livestock harvesting facility is not yet determined, this report will follow regulations set by CCH, which is more stringent than the other counties. Further investigations and site specific compliance to the locality of the new livestock harvesting facility is necessary.

C.1. DOH

DOH imposes statewide regulation regarding on-site wastewater disposal systems. On-site wastewater disposal systems must comply to HAR Title 11, Chapter 62, "Wastewater Systems". Specifically, DOH requires adherence to subchapter 2, "Wastewater Treatment Works". Subchapter 3, "Individual Wastewater Systems", does not apply to this feasibility study because it is in reference to domestic wastewater. New and proposed effluent disposal systems must consist of a primary disposal component and a separate 100% back-up disposal component. Recycled water requirements are also covered under subchapter 2.

In accordance with HAR Title 11, Chapter 23, "Underground Injection Control", subsurface wastewater disposal requires Underground Injection Control (UIC) permit and continuous monitoring. Because the mauka side of the UIC is considered area with underlying aquifer considered for drinking water source, this area only allows limited types of injection wells, and permit limitations are imposed with more stringent requirements. The following figures (Figure 1-4) show each island and respective UIC lines.

Figure 1. Island of Oahu and the UIC Line.

Reference: *Department of Health*[2]

[2] "Underground Injection Control Lines (UIC)," State of Hawaii, Department of Health, Safe Drinking Water Branch, accessed September 7, 2021, https://geoportal.hawaii.gov/datasets/underground-injection-control-lines-uic/explore?location=21.048232%2C-157.201646%2C9.90.

Figure 2. Island of Hawaii and the UIC Line.

Reference: *Department of Health[3]*

Figure 3. Island of Kauai and the UIC Line.

Reference: *Department of Health[3]*

[3] "Underground Injection Control Lines (UIC)," State of Hawaii, Department of Health, Safe Drinking Water Branch, accessed September 7, 2021, https://geoportal.hawaii.gov/datasets/underground-injection-control-lines-uic/explore?location=21.048232%2C-157.201646%2C9.90.

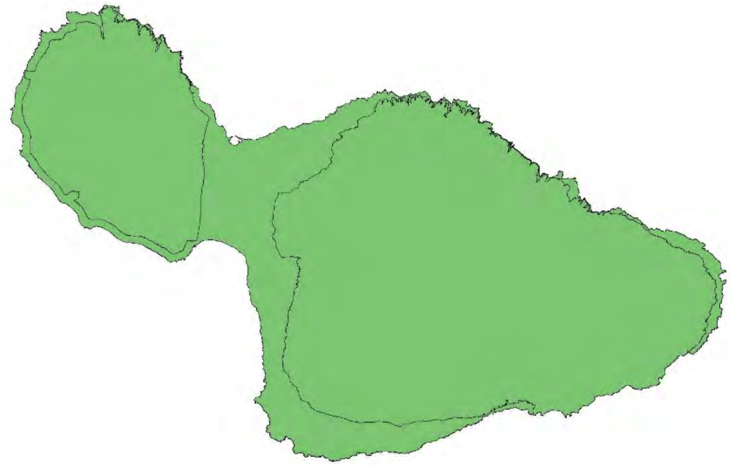

Figure 4. Island of Maui and the UIC Line.

Reference: **Department of Health**[4]

C.2. ENV

Each respective county regulates wastewater discharges to the municipal sewer system. Currently, only the ENV from CCH has a pretreatment plan program when discharging wastewater into the municipal sewer system. Limits on wastewater composition depends on the local wastewater treatment facility receiving the wastewater. The details for each wastewater treatment facility are still under development. An effluent discharge of more than 25,000 gpd will qualify the facility as a significant industrial user (SIU). However, a discharge of less than 25,000 gpd could significantly affect a local treatment plant with low average influent flow. Therefore, local treatment plants have the authority to classify any industrial user of their system as a categorical industrial user (CIU). As a SIU or a CIU the Facility must adhere to more stringent monitoring and reporting requirements, including installing a flow meter to record the volume of effluent discharging into the municipal sewer system.

ENV will not accept viscous and solid materials, water temperature higher than 140°F, and pH level outside of 5.5 to 11 from entering the municipal sewer systems. ENV requires reporting and monitoring of hair, oil, grease, chemical cleansers, and other pollutants (such as tallow) before effluent discharges into the municipal sewer system. If the livestock harvesting facility is using haul trucks instead of directly disposing wastewater through municipal sewer line, effluent in haul trucks must also comply with ENV regulations. Haul trucks must be monitored and submit monthly discharge report.

C.3. DEM-WWD (Hawaii County)

[4] "Underground Injection Control Lines (UIC)," State of Hawaii, Department of Health, Safe Drinking Water Branch, accessed September 7, 2021, https://geoportal.hawaii.gov/datasets/underground-injection-control-lines-uic/explore?location=21.048232%2C-157.201646%2C9.90.

DEM-WWD will not accept viscous and solid materials, water temperature higher than 150°F, pH level lower than of 5.5, and any water or waste containing more than 100 ppm by weight of fats, oil, and grease from entering the municipal sewer systems. The maximum acceptance for BOD and TSS is 190 mg/L and 210 mg/L, respectively. Other limitations include 40 mg/L of total nitrogen, 7 mg/L of total phosphorus, 50 mg/L of total chlorides above domestic potable water concentration, 380 mg/L of total dissolved solids above domestic potable water concentration, 11 mg/L of calcium, 430 mg/L of chemical oxygen demand, 11 mg/L of potassium, 1 mg/L of lead, and 140 mg/L of total organic carbon. Hawaii County requires monthly 24-hour flow weighted composite samplings for the above constraints. A monthly grab sample is required to check pH levels in the wastewater. An independent laboratory must test the samples, and the facility must send the findings to DEM-WWD within one week after the results are generated.

C.4. Environmental Management, Wastewater Reclamation Division (Maui County)

Environmental Management will not accept wastewater from livestock harvesting facility. All wastewater from livestock harvesting facility in Maui must be disposed of on-site.

C.5. DPW (Kauai County)

DPW will not accept viscous and solid materials, water temperature higher than 150°F, pH level lower than 5.5 and higher than 9.0, any toxic or poisonous substance, and any water or waste containing more than 100 ppm by weight of fats, oil, and grease from entering the municipal sewer systems.

DPW does not have a set parameter on the effluent content. DPW will determine whether wastewater disposal into the municipal sewer line is allowed after examining a more detailed effluent content and amount. Depending on the location of the livestock harvesting facility, the facility may need a connection to a privately owned wastewater plant.

D. Primary Wastewater Treatment Methods

Majority of solid and liquid wastes are separated within the harvesting facility by floor drain screens and traps. However, a high concentration of blood, oil, grease, animal hair, and scrap produced while processing meat, and other solid waste still exit within the liquid stream. To limit the waste loads sent to the liquid treatment processes, oil, grease, and suspended solids should be removed prior to discharging raw wastewater to the following processes.

D.1. Dissolved Air Flotation System

Dissolved air flotation (DAF) system removes fats, oil and grease (FOG), and suspended solids by dissolving air into the wastewater. Air dissolves into the recycled effluent under pressure to create air bubbles. FOG, and suspended solids adhere to the air bubbles which causes the particles to float to the water surface and removed by a skimmer. Heavier solids will sink to the bottom and will be removed. A DAF system can perform with or without chemical addition. Adding polymers to the influent improves the removal efficiency of the DAFT. A schematic of the DAF components is shown in Figure 5.

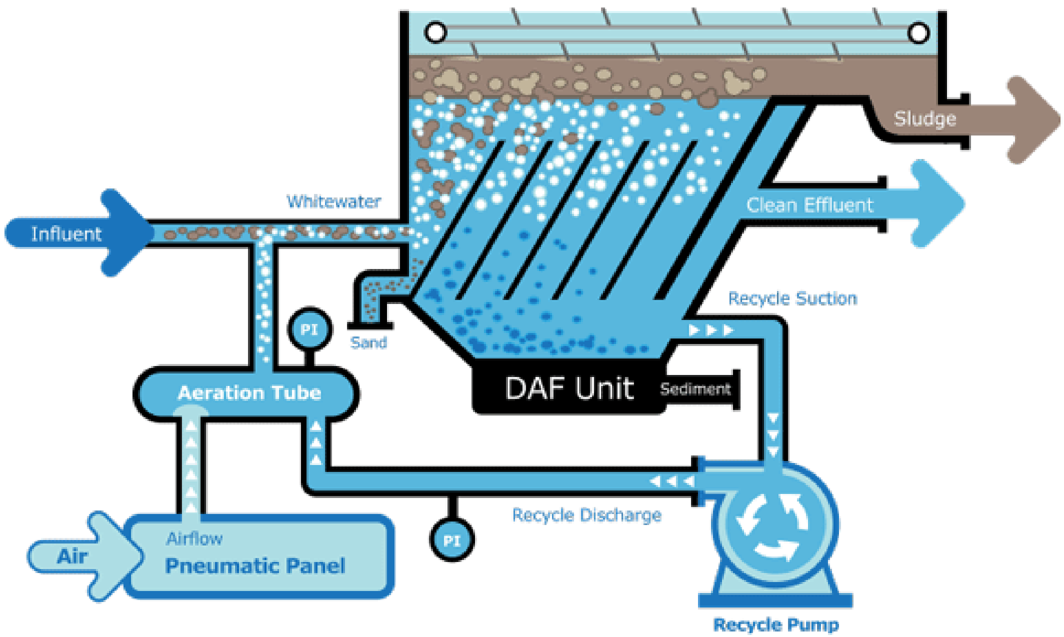

Figure 5. Example of a DAF Unit.

Reference: *PT. Artha Envriotama.*[5]

D.1.1. Technical Feasibility

The advantage of having a DAF system is it removes up to 95% of suspended solids~~,~~ and FOG before undergoing further treatment. Having this initial step speeds the process of producing desired effluent results. The average retention time is 10 to 20 minutes. Thickened sludge contains 3% to 5% of Total Solid (TS).

Equalization tank (EQ) is highly recommended before the DAF system to ensure continuous flow.

[5] “Dissolved Air Flotation (DAF),” PT. Artha Enviotama, accessed July 8, 2021, https://arthaenvirotama.com/en/product/dissolved-air-flotation-daf-en/.

D.1.2. Operational Feasibility

The high cost and maintenance of a DAF system compared to other pretreatment methods is one of the drawbacks. Purchasing a DAF system can be costly upfront ($395,000 per unit), and electricity and water necessary to run the system will add up over time.

A DAF system is designed to remove FOG and suspended solids. No manual assistance is necessary to skim or pump out unneeded waste. However, a trained technician is recommended to monitor the DAF system in case of a technical malfunction. Hiring or training a technician for the purpose of DAF system may be costly. A DAF system will operate intermittently correlating with the slaughterhouse working shift. While in operation, a DAF system requires a continuous flow with relatively stable flow rate of influent for successful solids removal performance. Therefore, a storage tank could be required prior to the DAF system. The sludge produced from a DAF system requires a separate tank to store and dispose of properly.

D.2. Grease Interceptor

A grease interceptor (GI) is a simple tank which allows FOG and solids to separate naturally. After influent flows into grease interceptors, the components with lower density than water float to the water surface and solids with density higher than water will sink to the bottom of the tank. The layer of wastewater situated below the grease and above the settled solids is piped to the next treatment process. The grease interceptor is designed with a minimum retention time of 30 minutes and sufficient volume to store the floating scum layer and settled sludge layer for several months. The scum layer is skimmed off from the water surface and solids are removed from the tank bottom every three to six months. Figure 6 shows an example of a GI system.

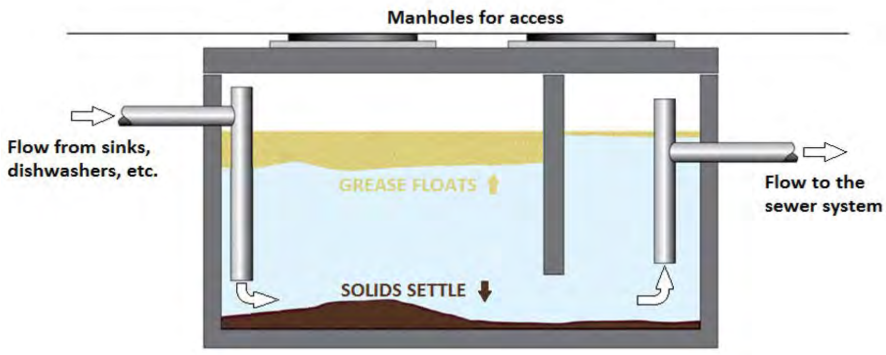

Figure 6. Example of a Grease Interceptor.

Reference: *Olathe Kansas.*[6]

D.2.1. Technical Feasibility

Having a pretreatment system will greatly reduce FOG and solids before entering further treatment. Typically, the grease interceptor is used prior to discharge from industrial users into the municipal sewer system or to ATU for enhancing the treatment efficiency. With proper GI sizing and maintenance FOG and TSS removal can be around 80%. The ENV regulates GIs for facilities discharging into their sewer system. An Industrial Wastewater Discharge Permit and approved GI design will be required prior installation if effluent will be discharged into the City's sewer system.

D.2.2. Operational Feasibility

The low capital cost and operation requirements make grease interceptor a competitive option for this study. One of the other advantages of a grease interceptor is that influent flow does not need to be continuous. For livestock harvesting facilities operating intermittently on certain days, a grease interceptor will not be an issue since FOG and solids will continue to separate over longer retention times. An interceptor will not require any specialized training or technicians to operate and maintain proper functioning. Since interceptors are typically gravity fed from their source they are typically installed below grade, reducing the above grade footprint of the system. Traffic rated units can be installed in parking lots or driveways. When properly maintained grease interceptors will help reduce nuisance odors and insects because they are typically fully enclosed units and installed below grade.

The disadvantage of a GI is that it must be cleaned manually every three to six months depending on amount of grease and solid accumulation. The volume of grease interceptor is calculated based on hydraulic retention time of 30 minutes. The scenario of 20 heads of

[6] "Fat, Oil and Grease Program," Olathe Kansas, accessed July 8, 2021, https://www.olatheks.org/government/utilities/sewer/fat-oil-and-grease-program.

cattle per day, two days per week will need a GI to hold liquid volume of 240 gallons and up to 2,400 gallons for 70 heads of cattle per day, five days per week.

D.3. Wastewater Screening System

A screening system is designed to effectively screen and dewater captured debris from wastewater. Because grass clippings and other debris exist in the pen washdown water, a screening system is recommended for protecting the downstream pumps and equipment. Hydroscreen, an example of one type of manufactured wastewater screening system, is a simple liquid-solids separation system in municipal and industrial applications. There are no moving parts, motors, and complicated connections. A conceptional diagram is shown in Figure 7.

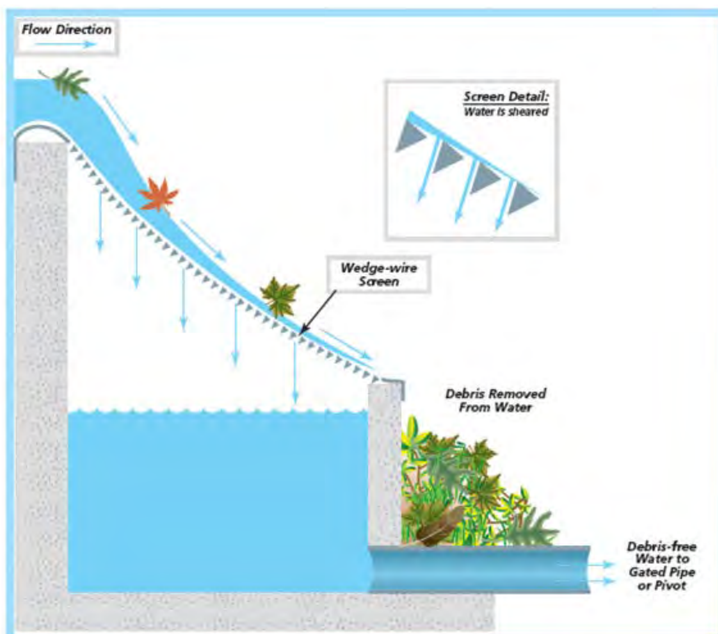

Figure 7. Cross-section diagram of Hydroscreen removing debris

***Reference: Hydroscreen Co. LLC*[7]**

D.3.1. Technical Feasibility

A screen size of 2 mm is recommended by DAF system manufactures to protect the DAF system. However, a separate screening system is not required for a packaged DAF system which already includes a screening system. For example, a Rotary Drum Screen is

[7] "Agriculture Diversion Screen," Hydroscreen Co. LLC, accessed August 23, 2021, http://www.hydroscreen.com/pdf/hydroscreenfarmflyer.pdf.

included in Clean Water Technology DAF system. A screening system also helps with relieving the solids built up in GI.

D.3.2. Operational Feasibility

Hydroscreen is a simple mechanical system that do not consume electricity. Depending on the separated solid characteristics, most of the solids falls off the screen by gravity as shown in Figure 7. Regularly manual cleaning is required. The footprint of Hydroscreen is between 40 inches by 19 inches and 60 inches by 51 inches based on the facility size and wastewater flow.

E. Secondary Wastewater Treatment Methods

Although the TSS, oil, and grease are mostly removed by the primary treatment process, BOD and TSS levels in the effluent is still over the limitation for final disposal, whether disposing through municipal sewer line or on-site. The secondary wastewater treatment process further treats the wastewater until the effluent quality meets the disposal requirements.

There are typically two disposal methods available when selecting sites for livestock facility: 1) discard the treated wastewater into municipal sewer line, or, 2) disposal/reuse on-site. In a meeting with CCH ENV, the regulation for discharging high strength industrial wastewater into municipal sewer system were discussed. These limitations are different from County to County. To meet treatment performance, aerated treatment units or aerated lagoon are the suggested options.

Based on Hawaii Administrative Rules, wastewater effluent for on-site disposal requires BOD and TSS concentration of 30 mg/L. To meet this treatment performance, a membrane bioreactor (MBR) and a moving bed biofilm reactor (MBBR) are the suggested treatment technologies. If an extra oxidation and disinfection process is applied following the treatment processes, the effluent could qualify as R-2. R-2 recycled water can be used for subsurface drip irrigation for golf course, parks, and above-ground food crops. With filtration, the effluent could qualify as R-1 recycled water which can used for other uses. The reuse of treated wastewater will be discussed in Section F.4.

The following methods are alternatives in secondary wastewater treatment for satisfying disposal to sewer system or on-site. Each method has varying degree of effectiveness, footprint requirement, cost, and feasibility.

E.1. Aerated Treatment Unit

After primary treatment, the wastewater will be retained in an aerated treatment unit (ATU) prior to discharge into the sewer collection system. ATU is like a standard septic tank or a grease interceptor. As wastewater enters the tank, heavy solids settle to the bottom of the tank while greases and lighter solids float to the top of the water surface over time. Treatment efficiency in a standard septic tank is relatively low compared to other technologies. The typical septic tank BOD removal efficiency is 30-50%, and removal for TSS is 60-80%. For meeting the discharge requirement of domestic levels of BOD and TSS to the sewer system, a suspended growth ATU utilizing an aeration system to supply oxygen to the wastewater is recommended. The dissolved oxygen accelerates the activity of microorganisms and breakdown of waste through aerobic biological reaction. The aeration system also provides mixing that suspends the biomass in wastewater increasing its efficiency. A pilot test is recommended by the manufacturer to determine the aeration unit specifications and the tank size to ensure target effluent levels. Figure 8 shows an example of an aerated treatment unit. Waste that cannot be decomposed by the anerobic digestion will need to be removed from the ATU. Depending on the input sludge characteristics, ambient temperature, and system performance, pumping out by a vacuum truck is required every few years or up to three years.

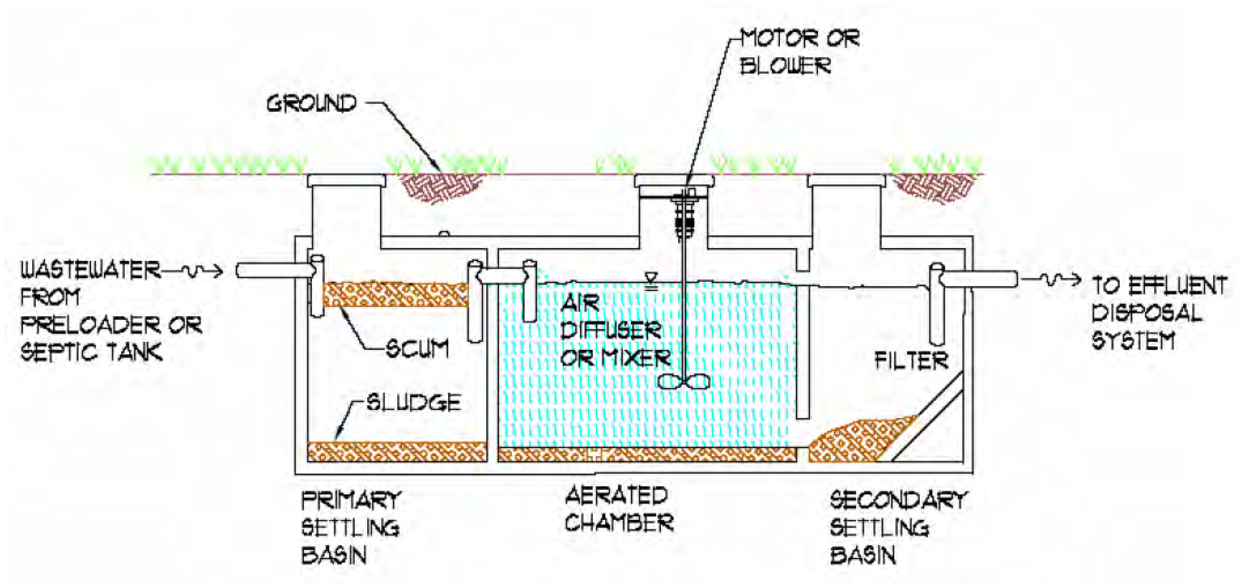

Figure 8. Example of an Aerobic Treatment Unit.

Reference: *Onsite Wastewater Treatment Survey and Assessment*[8]

E.1.1. Technical Feasibility

ATU provides partial treatment to wastewater before disposing into a municipal sewer system. In the ATU, solid separation, anaerobic digestion and aerobic treatment reduces BOD and TSS concentrations in wastewater. To enhance treatment performance, a pilot

[8] Onsite Wastewater Treatment Survey and Assessment, State of Hawaii Department of Business, Economic Development and Tourism Office of Planning, Hawaii Coastal Zone Management Program, Department of Health, March 2008.

study from the manufacture is recommended to ensure system design will reach target effluent levels.

E.1.2. Operational Feasibility

The advantage of an ATU is that influent flow does not need to be continuous. Meaning a livestock harvesting facility with an intermittent operation should result in longer retention times and produces higher quality effluent. The operation and maintenance requirements are one of the lowest compared to other technologies, which makes this application favorable to small facilities with limited flow of wastewater. Inspections every two months are recommended by EPA. (***Reference:*** *Decentralized Systems Technology Fact Sheet, Aerobic Treatment*[9]).

The disadvantage is that ATUs may often need cleaning depending on the amount of grease and solid accumulation. A vactor truck is used to remove floatable grease and settable solids from the bottom of the tank. The aeration system requires extra maintenance of the electrical, pumps, motors, or diffusers.

The minimum ATU tank volume required for 3,000 gpd and 30,000 gpd are 3,750 and 37,500 gallons, respectively. For handling peak flow, a tank volume of 5,000 and 50,000 gallons are recommended. The length with a 5,000-gallon tank is 18 feet, with a diameter of 8 feet and the length of a 50,000-gallon tank is 68 feet with a diameter is 12 feet (***Reference:*** *XERXES brochure*[10]). Typical installed cost ATU is $20,000-$30,000 per 1,000 gallons of wastewater.

E.2. Aerated Lagoon

Another form of secondary wastewater treatment is an aerated lagoon. An aerated lagoon consists of an earthen basin with aerators to promote the biological oxidation of wastewater. The bottom and side walls of the lagoon need to be lined to prevent wastewater exfiltration and groundwater contamination. The oxygen dissolves into water through the aeration system. On the bottom layer of the lagoon, oxygen is exhausted and anaerobic decomposition occurs. Figure 9 shows an example of an aerated lagoon and how an aerated lagoon operates.

[9] Decentralized Systems Technology Fact Sheet, Aerobic Treatment, EPA 832-F-00-31, September 2000.
[10] Installation Manual and Operating Guidelines for Fiberglass Underground Storage Tanks, Xerxes.

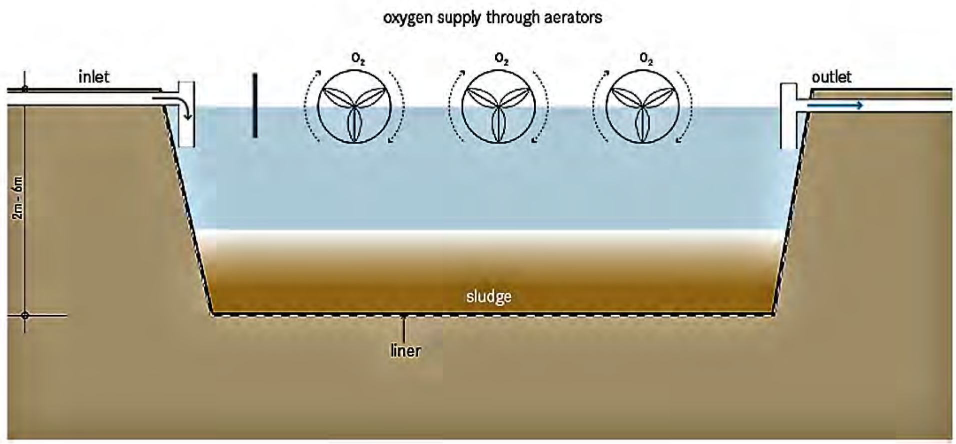

Figure 9. Example of an Aerated Lagoon.

Reference: *Tilley et al, 2014.*[11]

E.2.1. Technical Feasibility

An aerated lagoon is effective in removing TSS and BOD with proper operation. It requires a larger area than the package treatment systems. The depth is typically ten feet and detention time ranges from 10 to 30 days. Depending on site location, significant rainfall event should be considered when sizing for aerated lagoon.

E.2.2. Operational Feasibility

In general, an aerated lagoon can be operated with minimal maintenance. Influent flow does not need to be continuous. As the lagoon is an open area above ground, necessary signs and fence are recommended for safety reasons. The aeration system and pumps require energy input, and the accumulated sludge needs to be pumped every 20 to 30 years.

An aerated lagoon requires a footprint of 11,000 ft^2 for a facility slaughtering 20 heads of cattle per day, 2 days of slaughter per week, and 2 days of meat processing per week. For facility slaughtering 70 heads of cattle per day, 5 days of slaughter per week, and 5 days of meat processing per week, 36,000 ft^2 of aerated lagoon footprint is required.

The initial capital cost for an aerated lagoon is approximately $2,500-$7,500/1,000 gallons of wastewater,

E.3. Membrane Bioreactor (MBR)

Packaged wastewater treatment systems maximize land use and is a viable method for treating wastewater. The membrane bioreactor (MBR) is a wastewater treatment process combining membrane filtration and biological treatment. As with conventional wastewater treatment, influent will enter an EQ, undergo screening, the DAF system, primary treatment within the

[11]Tilley, et al, Compendium of Sanitation Systems and Technologies, 2nd revised edition.

MBR, secondary treatment within the MBR, waste activated sludge process, and then clarification. After the waste activated sludge process, wastewater passes through a membrane filter which separates sludge and dischargeable effluent, making the MBR process different than other treatments. Using the membrane separation technology instead of traditional clarifiers, the treatment processes have a reduced footprint. However, the membrane requires delicate maintenance and a complex operation and control system. Figure 11 shows an example of an MBR unit and how an MBR unit operates.

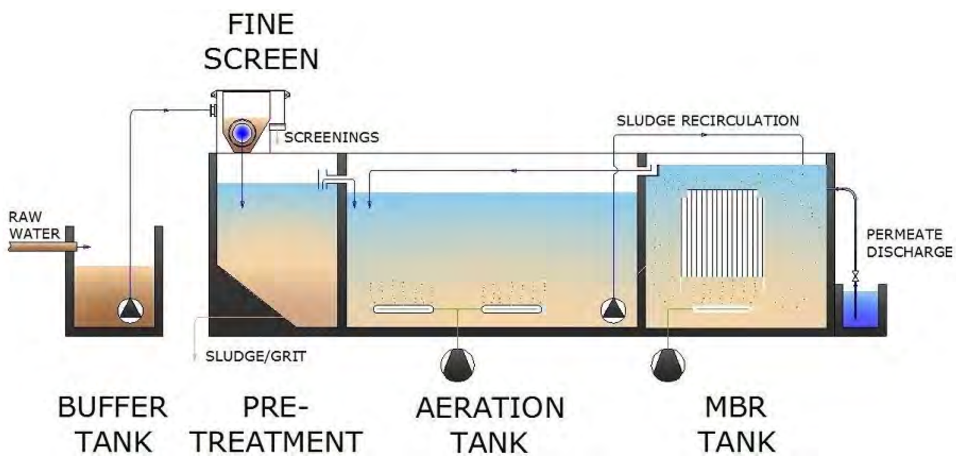

Figure 10. Example of an MBR.

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E.3.1. Technical Feasibility

The MBR method can successfully bring down high strength influent to a dischargeable effluent. Packaged wastewater treatment plants have a small footprint; hence this system is ideal for any sized facilities. In terms of time and efficiency, the MBR plant will achieve BOD and TSS reduction to 30 mg/L and 30 mg/L.

The DAF system is necessary to remove solids before MBR. Due to intermittent working schedule in livestock harvesting facility, an EQ tank is required for the upstream of the MBR to allow continuous feed into the system.

E.3.2. Operational Feasibility

The MBR packaged plant is a centralized wastewater treatment plant with similar treatment processes as a conventional wastewater treatment facility. A licensed wastewater treatment plant operator is recommended for a successful operation. Chemical handling and disposal are required for adjusting the pH and regeneration membrane. A series of parameters are

[12] Hydroflux epco, MENA WATER Packaged MBR, access July 29, 2021, https://www.hydrofluxepco.com.au/mena-water/packaged-mbr/technical/how-it-works

needed to be monitored and maintained within a proper range to achieve a good performance, including pH, dissolved oxygen (DO), mixed liquor suspended solids (MLSSs), etc. Therefore, the operation and maintenance (O&M) cost is much higher considering the maintenance hours and chemical consumption.

For livestock harvesting facility only operating two days of slaughter and two days of processing within a week with 20 heads of cattle per day, the expected space required is 30 feet length, 10 feet wide, and 14 feet high. For livestock harvesting facility operating five days of slaughter and five days of processing within a week with 70 heads of cattle per day, 60 feet length, 40 feet wide, and 18 feet high.

The initial capital cost for an MBR wastewater treatment plant is approximately $740k for smaller unit and $1.4 million for larger unit.

E.4. Moving Bed Biofilm Reactor (MBBR)

The moving bed biofilm reactor (MBBR) is another method for treating wastewater. The MBBR system consists of an aeration tank with special plastic carriers that provide a large surface where a biofilm grows. As influent is aerated in the tank, the carriers are mixed in to provide continuous contact with the wastewater. Following the aeration process, wastewater will continue to a clarifier or the DAF tank where sludge and effluent are separated. The separated sludge is disposed at an approved offsite facility. The treated effluent will exit the system for either subsurface disposal or further treatment. Figure 11 shows an example of an MBBR unit and how an MBBR unit operates.

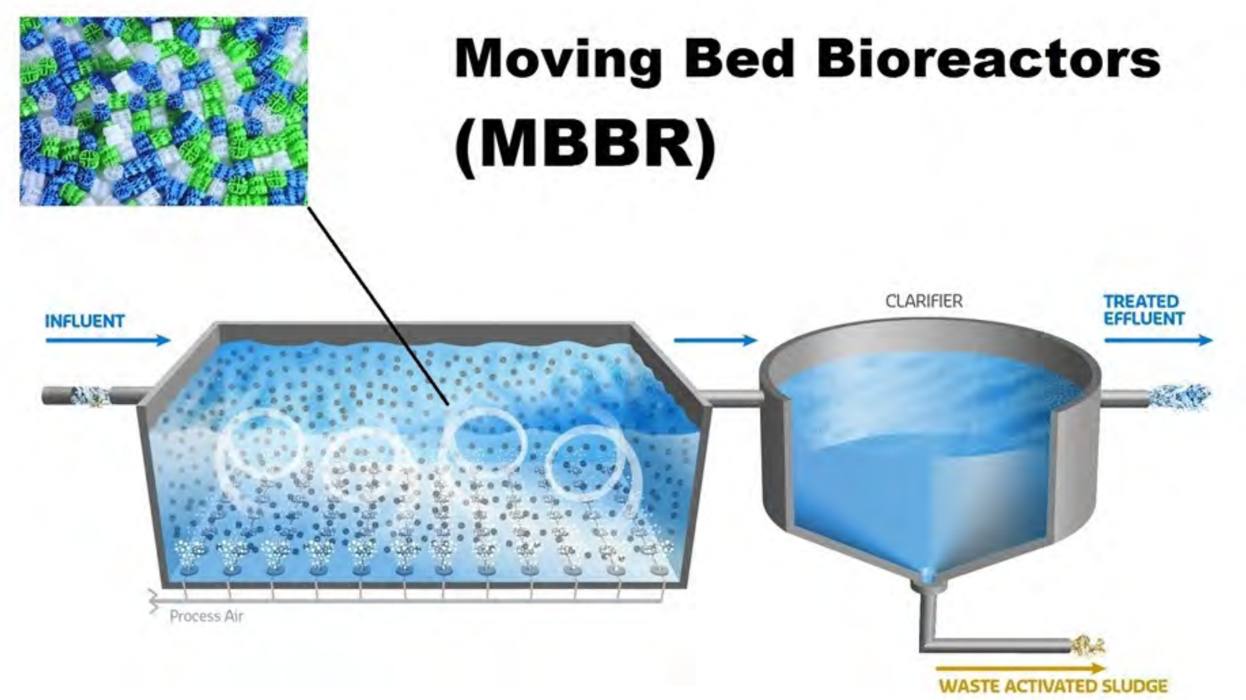

Figure 11. Example of an MBBR.

***Reference:** Gustawater Treatment.*[13]

E.4.1. Technical Feasibility

Packaged wastewater treatment plants have small footprint; therefore, this system is ideal for any sized facilities. A screening system is required prior to the MBBR for removing majority of the solids in raw wastewater. Due to intermittent working schedule in livestock harvesting facility, installing an EQ is highly recommended before the screening process when using an MBBR system.

E.4.2. Operational Feasibility

Due to the specialized mechanical and electrical components inherent with these types of facilities, services of a licensed wastewater treatment plant operator are recommended. This will add to the initial capital cost.

MBBR wastewater treatment plant is approximately $0.9 million for smaller unit and $1.1 million for larger unit.

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[13] Gustawater Treatment, The Ultimate Guide to MBBR, access July 13, 2021, https://www.gustawater.com/blog/mbbr.html

F. Liquid Disposal Method

On-site disposal is one option of disposing treated wastewater effluent. In accordance with HAR 11-62-26, the wastewater effluent requirements must not exceed BOD of 30 mg/L and TSS of 30 mg/L on the monthly average results from composite samples analysis. Any on-site disposal facility will require a separate 100% backup disposal component.

Another option is to reuse the treated wastewater. The modern package treatment systems, including MBR and MBBR, can provide sufficient treatment performance and meet the effluent quality requirements for recycled water. Treated effluent can be categorized into different grades depending on the level of treatment: R-1, R-2, and R-3. R-1 is ranked with highest treatment grade, and R-3 is ranked with the lowest treatment grade. Wastewater effluent qualified as R-3 water without any further treatment is applicable to on-site disposal method. However, R-3 water can be further treated to R-2 water when a disinfection process is employed, and R-2 water can be used for limited subsurface and surface drip irrigation. R-2 water can also be treated to R-1 level, which can be used more widely, and an additional filtration process is necessary.

Besides on-site disposal or reuse, wastewater can be discharged to a municipal sewer system for final disposal if the wastewater meets the water quality discharge criteria.

F.1. Leach Field

A leach field, also called a drainfield, is one type of subsurface wastewater disposal facility used to dispose of treated wastewater. A leach field also further removes contaminants and impurities. A conventional leach field consists of perforated pipes surrounded by media such as gravel covered with geotextile fabric and soil. The effluent passes from the perforated pipes into the media where biofilm grows on, adding further purification. Eventually wastewater enters the ground, and a small portion is taken up by plants through evapotranspiration. This system relies heavily on the soil to absorb the wastewater, so soil percolation is a critical parameter for sizing the facility footprint. A distribution box is usually used for connecting the upstream treatment system and the multiple pipes of a leach field. In Figure 12, a typical leach field (drainfield) served with septic tank is shown.

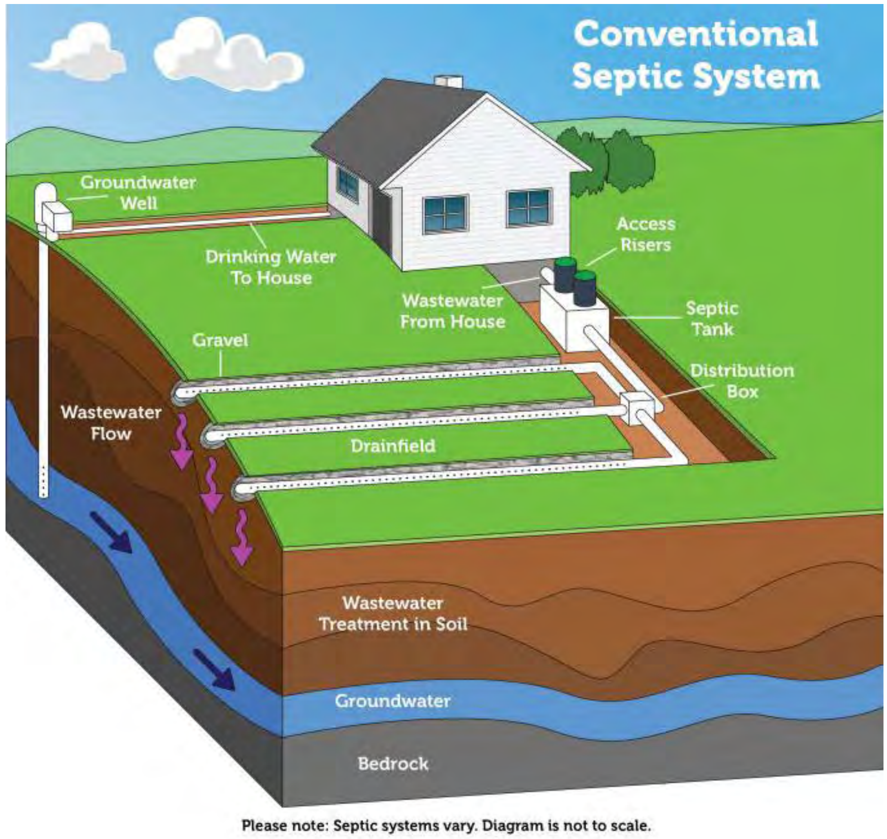


Figure 12. Example of a Leach Field (Drainfield).

Reference: *EPA Website.*[14]

F.1.1. Technical Feasibility

Leach field cannot be used in terrain where slope is too steep. Root barriers should be considered because root intrusions have negative influence on the purification performance. The footprint of a leach field footprint relies highly on the soil texture and the percolation rate. If the livestock harvesting facility has gravel/coarse sand with slow percolation rate, or clay/colloidal clay with rapid percolation rate, this method is not suitable. Based on the estimated flow rate of 3,000 gpd and 30,000 gpd, the leach field footprint ranges from 2,500 ft^2 to 15,000 ft^2, or 25,000 ft^2 to 150,000 ft^2 depending on the soil texture. A leach field is infeasible if the groundwater table is close to ground surface. The cost of leach field is typically \$14,000 to \$36,000 per 1,000 gallons per day of flow. (***Reference:*** *Wastewater Resources Research Center and Engineering Solutions, Inc* [15]).

[14] EPA: Types of Septic Systems, accessed, July 13, 2021, https://www.epa.gov/septic/types-septic-systems
[15] Onsite Wastewater Treatment Survey and Assessment, March 2008, Water Resources Research Center, Engineering Solution, Inc..

F.1.2. Operational Feasibility

A leach field requires the least operation and maintenance among all the liquid disposal methods described in this report. Yearly inspection should be provided to confirm the water is percolating properly. Heavy equipment should be kept away from the leach field for protecting the underground pipeline. However, the system cannot be restored once the pipeline or soil get clogged. Therefore, solid separation in the upstream treatment process is necessary.

F.1.3. Legal Feasibility

Leach field is not allowed above the No Pass Zone according to BWS.

Due to possible effluent entering ocean and damaging coral reefs and sea life, subsurface disposal system may require permit under Clean Water Act.

F.2. Seepage Pit

Another subsurface disposal method is a seepage pit. A seepage pit is an earthen well that is lined with porous masonry. Wastewater is collected into the underground well for a gradual seepage into the ground. A seepage pit shall not be constructed in soils having a percolation rate slower than 10 mins/in or rapid percolation. The bottom of the seepage pit should have vertical separation to the seasonal high groundwater table by more than three feet. When multiple seepage pits are built, each seepage pit should be individually connected to a distribution box. Figure 14 shows an example of a seepage pit and how a typical seepage pit operates.

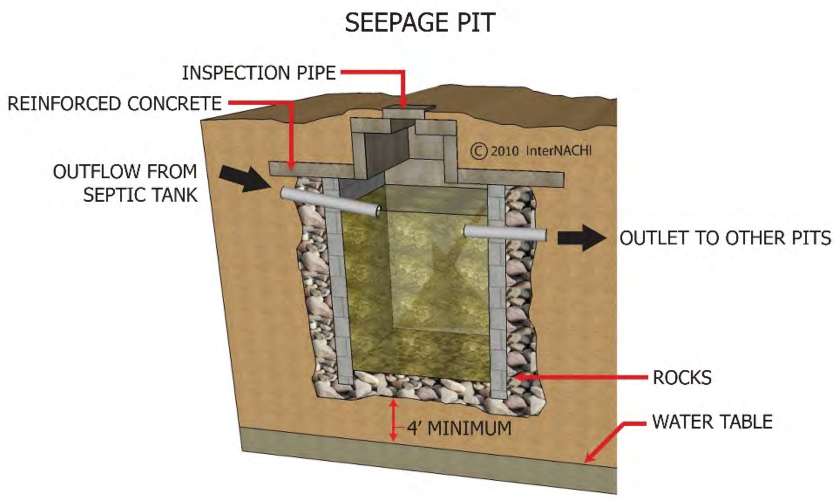


Figure 13. Example of a Seepage Pit.

Reference: *International Association of Certified Home Inspectors.*[16]

Note: 1) The minimum distance of seepage pit bottom to water table is three feet according to HAR 11-62-34.

F.2.1. Technical Feasibility

Similar to the leach field, the soil texture is a key factor for a seepage pit as well. The requirement of soil percolation rate must be faster than 10 min/in. The water table should be three feet lower than the bottom of the seepage pit. Therefore, a site location of soil with a low percolation rate or a high groundwater table is infeasible for this disposal method. The typical installation cost of seepage pit is $20,000 per 1,000 gallons of wastewater per day. (***Reference:*** *Wastewater Resources Research Center and Engineering Solutions, Inc* [17]).

F.2.2. Operational Feasibility

The only maintenance and operation required for seepage pit is to pump the accumulated sludge if the upstream processes allow passage of solids. The required absorption area is same as the leach field. However, the seepage pit has a much smaller footprint than perforated pipes.

[16] Seepage Pit, International Association of Certified Home Inspectors, accessed, July 15, 2021, https://www.nachi.org/gallery/tank/seepage-pit-1

[17] Onsite Wastewater Treatment Survey and Assessment, March 2008, Water Resources Research Center, Engineering Solution, Inc..

F.2.3. Legal Feasibility

As a subsurface disposal method, a seepage pit is not allowed above the No Pass Zone (BWS) and UIC line and will need permits and continuous monitoring. According to HAR 11-62-34, a seepage pit is allowed only when one of the following are met: space is insufficient for leach field to be applicable; the presence of a limiting layer more than seven feet in depth which overlies suitable soils of sufficient thickness; or a slope of the finished elevation of the lot is greater than 12%.

Due to possible effluent entering ocean and damaging coral reefs and sea life, subsurface disposal system may require permit under Clean Water Act.

F.3. Evapotranspiration System

When the traditional on-site subsurface wastewater disposal methods described above are forbidden in No Pass Zone and UIC line, the evapotranspiration (ET) disposal system is an alternative to protecting the surface water and groundwater. An ET system disposes wastewater into atmosphere through evaporation from soil surface and/or through transpiration by plants. In ET systems, a liner is placed on the bottom of the sand bedding to prevent wastewater releasing into the surrounding water systems. Water-tolerant plants are planted for providing plant transpiration. Figure 14 shows an example of a typical ET system.

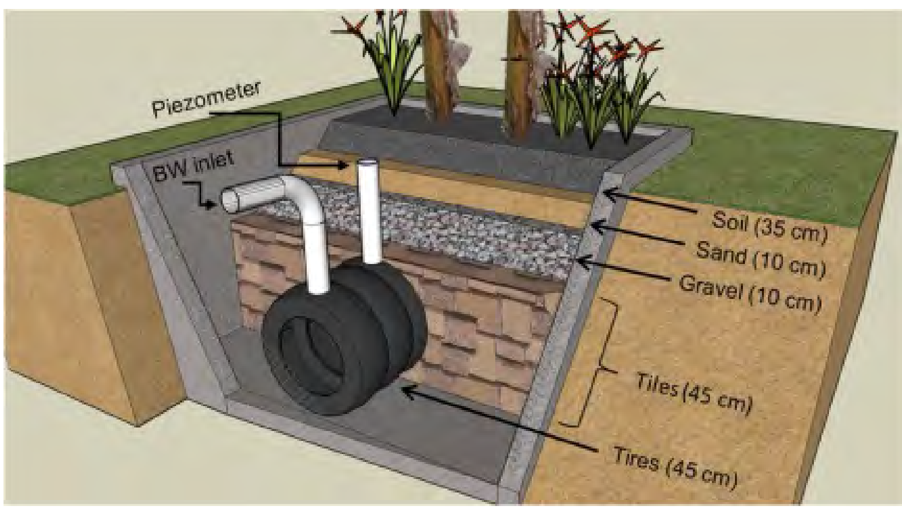


Figure 14. Example of a Typical ET System

Reference: *Paulo, et al..*[18]

[18] Paulo, P. L., Galbiati, A. F., Magalhães Filho, F. J. C., Bernardes, F. S., Carvalho, G. A., & Boncz, M. Á. (2019). Evapotranspiration tank for the treatment, disposal and resource recovery of blackwater. *Resources, Conservation and Recycling*, *147*, 61-66.

F.3.1. Technical Feasibility

The disposal efficiency of ET system is governed by precipitation, wind speed, humidity, solar radiation, and temperature. The EPA Technology Fact Sheet suggests that ET system is feasible to sites where evaporation exceeds annual rainfall by at least 24 inches. Plants used in ET systems should be able to handle the variation of water level in sand bed, whereas the plant should not have hair roots that will clog the distribution pipes. The typical cost of ET system is up to $50,000 per 1,000 gallons of wastewater per day. (***Reference:*** *Wastewater Resources Research Center and Engineering Solutions, Inc* [19]).

F.3.2. Operational Feasibility

ET system is a simple technology that requires minimal O&M, including typical yard maintenance. The footprint of ET systems depends on wastewater flow rate, annual evapotranspiration rate, and annual precipitation rate.

Footprint required for ET is determined by:

$$A = nQ/ET - P$$

where: A = surface area required to evaporate the wastewater
n = coefficient, which varies from 1 to 1.6
Q = annual flow volume
ET = annual evapotranspiration rate
P = annual precipitation rate

(***Reference:*** *Onsite Wastewater Treatment Systems Manual*[20].)

F.3.3. Legal Feasibility

The ET system is feasible for sites located in No Pass Zone and UIC line.

F.4. Reuse Treated Wastewater

There are different grades of recycled water depending on the level of treatment that the wastewater receives; R-1, R-2, and R-3. R-1, the highest grade of recycled water, wastewater undergoes oxidation, filtration, and disinfection. R-2 undergoes oxidation and disinfection. R-3 wastewater only undergoes oxidation. Reusing treated wastewater may be an asset within the facility. However, the approval process and operation of a wastewater reclamation facility, requires an extensive the additional educational and monitoring program in accordance with the State of Hawaii, Department of Health Reuse Guidelines.

[19] Onsite Wastewater Treatment Survey and Assessment, March 2008, Water Resources Research Center, Engineering Solution, Inc.

[20] Onsite Wastewater Treatment Systems Manual, EPA/625/R-00/008, February 2002.

F.4.1. Technical Feasibility

Both the MBR and MBBR should be capable of producing wastewater suitable for reuse. R-3 water is classified as wastewater with BOD and TSS concentration no greater than 60 mg/L. To produce R-2 recycled water, the recommended target for both BOD and TSS is a maximum of 10 mg/L. Disinfection shall be based on a theoretical chlorine contact time of 15 minutes and an actual modal contact time of 10 minutes or more throughout which chlorine residual is 0.5 mg/L. Automatic control of chlorine dosage, continuous monitoring, data logging and chlorine residual reporting are required. As a result, the disinfected effluent must be sampled. Fecal coliform analysis with a requirement of media density must not exceed 23/100 milliliter of the last seven days, and density must not exceed 200/100 milliliter in more than one sample in any 30-day period.

R-1 recycled water requires both BOD and TSS to be less than 5 mg/L. Filtration is required and different limits for media versus membrane filtration are set to ensure that the technology is operating properly and efficiently. Media filtration system uses sand, granular, cloth or other media, and turbidity shall not exceed 10 Nephelometric Turbidity Unit (NTU) at any time. Membrane filtration systems including microfiltration, ultrafiltration, nanofiltration or reverse osmosis, shall not exceed the turbidity of 0.5 NTU at any time. Chlorine or UV disinfection is necessary to break down fecal coliform to not exceed 2.2/100 milliliters at median density for the last seven days, 23/100 milliliters in any 30-day period and 200/100 milliliters at any time. For more details about the technical requirements, refer to *Reuse Guidelines* by DOH Wastewater Branch.

There are series of technical requirements for the various qualities of recycled water and to construct a wastewater reclamation facility. The application submittal consists of an engineering report and construction plans. After approval and construction, pilot testing or test results must demonstrate compliance with requirements then DOH will issue an approval for use. The complexity of the process and large cost makes infeasible to small livestock harvesting facility.

F.4.2. Operational Feasibility

R-3 can only be used as drip or subsurface drip irrigation for:

1) Non-edible vegetation in areas with limited public access;
2) Fodder, fiber, and seed crops not consumed by humans; and
3) Timber and trees not bearing food crops.

Due to limitations associated with R-3 recycled water, we suggest treating wastewater to at least R-2 level.

R-2 subsurface drip irrigation is allowed for:

1) Golf course landscaping;
2) Parks, athletic fields, schoolyards, cemeteries;

3) Above-ground food crops (such as fruit trees) where the edible portion of the crop has minimal contact with the recycled water;
4) Impoundments without fountains or any other water features that generate spray or mist;
5) Landscapes around certain residential property such as condominiums that have a recycled water manager responsible for the landscape irrigation; and
6) Freeway, roadside, and medial strip landscaping.

R-2 subsurface drip or subsurface drip irrigation is allowed for:

1) Non-edible vegetation in areas with limited public access;
2) Sod farms;
3) Ornamental plants for commercial use;
4) Fodder, fiber, and seed crops not consumed by humans; and
5) Timber and trees not bearing food crops.

Although R-2 spray irrigation is generally prohibited, R-2 spray irrigation may be allowed provided that an adequate buffer exists between the areas being sprayed and the adjacent residential or publicly accessible area.

R-1 requires oxidation, filtration, and disinfection. R-1 recycled water may be used for:

1) All landscape and agricultural irrigation via spray, surface drip or subsurface drip irrigation
2) Irrigation of a home on agricultural land or condominium property regimes provided there is recycled manager.
3) Drinking water for livestock, and poultry except for dairy animals that produce milk for human consumption
4) Restricted recreational impoundments such as golf course hazards, landscape water features, fountains, waterfalls
5) Irrigation storage reservoirs and ponds
6) Fish hatchery basins.
7) Dampening, wet sweeping and/or wash-down of streets, roads, parking lots, and walkways
8) Flushing toilets, urinals, and sanitary sewers where permitted by the applicable county plumbing code.
9) High pressure water cleaning of surfaces
10) Agricultural cleaning to wash down animals such as cattle, livestock, animal pens and housing
11) Cooling of power equipment while cutting, coring or drilling pavements, walls and other hard surfaces
12) Water jetting to consolidate backfill material around piping for recycled water, non-potable water, sewage, storm drains, gas and electrical conduits
13) Washing aggregate and concrete manufacturing
14) Boiler feed water.
15) Industrial processes and industrial cooling
16) Cooling in air conditioning systems

17) Firefighting
18) Test water for gas pipeline testing.

Disinfection method includes UV disinfection or chlorination, and both methods require properly trained technicians for operation and maintenance. Monitoring the effluent water quality and submitting relative reports to DOH is also required. Recycled water shall only be applied in approved areas. Best Management Practices (BMPs) refer to effective and practicable activities, conduct prohibitions, treatment requirements, schedule, maintenance, and other practices. Backflow prevention should be protecting the potable water supply. Color identification and labeling of the components should be used for component identification purpose. Public education and employee training are necessary for safety consideration.

From the livestock harvesting facility standpoint, the use of recycled water within the facility raises concerns for potential contamination. Operators must ensure recycled water never touches manufactured meats. Recycled water is more ideal if using outside of the facility and applied subsurface.

F.4.3. Legal Feasibility

An application process must be conducted through DOH. DOH will then approve or reject the construction of a wastewater reclamation facility and use of recycled water. Using recycled water requires extensive monitoring and education within facility. This includes adding “do not drink” signs around the area recycled water are in use. For more details about the legal requirements, refer to *Reuse Guidelines* by DOH Wastewater Branch. Discussion with DOH personnel is necessary for this option.

F.5. Disposing Through Municipal Sewer System

The high strength wastewater from livestock harvesting facility can be pretreated on site using simple and low O&M cost treatment systems, such as ATU and lagoon as discussed in the previous section. Then, wastewater may be discharged into a municipal sewer system for additional treatment and final disposal. Collecting effluent and periodically transferring treated wastewater through hauling trucks to the nearest wastewater facility may be feasible if municipal sewer line does not exist near the livestock harvesting facility. However, Maui County will not allow disposing wastewater through municipal sewer system.

F.5.1. Technical Feasibility

Wastewater prior to discharging into municipal sewer line must meet the industrial wastewater discharge requirement. Ideally, the on-site pretreatment system connects to the nearby municipal sewer line, and that the effluent gravity flows or is pumped to the sewer system. If the municipal sewer is not available for connection, hauling trucks can be employed for the hauling work. In this case, a holding tank should be constructed.

F.5.2. Operational Feasibility

Aside from periodically cleaning the grease interceptor, this method is a low maintenance system. Discharging high strength wastewater into the municipal sewer system does come with a monthly surcharge. These costs will add up over time and should be considered in the overall operating costs of the facility. Investing initially in a treatment system to reduce the BOD and TSS to lower levels may be more cost friendly in the long term.

F.5.3. Legal Feasibility

Maui County does not allow wastewater from livestock harvesting facility into the municipal sewer system.

For wastewater entering the sewer system in any other counties besides Maui, pretreatment is required. The preferred effluent target for BOD and TSS would be the same as the average domestic wastewater level concentrations. This could allow discharge into the municipal sewer without additional SIU or CIU requirements and surcharges, depending on the local wastewater treatment plant (WWTP). According to SIC Code 2011, municipal sewers accept industrial wastewater with a high TSS strength of up to 1,000 ppm, but this comes with a higher surcharge rate than domestic wastewater.

G. Sludge Disposal Method

The sludge generated through the water treatment processes need proper disposal. These sludges consist of residual suspend solid in a waste stream and biosolid generated during biological treatment process. For a grease interceptor, lagoon and ATU, sludge floats up or settles down in the pond or tank, and a service truck is needed to pump out the sludge as required. The floating sludge gets separated from wastewater in the DAF tank. MBR uses membrane to separate solid and liquid and produce waste sludge. Similarly, waste sludge is separated in the clarifier of MBBR. The waste sludge from the DAF, MBR and MBBR is usually in the form of a liquid or semisolid liquid, depending on the operations.

G.1. Sludge Drying Bed

A sludge drying bed is the most widely used method for sludge dewatering in the United States. The drying bed is a shallow tank divided into multiple rectangular cells. The cells are sized for one or two beds to be filled in a normal loading cycle. 9 to15 inches of sand is placed over 8 to18 inches of graded gravel. Underdrain piping are installed at the bottom of the gravel layer. The drying of sludge can be divided into two different stages: drainage and evaporation.

The drainage will be cycled back to the influent stream and go through the whole treatment process again. Sludge drying beds with greenhouse-type enclosures allow sludge dewatering throughout the year regardless of weather. Once the sludge is fully dried, the sludge cake is removed by manual shoveling or a front-end loader, depending on the size of facility, into wheelbarrows or trucks for disposal. In summary, sludge drying bed reduces sludge amount and changes sludge form to sludge cake so that the operability for final disposal is improved. Figure 15 shows an example of a sludge drying bed.

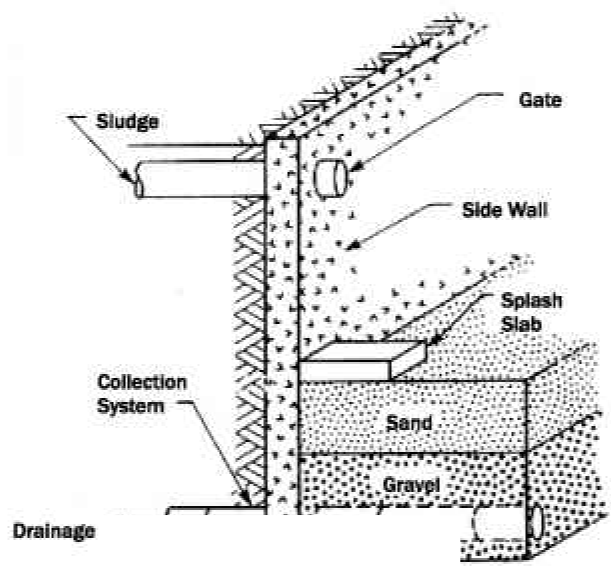


Figure 15. Example of a Sludge Drying Bed

Reference: *Climate Policy Watcher Website.*[21]

G.1.1. Technical Feasibility

A sludge drying bed is a feasible alternative for thickening and dewatering wastewater sludge if land area is available. Because this technology highly relies on evaporation, weather conditions are an important factor to be considered. A greenhouse-type enclosure can be installed to prevent the influence from precipitation. Therefore, a sludge drying bed is better adaptable for sites located in dry areas.

G.1.2. Operational Feasibility

Liquid sludge is typically pumped into the drying beds where the dried sludge cake eventually needs to be removed manually. The sludge drying bed is not a final disposal method, but it thickens and dewaters the sludge, so the sludge volume is greatly reduced

[21] The Main Advantages of Sludge Drying Beds, Climate Policy Watcher, https://www.climate-policy-watcher.org/wastewater-sludge/drying-beds.html

for further handling. The sludge cake can be composted with other solid waste or hauled off-site for land field disposal. Odor emissions and vector attraction must be controlled due to the unstable nature of the DAF sludge.

G.2. Composting

The wastewater sludge can be combined with other solid wastes for composting on-site. However, the thickening or dewatering of the sludge is necessary to achieve a moisture content of 40-60% by weight within the composter.

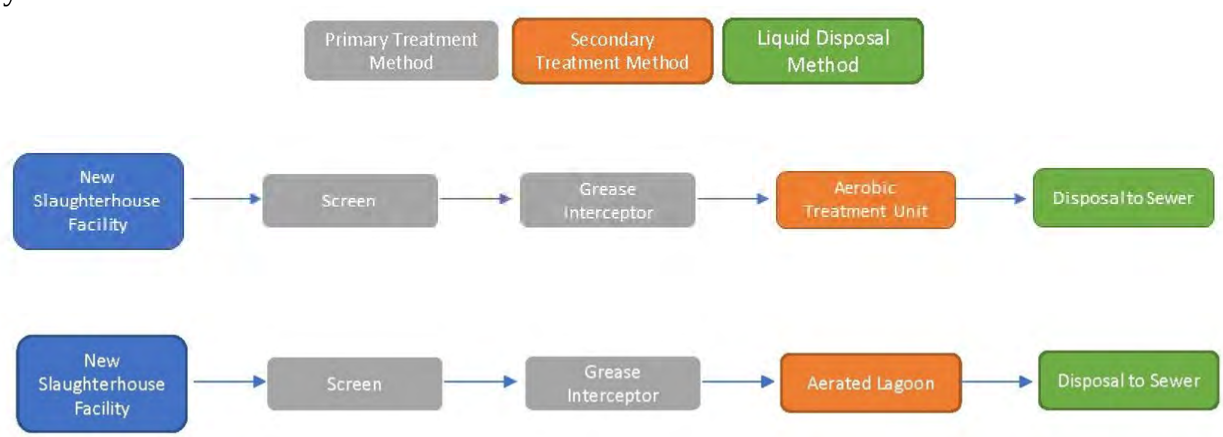
G.3. Hauling off-Site

Pumper trucks can be used to haul waste sludge off-site periodically. A storage tank is required for holding sludge prior to disposal. The hauled sludge can be discharged into the sewer system with an approved permit.

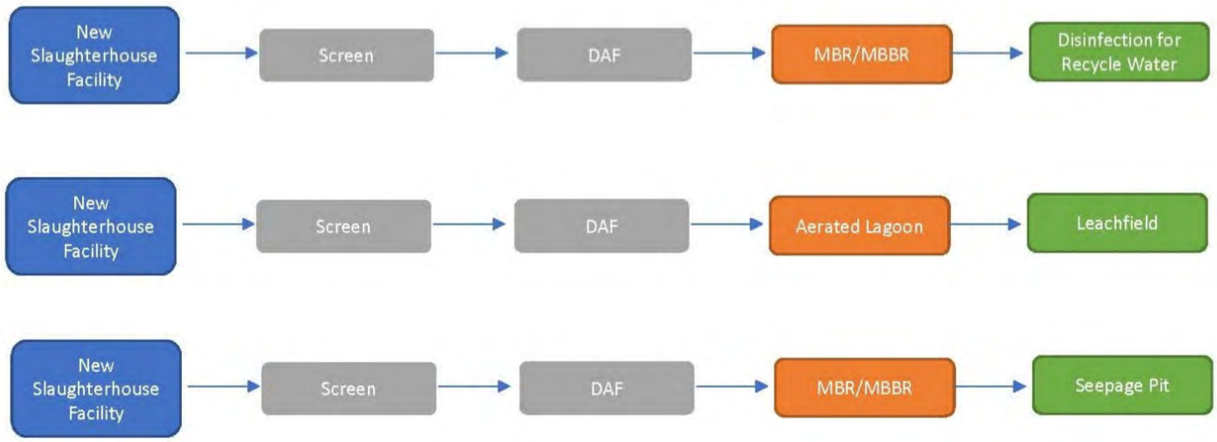
H. Recommended Alternatives

Choosing the best wastewater treatment option heavily depends on (but not limited to) a location, an available space, the weather, and the site soil type of the future livestock harvesting facility. Ideally, the best option has minimal maintenance, ease of use, least overhead cost, affordable operation cost, and effective reduction of BOD and TSS while complying to all policies.

Here are a few recommended alternatives when considering disposal into a municipal sewer system:



The following are recommended alternatives for on-site discharge and disposal:



In summary, the suitable choices of treatment technology and liquid disposal method can be determined by following the flow diagram in Figure 16.

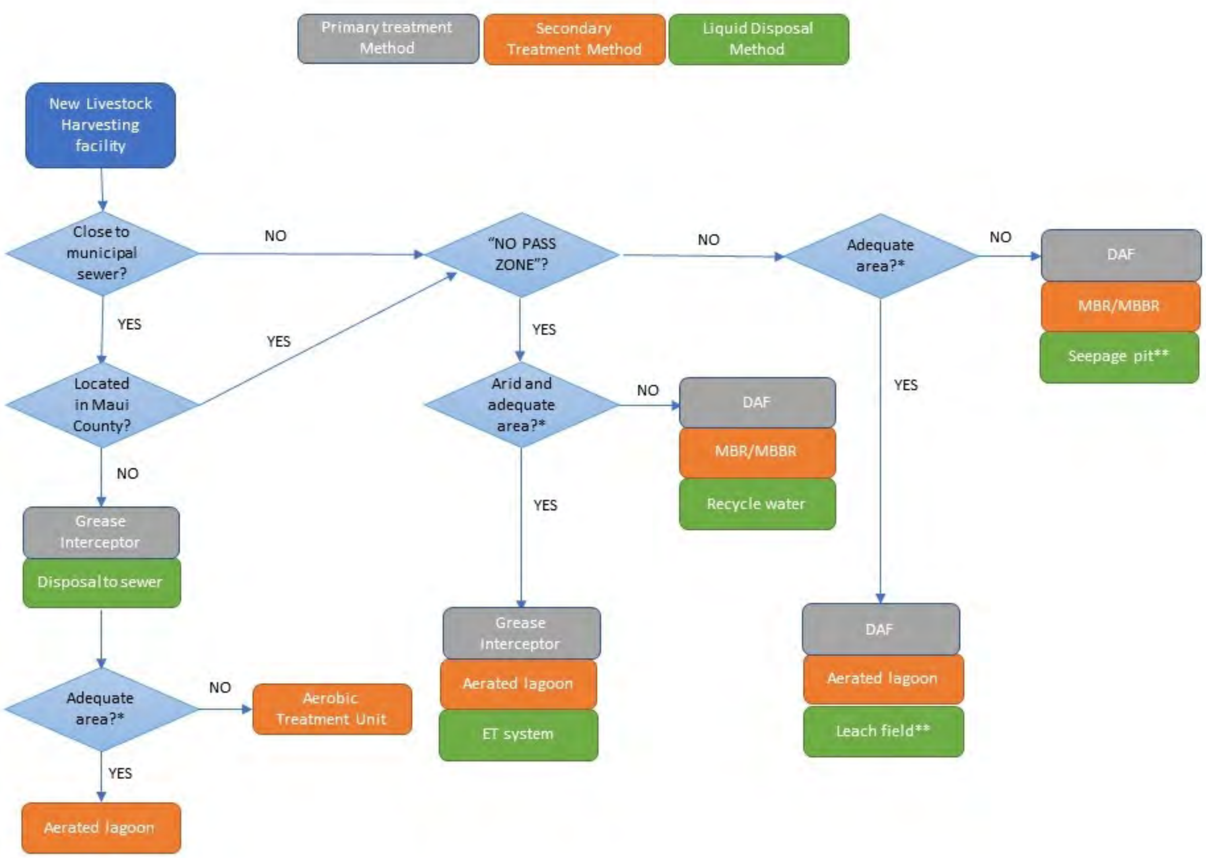


Figure 16. Flowchart for determining treatment technology and liquid disposal method.

*For adequate area in an aerated lagoon, an ET system, and a leach field, see corresponding sections in the report. Sizing greatly depends on soil type in site and wastewater generated from facility.
**Depending on the elevation of groundwater table, leach field and seepage pit may not be feasible.

The following tables summarizes each treatment processes:

Table 3. Pros and Cons of Primary Treatment Process

Primary Treatment	Technical Feasibility		Operational Feasibility	
	Pros	Cons	Pros	Cons
Hydro screen	• No electrical power required • Retention time is short • Simple system design • Low capital cost • Small footprint • Protection to all downstream pumps and equipment	N/A	• Low operation requirement	• Need manually cleaning and transfer the solid waste
Dissolved Air Floatation (DAF)	• Short retention time	• Large capital cost • An EQ is necessary prior to DAF	• Automatic operation	• More parts are needed for maintenance • Manually cleaning required • Trained technical personal required
Grease Interceptor (GI)	• No electrical power • Tank is installed underground.	• Retention time is longer than other methods • Large footprint	• Low maintenance requirement: Maintenance frequency is once every several months	• Pump truck required for cleaning

Table 4. Pros and Cons of Secondary Treatment Process

Secondary Treatment	Technical Feasibility		Operational Feasibility	
	Pros	Cons	Pros	Cons
Aerated Treatment Unit (ATU)	• Low capital cost • Installed underground • Simple system design	• Large footprint • Additional tanks need to be installed for treating a higher influent flow	• Low maintenance requirement: maintenance frequency is once every several years	• Pump truck required for cleaning
Aerated Lagoon	• Low capital cost • Simple system design	• Large footprint • Additional lagoons should be built to handle a higher influent flow	• Low maintenance requirement: maintenance frequency is about once every 10 years	• Pump truck required for cleaning • Aeration systems require maintenance
Membrane Bioreactor (MBR)	• Small footprint • High efficiency of removing BOD and TSS • Customized unit can break down high TN • A UV disinfection unit can be complied to treat the effluent for recycled water • Can handle a variation of influent flow • Easy to add in extra reaction tank for treating a higher flow	• An EQ prior to the system is required • High capital cost • System is complex and the failure risk is high than the other treatment technologies • A series of critical parameters for a good performance • Sludge generated through the process requires recycling, and a portion need to be wasted	• System supports remote operation. • System can be set as automatic operation	• Operation is complex and a trained technical personal is required • System includes a series of measuring instruments (pH, DO meter, etc.) and requires extra maintenance • The addiction chemical requires special handling • Sludge wasted from the process need be disposed separately
Moving Bed Biofilm Reactor (MBBR)	• Small footprint. • Can handle a variation of influent flow • Easy to add in extra reaction tank or media for treating a higher flow • Recycle of sludge is not needed	• An EQ prior to the system is required • High capital cost • Solid separation process (e.g. DAF) following with the system is required • Addition of Carbon resource maybe required when inflow rate is low.	• Maintenance and operation are easy	• A trained technical personal is needed • Sludge generated from the process need be disposed separately

Table 5. Pros and Cons of Liquid Disposal Process

Liquid Disposal	Technical Feasibility		Operational Feasibility		Legal Feasibility	
	Pros	**Cons**	**Pros**	**Cons**	**Pros**	**Cons**
Leach Field	• Installation is undergrounded • System can provide addition treatment • Low capital cost compared to recycle of wastewater	• Large footprint • The footprint relates to soil percolation rate • Cannot be installed in steep terrain • Upstream process should remove solid from effluent	• Low maintenance requirement.	• System cannot be restored if system is failed • Heavy equipment should be kept away from the installation area	N/A	• Not allowed in “No Pass Zone”/UIC • Groundwater table must be low • Infeasible in certain soil types • 100% backup disposal component required
Seepage Pit	• Installation is undergrounded • Small footprint • Low capital cost compared to recycle of wastewater	N/A	• Low maintenance requirement.	• Need to be pumped clean every three to five years.	N/A	• Not allowed in “No Pass Zone”/UIC • Groundwater table must be low • Infeasible in certain soil types • 100% backup disposal component required • Only allowed on the site locations where cannot use leach field

ET System	• Low capital cost compared to recycle of wastewater	• Large footprint • Footprint relates to the site year-round weather. • Possible of salt accumulates in ET system	• Low maintenance requirement.	N/A	• Can be built in “No Pass Zone” /UIC with permit	• 100% backup disposal component required
Recycle	• Small footprint • Environment friendly	• High capital cost • Chemical need special handling if using chlorine disinfection	N/A	• A trained technical personal is needed • High O&M cost • Recycled water may have limited use when contacting with food products	• Can be built in “No Pass Zone” /UIC with permit	• Stringent rules must be followed when using recycled water. • Community education and labeling required.
Municipal Sewer	• Upstream wastewater treatment processes can be simplified • Environment friendly • Lowest overall capital cost	• Site location should be close to municipal sewer system, or • Hauling truck requires to transfer the wastewater	• No maintenance requirement	• Monthly sewer bill maybe costly	• Can be built in “No Pass Zone” /UIC with permit	• Must comply to County and receiving wastewater treatment facility requirements • Not allowed in Maui County

The following tables summarize the estimated front cost and footprint of each treatment process.

Table 6. Estimated footprint and cost for each Primary Treatment

Primary Treatment	20 Cattle Heads Slaughtered Per Day, 2 Days Per Week		70 Cattle Heads Slaughtered Per Day, 5 Days Per Week	
	Estimated Front Cost	Estimated Footprint	Estimated Front Cost	Estimated Footprint
Hydro screen	$15,000	Length: 22” Width: 41”	$20,000	Length: 40” Width: 41”
DAF	$400,000	Length: 7 ft Width: 4 ft 4 in Height: 6 ft 8 in	$400,000	Length: 7 ft Width: 4 ft 4 in Height: 6 ft 8 in
GI	$10,000	Length: 7 ft Width: 4 ft	$20,000	Length: 16 ft Width: 7 ft

Table 7. Estimated footprint and cost for each Secondary Treatment

Secondary Treatment	20 Cattle Heads Slaughtered Per Day, 2 Days Per Week		70 Cattle Heads Slaughtered Per Day, 5 Days Per Week	
	Estimated Front Cost	Estimated Footprint	Estimated Front Cost	Estimated Footprint
ATU	$100,000	Diameter: 8 ft Length: 18 ft	$200,000	Diameter: 12 ft Length: 68 ft
Aerated Lagoon *	$150,000	Width: 94 ft Length: 112 ft	$300,000	Width: 124 ft Length: 288 ft
MBR	$800,000	Length: 40 ft Width: 20 ft Height: 14 ft	$1,400,000	Length: 80 ft Width: 40 ft Height: 18 ft
MBBR	$900,000	Length: 40 ft Width: 20 ft	$1,500,000	Length: 80 ft Width: 20 ft

Note: * Aerated lagoon is sized without considering storm event.

Table 8. Estimated footprint and cost for each Liquid Disposal

Liquid Disposal	20 Cattle Heads Slaughtered Per Day, 2 Days Per Week		70 Cattle Heads Slaughtered Per Day, 5 Days Per Week	
	Estimated Front Cost	Estimated Footprint	Estimated Front Cost	Estimated Footprint
Leach Field	\$50,000 – \$100,000 per leach field (100% back up disposal component is required)	Depending on percolation rate: from 2,500 sqft to 15,000 sqft. Twice as much area needed for 100% back up disposal component	\$400,000 – \$1,000,000 per leach field (100% back up disposal component is required)	Depending on percolation rate: 25,000 sqft to 150,000 sqft. Twice as much area needed for 100% back up disposal component
Seepage Pit	\$60,000 per seepage pit. (100% back up disposal component is required)	Depending on percolation rate and allowable depth. Twice as much area needed for 100% back up disposal component.	\$300,000 per seepage pit. (100% back up disposal component is required)	Depending on percolation rate and allowable depth. Twice as much area needed for 100% back up disposal component.
ET System	\$15,000 per ET system	Depend on coefficient, annual evapotranspiration rate, and annual precipitation rate.	\$150,000 per ET system	Depend on coefficient, annual evapotranspiration rate, and annual precipitation rate.
Recycle	\$500,000	Length: 20 feet Width: 20 feet	\$1,000,000	Length: 40 feet Width: 40 feet
Municipal Sewer	~\$700/month	Not Applicable	~\$6,000/month	Not Applicable

Table 9. Estimated cost per recommended alternatives

Scenario	Alternatives	Estimated Cost	
		20 Heads Slaughtered Per Day, 2 Days Per Week	70 Heads Slaughtered Per Day, 5 Days Per Week
1	• Screen • GI • ATU • Municipal Sewer Disposal*	$125,000	$240,000
2	• Screen • GI • Aerated Lagoon • Municipal Sewer Disposal*	$175,000	$340,000
3	• Screen • GI • Aerated Lagoon • ET	$205,000	$640,000
4	• Screen • DAF • MBR • Recycled Water	$1,715,000	$2,820,000
5	• Screen • DAF • MBBR • Recycled Water	$1,815,000	$2,920,000
6	• Screen • DAF • Aerated Lagoon • Leach Field	$665,000 to $765,000	$1,520,000 to $2,720,000
7	• Screen • DAF • MBR • Seepage Pit	$1,335,000	$2,420,000
8	• Screen • DAF • MBBR • Seepage Pit	$1,435,000	$2,520,000

Notes: * Disposal to municipal sewer line not included due to monthly cost and location dependency on allowable connection

APPENDIX B

LIVESTOCK HARVESTING COMPOST STUDY

Table of Contents

B. Composting

One way to dispose of waste is composting, in which waste is degraded and transformed by microorganisms into organic and inorganic by-products.[1] The types of composting methods will be discussed along with the technical, operational and legal feasibility of composting.

B.1. Types of Composting Methods

There are five types of composting methods, 1) onsite, 2) vermicomposting, 3) aerated static pile composting, 4) passive aerated (turned) windrow and 5) in-vessel composting. For animal by-products, onsite, vermicomposting and aerated static pile composting cannot be used. Onsite composting is meant for small amounts of waste, typically at your house. Meat or fish bones and scraps should not be composted because it will cause odor problems and attract pests.[2] Vermicomposting uses worms to break down waste. This method cannot be done as worms will have a challenging time digesting animal by-product.[3] Aerated static pile composting is compiling mixed waste in a large pile with bulking agents such as wood chips to aerate the pile. According to the Environmental Protection Agency (EPA), this does not work well for composting animal by-products or grease from food processing industries.[4]

The two methods capable of composting animal by-products are passive aerated windrow composting and in-vessel composting. Passive aerated windrow forms organic waste such as meat, animal manure and animal by-products into rows of long piles called "windrows" in which they are aerated through the turning of the piles, manually or mechanically. Passive aerated windrows have open-ended pipes that are pushed into the bottom of the windrow widthwise (Figure 1). The ends of the pipe are always open, and are perforated with a line of holes facing down. This helps air flow and allows any liquid from the windrow to drain.[5] Passively aerated windrows take about 10 to 12 weeks to compost.[6]

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[1] Ayilara, Modupe Stella, Oluwaseyi Samuel Olanrewaju, Olubukola Oluranti Babalola, and Olu Odeyemi. 2020. "Waste Management through Composting: Challenges and Potentials." *Sustainability (Switzerland)*. MDPI AG. https://doi.org/10.3390/su12114456.

[2] "Composting At Home | US EPA." n.d. Accessed July 23, 2021. https://www.epa.gov/recycle/composting-home.

[3] "Learn About Vermicomposting at Home | FoodPrint." n.d. Accessed July 26, 2021. https://foodprint.org/eating-sustainably/composting-and-food-waste/vermicomposting-101/.

[4] "Types of Composting and Understanding the Process | US EPA." n.d. Accessed July 19, 2021. https://www.epa.gov/sustainable-management-food/types-composting-and-understanding-process#aeratedstatic.

[5] "On-Farm Composting Methods." n.d. Accessed July 26, 2021. http://www.fao.org/3/y5104e/y5104e07.htm.

[6] United States Department of Agriculture Natural Resources Conservation Service Montana. n.d. "Operation and Maintenance Guide for Your Composting Facility," 42–56.

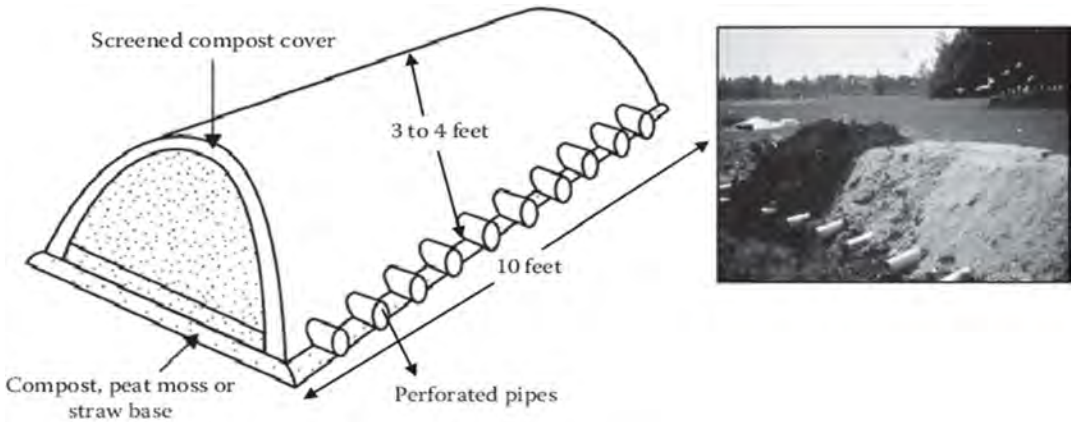

Figure 1. Passive Aerated Windrow.

Reference: *Yadav, Sangeeta, "Use of PMDE with sugar press mud or sugar industries press mud for composting: a green technology for safe disposal in the environment," January 2014.*

The process for passive aerated windrows is:

1) Optimize mixture for using shredders and/or chippers
2) Mix material using a mixer
3) Arrange windrows
    a. Establish a base of carbon material
    b. Lay down perforated pipes
    c. Overlay waste
    d. Put a screened compost cover on top

In-vessel composting is composting organic waste into a drum, silo, concrete-lined trench or similar equipment (Figure 2). An in-vessel unit controls temperature, aeration and moisture to accelerate decomposition. For in-vessel composting, the time it takes for waste to compost depends on the storage unit. For rectangular agitated beds, the active composting time ranges from two to four weeks. For rotating drums, the time ranges from three to eight days and for vertical silos, the time ranges from one to two weeks.[7]

The process for in-vessel composting is:

1) Optimize mixture for using shredders and/or chippers
2) Load mixture in-vessel
3) Air and water are supplied and oxygen and moisture levels and temperature are monitored for two to four weeks
4) Mixture is laid out in piles to continue break down
5) If needed, compost can be screened to remove large clumps
6) Bag/bulk compost to market (if desired) or use as compost [8]

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[7] United States Department of Agriculture Natural Resources Conservation Service Montana. n.d. "Operation and Maintenance Guide For Your Composting Facility," 42–56.

[8] "Technologies Overview - In-Vessel Composing | Alternative Waste Treatment Guide." n.d. Accessed August 13, 2021. http://awtguide.environment.gov.za/content/technologies-overview-vessel-composing.

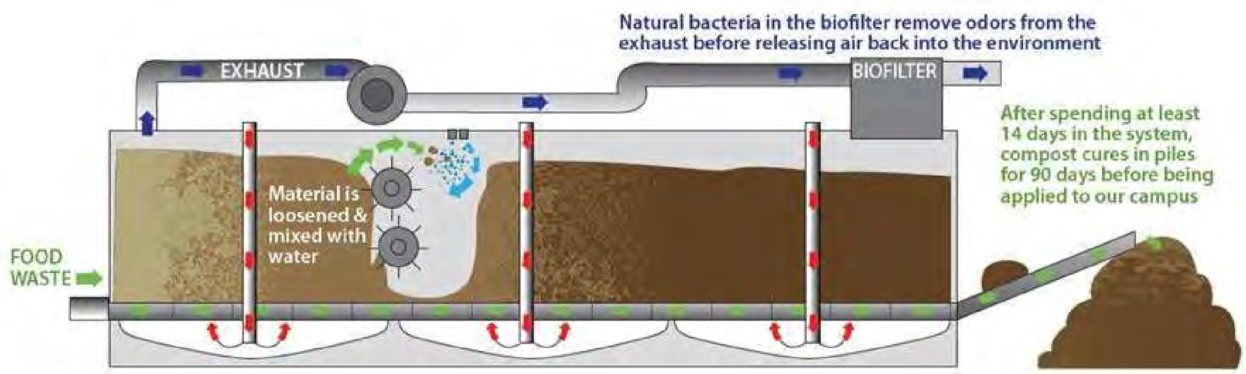

Figure 2. In-Vessel Composter.

Reference: *Ohio State University.*

Table 1 shows the pros and cons for these two methods. In summary, passive aerated windrows offer flexibility, while in-vessel composting offers controllability.

Table 1. Pros and Cons for Passive Aerated (turned) Windrow and In-Vessel Composting

Passive aerated (turned) windrow		**In-vessel composting**	
Pros	Cons	Pros	Cons
Can do any type of organic waste	Requires lots of land, equipment and labor	Can do any type of organic waste	Expensive
There is no size restriction. Size is only restricted by space.	Weather dependent. If too hot, a cover or a shelter is needed to prevent water from evaporating. During rainy seasons, the pile must be adjusted so water runs off the pile, odors.	Very little odor or leachate produced	Technical expertise needed to operate properly
	Odor needs to be controlled	Uses less land and labor than windrow composting	Size is dependent on storage container used
	More regulations may need to be met	Can have control of environmental conditions such as temperature, moisture and airflow	
	Stabilization of piles need to be considered	Can be used in any weather; not weather dependent	

B.2. Requirements

To “control” the compost to ensure safety and environmental concerns such as spontaneous combustion, attractant of animals and odor, five requirements must be monitored: 1) temperature, 2) moisture, 3) oxygen, 4) waste size and 5) mixture.

B.2.1. Temperature

The temperature of the pile’s core should be at least 140 ºF.[9] The monitoring of temperatures using thermometers is needed as it affects the rate of decomposition and the destruction of pathogenic bacteria, fungi and some seed.[10] As the temperature cools, piles may need to be larger than usual to minimize surface cooling.

B.2.2. Moisture

There have been many studies understanding what moisture level is ideal or optimum for composting. Moisture affects the temperature — the higher the moisture, the higher the temperature. Researchers at Louisiana State University found that adequate temperature was reached at moisture levels ranging from 25% to 37% and determined the minimum moisture content should be 32% (Lavergne et al., 2006). University of Delaware recommended the optimum moisture content to be 35% and states the “optimum” litter moisture depends on other factors such as the age of the litter, type of litter base, nutrient content (carbon-to-nitrogen ratio) and ambient temperature.[11] However, Texas Manure concluded that moisture should be at 50% to 60% by mass (wet basis).[12] The United States Department of Agriculture (USDA) recommends a moisture level within the range of 40% to 60% to maintain adequate moisture.[13]

To check the moisture of compost, one can grab a handful of compost and squeeze it. If droplets are coming out, the compost is too wet. If no droplets are coming out, drop the compost and look at the palm of your hand. If it does not have sheen of water, it is too dry.

Wet basis moisture content can be calculated by measuring a given sample of material’s mass, oven drying it and measuring the mass of the remains. While dedicated devices are not necessary to perform these measurements, there do exist devices on the market for this purpose such as the Vapor Sorption Analyzer.[14]

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[9] “Types of Composting and Understanding the Process | US EPA.” n.d. Accessed July 19, 2021. https://www.epa.gov/sustainable-management-food/types-composting-and-understanding-process.

[10] Cornell Waste Management Institute. 2008. “Natural Rendering: Composting Livestock Mortality and Butcher Waste.” https://datcp.wi.gov/Documents/cornellcompostguide.pdf.

[11] “In-House Windrow Composting Q and A | The Poultry Site.” n.d. Accessed July 19, 2021. https://www.thepoultrysite.com/articles/inhouse-windrow-composting-q-and-a.

[12] “Composting Large Animal Carcasses - Texas Animal Manure Management Issues.” n.d. Accessed July 19, 2021. https://tammi.tamu.edu/2017/07/20/composting-large-animal-carcasses/.

[13] USDA. 2017. “Conservation Practice Standard. Composting Facility.” *Natural Resources Conservation Service*, no. October: 1–3.

[14] “VAPOR SORPTION ANALYZER | Moisture Sorption Isotherm | METER Food.” n.d. Accessed August 3, 2021. https://www.metergroup.com/food/products/vsa/.

B.2.3. Oxygen

The windrow should be aerated to speed up decomposition. Oxygen can be introduced to the windrow by turning the windrow, placing the pile on a series of pipes or including bulking agents such as wood chips.[15]

The frequency of turning depends on the rate of decomposition, moisture level and desired composting time.[16] Besides speeding up decomposition, turning the windrow can ensure that carbon is converted to carbon dioxide instead of methane.[17] In addition, turning will ensure that the windrow is heated evenly, and that moisture is distributed equally.[18]

B.2.4. Waste Size

The size of the waste should be broken down into small pieces by grinding, chipping or shredding material. Small pieces make it easier for microorganisms to feed and improve the pile insulation to help maintain optimum temperatures. Pieces should not be so small that it prevents air from flowing through the pile.

B.2.5. Mixture

A balance of green (which contains nitrogen) and brown (which contains carbon and little nitrogen) organic materials is recommended to control decomposition.[19] Some examples of suitable materials are wood chips, wood shavings, straw, yard or brush trimmings, and partially composted leaves. The needed amount of carbon material is usually dependent on the weight of livestock being composted. A general rule to follow is using three to six cubic yards of carbon material for every 1,000 pounds of livestock. [20] Manure is another optimal material that can be added to the compost as an extra supply of nitrogen or moisture. The USDA recommends a carbon-to-nitrogen ratio between 25:1 and 40:1.[21]

B.3. Technical Feasibility

The disadvantages of composting include a long duration of composting, odor production, processing blood, and release of greenhouse gases (carbon dioxide, sulfur dioxide, nitrogen dioxide) into the

[15] "Types of Composting and Understanding the Process | US EPA." n.d. Accessed July 19, 2021. https://www.epa.gov/sustainable-management-food/types-composting-and-understanding-process.

[16] "On-Farm Composting Methods." n.d. Accessed July 26, 2021. http://www.fao.org/3/y5104e/y5104e07.htm.

[17] Gooding, Charles H., and David L. Meeker. 2016. "Review: Comparison of 3 Alternatives for Large-Scale Processing of Animal Carcasses and Meat by-Products." *Professional Animal Scientist*. Elsevier Inc. https://doi.org/10.15232/pas.2015-01487.

[18] "In-House Windrow Composting Q and A | The Poultry Site." n.d. Accessed July 19, 2021. https://www.thepoultrysite.com/articles/inhouse-windrow-composting-q-and-a.

[19] "In-House Windrow Composting Q and A | The Poultry Site." n.d. Accessed July 19, 2021. https://www.thepoultrysite.com/articles/inhouse-windrow-composting-q-and-a.

[20] Miller, Lori P., Amy Buckendahl, Gary A. Flory, Robert W. Peer, Mark L. Hutchinson, Mark A. King, Josh B. Payne, et al. 2017. "Livestock Mortality Composting Protocol.," 1–34.

[21] USDA. 2017. "Conservation Practice Standard. Composting Facility." *Natural Resources Conservation Service*, no. October: 1–3.

atmosphere and the depletion of oxygen. Compost that does not rot, or nonbiodegradable material will smell and generate methane gas, which contributes to the greenhouse gas effect.

B.3.1. Long Duration of Composting

There are different catalysts to speed up composting. This includes using water hyacinth, compost activators, biochar, and the Berkeley Method.

Water hyacinth is a free-floating aquatic plant, growing in or near water that has a high production rate. Water hyacinth can be used as a substrate for compost or biogas production. They have high concentrations of nutrients such as nitrogen and can be used as a fertilizer. The amount of nitrogen can speed up the composting process as microbes feed on nitrogen, triggering growth. In addition, their high level of moisture can supply water to the compost.[22] However, its high level of moisture may prolong the composting process and reduce the quality of the compost as nitrogen can be lost through leaching and denitrification.[23] Besides its application with composting, the water hyacinth can be used to clean wastewater as they absorb and digest pollutants.

Another method to speed up composting includes using compost activators, also called bacterial jump starters and nitrogen fertilizer. There are many types such as commercial fertilizer, blood meal, alfalfa meal or concentrated manure. The amount of activators depends on the concentration of nitrogen in the compost.[24] Furthermore, adding biochar, a charcoal, to compost can also speed up the process. Research from the Department of Soil and Water Conservation and Organic Waste Management in Murcia, Spain, shows that adding three percent (3%) dry weight of biochar can decrease composting time by 20%.[25]

The Berkeley Method introduced by Professor Robert Raabe will compost materials within two to three weeks. The Berkeley Method involves the following steps:

1) Chop material to 1/2 to 1-1/2 inches.
2) Carbon to nitrogen ratio should be 30:1.
3) Moisture level should be 50%.
4) Pile should be at least 3’ x 3’ x 3’ to prevent heat loss and to build up the heat needed.
5) The pile should be turned daily or every other day. If the pile is turned daily, it will take two weeks or a little longer to compost. If the pile is turned every other day, it will take about three weeks.

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[22] Gunnarsson, Carina C., and Cecilia Mattsson Petersen. 2007. “Water Hyacinths as a Resource in Agriculture and Energy Production: A Literature Review.” *Waste Management* 27 (1): 117–29. https://doi.org/10.1016/J.WASMAN.2005.12.011.

[23] Beesigamukama, Dennis, John Baptist Tumuhairwe, John Muoma, John M Maingi, Omwoyo Ombori, Dative Mukaminega, Josephine Nakanwagi, and Alice Amoding. 2018. “Improving Water Hyacinth-Based Compost for Crop Production.” *Journal of Agricultural Science and Food Technology* 4 (3): 52–63. http://pearlresearchjournals.org/journals/jasft/idex.html.

[24] Kansas State University Research and Extension. n.d. “Compost Activators.”

[25] M, Sánchez-García, Alburquerque JA, Sánchez-Monedero MA, Roig A, and Cayuela ML. 2015. “Biochar Accelerates Organic Matter Degradation and Enhances N Mineralisation during Composting of Poultry Manure without a Relevant Impact on Gas Emissions.” *Bioresource Technology* 192 (September): 272–79. https://doi.org/10.1016/J.BIORTECH.2015.05.003.

6) Nothing should be added once the pile has started to compost. The only exception is water and sawdust. If the pile gets dry, water can be added. If ammonia odor is present, sawdust can be added.
7) Ashes, soil and manure from carnivorous animals should not be added.[26]

B.3.2. Odor Production

Passive Aerated Windrow

Aeration plays a vital role in odor production. Providing air to the windrow through blowers and altering the pile size and porosity of the compost mix by adding amendments such as sawdust will aerate the windrows.[27, 28] Aeration from blowers followed by biofiltration, a process in which humid, contaminated air is passed through a porous material, was found to reduce the odor from biosolids by 98%. In addition, biofiltration changed the character of the odor, producing a less offensive odor with an earthly odor.[29] A biofilter layer can be added over the windrows to prevent the release of odors. The layer must be at least six inches thick and consist of shredded yard waste, authorized bulking agents or cured compost.[30] Another way to minimize odor is choosing an area for your compost facility that has landscape features that can buffer the wind.[31]

In-vessel

There is very minimal odor produced from the in-vessel compost because of the containment of the waste. A biofilter will remove odors from the system's exhaust before releasing air back into the environment. The adjustments of airflow, moisture, and temperature can all be controlled which helps to prevent the production of odor.[32]

B.3.3. Processing Blood

Passive Aerated Windrow

Blood can be deposited in the aerated windrow for composting. There seems to be no state or city regulations that prohibit blood from being composted in Hawai'i. Factors to consider when composting blood from slaughterhouse waste is the high risk of odor and vermin, pests and

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[26] Raabe, Robert D. n.d. "The Rapid Composting Method."

[27] United States Department of Agriculture Natural Resources Conservation Service Montana. n.d. "Operation and Maintenance Guide For Your Composting Facility," 42–56.

[28] "Odor Management." n.d. Accessed July 30, 2021. http://compost.css.cornell.edu/odors/odor.html.

[29] Rosenfeld, Paul, Mark Grey, and Paul Sellew. 2004. "Measurement of Biosolids Compost Odor Emissions from a Windrow, Static Pile, and Biofilter." *Water Environment Research* 76 (4): 310–15. https://doi.org/10.2175/106143004x141898.

[30] Ohio Environmental Protection Agency. 2019. "Odor Management Practices for Composting Facilities."

[31] USDA. 2017. "Conservation Practice Standard. Composting Facility." *Natural Resources Conservation Service*, no. October: 1–3.

[32] "Types of Composting and Understanding the Process | US EPA." n.d. Accessed July 19, 2021. https://www.epa.gov/sustainable-management-food/types-composting-and-understanding-process.

scavengers, and the high nitrogen levels of blood.[33] Besides composting blood, another method to manage blood is to make blood meal by drying it out. Blood meal can be used to help fertilize and add nitrogen to compost.

In-vessel

Blood can be added into the mixture in any in-vessel system. The high risk of odor and vermin, pests and scavengers are absent due to the enclosed system. The level of nitrogen must be monitored whether blood is being composted or not.

B.3.4. Release of Greenhouse Gases

Passive Aerated Windrow

Aeration helps to reduce methane production as well as the microbes that help to oxidize any leftover methane before being released into the atmosphere.[34] Greenhouse gases such as methane tend to thrive in anaerobic climates. As long as the windrow is properly controlled and has enough oxygen, the greenhouse gases produced are minimal.

In-vessel

The production of greenhouse gases is limited. With the waste being entirely contained until fully usable compost, the carbon dioxide, nitrous oxide and methane that are produced are kept within the vessel. The in-vessel compost should also be kept aerated and properly controlled to avoid excess production of greenhouse gases.

B.4. Operational Feasibility

B.4.1. Housing the Compost

Passive Aerated Windrow

For passive aerated windrow composting, the windrow can be indoors or outdoors and is determined by the climate of the location. If the location is in a cooler climate, it is best to have the windrow outside to get some sun to speed up decomposition. If the location is in a hotter climate, it is best to have the windrow inside, so it does not dry out.

