SCALABLE AND REPLICABLE LIVESTOCK HARVESTING FACILITY, STATEWIDE

VOLUME I
MASTER PLAN AND FEASIBILITY ANALYSIS

DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESOURCE MANAGEMENT DIVISION

IN COOPERATION WITH
HAWAIʻI CATTLEMEN'S COUNCIL, INC.

OCTOBER 2022

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PREPARED FOR
STATE OF HAWAI‘I
DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESOURCE MANAGEMENT DIVISION

IN COOPERATION WITH
HAWAI‘I CATTLEMEN’S COUNCIL, INC.

PROJECT TEAM

EKNA Services, Inc.
Amalgamated Endeavors, Inc.
Community Planning and Engineering, Inc.
Coffman Engineers, Inc.
Dale R. Woerner, Ph.D.
ECS, Inc.
Food and Livestock Planning, Inc.
J. Uno & Associates, Inc
Paul Kikuchi, LLC.
RWG Design Services
SMS Research
Structural Hawaii, Inc.

SUMMARY AND CONCLUSIONS

In 2019, Hawai‘i Department of Agriculture and Hawai‘i Cattlemen’s Council, Inc. embarked on a feasibility study and master plan project for the establishment of livestock harvesting facility(ies) in the state of Hawai‘i. The project included the design of a scalable plant that a third party could adapt to a parcel and build a future processing facility. The feasibility study, master plan and design may be used as a marketing tool to attract investors and future construction of a livestock harvesting facility in Hawai‘i.

The timing of the study coincided with the coronavirus pandemic, which created production and supply chain delays and shortages. The pandemic highlighted our dependency on imports, as statistics indicate that over 90% (ninety percent) of our commodities and food are imported. The development of a Hawai‘i-grown and -harvested livestock system would increase Hawai‘i’s food security. Therefore, the project has the following goals:

- Create a facility model that enables the sustainability of Hawai‘i’s beef industry, as well as addresses the economic, social and environmental impacts for the potential livestock harvesting facility.

- Create a marketing tool to attract investors for future construction of a livestock harvesting facility in Hawai‘i.

DATA COLLECTION AND ANALYSIS

The findings were based on information gathered about the livestock industry and consumer preferences in Hawai‘i. The data was obtained through interviews of ranchers, harvesting facility operators, food wholesalers and consumers (residents, Mainland residents and tourists) about the livestock industry in Hawai‘i.

In addition, research was conducted on consumer meat preferences, demand and opinions on grass-fed beef. University of Hawai‘i research and previous investigations indicate that market penetration for Hawai‘i-raised beef will increase if the issue of meat tenderness is addressed. The project’s data collection also revealed that one of the main limitations in Hawai‘i’s harvesting industry is a lack of refrigerated storage space. One other issue highlighted by smaller ranches was limited access to harvesting resources for their livestock.

Based on the analysis, Hawai‘i’s livestock harvesting industry is dominated by the harvesting of cattle for beef products, with swine harvesting for dressed carcasses, a far second. There are smaller harvesting quantities of sheep, goats and axis deer dependent in specific areas of the state. Hawai‘i grass-fed beef has a seven to 7%-9% (seven to nine percent) market infiltration rate in the statewide commercial beef market. The Hawai‘i raised and commercially harvested

pork (swine) market infiltration was estimated to be less than one percent (<1%). However, it should be noted that grey market-harvested pork (consumer purchase harvested swine directly from the rancher) has a significantly higher market penetration of approximately 5% (five percent). If grey market harvesting is shifted to commercial harvesting, the quantity of livestock commercially harvested would significantly increase.

CONCEPT DEVELOPMENT

The information and analysis provided a range of harvesting capacities to meet existing and forecasted livestock harvest demand in the state and by county. To achieve the scalability goal, design concepts placed an emphasis on maintaining a similar livestock processing scheme throughout the facility, independent of size. The common scheme provides common elements in the design and provides for a layout that allows for expansion to meet the design harvest capacity.

The scalability aspect is proven by using two cattle processing rates, which are indicative of the facility size range within the state. The two processing rates chosen were 20 animal units/day (AU/day) and 70 AU/day, representing a smaller and larger facility. At 20 AU/day, the facility processes 5,000 AU/year, while at 70 AU/day, the facility has the capacity to process 18,000 AU/year. However, due to the labor shortage for butchers and cutters the facility would initially process 10,000 AU/year using a limited work schedule.

DESIGN

The design parameters were based on the harvest size of the cattle and on market penetration into the Hawai‘i beef market. The average live weight of the cattle was 1,095 pounds. The study presents a preliminary design for a 70 AU/day facility, which includes on-site disposal subsystems for waste and wastewater. To provide flexibility in marketing and a consumer base, the facility was also designed to meet various standards such as USDA, British Retail Consortium (BRC), and Occupational Safety and Health Administration (OSHA) requirements.

The designed harvesting building has a footprint of 19,600 square feet, with a total site area of 25 acres. The design addresses the consumer’s beef tenderness issue by including a wet-aging refrigerated storage system. To increase refrigerated storage, additional refrigerated space and expansion capacity is included for dressed carcasses and finished products. The preliminary design is not site specific and the design drawings are presented in Volume II of the study. The construction cost for the facility is $51 million ($51,000,000), which is based on an unconstrained budget.

FINANCIAL FEASIBILITY

The feasibility study considers the sustainability of the livestock industry as a system and not standalone entities or parts. The system needs to consider the cost of maintaining pasture, fodder and feed, as well as providing a marketplace for the finished product at a reasonable price to consumers. The feasibility for the harvesting facility must provide a sustainable income to the rancher to maintain a consistent flow of quality livestock over the long term.

Currently, Hawai‘i’s beef industry ships the majority of calves to the Mainland to grow before they are harvested. The business model of the new harvesting facility must change the current calf-export model to a calf-to-harvest model. The change to a calf-to-harvest model will change pasture use, as the cattle will take 18 months or more to reach harvesting weight. Therefore, the longer pasture time changes the revenue stream for the ranchers and the carrying capacity of the pasture. Based on the pasture acreage available and type of pasture, it is estimated that current pasture lands can produce a low estimate of 33,188 cattle/year to a high estimate of 55,393 cattle/year. Given these estimates, the quantity of cattle to be processed at the proposed 70 AU/day rate is possible.

The new harvesting facility will need to compete with existing harvesting facilities to buy the cattle from ranchers and sell the finished product to wholesalers. These two variables, 1) cost of goods sold as stated above and 2) price to wholesalers, are significant factors attributing to the feasibility or profitability of the facility. In addition, the feasibility also considers the debt service and operating costs of the facility, which are less variable over time.

The difference between these two prices needs to provide the harvesting facility with adequate revenue to cover costs to construct the facility, lease or buy the land area required, reinvest into the facility, operate the facility and provide benefits to the investors. The financial feasibility conducted shows that 70 AU/day, with an annual processing capacity of 10,000 AU/year, may have a positive return on investment, using cost for goods sold and wholesale pricing based on the data collected. However, these two prices are dynamic and can be affected by environmental conditions, global pressures, local economics, consumer demand, etc.

The financial analysis showed that a 20 AU/day facility has a negative ROI, while a 70 AU/day facility operating at 40 AU/day capacity will have a marginally positive ROI. As production reaches a 70 AU/day capacity, the ROI increases to 15.25, with debt services. The ROI without debt services as production reaches 70 AU/day is 25.64, and the plant profitability is 29.57.

The study provides initial data collection for investors who will need to perform their due diligence for such a project. The investor will need to seek out a market before deciding on which island the facility will be constructed, selecting a site, and determining the economic viability on that island. The island ranching system will need to determine if the ranchers can supply the required AU at a consistent capacity and quality. The investor will also need to determine the harvesting capacity and species that will be harvested at the facility. In addition, the owner will need to contend with the issue of providing a harvesting time for smaller ranches, which may depend on issues such as the facility’s business model, type of cattle, beef quality, quantity, etc.

BRANDING AND MARKETING

The survey of consumers found that the reasons for selecting beef in the market differs when comparing Hawai‘i versus Mainland consumers. In Hawai‘i, the top reasons for selecting a specific brand or source of beef included, in this order: 1) grass-fed, 2) Hawai‘i (locally) grown, 3) good quality and 4) good growing environment, with good price, flavor and freshness rounding out the list. To maintain or increase market penetration, strong branding and marketing strategies must be incorporated into the livestock industry and for the harvesting facility.

The study proposes that Hawai‘i Cattlemen’s Council, Inc. or a similar livestock industry organization register **“**Hawai‘i Grass-fed Beef,**”** as well as the specific Seal of Assurance wording and trademark. For this trademark, the registering organization would need to identify the criteria for products that use the trademark. It is important to ensure that once the product is purchased, consumers will taste the quality and buy it again. Building awareness of what the brand and trademark conveys should also be managed by the registering organization.

FOOD SECURITY AND SUSTAINABILITY

The facility will provide for increased production of Hawai‘i-raised grass-fed beef to meet or exceed the existing market penetration and forecast growth. The development will provide long-term availability of fresh livestock finished products for the state. With global factors and climate change, the traditional sources of imported (into Hawai‘i) agricultural products will be impacted and the out-of-state suppliers may not be able to supply Hawai‘i with current products and/or with adequate quantities. The incorporation of wet-aging and increased refrigerated storage will provide a tender, quality product and allow for consistent supply of Hawai‘i-grown finished products to meet consumer demand. The increase in cost-effective Hawai‘i-grown and -finished agricultural products will increase Hawai‘i’s food security in the long-term.

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VOLUME II

(under separate cover)

SCALABLE AND REPLICABLE LIVESTOCK HARVESTING FACILITY, STATEWIDE

SIXTY PERCENT DESIGN DRAWINGS
70 AU/DAY LIVESTOCK HARVESTING FACILITY
(FOR PLANNING PURPOSES ONLY, NOT FOR CONSTRUCTION)

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CHAPTER 1
INTRODUCTION

This project was funded by the Hawai'i Department of Agriculture (HDOA) – Agricultural Resource Management Division (ARMD) and performed in collaboration with Hawai'i Cattlemen's Council, Inc. (HCC). HDOA and HCC are interested in (1) identifying opportunities to expand the capacity of livestock harvesting in Hawai'i and (2) assessing the future market potential for Hawai'i-grown livestock commodities.

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. Pigs not only were a source of food but also were involved in religious and ceremonial functions, and furnished material for making implements and ornaments. From the time of early imports made by Captain James Cook and George Vancouver during the late 1700s to the present day, the livestock industry continually expanded in scope and economic importance.

It is generally accepted that approximately 85%-90% (eighty-five to ninety percent) of food consumed in Hawai'i is imported from the continental United States 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, making imported food, feed and fodder costly. Imported goods are transported via airplane or ship over 2,000 miles. In the event of a catastrophic disaster such as a hurricane, tsunami and/or global pandemic in which 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.

In addition, expanding local production could contribute to the local economy through creation of jobs, taxes, and support of secondary businesses. It will also contribute to enhancing sustainability and food security by producing more food for Hawai'i's de facto population. In addition, climate change scenarios will alter production quantities and availability of imported food from agricultural areas outside of Hawai'i.

1.1 GOALS AND OBJECTIVES

The overarching commitment of Hawai'i's beef industry is to provide wholesome food to its community that is safe, secure, and sustainable. Recently, and maybe more so during the recent coronavirus pandemic, there has been an increasing consumer demand for locally sourced food and renewed focus on expanding local beef production. Several private labels have emerged over

[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.

the last 10 years, raising the flavor and tenderness profile for local beef, further driving demand. Therefore, the groundwork for expansion has been set.

As a result, the need to provide adequate facilities to enhance or support the livestock industry became apparent. The economic benefit of efficiencies achieved with consolidation should be balanced with the unique challenges Hawai'i's beef industry faces. These challenges include:

- The vulnerability of inter-island transportation of perishable goods and/or live animals as it relates to food security and safety, animal welfare, affordable shipping rates, labor disputes and equipment failure;
- The need to develop and maintain a diversified economic base and skilled labor force on outer islands;
- Limited competitive markets; and
- Quasi-public responsibility of state-owned food processing facilities.

Other challenges previously identified in previous studies include:

- Flexible marketing – direct sale vs. retained ownership;
- Increased capacity/access for all producers to harvest, process and market;
- Growth of market share through "coopetition" vs. direct competition;
- Compliance with regulatory planning concepts and concerns, especially as related to environmental issues;
- Preservation of the integrity of locally labeled beef; and
- Opportunity to expand locally branded products.

Our producers (ranchers)[4] continue to provide high-quality grass-fed beef year-round, which serves a loyal, sustainability-minded customer base that increasingly want to know where their food comes from. As part of the objectives and goals, the industry also supports the concept that allows each island to maintain autonomy over its beef production from gate to plate.

Therefore, to provide livestock harvesting to support the industry's commitment to food security, the stakeholders (HDOA-ARMD and HCC) embarked on this study for a scalable and replicable livestock harvesting facility. The scalability will allow this facility to hopefully meet the harvesting requirements for most of the islands. The following goals and objectives were established for this study, and will be used as guidelines in the decision-making, analysis and report generation.

1.1.1 Goals

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

- Create a marketing tool to attract investors for future construction of a livestock harvesting facility in Hawai'i.

[4] In this document livestock producers and ranchers are used interchangeably.

1.1.2 Objectives

Based on the two goals above, specific objectives were developed to facilitate the development of the project. The objectives are as follows:

- Determine the livestock capacity in Hawai‘i.
- Determine the existing and future market potential for Hawai‘i-grown livestock commodities in the state of Hawai‘i and continental U.S.
- Prepare a feasibility study, master plan and preliminary design that:
    - Address socioeconomic and environmental conditions;
    - Meets regulatory criteria and requirements, and
    - Is replicable and scalable, to the extent practicable.
- Explore ownership and business models.
- Quantify economic and social impact.
- Explore and present marketing and branding strategies.

1.2 REPORT ORGANIZATION

The report is organized with the following chapters.

Chapter 1 will identify the goals and objectives of the project.

Chapter 2 will present the historical and current harvesting quantities, consumer consumption rates, consumer and market values, and cost concerns.

Chapter 3 provides an analysis of the livestock demand and the livestock harvesting capacity in the state. Based on the demand/capacity analysis the initial facility requirements are described.

Chapter 4 provides alternatives for the harvesting facility and various components such as waste and wastewater disposal.

Chapter 5 describes the preferred concept of the harvesting facility and associated facilities.

Chapter 6 discusses several livestock business models, which could be used for the new facility.

Chapter 7 defines product branding and offers suggestions for livestock branding for local ranchers and producers.

Chapter 8 discusses the feasibility of the livestock harvesting facility.

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CHAPTER 2
INVENTORY AND MARKET RESEARCH

The objective of this section is to provide an overview of the livestock market in Hawai‘i in terms of local consumption, inventory, and the number of operations. Some of the biggest challenges of 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.[5,6] This information is also found in Appendix A.

The research and analyses utilize data obtained from multiple sources. These sources include the U.S. Department of Agriculture (USDA); state of Hawai‘i Department of Business, Economic Development and Tourism (DBEDT); University of Hawai‘i at Mānoa College of Tropical Agriculture and Human Resources (CTAHR); and various local businesses such as ranchers, harvest operations and grocery wholesalers. Based on the research, as well as consultations with field experts, there are currently no solid estimates of beef and pork supply and consumption for Hawai‘i. The same is true for imports and exports. While the U.S. Army Corps of Engineers (USACE) provides imports and exports trend data for Hawai‘i, 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*[7] population. After considering these concerns, the decision was to not employ this data and develop independent import and export estimates.

2.1 OVERVIEW OF CATTLE RANCH OPERATIONS

Of the large agrarian enterprises in Hawai‘i, cattle ranching remains one of the oldest and most sustainable. It began in the 1830s and has outlasted sugar and pineapple. According to NASS (2017) Census data, Hawai‘i has more than 1,000 beef producers and a combined cow-calf inventory of 137,930 heads.

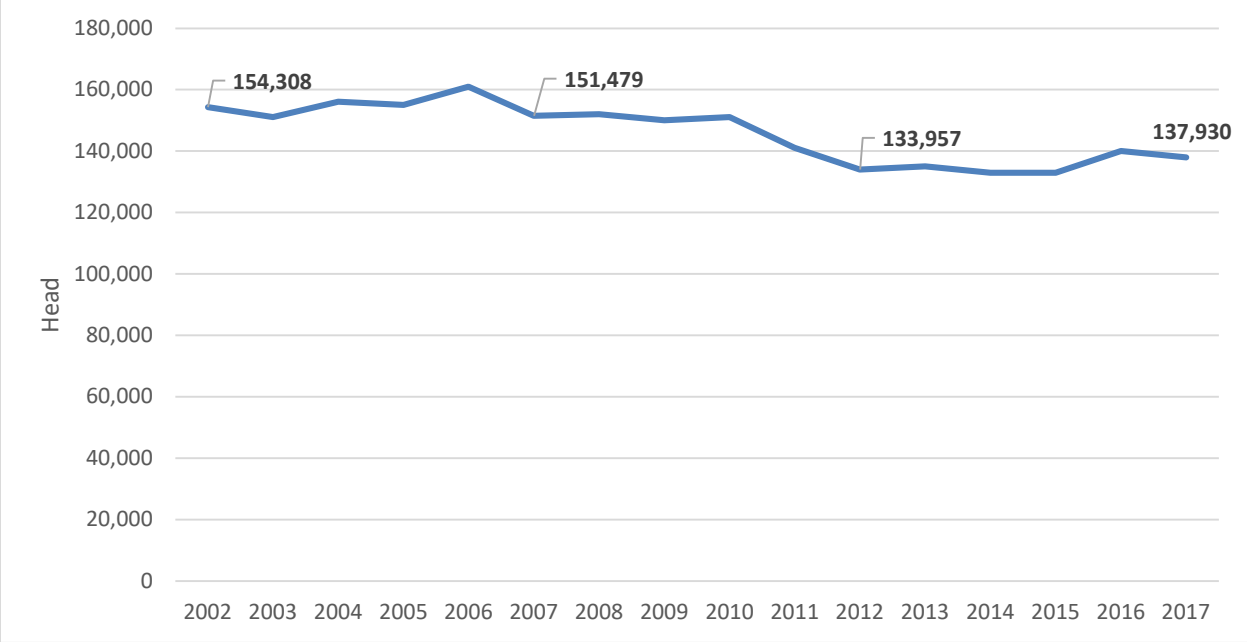
Exhibit 1 shows the cattle inventory in Hawai‘i since 2001. While the inventory of cattle did not appear to vary significantly in the past 20 years, the exhibit does not reveal the whole story of the cattle industry in Hawai‘i. A look back to 1961 shows that the inventory of cattle once reached its maximum at 249,000 heads in 1970 and 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, local harvest exhibited a decreasing trend beginning in the late 1980s. The decrease in cattle inventory was not a result of increasing local harvest but

[5] Food Security in Hawai‘i. George Kent.
[6] The Hawai‘i Beef Industry: Situation and Outlook Update. Cox and Bredhoff, 2003.
[7] 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.

an increase in exports of cattle and calves. Hawai‘i’s cattle industry has shifted from locally grown and harvested to exporting cattle and calves and importing beef to support local consumption. 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.

Exhibit 1. Inventory of Cattle in Hawai‘i, 2002 to 2017



Hawai‘i offers unique geographic and environmental features that support a robust ranching industry. In Hawaiian culture, lands were divided into pie-shaped regions extending from the mountains to the sea, known as ahupua‘a. Many ranches operate within these ahupua‘a and have more than one climate zone within their lands. Great variation may exist between the upcountry rainforest regions and drier makai lands. As a result, both intensive and extensive grazing strategies are employed to best utilize lands, which maximize production efficiencies and provide valuable ecosystem services. These services support conservation efforts and help preserve Hawai‘i’s natural resources. Among other things, Hawai‘i’s well-managed rangelands prevent erosion, reduce fuel load for wildfires and preserve watersheds.

As Hawai‘i has a moderate, tropical climate, producers enjoy a year-round grazing season. Often, ranchers separate herds into two breeding seasons within the year to maximize production. Smaller scale operations may be able to breed year-round. Kamehameha III was the first to bring instructional aid to Hawai‘i’s cattle growers, and today, they continue to be among the most progressive producers in the U.S. Educational workshops offered regularly, are well-attended and include topics such as low-stress handling techniques, range management, invasive species mitigation and herd health. Advanced breeding techniques — including artificial insemination, genomics testing and embryo transfer — are often used to improve genetics.

Island ranchers have organized representation through local and statewide associations, which advocate on their behalf socially and politically. Hawai‘i Cattlemen’s Council, Inc. (HCC) is the statewide umbrella group of five county-level cattlemen’s associations. HCC claims 150-plus member ranchers and represents over 60,000 heads of beef cows — more than 75% (seventy-five percent) of all beef cows in the state.

The production model most employed by ranchers in the state is the cow-calf model. The producer maintains a cow herd and sells or ships calves to the continental United States (Mainland) at weaning, when they are approximately six to eight months old. As no large-scale feeding operations exist in Hawai‘i, calves are generally shipped to pastures or grow yards on the Mainland before finishing in feed yards. Producers can choose to participate in a variety of marketing and shipping options. Some producers sell their weaned animals “at the gate” to a buyer, who then takes over shipping and marketing. Others prefer to retain full or partial ownership, maintaining more control of marketing options. Most weaned calves are shipped in modified livestock containers by boat, although a substantial number are also flown to the continental United States.

In recent years, there has been growing consumer demand for locally sourced beef. Few statistics are available, but this demand is reflected in increased retail shelf space, featured menu items and the popularity of local beef at farmers markets. Consumers are increasingly interested in knowing where their food comes from, who is producing it, potential health benefits and the smaller environmental footprint locally sourced food represents. (McCluskey et al. 2005; Xue et al. 2010; Kim et al. 2016)

In addition to rising demand, difficult logistics, increasing costs of shipping livestock to the Mainland and the ability for some regions of Hawai‘i to maintain pasture year-round make the grass-finished market an attractive alternative. Several local brands have already gained shelf space in island grocers. These include Kuahiwi Beef, Kuloa, Maui Cattle Company, Paniolo Cattle Company and Riverbend Ranch.

In 2018, a survey was completed among 140 beef 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, which includes 56 ranchers representing an estimated 44% (forty-four percent) of cows raised in Hawai‘i. The ranchers were distributed as follows:

- Island of Hawai‘i 48%
- Maui 21%
- Kaua‘i 18%
- O‘ahu 13%

The study estimated individual ranch herd sizes ranging from five (5) to 10,000 cows, with a mean of 588 heads and a median of 150 heads of cows. The county breakdown of average herd size is as follows:

- Island of Hawai‘i - 828 mother cows;
- Maui - 438 mother cows;
- Kaua‘i - 390 mother cows; and
- O‘ahu - 136 mother cows.

Other facts gained from the study:

- When calves were maintained through a stocker phase, they were sold at seven (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 harvested for local consumption.
- Overall, about 94% (ninety-four percent) of 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% (eighty-three percent) of responding ranches. Of these, 84% (eighty-four percent) used minerals (including salt and sulfur), and 23% (twenty-three percent) were molasses-based energy and mineral supplements. Protein supplement purchases were reported by just 2% (two percent) of responding ranches. Almost all supplementary feeds used by the majority of ranches were purchased within the state from feed stores.
- Forty percent (40%) of the ranches surveyed reported a dressing percentage, a measure of carcass yield, between 50%-60% (fifty to sixty percent) , whereas about 17% (seventeen percent) reported a higher range of 60%-65% (sixty to sixty-five percent) . The national industry dressing percentage at harvest averages 62% (sixty-two percent) for finished cattle and may range between 40% and 60% (forty and sixty percent) 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% (twenty-one percent) and 16% (sixteen percent) who sold directly to consumers and retailers, respectively. Ranchers in the remaining counties did not show a distinct pattern. This suggests that ranchers in Hawai‘i County might have a greater preference of marketing their beef cattle in bulk rather than in smaller quantities.
- Most ranches (91%) reported shipping their cattle over 80 km to harvesting facilities. This would include 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.

2.2 LOCAL HARVEST INDUSTRY

Harvest facilities were initially developed as a necessary service by ranch owners to provide a distribution channel for their ranch-grown livestock. A livestock harvesting facility on the Big Island has been in operation since the 1800s when the cattle ranch was started as a necessary service. Other livestock harvesting operations started more recently, and though harvesting facilities today continue to provide traditional services, many have also developed into marketing and distribution centers of livestock products. Some of the major harvesting facilities purchase livestock products from ranchers and develop their unique retail distribution channels and brand names. There are 13 livestock harvesting facilities in Hawai‘i, which are distributed by island as shown on Table 1. Not all harvesting facilities were interviewed (see interview list in Table 2).

Table 1
Number of Livestock Harvesting Facilities by Island

Harvesting Facilities by Island	
Island	Number of operations
O‘ahu	1
Maui	2
Hawai‘i Island	4
Kaua‘i	5
Moloka‘i	1

Table 2
Livestock Harvesting Facilities Interviewed

Island	Operation	Year Built
Kaua‘i	Makaweli Meat Company	1988
Kaua‘i	Andrades Slaughterhouse and Cattle Company	1900
Maui	Maui Cattle Co.	2002
Moloka‘i	Moloka‘i 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 operations is not ideal. The O‘ahu facility is large and currently underutilized due to a 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 because of a lack of storage capacity at harvesting facilities.

In-depth personal interviews were done with the owners/managers of the top nine harvesting operations in Hawai‘i. The interviews were with facilities on all islands, including smaller islands such as Moloka‘i.

All Hawai‘i-based harvesting facilities are USDA Certified. Only one harvesting facility located on the island of Hawai‘i is BRC (British Retail Consortium) and OSHA certified. An additional harvesting facility on O‘ahu is currently in the process of undergoing BRC certification.

The number of livestock animals harvested in Hawai‘i is small and shown in Table 3. To maintain each operations' confidentiality, individual production data is not presented. However, the range of cows harvested as an example ranges from 12 per annum to 5,280 per annum. The same applies to all other animals.

There is a Big Island harvesting facility that harvests for only three ranchers. The Maui Cattle Company slaughterhouse is owned by Mahi Pono Haleakalā Ranch, ‘Ulupalakua Ranch, Nobriga Ranch, Kaupō Ranch and Hana Ranch, and is exclusively utilized in harvesting their livestock.

Table 3
Estimated Harvesting Quantities

Estimates provided by nine (9) operations			Estimated total harvest 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

2.2.1 Locally Harvested, 2001-2020

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

(1) Commercial harvest includes harvesting and processing in federally inspected (FI) plants in compliance with USDA standards;

(2) On-farm harvest for home consumption includes animals harvested and processed on farms for home consumption. It excludes custom harvest for farmers at commercial facilities but includes mobile harvesting units on farms; and
(3) Non-federally inspected (NFI) farm harvest includes harvest and processing in plants that are compliant with individual state standards.

The total number of cattle harvested in Hawai‘i can be estimated by adding together all three factors). The Federal Meat Inspection Act (FMIA) requires that all meat sold commercially must pass an inspection in order to be labeled as safe and wholesome.[8] The USDA, however, does not provide any data for the non-federally inspected farm harvest. As such, only federally inspected harvest was considered in this section. The estimates for cattle slaughter will only be based on commercial slaughter and on-farm harvest for home consumption.

Exhibit 2 shows the historical trend for the number of cattle harvested in Hawai‘i from 2001 to 2019. According to the USDA, approximately 13,600 cattle[9] were harvested in 2019. Compared to 13,100 cattle in 2001, Hawai‘i harvested only 3.8% (three-point-eight percent) more cattle in 2019. Of the 13,600 cattle that were harvested, 13,400 cattle (98.5%) belonged to commercial harvest. The remaining 200 (1.5%) were harvested on-farm for home consumption. Since 2001, the number of cattle harvested has been within the range of 9,500 to 13,600, which happened in 2016 and 2019, respectively.

While the trend in Exhibit 2 does not show much volatility, a further examination on a longer series shows a consistent decline in local cattle harvest since around 1970. The additional information with a longer series is available in the Appendix A. In 1971, the number of locally harvested cattle was as high as 65,600 heads. Four decades later, it dropped significantly to 13,100 (-94.7%). Hawai‘i’s cattle industry shifted from local sales to Mainland exports. According to Melrose and Delparte (2003), this change began in the late 1980s and was a result of shipping economics, transportation costs and the high price of grain.[10] Calves were exported to the Mainland for finishing and sale because it cost more to ship grain to Hawai‘i for raising 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.

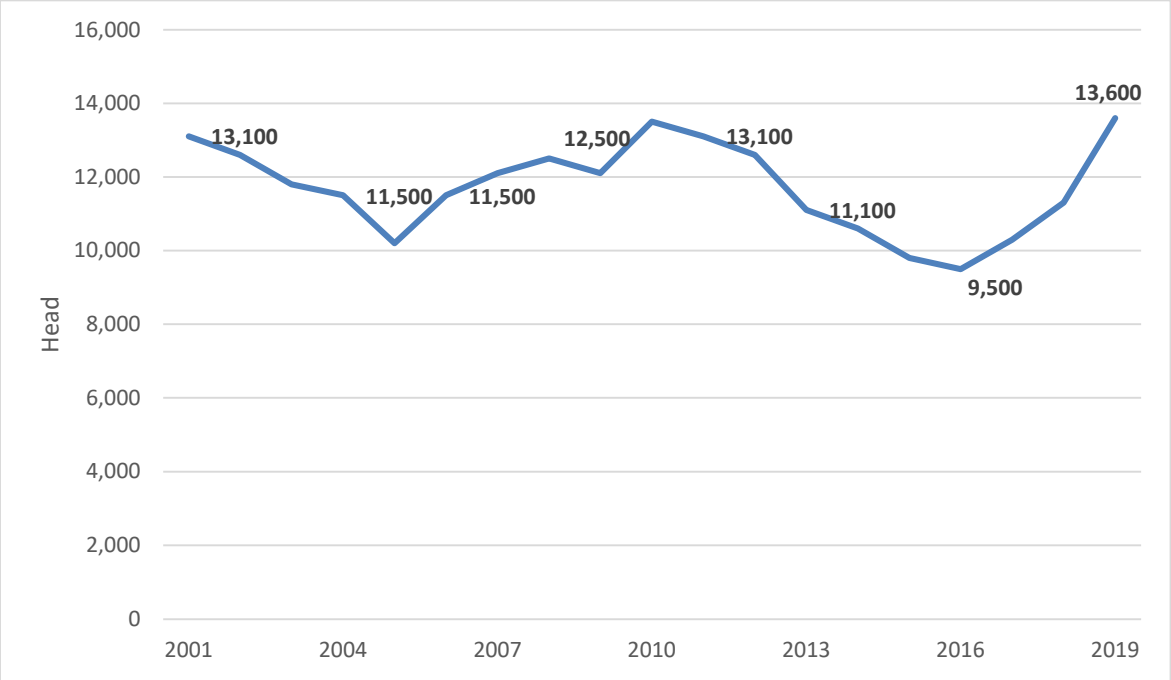
When local harvest declined, local production could no longer support the local demand and Hawai‘i consumers had to rely more on imported beef. Because harvest facilities currently only harvest cattle at approximately 20.7% (twenty-point-seven percent) of what they used to process, harvest facilities 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.[11]

Exhibit 3 provides the total beef produced in Hawai‘i in carcass weight. Carcass weight refers to the weight of the cattle after it is harvested and the head, hide, intestinal tract and internal organs

[8] USDA Summary of Federal Inspection Requirements for Meat Products, Food Safety and Inspection Service.
[9] Cattle were greater than or equal to 500 lbs.
[10] Melrose and Delparte, Baseline Study for Food Self-Sufficiency in Hawai‘i County. 2012.
[11] Local Beef Production to Grow with New Company Meats. *West Hawai‘i Today*.

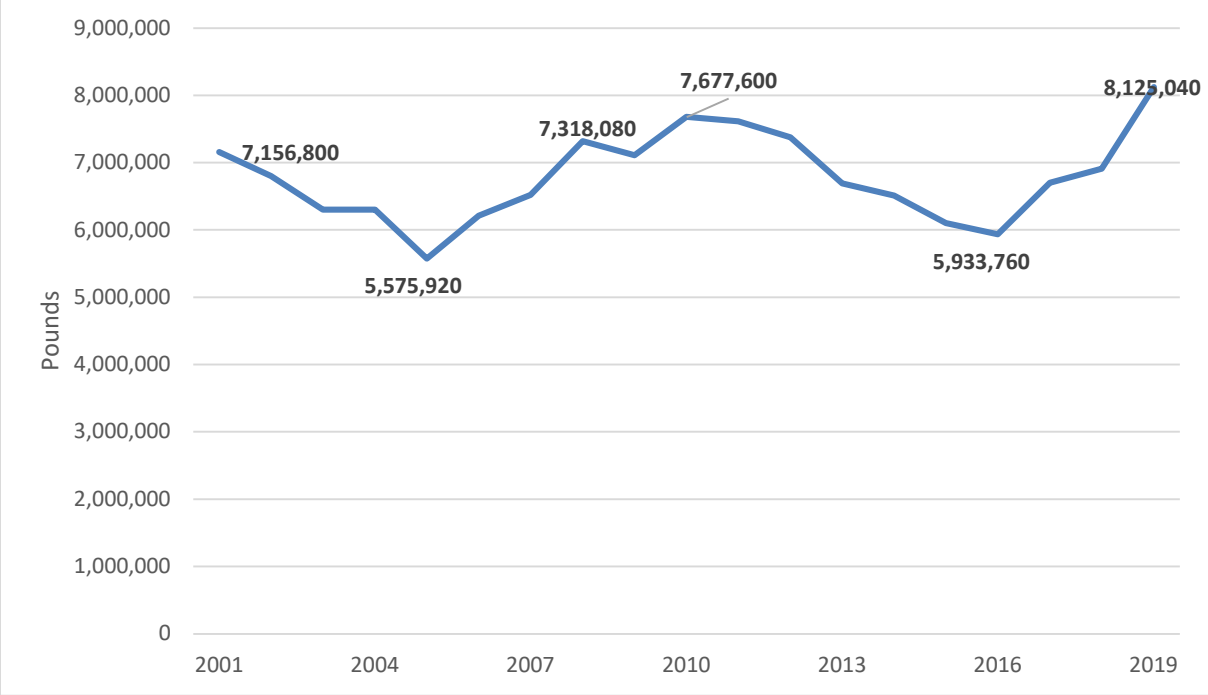
are removed.[12] The carcass weight of a grass-fed cattle is approximately 56% (fifty-six percent) of its live weight. Because the carcass weight is a factor of the live weight, Exhibit 3 exhibits a similar curve as in Exhibit 1.

Exhibit 2. Number of Cattle (Heads) Harvested Locally in Hawai‘i, 2001 to 2020



Source: USDA NASS, SMS Estimates.

Exhibit 3. Total Beef Produced in Hawai‘i, Carcass Weight, 2001 to 2036



Source: USDA NASS, SMS Estimates.

[12] Understanding Beef Carcass Reports. University of Georgia Extension.

2.2.2 Usage of Cow Hides and Innards

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

2.2.3 Cattle Export

As previously documented, a large number of cattle — 95% (ninety-five percent) — are exported to the Mainland. The Elsevier, Inc. survey data gathered estimates that a quarter of 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 four to 11 months. This average weaning age was similar to the 7.7 months reported for the Mainland western U.S. (Asem-Hiablie et al., 2017). At weaning, calves weighed on average 486 ± 81 lbs., with a range from 224 to 649 lbs.

One rancher 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 Hawai‘i over a three-year period. The cost of land used alone makes it a much less attractive option economically.