If the windrow is located outside, a cover can be put on top during rainy days or on hotter days to maintain the necessary temperature and moisture. If the windrow is too large and a cover is not available, the windrow can be designed and shaped with steep, pointed crowns and sloping sides to shed rain rapidly, especially in wetter climates.[35]

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[33] Graves, Robert E., and Gwendolyn M. Hattemer. 2010. "Chapter 2 Composting." *Environmental Engineering National Engineering Handbook*, no. November: 1–65.

[34] "Composting And Greenhouse Gas Emissions: A Producer's Perspective | BioCycle." n.d. Accessed August 2, 2021. https://www.biocycle.net/composting-and-greenhouse-gas-emissions-a-producers-perspective/.

[35] "Composting Large Animal Carcasses - Texas Animal Manure Management Issues." n.d. Accessed July 19, 2021. https://tammi.tamu.edu/2017/07/20/composting-large-animal-carcasses/.

Other considerations for dry climates are the supply of supplemental water needed to moisten the pile, and the consistent monitoring of the windrow's temperature. The larger the windrow, the more it is prone to combustion due to biological self-heating.[36]

In-vessel

For in-vessel composting, the system can be placed either indoors or outdoors and its location depends on the size. Cold weather does not affect in-vessel composting since insulation can be used or if size permits, can be moved indoors. If the weather is too hot, the in-vessel compost can also be located indoors.

B.4.2. Material

Carbon material such as wood chips is needed for composting to bury animal waste or offal. The supply of carbon material and the use of the end-product (i.e., where the end-product will go) are crucial to the operation of composting. Many companies and organizations offer wood chips or mulch for free or at a price in O'ahu, Hawai'i, Maui and Kaua'i.

Companies in O'ahu such as Imua Landscaping, Arbor Spirit Tree Care, Hawaiian Electric and Hawaiian Earth Products offer free wood chips or mulch on a first-come, first-serve basis. For Imua Landscaping, a typical load varies from as little as four cubic yards to as much as 20 cubic yards. Each load contains about 50% wood chips, 50% green, leafy material or pine needles. Of that, about 5% are unchipped brush, small sticks, and maybe a few scoops of dirt, gravel or trash.[37] For Arbor Spirit Tree Care, a typical load is about eight to 10 cubic yards of green wood, pine needles and leaves. The ratio of wood to leaves varies depending on season.[38] For Hawaiian Electric, a typical load is 10 cubic yards of mixed tree material.[39] Hawaiian Earth Products occasionally offer free mulch on certain days until supplies last.[40]

In Hawai'i, Kealakehe Mulch offers free mulch for commercial purposes only for self-loading. Otherwise, the loading fee is $10 per large scoop (greater than three cubic yards). West Hawai'i Organics Facility and East Hawai'i Organics Facility offer mulch for commercial purposes at $3 per cubic yard and $5 per cubic yard, respectively.[41]

In Maui, Maui Hauling Services and Kihei Compost, LLC delivers and dumps wood chips for a price per cubic yard or yard. Kihei Compost, LLC offers mulch at $10 per yard. Contact is needed

[36] "Composting Large Animal Carcasses - Texas Animal Manure Management Issues." n.d. Accessed July 19, 2021. https://tammi.tamu.edu/2017/07/20/composting-large-animal-carcasses/.
[37] "Free Wood Chips | Imua Landscaping Co. Inc. | Hawaii." n.d. Accessed August 31, 2021. https://www.imualand.com/free-wood-chips.
[38] "Free Wood Chips Honolulu, HI | Arbor Spirit Tree Care." n.d. Accessed August 31, 2021. https://arborspirit.com/free-wood-chips-bay-area/.
[39] "Frequently Asked Questions | Hawaiian Electric." n.d. Accessed August 31, 2021. https://www.hawaiianelectric.com/customer-service/frequently-asked-questions?FAQFilter1=490&page=1.
[40] Hawaiian Earth Recycling. n.d. "(O'ahu) Free Mulch Starting May 1st." Accessed September 17, 2021. https://www.menehunemagicbigisland.com/news.
[41] "Greenwaste & Food Discards - County of Hawai'i Department of Environmental Management." n.d. Accessed September 17, 2021. https://www.hawaiizerowaste.org/recycle/greenwaste-recycling/.

to be made to receive a quoted cost.[42,43] Only Maui EKO Systems at the Central Maui Landfill offers free green waste mulch for residents and businesses while supplies last. Pick-up and delivery are available for green waste mulch from the landfill.[44]

In Kaua'i, Seascapes, Shredco Hawai'i, Inc. and Kaua'i Tree Care offer wood chips for a price per cubic yard or yard. Seascapes is offering wood chips at $60 per yard. Delivery and pick-up options are available for all the companies.[45,46,47] There is no offer of free wood chips or mulch in Kaua'i.

B.4.3. Compost End-Product

The end-product from composting can be sold locally or domestically or be used for local farms in the state of Hawai'i. However, a discussion with the Hawai'i Department of Health (DOH) permit writer for composting and recycling facilities suggests it may be challenging to find a market for compost with animal waste as the market is unfamiliar. Currently, there is a facility in Hawai'i that is unable to dispose of their compost consisting of biosolids mixed with green waste and is seeking a place to dispose at. City policies restrict compost to the landfill to divert recyclable material away from landfills. Thus, the disposal of animal waste in landfills will not be accessible in the future. In addition to securing a source of carbon material and a customer for the end-product, the distance from the livestock harvesting facility site to the source of carbon material and drop-off of the end-product should be considered when evaluating the feasibility of a composting facility.

B.4.4. Space and Cost

Passive Aerated Windrow

The location of the composting area should have proper access, soils and buffers to keep the cost low.[48] The area should be at least 200 feet from a water body, watercourse or other landscape features that indicates the area is hydrologically sensitive; have at least a two-foot clearance around the waste; and have at least a two-foot thick of bulky, absorbent organic material.[49]

For 20 heads/day with two days of harvesting, 2,080 heads will be harvested annually. Each cattle produces 600 pounds of waste (assuming each cattle is 1,000 pounds, producing waste at 60%), totaling to 1,248,000 pounds of waste produced annually. For 70 heads/day with two days of

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[42] "Maui Hauling Services." n.d. Accessed September 17, 2021. https://mauihauling.services/maui-compost-delivered/.

[43] "Kihei Compost, LLC." n.d. Accessed September 17, 2021. http://www.kiheicompost.com/.

[44] "Landfill Information | Maui County, HI - Official Website." n.d. Accessed November 4, 2021. https://www.mauicounty.gov/765/Landfill-Information.

[45] "Wood-Chips – Kaua'i Seascapes Nursery, Inc." n.d. Accessed November 4, 2021. https://kauaiseascapesnursery.com/catalog/landscape-materials/wood-chips-pending-availability/.

[46] "ShredCo." n.d. Accessed November 4, 2021. https://shredcohawaii.com/landscape-garden-products/.

[47] "Kaua'i Tree Care - Wood Chips, Mulch." n.d. Accessed November 4, 2021. https://www.kauaitreecare.com/mulch/.

[48] The University of Maine. 2010. "Sustainable Carcass and Offal Management." 2010. https://extension.umaine.edu/publications/carcass-management/.

[49] Cornell Waste Management Institute. 2008. "Natural Rendering: Composting Livestock Mortality and Butcher Waste." https://datcp.wi.gov/Documents/cornellcompostguide.pdf.

harvesting, 7,280 heads will be harvested annually, totaling to 4,368,000 pounds of waste. Water weight is included in the total weight, so the amount of waste may be less.

The average amount of space needed to compost the residual from a cow is 14.3 square feet, which includes the working space needed for composting the butcher residual from processing a cow.[50] The amount of material to compost one ton of butcher waste is 5 cubic yards in which the material can be reused. There will be a 30% loss of material during composting in which 30% of the material will need to be added per ton, so additional material may not be necessary.[51] The square footage was calculated using the amount of space needed in cubic yards based on the amount of waste produced, then dividing that by the recommended maximum height of the windrow, which is eight feet (2.7 yards) tall.[52]

Summary of assumptions:

1) A composting time of six months was used.
2) A cow will produce 600 pounds of solid waste.
3) For one ton of butcher waste, 5 cubic yards of carbon material is needed.[53]
4) Each windrow will be 16 feet wide and 8 feet tall.
5) The estimated total low cost is based on the 2021 vacant land properties on sale at Hawaiʻi in the agricultural zone (around $1.75/square feet in August 2021). The estimated cost is based on 20 heads per day with two days of harvesting a week.
6) The estimated total high cost is based on the 2021 vacant land properties on sale at Oʻahu in the industrial zone with city and county utilities, including sewer and water (around $267.53/square feet in August 2021). The estimated cost is based on the 70 heads per day with five days of harvesting a week.

Table 2 shows how much space is required based on the amount of waste produced for four scenarios: 1) 20 heads/day, harvesting two days/week; 2) 20 heads/day, harvesting five days/week; 3) 70 heads/day, harvesting two days/week; 4) 70 heads/day, harvesting five days/week. The space required may be less depending on the decomposition rate. Calculations are based on composting the total amount of waste produced biannually. Table 3 shows the estimated cost for each design scenario.

A passive pile system comprised of 28, 2.44 by 4.27-meter bins was constructed to compost 5,200 kg (11,464 lbs) of meat processing by-products each week at Saranac, Michigan.[54] This is about 0.07 acres, not including the spacing between the bins. The by-products were grinded before

[50] Schwarz, Mary, Jean Bonhotal, and Dale Rozeboom. 2010. "The Space It Takes - Footprint Calculator for Composting Butcher Waste." *Cornell Waste Management Institute*. http://cwmi.css.cornell.edu/spaceittakes.pdf.

[51] Cornell Waste Management Institute. 2008. "Natural Rendering: Composting Livestock Mortality and Butcher Waste." https://datcp.wi.gov/Documents/cornellcompostguide.pdf.

[52] McSweeney, James. 2015. "Turned Windrow Composting. Sizing Your Composting Bed." *Vermont Agency of Natural Resources*. http://dec.vermont.gov/sites/dec/files/wmp/SolidWaste/Documents/ANR Sizing Your Composting Pad.pdf.

[53] Other sources may reference higher values (i.e. 15 yd^3). Cornell Waste Management Institute. 2008. "Natural Rendering: Composting Livestock Mortality and Butcher Waste." https://datcp.wi.gov/Documents/cornellcompostguide.pdf.

[54] Rozeboom, Dale W., Howard L. Person, Karl L. Jones, David Herb, and Jerrod O. Sanders. n.d. "Using Composting to Recycle Meat Processing By-Products."

composting, reducing the volume of animal tissue by-product by 250%. The system was sized appropriately for continuous flow of by-product. The mass of animal by-product is about half the mass predicted to be composted for the 20 heads/day design at 24,000 pounds/week. The amount of space needed could be smaller than expected.

Table 2. Waste Produced and Space Required for 20 Heads and 70 Heads for Passive Aerated Windrow

	Waste Produced Annually (lbs)	Space Required for Windrows (square feet) [acres]	Space Required for Pile of Carbon Material (square feet) [acres]	Total Space Required (square feet) [acres]* / Windrow Length
20 heads/day (harvesting 2 days/week)	576,000	10,817 [0.25]	1,447 [0.03]	27,912 [0.64] / 40.1’
20 heads/day (harvesting 5 days/week)	1,440,000	26,885 [0.62]	3,116 [0.07]	48,773 [1.12] / 99.6’
70 heads/day (harvesting 2 days/week)	2,016,000	37,596 [0.86]	4,181 [0.10]	62,633 [1.44] / 139’
70 heads/day (harvesting 5 days/week)	5,040,000	93,833 [2.15]	9,559 [0.22]	135,181 [3.10] / 348’

*Space includes area for movement area; movement area is 9” between each windrow with a 21 feet perimeter around the windrows. There are 15 windrows.

Table 3. Estimated Cost for 20 Heads and 70 Heads for Passive Aerated Windrow

	Estimated Cost for Land (2021 dollars) - Low	Estimated Cost for Land (2021 dollars) - High	Carbon Material Cost	Total Cost - Low	Total Cost - High
20 heads/day (harvesting 2 days/week)	$189,550	$28,957,177	$11,053	$200,603	$28,968,230
20 heads/day (harvesting 5 days/week)	$429,084	$65,550,322	$27,562	$456,646	$65,577,884
70 heads/day (harvesting 2 days/week)	$585,043	$89,375,834	$38,568	$623,610	$89,414,402
70 heads/day (harvesting 5 days/week)	$1,383,998	$211,430,654	$96,348	$1,480,346	$211,527,002

Vertical Composting

Vertical composting can be a more efficient and quicker way of producing compost if done in small batches and in well-controlled environments. The entire vertical compost system should be around 3’x3’x3’ or a cubic yard. The size of the compost system is based on manageability, weight and heat.[55] A vertical bin would be used and would contain multiple stages or levels, which would help to obtain optimal airflow and moisture. For bacteria and microbes to be efficient, the compost must be damp and not wet, and must also have enough oxygen to survive.[56]

The topmost level would be where fresh waste would be placed; depending on the type of waste and amount, it could take anywhere from four to six weeks to break down. The next level would be where the decomposed waste on the top level would drop down to, which could be managed with sliding doors. Here the compost will be aerated and continue to decompose even further. The bottom level would be where the usable compost retains. After about eight to 12 weeks the top layer should reach the bottom layer.

In-vessel

For in-vessel composting, there are many types of storage facilities that can be used. This includes bins, passively aerated bins, rectangular agitated beds, silos, rotating drums or transportable containers.[57] The use of land is less than the amount of land required for windrow composting since everything is within the vessel itself.[58] Depending on how much waste is being put into the compost, the in-vessel compost could be small enough to fit inside of a restaurant kitchen or it could be as big as a bus. In-vessel composting is a more expensive proposition in terms of upfront costs.

A current large in-vessel bin unit, the HotRot 3518, is 72’ long by 16’ wide by 14’ high.[59] The bin has an area of 1,152 square feet. Table 4 shows the number of bins needed using the HotRot 3518 based on the amount of waste and carbon material needed for the four scenarios. The cost for in-vessel composting includes the prices presented in Table 3, along with annual operation and maintenance costs for the technology. The cost ranges from $61 to $534 per dry ton of biosolids composted.[60] The price is for biosolids, which are organic materials produced during wastewater treatment, and does not best represent the additional cost for operation and maintenance to compost offal.

Table 4. Waste Produced and Space Needed for 20 Heads and 70 Heads for In-Vessel Composting

	Total Space Required	Total Bins Needed*

[55] Planet Natural. n.d. “Physics of Composting.” Accessed August 2, 2021. https://www.planetnatural.com/composting-101/science/physics/.

[56] “Vertical Composting.” n.d. Accessed August 2, 2021. https://homeguides.sfgate.com/vertical-composting-78553.html.

[57] “On-Farm Composting Methods.” n.d. Accessed July 26, 2021. http://www.fao.org/3/y5104e/y5104e07.htm.

[58] “Types of Composting and Understanding the Process | US EPA.” n.d. Accessed July 19, 2021. https://www.epa.gov/sustainable-management-food/types-composting-and-understanding-process.

[59] BioCycle. n.d. “What’s New - In-Vessel Composting.” Accessed August 2, 2021. https://www.biocycle.net/whats-new-in-vessel-composting/.

[60] EPA. 2000. “Biosolids Technology Fact Sheet. In-Vessel Composting of Biosolids.” https://www3.epa.gov/npdes/pubs/invessel.pdf.

(square feet) [acres]		
20 heads/day (harvesting 2 days/week)	108,241 [2.48]	94
20 heads/day (harvesting 5 days/week)	245,025 [5.63]	213
70 heads/day (harvesting 2 days/week)	334,084 [7.67]	291
70 heads/day (harvesting 5 days/week)	790,321 [18.14]	687

Note: * The number of bins vary and may be less as the total space required accounts for the working space needed.

In conclusion, the land area for composting depends on the method, time and decomposition rate of the compost that relies on the requirements mentioned earlier, temperature, moisture, oxygen, waste size and mixture.

B.5. Legal Feasibility

According to the Hawai‘i Administrative Rules (HAR), Title 11, DOH Chapter 58.1, Subchapter 4, Section 41, a permit for a solid waste management facility under composting is needed for a composting facility for sewage sludge, green waste and other solid wastes. In HAR, Title 11, DOH Chapter 58.1, Subchapter 1, Section 4, an agriculture exemption can be granted in which exempts the solid waste permit if the facility composts their waste generated from agricultural activities, uses the compost on their land and does not accept feedstocks or distribute the compost to the public.

A composting facility needs to be built on an impermeable surface such as a concrete pad to prevent groundwater contamination and to implement environmental controls, such as leachate collection, odor, vector, litter, noise and dust control, and stormwater management. If possible, the area should be enclosed so the public does not have access.

For solid waste that possesses a pathogen concern, three methods are accepted. This includes the windrow composting method, aerated static pile method and enclosed or in-vessel composting method. The temperature of the mixture must not be less than 55ºC (131ºF) for at least three consecutive days for all methods. A minimum of five turnings is required during a period of 15 consecutive days for the windrow composting method. If compost is planned to be distributed to the public, the compost needs to be laboratory tested for pathogens.[61]

Additionally, regulations concerning temperature requirements to reduce pathogens must be met. For a windrow and an aerated static pile process, the temperature must be taken six to eight inches below the surface. For an aerated static pile process, the temperature must be taken six to eight inches from the aeration pipe. For an enclosed vessel system, the temperature must be taken six to eight inches inside the vessel wall and six to eight inches from the aeration piping. The temperature must be monitored daily.[62] The cost of paving an impermeable surface, implementing environmental controls, and pathogen testing from a laboratory needs to be considered when developing a composting facility.

[61] Discussion with DOH permit writer for composting and recycling facilities, September 27, 2021.

[62] Department of Health. 1994. *Hawai'i Administrative Rules Title 11 Department of Health Chapter 58.1 Solid Waste Management Control*.

B.6. Existing Compost Operations

A livestock harvesting facility in New Mexico started in 1994. The neighboring city requested a composting facility to environmentally dispose of the waste from the plant as there were no facilities to dispose of the waste close by. The composting facility was soon developed and has been operating for 15 years.

The harvesting facility slaughters and processes about 15 cattle and 12-15 hogs a week, producing about four to six tons of waste. They use six to 10 acres of land that are comprised of two static piles that are 3.3 yards high and 300 yards long. The piles are aerated from normal operations of moving and adding to the piles, and are turned when the compost is ready. Once the waste is composted, the soil is reused. The typical composting time frame is six to eight months. No major considerations to or adjustments to speed up the composting process was used as land availability is not an issue and time is flexible. The end-product is compost used to cover the city's landfill to eliminate odors.

The composting facility composts almost all waste from the meat packing plant, including blood, bones, hides and paunches. However, the facility does not compost any wastewater solids such as grease and any by-products. After six to eight months, bones are brittle and can be grounded and used with composting. If soil from composting is to be used for something else, the compost can be screened to remove any bone fragments.[63]

B.7. Composting Design for 70 Heads

Based on the demand of cattle and the historical operations of a livestock harvesting facility in Hawai'i, the maximum cattle slaughtered is 10,000. This yields for about four days a week at 70 heads a day. The design parameters for 70 heads/day, harvesting four days/week are:

1) Windrow dimensions: 278 feet long, 18 feet wide, 8 feet high
    a. Consists of two feet of carbon material, then six feet of offal, then covered with a foot of carbon material.
    b. Width between windrow is 9 inches, determined by turner.
    c. The perimeter width of the windrow is 21 feet, determined by the width of the turner.
2) Windrows will be grouped in pairs to offer flexibility in turning and for reuse of compost as the base for the next windrow.
3) There will be 15 windrows.
4) Carbon material pile storage dimensions: 88 feet long, 88 feet wide, 8 feet high
    a. This pile will be used to put more carbon material as decomposition occurs and more carbon material is needed for composting.
5) Composting area will be 320 feet by 278 feet (2.5 acres).
6) Equipment needed:
    a. Grinder
        i. Will be inside facility
    b. Turner
        i. Will be outside facility
    c. Mulcher

[63] Interview with owner of livestock harvesting facility in New Mexico, August 19, 2021.

    i. Needed if source of carbon material is not accessible or if carbon material is in huge pieces.
    ii. Will be outside facility

The methodology to determine the area needed for composting are:

1) Step 1: Calculate the volume of carbon material needed, and volume of offal produced from the mass of offal produced.
    a. The mass of offal produced was determined by the amount of heads slaughter per day, the number of harvesting days, the amount of waste produced per cattle, and the composting duration.
    b. The volume of offal produced was calculated based on the amount of offal produced during the composting duration divided by the density of offal.
    c. The volume of carbon material needed for the volume of offal was calculated using the amount of carbon material needed per ton of waste produced and the amount of waste produced during the composting duration.
        i. The amount of carbon material needed per ton of waste produced was calculated using the total volume of carbon material required in a windrow (trapezoidal prism) with preset dimensions divided by the weight of the offal in the waste section of that windrow
            1. The weight of the offal in the preset windrow was calculated using the same method as the previous step
        ii. The refilling of carbon material was added using the decomposition rate of 19% loss in mass in 6 months.
2) Step 2: From these values and considering the assumptions listed, the number and size of windrows were determined. The volume of carbon material and offal from these values were calculated and compared to the volume of carbon material needed and the volume of offal produced. The volume of carbon material and offal must be greater than the volume of carbon material needed, and the volume of offal produced. The area of all the windrows can be calculated.
    a. The size of the windrow (height and width) is limited by the turner.
    b. The width between windrows is determined by the turner.
    c. The width is twice as much as the height as the windrow is shaped as a trapezoidal prism.
3) Step 3: Calculate the area of the pile needed to refill the carbon material.
4) Step 4: Consider the additional space needed for any equipment to maneuver and/or operate around the composting site.
    a. The turn radius of the turner was considered based on a 45 degree turn angle and 10 feet wheelbase.
    b. The width of the turner was considered.
5) Step 5: Combine the area of all the windrows, the area of the pile and the additional space needed for the equipment to obtain the total area required for the composting site.

Assumptions were made to compute the area of the composting site for each step. These include:

1) Step 1:
    a. 70 heads will be slaughtered a day with 4 days of slaughtering/harvesting a week.
    b. A composting time of six months was used.

c. A cow will produce 600 pounds of solid waste.
d. Density of offal is 66 lb/ft^3 (1,057.22 kg/m^3).[64]
e. Minimum amount of carbon material needed per butcher waste ton is 5 yd^3.[65]
f. Decomposition rate of wood chips is 19% decrease in mass in 6 months.[66]

2) Step 2:
   a. The Topturn X63 windrow turner will be used for turning the windrows. The maximum windrow width and height it can turn is 18.7 feet and 8.5 feet, respectively. The width of the Topturn X63 is 20.2 feet.[67]
   b. The space between the windrows is 3/4" inches to allow access for the turner (maximum windrow width for turner subtracted from the width of turner then divided by two).
   c. Windrow is shaped as a triangular prism.
   d. There will be one row of windrows for ease of calculation.
3) Step 3:
   a. Density of dry carbon material is 23.72 lb/ft^3 (380 kg/m^3).[68]
   b. The area of the pile to restock the carbon material decomposed and area of the composting site are squared (width and length are the same) for ease of calculation.
   c. The height of the pile to restock the carbon material is the same as the height of the windrow.
4) Step 4:
   a. The distance from the edge of the front wheel to the edge of the back wheel of the Topturn X63 is 9.8 feet. This will be used as the wheelbase.[69]

Table 4 and Table 5 shows the space needed and cost for 70 heads a day, harvesting three days a week. The Berkeley Method described earlier takes two to three weeks to compost the waste. At a factor of safety of 1.3 to 2, the duration for composting will be a month with the grinder. By grinding the waste, the total amount of space needed, and the total cost are both reduced by five.

Table 5. Comparison of Space Needed for 70 Heads With and Without a Grinder

	Waste Produced Annually (lbs)	Compost Duration	Space Required for Waste (square feet) [acres]	Space Required for Carbon Material (square feet) [acres]	Space Required for Pile of Carbon Material	Total Space Required (square feet) [acres]* / Windrow Length

[64] Schwarz, Mary, Jean Bonhotal, and Dale Rozeboom. 2010. "The Space It Takes - Footprint Calculator for Composting Butcher Waste." *Cornell Waste Management Institute*. http://cwmi.css.cornell.edu/spaceittakes.pdf.
[65] Other sources may reference higher values (i.e. 15 yd^3). Cornell Waste Management Institute. 2008. "Natural Rendering: Composting Livestock Mortality and Butcher Waste." https://datcp.wi.gov/Documents/cornellcompostguide.pdf.
[66] Slaven, Isaac, Eva Haviarova, and Daniel Cassens. 2011. "Properties of Wood Waste stored for energy Production." Purdue University Publication ID-421-W.
[67] Komptech. n.d. "Topturn X63." Accessed November 17, 2021. https://www.komptech.com/fileadmin/komptech/user_upload/Topturn_X63_E_2020.pdf.
[68] AVCalc LLC. n.d. "Density of Wood Chips, Dry." Accessed September 17, 2021. https://www.aqua-calc.com/page/density-table/substance/wood-blank-chips-coma-and-blank-dry.
[69] Komptech. n.d. "Topturn X63." Accessed November 17, 2021. https://www.komptech.com/fileadmin/komptech/user_upload/Topturn_X63_E_2020.pdf.

					(square feet) [acres]	
No Grinder	8,736,000	6 months	218,400 [5.01]	221,130 [5.08]	21,007 [0.48]	638,401 [14.66] / 757’
Grinder	8,736,000	1 month	36,400 [0.84]	36,855 [0.85]	3,501 [0.08]	123,201 [2.83] / 309’

Table 6. Comparison of Cost for 70 Heads With and Without a Grinder

	Estimated Cost for Land (2021 dollars) – Low	Estimated Cost for Land (2021 dollars) - High	Carbon Material Cost	Total Cost - Low	Total Cost - High
No Grinder	$1,117,958	$170,788,250	$77,088	$1,195,046	$170,865,338
Grinder	$215,748	$32,959,352	$12,887	$228,635	$32,972,239

APPENDIX C

EXAMPLE:

NATURAL WASTEWATER SYSTEM

PROCESSING WASTEWATER VOLUME ANALYSIS

Example: Natural Wastewater System Approach – Processing Wastewater Volume Analysis

This example looks at the alternative processing of wastewater through a series of pond(s) to meet discharge requirements for wastewater concentrations of Biological Oxygen Demand (BOD) less than 30 ppm (mg/l), Total Suspended Solids (TSS) less than 30 ppm (mg/l) and significant reduction of the nutrient load. The example follows the analysis performed for the Hawaiʻi Meats Harvesting Plant, known as *The Living Machine*.[1] For this example, the estimated wastewater flow is 600 gallons per cattle unit (head), which includes wastewater from cleaning, slaughter and processing. Table 1 presents the estimated average daily flow for both the 20 head/day and 70 head/day concepts, with two slaughter and processing frequencies during the week.

Table 1
Estimated Flow Based on 20 Head and 70 Head Facilities

Concept	Number of Days for Slaughter per Week	Average Flow (gpd)
20 head facility	2	3,429
20 head facility	5	8,571
70 head facility	2	12,000
70 head facility	5	30,000

Natural Wastewater Treatment Analysis

Twenty (20) head/day and 70 head/day livestock facilities are considered small harvesting facilities. Therefore, low cost, low maintenance and low energy requirements should be considered when determining wastewater treatment methods. Minimizing the need of complex mechanical processes will ease the responsibilities and maintenance requirements of the staff. From discussions with local owners of livestock harvesting facilities, it appears that a passive system with easier maintenance is preferred for any on-site wastewater treatment. This allows owners to focus primarily on the livestock harvesting processes.

[1] Reference: Strategic Solutions, Inc. & Ocean Arks International, *Design & Construction of the Natural Wastewater Treatment System with Restorers,* December 2003.

Primary Treatment Recommendations

The 20 head/day and 70 head/day livestock harvesting facility concepts show that processing wastewater will be collected and piped to a pump pit in the *Inedible Materials Load-Out* area of the facility, where it will be pumped into a rotary screen for solids removal. Solids collected from the screening process will be added and disposed of with the other inedible materials. It is expected that the wet well and pump pit in the *Inedible Materials Load-Out* area will provide a level of gravity separation of fine solids and grease before and after the rotary screening process.

Depending on the effectiveness of the rotary screen, a catch basin or grease interceptor may be required to remove finer solids and grease remaining in effluent. This may be the most economical choice since these options have no moving parts and no electrical equipment; therefore, maintenance costs will be minimal.[2] This option could also provide a level of flow equalization for the system.

Other Design Considerations

For the sizing and construction of treatment ponds and constructed wetlands, it is required to have additional capacity for significant rainfall events. The significant rainfall event is typically based on a design storm event, such as the 25-year 24-hour rainfall storm event. The storm event will be based on the rules and regulations pertaining to a specific site. The additional pond depth (or freeboard) increases pond capacity to ensure the pond and wetland treatment systems function properly and prevents overflow of treatment systems during a storm event. The estimated amount of rainfall for this example considers the use of the net surface rainfall analysis and the 25-year 24-hour storm event. Local rules and regulations may require the rainfall event without consideration of evapotranspiration to provide maximum capacity and also require a factor-of-safety or risk analysis. Table 2 presents a summary of rainfall and evapotranspiration[3] amounts for the islands.

[2] EPA, *Technical Development Document for the Final Effluent Limitations Guidelines and Standards for the Meat and Poultry Products Point Source Category (40 CFR 432),* 2004, 8-2
[3] University of Hawaii, *Evapotranspiration of Hawaii,* 2014.

Table 2
Rainfall, Storm Events, and Evaporation for Pond and Wetland

Locations	Annual Rainfall (in)	Peak Monthly Surface Rainfall (in)	Storm Event (in)	Evaporation (in)
Hawaiʻi	60	11	16	32
Oʻahu	53	8	11	42
Maui	38	4	8	44
Kauaʻi	52	7	12	69
Molokaʻi	20	2	8	40
Kahoʻolawe	15	1	7	16
Lānaʻi	25	2	6	30

Annual Surface Rainfall Analysis

The annual surface rainfall data was collected for seven of the Hawaiian islands.Different locations throughout Hawaiʻi, Oʻahu, Kauaʻi, Maui and Molokaʻi were used. Only one location for Lānaʻi and Kahoʻolawe were used. The locations chosen were based on population and agricultural area. The maps of the isohyet lines for the Hawaiian islands found in University of Hawaiʻi's Rainfall Atlas[4] were used to gather the information. The annual surface rainfall is the total amount of rainfall throughout an entire year over a specific location. Out of all the different locations used to gather data, the Hilo area was found to have the greatest amount of rainfall of 140 inches. The peak monthly net rainfall and 25-year 24-hour storm rainfall data from this area was used for a conservative estimate for the additional capacity needed of the wetland and pond.

Net Surface Rainfall Analysis

The net surface rainfall was calculated by taking the greatest amount of rainfall of a specific location and subtracting the amount of evaporation that took place in the same month. The

[4] University of Hawaii, *Spatial Trend Analysis of Hawaiian Rainfall from 1920 to 2012,* 2017.

greatest amount of surface rainfall out of all the different locations was taken to ensure that the dimensions of the wetland would be enough to hold all the rainwater and wastewater within. For this example, a net surface rainfall produced an additional pond depth of 11 inches for both the treatment pond and constructed wetland.[5]

25-Year 24-Hour Rainfall Analysis

The 25-year 24-hour rainfall event was used as the basis of design for a lagoon or wetland to prevent overflow of wastewater during a storm event. The same locations used for the rainfall were also used for the storm event. The greatest amount of rain for the 25-year 24-hour rain event out of all the different locations was used to ensure no overflow in case of a storm event. It is recommended to design the pond and wetland volumes with an additional capacity to account for at least 16 inches of rainfall during a storm event.[6]

Waste Stabilization Pond Analysis

The first treatment after the pretreatment in the natural treatment processes consists of waste stabilization pond systems that are either anaerobic, aerobic, facultative or aerated. This would be similar to primary treatment in a traditional wastewater treatment facility.

Facultative Pond Design Feasibility and Analysis

A facultative pond is the most commonly used wastewater treatment pond option. This system takes advantage of both anaerobic and aerobic processes for the treatment and removal of BOD. To estimate the pond system retention time and sizing, the Wehner-Willhelm equation was used. The theoretical retention time required to reduce BOD to acceptable levels was calculated to be 41 days.

Typical BOD loading for a facultative pond for municipal wastewater treatment ranges from 196 to 500 lb/acre/day (22-56 kg/1000m^2 /day) and typically achieves BOD concentration reductions of 80-95%. Livestock harvesting facilities have much greater BOD concentrations, therefore it is recommended that mechanical aeration is added. The addition of aeration helps to treat higher-strength biodegradable industrial wastewater and provides more reliable BOD removal. Theoretically if 95 percent (95%) reduction is achieved the BOD, the BOD concentration in the effluent would be reduced to

[5] Frazier, A.G., Giambelluca, T.W., Diaz, H.F. and Needham, H. L., *Comparison of Geostatistical Approaches to Spatially Interpolate Month-Year Rainfall for the Hawaiian Islands,* 2016, 36(3).
[6] U.S. Department of Commerce Weather Bureau, *Rainfall-Frequency Atlas of the Hawaiian Islands,* 1962, 55.

approximately 120 mg/L, and similar to typical domestic household wastewater concentrations.

Wehner-Wilhelm Equation

The Wehner-Wilhelm Equation is used when designing for conditions between ideal plug flow and complete mix.

$$\frac{C_e}{C_0} = \frac{4\,a e^{1/(2D)}}{(1+a)^2\,(e^{a/2D}) - (1-a)^2\,(e^{-a/2D})}$$

where:

C_0 = influent BOD concentration, mg/L
C_e = effluent BOD concentration, mg/L
e = base of natural logarithms, 2.7183
$a = (1 + 4ktD)^{0.5}$
k = 1st order reaction rate constant/d
t = HRT, d
D = dimensionless dispersion number
$D = H/vL = Ht/L^2$
H = axial dispersion coefficient, area per unit time
v = fluid velocity, length per unit time
L = length of travel path of a typical particle

A depth of eight feet (8')[7] is used for a facultative pond with a slope ratio of 1-to-1. The eight-foot (8') depth was established as it is generally the shallowest recommended depth of an anaerobic pond system. This is also an acceptable depth for mechanical aeration, if needed. Tables 3 and 4 present the estimated processing flow, pond volumes and sizing.

Table 3
Estimated Processing Flow and Pond Volume

Concept	Days for Slaughter / Week	Estimated flow (gpd)	Estimated Pond Depth (ft)	Volume (gallons)	Volume (cubic ft)
20 head facility	2	3429	8	140,589	18,794
20 head facility	5	8571	8	351,411	46,977
70 head facility	2	12000	8	492,000	65,771
70 head facility	5	30000	8	1,230,000	164,427

Note: Based on an estimated 41-day retention time.

[7] This depth does not include freeboard to accommodate other rainfall or flooding scenarios.

Table 4
Estimated Facultative Pond Dimensions

Concept	Days for Slaughter / Week	Pond Depth (ft)	Slope Ratio	Length (ft)	Width (ft)	Surface Area (sf)
20 head facility	2	8	1 to 1	100	34	3,331
20 head facility	5	8	1 to 1	149	50	7,374
70 head facility	2	8	1 to 1	174	58	9,982
70 head facility	5	8	1 to 1	265	82	23,288

Anaerobic Pond Design Feasibility and Analysis

Anaerobic ponds are effective at treating high-strength organic waste, but these ponds normally are unable to produce effluent that can be discharged due to high levels of BOD remaining in the effluent. Anaerobic pond wastewater treatment is typically followed by an aerobic or facultative pond system to further reduce BOD concentrations to an acceptable level. For estimating the size of the pond system with a high predicted BOD load of 2,424 ppm (2,420 mg/l), it is assumed that 60-85% BOD reduction would be achieved from the anaerobic pond prior to entering a secondary facultative pond. This reduced BOD concentration was used to estimate the detention time and size of the facultative pond. Theoretically, to achieve the 91-97% BOD removal the system will require another pond system such as an aerobic or facultative pond treatment process.

A retention time of 31 days was estimated for the anaerobic pond and facultative pond systems. The pond retention time and estimated facility flow is used to estimate a minimum pond volume, which will ensure that the minimum treatment retention time is achieved. Anaerobic ponds are generally deeper than aerobic and facultative ponds. A depth of 10 to 15 feet was used, along with a slope ratio of 1-to-1 to determine potential dimensions of an on-site anaerobic treatment pond system. A facultative pond is recommended as the secondary pond for further treatment when using an anaerobic pond for initial treatment. A depth of eight feet (8’) is used for a facultative pond with a slope ratio of 1-to-1. Tables

5-7 present the calculated pond volumes and sizing for the anaerobic and facultative ponds system.

Table 5
Estimated Anaerobic and Facultative Processing Flow and Pond Volume

Concept	Harvesting Days / Week	Flow (gpd)	Pond Depth (ft)	Volume (gallons)	Volume (cubic ft)
20 hd/day facility	2	3,429	10	106,299	14,210
20 hd/day facility	5	8,571	15	265,701	35,519
70 hd/day facility	2	12,000	15	372,000	49,729
70 hd/day facility	5	30,000	15	930,000	124,323

Table 6
Estimated Anaerobic Pond Size

Concept	Harvesting Days / Week	Pond Depth (ft)	Slope Ratio	Length (ft)	Width (ft)	Surface Area (sf)
20 hd/day facility	2	10	1 to 1	85	28	2,425
20 hd/day facility	5	15	1 to 1	114	38	4,354
70 hd/day facility	2	15	1 to 1	130	43	5,610
70 hd/day facility	5	15	1 to 1	188	63	11,742

Table 7
Estimated Secondary Facultative Pond Size

Design	Harvesting Days / Week	Depth (ft)	Slope Ratio	Length (ft)	Width (ft)	Surface Area (sf)
20 hd/day facility	2	8	1 to 1	89	30	2,641
20 hd/day facility	5	8	1 to 1	132	44	5,757
70 hd/day facility	2	8	1 to 1	153	51	7,759
70 hd/day facility	5	8	1 to 1	232	78	17,929

Partial Mix Aerated Pond Design Feasibility and Analysis

As noted in the facultative pond analysis, due to high concentrations of BOD expected from a livestock facility, mechanical aeration will provide a more reliable BOD removal system. A partially mixed aerated pond will allow the treatment of influent with higher BOD levels with a relatively short mean cell residence time. A pond treatment system can also be combined with an aquacultural production system to provide additional nutrient removal and treatment within the pond. Another advantage of an aerobic partial mixed pond is the reduced potential for unpleasant odors.

A disadvantage of aerobic ponds is that the effluent will contain high TSS due to the production of algae as part of the aerobic process. This is normally addressed by limiting aeration in the final cell of the pond treatment system to allow solids to settle. The following equation was used to determine the detention time for the partially mixed aerated treatment pond design.

$$\frac{C_n}{C_o} = \frac{1}{[1 + (kt/n)]^n} \qquad (3\text{-}3)$$

Where:

C_n = effluent BOD_5 concentration in cell n, mg/L
C_o = influent BOD_5 concentration, mg/L
k = first order reaction rate constant /d
= 0.276 day^{-1} at 20° C (assumed to be constant in all cells)
t = total hydraulic residence time in pond system, d
n = number of cells in the series

The estimated partially mixed pond retention time required to reduce BOD concentration to acceptable levels was calculated to be 37 days. This is assuming that the pond will be broken up into a minimum of three equal cells using dividing baffles. Tables 8 and 9 provide a summary of pond size and flow.

Table 8
Estimated Processing Flow and Pond Volume

Concept	Harvesting Days / Week	Estimated flow (gpd)	Depth (ft)	Volume (gallons)	Volume (cubic ft)
20 hd/day facility	2	3,429	8	126,873	16,960
20 hd/day facility	5	8,571	8	317,127	42,394
70 hd/day facility	2	12,000	8	444,000	59,354
70 hd/day facility	5	30,000	8	1,110,000	148,385

Note: Based on an estimated 600 gal/head and 37-day retention time.

Table 9
Partial Mix Aerated Pond Size

Concept	Harvesting Days /Week	Pond Depth (ft)	Slope Ratio	Length (ft)	Width (ft)	Surface Area (sf)
20 hd/day facility	2	8	1 to 1	96	32	3,057
20 hd/day facility	5	8	1 to 1	143	48	6,730
70 hd/day facility	2	8	1 to 1	166	56	9,096
70 hd/day facility	5	8	1 to 1	252	84	21,150

A partially mixed aerated pond will generally be more reliable for BOD concentration reduction than an anaerobic system. In addition, the partially mixed aerated pond could simulate a facultative pond with both aerobic and anaerobic zones depending on the location of mechanical aeration. This system is the most flexible for system adjustments based on varying loading from the livestock harvesting facility.

Aeration Requirements of a Partially Mixed Aerated Treatment Pond

Aeration of a pond system increases the dissolved oxygen (DO) concentration in the pond to accelerate the reduction of BOD. The air or oxygen is supplied by means of surface aerators or diffused aeration units. The use of pure oxygen (O_2) will saturate the water quicker when compared to air. However, O_2 must be handled and stored with care and has a higher supply cost than air. Aerators and/or diffusers provide additional mixing and suspends solids in water longer. The amount of O_2 required varies from 0.7 to 1.4 times the amount of BOD to be removed. See Table 10 for estimated oxygen demand required for pond treatment.

Table 10
O_2 Demand Requirements for Partially Mixed Aerated Treatment Pond

Concept	Operating Days	Flow (gpd)	O_2 (lb per day)
20 hd / day	2	3,429	85
20 hd / day	5	8,571	212
70 hd / day	2	12,000	297
70 hd / day	5	30,000	742

Table 11 shows the diffused air equipment with a standard transfer rate based on O_2 demand from the *Water Environment Federation Liquid Stream Fundamentals: Aeration Design Fact Sheet*.[8] This provides a comparison of oxygen supply and power demands by selected aeration device.

Secondary Treatment Considerations

As the primary pond system will not reduce BOD and TSS concentrations to an acceptable level for discharge into a leach field, a secondary treatment is required. For this system, a constructed wetland pond system was chosen. The constructed wetland provides a filtration system for suspended solids and a biological system for the removal of bacteria and nutrients. The design goal is to reduce BOD concentration to 30 ppm (mg/l) and TSS concentration to 30 ppm (mg/l). The disadvantage of a constructed wetland is the amount of land required, especially if land acquisition cost is high. Two constructed wetland systems are considered.

[8] Water Environment Federation, Municipal Resource Recovery Design Committee - Liquid Stream Fundamentals: Aeration Design Fact Sheet, 2017

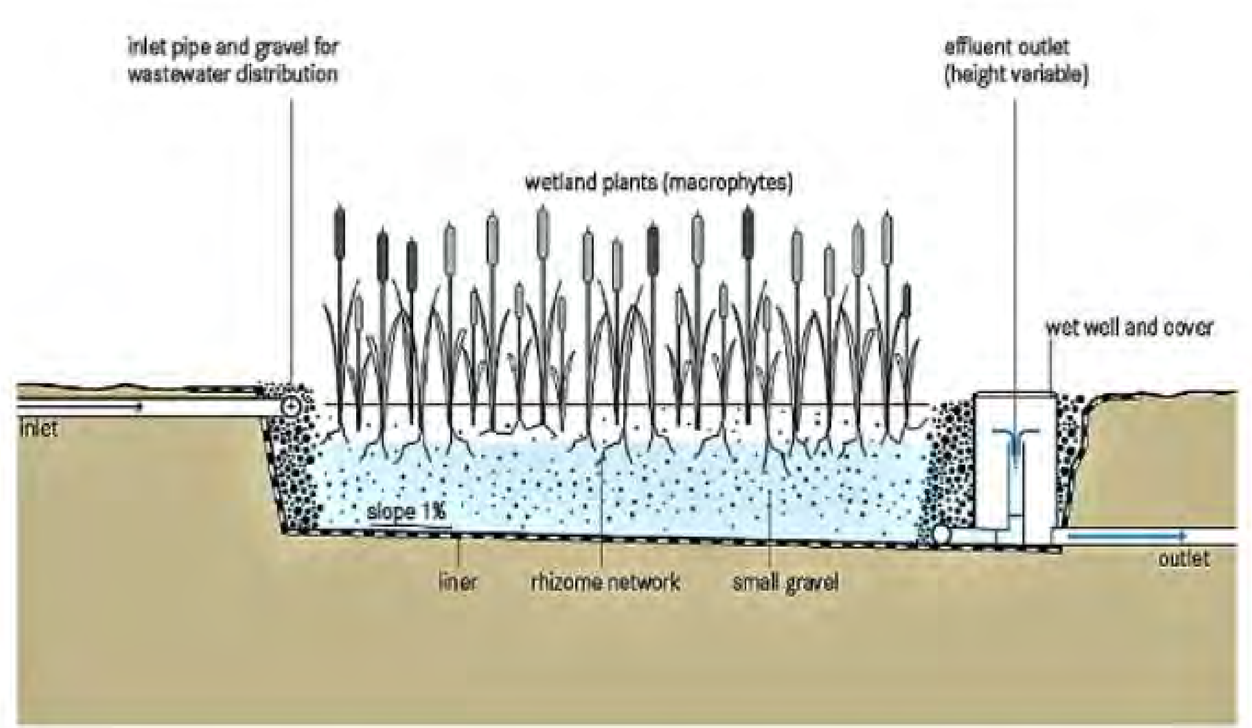
Table 11
Comparison of O_2 Demand and Power Requirements

Diffused Aeration Devices	**Standard Transfer Rate (lb/O_2 / hp*h)**
Fine Bubble	2.0 – 3.3 (1.2-2.0)
Medium Bubble	1.6 – 2.6 (1.0-1.6)
Coarse Bubble	1.0 – 2.0 (0.6-1.2)
Tubular System or Static Tube	2.0 – 2.6 (1.2-1.6)
Jet	2.0 – 4.0 (1.2-2.4)
Aspirator Jet	2.5 – 4.0 (1.2-2.4)
U-tube	2.1 – 4.0 (1.3-2.4)
Mechanical Aerators	
Surface Low-Speed	2.5 – 3.5
Surface Low-Speed with Draft Tub	2.0 – 4.6
Surface High-Speed	1.8 – 2.3
Submerged Turbine with Draft Tube	2.0 – 3.3
Submerged Turbine	1.8 – 3.5
Submerged Turbine with Sparger	2.0 -3.3
Horizontal Rotor	1.5 – 3.6

Values in brackets are directly from the reference which was provided in kg O_2 /kW*h. For consistency purposes values are converted to lb O_2/hp*h.
Source: Water Environment Federation, Municipal Resource Recovery Design Committee - Liquid Stream Fundamentals: Aeration Design Fact Sheet, 2017

Subsurface Flow Constructed Wetland

The subsurface flow constructed wetland (SSFCW) (Figure 1) provides a safe alternative to treat wastewater as the water surface is typically below the top of the gravel bed, thus minimizing the risk of exposure. The gravel bed in the SSFCW allows for the collection of substrates separated from the water and provides a place for bacteria to thrive, which increases the denitrification rate of wastewater. Tables 12 and 13 show the design characteristics of a constructed wetland with four different flow regimes, depending on the number of livestock harvested each week. The design accounts for the storage of net rainfall accumulation.



Schematic of the Horizontal Subsurface Flow Constructed Wetland. Source: TILLEY et al. (2014)

Figure 2. Schematic of Subsurface Flow Constructed Wetland (Tilley et.al., 2014)

The following equation was used to size the wetland given the different flow regimes. Figure 2 was used to find the value of K_{BOD}, which was 0.22 based on a temperature of 24° C (75° F).

$$A_h = \frac{Q_d (\ln C_i - \ln C_e)}{K_{BOD}}$$

- A_h = Surface area of bed (m^2)
- Q_d = average daily flow rate of sewage (m^3/d)
- C_i = influent BOD_5 concentration (mg/l)
- C_e = effluent BOD_5 concentration (mg/l)
- K_{BOD} = rate constant (m/d)

K_{BOD} is determined from the expression $K_T dn$, where,

- K_T = $K_{20} (1.06)^{(T-20)}$
- K_{20} = rate constant at 20 °C (d^{-1})
- T = operational temperature of system (°C)
- d = depth of water column (m)
- n = porosity of the substrate medium (percentage expressed as fraction)

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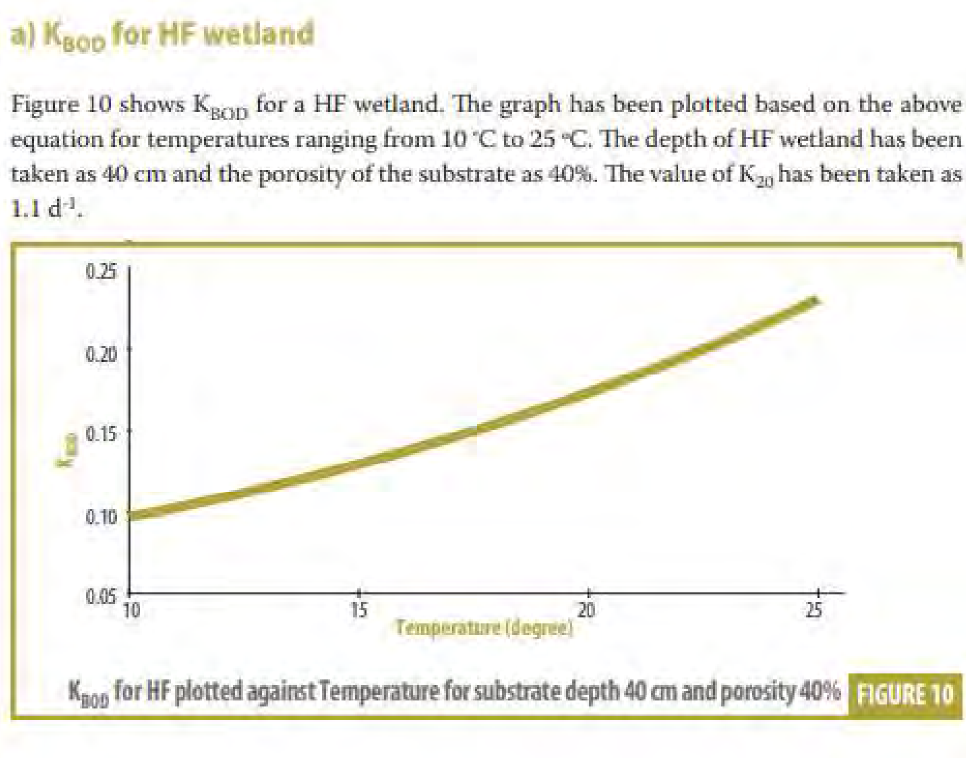

a) K_{BOD} for HF wetland

Figure 10 shows K_{BOD} for a HF wetland. The graph has been plotted based on the above equation for temperatures ranging from 10 °C to 25 °C. The depth of HF wetland has been taken as 40 cm and the porosity of the substrate as 40%. The value of K_{20} has been taken as 1.1 d^{-1}.

K_{BOD} for HF plotted against Temperature for substrate depth 40 cm and porosity 40% FIGURE 10

Figure 2. K_{BOD} plot versus Temperature in Degrees Celsius.

The Hydraulic Retention Time (HRT) was computed using the following equation for both the subsurface flow and surface flow wetland.

$$HRT = \frac{As*d*n}{Q}$$

The parameters are as follows:

- As is the surface area in ft^2;
- d is the depth in ft;
- n is the porosity of the gravel material; and
- Q is the flow rate in ft^3/day.

Table 12
Estimated Process Flow, Wetland Volume and Hydraulic Retention Time

Concept	Harvesting Days / Week	Estimated Flow (gpd)	Bed Depth (ft.)	Volume (cubic ft.)	HRT (days)
20 hd/day facility	2	3,429	3.3	4,832	4.2
20 hd/day facility	5	8,571	3.3	12,044	4.7
70 hd/day facility	2	12,000	3.3	16,876	5.0
70 hd/day facility	5	30,000	3.3	42,227	5.2

The bed depth of the constructed wetland takes into account the net surface rainfall, 25-year 24-hour storm event and the daily inflow requirements. The gravel depth remains a constant two feet (2') to ensure effective treatment of the wastewater through bacteria growing in the gravel bed, as well as the uptake of nitrogen through the plant roots. The slope of the wetland bottom is one percent (1%) to provide flow through the pond.

Table 13
Subsurface Flow Constructed Wetland Size

Concept	Number Days for Slaughter / Week	Estimated Gravel Depth (ft)	L/W Ratio	Length (ft)	Width (ft)	Surface Area (sf)
20 head facility	2	2	2 to 1	53	27	1,449
20 head facility	5	2	2 to 1	85	43	3,610
70 head facility	2	2	2 to 1	101	50	5,059
70 head facility	5	2	2 to 1	159	80	12,659

Surface Flow Constructed Wetland

A surface flow constructed wetland, or free water system wetland, is mostly used to treat high volumes of wastewater (Figure 3). Since the four design flow rates used are considered small volumes, it would not be economically wise or efficient to use a surface flow constructed wetland as a secondary treatment. As the water surface is above the gravel bed, it increases the risk of exposure and may emit unwanted odor. The addition of floating aquatic plants (FAQ) in the system would accelerate the denitrification and BOD reduction process from the wastewater, but floating aquatic plants will increase TSS in the effluent. An increase of TSS could result in clogging of the outlet pipes.

The total bed depth takes into account the net rainfall, 25-year 24-hour storm event and wastewater inflow. The bed will be lined with an impervious liner. The depth of wastewater should be about 15.6 inches and the depth of gravel/soil over the liner will be two feet (2').

The wetland for the 20-head facility operating two days a week did not need to be broken up into cells because the flow rate was so small compared to the other three flow rates. The wetland for the 70-head facility operating five days a week needed to be broken up into five cells because of the larger flow rate and for an efficient processing of the effluent. The design bottom slope is one percent (1%) to assist the water flow. The following equation was used to estimate the number of cells needed within the wetland. Tables 14 and 15 present the flow, retention time and dimensions for a surface constructed wetland.

$$\mathbf{A_c = Q_s / K_f\,(dH/ds)}$$

- A_c = Cross sectional area of the bed (m^2)
- Q_s = average flow (m^3/s)
- K_f = hydraulic conductivity of the fully developed bed (m/s)
- dH/ds = slope of bottom of the bed (m/m)

Table 14
Process Flow, Wetland Volume and Hydraulic Retention Time

Concept	Days for Harvest / Week	Design Flow (gpd)	Bed Depth (ft)	Volume (cubic ft)	HRT (days)
20 hd/day facility	2	3,430	3.3	1,660	4.1
20 hd/day facility	5	8,570	3.3	4,150	4.3
70 hd/day facility	2	12,000	3.3	5,800	4.5
70 hd/day facility	5	30,000	3.3	21,760	6.8

Table 15
Surface Flow Constructed Wetland Dimensions

Concept	Days for Harvest / Week	Number of Cells	Cell Length (ft)	Cell Width (ft)	Total Surface Area (sf)
20-head facility	2	1	41	21	1,048
20-head facility	5	3	34	21	2,619
70-head facility	2	3	48	21	3,667
70-head facility	5	5	48	31	9,168

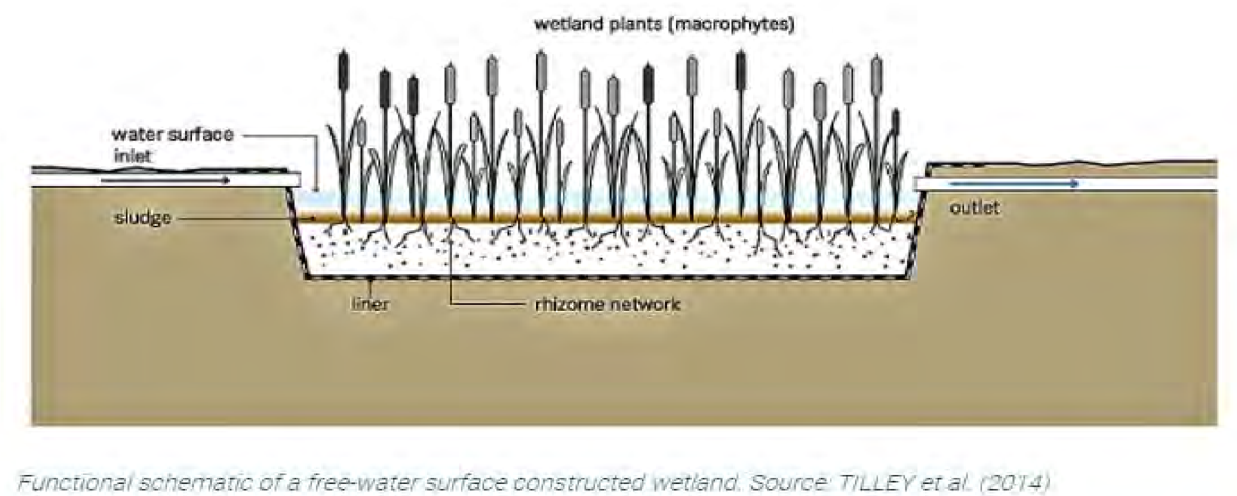

Figure 3. Schematic of a Surface Constructed Wetland (Tilley et al, 2014).

Transfer of Water Between Treatment Ponds and Constructed Wetlands

It is recommended that a control structure be used to transfer and regulate the water levels between the treatment pond(s) and constructed wetlands (Figure 4). A control structure can also be used to measure pond and wetland water depths, and provide an easy access point for pumping, if needed. Within the control structure, the water level is typically controlled by adjusting slide gates, valves or similar devices.

Both treatment ponds and wetlands require additional capacity to account for net rainfall and the load from a 25-year 24-hour storm. A direct gravity pipe connection, siphon or overflow between the treatment pond and wetland will not allow for adjustments to increase the pond capacity before a heavy rainfall event. Without a regulating control structure, surcharged conditions within the treatment pond would discharge directly downstream to the wetland and overload the system. A 20 hd/day or 70 hd/day livestock harvesting facility will have inconsistent and relatively small flows, which makes it difficult to regulate water depth and the transfer of water between the pond and wetland systems. It is recommended to use an overshot sluice gate or inline weir so that the desired water depth can be preselected and adjusted to meet pond detention times. Adjustments can also be made to provide continuous flow into the wetland area to ensure proper function of the system.

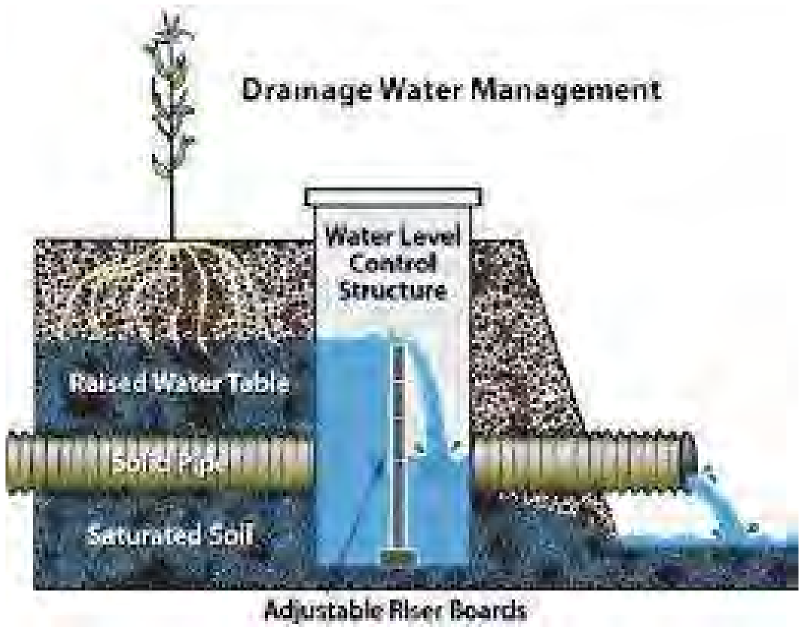

Figure 4. Example of a Water Level Control Structure for Drainage Water Management (USDA Natural Resources Conservation Service, Drainage Water Management Site).

Filtration and Disinfection

The effluent from the constructed wetland will be collected in a sump and pumped to either one of two systems: 1) a leach field or 2) a reuse system. For the leach field disposal, the effluent is directly piped into a leach field that is appropriately dimensioned. The leech field dimensions will be based on the soil percolation rate. Note that leach fields are not permitted in certain areas of the state; in these areas, an evapotranspiration pond will be used.

For R-2 recycled wastewater, the effluent is required to be filtered and disinfected per Hawaiʻi Administrative Rules. Considering maintenance and ease of operation, a sand filtration unit is recommended to filter effluent prior to disinfection. Other filtration systems will work, but the potentially high levels for suspended solids may increase the frequency to replace membranes or filters.

For disinfection and reuse in an agricultural setting, the use of an ultraviolet (UV) system for disinfection is recommended. The use of chlorine in an agricultural setting may not be conducive to the crops, and the UV disinfection requires less maintenance and has a lower operating cost. The UV disinfection system does not require the handling of chemicals or creates a harmful byproduct.

Summary for an On-site Natural Wastewater Treatment System

As anaerobic ponds are generally used for the treatment of industrial wastewater, which has higher organic loading, the use of an anaerobic pond followed by an aerobic or facultative pond is one alternative considered. However, as BOD concentrations are high, the detention time through an anaerobic and facultative pond system will be long. Therefore, the anaerobic and facultative pond system was dismissed.

The preferred system is a partially mixed aerated pond system combined with a constructed wetland, with final discharge into a leach field. Figure 5 provides a flow diagram for a natural wastewater treatment process, with an option of discharging into a reuse system. The effluent enters the mixed pond for aerobic processing. This first treatment is to significantly reduce BOD from 2,420 mg/l to 121 mg/l and the suspended solids of approximately to 10 percent (10%) of the initial concentration (1,008 mg/l to 79 mg/l). If floating aquatic plants are incorporated into the design, the plants would be grown in the first cell of the mixed pond. The concept shows that aeration is introduced into the effluent in the first two cells of the pond.

The effluent is discharged using a flow-controlled structure into the constructed wetland. The constructed wetland should be designed to reduce the effluent to a BOD level of 30 mg/l and total suspended solids concentration of 30 mg/l. The final effluent is discharged into a leach field for final disposal. If recycling of the final effluent is preferred, the effluent needs to be filtered and disinfected to meet R-2 recycled water requirements. Green waste from the ponds would be harvested to supplement a compost facility or to an off-site disposal system.

Table 16 provides a summary of initial effluent flow and storage volumes for the partially mixed aerated pond system and constructed wetlands. The final effluent is discharged into a leach field.

The size of the leach field is not included at this time and will be determined based on site-specific soil types and the location of the facility.

Table 16
Estimated Volume of Partial Mixed Aerated Pond and Constructed Wetlands

Concept	Days for Slaughter per Week	Average Daily Flow (gpd)	Mixed Aerated Pond (cubic feet)	Constructed Wetlands (cubic feet)
20 AU/day facility	2	3,429	16,960	1,658
	5	8,571	42,394	4,145
70 AU/day facility	2	12,000	59,354	5,803
	5	30,000	148,385	21,760

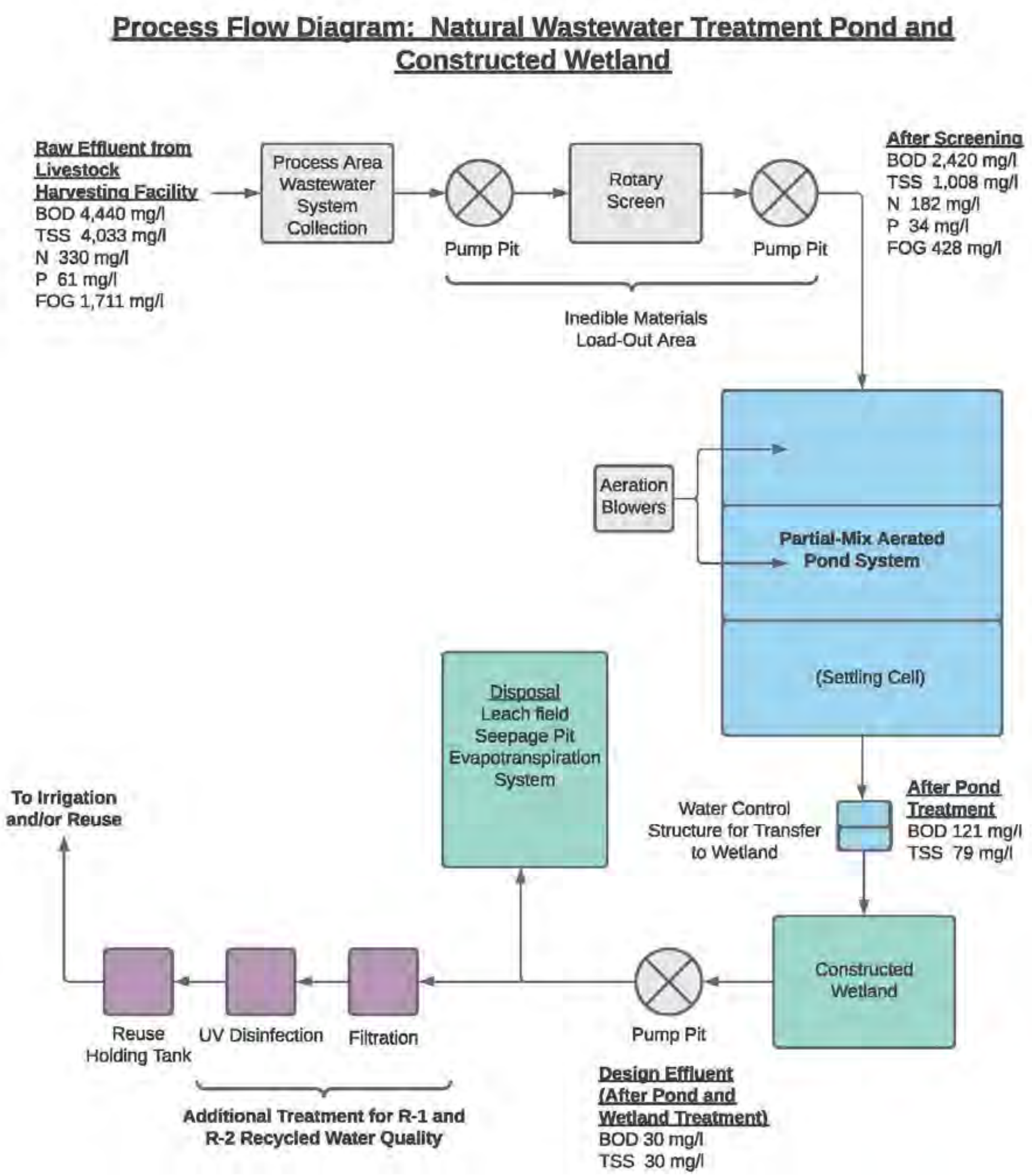

Figure 5. Process Flow Diagram of a Natural Wastewater Treatment System.

APPENDIX C

THE HAWAI‘I LIVESTOCK MARKET ECONOMIC IMPACT ANALYSIS

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Prepared for

The State of Hawai'i, Department of Agriculture
Hawai'i Cattlemen's Council

February 2022

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EXECUTIVE SUMMARY

The State of Hawaiʻi, Department of Agriculture (HDOA) and the Hawaiʻi Cattlemen's Council (HCC) are interested in the viability of a scalable and replicable livestock harvesting facility in Hawaiʻi . Both entities believe a harvesting facility would be beneficial to consumers across the state and support Hawaiʻi's beef industry.

This report examines the economic impact of Hawaiʻi's livestock industry on other industries in the state, and then examines the economic impact a specific facility would have on various industries.

Utilizing the State of Hawaiʻi's 2017 Input-Output model, we estimate the livestock industry impacts the State's economy by generating:

- $49.5 million in additional economic output,
- 536 additional jobs,
- $16.9 million in additional earnings, and
- $2.1 million in state tax revenue.

The industries that are the largest beneficiaries of economic activity from the livestock industry are *crop production* ($4.5 million in economic output; 102 jobs created; $2.4 million in earnings; $125,000 in state tax revenue), *state and local government* ($3.5 million in economic output; 43 jobs created; $2.5 million in earnings; $127,000 in state tax revenue), *real estate* ($5.1 million in economic output; 27 jobs created; $721,000 in earnings; $303,000 in state tax revenue), *animal production* ($3.2 million in economic output; 51 jobs created; $1.3 million in earnings; $64,000 in state tax revenue), and *food processing* ($3.1 million in economic output; 35 jobs created; $608,000 in earnings; $58,000 in state tax revenue).

A proposed harvesting facility that is approximately 25,000 square feet in size and harvests 70 head of cattle per day would cost approximately $51 million to construct (or $2,059 per square foot). Using the same I-O model, we estimate this private investment would impact the State's economy by generating or supporting:

- $32.2 million in additional economic output,
- 314 jobs,
- $12.1 million in additional earnings, and
- $1.9 million in state tax revenue.

The industries that would be the largest immediate beneficiaries of this project are those most related to the design and construction of new properties, such as *architectural and engineering services*, *heavy and civil engineering and constructio*n, and *construction of other types of buildings*. Combined, we estimate these industries would be impacted by $9.8 million in additional output, 95 jobs, $4.2 million in earnings, and $679,000 in state tax revenue.

Other industries that would be primed by the proposed facility include *single-family home construction* ($3.3 million in economic output; 30 jobs supported; $1.4 million in earnings; $223,000 in state tax revenue), *retail trade* ($2.3 million in economic output; 30 jobs supported; $849,000 in earnings; $150,000 in state tax revenue), *wholesale trade* ($1.7 million in economic output; 14 jobs supported; $522,000 in earnings; $42,000 in state tax revenue), and *real estate* ($2 million in economic output; 11 jobs supported; $279,000 in earnings; $118,000 in state tax revenue).

PROJECT BACKGROUND

The State of Hawai‘i, Department of Agriculture (HDOA), in cooperation with the Hawai‘i Cattlemen's Council (HCC) is seeking to determine the viability of a scalable and replicable livestock harvesting facility in Hawai‘i. The potential project is expected to implement the following goals:

- To create a facility model that serves the food security and sustainability needs of Hawai‘i's beef industry,
- To address the economic, social, and environmental impacts of a potential facility,
- To meet environmental conditions and design a facility model that can be scaled up or down to meet production needs,
- To quantify the current livestock capacity in Hawai‘i and project the growth of the industry that includes safeguards against oversupply and/or undersupply of cattle, and
- To support the local livestock industry and its related businesses thereby expanding the State's economic diversifications.

The definition of livestock includes cattle, sheep, horses, goats, and other domestic animals ordinarily raised or used on the farm.[1] The livestock industry is, therefore, considered more of the animal production industry, which belongs to the broader agriculture, forestry, fishing, and hunting sectors.

In 2019, the agriculture, forestry, fishing, and hunting sectors accounts for about $509 million, or 0.5 percent of Hawai‘i's total nominal gross domestic product (GDP).[2] Compared to some other major sectors such as the real estate, government, accommodation and food services, etc., the agriculture, forestry, fishing and hunting sectors contributed relatively less to the economy of Hawai‘i. The share of GDP for the agriculture sector continues to decline from 0.8 percent since 2001 to 0.6 percent in 2017 then to 0.5 percent in 2019.

While the GDP provides a mean of measuring the economic performance and diversification, it cannot be used to assess the impacts of an industry or the impacts of a new development to an economy. For that reason, conducting an economic impact analysis is necessary to assess how and to what extent the new development will impact other industries and the economy of Hawai‘i.

[1] "29 CFR § 780.328 - Meaning of livestock.", Cornell Law School.
[2] "Hawai‘i's Economic Structure: An Analysis Using Industry Level Gross Domestic Product Data April 2020 Update", State of Hawai‘i Department of Business, Economic Development and Tourism, April 2019.

STUDY OBJECTIVE

The purpose of this economic impact analysis is to quantify the economic impact of the livestock industry and the potential development of the livestock harvesting facility on jobs, earnings, outputs, and local tax base. Specifically, the analysis is of twofold. The first part of the analysis focuses on estimating the economic impacts generated by the livestock industry at a macroscopic level. The second part of the analysis, on the other hand, focuses on the economic impacts created by the construction of a livestock harvesting facility. These effects are expressed in terms of direct, indirect, and induced economic outputs.

GENERAL APPROACH

One of the most common approaches to estimate the economic impacts in a region or state due to the economic changes is the use of the input-output model (I-O). The I-O model is a quantitative economic model that describes the interdependent relationship between different sectors in an economy. When there is a change in final demand for a particular sector, or a new investment entering the economy, the I-O model can be used to examine how one sector can influence other sectors. The economic impact of the livestock industry spending and the construction project spending are measured in terms of its effects on output, jobs, earnings, and taxes. Specifically, there are two types of economic effects:

Primary effect

- *Direct* output/jobs/earnings/taxes are created in <u>industries that are directly associated</u> with the livestock industry and the construction of the livestock harvesting facility

Ripple effect

- Indirect output/jobs/earnings/taxes are created in <u>businesses</u> that supply goods and services to the livestock industry and industries that are directly associated with the construction project
- Induced output/jobs/earnings/taxes are created as the <u>workers</u> re-spend their income on goods and services in the economy due to the change in jobs and earnings induced by the new construction project or change in final demand in the livestock industry

The general concept of the I-O framework works in the following way. When an exogenous investment is injected into one or more industries for economic development, those industries will then create more jobs and employ more workers. Those workers will earn salaries and the state tax revenues are created via the income tax, profit tax, and property tax, etc. These are the direct impact of the exogenous investment in terms of jobs, earnings, and taxes.

The economic impacts, however, do not stop there but continue to spread over the industries. This happens because the cost of one industry is the income of the other industries. The exogenous investment creates the chain effects as the first-tier industries buy goods and services from other businesses. To meet the increased demand, those businesses will have to create more jobs and employ more workers to increase the output. These are the indirect impacts.

When the newly hired workers earn their salaries and re-spend their income to purchase goods and services, they are stimulating the economy. These are the induced impacts. The chain effects keep circulating in the economy in each successive round and eventually fade out due to the leakage in purchasing power from imports.

The total (direct + indirect + induced) economic impact on output, jobs, earnings, and taxes can be estimated with the Type II multipliers[3]. In the current study, all model parameters are taken from the 2017 State of Hawaiʻi I-O model developed by the State of Hawaiʻi, Department of Business, Economic Development and Tourism (DBEDT).

THE LIVESTOCK INDUSTRY

In the case of the livestock industry, estimating its economic impacts requires a slightly modified approach, but the general concept still applies. We take livestock sales figures and examine the economic effects on jobs, earnings, and taxes as the expenditures circulate in the economy. At the first layer, the livestock industry is about animal production. These industries create employment for workers and state taxes. The workers, on the other hand, earn salary by providing services to them. Again, this creates the direct impact.

At the second layer, the livestock industry purchases goods and services from other businesses before and after the harvest of livestock. For instance, the harvest of livestock may require specific equipment and refrigerator storage. These physical capitals will need to be purchased from other industries. Once the livestock is harvested, the meat needs to be packaged, frozen, and transported to the wholesale warehouse and retail stores. The businesses that provide these goods and services create indirect jobs to support the livestock industry. These indirect jobs create earnings and taxes in the economy.

At the third layer, the workers from the first-tier industries and their associated supporting businesses re-spend their earned income to purchase goods and services from different sectors. Their earned income and taxes continue to circulate and stimulate the economy, which creates the induced impact.

To estimate the economic impact of the livestock industry, we have taken a narrow scope[4] of defining the livestock industry. In this analysis, we utilize the United States Department of Agriculture's (U.S.D.A.) 2017 Census of Agriculture, which provides information and sales data for farms in Hawaiʻi. The data can be subdivided by North American Industry Classification System (NAICS) codes, which allows us to use sales data for specific subindustries that can be classified as livestock industries. Thus, our input data for the model are based on the sales data collected by the U.S.D.A. for livestock-oriented farms in the state of Hawaiʻi.

[3] The Type II multipliers are the ratios of the total effect to the direct effects, i.e. (direct effect + indirect effect + induced effect) / direct effect.

[4] An earlier version of this report took a more expansive definition of the livestock industry but suffered from data omissions. We have chosen to use sales data from the Census of Agriculture because the values are valid and more applicable to an input-output analysis.

The Census of Agriculture data indicate that the total statewide agricultural sales in 2017 were approximately $563.8 million, and livestock related sales were approximately $72.7 million[5]. As the data are only updated every five years, we wanted to use a sales figure that was a little more contemporaneous. To accomplish this, we took the sales figure for livestock in 2017 and applied an inflation calculator to give an approximation of the value of $72.7 million in 2021[6]. After applying inflation to the original value, we arrived at an estimate of livestock sales in 2021, which is approximately $82.2 million. This figure represents the value of the input that will be distributed in the I-O model.

The State of Hawaiʻi I-O model includes values for the dollar amount of purchases and sales within the agriculture industry that are attributable to 62 other industries in the state. These values provide us with a quantifiable measure of the interrelationships between agriculture and other industries. However, we can also use the model to determine interrelationships between the 62 industries themselves. Using these values we multiply the industry-by-industry matrices by the proportion of purchases by other industries within agriculture. The resulting values provide us with industry level multipliers, which can then be aggregated to determine the livestock industry's impact on the other individual industries in the model. We then multiply the 2021 livestock sales data by the multipliers we have generated to obtain the total (direct, indirect, and induced) economic impact of the livestock industry.

ECONOMIC IMPACT OF THE LIVESTOCK INDUSTRY

Table 1 presents the estimated economic impact of the livestock industry. Overall, sales in the livestock industry in Hawaiʻi are estimated to generate additional economic output of $49.5 million in economic activity. The industry creates as many as 536 full-time equivalent jobs and approximately $16.9 million in earnings. It is estimated that the livestock industry also contributes about $2.1 million to the state tax revenues.

The total (direct, indirect, and induced) economic impact of the livestock industry spreads across a wide variety of industries in Hawaiʻi. Of the $49.5 million economic output, $5.1 million (10%) of economic output is generated in the real estate industry. In Hawaiʻi, the real estate, rental, and leasing industry had the largest share of Gross Domestic Product (GDP) in 2017 and 2018. [7] Similarly, the livestock industry generates $4.6 million in output in the air transportation industry, $4.5 million in the crop production industry, $3.5 million in state and local government, $3.2 million in animal production, $3.1 million in food processing, $2.2 million in wholesale trade, $1.6 million in the accommodations industry, and over $21 million in various other industries.[8]

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[5] We used sales data for beef and dairy cattle, hog and pig farming, poultry and egg production, and sheep and goat farming and excluded sales for animal aquaculture as that subindustry is substantively different than the other subindustries under analysis.

[6] We are assuming that sales in the industry would be constant over time and any increase is due to inflation rather than an uptick in sales.

[7] "Hawaiʻi's Economic Structure: An Analysis Using Industry Level Gross Domestic Product Data April 2020 Update", State of Hawaiʻi Department of Business, Economic Development and Tourism, April 2019.

[8] Other industries include sectors like telecommunications, transportation, waste management, hospitals, educational services, and federal, state, and local government, among others.

Based on the I-O model, the livestock industry creates around 536 full-time equivalent jobs in other industries across the state of Hawaiʻi. Unsurprisingly, the livestock industry generates the greatest number of jobs in sectors associated with agriculture. Approximately 102 jobs are created in crop production, 51 are created in animal production, 43 in state and local government, 35 in food processing, and 14 in support activities for agriculture. Another 27 jobs are created in real estate and air transportation, each, 19 in truck and rail transportation, 17 and 13 in the respective eating and drinking and accommodations industries,15 each in wholesale and retail trade, 13 in the administrative and support services, and approximately 144 jobs in various other industries.

In terms of the total economic impact on earnings, the livestock industry is estimated to generate $16.9 million in earnings across multiple industries. The livestock industry is particularly beneficial to the state and local government sector, in which an additional $2.5 million of earnings are generated. The industry produces $2.4 million in additional earnings for the crop production industry, $1.3 million for the animal production industry, $949,000 for air transportation, $721,000 in real estate, $649,000 in wholesale trade, $609,000 in food processing, and $584,000 in truck and rail transportation. The balance of the $16.9 million in earnings are spread across the eating and drinking and accommodations sectors, administrative and support services, retail trade, support activities for agriculture, and a host of other local industries.

In terms of fiscal impact, the livestock industry is estimated to contribute an additional $2.1 million to the local tax base. The real estate industry is likely to produce $304,000 in additional tax revenue, followed by the accommodations industry ($168,000), state and local government ($127,000), and crop production ($125,000). While the animal production industry benefits in 51 additional jobs, the state acquires $64,000 in tax revenue from these positions. Various other industries generate the remaining $1.3 million in state tax revenues. It should be noted that these fiscal impacts include the income tax, General Excise tax (GE), Transient Accommodation Tax (TAT), and other tax.

Table 1. Estimated Economic Impact of the Livestock Industry

Industry	**Estimated Total Output** (Direct, Indirect and Induced)	**Estimated Total Jobs** (Direct, Indirect and Induced)	**Estimated Total Earnings** (Direct, Indirect and Induced)	**Estimated Total State Tax** (Direct, Indirect and Induced)
Crop production	$4,464,001	102	$2,415,577	$124,708
Animal production	$3,170,577	51	$1,259,620	$64,349
State and local government	$3,536,251	43	$2,548,255	$126,558
Food processing	$3,116,096	35	$608,546	$58,315
Real estate	$5,137,281	27	$720,661	$303,681
Air transportation	$4,630,090	27	$948,898	$76,196
Truck and rail transportation	$1,384,274	19	$584,147	$94,088
Eating and drinking	$1,125,642	17	$425,568	$73,785
Retail trade	$1,140,114	15	$421,456	$74,429
Wholesale trade	$2,163,427	15	$648,976	$51,730
Support activities for agriculture	$689,438	14	$381,329	$43,962
Accommodation	$1,591,731	13	$408,452	$168,089
Administrative and support services	$657,784	13	$447,903	$52,608
Various other industries	$16,686,263	144	$5,081,292	$788,584
Total	***$49,492,970***	***536***	***$16,900,680***	***$2,101,080***

Source: U.S.D.A. 2017 Census of Agriculture, SMS Estimates.

ECONOMIC IMPACT ANALYSIS OF THE LIVESTOCK HARVESTING FACILITY

In the previous section, we examined and estimated the economic impacts generated by the livestock industry to the State of Hawaiʻi at the macroscopic level. In this section we examine the economic impact of a private investment project on the State. Specifically, we estimate the statewide economic impact, as measured by output, jobs, earnings, and taxes, that would be generated by the construction of a livestock harvesting facility.

To carry out this economic impact analysis, we relied on an outside firm to provide a cost estimate for the construction of a livestock harvesting facility. J. Uno and Associates, a construction cost consultant based in Honolulu, prepared a project cost estimate for a livestock harvesting facility that could process approximately 70 head of cattle per day[9]. The cost estimate includes several line items and associated costs for the direct costs of labor and materials related to items like architecture, site work, electrical set-up, and landscaping of the project. The estimate also includes indirect costs such as direct and prime contractor markups, bonding and insurance, and the State of Hawaiʻi's general excise tax. In total, the project estimate for a proposed 24,768 square foot livestock harvesting facility that processes 70 head of cattle per day is $50,997,000 (in current U.S. dollars).

To determine the economic impact of a private investment of nearly $51 million we used the State of Hawaiʻi's 2017 Input-Output Model. As was the case with generating estimates of economic impact according to industry, the I-O model includes transaction tables that show the amount of private investment associated purchases from other industries in Hawaiʻi. The top three industries with the most purchases under the "private investment" moniker include construction (of other buildings), the single-family home construction sub-industry, and retail trade. Other industries that contribute to private investment output include heavy and civil engineering construction, wholesale trade, eating and drinking, real estate, architectural and engineering services, computer systems design services, administrative and support services, accommodation, other professional services, and a combination of other smaller industries.

The contributions of each industry to private investment in the I-O transaction table vary significantly. For example, heavy and civil engineering construction purchases totaled almost $953 million of all private investment, compared to retail trade purchases, which accounted for $464 million of all private investment. However, we're also interested in the secondary interactions among other industries that are economically intertwined with the industries that contribute to purchases within private investment. Thus, using the I-O model's total requirements tables we multiply the industry-by-industry multipliers by the proportion of shares of industry within the private investment table to calculate multipliers for all 62 industries. When summed, these values provide individual industry multipliers which can be used to examine the project's impact across various industries.

[9] The location of the facility is non-specific to a particular island and the economic impacts would be statewide rather than any particular island.

As was the case in the previous section, we multiplied the investment amount of $51 million by the Type-II multipliers from the 2017 Hawaiʻi I-O model for each industry and summed the results, which provide the total (direct, indirect, and induced) economic impacts to output, jobs, earnings, and taxes.

Table 2 (see below) presents the estimated economic impact of investing $50,997,000 into the economy for the purpose of building a livestock harvesting facility. Our estimates show that this capital infusion would generate additional statewide economic output by $32.2 million, $12.1 million in earnings, $1.9 million in state tax revenue, and support 314 jobs.

The creation of this facility will have the largest impact on industries most related to the construction industry. Of the $32.2 million in additional economic output created by this project, approximately $6.9 million (21%) would be in construction of buildings, $1.9 million (6%) in heavy and civil engineering construction and nearly $1.04 million (3%) in architectural and engineering services.

The project is estimated to generate additional economic output in other industries as well. The second largest impact will be in single-family construction, which is estimated to generate an additional $3.3 million increase in economic output. Relatedly, we estimate the real estate industry will generate nearly $2 million in additional economic output.

We estimate an increase of $2.3 million in retail trade, $1.7 million in wholesale trade, $1.6 million in the combined eating and drinking and accommodations industries, $909,000 in computer system design services, $514,000 in administrative and support services industry, and $477,000 in businesses that support other professional services. We also expect an increase of over $9.6 million in output across other smaller industries in the state[10].

The project's estimated economic impacts also include the support of approximately 314 full-time equivalent jobs. Job types include both professional and trades. As was the case with economic output, jobs in industries related to building design and construction are most likely to be positively affected by the livestock harvesting facility. More than 95 jobs in architecture and construction will be supported, along with 30 related to single-family construction. We estimate another 30 jobs will be supported in retail trade, 14 in wholesale trade, 12 in businesses associated with eating and drinking, 11 in real estate, 11 jobs in the computer systems design services industry, 10 jobs in the administrative and support services sector, 7 in accommodations, 7 in other professional services, and 82 jobs supported across other industries.

In terms of earnings, we estimate the proposed harvesting facility will generate just over $12 million statewide. Of that $12 million, $4.2 million in additional earnings are estimated to be created in industries linked to general construction, and $1.4 million in additional earnings likely to be generated in the single-family home construction sub-industry. Earnings for retail trade are estimated to increase by $849,000, followed by computer systems design services ($694,000), wholesale trade ($522,000), administrative and support services ($350,000), eating and drinking businesses ($296,000), real estate ($279,000), other professional services ($208,000), and the accommodations sector ($201,000). Various other industries are estimated to contribute just over $3 million in earnings.

[10] Other industries include sectors like telecommunications, transportation, waste management, hospitals, educational services, and federal, state, and local government, among others.

Our estimates of the economic impacts associated with the construction of this proposed livestock harvesting facility indicate substantial increases in Hawai‘i’s economic output, earnings, and jobs. We also estimate that the State will collect an additional $1.9 million in taxes[11] as a result of this investment. Specifically, we estimate the construction-related industries will generate approximately $679,000 in tax revenue, the single-family construction sub-industry will generate around $223,000 in tax revenue, retail trade and wholesale trade will contribute $150,000 and $42,000, respectively, and real estate will generate about $118,000 in tax revenue. Other industries impacted by this private investment will contribute approximately $697,000 in state tax revenue.

[11] These include revenue generated from the state income tax, the general excise tax, and the transient accommodation tax.

Table 2. Estimated Economic Impact of a Livestock Harvesting Facility

Industry	Estimated Total Output (Direct, Indirect and Induced)	Estimated Total Jobs (Direct, Indirect and Induced)	Estimated Total Earnings (Direct, Indirect and Induced)	Estimated Total State Tax (Direct, Indirect and Induced)
Construction of other buildings	$6,860,583	65	$2,901,717	$467,556
Single-family construction	$3,266,124	30	$1,381,423	$222,590
Retail Trade	$2,297,704	30	$849,373	$150,000
Heavy and civil engineering construction	$1,901,814	19	$804,382	$131,782
Wholesale trade	$1,739,597	14	$521,838	$41,595
Eating and drinking	$782,253	12	$295,744	$51,276
Real estate	$1,989,787	11	$279,129	$117,622
Architectural and engineering services	$1,037,442	11	$520,044	$80,070
Computer systems design services	$909,474	11	$693,804	$75,868
Administrative and support services	$514,277	10	$350,185	$41,130
Accommodation	$783,909	7	$201,158	$82,782
Other professional services	$477,532	7	$207,559	$34,421
Various other industries	$9,615,291	87	$3,090,223	$411,530
Total	***$32,175,787***	***314***	***$12,096,579***	***$1,908,222***

Source: Hawai'i State Input-Output Study: 2017, SMS Estimates, J. Uno and Associates Cost Estimate.

REFERENCES

[1] https://www.meatinstitute.org/index.php?ht=a/GetDocumentAction/i/93337#:~:text=The%20industry%20contributes%20approximately%20%24894,million%20jobs%20in%20the%20U.S.

[2] https://nami.guerrillaeconomics.net/reports/cd26765e-0eab-4a13-aa13-cd32f89895c1?

[3] https://nami.guerrillaeconomics.net/reports/11a7f893-8f27-4da1-9c03-f2351fa8072b?

APPENDIX D

BASIS OF DESIGN

Oct 2022 | Final

Scalable Livestock Harvesting Facility Basis of Design

State of Hawaii

Prepared for:

State of Hawaii, Department of Agriculture (HDOA)

Prepared by:

EKNA Services, Inc.

PROJECT TEAM

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Plumbing:	Coffman Engineers, Inc.
Fire Protection:	Coffman Engineers, Inc.
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	Food and Livestock Planning, Inc. (Keith Deehan)

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1 Introduction

1.1 Project Summary

The following report presents the basis of design for a Statewide Scalable and Replicable Livestock Harvesting Facility for the State of Hawai'i. The design provides a review of the facility concept, harvesting process, facility infrastructure, on-site infrastructure, parking, and alternatives for solid and wastewater treatment and disposal.

1.2 Project Goals

The following goals and objectives were developed for this project:

1. Create a facility model that enables the sustainability of Hawaii's beef industry, as well as addresses the economic, social, and environmental impacts of a potential facility.

2. Create a marketing tool to attract investors for future construction of a livestock harvesting facility in Hawaii.

1.3 Project Design Concept

The scalable livestock harvesting facility consists of a 4,950 sf covered livestock area and a 19,893 sf processing building. The facility harvesting and fabrication area is designed to slaughter and process a maximum of 70 heads/day, four days/week.

A major design element of the livestock harvesting facility is the treatment and disposal of solids and meat processing wastewater. The facility design considers both wastewater disposal to sewer, as well as on-site wastewater treatment and disposal. Natural wastewater treatment lagoons and constructed wetlands are utilized to treat wastewater to acceptable levels. Designated composting areas were designed to handle the solid waste produced from the facility.

Other design elements outside of the facility include the construction/post-construction BMP's, utilities, parking, sidewalks, and solar photovoltaic roof system.

Estimated Project Cost: $51,333,000

2 General Conceptual Plans

This section describes the assumptions used to determine the facility size and design.

2.1 References

The following references are used in the design:

1. Development Document for the Proposed Effluent Limitations Guidelines and Standards for the Meat and Poultry Products Industry Point Source Category, Environmental Protection Agency (EPA), 2002
2. Food Safety and Inspection Service (FSIS) of the United States Department of Agriculture (USDA) CFR Title 9 Chapter III Subchapters A, D and E
3. United States Department of Agriculture (USDA) Agriculture Handbook No. 570
4. United States Department of Agriculture (USDA) Hazard Analysis Critical Control Point (HACCP) Standards
5. American Meat Institute (AMI) Facility Sanitary Design Standards
6. "Humane Livestock Handling" 2008 by Temple Grandin
7. Global Food Safety Initiative (GFSI) Standards

2.2 Facility Production

Based on the demand of cattle and the historical operations of a livestock harvesting facility in Hawai'i, the demand range selected was from 1,500 to 10,000 AU per year. The Facility is designed to handle 10,000 per year. This yields for about four days a week at 70 head per day of cattle. The facility is designed to process grass fed and finished beef, cull cows, hogs, sheep and goats. Hogs, sheep and goats are typically slaughtered and sold as dressed carcasses with no further processing required, so they can be processed at higher rates per day. Beef quarters or eighths can also be received from other harvest facilities for further processing in this facility. The process description below is based on the harvesting and further processing of cattle.

1. Harvesting and Fabrication Process

A. Livestock is received at the far end of the Livestock Building. Stock trailers can be unloaded in the drive-through bay and semi-trailers can be backed into the unloading door. They are then placed into one of several holding pens where they can recover from the trip and be presented to the USDA for anti-mortem inspection prior to being harvested.

B. After anti-mortem inspection, the livestock are walked to the crowd pen, ready for the harvesting operation. They are fed single file into the lead-in chute. Cattle are fed to the Beef Knock Box and small stock (hogs, sheep, goats) to the Small Stock Restrainer for stunning and discharge to the Dry Landing Area.

C. The carcass is them shackled by one hind leg and hoisted off the floor for sticking, bleeding and on-the-rail dressing.

D. After bleeding, the skinning process begins. At the First Leggers Stand, the free leg, butt and rump are skinned, the foot removed, a trolley inserted and hoisted onto the dressing rail. Then the shackle is released, and the carcass is moved to the Second Legging Platform.

E. At the Second Legging Platform, the free leg, butt and rump are skinned, the foot removed, a trolley inserted and hoisted onto the dressing rail, bung is dropped, pizzle or udder removed and the carcass is moved to the Rim Over Platform.

F. The hide on the belly is marked for skinning and the hide is skinned back in the flank and shoulder areas.

G. The head is skinned, ears, snout and lips removed, the head is removed from the carcass, flushed, trimmed, tongue pulled out and the head is placed in a loop for presentation to the USDA Inspector. The Weasand is rodded and tied off.

H. At the Hide Puller Station, the fore shanks are skinned, front feet removed, and the hide is removed from the carcass. Then the carcass is moved to the Hide-Off Harvest Area.

I. At the Brisket Station, the carcass breast is marked, opened and the breastbone is sawn. Then the carcass is then moved to the Evisceration and Splitting Station.

J. The belly is opened, viscera dropped into a cart, heart and lungs removed and viscera and is presented to the USDA Inspector. The carcass is split and then moved to the Final Trim and Inspection Station.

K. The carcass is trimmed for Carcass Inspection. After Final Inspection, the carcass is washed, cycled through the High Voltage Stimulator and transferred to the Carcass Chill Cooler.

L. After the carcasses are chilled for 24 hours, they are moved and sorted into the Carcass Sales Cooler rails.

M. In the Fabrication Room, carcasses are scaled, the chuck is removed and hung off onto a low rail where the shoulder clod and paddle bone are removed before landing on a band saw.

N. From the remainder of the carcass, the wing and loin are cut off, and conveyed to a band saw for separating into primals. The remaining round is boned, hanging on-the-rail.

O. The table operations include separating, boning and trimming the primals into saved cuts for vacuum packaging and boneless trimmings for further processing into ground beef.

P. Saved cuts from the boning and trimming operations will be placed is bags and vacuum packaged, placed into boxes, weighed, labeled and taped closed, then palletized and moved to the Finished Goods Cooler. Some saved cuts can also be racked and moved to the Value-Added Line for further processing into steaks, roasts, etc. Vacuum packaged cuts can also be wet aged in the Finished Goods Cooler before further processing or shipping to customers.

Q. Beef Trimmings will be sorted by type and fat/lean percentage and stagged for further processing into fresh or frozen ground beef patties, 1 lb. bricks or 5 lb. bulk packages.

R. A roll-stock vacuum packaging machine is provided for vacuum packaging or gas flush packaging of value-added cuts and ground beef products.

S. A nitrogen cabinet is provided for individually quick-freezing items as well as a Blast Freezer for freezing and holding of boxed products.

T. Finished Products will be shipped to customers and packaging materials will be received in the Shipping/Receiving Dock.

U. Inedible materials will be removed from the facility in the Inedible Materials Load-out Area and transported to an on-site composting area. A bone grinder is provided to beak-down large items such as hoofs, hides, viscera and bones.