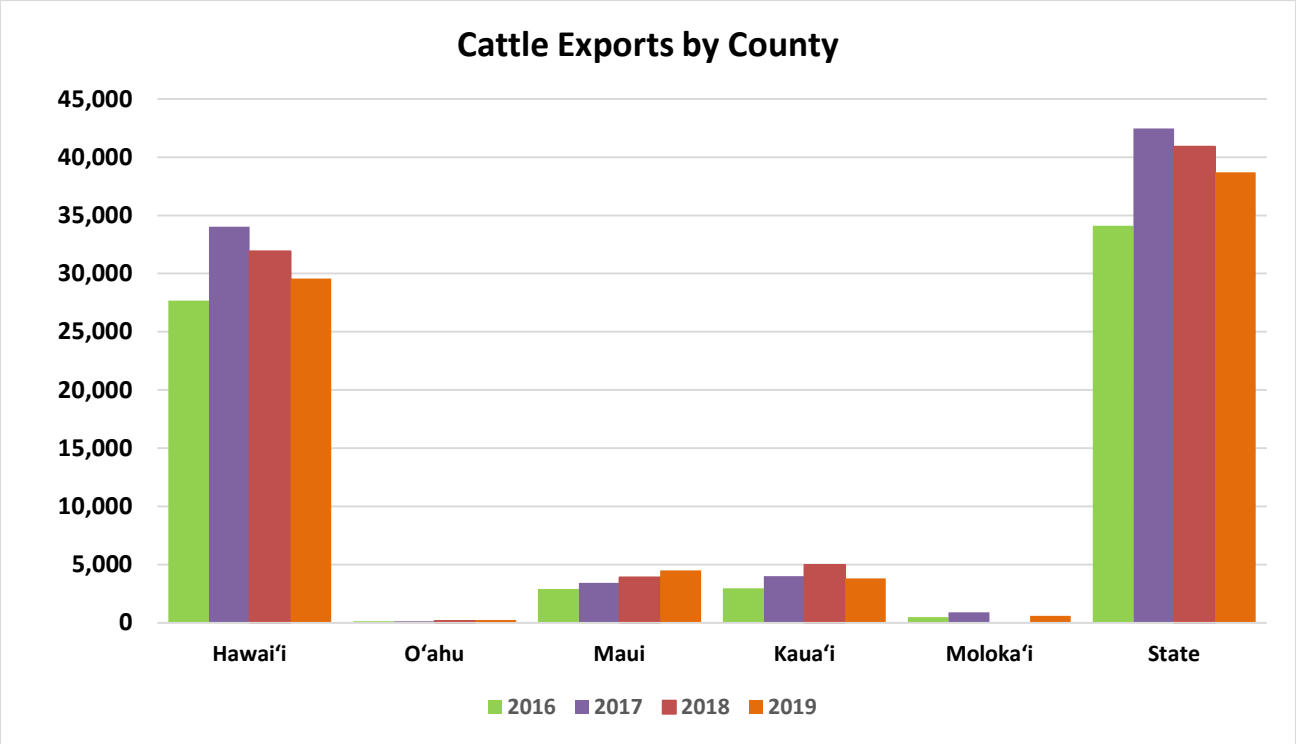
The larger farmers market/ship their cattle directly to ranches on the Mainland, while smaller operations market their cattle to the Mainland through five (5) fate buyers or consolidators. The price per pound received is low and is greatly affected by the cost of shipping.

Hawai‘i Meats acquired the lease and management of the Kalaeloa slaughterhouse and a Kaua‘i cattle operation with about 2,500 animals that had been part of Kunoa. Recent volume at the Hawai‘i Meat Company slaughterhouse was up to about 120 animals a week, but the facility was only in operation three days a week. They want 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, thus improving the quality of locally grown grass-fed beef and increasing local beef sustainability. Cattle exports have shrunk by about 7,000 heads since 2006. In the same timeframe, inventory has been reduced by about 20,000 heads, and harvest has increased by about 3,000 or 4,000 heads.

Exhibit 4 summarizes the total cattle exports by state and county. Since most of the cattle are raised on the island of Hawai‘i, it exports the most cattle out of state ranging from 27,000 heads to 34,000 heads. In sum, the state of Hawai‘i exported 34,000 to 42,000 heads of cattle between 2016 and 2019.

Exhibit 4. Cattle Exports by County, 2016-2019



Source: State of Hawai'i DOA

2.3 BEEF CONSUMPTION IN HAWAI'I

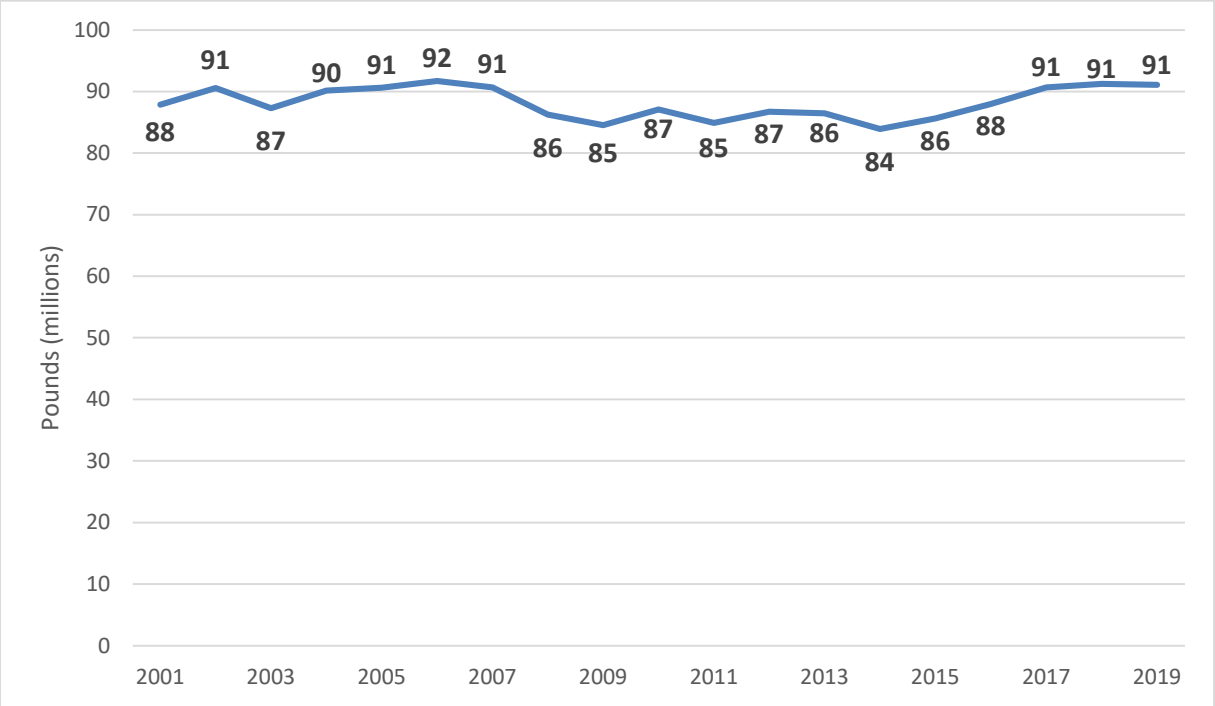
The overall beef consumption is shown in Exhibit 5. The solid blue line presents the historical consumption estimates from 2001 through 2019. In 2019, it was estimated that people in Hawai'i consumed approximately 91.1 million pounds of beef. Compared to 87.8 million pounds of beef in 2001, beef consumption had increased by 10.6% (ten-point-six) percent in five years, with an average annual growth rate of 0.53% (zero-point-fifty-three percent). The consumption trend data was estimated using the *de facto* population in Hawai'i in conjunction with the U.S. per capita consumption data.[13] A related study conducted by CTAHR suggests that beef consumption was projected to be 84.6 and 85.1 million pounds in 2005 and 2010, respectively.[14] The estimates appear to lie within the reasonable range. As can be seen in Exhibit 4, beef consumption has shown an increasing trend between 2015 and 2019, an upward trajectory that is a result of growth in the *de facto* population and rising per capita beef consumption during the same period.

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

In 2020, however, beef consumption was 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%). 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 the military population and persons who are temporarily absent remain 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 the *de facto* population will likely result in declining beef consumption due to a significant reduction of visitors. Beef consumption was expected to be 83.3 million pounds in 2020, a substantial decrease from 91.1 million pounds in 2019 (-8.5%).

Exhibit 5. Overall Beef Consumption in Hawai‘i, 2001 to 2019



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.

2.3.1 Consumption by County, 2001-2020

This section reviews beef consumption by county from 2001 to 2019. As mentioned in the methodology, there are no existing beef consumption estimates available at the state and county

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

levels. A reasonable approach to estimating county consumption would be to segment the overall consumption proportionate to the *de facto* population of each county. This approach assumes similar consumption patterns across all four counties.

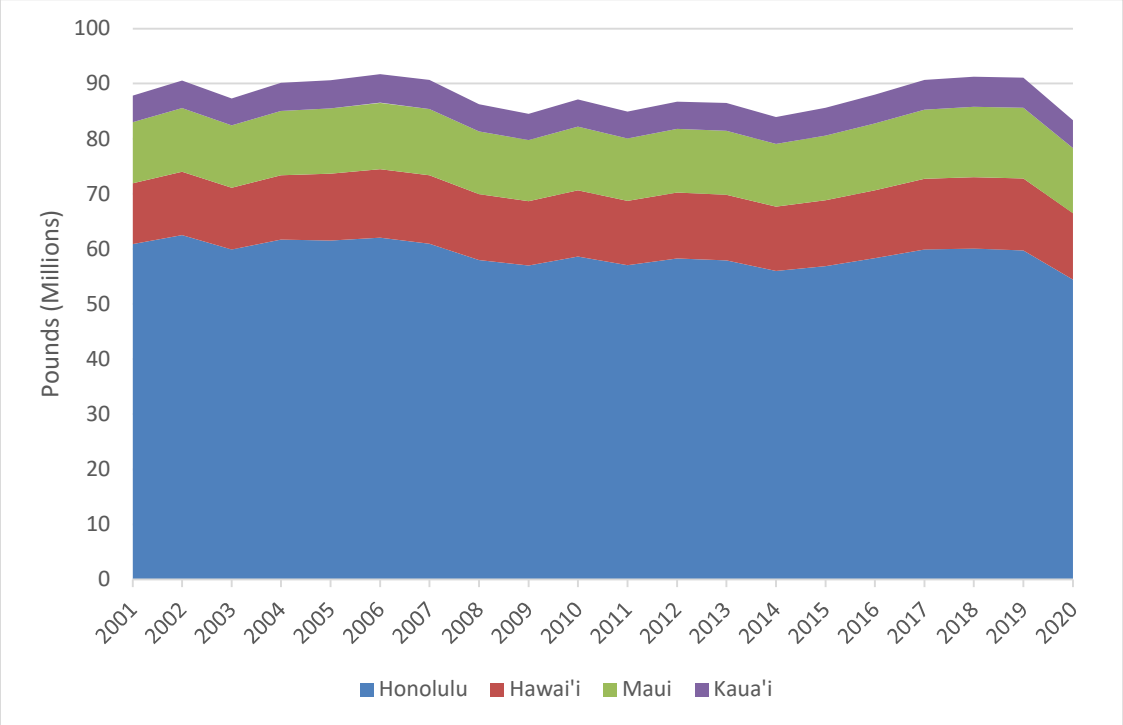
Table 4 summarizes the overall beef consumption by county into two parts: historical and projected. Beef consumption is shown graphically in Exhibit 6. Across all four counties, Honolulu has the highest overall beef consumption, followed by Hawai'i, Maui and Kaua'i.

Table 4
Overall Beef Consumption by County, 2001 to 2016

	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
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

Source: USDA Agricultural Projections to 2029; DBEDT State Databook 2019; and SMS Estimates.

Exhibit 6 Overall Beef Consumption by State and County, 2001 to 2020



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% (one-point-nine percent). The slight decrease in consumption was due to the declining population over the past two years. Honolulu is the most populous county in the state, and accounts for 60% (sixty percent) of its *de facto*

population. The pandemic is expected to cause a significant drop in the *de facto* population in Honolulu 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.

The overall beef consumption for Hawai‘i, Maui and Kaua‘i counties was 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, the decline in the *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 Hawai‘i, 11.8 million pounds for Maui and five million pounds for Kaua‘i. According to DBEDT’s projections, the resident population will continue to increase for all four counties in the future, despite Honolulu seeing a declining population for two consecutive years in 2018 and 2019. Visitors are also expected to recover when COVID-19 alleviates and when global tourism is fully reopened. The population increase and non-decreasing per capita beef consumption will lead to an increase in overall beef consumption.

In a study conducted by UH CTAHR, researchers utilized import, export and local production data to estimate Hawai‘i’s food consumption.[16] The initial strategy was to borrow the same concept and apply it to beef consumption. However, from the USACE and Census data, it is understood that this is not possible based on the issues described above. Therefore, the equation below was reversed and utilized the independent 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 was measured in monetary units and required some price per unit conversions prior to being used.

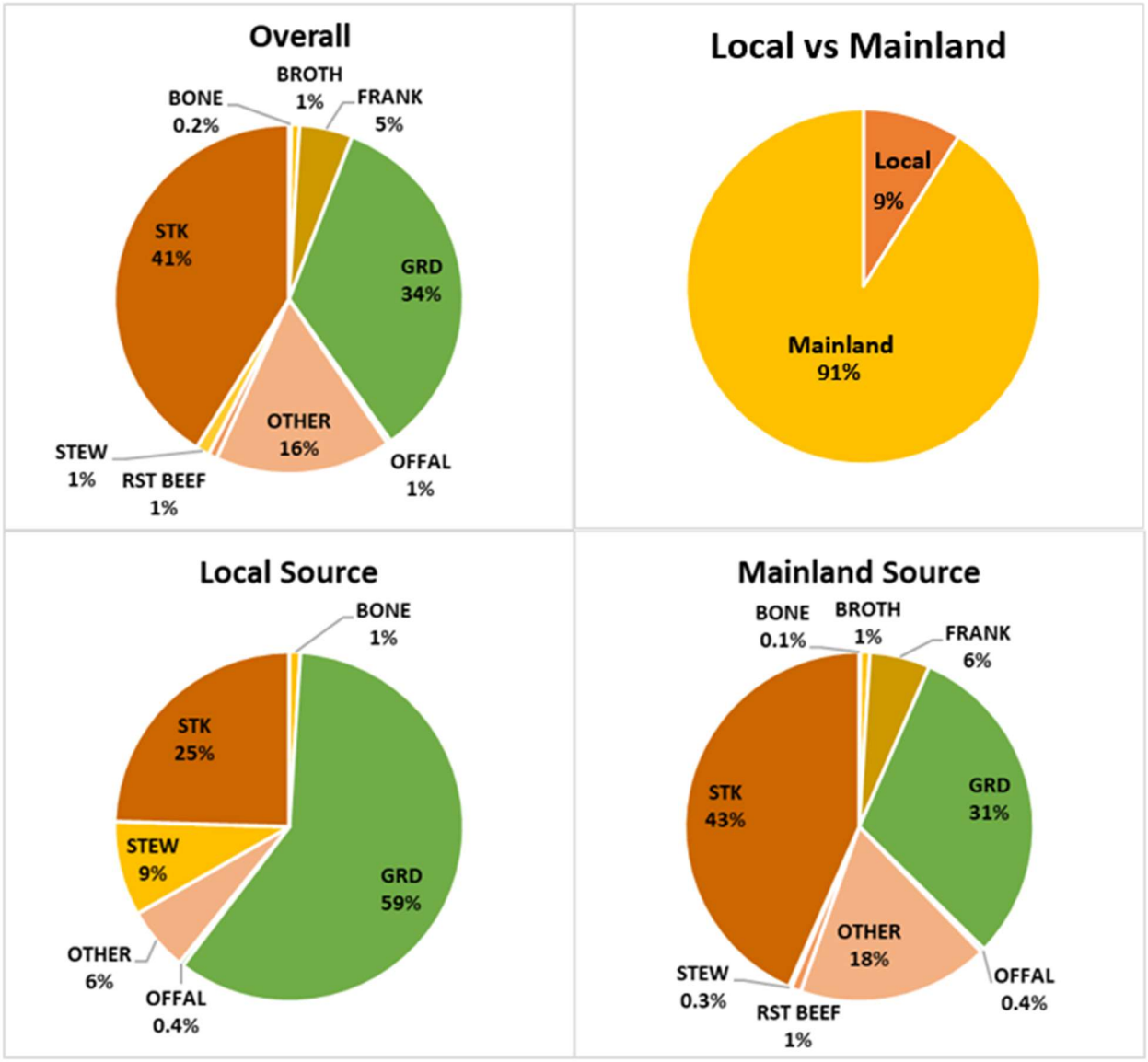
2.3.2 Consumption by Type of Beef

This section covers the distribution of different beef cuts consumed. The following data was provided by two distributors that requested confidentiality. Their share in the market is sufficiently large, such that these distributors’ sales distribution by cut is representative of the Hawai‘i beef market as a whole. Despite confidence in the representation of this data, there is no market share estimate accurate enough to upscale to the whole market. The consumption estimates found that extrapolating USDA data is within the range resultant from extrapolating these distributors’ market share. Additionally, providing an exact market share of these distributors would break confidentiality agreements.

As shown in Exhibit 7, 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.

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

Exhibit 7. Cuts of Beef in the Market, Local vs. Mainland sources



Source: Local food distributors, USDA, SMS Estimates

More telling for the 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, 94% (ninety-four percent) 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 and acreage to grow cattle to maturity, which results in a beef cut that is leaner than the current market's preference of tender beef cuts. As a result, 59% (fifty-nine percent) of locally produced beef is mixed with more fatty undesirable parts to make ground beef. Leaner meats become more tender when boiled or cooked for a longer duration, so at least 9% (nine percent) of locally produced beef is sold as stew meat.

Figures for Mainland-sourced beef are very similar to the overall figures, as only 9% nine 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, which is making efforts to source more of their meats locally.

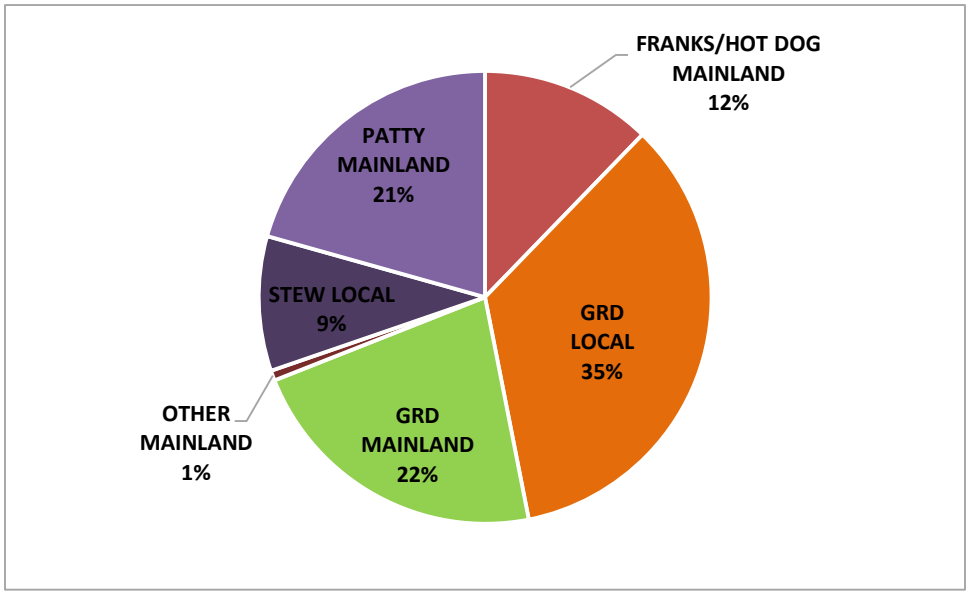
2.3.3 Department of Education Annual Purchases

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

As shown in Exhibit 8, the DOE purchased 1.4 million pounds of beef for $5.7 million from local confidential distributors in 2019. Of the beef purchased, 57% (fifty-seven 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. As expected, the DOE spent about 25% (twenty-five percent) more per pound on locally produced beef than 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. Although local beef is more expensive, it is not necessarily of better quality. As shown by this analysis, local beef is not used for patties or sausages because, as mentioned earlier, it is best used in a dish in which flavor and texture are less important, like stews and chilis.

Exhibit 8. Distribution of Hawai‘i DOE Beef Purchases by Type, 2019



Source: Local food distributors.

In March 2019, with a staff of 45 people, 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.

2.3.4 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, breeding, etc. These attributes are the intrinsic values of the product. In the study “Hawai‘i Grass-fed Beef Quality Standards,” the researcher suggested that besides intrinsic values, consumers are also looking for extrinsic values when making their purchase decisions. Extrinsic attributes may include the following:

- How cattle are raised;
- Whether cattle have received antibiotics or growth hormones;
- Whether cattle are Hawai‘i-grown; or
- Whether cattle are sustainably or humanely raised.

These extrinsic 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.[17,18]

Intrinsic Values of Beef

Since all Hawai‘i-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 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 harvest operations have experienced consumer's’ resistance to local grass-fed beef. As an example, Moloka‘i Livestock Cooperative markets their prime cuts on the island as “Moloka‘i grass-fed beef.” Demand for the product is low and not growing.

To improve quality, University of Hawai‘i 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 seven (7) frame score, but this beef is much too tough. There is a need to inform consumers that smaller is better.

[17] Hawai‘i Grass-fed Beef Quality Standards, Hawai‘i Cattlemen’s Council, 2020.
[18] McCluskey J et al., U.S. Grass-Fed Beef: Marketing Health Benefits, February 2005.

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

University of Hawai‘i CTAHR’s grass-fed beef research program and extension efforts to communicate research results with ranchers and other stakeholders appears to have helped improve the tenderness of Hawai‘i grass-fed beef. A younger harvest 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 Kaua‘i 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 the 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 Hawai‘i, bred by University of Hawai‘i in collaboration with University of Queensland, Australia, with the specific purpose of improving sustainable beef production. The improvement in animal growth and carcass traits is likely due to the enhanced nutritional quality of the grass-legume forage mixture.

One of the major ranch and harvest facility operators is putting their resources into four areas to improve Hawai‘i-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 locally grown grass-fed beef; and
- Improving the eating quality and being 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, labels add value for consumers in terms of additional warranty. By including the labels to show how cattle are raised or whether they have received antibiotics or growth hormones, consumers can feel safer and more informed of what they are eating. Moreover, they can

easily differentiate whether the beef products are locally grown or imported from elsewhere. According to the “Hawai‘i Grass-fed Beef Quality Standards” study, most of Hawai‘i 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 local demand can be built up, which will, in turn, bring sustainability to the local beef industry and diversity to the state.

2.4 LOCAL HOG INDUSTRY

The first pigs (swine) were brought to the Hawaiian Islands by Polynesians as early as the fourth century A.D. Skeletal remains of pigs and recorded traditional 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 heads was attained. The trend has been downward since then.

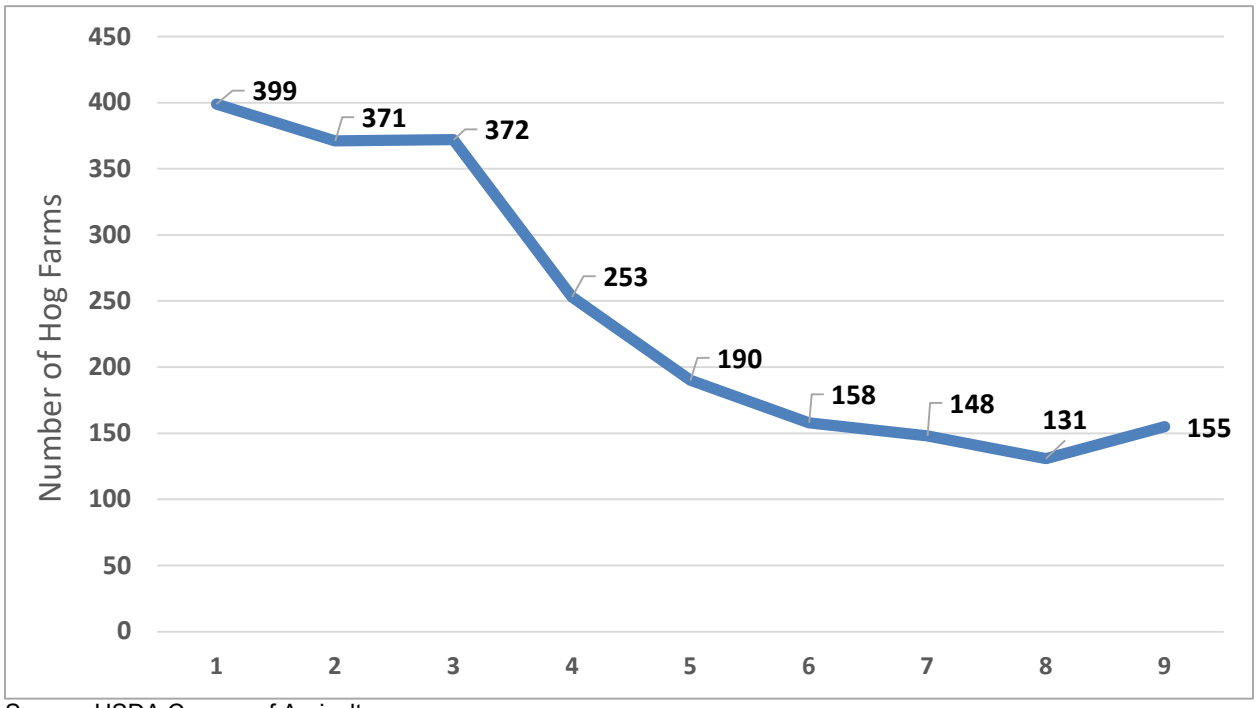
Domesticated pua‘a carried strong cultural value in traditional Hawai‘i. Aside from being an important possession and food source, an oral tradition describes the adventures of Kamapua‘a (the pig child), a powerful demigod who ranged over the islands and into the sea. Even the name of the traditional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

Unlike the cattle producer market, the hog (swine) market is fragmented. As reflected in Exhibit 9, the USDA estimated the number of pig farms in Hawai‘i that report pig sales at 155 farms in 2017. Based on discussions with experts at University of Hawai‘i CTAHR and some of the pig farmers in Hawai‘i, the number of pig farms with reported sales has not changed much in the past three years. The number of pig farms reported by the USDA is understated. It is estimated that there are approximately 400-plus pig farms in Hawai‘i based on conversations with market experts. Most of the pig farms are small, with less than 30 pigs a farm.

Exhibit 9. Number of Pig Farms with Sales, 1978-2017



Source: USDA Census of Agriculture

Most pig farms are family-run operations. University of Hawai‘i pig experts, as well as local harvest facility operators, estimate that 80%-90% (eighty to ninety percent) of local pigs are purchased by local residents directly from local pig farms and harvested for immediate consumption. An example of the issues faced by hog farmers is Hawai‘i’s David Souza (Wai‘anae Pig Farm). He sells only two pigs a week harvested by Hawai‘i Meat Company slaughterhouse to Tamura’s. The other 90% (ninety percent) of his revenue is achieved through other, more direct distribution channels. Some of the larger farms present in Hawai‘i are:

- Jay’s Hog Farm in Wai‘anae, O‘ahu (480 sows);
- David Wong in Wai‘anae, O‘ahu (800 sows);
- Kaneshiro Farms in Koloa, Kaua‘i (100 sows); and
- Two Lady Farmers in Wai‘anae, O‘ahu (not available).

As reported by 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 harvest 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 Hawai‘i pork is of very high quality, according to field experts. Most hogs in Hawai‘i 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 harvest facility, including a production and processing facility to market their products jointly. They recognize that one of the key dilemmas facing them are transportation costs

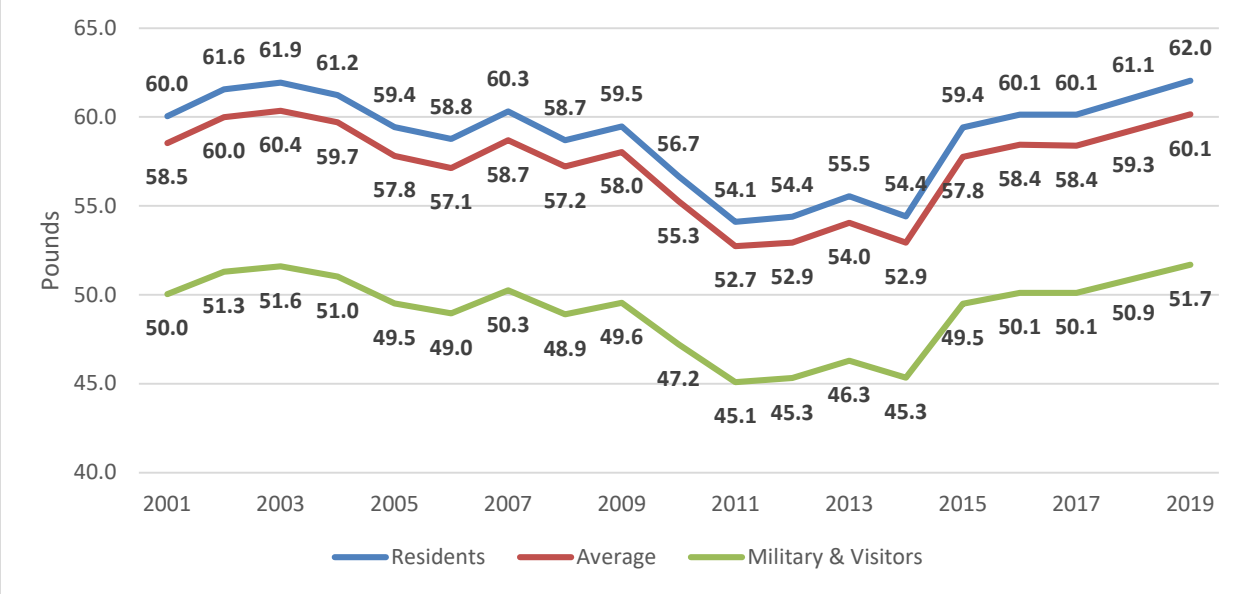
to reach the majority of Hawai‘i consumers on the island of O‘ahu. They plan to increase the numbers of pigs managed on their farms from a current population of 4,500 to 7,000.

2.4.1 Existing Pork Consumption

Much like beef consumption, there is no accurate data for the state of Hawai‘i regarding pork consumption. Therefore, U.S. per capita pork consumption was used as a surrogate. However, the assumption is that the consumption rate for the entire population is not the same. According to several consulting experts, Hawai‘i residents consume 20% (twenty 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 below in “Local Hog Industry,” a significant portion of this extra pork consumed by locals is not tracked or federally inspected due to farm-to-table sales.

Exhibit 10 presents the per capita consumption of Hawai‘i military, visitors and residents. Due to the resident-majority population in Hawai‘i, per capita pork consumption of the *de facto* population varies between 16% and 18% (sixteen and eighteen 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 Hawai‘i 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 200. 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.

Exhibit 10. Pork Consumption Per Capita, Statewide, 2001 to 2019



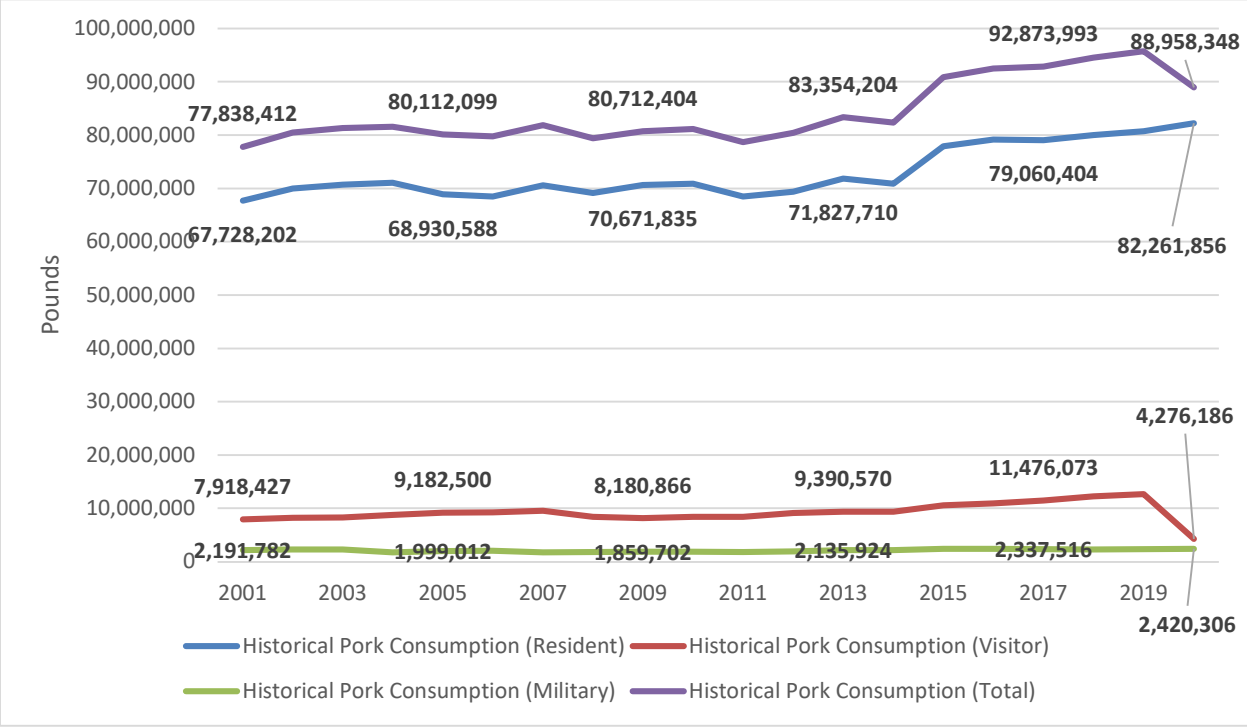
The overall pork consumption by population sector is shown in Exhibit 11. In 2019, it is estimated that people in Hawai‘i consumed approximately 92.9 million pounds of pork. Compared to 77.8 million pounds of pork in 2001, pork consumption had increased by 23% (twenty-three percent)

in 18 years with an average annual growth rate of 1.2% (one-point-two percent). The consumption trend data was estimated using the military, visitor average daily census and resident populations in Hawai'i in conjunction with the U.S. per capita consumption data.[19]

The 10.4% (ten-point-four percent) increase from 2014 to 2015 is a result of the 9% (nine 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% (one-point-two percent) since 2001.

In 2020, however, pork consumption is expected to drop abruptly due to the outbreak of the 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% (seven-point-one percent) — less than the 8.5% (eight-point-five percent) decrease in beef consumption.

Exhibit 11. Overall Pork Consumption, Statewide, 2001 to 2019



2.4.2 Consumption by County, 2001-2020

This section reviews the pork consumption by county for 2001-2020. 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 5 and Exhibit 12 show the historical pork consumption by county.

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

Table 5
Overall Pork Consumption by County in Pounds, 2001 to 2016

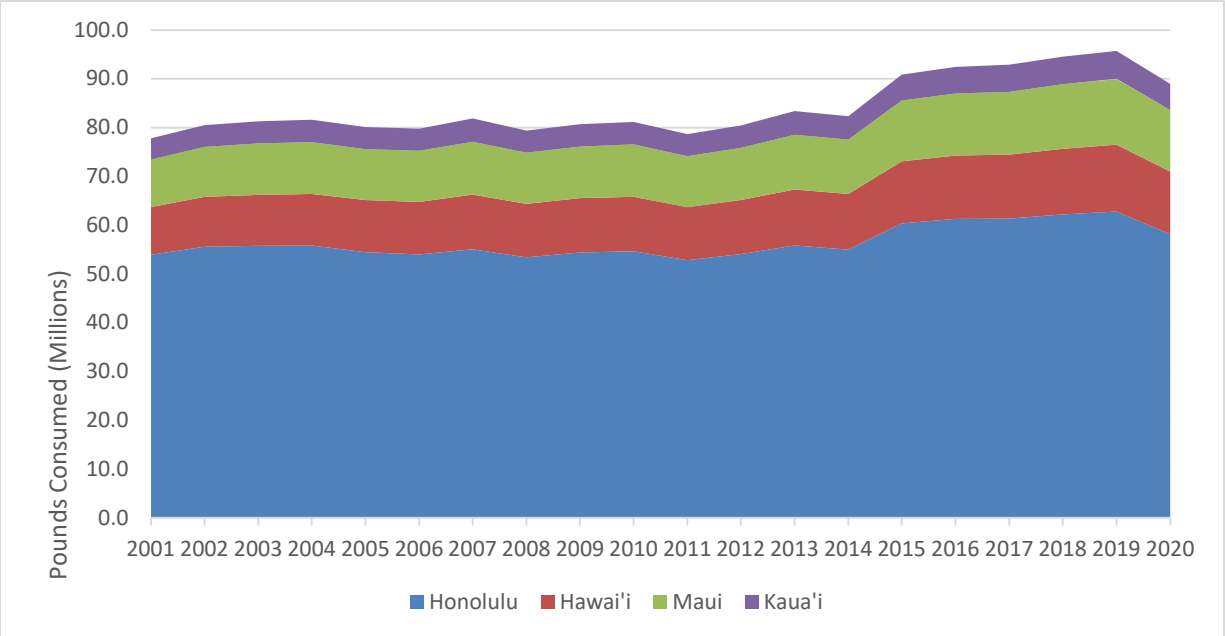
Year	Honolulu County		Hawai'i County		Maui County		Kaua'i County		State of Hawai'i	
	De Facto Population (Persons)	Beef Consumption (Pounds)	*De Facto* Population (Persons)	Beef Consumption (Pounds)	*De Facto* Population (Persons)	Beef Consumption (Pounds)	*De Facto* Population (Persons)	Beef Consumption (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
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

Source: USDA Agricultural Projections to 2029; DBEDT State Databook 2019; and 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% (four percent) . The increasing consumption mostly followed the trend of de facto population. Honolulu County is the most populous county in the state, and accounts for 60% (sixty 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.