V. See below for estimated manning requirements for the facility.

W. See below for a breakdown of beef livestock harvesting properties.

HAWAII GANG LINE-UP HARVEST
10 HEAD PER HOUR LINE SPEED

HIDE-ON HARVEST AREA	
Receives, Unloads and Moves Livestock	1
Feed Knock Box, Stun, Roll-out, Shackle, Hoist, Stick and Bleed	1
Skin 1st Leg and Rump, Cut-off Foot, Insert Trolley, Hang-ff and Release Shackle	1
Skin 2nd Leg and Rump, Cut-off Foot, Insert Trolley and Hang-off	1
Skin Head, Cut-off Ears, Snout and Lips, Remove Head, Flush, Present to Inspector	1
Skin Flanks and Shoulder, Mark Shanks, Cut-off Front Feet and Pull Hide	1
SUB-TOTAL	6
HIDE-OFF HARVEST AREA	
Saw Brisket	1
Open and Eviscerate, Present Viscera to Inspector, Split Carcass, Save Offal	1
Final Carcass Trim and Wash Carcass	1
Work-up Offal and Tripe	1
Handle Blood, Hide and Inedible Materials	1
Load Carcass Chill Cooler	1
SUB-TOTAL	6
TOTAL HARVEST OPERATIONS	12

HAWAII GANG LINE-UP FABRICATION
10 HEAD PER HOUR LINE SPEED

RAIL OPERATIONS	
Bring Carcasses from Sales Cooler	1
Scale, Saw and Hang-off Chuck	1
Pull Shoulder Clod and Pull Paddle Bone	1
Saw and Drop Wing and Loin, Drop and Saw Chuck, Saw Off Rib and Short Rib, Saw Head Loin from Short Loin	1
Pull Knuckle, Drop Inside and Gooseneck, Bone Shank	1
SUB-TOTAL	5
TABLE OPERATIONS	
Pull and Trim Tenderloin, Pull and Trim Flank Steak	1
Chine Rib and Short Loin, Bone and Trim Strip	1
Separate, Bone and Trim Top Butt, Separate Bottom Butt, Trim Hanging Tender	1
Separate Inside and Gooseneck, Trim Gooseneck, Trim Knuckle, Trim Inside	1
Make Short Rib and Bone Rib	1
Bone and Trim Arm Chuck, Trim Clod	1
Bone and Trim Blade Chuck	2
Trim Chuck, Bone and Trim Brisket	1
Bone Plate, Pull and Trim Skirt Steaks	1
SUB-TOTAL	10

<u>MISCELLANEOUS</u>	
Sort Trimmings	1
Bone-guard and Bag Cuts	1
Bag Thin Meats and Rework Leakers	1
Operate Chamber Machine	1
Weight Grade and Box Cuts	2
Scale, Label and Tape Boxes	1
Palletize and Move Pallets	1
Cut and Trim Steaks and Roasts	5
Grind and Package Ground Beef and Value-Added Products	4
Material Handler	1
Work Cooler, Freezer and Dry Storage	2
Work Shipping and Receiving	1
SUB-TOTAL	21
TOTAL FABRICATION OPERATIONS	36
<u>SUPPORT OPERATIONS</u>	
Plant Manager	1
QA Manager	1
Clean-up	7
Maintenance	2
Office	6
SUB-TOTAL	17
TOTAL FACILITY	65

Description	Value (Typical/Average per Beef Animal Unit)
Cattle Weight	1,095 pounds
Dressed Cattle Weight (yield)	657 pounds
Ground	270 pounds
(Percent of product)	41 percent
Cuts	200 pounds
(Percent of product)	30 percent
Offal	20 pounds
(Percent of yield)	3 percent
Total Inedibles (bone and fat)	170 pounds

Table 1: Beef Livestock Harvesting Properties

2.3 Detailed Facility Design Criteria

See Appendix A

2.4 Facility Wastewater Generation

1. Processing Wastewater Volume

The 2002 Environmental Protection Agency (EPA) Development Document for the Proposed Effluent Limitations Guidelines and Standards for the Meat and Poultry Products Industry Point Source Category was used as a general guideline for estimating processing wastewaters.

	Process Wastewater Generated (gallons per 1,000 lbs. of Animal Unit)	
	First Processing[a]	Further Processing[b]
Small Facilities	348	672
Non-small Facilities	323	555

[a] Production unit for processing is 1,000 lbs. of live weight (LW). These numbers include facilities that may also generate wastewater from cutting operations.
[b] Production unit for further processing operations is 1,000 lbs. of finished product.
Data source: Meat and Poultry Products (MPP) detailed surveys.

Figure 1. 2002 EPA Wastewater Volumes Produced by Meat Facilities (Beef Production)

Where: Live Weight = 1,095 lb
Dressed Carcass Weight = 657 lb
Ground Beef = 270 lb

Estimated Wastewater Volume:
= (348 x (Live Weight lb/1,000 lb)) + (672 x (Ground Beef lb/1,000 lb))
= (348 x (1,095 lb/1,000 lb)) + (672 x (270 lb/1,000 lb))
= 562.5 gal / AU

Therefore, conservatively, it is assumed that **600 gallons** of processing wastewater is generated per head.

When operating 4 days a week at 70 heads a day, the facility will process 280 AU a week. Therefore, the weekly and average daily processing wastewater flow is as follows:

280/week x 600 gal/AU = 168,000 gal/week = 24,000 gal/day

2. Wastewater Characteristics

The typical wastewater composition from a livestock harvesting facility is shown below.

Compound/Nutrient	Raw Effluent, ppm (mg/L)	After Screening, ppm (mg/L)
Biological Oxygen Demand (BOD)	4,448 (4,440)	2,424 (2,420)
Chemical Oxygen Demand (COD)	6,490 (6,478)	3569 (3,563)
Suspended Solids (SS)	4,040 (4,033)	1,010 (1,008)
Total Nitrogen	331 (330)	182 (182)
Total Phosphorus	61 (61)	34 (34)
Oil & Grease	1,714 (1,711)	429 (428)

Source: Food and Livestock Planning, Inc.
Note: Effluent does not include blood from the sticking process

Figure 2. Wastewater Characteristics of Livestock Harvesting Effluent

3 Civil

3.1 Drainage

See Appendix B.

3.2 Sewer

See Appendix B.

3.3 Constructed Wetland

The assumed parameters for the constructed wetland design include design flow rate of 24,000 gpd, influent BOD of 300 mg/L, and influent TSS of 1,008 mg/L. The target effluent is BOD of less than 30 mg/L and TSS of less than 30 mg/L. A maximum bed depth of 2 ft was selected according to the EPA Guidance for Design and Construction of a Subsurface Flow Constructed Wetland (1999). Additionally, a length-to-width ratio of 3 was chosen to provide flexibility for future operational adjustments.

The EPA Manual for Constructed Wetlands Treatment of Municipal Wastewaters (1999) suggests that media at the inlet zone (first 6.56 ft) and outlet zone (first 3.28 ft from the opposite end) should be between 1.5 – 3 inches to minimize clogging. Media in the treatment zone should be between 3/4 to 1 inch for ease of handling and to minimize clogging. Due to the porous nature of the media, the bottom of the constructed wetland must be lined with an impermeable layer, such as a synthetic liner. Selection of plants and media type should be based on local availability at the selected site to minimize cost.

Inlet and outlet structures distribute flow into the wetland, control the flow path through the wetland, and control the water depth. One of the suggested inlet and outlet structures is perforated PVC pipes.[1] The proposed constructed wetland will have 4” perforated pipes at the inlet and outlet running across the width of the wetland. This will allow uniform distribution of flow across the wetland inlet width and uniform collection of effluent across the wetland outlet width. The outlet will lead to a water control structure located at the end of the wetland where the water level is controlled by a swiveling elbow.[2] The use of an adjustable outlet will help maintain an adequate hydraulic gradient in the bed and offers flexibility in operating and maintaining the wetland, such as the capability to flood and drain the system as needed. Note that the size of the pipes and the size and spacing of the orifices will depend on the actual flow rate and the hydraulics of the inlet/outlet structures.

1 Office of Research and Development, 2000. “Manual: Constructed Wetlands Treatment of Municipal Wastewaters”. Cincinnati, Ohio; U.S. Environmental Protection Agency, 91.
2 UN-HABITAT, 2008. “Constructed Wetlands Manual.” Nepal, Kathmandu; UN-HABITAT Water for Asian Cities Programme, 32-33.

The required surface area of the constructed wetland can be calculated using the following first-order BOD removal equation3:

$$A_s = Q*\ln(C_0/C_e)/K_T dn$$

Where:
Q = Flowrate (cfs)
C_0 = Influent BOD (mg/L)
C_e = Effluent BOD (mg/L)
d = Average water depth (ft) = 1.64 ft [4]
K_T = Rate constant at 25°C (d^{-1}) = $K_{20}\theta^{T-20}$
K_{20} = Rate constant at 20°C = 1.104 d^{-1}
θ = 1.06
T = Temperature of water (°C)
n = Porosity = 0.35 [5]

For a design temperature of 20°C, the required top surface area of the constructed wetland is 20,667 ft^2 with corresponding dimensions 83' W x 249' L. The wetland will have a slope of 0.5 to 1% for ease of construction and proper draining.6

Based on wetland dimensions, the hydraulic retention time (HRT) is calculated as follows:

$$HRT = (Volume \times porosity)/Flowrate = 4.1\ d$$

An exterior berm will enclose the constructed wetland to prevent unregulated flow releases. The exterior berm will provide a 2 ft freeboard to contain a 25-year 24-hour storm rainfall amount. The berm will have a side slope of 3:1 (H:V) with a bench width of 5 ft to permit service vehicle access.7 Concrete fabric will be used to line the berm as an erosion control measure.

3.4 Water

See Appendix B.

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3 Reed, S. C. 1993. "Guidance for design and construction of a subsurface flow constructed wetland." Dallas, Texas; U.S. Environmental Protection Agency, Region 6, Water Management Division, Municipal Facilities Branch, Technical Section, 10.
4 Typical range 0.4 to 0.5 m. Office of Research and Development. "Manual: Constructed Wetlands Treatment of Municipal Wastewaters", 117.
5 n = 0.35 if planted; n = 0.45 if unplanted. Reed, S.C. "Guidance for design and construction of a subsurface flow constructed wetland", 10.
6 Office of Research and Development. "Manual: Constructed Wetlands Treatment of Municipal Wastewaters", 117.
7 Ibid, 123.

3.5 Zoning

See Appendix B.

3.6 Composting

This section discusses the basis for the design of the composting layout plan. The solid waste from the livestock harvesting facility will be composted using passive aerated windrows. The passive aerated windrows will have 4" diameter perforated pipes along the length of the windrow to supply air into the pile.

As mentioned in 2.B.1. Design Parameters, based on the demand of cattle and the historical operations of a livestock harvesting facility in Hawai'i, the maximum cattle slaughtered is 10,000 per year. This yields approximately four days a week at 70 heads a day.

Windrows

Assuming each cattle produces 600 lbs of solid waste (assuming each cattle is 1,000 pounds, producing waste at 60%) and has a density of 66 lb/ft^3 (1,057.22 kg/m^3),[8] the total waste volume produced from a 70 head/day facility, operating 4 days/week with a composting time of 6 months, or 24 weeks, is computed as follows:

$$70 \text{ head/day} \times 4 \text{ days/week} \times 24 \text{ weeks} \times (600 \text{ lb/head} / 66 \text{ lb/ft}^3) = 61{,}091 \text{ ft}^3$$

The minimum amount of carbon material needed per ton of butcher waste is 5 yd^3.[9]

Therefore:

Total volume of carbon material required =

$$70 \text{ head/day} \times 4 \text{ days/week} \times 24 \text{ weeks} \times (600 \text{ lb/head} / 2000 \text{ lb/ton}) \times 5 \text{ yd}^3\text{/ton} = 10{,}080 \text{ yd}^3 \text{ or } 272{,}160 \text{ ft}^3$$

$$\text{Total windrow volume} = \text{Volume of waste} + \text{Volume of carbon material} = 333{,}251 \text{ ft}^3$$

8 Schwarz, Mary, Jean Bonhotal, and Dale Rozeboom. 2010. "The Space It Takes - Footprint Calculator for Composting Butcher Waste." *Cornell Waste Management Institute*. http://cwmi.css.cornell.edu/spaceittakes.pdf.

9 Other sources may reference higher values (i.e. 15 yd^3). Cornell Waste Management Institute. 2008. "Natural Rendering: Composting Livestock Mortality and Butcher Waste." https://datcp.wi.gov/Documents/cornellcompostguide.pdf.

Based on the assumption that each windrow is shaped as a trapezoidal prism, the windrow dimensions can be calculated using the following equation10:

$$V = \frac{d}{6}(A_t + A_b + 4A_m)$$

Where:

Area of top, A_t = LW

Area of bottom, A_b = (L – 2sd)(W-2sd)

Area of mid-section, A_m = (L-sd)(W-sd)

L = Length of windrow

W = Width of windrow

d = Height of windrow

s = Side slope = 1

The windrow dimensions are based on specifications of the windrow turner, the Topturn X63 or equivalent. The maximum windrow width and height it can turn is 18.7 feet and 8.5 feet, respectively. Using windrow width and height dimensions of 18 feet and 8 feet, respectively, the total length of the windrow required for composting is 4,170 ft. With 15 windrows, the length of each windrow is 278 ft.

Spacing

The minimum width of access aisles is 21 feet to provide enough space for a windrow turner. This is based on the width of the Topturn X63, 20.2 feet, or equivalent.11 The minimum space between the windrows is 9 inches to allow access for the turner.

Storage

Carbon material used for composting will be stored on site. The total amount of carbon material needed for composting can be approximated using the sum of carbon material needed for composting and carbon material lost through decomposition. The decomposition rate of wood chips is 19% decrease in mass in 6 months.12 Therefore, the total amount of carbon material lost over 6 months is 51,710 ft^3; and the total amount of carbon material needed for composting is 323,870 ft^3.
Using the same geometrical assumptions as a typical windrow, the total space needed for carbon material storage is 7,744 ft^2 (0.18 ac).

10 Rural Water Branch. 2012. "Dugout volume calculator." Agriculture and Forestry: Applications & Tools. Retrieved from https://www.agric.gov.ab.ca/app19/calc/volume/dugout.jsp

11 Komptech. n.d. "Topturn X63." Accessed November 17, 2021. https://www.komptech.com/fileadmin/komptech/user_upload/Topturn_X63_E_2020.pdf.

12 Slaven, Isaac, Eva Haviarova, and Daniel Cassens. 2011. "Properties of Wood Waste stored for energy Production." Purdue University Publication ID-421-W.

Stormwater Runoff Prevention and Leachate Collection

According to the “Solid Waste Management Control, Subchapter 4”, compost storage must be in an area minimizing leachate release into groundwater; all leachates must be collected and treated; and adequate drainage to prevent standing water and to control “run-on” and “run-off” of rainwater is required. The proposed composting facility will have a leachate collection system to collect runoff and leachate in an enclosed area. The surface of the composting area is an impermeable compacted base layer surrounded by a gravel bed. Run-off will be drained into a gravel layer with 4” perforated pipes where leachate will be collected and conveyed off-site for treatment. The bottom of the dugout will be lined with an impermeable high-density polyethylene (HDPE) geomembrane layer to prevent leachate from leaving the system.

An exterior berm will enclose the composting area to prevent stormwater and leachate run-off. The suggested side slope for the berm is 2:1 (H:V) with a bench width of 5 ft following the City and County of Honolulu Storm Water Best Management Practice Manual for maximum slope and minimum access bench for berms. The berm should have a minimum of one access entrance with a suggested slope of 12:1 (H:V) for vehicle access.13 Concrete fabric will be used to line the berm as an erosion control measure. Further investigation, site-specific information, and standard requirements will dictate the rainfall capacity of the leachate collection system and the limits of the impervious composting area.

A stabilized ingress/egress will be installed to reduce the tracking of mud and dirt outside of the composting site.

Solar Shade

Two options are considered for the composting layout plan: with solar shade and without solar shade. A composting layout without solar shade will require approximately 183,000 ft^2 (4.2 ac) land space while a composting layout with solar shade will require approximately 228,200 ft^2 (5.2 ac) land space. Composting layout with solar shade will require less rainfall storage capacity than composting layout without solar shade.

4 Structural

4.1 Project Overview

The project consists of a one-story processing facility (currently 19,500 SF) with an adjacent covered livestock area (currently 5,000 SF). Exact site of build is not yet determined. The processing facility is constructed of steel moment frames with steel beams and a metal roof deck. The roof framing is sized for significant equipment loading, a photovoltaic panel system, a walkable suspended ceiling system and wind uplift.

13 Department of Public Works. 1984. “Standard Details for Public Works Construction.” Hawaii.

Supplemental support beams are provided below the roof framing to accommodate specialized equipment loading. The exterior walls of the processing facility are constructed of precast insulated wall panels. The interior walls consist of light-gauge stud walls with insulated panels as applicable. The livestock area is constructed of a prefabricated metal building. The foundation system is reinforced slab-on-grade, conventional continuous and isolated footings, and retaining walls at docks and interior pits.

4.2 Codes and Standards

1. Concrete

a. ACI 301-Structural Concrete for Buildings
b. ACI 301 – Structural Concrete for Buildings
c. ACI 302 – Guide for Concrete Floor and Slab Construction
d. ACI 304 – Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete
e. ACI 305R – Hot Weather Concreting
f. ACI 306R – Cold Weather Concreting
g. ACI 308 – Standard Practice for Curing Concrete
h. ACI 318 – Building Code Requirements for Structural Concrete
i. ASTM A185 – Welded Steel Wire Fabric for Concrete Reinforcement
j. ASTM A615 – Deformed and Plain Billet Steel Bars for Concrete Reinforcement
k. ASTM C33 – Concrete Aggregate
l. ASTM C94 – Ready-Mixed Concrete
m. ASTM C150 – Portland Cement
n. ASTM C260 – Air Entraining Admixtures for Concrete
o. ASTM C494 – Water Reducing Admixtures
p. ASTM C618 – Fly Ash
q. CRSI – Concrete Reinforcing Steel Institute – Manual of Practice

2. Steel

a. AISC – Code of Standard Practice – Manual of Steel Construction
b. ASTM A992, GR.50 – Structural Steel W & WT Shapes
c. ASTM A36 – Structural Steel Plates, Bars & Angles
d. ASTM A53 – Pipe Steel, Black and Hot Dipped, Zinc-Coated, Welded and Seamless
e. ASTM A325/A490 – High Strength Bolts for Structural Steel Joints
f. ASTM A500 – Cold Formed Welded and Seamless Carbon Steel Structural Tubing in Round and Shapes
g. ASTM A501 – Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
h. ASTM A653 – Specification for Steel Sheet, Zinc Coated or Zinc-Iron Alloy Coated by the hot-dip process
i. ASTM A1008 – Specification for Steel Sheet, for Painted Metal Deck

j. AWS D1.1 – Structural Welding Code – Steel
k. AWS D1.3 – Structural Welding Code – Sheet Steel
l. SDI (Steel Deck Institute) – Design Manual for Roof Decks

4.3 Materials

1. Concrete

a. Portland Cement: ASTM C150, Type 1
b. Normal Weight Aggregates: ASTM C33 – Nominal maximum aggregate size: 3/4 inch
c. Reinforcing Steel: ASTM A615, 60 ksi yield grade; deformed billet steel bars
d. Welded Steel Wire Fabric: ASTM A185 – Plain Type; in sheets; unfinished; roll stock not permitted
e. Footings and Foundation Walls: Normal weight concrete, Compressive Strength (28 Days) = 3000 psi.
f. Interior Slab-On-Grade: Compressive Strength (28 Days): = 4000 psi.
g. Exterior Slab-On-Grade and Freezer Slabs: Compressive Strength (28 Days): = 4500 psi.

2. Steel

a. Steel Angles and Plates: ASTM A36
b. Rolled Steel Structural Shapes: ASTM A992
c. Cold-Formed Structural Tubing: ASTM A500, Grade B
d. Hot-Formed Structural Tubing: ASTM A501, seamless or welded
e. Pipe: ASTM A53 Grade B, Finish Black.
f. Carbon Steel Bolts and Nuts: ASTM A307.
g. High-Strength Structural Bolts: ASTM A325/A490.
h. Anchor Bolts: ASTM A36, threaded rod.
i. Welding Materials: AWS D1.1; E70xx minimum.

4.4 Design Criteria (subject to change upon site selection)

1. Building Code

a. International Building Code 2018 w/local amendments.

2. Live Loads

a.	Manufacturing	125 psf
b.	Storage	125 psf
c.	Offices	50 psf
d.	Mechanical	125 psf or as applicable
e.	Equipment	155 psf or as applicable
f.	Roof	20 psf

3. Wind Loads

a.	Wind Speed	200 mph
b.	Building Risk Category	II
c.	Wind Exposure Category	Exp C

4. Wind Loads

a.	Building Risk Category	II
b.	Seismic Importance Factor	1.25
c.	Site Class	D

4.5 Structural Systems

1. Foundation System

a. Unless deemed otherwise by Site: Foundations shall be supported on reinforced concrete spread footings proportioned as required by existing soil conditions. Exterior walls will be supported on foundation walls and continuous footings founded as required for frost protection, pit recesses, or as necessitated by existing soil conditions.

2. Floors

a. Unless deemed otherwise by Site: the floor slab shall be constructed with a 6" reinforced concrete slab over a 15 mil. vapor barrier at the offices, an 8" reinforced concrete slab with a 15 mil. vapor barrier as appropriate for final flooring, in the remaining areas. Slabs shall be thickened further at point loads of equipment or posts. Thermal isolation shall be provided as required by the Architectural drawings.

3. Roofs

a. The roof at the Processing building shall consist of 1 ½"-20 ga. galvanized metal roof deck spanning to steel wide flanged beams with HSS columns.

b. The roof at the Livestock area shall consist of a pre-engineered steel building with steel moment frames, steel purlins, and metal deck.

c. The exterior canopies at entrances shall be constructed of pre-engineered aluminum canopies or steel supported by the building enclosure.

4. Enclosure

a. The Processing building enclosure shall consist of Precast concrete panels that are laterally supported back to the building frames.

5. Lateral Load Resisting

a. The beam and columns at the Processing building shall be incorporated into moment or braced frames to resist seismic and wind forces.

b. The frames at the Livestock area shall be incorporated into moment or braced frames to resist seismic and wind forces.

5 Mechanical

See Appendix C.

6 Plumbing Systems

See Appendix C.

7 Fire Sprinklers

See Appendix C.

8 Electrical

8.1 References

1. NFPA 1: Uniform Fire Code, 2012 with local amendments

2. NFPA 70: National Electrical Code (NEC), 2017

3. NFPA 72: National Fire Alarm Code, 2010

4. IESNA: Illuminating Engineering Society of North America (IESNA) Lighting Handbook, Tenth Edition

5. IBC: International Building Code, 2012

6. IECC: International Energy Conservation Code, 2015 with local amendments

8.2 Overview

The electrical scope of work will include underground electrical utility services (power, telephone, internet/data); exterior lighting for operations, safety and security; secondary electrical distribution systems; interior lighting systems; a standby generator and associated standby power distribution system to support selected loads; and a fire alarm system.

8.3 Project Description

1. Primary Exterior Electrical Distribution

a. Primary electrical utility service for the facility is proposed to be extended from the electrical utility distribution system at a location closest to the project site.

b. A concrete encased ductline will be extended to a utility company pad mounted transformer located on project site.

c. The utility company will be responsible for all primary cabling and the pad-mounted transformer. The project will provide handholes, empty ductlines and the transformer pad for utility company use.

d. It is anticipated that there will be service charges, assessed by the electrical utility company provide electrical service to the site. Service charges will be determined by the utility company.

2. Secondary Electrical Distribution

a. Secondary power from the utility company transformer will be provided at 480/277 volts, three phase, four-wire.

b. Underground secondary electrical service feeders, consisting of copper conductors installed in concrete encased ductlines, will be extended from the pad mounted transformer to a metering switchboard in the main electrical room.

c. The metering switchboard will be service-entrance rated. The main circuit breaker will be provided with an energy-reducing maintenance switch with a local status indicator to reduce the arc flash clearing time of circuit breaker.

d. A single utility company revenue meter will be provided for the facility.

e. Surge protection devices (SPDs) will be provided at the metering switchboard and 480 volt distribution panels. The SPDs will be integrated into the switchboards and distribution panels and mounted directly to the bus bars via an integral disconnect switch. Integrating the surge device into the electrical assembly is recommended to minimize the system let-through voltage at the bus when compared to traditional cable connected surge protectors.

3. Exterior Telecommunications Distribution

a. Telecommunications (telephone/internet/data/cable television) service is proposed to be derived from Hawaiian Telcom and Spectrum distribution systems. Underground handholes and empty concrete encased ductlines, in accordance with Hawaiian Telcom and Spectrum standards to the telecommunications entrance facility (telecommunications room) within the building.

b. The furnishing and installation of Hawaiian Telcom and Spectrum service entrance cables will be by the respective utility companies. The project will provide the empty ductlines and handholes.

4. Exterior Lighting

a. Energy efficient, fully shielded LED luminaires will be provided around the entire perimeter of the building for safety, security and general illumination. Building mounted luminaires will be provided with occupancy sensors to automatically dim the luminaires by 30 percent during night time hours, when activity has not been detected for 15 minutes or more, to conform to the Building Energy Conservation Code. The luminaires will automatically come to full level when occupancy in the area is detected.

b. Fully shielded LED pole mounted luminaires will be provided for illumination of driveways, vehicle parking areas and pedestrian walkways. Target lighting levels will be as recommended by the IESNA Lighting Handbook, as appropriate for intended night time usage and occupancy of the facility. These luminaires will be controlled by time clock controls incorporated into the lighting control panels.

c. All light pole assemblies will be grounded and bonded.

5. Standby (Generator) Power

a. A standby generator will be provided to support refrigeration loads, emergency egress lighting, electronic security and communications equipment loads only. The generator will **not** be sized to support the entire building.

b. The generator set will be diesel-fired and pad mounted with a stainless steel weatherized, sound attenuated enclosure to provide for protection against the elements. The fuel tank for the generator will be mounted at the base of the generator unit.

c. An automatic transfer bypass/isolation switch will be located in the main electrical room

d. The on-site generator fuel storage system capacity has not been determined. Fuel storage capacity should be based on the desired generator run time.

6. Interior Wiring Systems

a. The secondary electrical distribution system for the facility will be at 480/277 volts, 3-phase, 4 wire, 60 hertz. Step down, shielded isolation, "K" rated, dry-type transformers will be utilized to provide 208/120 volt, 3-phase, 4 wire, 60 hertz power to computers and other utilization equipment. Lighting, air conditioning equipment and livestock processing equipment will be powered at the 480/277 voltage level where feasible.

b. Electrical wiring systems will consist of insulated copper conductors in raceways. A separate insulated green equipment grounding conductor will be provided for each feeder and branch circuit. Raceways will be concealed whenever possible. Separate neutrals will be provided for all 120 volt branch circuits to mitigate the effect of harmonics associated with non-linear loads.

c. Electrical equipment enclosures will be NEMA Type 1 for dry, interior locations and NEMA Type 4X, stainless steel for exterior and wet interior locations.

7. Distribution and Branch Circuit Panelboards

a. Panelboards will be equipped with copper bussing and bolt-on molded case circuit breakers. Spare breaker and provisions for future breakers will be provided to accommodate future power needs.

b. Panelboards will be equipped with separate ground buses.

8. Receptacles

a. Convenience receptacles will be provided throughout the buildings. Each habitable room will have a minimum of one (1) receptacle on each wall of approximately ten (10) feet maximum on center.

b. Storage and utility rooms will have one (1) receptacle adjacent to the entry doorway.

c. Receptacles located in restrooms, adjacent to sinks, withing livestock processing areas and at building exteriors will be ground-fault circuit interrupting type for personnel safety.

d. Special purpose receptacles will be provided as required to serve specialized equipment as identified.

e. Convenience receptacles located at building exteriors will be provided with weatherproof, cast aluminum, in-use type, pad-lockable covers to prevent unauthorized usage of these receptacles.

9. Interior Lighting

a. Target footcandle levels will be as recommended by the IESNA Lighting Handbook.

b. General interior illumination will be provided by energy efficient LED luminaires.

c. Luminaires located within administrative spaces will be recessed direct/indirect type to achieve uniform lighting levels and minimize glare on computer screens and work surfaces.

d. Luminaires within cold storage or livestock processing areas will be fully gasketed, vaporproof type and rated for the ambient temperature within these areas.

e. Multi-level and/or zoned switching will be provided in large rooms and spaces for energy conservation and selectivity for task illumination.

f. Occupancy sensors will be provided in private offices, storage rooms, restrooms and other single occupant rooms to meet energy efficiency standards as required by the City Building Energy Conservation Code.

g. Occupancy sensors will **not** be provided at livestock processing areas. Operational and security concerns related to the possibility of nuisance shutoff of lights will outweigh the potential for energy savings associated with use of occupancy sensors.

h. An automatic shutoff lighting control system can be provided for the processing areas if a regular building operations schedule can be identified. The automatic shutoff system will function on a scheduled, time-of-day basis that turns lighting off at specific, programmed times. Override switches will be provided at selected locations along circulation pathways to allow for after-hours control of lights if needed.

i. Integral battery backup modules within selected luminaires will provide for emergency egress lighting. In addition, battery packs will be used in areas with critical operations where even momentary outages while the generator set is starting might create a hazardous situation.

j. Illuminated LED exit signs with integral battery packs will be provided for all emergency exits and exit passageways.

10. Fire Alarm System

a. A complete, addressable, electrically supervised, non-voice evacuation fire alarm system will be provided for the building.

b. The fire alarm system will include pull stations, visual notification appliances, horns, smoke detectors, elevator capture, fire sprinkler system connections, duct detector connections and interface with other building systems where required.

9 Equipment

See Appendix D for Equipment list.

10 Solar Photovoltaics

A utility-interactive photovoltaic (PV) system with roof-mounted photovoltaic panels will be provided for the facility. Solar PV system shall be installed in accordance with the International Building Code, NFPA 70 and requirements of the applicable electrical utility company.

Coordination with the utility company will be required to discuss the adequacy of utility company distribution system for interconnection with PV system. The utility company will determine requirements and restrictions for PV system interconnection when the PV system design is submitted to the utility company for review. The utility company may require an interconnection study to determine potential impacts to the utility company distribution system resulting from implementation of the facility PV system.

APPENDIX A

Design Criteria

C. Facility Design Criteria:

I. Concrete

A. Floor slabs for Harvest Areas #1 and #2, Inedible Materials Load-Out, Vestibule, Carcass Chill Coolers #1 and #2, Carcass Sales Cooler, Fabrication, Dry Storage, Finished Goods Cooler, Blast Freezer, Shipping/Receiving, Plant Services and the Livestock Building shall be minimum 8" thick, reinforced concrete, depending on final loading configuration and the recommendations contained within the geotechnical report, over a continuous vapor barrier. Provide 6" thick reinforced concrete over a continuous vapor barrier in all other areas. Expansion and construction joints shall include shear plates and be armored and sealed to resist spalling. The floors shall be sloped to drain in areas that contain floor drains and shall be topped with a dry shake hardener to a light broom finish. Floor slope shall be a minimum of 1/8"/FT and a maximum of ¼"/FT. Provide a special deep grooved floor texture where animals walk in the Livestock Building.

B. Floor slabs in the Blast Freezer shall be insulated. The underfloor insulation will be Dow freezer mate with R-Value as listed in the state energy code requirements for refrigerated spaces. See Division 7, Thermal and Moisture Protection.

C. All perimeter IMP walls in wash down, warehouse, process or packaging areas shall be protected by 6" thick x 24" tall concrete curbs with tops sloped down 4" from back to front and a smooth steel trowel finish. All curbs, whether for containment at wet areas or base protection of walls and partitions shall be doweled into the floor slab.

II. Miscellaneous Steel

A. Steel bollards and goal posts shall consist of 6-inch ϕ x 5' high interior and 8-inch ϕ x 8' high exterior, galvanized schedule 40 pipe, concrete filled with round end caps.

B. Dock pit edges shall be protected by steel angles anchored to the concrete slab with Nelson stud embeds per the dock leveler equipment manufacturers recommendations.

C. Exterior canopies shall be provided at plant entrance doors and at all dock doors.

D. All miscellaneous and structural steel located in areas subjected to wash down shall have a paint-grip galvanized finish.

III. THERMAL AND MOISTURE PROTECTION

A. Underfloor / Perimeter Insulation:

i. Two (2) layers of 3 1/2” thick Dow Freezer Mate extruded polystyrene underfloor insulation over a continuous 10-mil vapor barrier over a 3” thick mud slab over an underfloor electric or glycol heating system shall be included beneath the Blast Freezer wear slab.

ii. One (1) layer of 3 1/2” thick x 4’ wide horizontal underfloor insulation shall be included at the building exterior walls of refrigerated rooms and at the Blast Freezer door opening. Heat tracing will also be required at the Blast Freezer door opening (6W/ft in RGC).

See Refrigeration Contractor for underfloor heating requirements.

B. Floor slab joints shall be filled with a joint filler appropriate to the environmental conditions of the space such as multi-component, chemical curing, self-leveling polyurethane “THC-900” as manufactured by Tremco or approved equal.

C. Interior walls and ceilings enclosing all production and/or refrigerated areas are to be constructed of 4-inch or 6-inches thick pre-finished isocyanurate insulated metal wall panels with 26 gauge stucco-embossed galvanized metal surfaces and white, baked on Kynar finish on exposed faces as manufactured by Metl-Span Corporation or Kingspan, Inc. All panels to have class 1 flame spread classification, a maximum flame spread index of 75 and a smoke developed rating of less than 450. Refrigerated rooms +32 degrees F or above shall be a minimum of R-28. Rooms below +32 degrees F shall have a minimum R 36 walls and R-40 ceilings.

D. Insulated Wall Panel Sealants: All insulated wall panels shall have interior panel joints sealed on the warm side with a continuous bead of polyurethane-butyl sealant. All IMP joint and trim seams in wash-down rooms shall be sealed with a matching color silicone sealer.

E. Concrete Wall Sealants: The concrete wall panels shall have exterior vertical joints sealed with a caulking material that is suitable for an exterior environment such as multi-component, chemical curing, dynamic formulated polyurethane “Dymeric 511” as manufactured by Tremco or approved equal. Interior concrete vertical joints shall be sealed with one component elastomeric sealant as manufactured by Tremco or approved equal. All openings and penetrations through the exterior building envelope shall be sealed. Additional caulking/sealing shall be installed as required to complete the thermal envelope.

F. The roofing material shall be a standing seam insulated metal roof system by Metl Span, Kingspan or approved equal with R-Value as listed in the state energy code requirements.

IV. Doors and Windows

A. Interior/Exterior Doors:

i. Low Temperature Hinged, Sliding and Track Doors - Freezer and cooler personnel doors will be as manufactured by Jamison, Hercules, Weiland or approved equal. Doors shall be 4" thick minimum, foamed-in-place polyurethane foam core with facings of 26-gauge galvanized steel and factory applied white paint finish. Doors servicing rooms below freezing shall be provided with heated frames. Doors will be powered or manually operated as required. Exterior door latch to be spring activated with provision for padlocking. Manual emergency safety release devices shall be provided where required.

ii. All High-Speed Roll-up Doors shall have insulated curtains, thickness appropriate to temperature differential and shall be actuated by a floor loop or wall button. High-Speed Roll-up Doors in exit paths shall be provided with battery back-up for normally open position when required. Doors shall be Albany RR300 or approved equal.

iii. Chemical resistant fiberglass doors, 3'x7', with stainless steel frames shall be used at areas subject to wash-down as manufactured by Weiland Inc. or approved equal.

iv. Insulated bump doors shall be Durulite Industrial Traffic Doors with stainless steel tube frame as manufactured by Chase Doors or approved equal.

v. All doors except restroom and USDA office doors shall contain view lights for safety.

B. All truck dock door openings shall be MxV doors as manufactured by DL Manufacturing, 8' wide x 9' high x 2" thick urethane insulated, sectional, spring loaded overhead doors with heavy duty 3" track and weather-stripping.

C. Insulated Steel Roll-up Doors, a 3'-4" wide x 7'-0" high, manually operated door, shall be provided at the cattle entrance to Harvest Area #1 and a 2'-4" wide x 7'-0" high, manually operated door, shall be provided at the small stock entrance to Harvest Area #1.

D. All windows in cold environments shall be minimum duel glazed and have stainless steel, thermally broken, heated frames as manufactured by Anthony International or approved equal. Windows are to have heat tape tracing (connected to a 110 V circuit).

V. FINISHES

A. Office and employee welfare areas shall be provided with a suspended 2' x 2' x 5/8" acoustical lay-in ceiling in "T"-bar grid, rated for a temperature of 90° F and a humidity of 90% by Armstrong or approved equal. Provide washable tiles in employee welfare areas.

B. All toilet rooms shall have full height, 12"x12" ceramic or porcelain tile wall finish over ½" cement board.

C. All exposed columns in non-wash down, non-production areas shall be painted to 10 feet AFF with two coats of acrylic paint over shop primer, Sherwin-Williams or approved equal.

D. All exposed columns and exposed concrete wall surfaces in wash down areas shall be coated with a two-part epoxy sealer full height.

E. All floors in Harvest Areas #1 and #2, Inedible Materials Load-Out, Vestibule, Hygiene Locks and Fabrication shall have ¼" thick trowel-on urethane composite floor topping with integral coved base extending 6" up the face of curb/wall.

F. All floors in toilet rooms and employee locker rooms shall have 1/8" Dura-Quartz seamless epoxy with clear top-coat.

G. All office area floors shall be 12"x12" vinyl composition tile with 4" high vinyl cove base.

H. All floors in Carcass Chill Coolers #1 and #2, Carcass Sales Cooler, Finished Goods Cooler, Blast Freezer, Shipping/Receiving, Dock Office, Dry Storage, Plant Services, Electrical, Voice/Data, Maintenance, Laundry/Sanitation and the Livestock Building shall have a sealed concrete floor finish.

VI. SPECIALTIES

A. Toilet partitions and urinal screens shall be stainless steel.

B. Lockers shall be, 12” wide x 18” deep, double tier, solid UHMW plastic by Bradley Corporation or approved equal with recessed handle with padlocking capabilities, permanent numbering plates, sloped tops and anchoring devices for a freestanding application on a 4” high base. ADA compliant benches shall also be provided.

VII. Loading Dock Equipment

A. Horizontal, pit mounted, pneumatic dock levelers, Kelly model FX or approved equal, shall be provided at all truck dock doors, 6’ wide x 8’ deep, 50,000 lb, static capacity with a surface mounted vehicle restraint system, all operated by a master control panel that includes door operation, communicating lights and LED dock light. All equipment shall be of best quality by Kelly, Rite-Hite, Serco or Power-Ramp.

B. Dock seals with 22 oz. fabric shall be installed at all truck dock doors.

C. Dock bumpers shall be steel faced.

D. Automatic Trailer Restraints, Kelly model Star 4 or approved equal shall be installed at all truck dock doors.

VIII. Miscellaneous Equipment

A. All equipment, including processing equipment, overhead rail system, furniture, lockers, cubicles, appliances, vending machines, shelving, computers, and similar moveable equipment shall be as called for in the specifications and shall be furnished and installed by the General Contractor.

B. All pallet storage racking shown on the drawings shall be heavy duty structural, style with powder coated finish. Provide galvanized steel mesh shelving on all load beams.

APPENDIX B

Civil Drainage, Water, and Zoning

A. CIVIL – DRAINAGE

1. GENERAL DESCRIPTION

   This section describes the basis for the design for stormwater drainage for a livestock harvesting facility in an undetermined location. The purpose is to avoid flooding and sediment erosion from stormwater due to the increased impervious area. Stormwater will flow within the proposed facility and into multiple dry wells.

2. DESIGN REFERENCES

   a. Storm Drainage Standard, Department of Public Works, County of Hawaii, October 1970.

3. EXISTING CONDITIONS

   Because this project is a feasibility study for a statewide livestock harvesting facility, the location is undetermined. For the sake of design, the location is assumed to be in Paauilo, Hawaii County. The existing condition is also assumed as a relatively flat, grassed lot.

   The stormwater drainage area will focus on the area where the facility building, parking area, and driveways will be constructed.

   The volumetric flow is calculated by the Rational Method:

$$Q = CIA$$

   Where: Q = volumetric flow (cfs)
   C = Weighted Runoff Coefficient
   I = Rainfall Intensity for 10-year storm
   A = Drainage area (acres)

   Runoff coefficient is determined from Table 1 – Guide for the Determination of Runoff Coefficients for Built-up Areas

Table 1

GUIDE FOR THE DETERMINATION OF RUNOFF COEFFICIENTS FOR BUILT-UP AREAS*

WATERSHED CHARACTERISTICS	EXTREME	HIGH	MODERATE	LOW
INFILTRATION	NEGLIGIBLE 0.20	SLOW 0.14	MEDIUM 0.07	HIGH 0.0
RELIEF	STEEP (> 25%) 0.08	HILLY (15 - 25%) 0.06	ROLLING (5 - 15%) 0.03	FLAT (0-5%) 0.0
VEGETAL COVER	NONE 0.07	POOR (< 10%) 0.05	GOOD (10 - 50%) 0.03	HIGH (50 - 90%) 0.0
DEVELOPMENT TYPE	INDUSTRIAL & BUSINESS 0.55	HOTEL-APARTMENT 0.45	RESIDENTIAL 0.40	AGRICULTURAL 0.15

*NOTE: *The design coefficient "c" must result from a total of the values for all four watershed characteristics of the site.*

Exhibit 1: Existing Condition Runoff Coefficient

Therefore:
C = 0.07 + 0.0 + 0.0 + 0.15 = **0.22**

Rainfall intensity for 10-year storm is determined by Plate 1.

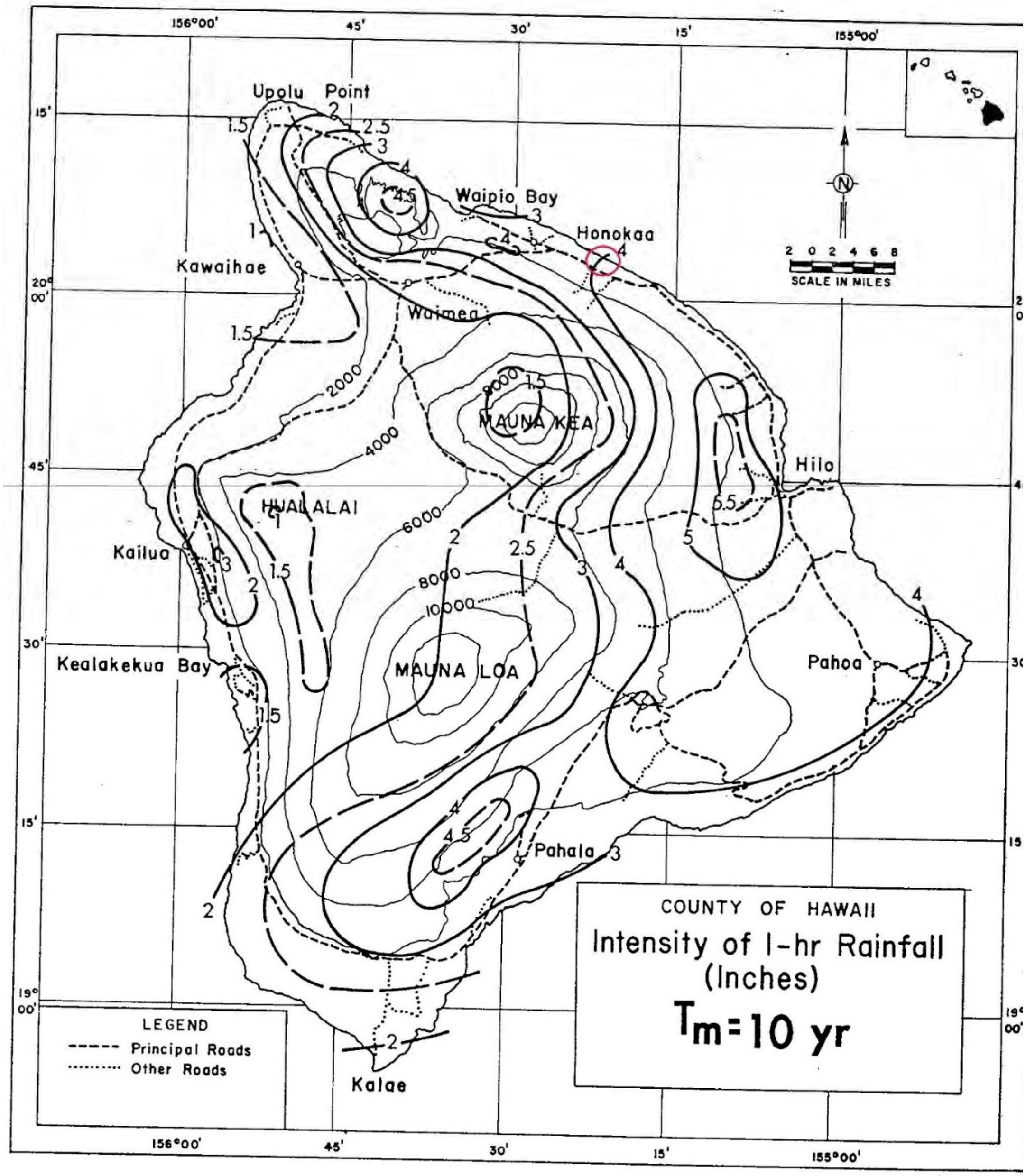


Plate 1

Exhibit 2: Rainfall Intensity for 10-year Storm

The 10-year storm rainfall intensity, I_{10}, is determined as 4 in/hr.

In finding the time of concentration, this design assumes that the existing condition is a grassed surface with 2% slope in a 4.96-acre area. The path of travel is 380 feet.

From this information and from Plate 3, time of concentration is determined. Plate 4 defines the rainfall intensity for indicated durations.

Plate 3

Overland Flow Chart

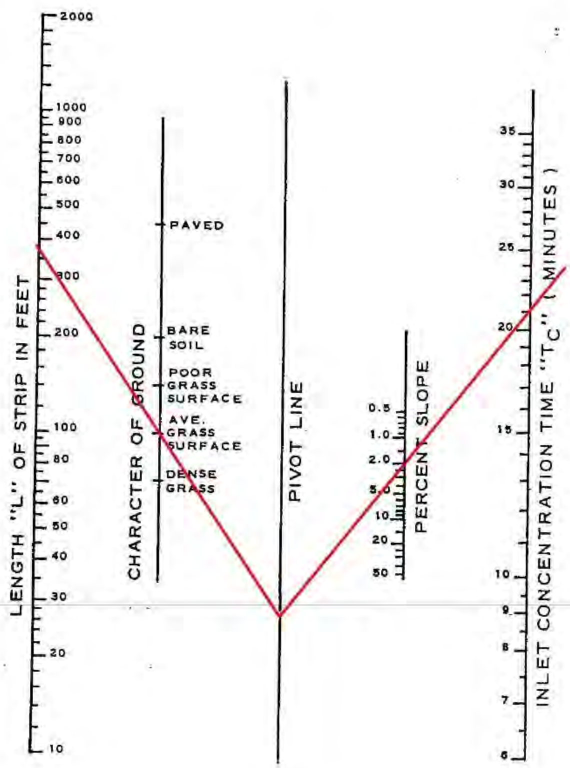


Plate 4

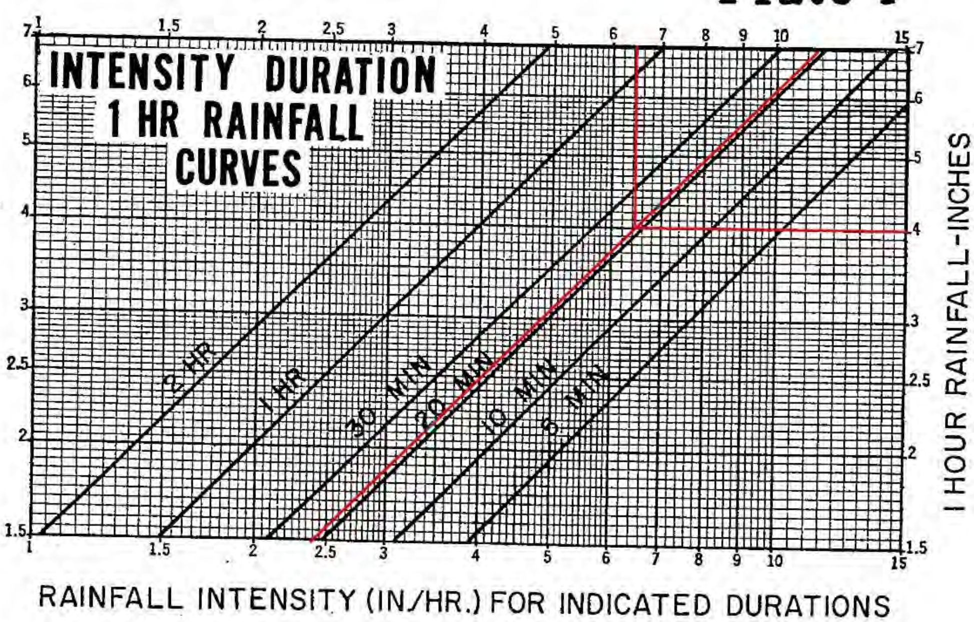


Exhibit 3: Time of Concentration and Corresponding Rainfall Intensity for Existing Condition

Time of concentration, T_m, is 21 minutes, and rainfall intensity, I, is 6.41 in/hr.

Therefore, the runoff quantity, Q, for existing conditions is:

$$Q = CIA$$

C = 0.22
I = 6.41 in/hr
A = 4.96 acres

Q = 0.22 x 6.41 x 4.96 = **6.99 cfs**

4. PROPOSED CONDITION

The proposed condition will follow closely with the existing condition.

Runoff coefficient is determined from Table 1 – Guide for the Determination of Runoff Coefficients for Built-up Areas

Table 1

GUIDE FOR THE DETERMINATION OF RUNOFF COEFFICIENTS FOR BUILT-UP AREAS*

WATERSHED CHARACTERISTICS	EXTREME	HIGH	MODERATE	LOW
INFILTRATION	NEGLIGIBLE 0.20	SLOW 0.14	MEDIUM 0.07	HIGH 0.0
RELIEF	STEEP (> 25%) 0.08	HILLY (15 - 25%) 0.06	ROLLING (5 - 15%) 0.03	FLAT (0-5%) 0.0
VEGETAL COVER	NONE 0.07	POOR (< 10%) 0.05	GOOD (10 - 50%) 0.03	HIGH (50 - 90%) 0.0
DEVELOPMENT TYPE	INDUSTRIAL & BUSINESS 0.55	HOTEL - APARTMENT 0.45	RESIDENTIAL 0.40	AGRICULTURAL 0.15

**NOTE: The design coefficient "c" must result from a total of the values for all four watershed characteristics of the site.*

Exhibit 4: Proposed Condition Runoff Coefficient

Therefore:
C = 0.20 + 0.0 + 0.05 + 0.55 = **0.80**

Rainfall intensity for 10-year storm is the same as the existing condition:
I_{10} = 4 in/hr

In finding the time of concentration, this design assumes the proposed condition with a 2% slope in a 4.96-acre area. The path of travel is 380 feet.

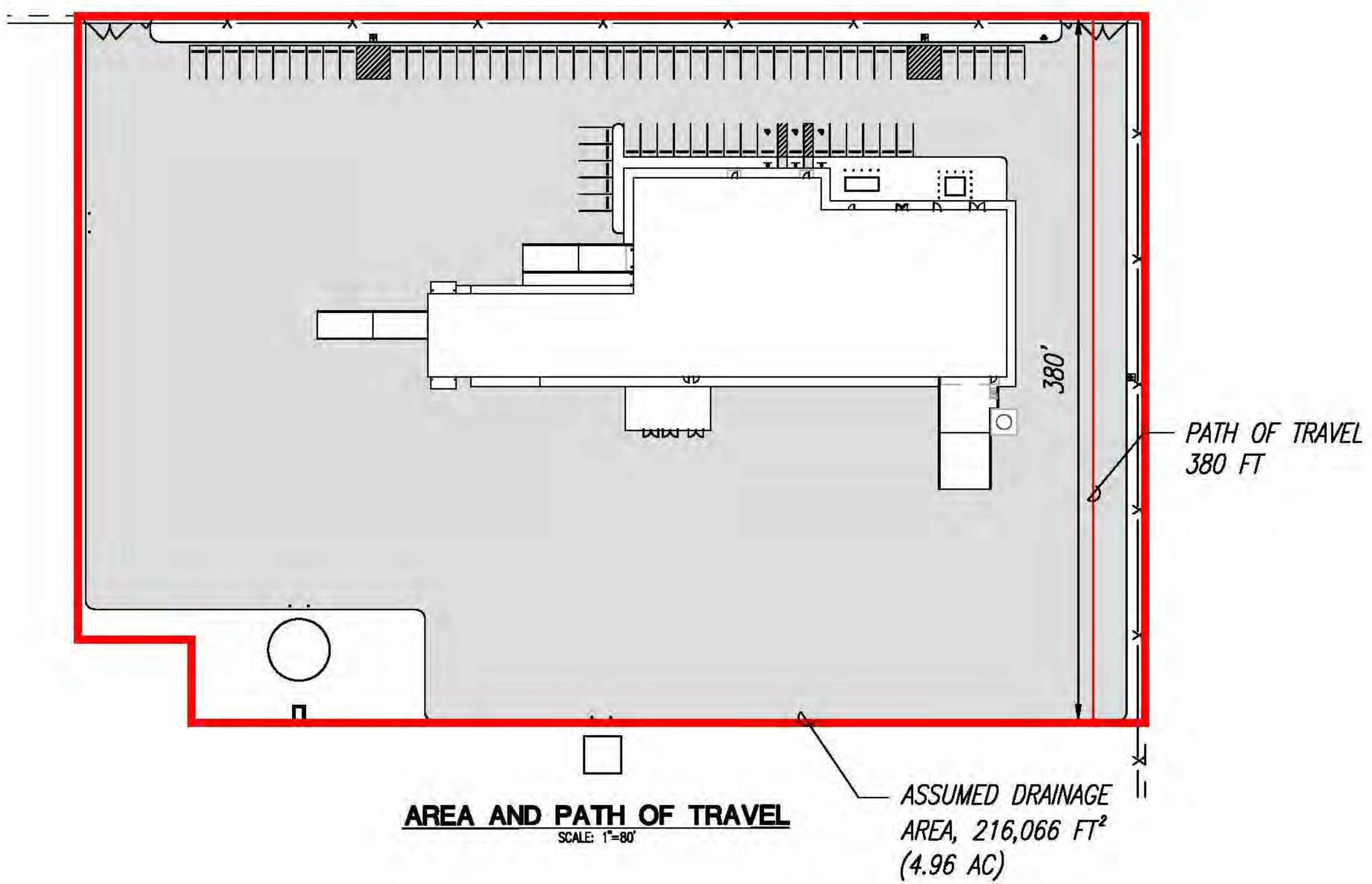
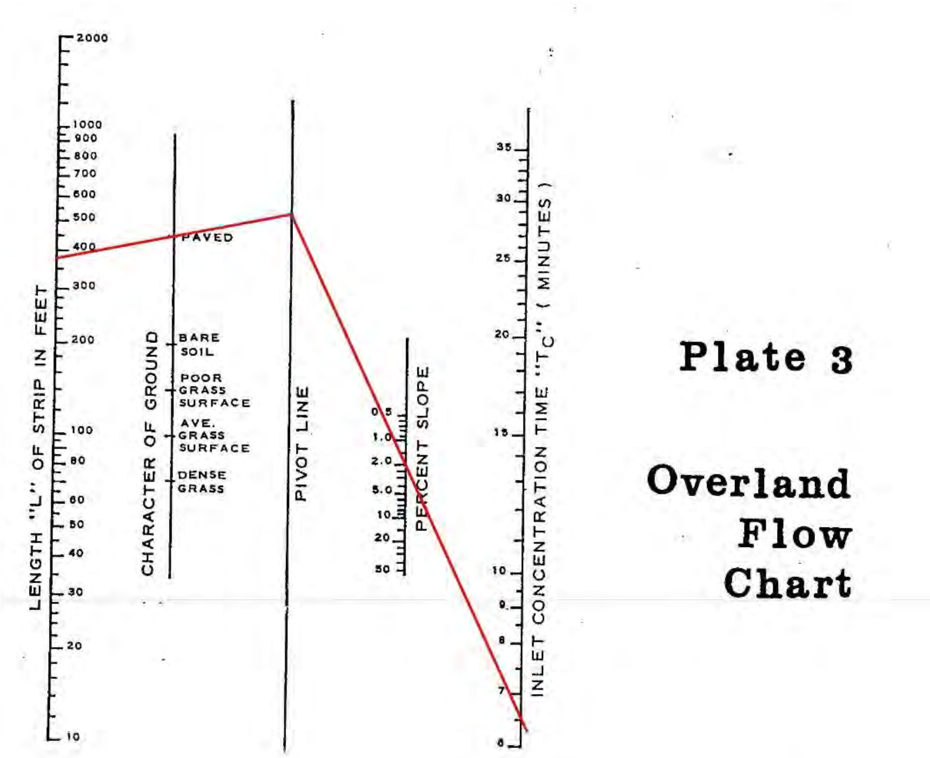


Exhibit 5: Proposed Condition Drainage Area and Path of Travel

From this information and from Plate 3, time of concentration is determined. Plate 4 defines the rainfall intensity for indicated durations.



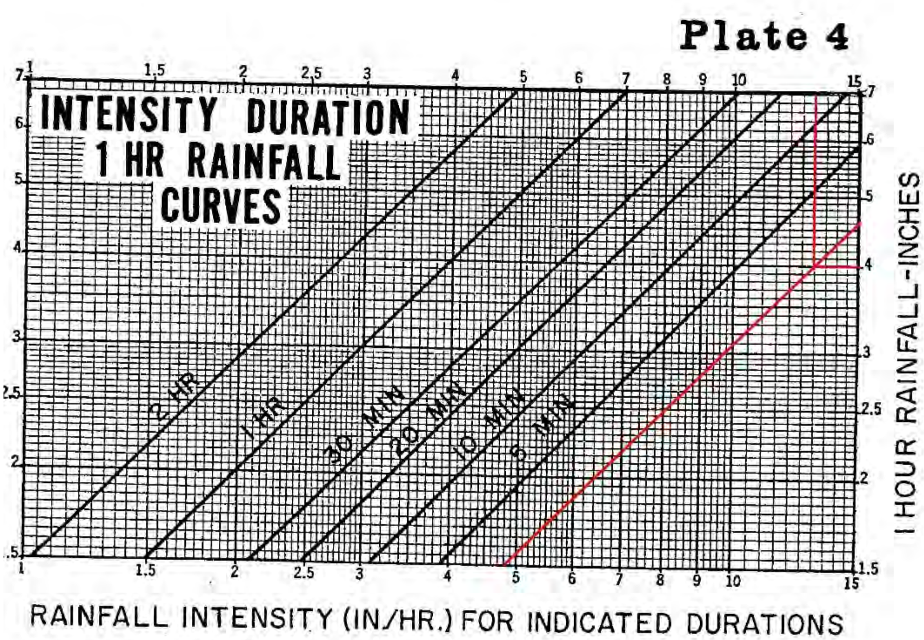


Exhibit 6: Time of Concentration and Corresponding Rainfall Intensity for Proposed Condition

Time of concentration, T_m, is 6.5 minutes, and rainfall intensity, I, is 13 in/hr.

Therefore, the runoff quantity, Q, for existing conditions is:

$$Q = CIA$$

C = 0.80
I = 13 in/hr
A = 4.96 acres

Q = 0.80 x 13 x 4.96 = **51.58 cfs**

The difference in runoff quantity between existing condition and proposed condition is **44.59 cfs**.

The maximum drywell capacity recommended by the Department of Public Works, County of Hawaii is 6 cfs; therefore, 8 dry wells are needed for this site.

When the location is decided, storm water quality and storm drainage system must follow site specific protocols in accordance to required standards. Geotechnical investigations are required especially when determining sizing and feasibility for retention BMP's.

B. CIVIL – SEWER

1. GENERAL DESCRIPTION

   This section describes the basis for the design for sewer in the livestock harvesting facility. There are two separate sewer systems: one for livestock facility wastewater and one as domestic wastewater. The wastewater from livestock harvesting facilities is more concentrated and produces greater amount than typical domestic wastewater, therefore further treatment is required before any form of disposal.

2. DESIGN REFERENCES

   a. City and County of Honolulu Department of Environmental Services Division of Environmental Quality, Policy for Industrial Wastewater Discharge Permit Grease Interceptor Project Review, September 2019.

   b. Department of Environmental Services, Wastewater Design Standard, City and County of Honolulu, Chapter 2, Design of Gravity Sewers.

   c. Manual of Septic-Tank Practice, U.S. Department of Health, Education and Welfare, Public Health Service Publication No. 526.

   d. State of Hawaii Department of Health Regulations, Hawaii Administrative Rules, Title 11, Chapter 62 – Wastewater Systems.

   e. Uniform Plumbing Code 2000 Edition, International Association of Plumbing and Mechanical Officials.

f. United States Department of Agriculture, Natural Resources Conservation Service, Web Soil Survey, https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm

g. US Environmental Protection Agency, Decentralized Systems Technology Fact Sheet, EPA 832-F-00-079, September 2000.

h. United States EPA, Decentralized Systems Technology Fact Sheet, EPA 832-F-00-079, September 2000.

i. Wastewater Engineering: Treatment and Reuse, Metcalf & Eddy, Inc., 2002.

j. Wastewater Engineering Treatment and Resource Recovery, Metcalf & Eddy, AECOM, Fifth edition.

k. Xerex by Shawcor, Water and Wastewater Fiberglass Underground Storage Tanks Brochure.

3. DOMESTIC WASTEWATER

Domestic wastewater includes laundry, shower, water closet, urinal, lavatories, sink, emergency eye wash station, and drinking fountain.

Table 1 represents the estimated water supply fixtures, numbers of fixtures, and water supply fixture units (WSFU) taken from the livestock facility design.

	Public	Unit No.	Total
Laundry	1.5	1	1.5
Shower	2	2	4
Water Closet, 1.6 GPF Flushometer Tank	2.5	5	12.5
Urinal, flush tank	2	1	2
Lavatories	1	6	6
Sink, Washup	2	2	4
Emergency Eye Wash*	1	1	1
Drinking Fountain	0.5	2	1
		Total	32

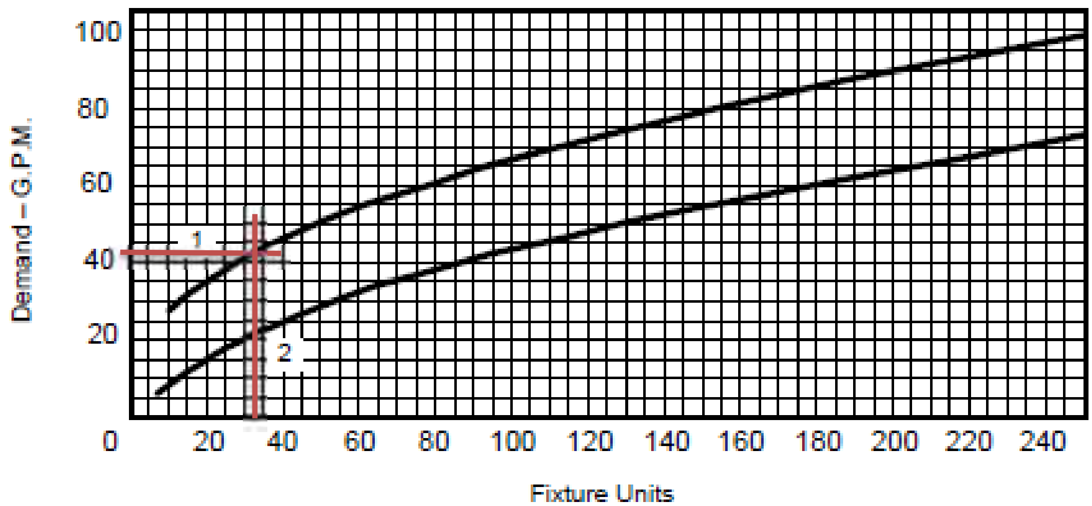
* For this calculation, Emergency Eye Wash is assumed the same as Lavatory.

Table 1: Domestic Water Supply Fixture Units

Scale Demand Load chart is used to determine required water demand for 32 WSFU.

CHART A-3

Enlarged Scale Demand Load



No. 1 is for predominantly flushometer valve systems
No. 2 is for predominately flush tank systems
Exhibit 7: Water demand in accordance to Water Supply Fixture Units

From Chart A-3, the domestic water demand is estimated to be **42 gpm**.

From HAR 11-62, Table I, factories generate 35 gallons of wastewater per person, per shift. This quantity excludes industrial waste. A self-service laundry per machine generates 300 gallons a day.

The livestock harvesting facility is designed for 70 workers per shift and 2 shifts per day.

According to Wastewater Engineering: Treatment and Reuse, from Table 3-3 "Typical Wastewater flowrates from commercial sources in United States", public lavatory generates 3 gallons per user per day. For this facility, 50 visitors per day is assumed. Visitors may include, but not limited to, truck drivers and customers for retail utilizing the restrooms.

This approximately estimates domestic wastewater as:

70 people/shift x 2 shifts/day x 35 gal/person = 4,900 gpd
1 laundry machine = 300 gpd
50 visitors/day x 3 gal/visitor = 150 gpd
Total average daily flow = 4,900 gpd + 300 gpd + 150 gpd = **5,350 gpd**

a. Pipe Size

According to City and County of Honolulu (CCH) Wastewater Design Standards, the minimum pipe size diameter is 8 inches; and the minimum slope is 0.0052 ft/ft. The minimum velocity at full flow is 2.5 ft/s, and the maximum velocity is

10 ft/s.

Peak flowrate, Q, is converted from 42 gpm to 0.09 cfs.

For 8-inch diameter pipe, the full capacity flow is calculated as

$$Q = VA$$

Where: Q = Flowrate (cfs)
V = Velocity of flow (ft/s)
A = Cross-sectional flow area (ft^2)

Cross-sectional flow area for full flow is determined as:

$$A = \frac{d^2}{4}\pi$$

Where: A = Cross-sectional flow area (ft^2)
d = diameter of pipe (ft) = 8 in = 0.6667 ft

Therefore:

$$A = \frac{(0.6667)^2}{4}\pi$$

$= 0.3491\ ft^2$

Minimum velocity at full flow is 2.5 ft/s, therefore:

Q = (0.3491) x (2.5)
= 0.8727 cfs at full capacity

The percentage of peak flow occupying 8-inch pipe is:

$$\frac{0.09\ cfs}{0.8727\ cfs} \times 100\% = 10.31\%$$

The accepted pipe materials from CCH are VCP, PVC, and FPVC.

b. Domestic Wastewater Treatment System

Because the location of this facility is unknown, two options for domestic wastewater are considered: 1) connecting to a nearby sewer line after consulting the corresponding municipal wastewater treatment plant; and 2) onsite disposal.

If connecting to municipal wastewater system, further treatment is not required.

For onsite wastewater disposal, the wastewater must go through further treatment. A septic tank will first treat the domestic wastewater. The treated wastewater will then be disposed of in a leach field. However, further investigation, site specific information, and standard requirements will dictate the feasible and best wastewater treatment and disposal.

i. Septic Tank

As determined in previous section, average daily flow is 5,350 gpd and peak flow is 42 gpm.

The sizing requirement is determined from HAR 11-62-31.1:

For wastewater flow greater than 1,000 gpd

Minimum capacity gallons = 1,000 + (Q-800) x 1.25

Where: Q = Average Daily Flow in gpd = 5,350 gpd

Therefore, the required minimum tank volume is:

1,000 + (5,350 – 800) x 1.25 = 6,688 gallons

From a manufacturer, Jensen Precast, a 7 feet 8 inch wide, 33 feet 2 inch long, and 7 feet 10 inches tall septic tank which holds 8,000 gallon is available. The detail for this model is in Appendix A.

ii. Leach Field

For the sake of the design, as mentioned in earlier sections, the proposed facility is in Paauilo (Hawaii County). According to USDA Web Soil Survey (see Appendix B), the site consists of Ookala medial silty clay loam. Silty clay loam has an application rate of 0.2 gpd/ft^2 according "Table 1: suggested Rates of Wastewater Application" from "EPA Decentralized Systems Technology Fact Sheet".

Therefore:

$$\text{Area for leach field} = \frac{5{,}350\ gpd}{0.2\ gpd/sf}$$
$$= 26{,}750\ ft^2$$
$$= 0.614\ \text{acre}$$

This is also within an assumption that the topography of the site is relatively flat. According to EPA Onsite Wastewater Treatment and Disposal Systems, leach field trenches may be up to 100 ft long, 1 to 3 ft width, and separated by 6 ft or more. Slope must be 1/8" per foot or less. Depth of leach field is typically 2 to 5 ft.

The HAR 11-23 requires primary component and a separate 100% back-up disposal component. Thus, twice as much area is necessary for leach field creating a required 53,500 ft^2. For this plan, a leach field is designed with 200 ft width and 300 ft length, creating an area of 60,000 ft^2.

4. LIVESTOCK HARVESTING WASTEWATER

From RWS Design Services, the facility is designed for processing 70 cattle head per day. Including evisceration process, 600 gallons of wastewater is projected per cattle head which generates 42,000 gallons of wastewater per day. Per EKNA, the facility will operate 4 days per week.

From EKNA, Table 2 shows the content of wastewater from the facility:

	Raw Wastewater mg/L	Wastewater After Screening mg/L
BOD	4,440	2,420
COD	6,478	3,563
TSS	4,033	1,008
Total Nitrogen	330	182
Total Phosphorus	61	34
Oil and Grease	1,711	428

Table 2: Estimated Livestock Harvesting Wastewater Composition

a. Pipe Size

The average flowrate is 42,000 gpd (0.06 cfs) on a working day. However, the peak pump flowrate is unknown.

Hence, 150 gpm of wastewater is assumed as a maximum pump flowrate from livestock harvesting facility. 150 gpm is converted as 0.33 cfs.

From CCH Wastewater Design Standards, the minimum pipe size diameter is 8 inches; and the minimum slope is 0.0052 ft/ft. As calculated in Section 3.a., the flowrate at full capacity in 8-inch pipe is 0.8727 cfs.

The percentage of average flowrate on a working day occupying 8-inch pipe is:

$$\frac{0.33\ cfs}{0.8727\ cfs} \times 100\% = 37.81\%$$

The accepted pipe materials from CCH are VCP, PVC, and FPVC.

b. Wastewater Treatment for Disposal Through Municipal Sewer

If an existing municipal sewer is available within a reasonable range, livestock harvesting wastewater can be disposed by connecting into the existing municipal sewer. However, consultation is required since respective municipal sewer line and treatment plants may not accept additional disposal. In addition, each county will have specific requirements on the composition of wastewater before entering the municipal sewer. Maui County will not allow any livestock harvesting wastewater into the municipal sewer system.

Because the livestock harvesting wastewater is approximately 10 times more concentrated than the domestic wastewater, livestock harvesting wastewater must undergo series of treatment before disposing into municipal sewer. The suggested method includes grease interceptor and aerated lagoon system. However, this method may not be feasible due to factors including but not limited to space availability and site-specific standard requirements.

i. Grease Interceptor

In accordance with City and County of Honolulu, Policy for Industrial Wastewater Discharge Permit Grease Interceptor Project Review, drainage fixture units (DFU) must be determined before calculating the required grease interceptor size. For this facility, DFU is calculated as shown on Table 3.

Fixture	Hard Connected	Number of Units	DFU Subtotal
Floor Drain (trap size 4”)	35	8	280
Commercial sink with food waste	22	3	66
		Total DFU’s	346

Table 3: Drainage Fixture Unit for Grease Interceptor

Maximum flow rate is determined by multiplying 0.7 to the total DFU’s.

$$346 \times 0.7 = 242.2 \text{ gpm}$$

The minimum required grease interceptor is determined as follows:

$$V = F \times R \times S$$

Where: V = minimum grease interceptor operating volume (gallons)
F = maximum flowrate (gpm), 242.2 gpm
R = retention time (min), 30 minutes
S = storage factor, 25%

Therefore:

$$V = 242.2 \times 30 \times 1.25$$
$$= 9{,}075 \text{ gallons}$$

A 10,000-gallon battery grease interceptor is available by Jensen Precast. See Appendix C for plan of this product.

ii. Aerated Lagoon

Aerated lagoon sizing is based on manufacturer’s calculations. The assumed parameters include design flow rate of 30,000 gpd, influent BOD of 1,350 mg/l, and influent TSS of 1,320 mg/l. The target effluent is BOD of less than 30 mg/l and TSS of less than 30 mg/l. See Appendix D for the aerated lagoon proposal and plan from Nexom.

The aerated lagoon consists of cell #1 and cell #2. Cell #1 has 40 feet by 40 feet bottom area. Cell #2 has 40 feet by 70 feet bottom area. Both cells have a total of 14 feet depth (3 feet of freeboard inclusive) with 3 to 1 side slopes.

Because the site location is unknown, sizing does not consider storm water mitigation.

c. Wastewater Treatment for On-site Disposal

If disposal through municipal sewer is infeasible, wastewater generated from livestock harvesting must be eliminated within the facility. The influent must undergo a more intensive treatment than with disposal through municipal sewer.

After the rotary screening in the livestock harvesting facility, the wastewater will collect in the transfer pump station and conveyed through the dissolved air flotation system (DAF), treated further within aerated lagoon, enter constructed wetland, and then finally disposed within leach field.

Further investigation is required for (but not limited to) site specific standards, soil conditions, weather conditions, allowable space, topography, and whether the site is within the underground injection control (UIC) and/or Board of Water Supply's (BWS) no-pass zone.

i. Transfer Pump Station

The transfer pump station delivers wastewater from the livestock facility to the DAF system. Flow to the DAF will be intermittent but at steady flow rate.

ii. Dissolved Air Flotation (DAF) System

Consult with manufacturer on DAF system is based on manufacturer's specification. DAF systems removes up to 95% of suspended solids and fat, oil, and grease (FOG).

See Appendix E for DAF plan provided by World Water Works.

iii. Aerated Lagoon

As mentioned in Section B.4.b.ii., aerated lagoon sizing is based on manufacturer's calculations. The parameters and sizing are the same as on-site disposal method. See Appendix D for the aerated lagoon proposal and plan.

iv. Constructed Wetland

Constructed wetland is designed by a different consulting engineer. Parameters are followed in accordance with the consulting engineer's instructions.

v. Leach Field

As mentioned in Section B.3.b.ii, the proposed facility is in Paauilo (Hawaii County), and the site consists of Ookala medial silty clay loam (see Appendix B). Silty clay loam has an application rate of 0.2 gpd/ft^2 according "Table 1: suggested Rates of Wastewater Application" from "EPA Decentralized Systems Technology Fact Sheet".

Therefore:

$$\text{Area for leach field} = \frac{24{,}000\ gpd}{0.2\ gpd/sf}$$
$$= 120{,}000\ ft^2$$
$$= 2.755\ acre$$

This is also within an assumption that the topography of the site is relatively flat. According to EPA Onsite Wastewater Treatment and Disposal Systems, leach field trenches may be up to 100 ft long, 1 to 3 ft width, and separated by 6 ft or more. Slope must be 1/8" per foot or less. Depth of leach field is typically 2 to 5 ft.

The HAR 11-23 requires primary component and a separate 100% back-up disposal component. Thus, twice as much area is necessary for leach field. For this plan, a 2 separate leach field is designed with 300 ft width and 400 ft length, creating an area of 120,000 ft^2 per leach field. The total leach field area with 100% back up is 240,000 ft^2.

C. <u>CIVIL – WATER</u>

1. GENERAL DESCRIPTION

The water system design will include lateral pipe sizing required to feed into the livestock harvesting facility.

Potable water for domestic use and industrial use is separated within the building.

2. DESIGN REFERENCES

a. Water System Standards, State of Hawaii, 2002

3. POTABLE WATER

As determined in Section B.3. based on the fixture units, domestic potable water requires peak flow of 42 gpm.

From Water System Standards, fire flow requirements are found by following exhibit:

Table 100-19 - FIRE FLOW REQUIREMENTS				
LAND USE	FLOW (GPM)/DURATION (HRS)/FIRE HYDRANT SPACING (FT.)			
	HAWAII	KAUAI	MAUI	OAHU
Agriculture	500/0.5/600 (1)	250/1/500	500/2/500	1000/0.5/700
Rural			1000/2/500	
Single Family	(2)	(4)	1000/2/350	1000/1/350
Duplex	1500/1/300	(4)	1250/2/350	1000/1/350
PUD Townhouse and Low Rise Apartments	1500/1/300	(4)	(5)	1500/1/250
Schools, Neighborhood Businesses, Small Shopping Centers, Hotels (except Maui), and High Rise Apartments	2000/2/300	2000/2/350	2000/2/250	2000/2/250
Light Industry, Downtown Business, Large Shopping Center, and Hospitals	2,000/2/300	3000/3/350	2000/2/250	4000/3/250
Heavy Industry, Hotels	2,000/2/300	3000/3/350	2,500/2/ 250	(3)

(1) - Applies to one acre lot size or less
(2) - 10,000 sq. ft. or larger lot size = 500/2/600; Less than 10,000 sq. ft. lot size = 1000/1/600
(3) - Subject to special review and control by Manager
(4) - R-2 = 500/1/500 R-4 = 750/2/500 R-6 = 1000/2/500 R-10 = 1250/2/350
R-20 = 1500/2/350 RR-10 = 1500/2/350 RR-20 = 2000/2/350
(5) - A-1 = 1500/2/250 A-2 = 2000/2/250

Note:
1. On dead end streets, the last F.H. shall be located at one half the spacing distance for F.H.s from the last house/unit (frontage property line or to the driveway/access for the property).
2. Spacing of fire hydrant shall be measured along the roadway.

Exhibit 8: Fire Flow Requirements

Assuming the location as Hawaii, fire hydrants must be spaced for 300 feet with 2,000 gpm.

Currently, fixture units within the livestock harvesting processing plant are unknown, hence the peak design flow cannot be determined. Because the site location is undisclosed, pressure head in the site required to determine piping size is also unknown. When the location of this facility is established, the consulting engineer must verify and calculate the required potable water sizing appropriate for necessary pressure and quantity of potable for the site.

From discussion with mechanical engineer, 8-inch diameter pipe is utilized in the plan. This will need verification or amendment from consulting engineer.

D. CIVIL – ZONING

1. GENERAL DESCRIPTION

Livestock harvesting plant is allowed on certain land zones. The type of identification and requirements differ from each county.

2. DESIGN REFERENCE

   a. 2010 ADA Standards for Accessible Design, Department of Justice, 2010.

   b. Unofficial Online Version, Hawai’i County Code, Chapter 25 Zoning, 1983 (2016 Edition, as Amended)

   c. Kaua’i County Code, Title IV County Planning and Land Development

   d. Maui County Code, Title 19 Zoning, 2021

   e. Revised Ordinances of Honolulu, Chapter 21 Land Use Ordinance, City and County of Honolulu, 1990.

3. CITY AND COUNTY OF HONOLULU

   According to Land Use Ordinance, animal product processing is permitted in districts I-2 and I-3. Within those areas, minor and major composting is allowed in zone I-2. Food manufacturing and processing are permitted in zone I-1, I-2, I-3, and IMX-1. Therefore, I-2 zoning district is considered if the proposed facility is within City and County of Honolulu.

   I-2 zoning district is classified as intensive industrial. The following are setback requirements in I-2 zoning districts:

   a. Where a zoning lot adjoins a zoning lot in a residential, apartment, apartment mixed use or resort district, the residential, apartment, apartment mixed use or resort district height setbacks shall be applicable at the buildable area boundary line on the side of the industrial zoning lot.

   b. On zoning lots adjacent to a street, no portion of a structure shall exceed a height equal to twice the distance from the structure to the vertical projection of the center line of the street.

   c. Other setback requirements are shown in Exhibit 9.

<table>
<tr><th colspan="2" rowspan="2">Development Standard</th><th colspan="4">District</th></tr>
<tr><th>I-1</th><th>I-2</th><th>I-3</th><th>IMX-1</th></tr>
<tr><td colspan="2">Minimum lot area (square feet)</td><td>7,500</td><td>7,500</td><td>7,500</td><td>5,000</td></tr>
<tr><td colspan="2">Minimum lot width and depth (feet)</td><td>60</td><td>60</td><td>60</td><td>50</td></tr>
<tr><td rowspan="2">Yards (feet):</td><td>Front[1]</td><td>10</td><td>5</td><td>0</td><td>5</td></tr>
<tr><td>Side and rear</td><td>0[2]</td><td>0[2]</td><td>0[2]</td><td>0[3]</td></tr>
<tr><td colspan="2">Maximum building area (percent of zoning lot)</td><td colspan="4">80

However, the building area may be increased to include all of the buildable area of the zoning lot provided all structures beyond the designated 80 percent building area shall:

a. Provide a minimum clear interior height of 18 feet;

b. Contain no interior walls, except for those between a permitted use and a special accessory office; and

c. Provide a minimum distance of 40 feet between interior columns and other structural features</td></tr>
<tr><td colspan="2">Maximum density (FAR)</td><td>1.0</td><td>2.5</td><td>2.5</td><td>1.5 - 2.5
see Sec. 21-3.140-1(c)</td></tr>
<tr><td colspan="2">Maximum height (feet)</td><td>40</td><td colspan="3">per zoning map</td></tr>
<tr><td colspan="2">Height setbacks</td><td colspan="3">per Sec. 21-3.130-1(c)</td><td>per Sec. 21-3.140-1(c)</td></tr>
</table>

[1]Except for necessary access drives and walkways, all front yards shall be landscaped. Where a zoning lot adjoins a residential, apartment, apartment mixed use or resort district and forms a continuous front yard, the lot or the first 100 feet of the lot (whichever is less) shall conform to the front yard requirements for the dwelling use of the adjoining district (see Figure 21-3.6).
[2]Where the side or rear property line of a zoning lot adjoins the side or rear yard of a zoning lot in a residential, apartment, apartment mixed use or resort district, there shall be a side or rear yard which conforms to the side or rear yard requirements for dwelling use of the adjoining district. In the I-3 district only, this yard shall be not less than 15 feet. In addition, see Section 21-4.70-1 for landscaping and buffering requirements.
[3]Where the side or rear property line of a zoning lot adjoins the side or rear yard of a zoning lot in a residential, apartment, apartment mixed use or resort district, there shall be a side or rear yard which conforms to the side or rear yard requirements for dwelling use of the adjoining district.
(Added by Ord. 99-12; Am. Ord. 03-37)

Exhibit 9: City and County of Honolulu Industrial Use Districts Development Standards

d. Any use located in the I-2 district shall be screened from any adjacent zoning lot in a residential, apartment, apartment mixed use, or resort district by a solid wall size feet in height erected and maintained along side and rear property lines. Such walls shall not project beyond the rear line of an adjacent front yard in the residential, apartment, apartment mixed use, or resort district. In addition, a five-foot-wide landscaping strip shall be provided along the outside of the solid wall.

e. Parking Facilities

Parking lots of five or more spaces shall provide a minimum 5-foot landscape strip adjacent to any adjoining street right-of-way. This 5-foot strip shall contain a continuous screening hedge not less than 36 inches in height with plantings no more than 18 inches on center. If the landscape strip is wider than 5 feet, the hedge may be placed elsewhere in the strip. A minimum 36-inch-high wall or fence may be placed behind the setback line in lieu of a hedge. If a wall or solid fence is erected, either a vine or shrub shall be planted at the base of the wall or solid fence on the side fronting the property line. One canopy form tree a minimum of two-inch caliper shall be planted in the landscape strip for each 50 feet or major fraction of adjacent lineal street frontage.

To provide shade in open parking lots and minimize visibility of paved surfaces, parking lots with more than 10 parking stalls shall provide one canopy form tree a minimum of two-inch caliper for every six parking stalls or major fraction thereof. Each tree shall in a planting area and/or tree well no less than nine square feet in area. If wheel stops are provided, continuous planting areas with low ground cover, and tree wells with trees centered at the corner of parking stalls may be located within the three-foot overhang space of parking stalls. Hedges and other landscape elements, including planter boxes over six inches in height, are not permitted within the overhang space of the parking stalls. Trees shall be sited to evenly distribute shade throughout the parking lot.

For industrial use land (which includes food manufacturing and processing; freight movers; heavy equipment sales and rentals; linen suppliers; manufacturing, processing, and packaging (light or general); maritime-related sales, construction, maintenance and repairing; motion picture and television studios; petroleum processing; port facilities; publishing plants for newspapers, books and magazines; salvage, scrap and junk storage and processing; storage yards; warehousing; waste disposal and processing; and wholesale and retail establishments dealing primarily in bulk materials delivered by or to ship, or by ship and truck in combinations), 1 parking stall per 1,500 square feet is required.

Since the livestock harvesting facility has 24,883 square feet of floor area:

$$24{,}883 / 1{,}500 = 16.59 \text{ stalls}$$

Hence, 17 parking stalls are required in this facility. Minimum dimensions for standard-sized automobile parking spaces shall be at least 18 feet in length and 8 feet 3 inches in width.

According to ADA standards, at least one parking stall must be an accessible parking space for 17 parking stalls provided in the parking facility. Within the accessible parking space, 1 of every 6 accessible stall must be van accessible. Therefore, 1 van-accessible parking stall is required.

4. KAUA'I COUNTY

The district allowed in Kaua'i County for livestock harvesting facility is assumed as IG, general industrial. By the code, general industrial includes all business, industrial processing, or storage uses that are generally considered offensive to the sense or pose some potential threat or hazard to health, safety, and welfare. This District shall not be located adjacent to Residential or Resort Districts unless there is physical or geographical protection from those characteristics of the uses considered to be offensive or hazardous.

The following are requirements within the IG zoning district:

a. The minimum lot area in General Industrial District shall be 10,000 square feet.

b. Minimum distance of any building from the right-of-way of a public or private streets is 15 feet. Minimum distance of any building from a side property line when the adjacent Use District is industrial is zero. When the adjacent Use District is other than industrial, the minimum distance to the side property line is 15 feet. Minimum distance of any building to a rear property line is 15 feet.

c. The minimum driveway width in Industrial Districts is 20 feet if there is two-way traffic and 14 feet if there is one-way traffic. No parking lot pavement edge located closer than 5 feet from the right-of-way line of a public street. Park vehicles must not protrude into the setback. All parking lots must be screened from public throughfares by a fence, wall, or plant screen not less than 4 feet high, provided that the screening height is lowered to the standard as required under the County Traffic Code or to the standards of the Department of Public Works, at street corners, driveway intersections, and other locations. The setback area between the parking area paving and the public right-of-way must be planted and not paved.

d. Paved off-street parking must provide either 1 parking stall for each 3 employees, or 1 parking stall for every 500 square feet of gross floor area of the building where the number of employees is unknown. One parking stall must be designated for visitors for each 200 square feet of office space. Parking spaces for trucks, equipment, or other vehicles used in the conduct of the business is required.

   The total required parking stall in Kaua'i County is:
   70 employees/shift x 2 shifts = 140 employees
   140 employees ÷ 3 stalls/employees = 47 stalls

According to the architectural plan, there are total of 923 square feet of office space.

923 sqft / 200 sqft = 5 stalls

Total required parking spaces are 52 parking stalls.

According to ADA standards, at least 3 parking stalls must be an accessible parking space for 52 parking stalls provided in the facility. Within the accessible parking space, 1 of every 6 accessible stall must be van accessible. Therefore, 1 van-accessible parking stall is required.

e. No building shall exceed 50 feet in height unless it can be demonstrated that a greater height is essential to the functioning of the development and that no reasonable alternative exists.

f. No single retail or wholesale establishment within an Industrial District may occupy more than 75,000 gross square feet in floor area.

5. MAUI COUNTY

"Slaughter of animals" and "fertilizer manufacture" are allowed in M-3 restricted industrial district. In the "19.25.010 Purpose and intent", general retail and office uses are specifically excluded from this district. However, "office space related to the on-site permitted use" and "retail, or indoor product display area" for 20% of gross floor area are allowed as accessory uses and structures. Under the County's special use permit, "slaughter of animals" and "fertilizer manufacture" are also allowed in M-2 heavy industrial district. For this design, M-3 zoning district is considered.

Exhibit 10 shows the development standards for M-3.

	M-3
Minimum lot area (square feet)	10,000
Minimum lot width (in feet)	75
Maximum building height (in feet)	90
Minimum yard setback (in feet)	
Front	None
Side and rear	0 or the same as the adjoining zoning category whichever is greater
Free standing antenna or wind turbine structures height and setback	Maximum height of 199 feet and shall be set back 1 foot for every foot in height from all property lines
Accessory structures allowed within setback area	Mailboxes, trash enclosures, boundary walls, and ground signs

Exhibit 10: Maui County Development Standard for M-3 District

In Maui County Code 19.36B.020 (Designated number of off-street parking spaces), industrial or storage uses requires 1 parking stall per 1,500 square feet, provided that the minimum is 3 stalls.

Since the livestock harvesting facility has 24,883 square feet of floor area:

$$24{,}883 / 1{,}500 = 16.59 \text{ stalls}$$

Hence, 17 parking stalls are required in this facility. According to Maui Code 19.36B.0.60, dimensions for standard-sized automobile parking stall is least 18 feet in length and 8.5 feet in width with vertical clearance of 7 feet.

According to ADA standards, at least one parking stall must be an accessible parking space for 17 parking stalls provided in the parking facility. Within the accessible parking space, 1 of every 6 accessible stall must be van accessible. Therefore, 1 van-accessible parking stall is required.

6. HAWAI'I COUNTY

In Hawai'i County Code Chapter 25 Section 25-5-152, slaughterhouses are permitted in MG, general industrial districts.

The height limit in MG district is 50 feet, but industrial structure may be built up to 100 feet if extra height is determined as functionally necessary by the director. The minimum lot area is 20,000 square feet. Each building site must have a minimum building site average width of 100 feet.

The front yard must be at least 20 feet and landscaped, except for drives and walkways. Side and rear yards are not required unless the adjoining building site is in RS, RD, RM, or RCX district. When the adjoining building site is in RS, RD, RM or RCX district, a side or rear yard must conform to the requirements for dwelling use of the district. Where any required side or rear yard in the MG district adjoins a building site in an RS, RD, RM, or RCX district, a solid wall 6 feet in height must be erected and maintained along the side and rear property lines adjoining.

Standard-sized automobile parking spaces must be at least 18 feet in length and 8 feet and 6 inches in width. From Section 25-4-51 (13), industrial uses in MG districts require 1 parking stall for each 400 square feet of gross floor. Since the livestock harvesting facility has 24,883 square feet of floor area:

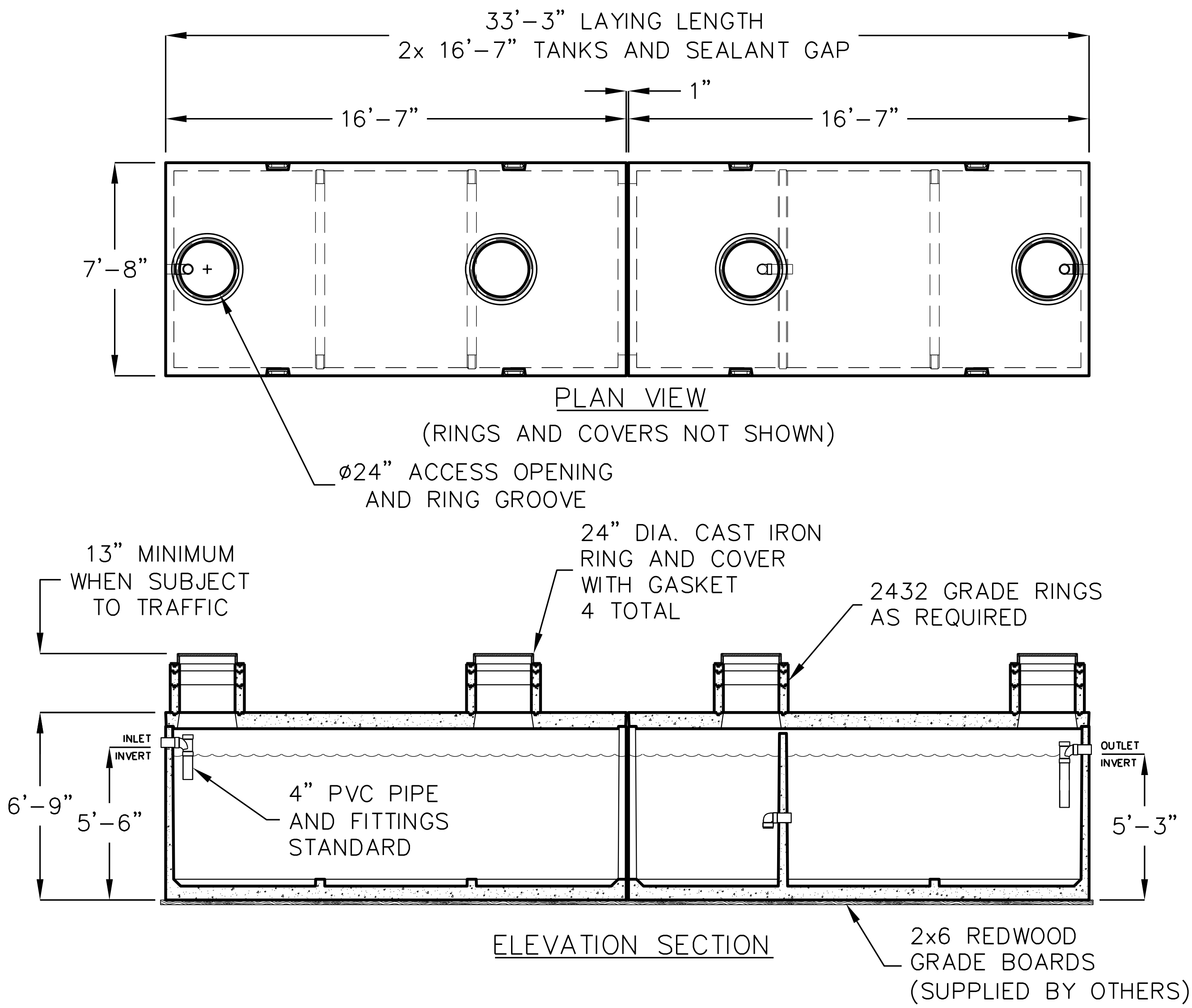
$$24{,}883 / 400 = 63 \text{ stalls}$$

Hence, 63 parking stalls are required in this facility. According to ADA standards, at least 3 parking stalls must be an accessible parking space for 52 parking stalls provided in the facility. Within the accessible parking space, 1 of every 6 accessible stall must be van accessible. Therefore, 1 van-accessible parking stall is required.

APPENDIX A:
SEPTIC TANK DETAILS

8,000 GALLON BATTERY SEPTIC TANK

MODEL 2XJZ4000-ST



OPERATING CAPACITY: 8,000 GALLONS

DESIGN LOAD: H–20 TRAFFIC WITH DRY SOIL CONDITIONS (WATER LEVEL BELOW TANK) AND 13 INCHES TO 5 FEET EARTH COVER.

BEDDING NOTE: SUITABLE SUB–BASE BEDDED WITH GRANULAR MATERIAL SHALL BE PREPARED TO HANDLE ANTICIPATED LOADS.

FOR COMPLETE DESIGN AND PRODUCT INFORMATION CONTACT JENSEN PRECAST.

APPENDIX B:
NRCS WEB SOIL SURVEY SOIL MAP

Map Scale: 1:4,630 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0, 50, 100, 200, 300

Feet: 0, 200, 400, 800, 1200

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 5N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Unit Polygons

Soil Map Unit Lines

Soil Map Unit Points

Special Point Features

Blowout

Borrow Pit

Clay Spot

Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh or swamp

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Island of Hawaii Area, Hawaii
Survey Area Data: Version 14, Sep 15, 2021

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jan 29, 2017—Oct 11, 2020

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

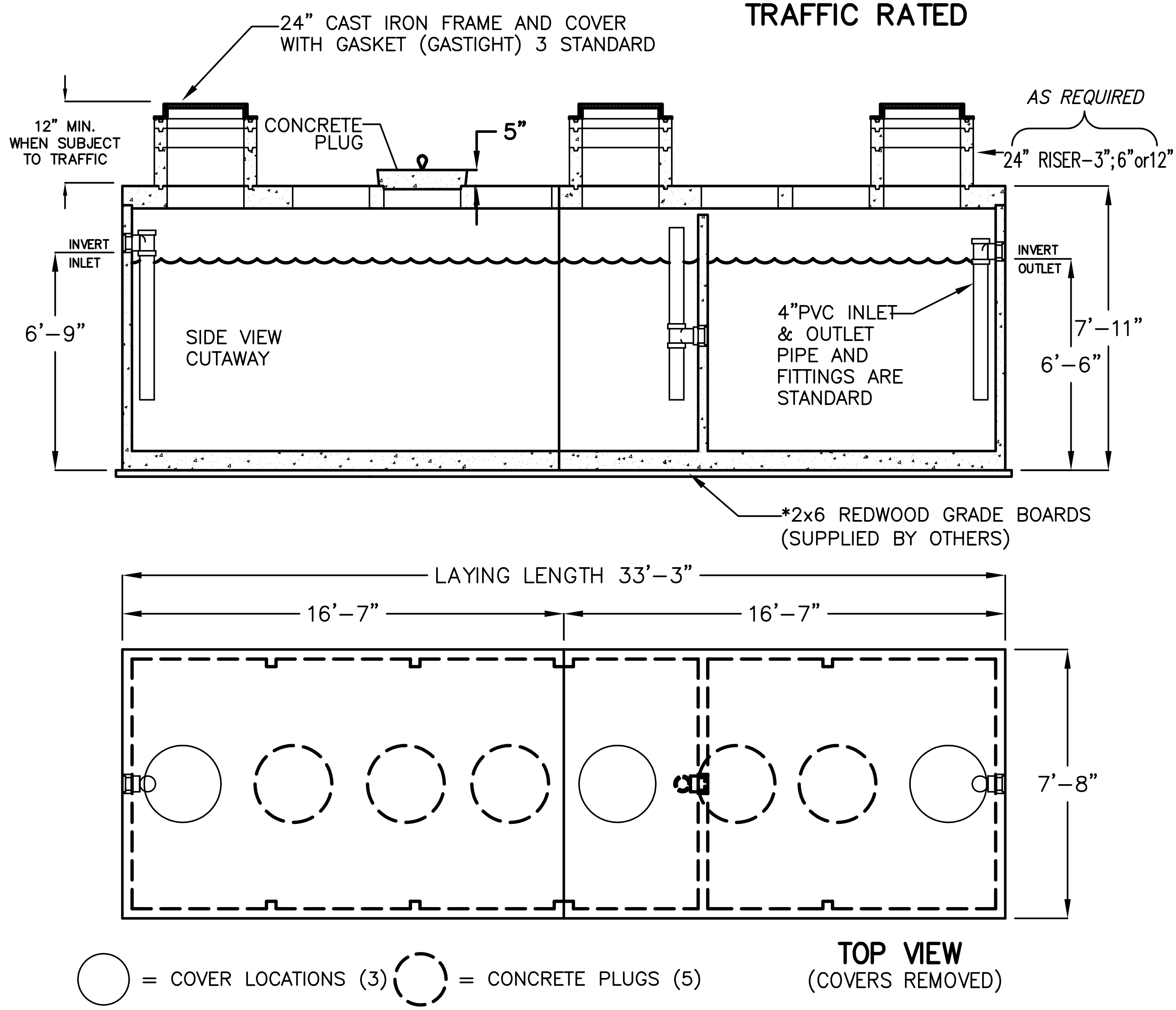
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
951	Ookala medial silty clay loam, 0 to 10 percent slopes	9.7	21.6%
952	Ookala medial silty clay loam, 10 to 20 percent slopes	35.1	78.1%
Totals for Area of Interest		**44.9**	**100.0%**

APPENDIX C:
GREASE INTERCEPTOR DETAILS

10,000 GALLON
BATTERY GREASE INTERCEPTOR

MODEL 2XJZ5000-G

TRAFFIC RATED



TOP VIEW
(COVERS REMOVED)

LIQUID CAPACITY: 10,000 GALLONS.