The share of *de facto* population in Hawai'i, Maui and Kaua'i counties 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 the *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 Hawai'i County, 12.6 million pounds for Maui and 5.8 million pounds for Kaua'i.

Exhibit 12. Overall Pork Consumption by County, 2001-2020



2.4.3 Local Hog Industry

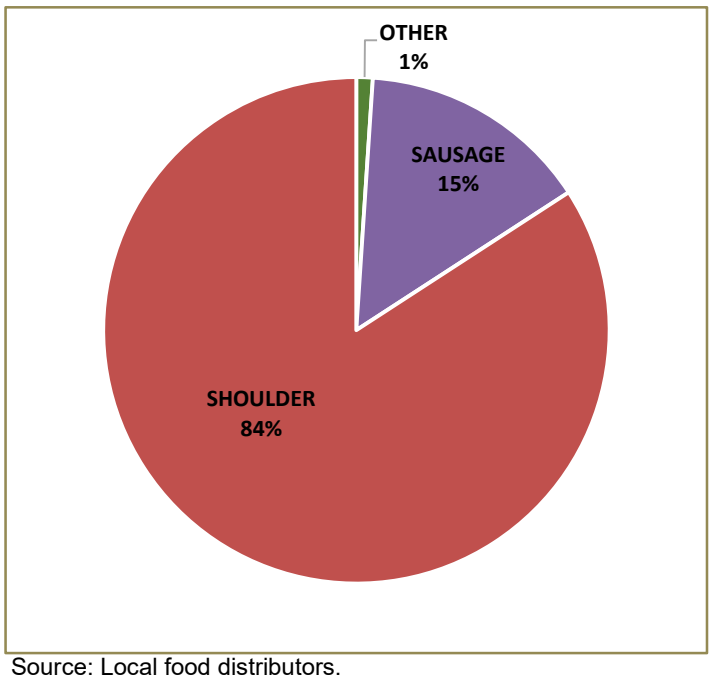
The data discussed in this section was acquired from the 2012 and 2017 USDA NASS census. For the purposes of this section, a "farm" owns hogs — they do not necessarily sell the hogs or pork. In 2017, there were 226 hog farmers in Hawai'i — 93 in Hawai'i, 28 in Honolulu, 80 in Maui and 25 in Kaua'i. From 2012 to 2017, Hawai'i County gained 23, Honolulu lost 32, and the remaining counties gained a combined four for an overall loss of five farmers.

2.4.4 Department of Education Annual Purchases

This section covers Hawai'i Department of Education's pork purchasing patterns. The topics of interest are purchases by type of pork and by production source, as well as 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 in 2019 and none of it was sourced locally. As shown in Exhibit 13, most of the purchased pork (by weight) is from a cut of shoulder or butt used for stews, about 15% (fifteen percent) is used in sausage patties and links, and 1% (one percent) is incorporated into an assortment of products like pork gravy.

Exhibit 13. Distribution of Hawai'i DOE Pork Purchases by Type, 2019



Source: Local food distributors.

2.4.5 Issues Facing the Industry

The following issues were identified through interviews and literature review and 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 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, compared to small operators, which is less desirable.
- The supply and types of cuts available are uncertain at times.
- Transportation costs of shipping pork from neighbor islands to O‘ahu is unaffordable.

2.4.6 Pork Annual Imports, 2001-2020

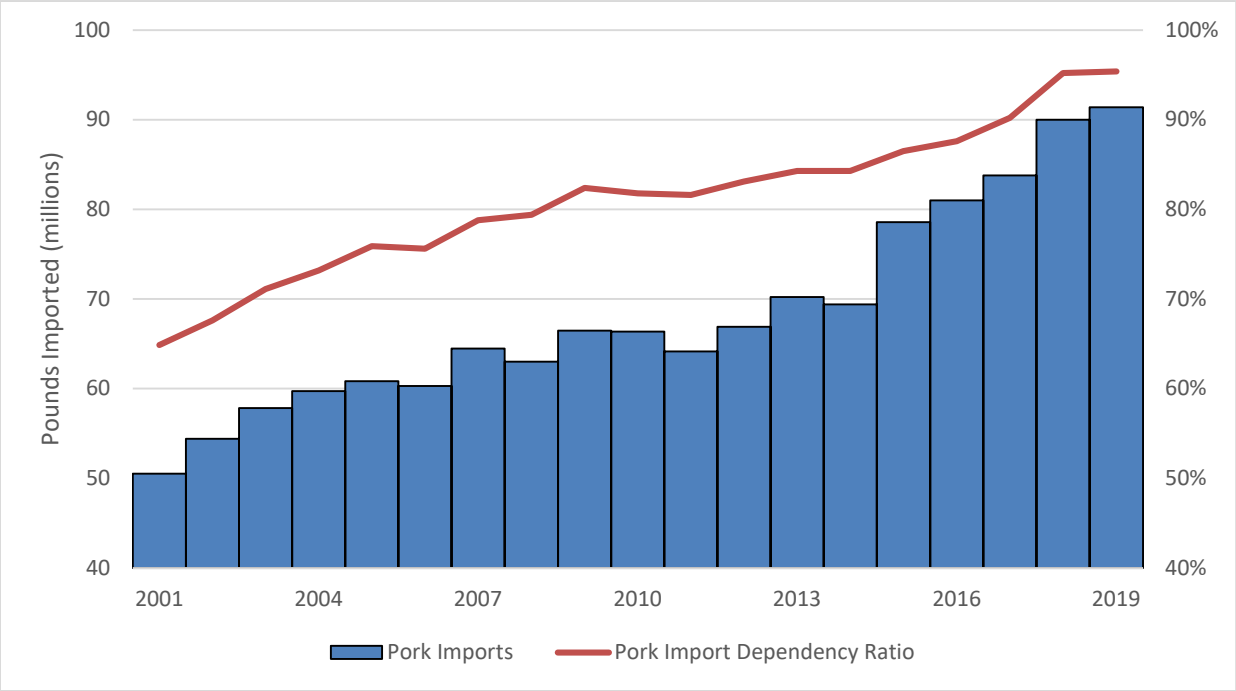
In determining the consumption of pork in Hawai‘i, analysis heavily cited a University of Hawai‘i study that examines food availability across all types of food in Hawai‘i (Loke and Leung, 2013). Following the study’s exact methods is not viable for the purposes of this study, as U.S. Army Corps of Engineers’ import data is provided only for general meats, not pork specifically. Once determining consumption through other methods described in “Consumption per Capita” and “Overall Hawai‘i Consumption,” it was decided 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 Hawai‘i.

Export data is from the USDA “U.S. agricultural exports, State detail by commodity” dataset. Data was provided as monetary value in USD ($) and was 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, Exhibit 14 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 Hawai‘i’s pork consumption is.

Over a period of 10 years, annual pork imports saw an increase of 20% (twenty percent) , going from 79.2 million pounds in 2010 to 95.2 pounds in 2019. This is much larger than the 6% (six percent) increase in beef imports seen 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 harvested in Hawai‘i decreasing by 67% (sixty-seven percent) over the same period, as described later. Between 2020 and 2021, annual imports decrease by 2% (two 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.

Exhibit 14. Estimated Pork Imports, 2001-2019



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

2.4.7 Locally Harvested, 2001-2020

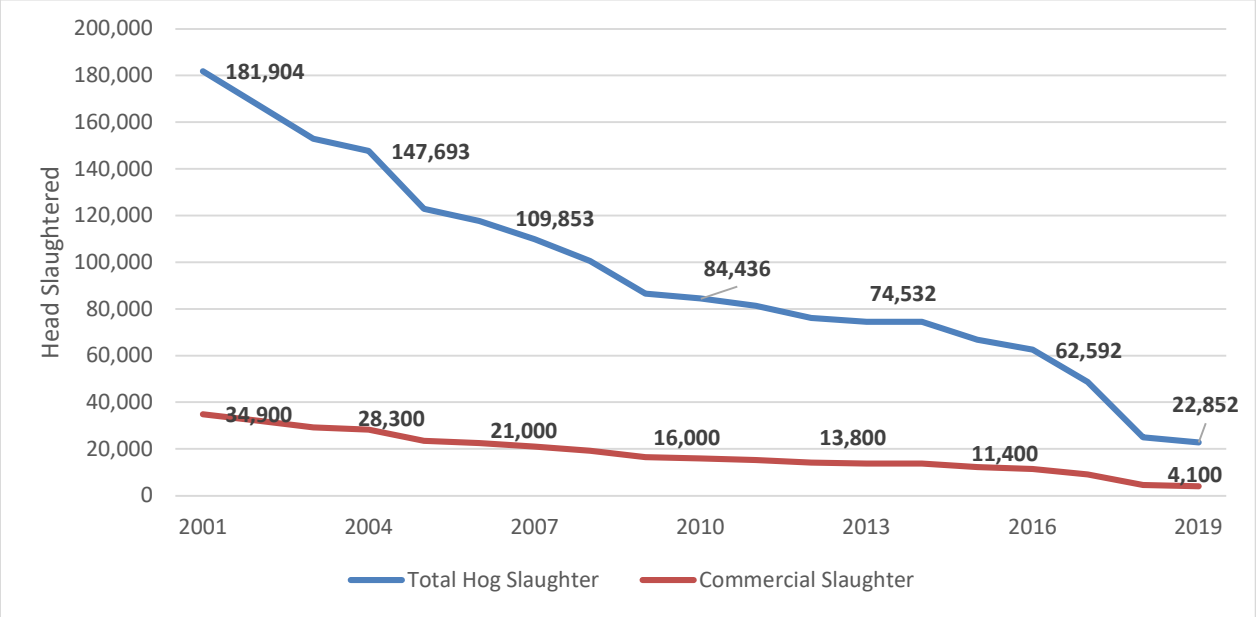
The harvest of hogs consists of (1) commercial harvest, (2) on-farm harvest for home consumption and (3) farm-to-table harvest, also known as the "grey market." As in the case with cattle, all beef sold in the commercial market must pass federal inspection from the USDA. Farm-to-table harvest, however, 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 harvested in Hawai'i's grey market and only a rough estimate can be inferred by local producers. The analysis adopted an estimate of 80% (eighty percent) of locally produced pork that are sourced from the grey market. With no other grey market-related sources available, this would be the most reliable estimate from Hawai'i's local producers.

Based on 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 big agricultural producers on the Mainland.[20] Unlike big agricultural competitors whose pork can be sold at an extremely low price, 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 a 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 harvest of hogs.

[20] Saving Hawai'i's Pig Farms. Honolulu Civil Beat.

Exhibit 15 presents the estimated total number of hogs harvested locally in Hawai‘i since 2001. The total also includes the estimated number of hogs harvested in the grey market. The estimates for the grey market were assumed to follow the trend of commercial harvest in the absence of historical data. As can be seen in Exhibit 15, the total number of hogs have been declining substantially since 2001. A longer series suggests that the decline began in 1988.[21] This appears to be consistent with the disappearance of many pig farms in Hawai‘i.

Exhibit 15. Number of Total Hogs (Heads) Harvested in Hawai‘i, 2001-2019



Source: USDA NASS, SMS Estimates

According to the Swine Task Force Report prepared by the DOA, CTAHR and Hawai‘i Farm Bureau Federation, local producers lost market share to the cheaper imported pork due to consumers' inability to differentiate between local and imported pork. O‘ahu's only USDA-certified hog and cattle harvest facility, which was built with the intent of handling both cattle and hog, found it difficult to keep operating because of the decline in cattle harvest due to exporting. 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 harvest facilities, purchasing grain-based feed, transportation, land, labor and waste management, coupled with the decline in cattle harvest, appear to be the major causes for the decline in hog harvest 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 demand for local pork from dine-in restaurants, O‘ahu's pig farm bounced back in sales in the wake of people fearing the shutdown of the meat processing facilities in the Mainland.[22] This provided an opportunity for more consumers to try local, fresh pork. On the other hand, the expected increase in local cattle harvest will share the

[21] 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.

[22] O‘ahu pig farm bouncing back after pandemic slashed its pork sales. Hawai‘i News Now.

cost of operating the harvest facility, which will lower the cost of hog harvest and likely keep the harvest facility operating.

According to Erin Borror, an economist with the U.S. Meat Export Federation, the success of small farms all came from carving a niche and branding the pork as a higher value product for the customers."[23] 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 Hawai'i'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 Hawai'i. When the demand for local fresh pork increases, local harvest (supply) will need to increase to keep up with the demand. By 2030, it is projected that the local harvest of hogs will climb back to 63,000 heads. And by 2036, the local harvest of hogs is expected to reach 86,000 heads.

2.5 THE SHEEP MARKET IN HAWAI'I

Little data is available about the sheep market in Hawai'i. The following are sheep farms listed in the Hawai'i Sheep and Goat Association.

- Āhualoa Hog Farm, Āhualoa.
- Aloha 'Āina Tropicals, Laupāhoehoe, lamb.
- 'Āina Pono Livestock, Hilo, goat, lamb and mutton.
- Double D Ranch, Laupāhoehoe.
- Kahuā Ranch, North Kohala, lamb.
- Kalopi Ranch, Waimea, goats, and sheep.
- Kapua Gulch Farms, Kapa'au, lamb and mutton.
- Kapāpala Ranch, Pāhala.
- Kuahiwi Ranch, Nā'ālehu.
- Maluhia Farm, Hāmākua, lamb and mutton.
- Michael Tomich, Kona.
- Pa'ahana Livestock, Waimea, goat.
- Primal Cuts, North Kohala.
- Thema Black, Kona and Waimea.
- Waiākea Uka Ranch, Waimea, lamb, and mutton.

The interview process made an effort to contact the owners of some of the sheep farms, who were reluctant to provide data. The executive director of the association has no data available on the market or production in Hawai'i. Only limited information about sheep harvest was provided by harvesting operations. There was discussion that a plurality of goats and sheep raised on Hawai'i farms are harvested at the farms and sold directly to consumers. This means the 1,200 harvested sheep reported by the USDA in 2019 is likely far lower than reality.

[23] Saving Hawai'i's Pig Farms. Honolulu Civil Beat.

A development opportunity for the struggling sheep farmers in Hawai‘i 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 1980s, is sustainable and efficient, and reduces operating costs for both the farmer and 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 Hawai‘i because of its limited space and high average amount of sunlight per year.

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

2.6 DEER AND ELK MARKET IN HAWAI‘I

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 harvested in a harvesting facility must include a USDA agent to permit the deer to be harvested in an approved USDA facility. This is common practice across the islands. The industry is trying to shrink, not grow their inventory and it will likely remain small.

While it is small, Hawai‘i’s venison industry is not nonexistent. Currently, Hawai‘i Meat Company on O‘ahu sells approximately 30,000 lbs. of Maui venison a month. There is a harvesting facility on Lāna‘i, which does only axis deer for community sale. The Lāna‘i facility is about six years old and has the capacity to harvest four (4) deer an hour (dressed carcass). The Moloka‘i livestock facility may harvest one deer every two weeks for local community sale.

CHAPTER 3
DEMAND/CAPACITY ANALYSIS AND FACILITY REQUIREMENTS

This section discusses the forecasts and future demand of the livestock industry. The analysis builds on the inventory and population growth presented in the previous chapter. The results of the demand/capacity analysis will be used to develop facility requirements for a scalable livestock harvesting facility.

As discussed in Chapter 2, due to unavailable historical data, the consumption (demand) estimates were derived based on a combination of the assumptions, as follows:

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

Assumption 2: 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).

Assumption 3: Hawai'i's historical per capita beef consumption is assumed to follow a similar pattern as the U.S.'s per capita beef consumption.

Assumption 4: Hawai'i'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.

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

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

Based on assumptions one (1) through six (6), the total consumption for beef and pork was estimated 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 the beef and pork market.

3.1 FORECAST BEEF CONSUMPTION

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. USDA projections were published just prior to the

outbreak of the pandemic and therefore did not account for the impacts. USDA projections were adopted with care and evaluated for the short-term impacts on beef per capita consumption.

Exhibit 16 presents the historical and projected per capita beef consumption for 2001 to 2036. In 2001, per capita beef consumption was estimated at 66 pounds. It remained relatively stable through 2007 and, since then, exhibited a sharp decline through 2014 at 53.9 pounds. After 2014, the per capita consumption of beef slowly climbed back up to 57.2 pounds in 2019. The sharp decline between 2007 and 2014 was caused by the impact of the Great Recession. The Great Recession lowered households' disposable income, along with the strong meat price as a result of limited supplies due to rising feed prices.[24] When the beef supply was adjusted from the loss in 2015, the stable or declining retail prices of beef have increased the consumers' demand for beef. As such, per capita beef consumption rebounded slightly between 2014 and 2019.[25]

In 2020, beef consumption per capita is expected to increase by 0.9% (zero-point-nine 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 gatherings 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% (twenty percent) compared to April of 2019.[26] Some reports have suggested that grocery stores did see significant shortages of beef amid the pandemic and that the stocks of meat were depleted.[27] The temporary shortages led to higher prices and a sense of food insecurity drove the surge in demand.

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

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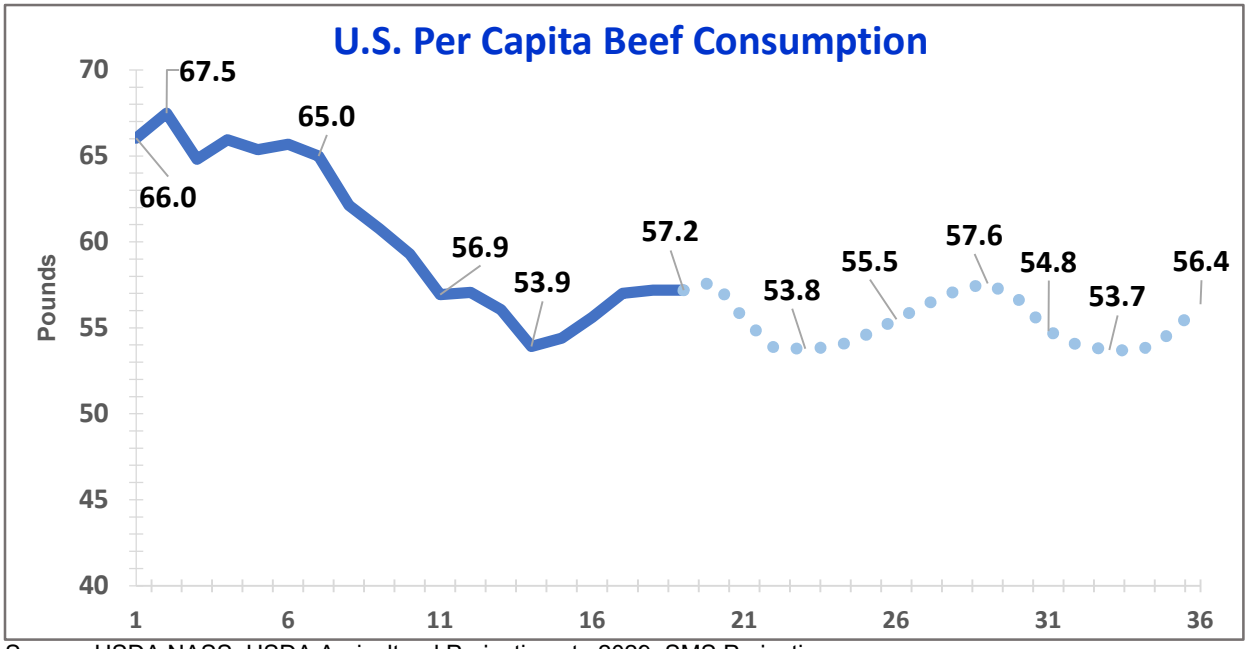
[24] Pass the Meat: U.S. meat consumption turns higher. David Widmar, 2016. Agricultural Economic Insights.
[25] U.S. per capita consumption of total meat was up in 2017. USDA Economic Research Service.
[26] Another look at availability and prices of food amid the COVID-19 pandemic. Robert Johansson, 2020. USDA.
[27] Meat was once in short supply amid pandemic. Now, it is on sale. *The Wall Street Journal*.

Exhibit 16. Per Capita Beef Consumption in the U.S., 2001-2036



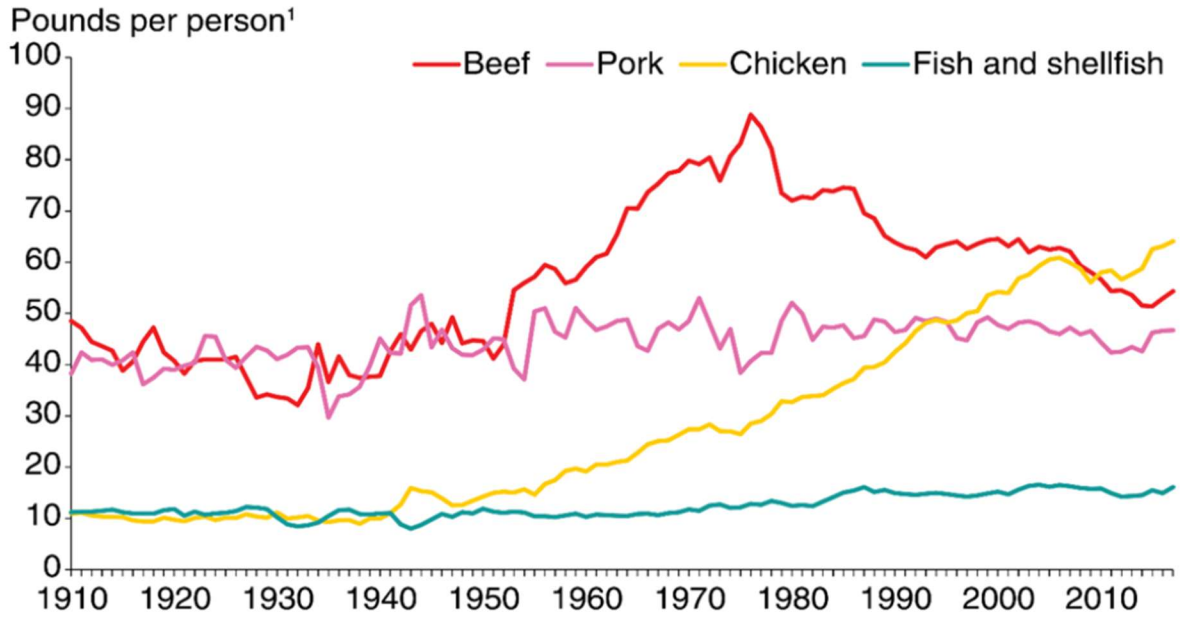
Source: USDA NASS; USDA Agricultural Projections to 2029; SMS Projections.

While beef consumption studies agree that the amount of beef that average Americans consume has declined steadily since the 1970s, and particularly throughout the past two decades, many cite different reasons for the decline. Exhibit 17 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.

A rigorous study published by 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 that lower consumption of red meat may be beneficial in terms of nutrition and as well as for 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 1980s reaching similar conclusions.

Exhibit 17. U.S. Per Capita Availability of Beef, Pork, Chicken and Fish/Shellfish, 1910-2017

Source: USDA, Economic Research Service, Food Availability Data.



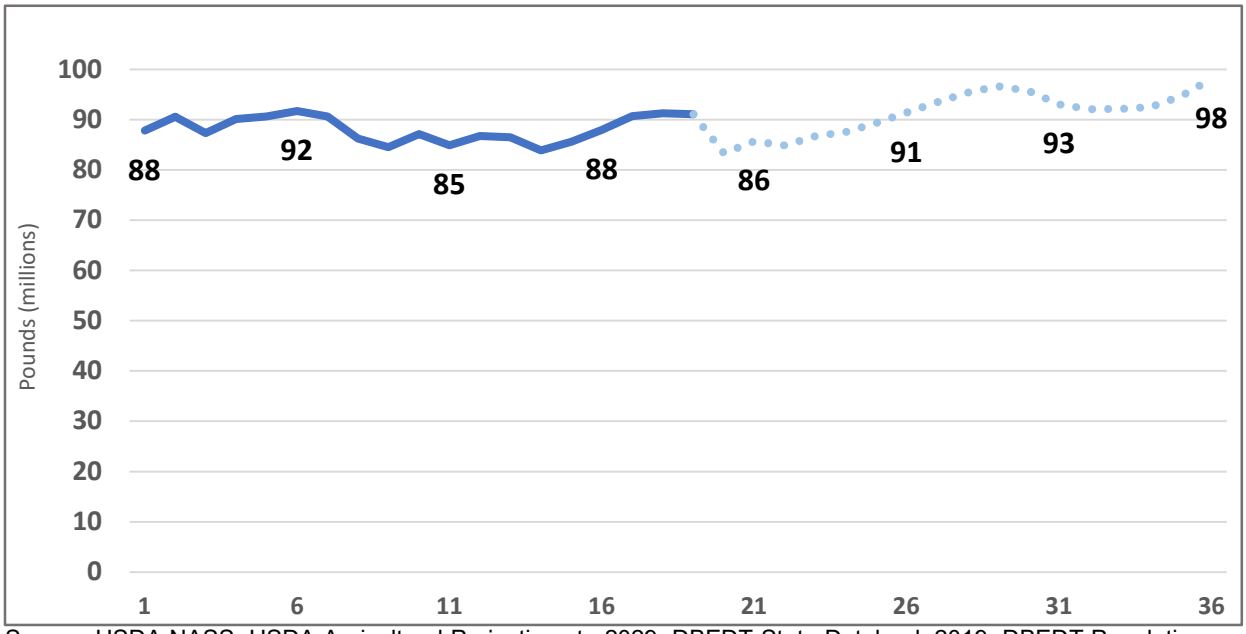
Note: 1. Calculated on the basis of raw and edible meat in boneless, trimmed (edible) weight. Excludes edible offals, bones, viscera, and game from red meat. Includes skin, neck, and giblets from chicken. Excludes use of chicken for commercially prepared pet food.
Source: USDA., Economic Research Service,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

Alternatively, Daren R. Williams, 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). NCBA also makes it clear that a reasonable amount of lean, nutrient dense beef is important, and that eliminating beef consumption entirely may not be best for a balanced diet (NCBA article).

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

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 Exhibit 18 presents the projected overall beef consumption for 2020-2036. As stated earlier, this assumes that beef per capita consumption patterns do not change significantly. 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, while the resident population growth was taken from the DBEDT long-range population and economic projection to 2045. Beef consumption is expected to recover to pre-pandemic levels no earlier than 2026. By 2036, beef consumption is estimated at around 98.2 million pounds.

Exhibit 18. Overall Beef Consumption (in pounds) in Hawai‘i, 2001-2036



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.

3.1.1 Forecast Consumption by County, 2001-2036

This section reviews 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 county consumption is to segment the overall consumption proportional to the *de facto* population of each county. This approach assumes similar consumption patterns across all four counties.

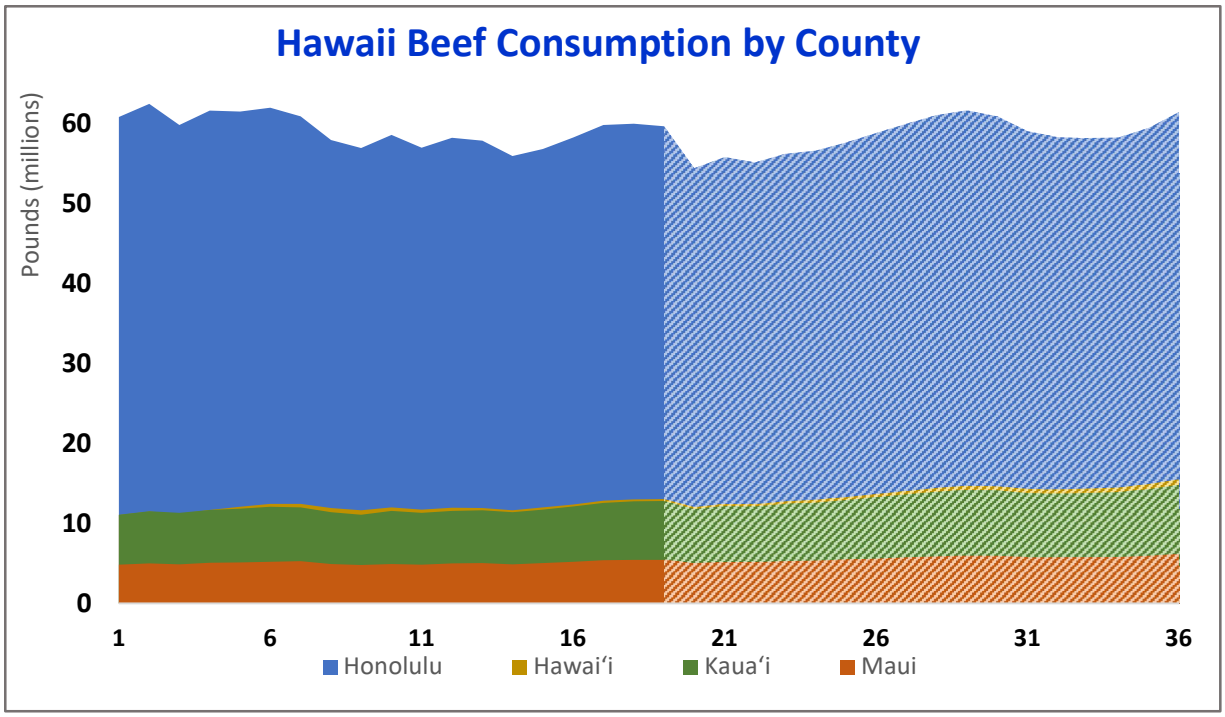
Table 6 summarizes the overall beef consumption by county into two parts: historical and projected. Across all four counties, Honolulu has the highest overall beef consumption, followed by Hawai‘i County, Maui and Kaua‘i. In 2036, the overall beef consumption is expected to increase to 15.6 million pounds, 14.9 million pounds and 6.2 million pounds for Hawai‘i, Maui and Kaua‘i counties, respectively. Exhibit 19 provides the trends of the overall historical and projected beef consumption by county for 2001-2036.

Table 6
Overall Beef Consumption by County in Pounds, 2001 to 2036

	Year	Honolulu County		Hawai'i County		Maui County		Kaua'i County		State of Hawai'i	
		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

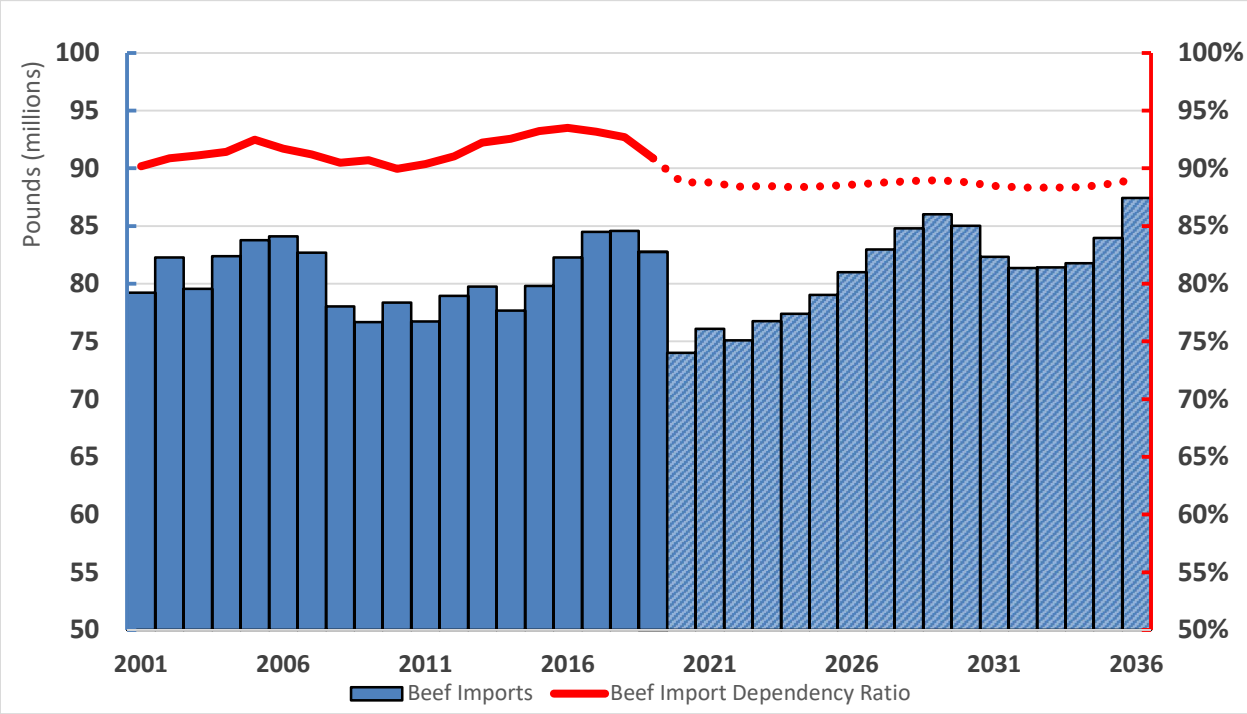
Source: USDA Agricultural Projections to 2029; DBEDT State Databook 2019; DBEDT Population and Economic Projections for the State of Hawai'i to 2045; SMS Estimates.

Exhibit 19. Overall Beef Consumption by County in Pounds, 2001-2036



The data resulting from this analysis are shown below in Exhibit 20. 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% (ninety percent) and 95% (ninety-five percent) ; approximately 5% (five percent) to 10% (ten percent) of beef consumed is produced locally. As beef consumption decreases and local harvest increases through 2020, Hawai'i's dependence on beef imports is expected to decrease to around 88% (eighty-eight percent) . As local cattle companies continue to put effort into increasing local beef production, Hawai'i's beef IDR is expected to stabilize between 85% (eighty-five percent) and 90% (ninety percent) , along with increasing consumption through the next two decades.

Exhibit 20. Estimated Beef Imports, 2001-2036



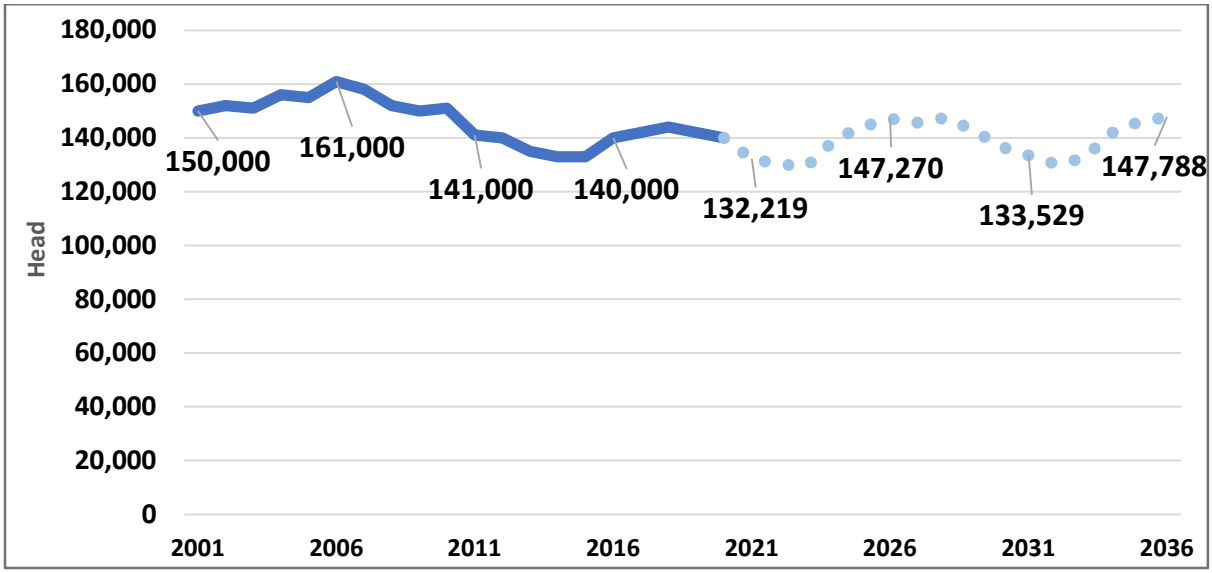
Source: USDA, ERS, FAS, GATS, NASS; SMS Estimates.