- TANK DESIGNED FOR H-20 TRAFFIC WHEEL LOAD WITH DRY SOIL CONDITIONS (WATER TABLE BELOW TANK) & EARTH COVER OVER TANK NOT TO EXCEED 4 FT.
- SUITABLE NATIVE OR SUB-BASE SHALL BE PREPARED TO HANDLE ANTICIPATED LOADS. THE EXCAVATION SHALL BE BEDDED WITH SUITABLE GRANULAR MATERIAL AND SHALL BE COMPACTED TO 90% MAXIMUM DRY DENSITY, OR TO REQUIREMENTS OF THE PROJECT GEOTECHNICAL ENGINEER.
- FOR COMPLETE DESIGN AND PRODUCT INFORMATION CONTACT JENSEN PRECAST.

MINIMUM EXCAVATION SIZE:
8'-8" X 34'-3" X DEPTH REQ'D.

10-01-03
10000G_2XJZ5000-W.dwg

JENSEN PRECAST®

APPENDIX D:
NEXOM PROPOSAL FOR AERATED LAGOON

HAWAII LIVESTOCK COOPERATIVE OAHU, HI

Preliminary Proposal for Design, Supply and Installation Inspection of the Wastewater Treatment System Upgraded with optAER

September 20, 2021

technologies for cleaner water

5 Burks Way · Winnipeg MB · R2J 3R8
888·426·8180 • **www.nexom.com**

Project Overview

Nexom is pleased to propose an OPTAER lagoon aeration-based wastewater treatment system for the Hawaii Livestock Cooperative in Oahu, HI.

The proposed system is designed for continuous discharge and would consist of the following processes and technologies:

- Construct two new lagoon cells (by others).
- Implement OPTAER® fine bubble complete mix aeration with floating laterals in cell 1.
- Implement OPTAER® fine bubble partial mix aeration with floating laterals in cell 2.
- Implement partial settling in cell 2.

System Design Parameters

Preliminary design loads and effluent objectives are presented in the following tables:

		Influent	Effluent Targets
Design Flow (DMF)	gallons/day	30,000	
$cBOD_5$	mg/l	1,350	<30
TSS	mg/l	1,320	<30

Approximate cell sizes and retention times are presented in the following table:

Cell	Reactor Type	Water Depth (ft)	Water Volume (gallons)	Nominal Retention Time (days)
1a	Complete Mix	11	468,370	15.6
1b	Partial Mix / Settling	11	648,576	21.7
	Total		**1,116,946**	**37.3**

Aeration design parameters are presented in the following table:

	Cell 1 (CM)	Cell 2 (PM)	Totals
Alpha	0.50	0.50	
Beta	0.95	0.95	
Theta	1.024	1.024	
Summer Water Temperature (°C)	25	25	
Winter Water Temperature (°C)	20	20	
Site elevation (ft)	23	23	
# H3-4 diffusers (Fine Bubble)	24	10	34
SCFM per diffuser	12.0	12.0	
Total SCFM	288	120	408

optAER Lagoon Treatment Processes

The primary purpose of the aerated ponds is to provide oxygen and residence and contact time to natural bacteria, which ultimately convert the wastewater contaminants (BOD_5, ammonia, and TSS) to carbon dioxide, water, and inert ash and nitrates. Aerated ponds effectively control odours and provide internal sludge digestion.

COMPLETE MIX (CM) CELL

Complete mix cells use closely spaced diffusers and relatively high airflow rates to mix the wastewater vigorously and maintain all solids in suspension.

Because the aeration bubbles not only provide oxygen but also mix the water, the oxygen is evenly distributed throughout the water body. The bubbles produced by the air diffusers result in high total surface area per cubic meter of air introduced into the system.

Utilizing aerated complete mix ponds provides the following:

- Accelerated BOD removal (compared to partial mix lagoons)
- Shortened retention time

With complete mix ponds, sludge accumulation in the cells will be minimal (theoretically zero). Experience shows however that some sludge accumulation can occur on the side slopes. Biomass and other solids would be carried from the complete mix cell to the aerated secondary cells (partial mix cells).

PARTIAL MIX (PM) CELL

With aerated partial mix cells, the diffuser density is based upon oxygen demand. The OPTAER system does not rely on algae or natural surface aeration for providing oxygen to the wastewater.

The diffusers are suspended near the bottom of the cells. Through the rise of the bubbles and subsequent mixing, convection cells are created between the diffusers. Not only does the water rise with the bubbles, the solids settle out through the downward motion of the water between the diffusers where the circulation loop is completed. This combined with the slow rate of bubble rise contributes to the overall efficiency of the system. Because of low sludge production in the system, retention time is retained for long term BOD5 removal.

When the solids reach the bottom of the lagoon, additional oxygen for biodegradation is provided through the diffusers near the cell bottom. This process results in minimal organic bottom sludge accumulation. Aerobic digestion takes place within the aerated cells at the sludge water interface.

Fine bubble diffuser

FINE BUBBLE MEMBRANE DIFFUSERS

Fine bubble diffusers are used to provide oxygen to the wastewater. The diffusers consist of an air distribution body with individual tubular EPDM membranes extending outwards in a horizontal plane. This design prevents bubbles from coalescing, and results in an excellent oxygen transfer rate with minimal head loss.

The diffusers are suspended with a marine grade rope directly under the lateral, at a uniform depth. The rope is attached to the floating header for ease of diffuser retrieval. Each diffuser is attached to a small concrete weight, encased in HDPE pipe. Diffuser assemblies can be retrieved from a boat with no special equipment.

AIR DISTRIBUTION SYSTEM: FLOATING LATERALS

Laterals connect to the shallow buried header with flanged connections (by others), and float on the water surface. Each lateral is individually valved for ease of maintenance. With floating laterals, there are no concrete weights required to be in contact with the bottom of the basin. Laterals are secured against wind action with a stainless-steel cable system. The cables are fastened to anchors in the berm using a manually adjusted lateral tensioning assembly.

All header and lateral piping, joints, and fittings are thermally fused HDPE. With floating laterals, the cells do not have to be dewatered or taken out of service for system installation or maintenance. All maintenance can be performed from a boat with a 2-person crew.

Positive Displacement Blowers

Positive displacement blowers are used to provide air supply for the treatment system. Blowers are designed to provide the required airflow at normal system operating pressure and have the capability of operating at the maximum required pressure intermittently for diffuser purging. The blowers are equipped with sound attenuating enclosures.

Blowers are summarized in the following table:

		Lagoon
Number of blowers total		2
Number of blowers on duty		1
Number of blowers on standby		1
Motor nameplate horsepower	hp	25
Design airflow per blower	SCFM	408
Normal operating pressure	psi	6.5
Maximum Required Pressure	psi	7.9

Budgetary Capital Cost

Included in the wastewater treatment system capital cost are:

- Nexom System Process Design
- CAD Drawings and specifications
- Operation and maintenance manuals
- Project Record Drawings

OPTAER® LAGOON AERATION SYSTEM:

- Floating lateral piping, feeder piping fittings and valves as required
- H3-4 Diffuser assemblies complete with EPDM Membranes and pre-cast diffuser weights.
- Self-tensioning lateral assemblies and anchor posts.

AIR SUPPLY

- Two (2) 25 hp positive displacement blowers with sound attenuating enclosures
- Blower control panel with motor starters

BUDGETARY COST FOR THE OPTAER SCOPE:

All prices are subject to final design review.

The quote being provided is in effect for 60 days. Should a purchase order be awarded during that 60-day period, it is understood that shipment of the product will be allowed within a period of 180 days from the date of the purchase order. Should the goods not be required to be delivered until after that time horizon, the company reserves the right to adjust pricing to reflect inflationary changes incurred and expected until the shipment date is reached.

ITEMS SPECIFICALLY NOT INCLUDED:

- Shipping to site (Ex Works Winnipeg, MB, Canada)
- Material offloading and secure on-site storage
- Installation of Nexom supplied equipment (installation is available, but outside the scope of this proposal)
- ***Equipment installation inspection/start-up/commissioning/training (on-site inspection is available, but outside the scope of this proposal)***
- Civil works including lagoon cells design and construction, liner, transport piping, inter-cell piping, discharge piping, manholes, valves, access roads to site, site roads and landscaping, lagoon desludging etc. if required
- Concrete for anchor posts
- Main air supply header with manual blow-off assembly and flanged lateral connections
- Site Preparation and Restoration

Questions or Comments?

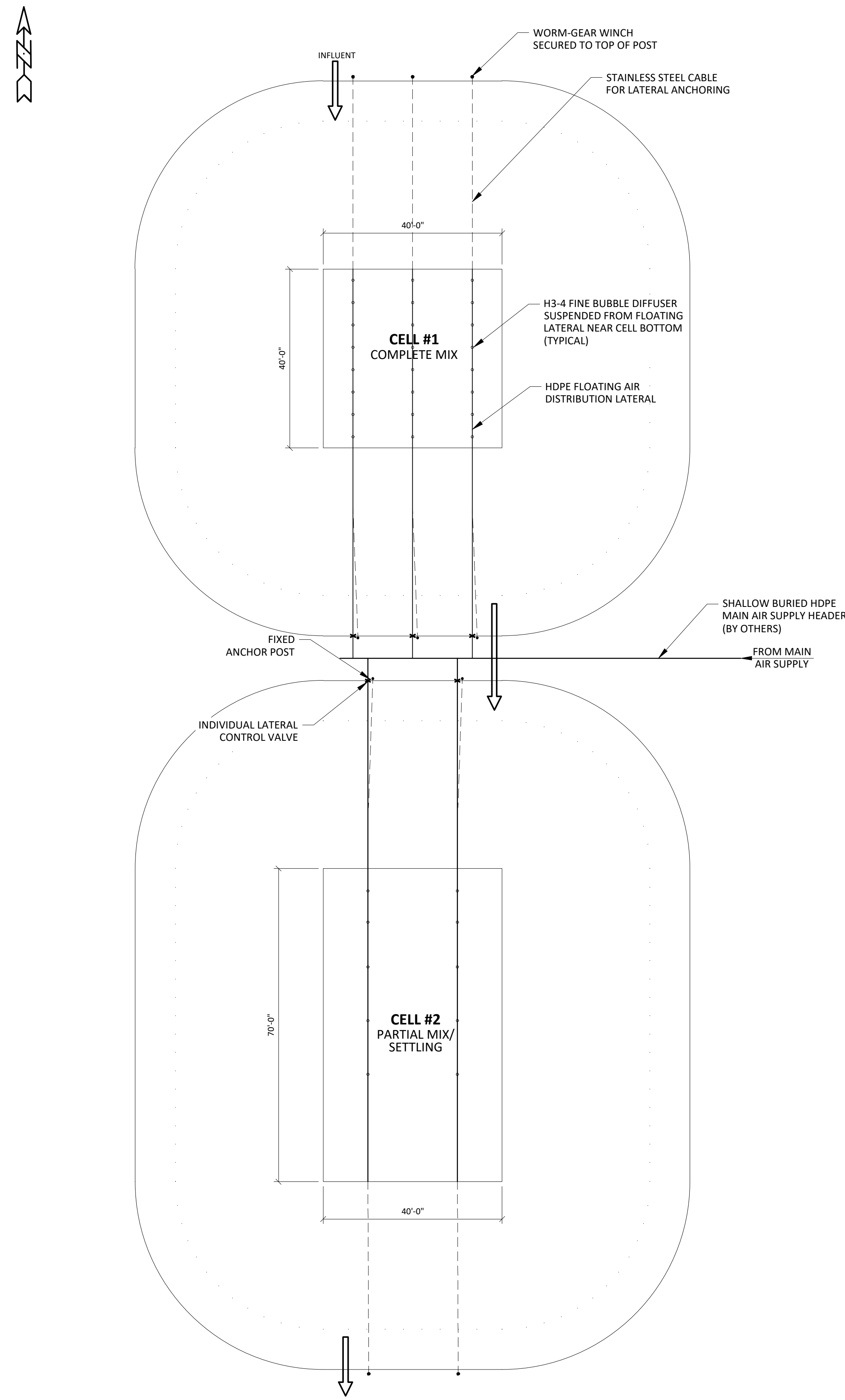
Any questions or comments can be directed to:

Patrick Ely
Regional Sales Manager
patrick.ely@wastewater.com
573-356-0316

Nexom
Info@nexom.com
888-426-8180
5 Burks Way · Winnipeg MB · R5T 0C9
www.nexom.com

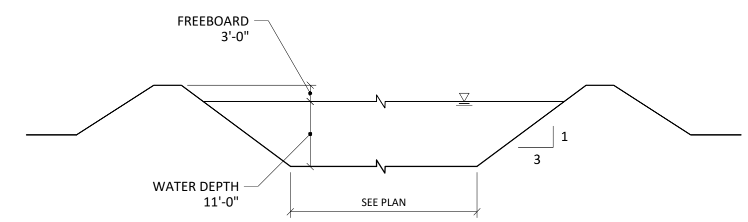
PLOT SIZE: 610mm x 914mm (24" x 36")

REDUCED SIZE PLOT - DO NOT SCALE



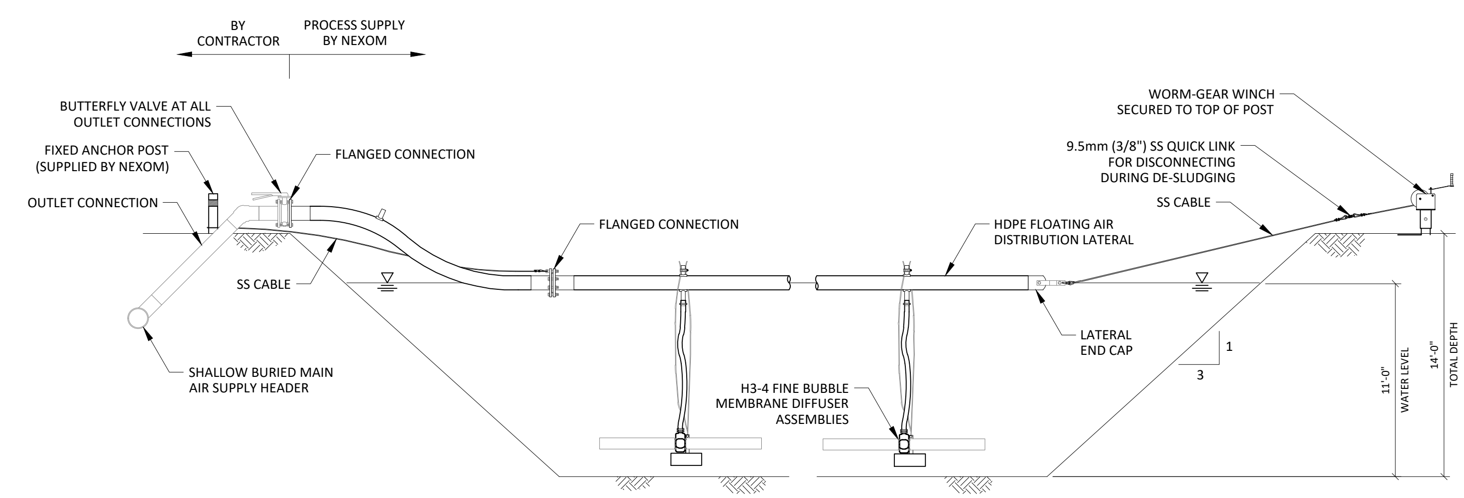
AERATION LAYOUT - 30 000 GPD

SCALE: 1:150



TYPICAL SECTION - AERATED CELLS

SCALE: N.T.S.



AERATED LAGOON SECTION

SCALE: N.T.S.

Nexom
technologies for cleaner water

5 Burks Way
Navin, Manitoba
Canada R5T 0C9
888-426-8180
www.nexom.com

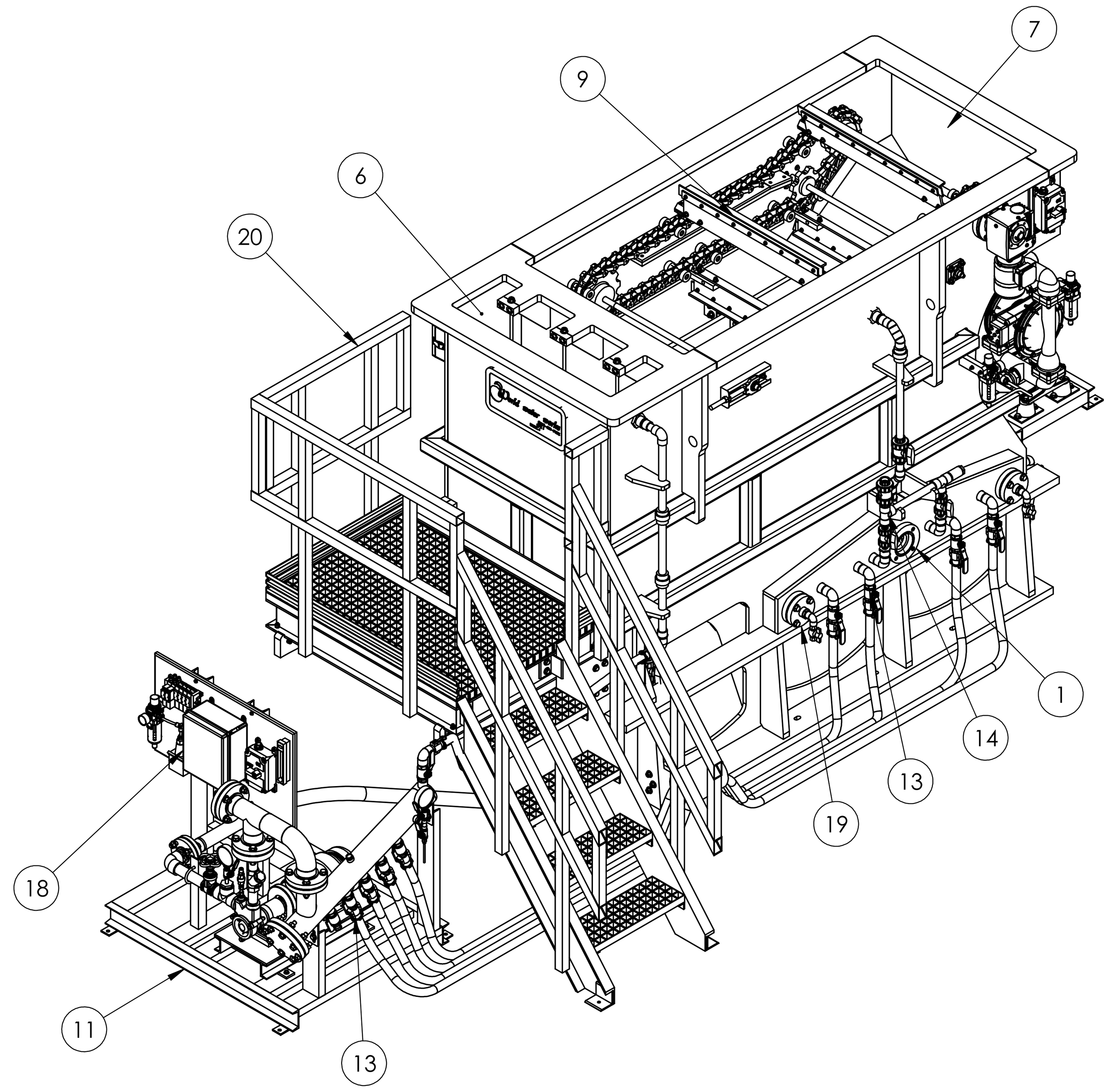
PROJECT:	HAWAII LIVESTOCK COOPERATIVE - OAHU, HI PROPOSED WASTEWATER TREATMENT SYSTEM - 30 000 GPD
TITLE:	OPTAER SYSTEM AERATION LAYOUT, TYPICAL SECTION, LOCATION PLAN

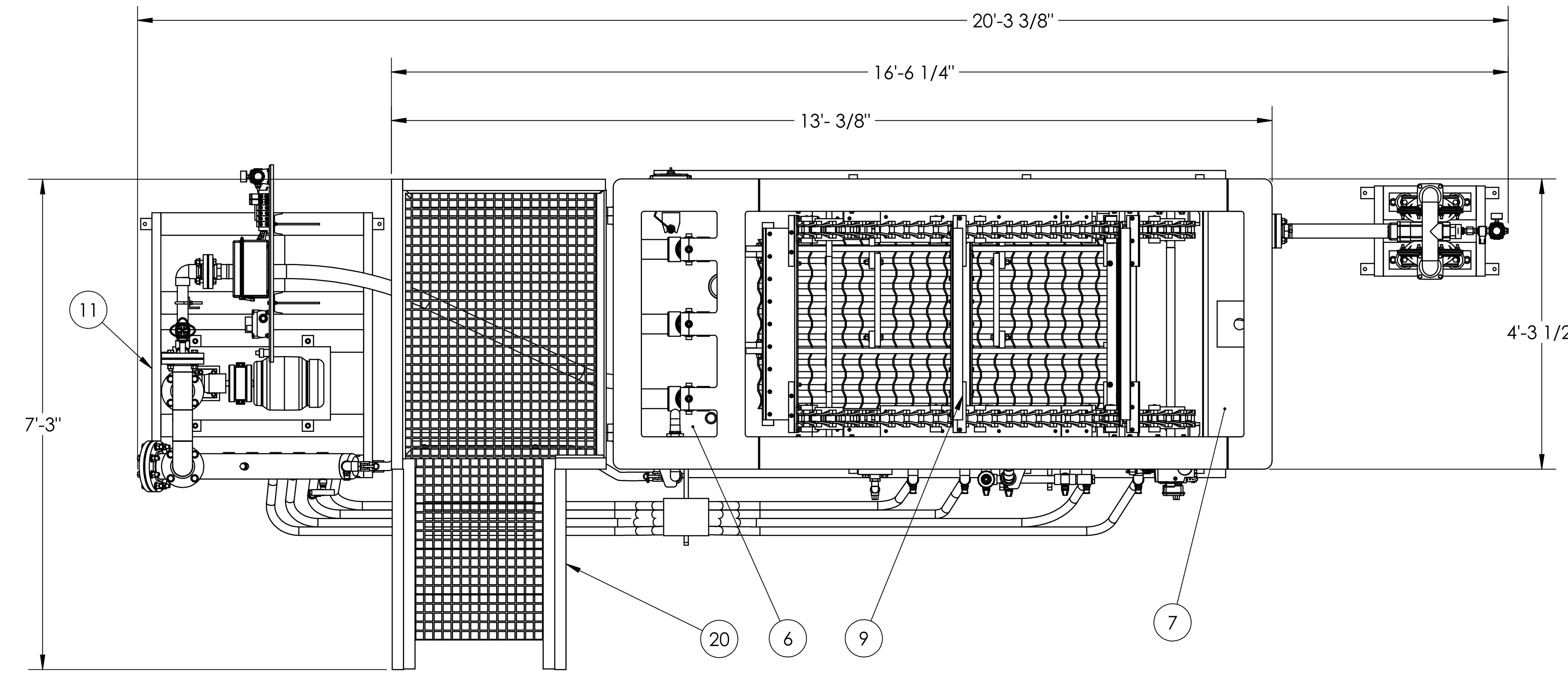
DRAWN BY:	APPROVED BY:	SCALE:	DRAWING NO.	SHT.	REV.
MR	ML	AS NOTED	NE01	1 of 1	0
DATE: 2021/09/21	FILE # CD7442.02				

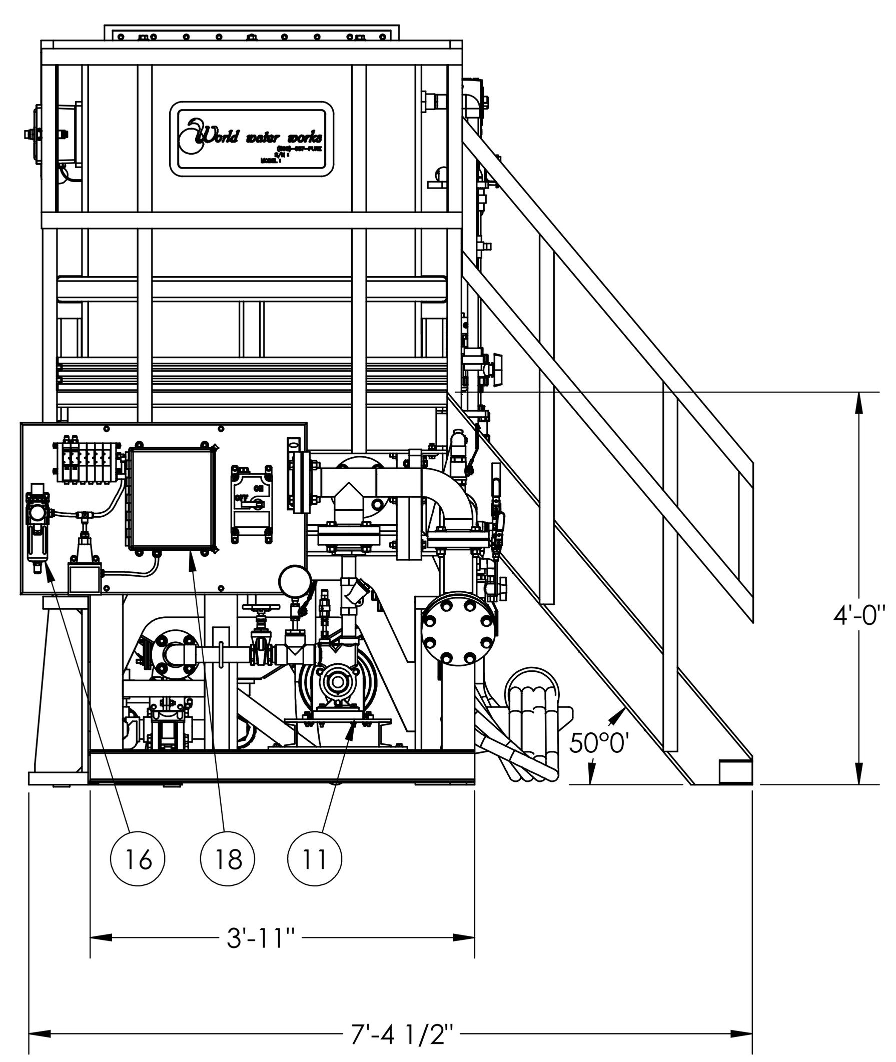
APPENDIX E:
DISSOLVED AIR FLOTATION SYSTEM (DAF) DETAILS

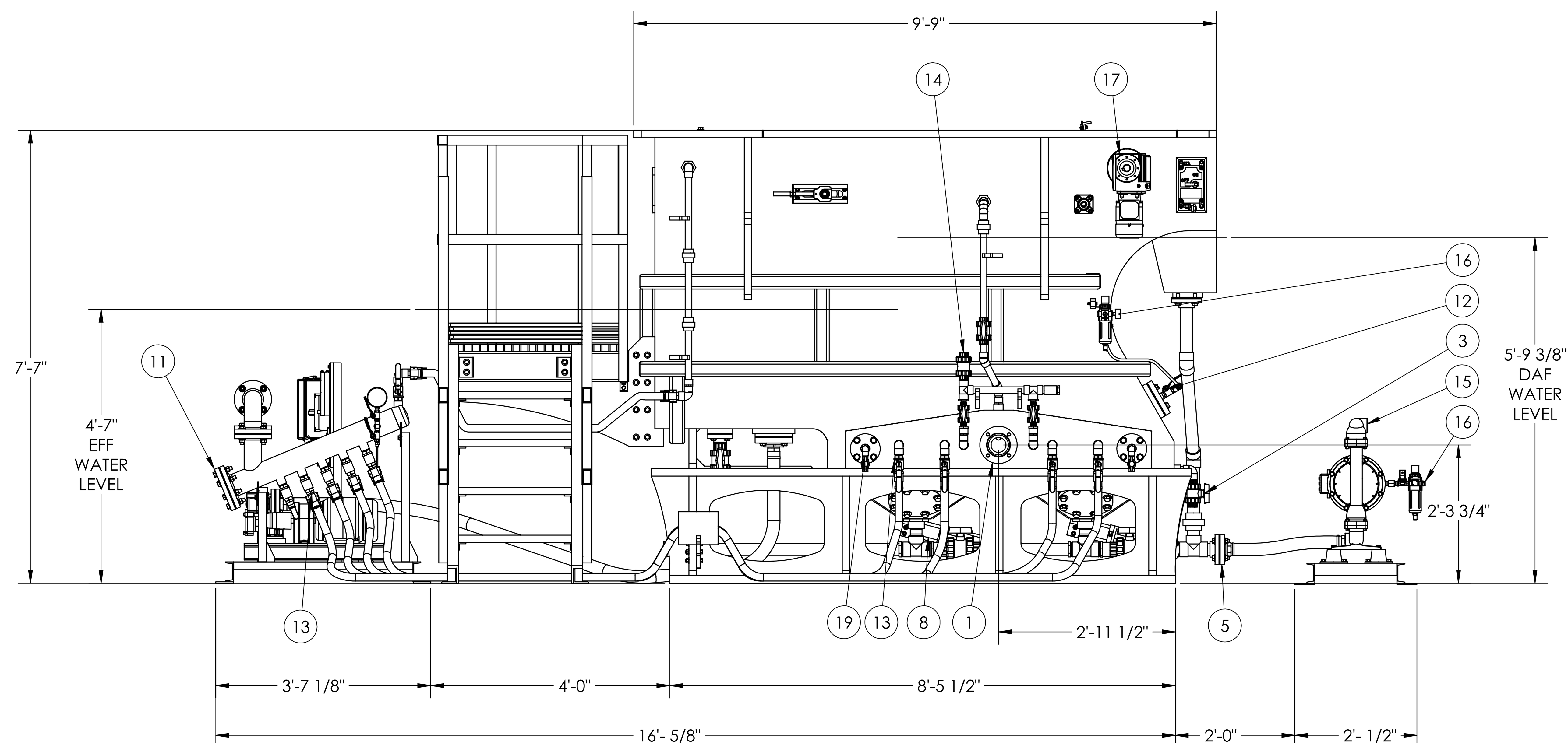
RSP-30MS-R-B DAF

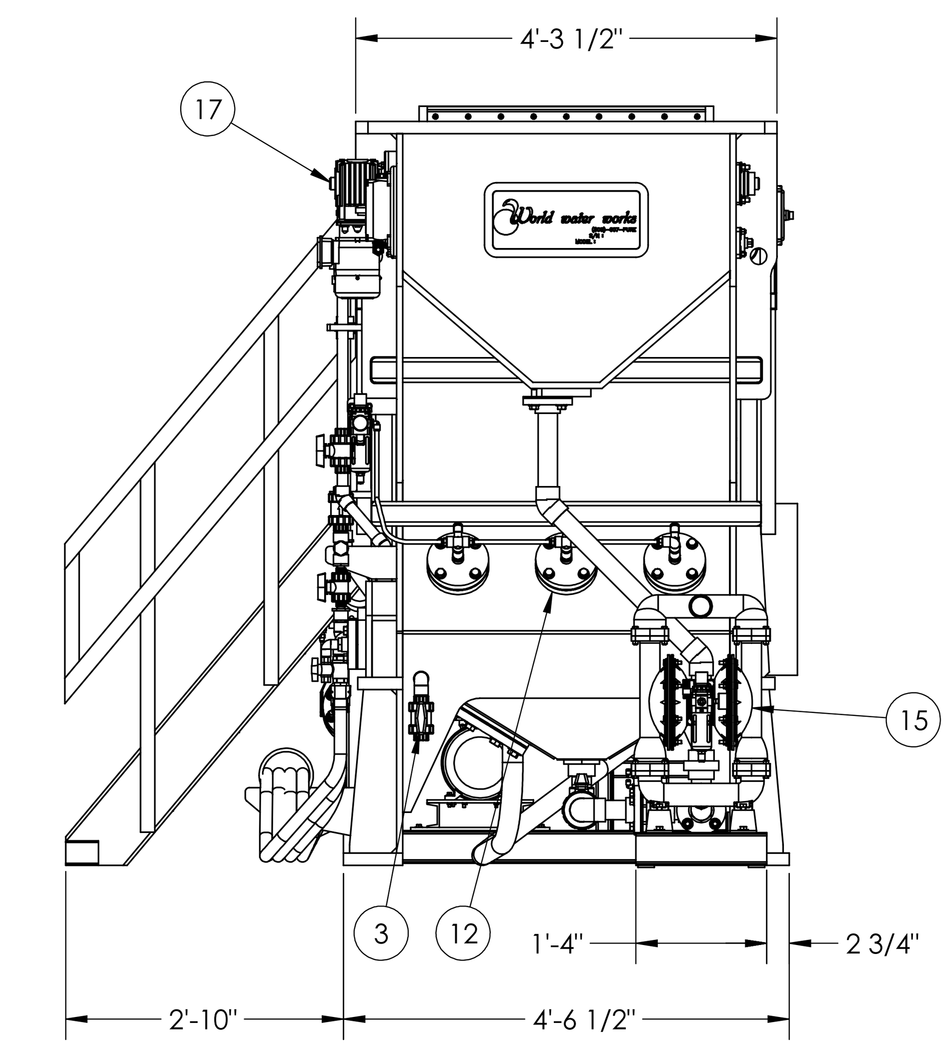
ITEM NO.	DESCRIPTION
1	INFLUENT, 3" FLANGE 150 LB
2	EFFLUENT, 4" FLANGE 150 LB
3	INFLUENT DRAIN, 1" PVC BALL VALVE
4	EFFLUENT DRAIN, 1-1/2" PVC BALL VALVE
5	SLUDGE DISCHARGE, 2" FLANGE 150 LB
6	CLEAN WATER EFFLUENT WEIR BOX
7	SLUDGE HOPPER
8	CONE BOTTOM SOLIDS REMOVAL VALVES (AUTO), 2"
9	SKIMMER PADDLE
10	DAG RECIRCULATION, 3" FLANGE 150 LB
11	DAG PUMP SKID (PER SALES PROPOSAL)
12	AIR BLOWDOWN
13	DISSOLVED AIR INJECTION VALVES
14	POLYMER INJECTION
15	SLUDGE PUMP, 2" AOD
16	1/2" AIR CONNECTION 50 PSI (MIN)"
17	SOLIDS SKIMMER & GEAR DRIVE MOTOR (1/2 HP)
18	JUNCTION PANEL
19	SAMPLE PORT, 1/2" PVC BALL VALVE
20	WALKWAY, STD

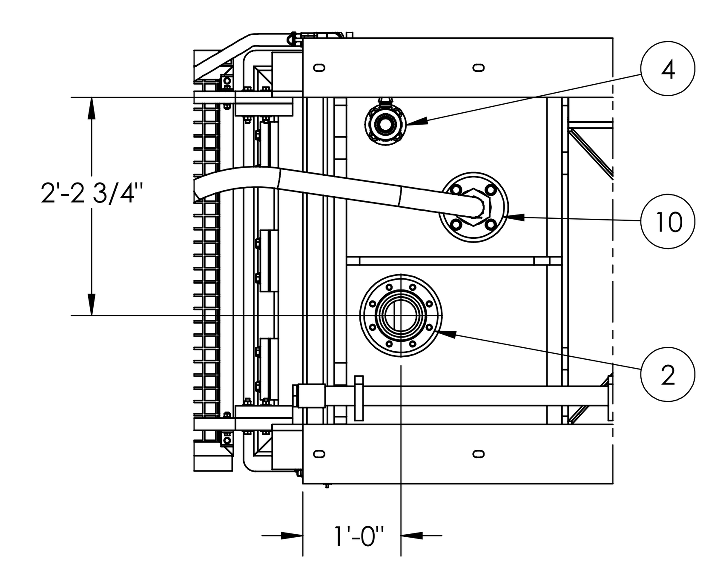












GENERAL NOTES

1. ALL IS TO BE CONSTRUCTED GREY FROM HIGH IMPACT NATURAL STRESS RELIEVED, VIRGIN COPOLYMER POLYPROPYLENE. U.O.W.S
2. SERVICE: WASTE WATER @ 40° ~ 130°
3. ALL FLANGES TWO-HOLED TO THE CENTER LINE
4. STEEL REINFORCEMENTS TO BE: 304 STAINLESS STEEL
5. ALL DIMENSIONS SHOWN APPLY TO AMBIENT TEMPERTURE (NON-EXPAND)
6. SOME HIDDEN LINES AND COMPONENTS OMITTED FOR CLARITY
7. TANKS TO BE TRANPORTED EMPTY
8. ALL GASKET MATERAIL TO BE 3/16" THK. EPDM
9. ALL FASTENERS TO BE 304 SS
10. HYDRO. TEST TO BE ADMINSTRATED BEFORE SHIPMENT
11. ALL FLANGES FACES TO BE PROTECTED WITH WOOD BLANKS FOR SHIPPING

EMPTY WEIGHT: 3,400 LBS
OPERATIONAL WEIGHT: 6,650 LBS

NOT FOR CONSTRUCTION

WWW CONFIDENTIAL

REV	DATE	DESCRIPTION	BY

World water works
1-800-607-PURE
4000 SW 113th * OKLAHOMA CITY, OK 73137

CLIENT: --
LOCATION: --
FILE NAME: WWW-GA-SALES DRAWING RSP-30MSN-R-B
DESCRIPTION: GA-SALES DRAWING RSP-30MSN-R-B

SALES DRAWING
P.O.#:
DRAWN BY: AH
CHECKED BY: ES
DATE: 12/01/14
SCALE: 1:20
JOB #: --
DRAWING # M1
SHEET: 1 OF 1 SHEETS

APPENDIX C

Mechanical, Plumbing, and Fire Sprinklers

A. MECHANICAL

A.1. STANDARDS AND REFERENCES

1. IBC	International Building Code, 2018 edition and City and County of Honolulu, amendments
2. IECC	International Energy Code, 2018 edition and City and County of Honolulu, amendments
3. UPC	Uniform Plumbing Code, 2018 edition and City and County of Honolulu, amendments (anticipated to be adopted May 2022)
4. ASHRAE	HVAC Applications Handbook, 2019
5. ASHRAE 15	Safety Standard for Refrigeration Systems, 2019
6. ASHRAE 34	Designation and Safety Classification of Refrigerants, 2019
7. ASHARE 62	Ventilation for Acceptable Indoor Air Quality, 2016
8. ASHRAE 90.1	Energy Standard for Buildings Except for Low-Rise Residential Buildings, 2016
9. NFPA 1	Fire Code 2018 Edition and City and County of Honolulu, amendments (projected to be adopted)
10. NFPA 30	
11. NFPA 58	Liquefied Petroleum Gas Code, 2020
12. NFPA 70	National Electric Code, 2017 Edition and City and County of Honolulu amendments
13.	
14. NFPA 90A	Standard for the Installation of Air-Conditioning and Ventilating Systems
15. NFPA 91	Standard for Exhaust systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids, 2017

16. ASPE	Plumbing Engineering Design Handbooks
17.	
18. DOH 11-39	Department of Health Administrative Rules Title 11 Chapter 39, Air Conditioning and Ventilating

A.2. MECHANICAL

A.2.1. General Information

Mechanical systems include heating, ventilation, and air conditioning systems (HVAC). Heating and air conditioning will be provided for comfort humidity control for most of the spaces in the facility. Many of the rooms in this facility have very stringent temperature and humidity requirements for each of the rooms, if a room is not listed in this reference, then verify room conditions with the Users. The electrical room shall be air conditioned since there will be a lot of high heat producing equipment installed in the room.

A.2.2. Office Areas

The air conditioning system for the office areas shall consist of a packaged air conditioning unit (PACU) and variable air diffusers (VAD) throughout the office areas. The single PACU shall be located on the roof. The air distribution system shall be a medium velocity duct system with VADs provided throughout the space for temperature control. Outside air (OA) to be provided to each PACU to meet the ventilation requirements.

Restrooms and showers shall be exhausted by an exhaust fan. Conditioned make-up air shall be provided by the PACU.

A.2.3. Plant Services Areas

The air conditioning system for the Plant Services Areas shall consist of three individual PACUs for the Plant Services Area, Laundry & Sanitation, and Maintenance Shop. The Dock Office shall be provided with a ducted horizontal DX split unit. OA to be provided to each PACU and ducted horizontal DX split unit to meet the ventilation requirements.

The Electrical and Voice/Data rooms shall be served by a 24/7 ducted DX split unit, no OA is required for this space.

The Laundry & Sanitation room shall be provided with a dryer exhaust fan. Conditioned make-up air shall be provided by the PACU serving this space.

The Maintenance Shop shall be provided with a welding hood exhaust fan. Conditioned make-up air shall be provided by the PACU serving this space.

A.2.4. Non-Refrigerated Areas

The air conditioning system for the Non-Refrigerated Areas shall be provided with a PACU for Harvest Areas #1 and #2. OA to be provided to the PACU to meet ventilation requirements.

Harvest #1 and #2 shall be provided with supply and exhaust fans, sized to provide 15 air changes/hour (ACH) of unconditioned air during clean-up mode. These areas are to be kept negative relative to adjacent areas.

The two Hygiene Lock spaces shall be provided with transfer air fans that transfers air to their adjacent spaces: Harvest #2 and Fabrication Room.

The Vestibule and Dry Storage does not have any ventilation requirements.

A.2.5. Refrigerated Areas

The air conditioning system shall be provided with an industrial refrigeration type system: ground mounted compressor/air condensing units (ACU) and individual or skid mounted in-room evaporator units (EU). OA shall be provided with a PACU that provides conditioned 100% OA to positively pressurize the space. The rooftop PACU shall be provided in the Fabrication Room and be distributed to adjoining areas.

Air Curtains (AC) shall be wall mounted and provided throughout the space in locations of entry and egress between adjacent spaces to create an air barrier to prevent the loss of conditioned air.

Carcass Chill Cooler #1 and #2 shall have a holding temperature of +34°F. With capacity for chilling 900#/dressed beef carcasses split into sides in 24 hours. Allow 2 Head/T.R. for refrigeration product load. Provide two evaporators with electric defrost allowing for alternating defrost. EUs shall be provided with variable speed fans with in-room temperature and speed controls. Also provide carcass spray chill system including water chiller, distribution piping and control panel.

Carcass Sales Cooler shall have a holding temperature of +34°F. Allow 8 Head/T.R. for refrigeration product load. Provide two evaporators with electric defrost allowing for alternating defrost.

Fabrication Room shall have a holding temperature of +42°F. Provide a total of eight (8) EUs designed with low velocity for employee comfort and low noise level. EUs shall be provided with variable speed fans with in-room temperature and speed controls.

Finished Goods Cooler shall have a holding temperature of +32°F. With capacity for chilling 200# per head/day of +42°F boxed product to +34°F in 24 hours and an overall holding capacity of 76,500# (20HD/Day) and 150,000# (70HD/Day). Provide a minimum of two (2) EUs with electric defrost.

Blast Freezer shall have a holding temperature of -10°F. With capacity for freezing 270# per head/day +42°F boxed product to -0°F in 24 hours and an overall holding capacity of 31,500# (20HD/Day) and 66,000# (70HD/Day). Provide a minimum of one (1) EU with electric defrost.

Shipping/Receiving Dock shall have a holding temperature of +45°F. Provide a minimum of two (2) EU. Defrost is not required for these units.

Inedible Materials shall be provided with a holding temperature of +45°F. With capacity for holding 545# per head/day of warm material. Provide a minimum of two (2) EUs. Defrost is not required for these units.

Fabrication Room and Inedible Materials shall be provided with supply and exhaust fans, sized to provide 15 ACH of unconditioned air during clean-up mode. The Fabrication Room shall be the most positive to adjacent areas.

A.2.6. Livestock Pen Area

The ventilation system shall consist of high velocity low speed (HVLS) fans to push air for cross ventilation. Provide interlocked supply and exhaust air fans to keep the air balanced.

This area will be kept negative relative to adjacent areas.

A.2.7. Design Conditions

The cooling systems will be designed to maintain a space temperature as listed above in Section A.2.1: General Information. At the listed temperatures, the relative humidity (RH%) will be approximately 50%. The HVAC equipment for will be sized using computer-based load calculation program utilizing weather data for Honolulu, Hawaii until finalized location is specified.

The selected refrigerant for the industrial refrigeration system is R-448A and R-449A. The selected refrigerant for all other systems is R-410A.

The primary energy conservation requirement is to reduce the building energy consumption by 30% below ASHRAE 90.1-2010.

A.2.8. Systems and Materials

A.2.9. Outdoor Design Conditions

The new facility shall be air conditioned as required by the referenced criteria. Per ASHRAE 62.1,

- 1.0% summer Design Dry Bulb Temperature = 89.8 °F
- 1.0% summer Design Wet Bulb Temperature = 73.0 °F
- 1.0% Humidity Ratio (HR) = 125 grains/lb dry air
- 1.0% Mean Coincident Dry Bulb Temperature = 81.9 °F

A.2.10. Indoor Design Conditions

Space Type	**Cooling Indoor Design**	**Heating Indoor Design**	**Ventilation (ASHRAE 62.1)**	
			Rp, cfm/ person	**Ra, cfm/ft^2**
Office Area	75°F Dry Bulb +/- 2 degrees, 50% - 60% Relative Humidity	N/A	5	0.06
Break Room	75°F Dry Bulb, 50% Relative Humidity	N/A	5 Note 2	0.06 Note 2
Toilets	N/A	N/A	Note 1	Note 1
Lockers	75°F Dry Bulb +/- 2 degrees, 50% - 60% Relative Humidity	N/A	Note 3	Note 3
Plant Services Area	78°F Dry Bulb+/- 2 degrees, 50% -60% Relative Humidity	N/A	5	0.06
Telecom Rooms	75°F Dry Bulb+/- 2 degrees, 50% - 60% Relative Humidity	N/A	0	N/A
Laundry & Sanitation Room	78°F Dry Bulb+/- 2 degrees, 50% -60% Relative Humidity	N/A	5	0.06
Maintenance Services	78°F Dry Bulb+/- 2 degrees, 50% -60% Relative Humidity	N/A	5	1.0
Electrical and Voice/Data	75°F Dry Bulb+/- 2 degrees, 50% - 60% Relative Humidity	N/A	0	N/A
Non-Refrigerated Areas	78°F Dry Bulb+/- 2 degrees, 50% - 60% Relative Humidity Note 4	N/A	10 Note 4	0.18 Note 4
Refrigerated Areas	Note 5	N/A	0	Note 5

Notes:

1. *Provide exhaust rate of 50 cfm per water closet or urinal minimum as per ASHRAE 62.1 or 2 CFM per square ft for AC conditioned make up air, 4 CFM per sq. ft for unconditioned make up air per HI DOH, whichever is higher.*
2. *Provide exhaust rate of 0.3 cfm/ft^2.*
3. *Provide exhaust rate of 0.5 cfm/ft^2.*
4. *No requirement for Hygiene Lock and Vestibule.*
5. *Varies, refer to Section A.2.1.4.*

A.2.11. Air Conditioning System

The HVAC system will consist of rooftop mounted PACUs, DX split units; wall mounted air-cooled condensing units (ACCU) and horizontal ducted fan coil units (FCU), ground mounted ACUs, ceiling mounted EUs, wall mounted ACs.

The HVAC system will be selected based on functional requirements, ease of maintenance and energy efficiency. The type of HVAC system will be selected to provide the most energy efficient system.

Equipment located outdoors shall be rated with galvanized steel casing, gasketed for outdoor exposure, and with a sloping top. The outside casing galvanized steel would be specified to be coated with Ameron PSX-700 – a weatherable epoxy that embodies properties of both higher performance epoxy and an acrylic polyurethane in one coat. All PACUs shall be double-wall insulated construction, centrifugal or dual plug type supply fans, high efficiency air filter sections, DX coils with UV-C lamps, and wrap around heat exchanger coils to provide proper dehumidification without overcooling conditioned air.

Duct smoke detectors shall be provided at the supply air outlet of PACUs over 2,000 CFM. Upon detection of smoke, the fans shall automatically stop, and signal shall be sent to the fire alarm system.

The HVAC systems will be controlled by wall mounted electronic thermostats. Package air conditioning systems will have hot-gas reheat to help control the humidity within the spaces.

All interior ductworks will be galvanized sheet metal and insulated with exterior foil faced, fiberglass duct wrap for improved indoor air quality. Transfer air ductwork to be lined to prevent noise carryover/cross talk. Exterior duct work for outside air and exhaust air shall be sealed and provided with sloped duct roofs to eliminate ponding of water.

Sound attenuation requirements shall be evaluated when noise criteria are known for each space. Acoustical duct silencers shall be required as recommended by acoustical consultant.

Condensate drainage piping shall be type DWV copper pipe and fittings with insulation and jacketing as required. Condensate shall drain to dry-wells located in various areas outside of the building.

A.2.12. Ventilation

General exhaust will include rooftop exhaust fans and inline exhaust fans with interconnecting ductwork.

The processing area will be provided with both exhaust fans and supply fans which will run during the day when the area is being cleaned. The ventilation system will be used to remove the moisture during cleaning hours.

The make-up air for the general exhaust systems will be via conditioned OA for the Office Area and all other areas during harvesting and non-conditioned OA for the harvesting areas during clean-up.

HVLS circulating fans will be provided to increase air movement.

A.2.13. Serviceability and Maintainability

The HVAC system will be located inside the building where possible to extend the life of the equipment and provide easier servicing and maintenance. All exterior equipment will be coated with factory corrosion coating designed for coastal areas.

A.3. PLUMBING SYSTEMS

A.3.1. Plumbing

The plumbing fixtures shall be water conserving type. All new water piping will be connecting to a new water lateral that is being provided by the Civil Engineer. Advanced water meters to be provided to monitor building indoor potable water consumption. Separate advanced water meters shall be provided for interior cold water and hot water.

Plumbing fixtures shall be low-water consumption type, standard design, commercial grade and quality.In order to meet EPACT 2005 and CASBEE requirements, ultra low-flow water conserving plumbing fixtures shall be considered.Accessible ADA compliant plumbing fixtures will be provided as required.

The following types of fixtures shall be provided, verify fixtures with Users:

- Water Closet: Floor mounted, flush valve sensor type, vitreous china, elongated bowl, 4.85 lpf (1.28 gpf).
- Urinal: Wall hung ultra-low flow sensor type.
- Lavatory: Wall hung vitreous china or countertop built-in type with 1.325 l/min (0.35 gpm) sensor operated faucets with grid drain strainer.
- Shower: Pressure balanced, single control mixing valve type with shower head of brass construction.
- Sink: Stainless steel single or double compartment sink with hot and cold water faucet with gooseneck spout.
- Service Sink: Enameled cast iron type with stainless steel rim guard and hot and cold water faucet with pail hook and hose connection.
- Emergency eyewash: Wall mounted with plastic bowl and eye/face wash heads.

A.3.2. Sanitary and Vent Piping

A.3.3. Domestic Area

The drainage, waste, and vent (DWV) piping will be schedule 40 polyvinyl chloride (PVC) with PVC fittings for underground applications and n-hub cast iron with hubless fittings for above grade applications. Air conditioning condensate drain piping will be insulated schedule 40 PVC or insulated type L, hard drawn copper.

A.3.4. Process Area

The Process Area Wastewater system shall be piped separate from any sanitary piping to a point not less than 5' outside the building. This system shall be a Combination Waste and Vent System if allowed by the local jurisdiction. It will serve all waste generating sources in Harvest Areas #1 and #2, Carcass Chill Cooler and Carcass Sales Cooler, Hygiene Locks, Vestibule, Inedible Materials Load-Out, Fabrication Room, Finished Goods Cooler, Dry Storage, Shipping/Receiving Dock and Plant Services Area.

The Process Area Wastewater system shall be piped to a pump pit in the Inedible Materials Load-Out Area where it will be pumped over a Rotary Screen to remove solids before leaving the building. After leaving the building the wastewater will pass through a grease interceptor before heading to the processing facility.

All floor drains shall be stainless steel except in the Finished Goods Cooler, Shipping/Receiving Dock, Office Area, and Plant Services Area with a 4" dia. discharge. Provide heavy duty, Cast Iron floor drains in the Finished Goods Cooler, and Shipping/Receiving Dock with a 4" dia. Discharge. Provide heavy duty, Cast Iron floor drains in the Office Area and Plant Services Area with a 2" dia. discharge. All traps shall be 4” dia. Cast Iron unless noted otherwise. Provide 4” dia. Sch. 10, 316L stainless steel traps in Fabrication Room. It is anticipated that the underfloor process water piping system will consist of a series of 6” laterals (downstream of the 4” traps) feeding into the 6” mains. These lines will be sloped at a minimum 2% unless noted otherwise.

The sewer pipe and fittings downstream of the pee traps shall be constructed of Cast Iron pipe material and appropriately sized based on anticipated loads.

All stainless steel floor drains shall be as manufactured by Wicketts or approved equal with IAPMO approval. These drains shall be Type 316L stainless steel, 8” deep with removable basket, 4” diameter outlet and 12” heavy duty solid stainless steel top.

All Cast Iron floor drains shall be as manufactured by Zurn or approved equal with IAPMO approval. These shall be Cast Iron, 8” deep with removable basket, 4” diameter outlet and 12” dia. Dur-Resist cast iron grates.

Floor drains located in the cooler areas shall have deep seal P-traps. These traps shall be cast iron.

Stainless steel floor sinks or hub drains shall be located to collect condensate from the refrigeration evaporators as well as point source discharges from processing and plant services equipment. Hub drains shall be located within the thickened wall protection curbs and shall have appropriately sized increasers.

Exposed vent piping shall transition to Schedule 40 PVC at 6” above finish floor and be sized as required for either a standard vented system or, where applicable, a combination waste and vent system. All attachment hardware to be stainless steel (Sanistrut or approved equal).

Battery chargers shall be opportunity-type. No acid neutralization pit will be required.

A.3.5. Domestic Hot and Cold Water Serving the Process Areas

Domestic hot and cold water, defined as water provided upstream of the Plant Services Area back flow prevention device, shall be provided for process hand wash and meat wash sinks in the process areas. The source of domestic hot water shall be provided by multiple gas water heaters (GWH), heating water up to 185 ºF then brought back down to 120 ºF via a digital mixing station.

These systems will be constructed of Type-K copper piping and fittings with soldered joints and insulated with 1” minimum closed-cell elastomeric insulation above ceilings and in non-process areas. Exposed insulation in processing areas shall be covered with a .016”, white, PVC covering. Exposed Domestic tempered water drops in production spaces will be type 304, Sch. 40S, threaded, stainless steel pipe and fittings with no insulation below 8’ above finished floor.

All domestic/plant cold and hot water shall be softened prior to entrance into the facility.

A.3.6. Plant Hot Water

Plant hot water (140 ºF), shall be provided by GWHs and piped through a plant hot water loop system to hose stations and plant hot water needs. The maximum expected flow rate is 100 GPM and minimum pressure is 60 PSI. The GWH shall have the capacity to allow for maximum capacity during the daily clean-up process. The source of plant hot water shall be provided by multiple GWHs, heating water up to 185 ºF then brought back down to 140 ºF via a digital mixing station.

The plant hot water supply shall be piped throughout the plant in a looped system to all processing areas, plant services area and all clean- up stations. The distribution header and the branch lines shall be sized for their maximum simultaneous load.

All plant hot water lines in non-process areas shall be constructed of Type-K copper pipe and fittings and insulated with 1 1/2" minimum closed-cell elastomeric insulation with a .016", white, PVC covering. Plant hot water in production spaces will be constructed of type 304, Sch. 40S, threaded stainless steel pipe and fittings with the same insulation as described above. Exposed piping drops below 8' above finished floor will not be insulated.

A.3.7. Booster Pressure Plant Hot Water

The boosted pressure hot water system (140 ºF), shall be supplied from the plant hot water heater system and will serve all clean-up stations in the processing area.

Boosted pressure plant hot water shall be provided by boosting the plant hot water pressure to 200 PSI. The maximum expected flow rate is 90 GPM.

No recirculation from the processing areas is required. The distribution header and the branch lines shall be sized for their maximum simultaneous load.

All boosted pressure plant hot water lines in all areas shall be constructed of type 304, Sch. 40S, welded stainless steel pipe and fittings and insulated with 1 1/2" minimum closed-cell elastomeric insulation with a .016", white, PVC covering. Exposed piping drops below 8' above finished floor shall not be insulated

A.3.8. Plant Sterilization Water

The GWHs shall be able to provide plant sanitation water (185 ºF min.), to be used in process equipment sanitization through a loop system to hose stations and knife boxes in the processing area. The maximum expected flow rate is 40 GPM and minimum pressure is 60 PSI.

From the hot water plant system, plant sterilization water shall be delivered to multiple locations on the Harvest and Fabrication areas as a continuous loop, returning back to the hot water plant system in a timely manner.

Sterilization water piping shall be type 304, Sch. 40S, threaded stainless steel pipe and fittings with all runs being insulated with 2” minimum ISO-HT insulation, vinyl wrapped. Provide stainless wrap in processing areas from 8’ above finished floor to the point of use.

A.3.9. Pressure Washer System

The pressure washer units will be provided for the Industrial Area. The pressure washer system will include high pressure piping and pressure washer wands. Location of system to be determined.

A.3.10. Compressed Air

Low-pressure compressed air will be provided for the Industrial Area. The system shall consist of air compressors, receivers and refrigerated dryer. System will supply compressed air to multiple drops throughout the space. The designer shall verify the number and location of the drops with the Users of the facilities during the BCP and design stages. Each drop shall have air/water filter, pressure regulator, pressure gauge and 50 ft or 100 ft retractable compressed air hose reels (verify type with the Users). The compressed air system will be provided with a small oil/water separator to remove all oil from the condensate.

A.3.11. Emergency Fixtures

Provide emergency eyewash/shower combination station for areas that will contain hazardous items. Emergency fixture type should be based on the material safety data sheet for the hazardous material being stored.

A.3.12. Pipe Support Materials

All pipe support material in non-process areas (including the attic spaces) shall be pre-galvanized Unistrut or approved equal, attached with galvanized all-thread. All process area piping such as cleanup stations, etc. shall be comprised of all stainless steel Sanistrut or approved equal with stainless hardware and stainless threaded rod.

A.4. Fire Sprinklers

Provide wet pipe fire sprinkler system throughout entire space, located in the interstitial space between the ceiling and the roof of the facility. The riser down to the sprinkler pendants shall be dry piped to prevent freezing in the refrigeration areas.

APPENDIX D

Equipment List

		State of Hawaii Livestock Harvest and Further Processing Facility												
Equip #	Quantity	Description	Voltage	Phase	HP	Amps	KVA	W/WO Controls	Cord Drop vs. Hard Wire	Air 100 psi, CFM, 1/2" min. drop	H & C Water, 1/2" min. drop	185 PHW, GPM, 1/2" min. drop	NG	Comments
		HARVEST AREA #1 EQUIPMENT												
H-01	1	Vertical Knocking Pen Entrance Gate, 34" wide, pneumatically operated w/ 3" dia. cylinder and manual operating valve, see specifications.	-	-	-	-	-	-	-	10	-	-	-	
H-02	1	Vertical Knocking Pen Discharge Door, 5' high x 8' long w/ heavy duty frame, pneumatically operated w/ two 4" dia. cylinders, manual operating valve and head restrainer device, see specifications.	460	3ph	2 1/2	4.8	3.824	W	CD	20	-	-	-	
H-03	1	Pneumatic Captive Bolt Stunner, Jarvis model USSS-21 or approved equal with air hose assembly, air FLR and balancer.	-	-	-	-	-	-	-	175 PSI, 1.45 CFM/ cycle	-	-	-	Needs overhead support.
H-04	1	Air Compressor for Stunner, Quincy Model QT-54 or approved equal, 175 PSI with 60 gallon vertical tank and adjustable pressure switch.	230	1ph	5	28	11.1544	WO	HW		-	-	-	
H-05	40	Ft. S6"x12.5# I-beam Oval Track, 10'-0"x11'-0", including necessary (4) 36" radius x 90 deg. curves, all necessary hangers, all with hot dip galvanized finish. Also includes all necessary galvanized beam clamps to attach to building support steel supplied by others, 3/4" stainless steel vertical and diagonal bracing rods threaded on each end and welded I-beam attachments, see specifications.	-	-	-	-	-	-	-	-	-	-	-	
H-06	1	Mono-rail Hoist, 1 ton capacity w/ heavy duty trolley, plated link chain and hook, see specifications.	460	3ph	2 1/2	4.8	3.824	W	CD w/ Reel	-	-	-	-	
H-07	1	Mono-rail Hoist, 1 ton capacity w/ heavy duty trolley, plated link chain and hook, see specifications.	460	3ph	2 1/2	4.8	3.824	W	CD w/ Reel	-	-	-	-	
H-08	1	Electric Hoist, 1/2 ton capacity, plated link chain and hook, for raising empty trolley baskets to legging bench, see specifications.	460	3ph	2 1/2	4.8	3.824	W	CD	-	-	-	-	Needs overhead support.
H-09	1	3'-0" x 12'-7" Stationary First and Second Legging Platform, 100" high w/ 45 degree bend, Fibergrate top, heavy duty stainless steel framework, access ship's ladder to Rim Over Platform, guard rails and lavatory support.	-	-	-	-	-	-	-	-	-	-	-	
H-10	1	Electric Hoist, 1/2 ton capacity, plated link chain and hook, for raising second leg trolley onto rail, see specifications.	460	3ph	2 1/2	4.8	3.824	W	CD	-	-	-	-	Needs overhead support.
H-11	1	Portable Stainless Steel Blood Trap, 12.5 gallon capacity w/ 48" dia. Funnel.	-	-	-	-	-	-	-	-	-	-	-	
H-12	1	Low Voltage Beef Stimulator, Jarvis model ES-4 or approved equal w/ wall mounted control panel and nose clamp.	120	1ph	65 W	0.25	0.081	W	HW	-	-	-	-	
H-13	1	Stainless Steel Head Flush and Inspection Cabinet, 30"x33"x5'-6" high w/ two head inspection loops, head flush nozzel & 6' hose.	-	-	-	-	-	-	-	-	3/4" PCW	-	-	3" Hub Drain.
H-14	678	Ft. Overhead Rail System with 1/2" x 2-1/2", round edge, hot rolled steel tracking with electro plated finish, 1/2"x 2-1/2" hot forged steel 12" drop hangers with hot dip galvanized finish. Includes (13) 90 deg. curves, (3) 45 deg. curves, (9) 1,500# capacity automatic switches, (18) 1,500# capacity gear operated switches, (9) manual trolley stops, (5) fixed end stops. Also includes all necessary galvanized beam clamps to attach to building support steel supplied by others, 3/4" stainless steel vertical and diagonal bracing rods threaded each end and galvanized rail beam framing, see specifications.	-	-	-	-	-	-	-	-	-	-	-	
H-15	1	Hog/Sheep Insulated Stun Box w/ top access stunning, see specifications.	-	-	-	-	-	Hand	-	1.16 CF/cycle @ 90 PSI	-	-	-	
H-16	1	Electric Stunner, Best & Donovan model ES or approved equal w/ hand held prod.	120	1ph	50 W	-	0.063	W	CD	-	-	-	-	
H-17	1	Hog Combination Scalder/Dehairing Machine, portable, UltraSource model JWE 25 or approved equal for 100# to 500# hogs w/ pneumatic operated lid and ejection rake, stainless steel cover and housing.	230	3ph	3 KW & 10.0 KW	-	12	W	CD	-	-	-	-	Fill with hose.
H-18	1	Hog Singer w/ 10' hose	-	-	-	-	-	-	-	-	-	-	3/4" NG	

		State of Hawaii Livestock Harvest and Further Processing Facility											
Equip #	Quantity	Description	Voltage	Phase	HP	Amps	KVA	W/WO Controls	Cord Drop vs. Hard Wire	Air 100 psi, CFM, 1/2" min. drop	H & C Water, 1/2" min. drop	185 PHW, GPM, 1/2" min. drop	NG	Comments
H-19	1	3'-0" x 7'-8" Stationary Rim Over Platform, 50" high w/ irregular shaped end, Fibergrate top, heavy duty stainless steel framework, access ship's ladder, guard rails and lavatory support.	-	-	-	-	-	-	-	-	-	-	-	
H-20	4	Pneumatic Dehiders, Jarvis model JC-IIIA or approved equal w/ filter/lubricator/regulator and 16' hose.	-	-	-	-	-	-	-	12 CFM ea.@ 45 PSI	-	-	-	
H-21	1	Drum Type Hide Puller, UltraSource or approved equal Roll-O-Matic w/ 2 speed hoist, stn.stl. hide & leg chains, leg hold down ring and two stepped operator platform, see specifications.	460	3ph	2 1/2	4.8	3.824	W	CD	-	-	-	-	
H-22	6	Single Station Hand Wash Sink, 15.75" W x 15" D, 14 ga. Type 304 stainless steel with two knee operated valves, soap dispenser and towel dispenser.	-	-	-	-	-	-	-	-	1/2" DCW 1/2" DHW	-	-	1 1/2" NPT drain.
H-23	5	Stainless Steel Knife Sterilizer Box, 5"x8"x8" deep, hung from sink and overflows to sink bowl.	-	-	-	-	-	-	-	-	-	1 ea.	-	
		HARVEST AREA #2 EQUIPMENT												
H-24	1	2'-8" x 3'-6" Stationary Brisket Saw Platform, 7" high w/ Fibergrate top, stainless steel framework, lavatory support and adjustable legs.	-	-	-	-	-	-	-	-	-	-	-	
H-25	1	Brisket Saw, Jarvis model MG-1E or approved equal w/ Balancer, trolley and monorail track.	460	3ph	1 1/2	3	2.390	W	CD	-	-	-	-	Needs overhead support.
H-26	2	Stainless Steel Paunch & Viscera Inspection Truck w/ water operated lift mechanism for dumping into barrels, 16" to 37" and offal tray.	-	-	-	-	-	-	-	-	-	-	-	
H-27	1	Pneumatic Eviscerating Rail Dropper/Carcass Spreader w/ manual operated control valves, flow controls, internal piping and filter/lubricator/regulator, see specifications.	-	-	-	-	-	Hand	-	3.2 CF/Cycle @ 100 PSI	-	-	-	
H-28	1	2'-8" x 4'-0" Stationary Splitters Platform, 12" high w/ Fibergrate top, stainless steel framework, step and adjustable legs.	-	-	-	-	-	-	-	-	-	-	-	
H-29	1	Splitting Saw, Jarvis model M59 or approved equal w/ Balancer, Jarvis model 4042010, trolley and monorail track.	460	3ph	2	3.4	2.709	W	CD	-	-	-	-	Needs overhead support.
H-30	1	2'-8" x 5'-0" Elevating Trim & Inspection Platform, hydraulically powered, 18" to 60" high w/ Fibergrate top, stainless steel framework, access step, lavatory support and hydraulic power unit.	460	3ph	5	7.6	6.055	WO	HW	-	-	-	-	
H-31	1	Rail Scale w/ 42" long rail section, see specifications.	120	1ph	-	10	1.2	W	HW	-	-	-	-	
H-32	1	Electric Hoist, 1/2 ton capacity for lowering condemned carcasses, see specifications.	460	3ph	2 1/2	4.8	3.824	W	CD	-	-	-	-	
H-33	1	Carcass Wash Platform 3'-0" Deep x 4'-0" wide x 60" high w/ Fibergrate top, stainless steel framework, access ship's ladder and adjustable legs.	-	-	-	-	-	-	-	-	-	-	-	
H-34	1	Carcass Wash Spray Shield, stainless steel construction.	-	-	-	-	-	-	-	-	-	-	-	
H-35	1	Small Plant High Voltage Carsass Stimulator, Millard MFg. or approved equal, with safe entry floor mats and walking beam to cycle beef sides through the unit.	230	1ph	-	28	11.1544	W	HW	20	-	-	-	
H-36	1	Head and Pluck Work-up Table, 42" W x 30" D x 34" H with cutting board top, stainless steel framework and adjustable legs.	-	-	-	-	-	-	-	-	-	-	-	
H-37	10	Offal Chilling Racks, stainless steel, portable w/ casters.	-	-	-	-	-	-	-	-	-	-	-	
H-38	100	Beef Trolleys, see specifications.	-	-	-	-	-	-	-	-	-	-	-	
H-39	100	Hog Gambrels, see specifications.	-	-	-	-	-	-	-	-	-	-	-	
H-40	100	Sheep Trolleys, see specifications.	-	-	-	-	-	-	-	-	-	-	-	
H-41	100	Forequarter Hooks, see specifications.	-	-	-	-	-	-	-	-	-	-	-	
H-42	1	Stomach Opening Table, heavy duty stainless steel construction with paunch dumping section and rinsing cone.	-	-	-	-	-	-	-	-	3/4" PCW	-	-	Hand Operated Spray drop above table

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Equip #	Quantity	Description	Voltage	Phase	HP	Amps	KVA	W/WO Controls	Cord Drop vs. Hard Wire	Air 100 psi, CFM, 1/2" min. drop	H & C Water, 1/2" min. drop	185 PHW, GPM, 1/2" min. drop	NG	Comments
H-43	1	Fixed Column Dumper for 600# capacity carts.	460	3ph	2	3.4	2.709	W	HW	-	-	-	-	
H-44	1	Two Speed, Reversing Tripe Washer/Refiner, La Parmentiere Mexicali model 670R or approved equal with funnel hopper and thermostatic mixer.	460	3ph	15	21	16.7316	WO	HW	10	1" PCW	4.4	-	
H-45	1	Head and Pluck Work-up Table, 42" W x 30" D x 34" H with cutting board top, stainless steel framework and adjustable legs.	-	-	-	-	-	-	-	-	-	-	-	
H-46	3	Empty Trolley Carts, 16" x 24", portable w/ casters.	-	-	-	-	-	-	-	-	-	-	-	
H-47	1	Trolley Oil Dip Tank, 28" x 34" w/ electric heating element.	120	1ph	1,100 W	-	1.375	W	CD	-	-	-	-	
H-48	1	Electric Hoist, 1/2 ton capacity for transferring trolley carts to/from oil dip tank, see specifications.	460	3ph	2 1/2	4.8	3.824	W	CD	-	-	-	-	
H-49	4	Single Station Hand Wash Sink, 15.75" W x 15" D, 14 ga. Type 304 stainless steel with two knee operated valves, soap dispenser and towel dispenser, curb mounted on stainless steel frame.	-	-	-	-	-	-	-	-	1/2" DCW 1/2" DHW	-	-	1 1/2" NPT drain.
H-50	4	Stainless Steel Knife Sterilizer Box, 5"x8"x8" deep, hung from sink and overflows to sink bowl.	-	-	-	-	-	-	-	-	-	1 ea.	-	
		FABRICATION ROOM EQUIPMENT												
F-1	1	Rail Scale w/ 42" long rail section, see specifications.	120	1ph	-	10	1.2	W	HW	-	-	`	-	
F-2	1	Breaking Saw, Kentmaster Zip Saw or approved equal.	120	1ph	-	15	1.8	W	CD	-	-	-	-	
F-3	1	Electric Powered, Carcass Lowerator, 11'-0" to 7'-6", see specifications.	460	3ph	2	3.4	2.709	WO	HW	-	-	-	-	
F-4	1	Inclined Product Belt Conveyor, 24" wide x 6'-0" long with stainless steel framework, modular plastic belt and electric drive.	460	3ph	1	2.1	1.673	W	HW	-	-	-	-	
F-5	1	Inclined Product Belt Conveyor, 24" wide x 13'-0" long with stainless steel framework, modular plastic belt and electric drive.	460	3ph	1	2.1	1.673	W	HW	-	-	-	-	
F-6	1	Pneumatic Lift with hand operated control valve.	-	-	-	-	-	Hand	-	10	-	-	-	
F-7	1	Breaking Saw, Kentmaster Zip Saw or approved equal.	120	1ph	-	15	1.8	W	CD	-	-	-	-	
F-8	1	Band Saw, Butcher Boy, Model SA-30 or approved equal with fixed top, electric drive and water spray.	460	3ph	7 1/2	10.8	8.60483	WO	HW	-	1/2" PCW	-	-	Hand Operated Spray drop above saw
F-9	1	Saw and Operator's Platform with heavy duty stainless steel framework and fibergrate top.	-	-	-	-	-	-	-	-	-	-	-	
F-10	1	Boning Table, 30" wide x 24'-8" long with heavy duty stainless steel framework, modular plastic belt, variable speed electric drive, (8) cutting board stations and (8) ergonomic work stands.	460	3ph	3	4.8	3.824	WO	HW	-	-	-	-	
F-11	1	Trim Crossover Belt Conveyor, 8" wide x 9'-0" long with stainless steel framework, modular plastic belt and electric drive.	460	3ph	1	2.1	1.673	W	HW	-	-	-	-	
F-12	1	Overtable Bone and Inedible Trim Belt Conveyor, 20" wide x 22'-0" long with stainless steel framework, modular plastic belt, electric drive and discharge slide.	460	3ph	2	3.4	2.709	W	HW	-	-	-	-	
F-13	1	Band Saw, Butcher Boy, Model SA-20 or approved equal with fixed top, electric drive and water spray.	460	3ph	3	4.8	3.824	W	HW	-	1/2" PCW	-	-	Hand Operated Spray drop above saw
F-14	1	Saw and Operator's Platform with heavy duty stainless steel framework and fibergrate top.	-	-	-	-	-	-	-	-	-	-	-	
F-15	1	Membrane Skinner, Grasselli, Model RST520M or approved equal with electric drive.	460	3ph	2	3.4	2.709	W	HW	-	-	-	-	
F-16	1	Skinner and Operator's Platform with heavy duty stainless steel framework, fibergrate top and tote stand.	-	-	-	-	-	-	-	-	-	-	-	
F-17	1	Product Crossover Belt Conveyor, 24" wide x 8'-0" long with stainless steel framework, modular plastic belt and electric drive.	460	3ph	1	2.1	1.673	W	HW	-	-	-	-	
F-18	1	Trim Sorting Belt Conveyor, 24" wide x 10'-0" long with stainless steel framework, modular plastic belt and electric drive.	460	3ph	1	2.1	1.673	W	HW	-	-	-	-	

State of Hawaii Livestock Harvest and Further Processing Facility

Equip #	Quantity	Description	Voltage	Phase	HP	Amps	KVA	W/WO Controls	Cord Drop vs. Hard Wire	Air 100 psi, CFM, 1/2" min. drop	H & C Water, 1/2" min. drop	185 PHW, GPM, 1/2" min. drop	NG	Comments
F-19	1	Table, 24" W x 24" L x 34" H with stainless steel top, stainless steel framework, undershelf and adjustable legs.	-	-	-	-	-	-	-	-	-	-	-	
F-20	1	Manual Bagger.	-	-	-	-	-	-	-	-	-	-	-	
F-21	1	Bag Rack.	-	-	-	-	-	-	-	-	-	-	-	
F-22	1	Packaging Pacing Belt Conveyor, 30" wide x 4'-0" long with stainless steel framework, modular plastic belt and electric drive.	460	3ph	1	2.1	1.673	W	HW	-	-	-	-	
F-23	1	4'-0"X7'-0" Double Chamber Vacuum Packaging Machine, Koch Ultravac, Model 800 D or approved equal, w/ 10 HP Vacuum Pump.	240	3ph	10	25	10.392	W	CD	10	1/2" PCW	-	-	
F-24	1	Shrink Tunnel, Koch UltraShrink 3012 or approved equal.	460	3ph	1	2.1	1.673	W	HW	-	-	-	-	
F-25	1	Bag Blow-off Unit.	460	3ph	1	2.1	1.673	W	HW	-	-	-	-	
F-26	1	Bagged Product Belt Conveyor, 20" wide x 10'-0" long with stainless steel framework, modular plastic belt and electric drive.	460	3ph	2	3.4	2.709	W	HW	-	-	-	-	
F-27	8	Box Packoff Stations, stainless steel framework with roller top.	-	-	-	-	-	-	-	-	-	-	-	
F-28	1	Box Takeaway Belt Conveyor, 20" wide x 10'-0" long with stainless steel framework, modular plastic belt and electric drive.	460	3ph	2	3.4	2.709	W	HW	-	-	-	-	
F-29	1	Portable Boxing Bench Scale, 20" x 24" platform, 150# capacity with roller top, bench stand, castors, NEMA 4X pillar supported indicator with +/-1# accuracy, heavy duty stainless steel construction.	120	1ph	-	3	0.36	W	CD	-	-	-	-	
F-30	1	Label Printer to print production lot number, product I.D., piece count and box net weight in human readable and serialized bar code format. Label to be hand applied.	120	1ph	-	3	0.36	W	CD	-	-	-	-	
F-31	1	Table, 24" W x 24" L x 34" H with stainless steel top, stainless steel framework, undershelf and adjustable legs.	-	-	-	-	-	-	-	-	-	-	-	
F-32	1	Carton Taper.	120	1ph	1/2	4.4	0.528	W	CD	-	-	-	-	
F-33	1	Roller Conveyor, 20" wide x 4'-0" long with stainless steel framework and plastic rollers.	-	-	-	-	-	-	-	-	-	-	-	
F-34	1	RISCO model RS 916 Grinder/Stuffer or approved equal with cart loader, grinder/forming head and brick/loaf portioning system.	460	3ph & 1ph	20 & 1.5	27.4	21.831	W	CD	10	-	-	-	
F-35	1	RISCO model ______ Pattie Portioning System for use with RS 916 Grinder/Stuffer.	-	-	-	-	-	-	-	-	-	-	-	Utilities included in item F-34
F-36	1	Table, 40" W x 60" L x 34" H with stainless steel top, stainless steel framework, undershelf and adjustable legs.	-	-	-	-	-	-	-	-	-	-	-	
F-37	1	Roll Stock Vacuum Packaging machine.	230	3ph	-	50	19.919	W	HW	10	1/2" PCW	-	-	
F-38	1	Busch RA 0255 Vacuum Pump or approved equal for Roll Stock machine.	460	3ph	10	14	11.1544	WO	HW	-	-	-	-	Pipe to & interlock with item F-37
F-39	1	Ink Jet Printer, Bellmark or approved equal.	120	1ph	-	3	0.36	W	CD	5	-		-	
F-40	1	Metal Detector with reject system.	120	1ph	1/2	4.4	0.528	W	CD	10	-		-	
F-41	1	Boxing Table, 24" W x 24" L x 34" H with stainless steel top, stainless steel framework, undershelf and adjustable legs.	-	-	-	-	-	-	-	-	-	-	-	
F-42	1	Portable Boxing Bench Scale, 20" x 24" platform, 150# capacity with roller top, bench stand, castors, NEMA 4X pillar supported indicator with +/-1# accuracy, heavy duty stainless steel construction.	120	1ph	-	3	0.36	W	CD	-	-	-	-	
F-43	1	Label Printer to print production lot number, product I.D., piece count and box net weight in human readable and serialized bar code format. Label to be hand applied.	120	1ph	-	3	0.36	W	CD	-	-	-	-	
F-44	1	Table, 24" W x 24" L x 34" H with stainless steel top, stainless steel framework, undershelf and adjustable legs.	-	-	-	-	-	-	-	-	-	-	-	
F-45	1	Band Saw, Butcher Boy, Model SA-20 or approved equal with moving top, electric drive and water spray.	460	3ph	3	4.8	3.82437	WO	HW	-	1/2" PCW	-	-	Hand Operated Spray drop above saw
F-46	1	Saw and Operator's Platform with heavy duty stainless steel framework and fibergrate top.	-	-	-	-	-	-	-	-	-	-	-	

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Equip #	Quantity	Description	Voltage	Phase	HP	Amps	KVA	W/WO Controls	Cord Drop vs. Hard Wire	Air 100 psi, CFM, 1/2" min. drop	H & C Water, 1/2" min. drop	185 PHW, GPM, 1/2" min. drop	NG	Comments
F-47	1	Boning Table, 20" wide x 11'-0" long with heavy duty stainless steel framework, modular plastic belt, variable speed electric drive, (4) cutting board stations and (6) tote supports.	460	3ph	3	4.8	3.824	WO	HW	-	-	-	-	
F-48	1	Floor Platform Scale for 600# capacity ingredient carts, above floor low profile portable style with 3' x 3' platform, access ramps, heavy duty stainless steel construction, NEMA 4X wall mounted indicator with data output and +/-1# accuracy.	120	1ph	-	3	0.36	W	CD	-	-	-	-	
F-49	1	Fixed Column Dumper for 600# capacity carts.	460	3ph	2	3.4	2.709	W	HW	-	-	-	-	
F-50	1	300# Capacity Course Mixer/Grinder, Hollymatic model 3000 or approved equal with foot switch.	460	3ph	10 & 1.5	36	28.6828	W	HW	-	-	-	-	
F-51	1	300# Capacity Fine Mixer/Grinder, Hollymatic model 3000 or approved equal with foot switch and Gemini connection.	460	3ph	10 & 1.5	36	28.6828	W	HW	-	-	-	-	
F-52	1	Access Platform with heavy duty stainless steel framework and fibergrate top.	-	-	-	-	-	-	-	-	-	-	-	
F-53	1	Offal Packing Table, 36" deep x 48" wide with box loading shelf, stainless steel framework and cutting board top.	-	-	-	-	-	-	-	-	-	-	-	
F-54a	1	Nitrogen Double Door Cabinet Batch Freezer, 384#/batch, +40 deg. F inlet, 0 deg. F outlet with automatic on-off control, 4 stn. stl. dollies, 4 stn. stl. racks and 76 stn. stl. trays.	460	3ph	-	12	9.561	W	HW	-	-	-	-	Pipe vent to wall mounted exhaust fan.
F-54b	1	Bulk Nitrogen Tank, 3,000 gallon.	-	-	-	-	-	-	-	-	-	-	-	Nitrogen piping to cabinet, item F-54a, by vendor.
F-55	1	Pneumatic Lift with hand operated control valve.	-	-	-	-	-	Hand	-	10	-	-	-	
F-56	4	Product Wash Sink, 19.75" W x 19" D, 14 ga. Type 304 stainless steel with one knee operated valves and perforated tray, curb mounted on stainless steel frame.	-	-	-	-	-	-	-	-	1/2" DCW	-	-	1 1/2" NPT drain.
F-57	4	Stainless Steel Knife Sterilizer Box, 5"x8"x8" deep, hung from sink and overflows to sink bowl.	-	-	-	-	-	-	-	-	-	1 ea.	-	
F-58	4	Single Station Hand Wash Sink, 15.75" W x 15" D, 14 ga. Type 304 stainless steel with two knee operated valves, soap dispenser and towel dispenser, curb mounted on stainless steel frame.	-	-	-	-	-	-	-	-	1/2" DCW 1/2" DHW	-	-	1 1/2" NPT drain.
		HYGIENE LOCK EQUIPMENT												
HL-1	4	Single Station Hand Wash Sink, 15.75" W x 15" D, 14 ga. Type 304 stainless steel with two knee operated valves, soap dispenser and towel dispenser, curb mounted on stainless steel frame.	-	-	-	-	-	-	-	-	1/2" DCW 1/2" DHW	-	-	1 1/2" NPT drain.
HL-2	2	Boot Sole Washer, Roser model 11741 or approved equal.	460	3ph	1	2.1	1.673	W	HW	-	1/2" PCW 1/2" PHW	-	-	1 1/2" NPT drain.
		FINISHED GOODS COOLER EQUIPMENT												
FG-1	100	Pallet Rack for refrigerated products, selective style with uprights, load beams and wire shelving, 5 rows x 4 bays (8 pallets wide) x 3 high, less tunnels = 100 pallet positions, painted finish.	-	-	-	-	-	-	-	-	-	-	-	
		BLAST FREEZER EQUIPMENT												
BF-1	44	Pallet Rack for refrigerated products, selective style with uprights, load beams and wire shelving, 2 rows x 4 bays (8 pallets wide) x 3 high, less tunnel = 44 pallet positions, painted finish.	-	-	-	-	-	-	-	-	-	-	-	

Equip #	Quantity	State of Hawaii Livestock Harvest and Further Processing Facility Description	Voltage	Phase	HP	Amps	KVA	W/WO Controls	Cord Drop vs. Hard Wire	Air 100 psi, CFM, 1/2" min. drop	H & C Water, 1/2" min. drop	185 PHW, GPM, 1/2" min. drop	NG	Comments
		DRY STORAGE EQUIPMENT												
DS-1	38	Pallet Rack for refrigerated products, selective style with uprights, load beams and wire shelving, 2 rows x 3 1/2 bays (7 pallets wide) x 3 high, less tunnel = 38 pallet positions, painted finish.	-	-	-	-	-	-	-	-	-	-	-	
		INEDIBLE AREA EQUIPMENT												
IA-1	1	Wastewater Internally Fed Rotary Screen, IPEC model IFS 3648 or approved equal with 6" ID pipe inlet, 8" ID pipe outlet and 0.040 slot screen drum.	460	3ph	3/4	1.6	1.275	WO	HW	-	1 1/4" PHW	-	-	
IA-2	1	High Lift Combo/Barrel Dumper with self contained hydraulic power unit.	460	3ph	10	14	11.1544	WO	HW	-	-	-	-	
IA-3	1	Bone Grinder, ANCO model Duracut Prebreaker or approved equal with stainless steel feed chute with "rare earth" magnet, 25 mm cutters and 7' high heavy duty stainless steel stand.	460	3ph	100	130.04	103.609	WO	HW	-	-	-	-	
		MISCELLANEOUS EQUIPMENT												
M-1	7	Frock Racks, 1/4" x 2" stainless steel flat bar with 1/4" dia. x 1-1/2" lg. stainless steel hooks on 6" centers, 2 @ 6 hooks, 4 @ 8 hooks and 2 @ 12 hooks each.	-	-	-	-	-	-	-	-	-	-	-	
		SHIPPING/RECEIVING DOCK												
SR-1	1	Walkie Stacker, Toyota model 8BWS13, 2,500# load capacity, 143" lift height with battery and charger.	460	3ph	-	20	15.9349	W	HW	-	-	-	-	
SR-2	1	Shipping Dock Floor Scale.	120	1ph	-	3	0.36	W	CD	-	-	-	-	
							423.64							

APPENDIX E

60% Design Drawings

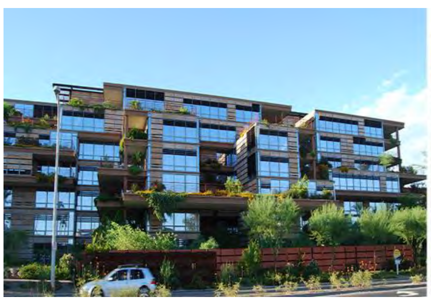
(SEE VOLUME II - UNDER SEPARATE COVER)

APPENDIX E

COST ESTIMATE

J. UNO & ASSOCIATES

CONSTRUCTION COST CONSULTANTS



Cost Estimate for:

PROJECT NAME:	**DEPARTMENT OF AGRICULTURE - STATE OF HAWAII**
	70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY
LOCATION:	**VARIOUS LOCATIONS, HAWAII**
DATE:	**4/19/2022**
PROJECT NO.:	**20321**
J. UNO NO.:	**21-226**
PREPARED FOR:	**EKNA SERVICES, INC.**
SUBMITTAL:	**60% DESIGN**

1210 Ward Avenue, Suite 204 | Honolulu, Hawaii 96814 | Telephone: 808.947.6855 | www.j-uno-associates.com

P R O J E C T   C O S T   S U M M A R Y

PROJECT:	**70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY**				ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.:	20321		DATE:	4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL:	60% DESIGN		CHECKED BY:	J. UNO
QTY BY:	J. UNO ASSOCIATES	PRICES BY:	J. UNO ASSOCIATES		DATE CHECKED:	4/19/2022

DESCRIPTION	QTY	UNIT	TOTAL UNIT COST	TOTAL
PROJECT COST SUMMARY - 70 HD				
BASE BID - MUNICIPAL WASTE DISPOSAL	1	LS		$49,174,000
TOTAL ESTIMATED CONSTRUCTION COST,	**1**	**LS**		**$49,174,000**
PROJECT COST SUMMARY - 70 HD				
BASE BID - ON SITE WASTE DISPOSAL	1	LS		$51,333,000
TOTAL ESTIMATED CONSTRUCTION COST,	**1**	**LS**		**$51,333,000**

PROJECT:	**70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY**			ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.:	20321	DATE:	4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL:	60% DESIGN	CHECKED BY:	J. UNO
QTY BY:	J. UNO ASSOCIATES	PRICES BY:	J. UNO ASSOCIATES	DATE CHECKED:	4/19/2022

PROJECT NOTES & BASIS OF COST ESTIMATE

BASIS OF ESTIMATE:

Project Type:	New Construction
Estimate Purpose:	Construction Budget Determination
Estimate Level:	60% Submittal
Method:	Quantity Takeoff, Square Foot

ESTIMATING TEAM & QUALITY CONTROL:

Lead Estimator:	J. Uno, CCP, PMP, VMA, LEED AP BD+C, Principal Estimator
Estimator(s):	D. Ing, Project Estimator
Estimator(s):	A. Davis, Project Estimator
Estimator(s):	G. Lazo, Junior Estimator
Estimator(s):	C. Stanley, Junior Estimator
Estimator(s):	C. Chon, Junior Estimator
Quality Control:	B. Katayama, Principal Estimator

SUBCONSULTANT ESTIMATES PROVIDED BY:		**RECEIVED ON:**
Civil - Sitework/ Imprv:	J. Uno & Associates, Inc.	April 19, 2022
Civil - Utilities:	J. Uno & Associates, Inc.	April 19, 2022
Site Electrical:	J. Uno & Associates, Inc.	April 19, 2022
Landscaping:	J. Uno & Associates, Inc.	April 19, 2022
Structural:	J. Uno & Associates, Inc.	April 19, 2022
Architectural:	J. Uno & Associates, Inc.	April 19, 2022
Mechanical - Plumbing:	Coffman Engineers	March 25, 2022
Mechanical - HVAC:	Coffman Engineers	March 25, 2022
Fire Sprinklers:	Coffman Engineers	March 25, 2022
Fire Alarm:	J. Uno & Associates, Inc.	April 19, 2022
Electrical - P&L:	J. Uno & Associates, Inc.	April 19, 2022
Telecomm:	J. Uno & Associates, Inc.	April 19, 2022

REFERENCED DOCUMENTS:

Name of Drawings:	2022.02.25 Scalable Livestock Harvesting Facility - 60% Design Drawings.pdf
Level of Drawings:	60% Design
Provided By:	EKNA Service, Inc.
Date Provided:	3/16/2022

CONTRACT & BIDDING ASSUMPTIONS:

Contract:	Design-Bid-Build
Bidding Situation:	Non-restrictive, competitive bids from a minimum of 4 to 5 qualified prime contract bidders. If the number of bidders amounts to less than this minimum amount, cost increases may occur.

CONSTRUCTION SCHEDULE & DURATION:

Bid Date:	January 1, 2023
Bid Award Date:	March 1, 2023
Construction Start Date:	June 1, 2023
Construction End Date:	January 1, 2025
Estimated Duration:	18 Months

PROJECT:	**70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY**			ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.:	20321	DATE:	4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL:	60% DESIGN	CHECKED BY:	J. UNO
QTY BY:	J. UNO ASSOCIATES	PRICES BY:	J. UNO ASSOCIATES	DATE CHECKED:	4/19/2022

PROJECT NOTES & BASIS OF COST ESTIMATE

COST BASIS:

Material Costs:	Based on historical local data & vendor quotes.
Labor Costs:	Prevailing wage union rates & fringe benefits.
Labor Productivity:	Based on historical local data & vendor quotes.
Equipment Costs:	Based on historical local data & vendor quotes.

MARKUPS:

Design Contingency:	Allowance to cover various construction cost increases due to design incompleteness and design and detail changes.
Prime Contractor:	Prime contractor markups include field overhead, home office expenses, profit, bonds and insurance.
Sub Contractor(s):	Sub contractor markups include field overhead, home office expenses and profit.
Bonds & Insurances:	The estimate includes Bonds & Insurances.
Taxes:	The estimate includes Hawaii General Excise Tax (GET) on the overall contract amount.
Escalation to Midpoint:	The estimate includes Escalation to the Approximate Midpoint of Construction.

ESTIMATE ASSUMPTIONS:

Facility Size:	Assumes 70 Head per Day
Facility Location:	Assumes Rural Oahu Location, Location Adjustments must be made for specific sites on Neighbor Island locations
Site Utilities:	Assumes Utility Connections are readily available at the perimeter of the Site
Phasing:	Assume no phasing of project scope through construction.
Access Restrictions:	Assume no access restrictions to contractor throughout duration of work.
Workhours:	Assume normal daytime workhours with no planned overtime.
Geotechnical:	Assume existing soil retains adequate load bearing properties for the proposed foundations.

EXCLUDED COSTS:

1. Soft Costs
2. Monorails, Chain Hoists, Trolleys, etc.
2. Furniture, Fixtures & Equipment (FF&E) Unless Otherwise Noted
3. Owner's Construction Contingency (Change Orders From Unforeseen Conditions)
4. Owner's Scope Contingency (Change Orders From Owner's Scope Changes)

GENERAL NOTE:

This estimate is an opinion of probable construction cost created by J. Uno & Associates, Inc (J. UNO). It is based on delivered information, documentation and prices assumed to be true, accurate and valid at the time of estimation. J. UNO uses proprietary procedures and formulae in producing this estimate, and it represents our experience and qualifications as construction cost professionals generally familiar with the industry in respective areas. J. UNO shall not be held liable for design changes made after this estimate has been submitted, nor for errors and omissions not exposed during a normal design review process. The recipient of this estimate is urged to review it carefully and address any discrepancies. This estimate shall not be altered without prior consent from J. UNO.

PROJECT:	**70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY**			ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.:	20321	DATE:	4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL:	60% DESIGN	CHECKED BY:	J. UNO
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	ENCLOSED		UNENCLOSED		TOTAL AREA	
DESCRIPTION	AREA	% FACTOR	AREA	% FACTOR	TOTAL	UOM
PROJECT AREA ANALYSIS						
PRIMARY FACILITIES						
70 HD FACILITY	24,768	100%	-	50%	**24,768**	**ASF**

PROJECT AREA CALCULATION NOTES

PRIMARY FACILITIES

Project areas are calculated using an adjusted square foot (ASF) or adjusted square meter (ASM) method.
100% of enclosed spaces + 50% of unenclosed covered spaces = total ASF or ASM

PROJECT:	70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY			ESTIMATE NO.:	21-226
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ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL:	60% DESIGN	CHECKED BY:	J. UNO
QTY BY:	J. UNO ASSOCIATES	PRICES BY:	J. UNO ASSOCIATES	DATE CHECKED:	4/19/2022

	QTY/DURATION		RATE		
DESCRIPTION	QTY	UOM	RATE	UOM	TOTAL
JOB OFFICE OVERHEAD ASSUMPTIONS					
SUPERVISION & MANAGEMENT					
Project Manager	24	mo	$19,350	mo	$464,389
Superintendents, General	18	mo	$16,477	mo	$296,585
Superintendents, Civil	4	mo	$16,477	mo	$65,908
Superintendents, Electrical	6	mo	$18,125	mo	$108,748
Superintendents, Mechanical	12	mo	$17,301	mo	$207,609
Pickup Truck, 1/2 Ton, Crew Cab	18	mo	$1,750	mo	$31,500
Pickup Truck, 1/2 Ton, Crew Cab	18	mo	$1,750	mo	$31,500
ADMINISTRATION JOB OFFICE					
FIELD OFFICE ADMINISTRATION PERSONNEL					
Office Managers	18	mo	$12,835	mo	$231,031
Clerks, Typists, Bookkeepers, Receptionist	4	mo	$6,044	mo	$24,174
FIELD OFFICE BUILDING & SUPPLIES					
Office Trailer, Delivery & Return	1	ea	$9,343	ea	$9,343
Office Trailer, Furnished, Rent/Month, No Util.	18	mo	$2,664	mo	$47,953
Office Equipment & Furniture	18	mo	$500	mo	$9,000
Office Supplies	18	mo	$100	mo	$1,800
FIELD OFFICE SECURITY PERSONNEL					
Security Chiefs	9	mo	$15,255	mo	$137,292
Security Watchmen & Guards	18	mo	$5,295	mo	$95,317
FIELD OFFICE UTILITY INSTALLATION					
Install Telcom	1	ea	$500	ea	$500
Install Electrical	1	ea	$500	ea	$500
Install Sewer	1	ea	$500	ea	$500
Install Water	1	ea	$500	ea	$500
FIELD OFFICE UTILITY USSAGE FEES					
Usage Fees, Telcom	18	mo	$400	ea	$7,200
Usage Fees, Electrical	18	mo	$300	ea	$5,400
Usage Fees, Sewer	18	mo	$100	ea	$1,800
Usage Fees, Water	18	mo	$150	ea	$2,700
ENGINEERING & SURVEYING					
FIELD ENGINEERING PERSONNEL					
Engineers, Project	18	mo	$13,778	mo	$247,996
Engineers, Project	18	mo	$13,778	mo	$247,996
QUALITY CONTROL & TESTING					
Quality Control Engineer	18	mo	$18,501	mo	$333,011
Food Safety QA Engineer	18	mo	$18,501	mo	$333,011
SAFETY & TRAFFIC CONTROL					
SAFETY MANAGEMENT					
Safety Engineers	18	mo	$17,235	mo	$310,237

J O B   O F F I C E   O V E R H E A D   A S S U M P T I O N S

PROJECT:	70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY			ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.:	20321	DATE:	4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL:	60% DESIGN	CHECKED BY:	J. UNO
QTY BY:	J. UNO ASSOCIATES	PRICES BY:	J. UNO ASSOCIATES	DATE CHECKED:	4/19/2022

	QTY/DURATION		RATE		
DESCRIPTION	QTY	UOM	RATE	UOM	TOTAL
JOB OFFICE OVERHEAD ASSUMPTIONS					
SANITATION FACILITIES/ TEMP. BUILDINGS					
SANITATION FACILITIES					
Water Closet, Chemical Portable Toilet	36	mo	$760	mo	$27,360
Handwashing Stations	18	mo	$199	mo	$3,581
Handwashing Stations Return Charge	2	ea	$366	ea	$733
TEMPORARY BUILDINGS					
Storage Boxes, 20'x8' *Incl. Delivery & Return	18	mo	$800	mo	$14,400
Temporary Fencing, Chain Link, 8' High, 11.5 Ga.	100	lf	$17.95	lf	$1,795
Rental Charge Per Month	18	mo	$80	mo	$1,440
GENERAL EQUIPMENT EXPENSES					
HOOK SERVICES					
Crane, Mobilization & Demobilization	2	ea	$25,000	ea	$50,000
Crane, Equipment Operator	32	wk	$3,910	wk	$125,133
Crane, Riggers	32	wk	$9,288	wk	$297,216
Crane, Hydraulic, Truck Mtd., 15 Ton, 50' Boom, w/ Op	160	dy	$995	dy	$159,200
MISC. VEHICLES & EQUIPMENT					
Water Truck, 4,000 Gal.	2	mo	$6,000	mo	$12,000
Telehandler Forklift, 10,000 lb	12	mo	$5,200	mo	$62,400
Manhoist, Scissors Lift, 32'	36	mo	$1,440	mo	$51,840
Manhoist, Articulating Lift, Rough Terrain, 60'	6	mo	$2,950	mo	$17,700
PROJECT SITE UTILITIES & CLEANUP					
SITE CLEANUP					
Daily Site Cleanup	18	mo	$1,444	mo	$25,992
Final Site Cleanup	160	hr	$433	hr	$69,312
Rental, Dumpster 40 CY Trash Bin *Incl. Mobe	18	mo	$966	mo	$17,388
Project Garbage Service & Disposal Fee	18	mo	$1,200	mo	$21,600
MISC. PROJECT EXPENSES					
Project Sign, High Intensity Reflectorized, 4x8	32	sf	$64	sf	$2,048
MOBILIZATION & PREPATORY WORK					
Mob. Truck, 10,000 GVW w/ 8'x12' Flat Bed	2	wk	$1,900	wk	$3,800
Mobilization Crew	80	hr	$480	hr	$38,390
DEMOBILIZATION WORK					
Mob. Truck, 10,000 GVW w/ 8'x12' Flat Bed	1	wk	$1,900	wk	$1,900
Demobilization Crew	40	hr	$480	hr	$19,195
TOTAL, JOOH,					**$4,277,923**
% OF COST TO PRIME,					11.92%

P R O J E C T C O S T S U M M A R Y					
PROJECT:	**70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY**			ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.:	20321	DATE:	4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL:	60% DESIGN	CHECKED BY:	J. UNO
QTY BY:	J. UNO ASSOCIATES	PRICES BY:	J. UNO ASSOCIATES	DATE CHECKED:	4/19/2022

PROJECT COST SUMMARY - 70 HD - MUNICIPAL SEWER DISPOSAL

CODE	DESCRIPTION	QTY	UNIT	UNIT COST (TOTAL)	TOTAL
(EN)	HAZMAT/ ENVIRONMENTAL (SUB)	1	LS		NONE ASSUMED
(CS)	CIVIL - SITEWORK/ IMPROVEMENTS	1	LS		$4,349,097
(CU)	CIVIL/ MECHANICAL - UTILITIES	1	LS		$550,987
(SE)	SITE ELECTRICAL/ TELECOM (SUB)	1	LS		$1,274,590
(LS)	LANDSCAPING (SUB)	1	LS		$793,726
(ST)	STRUCTURAL (SUB)	24,768	ASF	$183.79	$4,552,081
(AR)	ARCHITECTURAL (SUB)	24,768	ASF	$112.43	$2,784,653
(PL)	MECHANICAL - PLUMBING (SUB)	140	FIXT	$12,935.80	$1,811,013
(ME)	MECHANICAL - HVAC (SUB)	24,768	ASF	$252.47	$6,253,169
(FP)	FIRE PROTECTION - SPRINKLERS (SUB)	24,768	ASF	$35.97	$890,840
(FA)	FIRE PROTECTION - ALARM (SUB)	24,768	ASF	$7.55	$186,952
(EL)	ELECTRICAL - POWER & LIGHTING (SUB)	24,768	ASF	$129.33	$3,203,296
(TC)	COMMUNICATIONS & SECURITY (SUB)	24,768	ASF	$5.87	$145,465
(FF)	FURNITURE, FURNISHINGS & EQUIPMENT (FF&E) (SUB)	1	LS		$636,405
SUBTOTAL, ESTIMATED DIRECT COST (INCLUDES SUBCONTRACTOR MARKUPS),					**$27,432,274**

PROJECT:	**70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY**			ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.:	20321	DATE:	4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL:	60% DESIGN	CHECKED BY:	J. UNO
QTY BY:	J. UNO ASSOCIATES	PRICES BY:	J. UNO ASSOCIATES	DATE CHECKED:	4/19/2022

DESCRIPTION	QTY	UNIT	TOTAL UNIT COST	TOTAL
PROJECT COST SUMMARY - 70 HD - MUNICIPAL SEWER DISPOSAL				
DIRECT MARKUPS				
LOCATION FACTOR, TBD				
ESCALATION TO MIDPOINT OF CONSTRUCTION (CPI-U),	16.29%			$4,469,175
DESIGN CONTINGENCY,	12.50%			$3,987,681
SUBTOTAL, ESTIMATED DIRECT COST TO PRIME,				**$35,889,129**
PRIME CONTRACTOR MARKUPS				
PRIME CONTRACTOR'S JOOH,	11.92%			$4,277,923
PRIME CONTRACTOR'S HOOH,	5.10%			$2,048,520
PRIME CONTRACTOR'S PROFIT,	8.00%			$3,377,246
BOND & INSURANCE,	3.00%			$1,367,785
G.E. TAX,	4.712%			$2,212,784
TOTAL ESTIMATED CONTRACT COST,				**$49,173,386**
ROUNDED,	**24,768**	**ASF**	**$1,985.38**	**$49,174,000**

PROJECT:	70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY		ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.: 20321	DATE:	4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL: 60% DESIGN	CHECKED BY:	J. UNO
QTY BY:	J. UNO ASSOCIATES	PRICES BY: J. UNO ASSOCIATES	DATE CHECKED:	4/19/2022

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL TOTAL
(CS) CIVIL - SITEWORK/ IMPROVEMENTS								
G1010 - SITE CLEARING								
SITE CLEARING								
Clearing and Grubbing	14	acr			$11,107.80	$150,134	$11,107.80	$150,134
EROSION CONTROLS								
Construction Fence	3,072	lf	$11.35	$34,867	$32.15	$98,765	$43.50	$133,632
Filter Sock	3,072	lf	$5.00	$15,360	$3.75	$11,520	$8.75	$26,880
G1030 - SITE EARTHWORK								
GRADING								
Fine Grading	14	acr			$11,979.00	$161,910	$11,979.00	$161,910
G2020 - PARKING LOTS								
PAVING								
AC Pavement, 3" Thick	158,174	sf	$3.25	$514,066	$1.54	$243,193	$4.79	$757,258
Base Course, 6"	2,929	cy	$48.00	$140,599	$16.00	$46,866	$64.00	$187,465
Subbase Course, 6"	2,929	cy	$32.00	$93,733	$16.00	$46,866	$48.00	$140,599
MARKING & SIGNAGE								
Parking Stall Striping, 4" Wide	1,716	lf	$0.45	$772	$4.00	$6,864	$4.45	$7,636
Sign & Post, Includes Footing	3	ea	$500.00	$1,500	$600.00	$1,800	$1,100.00	$3,300
Wheel Stops, Concrete	67	ea	$85.00	$5,695	$100.00	$6,700	$185.00	$12,395
G2030 - PEDESTRIAN PAVING								
WALKWAYS								
Concrete Paving, 6"	3,304	sf	$11.70	$38,657	$14.55	$48,073	$26.25	$86,730
Base Course, 6"	61	cy	$48.00	$2,937	$16.00	$979	$64.00	$3,916
G2040 - SITE DEVELOPMENT								
SITE IMPROVEMENTS								
Perimeter Chain-Link Fencing	3,038	lf	$44.00	$133,672	$33.33	$101,267	$77.33	$234,939
Swing Gates, 24'W	2	ea	$1,500.00	$3,000	$800.00	$1,600	$2,300.00	$4,600
Mech Yard	1,070	sf	$32.00	$34,240	$30.00	$32,100	$62.00	$66,340
Mech Yard Fencing	139	lf	$38.50	$5,352	$33.33	$4,633	$71.83	$9,985
Gates, Double	3	pr	$850.00	$2,550	$800.00	$2,400	$1,650.00	$4,950
Holding Pen Ramp	920	sf	$6.65	$6,118	$7.60	$6,992	$14.25	$13,110
Loading Dock Ramp	1,240	sf	$6.65	$8,246	$7.60	$9,424	$14.25	$17,670
Shipping/Receiving Ramp	1,702	sf	$6.65	$11,318	$7.60	$12,935	$14.25	$24,254
Solid Waste Compost Area	183,488	sf	$5.00	$917,440	$3.75	$688,080	$8.75	$1,605,520
Gravel Access Road	405	sf						
Excavation	8	cy			$43.75	$328	$43.75	$328
Gravel Fill	8	bcy	$73.27	$550	$118.75	$891	$192.02	$1,440
Compaction	405	sf			$1.50	$608	$1.50	$608
Hauling of Excv. Soil	8	lcy			$17.19	$142	$17.19	$142

PROJECT:	**70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY**		ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.: 20321	DATE:	4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL: 60% DESIGN	CHECKED BY:	J. UNO
QTY BY:	J. UNO ASSOCIATES	PRICES BY: J. UNO ASSOCIATES	DATE CHECKED:	4/19/2022

(CS) CIVIL - SITEWORK/ IMPROVEMENTS

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL TOTAL
Aerated Lagoon 1	13,721	sf	$4.00	$54,884	$3.75	$51,454	$7.75	$106,338
Base Course	254	bcy	$73.27	$18,618	$59.38	$15,087	$132.65	$33,705
Geotextile Fabric	13,721	sf	$0.17	$2,318	$0.67	$9,147	$0.84	$11,465
Polypropylene Liner	13,721	sf	$0.17	$2,318	$0.67	$9,147	$0.84	$11,465
Aerated Lagoon 2	17,516	sf	$4.00	$70,064	$3.75	$65,685	$7.75	$135,749
Base Course	324	bcy	$73.27	$23,768	$59.38	$19,259	$132.65	$43,027
Geotextile Fabric	17,516	sf	$0.17	$2,959	$0.67	$11,677	$0.84	$14,636
Polypropylene Liner	17,516	sf	$0.17	$2,959	$0.67	$11,677	$0.84	$14,636
Blower Building	548	sf						
Floor Slab, 12"	548	sf						
Excavation	10	bcy			$43.75	$444	$43.75	$444
Compact Exist. Subgrade	603	sf			$1.19	$716	$1.19	$716
Base Course	10	bcy	$73.27	$744	$59.38	$603	$132.65	$1,346
Vapor Barrier	548	sf	$0.17	$93	$0.67	$365	$0.84	$458
Formwork	240	sf	$2.20	$528	$4.00	$960	$6.20	$1,488
Rebar Reinforcement	3,426	lb	$1.10	$3,772	$1.00	$3,426	$2.10	$7,198
Concrete	27	cy	$245.25	$6,722	$54.69	$1,499	$299.93	$8,220
Trowel/ Float Finish	644	sf			$2.00	$1,288	$2.00	$1,288
Hauling of Excv. Soil	11	lcy			$17.19	$192	$17.19	$192
Concrete Walls, 12"	2,776	sf						
Formwork	5,552	sf	$4.40	$24,429	$6.67	$37,013	$11.07	$61,442
Rebar Reinforcement	19,535	lb	$1.10	$21,510	$1.00	$19,535	$2.10	$41,045
Concrete	103	cy	$245.25	$25,215	$109.38	$11,245	$354.62	$36,460
Grind & Rub Finish	5,552	sf			$2.00	$11,104	$2.00	$11,104
Roof Beams, 18"x12"	91	lf						
Shoring, Pipe Column	137	sf	$3.00	$410	$4.00	$546	$7.00	$956
Formwork	322	sf	$4.40	$1,415	$6.67	$2,143	$11.07	$3,558
Rebar Reinforcement	910	lb	$1.10	$1,002	$1.00	$910	$2.10	$1,912
Concrete	5	cy	$245.25	$1,240	$109.38	$553	$354.62	$1,793
Grind & Rub Finish	455	sf			$2.00	$910	$2.00	$910
Roof Slab, 12"	1,121	sf						
Shoring, Pipe Column	1,121	sf	$3.00	$3,363	$4.00	$4,484	$7.00	$7,847
Formwork	1,324	sf	$4.40	$5,823	$6.67	$8,823	$11.07	$14,647
Rebar Reinforcement	4,982	lb	$1.10	$5,486	$1.00	$4,982	$2.10	$10,468
Concrete	42	cy	$245.25	$10,182	$109.38	$4,541	$354.62	$14,723
Trowel/ Float Finish	2,445	sf			$2.00	$4,889	$2.00	$4,889
Equipment Pad, 4"	46	sf						
Formwork	35	sf	$2.20	$77	$4.00	$139	$6.20	$216
Rebar Reinforcement	70	lb	$1.10	$77	$1.00	$70	$2.10	$148
Concrete	1	cy	$245.25	$138	$54.69	$31	$299.93	$169
Trowel/ Float Finish	60	sf			$2.00	$120	$2.00	$120
Blower, Equipment	2	ea	$20,000.00	$40,000	$3,400.00	$6,800	$23,400.00	$46,800

PROJECT:	70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY		ESTIMATE NO.: 21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.: 20321	DATE: 4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL: 60% DESIGN	CHECKED BY: J. UNO
QTY BY:	J. UNO ASSOCIATES	PRICES BY: J. UNO ASSOCIATES	DATE CHECKED: 4/19/2022

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL TOTAL
(CS) CIVIL - SITEWORK/ IMPROVEMENTS								
Emergency Generator Pad	157	sf						
Excavation	3	bcy			$43.75	$127	$43.75	$127
Compact Exist. Subgrade	173	sf			$1.19	$205	$1.19	$205
Base Course	3	bcy	$73.27	$213	$59.38	$173	$132.65	$386
Vapor Barrier	157	sf	$0.17	$27	$0.67	$105	$0.84	$131
Formwork	138	sf	$2.20	$303	$4.00	$550	$6.20	$853
Rebar Reinforcement	1,236	lb	$1.10	$1,361	$1.00	$1,236	$2.10	$2,597
Concrete	10	cy	$245.25	$2,425	$54.69	$541	$299.93	$2,966
Trowel/ Float Finish	212	sf			$2.00	$424	$2.00	$424
Hauling of Excv. Soil	3	lcy			$17.19	$55	$17.19	$55
Transformer Pad	120	sf						
Excavation	2	bcy			$43.75	$97	$43.75	$97
Compact Exist. Subgrade	132	sf			$1.19	$157	$1.19	$157
Base Course	2	bcy	$73.27	$163	$59.38	$132	$132.65	$295
Vapor Barrier	120	sf	$0.17	$20	$0.67	$80	$0.84	$100
Formwork	110	sf	$2.20	$242	$4.00	$440	$6.20	$682
Rebar Reinforcement	963	lb	$1.10	$1,060	$1.00	$963	$2.10	$2,023
Concrete	8	cy	$245.25	$1,889	$54.69	$421	$299.93	$2,311
Trowel/ Float Finish	164	sf			$2.00	$328	$2.00	$328
Hauling of Excv. Soil	2	lcy			$17.19	$42	$17.19	$42
Bollards, Painted	20	ea	$1,200.00	$24,000	$200.00	$4,000	$1,400.00	$28,000
SUBTOTAL,	**1**	**LS**		**$2,332,486**		**$2,016,611**		**$4,349,097**

C O S T A N A L Y S I S

PROJECT:	**70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY**		ESTIMATE NO.: 21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.: 20321	DATE: 4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL: 60% DESIGN	CHECKED BY: J. UNO
QTY BY:	J. UNO ASSOCIATES	PRICES BY: J. UNO ASSOCIATES	DATE CHECKED: 4/19/2022

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL TOTAL
(CU) CIVIL/ MECHANICAL - UTILITIES								
G3010 - WATER SUPPLY								
WATERLINE								
8" Waterline, In Place Complete	669	LF						
Excavation	297	cy			$56.25	$16,725	$56.25	$16,725
Hauling of Excv. Soil	327	lcy			$11.88	$3,884	$11.88	$3,884
Pipe Bedding	119	lcy	$99.78	$11,867	$28.13	$3,345	$127.91	$15,212
Backfill, Exist. Soil	178	bcy			$28.13	$5,018	$28.13	$5,018
Water Line, 8" Dia. PVC	669	lf	$26.40	$17,662	$15.00	$10,035	$41.40	$27,697
Connection to Building	1	ea	$500.00	$500	$1,500.00	$1,500	$2,000.00	$2,000
Connection to Exist. Water Line	2	ea	$500.00	$1,000	$3,750.00	$7,500	$4,250.00	$8,500
Water Meter	1	ea	$10,000.00	$10,000	$2,040.00	$2,040	$12,040.00	$12,040
Reduced Pressure Backflow Preventer, 8"	1	ea	$24,000.00	$24,000	$4,200.00	$4,200	$28,200.00	$28,200
Fire Hydrant	3	ea	$4,800.00	$14,400	$7,100.00	$21,300	$11,900.00	$35,700
G3020 - SANITARY SEWER								
SEWER LINE								
8" Sewer, In Place Complete	1,130	LF						
Excavation	502	cy			$56.25	$28,250	$56.25	$28,250
Hauling of Excv. Soil	552	lcy			$11.88	$6,560	$11.88	$6,560
Pipe Bedding	201	lcy	$99.78	$20,045	$28.13	$5,650	$127.91	$25,695
Backfill, Exist. Soil	301	bcy			$28.13	$8,475	$28.13	$8,475
Sanitary Line, 8" Dia. PVC	1,130	lf	$26.40	$29,832	$15.00	$16,950	$41.40	$46,782
Connection to Building	3	ea	$500.00	$1,500	$1,500.00	$4,500	$2,000.00	$6,000
Connection to Exist. Sanitary Line	1	ea	$500.00	$500	$3,750.00	$3,750	$4,250.00	$4,250
Sewer Manholes	6	ea	$11,600.00	$69,600	$3,400.00	$20,400	$15,000.00	$90,000
Grease Interceptor	1	ea	$45,000.00	$45,000	$15,000.00	$15,000	$60,000.00	$60,000
G3030 - STORM SEWER								
STORM DRAINAGE								
Drywell	6	ea	$15,000.00	$90,000	$5,000.00	$30,000	$20,000.00	$120,000
SUBTOTAL,	**1**	**LS**		**$335,905**		**$215,082**		**$550,987**

PROJECT:	**70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY**		ESTIMATE NO.: 21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.: 20321	DATE: 4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL: 60% DESIGN	CHECKED BY: J. UNO
QTY BY:	J. UNO ASSOCIATES	PRICES BY: J. UNO ASSOCIATES	DATE CHECKED: 4/19/2022

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL
(SE) SITE ELECTRICAL/ TELECOM (SUBCONTRACTOR)								
G4010 - ELECTRICAL DISTRIBUTION								
PRIMARY DISTRIBUTION (CONDUIT ASSUMED FROM XFMR PAD TO NORTH PROPERTY LINE)								
Ductbank, 2'W x 4'D	110	lf						
Excavation	33	bcy			$47.75	$1,556	$47.75	$1,556
Compaction, Trench Bottom	220	sf			$1.29	$283	$1.29	$283
Concrete	8	cy	$245.25	$1,998	$59.69	$486	$304.93	$2,485
Reinforcing Steel	978	lbs	$1.10	$1,077	$1.10	$1,076	$2.20	$2,152
Backfill, Native Soils	28	lcy			$64.38	$1,783	$64.38	$1,783
Compaction, 12" Lifts	660	sf			$1.29	$850	$1.29	$850
Hauling/Disposal of Spoils	9	lcy	$15.00	$134	$18.44	$165	$33.44	$300
Conduit, PVC Sch40, 4"	220	lf	$18.77	$4,129	$14.75	$3,245	$33.52	$7,374
Concrete Pad, 8" Thick	100	sf	$12.78	$1,275	$21.07	$2,102	$33.85	$3,377
SECONDARY DISTRIBUTION								
Ductbank, 2'W x 4'D	40	lf						
Excavation	12	bcy			$47.75	$566	$47.75	$566
Compaction, Trench Bottom	80	sf			$1.29	$103	$1.29	$103
Concrete	3	cy	$245.25	$727	$59.69	$177	$304.93	$904
Reinforcing Steel	356	lbs	$1.10	$392	$1.10	$391	$2.20	$783
Backfill, Native Soils	10	lcy			$64.38	$649	$64.38	$649
Compaction, 12" Lifts	240	sf			$1.29	$309	$1.29	$309
Hauling/Disposal of Spoils	3	lcy	$15.00	$49	$18.44	$60	$33.44	$109
Conduit, PVC Sch40, 4"	240	lf	$18.77	$4,505	$14.75	$3,540	$33.52	$8,045
Wire, 500MCM, XHHW, Copper	1,030	lf	$18.62	$19,174	$6.60	$6,795	$25.22	$25,970
Wire, 350MCM, XHHW, Copper	343	lf	$13.66	$4,689	$5.83	$2,001	$19.49	$6,690
G4020 - SITE LIGHTING								
EGRESS/ SECURITY LIGHTING (NOT ON DRAWINGS)								
Egress, Wall Pack, w/ Batt, at Exterior Doo	10		$750.00	$7,500	$440.00	$4,400	$1,190.00	$11,900
Security, Wall Pack, Flood Light	26		$1,500.00	$39,000	$1,180.00	$30,680	$2,680.00	$69,680
Security, 35' Pole Light, Flood Light	14		$12,500.00	$175,000	$2,960.00	$41,440	$15,460.00	$216,440
G4030 - SITE COMMUNICATION AND SECURITY								
TELECOM/CATV/SPARE INFRASTRUCTURE (NOT ON DRAWING)								
Ductbank, 2'W x 4'D	130	lf						
Excavation	39	bcy			$47.75	$1,839	$47.75	$1,839
Compaction, Trench Bottom	260	sf			$1.29	$335	$1.29	$335
Concrete	10	cy	$245.25	$2,362	$59.69	$575	$304.93	$2,936
Reinforcing Steel	1,156	lbs	$1.10	$1,272	$1.10	$1,271	$2.20	$2,543
Backfill, Native Soils	33	lcy			$64.38	$2,108	$64.38	$2,108
Compaction, 12" Lifts	780	sf			$1.29	$1,004	$1.29	$1,004
Hauling/Disposal of Spoils	11	lcy	$15.00	$159	$18.44	$195	$33.44	$354
Conduit, PVC Sch40, 4"	390	lf	$18.77	$7,320	$14.75	$5,753	$33.52	$13,072
Communications Hand Hole	1	ea	$4,500.00	$4,500	$2,220.00	$2,220	$6,720.00	$6,720

C O S T A N A L Y S I S

PROJECT:	**70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY**		ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.: 20321	DATE:	4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL: 60% DESIGN	CHECKED BY:	J. UNO
QTY BY:	J. UNO ASSOCIATES	PRICES BY: J. UNO ASSOCIATES	DATE CHECKED:	4/19/2022

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL TOTAL
(SE) SITE ELECTRICAL/ TELECOM (SUBCONTRACTOR)								
G4090 - OTHER SITE ELECTRICAL UTILITIES								
GENERATOR								
Generator, 750kW, 480/277V, Enclosure	1	ea	$450,000	$450,000	$43,200.00	$43,200	$493,200	$493,200
EMERGENCY DISTRIBUTION								
Ductbank, 2'W x 4'D	75	lf						
Excavation	22	bcy			$47.75	$1,061	$47.75	$1,061
Compaction, Trench Bottom	150	sf			$1.29	$193	$1.29	$193
Concrete	6	cy	$245.25	$1,362	$59.69	$332	$304.93	$1,694
Reinforcing Steel	667	lbs	$1.10	$734	$1.10	$733	$2.20	$1,467
Backfill, Exist. Soil	19	lcy			$64.38	$1,216	$64.38	$1,216
Compaction, 12" Lifts	450	sf			$1.29	$579	$1.29	$579
Hauling/Disposal of Spoils	6	lcy	$15.00	$92	$18.44	$113	$33.44	$204
Conduit, PVC Sch40, 4"	300	lf	$18.77	$5,631	$14.75	$4,425	$33.52	$10,056
Conduit, PVC Sch40, 1"	75	lf	$3.81	$286	$3.41	$256	$7.22	$541
Wire, 500MCM, XHHW, Copper	1,287	lf	$18.62	$23,968	$6.60	$8,494	$25.22	$32,462
Wire, 350MCM, XHHW, Copper	429	lf	$13.66	$5,861	$5.83	$2,501	$19.49	$8,362
Wire, 250MCM, XHHW, Copper	429	lf	$10.63	$4,559	$4.40	$1,888	$15.03	$6,446
Wire, #10 AWG, XHHW, Copper	399	lf	$0.58	$233	$1.17	$466	$1.75	$698
SITE OPTION #1 - CONNECT TO EXISTING SEWER								
Blower Bldg & Aerated Lagoon Power	1	ls	$30,000.00	$30,000	$20,000.00	$20,000	$50,000.00	$50,000
SUBTOTAL,				$797,985		$203,413		$1,001,399
SUBCONTRACTOR JOOH,			5.00%	$39,899	5.00%	$10,171	5.00%	$50,070
SUBCONTRACTOR HOOH,			10.20%	$85,464	10.20%	$21,786	10.20%	$107,250
SUBCONTRACTOR PROFIT,			10.00%	$92,335	10.00%	$23,537	10.00%	$115,872
SUBTOTAL,	**1**	**LS**		**$1,015,684**		**$258,907**		**$1,274,590**

C O S T A N A L Y S I S

PROJECT:	**70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY**	ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII PROJECT NO.: 20321	DATE:	4/19/2022
ARCHITECT:	EKNA SERVICES, INC. SUBMITTAL: 60% DESIGN	CHECKED BY:	J. UNO
QTY BY:	J. UNO ASSOCIATES PRICES BY: J. UNO ASSOCIATES	DATE CHECKED:	4/19/2022

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL TOTAL
(LS) LANDSCAPING (SUBCONTRACTOR)								
G205003 - TOPSOIL & PLANTING BEDS								
Top Soil, 2" Thick	1,080	cy	$72.00	$77,789	$16.00	$17,287	$88.00	$95,076
G205004 - SEEDING, SPRIGGING & SODDING								
Grassing	175,026	sf	$0.15	$26,254	$0.35	$61,259	$0.50	$87,513
G205007 - IRRIGATION SYSTEMS								
Irrigation System	175,026	sf	$0.80	$140,021	$1.61	$281,792	$2.41	$421,813
OTHER								
Maintenance Period	12	mo			$1,600.00	$19,200	$1,600.00	$19,200
SUBTOTAL,				$244,064		$379,537		$623,602
SUBCONTRACTOR JOOH,			5.00%	$12,203	5.00%	$18,977	5.00%	$31,180
SUBCONTRACTOR HOOH,			10.20%	$26,139	10.20%	$40,648	10.20%	$66,788
SUBCONTRACTOR PROFIT,			10.00%	$28,241	10.00%	$43,916	10.00%	$72,157
SUBTOTAL,	**1**	**LS**		**$310,647**		**$483,079**		**$793,726**

PROJECT:	**70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY**		ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.: 20321	DATE:	4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL: 60% DESIGN	CHECKED BY:	J. UNO
QTY BY:	J. UNO ASSOCIATES	PRICES BY: J. UNO ASSOCIATES	DATE CHECKED:	4/19/2022

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL TOTAL
(ST) STRUCTURAL (SUBCONTRACTOR)								
PROCESSING FACILITY								
A1010 - STANDARD FOUNDATIONS								
WALL FOUNDATIONS								
WF- - 2'0"x1'0"xL	445	LF						
Excavation	199	bcy			$43.75	$8,692	$43.75	$8,692
Compact Exist. Subgrade	1,788	sf			$1.19	$2,123	$1.19	$2,123
Base Course	16	bcy	$73.27	$1,208	$59.38	$979	$132.65	$2,186
Formwork	1,341	sf	$2.20	$2,950	$4.00	$5,364	$6.20	$8,314
Rebar Reinforcement	3,956	lb	$1.10	$4,355	$1.00	$3,956	$2.10	$8,311
Concrete	33	cy	$245.25	$8,084	$54.69	$1,803	$299.93	$9,887
Backfill, Exist. Soil	66	bcy			$59.38	$3,939	$59.38	$3,939
Hauling of Excv. Soil	146	lcy			$17.19	$2,502	$17.19	$2,502
COLUMN FOUNDATIONS & PILE CAPS								
F-4 - 4'0"x4'0"x1'0"	4	EA						
Excavation	16	bcy			$43.75	$700	$43.75	$700
Compact Exist. Subgrade	144	sf			$1.19	$171	$1.19	$171
Base Course	1	bcy	$73.27	$87	$59.38	$70	$132.65	$157
Formwork	96	sf	$2.20	$211	$4.00	$384	$6.20	$595
Rebar Reinforcement	261	lb	$1.10	$287	$1.00	$261	$2.10	$548
Concrete	2	cy	$245.25	$581	$54.69	$130	$299.93	$711
Backfill, Exist. Soil	4	bcy			$59.38	$264	$59.38	$264
Hauling of Excv. Soil	13	lcy			$17.19	$218	$17.19	$218
F-4.5 - 4'6"x4'6"x1'0"	19	EA						
Excavation	89	bcy			$43.75	$3,902	$43.75	$3,902
Compact Exist. Subgrade	803	sf			$1.19	$953	$1.19	$953
Base Course	7	bcy	$73.27	$522	$59.38	$423	$132.65	$945
Formwork	513	sf	$2.20	$1,129	$4.00	$2,052	$6.20	$3,181
Rebar Reinforcement	1,568	lb	$1.10	$1,726	$1.00	$1,568	$2.10	$3,293
Concrete	14	cy	$245.25	$3,495	$54.69	$779	$299.93	$4,274
Backfill, Exist. Soil	23	bcy			$59.38	$1,379	$59.38	$1,379
Hauling of Excv. Soil	73	lcy			$17.19	$1,247	$17.19	$1,247
F-5 - 5'0"x5'0"x1'0"	5	EA						
Excavation	27	bcy			$43.75	$1,191	$43.75	$1,191
Compact Exist. Subgrade	245	sf			$1.19	$291	$1.19	$291
Base Course	2	bcy	$73.27	$170	$59.38	$137	$132.65	$307
Formwork	150	sf	$2.20	$330	$4.00	$600	$6.20	$930
Rebar Reinforcement	509	lb	$1.10	$561	$1.00	$509	$2.10	$1,070
Concrete	5	cy	$245.25	$1,135	$54.69	$253	$299.93	$1,389
Backfill, Exist. Soil	7	bcy			$59.38	$396	$59.38	$396
Hauling of Excv. Soil	23	lcy			$17.19	$389	$17.19	$389

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL
(ST) STRUCTURAL (SUBCONTRACTOR)								
PROCESSING FACILITY								
F-5.5 - 5'6"x5'6"x1'6"	4	EA						
Excavation	29	bcy			$43.75	$1,276	$43.75	$1,276
Compact Exist. Subgrade	225	sf			$1.19	$267	$1.19	$267
Base Course	2	bcy	$73.27	$164	$59.38	$133	$132.65	$297
Formwork	176	sf	$2.20	$387	$4.00	$704	$6.20	$1,091
Rebar Reinforcement	739	lb	$1.10	$814	$1.00	$739	$2.10	$1,554
Concrete	7	cy	$245.25	$1,649	$54.69	$368	$299.93	$2,016
Backfill, Exist. Soil	8	bcy			$59.38	$457	$59.38	$457
Hauling of Excv. Soil	24	lcy			$17.19	$406	$17.19	$406
F-6 - 6'0"x6'0"x1'6"	7	EA						
Excavation	58	bcy			$43.75	$2,541	$43.75	$2,541
Compact Exist. Subgrade	448	sf			$1.19	$532	$1.19	$532
Base Course	5	bcy	$73.27	$342	$59.38	$277	$132.65	$619
Formwork	336	sf	$2.20	$739	$4.00	$1,344	$6.20	$2,083
Rebar Reinforcement	1,540	lb	$1.10	$1,696	$1.00	$1,540	$2.10	$3,236
Concrete	14	cy	$245.25	$3,433	$54.69	$766	$299.93	$4,199
Backfill, Exist. Soil	15	bcy			$59.38	$862	$59.38	$862
Hauling of Excv. Soil	48	lcy			$17.19	$823	$17.19	$823
F-7 - 7'0"x7'0"x2'0"	1	EA						
Excavation	12	bcy			$43.75	$525	$43.75	$525
Compact Exist. Subgrade	81	sf			$1.19	$96	$1.19	$96
Base Course	1	bcy	$73.27	$66	$59.38	$54	$132.65	$120
Formwork	70	sf	$2.20	$154	$4.00	$280	$6.20	$434
Rebar Reinforcement	399	lb	$1.10	$440	$1.00	$399	$2.10	$839
Concrete	4	cy	$245.25	$890	$54.69	$198	$299.93	$1,089
Backfill, Exist. Soil	3	bcy			$59.38	$176	$59.38	$176
Hauling of Excv. Soil	10	lcy			$17.19	$171	$17.19	$171
F-7.5 - 7'6"x7'6"x2'0"	1	EA						
Excavation	13	bcy			$43.75	$585	$43.75	$585
Compact Exist. Subgrade	90	sf			$1.19	$107	$1.19	$107
Base Course	1	bcy	$73.27	$76	$59.38	$62	$132.65	$138
Formwork	75	sf	$2.20	$165	$4.00	$300	$6.20	$465
Rebar Reinforcement	458	lb	$1.10	$505	$1.00	$458	$2.10	$963
Concrete	4	cy	$245.25	$1,022	$54.69	$228	$299.93	$1,250
Backfill, Exist. Soil	3	bcy			$59.38	$187	$59.38	$187
Hauling of Excv. Soil	11	lcy			$17.19	$193	$17.19	$193

C O S T A N A L Y S I S					
PROJECT:	70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY			ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.:	20321	DATE:	4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL:	60% DESIGN	CHECKED BY:	J. UNO
QTY BY:	J. UNO ASSOCIATES	PRICES BY:	J. UNO ASSOCIATES	DATE CHECKED:	4/19/2022

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL
(ST) STRUCTURAL (SUBCONTRACTOR)								
PROCESSING FACILITY								
F-8.5 - 8'6"x8'6"x2'0"	10	EA						
Excavation	163	bcy			$43.75	$7,146	$43.75	$7,146
Compact Exist. Subgrade	1,103	sf			$1.19	$1,309	$1.19	$1,309
Base Course	13	bcy	$73.27	$980	$59.38	$794	$132.65	$1,775
Formwork	850	sf	$2.20	$1,870	$4.00	$3,400	$6.20	$5,270
Rebar Reinforcement	5,887	lb	$1.10	$6,482	$1.00	$5,887	$2.10	$12,369
Concrete	54	cy	$245.25	$13,125	$54.69	$2,927	$299.93	$16,052
Backfill, Exist. Soil	35	bcy			$59.38	$2,089	$59.38	$2,089
Hauling of Excv. Soil	141	lcy			$17.19	$2,423	$17.19	$2,423
F-9 - 9'0"x9'0"x2'0"	4	EA						
Excavation	72	bcy			$43.75	$3,137	$43.75	$3,137
Compact Exist. Subgrade	484	sf			$1.19	$575	$1.19	$575
Base Course	6	bcy	$73.27	$440	$59.38	$356	$132.65	$796
Formwork	360	sf	$2.20	$792	$4.00	$1,440	$6.20	$2,232
Rebar Reinforcement	2,640	lb	$1.10	$2,907	$1.00	$2,640	$2.10	$5,547
Concrete	24	cy	$245.25	$5,886	$54.69	$1,313	$299.93	$7,198
Backfill, Exist. Soil	15	bcy			$59.38	$880	$59.38	$880
Hauling of Excv. Soil	63	lcy			$17.19	$1,076	$17.19	$1,076
F-9.5 - 9'6"x9'6"x2'0"	2	EA						
Excavation	39	bcy			$43.75	$1,714	$43.75	$1,714
Compact Exist. Subgrade	265	sf			$1.19	$314	$1.19	$314
Base Course	3	bcy	$73.27	$245	$59.38	$198	$132.65	$443
Formwork	190	sf	$2.20	$418	$4.00	$760	$6.20	$1,178
Rebar Reinforcement	1,471	lb	$1.10	$1,619	$1.00	$1,471	$2.10	$3,090
Concrete	13	cy	$245.25	$3,279	$54.69	$731	$299.93	$4,010
Backfill, Exist. Soil	8	bcy			$59.38	$462	$59.38	$462
Hauling of Excv. Soil	35	lcy			$17.19	$594	$17.19	$594
F-11 - 11'0"x11'0"x2'4"	1	EA						
Excavation	27	bcy			$43.75	$1,186	$43.75	$1,186
Compact Exist. Subgrade	169	sf			$1.19	$201	$1.19	$201
Base Course	2	bcy	$73.27	$164	$59.38	$133	$132.65	$297
Formwork	125	sf	$2.20	$274	$4.00	$498	$6.20	$772
Rebar Reinforcement	1,149	lb	$1.10	$1,265	$1.00	$1,149	$2.10	$2,413
Concrete	10	cy	$245.25	$2,561	$54.69	$571	$299.93	$3,132
Backfill, Exist. Soil	5	bcy			$59.38	$299	$59.38	$299
Hauling of Excv. Soil	24	lcy			$17.19	$417	$17.19	$417

PROJECT:	**70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY**		ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.: 20321	DATE:	4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL: 60% DESIGN	CHECKED BY:	J. UNO
QTY BY:	J. UNO ASSOCIATES	PRICES BY: J. UNO ASSOCIATES	DATE CHECKED:	4/19/2022

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL TOTAL
(ST) STRUCTURAL (SUBCONTRACTOR)								
PROCESSING FACILITY								
A1030 - SLAB ON GRADE								
STANDARD SLAB ON GRADE								
S1 - SLAB ON GRADE, 6" THK	3,659	SF						
Over-Excavation	95	bcy			$36.46	$3,459	$36.46	$3,459
Excavation	68	bcy			$43.75	$2,964	$43.75	$2,964
Compact Exist. Subgrade	4,025	sf			$1.19	$4,780	$1.19	$4,780
Select Granular Fill	27	bcy	$53.00	$1,437	$59.38	$1,609	$112.38	$3,046
Base Course	68	bcy	$73.27	$4,965	$59.38	$4,023	$132.65	$8,988
Vapor Barrier	3,659	sf	$0.17	$618	$0.67	$2,439	$0.84	$3,057
Formwork	408	sf	$2.20	$898	$4.00	$1,632	$6.20	$2,530
Rebar Reinforcement	9,100	lb	$1.10	$10,020	$1.00	$9,100	$2.10	$19,119
Concrete	73	cy	$245.25	$17,853	$54.69	$3,981	$299.93	$21,834
Trowel/ Float Finish	3,795	sf			$2.00	$7,590	$2.00	$7,590
Hauling of Excv. Soil	179	lcy			$17.19	$3,075	$17.19	$3,075
S2 - SLAB ON GRADE, 8" THK	14,700	SF						
Over-Excavation	381	bcy			$36.46	$13,895	$36.46	$13,895
Excavation	272	bcy			$43.75	$11,910	$43.75	$11,910
Compact Exist. Subgrade	16,170	sf			$1.19	$19,202	$1.19	$19,202
Select Granular Fill	109	bcy	$53.00	$5,771	$59.38	$6,465	$112.38	$12,237
Base Course	272	bcy	$73.27	$19,947	$59.38	$16,163	$132.65	$36,110
Vapor Barrier	14,700	sf	$0.17	$2,483	$0.67	$9,800	$0.84	$12,283
Formwork	1,183	sf	$2.20	$2,602	$4.00	$4,730	$6.20	$7,332
Rebar Reinforcement	48,775	lb	$1.10	$53,706	$1.00	$48,775	$2.10	$102,481
Concrete	390	cy	$245.25	$95,694	$54.69	$21,339	$299.93	$117,033
Trowel/ Float Finish	15,130	sf			$2.00	$30,260	$2.00	$30,260
Hauling of Excv. Soil	719	lcy			$17.19	$12,352	$17.19	$12,352
S3 - SLAB ON GRADE, 8" THK	5,102	SF						
Over-Excavation	132	bcy			$36.46	$4,822	$36.46	$4,822
Excavation	94	bcy			$43.75	$4,134	$43.75	$4,134
Compact Exist. Subgrade	5,612	sf			$1.19	$6,664	$1.19	$6,664
Select Granular Fill	38	bcy	$53.00	$2,003	$59.38	$2,244	$112.38	$4,247
Base Course	94	bcy	$73.27	$6,923	$59.38	$5,610	$132.65	$12,533
Vapor Barrier	5,102	sf	$0.17	$862	$0.67	$3,401	$0.84	$4,263
Formwork	744	sf	$2.20	$1,638	$4.00	$2,977	$6.20	$4,615
Rebar Reinforcement	19,543	lb	$1.10	$21,518	$1.00	$19,543	$2.10	$41,061
Concrete	156	cy	$245.25	$38,342	$54.69	$8,550	$299.93	$46,892
Trowel/ Float Finish	5,373	sf			$2.00	$10,745	$2.00	$10,745
Hauling of Excv. Soil	249	lcy			$17.19	$4,287	$17.19	$4,287

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL
(ST) STRUCTURAL (SUBCONTRACTOR)								
PROCESSING FACILITY								
S4 - SLAB ON GRADE, 8" THK	753	SF						
Over-Excavation	20	bcy			$36.46	$712	$36.46	$712
Excavation	14	bcy			$43.75	$610	$43.75	$610
Compact Exist. Subgrade	828	sf			$1.19	$984	$1.19	$984
Select Granular Fill	6	bcy	$53.00	$296	$59.38	$331	$112.38	$627
Base Course	14	bcy	$73.27	$1,022	$59.38	$828	$132.65	$1,850
Polystyrene Insulation, 3.5", 2 Layer	1,506	sf	$1.95	$2,937	$2.00	$3,012	$3.95	$5,949
Vapor Barrier	753	sf	$0.17	$127	$0.67	$502	$0.84	$629
Formwork	207	sf	$2.20	$456	$6.00	$1,243	$8.20	$1,699
Rebar Reinforcement	2,789	lb	$1.10	$3,071	$1.00	$2,789	$2.10	$5,860
Concrete	22	cy	$245.25	$5,472	$54.69	$1,220	$299.93	$6,692
Trowel/ Float Finish	828	sf			$4.00	$3,313	$4.00	$3,313
Hauling of Excv. Soil	37	lcy			$17.19	$633	$17.19	$633
B1010 - FLOOR CONSTRUCTION								
STRUCTURAL FRAME								
STRUCTURAL STEEL COLUMNS								
C1, HSS 10x10x1/2	30	ton	$3,349.50	$100,211	$4,722.22	$141,281	$8,071.72	$241,493
C2, HSS 10x10x5/8	7	ton	$3,349.50	$23,010	$4,722.22	$32,440	$8,071.72	$55,450
C3, HSS 12x12x5/8	10	ton	$3,349.50	$33,296	$4,722.22	$46,942	$8,071.72	$80,239
Hot Dipped Galv, Add To Material	33,631	lb	$3.74	$125,778			$3.74	$125,778
FILL								
Geofoam Fill @ Stun Area	7	cy	$86.33	$604	$150.00	$1,050	$236.33	$1,654
STRUCTURAL FRAME								
CATWALK FRAMING								
Steel Framing	1	ton	$3,349.50	$3,350	$4,722.22	$4,722	$8,071.72	$8,072
Railing	62	lf	$165.00	$10,230	$13.54	$840	$178.54	$11,070
GRATING								
CATWALK GRATING	164	sf						
Steel Grating	164	sf	$16.50	$2,706	$16.67	$2,733	$33.17	$5,439
SUMPS & PITS								
INEDIBLE BIN SUMP, 4'-9" Dia.	1	ea						
Excavation	3	bcy			$145.83	$438	$145.83	$438
Compact Exist. Subgrade	20	sf			$11.88	$238	$11.88	$238
Base Course	1	bcy	$73.27	$37	$475.00	$238	$548.27	$274
Rebar Reinforcement	125	lb	$1.10	$138	$3.20	$400	$4.30	$538
Concrete Base	1	cy	$245.25	$245	$437.50	$438	$682.75	$683
60" Dia. Precast R.C. Pipe	4	lf	$160.00	$640	$200.00	$800	$360.00	$1,440

PROJECT:	70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY		ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.: 20321	DATE:	4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL: 60% DESIGN	CHECKED BY:	J. UNO
QTY BY:	J. UNO ASSOCIATES	PRICES BY: J. UNO ASSOCIATES	DATE CHECKED:	4/19/2022

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL TOTAL
(ST) STRUCTURAL (SUBCONTRACTOR)								
PROCESSING FACILITY								
MANURE PIT - 4'0"x4'0"x6'0" DEEP	1	EA						
Excavation	10	bcy			$218.75	$2,285	$218.75	$2,285
Compact Exist. Subgrade	36	sf			$6.60	$238	$6.60	$238
Base Course	0	bcy	$73.27	$22	$1,900.00	$563	$1,973.27	$585
Formwork	29	sf	$2.20	$65	$14.29	$419	$16.49	$484
Rebar Reinforcement	87	lb	$1.10	$96	$9.52	$828	$10.62	$923
Concrete	1	cy	$245.25	$194	$875.00	$691	$1,120.25	$885
Conc. Admixture, Corrosion Inhib.	1	cy	$78.38	$62			$78.38	$62
Backfill, Exist. Soil	1	bcy			$475.00	$645	$475.00	$645
Hauling of Excv. Soil	10	lcy			$17.19	$172	$17.19	$172
LEVELER PIT - 6'6"x7'6"x4'0" DEEP	3	EA						
Excavation	52	bcy			$218.75	$11,449	$218.75	$11,449
Compact Exist. Subgrade	242	sf			$6.60	$1,598	$6.60	$1,598
Base Course	3	bcy	$73.27	$198	$1,900.00	$5,146	$1,973.27	$5,344
Formwork	154	sf	$2.20	$339	$14.29	$2,200	$16.49	$2,539
Rebar Reinforcement	794	lb	$1.10	$875	$9.52	$7,566	$10.62	$8,441
Concrete	7	cy	$245.25	$1,771	$875.00	$6,319	$1,120.25	$8,091
Conc. Admixture, Corrosion Inhib.	7	cy	$78.38	$566			$78.38	$566
Backfill, Exist. Soil	7	bcy			$475.00	$3,096	$475.00	$3,096
Hauling of Excv. Soil	50	lcy			$17.19	$866	$17.19	$866
CONC. PIT WALL, 8" THK	539	SF						
Formwork	1,078	sf	$4.40	$4,743	$6.67	$7,187	$11.07	$11,930
Rebar Reinforcement	2,529	lb	$1.10	$2,784	$1.00	$2,529	$2.10	$5,313
Concrete	13	cy	$245.25	$3,264	$109.38	$1,456	$354.62	$4,720
Conc. Admixture, Corrosion Inhib.	13	cy	$78.38	$1,043			$78.38	$1,043
Grind & Rub Finish	1,078	sf			$2.00	$2,156	$2.00	$2,156
SLABS								
HOUSEKEEPING PAD, 4" THK	29	SF						
Formwork	18	sf	$4.40	$79	$13.33	$239	$17.73	$318
Rebar Reinforcement	43	lb	$1.10	$47	$2.00	$86	$3.10	$133
Concrete	0.36	cy	$245.25	$88	$218.75	$78	$464.00	$166
Trowel/ Float Finish	47	sf			$4.00	$188	$4.00	$188
CONC. SLAB @ STUN AREA, 6" THK	84	SF						
Formwork	37	sf	$4.40	$161	$13.33	$489	$17.73	$650
Rebar Reinforcement	187	lb	$1.10	$206	$2.00	$373	$3.10	$579
Concrete	2	cy	$245.25	$381	$218.75	$340	$464.00	$722
Trowel/ Float Finish	121	sf			$4.00	$483	$4.00	$483

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL
(ST) STRUCTURAL (SUBCONTRACTOR)								
PROCESSING FACILITY								
CONC. PAD @ STUN AREA, 12" THK	15	SF						
Formwork	23	sf	$4.40	$102	$13.33	$310	$17.73	$412
Rebar Reinforcement	67	lb	$1.10	$73	$2.00	$133	$3.10	$207
Concrete	1	cy	$245.25	$136	$218.75	$122	$464.00	$258
Trowel/ Float Finish	38	sf			$4.00	$153	$4.00	$153
WALLS								
CONC. WALL, 6" THK @ STUN AREA	44	SF						
Formwork	88	sf	$4.40	$387	$6.67	$587	$11.07	$974
Rebar Reinforcement	155	lb	$1.10	$170	$1.00	$155	$2.10	$325
Concrete	1	cy	$245.25	$200	$109.38	$89	$354.62	$289
Conc. Admixture, Corrosion Inhib.	1	cy	$78.38	$64			$78.38	$64
Grind & Rub Finish	88	sf			$2.00	$176	$2.00	$176
B1020 - ROOF CONSTRUCTION								
STRUCTURAL FRAME								
STRUCTURAL STEEL ROOF BEAMS								
W6x16	8	ton	$3,349.50	$27,064	$4,722.22	$38,156	$8,071.72	$65,220
W16x26	4	ton	$3,349.50	$14,631	$4,722.22	$20,627	$8,071.72	$35,257
W16x31	11	ton	$3,349.50	$35,719	$4,722.22	$50,358	$8,071.72	$86,077
W18x35	18	ton	$3,349.50	$61,430	$4,722.22	$86,606	$8,071.72	$148,035
W18x40	15	ton	$3,349.50	$49,305	$4,722.22	$69,511	$8,071.72	$118,816
W24x55	15	ton	$3,349.50	$49,003	$4,722.22	$69,086	$8,071.72	$118,089
W24x62	3	ton	$3,349.50	$11,526	$4,722.22	$16,249	$8,071.72	$27,775
W24x76	8	ton	$3,349.50	$26,729	$4,722.22	$37,683	$8,071.72	$64,412
L6x4x5/16	1	ton	$3,349.50	$4,657	$4,722.22	$6,566	$8,071.72	$11,224
ROOF DECKS & SLABS								
STEEL DECKING								
Metal Decking, 1.5" Thk x 20ga	19,888	sf	$5.46	$108,536	$2.43	$48,339	$7.89	$156,875
B2010 - EXTERIOR WALLS								
EXTERIOR CLOSURE								
Pre-Cast Concrete Wall Panels, 8"	17,325	sf	$37.52	$650,000	$2.51	$43,565	$40.03	$693,565
EXPANSION JOINTS								
EXPANSION JOINTS	96	lf						
Expansion Joints	96	lf	$42.00	$4,032	$16.67	$1,600	$58.67	$5,632

PROJECT:	70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY			ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.:	20321	DATE:	4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL:	60% DESIGN	CHECKED BY:	J. UNO
QTY BY:	J. UNO ASSOCIATES	PRICES BY:	J. UNO ASSOCIATES	DATE CHECKED:	4/19/2022

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL TOTAL
(ST) STRUCTURAL (SUBCONTRACTOR)								
PROCESSING FACILITY								
C2010 - INTERIOR WALLS								
CONCRETE CURB WALLS								
CONC. CURB, ANGLED TOP, 0'6"x2'0"›	1,325	LF						
Formwork	6,628	sf	$4.40	$29,161	$6.67	$44,183	$11.07	$73,344
Rebar Reinforcement	9,324	lb	$1.10	$10,267	$1.00	$9,324	$2.10	$19,591
Concrete	49	cy	$245.25	$12,035	$109.38	$5,367	$354.62	$17,403
Trowel/ Float Finish	6,625	sf			$2.00	$13,250	$2.00	$13,250
C2010 - STAIR CONSTRUCTION								
INTERIOR STAIR CONSTRUCTION								
CONC. STAIRS	3	VLF						
Shoring, Pipe Column	23	sf	$4.50	$102	$16.00	$362	$20.50	$464
Formwork	49	sf	$6.60	$324	$26.67	$1,311	$33.27	$1,635
Rebar Reinforcement	35	lb	$1.10	$38	$4.00	$138	$5.10	$176
Concrete	0.2	cy	$245.25	$42	$437.50	$76	$682.75	$118
Conc. Admixture, Corrosion Inhib.	-	cy	$78.38				$78.38	
Trowel/ Float Finish	56	sf			$8.00	$448	$8.00	$448
B1 - SUPERSTRUCTURE								
Pre-Engineered Metal Building, Complete	4,996	sf	$56.00	$279,776	$38.00	$189,848	$94.00	$469,624
Prefabricated Canopy	344	sf	$30.00	$10,320	$8.00	$2,752	$38.00	$13,072
SUBTOTAL,				$2,085,565		$1,490,838		$3,576,402
SUBCONTRACTOR JOOH,			5.00%	$104,278	5.00%	$74,542	5.00%	$178,820
SUBCONTRACTOR HOOH,			10.20%	$223,364	10.20%	$159,669	10.20%	$383,033
SUBCONTRACTOR PROFIT,			10.00%	$241,321	10.00%	$172,505	10.00%	$413,826
SUBTOTAL,	**24,768**	**ASF**	**$107.18**	**$2,654,527**	**$76.61**	**$1,897,553**	**$183.79**	**$4,552,081**

C O S T A N A L Y S I S

PROJECT:	70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY			ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.:	20321	DATE:	4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL:	60% DESIGN	CHECKED BY:	J. UNO
QTY BY:	J. UNO ASSOCIATES	PRICES BY:	J. UNO ASSOCIATES	DATE CHECKED:	4/19/2022

			MATERIAL / SUB		LABOR / EQPT		TOTAL	
DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL
(AR) ARCHITECTURAL (SUBCONTRACTOR)								
B2010 - EXTERIOR WALLS								
EXTERIOR COATINGS								
Painting, Walls	17,325	sf	$0.45	$7,796	$2.50	$43,313	$2.95	$51,109
Painting, Columns @ Livestock Area	1,133	sf	$0.45	$510	$2.50	$2,833	$2.95	$3,342
Painting, Fencing @ Livestock Area	1,184	sf	$0.45	$533	$2.50	$2,960	$2.95	$3,493
Ceiling Painting @ Livestock Area	4,950	sf	$0.45	$2,228	$2.50	$12,375	$2.95	$14,603
Painting, Downspouts	231	lf	$0.45	$104	$2.50	$578	$2.95	$681
B2020 - EXTERIOR WINDOWS								
WINDOWS								
Window & Frame, Exterior	226	sf	$75.00	$16,950	$30.00	$6,780	$105.00	$23,730
B2030 - EXTERIOR DOORS								
SOLID DOORS								
Swing Cooler Door & Frame, Single	2	ea	$3,500.00	$7,000	$200.00	$400	$3,700.00	$7,400
FGDxSSF, Vision Panel, Single	6	ea	$5,500.00	$33,000	$200.00	$1,200	$5,700.00	$34,200
FGDxSSF, Vision Panel, Double	2	pr	$11,000.00	$22,000	$400.00	$800	$11,400.00	$22,800
Durulite Insul. Bump Door, Alum. Fran	2	ea	$8,500.00	$17,000	$200.00	$400	$8,700.00	$17,400
GATES & HOLDING PENS								
12'-0" Gate	1	ea	$2,200.00	$2,200	$200.00	$200	$2,400.00	$2,400
11'-11" Gate	2	ea	$2,200.00	$4,400	$200.00	$400	$2,400.00	$4,800
8'-6" Gate	10	ea	$1,600.00	$16,000	$120.00	$1,200	$1,720.00	$17,200
8'-0" Gate	5	ea	$1,500.00	$7,500	$120.00	$600	$1,620.00	$8,100
6'-0" Gate	1	ea	$1,200.00	$1,200	$120.00	$120	$1,320.00	$1,320
8'-8" Crowd Gate	1	ea	$1,200.00	$1,200	$400.00	$400	$1,600.00	$1,600
Handler Gates	5	ea	$900.00	$4,500	$120.00	$600	$1,020.00	$5,100
Slide Gates	1	ea	$1,500.00	$1,500	$150.00	$150	$1,650.00	$1,650
Back Up Gate	1	ea	$1,500.00	$1,500	$150.00	$150	$1,650.00	$1,650
Solid Fence	785	sf	$12.50	$9,813	$16.67	$13,083	$29.17	$22,896
Holding Pen Fences	399	lf	$85.00	$33,915	$10.00	$3,990	$95.00	$37,905
OVERHEAD & ROLL-UP DOORS								
Insul. Steel Roll-Up door, 3'2"x8'0"	1	ea	$1,500.00	$1,500	$600.00	$600	$2,100.00	$2,100
Insul. Steel Roll-Up door, 2'4"x7'0"	1	ea	$1,500.00	$1,500	$600.00	$600	$2,100.00	$2,100
Insul. Urethane Roll-Up Door, 8'0"x8'0	3	ea	$3,500.00	$10,500	$1,200.00	$3,600	$4,700.00	$14,100
Insul. Urethane Roll-Up Door, 6'0"x8'0	1	ea	$3,500.00	$3,500	$1,200.00	$1,200	$4,700.00	$4,700

PROJECT:	70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY		ESTIMATE NO.: 21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.: 20321	DATE: 4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL: 60% DESIGN	CHECKED BY: J. UNO
QTY BY:	J. UNO ASSOCIATES	PRICES BY: J. UNO ASSOCIATES	DATE CHECKED: 4/19/2022

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL TOTAL
(AR) ARCHITECTURAL (SUBCONTRACTOR)								
B3010 - ROOF COVERINGS								
HIGH SLOPE ROOF COVERINGS								
Standing Seam Metal Roofing	20,499	sf	$9.85	$201,915	$6.25	$128,119	$16.10	$330,034
ROOF INSULATION & FILL								
Coverboard, 5/8" Thk	20,499	sf	$1.15	$23,574	$0.67	$13,666	$1.82	$37,240
FLASHINGS & TRIM								
Metal Edge Flashing, Galv Steel	825	lf	$3.00	$2,477	$4.00	$3,300	$7.00	$5,777
GUTTERS & DOWNSPOUTS								
Gutters, Galv Steel	490	lf	$6.17	$3,024	$13.33	$6,533	$19.51	$9,558
Downspouts, Galv Steel, Rect. 3x4	231	lf	$5.89	$1,362	$12.50	$2,888	$18.39	$4,249
OTHER ROOFING								
Precast Concrete Splashblock	9	ea	$35.00	$315	$20.00	$180	$55.00	$495
Perforated Metal Closure Panel	375	sf	$10.00	$3,750	$4.00	$1,500	$14.00	$5,250
C1010 - PARTITIONS								
FIXED PARTITIONS								
4" Insulated Metal Panel Walls	21,159	sf	$13.75	$290,936	$12.50	$264,488	$26.25	$555,424
6" Insulated Metal Panel Walls	2,730	sf	$17.60	$48,048	$12.50	$34,125	$30.10	$82,173
4" Metal Stud Wall Framing	7,299	sf	$1.73	$12,605	$3.13	$22,809	$4.85	$35,415
Batt Insulation	7,299	sf	$0.94	$6,825	$1.11	$8,110	$2.05	$14,935
6" Metal Stud Wall Framing	340	sf	$2.06	$699	$3.13	$1,063	$5.18	$1,762
Batt Insulation	340	sf	$0.94	$318	$1.11	$378	$2.05	$696
INTERIOR WINDOWS								
Window & Frame, Interior	58	sf	$50.00	$2,900	$30.00	$1,740	$80.00	$4,640
C1020 - INTERIOR DOORS								
STANDARD INTERIOR DOORS								
Insul. Metal Bump Door, Dbl. Acting, S	5	ea	$5,500.00	$27,500	$285.71	$1,429	$5,785.71	$28,929
HMDxHMF, Flush, Single	10	ea	$3,250.00	$32,500	$100.00	$1,000	$3,350.00	$33,500
HMDxHMF, Flush, Single w/ Vision Pa	5	ea	$3,250.00	$16,250	$100.00	$500	$3,350.00	$16,750
Insul. Metal Bump Door, Dbl. Acting, D	3	pr	$12,500.00	$37,500	$444.44	$1,333	$12,944.44	$38,833
Insul. Metal Door, Sliding Motorized w	5	ea	$8,500.00	$42,500	$400.00	$2,000	$8,900.00	$44,500
Insul. Metal Door, Sliding Motorized w	1	ea	$8,500.00	$8,500	$400.00	$400	$8,900.00	$8,900
Swing Cooler Door w/ Vision Panel & I	1	ea	$3,500.00	$3,500	$400.00	$400	$3,900.00	$3,900
Swing Cooler Door & Frame, Single	4	ea	$3,500.00	$14,000	$400.00	$1,600	$3,900.00	$15,600
SWDxSWF, Single w/ Vision Panel	4	ea	$2,000.00	$8,000	$400.00	$1,600	$2,400.00	$9,600
C1030 - FITTINGS								
COMPARTMENTS, CUBICLES, & TOILET PARTITIONS								
Toilet Room Partition	3	ea	$2,230.17	$6,691	$400.00	$1,200	$2,630.17	$7,891
Urinal Screen	1	ea	$572.53	$573	$200.00	$200	$772.53	$773

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL TOTAL
(AR) ARCHITECTURAL (SUBCONTRACTOR)								
TOILET & BATH ACCESSORIES								
TP-1, Toilet Paper Dispenser	2	ea	$138.26	$277	$50.00	$100	$188.26	$377
TP-2, Jumbo Roll Toilet Paper Dispens	3	ea	$138.26	$415	$50.00	$150	$188.26	$565
TSC-1, Toilet Seat Cover Dispenser	5	ea	$105.94	$530	$50.00	$250	$155.94	$780
GB-1, Metal Grab Bar, 36"	6	ea	$47.01	$282	$50.00	$300	$97.01	$582
GB-2, Metal Grab Bar, 42"	6	ea	$48.01	$288	$50.00	$300	$98.01	$588
GB-3, Metal Grab Bar, 16"	4	ea	$48.01	$192	$50.00	$200	$98.01	$392
MR-1, Framed Mirror, 20"x40"	6	ea	$75.20	$451	$100.00	$600	$175.20	$1,051
SD-1, Soap Dispenser	4	ea	$77.37	$309	$50.00	$200	$127.37	$509
PTD-2, Paper Towel Dispenser Waste	4	ea	$965.49	$3,862	$200.00	$800	$1,165.49	$4,662
BCS-1, Baby Changing Station	1	ea	$358.42	$358	$100.00	$100	$458.42	$458
SR-1, Shower Curtain Rod	2	ea	$47.01	$94	$50.00	$100	$97.01	$194
SB-1, Shower Bench	2	ea	$402.50	$805	$200.00	$400	$602.50	$1,205
Apron Hooks	34	lf	$65.00	$2,210	$16.00	$544	$81.00	$2,754
IDENTIFYING DEVICES								
Room Signage	52	ea	$250.00	$13,000	$100.00	$5,200	$350.00	$18,200
DOCK EQUIPMENT								
Dock Levelers	3	ea	$4,800.00	$14,400	$1,000.00	$3,000	$5,800.00	$17,400
Dock Sealer, Det. 7/G-19	3	ea	$3,200.00	$9,600	$600.00	$1,800	$3,800.00	$11,400
LOCKERS								
Wardrobe Locker, 2 Tier	47	ea	$281.25	$13,219	$20.00	$940	$301.25	$14,159
COUNTERS								
SS-1, Solid Surface Countertop	18	sf	$50.00	$900	$37.50	$675	$87.50	$1,575
CABINETS								
Cabinets, Base	9	lf	$300.00	$2,700	$150.00	$1,350	$450.00	$4,050
Cabinets, Storage	12	lf	$250.00	$3,000	$150.00	$1,800	$400.00	$4,800
Cabinets, Wall	12	lf	$250.00	$3,000	$150.00	$1,800	$400.00	$4,800
OTHER FITTINGS								
Roof Access Ladder, 25'-6"H	1	ea	$1,500.00	$1,500	$800.00	$800	$2,300.00	$2,300
Interstital Access Ladder, 18'H	1	ea	$1,000.00	$1,000	$800.00	$800	$1,800.00	$1,800
8"x96"H Galv. Bollard, Conc. Filled	6	ea	$1,500.00	$9,000	$300.00	$1,800	$1,800.00	$10,800
6"x60"H Galv. Bollard, Conc. Filled	4	ea	$1,200.00	$4,800	$300.00	$1,200	$1,500.00	$6,000
3"x42"H Galv. Bollard	11	ea	$1,000.00	$11,000	$300.00	$3,300	$1,300.00	$14,300

PROJECT:	70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY	ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.: 20321 / DATE:	4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL: 60% DESIGN / CHECKED BY:	J. UNO
QTY BY:	J. UNO ASSOCIATES	PRICES BY: J. UNO ASSOCIATES / DATE CHECKED:	4/19/2022

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL TOTAL
(AR) ARCHITECTURAL (SUBCONTRACTOR)								
C2010 - STAIR CONSTRUCTION								
INTERIOR STAIR CONSTRUCTION								
Handrail, Hot Dip Galv. Steel	14	lf	$75.00	$1,050	$16.67	$233	$91.67	$1,283
Guardrail, Hot Dip Galv. Steel	8	lf	$200.00	$1,600	$33.33	$267	$233.33	$1,867
C3010 - WALL FINISHES								
GYPSUM WALLBOARD FINISHES								
Gypsum Wallboard, Taped & Finished	9,773	sf	$2.10	$20,523	$2.08	$20,360	$4.18	$40,884
TILE & TERRAZZO WALL FINISHES								
Ceramic Tile Wainscot	1,500	sf	$5.00	$7,500	$20.00	$30,000	$25.00	$37,500
1/2" Cement Board	1,500	sf	$0.81	$1,210	$2.08	$3,125	$2.89	$4,335
PAINTING TO WALLS								
Painting, Walls	10,761	sf	$0.42	$4,520	$2.50	$26,903	$2.92	$31,422
EPOXY WALL COATING								
Sikagard Epoxy Coating, Base	4,001	sf	$2.64	$10,563	$4.00	$16,004	$6.64	$26,567
Sikagard Epoxy Coating, Top Coat	8,002	sf	$2.97	$23,766	$2.50	$20,005	$5.47	$43,771
C3020 - FLOOR FINISHES								
RESILIENT FLOOR FINISHES								
Vinyl Tile Flooring	2,358	sf	$5.00	$11,790	$2.00	$4,716	$7.00	$16,506
WALL BASE FINISHES								
Resilient Wall Base	786	lf	$1.50	$1,179	$2.00	$1,572	$3.50	$2,751
FLOOR TOPPINGS AND TRAFFIC MEMBRANES								
EPOXY FLOORING								
Duraquartz Epoxy w/ Clear Coat	719	sf	$3.00	$2,157	$4.00	$2,876	$7.00	$5,033
Ceramic Tile Wall Base	297	lf	$5.00	$1,485	$20.00	$5,940	$25.00	$7,425
1/4" Urethane Topping	7,877	sf	$6.00	$47,262	$4.00	$31,508	$10.00	$78,770
HARDENERS AND SEALERS								
Clear Ashford Formula Concrete Seale	12,543	sf	$1.25	$15,679	$2.00	$25,086	$3.25	$40,765
C3030 - CEILING FINISHES								
GYPSUM WALLBOARD CEILING FINISHES								
Gypsum Board Ceiling, Suspended	745	sf	$2.10	$1,565	$3.13	$2,328	$5.23	$3,893
ACOUSTICAL CEILING TILES & PANELS								
Acoustical Ceiling Tiles, Suspended	2,595	sf	$2.30	$5,969	$2.00	$5,190	$4.30	$11,159
PAINTING AND STAINING CEILINGS								
Painting, Ceiling	745	sf	$0.30	$224	$2.70	$2,014	$3.00	$2,237

C O S T A N A L Y S I S					
PROJECT:	**70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY**			ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.:	20321	DATE:	4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL:	60% DESIGN	CHECKED BY:	J. UNO
QTY BY:	J. UNO ASSOCIATES	PRICES BY:	J. UNO ASSOCIATES	DATE CHECKED:	4/19/2022

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL TOTAL
(AR) ARCHITECTURAL (SUBCONTRACTOR)								
SUSPENSION SYSTEMS								
Ceiling Suspension System	3,340	sf	$2.30	$7,682	$2.08	$6,958	$4.38	$14,640
OTHER CEILING & CEILING FINISHES								
6" Urethane Insul. Metal Ceiling Panel	14,324	sf	$3.03	$43,330	$3.13	$44,763	$6.15	$88,093
SUBTOTAL,				$1,310,353		$877,447		$2,187,800
SUBCONTRACTOR JOOH,			5.00%	$65,518	5.00%	$43,872	5.00%	$109,390
SUBCONTRACTOR HOOH,			10.20%	$140,339	10.20%	$93,975	10.20%	$234,313
SUBCONTRACTOR PROFIT,			10.00%	$151,621	10.00%	$101,529	10.00%	$253,150
SUBTOTAL,	**24,768**	**ASF**	**$67.34**	**$1,667,830**	**$45.09**	**$1,116,823**	**$112.43**	**$2,784,653**

C O S T A N A L Y S I S

PROJECT:	**70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY**			ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.:	20321	DATE:	4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL:	60% DESIGN	CHECKED BY:	J. UNO
QTY BY:	COFFMAN	PRICES BY:	COFFMAN	DATE CHECKED:	4/19/2022

(PL) MECHANICAL - PLUMBING (SUBCONTRACTOR)

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL TOTAL
PLUMBING								
Gas Water Heater (1350 MBH)	5	ea	$140,000	$700,000	$6,000	$30,000	$146,000	$730,000
Hot Water Recirc Pump	2	ea	$1,400.00	$2,800	$2,520.00	$5,040	$3,920.00	$7,840
Digital Mixing Station	2	ea	$6,500.00	$13,000	$5,000.00	$10,000	$11,500.00	$23,000
Water Softener	1	ea	$468.00	$468	$908.00	$908	$1,376.00	$1,376
Expansion Tank (26 Gal)	1	ea	$1,800.00	$1,800	$500.00	$500	$2,300.00	$2,300
Air Compressor	2	ea	$18,720.00	$37,440	$5,500.00	$11,000	$24,220.00	$48,440
Grease Interceptor	1	ea	$50,000.00	$50,000	$30,000.00	$30,000	$80,000.00	$80,000
Pressure Wash System	1	ea	$20,000.00	$20,000	$15,000.00	$15,000	$35,000.00	$35,000
Water Closets (FV Included)	5	ea	$1,800.00	$9,000	$1,350.00	$6,750	$3,150.00	$15,750
Urinal (FV Included)	1	ea	$1,250.00	$1,250	$850.00	$850	$2,100.00	$2,100
Lavatory	6	ea	$1,290.00	$7,740	$1,360.00	$8,160	$2,650.00	$15,900
Shower	2	ea	$2,235.00	$4,470	$980.00	$1,960	$3,215.00	$6,430
Kitchen Sink	1	ea	$395.00	$395	$665.00	$665	$1,060.00	$1,060
Mop Sink	1	ea	$2,750.00	$2,750	$1,050.00	$1,050	$3,800.00	$3,800
Hand Sink	22	ea	$550.00	$12,100	$900.00	$19,800	$1,450.00	$31,900
Hose Station (140 Deg)	14	ea	$550.00	$7,700	$1,050.00	$14,700	$1,600.00	$22,400
Hose Station (180 Deg)	5	ea	$550.00	$2,750	$1,100.00	$5,500	$1,650.00	$8,250
Drinking Fountain	2	ea	$2,500.00	$5,000	$895.00	$1,790	$3,395.00	$6,790
Emergency Eye Wash Station	2	ea	$2,500.00	$5,000	$1,500.00	$3,000	$4,000.00	$8,000
Floor Drain, 4" Trap	42	ea	$670.00	$28,140	$350.00	$14,700	$1,020.00	$42,840
Floor Drain. 2" Trap	8	ea	$330.00	$2,640	$350.00	$2,800	$680.00	$5,440
Floor Cleanout, 6"	5	ea	$145.00	$725	$95.00	$475	$240.00	$1,200
Floor Cleanout, 4"	16	ea	$130.00	$2,080	$95.00	$1,520	$225.00	$3,600
Floor/Wall Cleanout, 2"	6	ea	$120.00	$720	$95.00	$570	$215.00	$1,290
Floor Sink, 2"	2	ea	$420.00	$840	$350.00	$700	$770.00	$1,540

C O S T   A N A L Y S I S

PROJECT:	**70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY**			ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.:	20321	DATE:	4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL:	60% DESIGN	CHECKED BY:	J. UNO
QTY BY:	COFFMAN	PRICES BY:	COFFMAN	DATE CHECKED:	4/19/2022

			MATERIAL / SUB		LABOR / EQPT		TOTAL	
DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL
(PL) MECHANICAL - PLUMBING (SUBCONTRACTOR)								
Sanitary Waste & Vent Piping (Fitt. Incl.)	950	lf	$15.00	$14,250	$35.00	$33,250	$50.00	$47,500
Copper Domestic Water Piping (Fitt. Incl.)	1,600	lf	$15.00	$24,000	$30.00	$48,000	$45.00	$72,000
Type 304 SS Sch 40 Piping (Fitt. Incl.)	1,150	lf	$25.00	$28,750	$50.00	$57,500	$75.00	$86,250
Hot Water Pipe Insulation	250	lf	$18.00	$4,500	$20.00	$5,000	$38.00	$9,500
Piping Accessories & Supports	1	ls	$16,250.00	$16,250	$15,500.00	$15,500	$31,750.00	$31,750
Flue vent	1	ls	$6,700.00	$6,700	$8,600.00	$8,600	$15,300.00	$15,300
LPG Piping	1	ls	$4,500.00	$4,500	$4,800.00	$4,800	$9,300.00	$9,300
Testing & Balancing	1	ls	$8,000.00	$8,000	$12,000.00	$12,000	$20,000.00	$20,000
Miscellaneous	1	ls	$10,000.00	$10,000	$15,000.00	$15,000	$25,000.00	$25,000
SUBTOTAL,				$1,035,758		$387,088		$1,422,846
SUBCONTRACTOR JOOH,			5.00%	$51,788	5.00%	$19,354	5.00%	$71,142
SUBCONTRACTOR HOOH,			10.20%	$110,930	10.20%	$41,457	10.20%	$152,387
SUBCONTRACTOR PROFIT,			10.00%	$119,848	10.00%	$44,790	10.00%	$164,638
SUBTOTAL,	**140**	**FIXT**	**$9,416.59**	**$1,318,323**	**$3,519.21**	**$492,689**	**$12,935.80**	**$1,811,013**

C O S T A N A L Y S I S

PROJECT:	**70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY**			ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.:	20321	DATE:	4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL:	60% DESIGN	CHECKED BY:	J. UNO
QTY BY:	COFFMAN	PRICES BY:	COFFMAN	DATE CHECKED:	4/19/2022

			MATERIAL / SUB		LABOR / EQPT		TOTAL	
DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL
(ME) MECHANICAL - HVAC (SUBCONTRACTOR)								
HVAC								
PACU-1 Thru 5	1	ea	$286,000	$286,000	$30,240.00	$30,240	$316,240	$316,240
Industrial Refrigeration System	1	ls	$2,140,428	$2,140,428	$435,000	$435,000	$2,575,428	$2,575,428
ACCU/FCU	2	ea	$3,500.00	$7,000	$1,050.00	$2,100	$4,550.00	$9,100
VAD	25	ea	$650.00	$16,250	$110.00	$2,750	$760.00	$19,000
PIM	2	ea	$950.00	$1,900	$840.00	$1,680	$1,790.00	$3,580
SF-1 thru 4, Model RSFP	41,500	cfm	$1.10	$45,650	$0.25	$10,375	$1.35	$56,025
SF-5	1	ea	$20,000.00	$20,000	$2,100.00	$2,100	$22,100.00	$22,100
EF-1 thru 5, TF-1/2, Model CSP	1,590	cfm	$1.25	$1,988	$1.60	$2,544	$2.85	$4,532
EF-6 thru 8, Model GB	38,830	cfm	$1.10	$42,713	$0.25	$9,708	$1.35	$52,421
EF-9	1	ea	$11,000.00	$11,000	$1.29	$1,290	$11,001.29	$12,290
Circulating Fan, 10' Dia.	4	ea	$4,680.00	$18,720	$945.00	$3,780	$5,625.00	$22,500
Air Curtain - 42"L	2	ea	$2,500.00	$5,000	$375.00	$750	$2,875.00	$5,750
Air Curtain - 48"L	4	ea	$2,700.00	$10,800	$405.00	$1,620	$3,105.00	$12,420
Air Curtain - 60"L	3	ea	$3,230.00	$9,690	$485.00	$1,455	$3,715.00	$11,145
Air Curtain - 72"L	4	ea	$3,920.00	$15,680	$590.00	$2,360	$4,510.00	$18,040
Air Curtain - 86"L	5	ea	$4,760.00	$23,800	$715.00	$3,575	$5,475.00	$27,375
Ductwork (Fittings and Accessories Incl.)	1	ls	$491,800	$491,800	$228,360	$228,360	$720,160	$720,160
Ductwork Insulation	1	ls	$467,200	$467,200	$251,600	$251,600	$718,800	$718,800
Air Devices	150	ea	$200.00	$30,000	$80.00	$12,000	$280.00	$42,000
Condensate Drain Pipe (Fittings/Acc. Incl.)	1	ls	$2,000.00	$2,000	$2,500.00	$2,500	$4,500.00	$4,500
Refrigerant Pipe (Fittings/Acc. Incl.)	140	lf	$15.00	$2,100	$20.00	$2,800	$35.00	$4,900
Pipe Insulation	190	lf	$12.00	$2,280	$20.00	$3,800	$32.00	$6,080
			$3.00				$3.00	
Controls	1	ls	$40,000.00	$40,000	$45,000.00	$45,000	$85,000.00	$85,000
Control Wiring	1	ls	$40,000.00	$40,000	$40,000.00	$40,000	$80,000.00	$80,000
Testing and Balancing	1	ls	$5,000.00	$5,000	$30,000.00	$30,000	$35,000.00	$35,000
Corrosion Protection	1	ls	$7,750.00	$7,750	$15,750.00	$15,750	$23,500.00	$23,500
Miscellaneous	1	ls	$10,000.00	$10,000	$15,000.00	$15,000	$25,000.00	$25,000
SUBTOTAL,				$3,754,749		$1,158,137		$4,912,885
SUBCONTRACTOR JOOH,			5.00%	$187,737	5.00%	$57,907	5.00%	$245,644
SUBCONTRACTOR HOOH,			10.20%	$402,134	10.20%	$124,036	10.20%	$526,170
SUBCONTRACTOR PROFIT,			10.00%	$434,462	10.00%	$134,008	10.00%	$568,470
SUBTOTAL,	**24,768**	**ASF**	**$192.95**	**$4,779,081**	**$59.52**	**$1,474,088**	**$252.47**	**$6,253,169**

PROJECT:	**70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY**			ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.:	20321	DATE:	4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL:	60% DESIGN	CHECKED BY:	J. UNO
QTY BY:	J. UNO ASSOCIATES	PRICES BY:	J. UNO ASSOCIATES	DATE CHECKED:	4/19/2022

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL TOTAL
(FP) FIRE PROTECTION - SPRINKLERS (SUBCONTRACTOR)								
D4010 - SPRINKLERS								
Fire Sprinkler System, Complete	1	ls	$419,940	$419,940	$279,960	$279,960	$699,900	$699,900
SUBTOTAL,				$419,940		$279,960		$699,900
SUBCONTRACTOR JOOH,			5.00%	$20,997	5.00%	$13,998	5.00%	$34,995
SUBCONTRACTOR HOOH,			10.20%	$44,976	10.20%	$29,984	10.20%	$74,959
SUBCONTRACTOR PROFIT,			10.00%	$48,591	10.00%	$32,394	10.00%	$80,985
SUBTOTAL,	**24,768**	**ASF**	**$21.58**	**$534,504**	**$14.39**	**$356,336**	**$35.97**	**$890,840**

J.UNO & ASSOCIATES	PROJECT:	**70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY**			ESTIMATE NO.:	21-226
	LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.:	20321	DATE:	4/19/2022
	ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL:	60% DESIGN	CHECKED BY:	J. UNO
	QTY BY:	J. UNO ASSOCIATES	PRICES BY:	J. UNO ASSOCIATES	DATE CHECKED:	4/19/2022

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL TOTAL
(FA) FIRE PROTECTION - ALARM (SUBCONTRACTOR)								
D503001 - FIRE ALARM & DETECTION SYSTEMS								
FIRE ALARM SYSTEM								
Fire Alarm Control Panel	1	ea	$15,000.00	$15,000	$3,520.00	$3,520	$18,520.00	$18,520
Notification Devices	29	ea	$250.00	$7,250	$110.00	$3,190	$360.00	$10,440
Notification Devices, Antimicrobial	30	ea	$850.00	$25,500	$110.00	$3,300	$960.00	$28,800
Initiation Devices	3	ea	$220.00	$660	$110.00	$330	$330.00	$990
Initiation Devices, Antimicrobial	2	ea	$850.00	$1,700	$110.00	$220	$960.00	$1,920
Conduit, 3/4" EMT, w/ Fittings & Boxes	960	lf	$2.35	$2,257	$13.75	$13,200	$16.10	$15,457
Conduit, 3/4" Alum, w/ Fittings & Boxes	3,040	lf	$5.43	$16,511	$13.75	$41,800	$19.18	$58,311
FA Cable, Data & Limited Pwr Circuit	8,800	lf	$0.64	$5,667	$0.77	$6,776	$1.41	$12,443
SUBTOTAL,				$74,545		$72,336		$146,881
SUBCONTRACTOR JOOH,			5.00%	$3,727	5.00%	$3,617	5.00%	$7,344
SUBCONTRACTOR HOOH,			10.20%	$7,984	10.20%	$7,747	10.20%	$15,731
SUBCONTRACTOR PROFIT,			10.00%	$8,626	10.00%	$8,370	10.00%	$16,996
SUBTOTAL,	**24,768**	**ASF**	**$3.83**	**$94,882**	**$3.72**	**$92,070**	**$7.55**	**$186,952**

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL
(EL) ELECTRICAL - POWER & LIGHTING (SUBCONTRACTOR)								
D5010 - ELECTRICAL SERVICE & DISTRIBUTION								
SWITCHBOARDS								
Swbd, 65kAIC, 480/277V, 3Ph, 4W, 2500A	1	ea	$150,000	$150,000	$19,800.00	$19,800	$169,800	$169,800
Emer. Swbd, 480/277V, 3Ph, 4W, 1200A	1	ea	$70,000	$70,000	$8,800.00	$8,800	$78,800.00	$78,800
INTERIOR TRANSFORMERS								
Dry Xfmr, 112.5kVA, 480:208/120V, 3Ph, 4	2	ea	$35,000	$70,000	$4,400.00	$8,800	$39,400.00	$78,800
EMERGENCY SYSTEM TRANSFORMER								
Dry Xfmr, 112.5kVA, 480:208/120V, 3Ph, 4	2	ea	$45,000	$90,000	$4,400.00	$8,800	$49,400.00	$98,800
DISTRIBUTION PANELS								
Panel, 400A, 208/120V, 3Ph, 4W, Stainless	2	ea	$18,000	$36,000	$2,640.00	$5,280	$20,640.00	$41,280
PANELS								
Panel, 225A, 208/120V	6	ea	$6,500.00	$39,000	$1,320.00	$7,920	$7,820.00	$46,920
Panel 4L, 100A, 480/277V	1	ea	$3,500.00	$3,500	$880.00	$880	$4,380.00	$4,380
EMERGENCY SYSTEM PANELS								
Panel, 225A, 208/120V, 3Ph, 4W	6	ea	$6,500.00	$39,000	$1,760.00	$10,560	$8,260.00	$49,560
Panel 4L, 100A, 480/277V, 3Ph, 4W	1	ea	$3,500.00	$3,500	$1,760.00	$1,760	$5,260.00	$5,260
FEEDER ALLOWANCE								
Feeders From Swbd to All Panels, Xfmrs, and Sub-Panels	1	ls	##########	$150,000	##########	$130,000	##########	$280,000
ENCLOSED CIRCUIT BREAKERS								
Circuit Breaker, 1200A, 42kAIC, 3Ph, 4W	1	ea	$30,000.00	$30,000	$1,760.00	$1,760	$31,760.00	$31,760
D5020 - LIGHTING AND BRANCH WIRING								
POWER DEVICES & EQUIPMENT CONNECTIONS								
Outlet, Duplex	70	ea	$45.00	$3,150	$165.00	$11,550	$210.00	$14,700
Outlet, Duplex, GFCI	21	ea	$75.00	$1,575	$176.00	$3,696	$251.00	$5,271
Hardwired, 120V, w/ Motor Rated Switch	3	ea	$161.00	$483	$440.00	$1,320	$601.00	$1,803
Hardwired, 208V, w/ 30A Disc	2	ea	$1,192.00	$2,384	$385.00	$770	$1,577.00	$3,154
Hardwired, 208V, 3PH, w/ 60A Disc	1	ea	$1,396.00	$1,396	$759.00	$759	$2,155.00	$2,155
Hardwired, 480V, 3PH, w/ 30A Disc	28	ea	$1,192.00	$33,376	$440.00	$12,320	$1,632.00	$45,696
Hardwired, 480V, 3PH, w/ 60A Disc	2	ea	$1,396.00	$2,792	$990.00	$1,980	$2,386.00	$4,772
Hardwired, 480V, 3PH, w/ 200A Disc	1	ea	$4,596.00	$4,596	$1,760.00	$1,760	$6,356.00	$6,356
Cord Drop, 120V, 20A Twistlock	13	ea	$125.00	$1,625	$811.25	$10,546	$936.25	$12,171
Cord Drop, 208V, 3PH, 20A Twistlock	2	ea	$165.00	$330	$885.00	$1,770	$1,050.00	$2,100
Cord Drop, 208V, 3PH, 40A Twistlock	1	ea	$235.00	$235	$1,180.00	$1,180	$1,415.00	$1,415
Cord Drop, 480V, 3PH, 20A Twistlock	9	ea	$195.00	$1,755	$958.75	$8,629	$1,153.75	$10,384
Cord Drop, 480V, 3PH, 40A Twistlock	1	ea	$345.00	$345	$1,253.75	$1,254	$1,598.75	$1,599
Cord Drop Reel, 480V, 3PH, 20A Twistlock	2	ea	$995.00	$1,990	$1,032.50	$2,065	$2,027.50	$4,055

(EL) ELECTRICAL - POWER & LIGHTING (SUBCONTRACTOR)

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL TOTAL
Conduit, 3/4"	10,450	lf	$5.16	$53,883	$7.04	$73,568	$12.20	$127,451
Conduit, 1"	500	lf	$10.24	$5,122	$8.58	$4,290	$18.82	$9,412
Conduit, 2"	100	lf	$18.80	$1,880	$22.00	$2,200	$40.80	$4,080
Wire, #12 AWG, THHN, Copper	43,270	lf	$0.26	$11,423	$0.80	$34,745	$1.07	$46,169
Wire, #10 AWG, THHN, Copper	17,424	lf	$0.41	$7,092	$0.88	$15,333	$1.29	$22,425
Wire, #6 AWG, THHN, Copper	2,904	lf	$1.14	$3,322	$1.35	$3,929	$2.50	$7,251
Wire, #4/0 AWG, THHN, Copper	629	lf	$7.78	$4,893	$3.98	$2,505	$11.76	$7,399
MECHANICAL CONNECTIONS								
AC Connection, 480V, w/ 30A Disc NEMA 1	2	ea	$218.00	$436	$275.00	$550	$493.00	$986
AC Connection, <5 HP, w/ Motor Rated Sw	17	ea	$110.00	$1,870	$110.00	$1,870	$220.00	$3,740
AC Conn, 480V, w/ 60A Disc, NEMA 4X SS	1	ea	$1,055.00	$1,055	$366.30	$366	$1,421.30	$1,421
ACCU Conn., 208V, w/ 60A Disc, NEMA 4X	1	ea	$855.00	$855	$366.30	$366	$1,221.30	$1,221
CF Connection, <5 HP, w/ Motor Rated Sw	4	ea	$15.00	$60	$110.00	$440	$125.00	$500
EF Connection, <5 HP, w/ Motor Rated Sw	5	ea	$15.00	$75	$110.00	$550	$125.00	$625
EF Conn, 480V, w/ 60A Disc, NEMA 4X SS	4	ea	$28.00	$112	$366.30	$1,465	$394.30	$1,577
EU Connection, w/ 30A Disc, NEMA 1	11	ea	$218.00	$2,398	$275.00	$3,025	$493.00	$5,423
EU Connection, w/ Manual Motor Sw	2	ea	$218.00	$436	$275.00	$550	$493.00	$986
FCU Connection, 208V, w/ Motor Rated Sw	2	ea	$110.00	$220	$110.00	$220	$220.00	$440
PACU Conn, 480V, w/ 60A Disc, NEMA 4X S	5	ea	$1,055.00	$5,275	$366.30	$1,832	$1,421.30	$7,107
EF Conn, 480V, w/ 60A Disc, NEMA 4X SS	5	ea	$1,055.00	$5,275	$366.30	$1,832	$1,421.30	$7,107
Gas Water Heater Conn. w/ Motor Rated S	5	ea	$110.00	$550	$110.00	$550	$220.00	$1,100
HWRP & DMS Conn.	4	ea	$110.00	$440	$110.00	$440	$220.00	$880
Water Softener Conn, w/ Motor Rated Sw	1	ea	$110.00	$110	$110.00	$110	$220.00	$220
Conduit, EMT, 1"	750	lf	$4.50	$3,372	$8.58	$6,435	$13.08	$9,807
Conduit, EMT, 3/4"	4,240	lf	$2.35	$9,969	$7.04	$29,850	$9.39	$39,819
Wire, #6 AWG, THHN, Copper	4,125	lf	$1.14	$4,719	$1.35	$5,581	$2.50	$10,300
Wire, #8 AWG, THHN, Copper	908	lf	$0.72	$649	$1.10	$998	$1.82	$1,647
Wire, #10 AWG, THHN, Copper	9,328	lf	$0.41	$3,796	$0.88	$8,209	$1.29	$12,005
Wire, #12 AWG, THHN, Copper	13,992	lf	$0.26	$3,694	$0.80	$11,236	$1.07	$14,929
LIGHTING CONTROL								
Switch, Single Pole	26	ea	$40.00	$1,040	$165.00	$4,290	$205.00	$5,330
Switch, Occupancy Sensor, Wall Mounted	24	ea	$275.00	$6,600	$264.00	$6,336	$539.00	$12,936
LIGHTING FIXTURES								
Type 1 - Linear, Surface, 4' x 15", LED	21	ea	$1,150.00	$24,150	$590.00	$12,390	$1,740.00	$36,540
Type 2 - Linear, Surface, 4' x 15", LED	62	ea	$850.00	$52,700	$590.00	$36,580	$1,440.00	$89,280
Type 3 -Recessed, 2 x 4, LED	24	ea	$165.00	$3,960	$220.00	$5,280	$385.00	$9,240
Type 4 -Recessed, 1 x 4, LED	14	ea	$200.00	$2,800	$440.00	$6,160	$640.00	$8,960
Type 5 - Linear, Stem Mount, 4' x 8", LED	21	ea	$135.00	$2,835	$330.00	$6,930	$465.00	$9,765

PROJECT:	**70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY**	ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.: 20321	DATE: 4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL: 60% DESIGN	CHECKED BY: J. UNO
QTY BY:	J. UNO ASSOCIATES	PRICES BY: J. UNO ASSOCIATES	DATE CHECKED: 4/19/2022

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL TOTAL
(EL) ELECTRICAL - POWER & LIGHTING (SUBCONTRACTOR)								
LIGHTING BRANCH								
Conduit, EMT, 3/4"	2,130	lf	$2.35	$5,008	$7.04	$14,995	$9.39	$20,003
Wire, #12 AWG, THHN, Copper	9,372	lf	$0.26	$2,474	$0.80	$7,526	$1.07	$10,000
D5030 - OTHER ELECTRICAL SERVICES								
TRANSFER SWITCHES								
Automatic Transfer Switch, 1200A, Bypass-Isolation, 480/227V, 3Ph, 4W	1	ea	$40,000.00	$40,000	$2,640.00	$2,640	$42,640.00	$42,640
PHOTO-VOLTAIC (PV) SYSTEM								
PV System, 185.0 kW	185	kW	$3,300.00	$610,500	$1,700.00	$314,500	$5,000.00	$925,000
SUBTOTAL,				$1,622,081		$894,631		$2,516,711
SUBCONTRACTOR JOOH,			5.00%	$81,104	5.00%	$44,732	5.00%	$125,836
SUBCONTRACTOR HOOH,			10.20%	$173,725	10.20%	$95,815	10.20%	$269,540
SUBCONTRACTOR PROFIT,			10.00%	$187,691	10.00%	$103,518	10.00%	$291,209
SUBTOTAL,	**24,768**	**ASF**	**$83.36**	**$2,064,600**	**$45.97**	**$1,138,695**	**$129.33**	**$3,203,296**

PROJECT:	**70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY**				ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.:	20321		DATE:	4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL:	60% DESIGN		CHECKED BY:	J. UNO
QTY BY:	J. UNO ASSOCIATES	PRICES BY:	J. UNO ASSOCIATES		DATE CHECKED:	4/19/2022

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL TOTAL
(TC) COMMUNICATIONS & SECURITY (SUBCONTRACTOR)								
D503002 - TELECOMMUNICATIONS SYSTEMS								
Covered Livestock	4,875	sf	$0.60	$2,925	$0.40	$1,950	$1.00	$4,875
Processing Building	19,893	sf	$3.30	$65,647	$2.20	$43,765	$5.50	$109,412
SUBTOTAL,				$68,572		$45,715		$114,287
SUBCONTRACTOR JOOH,			5.00%	$3,429	5.00%	$2,286	5.00%	$5,714
SUBCONTRACTOR HOOH,			10.20%	$7,344	10.20%	$4,896	10.20%	$12,240
SUBCONTRACTOR PROFIT,			10.00%	$7,934	10.00%	$5,290	10.00%	$13,224
SUBTOTAL,	**24,768**	**ASF**	**$3.52**	**$87,279**	**$2.35**	**$58,186**	**$5.87**	**$145,465**

C O S T A N A L Y S I S

PROJECT:	**70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY**				ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.:	20321		DATE:	4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL:	60% DESIGN		CHECKED BY:	J. UNO
QTY BY:	J. UNO ASSOCIATES	PRICES BY:	J. UNO ASSOCIATES		DATE CHECKED:	4/19/2022

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL TOTAL
(FF) FURNITURE, FURNISHINGS & EQUIPMENT (FF&E) (SUBCONTRACTOR)								
E1010 - COMMERCIAL EQUIPMENT								
PROCESSING EQUIPMENT								
Processing Equipment	1	ls	$250,000	$250,000	$250,000	$250,000	$500,000	$500,000
SUBTOTAL,				$349,299		$309,385		$500,000
SUBCONTRACTOR JOOH,			5.00%	$17,465	5.00%	$15,469	5.00%	$25,000
SUBCONTRACTOR HOOH,			10.20%	$37,410	10.20%	$33,135	10.20%	$53,550
SUBCONTRACTOR PROFIT,			10.00%	$40,417	10.00%	$35,799	10.00%	$57,855
SUBTOTAL,	**1**	**LS**		**$444,592**		**$393,788**		**$636,405**