3.1.2 Cattle Inventory and Usage

Understanding the destinations of the 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 harvested locally. Since 2001, cattle export and harvest as a percentage of inventory has remained fairly constant, with variations of up to 3% (three percent) and 1% (one percent) in either direction for export or harvest, respectively. By this analysis, Hawai‘i ranchers export an average of four times as many cattle as it harvests.

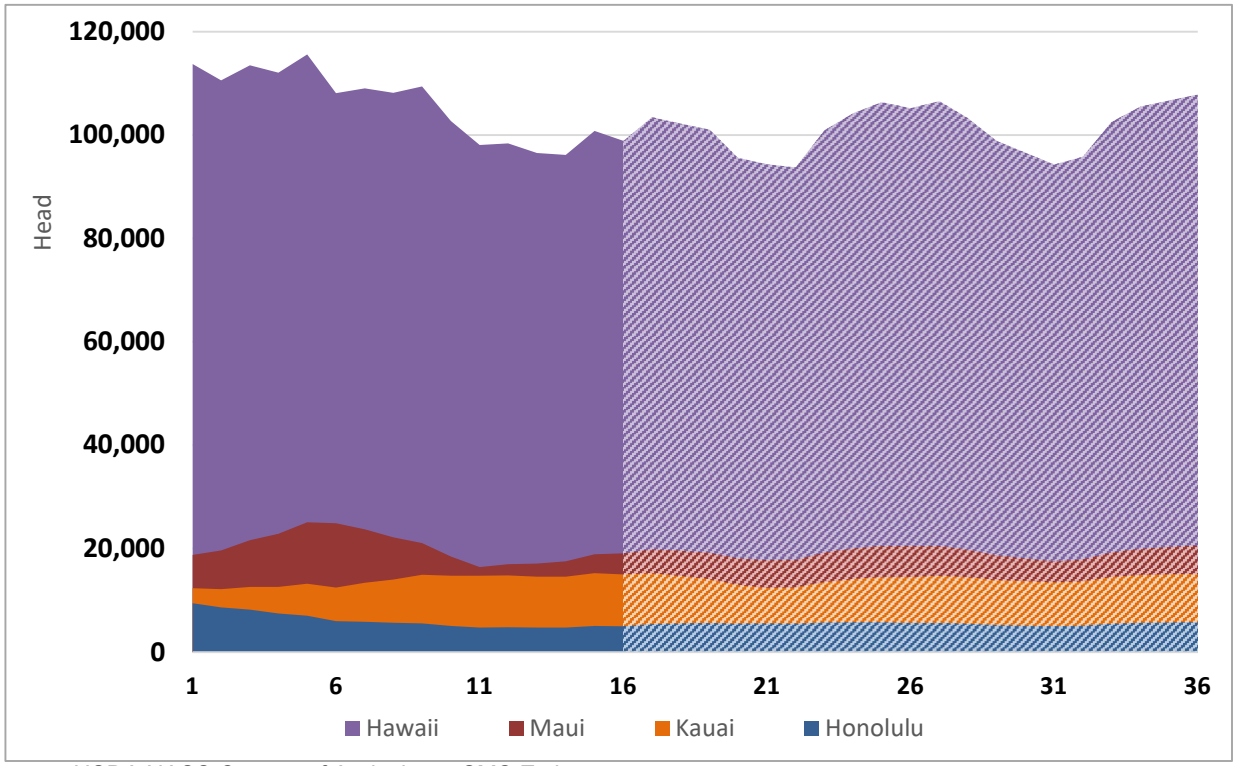
Cattle inventory for 2021-2036 is projected based on the trend and patterns of historical data with the perception of ranch owners about the future cattle industry (Exhibit 21). Overall, the cattle inventory for the next 15 years is expected to exhibit a slightly upward trend. The growth in cattle inventory is likely caused by an increased demand for locally grown beef from the DOE. In addition, some companies are putting an effort into establishing locally grown beef as their own brands sold in stores and restaurants 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. Cattle inventory is expected to recover to 144,115 heads (+2.9%) and 147,788 heads (+5.6%) by 2025 and 2030, respectively.

Exhibit 21. Inventory of Cattle in Hawai‘i, 2001-2036



Source: USDA NASS, SMS Estimates.

Exhibit 22. Inventory of Cattle in Hawai‘i by County, 2002-2036



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.

Exhibit 22 shows the historical and interpolated cattle inventory for Honolulu, Hawai‘i, Kaua‘i and Maui counties. Of the four counties, Hawai‘i 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 — equivalent to 71.7% (seventy-one-point-seven percent) to 73.7% (seventy-three-point seven percent) of 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 a later section of this report.

The second largest inventory of cattle can be found in Maui, which accounted for 12.2% (twelve-point-two percent) to 16.5% (sixteen-point-five percent) (16.5%) of total cattle between 2002 and 2017. Maui also has the second largest proportion of pastureland in the state (21.3%). Kaua‘i had 8%-11% (eight to eleven percent) of cattle inventory during the same period, and Honolulu consistently had the smallest share of cattle inventory, accounting for 3.5% (three-point-five percent) to 6.2% (six-point-two 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% (three-point-one percent).

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

3.1.3 Forecast Locally Harvested, 2001-2036

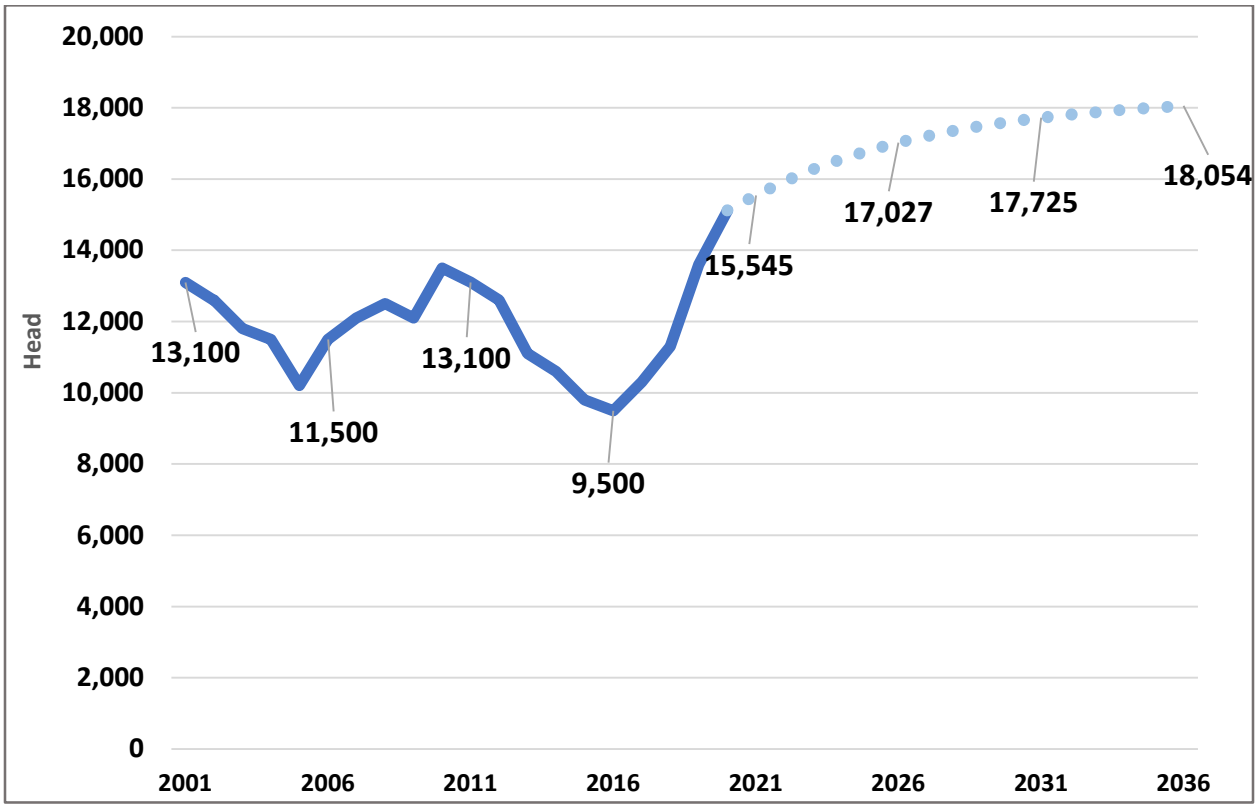
If one considers, if we were to instead keep and raise the exported calves (39,000 heads on average) to maturity and slaughter them locally, we would produce an additional 24 million pounds of edible beef, which would account for 26% (twenty-six percent) of the total beef consumed locally. This would reduce our reliance on imported beef significantly. Certainly, Hawai‘i does not have sufficient pasturelands, storage, labor and slaughter capacity to retain all calves at the current stage, but it would be an ultimate goal to keep and raise a large portion of calves locally in the future.

Exhibit 23 also provides projections for the number of cattle harvested from 2020 to 2036. Many Hawai‘i ranchers are striving to expand Hawai‘i’s homegrown beef supply in the local market. With more investment in the Honolulu harvesting facility and the recent acquisition by Mahi Pono for capacity expansion,[28] the number of cattle harvested will likely increase substantially. In 2025, the

[28] Mahi Pono Acquires Slaughterhouse, Investments are being made to expand capacity. *The Maui News*.

number of cattle harvested is expected to increase to about 16,812 heads, or 23& twenty-three percent) from 2019. In 2036, cattle harvesting is projected to reach 18,054 heads, an increase of 32.7% (thirty-two-point-seven percent) from 2019.

Exhibit 23. Number of Cattle (Heads) Harvested Locally in Hawai‘i, 2001-2036

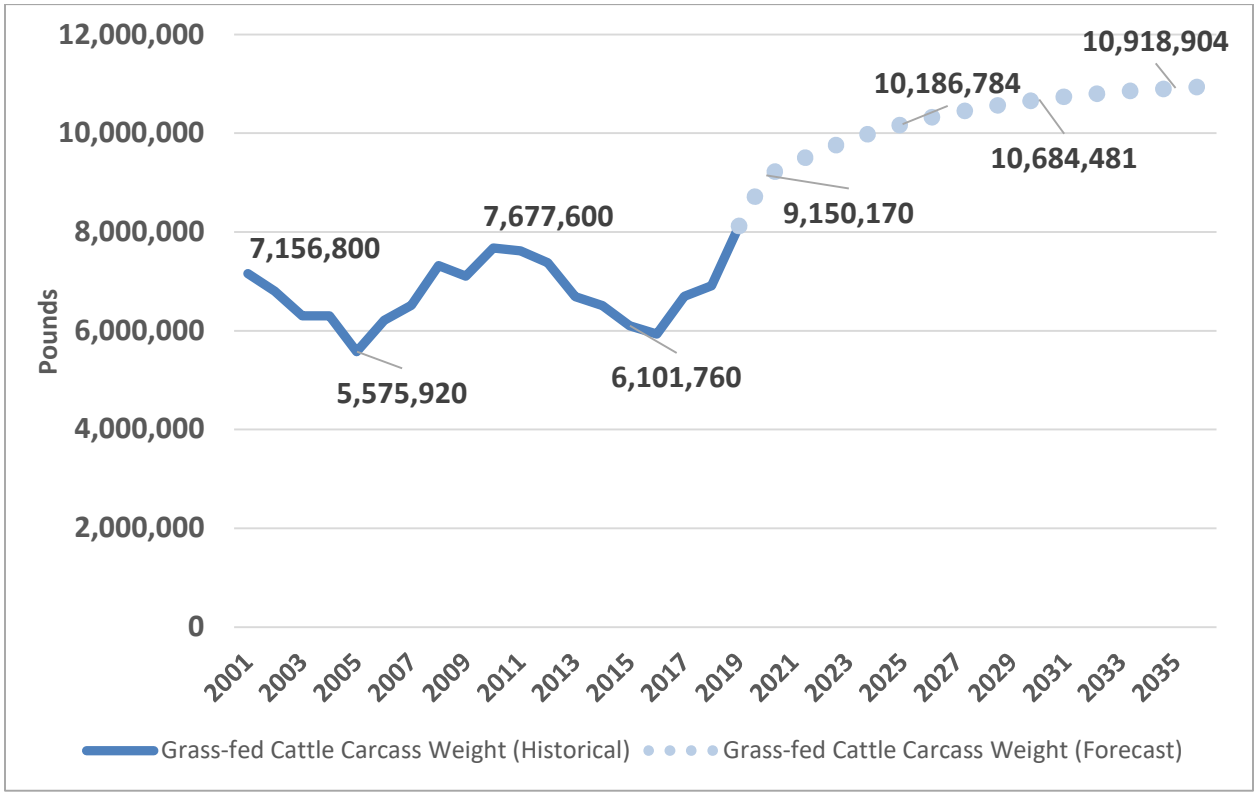


Source: USDA NASS, SMS Estimates.

While increased capacity of the harvest facilities 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, some operators estimated that the exports of calves can be reduced from 95% (ninety-five percent) to around 90%-92% (ninety to ninety-two percent). This will keep some of the cattle from leaving Hawai‘i when calves mature, with them eventually being harvested and consumed in Hawai‘i’s beef market. It should be noted that the forecast does not eliminate the current export of calves in the future and will coexist with calves to the Mainland. Calf export operations will continue, although the number of heads 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.

Exhibit 24 provides the past and forecast total beef produced in Hawai‘i in carcass weight. Because the carcass weight is a factor of the live weight, Exhibit 24 exhibits a similar curve as in Exhibit 23.

Exhibit 24. Total Beef Produced in Hawai‘i, Carcass Weight, 2001-2036



Source: USDA NASS, SMS Estimates.

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 will continue to dominate the inventory 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 and Kaua‘i.

3.1.4 Pasture Capacity and Local Cattle Growth

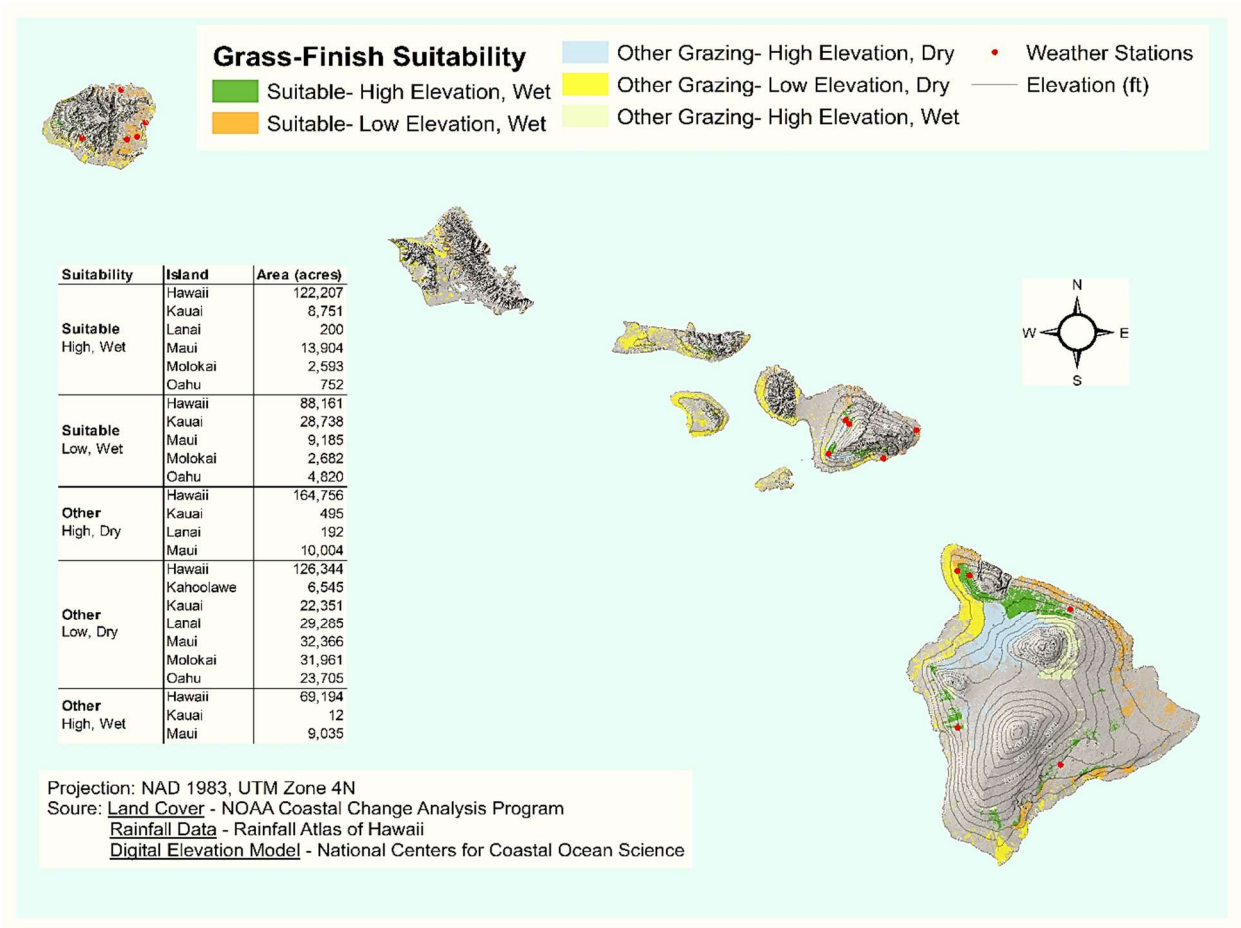
This section covers the pasture capacity in Hawai‘i and the potential growth of local grass-finished cattle. The data discussed in this section was acquired from the 2012 and 2017 USDA NASS census, as well as a series of studies conducted by UH CTHAR. For the purposes of this section, a “rancher” is 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, 193 in Maui and 132 in Kaua‘i. 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 Hawai‘i’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.[29]

[29] USDA Census of Agriculture, 2017 State and County Profiles – Hawai‘i

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. examined the suitability of Hawai'i's geography for forage-finished beef production. Exhibit 25 shows the five types of pastures and their locations on each island suitable either for cattle grazing or cow-calf operation. It was estimated that there were 808,238 acres of pasture lands throughout the state, or 11.6% (eleven-point-six percent) of the total land area that may be suitable for grazing at the time the reports were published.[30] Since then, close to 10,000 acres of new land near the central valley of Maui has become available for conversion to grazing land after the shutdown of sugarcane production. The latest total acre of pasture lands is, therefore, estimated at 818,238 acres.

Exhibit 25. Distribution of Hawai'i Pastureland by Type



Suitability	Island	Area (acres)
Suitable High, Wet	Hawaii	122,207
	Kauai	8,751
	Lanai	200
	Maui	13,904
	Molokai	2,593
	Oahu	752
Suitable Low, Wet	Hawaii	88,161
	Kauai	28,738
	Maui	9,185
	Molokai	2,682
	Oahu	4,820
Other High, Dry	Hawaii	164,756
	Kauai	495
	Lanai	192
	Maui	10,004
Other Low, Dry	Hawaii	126,344
	Kahoolawe	6,545
	Kauai	22,351
	Lanai	29,265
	Maui	32,366
	Molokai	31,961
	Oahu	23,705
Other High, Wet	Hawaii	69,194
	Kauai	12
	Maui	9,035

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

Before estimating the number of grass-finished cattle that can be raised on these pasturelands, we need to understand the difference between each type of pastureland. Fukumoto et al. classified the pasturelands into grass-finished suitability zones based on their elevation and rainfall criteria. Table 7 summarizes the criteria and definitions for each suitability zone.

[30] Fukumoto et al, UH CTAHR, 2015

Table 7
Definition of Grazing Suitability Zones

Elevation	Rainfall	Suitability Zones
Low, < 2,000 ft.	Dry, < 50 inch / year	Suitable for other grazing (cow-calf op.)
	Wet, > 50 inch / year	Suitable for high-quality grass-finish beef
High, > 2,000 ft.	Dry, < 30 inch / year	Suitable for other grazing (cow-calf op.)
High, > 4,500 ft.	Wet, > 30 inch / year	Suitable for other grazing (cow-calf op.)
High, 2,000 to 4,500 ft.	Wet, > 30 inch / year	Suitable for high-quality grass-finish beef

Source: Fukumoto at el. 2015. University of Hawai'i, College of Tropical Agriculture and Human Resources

Pasturelands are considered suitable for high-quality grass-finished beef only if their rainfall is greater than 50 inches per year at an elevation of less than 2,000 feet, or if their rainfall is greater than 30 inches per year at an elevation between 2,000 and 4,500 feet. Pasturelands where one of these criteria is not true are considered suitable only for cow-calf production. Forages that grow in high elevation wet zones generally have better quality, digestibility and nutrition than those grown in low-elevation wet zones. The quality of forages is one of the key factors that influences the number and sustainability of grass-finished cattle in Hawai'i. Cattle grazed on high quality pasturelands usually takes a shorter time to finish (18 months of grazing after weaning at five to six months), whereas cattle grazed on lower quality pasturelands can take a longer time to finish (24 months of grazing after weaning at five to six months).

To estimate the number of grass-finished cattle that can be raised on the maximum pasture capacity, we need to consider the time component in cattle production. Therefore, we introduce the concept of stocking rate. Stocking rate is defined as the number of Animal Units (AU)[31] per unit area over a given period of time.[32] The period of time is how long the animal units are on the pasture; it can be of day (AUD), month (AUM) or year (AUY). The stocking rate can be expressed as:[33]

$$\frac{AUMs}{Acre} \; or \; \frac{Acres}{AUM}$$

Different types of pasturelands can have varying stocking rates ranging from two acres per AU to as much as 30 acres per AU. Experts in the field suggest a stocking rate of three to four acres per AU for high-elevation wet zones. Low-elevation wet zones, on the other hand, could have a stocking rate of one to two acres per AU. Pasturelands suitable for cow-calf operation only can have a wider stocking rate ranging from 15 to 30 acres per AU on average. It should be noted that these stocking rates are generalizations for the purpose of this analysis. Actual stocking rates can differ by pasture location and are subject to forage production, which is highly dependent on the level of precipitation and seasonality.

[31] Animal unit (AU) is (1) a lactating 1000-pound cow with a calf; (2) any combination of animals with a forage demand of 26 pounds of dry matter per day. Throne and Stevenson. 2007.
[32] Stocking rate: The most important tool in the toolbox. Throne and Stevenson. 2007.
[33] Doing the math: calculating a sustainable stocking rate. Amanda Hanrock, Range and Natural Resource Specialist. 2006.

Table 8 presents the annualized estimates for grass-finished cattle suitable zones. It should be emphasized that, of the 818,238 acres of pasture lands, only 282,000 acres (34.5%) can be used for grass-finished cattle production due to the forage quality constraint. All pasturelands, however, can be used for cow-calf production.

Overall, it is estimated that the 282,000 acres of high-quality pasturelands can accommodate between 33,200 and 55,400 heads of cattle annually. The remaining 536,000 acres of "other" pasturelands are mainly used for cow-calf production, which are more suitable for grazing breeding herd rather than beef cow.[34]

The calculation was performed using the following equation:

$$Annualized\ grass - finish\ cattle\ = \frac{Total\ acres}{Grazing\ Season}\ x\ \frac{1}{AUM}\ x\ \frac{12\ months}{Grazing\ Season}$$

Where (1) AUM = AUY / 12 months per year,

(2) AUY = Acres per AU per year,

(3) the last term in the equation represents the annualization factor

Example:

The island of Hawai'i has 122,207 acres of high-elevation wet zones. The stocking rate is around three to four acres per AU. Because the high-elevation wet zones yield high-quality forages, cattle will generally take a shorter amount of time to finish at 18 months. Applying the equation above, we have:

High Estimates:

$$Annualized\ grass - finish\ cattle\ = \frac{122{,}207\ acres}{18\ months}\ x\ \frac{12\ months}{3\ acres\ per\ animal\ unit\ per\ year}\ x\ \frac{12\ months}{18\ months}$$

$$Annualized\ grass - finish\ cattle\ = 18{,}105\ AU\ per\ year\ on\ pasture$$

Low Estimates:

$$Annualized\ grass - finish\ cattle\ = \frac{122{,}207\ acres}{18\ months}\ x\ \frac{12\ months}{4\ acres\ per\ animal\ unit\ per\ year}\ x\ \frac{12\ months}{18\ months}$$

$$Annualized\ grass - finish\ cattle = 13{,}579\ AU\ per\ year\ on\ pasture$$

Recall that the cattle-growing cycle on pastures is between 18 to 24 months depending on the forage quality. This means that producers will not harvest cattle if they have not grazed on pastures for at least 18 to 24 months. The annualized estimates in Table 8 summarize the number of cattle on pastures that can be harvested in any given year.

The pasturelands on Hawai'i island alone can accommodate around 24,600 to 40,100 heads of grass-finished cattle per year. That accounts for 72%-74% (seventy-two to seventy-four percent) of all grass-finished cattle in the state. Kaua'i, on the other hand, can support 4,600 to 8,500

[34] Cattle that are raised for the purpose of beef production.

heads of grass-finished cattle per year (13%-15%), followed by Maui (3,300 to 5,400 heads at 10%) and O‘ahu (680 to 1,300 heads at 2%).

Although 65.5% (sixty-five-point-five percent) of pasturelands are not suitable for grass-finished beef production in Hawai‘i, they serve as the major source of forage for the breeding herd that produces calves. Without these pasturelands, grass-finished cattle and the breeding herd may compete with each other if grazed on the same unit of land. Moreover, the breeding herd is essential to Hawai‘i’s cattle industry as it is the cow-calf sector that provides the animals to the grass-finished sector. This implies that the supply of grass-finished beef will rely entirely on the cow-calf sector if producers decide to retain all calves and grass-finish them locally.

The live weight of a finished cattle is, on average, around 1,095 pounds. The average dressing percentage is at approximately 56% (fifty-six percent) , which equates to 613 pounds per head of cattle.[35] After taking out the percent of inedible and unusable portions at 27% (twenty-seven percent) , a grass-finished cow yields roughly 448 pounds of edible beef. If we multiply this by the maximum grass-finish cattle capacity in Table 8, Hawai‘i will be capable of producing 24.8 million pounds of edible beef. Compared to the estimated future beef consumption at 98.1 million pounds, Hawai‘i can, at best, produce approximately 25% (twenty-five percent) of beef consumed in the state. Obviously, even if all 282,000 acres of high-quality pasturelands were fully utilized, the supply of Hawai‘i's grass-finished beef is still far from meeting the local demand without the imports of beef. Therefore, we expect that the current hybrid business model (i.e., exporting calves to the Mainland and cow-calf production) will continue to coexist in the future, except that the proportion between the two options may vary depending on which operation is more profitable and feasible for producers. In general, ranchers or producers grow more than just grass-finished cattle, and they make their own decisions on the mix of animals and pasture usage.

It should be noted that there is currently less than 1% (one percent) of irrigated pasture besides the 300 acres of pasture lands on Maui.[36] The future capacity estimation in Table 8 is assumed with the increased use of irrigation and pasture management. Currently, there is a restriction on the use of agricultural water from state-owned agricultural water systems for the irrigation of pastures pursuant to Hawai‘i Administrative Rules Section 4-157-3(i). Currently, only pasturelands in the Honoka‘a-Pa‘auilo irrigation system may use agricultural water for irrigation. Consumers for use of water for pastureland from other state-owned agricultural water systems must apply for use from the Hawai‘i Board of Agriculture. This rule may be revised by an administrative rule revision or by legislative action. This administrative rule does not apply to privately owned irrigation systems.

[35] Schweihofer et al, Michigan State University Extension, 2013
[36] Throne M.S., Personal communication, July 14, 2021

Table 8

Estimated Cattle Capacity on Zones Suitable for Grass-Finished Beef Production

Island	Suitability	Elevation	Climate	Area (acres)	Stocking Rate (Number of Acres /Animal Unit/Year) (AUY)	Grazing Season	Stocking Rate (Number of Acres /Animal Unit/Month) (AUM)	Annualized Estimates (Low Est.)	Annualized Estimates (High Est.)
Hawai'i	Suitable for grass-finished beef production	High	Wet	122,207	3 to 4	18	0.250 to 0.333	13,579	18,105
Hawai'i	Suitable for grass-finished beef production	Low	Wet	88,161	1 to 2	24	0.083 to 0.167	11,020	22,040
Hawai'i	Suitable for grass-finished beef production	Subtotal		210,368				24,599	40,145
Kaua'i	Suitable for grass-finished beef production	High	Wet	8,751	3 to 4	18	0.250 to 0.333	972	1,296
Kaua'i	Suitable for grass-finished beef production	Low	Wet	28,738	1 to 2	24	0.083 to 0.167	3,592	7,185
Kaua'i	Suitable for grass-finished beef production	Subtotal		37,489				4,565	8,481
Lāna'i	Suitable for grass-finished beef production	High	Wet	200	3 to 4	18	0.250 to 0.333	22	30
Lāna'i	Suitable for grass-finished beef production	Low	Wet	0	1 to 2	24	0.083 to 0.167	0	0
Lāna'i	Suitable for grass-finished beef production	Subtotal		200				22	30
Maui	Suitable for grass-finished beef production	High	Wet	13,904	3 to 4	18	0.250 to 0.333	1,545	2,060
Maui	Suitable for grass-finished beef production	Low	Wet	9,185	1 to 2	24	0.083 to 0.167	1,148	2,296
Maui	Suitable for grass-finished beef production	Subtotal		23,089				2,693	4,356
Moloka'i	Suitable for grass-finished beef production	High	Wet	2,593	3 to 4	18	0.250 to 0.333	288	384
Moloka'i	Suitable for grass-finished beef production	Low	Wet	2,682	1 to 2	24	0.083 to 0.167	335	671
Moloka'i	Suitable for grass-finished beef production	Subtotal		5,275				623	1,055
O'ahu	Suitable for grass-finished beef production	High	Wet	752	3 to 4	18	0.250 to 0.333	84	111
O'ahu	Suitable for grass-finished beef production	Low	Wet	4,820	1 to 2	24	0.083 to 0.167	603	1,205
O'ahu	Suitable for grass-finished beef production	Subtotal		5,572				686	1,316
Kaho'olawe	Suitable for grass-finished beef production	High	Wet	0	3 to 4	18	0.250 to 0.333	0	0
Kaho'olawe	Suitable for grass-finished beef production	Low	Wet	0	1 to 2	24	0.083 to 0.167	0	0
Kaho'olawe	Suitable for grass-finished beef production	Subtotal		0				0	0
State	Suitable for grass-finished beef production	High	Wet	148,407	3 to 4	18	0.250 to 0.333	16,490	21,986
State	Suitable for grass-finished beef production	Low	Wet	133,586	1 to 2	24	0.083 to 0.167	16,698	33,397
State	Suitable for grass-finished beef production	Total		281,993				33,188	55,383

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

Note 1: The stocking rates used are a generalization. In practice, the stocking rates may vary according to the pasture locations and forage production fluctuation due to precipitation and seasonality.

Note 2: The AUM is calculated by dividing the AUY by 12. For example, 3 / 12 = 0.25 and 4/12 = 0.33333.

Note 3: The formula for calculating the annualized low and high estimates of cattle is as follow: (Acres / Grazing season / AUM) * (12/Grazing season).

3.1.5 Limitations, Constraints and Post-Harvest Issues

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

Today, Hawai‘i imports nearly 90% (ninety percent) of all beef consumed in the state from Mainland or international markets. Conversely, Hawai‘i ranchers export about 80% (eighty percent) of Hawai‘i cattle to the Mainland to be backgrounded, fed out and harvested. The main reason for this is a shift away from local feedlot beef production because of the rising cost of production, including grain import costs in the ‘90s. As costs increased, Hawai‘i beef producers (ranchers) began shipping weaned calves to the Mainland, which was and remains less expensive. The consequence of the contraction of locally finished beef animals was the closing of several harvest plants across the state due to exports and less demand for the facilities. Few remain operational today. As a result, the “harvest bottleneck” remains a major challenge to increasing local beef production.

Finishing in Hawai‘i 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 concentrated diets were reported.

The loss of cattle supplies due to the increase in calves exported led to the shutdown of the final feeding operation.[37] According to the USDA, a feeding operation is defined as congregating animals, feed, manure and urine, dead animals and production operations on a small land area where feed is brought to the animals rather than animals grazing or animals seeking feed in fields or pasturelands. The shutdown of the final feeding operation means that it is no longer an option for Hawai‘i ranchers. They will have to seek alternative ways to raise and market their cattle.

Recently, Hawai‘i Pacific University’s Oceanic Institute (OI) has opened an innovative feed mill in Hilo intending to provide local farmers with cheaper animal feed through donations from Ulupono Initiative and Mclnerny Foundation, as well as support from USDA, HDOA and DLNR. The feed mill incorporates local ingredients such as corn, soy, alfalfa and co-products from agriculture, fisheries and biodiesel sectors to produce experimental feeds. Because a portion of the animal feed may now be produced locally in Hawai‘i using ingredients from the local supply chain rather than importing from out of state, the cost of feed may be lowered.

Grass-finished beef requires more pasture acreage and more time than finishing beef on concentrated feeds in a feedlot. If harvest capacity is the primary limiting factor in the adoption of grass-finished beef production in Hawai‘i, then pasture space is the next most limiting factor. For the industry to shift from its current model (shipping weaned calves to the Mainland) to retaining and finishing all beef animals on grass, it will require either (1) reducing the current breeding herd by a certain proportion in order to maintain the forage demand and forage availability, or (2) acquiring more pasturelands to carry the calves for at least 18 to 24 months.[38] As mentioned

[37] Raising cattle in Hawai‘i. Hawai‘i Beef Industry Council
[38] Thorne, M.S. Memorandum to the Dean and Director of CTHAR. 2008.

earlier, Hawai‘i does possess the pastureland to accommodate more cattle, but the land acquisition may need to undergo a series of time consuming and complex legal procedures, regulations and environmental impact assessments. Moreover, additional development on those acquired lands will be needed prior to being used, which will significantly burden the cost on the producers and eventually be passed on to the consumers.

Water and Climate Change

While Hawai‘i possesses the land for cattle raising, the condition of grazing lands is one of the primary key factors that sustain grass-finished beef production. One major input to the pasture, to provide a consistent and quality production output is a consistent supply of water. Droughts have significantly impacted cattle yield in Hawai‘i. For example, during the circa 2007 drought, the number of cattle units shipped out of Kawaihae Harbor dropped from an average of 304 prior to 2007 to an average of 43 after 2008.

In addition, 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.[39] 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, 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% (forty-nine percent) of the total land area that was considered as pasture have experienced increases in precipitation variability between 1901 and 2014.[40]

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 its beef imports to raising and harvesting 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 is to increase the irrigation on grazing lands from agricultural water systems. The consequences are that these investments may incur considerable amounts 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.

Limitations on Grazing Lands

Another limitation on the availability of grazing lands is that there are numerous competing interests and pressures for land use in the state, which includes, but is not limited to, reforestation, urbanization, biofuel production, expansion of state and national park boundaries, wildlife sanctuaries and military installations.[41]

[39] Fukumoto et al, UH CTAHR, 2015
[40] Sloat et al, “Increasing importance of precipitation variability on global livestock grazing lands”, 2018.
[41] Thorne M.S. (2008). Memorandum to the Dean and Director of CTHAR.

In addition, grazing lands are constantly under pressure from introduced plant and animal species which destroy pasture grass. These introduced species reduce the acreage of active pasturelands available for grazing, and some plant species are deadly to livestock. As droughts increase the pasture becomes more susceptible to invasive plant species and to erosion. Ranchers have adopted integrated weed management on pastures to control the infestation. However, more funds and effort are needed to control these invasive species, and to slow the introduction of invasive species into the state.

Adequate Qualified Butchers:

There is an apparent shortage of qualified butchers, and no local education is available.