P R O J E C T C O S T S U M M A R Y						
PROJECT:	70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY				ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.:	20321		DATE:	4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL:	60% DESIGN		CHECKED BY:	J. UNO
QTY BY:	J. UNO ASSOCIATES	PRICES BY:	J. UNO ASSOCIATES		DATE CHECKED:	4/19/2022

PROJECT COST SUMMARY - 70 HD - ON SITE WASTE DIPOSAL

CODE	DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL
(EN)	HAZMAT/ ENVIRONMENTAL (SUB)	1	LS		NONE ASSUMED
(CS)	CIVIL - SITEWORK/ IMPROVEMENTS	1	LS		$5,255,555
(CU)	CIVIL/ MECHANICAL - UTILITIES	1	LS		$836,971
(SE)	SITE ELECTRICAL/ TELECOM (SUB)	1	LS		$1,287,318
(LS)	LANDSCAPING (SUB)	1	LS		$793,726
(ST)	STRUCTURAL (SUB)	24,768	ASF	$183.76	$4,551,393
(AR)	ARCHITECTURAL (SUB)	24,768	ASF	$112.43	$2,784,653
(PL)	MECHANICAL - PLUMBING (SUB)	140	FIXT	$12,935.80	$1,811,013
(ME)	MECHANICAL - HVAC (SUB)	24,768	ASF	$252.47	$6,253,169
(FP)	FIRE PROTECTION - SPRINKLERS (SUB)	24,768	ASF	$35.97	$890,840
(FA)	FIRE PROTECTION - ALARM (SUB)	24,768	ASF	$7.55	$186,952
(EL)	ELECTRICAL - POWER & LIGHTING (SUB)	24,768	ASF	$129.33	$3,203,296
(TC)	COMMUNICATIONS & SECURITY (SUB)	24,768	ASF	$5.87	$145,465
(FF)	FURNITURE, FURNISHINGS & EQUIPMENT (FF&E) (SUB)	1	LS		$636,405
SUBTOTAL, ESTIMATED DIRECT COST (INCLUDES SUBCONTRACTOR MARKUPS),					**$28,636,757**

P R O J E C T C O S T S U M M A R Y					
PROJECT:	70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY			ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.:	20321	DATE:	4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL:	60% DESIGN	CHECKED BY:	J. UNO
QTY BY:	J. UNO ASSOCIATES	PRICES BY:	J. UNO ASSOCIATES	DATE CHECKED:	4/19/2022

DESCRIPTION	QTY	UNIT	TOTAL	
			UNIT COST	TOTAL
PROJECT COST SUMMARY - 70 HD - ON SITE WASTE DIPOSAL				
DIRECT MARKUPS				
LOCATION FACTOR, TBD				
ESCALATION TO MIDPOINT OF CONSTRUCTION (CPI-U),	16.29%			$4,665,405
DESIGN CONTINGENCY,	12.50%			$4,162,770
SUBTOTAL, ESTIMATED DIRECT COST TO PRIME,				**$37,464,932**
PRIME CONTRACTOR MARKUPS				
PRIME CONTRACTOR'S JOOH,	11.92%			$4,465,756
PRIME CONTRACTOR'S HOOH,	5.10%			$2,138,465
PRIME CONTRACTOR'S PROFIT,	8.00%			$3,525,532
BOND & INSURANCE,	3.00%			$1,427,841
G.E. TAX,	4.712%			$2,309,941
TOTAL ESTIMATED CONTRACT COST,				**$51,332,468**
ROUNDED,	**24,768**	**ASF**	**$2,072.55**	**$51,333,000**

C O S T   A N A L Y S I S

PROJECT:	70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY			ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.:	20321	DATE:	4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL:	60% DESIGN	CHECKED BY:	J. UNO
QTY BY:	J. UNO ASSOCIATES	PRICES BY:	J. UNO ASSOCIATES	DATE CHECKED:	4/19/2022

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL TOTAL
(CS) CIVIL - SITEWORK/ IMPROVEMENTS (SUBCONTRACTOR)								
G1010 - SITE CLEARING								
SITE CLEARING								
Clearing and Grubbing	25	acr			$11,107.80	$273,063	$11,107.80	$273,063
EROSION CONTROLS								
Construction Fence	4,147	lf	$11.35	$47,068	$32.15	$133,326	$43.50	$180,395
Filter Sock	3,072	lf	$5.00	$15,360	$3.75	$11,520	$8.75	$26,880
G1030 - SITE EARTHWORK								
GRADING								
Fine Grading	25	acr			$11,979.00	$294,480	$11,979.00	$294,480
G2020 - PARKING LOTS								
PAVING								
AC Pavement, 3" Thick	159,203	sf	$3.25	$517,410	$1.54	$244,775	$4.79	$762,184
Base Course, 6"	2,948	cy	$48.00	$141,514	$16.00	$47,171	$64.00	$188,685
Subbase Course, 6"	2,948	cy	$32.00	$94,343	$16.00	$47,171	$48.00	$141,514
MARKING & SIGNAGE								
Parking Stall Striping, 4" Wide	1,716	lf	$0.45	$772	$4.00	$6,864	$4.45	$7,636
Sign & Post, Includes Footing	3	ea	$500.00	$1,500	$600.00	$1,800	$1,100.00	$3,300
Wheel Stops, Concrete	67	ea	$85.00	$5,695	$100.00	$6,700	$185.00	$12,395
G2030 - PEDESTRIAN PAVING								
WALKWAYS								
Concrete Paving, 6"	3,530	sf	$11.70	$41,301	$14.55	$51,362	$26.25	$92,663
Base Course, 6"	65	cy	$48.00	$3,138	$16.00	$1,046	$64.00	$4,184
G2040 - SITE DEVELOPMENT								
SITE IMPROVEMENTS								
Perimeter Chain-Link Fencing	4,105	lf	$44.00	$180,620	$33.33	$136,833	$77.33	$317,453
Swing Gates, 24'W	2	ea	$1,500.00	$3,000	$800.00	$1,600	$2,300.00	$4,600
Mech Yard	1,024	sf	$32.00	$32,768	$30.00	$30,720	$62.00	$63,488
Mech Yard Fencing	137	lf	$38.50	$5,275	$33.33	$4,567	$71.83	$9,841
Gates, Double	3	pr	$850.00	$2,550	$800.00	$2,400	$1,650.00	$4,950
Holding Pen Ramp	920	sf	$6.65	$6,118	$7.60	$6,992	$14.25	$13,110
Loading Dock Ramp	1,240	sf	$6.65	$8,246	$7.60	$9,424	$14.25	$17,670
Shipping/Receiving Ramp	1,702	sf	$6.65	$11,318	$7.60	$12,935	$14.25	$24,254
Constructed Wet Land	33,800	sf	$4.00	$135,200	$3.75	$126,750	$7.75	$261,950
Leach Fields	299,523	sf						
Distribution Box	2	ea	$500.00	$1,000	$1,200.00	$2,400	$1,700.00	$3,400
Excavation	1,028	cy			$43.75	$44,960	$43.75	$44,960
4" Perforated Pipe	3,083	lf	$2.20	$6,783	$8.00	$24,664	$10.20	$31,447
Gravel Fill	685	bcy	$73.27	$50,200	$59.38	$40,678	$132.65	$90,879
Backfill, Exist. Soil	114	bcy			$59.38	$6,780	$59.38	$6,780
Hauling of Excv. Soil	251	lcy			$17.19	$4,318	$17.19	$4,318

PROJECT:	**70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY**		ESTIMATE NO.: 21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.: 20321	DATE: 4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL: 60% DESIGN	CHECKED BY: J. UNO
QTY BY:	J. UNO ASSOCIATES	PRICES BY: J. UNO ASSOCIATES	DATE CHECKED: 4/19/2022

(CS) CIVIL - SITEWORK/ IMPROVEMENTS (SUBCONTRACTOR)

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL TOTAL
Solid Waste Compost Area	182,377	sf	$5.00	$911,885	$3.75	$683,914	$8.75	$1,595,799
Gravel Access Road	405	sf						
Excavation	8	cy			$43.75	$328	$43.75	$328
Gravel Fill	8	bcy	$73.27	$550	$118.75	$891	$192.02	$1,440
Compaction	405	sf			$1.50	$608	$1.50	$608
Hauling of Excv. Soil	8	lcy			$17.19	$142	$17.19	$142
Aerated Lagoon 1	13,656	sf	$4.00	$54,624	$3.75	$51,210	$7.75	$105,834
Base Course	253	bcy	$73.27	$18,530	$59.38	$15,015	$132.65	$33,545
Geotextile Fabric	13,656	sf	$0.17	$2,307	$0.67	$9,104	$0.84	$11,411
Polypropylene Liner	13,656	sf	$0.17	$2,307	$0.67	$9,104	$0.84	$11,411
Aerated Lagoon 2	17,516	sf	$4.00	$70,064	$3.75	$65,685	$7.75	$135,749
Base Course	324	bcy	$73.27	$23,768	$59.38	$19,259	$132.65	$43,027
Geotextile Fabric	17,516	sf	$0.17	$2,959	$0.67	$11,677	$0.84	$14,636
Polypropylene Liner	17,516	sf	$0.17	$2,959	$0.67	$11,677	$0.84	$14,636
Blower Building	548	sf						
Floor Slab, 12"	548	sf						
Excavation	10	bcy			$43.75	$444	$43.75	$444
Compact Exist. Subgrade	603	sf			$1.19	$716	$1.19	$716
Base Course	10	bcy	$73.27	$744	$59.38	$603	$132.65	$1,346
Vapor Barrier	548	sf	$0.17	$93	$0.67	$365	$0.84	$458
Formwork	240	sf	$2.20	$528	$4.00	$960	$6.20	$1,488
Rebar Reinforcement	3,426	lb	$1.10	$3,772	$1.00	$3,426	$2.10	$7,198
Concrete	27	cy	$245.25	$6,722	$54.69	$1,499	$299.93	$8,220
Trowel/ Float Finish	644	sf			$2.00	$1,288	$2.00	$1,288
Hauling of Excv. Soil	11	lcy			$17.19	$192	$17.19	$192
Concrete Walls, 12"	2,776	sf						
Formwork	5,552	sf	$4.40	$24,429	$6.67	$37,013	$11.07	$61,442
Rebar Reinforcement	19,535	lb	$1.10	$21,510	$1.00	$19,535	$2.10	$41,045
Concrete	103	cy	$245.25	$25,215	$109.38	$11,245	$354.62	$36,460
Grind & Rub Finish	5,552	sf			$2.00	$11,104	$2.00	$11,104
Roof Beams, 18"x12"	91	lf						
Shoring, Pipe Column	137	sf	$3.00	$410	$4.00	$546	$7.00	$956
Formwork	322	sf	$4.40	$1,415	$6.67	$2,143	$11.07	$3,558
Rebar Reinforcement	910	lb	$1.10	$1,002	$1.00	$910	$2.10	$1,912
Concrete	5	cy	$245.25	$1,240	$109.38	$553	$354.62	$1,793
Grind & Rub Finish	455	sf			$2.00	$910	$2.00	$910
Roof Slab, 12"	1,121	sf						
Shoring, Pipe Column	1,121	sf	$3.00	$3,363	$4.00	$4,484	$7.00	$7,847
Formwork	1,324	sf	$4.40	$5,823	$6.67	$8,823	$11.07	$14,647
Rebar Reinforcement	4,982	lb	$1.10	$5,486	$1.00	$4,982	$2.10	$10,468
Concrete	42	cy	$245.25	$10,182	$109.38	$4,541	$354.62	$14,723
Trowel/ Float Finish	2,445	sf			$2.00	$4,889	$2.00	$4,889

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL
(CS) CIVIL - SITEWORK/ IMPROVEMENTS (SUBCONTRACTOR)								
Equipment Pad, 4"	46	sf						
Formwork	35	sf	$2.20	$77	$4.00	$139	$6.20	$216
Rebar Reinforcement	70	lb	$1.10	$77	$1.00	$70	$2.10	$148
Concrete	1	cy	$245.25	$138	$54.69	$31	$299.93	$169
Trowel/ Float Finish	60	sf			$2.00	$120	$2.00	$120
Blower, Equipment	2	ea	$20,000.00	$40,000	$3,400.00	$6,800	$23,400.00	$46,800
Transfer Pump Station	109	sf						
Floor Slab, 14"	109	sf						
Excavation	55	bcy			$43.75	$2,384	$43.75	$2,384
Compact Exist. Subgrade	120	sf			$1.19	$142	$1.19	$142
Base Course	2	bcy	$73.27	$148	$59.38	$120	$132.65	$268
Vapor Barrier	109	sf	$0.17	$18	$0.67	$73	$0.84	$91
Formwork	119	sf	$2.20	$262	$4.00	$477	$6.20	$740
Rebar Reinforcement	1,123	lb	$1.10	$1,236	$1.00	$1,123	$2.10	$2,359
Concrete	9	cy	$245.25	$2,203	$54.69	$491	$299.93	$2,694
Trowel/ Float Finish	158	sf			$2.00	$316	$2.00	$316
Hauling of Excv. Soil	60	lcy			$17.19	$1,030	$17.19	$1,030
Concrete Walls, 12"	845	sf						
Formwork	1,690	sf	$4.40	$7,436	$6.67	$11,267	$11.07	$18,703
Rebar Reinforcement	5,946	lb	$1.10	$6,547	$1.00	$5,946	$2.10	$12,494
Concrete	31	cy	$245.25	$7,675	$109.38	$3,423	$354.62	$11,098
Grind & Rub Finish	1,690	sf			$2.00	$3,380	$2.00	$3,380
Roof Slab, 12"	109	sf						
Shoring, Pipe Column	109	sf	$3.00	$327	$4.00	$436	$7.00	$763
Formwork	172	sf	$4.40	$757	$6.67	$1,147	$11.07	$1,903
Rebar Reinforcement	484	lb	$1.10	$533	$1.00	$484	$2.10	$1,018
Concrete	4	cy	$245.25	$990	$109.38	$442	$354.62	$1,432
Trowel/ Float Finish	281	sf			$2.00	$562	$2.00	$562
Equipment Pad, 8"	64	sf						
Formwork	51	sf	$2.20	$113	$4.00	$206	$6.20	$319
Rebar Reinforcement	199	lb	$1.10	$219	$1.00	$199	$2.10	$417
Concrete	2	cy	$245.25	$389	$54.69	$87	$299.93	$476
Trowel/ Float Finish	93	sf			$2.00	$187	$2.00	$187
Emergency Generator Pad	157	sf						
Excavation	3	bcy			$43.75	$127	$43.75	$127
Compact Exist. Subgrade	173	sf			$1.19	$205	$1.19	$205
Base Course	3	bcy	$73.27	$213	$59.38	$173	$132.65	$386
Vapor Barrier	157	sf	$0.17	$27	$0.67	$105	$0.84	$131
Formwork	138	sf	$2.20	$303	$4.00	$550	$6.20	$853
Rebar Reinforcement	1,236	lb	$1.10	$1,361	$1.00	$1,236	$2.10	$2,597
Concrete	10	cy	$245.25	$2,425	$54.69	$541	$299.93	$2,966
Trowel/ Float Finish	212	sf			$2.00	$424	$2.00	$424
Hauling of Excv. Soil	3	lcy			$17.19	$55	$17.19	$55

C O S T A N A L Y S I S

PROJECT:	**70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY**		ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.: 20321	DATE:	4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL: 60% DESIGN	CHECKED BY:	J. UNO
QTY BY:	J. UNO ASSOCIATES	PRICES BY: J. UNO ASSOCIATES	DATE CHECKED:	4/19/2022

			MATERIAL / SUB		LABOR / EQPT		TOTAL	
DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL
(CS) CIVIL - SITEWORK/ IMPROVEMENTS (SUBCONTRACTOR)								
Transformer Pad	120	sf						
Excavation	2	bcy			$43.75	$97	$43.75	$97
Compact Exist. Subgrade	132	sf			$1.19	$157	$1.19	$157
Base Course	2	bcy	$73.27	$163	$59.38	$132	$132.65	$295
Vapor Barrier	120	sf	$0.17	$20	$0.67	$80	$0.84	$100
Formwork	110	sf	$2.20	$242	$4.00	$440	$6.20	$682
Rebar Reinforcement	963	lb	$1.10	$1,060	$1.00	$963	$2.10	$2,023
Concrete	8	cy	$245.25	$1,889	$54.69	$421	$299.93	$2,311
Trowel/ Float Finish	164	sf			$2.00	$328	$2.00	$328
Hauling of Excv. Soil	2	lcy			$17.19	$42	$17.19	$42
Bollards, Painted	31	ea	$1,200.00	$37,200	$200.00	$6,200	$1,400.00	$43,400
SUBTOTAL,	**1**	**LS**		**$2,627,113**		**$2,628,442**		**$5,255,555**

PROJECT:	70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY		ESTIMATE NO.: 21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.: 20321	DATE: 4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL: 60% DESIGN	CHECKED BY: J. UNO
QTY BY:	J. UNO ASSOCIATES	PRICES BY: J. UNO ASSOCIATES	DATE CHECKED: 4/19/2022

			MATERIAL / SUB		LABOR / EQPT		TOTAL	
DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL
(CU) CIVIL/ MECHANICAL - UTILITIES (SUBCONTRACTOR)								
G3010 - WATER SUPPLY								
WATERLINE								
8" Waterline, In Place Complete	658	LF						
Excavation	292	cy			$56.25	$16,450	$56.25	$16,450
Hauling of Excv. Soil	322	lcy			$11.88	$3,820	$11.88	$3,820
Pipe Bedding	117	lcy	$99.78	$11,672	$28.13	$3,290	$127.91	$14,962
Backfill, Exist. Soil	175	bcy			$28.13	$4,935	$28.13	$4,935
Water Line, 8" Dia. PVC	658	lf	$26.40	$17,371	$15.00	$9,870	$41.40	$27,241
Connection to Building	1	ea	$500.00	$500	$1,500.00	$1,500	$2,000.00	$2,000
Connection to Exist. Water Line	2	ea	$500.00	$1,000	$3,750.00	$7,500	$4,250.00	$8,500
Water Meter	1	ea	$10,000.00	$10,000	$2,040.00	$2,040	$12,040.00	$12,040
Reduced Pressure Backflow Preventer, 8"	1	ea	$24,000.00	$24,000	$4,200.00	$4,200	$28,200.00	$28,200
Fire Hydrant	3	ea	$4,800.00	$14,400	$7,100.00	$21,300	$11,900.00	$35,700
G3020 - SANITARY SEWER								
SEWER LINE								
4" Sewer, In Place Complete	1,555	LF						
Excavation	691	cy			$56.25	$38,875	$56.25	$38,875
Hauling of Excv. Soil	760	lcy			$11.88	$9,028	$11.88	$9,028
Pipe Bedding	276	lcy	$99.78	$27,584	$28.13	$7,775	$127.91	$35,359
Backfill, Exist. Soil	415	bcy			$28.13	$11,663	$28.13	$11,663
Sanitary Line, 4" Dia. PVC	1,555	lf	$26.40	$41,052	$15.00	$23,325	$41.40	$64,377
8" Sewer, In Place Complete	1,463	LF						
Excavation	650	cy			$56.25	$36,575	$56.25	$36,575
Hauling of Excv. Soil	715	lcy			$11.88	$8,494	$11.88	$8,494
Pipe Bedding	260	lcy	$99.78	$25,952	$28.13	$7,315	$127.91	$33,267
Backfill, Exist. Soil	390	bcy			$28.13	$10,973	$28.13	$10,973
Sanitary Line, 8" Dia. PVC	1,463	lf	$8.75	$12,804	$15.00	$21,945	$23.75	$34,749
Connection to Building	3	ea	$500.00	$1,500	$1,500.00	$4,500	$2,000.00	$6,000
Connection to Exist. Sanitary Line	1	ea	$500.00	$500	$3,750.00	$3,750	$4,250.00	$4,250
EQ Tank	1	ea	$5,000.00	$5,000	$3,400.00	$2,500	$8,400.00	$7,500
Dissolved Air Flotation System	1	ea	$5,000.00	$5,000	$3,400.00	$2,500	$8,400.00	$7,500
DAF Equipment Pad	246	sf	$11.40	$2,805	$11.83	$2,911	$23.24	$5,716
Sewer Manholes	6	ea	$11,600.00	$69,600	$3,400.00	$20,400	$15,000.00	$90,000
Grease Interceptor	1	ea	$45,000.00	$45,000	$15,000.00	$15,000	$60,000.00	$60,000
Septic Tank	1	ea	$20,000.00	$20,000	$12,000.00	$12,000	$32,000.00	$32,000
Transfer Pump, Equipment	2	ea	$20,000.00	$40,000	$3,400.00	$6,800	$23,400.00	$46,800
G3030 - STORM SEWER								
STORM DRAINAGE								
Drywell	7	ea	$15,000.00	$105,000	$5,000.00	$35,000	$20,000.00	$140,000
SUBTOTAL,	**1**	**LS**		**$483,545**		**$359,143**		**$836,971**

PROJECT:	**70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY**		ESTIMATE NO.: 21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.: 20321	DATE: 4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL: 60% DESIGN	CHECKED BY: J. UNO
QTY BY:	J. UNO ASSOCIATES	PRICES BY: J. UNO ASSOCIATES	DATE CHECKED: 4/19/2022

(SE) SITE ELECTRICAL/ TELECOM (SUBCONTRACTOR)

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL TOTAL
G4010 - ELECTRICAL DISTRIBUTION								
PRIMARY DISTRIBUTION (CONDUIT ASSUMED FROM XFMR PAD TO NORTH PROPERTY LINE)								
Ductbank, 2'W x 4'D	110	lf						
Excavation	33	bcy			$47.75	$1,556	$47.75	$1,556
Compaction, Trench Bottom	220	sf			$1.29	$283	$1.29	$283
Concrete	8	cy	$245.25	$1,998	$59.69	$486	$304.93	$2,485
Reinforcing Steel	978	lbs	$1.10	$1,077	$1.10	$1,076	$2.20	$2,152
Backfill, Native Soils	28	lcy			$64.38	$1,783	$64.38	$1,783
Compaction, 12" Lifts	660	sf			$1.29	$850	$1.29	$850
Hauling/Disposal of Spoils	9	lcy	$15.00	$134	$18.44	$165	$33.44	$300
Conduit, PVC Sch40, 4"	220	lf	$18.77	$4,129	$14.75	$3,245	$33.52	$7,374
Concrete Pad, 8" Thick	100	sf	$12.78	$1,275	$21.07	$2,102	$33.85	$3,377
SECONDARY DISTRIBUTION								
Ductbank, 2'W x 4'D	40	lf						
Excavation	12	bcy			$47.75	$566	$47.75	$566
Compaction, Trench Bottom	80	sf			$1.29	$103	$1.29	$103
Concrete	3	cy	$245.25	$727	$59.69	$177	$304.93	$904
Reinforcing Steel	356	lbs	$1.10	$392	$1.10	$391	$2.20	$783
Backfill, Native Soils	10	lcy			$64.38	$649	$64.38	$649
Compaction, 12" Lifts	240	sf			$1.29	$309	$1.29	$309
Hauling/Disposal of Spoils	3	lcy	$15.00	$49	$18.44	$60	$33.44	$109
Conduit, PVC Sch40, 4"	240	lf	$18.77	$4,505	$14.75	$3,540	$33.52	$8,045
Wire, 500MCM, XHHW, Copper	1,030	lf	$18.62	$19,174	$6.60	$6,795	$25.22	$25,970
Wire, 350MCM, XHHW, Copper	343	lf	$13.66	$4,689	$5.83	$2,001	$19.49	$6,690
G4020 - SITE LIGHTING								
EGRESS/ SECURITY LIGHTING (NOT ON DRAWINGS)								
Egress, Wall Pack, w/ Batt, at Exterior Doo	10		$750.00	$7,500	$440.00	$4,400	$1,190.00	$11,900
Security, Wall Pack, Flood Light	26		$1,500.00	$39,000	$1,180.00	$30,680	$2,680.00	$69,680
Security, 35' Pole Light, Flood Light	14		$12,500.00	$175,000	$2,960.00	$41,440	$15,460.00	$216,440
G4030 - SITE COMMUNICATION AND SECURITY								
TELECOM/CATV/SPARE INFRASTRUCTURE (NOT ON DRAWING)								
Ductbank, 2'W x 4'D	130	lf						
Excavation	39	bcy			$47.75	$1,839	$47.75	$1,839
Compaction, Trench Bottom	260	sf			$1.29	$335	$1.29	$335
Concrete	10	cy	$245.25	$2,362	$59.69	$575	$304.93	$2,936
Reinforcing Steel	1,156	lbs	$1.10	$1,272	$1.10	$1,271	$2.20	$2,543
Backfill, Native Soils	33	lcy			$64.38	$2,108	$64.38	$2,108
Compaction, 12" Lifts	780	sf			$1.29	$1,004	$1.29	$1,004
Hauling/Disposal of Spoils	11	lcy	$15.00	$159	$18.44	$195	$33.44	$354
Conduit, PVC Sch40, 4"	390	lf	$18.77	$7,320	$14.75	$5,753	$33.52	$13,072
Communications Hand Hole	1	ea	$4,500.00	$4,500	$2,220.00	$2,220	$6,720.00	$6,720

C O S T A N A L Y S I S

PROJECT:	**70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY**			ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.:	20321	DATE:	4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL:	60% DESIGN	CHECKED BY:	J. UNO
QTY BY:	J. UNO ASSOCIATES	PRICES BY:	J. UNO ASSOCIATES	DATE CHECKED:	4/19/2022

			MATERIAL / SUB		LABOR / EQPT		TOTAL	
DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL
(SE) SITE ELECTRICAL/ TELECOM (SUBCONTRACTOR)								
G4090 - OTHER SITE ELECTRICAL UTILITIES								
GENERATOR								
Generator, 750kW, 480/277V, Enclosure	1	ea	$450,000	$450,000	$43,200.00	$43,200	$493,200	$493,200
EMERGENCY DISTRIBUTION								
Ductbank, 2'W x 4'D	75	lf						
Excavation	22	bcy			$47.75	$1,061	$47.75	$1,061
Compaction, Trench Bottom	150	sf			$1.29	$193	$1.29	$193
Concrete	6	cy	$245.25	$1,362	$59.69	$332	$304.93	$1,694
Reinforcing Steel	667	lbs	$1.10	$734	$1.10	$733	$2.20	$1,467
Backfill, Exist. Soil	19	lcy			$64.38	$1,216	$64.38	$1,216
Compaction, 12" Lifts	450	sf			$1.29	$579	$1.29	$579
Hauling/Disposal of Spoils	6	lcy	$15.00	$92	$18.44	$113	$33.44	$204
Conduit, PVC Sch40, 4"	300	lf	$18.77	$5,631	$14.75	$4,425	$33.52	$10,056
Conduit, PVC Sch40, 1"	75	lf	$3.81	$286	$3.41	$256	$7.22	$541
Wire, 500MCM, XHHW, Copper	1,287	lf	$18.62	$23,968	$6.60	$8,494	$25.22	$32,462
Wire, 350MCM, XHHW, Copper	429	lf	$13.66	$5,861	$5.83	$2,501	$19.49	$8,362
Wire, 250MCM, XHHW, Copper	429	lf	$10.63	$4,559	$4.40	$1,888	$15.03	$6,446
Wire, #10 AWG, XHHW, Copper	399	lf	$0.58	$233	$1.17	$466	$1.75	$698
SITE OPTION #2 - CONNECT TO ON-SITE SEPTIC								
Blower Bldg, Pump Bldg, & Aerated Lagoon Power	1	ls	$35,000.00	$35,000	$25,000.00	$25,000	$60,000.00	$60,000
SUBTOTAL,				$802,985		$208,413		$1,011,399
SUBCONTRACTOR JOOH,			5.00%	$40,149	5.00%	$10,421	5.00%	$50,570
SUBCONTRACTOR HOOH,			10.20%	$86,000	10.20%	$22,321	10.20%	$108,321
SUBCONTRACTOR PROFIT,			10.00%	$92,913	10.00%	$24,116	10.00%	$117,029
SUBTOTAL,	**1**	**LS**		**$1,022,048**		**$265,271**		**$1,287,318**

C O S T A N A L Y S I S

PROJECT:	**70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY**	ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII PROJECT NO.: 20321	DATE:	4/19/2022
ARCHITECT:	EKNA SERVICES, INC. SUBMITTAL: 60% DESIGN	CHECKED BY:	J. UNO
QTY BY:	J. UNO ASSOCIATES PRICES BY: J. UNO ASSOCIATES	DATE CHECKED:	4/19/2022

DESCRIPTION	QTY	UNIT	MATERIAL / SUB		LABOR / EQPT		TOTAL	
			UNIT COST	TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL
(LS) LANDSCAPING (SUBCONTRACTOR)								
G205003 - TOPSOIL & PLANTING BEDS								
Top Soil, 2" Thick	1,080	cy	$72.00	$77,789	$16.00	$17,287	$88.00	$95,076
G205004 - SEEDING, SPRIGGING & SODDING								
Grassing	175,026	sf	$0.15	$26,254	$0.35	$61,259	$0.50	$87,513
G205007 - IRRIGATION SYSTEMS								
Irrigation System	175,026	sf	$0.80	$140,021	$1.61	$281,792	$2.41	$421,813
OTHER								
Maintenance Period	12	mo			$1,600.00	$19,200	$1,600.00	$19,200
SUBTOTAL,				$244,064		$379,537		$623,602
SUBCONTRACTOR JOOH,			5.00%	$12,203	5.00%	$18,977	5.00%	$31,180
SUBCONTRACTOR HOOH,			10.20%	$26,139	10.20%	$40,648	10.20%	$66,788
SUBCONTRACTOR PROFIT,			10.00%	$28,241	10.00%	$43,916	10.00%	$72,157
SUBTOTAL,	**1**	**LS**		**$310,647**		**$483,079**		**$793,726**

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL TOTAL
(ST) STRUCTURAL (SUBCONTRACTOR)								
PROCESSING FACILITY								
A1010 - STANDARD FOUNDATIONS								
WALL FOUNDATIONS								
WF- - 2'0"x1'0"xL	445	LF						
Excavation	199	bcy			$43.75	$8,692	$43.75	$8,692
Compact Exist. Subgrade	1,788	sf			$1.19	$2,123	$1.19	$2,123
Base Course	16	bcy	$73.27	$1,208	$59.38	$979	$132.65	$2,186
Formwork	1,341	sf	$2.20	$2,950	$4.00	$5,364	$6.20	$8,314
Rebar Reinforcement	3,956	lb	$1.10	$4,355	$1.00	$3,956	$2.10	$8,311
Concrete	33	cy	$245.25	$8,084	$54.69	$1,803	$299.93	$9,887
Backfill, Exist. Soil	66	bcy			$59.38	$3,939	$59.38	$3,939
Hauling of Excv. Soil	146	lcy			$17.19	$2,502	$17.19	$2,502
COLUMN FOUNDATIONS & PILE CAPS								
F-4 - 4'0"x4'0"x1'0"	4	EA						
Excavation	16	bcy			$43.75	$700	$43.75	$700
Compact Exist. Subgrade	144	sf			$1.19	$171	$1.19	$171
Base Course	1	bcy	$73.27	$87	$59.38	$70	$132.65	$157
Formwork	96	sf	$2.20	$211	$4.00	$384	$6.20	$595
Rebar Reinforcement	261	lb	$1.10	$287	$1.00	$261	$2.10	$548
Concrete	2	cy	$245.25	$581	$54.69	$130	$299.93	$711
Backfill, Exist. Soil	4	bcy			$59.38	$264	$59.38	$264
Hauling of Excv. Soil	13	lcy			$17.19	$218	$17.19	$218
F-4.5 - 4'6"x4'6"x1'0"	19	EA						
Excavation	89	bcy			$43.75	$3,902	$43.75	$3,902
Compact Exist. Subgrade	803	sf			$1.19	$953	$1.19	$953
Base Course	7	bcy	$73.27	$522	$59.38	$423	$132.65	$945
Formwork	513	sf	$2.20	$1,129	$4.00	$2,052	$6.20	$3,181
Rebar Reinforcement	1,568	lb	$1.10	$1,726	$1.00	$1,568	$2.10	$3,293
Concrete	14	cy	$245.25	$3,495	$54.69	$779	$299.93	$4,274
Backfill, Exist. Soil	23	bcy			$59.38	$1,379	$59.38	$1,379
Hauling of Excv. Soil	73	lcy			$17.19	$1,247	$17.19	$1,247
F-5 - 5'0"x5'0"x1'0"	5	EA						
Excavation	27	bcy			$43.75	$1,191	$43.75	$1,191
Compact Exist. Subgrade	245	sf			$1.19	$291	$1.19	$291
Base Course	2	bcy	$73.27	$170	$59.38	$137	$132.65	$307
Formwork	150	sf	$2.20	$330	$4.00	$600	$6.20	$930
Rebar Reinforcement	509	lb	$1.10	$561	$1.00	$509	$2.10	$1,070
Concrete	5	cy	$245.25	$1,135	$54.69	$253	$299.93	$1,389
Backfill, Exist. Soil	7	bcy			$59.38	$396	$59.38	$396
Hauling of Excv. Soil	23	lcy			$17.19	$389	$17.19	$389

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL TOTAL
(ST) STRUCTURAL (SUBCONTRACTOR)								
PROCESSING FACILITY								
F-5.5 - 5'6"x5'6"x1'6"	4	EA						
Excavation	29	bcy			$43.75	$1,276	$43.75	$1,276
Compact Exist. Subgrade	225	sf			$1.19	$267	$1.19	$267
Base Course	2	bcy	$73.27	$164	$59.38	$133	$132.65	$297
Formwork	176	sf	$2.20	$387	$4.00	$704	$6.20	$1,091
Rebar Reinforcement	739	lb	$1.10	$814	$1.00	$739	$2.10	$1,554
Concrete	7	cy	$245.25	$1,649	$54.69	$368	$299.93	$2,016
Backfill, Exist. Soil	8	bcy			$59.38	$457	$59.38	$457
Hauling of Excv. Soil	24	lcy			$17.19	$406	$17.19	$406
F-6 - 6'0"x6'0"x1'6"	7	EA						
Excavation	58	bcy			$43.75	$2,541	$43.75	$2,541
Compact Exist. Subgrade	448	sf			$1.19	$532	$1.19	$532
Base Course	5	bcy	$73.27	$342	$59.38	$277	$132.65	$619
Formwork	336	sf	$2.20	$739	$4.00	$1,344	$6.20	$2,083
Rebar Reinforcement	1,540	lb	$1.10	$1,696	$1.00	$1,540	$2.10	$3,236
Concrete	14	cy	$245.25	$3,433	$54.69	$766	$299.93	$4,199
Backfill, Exist. Soil	15	bcy			$59.38	$862	$59.38	$862
Hauling of Excv. Soil	48	lcy			$17.19	$823	$17.19	$823
F-7 - 7'0"x7'0"x2'0"	1	EA						
Excavation	12	bcy			$43.75	$525	$43.75	$525
Compact Exist. Subgrade	81	sf			$1.19	$96	$1.19	$96
Base Course	1	bcy	$73.27	$66	$59.38	$54	$132.65	$120
Formwork	70	sf	$2.20	$154	$4.00	$280	$6.20	$434
Rebar Reinforcement	399	lb	$1.10	$440	$1.00	$399	$2.10	$839
Concrete	4	cy	$245.25	$890	$54.69	$198	$299.93	$1,089
Backfill, Exist. Soil	3	bcy			$59.38	$176	$59.38	$176
Hauling of Excv. Soil	10	lcy			$17.19	$171	$17.19	$171
F-7.5 - 7'6"x7'6"x2'0"	1	EA						
Excavation	13	bcy			$43.75	$585	$43.75	$585
Compact Exist. Subgrade	90	sf			$1.19	$107	$1.19	$107
Base Course	1	bcy	$73.27	$76	$59.38	$62	$132.65	$138
Formwork	75	sf	$2.20	$165	$4.00	$300	$6.20	$465
Rebar Reinforcement	458	lb	$1.10	$505	$1.00	$458	$2.10	$963
Concrete	4	cy	$245.25	$1,022	$54.69	$228	$299.93	$1,250
Backfill, Exist. Soil	3	bcy			$59.38	$187	$59.38	$187
Hauling of Excv. Soil	11	lcy			$17.19	$193	$17.19	$193

C O S T A N A L Y S I S

PROJECT:	**70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY**			ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.:	20321	DATE:	4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL:	60% DESIGN	CHECKED BY:	J. UNO
QTY BY:	J. UNO ASSOCIATES	PRICES BY:	J. UNO ASSOCIATES	DATE CHECKED:	4/19/2022

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL TOTAL
(ST) STRUCTURAL (SUBCONTRACTOR)								
PROCESSING FACILITY								
F-8.5 - 8'6"x8'6"x2'0"	10	EA						
Excavation	163	bcy			$43.75	$7,146	$43.75	$7,146
Compact Exist. Subgrade	1,103	sf			$1.19	$1,309	$1.19	$1,309
Base Course	13	bcy	$73.27	$980	$59.38	$794	$132.65	$1,775
Formwork	850	sf	$2.20	$1,870	$4.00	$3,400	$6.20	$5,270
Rebar Reinforcement	5,887	lb	$1.10	$6,482	$1.00	$5,887	$2.10	$12,369
Concrete	54	cy	$245.25	$13,125	$54.69	$2,927	$299.93	$16,052
Backfill, Exist. Soil	35	bcy			$59.38	$2,089	$59.38	$2,089
Hauling of Excv. Soil	141	lcy			$17.19	$2,423	$17.19	$2,423
F-9 - 9'0"x9'0"x2'0"	4	EA						
Excavation	72	bcy			$43.75	$3,137	$43.75	$3,137
Compact Exist. Subgrade	484	sf			$1.19	$575	$1.19	$575
Base Course	6	bcy	$73.27	$440	$59.38	$356	$132.65	$796
Formwork	360	sf	$2.20	$792	$4.00	$1,440	$6.20	$2,232
Rebar Reinforcement	2,640	lb	$1.10	$2,907	$1.00	$2,640	$2.10	$5,547
Concrete	24	cy	$245.25	$5,886	$54.69	$1,313	$299.93	$7,198
Backfill, Exist. Soil	15	bcy			$59.38	$880	$59.38	$880
Hauling of Excv. Soil	63	lcy			$17.19	$1,076	$17.19	$1,076
F-9.5 - 9'6"x9'6"x2'0"	2	EA						
Excavation	39	bcy			$43.75	$1,714	$43.75	$1,714
Compact Exist. Subgrade	265	sf			$1.19	$314	$1.19	$314
Base Course	3	bcy	$73.27	$245	$59.38	$198	$132.65	$443
Formwork	190	sf	$2.20	$418	$4.00	$760	$6.20	$1,178
Rebar Reinforcement	1,471	lb	$1.10	$1,619	$1.00	$1,471	$2.10	$3,090
Concrete	13	cy	$245.25	$3,279	$54.69	$731	$299.93	$4,010
Backfill, Exist. Soil	8	bcy			$59.38	$462	$59.38	$462
Hauling of Excv. Soil	35	lcy			$17.19	$594	$17.19	$594
F-11 - 11'0"x11'0"x2'4"	1	EA						
Excavation	27	bcy			$43.75	$1,186	$43.75	$1,186
Compact Exist. Subgrade	169	sf			$1.19	$201	$1.19	$201
Base Course	2	bcy	$73.27	$164	$59.38	$133	$132.65	$297
Formwork	125	sf	$2.20	$274	$4.00	$498	$6.20	$772
Rebar Reinforcement	1,149	lb	$1.10	$1,265	$1.00	$1,149	$2.10	$2,413
Concrete	10	cy	$245.25	$2,561	$54.69	$571	$299.93	$3,132
Backfill, Exist. Soil	5	bcy			$59.38	$299	$59.38	$299
Hauling of Excv. Soil	24	lcy			$17.19	$417	$17.19	$417

C O S T A N A L Y S I S

PROJECT:	**70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY**		ESTIMATE NO.: 21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.: 20321	DATE: 4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL: 60% DESIGN	CHECKED BY: J. UNO
QTY BY:	J. UNO ASSOCIATES	PRICES BY: J. UNO ASSOCIATES	DATE CHECKED: 4/19/2022

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL TOTAL
(ST) STRUCTURAL (SUBCONTRACTOR)								
PROCESSING FACILITY								
A1030 - SLAB ON GRADE								
STANDARD SLAB ON GRADE								
S1 - SLAB ON GRADE, 6" THK	3,659	SF						
Over-Excavation	95	bcy			$36.46	$3,459	$36.46	$3,459
Excavation	68	bcy			$43.75	$2,964	$43.75	$2,964
Compact Exist. Subgrade	4,025	sf			$1.19	$4,780	$1.19	$4,780
Select Granular Fill	27	bcy	$53.00	$1,437	$59.38	$1,609	$112.38	$3,046
Base Course	68	bcy	$73.27	$4,965	$59.38	$4,023	$132.65	$8,988
Vapor Barrier	3,659	sf	$0.17	$618	$0.67	$2,439	$0.84	$3,057
Formwork	408	sf	$2.20	$898	$4.00	$1,632	$6.20	$2,530
Rebar Reinforcement	9,100	lb	$1.10	$10,020	$1.00	$9,100	$2.10	$19,119
Concrete	73	cy	$245.25	$17,853	$54.69	$3,981	$299.93	$21,834
Trowel/ Float Finish	3,795	sf			$2.00	$7,590	$2.00	$7,590
Hauling of Excv. Soil	179	lcy			$17.19	$3,075	$17.19	$3,075
S2 - SLAB ON GRADE, 8" THK	14,700	SF						
Over-Excavation	381	bcy			$36.46	$13,895	$36.46	$13,895
Excavation	272	bcy			$43.75	$11,910	$43.75	$11,910
Compact Exist. Subgrade	16,170	sf			$1.19	$19,202	$1.19	$19,202
Select Granular Fill	109	bcy	$53.00	$5,771	$59.38	$6,465	$112.38	$12,237
Base Course	272	bcy	$73.27	$19,947	$59.38	$16,163	$132.65	$36,110
Vapor Barrier	14,700	sf	$0.17	$2,483	$0.67	$9,800	$0.84	$12,283
Formwork	1,183	sf	$2.20	$2,602	$4.00	$4,730	$6.20	$7,332
Rebar Reinforcement	48,775	lb	$1.10	$53,706	$1.00	$48,775	$2.10	$102,481
Concrete	390	cy	$245.25	$95,694	$54.69	$21,339	$299.93	$117,033
Trowel/ Float Finish	15,130	sf			$2.00	$30,260	$2.00	$30,260
Hauling of Excv. Soil	719	lcy			$17.19	$12,352	$17.19	$12,352
S3 - SLAB ON GRADE, 8" THK	5,102	SF						
Over-Excavation	132	bcy			$36.46	$4,822	$36.46	$4,822
Excavation	94	bcy			$43.75	$4,134	$43.75	$4,134
Compact Exist. Subgrade	5,612	sf			$1.19	$6,664	$1.19	$6,664
Select Granular Fill	38	bcy	$53.00	$2,003	$59.38	$2,244	$112.38	$4,247
Base Course	94	bcy	$73.27	$6,923	$59.38	$5,610	$132.65	$12,533
Vapor Barrier	5,102	sf	$0.17	$862	$0.67	$3,401	$0.84	$4,263
Formwork	744	sf	$2.20	$1,638	$4.00	$2,977	$6.20	$4,615
Rebar Reinforcement	19,543	lb	$1.10	$21,518	$1.00	$19,543	$2.10	$41,061
Concrete	156	cy	$245.25	$38,342	$54.69	$8,550	$299.93	$46,892
Trowel/ Float Finish	5,373	sf			$2.00	$10,745	$2.00	$10,745
Hauling of Excv. Soil	249	lcy			$17.19	$4,287	$17.19	$4,287

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL TOTAL
(ST) STRUCTURAL (SUBCONTRACTOR)								
PROCESSING FACILITY								
S4 - SLAB ON GRADE, 8" THK	753	SF						
Over-Excavation	20	bcy			$36.46	$712	$36.46	$712
Excavation	14	bcy			$43.75	$610	$43.75	$610
Compact Exist. Subgrade	828	sf			$1.19	$984	$1.19	$984
Select Granular Fill	6	bcy	$53.00	$296	$59.38	$331	$112.38	$627
Base Course	14	bcy	$73.27	$1,022	$59.38	$828	$132.65	$1,850
Polystyrene Insulation, 3.5", 2 Layer	1,506	sf	$1.95	$2,937	$2.00	$3,012	$3.95	$5,949
Vapor Barrier	753	sf	$0.17	$127	$0.67	$502	$0.84	$629
Formwork	207	sf	$2.20	$456	$6.00	$1,243	$8.20	$1,699
Rebar Reinforcement	2,789	lb	$1.10	$3,071	$1.00	$2,789	$2.10	$5,860
Concrete	22	cy	$245.25	$5,472	$54.69	$1,220	$299.93	$6,692
Trowel/ Float Finish	828	sf			$4.00	$3,313	$4.00	$3,313
Hauling of Excv. Soil	37	lcy			$17.19	$633	$17.19	$633
B1010 - FLOOR CONSTRUCTION								
STRUCTURAL FRAME								
STRUCTURAL STEEL COLUMNS								
C1, HSS 10x10x1/2	30	ton	$3,349.50	$100,211	$4,722.22	$141,281	$8,071.72	$241,493
C2, HSS 10x10x5/8	7	ton	$3,349.50	$23,010	$4,722.22	$32,440	$8,071.72	$55,450
C3, HSS 12x12x5/8	10	ton	$3,349.50	$33,296	$4,722.22	$46,942	$8,071.72	$80,239
Hot Dipped Galv, Add To Material	33,631	lb	$3.74	$125,778			$3.74	$125,778
FILL								
Geofoam Fill @ Stun Area	7	cy	$86.33	$604	$150.00	$1,050	$236.33	$1,654
STRUCTURAL FRAME								
CATWALK FRAMING								
Steel Framing	1	ton	$3,349.50	$3,350	$4,722.22	$4,722	$8,071.72	$8,072
Railing	62	lf	$165.00	$10,230	$13.54	$840	$178.54	$11,070
GRATING								
CATWALK GRATING	164	sf						
Steel Grating	164	sf	$16.50	$2,706	$16.67	$2,733	$33.17	$5,439
SUMPS & PITS								
INEDIBLE BIN SUMP, 4'-9" Dia.	1	ea						
Excavation	3	bcy			$145.83	$438	$145.83	$438
Compact Exist. Subgrade	20	sf			$11.88	$238	$11.88	$238
Base Course	1	bcy	$73.27	$37	$475.00	$238	$548.27	$274
Rebar Reinforcement	125	lb	$1.10	$138	$3.20	$400	$4.30	$538
Concrete Base	1	cy	$245.25	$245	$437.50	$438	$682.75	$683
60" Dia. Precast R.C. Pipe	4	lf	$160.00	$640	$65.00	$260	$225.00	$900

J.UNO & ASSOCIATES

PROJECT:	**70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY**			ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.:	20321	DATE:	4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL:	60% DESIGN	CHECKED BY:	J. UNO
QTY BY:	J. UNO ASSOCIATES	PRICES BY:	J. UNO ASSOCIATES	DATE CHECKED:	4/19/2022

			MATERIAL / SUB		LABOR / EQPT		TOTAL	
DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL
(ST) STRUCTURAL (SUBCONTRACTOR)								
PROCESSING FACILITY								
MANURE PIT - 4'0"x4'0"x6'0" DEEP	1	EA						
Excavation	10	bcy			$218.75	$2,285	$218.75	$2,285
Compact Exist. Subgrade	36	sf			$6.60	$238	$6.60	$238
Base Course	0	bcy	$73.27	$22	$1,900.00	$563	$1,973.27	$585
Formwork	29	sf	$2.20	$65	$14.29	$419	$16.49	$484
Rebar Reinforcement	87	lb	$1.10	$96	$9.52	$828	$10.62	$923
Concrete	1	cy	$245.25	$194	$875.00	$691	$1,120.25	$885
Conc. Admixture, Corrosion Inhib.	1	cy	$78.38	$62			$78.38	$62
Backfill, Exist. Soil	1	bcy			$475.00	$645	$475.00	$645
Hauling of Excv. Soil	10	lcy			$17.19	$172	$17.19	$172
LEVELER PIT - 6'6"x7'6"x4'0" DEEP	3	EA						
Excavation	52	bcy			$218.75	$11,449	$218.75	$11,449
Compact Exist. Subgrade	242	sf			$6.60	$1,598	$6.60	$1,598
Base Course	3	bcy	$73.27	$198	$1,900.00	$5,146	$1,973.27	$5,344
Formwork	154	sf	$2.20	$339	$14.29	$2,200	$16.49	$2,539
Rebar Reinforcement	794	lb	$1.10	$875	$9.52	$7,566	$10.62	$8,441
Concrete	7	cy	$245.25	$1,771	$875.00	$6,319	$1,120.25	$8,091
Conc. Admixture, Corrosion Inhib.	7	cy	$78.38	$566			$78.38	$566
Backfill, Exist. Soil	7	bcy			$475.00	$3,096	$475.00	$3,096
Hauling of Excv. Soil	50	lcy			$17.19	$866	$17.19	$866
CONC. PIT WALL, 8" THK	539	SF						
Formwork	1,078	sf	$4.40	$4,743	$6.67	$7,187	$11.07	$11,930
Rebar Reinforcement	2,529	lb	$1.10	$2,784	$1.00	$2,529	$2.10	$5,313
Concrete	13	cy	$245.25	$3,264	$109.38	$1,456	$354.62	$4,720
Conc. Admixture, Corrosion Inhib.	13	cy	$78.38	$1,043			$78.38	$1,043
Grind & Rub Finish	1,078	sf			$2.00	$2,156	$2.00	$2,156
SLABS								
HOUSEKEEPING PAD, 4" THK	29	SF						
Formwork	18	sf	$4.40	$79	$13.33	$239	$17.73	$318
Rebar Reinforcement	43	lb	$1.10	$47	$2.00	$86	$3.10	$133
Concrete	0.36	cy	$245.25	$88	$218.75	$78	$464.00	$166
Trowel/ Float Finish	47	sf			$4.00	$188	$4.00	$188
CONC. SLAB @ STUN AREA, 6" THK	84	SF						
Formwork	37	sf	$4.40	$161	$13.33	$489	$17.73	$650
Rebar Reinforcement	187	lb	$1.10	$206	$2.00	$373	$3.10	$579
Concrete	2	cy	$245.25	$381	$218.75	$340	$464.00	$722
Trowel/ Float Finish	121	sf			$4.00	$483	$4.00	$483

PROJECT:	70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY			ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.:	20321	DATE:	4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL:	60% DESIGN	CHECKED BY:	J. UNO
QTY BY:	J. UNO ASSOCIATES	PRICES BY:	J. UNO ASSOCIATES	DATE CHECKED:	4/19/2022

			MATERIAL / SUB		LABOR / EQPT		TOTAL	
DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL
(ST) STRUCTURAL (SUBCONTRACTOR)								
PROCESSING FACILITY								
CONC. PAD @ STUN AREA, 12" THK	15	SF						
Formwork	23	sf	$4.40	$102	$13.33	$310	$17.73	$412
Rebar Reinforcement	67	lb	$1.10	$73	$2.00	$133	$3.10	$207
Concrete	1	cy	$245.25	$136	$218.75	$122	$464.00	$258
Trowel/ Float Finish	38	sf			$4.00	$153	$4.00	$153
WALLS								
CONC. WALL, 6" THK @ STUN AREA	44	SF						
Formwork	88	sf	$4.40	$387	$6.67	$587	$11.07	$974
Rebar Reinforcement	155	lb	$1.10	$170	$1.00	$155	$2.10	$325
Concrete	1	cy	$245.25	$200	$109.38	$89	$354.62	$289
Conc. Admixture, Corrosion Inhib.	1	cy	$78.38	$64			$78.38	$64
Grind & Rub Finish	88	sf			$2.00	$176	$2.00	$176
B1020 - ROOF CONSTRUCTION								
STRUCTURAL FRAME								
STRUCTURAL STEEL ROOF BEAMS								
W6x16	8	ton	$3,349.50	$27,064	$4,722.22	$38,156	$8,071.72	$65,220
W16x26	4	ton	$3,349.50	$14,631	$4,722.22	$20,627	$8,071.72	$35,257
W16x31	11	ton	$3,349.50	$35,719	$4,722.22	$50,358	$8,071.72	$86,077
W18x35	18	ton	$3,349.50	$61,430	$4,722.22	$86,606	$8,071.72	$148,035
W18x40	15	ton	$3,349.50	$49,305	$4,722.22	$69,511	$8,071.72	$118,816
W24x55	15	ton	$3,349.50	$49,003	$4,722.22	$69,086	$8,071.72	$118,089
W24x62	3	ton	$3,349.50	$11,526	$4,722.22	$16,249	$8,071.72	$27,775
W24x76	8	ton	$3,349.50	$26,729	$4,722.22	$37,683	$8,071.72	$64,412
L6x4x5/16	1	ton	$3,349.50	$4,657	$4,722.22	$6,566	$8,071.72	$11,224
ROOF DECKS & SLABS								
STEEL DECKING								
Metal Decking, 1.5" Thk x 20ga	19,888	sf	$5.46	$108,536	$2.43	$48,339	$7.89	$156,875
B2010 - EXTERIOR WALLS								
EXTERIOR CLOSURE								
Pre-Cast Concrete Wall Panels, 8"	17,325	sf	$37.52	$650,000	$2.51	$43,565	$40.03	$693,565
EXPANSION JOINTS								
EXPANSION JOINTS	96	lf						
Expansion Joints	96	lf	$42.00	$4,032	$16.67	$1,600	$58.67	$5,632

C O S T A N A L Y S I S

PROJECT:	**70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY**				ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.:	20321		DATE:	4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL:	60% DESIGN		CHECKED BY:	J. UNO
QTY BY:	J. UNO ASSOCIATES	PRICES BY:	J. UNO ASSOCIATES		DATE CHECKED:	4/19/2022

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL TOTAL
(ST) STRUCTURAL (SUBCONTRACTOR)								
PROCESSING FACILITY								
C2010 - INTERIOR WALLS								
CONCRETE CURB WALLS								
CONC. CURB, ANGLED TOP, 0'6"x2'0"x	1,325	LF						
Formwork	6,628	sf	$4.40	$29,161	$6.67	$44,183	$11.07	$73,344
Rebar Reinforcement	9,324	lb	$1.10	$10,267	$1.00	$9,324	$2.10	$19,591
Concrete	49	cy	$245.25	$12,035	$109.38	$5,367	$354.62	$17,403
Trowel/ Float Finish	6,625	sf			$2.00	$13,250	$2.00	$13,250
C2010 - STAIR CONSTRUCTION								
INTERIOR STAIR CONSTRUCTION								
CONC. STAIRS	3	VLF						
Shoring, Pipe Column	23	sf	$4.50	$102	$16.00	$362	$20.50	$464
Formwork	49	sf	$6.60	$324	$26.67	$1,311	$33.27	$1,635
Rebar Reinforcement	35	lb	$1.10	$38	$4.00	$138	$5.10	$176
Concrete	0.2	cy	$245.25	$42	$437.50	$76	$682.75	$118
Conc. Admixture, Corrosion Inhib.	-	cy	$78.38				$78.38	
Trowel/ Float Finish	56	sf			$8.00	$448	$8.00	$448
B1 - SUPERSTRUCTURE								
Pre-Engineered Metal Building, Complete	4,996	sf	$56.00	$279,776	$38.00	$189,848	$94.00	$469,624
Prefabricated Canopy	344	sf	$30.00	$10,320	$8.00	$2,752	$38.00	$13,072
SUBTOTAL,				$2,085,565		$1,490,298		$3,575,862
SUBCONTRACTOR JOOH,			5.00%	$104,278	5.00%	$74,515	5.00%	$178,793
SUBCONTRACTOR HOOH,			10.20%	$223,364	10.20%	$159,611	10.20%	$382,975
SUBCONTRACTOR PROFIT,			10.00%	$241,321	10.00%	$172,442	10.00%	$413,763
SUBTOTAL,	**24,768**	**ASF**	**$107.18**	**$2,654,527**	**$76.59**	**$1,896,866**	**$183.76**	**$4,551,393**

PROJECT:	70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY		ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.: 20321	DATE:	4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL: 60% DESIGN	CHECKED BY:	J. UNO
QTY BY:	J. UNO ASSOCIATES	PRICES BY: J. UNO ASSOCIATES	DATE CHECKED:	4/19/2022

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL
(AR) ARCHITECTURAL (SUBCONTRACTOR)								
B2010 - EXTERIOR WALLS								
EXTERIOR COATINGS								
Painting, Walls	17,325	sf	$0.45	$7,796	$2.50	$43,313	$2.95	$51,109
Painting, Columns @ Livestock Area	1,133	sf	$0.45	$510	$2.50	$2,833	$2.95	$3,342
Painting, Fencing @ Livestock Area	1,184	sf	$0.45	$533	$2.50	$2,960	$2.95	$3,493
Ceiling Painting @ Livestock Area	4,950	sf	$0.45	$2,228	$2.50	$12,375	$2.95	$14,603
Painting, Downspouts	231	lf	$0.45	$104	$2.50	$578	$2.95	$681
B2020 - EXTERIOR WINDOWS								
WINDOWS								
Window & Frame, Exterior	226	sf	$75.00	$16,950	$30.00	$6,780	$105.00	$23,730
B2030 - EXTERIOR DOORS								
SOLID DOORS								
Swing Cooler Door & Frame, Single	2	ea	$3,500.00	$7,000	$200.00	$400	$3,700.00	$7,400
FGDxSSF, Vision Panel, Single	6	ea	$5,500.00	$33,000	$200.00	$1,200	$5,700.00	$34,200
FGDxSSF, Vision Panel, Double	2	pr	$11,000.00	$22,000	$400.00	$800	$11,400.00	$22,800
Durulite Insul. Bump Door, Alum. Fran	2	ea	$8,500.00	$17,000	$200.00	$400	$8,700.00	$17,400
GATES & HOLDING PENS								
12'-0" Gate	1	ea	$2,200.00	$2,200	$200.00	$200	$2,400.00	$2,400
11'-11" Gate	2	ea	$2,200.00	$4,400	$200.00	$400	$2,400.00	$4,800
8'-6" Gate	10	ea	$1,600.00	$16,000	$120.00	$1,200	$1,720.00	$17,200
8'-0" Gate	5	ea	$1,500.00	$7,500	$120.00	$600	$1,620.00	$8,100
6'-0" Gate	1	ea	$1,200.00	$1,200	$120.00	$120	$1,320.00	$1,320
8'-8" Crowd Gate	1	ea	$1,200.00	$1,200	$400.00	$400	$1,600.00	$1,600
Handler Gates	5	ea	$900.00	$4,500	$120.00	$600	$1,020.00	$5,100
Slide Gates	1	ea	$1,500.00	$1,500	$150.00	$150	$1,650.00	$1,650
Back Up Gate	1	ea	$1,500.00	$1,500	$150.00	$150	$1,650.00	$1,650
Solid Fence	785	sf	$12.50	$9,813	$16.67	$13,083	$29.17	$22,896
Holding Pen Fences	399	lf	$85.00	$33,915	$10.00	$3,990	$95.00	$37,905
OVERHEAD & ROLL-UP DOORS								
Insul. Steel Roll-Up door, 3'2"x8'0"	1	ea	$1,500.00	$1,500	$600.00	$600	$2,100.00	$2,100
Insul. Steel Roll-Up door, 2'4"x7'0"	1	ea	$1,500.00	$1,500	$600.00	$600	$2,100.00	$2,100
Insul. Urethane Roll-Up Door, 8'0"x8'0	3	ea	$3,500.00	$10,500	$1,200.00	$3,600	$4,700.00	$14,100
Insul. Urethane Roll-Up Door, 6'0"x8'0	1	ea	$3,500.00	$3,500	$1,200.00	$1,200	$4,700.00	$4,700
B3010 - ROOF COVERINGS								
HIGH SLOPE ROOF COVERINGS								
Standing Seam Metal Roofing	20,499	sf	$9.85	$201,915	$6.25	$128,119	$16.10	$330,034
ROOF INSULATION & FILL								
Coverboard, 5/8" Thk	20,499	sf	$1.15	$23,574	$0.67	$13,666	$1.82	$37,240

PROJECT:	**70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY**	ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII — PROJECT NO.: 20321	DATE:	4/19/2022
ARCHITECT:	EKNA SERVICES, INC. — SUBMITTAL: 60% DESIGN	CHECKED BY:	J. UNO
QTY BY:	J. UNO ASSOCIATES — PRICES BY: J. UNO ASSOCIATES	DATE CHECKED:	4/19/2022

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL TOTAL
(AR) ARCHITECTURAL (SUBCONTRACTOR)								
FLASHINGS & TRIM								
Metal Edge Flashing, Galv Steel	825	lf	$3.00	$2,477	$4.00	$3,300	$7.00	$5,777
GUTTERS & DOWNSPOUTS								
Gutters, Galv Steel	490	lf	$6.17	$3,024	$13.33	$6,533	$19.51	$9,558
Downspouts, Galv Steel, Rect. 3x4	231	lf	$5.89	$1,362	$12.50	$2,888	$18.39	$4,249
OTHER ROOFING								
Precast Concrete Splashblock	9	ea	$35.00	$315	$20.00	$180	$55.00	$495
Perforated Metal Closure Panel	375	sf	$10.00	$3,750	$4.00	$1,500	$14.00	$5,250
C1010 - PARTITIONS								
FIXED PARTITIONS								
4" Insulated Metal Panel Walls	21,159	sf	$13.75	$290,936	$12.50	$264,488	$26.25	$555,424
6" Insulated Metal Panel Walls	2,730	sf	$17.60	$48,048	$12.50	$34,125	$30.10	$82,173
4" Metal Stud Wall Framing	7,299	sf	$1.73	$12,605	$3.13	$22,809	$4.85	$35,415
Batt Insulation	7,299	sf	$0.94	$6,825	$1.11	$8,110	$2.05	$14,935
6" Metal Stud Wall Framing	340	sf	$2.06	$699	$3.13	$1,063	$5.18	$1,762
Batt Insulation	340	sf	$0.94	$318	$1.11	$378	$2.05	$696
INTERIOR WINDOWS								
Window & Frame, Interior	58	sf	$50.00	$2,900	$30.00	$1,740	$80.00	$4,640
C1020 - INTERIOR DOORS								
STANDARD INTERIOR DOORS								
Insul. Metal Bump Door, Dbl. Acting, S	5	ea	$5,500.00	$27,500	$285.71	$1,429	$5,785.71	$28,929
HMDxHMF, Flush, Single	10	ea	$3,250.00	$32,500	$100.00	$1,000	$3,350.00	$33,500
HMDxHMF, Flush, Single w/ Vision Pa	5	ea	$3,250.00	$16,250	$100.00	$500	$3,350.00	$16,750
Insul. Metal Bump Door, Dbl. Acting, D	3	pr	$12,500.00	$37,500	$444.44	$1,333	$12,944.44	$38,833
Insul. Metal Door, Sliding Motorized w	5	ea	$8,500.00	$42,500	$400.00	$2,000	$8,900.00	$44,500
Insul. Metal Door, Sliding Motorized w	1	ea	$8,500.00	$8,500	$400.00	$400	$8,900.00	$8,900
Swing Cooler Door w/ Vision Panel & I	1	ea	$3,500.00	$3,500	$400.00	$400	$3,900.00	$3,900
Swing Cooler Door & Frame, Single	4	ea	$3,500.00	$14,000	$400.00	$1,600	$3,900.00	$15,600
SWDxSWF, Single w/ Vision Panel	4	ea	$2,000.00	$8,000	$400.00	$1,600	$2,400.00	$9,600
C1030 - FITTINGS								
COMPARTMENTS, CUBICLES, & TOILET PARTITIONS								
Toilet Room Partition	3	ea	$2,230.17	$6,691	$400.00	$1,200	$2,630.17	$7,891
Urinal Screen	1	ea	$572.53	$573	$200.00	$200	$772.53	$773

PROJECT:	70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY		ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.: 20321	DATE:	4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL: 60% DESIGN	CHECKED BY:	J. UNO
QTY BY:	J. UNO ASSOCIATES	PRICES BY: J. UNO ASSOCIATES	DATE CHECKED:	4/19/2022

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL TOTAL
(AR) ARCHITECTURAL (SUBCONTRACTOR)								
TOILET & BATH ACCESSORIES								
TP-1, Toilet Paper Dispenser	2	ea	$138.26	$277	$50.00	$100	$188.26	$377
TP-2, Jumbo Roll Toilet Paper Dispens	3	ea	$138.26	$415	$50.00	$150	$188.26	$565
TSC-1, Toilet Seat Cover Dispenser	5	ea	$105.94	$530	$50.00	$250	$155.94	$780
GB-1, Metal Grab Bar, 36"	6	ea	$47.01	$282	$50.00	$300	$97.01	$582
GB-2, Metal Grab Bar, 42"	6	ea	$48.01	$288	$50.00	$300	$98.01	$588
GB-3, Metal Grab Bar, 16"	4	ea	$48.01	$192	$50.00	$200	$98.01	$392
MR-1, Framed Mirror, 20"x40"	6	ea	$75.20	$451	$100.00	$600	$175.20	$1,051
SD-1, Soap Dispenser	4	ea	$77.37	$309	$50.00	$200	$127.37	$509
PTD-2, Paper Towel Dispenser Waste	4	ea	$965.49	$3,862	$200.00	$800	$1,165.49	$4,662
BCS-1, Baby Changing Station	1	ea	$358.42	$358	$100.00	$100	$458.42	$458
SR-1, Shower Curtain Rod	2	ea	$47.01	$94	$50.00	$100	$97.01	$194
SB-1, Shower Bench	2	ea	$402.50	$805	$200.00	$400	$602.50	$1,205
Apron Hooks	34	lf	$65.00	$2,210	$16.00	$544	$81.00	$2,754
IDENTIFYING DEVICES								
Room Signage	52	ea	$250.00	$13,000	$100.00	$5,200	$350.00	$18,200
DOCK EQUIPMENT								
Dock Levelers	3	ea	$4,800.00	$14,400	$1,000.00	$3,000	$5,800.00	$17,400
Dock Sealer, Det. 7/G-19	3	ea	$3,200.00	$9,600	$600.00	$1,800	$3,800.00	$11,400
LOCKERS								
Wardrobe Locker, 2 Tier	47	ea	$281.25	$13,219	$20.00	$940	$301.25	$14,159
COUNTERS								
SS-1, Solid Surface Countertop	18	sf	$50.00	$900	$37.50	$675	$87.50	$1,575
CABINETS								
Cabinets, Base	9	lf	$300.00	$2,700	$150.00	$1,350	$450.00	$4,050
Cabinets, Storage	12	lf	$250.00	$3,000	$150.00	$1,800	$400.00	$4,800
Cabinets, Wall	12	lf	$250.00	$3,000	$150.00	$1,800	$400.00	$4,800
OTHER FITTINGS								
Roof Access Ladder, 25'-6"H	1	ea	$1,500.00	$1,500	$800.00	$800	$2,300.00	$2,300
Interstital Access Ladder, 18'H	1	ea	$1,000.00	$1,000	$800.00	$800	$1,800.00	$1,800
8"x96"H Galv. Bollard, Conc. Filled	6	ea	$1,500.00	$9,000	$300.00	$1,800	$1,800.00	$10,800
6"x60"H Galv. Bollard, Conc. Filled	4	ea	$1,200.00	$4,800	$300.00	$1,200	$1,500.00	$6,000
3"x42"H Galv. Bollard	11	ea	$1,000.00	$11,000	$300.00	$3,300	$1,300.00	$14,300
C2010 - STAIR CONSTRUCTION								
INTERIOR STAIR CONSTRUCTION								
Handrail, Hot Dip Galv. Steel	14	lf	$75.00	$1,050	$16.67	$233	$91.67	$1,283
Guardrail, Hot Dip Galv. Steel	8	lf	$200.00	$1,600	$33.33	$267	$233.33	$1,867

C O S T A N A L Y S I S			
PROJECT:	**70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY**	ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.: 20321	DATE: 4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL: 60% DESIGN	CHECKED BY: J. UNO
QTY BY:	J. UNO ASSOCIATES	PRICES BY: J. UNO ASSOCIATES	DATE CHECKED: 4/19/2022

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL
(AR) ARCHITECTURAL (SUBCONTRACTOR)								
C3010 - WALL FINISHES								
GYPSUM WALLBOARD FINISHES								
Gypsum Wallboard, Taped & Finished	9,773	sf	$2.10	$20,523	$2.08	$20,360	$4.18	$40,884
TILE & TERRAZZO WALL FINISHES								
Ceramic Tile Wainscot	1,500	sf	$5.00	$7,500	$20.00	$30,000	$25.00	$37,500
1/2" Cement Board	1,500	sf	$0.81	$1,210	$2.08	$3,125	$2.89	$4,335
PAINTING TO WALLS								
Painting, Walls	10,761	sf	$0.42	$4,520	$2.50	$26,903	$2.92	$31,422
EPOXY WALL COATING								
Sikagard Epoxy Coating, Base	4,001	sf	$2.64	$10,563	$4.00	$16,004	$6.64	$26,567
Sikagard Epoxy Coating, Top Coat	8,002	sf	$2.97	$23,766	$2.50	$20,005	$5.47	$43,771
C3020 - FLOOR FINISHES								
RESILIENT FLOOR FINISHES								
Vinyl Tile Flooring	2,358	sf	$5.00	$11,790	$2.00	$4,716	$7.00	$16,506
WALL BASE FINISHES								
Resilient Wall Base	786	lf	$1.50	$1,179	$2.00	$1,572	$3.50	$2,751
FLOOR TOPPINGS AND TRAFFIC MEMBRANES								
EPOXY FLOORING								
Duraquartz Epoxy w/ Clear Coat	719	sf	$3.00	$2,157	$4.00	$2,876	$7.00	$5,033
Ceramic Tile Wall Base	297	lf	$5.00	$1,485	$20.00	$5,940	$25.00	$7,425
1/4" Urethane Topping	7,877	sf	$6.00	$47,262	$4.00	$31,508	$10.00	$78,770
HARDENERS AND SEALERS								
Clear Ashford Formula Concrete Seale	12,543	sf	$1.25	$15,679	$2.00	$25,086	$3.25	$40,765
C3030 - CEILING FINISHES								
GYPSUM WALLBOARD CEILING FINISHES								
Gypsum Board Ceiling, Suspended	745	sf	$2.10	$1,565	$3.13	$2,328	$5.23	$3,893
ACOUSTICAL CEILING TILES & PANELS								
Acoustical Ceiling Tiles, Suspended	2,595	sf	$2.30	$5,969	$2.00	$5,190	$4.30	$11,159
PAINTING AND STAINING CEILINGS								
Painting, Ceiling	745	sf	$0.30	$224	$2.70	$2,014	$3.00	$2,237
SUSPENSION SYSTEMS								
Ceiling Suspension System	3,340	sf	$2.30	$7,682	$2.08	$6,958	$4.38	$14,640

PROJECT:	**70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY**				ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII		PROJECT NO.:	20321	DATE:	4/19/2022
ARCHITECT:	EKNA SERVICES, INC.		SUBMITTAL:	60% DESIGN	CHECKED BY:	J. UNO
QTY BY:	J. UNO ASSOCIATES		PRICES BY:	J. UNO ASSOCIATES	DATE CHECKED:	4/19/2022

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL TOTAL
(AR) ARCHITECTURAL (SUBCONTRACTOR)								
OTHER CEILING & CEILING FINISHES								
6" Urethane Insul. Metal Ceiling Panel	14,324	sf	$3.03	$43,330	$3.13	$44,763	$6.15	$88,093
SUBTOTAL,				$1,310,353		$877,447		$2,187,800
SUBCONTRACTOR JOOH,			5.00%	$65,518	5.00%	$43,872	5.00%	$109,390
SUBCONTRACTOR HOOH,			10.20%	$140,339	10.20%	$93,975	10.20%	$234,313
SUBCONTRACTOR PROFIT,			10.00%	$151,621	10.00%	$101,529	10.00%	$253,150
SUBTOTAL,	**24,768**	**ASF**	**$67.34**	**$1,667,830**	**$45.09**	**$1,116,823**	**$112.43**	**$2,784,653**

C O S T A N A L Y S I S

PROJECT:	70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY			ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.:	20321	DATE:	4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL:	60% DESIGN	CHECKED BY:	J. UNO
QTY BY:	COFFMAN	PRICES BY:	COFFMAN	DATE CHECKED:	4/19/2022

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL TOTAL
(PL) MECHANICAL - PLUMBING (SUBCONTRACTOR)								
PLUMBING								
Gas Water Heater (1350 MBH)	5	ea	$140,000	$700,000	$6,000	$30,000	$146,000	$730,000
Hot Water Recirc Pump	2	ea	$1,400.00	$2,800	$2,520.00	$5,040	$3,920.00	$7,840
Digital Mixing Station	2	ea	$6,500.00	$13,000	$5,000.00	$10,000	$11,500.00	$23,000
Water Softener	1	ea	$468.00	$468	$908.00	$908	$1,376.00	$1,376
Expansion Tank (26 Gal)	1	ea	$1,800.00	$1,800	$500.00	$500	$2,300.00	$2,300
Air Compressor	2	ea	$18,720.00	$37,440	$5,500.00	$11,000	$24,220.00	$48,440
Grease Interceptor	1	ea	$50,000.00	$50,000	$30,000.00	$30,000	$80,000.00	$80,000
Pressure Wash System	1	ea	$20,000.00	$20,000	$15,000.00	$15,000	$35,000.00	$35,000
Water Closets (FV Included)	5	ea	$1,800.00	$9,000	$1,350.00	$6,750	$3,150.00	$15,750
Urinal (FV Included)	1	ea	$1,250.00	$1,250	$850.00	$850	$2,100.00	$2,100
Lavatory	6	ea	$1,290.00	$7,740	$1,360.00	$8,160	$2,650.00	$15,900
Shower	2	ea	$2,235.00	$4,470	$980.00	$1,960	$3,215.00	$6,430
Kitchen Sink	1	ea	$395.00	$395	$665.00	$665	$1,060.00	$1,060
Mop Sink	1	ea	$2,750.00	$2,750	$1,050.00	$1,050	$3,800.00	$3,800
Hand Sink	22	ea	$550.00	$12,100	$900.00	$19,800	$1,450.00	$31,900
Hose Station (140 Deg)	14	ea	$550.00	$7,700	$1,050.00	$14,700	$1,600.00	$22,400
Hose Station (180 Deg)	5	ea	$550.00	$2,750	$1,100.00	$5,500	$1,650.00	$8,250
Drinking Fountain	2	ea	$2,500.00	$5,000	$895.00	$1,790	$3,395.00	$6,790
Emergency Eye Wash Station	2	ea	$2,500.00	$5,000	$1,500.00	$3,000	$4,000.00	$8,000
Floor Drain, 4" Trap	42	ea	$670.00	$28,140	$350.00	$14,700	$1,020.00	$42,840
Floor Drain. 2" Trap	8	ea	$330.00	$2,640	$350.00	$2,800	$680.00	$5,440
Floor Cleanout, 6"	5	ea	$145.00	$725	$95.00	$475	$240.00	$1,200
Floor Cleanout, 4"	16	ea	$130.00	$2,080	$95.00	$1,520	$225.00	$3,600
Floor/Wall Cleanout, 2"	6	ea	$120.00	$720	$95.00	$570	$215.00	$1,290
Floor Sink, 2"	2	ea	$420.00	$840	$350.00	$700	$770.00	$1,540

C O S T A N A L Y S I S

PROJECT:	70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY			ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.:	20321	DATE:	4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL:	60% DESIGN	CHECKED BY:	J. UNO
QTY BY:	COFFMAN	PRICES BY:	COFFMAN	DATE CHECKED:	4/19/2022

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL TOTAL
(PL) MECHANICAL - PLUMBING (SUBCONTRACTOR)								
Sanitary Waste & Vent Piping (Fitt. Incl.)	950	lf	$15.00	$14,250	$35.00	$33,250	$50.00	$47,500
Copper Domestic Water Piping (Fitt. Incl.)	1,600	lf	$15.00	$24,000	$30.00	$48,000	$45.00	$72,000
Type 304 SS Sch 40 Piping (Fitt. Incl.)	1,150	lf	$25.00	$28,750	$50.00	$57,500	$75.00	$86,250
Hot Water Pipe Insulation	250	lf	$18.00	$4,500	$20.00	$5,000	$38.00	$9,500
Piping Accessories & Supports	1	ls	$16,250.00	$16,250	$15,500.00	$15,500	$31,750.00	$31,750
Flue vent	1	ls	$6,700.00	$6,700	$8,600.00	$8,600	$15,300.00	$15,300
LPG Piping	1	ls	$4,500.00	$4,500	$4,800.00	$4,800	$9,300.00	$9,300
Testing & Balancing	1	ls	$8,000.00	$8,000	$12,000.00	$12,000	$20,000.00	$20,000
Miscellaneous	1	ls	$10,000.00	$10,000	$15,000.00	$15,000	$25,000.00	$25,000
SUBTOTAL,				$1,035,758		$387,088		$1,422,846
SUBCONTRACTOR JOOH,			5.00%	$51,788	5.00%	$19,354	5.00%	$71,142
SUBCONTRACTOR HOOH,			10.20%	$110,930	10.20%	$41,457	10.20%	$152,387
SUBCONTRACTOR PROFIT,			10.00%	$119,848	10.00%	$44,790	10.00%	$164,638
SUBTOTAL,	**140**	**FIXT**	**$9,416.59**	**$1,318,323**	**$3,519.21**	**$492,689**	**$12,935.80**	**$1,811,013**

C O S T A N A L Y S I S

PROJECT:	**70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY**				ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.:	20321		DATE:	4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL:	60% DESIGN		CHECKED BY:	J. UNO
QTY BY:	COFFMAN	PRICES BY:	COFFMAN		DATE CHECKED:	4/19/2022

			MATERIAL / SUB		LABOR / EQPT		TOTAL	
DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL
(ME) MECHANICAL - HVAC (SUBCONTRACTOR)								
HVAC								
PACU-1 Thru 5	1	ea	$286,000	$286,000	$30,240.00	$30,240	$316,240	$316,240
Industrial Refrigeration System	1	ls	$2,140,428	$2,140,428	$435,000	$435,000	$2,575,428	$2,575,428
ACCU/FCU	2	ea	$3,500.00	$7,000	$1,050.00	$2,100	$4,550.00	$9,100
VAD	25	ea	$650.00	$16,250	$110.00	$2,750	$760.00	$19,000
PIM	2	ea	$950.00	$1,900	$840.00	$1,680	$1,790.00	$3,580
SF-1 thru 4, Model RSFP	41,500	cfm	$1.10	$45,650	$0.25	$10,375	$1.35	$56,025
SF-5	1	ea	$20,000.00	$20,000	$2,100.00	$2,100	$22,100.00	$22,100
EF-1 thru 5, TF-1/2, Model CSP	1,590	cfm	$1.25	$1,988	$1.60	$2,544	$2.85	$4,532
EF-6 thru 8, Model GB	38,830	cfm	$1.10	$42,713	$0.25	$9,708	$1.35	$52,421
EF-9	1	ea	$11,000.00	$11,000	$1.29	$1,290	$11,001.29	$12,290
Circulating Fan, 10' Dia.	4	ea	$4,680.00	$18,720	$945.00	$3,780	$5,625.00	$22,500
Air Curtain - 42"L	2	ea	$2,500.00	$5,000	$375.00	$750	$2,875.00	$5,750
Air Curtain - 48"L	4	ea	$2,700.00	$10,800	$405.00	$1,620	$3,105.00	$12,420
Air Curtain - 60"L	3	ea	$3,230.00	$9,690	$485.00	$1,455	$3,715.00	$11,145
Air Curtain - 72"L	4	ea	$3,920.00	$15,680	$590.00	$2,360	$4,510.00	$18,040
Air Curtain - 86"L	5	ea	$4,760.00	$23,800	$715.00	$3,575	$5,475.00	$27,375
Ductwork (Fittings and Accessories Incl.)	1	ls	$491,800	$491,800	$228,360	$228,360	$720,160	$720,160
Ductwork Insulation	1	ls	$467,200	$467,200	$251,600	$251,600	$718,800	$718,800
Air Devices	150	ea	$200.00	$30,000	$80.00	$12,000	$280.00	$42,000
Condensate Drain Pipe (Fittings/Acc. Incl.)	1	ls	$2,000.00	$2,000	$2,500.00	$2,500	$4,500.00	$4,500
Refrigerant Pipe (Fittings/Acc. Incl.)	140	lf	$15.00	$2,100	$20.00	$2,800	$35.00	$4,900
Pipe Insulation	190	lf	$12.00	$2,280	$20.00	$3,800	$32.00	$6,080
			$3.00				$3.00	
Controls	1	ls	$40,000.00	$40,000	$45,000.00	$45,000	$85,000.00	$85,000
Control Wiring	1	ls	$40,000.00	$40,000	$40,000.00	$40,000	$80,000.00	$80,000
Testing and Balancing	1	ls	$5,000.00	$5,000	$30,000.00	$30,000	$35,000.00	$35,000
Corrosion Protection	1	ls	$7,750.00	$7,750	$15,750.00	$15,750	$23,500.00	$23,500
Miscellaneous	1	ls	$10,000.00	$10,000	$15,000.00	$15,000	$25,000.00	$25,000
SUBTOTAL,				$3,754,749		$1,158,137		$4,912,885
SUBCONTRACTOR JOOH,			5.00%	$187,737	5.00%	$57,907	5.00%	$245,644
SUBCONTRACTOR HOOH,			10.20%	$402,134	10.20%	$124,036	10.20%	$526,170
SUBCONTRACTOR PROFIT,			10.00%	$434,462	10.00%	$134,008	10.00%	$568,470
SUBTOTAL,	**24,768**	**ASF**	**$192.95**	**$4,779,081**	**$59.52**	**$1,474,088**	**$252.47**	**$6,253,169**

PROJECT:	**70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY**			ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.:	20321	DATE:	4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL:	60% DESIGN	CHECKED BY:	J. UNO
QTY BY:	J. UNO ASSOCIATES	PRICES BY:	J. UNO ASSOCIATES	DATE CHECKED:	4/19/2022

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL TOTAL
(FP) FIRE PROTECTION - SPRINKLERS (SUBCONTRACTOR)								
D4010 - SPRINKLERS								
Fire Sprinkler System, Complete	1	ls	$419,940	$419,940	$279,960	$279,960	$699,900	$699,900
SUBTOTAL,				$419,940		$279,960		$699,900
SUBCONTRACTOR JOOH,			5.00%	$20,997	5.00%	$13,998	5.00%	$34,995
SUBCONTRACTOR HOOH,			10.20%	$44,976	10.20%	$29,984	10.20%	$74,959
SUBCONTRACTOR PROFIT,			10.00%	$48,591	10.00%	$32,394	10.00%	$80,985
SUBTOTAL,	**24,768**	**ASF**	**$21.58**	**$534,504**	**$14.39**	**$356,336**	**$35.97**	**$890,840**

PROJECT:	**70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY**		ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.: 20321	DATE:	4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL: 60% DESIGN	CHECKED BY:	J. UNO
QTY BY:	J. UNO ASSOCIATES	PRICES BY: J. UNO ASSOCIATES	DATE CHECKED:	4/19/2022

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL TOTAL
(FA) FIRE PROTECTION - ALARM (SUBCONTRACTOR)								
D503001 - FIRE ALARM & DETECTION SYSTEMS								
FIRE ALARM SYSTEM								
Fire Alarm Control Panel	1	ea	$15,000.00	$15,000	$3,520.00	$3,520	$18,520.00	$18,520
Notification Devices	29	ea	$250.00	$7,250	$110.00	$3,190	$360.00	$10,440
Notification Devices, Antimicrobial	30	ea	$850.00	$25,500	$110.00	$3,300	$960.00	$28,800
Initiation Devices	3	ea	$220.00	$660	$110.00	$330	$330.00	$990
Initiation Devices, Antimicrobial	2	ea	$850.00	$1,700	$110.00	$220	$960.00	$1,920
Conduit, 3/4" EMT, w/ Fittings & Boxes	960	lf	$2.35	$2,257	$13.75	$13,200	$16.10	$15,457
Conduit, 3/4" Alum, w/ Fittings & Boxes	3,040	lf	$5.43	$16,511	$13.75	$41,800	$19.18	$58,311
FA Cable, Data & Limited Pwr Circuit	8,800	lf	$0.64	$5,667	$0.77	$6,776	$1.41	$12,443
SUBTOTAL,				$74,545		$72,336		$146,881
SUBCONTRACTOR JOOH,			5.00%	$3,727	5.00%	$3,617	5.00%	$7,344
SUBCONTRACTOR HOOH,			10.20%	$7,984	10.20%	$7,747	10.20%	$15,731
SUBCONTRACTOR PROFIT,			10.00%	$8,626	10.00%	$8,370	10.00%	$16,996
SUBTOTAL,	**24,768**	**ASF**	**$3.83**	**$94,882**	**$3.72**	**$92,070**	**$7.55**	**$186,952**

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL TOTAL
(EL) ELECTRICAL - POWER & LIGHTING (SUBCONTRACTOR)								
D5010 - ELECTRICAL SERVICE & DISTRIBUTION								
SWITCHBOARDS								
Swbd, 65kAIC, 480/277V, 3Ph, 4W, 2500A	1	ea	$150,000	$150,000	$19,800.00	$19,800	$169,800	$169,800
Emer. Swbd, 480/277V, 3Ph, 4W, 1200A	1	ea	$70,000	$70,000	$8,800.00	$8,800	$78,800.00	$78,800
INTERIOR TRANSFORMERS								
Dry Xfmr, 112.5kVA, 480:208/120V, 3Ph, 4	2	ea	$35,000	$70,000	$4,400.00	$8,800	$39,400.00	$78,800
EMERGENCY SYSTEM TRANSFORMER								
Dry Xfmr, 112.5kVA, 480:208/120V, 3Ph, 4	2	ea	$45,000	$90,000	$4,400.00	$8,800	$49,400.00	$98,800
DISTRIBUTION PANELS								
Panel, 400A, 208/120V, 3Ph, 4W, Stainless	2	ea	$18,000	$36,000	$2,640.00	$5,280	$20,640.00	$41,280
PANELS								
Panel, 225A, 208/120V	6	ea	$6,500.00	$39,000	$1,320.00	$7,920	$7,820.00	$46,920
Panel 4L, 100A, 480/277V	1	ea	$3,500.00	$3,500	$880.00	$880	$4,380.00	$4,380
EMERGENCY SYSTEM PANELS								
Panel, 225A, 208/120V, 3Ph, 4W	6	ea	$6,500.00	$39,000	$1,760.00	$10,560	$8,260.00	$49,560
Panel 4L, 100A, 480/277V, 3Ph, 4W	1	ea	$3,500.00	$3,500	$1,760.00	$1,760	$5,260.00	$5,260
FEEDER ALLOWANCE								
Feeders From Swbd to All Panels, Xfmrs, and Sub-Panels	1	ls	##########	$150,000	##########	$130,000	##########	$280,000
ENCLOSED CIRCUIT BREAKERS								
Circuit Breaker, 1200A, 42kAIC, 3Ph, 4W	1	ea	$30,000.00	$30,000	$1,760.00	$1,760	$31,760.00	$31,760
D5020 - LIGHTING AND BRANCH WIRING								
POWER DEVICES & EQUIPMENT CONNECTIONS								
Outlet, Duplex	70	ea	$45.00	$3,150	$165.00	$11,550	$210.00	$14,700
Outlet, Duplex, GFCI	21	ea	$75.00	$1,575	$176.00	$3,696	$251.00	$5,271
Hardwired, 120V, w/ Motor Rated Switch	3	ea	$161.00	$483	$440.00	$1,320	$601.00	$1,803
Hardwired, 208V, w/ 30A Disc	2	ea	$1,192.00	$2,384	$385.00	$770	$1,577.00	$3,154
Hardwired, 208V, 3PH, w/ 60A Disc	1	ea	$1,396.00	$1,396	$759.00	$759	$2,155.00	$2,155
Hardwired, 480V, 3PH, w/ 30A Disc	28	ea	$1,192.00	$33,376	$440.00	$12,320	$1,632.00	$45,696
Hardwired, 480V, 3PH, w/ 60A Disc	2	ea	$1,396.00	$2,792	$990.00	$1,980	$2,386.00	$4,772
Hardwired, 480V, 3PH, w/ 200A Disc	1	ea	$4,596.00	$4,596	$1,760.00	$1,760	$6,356.00	$6,356
Cord Drop, 120V, 20A Twistlock	13	ea	$125.00	$1,625	$811.25	$10,546	$936.25	$12,171
Cord Drop, 208V, 3PH, 20A Twistlock	2	ea	$165.00	$330	$885.00	$1,770	$1,050.00	$2,100
Cord Drop, 208V, 3PH, 40A Twistlock	1	ea	$235.00	$235	$1,180.00	$1,180	$1,415.00	$1,415
Cord Drop, 480V, 3PH, 20A Twistlock	9	ea	$195.00	$1,755	$958.75	$8,629	$1,153.75	$10,384
Cord Drop, 480V, 3PH, 40A Twistlock	1	ea	$345.00	$345	$1,253.75	$1,254	$1,598.75	$1,599
Cord Drop Reel, 480V, 3PH, 20A Twistlock	2	ea	$995.00	$1,990	$1,032.50	$2,065	$2,027.50	$4,055

C O S T A N A L Y S I S				
PROJECT:	70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY		ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.: 20321	DATE:	4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL: 60% DESIGN	CHECKED BY:	J. UNO
QTY BY:	J. UNO ASSOCIATES	PRICES BY: J. UNO ASSOCIATES	DATE CHECKED:	4/19/2022

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL TOTAL
(EL) ELECTRICAL - POWER & LIGHTING (SUBCONTRACTOR)								
Conduit, 3/4"	10,450	lf	$5.16	$53,883	$7.04	$73,568	$12.20	$127,451
Conduit, 1"	500	lf	$10.24	$5,122	$8.58	$4,290	$18.82	$9,412
Conduit, 2"	100	lf	$18.80	$1,880	$22.00	$2,200	$40.80	$4,080
Wire, #12 AWG, THHN, Copper	43,270	lf	$0.26	$11,423	$0.80	$34,745	$1.07	$46,169
Wire, #10 AWG, THHN, Copper	17,424	lf	$0.41	$7,092	$0.88	$15,333	$1.29	$22,425
Wire, #6 AWG, THHN, Copper	2,904	lf	$1.14	$3,322	$1.35	$3,929	$2.50	$7,251
Wire, #4/0 AWG, THHN, Copper	629	lf	$7.78	$4,893	$3.98	$2,505	$11.76	$7,399
MECHANICAL CONNECTIONS								
AC Connection, 480V, w/ 30A Disc NEMA 1	2	ea	$218.00	$436	$275.00	$550	$493.00	$986
AC Connection, <5 HP, w/ Motor Rated Sw	17	ea	$110.00	$1,870	$110.00	$1,870	$220.00	$3,740
AC Conn, 480V, w/ 60A Disc, NEMA 4X SS	1	ea	$1,055.00	$1,055	$366.30	$366	$1,421.30	$1,421
ACCU Conn., 208V, w/ 60A Disc, NEMA 4X	1	ea	$855.00	$855	$366.30	$366	$1,221.30	$1,221
CF Connection, <5 HP, w/ Motor Rated Sw	4	ea	$15.00	$60	$110.00	$440	$125.00	$500
EF Connection, <5 HP, w/ Motor Rated Sw	5	ea	$15.00	$75	$110.00	$550	$125.00	$625
EF Conn, 480V, w/ 60A Disc, NEMA 4X SS	4	ea	$28.00	$112	$366.30	$1,465	$394.30	$1,577
EU Connection, w/ 30A Disc, NEMA 1	11	ea	$218.00	$2,398	$275.00	$3,025	$493.00	$5,423
EU Connection, w/ Manual Motor Sw	2	ea	$218.00	$436	$275.00	$550	$493.00	$986
FCU Connection, 208V, w/ Motor Rated Sw	2	ea	$110.00	$220	$110.00	$220	$220.00	$440
PACU Conn, 480V, w/ 60A Disc, NEMA 4X S	5	ea	$1,055.00	$5,275	$366.30	$1,832	$1,421.30	$7,107
EF Conn, 480V, w/ 60A Disc, NEMA 4X SS	5	ea	$1,055.00	$5,275	$366.30	$1,832	$1,421.30	$7,107
Gas Water Heater Conn. w/ Motor Rated S	5	ea	$110.00	$550	$110.00	$550	$220.00	$1,100
HWRP & DMS Conn.	4	ea	$110.00	$440	$110.00	$440	$220.00	$880
Water Softener Conn, w/ Motor Rated Sw	1	ea	$110.00	$110	$110.00	$110	$220.00	$220
Conduit, EMT, 1"	750	lf	$4.50	$3,372	$8.58	$6,435	$13.08	$9,807
Conduit, EMT, 3/4"	4,240	lf	$2.35	$9,969	$7.04	$29,850	$9.39	$39,819
Wire, #6 AWG, THHN, Copper	4,125	lf	$1.14	$4,719	$1.35	$5,581	$2.50	$10,300
Wire, #8 AWG, THHN, Copper	908	lf	$0.72	$649	$1.10	$998	$1.82	$1,647
Wire, #10 AWG, THHN, Copper	9,328	lf	$0.41	$3,796	$0.88	$8,209	$1.29	$12,005
Wire, #12 AWG, THHN, Copper	13,992	lf	$0.26	$3,694	$0.80	$11,236	$1.07	$14,929
LIGHTING CONTROL								
Switch, Single Pole	26	ea	$40.00	$1,040	$165.00	$4,290	$205.00	$5,330
Switch, Occupancy Sensor, Wall Mounted	24	ea	$275.00	$6,600	$264.00	$6,336	$539.00	$12,936
LIGHTING FIXTURES								
Type 1 - Linear, Surface, 4' x 15", LED	21	ea	$1,150.00	$24,150	$590.00	$12,390	$1,740.00	$36,540
Type 2 - Linear, Surface, 4' x 15", LED	62	ea	$850.00	$52,700	$590.00	$36,580	$1,440.00	$89,280
Type 3 -Recessed, 2 x 4, LED	24	ea	$165.00	$3,960	$220.00	$5,280	$385.00	$9,240
Type 4 -Recessed, 1 x 4, LED	14	ea	$200.00	$2,800	$440.00	$6,160	$640.00	$8,960
Type 5 - Linear, Stem Mount, 4' x 8", LED	21	ea	$135.00	$2,835	$330.00	$6,930	$465.00	$9,765

PROJECT:	**70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY**			ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.:	20321	DATE:	4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL:	60% DESIGN	CHECKED BY:	J. UNO
QTY BY:	J. UNO ASSOCIATES	PRICES BY:	J. UNO ASSOCIATES	DATE CHECKED:	4/19/2022

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL TOTAL
(EL) ELECTRICAL - POWER & LIGHTING (SUBCONTRACTOR)								
LIGHTING BRANCH								
Conduit, EMT, 3/4"	2,130	lf	$2.35	$5,008	$7.04	$14,995	$9.39	$20,003
Wire, #12 AWG, THHN, Copper	9,372	lf	$0.26	$2,474	$0.80	$7,526	$1.07	$10,000
D5030 - OTHER ELECTRICAL SERVICES								
TRANSFER SWITCHES								
Automatic Transfer Switch, 1200A, Bypass-Isolation, 480/227V, 3Ph, 4W	1	ea	$40,000.00	$40,000	$2,640.00	$2,640	$42,640.00	$42,640
PHOTO-VOLTAIC (PV) SYSTEM								
PV System, 185.0 kW	185	kW	$3,300.00	$610,500	$1,700.00	$314,500	$5,000.00	$925,000
SUBTOTAL,				$1,622,081		$894,631		$2,516,711
SUBCONTRACTOR JOOH,			5.00%	$81,104	5.00%	$44,732	5.00%	$125,836
SUBCONTRACTOR HOOH,			10.20%	$173,725	10.20%	$95,815	10.20%	$269,540
SUBCONTRACTOR PROFIT,			10.00%	$187,691	10.00%	$103,518	10.00%	$291,209
SUBTOTAL,	**24,768**	**ASF**	**$83.36**	**$2,064,600**	**$45.97**	**$1,138,695**	**$129.33**	**$3,203,296**

C O S T A N A L Y S I S

PROJECT:	**70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY**			ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.:	20321	DATE:	4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL:	60% DESIGN	CHECKED BY:	J. UNO
QTY BY:	J. UNO ASSOCIATES	PRICES BY:	J. UNO ASSOCIATES	DATE CHECKED:	4/19/2022

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL TOTAL
(TC) COMMUNICATIONS & SECURITY (SUBCONTRACTOR)								
D503002 - TELECOMMUNICATIONS SYSTEMS								
Covered Livestock	4,875	sf	$0.60	$2,925	$0.40	$1,950	$1.00	$4,875
Processing Building	19,893	sf	$3.30	$65,647	$2.20	$43,765	$5.50	$109,412
SUBTOTAL,				$68,572		$45,715		$114,287
SUBCONTRACTOR JOOH,			5.00%	$3,429	5.00%	$2,286	5.00%	$5,714
SUBCONTRACTOR HOOH,			10.20%	$7,344	10.20%	$4,896	10.20%	$12,240
SUBCONTRACTOR PROFIT,			10.00%	$7,934	10.00%	$5,290	10.00%	$13,224
SUBTOTAL,	**24,768**	**ASF**	**$3.52**	**$87,279**	**$2.35**	**$58,186**	**$5.87**	**$145,465**

PROJECT:	**70 HEAD PER DAY LIVESTOCK HARVESTING FACILITY**			ESTIMATE NO.:	21-226
LOCATION:	VARIOUS LOCATIONS, HAWAII	PROJECT NO.:	20321	DATE:	4/19/2022
ARCHITECT:	EKNA SERVICES, INC.	SUBMITTAL:	60% DESIGN	CHECKED BY:	J. UNO
QTY BY:	J. UNO ASSOCIATES	PRICES BY:	J. UNO ASSOCIATES	DATE CHECKED:	4/19/2022

DESCRIPTION	QTY	UNIT	MATERIAL / SUB UNIT COST	MATERIAL / SUB TOTAL	LABOR / EQPT UNIT COST	LABOR / EQPT TOTAL	TOTAL UNIT COST	TOTAL TOTAL
(FF) FURNITURE, FURNISHINGS & EQUIPMENT (FF&E) (SUBCONTRACTOR)								
E1010 - COMMERCIAL EQUIPMENT								
PROCESSING EQUIPMENT								
Processing Equipment	1	ls	$250,000	$250,000	$250,000	$250,000	$500,000	$500,000
SUBTOTAL,				$310,269		$284,357		$500,000
SUBCONTRACTOR JOOH,			5.00%	$15,513	5.00%	$14,218	5.00%	$25,000
SUBCONTRACTOR HOOH,			10.20%	$33,230	10.20%	$30,455	10.20%	$53,550
SUBCONTRACTOR PROFIT,			10.00%	$35,901	10.00%	$32,903	10.00%	$57,855
SUBTOTAL,	**1**	**LS**		**$394,913**		**$361,932**		**$636,405**

APPENDIX F

HAWAI‘I GRASS-FED BEEF CONSUMER DEMAND

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HAWAI'I GRASS-FED BEEF CONSUMER DEMAND

Prepared for

The State of Hawai'i Department of Agriculture
Hawai'i Cattlemen's Council

March 2021

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CONTENTS

EXECUTIVE SUMMARY

The purpose of this study is to investigate the current beef and pork market with a thorough analysis of consumer preferences and patterns as well as to identify the future potential market for the Hawai‘i grass-fed beef. Our results show that there is a slightly higher proportion of Hawai‘i respondents consuming beef and pork than the mainland respondents. The frequency of consumption, eating patterns, and average monthly spending of beef are quite similar between the two groups of respondents. Pork, on the other hand, shows some variabilities in eating patterns between the two groups. When asked to identify the importance of attributes while purchasing beef and pork, the quality attribute is ranked the top by both groups of respondents.