- Lack of skilled labor and vocational education courses in developing knowledge of harvest facility operation, meat cutting and meat packaging. The ratio of trained meat cutters to unskilled labor is high, which drives up the labor cost for trained meat cutters.
- Laborers would rather look for similar positions on the Mainland as they cannot afford the housing in Hawai‘i, due to a lack of affordable housing for laborers.

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. Certified beef probably can demand a premium price, and the certification program would serve as an effective marketing tool.

Limited Harvest Operation and Storage Capacity

All operations are working below capacity, at only one shift per day. A large number are working at less than 30% (thirty 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 managers that a more aggressive marketing effort to promote locally grown grass-fed beef is necessary.
- Lack of adequate storage capacity (refrigeration) and advanced processing capability at harvest facilities. Processing equipment is mostly antiqued.

Shifting cattle exports back to retaining and harvesting locally may overload the capacity of harvest facilities and storage space rapidly despite current underutilization. While there are no solid estimates on the storage capacity, we have learned that some harvest facilities are underutilized because there is no sufficient storage space for carcasses. Once the harvest facilities or storage reach the maximum capacity, the production of beef will be limited as will the supply.

The beef industry is, therefore, actively looking for opportunities to expand the harvest in general, and specifically for a Hawai'i-based market cattle[42] and cull cattle.[43] According to the field expert, if the harvesting capacity is increased, exported cull cattle will most likely be harvested in Hawai'i.

Constraints 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 Hawai'i Department of Health (DOH) has set forth detailed guidelines for livestock waste management.[44] The expansion of local harvesting will demand a significant increase in the disposal of inedible parts as well as the waste. Whether the current waste management systems at plants have adequate capacity to handle the amount of waste while ensuring a satisfactory level of hygiene remains questionable.

Transportation

Cattle exports have shrunk by about 7,000 heads since 2006. In the same timeframe, inventory has been reduced by about 20,000 heads, and harvest has increased by about 3,000 or 4,000 heads. For live cattle exports there are two options: air transportation; and ocean-going cargo ships. There are some operations that use air transportation to ship cattle to the Mainland, typically with a Boeing 747 freighter. Ocean-going cargo going directly from the islands to the Mainland can use the transpacific cargo ships, either directly or with inter-island transportation provided by Young Brothers (YB).

Inter-island transportation is a major issue for neighbor island harvest operations. Live cattle shipped interisland is typically performed using YB. YB charges are approved by the Public Utilities Commission (PUC) but are considered expensive from an agricultural industry point-of-view.

The majority of cattle are grown on the island of Hawai'i and processed there, yet the majority of consumers are on the island of O'ahu. As for the finished product, inter-island transportation costs are considered by the industry as expensive. Similarly, as with live animals, there are two options: air transportation and YB. Individual shippers that can't fill an entire shipping container pay the highest prices for YB shipping. Freight consolidation to create full containers substantially reduces the cargo per pound shipping rates. Therefore, freight-forwarders or consolidation facilities should be considered to get better rates.

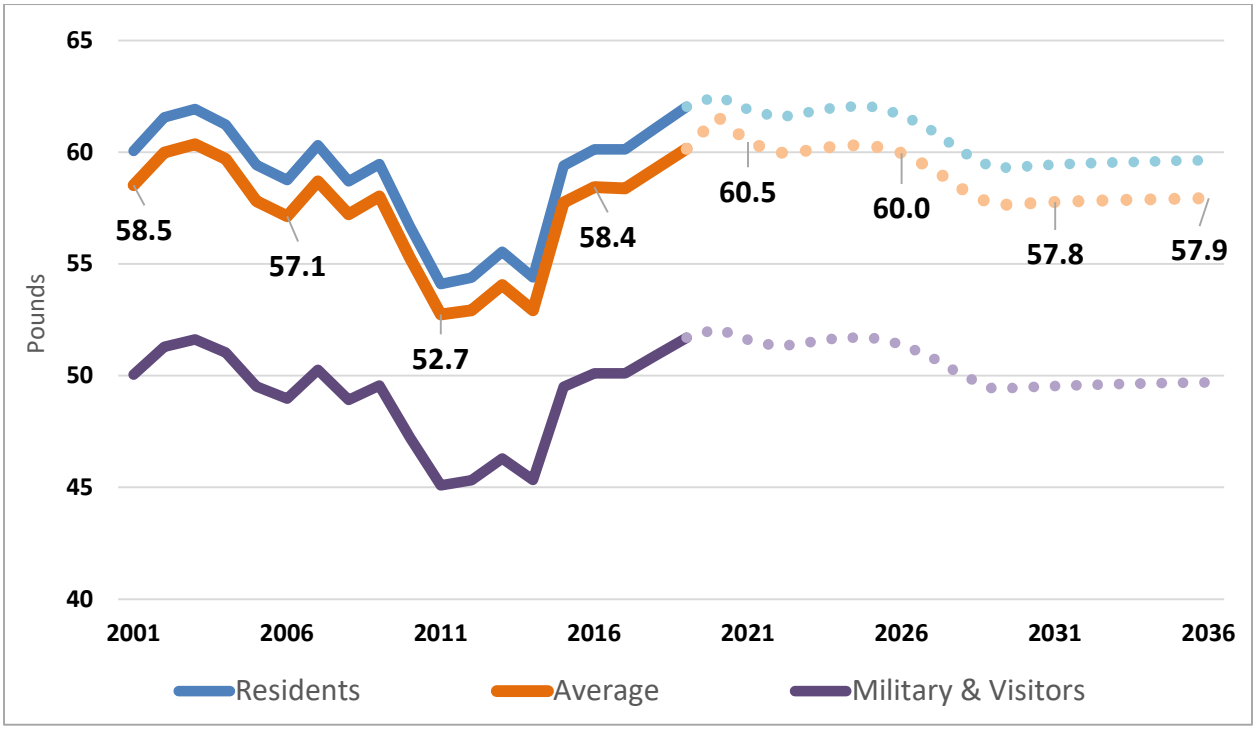
3.2 FORECAST PORK CONSUMPTION

Exhibit 26 below presents the per capita consumption of Hawai'i military, visitors and residents. Based on an estimate, the average military member or visitor will consume 52.1 pounds of pork, and the average Hawai'i resident will consume an estimated 62.5 pounds of pork — giving an

[42] Market cattle refers to cattle that are under 30 months of age.
[43] Cull cattle refers 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.
[44] Appendix for Livestock Waste Management, State of Hawai'i Department of Health, 2010.

average per capita consumption of 61.6 lbs. This is a slight increase from 58.5 pounds in 2001 and 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.

Exhibit 26. Pork Consumption Per Capita (in pounds) in Hawai'i, 2001-2036

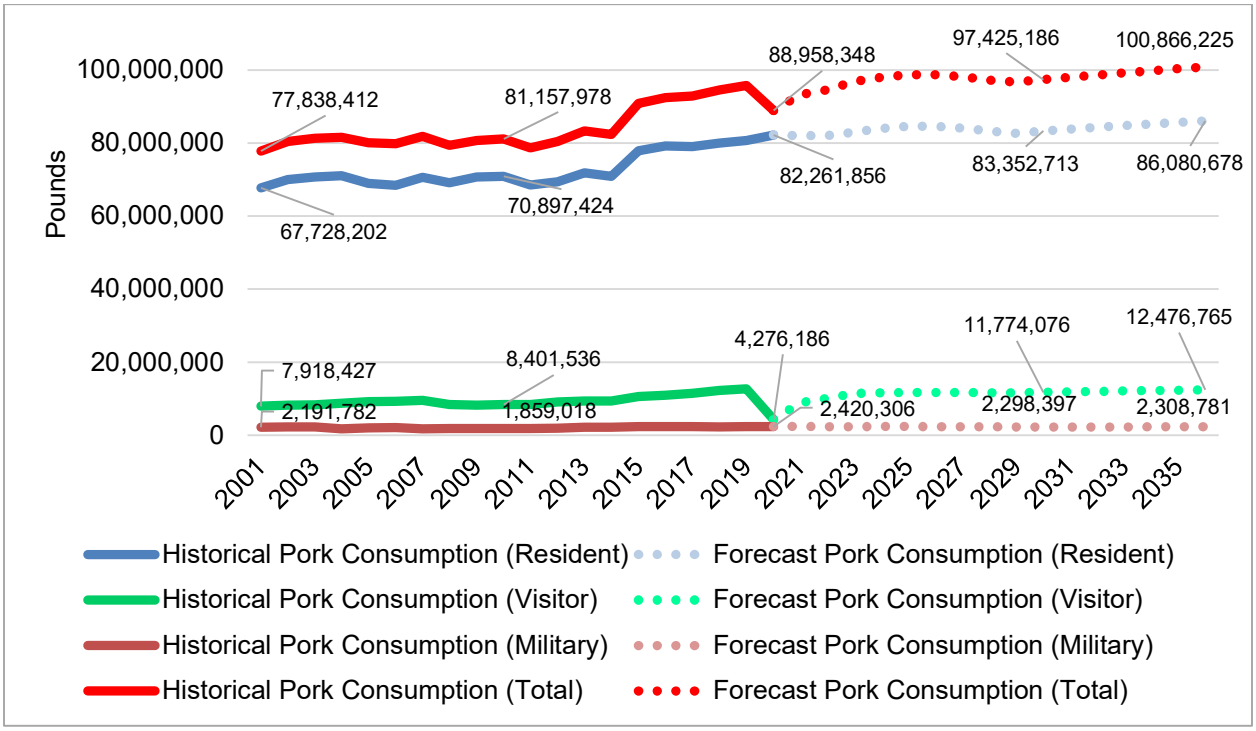


Source: USDA Agricultural Projections to 2029; DBEDT State Databook 2019; DBEDT Population and Economic Projections for the State of Hawai'i to 2045.

As the consumption is based on the *de facto* population, the forecast follows that projection. 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, Hawai'i residents consume about 20% (twenty percent) more pork than non-residents. The unknown in the forecast is the "grey market" hog industry. The historic and forecast consumption for the *de facto* populations is shown on Exhibit 27.

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 Exhibit 27 presents the projected overall pork consumption for 2020-2036. Pork consumption is expected to recover to the pre-pandemic level as soon as 2023. By 2036, pork consumption is estimated at around 101 million pounds.

Exhibit 27. Overall Pork Consumption (in pounds) in Hawai‘i, 2001-2036



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.

3.2.1 Consumption by County, 2001-2036

This section reviews pork consumption by county for 2001-2036. Table 9 summarizes the overall pork consumption by county into two parts: historical and projection. Across all four counties, Honolulu had the highest overall pork consumption, followed by Hawai‘i county, Maui and Kaua‘i between 2015 and 2019.

In 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.

By 2026, overall pork consumption is expected to increase to 14.8 million pounds, 14.4 million pounds and 6.1 million pounds for Hawai‘i county, Maui and Kaua‘i, respectively. 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.

Table 9
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.

3.3 SHEEP AND DEER

There is an opportunity to increase the sales of locally harvested sheep and deer. According to the USDA, the average American consumed 1.1 pounds of lamb or mutton in 2017. Assuming the average resident consumes the same amount, there is an opportunity to produce 1.7 million pounds of edible meat, or almost 20,000 heads of sheep based on the 2021 forecast population. There is a potential to market locally grown axis deer, although the venison market in Hawai'i is limited and Mainland sales may be an option.

3.4 DEMAND CAPACITY ANALYSIS

The market research and analysis form the basis of this demand-capacity analysis, which will be used to determine facility requirements for the scalable and replicable livestock harvesting facility design. Demand analysis will look at a range of market penetration percentages to determine the sizing of the harvesting facility. Cattle supply to the livestock harvesting facility will have an impact on export-calf quantities if more cattle are harvested to meet an increase in market penetration.

Analysis will be based on existing and forecast (2036) consumption scenarios, which represent the quantity of Hawai'i-grown grass-fed beef in the overall livestock market in Hawai'i (market penetration). The existing Hawai'i livestock harvesting capacity has been quantified using interviews with current livestock harvesting owners or managers.

Livestock demand will focus on beef and hogs as these livestock are the majority of Animal Units (AU) harvested. The intent of this analysis is to assist in determining requirements for a new facility — not the renovation and/or upgrade of existing facilities. The proposed facility(s) will be able to accommodate multiple livestock species and are being considered for all islands.

The availability of adequate livestock to meet the scenarios is assumed to be within the carrying capacity of state pasturelands, agriculture areas and agricultural industries. The availability of forecast and potential livestock harvesting quantities will be influenced by many other factors like labor, animal supply, weather, etc. Other factors such as, but not limited to, branding, market

acceptance, price, and intrinsic and extrinsic factors will determine the actual percentage of market penetration of Hawai‘i-grown grass-fed beef.

Most of the harvesting facilities are over 50 years old, with the oldest facility constructed in the 1900s. The facilities on Moloka‘i and Lāna‘i, which are a part of Maui County, are relatively newer harvesting facilities (2000 and 2014, respectively), and have limited demand compared to the other islands. The Moloka‘i and Lāna‘i livestock harvesting facilities are used to process cattle and axis deer, respectively. These newer facilities were designed for and probably continue to meet the livestock demand for that island, as well as current food safety and USDA requirements. Therefore, these islands may not need a new livestock harvesting facility but could benefit from renovations and/or upgrades to expand operations. The concepts described for a new facility may provide ideas for renovations/upgrades for existing facilities.

The analysis verifies HCC’s Hawai‘i county harvesting requirement of 5,000 AU per year (existing), and a future demand of 10,000 AU per year. However, as stated earlier, a 10,000 AU demand will impact the export-calf industry.

3.4.1 Livestock Demand

The existing livestock demand is based on the consumption of livestock by the existing and future *de facto* state population. The majority of livestock consumed in Hawai‘i is beef (cattle) and pork (hogs). There is a small percentage of sheep, goat and deer consumption, which is considered negligible in the facility requirements, but will require processing in existing and future facilities.

Based on harvesting and marketing data, the amount of Hawai‘i-grown cattle harvested for commercial consumption is shown in Table 10. Different data sources indicate that Hawai‘i-grown beef has a market penetration range from 6%-9% (six to nine percent) , while others believe it may be as high as 20% (twenty percent) . For this study, a beef market penetration of 7% (seven percent) is used and reflects cattle harvest quantities collected from the harvesting facilities. Similarly, the pork market penetration is based on the commercial harvesting data, which computes to 0.7% (zero-point-seven percent) . It should be noted that the inclusion of “grey” hog harvesting may substantially increase the market penetration percentage. It is interesting to note that at some facilities there is no processing of the dressed hog carcasses. One of the reasons that no hogs are processed is the use of whole hogs for the “kalua pig” (earthen oven-roasted pig) market.

It should be noted that the harvested livestock quantities shown in Table 10 may not be sold on the island on which it is harvested. Therefore, the market penetration by county may not be as depicted in Table 10. Harvested products are shipped from Hawai‘i island to O‘ahu, and similar exports may occur on other islands. O‘ahu has the largest livestock consumption of products within the state, while most ranching operations occur on the other main islands. Therefore, the market penetration for O‘ahu may be higher, while the market penetration on the other islands may be lower.

Table 10
Existing and Forecast Beef Consumption by County

	Statewide	Kaua'i	O'ahu	Maui	Hawai'i
2019 Total Consumption					
Beef (lbs)	91,067,548	5,475,738	59,697,424	12,827,157	13,067,226
Pork (lbs)	95,764,158	5,758,138	62,776,189	13,488,690	13,741,140
Hawai'i [(1)] Harvest Beef (lbs)	6,376,294	827,219	1,889,189	708,726	2,951,160
Market penetration	7.0%	15.1%	3.2%	5.5%	22.6%
Pork (lbs)	639,600	63,030	140,400	201,697	234,473
Market Penetration	0.7%	1.0%	0.2%	1.5%	1.7%
"Grey" Market Pork Harvest [(1)] (lbs)	5,226,125	515,016	1,147,198	1,648,051	1,915,860
Market Penetration	5.2%	8.1%	1.8%	10.8%	12.0%

Note: (1) Harvested livestock products may not stay on the island on which they are harvested and exported to other islands for market (such as O'ahu). Therefore, the market penetration percentage by county may be lower than computed in the table.

3.4.2 Existing Harvesting Quantities

Based on the seven (7) harvesting facilities contacted during the survey, the average operating percentage is 23% (twenty-three percent) of their maximum capacity, with a range of 20%-60% (twenty to sixty percent) . Due to the limited number of facilities and confidentiality, an island-by-island breakdown is not presented. Based on current and historical data, the statewide annual harvesting capacity is approximately 60,000 AU per year. However, there are limiting factors such as livestock availability, chill storage capacity, processing capacity, market demand, labor, inspection, etc.

Currently, the majority of AU harvested are cattle, with a small percentage being hogs, while other livestock are harvested at a much smaller quantity. The exception is the Lāna'i harvesting facility, which harvests axis deer. In the past, hog harvest quantities ranged from 10,000 to 12,000 AU a year, as live hogs were imported into Hawai'i. This practice ended due to opposition and campaigning by animal rights activists concerned with the humane treatment of imported hogs.

The number of cattle units harvested has also declined since the 1990s as imported grain-based feed/fodder became too expensive for the cattle industry. As a result, the export-calf market was developed, shipping calves to the Mainland at about 18 months of age to be raised in Mainland pastures and feedlots. This practice continues today with approximately 41,000 calves exported per year.

To accommodate different livestock species for harvest, different days or times typically are set aside for each species. This allows the facility to set up for the species to be harvested and meet USDA and other food safety and processing requirements. Therefore, although there is additional

capacity to harvest livestock, it also depends on the species involved and the feasibility of the operations to accommodate multiple species at their facility. Currently, the physical plant limitations are due to the age of the current facilities, with the most pressing issues being limited or inefficient processing systems and lack of chill storage capacity. Processing capacity is also limited by labor, inspection and, recently, COVID-19 rules and regulations.

As far as Hawai'i County, data collected shows that the total harvest for 2019 meets or exceeds 5,000 AU per year. Even with this demand, Hawai'i island facilities are probably operating at 20%-30% (twenty to thirty percent) of their designed harvesting capacity.

3.4.3 Forecast Harvesting Quantities

The forecast animal harvest is based on the demand capacity analysis, which shows a potential for an increase in livestock harvesting within the state. This is based on the expected population and forecasting principles. Table 11 shows the statewide 2019 beef and hog harvest and forecast 2036 harvest based on market research forecast. For beef, market penetration increases by 2% (two percent) . Similarly, pork market penetration increases by 2% (two percent) .

Table 11
Statewide Beef and Hog Harvesting

	2019 – Beef	Market Research Beef Forecast (est. 2029)[a]	2019 - Hog	Market Research Hog Forecast (est. 2029)[a]
	7% Market Penetration	9% Market Penetration	<1% Market Penetration	>3 % Market Penetration
Harvest (000 lbs)	6,375	8,080	640	3,200
Harvested per year (AU/year)	14,260	18,060	4,100	20,450
Harvested per week (AU/week)	274	347	80	400
Ground Beef				
Boxes / week	1,239	1,569		
Cuts				
Boxes / week	1,075	1,361		
Offal				
Boxes / week	199	252		

Notes: 1) All quantities are estimations and approximate, and to be used for planning purposes only.
2) Assume hog carcasses are not processed and dressed carcasses are provided whole to ranchers.
a) The forecast year is provided for planning purposes; the actual beef consumption should be monitored to adjust the market penetration year.

In addition, preliminary consumer demand research (upcoming interim report) shows that market penetration may increase to approximately 15% (fifteen percent) by 2028. Consumer demand research found that there is potential for a small-scale Hawai'i niche market on the Mainland. The

percent of market penetration will be limited by cattle and hog production, which are dependent on factors such as water, labor, land and other resources. The number of boxes per week is based on the following percentages for production: 41% (forty-one percent) ground beef, 30% (thirty percent) cuts and 3% (three percent) offal.[45]

The first scenario for beef and hog industries maintains the current market penetration, approximately 7% (seven percent) for each sector. The other scenarios are as follows with respective quantities shown in Table 12:

- Beef Industry
  - Doubling the market penetration percent to approximately 14% (fourteen percent) ,
  - Increasing market penetration to 20% (twenty percent) ; and
- Hog Industry
  - Converting a portion of the "grey" market hog harvesting to commercial grade harvesting to meet a market penetration of 5% (five percent) .

Table 12
Forecast Statewide Beef and Hog Harvesting

	2019 - Beef	2036 – Beef Forecast			2019 - Hog	2036 – Hog Forecast	
	Market Penetration	Market Penetration			Market Penetration	Market Penetration	
	7%	7%	14%	20%	<1%	<1%	5%
Harvest (000 lbs)	6,375	7,200	14,450	19,630	640	675	5,250
Harvested (AU/year)	14,260	16,150	32,310	43,900	4,100	4,300	33,500
Harvested (AU/week)	274	311	621	844	80	85	650
Ground Beef							
Boxes / week	1,239	1,406	2,808	3,816			
Cuts							
Boxes / week	1,075	1,220	2,436	3,310			
Offal							
Boxes / week	199	226	451	613			

Notes: 1) All quantities are estimations and approximate, and to be used for planning purposes only.
2) Assume hog carcasses are not processed and dressed carcasses are provided whole to ranchers.
3) Boxes are dependent on the size of boxes — used for planning purposes only.

[45] Offal products include the heart, liver, tongue, oxtail and kidney.

The quantities in Table 12 show the number of AU harvested based on the dressed carcasses percentage of approximately 60% (sixty percent)[46] and processing. Based on previous data analysis, it showed that 59% (fifty-nine percent) of beef is sold as ground beef, 40% (forty percent) is sold as cut beef (steaks, chops, etc.) and a small percentage of offal (organs, etc.) are sold. For the hog market, it is assumed that dressed hogs are returned to the rancher and that there is no processing of dressed hog carcasses. Facilities can be used for hog processing on days not used for beef processing, and with adequate regulatory cleaning and inspection. Table 12 also shows approximate quantities by weight and by boxes per week of ground beef, cut beef and offal for commercial sale by week.

Using the 20% (twenty percent) beef market share and 5% (five percent) hog market share, the total AU harvested per year is 77,400. This combined total AU exceeds the 2016 harvesting capacity of the statewide harvesting facilities. It should be noted that the processing rate for each livestock species is different and varies with the facility. The number of boxes per week is provided to assess storage and transportation facility requirements.

These forecasts show a range of numbers for the development of the facility and the timeline is provided to relate to population growth. However, actual demand will dictate the need for new facilities and/or renovation of existing facilities. As shown in the consumer market forecast (interim report), increased demand could occur within seven (7) years and may outstrip supply. The consumer forecast shows an optimistic view of having approximately 15% (fifteen percent) market penetration in the Hawai‘i beef market, which may not be attainable in the short term.

3.4.4 Demand by County

Tables 13-16 provide a breakdown of beef and hog demand for counties based on statewide demand. Harvesting quantities are based on 2019 livestock harvesting facility data provided through interviews. As stated earlier, actual harvested quantities may not be sold on-island to meet the on-island demand but sold to O‘ahu as it is the larger consumer market. This is especially true for Hawai‘i county facilities, which include one of the largest harvesting facilities in the state and encompasses a large percentage of the state’s Hawai‘i-grown cattle.

[46] Actual dressed carcass weights may differ. Initial surveys indicate a dress carcass weight of 56% of the live weight for Hawai‘i grass-fed cattle.

Table 13
Kaua‘i Beef and Hog Harvesting

	2019 - Beef	2036 – Beef Forecast			2019 - Hog	2036 – Hog Forecast	
	Market Penetration	Market Penetration			Market Penetration	Market Penetration	
	7%	7%	14%	20%	<1%	<1%	5%
Harvest (000 lbs)	830	940	1,880	2,550	63	66	515
Harvested per year (AU)	1,850	2,100	4,200	5,700	404	426	3,301
Harvested per week (AU)	36	40	81	110	8	8	64
Ground Beef							
Boxes / week	163	181	366	497			
Cuts							
Boxes / week	141	157	318	431			
Offal							
Boxes / week	26	29	59	80			

Notes: 1) All quantities are estimations and approximate, and to be used for planning purposes only.
2) Assume hog carcasses are not processed and dressed carcasses are provided whole to ranchers.

Table 14
O‘ahu Beef and Hog Harvesting

	2019 - Beef	2036 – Beef Forecast			2019 - Hog	2036 – Hog Forecast	
	Market Penetration	Market Penetration			Market Penetration	Market Penetration	
	7%	7%	14%	20%	<1%	<1%	5%
Harvest (000 lbs)	1,900	1,950	3,900	5,300	140	150	1,150
Harvested per year (AU)	4,225	4,350	8,700	11,830	900	950	7,350
Harvested per week (AU)	81	84	167	228	17	18	141
Ground Beef							
Boxes / week	366	380	755	1,031			
Cuts							
Boxes / week	318	329	655	894			
Offal							
Boxes / week	59	61	121	166			

Notes: 1) All quantities are estimations and approximate, and to be used for planning purposes only.
2) Assume hog carcasses are not processed and dressed carcasses are provided whole to ranchers.

Table 15
Maui Beef and Hog Harvesting

	2019 - Beef	2036 – Beef Forecast			2019 - Hog	2036 – Hog Forecast	
	Market Penetration	Market Penetration			Market Penetration	Market Penetration	
	7%	7%	14%	20%	<1%	<1%	5%
Harvest (000 lbs)	710	825	1,650	2,235	200	215	1,650
Harvested per year (AU)	1,585	1,840	3,680	5,000	1,290	1,360	10,565
Harvested per week (AU)	30	35	71	96	25	26	203
Ground Beef							
Boxes / week	136	158	321	434			
Cuts							
Boxes / week	118	137	278	377			
Offal							
Boxes / week	22	25	52	70			

Notes: 1) All quantities are estimations and approximate, and to be used for planning purposes only.
2) Assume hog carcasses are not processed and dressed carcasses are provided whole to ranchers.

Table 16
Hawai‘i Beef and Hog Harvesting

	2019 - Beef	2036 – Beef Forecast			2019 - Hog	2036 – Hog Forecast	
	Market Penetration	Market Penetration			Market Penetration	Market Penetration	
	7%	7%	14%	20%	<1%	<1%	5%
Harvest (000 lbs)	2,950	3,515	7,035	9,600	235	247	1,920
Harvested per year (AU)	6,600	7,860	15,730	21,370	1,505	1,585	12,280
Harvested per week (AU)	127	151	303	411	29	30	236
Ground Beef							
Boxes / week	574	683	1,370	1,858			
Cuts							
Boxes / week	498	592	1,188	1,612			
Offal							
Boxes / week	92	110	220	299			

Notes: 1) All quantities are estimations and approximate, and to be used for planning purposes only.
2) Assume hog carcasses are not processed and dressed carcasses are provided whole to ranchers.

3.5 FACILITY REQUIREMENTS

The goal is to have a conceptual design for a scalable and replicable livestock harvesting facility. To provide an efficient design, a demand range based on the possible scenarios was determined. Based on the potential scenarios and to provide a harvesting facility for 10,000 AU on the Big Island, the demand range selected was from 1,500 to 10,000 AU per year. These numbers are estimates — specific livestock and processing information may vary from island to island and from ranch to ranch. The sizing of a facility should be based on actual livestock demand, livestock size and species that will be harvested. These facility requirements are for planning purposes only and to establish a conceptual livestock harvesting facility to determine a facility concept. In addition, no actual site has been chosen and site characteristics may have a significant influence on the facility requirements and concept.

Facility requirements are based on the following average cattle data per unit and assumes that hogs, deer and other livestock species are harvested but not processed beyond the dressed carcass. The dressed carcass weight for cattle is based on a yield percentage of 56% (fifty-six percent) with the breakdown in Table 17.

TABLE 17
Beef Livestock Harvesting Properties

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

Based on forecasts for various market penetration rates, Table 18 shows the following range for the demand by island for 2036. The number of cattle per day is based on an operating schedule with two days (2 days) of harvest per week and three days (3 days) of processing. The limited number of operational days considers labor shortages that are having an impact on the current harvesting operation. However, the unconstrained processing schedule would be a six-day (6-day) harvest and processing operation.

Table 18
Summary of Demand by County

Description	Kaua'i	Honolulu	Maui	Hawai'i
Number of cattle per week	40 - 110	84 – 228	35 - 96	151- 411
Number of Cattle per day	20 – 55	42 – 113	18 - 48	76 - 206
Boxes – Ground beef per week	181 - 497	380 – 1,031	158 – 434	683 – 1,858
Boxes – Cuts per week	157 – 431	329 - 894	137 – 377	592 – 1,612
Boxes - Offal per week	61 - 166	329 – 894	25 – 70	110 – 299
Waste disposal pounds per day (average)	5,000 - 13,400	10,200 – 27,600	4,300 – 11,700	18,300 – 49,800
Number of hogs per week	8 - 64	18 – 141	26 - 203	30 – 236

It should be noted that Moloka'i and Lāna'i are below the 1,000 AU per year (or 20 per week) demand and have less older facilities than other islands. For those areas below 1,000 AU per year, commercially available mobile processing units could be an economical alternative. Manufacturers of mobile processing units include Friesla and TriVan, to name a couple. The USDA has resources available from the Food Safety and Inspection Service (FSIS) Small Plant Help Desk or from their cooperative Extension System and Niche Meat Processor Assistance Network (NMPAN) (website: An Introduction to Mobile Slaughter Units | USDA, April 25, 2021).

Other factors that may influence demand and facility requirements are meat tenderness and domestic (continental U.S.) markets. One concern about Hawai'i-grown grass-fed beef was its tenderness. For these facilities, wet-aging was chosen to improve tenderness in the grass-fed beef, and, therefore, adequate storage is provided in the design for this purpose.

Domestic markets were shown to be an interesting niche market, which may have a potential greater than the Hawai'i-based market. Although food sustainability is an objective, most farmers/ranchers are concerned about the financial/economic sustainability of the farm/ranch.

Hawai'i has relatively low rates for domestic air and maritime cargo due to the transportation network established by the visitor industry. Maritime cargo ships carry little product from Hawai'i to the Mainland and, therefore, offer lower rates for cargo to the Mainland. Air cargo typically is shipped in the cargo holds of passenger aircrafts, which allow for the majority of operating costs to be paid for by air passengers. In addition, air cargo carriers such as FedEx offer Hawai'i agriculture discounted rates and provide service to cities to major domestic and international airports.

The following assumptions were used to determine facility requirements:

- The site has suitable dimensions for the structure and ancillary improvements such as parking, roadways, setbacks and zoning requirements.
- The site is level (flat) with suitable soils and adequate drainage.
- Waste disposal will be analyzed; however, final determination will be site specific.
    - Additional research and discussion about reuse and recycling of specific offal products will be needed.

    - Transport to O‘ahu to be rendered at Island Commodities, Corp. for use as agricultural field supplements.
- The site will be in close proximity to utilities and a transportation network.
- Site-specific geotechnical information will be required for structural analysis and may alter the design.
- Structure will be pre-cast concrete walls.
- Ownership of meat and other branding issues are not considered at this time.
- Regulatory documentation to meet the various standards and regulations is beyond the scope of this study.
- Multi-species will be processed.
- Cattle will arrive in various truck sizes, from small stock trailers to semi-trailers (40-foot containers).
- Beef harvest operation — initially — two days per week due to labor concerns.
- Beef processing operation — initially — two to three days per week due to labor concerns.
- Hog harvest only, no processing.
- Majority ground beef processing (60% of total product).
- Cuts processing (40% of total product).
- Wet-aging to improve tenderness.
    - Storage for wet-aging from 14 to 21 days depending on shipping and product.
- Storage for frozen products (one to two weeks).
- Meet USDA, British and OSHA requirements.
- Meet all applicable building codes and standards.
- Ability to receive and process partially dressed carcasses (fourth, eights, etc.) from other livestock harvesting facilities.
- Include potential for value added processing, such as
    - Tripe processing,
    - individual quick-frozen patties; and
    - retail store.

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CHAPTER 4
ALTERNATIVE CONCEPT ANALYSIS

The goal of the project is to provide a concept facility that is scalable and replicable to meet the livestock harvesting demands in different areas of the state. To meet this goal, the demand and forecast analysis in the previous chapter determined the size and facility requirements for the facility. Pursuant to the project goal, the facility needs to be scalable and, therefore, the concepts provide two ends of the harvesting spectrum — small and large concept alternatives. Therefore, the processing facility concepts share similar building characteristics such as footprints, layout and processing to show scalability with the spectrum. The concepts for the building are replicable on all islands on suitable sites. Construction materials or substitutes are available on all major islands. The harvesting and fabrication equipment must be shipped into the state, and shipping costs and space availability may differ from island to island. As previously stated, a site was not selected, therefore, the actual building layout may not be suitable for all sites, associated land uses, site specific topography and utility availability.

In addition to the harvesting building, two other functions were studied to provide alternative solutions: 1) wastewater and solid waste treatment, and 2) energy supply. The waste alternative analysis includes concepts for off-site disposal and on-site treatment. The energy alternative concept presents a planning level analysis for the potential use of photovoltaic energy (solar panels) to partially power the facility. The chapter also includes environmental considerations, including a list of major permits that may be needed.

4.1 HARVESTING FACILITY CONCEPTS

Based on the facility requirements, concepts for a 20 animal units per day (AU/day) and 70 AU/day harvesting demand was developed. In addition, to allow for future expansion and to address Hawai‘i‘s labor shortage, the concept was based on a two-day (2-day) slaughter and three-day (three-day) processing schedule. However, it should be noted that use of harvest staff for fabrication line staff and/or vice versa may not be optimal or efficient (note: this arrangement has not worked in other facilities).

In the future, if additional processing capacity is needed, the number of operational days can be increased to accommodate the additional demand. This is workable if the labor pool has adequate workers with the required skill sets. The livestock harvesting per day capacity will be higher for smaller livestock such as hogs, sheep and goats. In the case of smaller AU, in which the final end product is the dressed carcasses, it is possible to perform the slaughter on days that are reserved for beef fabrication. Again, this will be a decision by the facility management and labor requirements.

Three initial concepts were considered in the alternative discussion and the concept layouts are presented in the following figures. Figures 1, 2 and 5 present the overall layout of the 20 AU/day and 70 AU/day concepts, respectively. Figure 2 provides a 70 AU/day concept with a mezzanine for offices, while Figure 5 presents a 70 AU/day concept on a single floor. Figures 3 and 4 provide

enlarged plans for the 70 AU/day two-story concept, and Figures 6 and 7 provide enlarged plans for the 70 AU/day single floor concept. The facilities represent the smaller and larger harvesting capacities and show the range of the floor area per function.

The concepts have similar functional areas to allow for scalability and flexibility. Table 19 shows a comparison of spatial dimensions for the various functional areas for the two (2) single floor concepts. The two-story (2-story) story concept was not considered further as the single floor concept was more efficient and accessibility issues arose during the initial discussions.

The pen area is designed for 10 cattle lots and the size and number of pens may need to be resized based on the location of the facility and the ranches it serves. Similarly, the type of vehicle that delivers the cattle to the facility will vary by location and, therefore, the cattle loading area and pens may need to be adjusted. Certain functions have similar areas in both concepts, such as the harvest area, shipping/receiving dock, retail store, etc.

Table 19
Comparison of Functional Areas

Description	20 AU/day (square feet)	70 AU/day (square feet)
Total floor area	14,060	19,660
Pen area	2,840	4,900
Harvest (including tripe)	2,030	2,040
Vestibule/Hygiene Lock	370	370
Fabrication	2,490	4,550
Carcass Chill Storage	450	980
Sale Chill Storage	500	1,130
Freezer	500	740
Finished goods Chill	1,230	1,980
Dry Goods Storage	600	660
Shipping/Receiving Dock	710	720
Value Added Products	n/a	400
Retail Sales	370	350
Office and employee	2,690	3,170
Support Facilities	1,420	1,800
Inedible and Waste-out	700	770

Note: Summation of the areas may not equal totals due to rounding.

The two (2) single-floor concepts have a similar processing line, making the facility scalable to meet different "base"[47] processing capacity. This linear processing feature expansion is readily seen in comparing the two concepts. The 70 AU/day facility has a lengthened fabrication line, by about 20 feet, to accommodate additional worker stations and fabrication requirements. The fabrication room for 70 AU/day was increased in length by approximately 60 feet to accommodate

[47] The "base" configuration should meet the livestock harvesting demand in the area or the investor. Currently 20 hd/day and 70 hd/day demands were used for the conceptual layout. Other areas may require different demand or have livestock demand which may not be beef dominated. The "base" design is critical to ensure the facility is not over- or under-sized for the area.

the increased capacity and to allow for additional expansion, if it is needed. The width of the fabrication room, as well as the overall exterior dimensions, are similar.