The general awareness of Hawai‘i grass-fed beef is low among the mainland respondents who purchase grass-fed beef compared to Hawai‘i. More than half of them have not heard about the Hawai‘i grass-fed beef. The Hawai‘i respondents show a much stronger favor in the Hawai‘i grass-fed beef, whereas the mainland respondents show no specific preference. The top two reasons for not purchasing grass-fed beef are the high prices and the unimportance of the type of beef. Over 90 percent of those who have purchased the Hawai‘i grass-fed beef are satisfied with the products. Also, over 90 percent of those who purchased grass-fed beef are likely to buy Hawaii grass-fed beef in the future.

Using an intent scale translation with the survey data, it is forecast that about 68,000 people and 306,000 people in Hawaii and the mainland will buy Hawaii grass-fed beef in two years, respectively. The demand for Hawaii grass-fed beef is forecast to gradually increase in 5 to 7 years. Three distinctive groups are identified to be the potential Hawaii grass-fed beef buyers: (1) young starter family, (2) more established family with a higher income, and (3) mature people with no children and are not working. The most important extrinsic factors to those who are likely to buy Hawai‘i grass-fed beef in the future are the natural label, grass-fed label, overall satisfaction, and food safety, while the most important intrinsic factors are appearance, taste, cow's diet, and tenderness. The survey data also suggest that there are likely two groups of beef and pork buyers in the market: (1) the quality-driven buyers, and (2) the average or frugal spenders.

PROJECT BACKGROUND

The State of Hawai‘i, Department of Agriculture (HDOA), in cooperation with the Hawai‘i Cattlemen’s Council (HCC) is currently seeking opportunities to establish and operate a new Scalable and Replicable Livestock Harvesting Facility in Hawai‘i. The potential project is expected to implement the following goals:

- To create a facility model that serves the sustainability needs of Hawai‘i’s beef industry,
- To address the economic, social, and environmental impacts of a potential facility,
- To meet environmental conditions and design a facility model that can be scaled up or down to meet production needs,
- To quantify the current livestock capacity in Hawai‘i and project the growth of the industry that includes safeguards against oversupply and/or undersupply of cattle, and
- To support the local livestock industry and its related businesses thereby expanding the State’s economic diversifications.

To examine the feasibility of the project, this study will explore the current situation of the livestock market and the current livestock consumption patterns. As part of the feasibility study and master plan, this study will also evaluate the potential market for Hawai‘i grass-fed beef products, which is the key driver for the sustainability of Hawai‘i’s beef industry.

STUDY OBJECTIVES

The primary objectives of this study are:

- To quantify the current livestock consumption patterns and the brands,
- To quantify the current consumption level of grass-fed beef and the associated consumers’ level of satisfaction,
- To evaluate different criteria considered by consumers when selecting livestock products and,
- To evaluate the consumers’ likelihood of purchasing Hawai‘i grass-fed beef products in the future

In addition to these objectives, a potential demand forecast for Hawai‘i grass-fed beef will be developed in this report based on the research results.

METHODOLOGY

SAMPLE

This section covers the research methodology used in this study. The current study is based on a survey of 1,419 respondents randomly drawn from five selected Core-Based Statistical Areas (CBSA)[1]. The sample was disproportionate, stratified, and randomly selected within the CBSA strata that made up of the following regions:

1. The State of Hawai‘i,
2. Chicago – Naperville – Elgin Area,
3. Los Angeles – Long Beach – Anaheim Area,
4. San Francisco – Oakland – Hayward Area, and
5. Seattle – Tacoma – Bellevue Area.

The randomly selected sample ensures that the sampling bias is reduced as much as possible and that the sample is representative of the entire population. The CBSAs were selected from the West and Midwest region defined by the Bureau of Labor Statistics (BLS) based on a combination of factors such as the population size, the proximity to Hawai‘i, and the expected market potential for Hawai‘i grass-fed beef. The survey instrument was developed as a collective effort of the project team. It consists of 42 questions encompassing different aspects of beef and pork consumption. The survey was conducted through a web panel between January 25, 2021 to February 12, 2021 to those who are at least 18 years of age and reside in one of the CBSAs with Internet access. To maximize the efficiency and generalizability of this study, respondents who reported not consuming any beef products were excluded in the initial stage of the survey. Table 0 provides a distribution of the number of respondents by CBSA. The 1,419 samples will provide an accurate result with a margin of error of ±2.6 percentage points at a 95 percent confidence level.

Table 0: Number of Respondents by CBSAs

CBSA	Population of 18 years or older[2]	Number of completes	Number of partially completes	Number of disqualifies due to not eating beef within CBSA	Total
State of Hawai‘i	1,117,456	200	42	30	272
Chicago – Naperville – Elgin Area	7,319,874	200	39	38	277
Los Angeles – Long Beach – Anaheim Area	10,330,346	210	31	57	298
San Francisco – Oakland – Hayward Area	3,766,419	202	40	58	300
Seattle – Tacoma – Bellevue Area	3,035,442	202	33	37	272
Total	25,569,537	1,014	185	220	1,419

[1] According to the U.S. Census and the Office of Management of Budget, Metropolitan and Micropolitan Statistical Areas are collectively referred to as the Core-Based Statistical Areas. Metropolitan Statistical Areas have at least one urbanized area of 50,000 people or more, plus adjacent territory that has a high degree of social and economic integration with the core; Micropolitan Statistical Areas have at least one urban cluster of at least 10,000 but less than 50,000 population, plus adjacent territory that has a high degree of social and economic integration with the core.

[2] U.S. Census American Community Survey 2015-2019 5-year Estimates

WEIGHTING

An expansion weight was calculated and applied to the data to reflect the actual size of the population. A better post-stratification procedure would be to perform the weighting adjustment known as raking, which adjusts the sample weights such that the socioeconomic status of the sample is a closer match to the population when only the marginal totals are known. This procedure, however, is not possible because there is no target information available regarding the population that consumes beef.

Because we are utilizing the expansion weights in the data, the respondents who were disqualified due to not consuming beef within the CBSAs are also included as part of the sample to truly reflect the entire population of 18 years of age or older. The inclusion of the disqualified respondents is used only in reporting the first question of the survey. In addition, the CBSA of Chicago, Los Angeles, San Francisco, and Seattle will be combined to form the mainland CBSA to enhance the interpretability of the results.

DATA ANALYSIS

FOOD PRODUCTS CONSUMPTION PATTERNS

General Food Consumption Patterns

The analysis begins with exploring the general consumption patterns of what food products people usually consume and the frequency of their consumption of each product. Figure 1 presents the general consumption patterns of seven major food products by CBSA. The selected major food products are beef, pork, chicken, fish, vegetables, fruit, and dairy products. According to the survey data, the percent of respondents consuming these food products is higher in Hawaiʻi than in the mainland CBSA for all seven food products. From now on, we will refer the “mainland CBSA” to as the “mainland”.

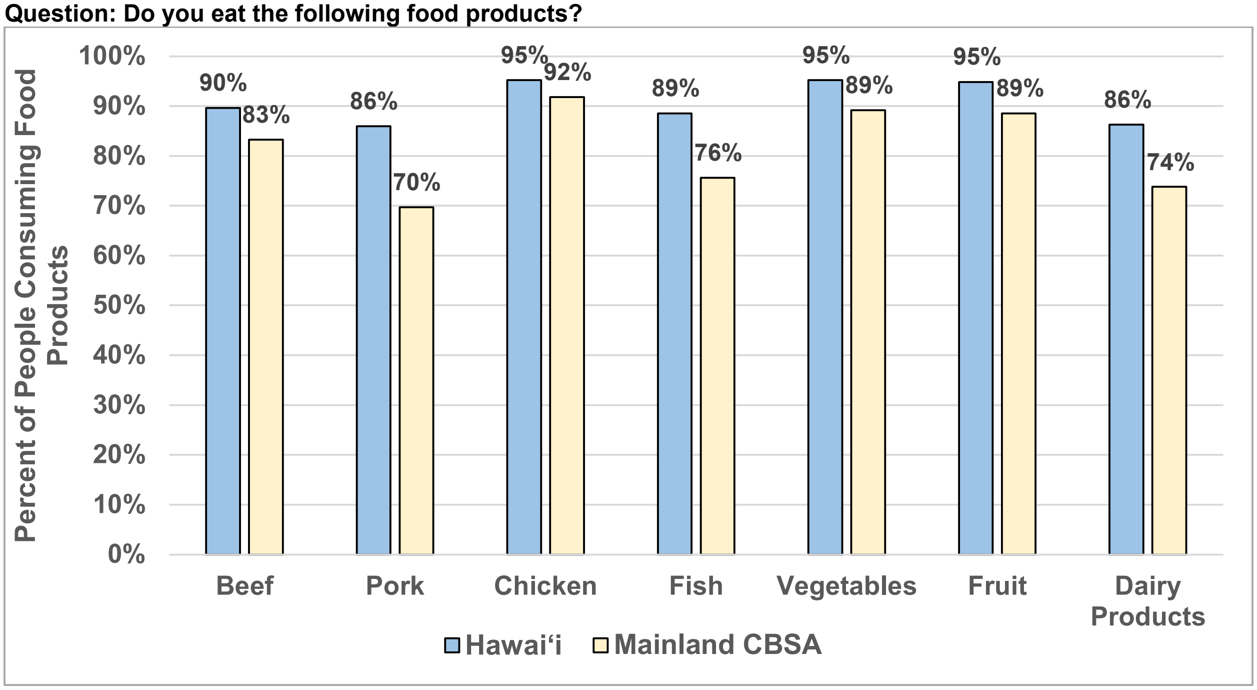
Approximately 90 percent of Hawaiʻi respondents said they consume beef, while 83 percent of mainland respondents reported the same. Compared to beef consumption, some fewer respondents consume pork in both Hawaiʻi (86%) and mainland (70%). It is worth noting that the percent of pork consumption in Hawaiʻi and mainland has the largest difference among all seven food products (16%). The substantial gap may be a result of a more diversified culture in Hawaiʻi than mainland.

On the other hand, the level of consumption in chicken is notably close for Hawaiʻi (95%) and mainland (92%). The fish products are also more popular in Hawaiʻi than in mainland. About 89 percent of respondents in Hawaiʻi said they consume fish, but only 76 percent of respondents in mainland reported fish consumption. The consumption pattern for vegetables is almost the same as fruit for both Hawaiʻi and mainland. As high as 95 percent of respondents in Hawaiʻi consume vegetables and fruit. In the mainland, although there is a slightly fewer percent of respondents who consume vegetables and fruit, the percentage is still quite high (89%). Lastly, dairy products[3] consumption are also more common in Hawaiʻi than in the mainland. Approximately 12 percentage points more respondents consume dairy products in Hawaiʻi (86%) than mainland (74%).

3 According to the USDA, dairy products include milk, yogurt, cheese, lactose-free milk, and fortified soy milk and yogurt. It does not include foods made from milk that contain little calcium and high content, such as cream cheese, sour cream, cream, and butter.

Figure 1. General Consumption Patterns of Food Products by CBSA

Question: Do you eat the following food products?



Source: Beef Consumer Survey, 2021.
Note: This is a multiple response question. Respondents can select more than one answer.

Frequency of Food Products Consumption

Based on the responses provided from the previous question, the respondents were asked about the consumption frequency for each food product they consume within a specific time interval. Figure 2 shows the consumption frequency for each food product by CBSA.

As can be seen from the graph below, the consumption frequency for beef products by Hawai'i respondents is almost identical to that of mainland respondents. Approximately 42 to 43 percent of respondents from both groups consume beef once or twice a week. Another 24 to 26 percent of respondents consume beef three to five times a week. The heavy beef consumers—those who consume beef more than five times per week account for about 15 to 16 percent for both groups. The light beef consumers who consume beef once or twice or less than once a month are around 16 to 18 percent. The results suggest that the consumption frequency of beef is quite similar between the Hawai'i respondents and the mainland respondents.

The consumption frequency for pork products is slightly different from beef in that it shows more variabilities between the Hawai'i respondents and the mainland respondents. The majority of the respondents from both groups consume pork once or twice a week, with the mainland respondents consuming more (Hawai'i: 39%, Mainland: 43%). Meanwhile, the percentage of respondents who consume pork three to five times or more than five times a week is mainly led by the Hawai'i group (Hawai'i: 21%, Mainland: 17%). The light pork consumers who consume pork less than once a month or less than once a month are at 39 percent for Hawai'i and 40 percent for the mainland. The data indicate that pork is likely to be consumed more in Hawai'i than in the mainland.

Figure 2. Frequency of Food Products Consumption by CBSA

Question: How often do you eat these food products

Hawai'i	**More than 5 times per week (almost daily)**	**3-5 times a week**	**Once or twice a week**	**Once or twice a month**	**Less than once a month**
Beef	15%	24%	43%	14%	4%
Pork	8%	13%	39%	33%	6%
Chicken	11%	29%	49%	9%	1%
Fish	6%	14%	49%	24%	7%
Vegetables	53%	30%	14%	3%	0%
Fruit	43%	28%	23%	3%	1%
Dairy Products	38%	30%	24%	7%	1%

Mainland CBSA	**More than 5 times per week (almost daily)**	**3-5 times a week**	**Once or twice a week**	**Once or twice a month**	**Less than once a month**
Beef	16%	26%	42%	14%	2%
Pork	6%	11%	43%	28%	12%
Chicken	11%	32%	47%	9%	1%
Fish	7%	13%	39%	31%	11%
Vegetables	47%	36%	14%	2%	1%
Fruit	47%	33%	15%	4%	1%
Dairy Products	49%	31%	17%	3%	0%

Source: Beef Consumer Survey, 2021.
Note: The base of this question is the number of respondents who checked "Yes" in the consumption question.

The consumption frequency for chicken products also looks similar between the Hawai'i respondents and the mainland respondents. Close to half of the respondents from Hawai'i (49%) and the mainland (47%) reported consuming chicken once or twice a week. There are slightly more heavy chicken consumers—those who consume three times or more a week in the mainland group than the Hawai'i group (Hawai'i: 40%, Mainland: 43%). The percent of light chicken consumers are about the same in both groups (10%).

The percent of respondents who consume fish products once or twice a week is about 10 percent higher in the Hawai'i group than in the mainland group. The percent of heavy fish consumers are approximately the same for both groups at 20 percent. The percent of light fish consumers—those who consume fish products once or twice a month or less than once a month, are dominated by the mainland respondents (42%). Overall, fish products are consumed more in Hawai'i.

The data indicate that the Hawai'i and mainland respondents are both heavy vegetable consumers. As high as 83 percent of them reported consuming vegetables three times or more per week. The percent of respondents who consume vegetables once or twice a week is also the same for both groups (14%).

Overall, the mainland respondents consume more fruit than Hawai'i respondents. Approximately 80 percent of the mainland respondents reported consuming fruit three times or more per week, whereas, in Hawai'i, only 71 percent of them reported the same. The same is true for dairy products. Close to half of mainland respondents consume dairy products almost every day (49%), which is 11 percentage points more than the Hawai'i respondents. Together, slightly more than

80 percent of the mainland respondents consume dairy products three or more times a week. Compared to just 68 percent of Hawaiʻi respondents, dairy products are consumed more in the mainland CBSA in terms of frequency, although there is a higher proportion of respondents consuming dairy products in Hawaiʻi.

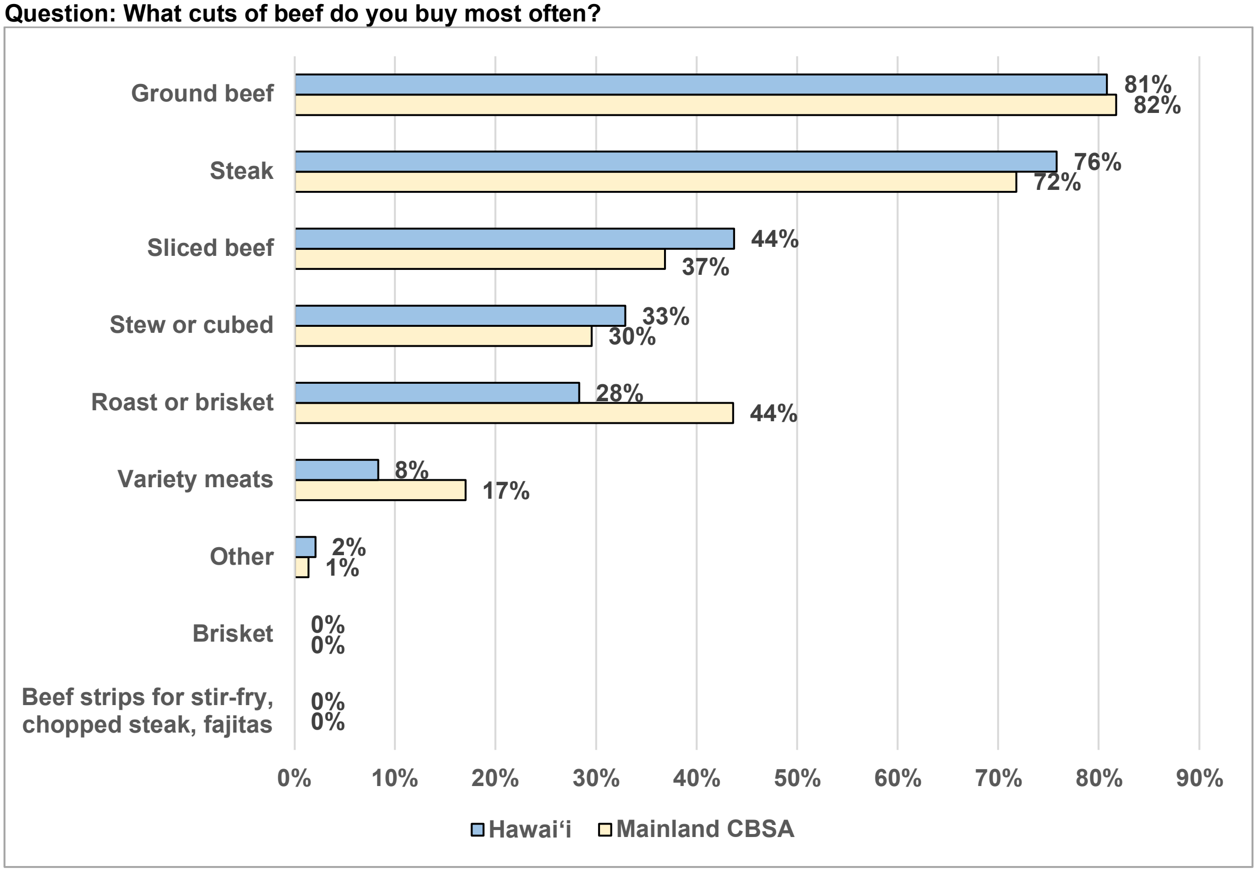
BEEF CONSUMPTION PATTERNS

Beef Consumption Preferences

In this section, we cover the consumption patterns specifically for beef. A series of questions regarding beef purchasing preferences, spending patterns, and desired beef attributes were asked to the respondents who reported consuming beef.

Figure 3. Cuts of Beef Most Often Purchased by CBSA

Question: What cuts of beef do you buy most often?



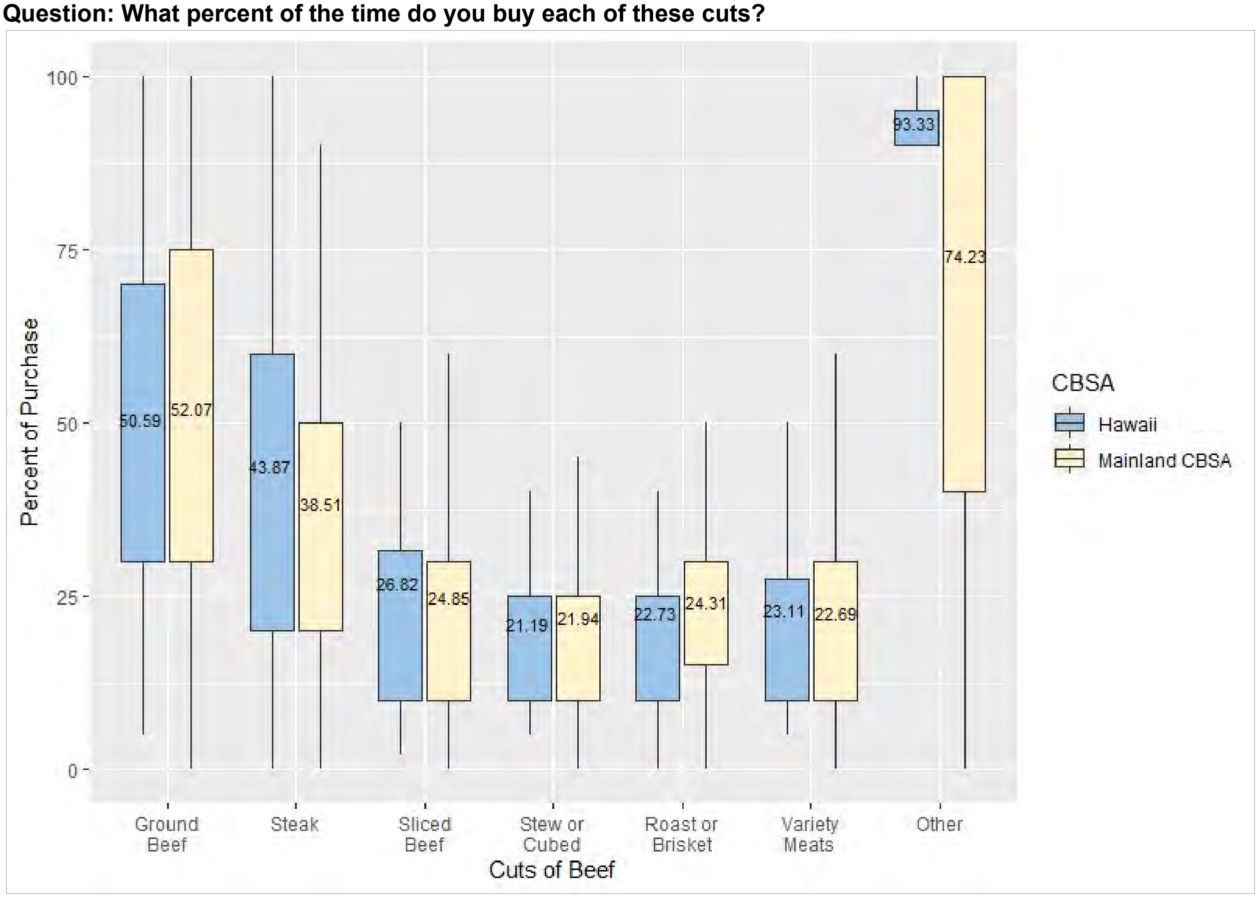
Source: Beef Consumer Survey, 2021.
Note: The base of this question is the number of respondents who consume beef.
This is a multiple response question. Respondents can select more than one answer.

Figure 3 presents the cuts of beef most often purchased by the Hawaiʻi and mainland respondents. Of all types of cuts, ground beef and steak are purchased most often for both Hawaiʻi and mainland respondents. More than 80 percent of respondents from both groups most often purchase ground beef. Steak is slightly more popular among Hawaiʻi respondents compared to the mainland respondents (Hawaiʻi: 72%, Mainland: 76%). Hawaiʻi respondents also buy sliced beef and stew or cubed more often than the mainland respondents. In contrast, a significantly higher percent of mainland respondents favor roast or brisket (44%) over Hawaiʻi respondents (28%).

The average percent of the time in which the respondents purchase different cuts of beef is summarized in Figure 4. Except for steak and “other” cuts of beef, the data show that the average percent of time respondents purchasing ground beef, sliced beef, stew or cubed, variety meats, roast or brisket, and are quite similar among Hawaiʻi and mainland respondents. On average, Hawaiʻi and mainland respondents purchase ground beef 51 to 52 percent of the time. On the other hand, Hawaiʻi respondents purchase steak for close to 44 percent of the time on average compared to just 39 percent for the mainland respondents. For cuts like sliced beef, stew or cubed, roast or brisket, and variety meats, both the Hawaiʻi and mainland purchase them for around 22 to 27 percent of the time on average, much lower than the ground beef and steak. It is also worth mentioning that despite the “other” meats category that has a higher percentage of time of purchase, it is likely a result of larger variability due to the small sample size in that category.

Figure 4. Average Percent of time Purchasing Cuts of Beef by CBSA

Question: What percent of the time do you buy each of these cuts?



Source: Beef Survey 2021
Note: The base is the number of respondents who selected the cuts of beef they most often purchase.

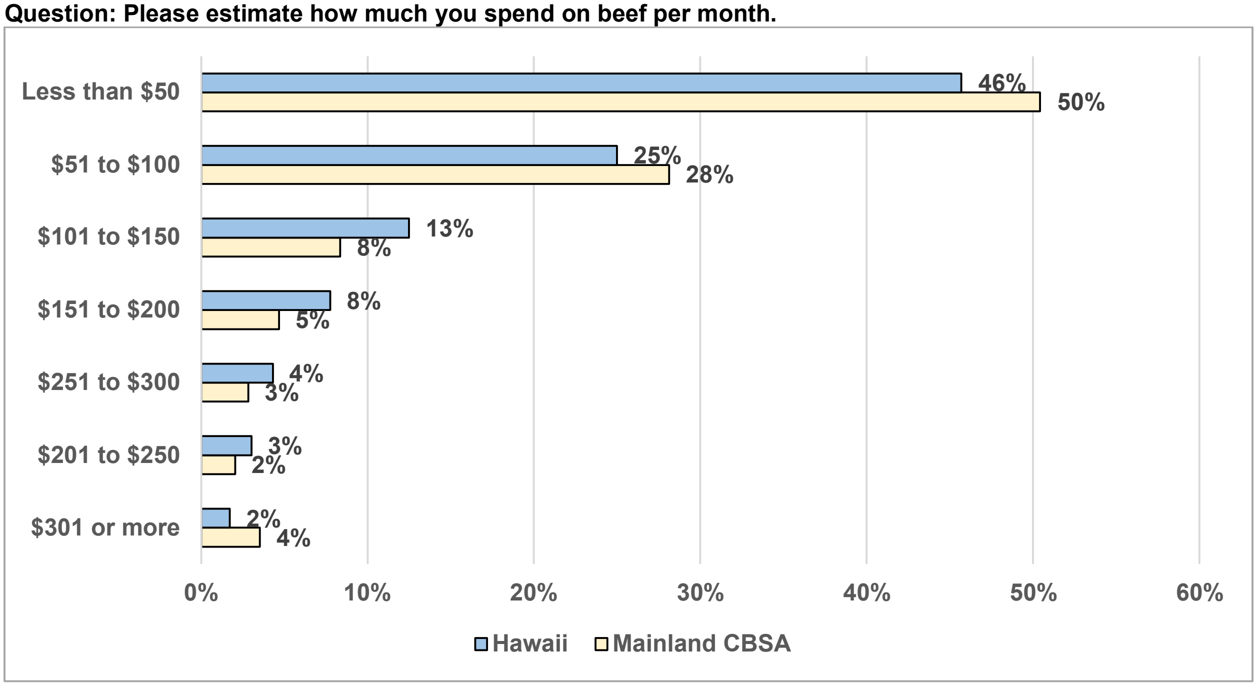
When the respondents were asked how much they spend on beef per month on average, over 70 percent of Hawaiʻi and Mainland respondents claimed to spend less than $100 per month. As much as 50 percent of mainland respondents even reported spending less than $50 on beef per month on average, while the slightly fewer percent of Hawaiʻi respondents reported the same

(46%). In general, there is a higher proportion of Hawaiʻi respondents than mainland respondents who spend more than $100 on beef per month on average (Hawaiʻi: 29.3%, Mainland: 21.4%).

Overall, the survey data suggest that the average monthly spending on beef for Hawaiʻi respondents is approximately $101.28. Compared to the mainland respondents ($95.25), the Hawaiʻi respondents spend $6.02 more on beef per month on average. Each year, the Bureau of Labor Statistics publishes data on consumer expenditures on a set of items which includes meats, poultry, fish, and eggs for the U.S and regions. However, the two results are not directly comparable as the current study does not capture the expenditures for the rest of the items listed and the geographies of interest are different.

Figure 5. Average Monthly Spending on Beef by CBSA

Question: Please estimate how much you spend on beef per month.



Source: Beef Survey 2021
Note: Data points that are potential outliers may distort the results significantly and have been removed accordingly.

Figure 5B shows the weighted average prices per pound of selected beef cuts by CBSA. These data were provided by the USDA during the period of 01/29 through 02/11. Despite some price differences are observed in some of the beef cuts sold between Hawaiʻi and the mainland, the overall differences are not substantial. This suggests that the people in Hawaiʻi do not necessarily pay a higher price per pound of beef than the people in the mainland. Meanwhile, our survey data only show a minimal difference in the average prices spent on beef between the Hawaiʻi and mainland respondents. These two components together indicates that the spending patterns on beef between the two groups of respondents are indeed quite similar to each other.

Figure 5B. Weighted Average Prices per Pound of Selected Beef Cuts by CBSA

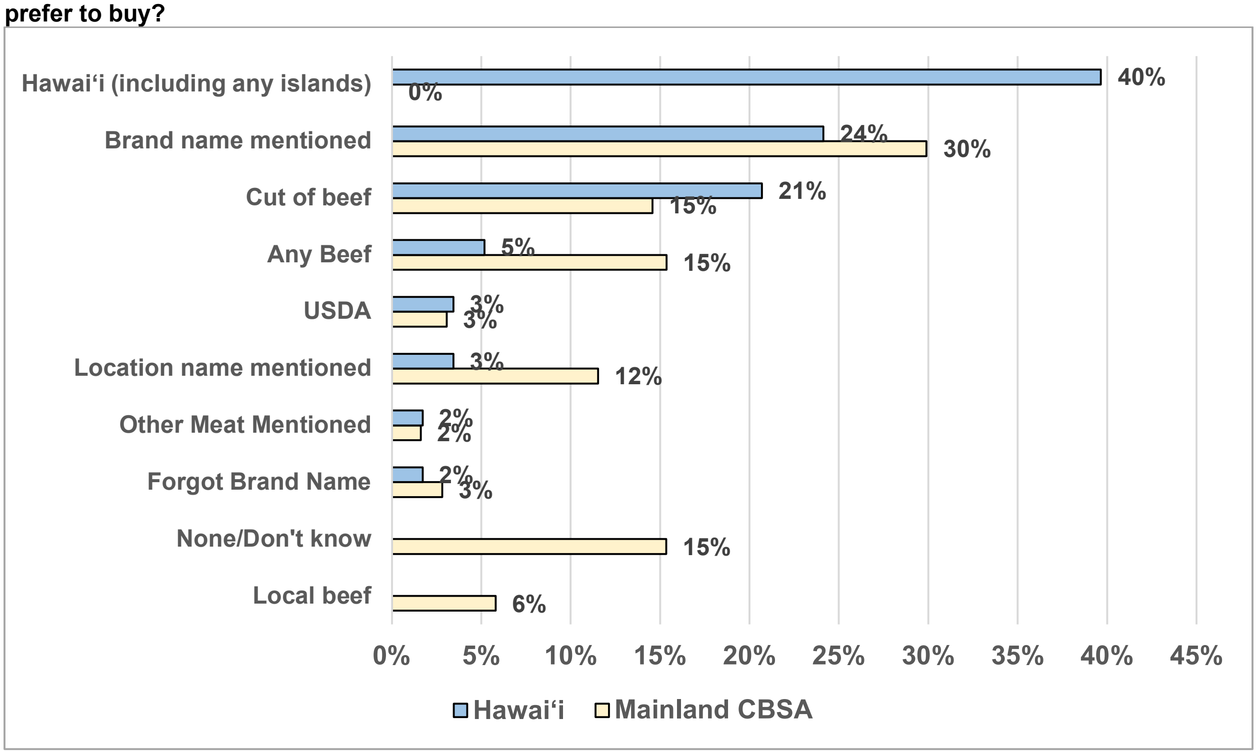
Period	CBSA	Selected Cuts	Weighted Average Price per Pound			
			Branded	Choice	Select	Non-labeled
1/29 - 2/4	IL	Bnls New York Strip Steak		$11.52		
1/29 - 2/4	IL	Bnls Top Sirloin Steak	$ 6.23	$ 6.02		
1/29 - 2/4	IL	Chuck/Shldr/Arm Roast	$ 4.31	$ 4.49		
1/29 - 2/4	IL	Chuck/Shldr/Arm Steak	$ 5.01	$ 4.89		
1/29 - 2/4	IL	London Broil	$ 3.99		$3.59	
1/29 - 2/4	IL	Brisket		$ 2.79		$ 12.97
1/29 - 2/4	IL	Ground Beef 90% Or More	$ 5.30			
1/29 - 2/4	IL	Ground Beef 80-89%				
1/29 - 2/4	CA	Bnls New York Strip Steak		$ 7.52		
1/29 - 2/4	CA	Bnls Top Sirloin Steak	11.72	$ 5.99		
1/29 - 2/4	CA	Chuck/Shldr/Arm Roast	$ 5.79	$ 2.97		
1/29 - 2/4	CA	Chuck/Shldr/Arm Steak	$ 4.99	$ 3.77		
1/29 - 2/4	CA	London Broil	$ 6.49	$ 3.58		
1/29 - 2/4	CA	Brisket		$ 1.99		$ 12.97
1/29 - 2/4	CA	Ground Beef 90% Or More				
1/29 - 2/4	CA	Ground Beef 80-89%	$ 2.99			
1/29 - 2/4	HI	Bnls New York Strip Steak		$ 8.99		
1/29 - 2/4	HI	Bnls Top Sirloin Steak	$ 7.99	$ 5.99		
1/29 - 2/4	HI	Chuck/Shldr/Arm Roast	$ 4.49	$ 5.99		
1/29 - 2/4	HI	Chuck/Shldr/Arm Steak	$ 5.99			
1/29 - 2/4	HI	London Broil	$ 5.49			
1/29 - 2/4	HI	Brisket		$ 3.99		$ 12.97
1/29 - 2/4	HI	Ground Beef 90% Or More				$ 2.25
1/29 - 2/4	HI	Ground Beef 80-89%				$ 2.49
2/5 - 2/11	IL	Bone-In Strip Steak	$ 5.85	$ 6.99	$5.99	$ 5.99
2/5 - 2/11	IL	Bnls New York Strip Steak	$ 9.02	$ 9.34		$ 7.99
2/5 - 2/11	IL	Bnls Top Sirloin Steak	$ 7.67	$ 5.96	$4.12	
2/5 - 2/11	IL	Eye Of Round Roast	$ 4.99	$ 5.99	$3.99	$ 4.29
2/5 - 2/11	IL	Chuck/Shldr/Arm Roast	$ 4.51	$ 5.33		
2/5 - 2/11	IL	Beef Short Ribs	$ 5.11	$ 6.42		
2/5 - 2/11	IL	Ground Beef 90% Or More	$ 5.89			$ 5.86
2/5 - 2/11	IL	Ground Beef 80-89%	$ 2.73			$ 2.60
2/5 - 2/11	IL	Tri-Tip	$ 6.42			
2/5 - 2/11	CA	Bone-In Strip Steak				$ 4.77
2/5 - 2/11	CA	Bnls New York Strip Steak	$ 9.34	$ 5.99	$8.99	$ 6.97
2/5 - 2/11	CA	Bnls Top Sirloin Steak		$ 5.99		$ 5.49
2/5 - 2/11	CA	Eye Of Round Roast				
2/5 - 2/11	CA	Chuck/Shldr/Arm Roast	$ 5.45	$ 4.99		$ 4.28
2/5 - 2/11	CA	Beef Short Ribs	$ 7.49	$ 5.99		$ 5.86
2/5 - 2/11	CA	Ground Beef 90% Or More				$ 3.00
2/5 - 2/11	CA	Ground Beef 80-89%				$ 3.54
2/5 - 2/11	CA	Tri-Tip	$ 5.98	$ 4.98		$ 3.98
2/5 - 2/11	HI	Bone-In Strip Steak		$ 5.77		
2/5 - 2/11	HI	Bnls New York Strip Steak		$ 8.99		
2/5 - 2/11	HI	Bnls Top Sirloin Steak		$ 4.99		
2/5 - 2/11	HI	Eye Of Round Roast				$ 2.99
2/5 - 2/11	HI	Chuck/Shldr/Arm Roast	$ 5.99	$ 5.58		
2/5 - 2/11	HI	Beef Short Ribs	$ 4.99			
2/5 - 2/11	HI	Ground Beef 90% Or More				$ 3.49
2/5 - 2/11	HI	Ground Beef 80-89%	$ 2.99			
2/5 - 2/11	HI	Tri-Tip	$ 5.99			

Source: USDA National Retail Report – Beef, Advertised Prices for Beef at Major Retail Supermarket Outlets ending during the period of 01/29 thru 02/11.

When asked if there is any specific brand of beef or geographic region where beef is sourced that respondents prefer to buy, about 25 to 26 percent of Hawaiʻi and mainland respondents answered in the affirmative. Figure 6 below presents their preferred source of beef. Close to 40 percent of Hawaiʻi respondents prefer local beef while none of the mainland respondents prefer beef sourced from Hawaiʻi. Around 24 to 30 percent of respondents mentioned a list of brand names they choose to buy. Another six percent of mainland respondents responded to local beef without specifying the brand.

Figure 6. Specific Source of Beef Preferred by CBSA

Question: Is there a specific brand of beef or a specific geographic region where beef is sourced that you prefer to buy?



Source: Beef Survey 2021
Note: Irrelevant responses are excluded from the analysis.

The Hawaiʻi and mainland respondents have substantial differences in terms of the brand of beef they prefer. Figure 7 shows the top 10 specific brands or sources of beef in which the respondents prefer by CBSA. Of those who responded, 29 percent of Hawaiʻi respondents prefer beef sourced from Hawaiʻi, followed by 10 percent from Costco. About 14 percent of Hawaiʻi respondents prefer brands like 5 Star Beef or Angus Beef. Another 15 percent prefer brands like Signature, Sterling, Mountain Apple Brand, or Tyson.

On the other hand, the mainland respondents mostly prefer beef sourced from the USA (7%), California (6%), or New Zealand (5%). In terms of the brand of beef, they prefer mainland brands such as Tyson (6%), 5 Star Beef (5%), Ralphs (4%), Kirkland (4%), and Kroger (4%).

When asked about the reasons why they prefer the specific brands or sources of beef, the Hawaiʻi respondents show a different pattern in reasons compared to the mainland respondents. The top three reasons among Hawaiʻi respondents are:

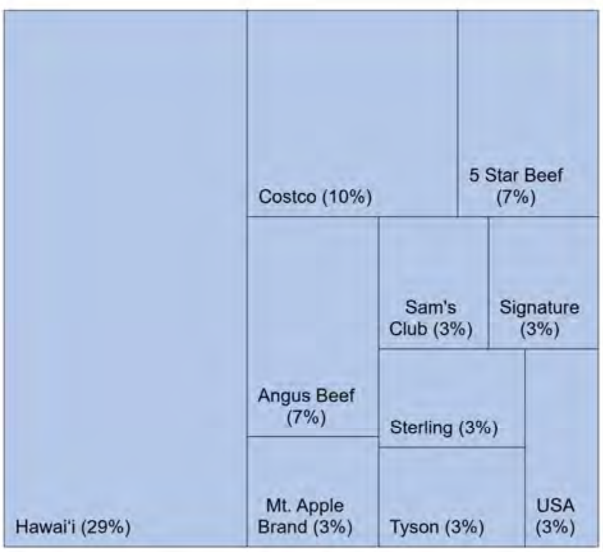
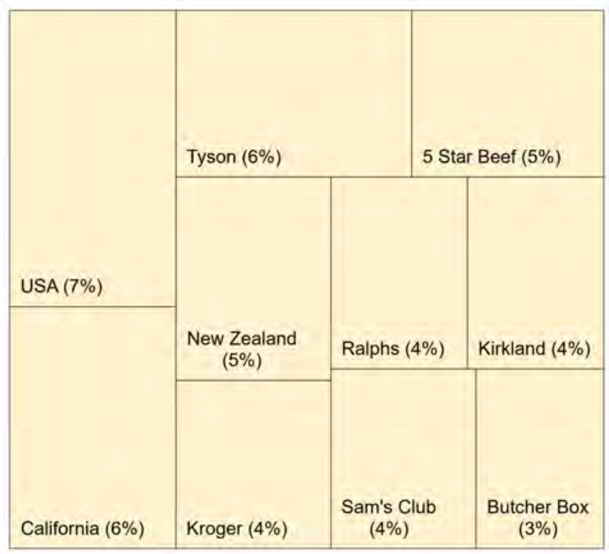
1. Grass-fed beef is better and more organic (52%),
2. Supporting local businesses/farms (13%), and
3. Good quality and high standard (13%).

Compared to the Hawaiʻi respondents, the mainland respondents are more quality-driven. They prefer specific brands or sources of beef that have good quality (32%) or have better flavor (22%). Close to 30 percent of them also think that grass-fed beef is better and more organic.

The data in Figure 8 suggest that the Hawaiʻi respondents care more about the extrinsic values of buying beef such as supporting the local economy and good for the environment. On the other hand, the mainland respondents care more about the intrinsic values of beef such as the taste or freshness when they purchase specific brands or sources of beef.

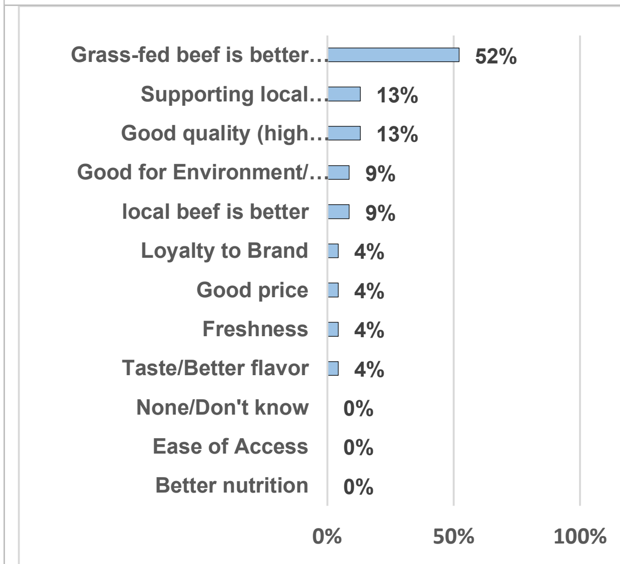
Figure 7. Top 10 Specific Brand of Beef or Source of Beef Preferred by CBSA

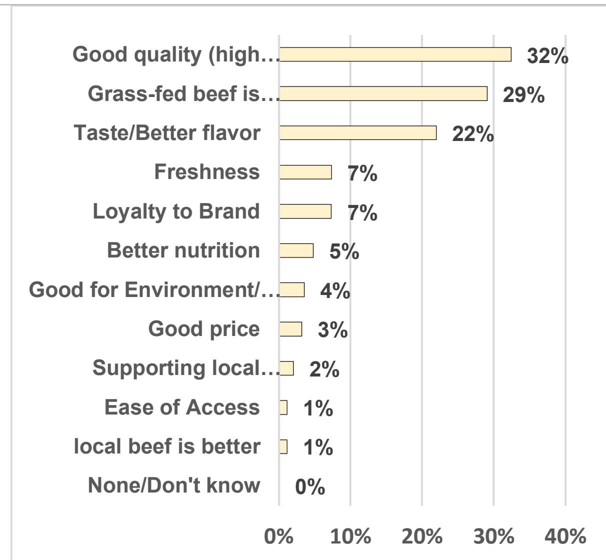
Question: Can you specify the brand or source of beef you prefer and why?

Hawaiʻi	Mainland CBSA
	

Source: Beef Survey 2021

Figure 8. Reasons for Preferring Specific Brand of Beef or Source of Beef by CBSA



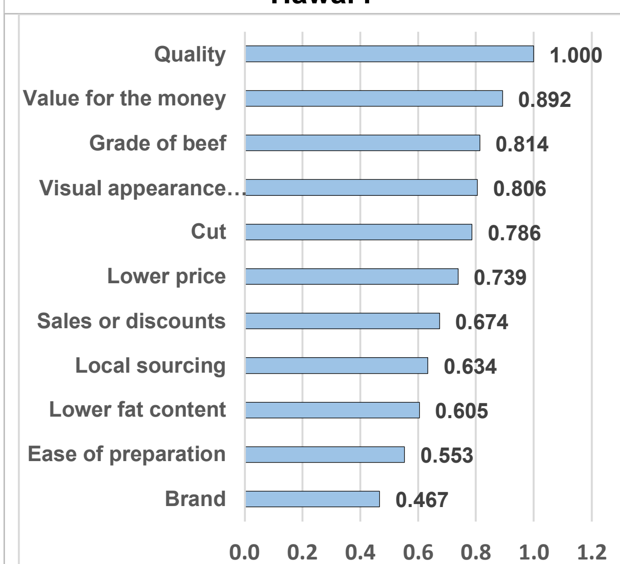


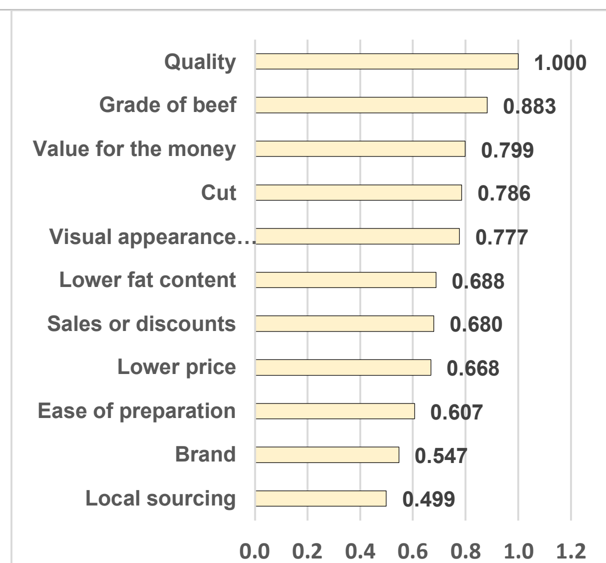
Source: Beef Survey 2021

The respondents were asked to rank a set of attributes in the order of importance when purchasing beef. These attributes encompass different areas such as quality, price, brand, and sourcing of beef. Figure 9 below presents the order of importance ranked by CBSA. A score was calculated for each of the attributes. The closer the score to one, the more important the associated attribute is when purchasing beef.

Figure 9. Order of Importance of Attributes When Purchasing Beef by CBSA

Question: Please rank the following attributes in order of importance when buying beef.





Source: Beef Survey 2021

Figure 9 shows that the top three most important attributes are identical for both Hawaiʻi and the mainland respondents albeit the order of the second and third attributes is different. Quality remains the most important factor when they purchase beef. The mainland respondents take into account the grade of beef more than the value for the money, while the converse is true for Hawaiʻi respondents. Cut and visual appearance or texture are the next attributes considered by both groups of respondents.

The order of importance starts to diverge among Hawaiʻi and the mainland respondents after the fifth attribute. Lower prices, sales, or discounts are the sixth important attributes considered by the Hawaiʻi respondents. In contrast, the mainland respondents consider lower fat content before the lower prices, sales, or discounts. An interesting finding here is that the brand of beef seems to be a less important factor when the respondents purchase beef. It was ranked the last and second to last by both groups of respondents.

When speaking of beef, consumers usually think about their eating experience of the products such as the palatability and quality, but less is focused on how the cattle are raised and whether the production is ethical. A study conducted by the Hawaiʻi Cattlemen's Council refers to these as extrinsic factors[4]. Extrinsic factors are different from intrinsic factors in that they may not directly associate with the eating experience of beef, but they add value to the product itself and may increase the consumers' purchasing confidence.

Figure 10. Importance of Beef Attributes by CBSA

Question: How important is each of the following attributes of beef are to you?

Geographic Areas	Attributes	Very important to Moderately important	Neutral	Low importance to Not important
Hawaiʻi	Appearance of meat - color and texture	88%	12%	0%
Mainland	Appearance of meat - color and texture	87%	10%	3%
Hawaiʻi	Food safety	88%	11%	1%
Mainland	Food safety	88%	10%	2%
Hawaiʻi	Meat delivered fresh, never frozen	66%	25%	9%
Mainland	Meat delivered fresh, never frozen	71%	21%	7%
Hawaiʻi	Natural label	57%	35%	8%
Mainland	Natural label	69%	24%	7%
Hawaiʻi	Ethical production and distribution	56%	30%	14%
Mainland	Ethical production and distribution	62%	29%	9%
Hawaiʻi	Locally sourced	55%	30%	15%
Mainland	Locally sourced	51%	33%	15%
Hawaiʻi	How and where the cattle are raised	51%	35%	14%
Mainland	How and where the cattle are raised	56%	31%	12%
Hawaiʻi	Branded product	51%	33%	16%
Mainland	Branded product	50%	33%	17%
Hawaiʻi	Organic	43%	31%	26%
Mainland	Organic	50%	27%	23%

Source: Beef Survey 2021

4 Hawaiʻi Cattlemen's Council, Hawaiʻi Grass-fed Beef Quality Standards. 2020.

A series of questions related to the extrinsic factors of beef were asked to the respondents in the survey. Figure 10 summarized the overall results:

1. The appearance of meat—color/texture is an important extrinsic factor that the respondents are seeking. Approximately 88 percent of respondents from both groups think that this is moderately important to very important.
2. As high as 88 percent of Hawaiʻi and mainland respondents think that food safety is very important to moderately important to them. The data suggest that the food safety of beef is a significant concern for the respondents regardless of their locations.
3. Having the meat delivered fresh and never frozen is the third most important extrinsic factor to both Hawaiʻi and mainland respondents. About 66 to 71 percent agree that this is very important to moderately important.
4. More mainland respondents (69%) than Hawaiʻi respondents (57%) think that having beef products labeled as natural is very important to moderately important. According to the USDA's definition, food labeled as "natural" does not contain artificial ingredients or preservatives and the ingredients are only minimally processed, although they may contain antibiotics, growth hormones, and other similar chemicals.
5. About 56 to 62 percent of Hawaiʻi and mainland respondents care about whether the production and distribution of beef products are ethical. Close to one-third of them are neutral to this factor.
6. About 55 percent of Hawaiʻi respondents think that it is important where the beef is locally sourced, while this factor is slightly less important to the mainland respondents (51%).
7. Only slightly more than half of Hawaiʻi (51%) and mainland respondents (56%) think that how and where the cattle are raised are important to them.
8. Whether the beef is a branded product seems relatively less important compared to all other factors. Only about half of Hawaiʻi and mainland respondents think that this factor is important. This is consistent with the earlier finding that brand was ranked at very low importance when respondents purchase beef.
9. Whether the beef is organic is the least important factor among all extrinsic factors. Less than half of Hawaiʻi think that is important (43%), while just half of the mainland respondents think the same (50%).

Figure 11 below shows a list of desired attributes where the respondents are seeking in a satisfying piece of beef. The respondents were asked to rate each of the desired attributes by the level of importance in their minds.

Figure 11. Desired Beef Attributes by CBSA

Question: What do you look for in a satisfying piece of beef?

Geographic Areas	Desired Attributes	Very important to Moderately important	Neutral	Low important to Not important
Hawai‘i	Taste	92%	7%	0%
Mainland	Taste	91%	7%	2%
Hawai‘i	Appearance – color/texture	88%	12%	0%
Mainland	Appearance – color/texture	87%	10%	3%
Hawai‘i	Tenderness	88%	12%	0%
Mainland	Tenderness	85%	12%	3%
Hawai‘i	Leaner/less fat	64%	25%	11%
Mainland	Leaner/less fat	75%	19%	6%
Hawai‘i	Strong meaty flavor	62%	34%	4%
Mainland	Strong meaty flavor	70%	25%	5%
Hawai‘i	Well-marbled/more fat	54%	34%	11%
Mainland	Well-marbled/more fat	62%	26%	12%
Hawai‘i	Cow’s diet	51%	37%	12%
Mainland	Cow’s diet	62%	27%	11%
Hawai‘i	Organic or hormone free	50%	33%	17%
Mainland	Organic or hormone free	59%	25%	16%

Source: Beef Survey 2021

It turns out that the top three desired attributes with the highest rate of importance are identical for both the Hawai‘i and mainland respondents. The top three desired attributes are:

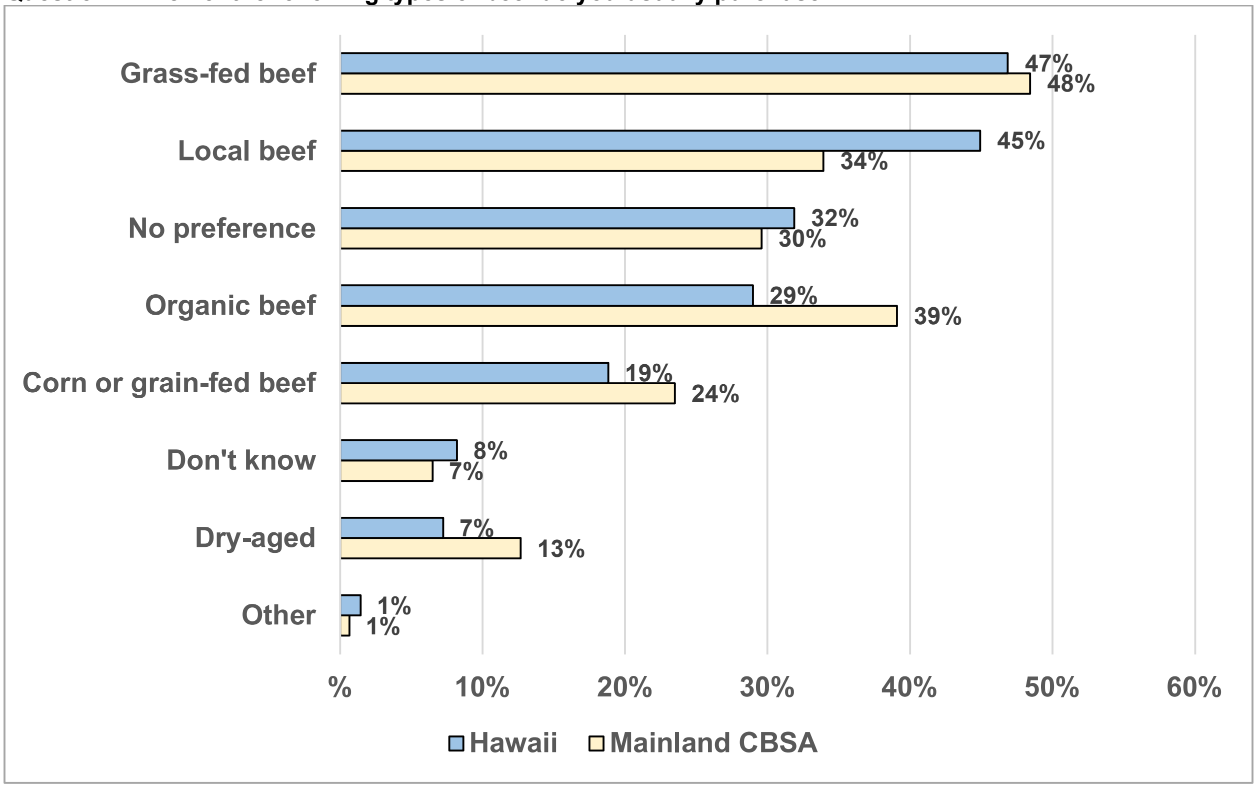
1. Taste (91 and 92%),
2. Appearance – color / texture (88 and 87%), and
3. Tenderness (85 and 88%)

Not only are the top three desired attributes the same for both groups of respondents, but the distribution of rating is also extremely similar. This suggests that regardless of where the respondents reside, they coincidentally think that a satisfying piece of beef should possess these attributes.

There is a pattern that a consistently higher percentage of mainland respondents are desiring the remaining attributes over Hawai‘i respondents. For instance, 75 percent of mainland respondents desire leaner beef, while only 64 percent of Hawai‘i respondents desire the same attribute. Another substantial difference is the attribute of cow’s diet. Only 51 percent of Hawai‘i respondents think that it is an important attribute, but there is about 62 percent of mainland respondents think the same. Other attributes such as strong meaty favor, well-marbled / more fat, and organic or hormone-free differ by 8 to 9 percent among Hawai‘i and mainland respondents.

Figure 12. Types of Beef Usually Purchase by CBSA

Question: Which of the following types of beef do you usually purchase?



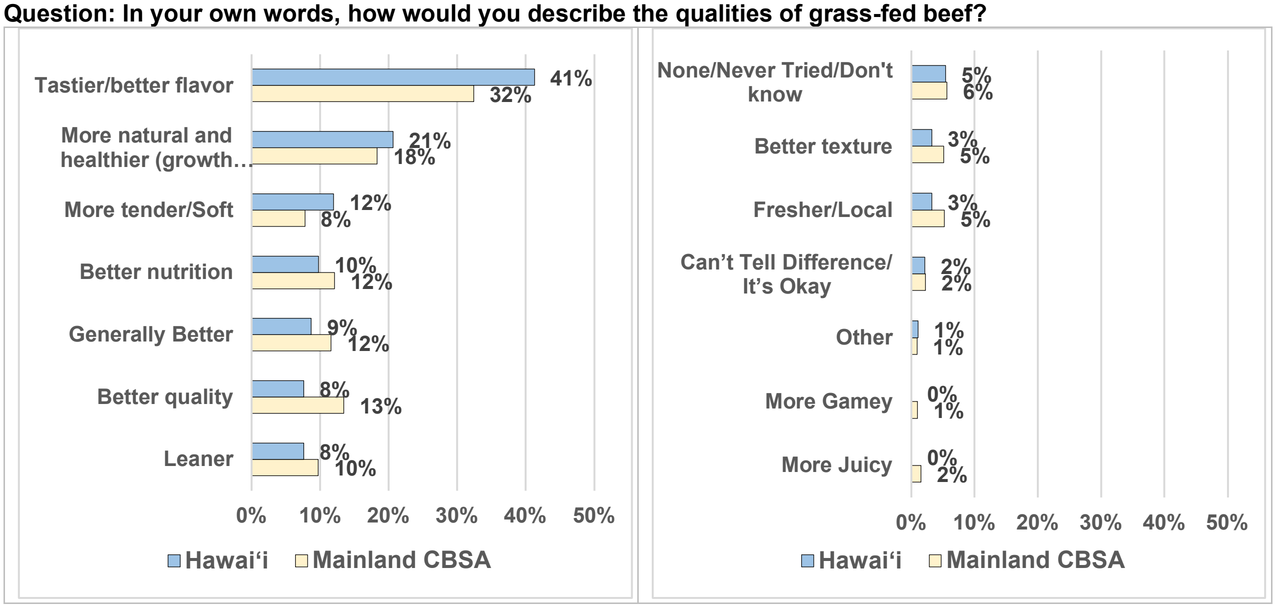
Source: Beef Survey 2021
Note: This is a multiple response question. Respondents can select more than one answer.

When the respondents were asked which types of beef they usually purchase, about 47 to 48 percent of Hawaiʻi and mainland respondents said they usually purchase grass-fed beef. The second most purchased type of beef differs between the two groups. The Hawaiʻi respondents are more likely to purchase local beef (45%), while only 34 percent of mainland respondents purchase local beef (34%). On the other hand, as high as 10 percentage points more mainland respondents purchase organic beef than the Hawaiʻi respondents. Slightly less than one-third of the respondents do not have any preference on the type of beef they purchase.

To increase the accuracy of the results, the base for the following subsections will be based on those who usually purchase grass-fed beef.

Grass-Fed Beef

Figure 13. Quality of Grass-fed Beef by CBSA
Question: In your own words, how would you describe the qualities of grass-fed beef?



Source: Beef Survey 2021
Note: The base is those who selected grass-fed beef in the previous question. Respondents can provide more than one description.

Respondents who usually purchase grass-fed beef were asked to describe the quality of the product. The survey data indicate that the Hawai‘i respondents have a slightly different perception of grass-fed beef compared to the mainland respondents.

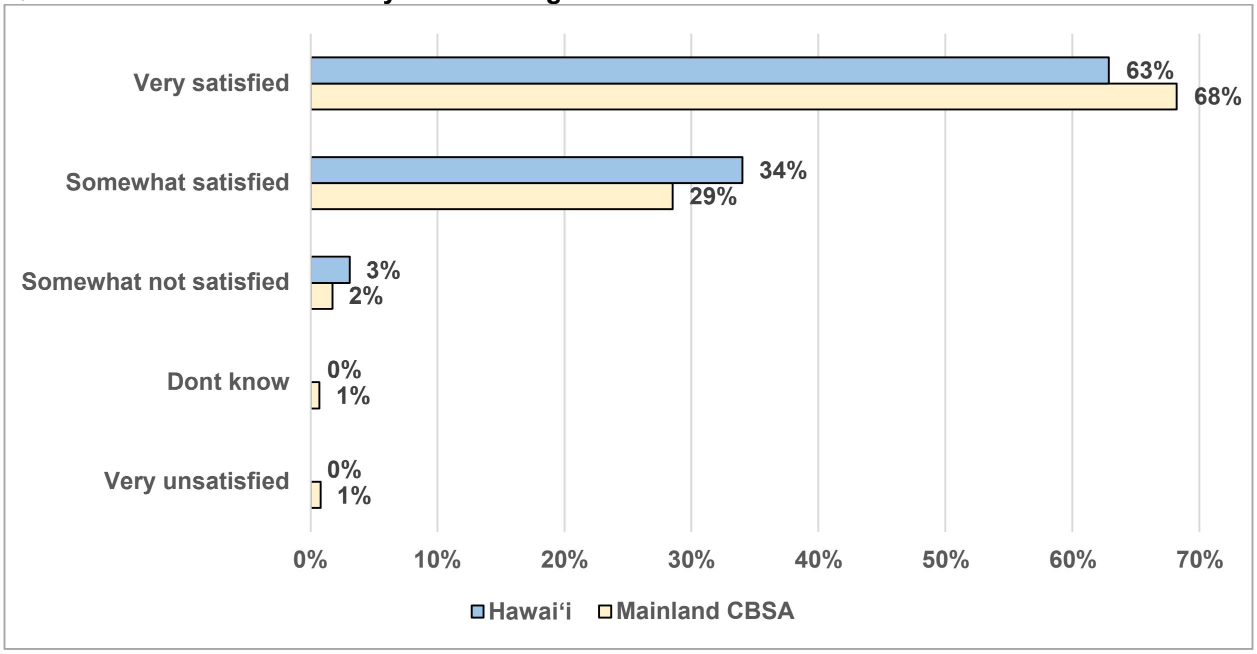
1. While both groups described the grass-fed beef to be tastier or have better flavor, the percentage of Hawai‘i respondents who said so is almost 10 percentage points higher than the mainland respondents.
2. Approximately 18 to 21 percent of respondents from each group described grass-fed beef as a cleaner product in the way that it is more natural, healthier, and antibiotic- or growth-hormone-free.
3. Only eight percent of mainland respondents mentioned that grass-fed beef is more tender or softer, while 12 percent of Hawai‘i respondents said the same.
4. A slightly higher percentage of mainland respondents described grass-fed beef as having better nutrition, generally better, having better quality, and leaner than the Hawai‘i respondents.

As can be seen in Figure 13, the mainland respondents have a more widespread distribution on the quality of grass-fed beef, whereas the Hawai‘i respondents are more focused on the taste, naturality, and tenderness of the product.

Overall, Figure 14 shows that both the Hawai‘i and mainland respondents seem quite satisfied with the grass-fed beef. Just slightly higher percent of mainland respondents feel very satisfied with grass-fed beef (68%) compared to the Hawai‘i respondents (63%). Only less than three percent from both groups are either somewhat dissatisfied or very dissatisfied with the grass-fed beef.

Figure 14. Satisfaction with Grass-fed Beef by CBSA

Question: How satisfied were you with the grass-fed beef?



Source: Beef Survey 2021

Note: The base is those who selected grass-fed beef in the previous question.

Hawai‘i Grass-fed Beef

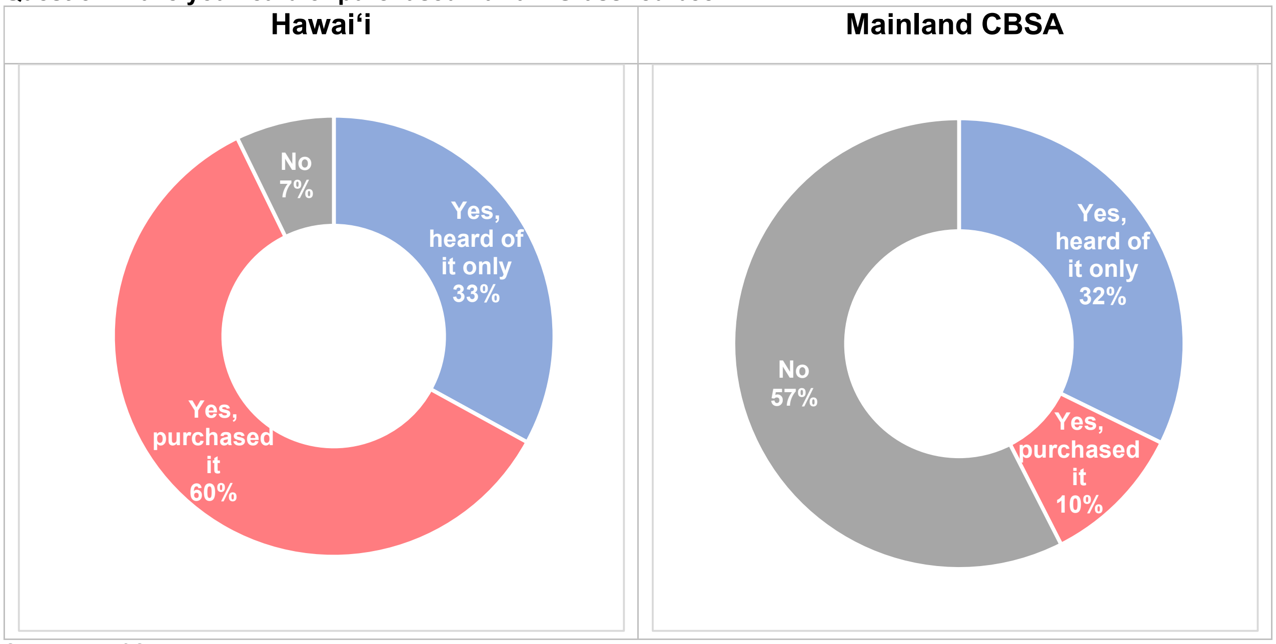
This subsection covers various topics regarding general awareness, satisfaction, quality, the importance of attributes, and the likelihood to purchase Hawai‘i grass-fed beef. We start with the general awareness of Hawai‘i grass-fed beef.

When asked whether the respondents have heard or purchased Hawai‘i grass-fed beef, the percent of respondents reported having heard of it only is about the same for both the Hawai‘i and mainland respondents (approximately 33%). Nevertheless, more than half of the mainland respondents said they have never heard of Hawai‘i grass-fed beef compared to just seven percent of Hawai‘i respondents. Also, there is only as little as 10 percent of mainland respondents who have ever purchased it, while close to 60 percent of Hawai‘i respondents reported having purchased it before.

The result is not too surprising as there are many different brands of beef that people can choose from on the mainland. But the survey data reflect that the branding of Hawai‘i grass-fed beef does not gain sufficient awareness in the mainland market. There may be room to increase the awareness of Hawai‘i grass-fed beef in the mainland market.

Figure 15. General Awareness of Hawaiʻi Grass-fed Beef

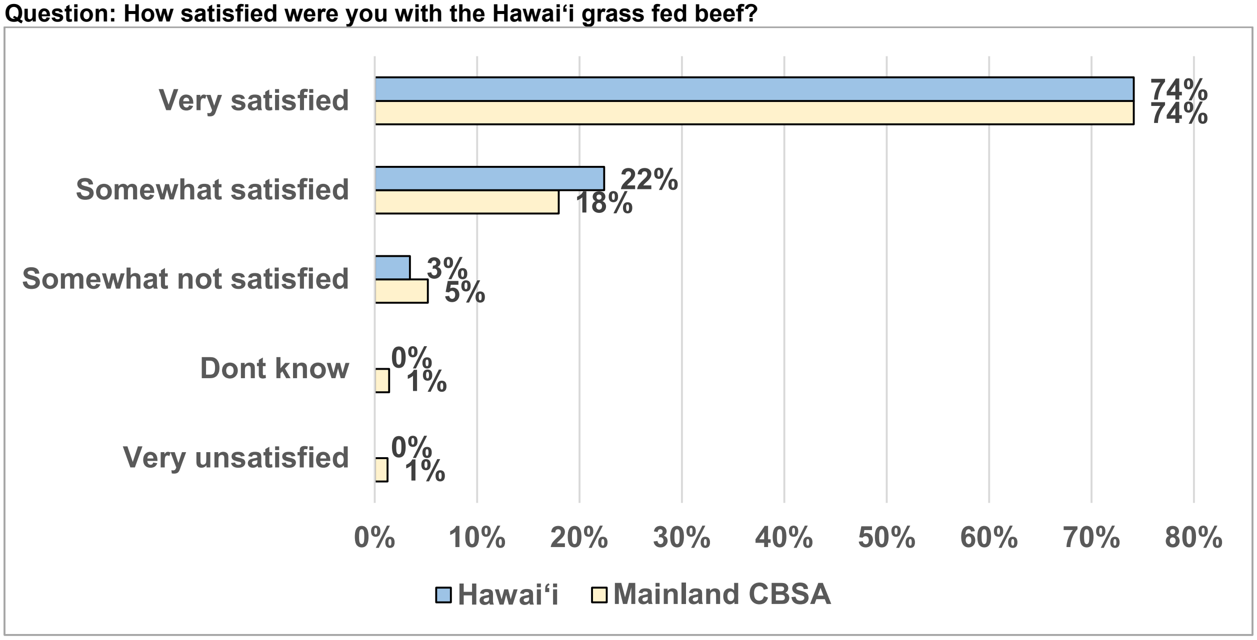
Question: Have you heard or purchased Hawaiʻi Grass-fed beef?



Source: Beef Survey 2021
Note: The base is those who selected grass-fed beef in the previous question.

Figure 16. Satisfaction with Hawaiʻi Grass-fed Beef

Question: How satisfied were you with the Hawaiʻi grass fed beef?

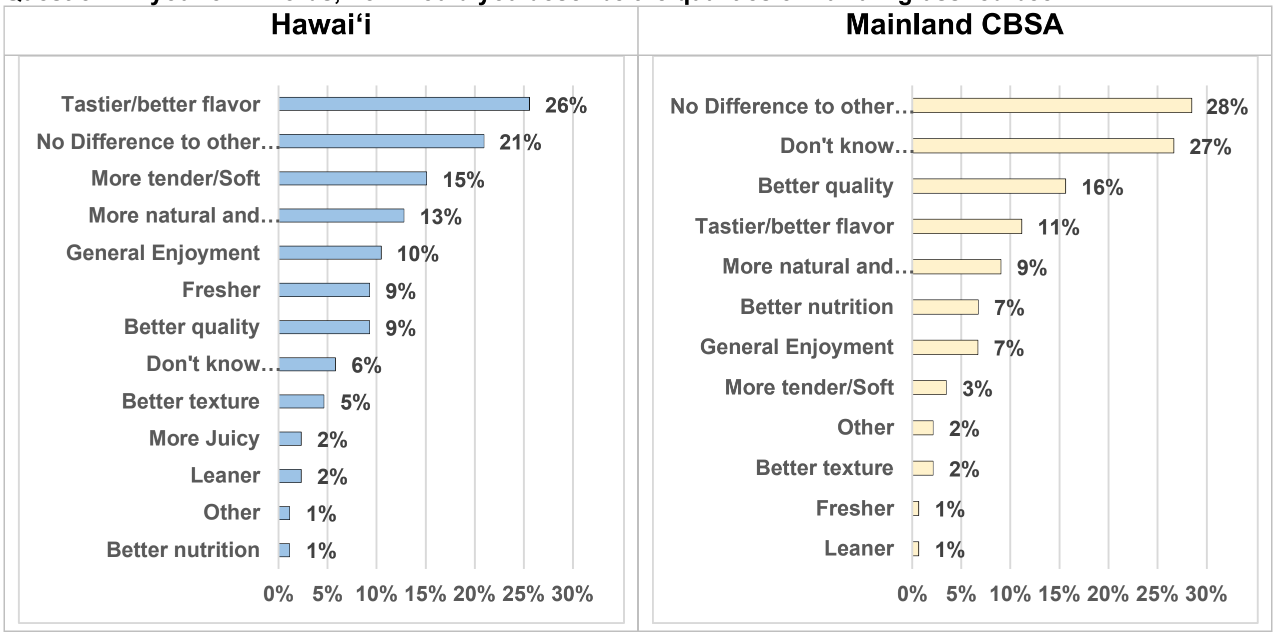


Source: Beef Survey 2021
Note: The base is those who have purchased Hawaiʻi grass-fed beef.

Of those who have purchased Hawaiʻi grass-fed beef, close to three-fourths of them reported being very satisfied with the product (74%) for both the Hawaiʻi and mainland respondents. Only less than six percent of respondents are somewhat dissatisfied or very dissatisfied with the Hawaiʻi grass-fed beef product.

Figure 17. Quality of Hawai‘i Grass-fed Beef

Question: In your own words, how would you describe the qualities of Hawai‘i grass-fed beef?



Source: Beef Survey 2021
Note: The base is those who have purchased Hawai‘i grass-fed beef. Respondents can provide more than one description.

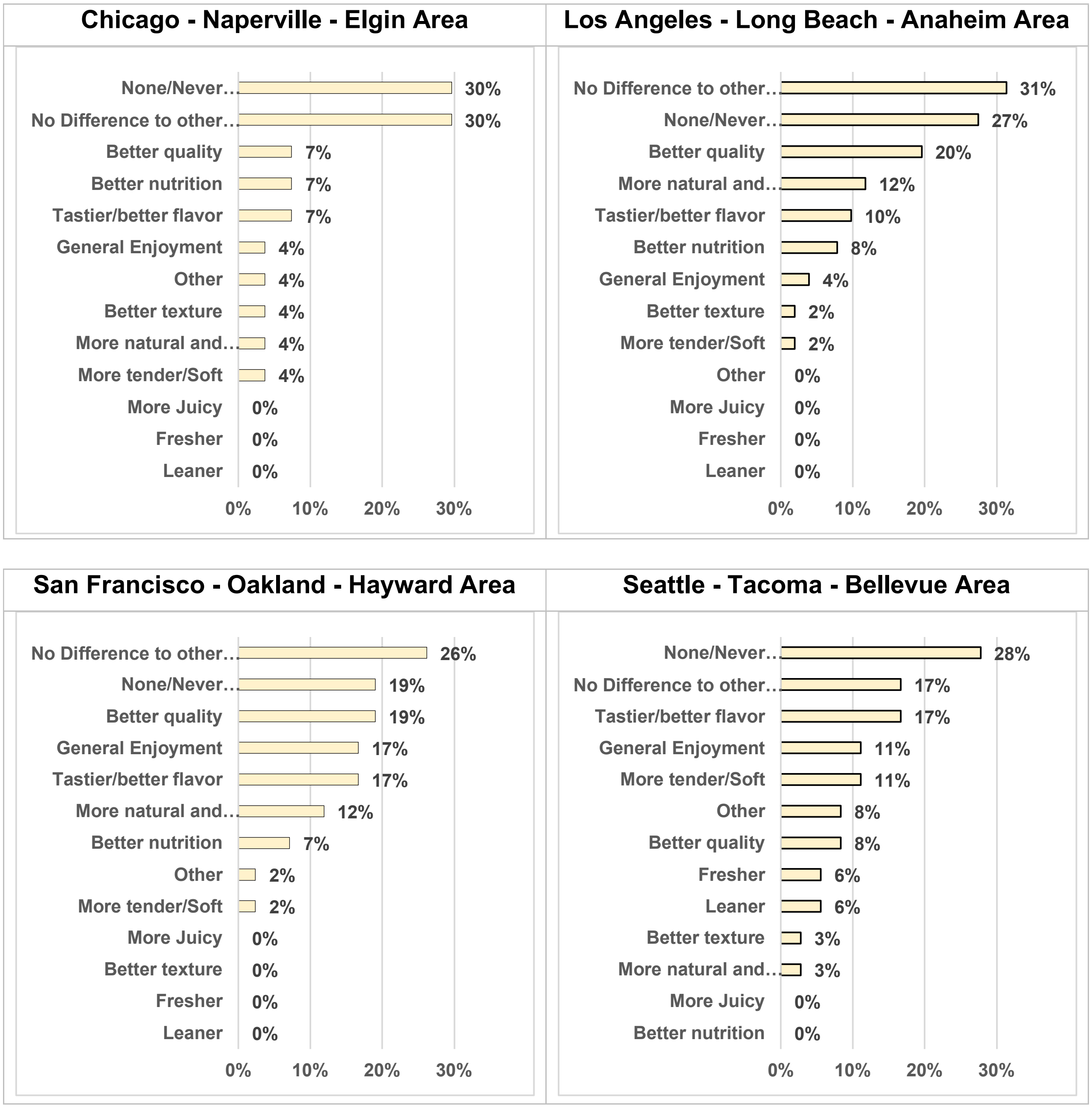
Figure 17 summarizes the results of how the respondents described the qualities of Hawai‘i grass-fed beef. The respondents from Hawai‘i and the mainland have radically different perceptions of the quality of Hawai‘i grass-fed beef. Interestingly, of the mainland respondents who have purchased Hawai‘i grass-fed beef, 28 percent of them reported that there is no difference to other beef. Another 27 percent of them had no idea how to describe the Hawai‘i grass-fed beef. In contrast, the top perception of Hawai‘i respondents is that the Hawai‘i grass-fed beef has tastier or better flavor (26%), although there is still 21 percent of them who said there is no difference to other beef.

1. Around 13 to 15 percent of Hawai‘i respondents who have purchased Hawai‘i grass-fed beef described it as more tender and more natural without antibiotics or growth hormones.
2. Approximately 11 to 16% of mainland respondents who have purchased Hawai‘i grass-fed beef described it as having better quality and better flavor.
3. Less than seven percent of respondents from both groups described the Hawai‘i grass-fed beef as leaner or having better texture.

Overall, it appears that the Hawai‘i respondents are better at differentiating the Hawai‘i grass-fed beef from other beef than the mainland respondents.

To further examine whether there are any regional differences, we also broke down the mainland into the original CBSAs. The results are shown in Figure 17B. Regardless of the regions, the top two perceptions of the mainland respondents to the Hawai‘i grass-fed beef are (1) “None/never tried” or (2) “No difference to other beef”. Among the four CBSAs, the Chicago area and the Los Angeles area have the highest proportion of respondents who said there is no difference (over 30%).

Figure 18B. Quality of Hawai‘i Grass-fed Beef by Mainland CBSA



Source: Beef Survey 2021

On the other hand, close to 20 percent of those who purchased Hawai‘i grass-fed beef from the San Francisco area and Los Angeles area said the Hawai‘i grass-fed beef has a better quality than other beef. That is significantly higher than the respondents from the Chicago and Seattle area. About 17 percent of those respondents from the San Francisco and Seattle area mentioned that the Hawai‘i grass-fed beef is tastier and has better flavor. By looking at the figures above, it is obvious that a higher proportion of respondents from the San Francisco area have a better perception on Hawai‘i grass-fed beef than the remaining three areas. In contrast, the respondents from the Chicago area have the least perception on Hawai‘i grass-fed beef products.

To better understand which type of beef products would provide the respondents with more satisfaction, a list of attributes regarding the palatability and eating experience of beef was given to the respondents. They were then asked to compare each specific attribute between grass-fed beef and Hawaiʻi grass-fed beef.

Figure 19. Comparisons of Grass-fed Beef and Hawaiʻi Grass-fed Beef by CBSA

Question: Now comparing regular grass-fed beef to Hawaiʻi grass-fed beef, please indicate which meat type would provide you more satisfaction about a specific attribute?

	Hawaii		Mainland CBSA	
Attributes	Grass-fed Beef	Hawaiʻi Grass-fed Beef	Grass-fed Beef	Hawaiʻi Grass-fed Beef
Overall Satisfaction	10%	90%	58%	42%
Flavor	13%	87%	61%	39%
Tenderness	15%	85%	49%	51%
Taste	16%	84%	43%	57%
Appearance	18%	82%	54%	46%
Color	23%	77%	50%	50%
Smell	24%	76%	47%	53%

Source: Beef Survey 2021
Note: The base is those who purchased both grass-fed and Hawaiʻi grass-fed beef in the previous question.

As can be seen in Figure 18, there is a consistent pattern that the Hawaiʻi respondents strongly favor the Hawaiʻi grass-fed beef over grass-fed beef. This is substantially different from the mainland respondents in that they do not show a clear preference for a specific type of beef.

Nine out of ten Hawaiʻi respondents reported that the Hawaiʻi grass-fed beef provides better overall satisfaction. In terms of flavor, tenderness, taste, and appearance, over 80 percent of Hawaiʻi respondents stated that the Hawaiʻi grass-fed beef provides them with more satisfaction over grass-fed beef. Another 77 percent of Hawaiʻi respondents think that the Hawaiʻi grass-fed beef is better than grass-fed beef in terms of color and smell.

In contrast, the following attributes are what the mainland respondents think the grass-fed beef provides them with more satisfaction than the Hawaiʻi grass-fed beef:

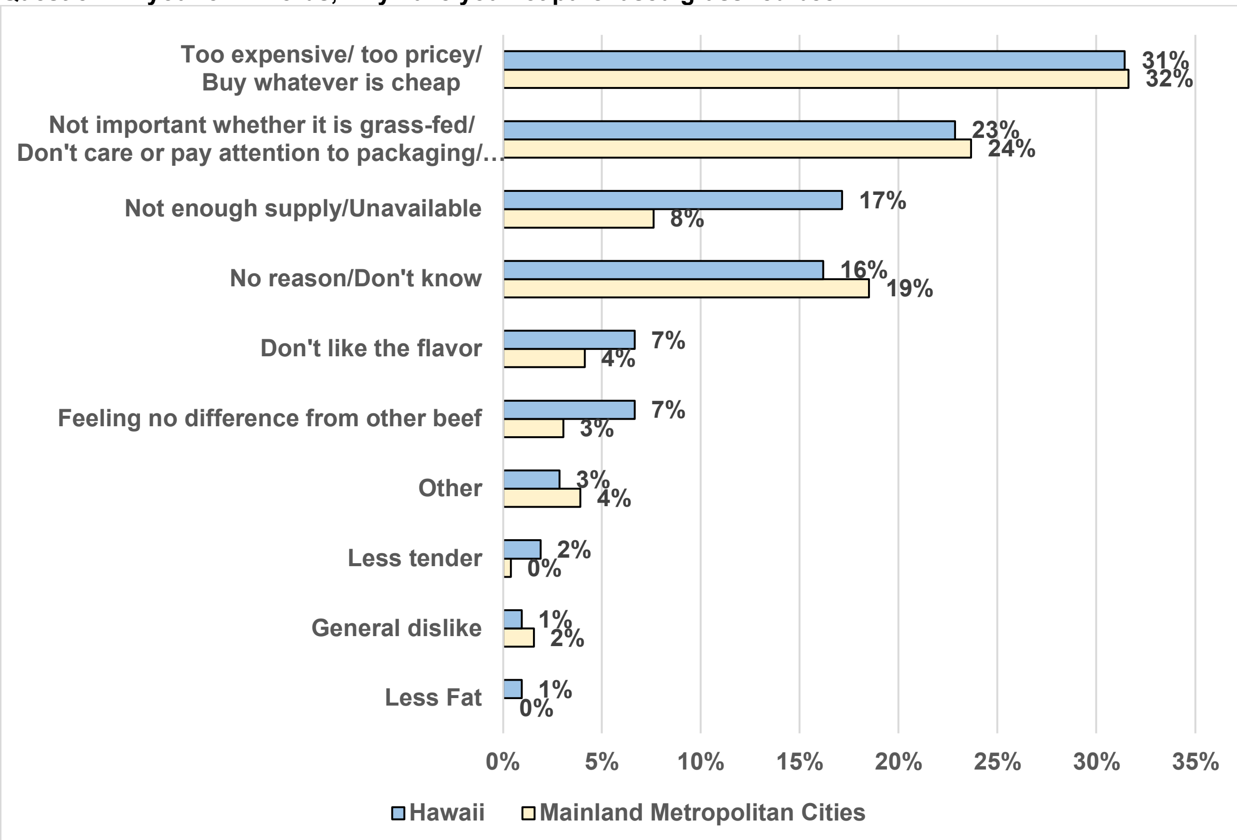
1. Flavor (61%),
2. Overall satisfaction (58%), and
3. Appearance (54%).

Alternatively, the mainland respondents also agreed that the Hawaiʻi grass-fed beef provides more satisfaction than the grass-fed beef in terms of taste (57%), smell (53%), tenderness (51%), and color (50%).

For the respondents who do not usually purchase grass-fed beef, we asked them the reasons why they have not purchased the product. Figure 19 presents the top 10 reasons selected by CBSA.

Figure 20. Top 10 Reasons for Not Purchasing Grass-Fed Beef by CBSA

Question: In your own words, why have you not purchased grass-fed beef?



Source: Beef Survey 2021
Note: The base is those who did not select purchasing grass-fed beef in the previous question.

The top two most common reasons for not purchasing grass-fed beef are identical for both the Hawaiʻi and mainland respondents. The very first reason being the high price of grass-fed beef. Approximately equal percent of respondents from both groups reported that the price of grass-fed beef is too expensive, and they would rather buy any beef that is cheaper (31 to 32%).

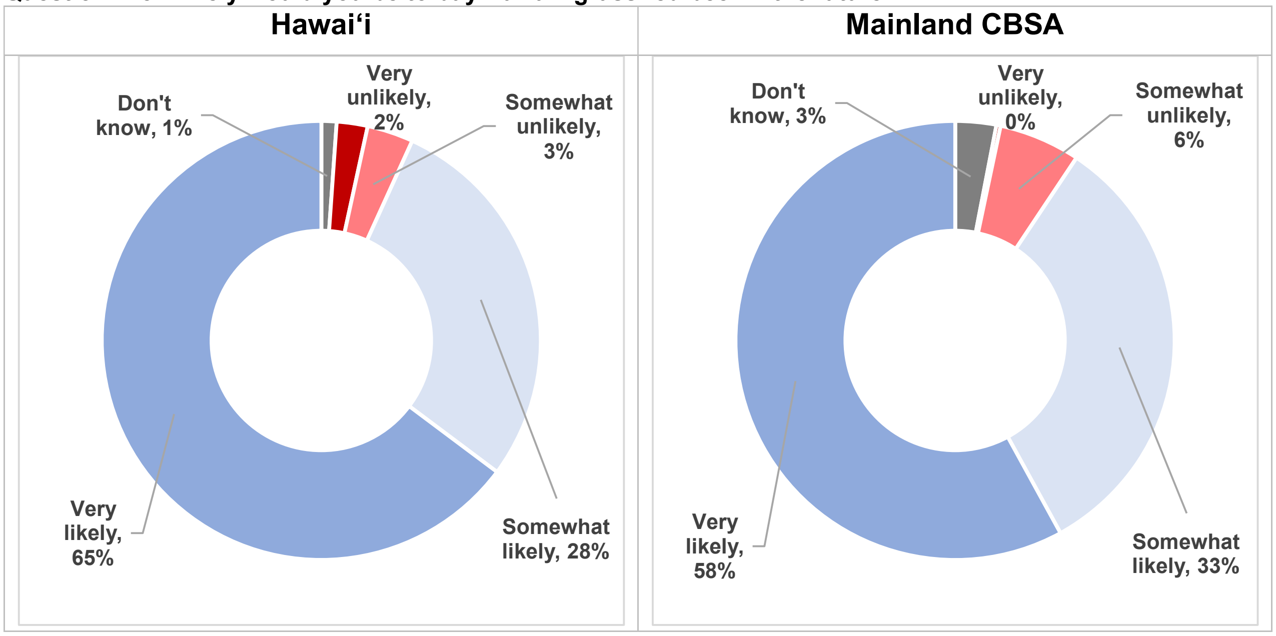
The second reason for not purchasing grass-fed beef is the unimportance of the grass-fed label to the respondents. Close to one-fourth of the Hawaiʻi and mainland respondents said they do not care or pay much attention to the packaging. Some respondents even do not recognize what grass-fed beef is.

The third reason is slightly different between the two groups of respondents. The Hawaiʻi respondents reported that there is simply not enough supply of grass-fed beef in the market (17%). The mainland respondents, on the other hand, have no specific reason for not purchasing grass-fed beef (17%).

The remaining reasons include disliking the flavor of grass-fed beef, feeling no different from other beef, less tender and fat, or generally dislike the product.

Figure 21. Likelihood to Purchase Hawai‘i Grass-fed Beef in the Future by CBSA

Question: How likely would you be to buy Hawai‘i grass-fed beef in the future?



Source: Beef Survey 2021
Note: The base is those who selected purchasing grass-fed beef in the previous question.

When the respondents were asked how likely they would be to purchase Hawai‘i grass-fed beef in the future, they seem to express a positive attitude towards the product.

Of the respondents who said they heard or purchased Hawai‘i grass-fed beef, approximately 65 percent of them reported that they would very likely purchase Hawai‘i grass-fed beef in the future. Those who said somewhat likely also account for 28 percent. Together, about 93 percent of the Hawai‘i respondents who usually purchase grass-fed beef will likely purchase the Hawai‘i grass-fed beef in the future.

The mainland respondents who usually purchase grass-fed beef also show a similar attitude. Fifty-eight percent (58%) of them will very likely purchase the Hawai‘i grass-fed beef. With another 33 percent who said somewhat likely to purchase, the percent of mainland respondents who will likely purchase Hawai‘i grass-fed beef reaches 91 percent.

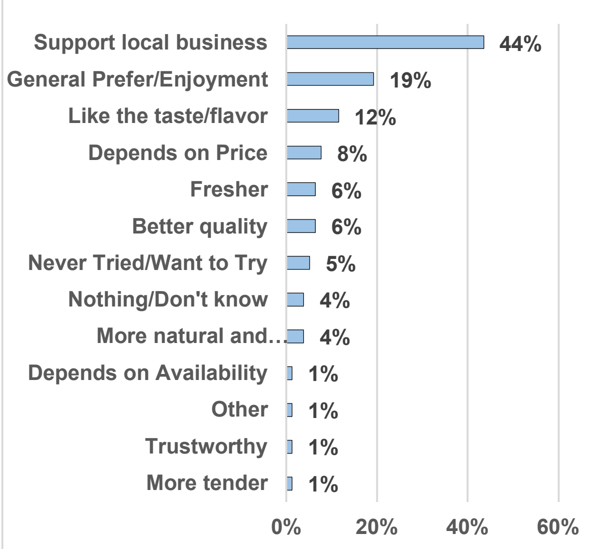
Some of the common reasons for likely to purchase Hawai‘i grass-fed beef in the future among Hawai‘i and mainland respondents include:

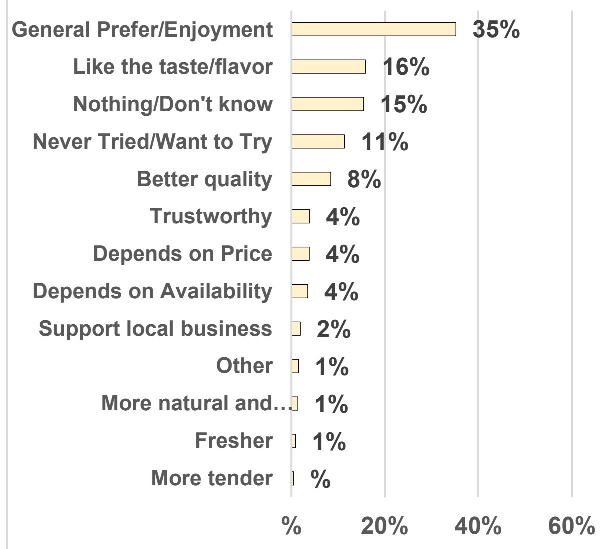
1. supporting local businesses,
2. general enjoyment,
3. like the taste or flavor of the product,
4. depends on the price of the product,
5. have never tried before and want to try, and
6. better quality.

Figure 22. Reasons for Likely to Purchase Hawai'i Grass-fed Beef by CBSA

Question: Why do you say that?

Hawai'i	Mainland CBSA

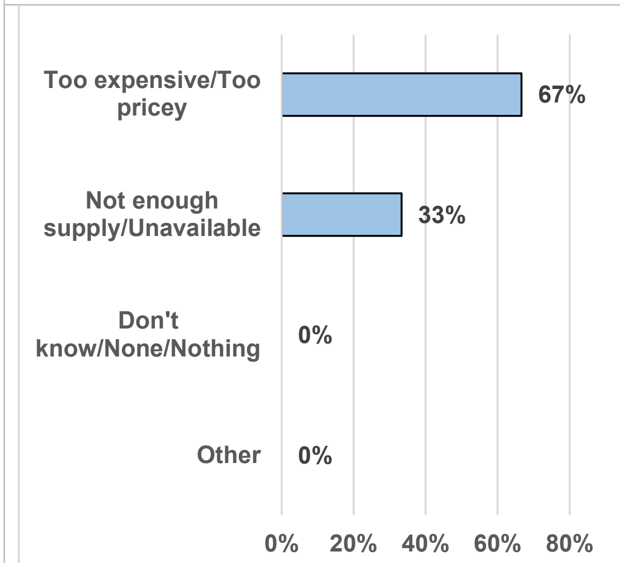


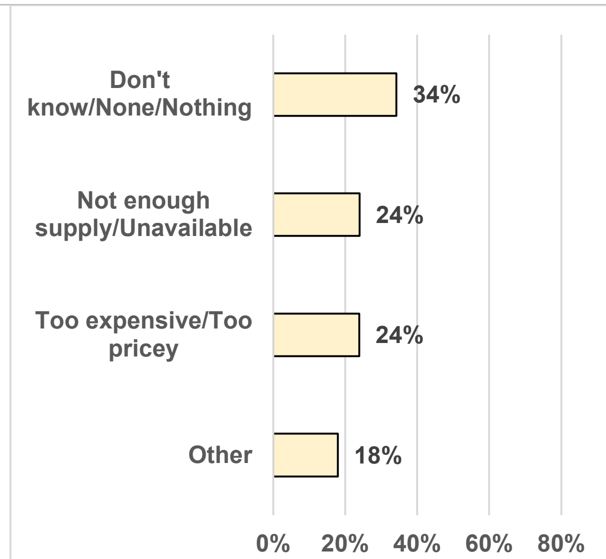


Source: Beef Survey 2021

Figure 23. Reasons for Unlikely to Purchase Hawai'i Grass-fed Beef

Hawai'i	Mainland CBSA





Source: Beef Survey 2021

On the other hand, respondents who reported unlikely to purchase Hawai'i grass-fed beef in the future are mostly due to undersupply or unaffordable price of the product. About 34 percent of mainland respondents who are unlikely to purchase Hawai'i grass-fed beef have no specific reasons.