Both concepts allow for expansion of the cooling and chill rooms, if more storage is required for the functional areas. In these concepts, a retail store is contemplated, and in the 70 AU/day concept “added value production” is accommodated in the fabrication area.

4.2 PROCESS FLOW

The general flow of the AU through both concepts is relatively similar and are shown in Figure 8 for the 70 AU/day facility. Starting at the live AU unloading into the pen area, the AU are then sorted into their respective pens in the pen area. Depending on the AU, the AU are placed in one of two restraint queues, prior to entering the harvesting area. The AU are then harvested through the harvest area, with the inedibles (hides, bones, etc.) moved to the inedible load out area. The internal organs are also sorted for edible products (such as tripe), and the waste contents are disposed of.

From the harvesting area, the dressed carcass moves to the “carcass cool” area and eventually to the “carcass sales” cooler. At that point the dressed carcass: 1) awaits fabrication or 2) moves to the shipping dock to be picked up by the AU’s owner. The output of whole dressed carcass such as hogs and deer would be typical for the small AU.

In the fabrication line, the various cuts and ground beef are processed, and then moved to the finished goods cooler. Within the fabrication area, ground beef patties and valued-added products can be produced. The beef cuts are vacuum sealed and moved into the finished storage chiller. The finished storage chiller is sized to provide wet-aged storage for approximately 12 to 21 days.[48] In addition, a blast freezer is provided for finished products as needed. The shipping dock neighbors the finished goods chill storage for efficient movement.

Along the fabrication line are offices and staff areas, support services and utilities. These are located and segregated from the AU processing to comply with food and work safety rules and regulations. The figure also depicts future expansion for the storage if needed.

The concept is designed to accept AU carcass portions through the shipping and receiving docks. Carcass portions are accepted at the dock and travel on rollers to the start of the fabrication line, near the exit from the carcass sales cooler.

[48] As noted earlier, wet-aging was chosen to alleviate some of the comments about the tenderness of grass-fed beef.

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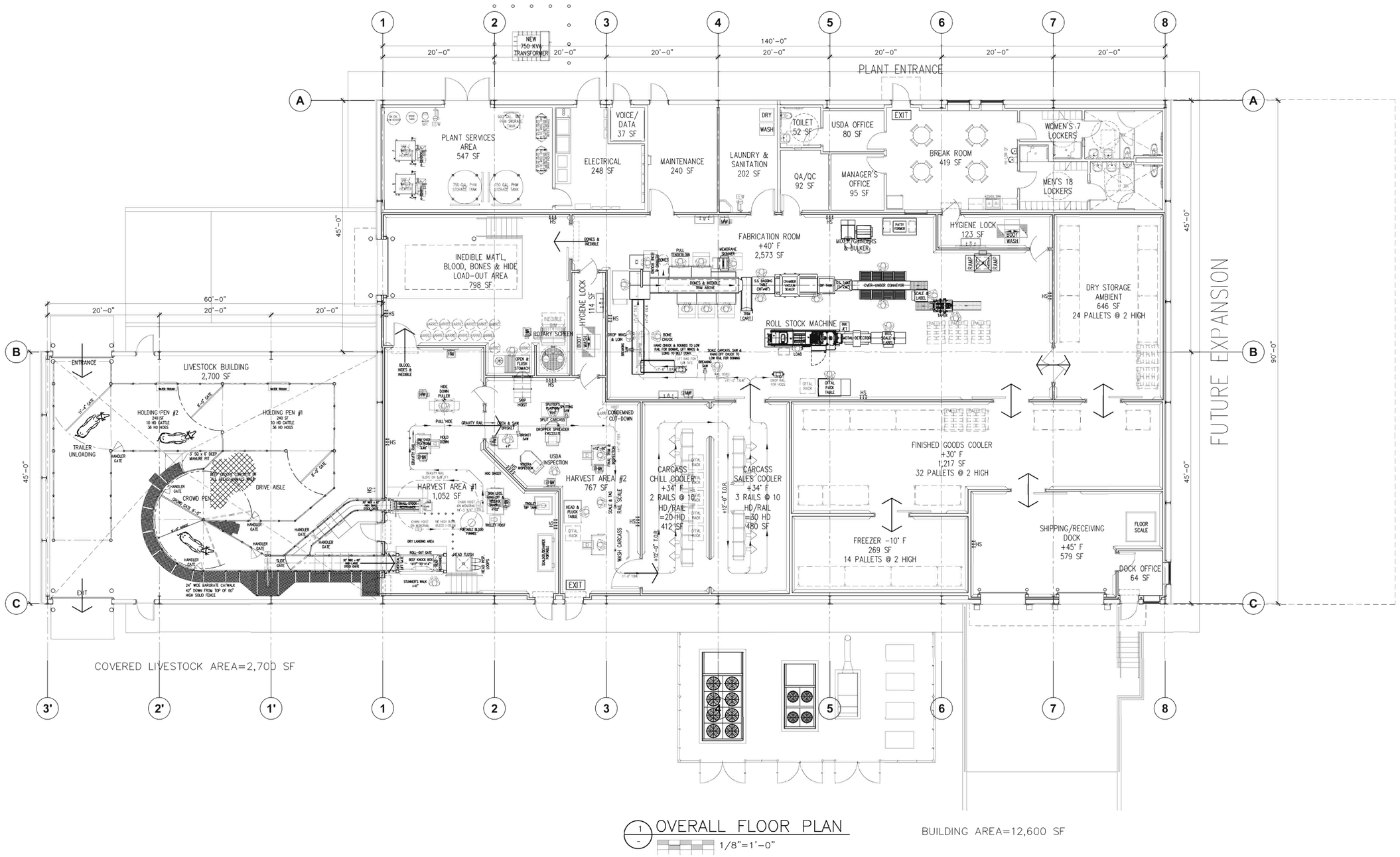
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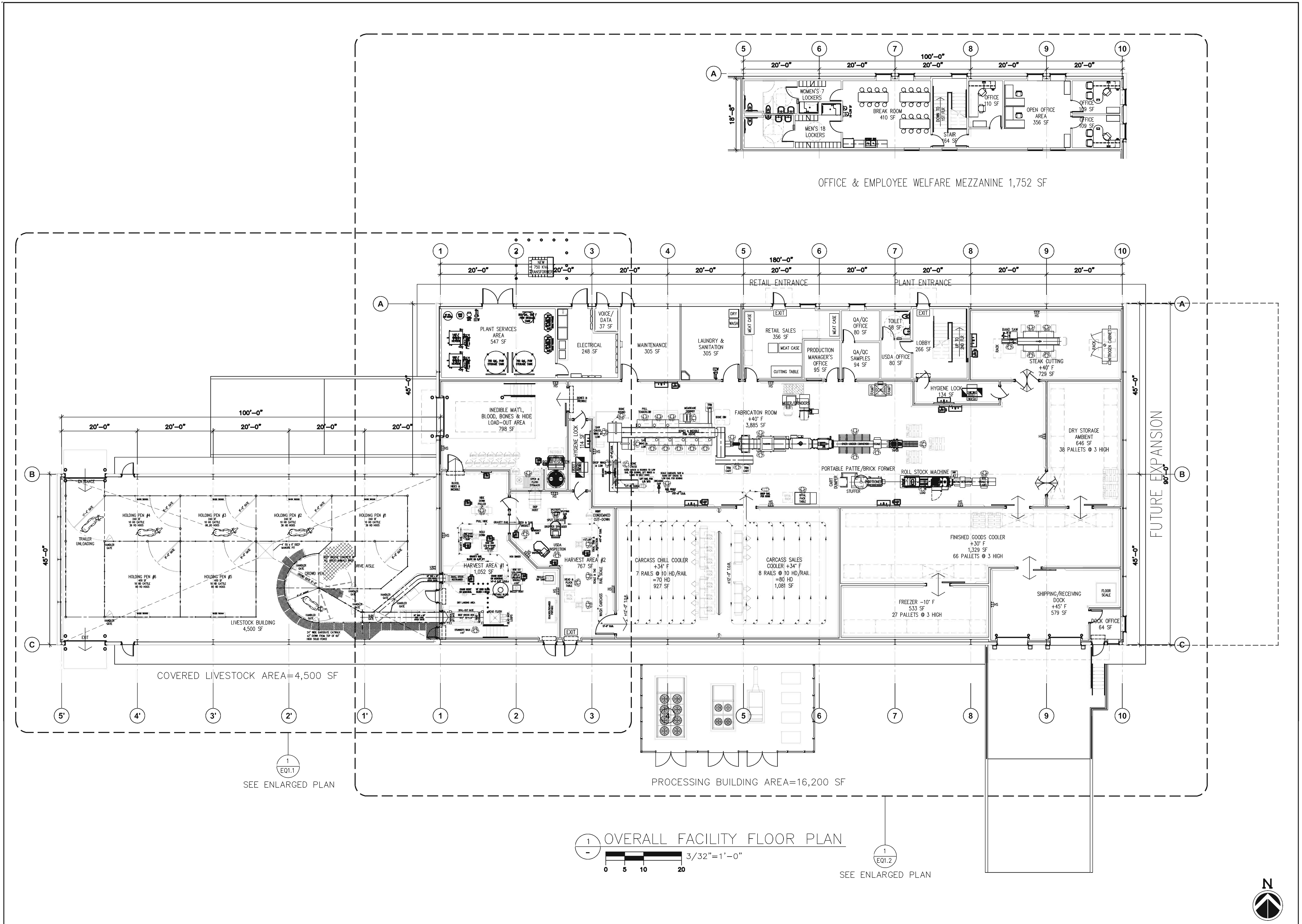
FUTURE EXPANSION
NEW 750-KVA TRANSFORMER
PLANT SERVICES AREA 547 SF
ELECTRICAL 248 SF
VOICE/ DATA 37 SF
MAINTENANCE 240 SF
LAUNDRY & SANITATION 202 SF
DRY WASH
TOILET 52 SF
USDA OFFICE 80 SF
QA/QC 92 SF
MANAGER'S OFFICE 95 SF
EXIT
BREAK ROOM 419 SF
WOMEN'S 7 LOCKERS
MEN'S 18 LOCKERS
HYGIENE LOCK 123 SF
FOOT WASH
RAMP
INEDIBLE MAT'L, BLOOD, BONES & HIDE LOAD-OUT AREA 798 SF
HYGIENE LOCK 114 SF
FABRICATION ROOM +40° F 2,573 SF
MIXER/GRINDERS & BULKER
PATTY FORMER
ROLL STOCK MACHINE
DRY STORAGE AMBIENT 646 SF 24 PALLETS @ 2 HIGH
ROTARY SCREEN
ENTRANCE
LIVESTOCK BUILDING 2,700 SF
HOLDING PEN #2 240 SF 10 HD CATTLE 36 HD HOGS
HOLDING PEN #1 240 SF 10 HD CATTLE 36 HD HOGS
TRAILER UNLOADING
CROWD PEN
DRIVE AISLE
HARVEST AREA #1 1,052 SF
HARVEST AREA #2 767 SF
USDA INSPECTION
CARCASS CHILL COOLER +34° F 2 RAILS @ 10 HD/RAIL =20 HD 412 SF
CARCASS SALES COOLER +34° F 3 RAILS @ 10 HD/RAIL =30 HD 480 SF
FINISHED GOODS COOLER +30° F 1,217 SF 32 PALLETS @ 2 HIGH
FREEZER -10° F 269 SF 14 PALLETS @ 2 HIGH
SHIPPING/RECEIVING DOCK +45° F 579 SF
FLOOR SCALE
DOCK OFFICE 64 SF
COVERED LIVESTOCK AREA=2,700 SF
BUILDING AREA=12,600 SF
OVERALL FLOOR PLAN
1/8"=1'-0"
0 2 4 6 8 10
N


OFFICE & EMPLOYEE WELFARE MEZZANINE 1,752 SF
WOMEN'S 7 LOCKERS
MEN'S 18 LOCKERS
BREAK ROOM 410 SF
STAIR 64 SF
OFFICE 110 SF
OPEN OFFICE AREA 356 SF
OFFICE 109 SF
OFFICE 109 SF
100'-0"
20'-0"
18'-8"
180'-0"
RETAIL ENTRANCE
PLANT ENTRANCE
PLANT SERVICES AREA 547 SF
VOICE/ DATA 37 SF
ELECTRICAL 248 SF
MAINTENANCE 305 SF
LAUNDRY & SANITATION 305 SF
RETAIL SALES 356 SF
MEAT CASE
CUTTING TABLE
PRODUCTION MANAGER'S OFFICE 95 SF
QA/QC OFFICE 80 SF
QA/QC SAMPLES 94 SF
TOILET 58 SF
USDA OFFICE 80 SF
LOBBY 266 SF
HYGIENE LOCK 134 SF
STEAK CUTTING +40° F 729 SF
INEDIBLE MAT'L, BLOOD, BONES & HIDE LOAD-OUT AREA 798 SF
HYGIENE LOCK 114 SF
FABRICATION ROOM +40° F 3,885 SF
PORTABLE PATTIE/BRICK FORMER
ROLL STOCK MACHINE
DRY STORAGE AMBIENT 646 SF 38 PALLETS @ 3 HIGH
FUTURE EXPANSION
HARVEST AREA #1 1,052 SF
HARVEST AREA #2 767 SF
USDA INSPECTION
CARCASS CHILL COOLER +34° F 7 RAILS @ 10 HD/RAIL =70 HD 927 SF
CARCASS SALES COOLER +34° F 8 RAILS @ 10 HD/RAIL =80 HD 1,081 SF
FINISHED GOODS COOLER +30° F 1,329 SF 66 PALLETS @ 3 HIGH
FREEZER -10° F 533 SF 27 PALLETS @ 3 HIGH
SHIPPING/RECEIVING DOCK +45° F 579 SF
FLOOR SCALE
DOCK OFFICE 64 SF
EXIT
HOLDING PEN #1
HOLDING PEN #2
HOLDING PEN #3
HOLDING PEN #4
HOLDING PEN #5
HOLDING PEN #6
TRAILER UNLOADING
ENTRANCE
CROWD PEN
LIVESTOCK BUILDING 4,500 SF
45'-0"
90'-0"
COVERED LIVESTOCK AREA=4,500 SF
PROCESSING BUILDING AREA=16,200 SF
1 EQ1.1 SEE ENLARGED PLAN
1 EQ1.2 SEE ENLARGED PLAN
1 OVERALL FACILITY FLOOR PLAN
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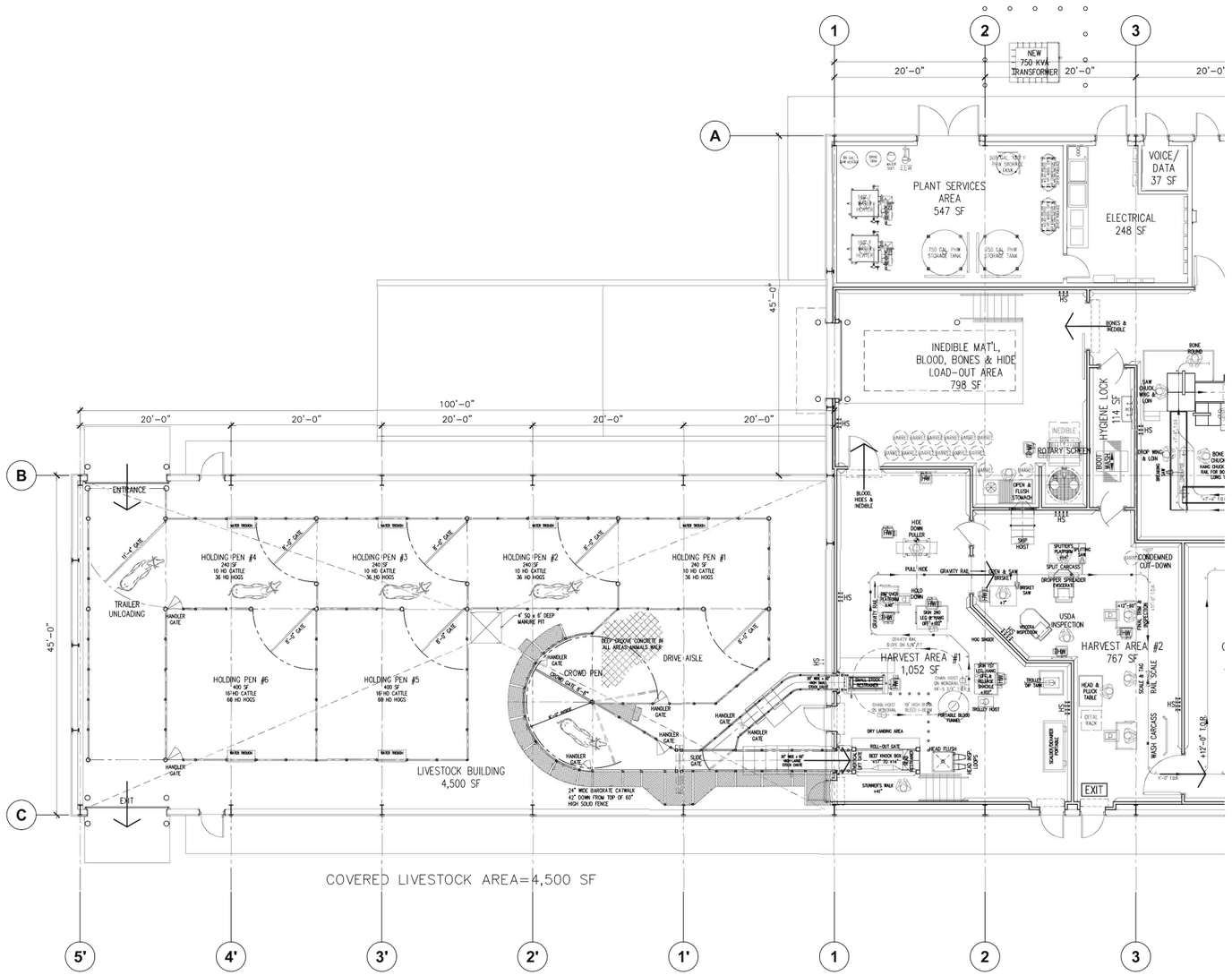

1 LIVESTOCK & HARVEST AREA FLOOR PLAN

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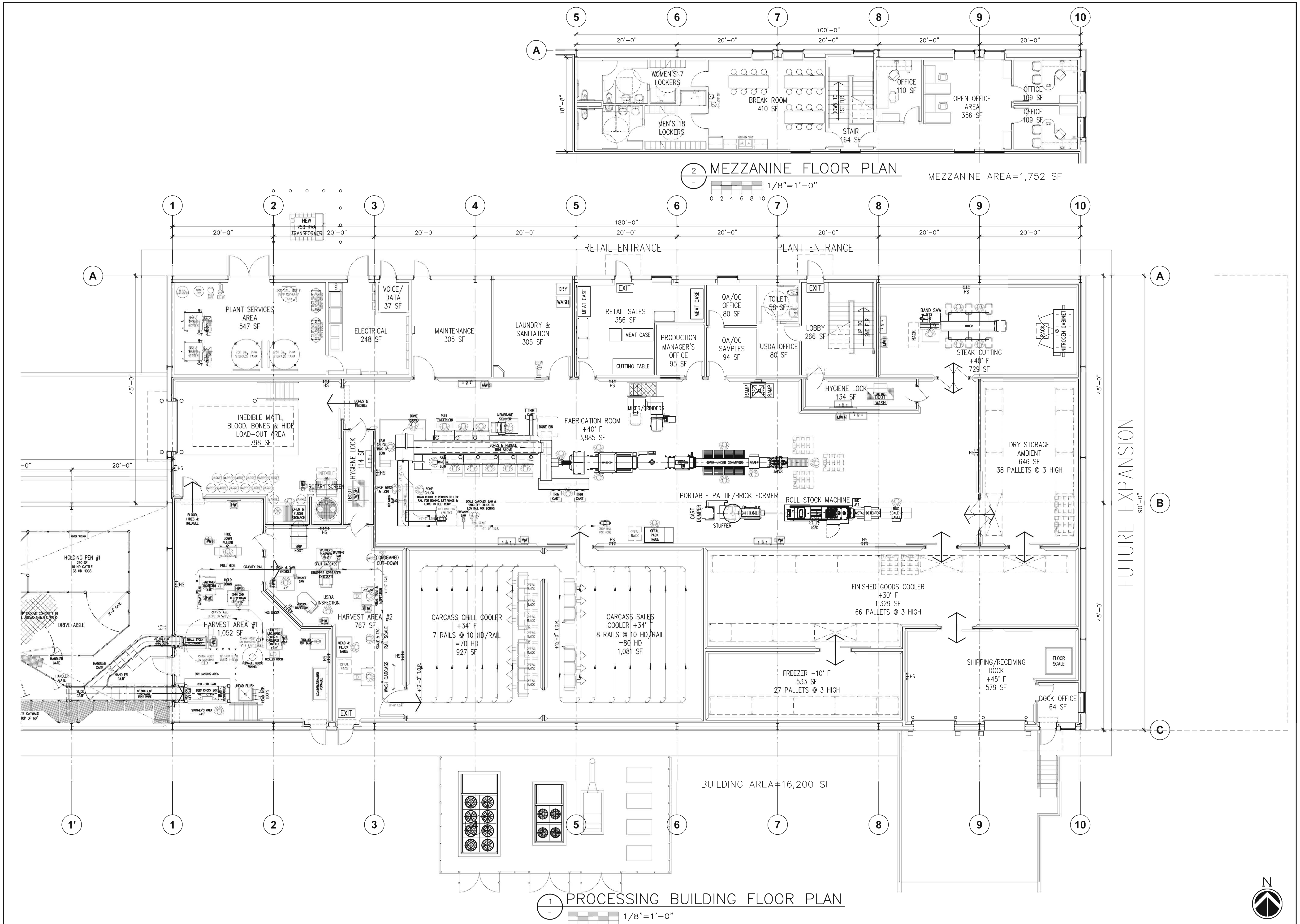
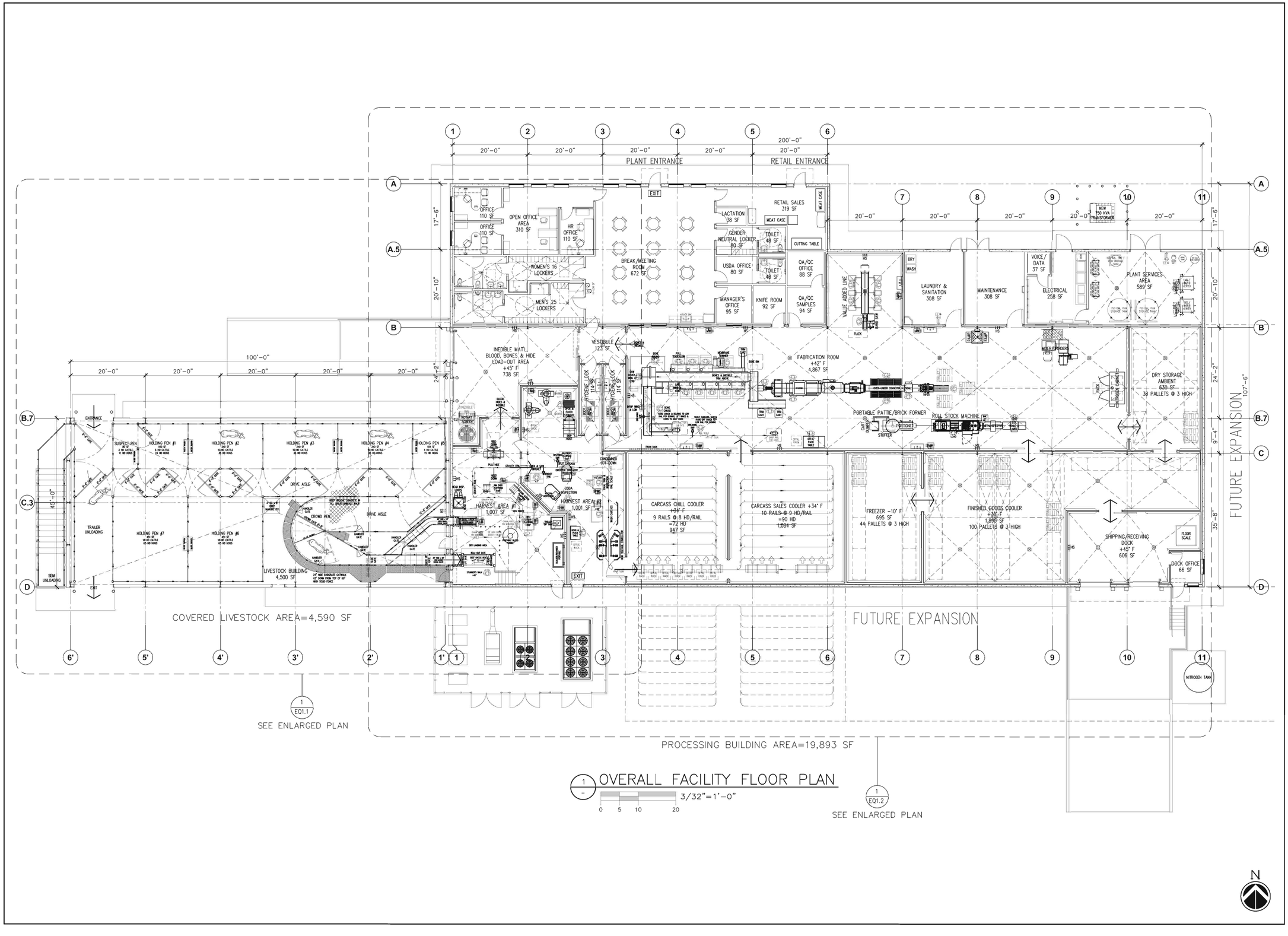
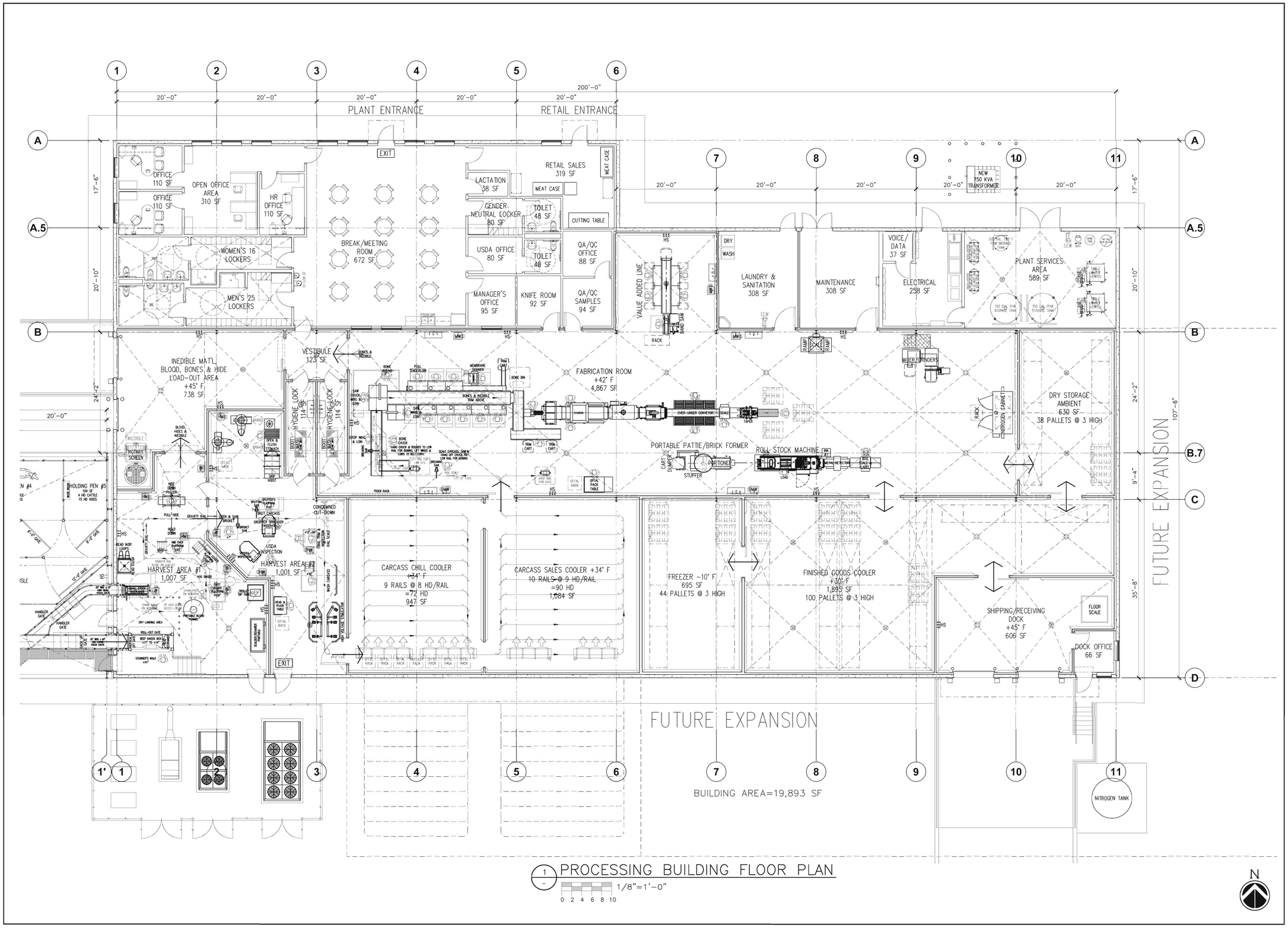

MEZZANINE FLOOR PLAN
1/8"=1'-0"
MEZZANINE AREA=1,752 SF
WOMEN'S 7 LOCKERS
MEN'S 18 LOCKERS
BREAK ROOM 410 SF
STAIR 164 SF
OFFICE 110 SF
OPEN OFFICE AREA 356 SF
OFFICE 109 SF
OFFICE 109 SF
RETAIL ENTRANCE
PLANT ENTRANCE
PLANT SERVICES AREA 547 SF
ELECTRICAL 248 SF
VOICE/DATA 37 SF
MAINTENANCE 305 SF
LAUNDRY & SANITATION 305 SF
RETAIL SALES 356 SF
PRODUCTION MANAGER'S OFFICE 95 SF
QA/QC OFFICE 80 SF
QA/QC SAMPLES 94 SF
TOILET 58 SF
USDA OFFICE 80 SF
LOBBY 266 SF
STEAK CUTTING +40° F 729 SF
HYGIENE LOCK 134 SF
INEDIBLE MAT'L, BLOOD, BONES & HIDE LOAD-OUT AREA 798 SF
HYGIENE LOCK 114 SF
FABRICATION ROOM +40° F 3,885 SF
PORTABLE PATTIE/BRICK FORMER
ROLL STOCK MACHINE
DRY STORAGE AMBIENT 646 SF 38 PALLETS @ 3 HIGH
HOLDING PEN #1
DRIVE AISLE
HARVEST AREA #1 1,052 SF
HARVEST AREA #2 767 SF
USDA INSPECTION
CARCASS CHILL COOLER +34° F 7 RAILS @ 10 HD/RAIL =70 HD 927 SF
CARCASS SALES COOLER +34° F 8 RAILS @ 10 HD/RAIL =80 HD 1,081 SF
FINISHED GOODS COOLER +30° F 1,329 SF 66 PALLETS @ 3 HIGH
FREEZER -10° F 533 SF 27 PALLETS @ 3 HIGH
SHIPPING/RECEIVING DOCK +45° F 579 SF
DOCK OFFICE 64 SF
FUTURE EXPANSION
BUILDING AREA=16,200 SF
PROCESSING BUILDING FLOOR PLAN
1/8"=1'-0"


PLANT ENTRANCE
RETAIL ENTRANCE
OFFICE 110 SF
OFFICE 110 SF
OPEN OFFICE AREA 310 SF
HR OFFICE 110 SF
WOMEN'S 16 LOCKERS
MEN'S 25 LOCKERS
BREAK/MEETING ROOM 672 SF
EXIT
LACTATION 38 SF
GENDER NEUTRAL LOCKER 80 SF
TOILET 48 SF
USDA OFFICE 80 SF
TOILET 48 SF
MANAGER'S OFFICE 95 SF
KNIFE ROOM 92 SF
QA/QC SAMPLES 94 SF
QA/QC OFFICE 88 SF
RETAIL SALES 319 SF
MEAT CASE
CUTTING TABLE
VALUE ADDED LINE
LAUNDRY & SANITATION 308 SF
MAINTENANCE 308 SF
VOICE/ DATA 37 SF
ELECTRICAL 258 SF
NEW 750 KVA TRANSFORMER
PLANT SERVICES AREA 589 SF
INEDIBLE MAT'L, BLOOD, BONES & HIDE LOAD-OUT AREA +45° F 738 SF
VESTIBULE 123 SF
HYGIENE LOCK 114 SF
HYGIENE LOCK 114 SF
FABRICATION ROOM +42° F 4,867 SF
PORTABLE PATTIE/BRICK FORMER
ROLL STOCK MACHINE
DRY STORAGE AMBIENT 630 SF 38 PALLETS @ 3 HIGH
ENTRANCE
SUSPECT PEN 80 SF 3 HD CATTLE 11 HD HOGS
HOLDING PEN #1 240 SF 6 HD CATTLE 14 HD HOGS
HOLDING PEN #2 240 SF 10 HD CATTLE 36 HD HOGS
HOLDING PEN #3 240 SF 10 HD CATTLE 36 HD HOGS
HOLDING PEN #4 240 SF 10 HD CATTLE 36 HD HOGS
HOLDING PEN #5 100 SF 4 HD CATTLE 15 HD HOGS
DRIVE AISLE
TRAILER UNLOADING
HOLDING PEN #7 420 SF 18 HD CATTLE 63 HD HOGS
HOLDING PEN #6 420 SF 18 HD CATTLE 63 HD HOGS
SEMI UNLOADING
CROWD PEN
HANDLER GATE
LIVESTOCK BUILDING 4,500 SF
HARVEST AREA #1 1,007 SF
HARVEST AREA #2 1,001 SF
USDA INSPECTION
CONDEMNED CUT-DOWN
CARCASS CHILL COOLER +34° F 9 RAILS @ 8 HD/RAIL =72 HD 947 SF
CARCASS SALES COOLER +34° F 10 RAILS @ 9 HD/RAIL =90 HD 1,084 SF
FREEZER -10° F 695 SF 44 PALLETS @ 3 HIGH
FINISHED GOODS COOLER +36° F 1,885 SF 100 PALLETS @ 3 HIGH
SHIPPING/RECEIVING DOCK +42° F 606 SF
FLOOR SCALE
DOCK OFFICE 66 SF
NITROGEN TANK
COVERED LIVESTOCK AREA=4,590 SF
FUTURE EXPANSION
PROCESSING BUILDING AREA=19,893 SF
FUTURE EXPANSION
SEE ENLARGED PLAN
SEE ENLARGED PLAN
OVERALL FACILITY FLOOR PLAN
3/32"=1'-0"
0 5 10 20
N