The USDA publishes a National Monthly Grass-fed Beef Report that provides the prices of commodity beef and grass-fed beef. Below is a snapshot of the grass-fed beef items, their average retail prices per pound, the average retail prices per pound of commodity beef, and the differences in price between the two types of beef products.

Item Description	($/lb)	Avg	Commodity Beef*	Grassfed Premium**
Ribeye Steak	15.00 - 27.52	21.09	7.43	13.66
Ribeye Roast	16.00 - 26.50	21.56	5.66	15.91
Chuck Roast	8.00 - 12.00	9.47	4.63	4.84
Flat Iron Steak	13.49 - 32.00	20.05	7.66	12.39
Rump Roast	8.00 - 10.99	9.56	4.19	5.37
Bottom Round Roast	7.00 - 9.00	8.08	4.18	3.90
Filet Mignon	19.00 - 35.51	29.15	13.37	15.78
Tenderloin	17.00 - 24.00	19.71	11.05	8.67
Tri Tip	9.00 - 15.25	12.08	6.42	5.66
Sirloin Steak	12.00 - 26.62	17.60	5.96	11.64
Sirloin Roast	8.73 - 12.49	10.58	4.99	12.31
Brisket	8.00 - 12.77	9.63	3.01	6.62
Flank Steak	8.99 - 24.19	15.85	7.52	8.33
Skirt Steak	12.73 - 20.14	15.17	9.51	5.66
Short Ribs	5.99 - 10.99	7.81	5.71	2.10
Stew Meat	8.25 - 11.25	9.98	5.18	4.80

Source: USDA National Monthly Grass-fed Beef Report for the month of February
* Prices averaged from the National Retail Beef Activity Report
** The difference in commodity retail beef prices and grass-fed retail beef prices

From the column that marked “Grassfed Premium”, we can see that the signs of the dollar amount are all positive, which implies that the grass-fed beef products are, indeed, more expensive than the commodity beef. The top five products that have the largest price differences between grass-fed beef and commodity beef are (1) Ribeye Roast (2) Filet Mignon, (3) Ribeye Steak, (4) Flat Iron Steak, and (5) Sirloin Roast. These price differences range from $11.64 to $15.91 per pound. If a person were to buy one pound of grass-fed ribeye steak instead of commodity beef ribeye steak every two weeks, it will likely cost her additional $355 a year for switching to buying grass-fed beef[5]. According to the non-profit organization—Consumer Report, the grass-fed beef is pricier than the commodity beef mainly because of two reasons: (1) it takes a year longer to raise the cattle to reach the slaughter weight, which increases the cost of production, and (2) grass-fed cattle tend to be smaller at slaughter, so the proportion of meat that can be sold is less per head[6].

We then asked the respondents to rate the level of importance for each of the following attributes on Hawai‘i grass-fed beef. Our survey data indicate that, although over 82 percent of Hawai‘i and mainland respondents rated each attribute as very important or moderately important, their composition is quite different.

If we only look at the grouped rating of importance, it will likely mask some interesting information hidden behind each attribute. For instance, there is an overall 92 percent of Hawai‘i respondents who think that eating satisfaction is very important to moderately important. However, when we look at the level of importance individually, the respondents are indeed more concerned about food safety (70%) than the overall eating satisfaction (68%).

[5] ($\$21.09/\text{lb}_{\text{grass-fed}}$ - $\$7.43/\text{lb}_{\text{commodity}}$) x 1lb x 26 weeks ≈ $355.16/year

[6] Why grass-fed beef costs more? You'll pay a little extra, but Consumer Reports' tests of ground beef show grass-fed is less likely to harbor dangerous bacteria. Consumer Report, 2018.

Another example would be whether the Hawai‘i grass-fed beef is genuinely Hawai‘i grown. Although both the Hawai‘i and mainland respondents (89%) think that this attribute is very important to moderately important to them, the result shows that only about 47 percent of mainland respondents think of it as a very important attribute compared to 63 percent of Hawai‘i respondents.

Figure 24. Importance of Hawai‘i Grass-fed Beef Attributes by CBSA

Question: Please tell us how important the following attributes of Hawai‘i grass fed beef are to you?

Hawai‘i	Very important	Moderately Important	Very important to Moderately important	Neutral	Low important to Not important
Food safety - knowing beef is wholesome, free of disease-causing agents	70%	19%	88%	12%	0%
Overall eating satisfaction	68%	24%	92%	8%	0%
Appearance of meat - color and texture	64%	26%	90%	9%	1%
Hawai‘i grown	63%	25%	89%	11%	0%
Meat delivered fresh, never frozen	57%	30%	87%	11%	1%
Natural label - never been treated with antibiotics or added hormones	56%	32%	89%	11%	0%
Grass fed label - fed 90% or more in pasture	56%	33%	90%	9%	1%
How and where the cattle are raised	52%	34%	86%	14%	0%
Branded product (recognized label with Hawai‘i and indicating specific producer)	46%	37%	83%	16%	1%

Mainland CBSA	Very important	Moderately Important	Very important to Moderately Important	Neutral	Low important to Not important
Food safety - knowing beef is wholesome, free of disease-causing agents	72%	21%	93%	6%	1%
How and where the cattle are raised	61%	26%	88%	9%	3%
Natural label - never been treated with antibiotics or added hormones	59%	34%	93%	5%	2%
Branded product (recognized label with Hawai‘i and indicating specific producer)	59%	28%	87%	9%	4%
Overall eating satisfaction	59%	35%	93%	6%	1%
Meat delivered fresh, never frozen	57%	31%	88%	9%	3%
Appearance of meat - color and texture	55%	33%	88%	11%	1%
Grass fed label - fed 90% or more in pasture	53%	39%	92%	8%	0%
Hawai‘i grown	47%	43%	89%	8%	3%

Source: Beef Survey 2021

We will summarize a few findings below:

1. There is a higher proportion of Hawaiʻi than mainland respondents who reported the overall eating satisfaction of Hawaiʻi grass-fed beef as very important.
2. A relatively higher proportion of Hawaiʻi respondents than mainland respondents think that the color and texture of the meat are very important.
3. A higher percent of mainland respondents care more about how and where the cattle are raised than the Hawaiʻi respondents.
4. Overall, the mainland respondents are more concerned about the natural label—never been treated with antibiotics or added hormones than the Hawaiʻi respondents.
5. A higher proportion of mainland respondents think that it is very important to have a branded product (i.e., a recognized label with Hawaiʻi and indicating specific producer).
6. The level of importance of grass-fed labels and meat being delivered fresh is about the same among Hawaiʻi and mainland respondents.

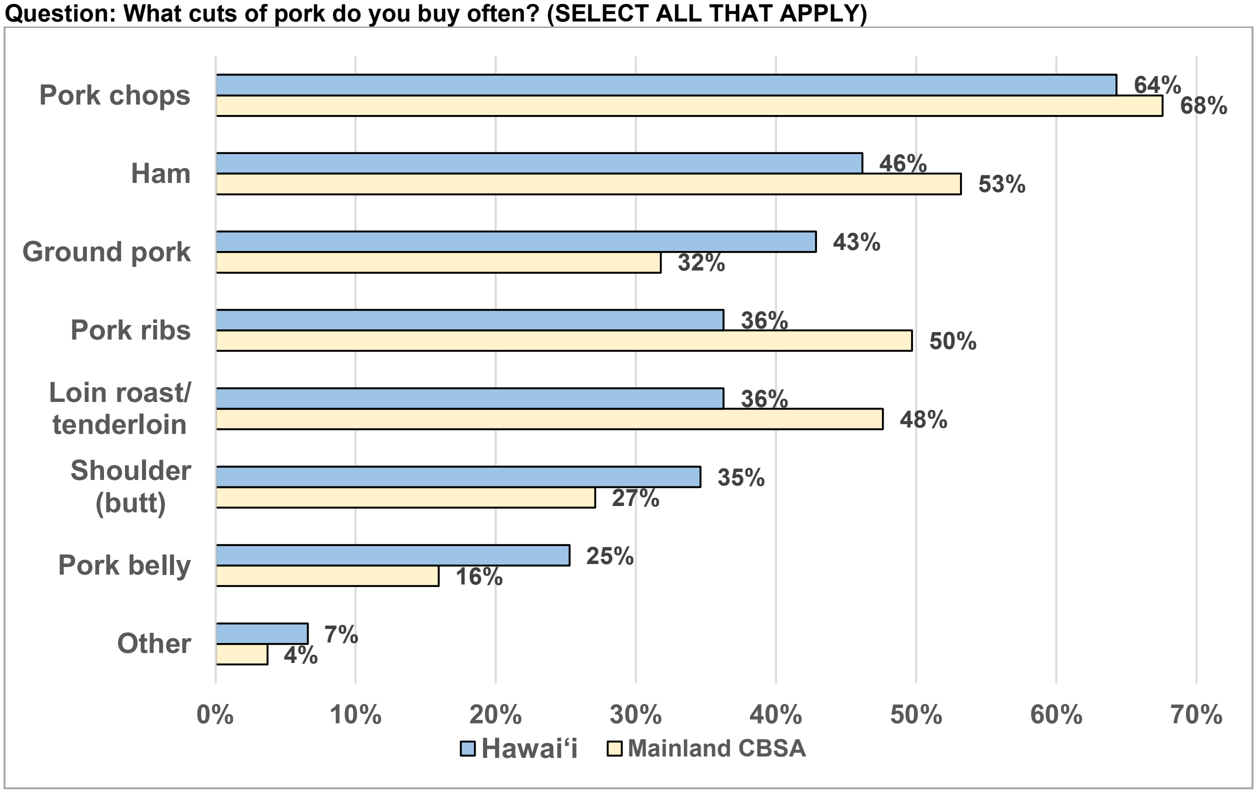
Having examined the beef consumption patterns, we now turn our focus to the pork consumption patterns starting in this section.

PORK CONSUMPTION PATTERNS

Pork Consumption Preferences

Figure 25. Cuts of Pork Most Often Buy by CBSA

Question: What cuts of pork do you buy often? (SELECT ALL THAT APPLY)



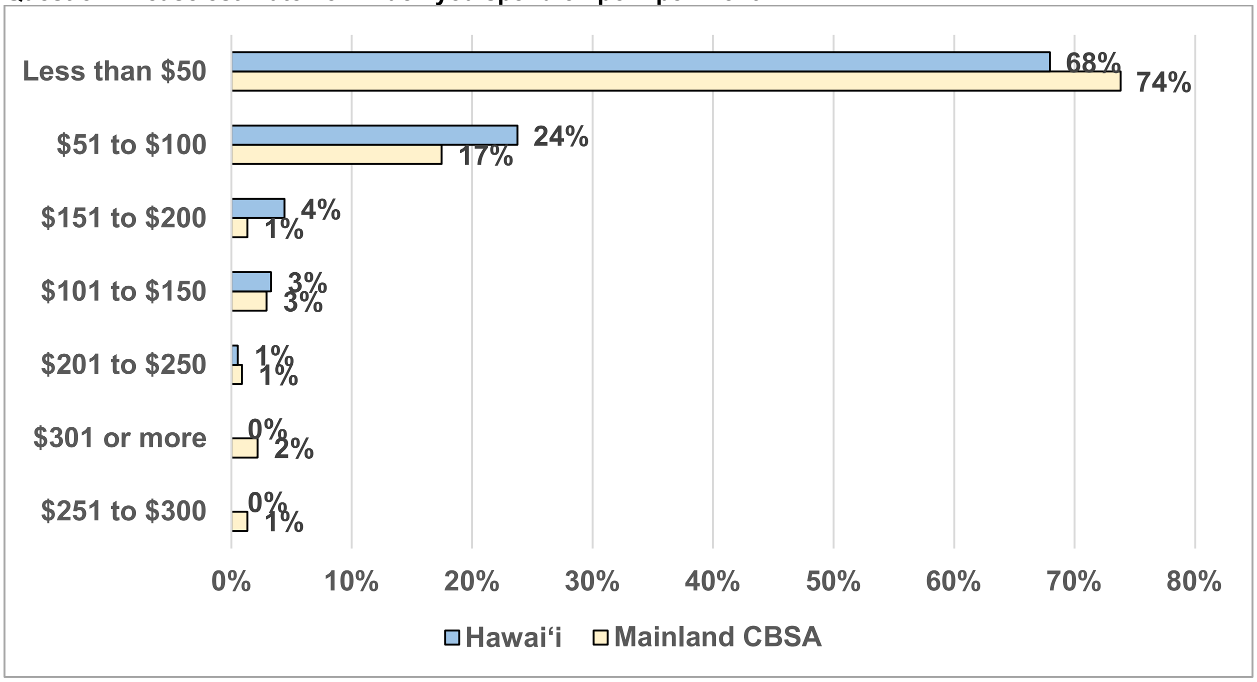
Source: Beef Survey 2021
Note: This is a multiple response. Respondents can provide more than one response. The base is those who consume pork.

When the respondents were asked about what cuts of pork they often buy, the majority of them indicated that they often buy pork chops. This is true for both the Hawai'i respondents (64%) and mainland respondents (68%). The second most purchased cut of pork among both two groups is ham, except that there are seven percentage points more mainland respondents buying ham than Hawai'i respondents.

Different from the mainland respondents, the third most popular cut of pork among Hawai'i respondents is the ground pork (43%). Compared to the mainland respondents, a higher proportion of Hawai'i respondents like to buy ground pork. In contrast, the mainland respondents seem to favor a lot more in pork ribs (50%) and loin roast or tenderloin (48%). Although the Hawai'i respondents also often buy pork ribs and loin roast or tenderloin, the extent is not as large as the mainland respondents (36%). The data also indicate that there are eight to nine percentage points more Hawai'i respondents who often buy shoulder (butt) or pork belly than the mainland respondents.

Figure 26. Average Monthly Spending on Pork by CBSA

Question: Please estimate how much you spend on pork per month?



Source: Beef Survey 2021
Note: Data points that are potential outliers may distort the results significantly and have been removed accordingly.

On average, the majority of respondents reported spending less than $50 per month on pork. There is a higher proportion of mainland respondents (74%) than Hawaiʻi respondents (68%) who falls into this lower price category. On the other hand, approximately one in four Hawaiʻi respondents (24%) reported spending between $51 to $100 on pork per month, which is about 7 percentage points higher than the mainland respondents. The proportion of Hawaiʻi and mainland respondents who spend more than $100 per month does not differ significantly.

Overall, the Hawaiʻi respondents spend an average of $54.71 on pork per month, while the mainland respondents spend, on average, $58.44 per month. Compared to the Hawaiʻi respondents, the mainland respondents spend only $3.74 more on pork per month. The pork consumption spending patterns look quite similar between the two groups of respondents.

Figure 25B shows the USDA estimated weighted average price per pound of selected pork cuts by CBSA. The prices per pound are only slightly higher in Hawaiʻi than the mainland CBSA for about half of the selected cuts of pork. Although our survey data show that the mainland respondents spend $3.74 more on pork per month than the Hawaiʻi respondents, the difference is insignificant. The level of pork consumption may be proportionally similar between Hawaiʻi and the mainland.

Figure 25B. Weighted Average Price per Pound of Selected Pork Cuts by CBSA

Period	Selected Cuts	Weighted Average Price per Pound					
		IL		CA		HI	
1/29 - 2/4	Loin Roast Bnls	$	1.82	$	2.04	$	1.99
1/29 - 2/4	Sirloin Roast Bnls	$	2.96			$	2.99
1/29 - 2/4	Rib End Chops B/In	$	2.49	$	1.97	$	3.99
1/29 - 2/4	Cc Chops B/In	$	2.80	$	2.33	$	2.49
1/29 - 2/4	Assorted Chops B/In	$	2.07	$	3.92	$	2.79
1/29 - 2/4	Sirloin Chops Bnls	$	1.79	$	1.79	$	2.99
1/29 - 2/4	Butt Roast Bnls	$	3.49	$	3.49	$	3.22
1/29 - 2/4	Ham, B/In	$	1.29	$	1.29	$	0.99
1/29 - 2/4	Sliced Bacon, 1 Lb Pkg	$	2.99	$	5.18	$	2.99
1/29 - 2/4	Pre-Cooked Bacon	$	25.54	$	25.54	$	28.74
1/29 - 2/4	Ground Pork	$	2.79			$	2.79
1/29 - 2/4	Italian Sausage	$	2.69	$	2.59	$	3.00
1/29 - 2/4	Pulled Pork	$	7.34	$	7.72	$	7.72
2/5-2/11	Loin Roast Bnls	$	1.92	$	1.89	$	3.99
2/5-2/11	Rib End Chops B/In			$	2.99	$	3.29
2/5-2/11	Cc Chops B/In	$	2.59			$	1.99
2/5-2/11	Assorted Chops B/In	$	1.67			$	1.49
2/5-2/11	Sirloin Chops Bnls	$	1.99	$	2.49	$	1.49
2/5-2/11	Backribs	$	3.73	$	3.58	$	2.99
2/5-2/11	Butt Roast Bnls	$	1.84	$	1.64	$	3.29
2/5-2/11	Spareribs	$	2.64	$	2.18	$	2.99
2/5-2/11	St. Louis Style Spareribs	$	2.90	$	4.21	$	2.99
2/5-2/11	Ham, B/In Butt	$	1.29			$	0.99
2/5-2/11	Ham, B/In Shank	$	0.99			$	0.99
2/5-2/11	Sliced Bacon, 1 Lb Pkg	$	5.15	$	5.27	$	3.49
2/5-2/11	Ground Pork	$	2.36	$	3.50	$	2.97
2/5-2/11	Bkfst Sausage, 1 Lb Roll	$	3.25	$	3.50	$	3.50
2/5-2/11	Dinner Sausage	$	3.67	$	3.59	$	3.99
2/5-2/11	Italian Sausage	$	3.13	$	3.49	$	3.99

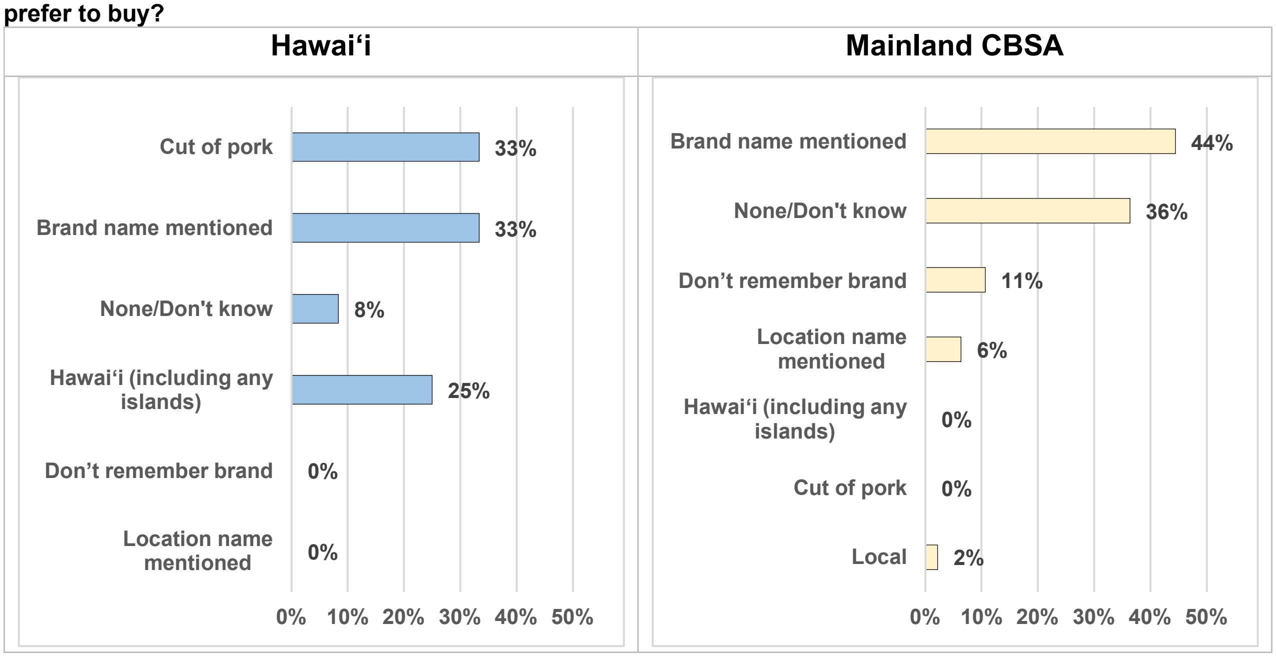
Source: USDA National Retail Report – Pork, Advertised Prices for Pork at Major Retail Supermarket Outlets ending during the period of 01/29 thru 02/11.

When the respondents were asked if there is a specific brand of pork or any specific geographic region where pork is sourced they prefer to buy, only eight percent of the Hawaiʻi respondents who consume pork reported yes. In contrast, the proportion of mainland respondents who reported having a specific brand of pork they prefer to buy is about twice as much as the Hawaiʻi respondents (15.3%).

Of the Hawaiʻi respondents who have a specific brand they prefer to buy, 33 percent mentioned different brand names. Another 25 percent reported that they prefer to buy pork that is sourced from Hawaiʻi (See Figure 26). The mainland respondents, however, do not seem to show the same preference for local pork (2%). While there is 44 percent of them provide the brand names of pork they like, slightly more than one-third of them do not know the specific brand name of pork (36%).

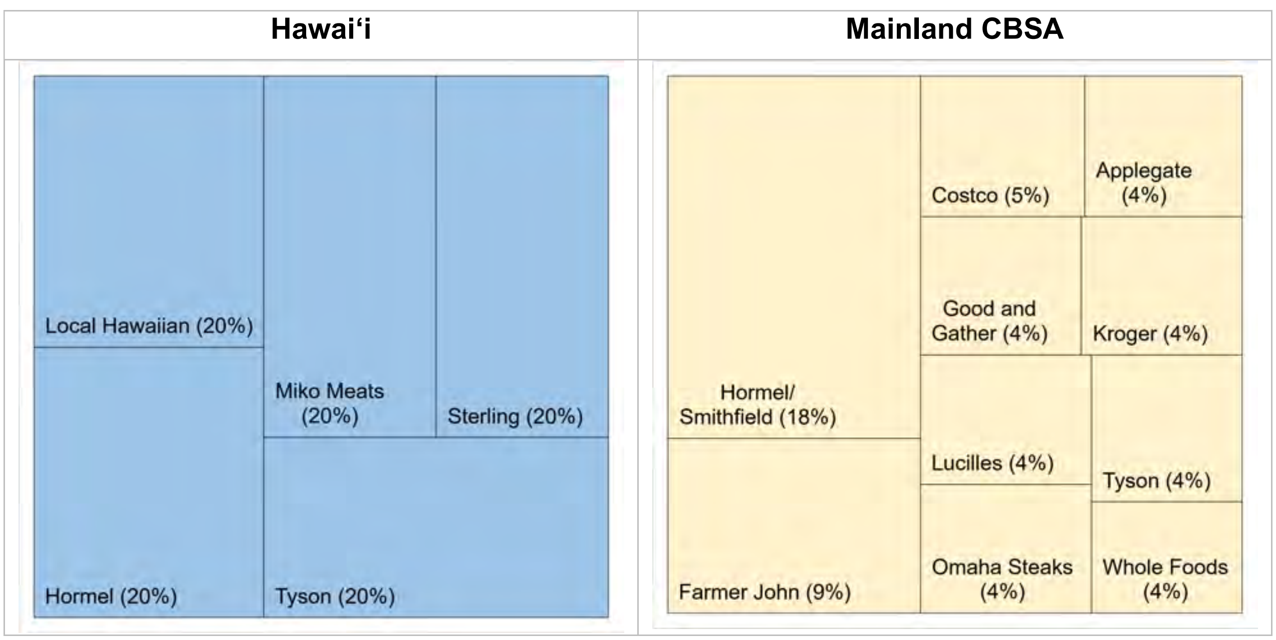
Figure 27. Specific Source of Pork Preferred by CBSA

Question: Is there a specific brand of pork or any specific geographic region where pork is sourced that you prefer to buy?



Source: Beef Survey 2021
Note: The base is those who consumes pork.

Figure 28. Top 10 Specific Brand of Pork or Source of Pork Preferred by CBSA



Source: Beef Survey 2021
Note: The base is those who mentioned a brand name.

Figure 27 shows the top 10 brand names of pork that are most popular among the Hawaiʻi and mainland respondents who mentioned a brand name.

The top 10 brand names preferred by the Hawaiʻi respondents are:

(1) Local Hawaiian (20%),
(2) Hormel (20%),
(3) Miko Meats (20%),
(4) Sterling (20%), and
(5) Tyson (20%).

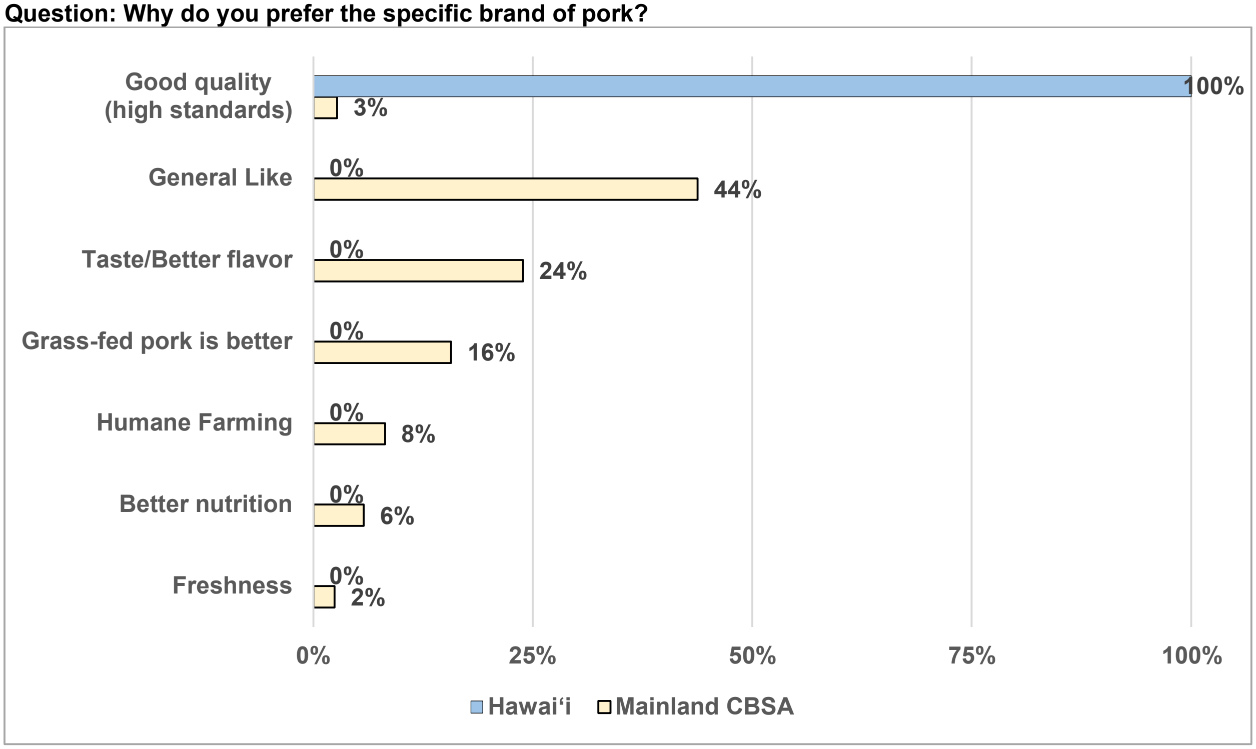
In contrast, the mainland respondents prefer brands such as

(1) Hormel / Smithfield (18%),
(2) Farmer John (9%),
(3) Costco (5%),
(4) Good and Gather, Lucilles, Omaha Steaks, Applegate, Kroger, Tyson, and Whole Food (4%)

When asked if there are specific reasons why they prefer the brands they mentioned, all of the Hawaiʻi respondents indicated that they have good quality or have high standards. The mainland respondents, on the other hand, generally like the brands (44%) or think they have better flavor or taste (24%). Another 16 percent of them prefer the brands because they are grass-fed pork.

Figure 29. Reasons for Preferring Specific Brand of Pork or Source of Beef by CBSA

Question: Why do you prefer the specific brand of pork?

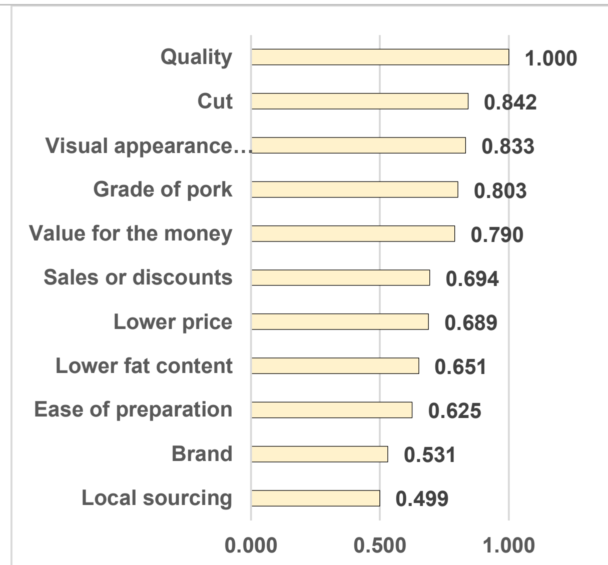


Source: Beef Survey 2021

As in the beef section, we asked the respondents to rank the following intrinsic attributes according to their importance when purchasing pork. Figure 29 shows the ranked attributes from the most important to the least important by CBSA. The closer the score to one, the more important the attribute is.

Figure 30. Order of Importance of Attributes When Purchasing Pork by CBSA

Question: Please rank the following attributes in order of importance when buying your preferred pork.

Hawai‘i	Mainland CBSA
	

Source: Beef Survey 2021

Two of the top three attributes are identical between the Hawai‘i and mainland respondents. Among a list of attributes, the quality of pork is being ranked as most important by both groups of respondents. Unlike the mainland respondents where the cut of pork is considered the second most important attribute, the Hawai‘i respondents take into account more on the value for the money. The visual appearance – color or texture of the pork is equally important and is ranked the third by both groups.

The grade of pork is also quite an important factor when the respondents purchase pork. The attributes like whether the pork has sales, discounts, or a lower price receive a medium importance ranking.

Meanwhile, attributes such as the ease of preparation, having lower fat content, where the pork is locally sourced, or the brand of the pork are ranked the lowest. This indicates that the respondents consider these attributes the least when they purchase pork.

After looking at the intrinsic attributes of pork, we will move on to the more extrinsic attributes of the pork. These extrinsic attributes encompass factors like food safety, how and where the pigs are raised, the production ethic, and whether the pork is organic, etc.

Figure 31. Importance of Pork Attributes by CBSA

Question: How important is each of the following attributes of pork are to you?

Geographic Area	Attributes	Very important to Moderately important	Neutral	Low important to Not important
Hawai‘i	Appearance of meat - color and texture	87%	12%	1%
Mainland CBSA	Appearance of meat - color and texture	86%	13%	2%
Hawai‘i	Food safety	87%	11%	2%
Mainland CBSA	Food safety	86%	12%	3%
Hawai‘i	Meat delivered fresh, never frozen	60%	30%	10%
Mainland CBSA	Meat delivered fresh, never frozen	69%	25%	6%
Hawai‘i	Ethical production and distribution	59%	27%	15%
Mainland CBSA	Ethical production and distribution	58%	33%	10%
Hawai‘i	Natural label	58%	30%	12%
Mainland CBSA	Natural label	64%	26%	9%
Hawai‘i	How and where the pigs are raised	53%	33%	14%
Mainland CBSA	How and where the pigs are raised	53%	33%	14%
Hawai‘i	Locally sourced	50%	38%	12%
Mainland CBSA	Locally sourced	48%	37%	15%
Hawai‘i	Branded product	47%	33%	20%
Mainland CBSA	Branded product	49%	36%	15%
Hawai‘i	Organic	44%	35%	22%
Mainland CBSA	Organic	46%	32%	22%

Source: Beef Survey 2021

As we can see in Figure 30, the Hawai‘i respondents behave quite similarly to the mainland respondents in terms of these attribute ratings. Besides the two attributes—the freshness of pork and whether the pork has a natural label, the remaining seven attributes that receive a rating of very important to moderately important do not differ by more than two percentage points between the two groups of respondents.

The attribute that gets the most rating of very important to moderately important are (1) the appearance of meat – color and texture, and (2) food safety[7]. As much as 86 to 87 percent of respondents from each group think that these two pork attributes are very important to them. It is worth mentioning that these two attributes also outweigh the third most-rated attribute by 17 to 27 percentage points.

Meat delivered fresh or never frozen pork is the third most important attribute of pork to the respondents. Sixty percent (60%) of Hawai‘i respondents and close to 70 percent of mainland respondents gave it a rating of very important.

The natural label[8] is another attribute where a higher proportion of mainland respondents see it as very important factor than the Hawai‘i respondents (64% vs. 58%). Close to 60 percent of respondents are very concerned about the ethical production and distribution of pork. Slightly more than half of the Hawai‘i and mainland respondents see how and where the pigs are raised as a very important factor to them (53%).

[7] In this context, food safety refers to knowing that the pork is wholesome and is free of disease-causing agents.
[8] The Natural label refers to meat that has never been treated with antibiotics or added hormones.

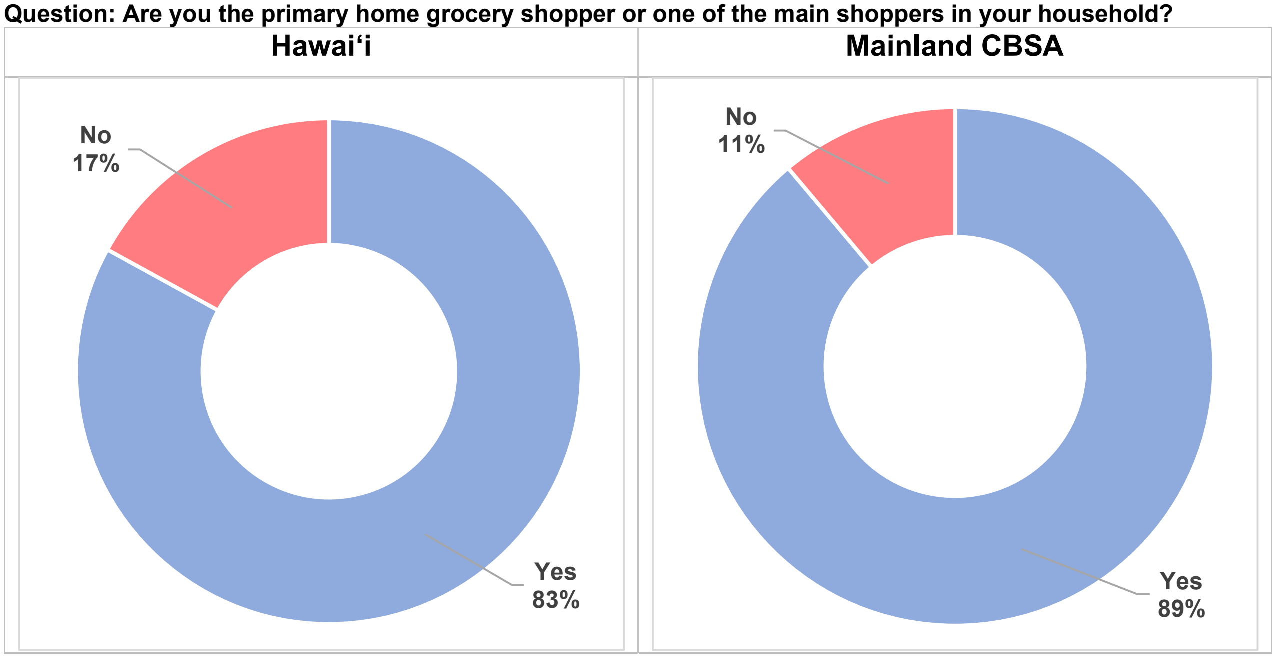
On the other hand, attributes like where the pork is locally sourced, a branded product[9], and whether the pork is organic get the least rating of very important (< 50%). More than one-third of the respondents are neutral to these attributes, meaning that the attributes are optional to have, and they are not as important as other attributes.

OTHER EXTERNAL FACTORS

Besides looking at the intrinsic and extrinsic values of the livestock products, it will also be valuable to see what kind of external factors will influence the respondents' decisions when they purchase meat. We begin by asking whether the respondents are the primary grocery shopper or one of the main shoppers in their household.

Figure 32. Primary Shopper in Household by CBSA

Question: Are you the primary home grocery shopper or one of the main shoppers in your household?



Source: Beef Survey 2021

The survey data show that 83 percent of Hawai'i respondents are the primary grocery shopper or one of the main shoppers, while a slightly higher proportion of mainland respondents reported the same (89%).

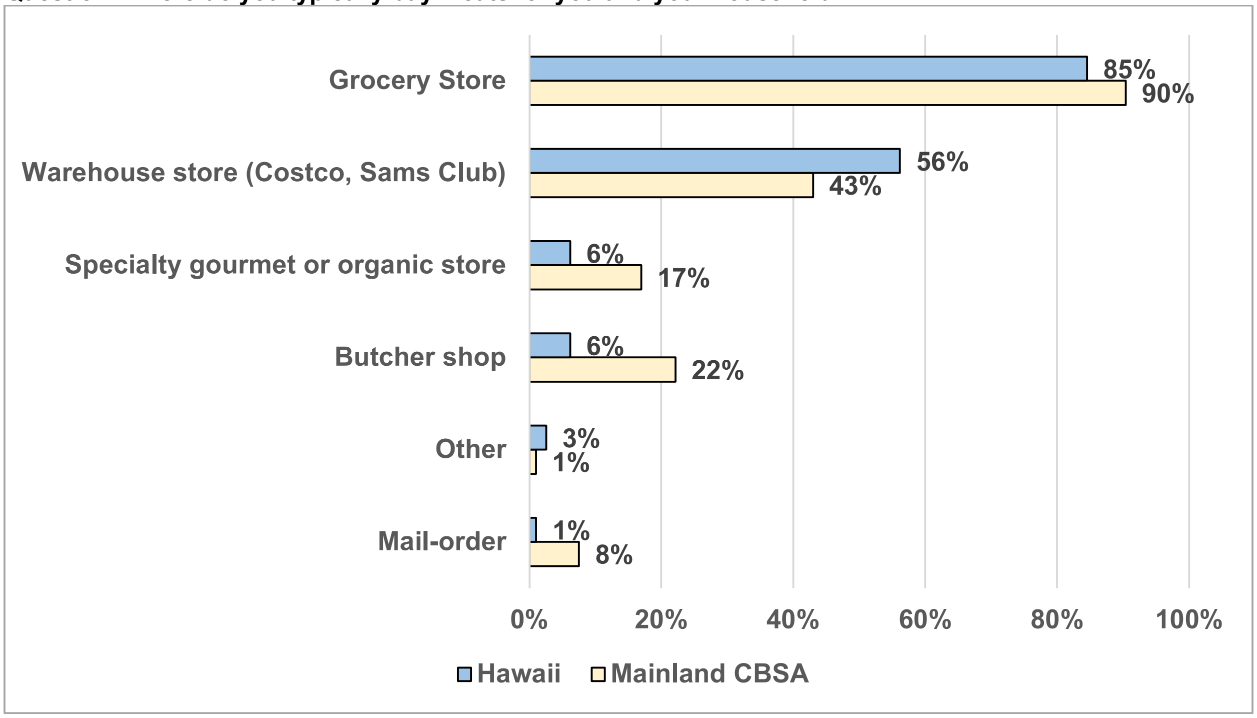
As much as 85 percent of Hawai'i respondents reported that they typically buy meats at the grocery store. An even higher percentage of the mainland respondents buy meats at the same place (90%).

Slightly more than half of the Hawai'i respondents also buy meats from the warehouse stores like Costco or Sam's Club (56%). The mainland respondents are, however, less likely to buy meats from these warehouse stores (43%). Compared to the Hawai'i respondents, the mainland respondents are two to three times more likely to buy meats from the specialty gourmet or organic store or butcher shop. Meanwhile, eight percent of them also reported buying meats through mail-order (See Figure 32).

9 Recognized label indicating specific producer or ranch.

Figure 33. Typical Places for Meats Purchase by CBSA

Question: Where do you typically buy meats for you and your household?



Source: Beef Survey 2021
Note: This is a multiple response question. The respondents can provide more than one answer.

Meat Purchase External Factors

In this section, we will analyze the external factors that may influence the respondents' meat buying decision. A set of external factors were given to the respondents and they were asked to express to what extent do they agree or disagree with each factor.

The majority of the respondents are experience-driven. More than 72 percent of the respondents strongly agree to agree that they are influenced by their previous experience when buying meat (Hawai'i: 72%, Mainland: 80%).

Figure 34. Meat Purchase Influential Factors by CBSA

Question: When I buy meat, I am influenced by…

Hawai'i	Strongly agree to Agree	Neutral	Disagree to Stronly disagree	Don't know
My previous experience	72%	18%	9%	1%
My hunger	48%	27%	25%	0%
My mood	44%	28%	27%	2%
My religion or cultural heritage	11%	18%	68%	2%

Mainland CBSA	Strongly agree to Agree	Neutral	Disagree to Stronly disagree	Don't know
My previous experience	80%	14%	6%	1%
My hunger	53%	27%	20%	1%
My mood	49%	25%	25%	1%
My religion or cultural heritage	23%	19%	57%	1%

Source: Beef Survey 2021

About half of the respondents are influenced by their hunger (Hawai‘i: 48%, Mainland: 53%). They buy meat because they want to fulfill their basic need and desire to eat. Slightly less than half of the respondents from each group are influenced by their mood, although about one in four respondents disagree with that. Interestingly, religion or cultural heritage does not appear to be an influential factor that affects the respondents when they buy meat. Over 57 percent of respondents from both groups disagree or strongly disagree that this factor will influence their meat buying decision.

Figure 35. Meat Purchase External Factors by CBSA

Question: When I buy meats, I am careful about the...

Hawai‘i	Strongly agree to Agree	Neutral	Disagree to Stronly disagree	Don't know
Health effects of the food product	66%	26%	8%	1%
Ethical production and distribution	51%	31%	15%	3%
Environmental sustainability	45%	40%	13%	2%
Integrity of the farmer	41%	39%	17%	3%
Mainland CBSA	**Strongly agree to Agree**	**Neutral**	**Disagree to Stronly disagree**	**Don't know**
Health effects of the food product	73%	21%	5%	1%
Ethical production and distribution	55%	32%	11%	2%
Environmental sustainability	52%	34%	12%	2%
Integrity of the farmer	48%	35%	14%	2%

Source: Beef Survey 2021

When the respondents were asked if they are careful about the health effects of the meat product, more than two-thirds of the Hawai‘i (66%) and mainland respondents (73%) strongly agree or agree with that. This suggests that the respondents are quite attentive to what they consume and the nutrition of meat products. Slightly more than half of the respondents from both groups also care about whether the production and distribution are ethical. Compared to the Hawai‘i respondents (45%), there is a higher proportion of mainland respondents (52%) who are careful about environmental sustainability when they buy meats. Meanwhile, no more than half of the respondents seem to be careful about the integrity of the farmer when they buy meats. Close to 35 to 40 percent of respondents reported being neutral to this external factor.

ESTIMATING FUTURE DEMAND

As mentioned earlier, an important goal of this study is to use the survey research results to forecast the potential demand for Hawai‘i grass-fed beef in the near future.

SMS created a model to determine the number of adult residents that would purchase Hawai‘i grass-fed beef at selected points in time. The model started with the respondent’s intention to buy Hawai‘i grass-fed beef in the future (see Figure 21, page 24 for a more complete discussion).

Table 1: Likelihood to Purchase Hawai‘i Grass-fed Beef in the Future by CBSA

	Hawaii	Mainland CBSA
Very likely	65%	58%
Somewhat likely	28%	33%
Somewhat unlikely	3%	6%
Very unlikely	2%	0%
Don’t know	1%	3%

Question: How likely would you be to buy Hawai‘i grass-fed beef in the future?

Next, the model included a predefined functional relationship to convert the stated intentions into estimates of actual purchase probabilities. This is called, Intent scale translation, and is a mathematical technique used by marketers to convert stated purchase intentions into purchase probabilities, that is, into an estimate of actual buying behavior. It takes survey data on consumers’ purchase intentions and converts it into actual purchase probabilities.

The model assigns values to each of these intention categories (likelihood to buy Hawai‘i grass-fed beef) that indicate the probability that the respondent would actually buy Hawai‘i grass-fed beef. This is an Intent Scale Translation - to take the survey data of stated purchase intentions and convert it into purchase probabilities, an estimate of actual buying behavior.

Very likely - **30%**
Somewhat likely **- 15%**
Somewhat unlikely - 0%
Very unlikely - 0%
Don’t know - 0%

With this simplified example, we expect that 25.5 percent [65%*50% + 28%*25% = 25.5%] of the respondents would actually buy Hawai‘i grass-fed beef in the future. We then applied this ratio to the number of adults residents in Hawai‘i from the U.S. Census to derive the expected demand.

For this forecast of future demand, we created three scenarios: 2 years, 5 years, and 7 years in the future. The scenarios were based on varying the probabilities of the Intent Scale Translation. The 2-year Scenario is illustrated above and assumes that the purchase probability is 30 percent for *very likely* and 15 percent for *somewhat likely*. The 5-year Scenario assumed that purchasing is 30 percent more than the 2-year Scenario, and the 7-year Scenario assumed intent to purchase was 70 percent higher.

Table 2: Intent Scale Translation (for those who previously purchased Hawaiian grass-fed beef)

Intent Scale	2-year	5-year	7-year
Very likely	30%	60%	100%
Somewhat likely	15%	30%	50%
Somewhat unlikely	0%	0%	0%
Very unlikely	0%	0%	0%
Don't know	0%	0%	0%

The model also considered different intent scale translations based on experience with Hawaiʻi grass-fed beef: Previously purchased and heard but not purchased. The research also indicated that on the Mainland, many heard of Hawaiʻi grass-fed beef but have not purchased it because of a lack of availability. Therefore, the intent scale translations were also adjusted lower for the Mainland residents who have not purchased Hawaiʻi grass-fed beef.

Finally, the intent scale translations for the 2-year Scenario were also set to mirror one-third of the people who said they have already purchased Hawaiʻi grass-fed beef. All other Scenarios were then adjusted accordingly.

A detailed explanation of how demand was calculated for each scenario appears in the Appendix.

Based on the forecast demand model, in the next two years, Hawaiʻi grass-fed beef would be bought by approximately 68,400 people in Hawaiʻi and approximately 306,000 people in major cities on the U.S. Mainland, annually.

Table 3: Future Demand for Hawaiʻi Grass-Fed Beef

City	2-year	5-year	7-year
Hawaiʻi	68,403	154,061	251,017
Mainland	306,289	692,292	1,264,560

Within seven years from now, Hawaiʻi grass-fed beef purchases should reach 251,000 people in Hawaiʻi and 1.26 million on the Mainland, annually.

SEGMENTATION ANALYSIS

Among Hawai'i residents who said they were likely to purchase Hawai'i grass-fed beef, we were able to identify three distinctive groupings.

The first grouping can be described as a young starter family, middle class but bringing in less than Hawai'i's median family income; married with one of the adults being Asian. They typically buy beef at the grocery store or warehouse store.

The second group is a more established family with a higher income.

The third is a mature couple with no children, not working. They will most likely will be Asian or White.

Number of Cases in each Cluster		Weighted	% of cases
Cluster	Young Starter Family	110,924	33%
	Established Higher Income Family	102,707	30%
	Mature Couple No Children	123,249	37%
Valid		336,880	100%

IDENTIFYING IMPORTANT FACTORS FOR LIKELIHOOD TO PURCHASE HAWAI'I GRASS-FED BEEF

To understand which extrinsic and intrinsic factors are the most important to the likelihood of purchasing Hawai'i grass-fed beef in the future, we can look at the intersection of the two questions of interest. Table 2 shows the percent of respondents who think each factor is very important to somewhat important and are very likely to somewhat likely to buy Hawai'i grass-fed beef.

The extrinsic factor that ranks the highest is the Natural label, that is, beef that has never been treated with antibiotics or added hormones. The second most important extrinsic factor is the Grass-fed label, which indicates that the cattle are fed 90% or more in the pasture, followed by the overall eating satisfaction. As equally important is the attribute of food safety. It seems that the respondents who are very likely or somewhat likely to buy Hawai'i grass-fed are very concerned about the naturality and safety of the beef products. Whether the beef is a branded product, Hawai'i-grown, being delivered fresh, or how the cattle are raised appear to be relatively less important to them.

Using the analogous strategy, we can see that the most important intrinsic factor to those who are likely to buy Hawai'i grass-fed beef in the future is the appearance of beef – color/texture. The taste of beef is the second most important intrinsic factor. It ranks only slightly after the appearance of beef. The third most important intrinsic factor is the cow's diet, followed by the tenderness of beef. It is worth mentioning that these respondents concern the least about whether the beef is well-marbled. Meanwhile, factors like strong meaty flavor, organic or hormone-free, and leaner beef are moderately important to these potential buyers.

Table 2: Likelihood of Purchasing Hawai'i Grass-fed Beef by Extrinsic and Intrinsic Factors

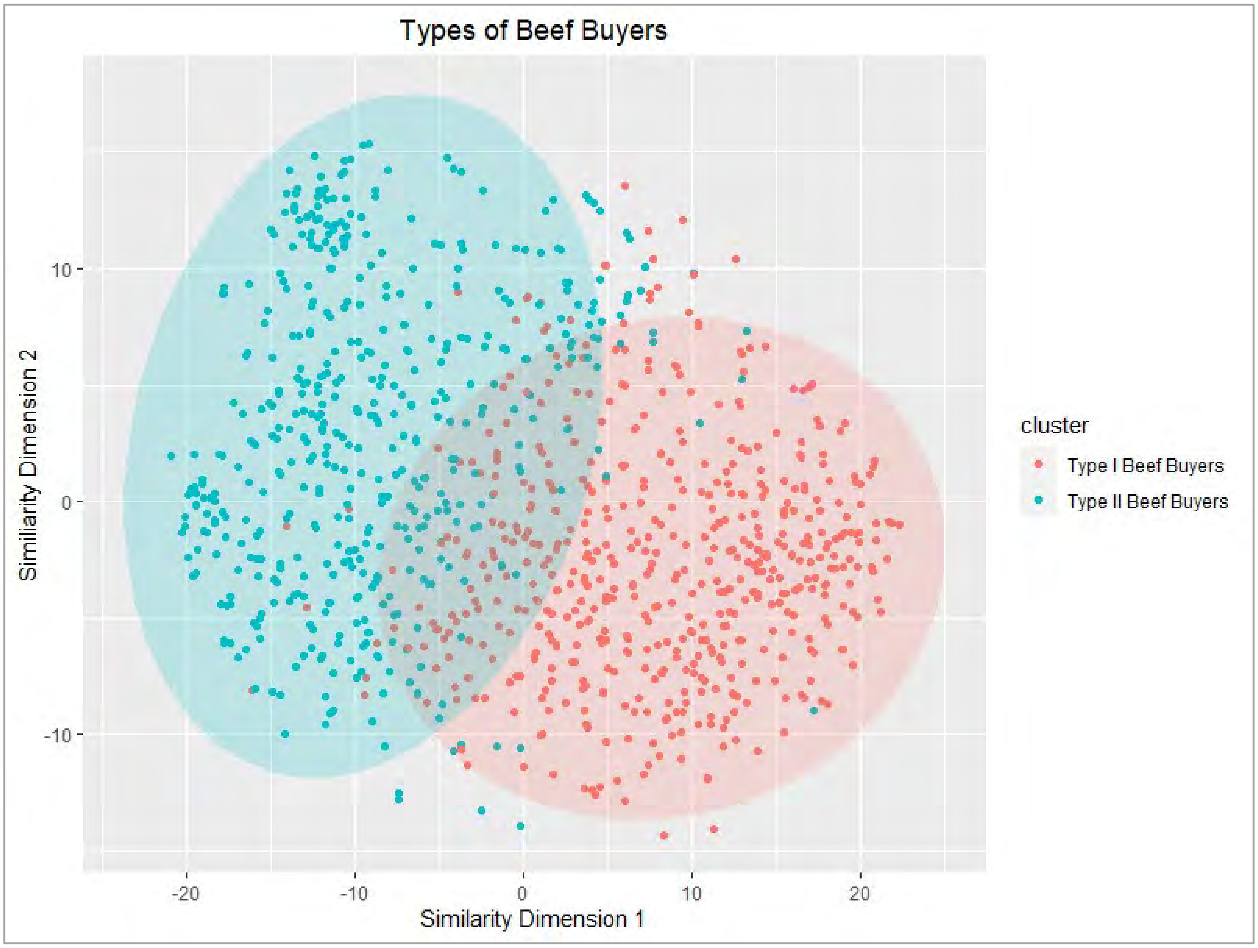
Rank	Extrinsic factors (Very important to somewhat important)	Very likely to Somewhat likely to buy Hawai'i grass-fed beef
1	Natural label - never been treated with antibiotics or added hormones	94.8%
2	Grass-fed label - fed 90% or more in pasture	94.7%
3	Overall eating satisfaction	94.6%
4	Food safety - knowing beef is wholesome, free of disease-causing agents	94.2%
5	Appearance of meat - color and texture	90.9%
6	Branded product (recognized label with Hawai'i and indicating specific producer)	89.6%
7	Hawai'i grown	89.1%
8	Meat delivered fresh, never frozen	88.8%
9	How and where the cattle are raised	87.9%
Rank	**Intrinsic factors (Very important to somewhat important)**	**Very likely to Somewhat likely to buy Hawai'i grass-fed beef**
1	Appearance – color/texture	93.9%
2	Taste	93.8%
3	Cow's diet	92.6%
4	Tenderness	90.7%
5	Strong meaty flavor	89.2%
6	Organic or hormone free	88.7%
7	Leaner/less fat	85.9%
8	Well-marbled/more fat	78.3%

Source: Beef Survey 2021

QUALITIES OF BEEF ANALYSIS

In this section, we analyze the groups of beef buyers based on the similarities of the buyers' preferences. The similarities were evaluated using a set of qualities of beef (i.e., the intrinsic and extrinsic factors of beef, and the order of importance during the beef purchase) covered in the previous section. The beef buyers with a high degree of homogeneity are grouped. Figure 35 shows that there are likely two groups of beef buyers in the beef market. For now, we will name these two groups of buyers as Type I and Type II beef buyers. We will further examine what these two groups of beef buyers represent by reviewing some of the qualities of beef.

Figure 35. Groups of Beef Buyers Based on Qualities of Beef



Source: Beef Survey 2021
Note: The labels and values on the x-axis and y-axis do not have any specific meaning. They are only used to visualize the types of buyers in terms of the qualities of beef in a lower dimension graph.

Table 3 presents the order of importance during the beef purchase by the groups of beef buyers. The values in the middle and the right column represent the average ranking of the associated beef attributes. The lower the value, the more important that attribute is.

As can be seen in Table 3, the beef attributes such as quality, grade of beef, visual appearance – color/texture, cut, lower fat content, local sourcing, and the brand received a higher ranking (lower values) among the Type I beef buyers relative to the Type II beef buyers. Among these

Table 3: Order of Importance of Beef Attributes During Beef Purchase by Groups of Beef Buyers

Order of importance during beef purchase (1 = Most important, 11 = Least important)	Type I Beef Buyers	Type II Beef Buyers
Quality	3.33	4.21
Grade of beef	4.04	5.48
Visual appearance – color/texture	5.39	5.64
Cut	5.47	5.48
Lower fat content	6.05	6.77
Value for the money	6.19	4.42
Local sourcing	6.95	8.75
Brand	6.99	7.99
Ease of preparation	7.02	6.93
Sales or discounts	7.23	5.28
Lower price	7.44	5.14

Source: Beef Survey 2021

attributes, the grade of beef, local sourcing, and the brand has the most notable differences between the two groups of buyers. Some of the attributes like cut, visual appearance – color/texture, and lower fat content, however, have scores that are quite close between the two groups of buyers.

In contrast, the Type II beef buyers ranked the value for the money, lower price, sales or discounts, and ease of preparation as the more important factors during the beef purchase. It is worth mentioning that three out of four of these attributes have a difference in value greater than 1.5 and all of them are related to the price and value of the beef products.

Figure 36 presents the importance of extrinsic factors of beef by the groups of beef buyers. The Type I beef buyers seem to value the extrinsic factors of beef to a much greater extent than the Type II beef buyers. In general, the Type I beef buyers are feeling “very important” to “moderately important” to the extrinsic factors, whereas most of the Type II beef buyers are seeing the extrinsic factors as “moderately important” to “neutral”.

For instance, approximately 83 percent of Type I beef buyers see food safety as very important, while the Type II beef buyers are more widespread in very important, moderately important, and neutral. The most substantial differences between the Type I and Type II beef buyers fall on the following extrinsic factors: (1) how and where the cattle are raised, (2) the beef is locally sourced, and (3) ethical production and distribution. Around 49 to 53 percent of Type II beef buyers are neutral to these factors. The Type I beef buyers are, on the other hand, quite concerned about these factors.

We move on to looking at the importance of intrinsic factors of beef. As in the case with the extrinsic factors, majority of the Type I beef buyers see the intrinsic factors of beef as "very important" to "moderately important". The Type I beef buyers who care about the tenderness of beef also care about the taste of the beef as well as their color and texture in a satisfying beef. Although some of the Type II beef buyers also see these as important factors, the proportion is not as substantial as the Type I beef buyers.

Figure 36: Importance of Extrinsic Factors of Beef by Groups of Beef Buyers

Types of Beef Buyers	Extrinsic Factors	Very important	Moderately important	Neutral	Low importance	Not important
Type I Beef Buyers	How and where the cattle are raised	42%	40%	14%	4%	0%
Type II Beef Buyers	How and where the cattle are raised	4%	19%	53%	13%	10%
Type I Beef Buyers	Food safety	83%	15%	2%	0%	0%
Type II Beef Buyers	Food safety	42%	33%	21%	1%	2%
Type I Beef Buyers	Natural label	61%	30%	8%	1%	0%
Type II Beef Buyers	Natural label	7%	33%	44%	10%	6%
Type I Beef Buyers	Locally sourced	41%	35%	18%	3%	2%
Type II Beef Buyers	Locally sourced	3%	18%	52%	15%	12%
Type I Beef Buyers	Appearance of meat - color/texture	76%	20%	2%	1%	0%
Type II Beef Buyers	Appearance of meat - color/texture	40%	36%	20%	3%	2%
Type I Beef Buyers	Branded product	36%	34%	22%	6%	2%
Type II Beef Buyers	Branded product	3%	22%	46%	18%	11%
Type I Beef Buyers	Meat delivered fresh, never frozen	58%	31%	9%	1%	1%
Type II Beef Buyers	Meat delivered fresh, never frozen	13%	35%	38%	8%	5%
Type I Beef Buyers	Organic	41%	32%	18%	4%	5%
Type II Beef Buyers	Organic	3%	17%	40%	21%	19%
Type I Beef Buyers	Ethical production and distribution	53%	33%	13%	1%	1%
Type II Beef Buyers	Ethical production and distribution	5%	27%	49%	11%	8%

Source: Beef Survey 2021

As high as 44 percent of them are neutral to the organic (or growth hormone fee) beef. This means that whether the beef is organic is not specifically important to them. The same is true for the cow's diet. Close to half of the Type II respondents are neutral to this intrinsic factor, whereas over 86 percent of Type I beef buyers see it as an important factor.

Based on the summary of these attributes, we can infer that the Type I beef buyers are most likely the quality driven beef customers. They do not only concern about the intrinsic values of beef such as the beef quality, the taste, and the texture, but they also concern about the extrinsic values like how and where the cattle were raised and whether they are organic. Prices and the values of money do not seem to be their first criteria when it comes to selecting and consuming beef. On the other hand, the Type II beef buyers are most likely the average or frugal spenders and consumers. They weigh the prices and the value of money more importantly than the Type I beef buyers when considering other factors. In addition, they do not care about the intrinsic and extrinsic factors of beef as much as the Type I beef buyers do.

Figure 37: Importance of Intrinsic Factors of Beef by Groups of Beef Buyers

Types of Beef Buyers	Intrinsic Factors	Very important	Moderately important	Neutral	Low importance	Not important
Type I Beef Buyers	Tenderness	70%	25%	5%	1%	0%
Type II Beef Buyers	Tenderness	32%	41%	22%	4%	1%
Type I Beef Buyers	Leaner/less fat	54%	33%	10%	3%	0%
Type II Beef Buyers	Leaner/less fat	15%	43%	31%	6%	5%
Type I Beef Buyers	Well-marbled/more fat	42%	34%	13%	8%	3%
Type II Beef Buyers	Well-marbled/more fat	10%	33%	43%	11%	3%
Type I Beef Buyers	Appearance – color/texture	74%	24%	2%	0%	0%
Type II Beef Buyers	Appearance – color/texture	34%	41%	19%	5%	1%
Type I Beef Buyers	Organic or hormone free	52%	33%	10%	2%	2%
Type II Beef Buyers	Organic or hormone free	4%	22%	44%	20%	10%
Type I Beef Buyers	Strong meaty flavor	49%	36%	14%	1%	0%
Type II Beef Buyers	Strong meaty flavor	13%	36%	42%	7%	2%
Type I Beef Buyers	Taste	83%	15%	1%	0%	0%
Type II Beef Buyers	Taste	51%	29%	15%	2%	2%
Type I Beef Buyers	Cow's diet	45%	41%	11%	2%	1%
Type II Beef Buyers	Cow's diet	2%	28%	49%	12%	9%

Source: Beef Survey 2021

IMPORTANCE OF ATTRIBUTES BY TYPES OF BEEF BUYERS

Besides looking at the attributes of beef by CBSA and the groups of beef buyers, it is also interesting to compare these attributes by the three types of beef buyers and see if they have different perspectives on these attributes.

Table 4. Order of Importance of Beef Attributes During Beef Purchase by Types of Beef Buyers

Order of Importance of Beef Attributes (1 = Most important, 11 = Least important)	Conventional Beef Buyers	Grass-fed Beef Buyers	Hawai'i Grass-fed Beef Buyers
Quality	3.80	3.61	3.72
Grade of beef	4.87	4.37	4.87
Lower fat content	6.33	6.51	5.92
Value for the money	4.96	5.82	5.92
Cut	5.36	5.55	6.04
Local sourcing	8.34	7.23	6.17
Brand	7.96	7.03	6.18
Visual appearance – color/texture	5.52	5.36	6.39
Ease of preparation	6.97	7.05	6.40
Sales or discounts	6.04	6.66	6.99
Lower price	5.99	6.87	7.40

Source: Beef Survey 2021

Note: Cells colored in red means that the specific attribute receives the highest ranking (lowest average values) across all three types of beef buyers; cells in green means it receives the lowest ranking (highest average values); cells in yellow means it receives the middle ranking.

Table 4 summarizes the three types of beef buyers: conventional beef buyers, grass-fed beef buyers, and Hawaiʻi grass-fed beef buyers by the beef attributes. The quality and the grade of beef are ranked relatively high by all three types of buyers. The Hawaiʻi grass-fed beef buyers ranked lower fat content, local sourcing, brand, and ease of preparation as the more important factors compared to the other two types of beef buyers. The grass-fed beef buyers, on the other hand, ranked the quality, grade of beef, and visual appearance – color/texture relatively higher than the other two types of beef buyers. The conventional beef buyers are slightly more price driven. They ranked the value for the money, cut, sales or discounts, and lower price to be the more important factors than the other two groups.

Table 5. Importance of Beef Intrinsic and Extrinsic Factors by Types of Beef Buyers

Beef Attributes:	Conventional Beef Buyers	Grass-fed Beef Buyers	Hawaiʻi Grass-fed Beef Buyers
Extrinsic Factors:			
Food safety	1.62	1.35	1.50
Appearance of meat - color and texture	1.68	1.43	1.51
Ethical production and distribution	2.56	1.88	1.54
Meat delivered fresh, never frozen	2.23	1.78	1.59
Natural label	2.38	1.68	1.66
Locally sourced	2.83	2.12	1.67
Organic	3.10	2.13	1.71
How and where the cattle are raised	2.77	1.93	1.74
Branded product	2.82	2.21	1.93
Intrinsic Factors:			
Taste	1.49	1.32	1.44
Appearance – color/texture	1.74	1.44	1.60
Organic or hormone free	2.79	1.85	1.64
Tenderness	1.75	1.53	1.65
Cow's diet	2.71	1.83	1.68
Strong meaty flavor	2.18	1.90	1.80
Well-marbled/more fat	2.42	2.12	1.81
Leaner/less fat	2.13	1.83	1.81

Source: Beef Survey 2021

Note: An average score of 1 – 1.99 = Very important to Moderately important; 2 – 2.99 = Moderately important to Neutral; 3 – 3.99 = Neutral to Low importance; 4 – 4.99 = Low importance to Not important.

The intrinsic and extrinsic factors of beef by the types of beef buyers are shown in Table 5. First, the food safety and the appearance of meat are the most important factors to all three types of beef buyers. They all have an average score between 1 to 1.99. Both the grass-fed and Hawaiʻi grass-fed beef buyers see the ethical production and distribution, fresh meat, natural label, as well as how and where the cattle are raised to be very important to moderately important factors. This, however, does not seem to be the case with the conventional beef buyers. Most of their average scores range between 2 to 2.99, which means that those extrinsic factors are only moderately important to neutral to them. The results also show that the Hawaiʻi grass-fed beef buyers are also quite concerned about locally sourced beef, organic beef, and branded products compared to the other two types of buyers.

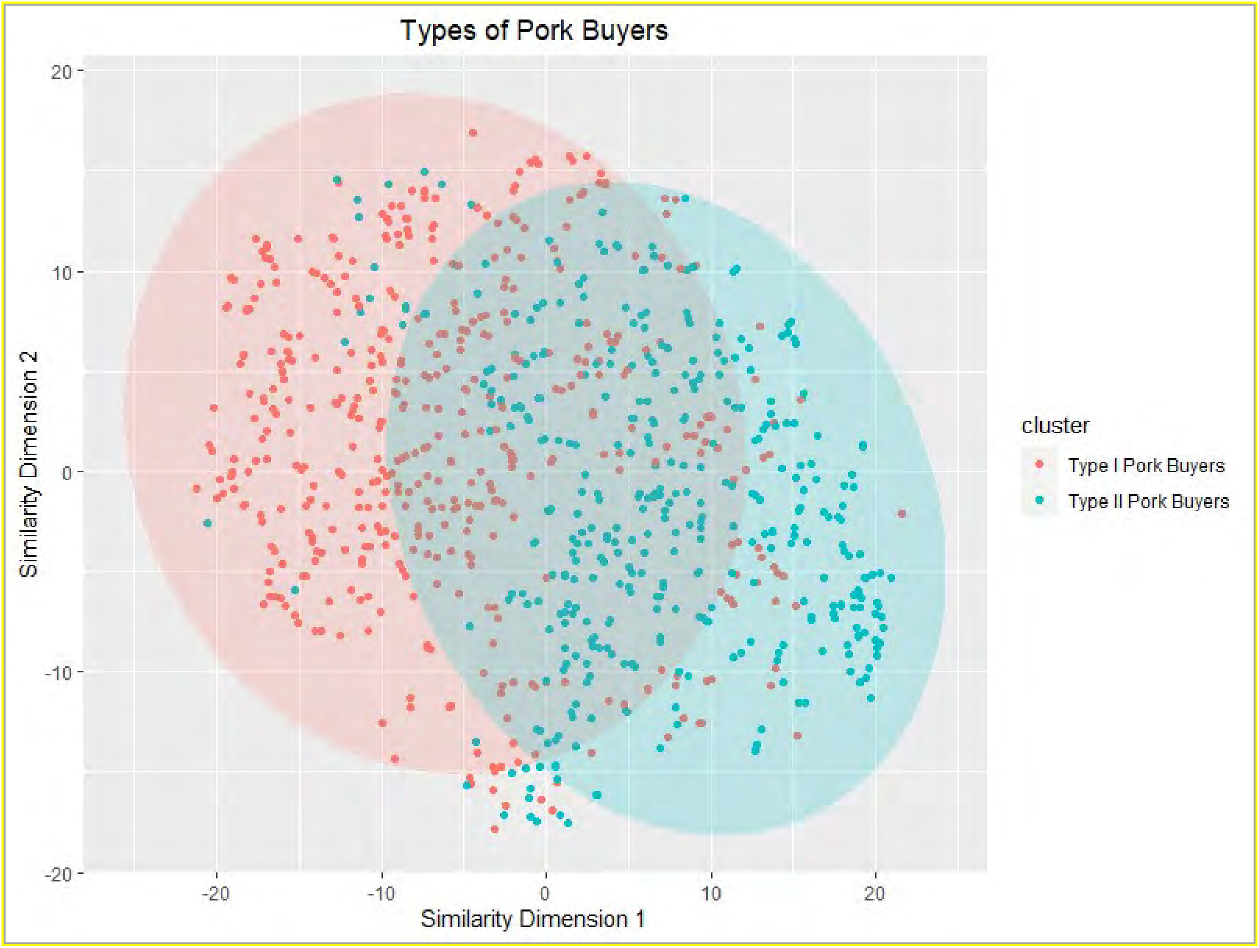
In terms of the intrinsic factors, the three types of beef buyers all considered the taste, appearance – color/texture, and tenderness of beef as the most important factors in a satisfying beef. Specifically, the grass-fed beef buyers value these intrinsic factors the most. Meanwhile, both the grass-fed and Hawaiʻi grass-fed beef buyers are concerned about the organic or hormone-free beef, cow's diet, strong meaty flavor, and beef with less fat. The conventional beef buyers, on the other hand, are feeling only moderately important to neutral on these factors.

In summary, the Hawaiʻi grass-fed beef buyers feel very important to moderately important to all of the extrinsic and intrinsic factors, followed by the grass-fed beef buyers who feel most of the factors are very important to moderately important. The conventional beef buyers concerned about these factors the least among all three types of beef buyers.

QUALITIES OF PORK ANALYSIS

As in the beef section, we will analyze the groups of pork buyers based on the patterns and the similarities of the buyers' preferences. As shown in Figure 38, there are likely two types of pork buyers in the pork market also, except that these two groups of pork buyers are not well separated as in the case with the beef buyers. The overlapping area between the two clusters represents the similar preferences between the two groups of pork buyers.

Figure 38. Types of Pork Buyers Based on Qualities of Pork



Source: Beef Survey 2021
Note: The labels and values on the x-axis and y-axis do not have any specific meaning. They are only used to visualize the types of buyers in terms of the qualities of pork in a lower dimension graph.

Table 6. Order of Importance of Pork Attributes During Pork Purchase by Types of Pork Buyers

Order of importance during pork purchase (1 = Most important, 11 = Least important)	**Type I Pork Buyers**	**Type II Pork Buyers**
Quality	4.04	3.39
Value for the money	4.35	6.55
Cut	5.31	4.68
Visual appearance – color/texture	5.31	4.84
Lower price	5.38	7.15
Sales or discounts	5.39	7.18
Grade of pork	5.96	4.72
Lower fat content	6.94	6.35
Ease of preparation	6.97	6.69
Brand	8.15	7.08
Local sourcing	8.23	7.38

Source: Beef Survey 2021

Again, we will start by looking at the order of importance of pork attributes during the pork purchase by the groups of pork buyers. The resulting patterns look quite similar to the order of importance of beef. Except for the value for the money, lower price, and sales or discounts, the Type II pork buyers gave a comparatively lower average score (i.e., higher ranking) to the remaining attributes such as quality, cut of pork, the grade of pork, visual appearance – color/texture, lower fat content, ease of preparation, brand, and local sourcing. The largest differences in attributes between the two groups of pork buyers are the value for the money, lower price, and sales or discounts. Each of these attributes has a difference of 1.7 to 2.2.

Figure 39: Importance of Extrinsic Factors of Pork by Types of Pork Buyers

Types of Pork Buyers	Extrinsic Factors	Very important	Moderately important	Neutral	Low importance	Not important
Type I Pork Buyers	How and where the pigs are raised	12%	21%	46%	12%	9%
Type II Pork Buyers	How and where the pigs are raised	42%	32%	20%	5%	1%
Type I Pork Buyers	Food safety	50%	27%	20%	2%	1%
Type II Pork Buyers	Food safety	79%	16%	3%	1%	0%
Type I Pork Buyers	Natural label	17%	27%	42%	9%	5%
Type II Pork Buyers	Natural label	56%	29%	11%	4%	0%
Type I Pork Buyers	Locally sourced	11%	17%	50%	14%	9%
Type II Pork Buyers	Locally sourced	36%	34%	24%	5%	1%
Type I Pork Buyers	Appearance of meat - color and texture	40%	37%	20%	2%	1%
Type II Pork Buyers	Appearance of meat - color and texture	71%	24%	5%	0%	0%
Type I Pork Buyers	Branded product	9%	22%	46%	13%	10%
Type II Pork Buyers	Branded product	32%	35%	26%	5%	1%
Type I Pork Buyers	Meat delivered fresh, never frozen	21%	33%	36%	6%	5%
Type II Pork Buyers	Meat delivered fresh, never frozen	54%	30%	14%	1%	0%
Type I Pork Buyers	Organic	9%	18%	42%	15%	15%
Type II Pork Buyers	Organic	36%	29%	22%	6%	7%
Type I Pork Buyers	Ethical production and distribution	16%	23%	47%	7%	7%
Type II Pork Buyers	Ethical production and distribution	47%	31%	17%	5%	1%

Source: Beef Survey 2021

Overall, the majority of Type II pork buyers are seeing the extrinsic factors as “very important” to “moderately important” to them. Some prominent attributes are the food safety and appearance of meat – color and texture. There are as many as 79 percent and 71 percent of them who see food safety and appearance of meat as very important factors compared to just 40 to 50 percent of Type I pork buyers, respectively. Attributes such as natural labels, meat being delivered fresh without frozen, as well as ethical production and distribution of pork are the next important factors considered by the Type II pork buyers.

In contrast to the Type II pork buyers, the Type I pork buyers are less concerned about these extrinsic factors as the distributions of importance are mostly centered between moderately important to neutral. Specifically, half of the Type II pork buyers are neutral to locally sourced pork. Approximately 46 to 47 percent of them also do not feel as important as to how and where the pigs are raised and whether the production and distribution of pork products are ethical.

Hence, the summary of attributes suggests that the Type II pork buyers are most likely quality-driven pork buyers. They ranked the quality types of attributes at the top when purchasing pork as well as valuing the extrinsic factors. Meanwhile, the Type I pork buyers are most likely the average or frugal spenders and consumers. They attempt to balance between the price and the value for the money with the extrinsic factors of pork. In other words, they may sacrifice some extrinsic factors that are less important to them in exchange for a lower price of the products.

SURVEY INSTRUMENT

BEEF CONSUMER SURVEY

Thank you for participating in this food consumption survey. All the information you provide will remain confidential.

S1 What is your residential zip code? |___||___||___||___||___|

[QUOTA: 200 HAWAII, 200 LOS ANGELES, 200 SAN FRANCISCO, 200 SEATTLE, 200 CHICAGO]

Q1 Please indicate whether you eat the following food products,
[IF YES FOR EACH PRODUCT], How many times per month do you eat...

<u>**Frequency of eating codes:**</u>

A. More than 5 times per week (almost daily)
B. 3-5 times a week
C. Once or twice a week
D. Once or twice a month
E. less than once a month

	Do you eat (Y/N)	How frequently
Beef		
Pork		
Chicken		
Fish		
Vegetables		
Fruit		
Dairy Products		

(IF NO FOR BEEF, SKIP TO Q19A.)

You have been randomly selected to answer questions about beef and personal consumption.

Q2 What cuts of beef do you buy often? *(SELECT ALL THAT APPLY)*

Ground beef .... O
Steak.. O
Roast or brisket .... O
Stew or cubed .... O
Sliced beef (e.g., teriyaki, stir-fry, fajitas, sandwich steak) O
Variety meats (e.g., heart, liver, kidney,
tongue, tripe, oxtail) .... O
Other:________________________________...... O

Q2a [PIPE IN CUTS SELECTED]
What percent of the time do you buy each of these cuts? [MUST ADD UP TO 100%]

Example:	**Ground Beef**	**50%**
	Steak	**20%**
	Stew or cubed	**30%**
	Total	**100%**

Q2b Please estimate how much you spend on beef per month? $|___||___||___||___|

Q3 Is there a specific brand of beef or any specific geographic region where beef is sourced that you prefer to buy?

Yes.. O
No [SKIP TO Q5] .... O

Q4 *(IF YES)* **Can you specify the brand or source of beef you prefer and why?**

Q5 Please rank the following attributes in order of importance when buying beef.

ROTATE	Most important
Lower price	O
Visual appeal – color/texture	O
Cut	O
Local sourcing	O
Brand	O
Ease of preparation	O
Quality	O
Lower fat content	O
Sales or discounts	O
Value for the money	O
Grade of beef	O
	Least Important

Q5a Please tell us how important the following attributes of beef are to you.

ROTATE	Not important 1	Low importance 2	Neutral 3	Moderately important 4	Very important 5
How and where the cattle are raised	O	O	O	O	O
Food safety - knowing beef is wholesome, free of disease-causing agents	O	O	O	O	O
Natural label - never been treated with antibiotics or added hormones	O	O	O	O	O
Locally sourced	O	O	O	O	O
Appearance of meat - color and texture	O	O	O	O	O
Branded product (recognized label indicating specific producer or ranch)	O	O	O	O	O
Meat delivered fresh, never frozen	O	O	O	O	O
Organic	O	O	O	O	O
Ethical production and distribution	O	O	O	O	O

Q6 What do you look for in a satisfying piece of beef?

ROTATE	Not important 1	Low importance 2	Neutral 3	Moderately important 4	Very important 5
Tenderness	O	O	O	O	O
Leaner/less fat	O	O	O	O	O
Well-marbled/more fat	O	O	O	O	O
Appearance – color/texture	O	O	O	O	O
Organic or hormone free	O	O	O	O	O
Strong meaty flavor	O	O	O	O	O
Taste	O	O	O	O	O
Cow's diet (grass-fed, grain fed, etc)	O	O	O	O	O

Q7 Which of the following types of beef do you usually purchase: *(CHECK ALL THAT APPLY)*

Grass-fed beef.. O
Corn or grain-fed beef.. O
Organic beef .... O
Local beef .... O
Dry-aged .... O
No preference... O
Other (specify): ______________________ .... O
Don't know .... O

[SKIP TO Q16 If Q7<> grass-fed beef]

Q8 In your own words, how would you describe the qualities of grass-fed beef.

Q12 ***(IF Q7=1)*** **How satisfied were you with the grass-fed beef?**

Very satisfied... O
Somewhat satisfied... O
Somewhat not satisfied... O
Very unsatisfied.. O

Q13 ***(IF Q7=1)*** **Have heard or purchased Hawai'i grass-fed beef?**

Yes, heard of it only.. O
Yes, purchased it.. O
No .... O

Q14 ***(IF Q13=2)*** **How satisfied were you with the Hawai'i grass fed beef?**

Very satisfied... O
Somewhat satisfied... O
Somewhat not satisfied... O
Very unsatisfied.. O

Q15 [IF Q13=q or 2] In your own words, how would you describe the qualities of Hawai'i grass fed beef?

Q10 Now comparing regular grass-fed beef to Hawai'i grass-fed beef, Please utilize the arrow to indicate which meat type would provide you with more satisfaction about a specific attribute? *(INDICATE PREFERENCE BY MOVING POINTER CLOSER TO THE BEEF TYPE THAT PROVIDES MORE SATISFACTION.)* ***(Note: This is a special type of question that works well on the web, but difficult to demonstrate on paper.)***

	Grass-fed beef	Hawai'i Grass-fed Beef
Flavor		
Color		
Tenderness		
Taste		
Appearance		
Smell		
Overall satisfaction		

Q16 ***(IF DID NOT PURCHASE GRASS FED BEEF)*** **In your own words, why have you not purchased grass-fed beef?**

____

____

Q17 How likely would you be to buy <u>Hawai'i</u> grass fed beef in the future?

Very likely .... O
Somewhat likely.. O
Somewhat unlikely... O
Very unlikely .... O
Don't know .... O

Q18 Why do you say that?

____

____

Q19 Please tell us how important the following attributes of Hawai'i grass fed beef are to you.

ROTATE	Not important 1	Low importance 2	Neutral 3	Moderately important 4	Very important 5
How and where the cattle are raised	O	O	O	O	O
Food safety - knowing beef is wholesome, free of disease-causing agents	O	O	O	O	O
Overall eating satisfaction	O	O	O	O	O
Natural label - never been treated with antibiotics or added hormones	O	O	O	O	O
Grass fed label - fed 90% or more in pasture	O	O	O	O	O
Hawai'i born and raised	O	O	O	O	O
Appearance of meat - color and texture	O	O	O	O	O
Branded product (recognized label with Hawai'i and indicating specific producer)	O	O	O	O	O
Meat delivered fresh, never frozen	O	O	O	O	O

(IF Q1 = NO FOR PORK, TERMINATE AND THANK. TRACK RESPONSES.)

Q2P What cuts of pork do you buy often? *(SELECT ALL THAT APPLY)*

Ground pork .... O
Loin roast/tenderloin .... O
Shoulder (butt).. O
Pork ribs.. O
Pork chops .... O
Pork belly .... O
Ham .... O
Other: ________________________ ...... O

Q2bP Please estimate how much do you spend on pork per month?

Q3P Is there a specific brand of pork or any specific geographic region where pork is sourced that you prefer to buy?

Yes.. O
No [SKIP TO Q6] .... O

Q5P Please rank the following attributes in order of importance when buying pork

ROTATE	Most important
Lower price	O
Visual appeal – color/texture	O
Cut	O
Local sourcing	O
Brand	O
Ease of preparation	O
Quality	O
Lower fat content	O
Sales or discounts	O
Value for the money	O
Grade of beef	O
	Least Important

Q19P Please tell us how important the following attributes of pork are to you.

ROTATE	Not important 1	Low importance 2	Neutral 3	Moderately important 4	Very important 5
How and where the cattle are raised	O	O	O	O	O
Food safety - knowing beef is wholesome, free of disease-causing agents	O	O	O	O	O
Natural label - never been treated with antibiotics or added hormones	O	O	O	O	O
Locally sourced	O	O	O	O	O
Appearance of meat - color and texture	O	O	O	O	O
Branded product (recognized label indicating specific producer or ranch)	O	O	O	O	O
Meat delivered fresh, never frozen	O	O	O	O	O
Organic	O	O	O	O	O
Ethical production and distribution	O	O	O	O	O

Q20 Are you one of the main grocery shoppers in your household?

Yes...O
No..O

Q20a Where do you typically buy beef for you and your household?

Grocery store/supermarket ....O
Warehouse store (Costco, Sam's Club) ....O
Butcher shop ....O
Specialty gourmet or organic store ....O
Mail-order ....O
Other [SPECIFY] ....O

Q20b When I buy food products, I am influenced by…[5-point Strongly Agree to Strongly Disagree]

ROTATE	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
	1	2	3	4	5
My mood	O	O	O	O	O
My hunger	O	O	O	O	O
My religion or cultural heritage	O	O	O	O	O
My previous experience	O	O	O	O	O
Mail-order	O	O	O	O	O
Other [SPECIFY]	O	O	O	O	O

Q20c When I buy food products, I am careful about the…[5-point Strongly Agree to Strongly Disagree]

ROTATE	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
	1	2	3	4	5
Health effects of the food product	O	O	O	O	O
Integrity of the farmer	O	O	O	O	O
Environmental sustainability	O	O	O	O	O
Ethical production and distribution	O	O	O	O	O

Demographics

Q21 What was your age on your last birthday?

|___||___| years old

Q22 Including yourself, how many people live in your household?

|___||___|

Q22a Of the XX people in your household, how many are under the age of 18?

|___||___|

Q23 How many years have you lived in Hawai'i?

Less than one year.......O
One to four years.......O
Five to nine years.......O
10 to 19 years.......O
20 years or more.......O
Born and raised here.......O
Don't know.......O
Refused.......O

Q24 Could you tell me approximately the total annual income of your household in 2020?

Less than $15,000.......O
$15,000 but less than $25,000.......O
$25,000 but less than $35,000.......O
$35,000 but less than $50,000.......O
$50,000 but less than $75,000.......O
$75,000 but less than $100,000.......O
$100,000 but less than $200,000.......O
$200,000 and over.......O
Don't know / Refused.......O

Q25 What is your employment status?

- Employed full time (20+ hours per week) .... O
- Employed part time (1-19 hours per week).......... O
- Not employed, looking for work .... O
- Not employed, not looking for work .... O
- Retired .... O
- Homemaker... O
- Student.. O
- Other (specify): ______________________ O
- Don't know / Refused... O

Q26 What was the highest education level you completed?

- Less than high school... O
- High school graduate.. O
- Business/Trade school .... O
- Some college.. O
- College graduate/Post graduate......................... O
- Don't know .... O
- Refused... O

Q27 Could you tell me your marital status?

- Single, never married.. O
- Married .... O
- Living with Partner .... O
- Separated/Divorced... O
- Widowed .... O
- Prefer not to answer .... O

Q28 Which background do you identify with most?

- American Indian or Alaska Native .... O
- Asian .... O
- Black or African American.................................. O
- Native Hawaiian or Other Pacific Islander .... O
- White .... O
- Other (Please specify) .... O
- Prefer not to answer .... O

Q29 What is your gender?

- Male.. O
- Female .... O
- Gender, non-conforming .... O
- Prefer not to answer .... O

APPENDIX

FORECAST OF DEMAND AND INTENT SCALE TRANSLATION

Intent scale translation

Intent scale translation is a mathematical technique used by marketers to convert stated purchase intentions into purchase probabilities, that is, into an estimate of actual buying behavior. It takes survey data on consumers purchase intentions and converts it into actual purchase probabilities.

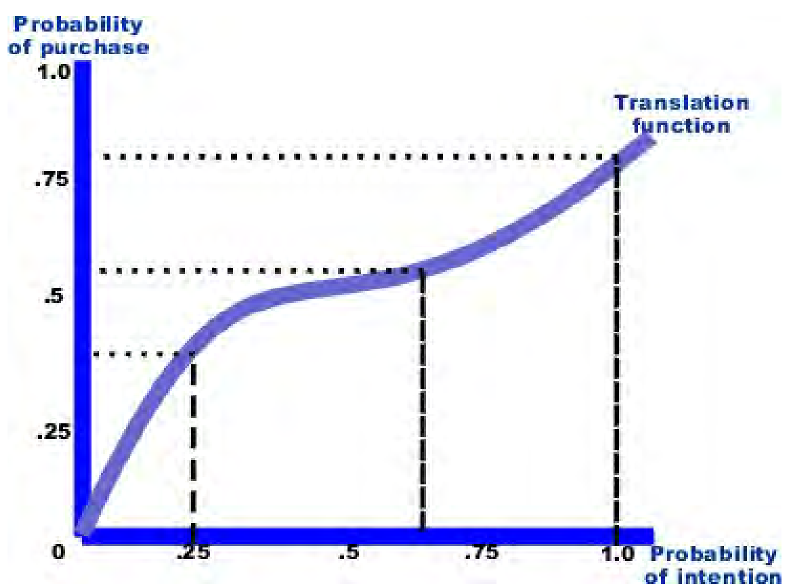
A survey might ask a question using a five-point scale such as:

Which is most true about product X?
___ I definitely would use product X
___ I probably would use product X
___ I might use product X
___ I probably would not use product X
___ I definitely would not use product X

A marketing researcher will first assign numerical values to these intention categories. If the numbers range from zero to one, they can be thought of as intent probabilities. This is a typical example:

definitely -> .99
probably -> .75
maybe -> .5
probably not -> .25
definitely not -> .01

Next, the researcher uses a predefined functional relationship to convert the stated intentions into estimates of actual purchase probabilities. The diagram that follows illustrates one such translation function. If a survey respondent were to choose a response of “definitely” and an intent probability of .99 was assigned to that category, then the actual probability of purchase could be read off the vertical axis. The translation function gives a value of about .8, indicating the specifiers of the function feel that not all people that claim they definitely intend to purchase will actually purchase.



Intent Translation

If a survey respondent were to choose a response of "probably not" and an intent probability of .25 was assigned to that category, then the actual probability of purchase could be read off the vertical axis as .35, indicating the specifiers of the function feel that some people that claim they probably will not purchase will actually purchase.

Forecast of Demand

The table below shows an example of how the demand forecast was calculated for the **Hawai'i Market.** Each of the steps in the calculations were indicated by a letter and was individually addressed below.

Table 4: Steps to Calculating Demand (Hawaii Market Only)

Hawai'i Market					
STEP	**Survey Question**	**Response from Survey**	**2-year**	**5-year**	**7-year**
A	How likely would you be to buy Hawai'i grass fed beef in the future?	Very likely / Somewhat likely	Very likely / Somewhat likely	Very likely / Somewhat likely	Very likely / Somewhat likely
B	Have you heard or purchased Hawai'i grass-fed beef? (Hawai'i Residents)				
	Yes, purchased it	75%/19%			
	Yes, heard of it only	45%/45%			
C	Intent Scale				
	Yes, purchased it		40%/20%	70%/40%	100%/50%
	Yes, heard of it only		15%/0%	30%/15%	45%/30%
D	Expected adult residents annually				
	Yes, purchased it		79,701	141,736	199,252
	Yes, heard of it only		8,627	25,882	43,137
E	**Total Forecast Demand annually**		**88,328**	**167,618**	**242,389**

For the estimation of demand, we needed to determine the number of adult residents that would actually buy Hawai'i grass-fed beef at any given time.

STEP A: We started with the respondent's intention to buy Hawai'i grass-fed beef in the future (Question 20)

STEP B: Then we looked at the respondent's awareness of Hawai'i grass-fed beef (Question 15)

20. How likely would you be to buy Hawai'i grass fed beef in the future?

Table 5: : Likelihood to Buy Hawaii Grass-fed Beef by Awareness of Hawaii Grass-Fed Bee (Hawai'i Respondents only)

			Have you heard or purchased Hawai'i grass-fed beef?							
			Yes, heard of it only		Yes, purchased it		No		Total	
			Count	Column N %	Count	Column N %	Count	Column N %	Count	Column N %
Hawaii	How likely would you be to buy Hawai'i grass fed beef in the future?	Very likely	57,516	45.2%	176,657	75.4%		0.0%	234,173	64.8%
		Somewhat likely	57,516	45.2%	45,191	19.3%	-	0.0%	102,707	28.4%
		Somewhat unlikely	8,217	6.5%	4,108	1.8%	-	0.0%	12,325	3.4%
		Very unlikely	4,108	3.2%	4,108	1.8%	-	0.0%	8,217	2.3%
		Don't know	-	0.0%	4,108	1.8%	-	0.0%	4,108	1.1%
		Total	127,357	100.0%	234,173	100.0%	28,758	0.0%	361,530	100.0%

Count: weighted to adult population in designated cities

Extrapolating to Adult Market Size (Count)

"Per 100 respondents" is a fairly difficult concept to grasp. Therefore, we apply the demand model's market penetration percentages to real-world numbers in order to make the data easier to understand and use. Specifically, the percentages are applied to the number of persons in each market segment (Hawai'i and U.S. Mainland). This is done through SPSS using the weighting scheme mentioned in the methodology section of the report.

STEP C: Then we assigned values to each of these intention categories (likelihood to buy) that indicate the probability that the respondent would actually buy Hawai'i grass-fed beef. This is an Intent Scale Translation - to take the survey data of stated purchase intentions and convert it into purchase probabilities, an estimate of actual buying behavior.

For this analysis, we actually created three different intent scale translations to form three demand scenarios: 2-year, 5-year, 7-year.

Table 6: Intent Scale Translation - Previously purchased

Yes, purchased it

Intent Scale	2 year	5 year	7 year
Very Likely	40%	70%	100%
Somewhat Likely	20%	40%	50%
Somewhat Unlikely	0%	0%	0%
Very Unlikely	0%	0%	0%
Don't know	0%	0%	0%

We also created a different set of scales for those who had previously bought Hawai'i grass-fed beef and those who only heard of Hawai'i grass-fed beef. The survey responses indicated that one of the barriers to purchasing Hawai'i grass-fed beef was the availability in market. Therefore, we assumed that conversion for these respondents would progress at a slower rate.

Table 7: Intent Scale Translation – Heard, But Not Purchased

Yes, heard of it only

Intent Scale	2 year	5 year	7 year
Very Likely	15%	30%	45%
Somewhat Likely	0%	15%	30%
Somewhat Unlikely	0%	0%	0%
Very Unlikely	0%	0%	0%
Don't know	0%	0%	0%

STEP D: In the next step, we conduct the translation function. In other words, we multiplied the number of respondents likely to buy with the percentage on the intent scale translations. We first conduct the translation on respondents who actually purchased Hawai'i grass-fed beef in the past, using the intent scale translations from Table 3.

Table 8: Calculation of Actual Purchase of Hawai‘i Grass-fed Beef (Previously Purchased)

Hawai‘i Respondents that Purchased Hawai‘i Grass fed Beef			2 Year Scenario		
			Likelihood to Buy	**Intent Scale Translation**	**% of population that will buy in 2 years**
Hawai‘i	How likely would you be to buy Hawai‘i grass-fed beef in the future?	Very likely	176,657	40%	70,663
		Somewhat likely	45191	20%	9,038
		Somewhat unlikely	4108	0	0
		Very unlikely	4108	0	0
		Don't know	4108	0	0
		Total	234,173		79,701

Then, we do the translation function again on those who have heard of Hawai‘i grass-fed beef, using the intent scale translations values from Table 4.

Table 9: Calculation of Actual Purchase of Hawai‘i Grass-fed Beef (Heard, But Not Purchased)

Hawai‘i Respondents that Purchased Hawai‘i Grass fed Beef			2 Year Scenario		
			Likelihood to Buy	**Intent Scale Translation**	**% of population that will buy in 2 years**
Hawai‘i	How likely would you be to buy Hawai‘i grass-fed beef in the future?	Very likely	57,516	15%	8,627
		Somewhat likely	57516	0%	0
		Somewhat unlikely	8217	0%	0
		Very unlikely	4108	0%	0
		Don't know	0	0%	0
		Total	234,173		8,627

STEP E: The totals from Table 5 and Table 6 are added together to determine the expect number of adult Hawai‘i residents that would buy Hawai‘i grass-fed beef two years from now. The translation function is then conducted for each time interval scenario: 2 Year, 5 Year and 7 Year.

Mainland Market

The forecast of demand on the mainland is conducted in the exact same way. The survey data provided the stated likelihood that residents would buy Hawaiʻi grass-fed beef in the future.

Table 10: : Likelihood to Buy Hawaii Grass-fed Beef by Awareness of Hawaii Grass-Fed Bee (Mainland Respondents only)

		Have you heard or purchased Hawaiʻi grass-fed beef?							
		Yes, heard of it only		Yes, purchased it		No		Total	
		Count	Column N %	Count	Column N %	Count	Column N %	Count	Column N %
How likely would you be to buy Hawaiʻi grass fed beef in the future?	Very likely	1,608,873	58.2%	504,338	57.1%		0.0%	2,113,211	58.0%
	Somewhat likely	908,915	32.9%	282,446	32.0%	-	0.0%	1,191,361	32.7%
	Somewhat unlikely	134,737	4.9%	84,806	9.6%	-	0.0%	219,543	6.0%
	Very unlikely	-	0.0%	11,160	1.3%	-	0.0%	11,160	.3%
	Don't know	109,836	4.0%	-	0.0%	-	0.0%	109,836	3.0%
	Total	2,762,361	100.0%	882,749	100.0%	4,943,656	0.0%	3,645,111	100.0%

Count: weighted to adult population in designated cities

The intent scale translation for those who previously purchased Hawaiʻi grass-fed beef remained the same as used in the Hawaiʻi example, but the Intent Scale Translation for Heard, But Not Purchased was different.

As mentioned earlier, the survey responses indicated that one of the barriers to purchasing Hawaiʻi grass-fed beef was the availability in market. We assumed that increasing availability in these large mainland markets would progress at an even slower rate than the Hawaiʻi market.

Table 11: Intent Scale Translation – Heard, But Not Purchased - Mainland

Yes, heard of it only

Intent Scale	2 year	5 year	7 year
Very Likely	7%	15%	25%
Somewhat Likely	0%	7%	15%
Somewhat Unlikely	0%	0%	0%
Very Unlikely	0%	0%	0%
Don't know	0%	0%	0%

Table 12: Forecast of Demand by Scenario and Region

		2-year	5-year	7-year
Hawai'i	Yes, purchased it	79,791	141,736	199,252
	Yes, heard of it only	8,627	25,882	43,137
	Total	88,328	167,618	242,389
Mainland	Yes, purchased it	258,224	466,015	645,561
	Yes, heard of it only	112,621	304,955	538,556
	Total	370,845	770,970	1,184,117