PLANT ENTRANCE
RETAIL ENTRANCE
EXIT
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OFFICE 110 SF
OPEN OFFICE AREA 310 SF
HR OFFICE 110 SF
WOMEN'S 16 LOCKERS
MEN'S 25 LOCKERS
BREAK/MEETING ROOM 672 SF
LACTATION 38 SF
GENDER NEUTRAL LOCKER 80 SF
TOILET 48 SF
USDA OFFICE 80 SF
TOILET 48 SF
MANAGER'S OFFICE 95 SF
KNIFE ROOM 92 SF
QA/QC OFFICE 88 SF
QA/QC SAMPLES 94 SF
RETAIL SALES 319 SF
MEAT CASE
CUTTING TABLE
VALUE ADDED LINE
RACK
DRY
WASH
LAUNDRY & SANITATION 308 SF
MAINTENANCE 308 SF
VOICE/ DATA 37 SF
ELECTRICAL 258 SF
NEW 750 KVA TRANSFORMER
PLANT SERVICES AREA 589 SF
INEDIBLE MAT'L, BLOOD, BONES, & HIDE LOAD-OUT AREA +45° F 738 SF
VESTIBULE 123 SF
HYGIENE LOCK 114 SF
HYGIENE LOCK 114 SF
FABRICATION ROOM +42° F 4,867 SF
PORTABLE PATTIE/BRICK FORMER
ROLL STOCK MACHINE
STUFFER
DRY STORAGE AMBIENT 630 SF 38 PALLETS @ 3 HIGH
HOLDING PEN #5 104 SF 4 HD CATTLE 15 HD HOOS
HARVEST AREA #1 1,007 SF
HARVEST AREA #2 1,001 SF
CONDEMNED CUT-DOWN
USDA INSPECTION
CARCASS CHILL COOLER +34° F 9 RAILS @ 8 HD/RAIL =72 HD 947 SF
CARCASS SALES COOLER +34° F 10 RAILS @ 9 HD/RAIL =90 HD 1,084 SF
FREEZER -10° F 695 SF 44 PALLETS @ 3 HIGH
FINISHED GOODS COOLER +30° F 1,895 SF 100 PALLETS @ 3 HIGH
SHIPPING/RECEIVING DOCK +45° F 606 SF
FLOOR SCALE
DOCK OFFICE 66 SF
NITROGEN TANK
FUTURE EXPANSION
FUTURE EXPANSION
BUILDING AREA=19,893 SF
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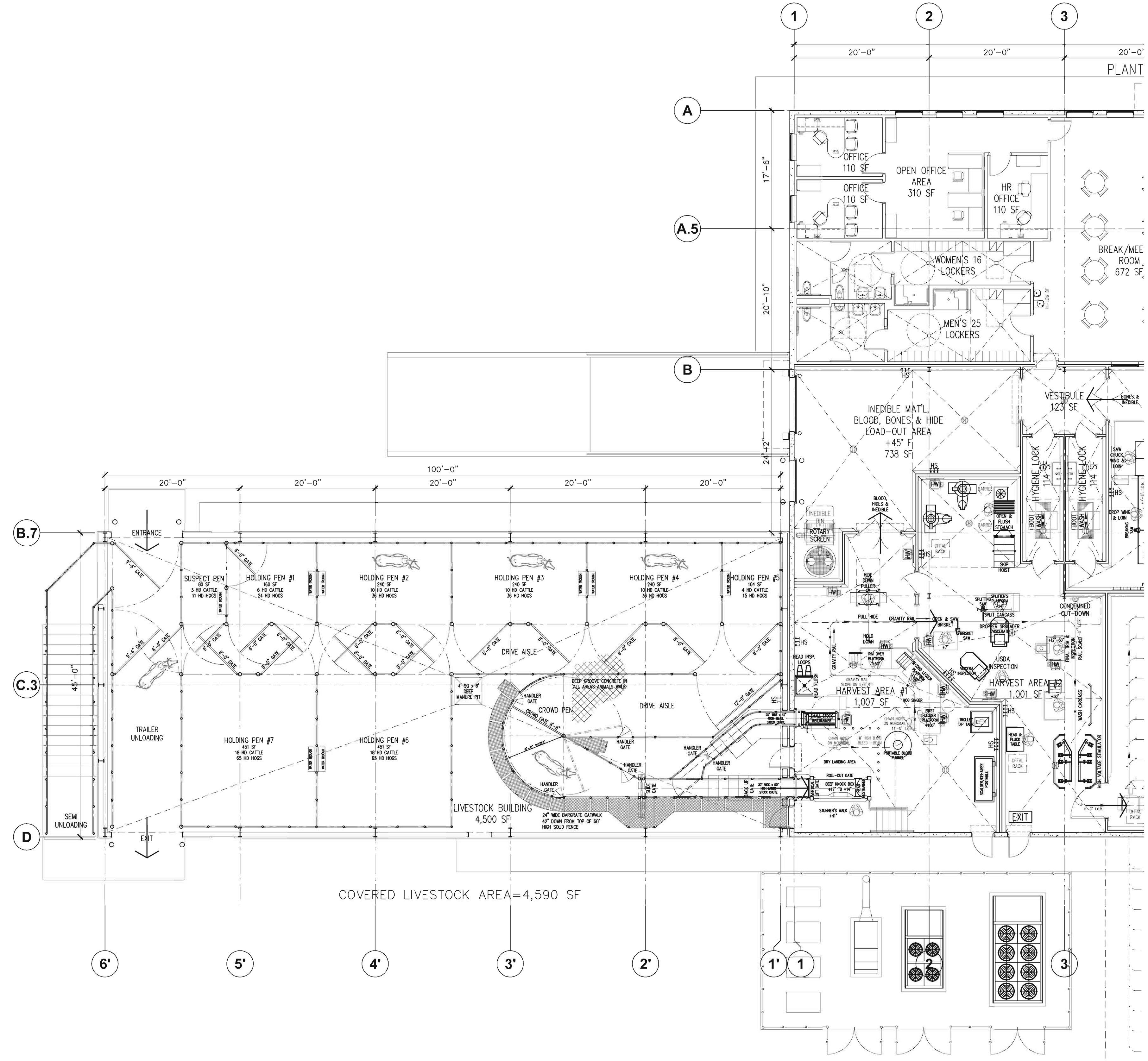
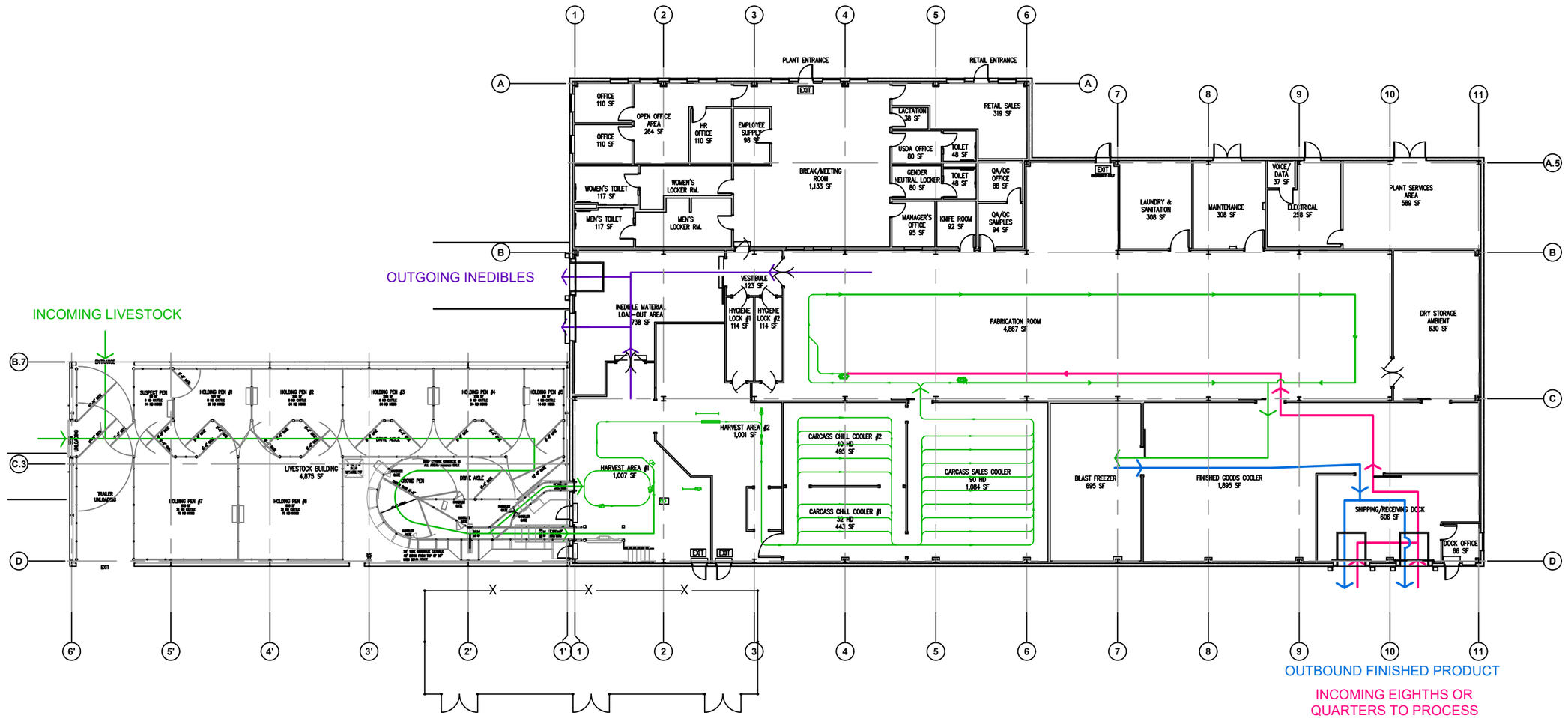
1/8"=1'-0"
0 2 4 6 8 10
N



LIVESTOCK & HARVEST AREA FLOOR PLAN

1/8"=1'-0"

0 2 4 6 8 10



CONCEPTUAL LIVESTOCK PROCESSING FLOW PLAN

NOT TO SCALE

Figure 8 - Process flow through the harvesting facility

4.3 ENERGY SUPPLY ALTERNATIVES (CONCEPTUAL)

As this facility could be operated on any island, the only alternative energy source consistently available is solar. Therefore, the study explores the use of a photovoltaic (PV) energy system for the facility. Specific islands may have opportunities with other alternative energy sources such as geothermal, wind, hydropower, biomass and wave. These other sources are site-specific and, therefore, should be explored by the facility owner if reasonable.

Therefore, a planning level estimate of the amount of PV energy based on the roof area was undertaken. In addition to a direct connection to the island's electrical grid, photovoltaic energy could provide substantial capacity for daylight electrical demand. The PV systems are assumed to utilize about 80% (eighty percent) of the roof area to allow for edge clearances, mechanical equipment and venting systems. It is assumed that an operational day is from 8 a.m. to 5 p.m., and chill areas and the freezer are in continuous operation.

The use of battery storage was not considered due to the cost of battery systems, limited life of the battery, fire hazards and additional disposal costs. In the future, as battery storage systems improve, this option should be analyzed. Therefore, the PV system will only be operational during sunlight hours, and the remainder of the energy will be from the electric grid on that island. However, the local energy supplier may require battery storage and/or other interconnect features not stated in this document.

Table 20 presents the PV generation for the 20 AU/day and 70 AU/day concepts. The analysis assumed the installation of 480-watt (W)-rated solar panels. The table compares the energy generation at different locations in the state, with different solar exposure. Most of the areas with higher solar ratings (typically on the Leeward or West Side) could deliver approximately 50% (fifty percent) on the Leeward parts of the island for the 20 AU/day concept. However, PV energy generation is much lower for the 70 AU/day concept. Island locations with lower solar constants, typically the Windward side or upcountry, have lower generating capacity. The percent estimates were based on the following energy demand for the concepts:

- Estimated 650 MWh/year for the 20 AU/day facility; and
- Estimated 1,300 MWh/year for the 70 AU/day facility.

The analysis did not account for a PV system over the parking area and in other areas of the property. The expansion of the PV system to cover other areas of the property will increase the amount of energy generated and reduce the dependency on the grid, but will increase construction costs, while decreasing electrical operating costs. Table 20 presents the percent of energy that will be generated with a PV system installed on the building only.

Table 20
Photovoltaic Energy Generation by Location

			20 AU/day Concept		70 AU/day Concept	
Island	**General Location**	**Solar Constant (kWh/m^2)**	**Energy Generated (MWh/yr)**	**Percent Total**	**Energy Generated (MWh/yr)**	**Percent Total**
Kauai	Kekaha	5.6	304	~47	442	~34
	Kapaa	5.5	301	~46	438	~34
Oahu	Kapolei	5.9	321	~49	467	~36
	Kahaluu	4.2	229	~35	334	~26
Maui	Lahaina	6.2	337	~52	490	~38
	Kula	5.0	277	~43	403	~31
Hawaii	Kawaihae	6.2	335	~52	488	~38
	Hilo	4.7	261	~40	379	~29

Note: Percentages are based on an energy demand of 650 MWh/yr for the 20 AU/day concept and 1,300 MWh/yr for the 70 AU/day concept.

4.4 WASTE AND WASTEWATER ALTERNATIVES

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

Approximately 58% (fifty-eight percent) of live animal weight is considered inedible 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, due to the small quantities for the AU process, there are no in-state processing facilities for hides. Therefore, the processing of hides was not considered feasible at this time and will be considered as waste. All 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.

The disposal and handling of solid waste and wastewater is a critical component for this facility and agricultural operations in general. The off-site disposal of solid waste is an option that should be explored by the owner of the facility and will be dependent on location, accessibility and cost.

Such facilities include but are not limited to landfills, compost facilities, processing facilities (such as Island Commodities Hawai‘i on O‘ahu), etc.

The owner/operator will need to determine which alternative best suits the facility, based on cost, location and community factors. The following section focuses on the on-site disposal of wastewater and solid waste from the animal processing operation. A detailed description of various alternatives is presented in Appendix B.

All on-site facilities need to follow the Hawai‘i Department of Health (HDOH) Guidelines for Livestock Harvesting Facility Waste Management.[49] This document provides guidance for treatment system location and on-site treatment design. The guidance outlines restrictions on the location, rainfall events and facility requirements.

For wastewater disposal, two general concepts were explored: 1) off-site disposal into a wastewater treatment plant (WWTP) or 2) on-site wastewater treatment system. Due to the characteristics of the wastewater, the disposal into an off-site WWTP will require on-site pre-treatment prior to entering a WWTP system. Therefore, this analysis provides pretreatment and on-site treatment alternatives.

4.4.1 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 waste 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.[50] The typical wastewater composition from a livestock harvesting facility shown in Table 21.

The volume of wastewater produced among different processing plants varies greatly. Based on EPA wastewater guidelines,[51] 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.

The waste and wastewater from the stock pen and harvesting and fabrication areas of the facility have different characteristics. The stock pen area waste consists of soil. Manure and other manure should be separated and disposed as solid waste while separated wash water from the

[49] University of Hawai‘i-Mānoa, Cooperative Extension Service, College of Tropical Agriculture and Human Resources, *Guidelines for Livestock Waste Management*, 2010.
[50] 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.
[51] 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*, 2002.

stock pen can be stored in a separate tank and used for land applications or irrigation. Manure can be removed by using a screen, which 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[52] from cattle and pig manure are 27,000 ppm and 37,000 ppm, respectively.

Table 21
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

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.[53]

4.5 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:

[52] American Society of Agricultural Engineers, 1999.
[53] 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.

- 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.

4.5.1 Solid Waste Facilities

An estimate for the quantity of solid waste from a livestock harvesting operation is about 25% (twenty-five 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 Hawai‘i Department of Health. Currently, some landfills allow for the disposal of livestock harvesting waste. However, this alternative may not be available in the future and is subject to 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 by rendering or landfill.

4.5.2 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 Hawai‘i, 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.[54]

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.

4.5.3 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

[54] State of Hawai‘i, 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*.

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

4.5.4 Rendering Facilities

Solid waste can be transported to a rendering facility, and there is one located in Kapolei, O‘ahu. The facility will take all solid waste and blood, with the possible exception of hides.[55] 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.[56]

4.5.5 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 inquiries by companies that promote these types of products. Unfortunately, the study could not verify the existence of these types of industries in Hawai‘i. In the future, these industries may be available in Hawai‘i or as an export commodity. In addition, if pet food was to be produced from the harvesting facilities, food safety regulations could be stringent and require upgrades to the facilities.

4.6 ON-SITE TREATMENT ALTERNATIVES

The on-site 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 are 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 B. Conventional and non-conventional alternatives presented for consideration include the following:

- Pretreatment
    - Screening,
    - Grease interceptor;
    - Dissolved air flotation, and
    - Filtration;

- Conventional Treatments
    - Septic tank,
    - Aerated lagoon,

[55] 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.
[56] Personal communication June 2021 with Baker Commodities and EKNA Services, Inc.

    - Membrane bioreactor,
    - Moving bed biofilm reactor,
    - Sand Bioreactor,
    - Seepage pit,
    - Evapotranspiration,
    - Leach field, and
    - Sludge Drying bed; and

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

4.6.1 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.

Sludge Drying Beds

Sludge drying beds are a 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 (nine to 15 inches) over graded gravel (eight 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.

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-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 30-40 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% (two percent) 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 waste in various states. A carcass disposal service by the livestock harvesting facility owner/operator may be an additional revenue source for the operator.

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, it may take years to compost.

Composting needs to include materials such as plants 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 Hawai‘i 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.

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 recommended 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 the 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.

4.6.2 On-Site Wastewater Treatment

An on-site wastewater treatment system will require capital and operating costs, as well as 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 B.

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 Hawai'i rules and regulations are administered by the Hawai'i Department of Health (HDOH) and may be found in Hawai'i 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.

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,[57] and no wells are permitted to be constructed

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

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 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.

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).[58] Additional treatment methods are required to further disinfect, increase water quality and purity of the effluent, and/or to meet various effluent quality requirements.

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.

Pretreatment

Pretreatment involves the removal of floating and settleable solids. Typical unit processes used for pretreatment are screening, catch basins and grease interceptors, dissolved air

[58] 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.

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, in which 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 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 accurately 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% (ninety-five percent) 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.

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.

Mechanical Wastewater Treatment Alternatives for Small Livestock Harvesting Facility

Mechanical treatment systems are a viable option for the treatment of wastewater if off-site 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 systems for small livestock facilities are presented below and in

Appendix B: 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 combine membrane filtration and biological treatment to remove sludge and produce 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) that “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 needed to stabilize the flow into the system. A clarifier or DAF would be recommended as a post-treatment method 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.

Sand Bioreactor

A sand bioreactor is a biofilm-based technology for wastewater treatment capable of removing FOG, BOD, and ammonia. The system is compatible with high-strength and high-fat content wastewater discharged from a meat processing plant.

A sand bioreactor usually consists of a bed of layered sand and gravel of various sizes, and inlet and outlet structures. Wastewater is applied to the top of a bed of sand and gets drawn down by gravity between the sand particles, which also traps suspended solids. Pretreatment such as a grease trap and screening will be required to separate pieces of bone, meat, and fat to prevent clogging of the system and to protect pumps, if needed, from wear.

One of the advantages of sand bioreactors is that they can tolerate fluctuations in flow, especially changes from negligible flow to very high flows, thus eliminating the need for an equalization tank.

Sand bioreactors can be operated with minimal maintenance. However, weeds tend to grow on open sand bioreactors; thus, maintenance will be required to eliminate weeds. A dosing tank will be required to control the daily application rate to ensure the system remains aerobic and to prevent clogging. No aerators are needed to add air to the system.

Conventional On-site Treated Effluent Disposal Alternatives

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

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 systems are dependent on the percolation rate of the surrounding soil.

These systems are low maintenance systems and require minimal operational intervention. They do 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 have 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 is 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 is filled with tiles, gravel and sand to provide a storage area. Plants are used to improve transpiration of the system.

The system is low maintenance and is 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.

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, digest retained sludge and 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% (fifty to eighty-five 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 and 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.[59]

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. 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.

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

Aerobic ponds can produce a stable effluent with short detention times, typically as short as two to six 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 more, with an aerobic layer overlying an anaerobic layer. These pond systems should have a detention time from five 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 rather 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 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 mediums, typically gravel and/or sand, as long as the material doesn't corrode from the wastewater. 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.[60]

Wetlands are usually more cost-effective than conventional wastewater treatments and have lower operating 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.[61] There is also a reduction in odor from the wastewater, with wetlands compared to conventional wastewater treatment systems.

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 is 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.[62]

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 of adequate land area for the wetland.[63]

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.

[60] EPA, *Constructed Wetlands Treatment of Municipal Wastewaters,*1999, 97-99, 66-67.
[61] EPA, *A Handbook of Constructed Wetlands,* 1990, 17.
[62] Savannah River Site, *Review of Constructed Subsurface Flow vs. Surface Flow Wetlands,* 2004, 14.
[63] EPA, *Wastewater Technology Fact Sheet Wetlands: Subsurface Flow,* 2000, 4.

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.[64] 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 amount of organic matter in the effluent from dead plant materials. Surface flow constructed wetlands require adequate land area.[65]

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 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.[66] 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. Plant material would be used to supplement an on-site composting facility to provide increased 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 break down proteins, bone and other solid waste. Table 22 provides examples of plant material that can be used in the pond and constructed wetland.

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.[67] 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 population growth and to provide oxygen transfer at the air/water interface.

[64] Salman Zafar, Bioenergy Consult, *Biogas from Slaughterhouse Wastes,* 2020.
[65] EPA, *Constructed Wetlands Treatment of Municipal Wastewaters,*1999, 97-99, 66-67.
[66] MDPI Sustainability, *Aquatic Macrophytes in Constructed Wetlands: A Fight against Water Pollution,* 2020, 6.
[67] Natural Resources Conservation Service, *Environmental Engineering National Engineering Handbook Chapter 3 Constructed Wetlands,* 2009, 3-4.

Table 22
Examples of Plants for Pond and Wetland Treatment

Types of Plants	Native Plants	Non-native Plants
Floating Aquatic Plants	ʻAeʻae	Duckweed, water hyacinth
Emergent Aquatic Macrophytes	Puʻukaa,ʻahuʻawa, makaloa, mhaʻakai, neke fern	Cattail, bulrush, giant reed, canna lily, arrowhead, green arum
Terrestrial Plants	ʻUki, ʻukiʻuki	Alemangrass, paragrass, floralta limprograss, bermudagrass

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.

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 a root system that 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). [68]

4.6.3 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 28 and the sample computations are shown in Appendix B.

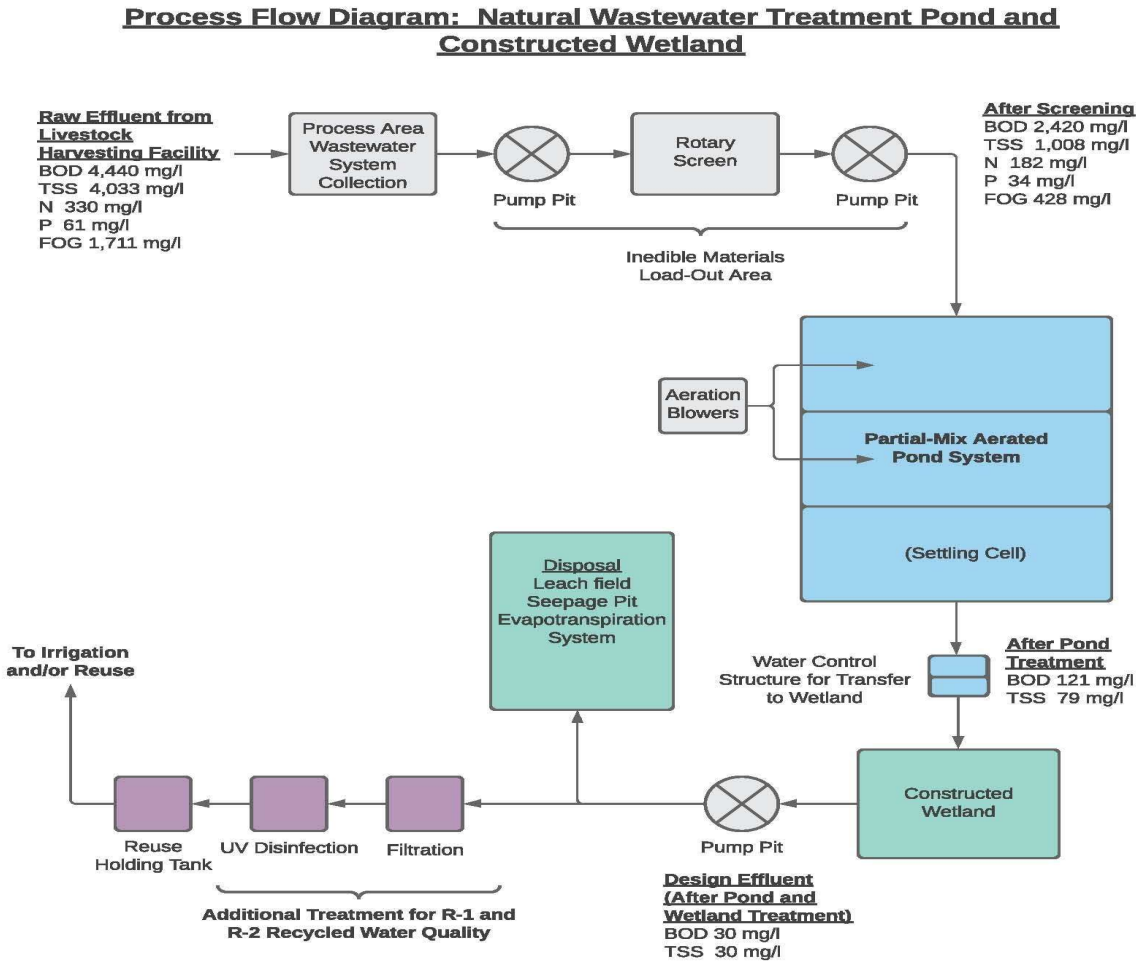
[68] Ecological Engineering, *Use of Aquatic and Terrestrial Plants for Removing Phosphorus from Dairy Wastewaters,* 1995, 371-390.

Table 23 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 23
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

Exhibit 28. Example of a Facultative Pond and Constructed Wetland System



4.6.4 Environmental Considerations

Various environmental constraints will affect the livestock harvesting facility such as odor, noise, waste handling and disposal, socio-economic issues and availability of water. In addition, accessibility and distance from the ranches also will need to be considered during the site selection of the facility.

Erosion and Sediment Control

Erosion and sediment are caused by wind, rain, washdown, etc., and require on-site control measures that comply with city, county, state and federal rules and regulations for construction and operation of the facility. During construction, the designer shall review the various rules and regulations, and at a minimum apply for a National Pollutant Discharge Elimination System – Notice of Intent for Construction (NPDES NOI-C) and comply with the State of Hawai'i Fugitive Dust rules and regulations. The NPDES and other permits will require temporary control measures during construction and permanent control measures during operations.

Climate Change Considerations

Climate change such as global warming and sea level rise should be a consideration for the new facility. Global warming and changes in the environment will increase the energy requirement of the facility to compensate for the increase in temperature differential. In addition, changes in temperature, storm intensity and atmospheric conditions will change the biological systems planned for the facility. These factors should be considered in the design of the facility.

As far as the location of the facility, it should be outside of any flood areas and tsunami impact areas to secure food processing through emergency conditions. In addition, coastal locations should carefully consider impacts due to sea level rise.

Socio-Economic and Economic Impacts

The development of such facilities may have beneficial and negative impacts to the community in which the development is located. In 2019, the agriculture, forestry, fishing and hunting sectors accounts for about $509 million, or 0.5% (zero-point-five percent) of Hawai'i's total nominal gross domestic product (GDP).[69] Compared to 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% (zero-point-eight percent) since 2001 to 0.6% (zero-point-six percent) in 2017 and to 0.5% (zero-point-five percent) in 2019. A detailed analysis on the economic impact of the facility is shown in Appendix C.

[69] "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.

The State of Hawai'i's 2017 Input-Output model, estimates 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.

As shown in Table 24, 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).

Table 24
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.

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 construction*, and *construction of other types of buildings* (see Table 25). 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).

Table 25
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.

Potential Environmental Impacts

Livestock harvesting facilities are known to have environmental impacts if not designed and/or operated properly. Typical environmental areas of concern are odor, water quality, waste and wastewater disposal, noise and community concerns. Therefore, the design and operation of the system incorporates components that will alleviate environmental impacts to the extent

reasonable and feasible. Site-specific impacts would include traffic, noise, archaeological and historical resources, cultural resources and zoning.

Traffic impacts should be less than significant as the number of workers per shift is small and the number of cattle trailers would be minimal — probably three to four larger semi-tractor cattle containers per day. These trailers will probably not be in peak hour morning or even traffic and, therefore, will not cause significant reduction of the roadway. Depending on the site location and vehicle types, roadways leading to the facility may require modification to turning radiuses, lane widths and pavement strength.

The facility may require changes to the transmission and distribution of utilities such as electricity, water and wastewater. The extent of the modifications will be determined by the site location and local utility requirements.

Stormwater runoff design will adhere to local rules and regulations, as well as NPDES rules and regulations. f in Honolulu or Maui counties, certain areas will need to adhere to the respective MS4 permit requirements. The facility design has both construction and permanent best management practices incorporated into the design. Runoff and leachate should not reach any receiving waters of the state unless properly treated. The designer needs to check state and county rules and regulations regarding the design rainfall event.

In general, the socioeconomic impact will be positive as the facility will create jobs and add to the local economy. An economic analysis is presented in Appendix C. This is in addition to the dollars added to the county and state economies. The facility will provide processing of locally sourced food and allow the state to move closer to achieving self-sufficient food production. To achieve sustainable livestock production and increase self-sufficiency, resources such as water need to be provided during low rainfall events and droughts.

Depending on the site location and existing use at that location, a flora and fauna survey may need to be undertaken to determine corresponding biota impacts. If overhead lights are required, the lights should be downward facing and shielded, and must follow DLNR standards to mitigate light impacts to sea birds. If wire fencing is used on-site or on the perimeter, the upper lines should not be barbed wire, and follow requirements to protect the Hawaiian Hoary bat.

Siting should of the facility should be in an area not subject to flooding or in a flood zone, and not in a Special Management Area or shoreline setback area. Depending on the site, archaeological, cultural and historical resources surveys may need to be undertaken. Construction impacts will include increased traffic and air quality impacts, due to the use of construction equipment and transportation of workers. However, these impacts should not be significant if all applicable rules and regulations are adhered to, and these will be short-term impacts.

Major Permits and Approvals

The facility will need to comply and obtain permits and approvals from various state of Hawai‘i and city and/or county agencies. Other major permits and approvals depending on the location and function may include, but are not limited to:

- Department of Health – Solid Waste Facility for composting system
- State of Hawai‘i – State Historic Preservation Division – 6E (historical, cultural and archaeological resources)
  - Section 106 for federal actions
- Clean Water Act Section 404 and 401
- Coastal Zone Management
- Special Management Area (coastal areas)
- Shoreline Setback Variance (coastal areas)
- U.S. Fish and Wildlife Section 7 (threatened and endangered species)
- National Marine Fisheries (coastal areas)
- Waste and wastewater compliance permits and applications (waste and wastewater disposal) depending on disposal methods.

If state of Hawai‘i lands and funds are being used, the applicant will need to comply with the state Environmental Assessment and Impact Statement rules and regulations (Hawai‘i Revised Statutes, Chapters 343 and 344). If federal fundings or approvals are required, then the applicant needs to comply with National Environmental Policy Act (NEPA) rules and regulations required by the responsible federal agency. The facility development may need to follow the rules and regulations on Environmental Justice.

Other requirements will be dependent on the zoning and location of the parcel and may include, but are not limited to:

- Noise requirements;
- Odor requirements;
- Property line setbacks;
- Parking stalls;
- Right-of-way access;
- Planning Review Use Application (City and County of Honolulu); and
- Variances.

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CHAPTER 5
PREFERRED CONCEPT

In discussion with HDOA and HCC, it was determined to provide preliminary design drawings for the 70 hd/day concept, as it allows the owner/operator to scale down to the design capacity for their site. In addition, it shows how other uses such as retail space could be incorporated into the design.

A specific site has not been selected; therefore, the drawings are conceptual, and the designer-on-record will need to modify the concepts for their specific needs and requirements. The design shows specific elements based on the assumptions and alternatives discussed in chapters 3 and 4. In addition, the designer-on-record will need to perform value engineering to meet the acceptable construction standards and methodologies of the area.

As stated earlier in the document, the alternatives available to the livestock facility will be dependent on the site selected. As waste and wastewater disposal are significant stumbling blocks for such a facility and possibly a significant capital cost, the availability of inexpensive alternatives should be included in the selection criteria. The design criteria for the alternative is presented in Appendix D, and the 60% (sixty percent) Design Drawings are presented in Volume II of this study.

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

As solid waste and wastewater disposal in smaller communities may become an issue beyond 2050, one potential 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 construction of the new wastewater treatment facility, and the government funds the operation and maintenance of the facility.

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

As there was no site selected for the design, various assumptions were used to complete the design drawings and calculations. In general, more stringent criteria were used in the overall design process. The following are notes and assumptions, which should be noted about the design presented in this chapter.

- Architectural design was not included as it is owner-specific and site-specific. In the design set, the General Conceptual Plans (GCP) drawings provide the overall facility layout with equipment (both users supplied, and contractor supplied). The GCP drawings also contained examples of the door, window, structural and mechanical details.
- The chill room may be divided to provide multiple chill areas for ease of maintenance and cleaning.
- Climate change may impact decomposition, heating and biological treatment values.
- The current refrigerant will be phased out in 2023, therefore, modification may be necessary.
- Use of best management practices will be site-specific; included are typical BMPs for construction and permanent use.
- May be beneficial to team with the county to develop a public-private partnership for composting facilities.

5.1 HARVESTING BUILDING

The harvesting building was designed at a 70 AU/day capacity based on cattle (beef) AU to achieve the 10,000 AU/year harvesting demand. At 10,000 AU/year the facility will be processing at about 50% (fifty percent) of its maximum capacity but will allow for future expansion. The annual capacity at 70 AU of beef/day would be around 18,000 AU of beef. A couple of options to run the harvesting facility are:

- Operate the facility at 40 AU/day for harvesting and fabrication; or
- Operate the facility with 70 AU/day by harvesting two (2) days a week and fabrication for three (3) days a week.
    - There is a concern that using the same staff for harvesting and fabrication may not be effective or efficient for the facility. In addition, the employees would probably prefer full-time jobs rather than part-time jobs. That being said, the current labor shortages with this skill may require other options in operating this facility.

The facility includes harvesting, fabrication, cold storage and wet-aging storage of finished products. The facility is designed to process grass-fed and finished beef, cull cows, hogs, sheep and goats. Finished products are to include vacuum-packaged bone-in and boneless sub-primals as well as the further processing of ground products, steaks, roasts and case-ready retail products. The facility can also provide services from harvest to dressed carcass and receive and process portions of dressed carcasses.

The main processing area is approximately 90 feet by 200 feet with a floor area of 19,983 sq. ft. The structure is designed as a steel gable frame building with three (3) bays on a slab on grade concrete floor. The main processing building supports functions such as the harvesting and fabrication areas, chill and finished storages, waste out, offices and employee areas. The floor areas for the various functions are shown in Table 26 and Figure 9.

Table 26
Comparison of Functional Areas

Description	Preferred Alternative (square feet)
Total Floor Area	19,660
Pen Area	4,900
Harvest (including tripe)	2,040
Vestibule/Hygiene Lock	370
Fabrication	4,550
Carcass Chill Storage	980
Sale Chill Storage	1,130
Freezer	740
Finished Goods Chill	1,980
Dry Goods Storage	660
Shipping/Receiving Dock	720
Value Added Products	400
Retail Sales	350
Office and Employee	3,170
Support Facilities	1,800
Inedible and Waste-out	770

Note: Summation of the areas may not equal totals due to rounding.

The livestock receiving area is 111 feet by 44 feet and covers an area of 4,875 square feet with seven holding pens, one suspect holding pen and a circular crowd pen. The size of the holding pens varies and is presented in Table 27. The livestock chute is designed to accommodate cattle, hogs, sheep and goats. The structure is designed as a single-bay pre-engineered steel structure with a concrete floor to provide open space for the interior layout. The loading area is designed to accommodate small stock trailers and large semi-trailer loads.

Table 27
Holding Pen Sizes

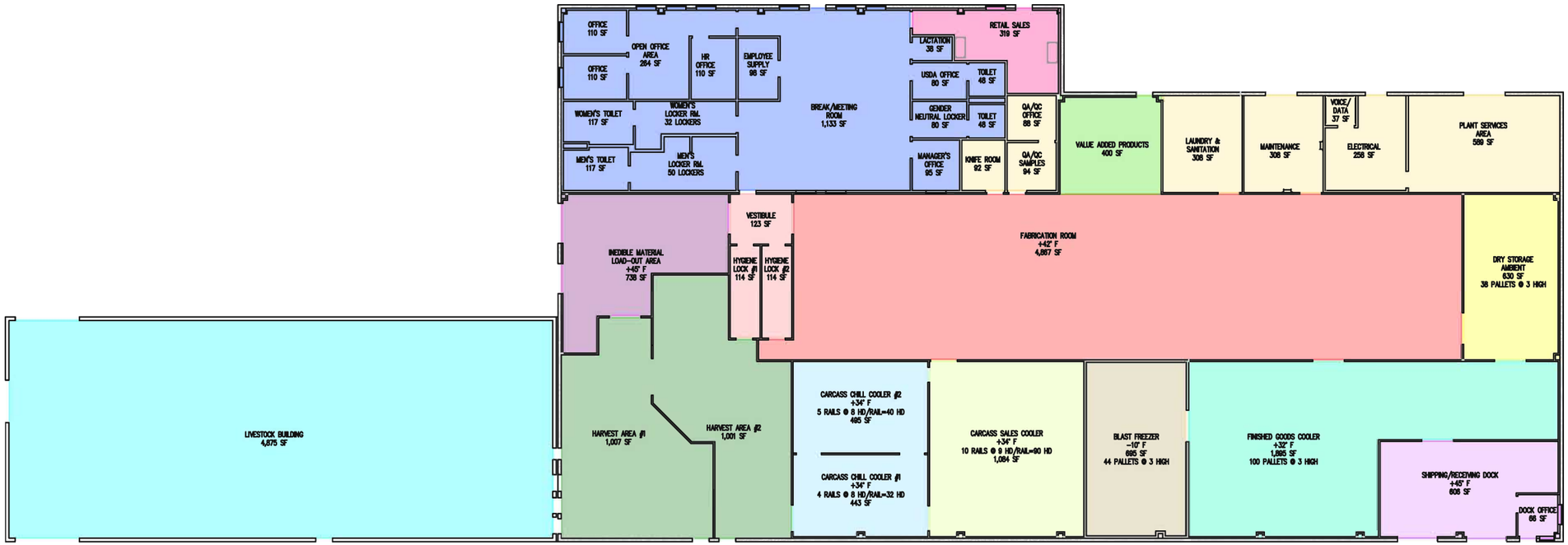
Holding Pen Number	Number of Cattle	Number of Hogs
1	8	29
2	9	34
3	9	34
4	9	34
5	4	14
6	21	75
7	21	75

The exterior walls of the main building are precast concrete and will preferably accommodate a tilt-up design and construction. The interior walls and ceilings have an insulated metal panel design to meet thermal, cleanliness and safety standards. Figure 10 shows the general design concept of the harvesting building, and the entire 60% (sixty percent) design drawing set is presented in Volume II. Full-size drawings are available upon request from Hawai‘i Department of Agriculture, Agricultural Resource Management Division (Telephone: 808-973-9473).

Mechanical and electrical systems are based on the 60% (sixty percent) design but have not been fully flushed out to the preliminary nature of the design. The mechanical systems are designed to provide the required cooling of the facility and to provide adequate systems for food safety requirements. Conceptual renderings of the harvesting facility are shown below in Figure 11. The renderings are based on the 60% (sixty percent) design plans and are conceptual in nature.

LEGEND

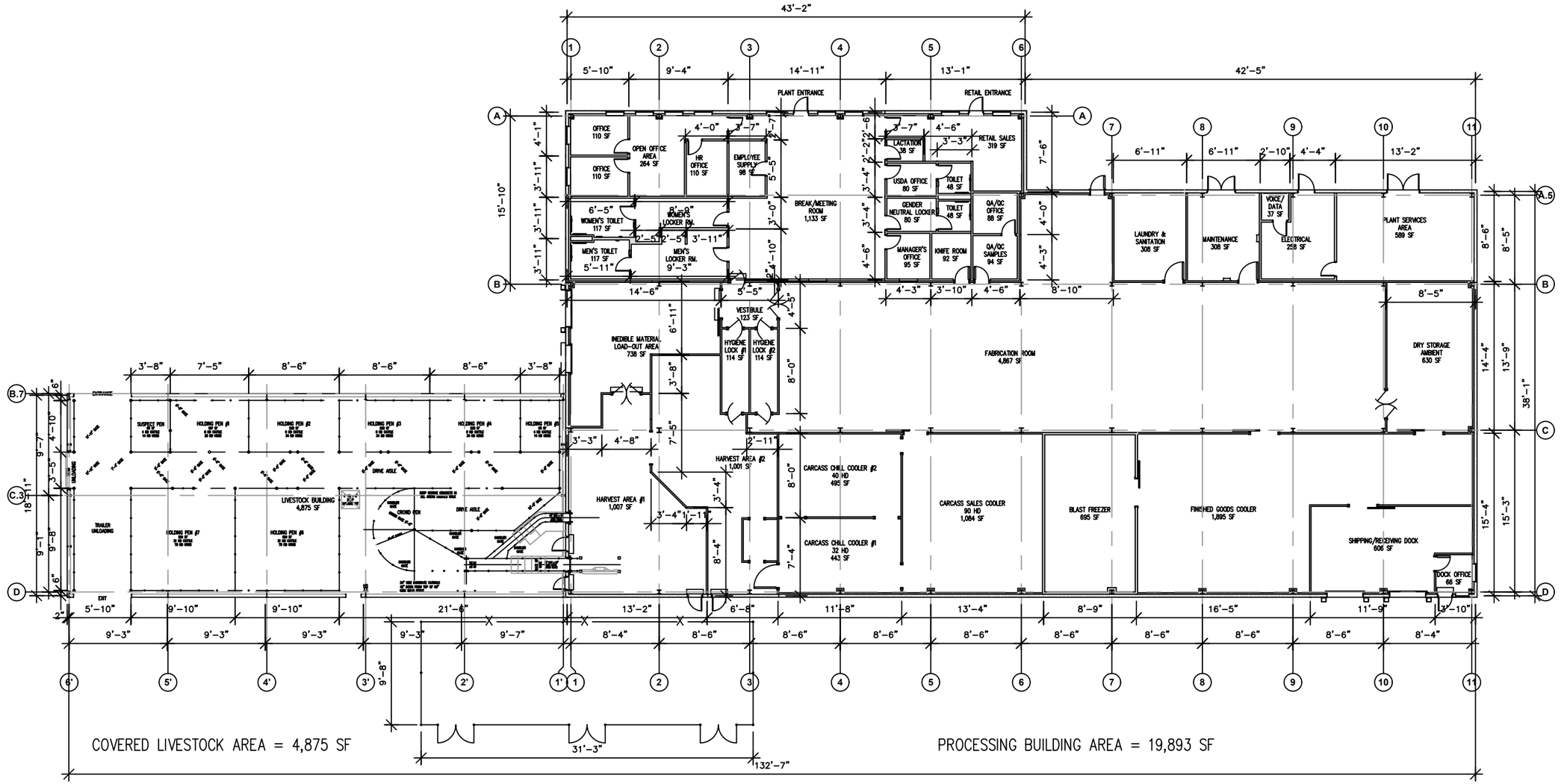
- PEN AREA
- HARVEST
- VESTIBULE/HYGIENE LOCK
- FABRICATION
- CARCASS CHILL STORAGE
- SALE CHILL STORAGE
- FREEZER
- FINISHED GOODS CHILL
- DRY GOODS STORAGE
- SHIPPING/RECEIVING DOCK
- VALUE ADDED PRODUCTS
- RETAIL SALES
- OFFICE AND EMPLOYEE
- SUPPORT FACILITIES
- INEDIBLE AND WASTE-OUT



PLAN VIEW – GENERAL BUILDING PLAN

NOT TO SCALE

TOTAL FACILITY AREA = 24,768 SF



TOTAL FACILITY AREA = 24,768 SF

PLAN VIEW – GENERAL BUILDING PLAN

NOT TO SCALE

Figure 10 - 60 percent (60%) design - building layout

Figure 11 – Rendering for the 70 AU per day livestock harvesting facility

5.1.1 Aging Process

The preferred concept is designed to accommodate wet aging for 21 days. The large storage space was based on interview comments that stated that existing chill storage volume is not

available in the current facilities. This added space will provide adequate storage for the facility, but it does add capital cost and operating expenses. The facility is designed to allow for expansion of the storage areas to accommodate additional space requirements, as stated in the industry interviews. Retail space is provided to allow for direct customer sales of the facility's products. If dry-aging is preferred, the equipment and sizing would need to be modified. If a facility would like to have dry- and wet-aging, the expansion areas could be used to accommodate both aging processes.

5.1.2 Interior Design Elements

For the interior construction the designers specified various design elements, and the following is a small subset:

- Floor slabs for the Harvest Areas, Inedible Materials Load-Out, Vestibule, Carcass Chill Cooler, 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, but may change depending on final loading configuration and the recommendations contained within the geotechnical report.
- 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.
- All perimeter walls in wash down, warehouse, process or packaging areas shall be protected by 6" thick x 24" tall concrete curbs with sloped tops. All curbs, whether for containment at wet areas or base protection of walls and partitions shall be doweled into the floor slab.
- Underfloor / Perimeter Insulation.
    - 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.
    - 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).
- Interior/Exterior Doors.
    - Low Temperature Hinged, Sliding and Track Doors — Freezer and cooler personnel doors will be 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.
    - 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.

- 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.
- Insulated bump doors shall be Durulite Industrial Traffic Doors with stainless steel tube frame as manufactured by Chase Doors or approved equal.

5.1.3 Electrical Design Elements

The electrical design shall comply with the current codes in affect, National Electrical Code (NEC) along with International Building Code (IBC), International Fire Code (IFC) and International Energy Conservation Code (IECC), along with all local and state amendments
as enforced by the local municipality.

The following spaces will have the following National Electrical Manufacturers Association (NEMA) rating.

- Offices, Employee Welfare Area, Retail Sales and Dock Office
  - Space atmosphere: Dry office; NEMA 1.
- Refrigerated Wash-down Production Areas, such as the Carcass Chill Cooler, Carcass Sales Cooler, Fabrication Room and Inedible Materials Load-Out.
  - Space atmosphere: Industrial, Wash-down, Corrosive; NEMA 4X.
- Refrigerated Storage Areas such as the Finished Goods Cooler, Blast Freezer and Shipping/Receiving.
  - Space atmosphere: Industrial, Wet Location; NEMA 3R.

5.1.4 Mechanical Design Elements

The mechanical and refrigeration design used the following assumptions for the non-refrigerated areas, such as the Harvest Area, Hygiene Locks, Vestibule and Dry Storage, and the Plant Service Areas, such as the Electrical, Voice/Data, Plant Services Area, Laundry and Sanitation, Maintenance Shop and Dock Office.

- Summer Conditions = 75°F Dry Bulb Temperature and 50% (fifty percent) Relative Humidity.
- Winter Conditions = 70°F Dry Bulb Temperature.

The Design Criteria for the areas such as the Carcass Chill Cooler, Carcass Sales Cooler, Fabrication Room, Finished Goods Cooler, Blast Freezer, Shipping/Receiving and Inedible Materials Load-Out include the following:

- Positive make-up air pressure will be provided in the Fabrication Area and be distributed to adjoining areas.
- The Fabrication Area shall be provided with 100% (one hundred percent) ventilation (15 air changes/hour) during clean-up mode.
- In-room evaporators in Carcass Coolers and Fabrication shall be provided with variable speed fans, with in-room temperature and fan speed controls.
- Carcass Chill Cooler (+34°F) – with product cooling capacity for chilling 900 lb./dressed beef carcasses split into sides in 24 hours.
  - Provide two evaporators with electric defrost allowing for alternating defrost.

    - Provide carcass spray chill system including water chiller, distribution piping and control panel.
- Carcass Sales Cooler (+34°F)
    - Provide two evaporators with electric defrost allowing for alternating defrost.
- Fabrication Room (+42°F)
    - Provide a minimum of two (2) work room style cooling coils (designed with low velocity for employee comfort and low noise level). Also includes a rooftop make-up air unit to provide positive pressure during production and 100% (one hundred percent) ventilation (15 air changes/hour) during clean-up.
- Finished Goods Cooler (+32°F) – with capacity for chilling 200 lbs. per head/day of +42°F boxed product to +34°F in 24 hours and an overall holding capacity of 150,000 pounds.
    - Provide a minimum of two (2) evaporators with electric defrost.
- Blast Freezer (-10°F) – with capacity for freezing 270 lbs. per head/day + 42°F boxed product to -0°F in 24 hours and an overall holding capacity 66,000 pounds.
    - Provide a minimum of two (2) evaporators with electric defrost.
- Shipping/Receiving Dock (+45°F)
    - Provide a minimum of two (2) evaporators. These will be wet surface coils not requiring defrost.
- Inedible Materials Load-Out (+45°F) – with capacity for holding 545 pounds per head/day of warm material.
    - Provide a minimum of two (2) evaporators. These will be wet surface coils not requiring defrost.

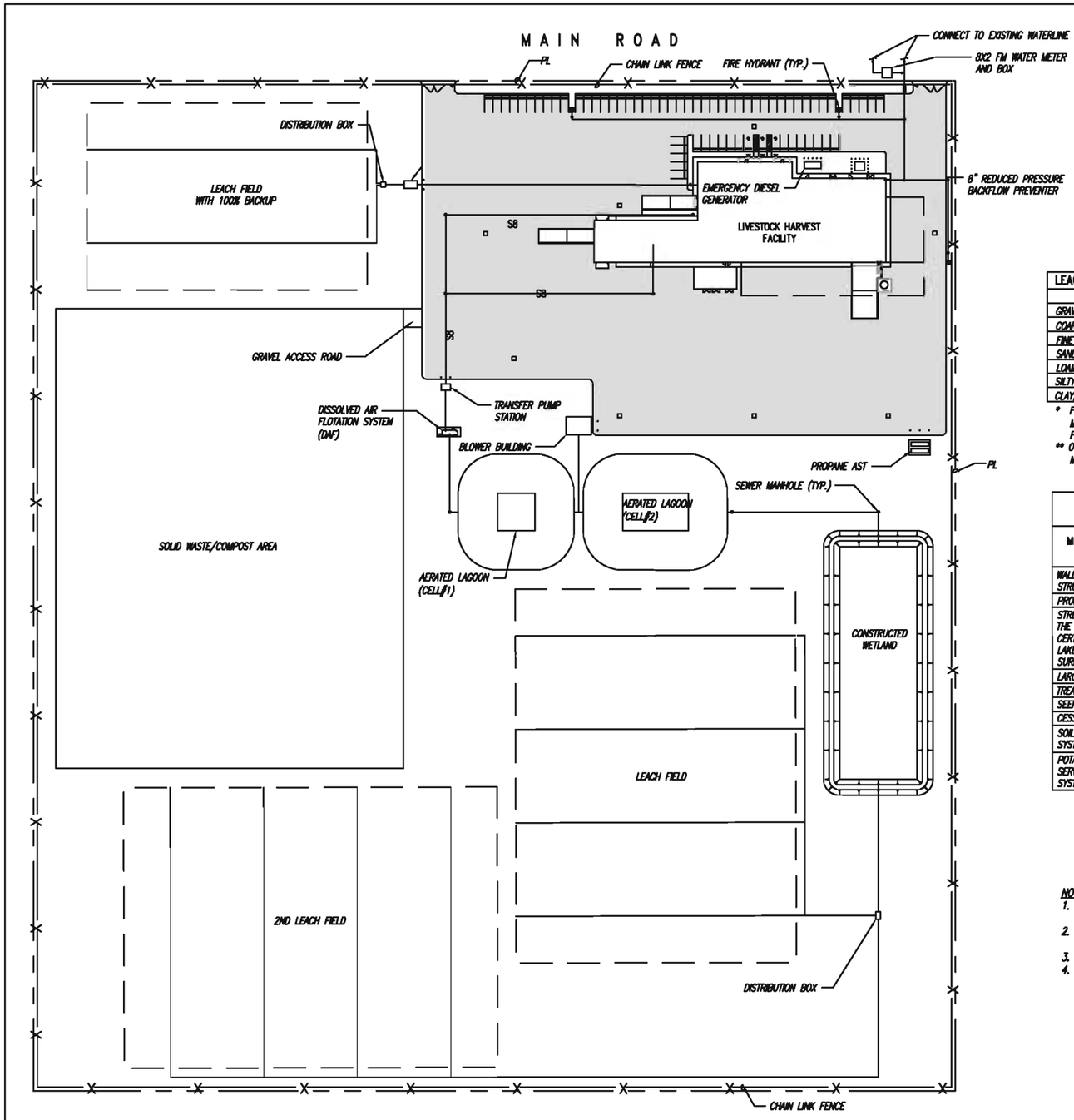
The Design Criteria for the Livestock Pen Area includes the following:

- In the summer, high-velocity fans will be used to move air for cross ventilation.
    - Supply and exhaust fans will be interlocked to keep the air balanced. High-volume/low-velocity ceiling fans will be provided to keep air moving in the winter. This area will be kept in negative pressure relative to adjacent rooms.

5.2 SITE DEVELOPMENT

The overall site layout is assumed to be flat and have access to electricity, water and roadways. The overall site is shown in Figure 12 and covers 25 acres, with a perimeter fence and visual screen. Access is through one main gate and an access roadway. The roadway and livestock loading are designed for vehicles from small trailers to semi-truck trailer combinations. Vehicle parking is designed to provide one stall per 400 sq. ft of gross floor area, which is required by the County of Hawai‘i.

The majority of the site is occupied by solid waste and wastewater treatment facilities. There is a large leach field for treated wastewater from both animal processing and human waste. The waste and wastewater treatment systems need to be redesigned to meet the site-specific requirements. The solid waste processing area is 4.2 acres, and the wastewater treatment area is 16.2 acres.



SITE PLAN

NOT TO SCALE

LIVESTOCK HARVESTING FACILITY WASTEWATER NOTES:

1. *DAF SYSTEM IS USED FOR PRIMARY TREATMENT TO REMOVE MAJORITY OF SOLIDS AND FOG FROM WASTEWATER.*
2. *AERATED LAGOON WITH TWO CELLS ARE DESIGNED TO BREAK DOWN WASTEWATER STRENGTH TO DOMESTIC LEVEL.*
3. *SUBSURFACE FLOW WETLAND PROVIDES FURTHER TREAMENT AND THE EFFLUENT IS QUALIFIED FOR DISCHARGE.*
4. *THIS COMBINATION OF TREATMENT PROCESSES ARE LOW IN COST; HOWEVER, THESE PROCESSES REQUIRE A LARGE FOOTPRINT. FOR A SITE WITH LIMITED SPACE OR WITHIN THE FLOODING ZONE AREA, PACKAGED MECHANICAL TREATMENT PROCESSES CAN BE CONSIDERED.*
5. *LEACH FIELD AREA IS HIGHLY RELATED TO SITE SOIL TYPES. SEE TABLE ABOVE.*
6. *LEACH FIELD CAN ONLY BE APPLIED IN AREA OUTSIDE OF "NO PASS ZONE". FOR AREAS MAUKA OF UIC LINES, LIMITED TYPES OF INJECTION WELLS ARE ALLOWED, PERMIT LIMITATIONS ARE IMPOSED, AND REQUIREMENTS ARE MORE STRINGENT THAN AREAS MAKAI OF UIC LINES.*
7. *THE EVAPOTRANSPIRATION SYSTEM IS HIGHLY RELATED TO SITE PRECIPITATION AND NET EVAPORATION CONDITIONS.*
8. *SEE THE FOLLOWING TABLE FROM HAR 11-62 FOR THE MINIMUM HORIZONTAL DISTANCE OF INDIVIDUAL WASTEWATER TREATMENT AND DISPOSAL UNITS FROM OTHER UNITS.*
9. *CONSULT CONTRACTOR FOR REQUIRED WASTEWATER PUMPING MECHANISM.*

LEACH FIELD SIZING FOR LIVESTOCK HARVESTING WASTEWATER	
SOIL TYPE	REQUIRED LEACH FIELD AREA (SQFT)
GRAVEL, COARSE SAND	*N/A*
COARSE TO MEDIUM SAND	*8,400 TO 15,000*
FINE TO LOAMY SAND	*15,960 TO 22,800*
SANDY LOAM TO LOAM	*23,280 TO 30,000*
LOAM TO POROUS SILT	*30,360 TO 39,600*
*SILTY CLAY LOAM, CLAY LOAM***	*UP TO 120,000*
CLAY, COLLOIDAL CLAY	*N/A*

** FOR SOIL PERCOLATION RATE OUTSIDE OF THE RANGE 1-120 MIN/INCH, LEACH FIELD AND SEEPAGE PIT IS NOT RECOMMENDED FOR LIQUID DISPOSAL*

*** OOKALA MEDIAL SILTY CLAY LOAM WITH PERCOLATION RATE OF 90 MIN/INCH IS ASSUMED IN THIS PLAN*

LEACH FIELD SIZING FOR DOMESTIC WASTEWATER	
SOIL TYPE	REQUIRED LEACH FIELD AREA (SQFT)
GRAVEL, COARSE SAND	*N/A*
COARSE TO MEDIUM SAND	*1,873 TO 3,344*
FINE TO LOAMY SAND	*3,558 TO 5,083*
SANDY LOAM TO LOAM	*5,190 TO 6,688*
LOAM TO POROUS SILT	*6,768 TO 8,828*
*SILTY CLAY LOAM, CLAY LOAM***	*UP TO 26,750*
CLAY, COLLOIDAL CLAY	*N/A*

** FOR SOIL PERCOLATION RATE OUTSIDE OF THE RANGE 1-120 MIN/INCH, LEACH FIELD AND SEEPAGE PIT IS NOT RECOMMENDED FOR LIQUID DISPOSAL*

*** OOKALA MEDIAL SILTY CLAY LOAM WITH PERCOLATION RATE OF 90 MIN/INCH IS ASSUMED IN THIS PLAN*

HAR 11-62 MINIMUM HORIZONTAL DISTANCE OF INDIVIDUAL WASTEWATER TREATMENT AND DISPOSAL UNITS				
MINIMUM HORIZONTAL DISTANCE FROM	CESSPOOL (FT)	TREATMENT UNIT (FT)	SEEPAGE PIT (FT)	SOIL ABSORPTION SYSTEM (FT)
WALL LINE OF ANY STRUCTURE OR BUILDING	*5*	*5*	*5*	*5*
PROPERTY LINE	*9*	*5*	*9*	*5*
STREAM, THE OCEAN AT THE SHORELINE CERTIFICATION, POND, LAKE, OR OTHER SURFACE WATER BODY	*50*	*50*	*50*	*50*
LARGE TREES	*10*	*5*	*10*	*10*
TREATMENT UNIT	*5*	*5*	*5*	*5*
SEEPAGE PIT	*18*	*5*	*12*	*5*
CESSPOOL	*18*	*5*	*18*	*5*
SOIL ABSORPTION SYSTEM	*5*	*5*	*5*	*5*
POTABLE WATER SOURCES SERVING PUBLIC WATER SYSTEMS	*1000*	*500*	*1000*	*1000*

FIRE FLOW REQUIREMENTS FOR HEAVY INDUSTRY	
COUNTY	FLOW (GPM)/DURATION (HRS)/FIRE HYDRANT SPACING (FT)
KAUAI	*3,000/3/350*
MAUI	*2,500/2/250*
OAHU	*SUBJECT TO SPECIAL REVIEW AND CONTROL BY MANAGER*
HAWAII	*2,000/2/300*

PARKING LOT REQUIREMENTS		
COUNTY	CODE	NUMBER OF PARKING SPACES
KAUAI	*FOR INDUSTRIAL DEVELOPMENTS, ONE PARKING STALL FOR EACH 3 EMPLOYEES, OR 1 PARKING STALL FOR EVERY 500 SQFT OF GROSS FLOOR AREA OF THE BUILDINGS WHERE THE NUMBER OF EMPLOYEES IS UNKNOWN. PARKING SPACES FOR TRUCKS, EQUIPMENT, OR OTHER VEHICLES USED IN THE CONDUCT OF THE BUSINESS. ONE PARKING STALL DESIGNATED FOR VISITORS FOR EACH TWO HUNDRED SQUARE FEET OF OFFICE SPACE.*	*52*
MAUI	*FOR INDUSTRIAL OR STORAGE USES, 1 STALL PER 1,500 SQFT PROVIDED THAT MINIMUM STALLS SHALL BE 3.*	*17*
OAHU	*FOR INDUSTRIAL, 1 STALL PER 1,500 SQFT.*	*17*
HAWAII	*FOR INDUSTRIAL USES, 1 STALL FOR EACH 400 SQFT OF GROSS FLOOR AREA.*	*63*

NOTES:

1. *FOR ZONING REQUIREMENTS, SEE SHEET SITE PLAN FOR MUNICIPAL SEWER DISPOSAL.*
2. *FOR A.C. PAVEMENT DETAILS AND SIDEWALK DETAILS, SEE SHEET SITE PLAN FOR MUNICIPAL SEWER DISPOSAL.*
3. *TOTAL PROPERTY AREA IS 24.49 ACRES.*
4. *FOR POSSIBLE LID MEASURES, SEE SHEET SITE PLAN FOR MUNICIPAL SEWER DISPOSAL.*

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5.3 ANIMAL SOLID WASTE AND WASTEWATER

The preferred concept assumes that wastewater and water disposal into a public or private system is not available. Therefore, a concept to treat waste and wastewater on-site is included in the preferred concept. On Oʻahu, Island Commodities will collect the solid wastes (for a fee). and process the waste at their facility to produce recycled products. The only waste element not recycled will be hides. For neighboring islands, Island Commodities can be used but storage and transportation costs may be prohibitive, though they may have other transportation and storage ideas for inter-island solutions for neighbor island facilities.

Wastewater may be able to be disposed of in a public or private wastewater treatment plant, with permission from the WWTP operator. However, current WWTP operators will require the pretreatment of the effluent prior to entering the WWTP collection system.

5.4 ON-SITE WASTEWATER TREATMENT

The current design for on-site wastewater treatment consists of two separate sewer systems: one for domestic wastewater and one for livestock facility wastewater.

5.4.1 Domestic Wastewater

The estimated flow rate for domestic wastewater is 5,350 gallons per day. For onsite wastewater disposal, a septic tank will first treat the domestic wastewater, which is then conveyed to a leach field for disposal. HAR 11-23 requires a primary component and a separate 100% (one hundred percent) backup disposal component, therefore, twice as much area is necessary for the leach field. The designed septic tank holds a capacity of 8,000 gallons and the leach field area is 1.38 acres.

5.4.2 Livestock Harvesting Wastewater

Livestock harvesting wastewater is approximately 10 times more concentrated than domestic wastewater, therefore, livestock harvesting wastewater must undergo a more intensive treatment than domestic wastewater. After rotary screening in the livestock harvesting facility, the wastewater will collect in a transfer pump station and conveyed through a dissolved air flotation system (DAF), treated further within an aerated lagoon, enter a constructed wetland, and then finally disposed of within a leach field.

The aerated lagoons are designed to handle a flow rate of 30,000 gallons per day and include a complete mix cell followed by a partial mix/settling cell with retention times of 15.6 days and 21.7 days, respectively. The total area of the aerated lagoons is 0.65 acres. The constructed wetland has a design flow rate of 24,000 gallons per day with a retention time of 4.1 days and a total bermed area of 0.57 acres. The total leach field area with 100% (one hundred percent) backup is 5.51 acres.

5.5 COMPOST SYSTEM

In the current design, the compost system is exposed to the elements. Rainfall and associated runoff are shown to be contained within the bermed containment area. In addition, Department of Health rules and regulations do not allow for standing water within the compost area. If rainfall accumulation is an issue, the compost area can be covered.

The Korean (Asian) composting process has fewer odors and requires less time on-site. However, there is a preprocessing component in an airtight vessel to accelerate the composting process. The preprocessing step utilizes microbes known as “effective microorganisms” or EM, which contain various species of yeast, lactic acid bacteria and purple non-sulfur bacteria, and a fermentation vessel that can be sealed hermetically and allow drainage of leachate. This process typically takes two weeks, during which drainage takes place periodically to prevent the contents from becoming too wet due to the excess liquid produced from fermentation. The resulting product can be digested rapidly by soil biota in a composting windrow.

5.5.1 Composting Facility

This design assumes that there are no other facilities on the island that accept animal processing byproducts and/or landfill disposal is not an option. The off-site landfill option would be the most economical and feasible for the facility owner/operator. An on-site facility would be under the jurisdiction of Hawai‘i Department of Health, Solid and Hazardous Waste Branch and would be considered a special waste landfill facility. Therefore, the owner/operator will require a permit from Hawai‘i Department of Health, Solid and Hazardous Waste Branch. The operation of this facility will require operational documentation, staff training, and input and output services. The processed compost will require exportation to users of the compost.

The current design shows a concept that has a minimal footprint and as one large composting area. The system is designed with manual rotation of the compost with a compost material mixture to an animal waste ratio of five (5) cubic yards per ton.[70] As per HAR 22-58.1-41(3)(D)(i), “a minimum of five (5) turnings is required during a period of 15 consecutive days with the temperature of the mixture being 55 degrees Celsius or greater within 6 to 8 inches below the surface of the pile.” Compost material contains a mixture of green material (high in nitrogen) and brown carbon material such as wood chips, wood shavings, straw, etc. If the green material can be harvested from the mixed pond and constructed wetlands, it could potentially yield 135 tons per year (for water hyacinth, broad-leaf cattail, and/or canna hybrid).[71] A balance of the green and brown material is recommended to control decomposition. The United States Department of Agriculture recommends a carbon to nitrogen ratio between 25:1 and 40:1.[72] Additional green and brown material will need to be imported to obtain the appropriate ratio for the compost mixtures.

[70] 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.
[71] Sandoval-Herazo, Mayerlin, et al. “Plant Biomass Production in Constructed Wetlands Treating Swine Wastewater in Tropical Climates.” Fermentation 7, no. 4 (2021): 296. https://doi.org/10.3390/fermentation7040296.
[72] USDA. 2017. “Conservation Practice Standard. Composting Facility.” *Natural Resources Conservation Service*, no. October: 1–3.

5.6 ESTIMATED CONSTRUCTION COST

The estimated cost for the 70 AU/day facility was developed based on the sixty percent (60%) design package and presented in Appendix E. The analysis is based on the material quantities derived from the design plans, Hawai'i-based production factors, and Hawai'i-based costs for material, equipment and labor.[73] The costs are from current bids and from trend analysis of historical data.

The labor costs are based on the higher of 1) Hawai'i-based labor rates and 2) Federal Davis-Bacon Act labor rates. The costs include a 12.5% (twelve-point-five percent) contingency factor as the design is not completed, and an annual construction cost increase of 8.5% (eight-point-five percent)/year. The construction is assumed to begin in June 2023. Based on the drawings and assumptions, the construction costs $51,333,000 in 2021 dollars.

5.7 LIMITATIONS

The following is a list of limitations, concerns and considerations about the preferred concept. The preferred concept is based on the harvesting facility purchasing livestock based on the live weight market price and owning the finished products. If the facility is processing large lots, the preferred concept is viable.

- The construction cost was undetermined during the design development and, therefore, the construction budget is considered unconstrained.
- Value engineering was not completed as it is the 60% (sixty percent) design, and no site has been selected.
- The current design is based on a beef animal lot of approximately 10 animals per pen. The potential owner may need to adjust the pen sizes to meet the demand based on the available animal units in the area.
- If smaller lots with producer (rancher) ownership of the dressed carcass and finished processed product is a goal, then the processing/fabrication line and the storage systems may need to be altered.
- An investor should:
    - Perform due diligence for the project such as, but not limited to, market demand, livestock demand, expected revenue, construction budget, functional areas to be included and project location;
    - Consider making the producers providing livestock to the facility partners in the business through creating a co-operative or by selling guaranteed shackle space to the producers and paying based on carcass cut out;
    - The facility will be designed to meet the investor's criteria and engineered to use the available "local" construction resources to the extent practical, meet the

[73] The cost estimation was not prepared using square foot costs and comparisons, as these types of estimates are typically inaccurate and do not recognize the vastly different technical details in the facilities. As someone put it, it's like comparing apples and oranges. Also, the comparison of continental U.S. prices was not used as the construction cost index in national publications are incorrect and do not reflect the actual construction costs in Hawai'i.

expected livestock demand, stay within the prescribed construction budget and other factors; and

- The actual design and construction will be an iterative process with the designer, construction contractor and investor throughout the entire design/construction process.

CHAPTER 6
LIVESTOCK OWNERSHIP

The discussion regarding financial analysis is a complex one, as there are many factors that will determine the actual feasibility and return on investment for the facility. The brief discussion in the section is about the ownership of the AU and processed product. The owner/operator will need to make the decision early on as it will determine the layout of the facility, cost and pricing.

The 70 AU/day facility designed in this study assumes for cattle that the operator purchases the AU and processes the carcass. The final beef product is owned by the operator and probably sold under the operator's label. For swine, the facility is designed to mainly harvest it and return the dressed carcass to the owner, thus charging a harvesting fee.

If a different type of ownership is chosen, the facility may need to be altered to match the AU ownership. Aspects of the facility are subject to change, taking into account the following considerations:

- The fabrication line may look different and sized appropriately;
- Pen sizes and the number of pens may change in order to manage the incoming cattle;
- Refrigerated storage should be adequate but may be altered based on the operator's preference; and
- If wet-aging is included in the facility, changes may need to be made if dry-aging is preferred.

The following is a brief description on the ownerships of the AU. There are three primary ownership alternatives, and each probably has different subsets or combinations. These ownership alternatives include: individual ownerships; user/producer ownership; and government/private ownership and lease to operator. There are also customized smaller shops, which can operate as a sole proprietorship and have different arrangements with ranchers. One such shop in Colorado does custom harvesting of cattle from different ranches. The shop then customizes the order by allowing the customer to select different cuts from different ranches, thus enhancing the ranch-to-table experience.

6.1 INDIVIDUAL OWNERSHIP INDEPENDENT OF THE SUPPLY

This option is the predominant profile of companies owning meat processing businesses in the U.S. Ownership is reflective of an individual, individuals or a company that purchase livestock from producers that process live animals into merchandisable meat products, and then merchandise the meat to customers. The exception to this strategy is not taking the risk of the animal purchase and the resultant sales but providing a processing service to others for a processing fee. The company finances the plant, property and equipment (PPE), and provides the operating capital and management for its operations. The incentive for this option is a sustainable return on investment (ROI), with acceptable return on sales (ROS) and return on equity (ROE). This entity can either provide:

- Custom processing services to those who are currently or in the future are marketing beef and proteins in Hawai‘i under their own brand name; and or
- Purchasing livestock from Hawai‘i’s producers, processing it into meat items and marketing them in Hawai‘i.

6.2 USER OR PRODUCER OWNERSHIP

Livestock producers (ranchers) typically sell their animals as market-ready, finished cattle, hogs or lambs to meat processors, or as calves, yearlings or lambs to feedlots prior to finishing. A few sophisticated producers in the U.S. have invested in meat processing to attract higher margins and/or to ensure they have a market for their livestock. There are several ways to accomplish this:

- A producer-owned company without rights and obligations to deliver livestock. A company is governed by a board of directors or members and hires a management team to run the company. The power and strength of the votes from the board of directors are based on the number of shares owned. This company, with a combination of debt and equity, finances the PPE and operating capital for the business. Examples of this are Highway 212 Beef in Minnesota, which has 13 producer-owners. Upper Iowa Beef in Lime Springs, Iowa, is owned by one large beef-producing family corporation. These companies purchase cattle from the region and not just from the owner’s herds. Their incentive is to make money for their investors and not just serve as a market for their own cattle.

- A producer-owned company with delivery rights and obligations. Each delivery right and obligation is treated as capital stock. In one case with a new beef company in Iowa, it is treated as preferred stock. Livestock producers purchase shares based on how many animals they Intend on bringing to the plant annually to be processed. The large pork processing and marketing company, Wholestone Foods (plant in Fremont, Nebraska), is organized in this fashion. Almost 100% (one hundred percent) of their supply comes from their owners. In the case with these large companies, the processing and marketing company itself purchases livestock from their owners on a formula price basis, and the marketing company sells meat to their customers under the company brand(s) and not the individual owner’s brands.

- A 100% (one hundred percent) custom processing company where the only market risk is the sale of hides, offal and some under-valued cuts that sell as commodities. This involves a combination of owners, some of which have their own labels, collectively building a plant where all animals are processed for a fee. An example of this scenario is Brush Processing (Brush, Colorado). One of the primary owners is Rocky Mountain Natural Foods, which brings its own purchased animals to the plant and merchandises most of the meat from these animals themselves. Several of the other owners do the same thing. They have organized this way to prevent the packing plant from competing with their own individual meat businesses.

6.3 GOVERNMENT/PRIVATE OWNERSHIP AND LEASE TO OPERATOR

The scenario of government ownership of a packing plant is unconventional but is currently done in Hawai‘i with the former Hawai‘i Beef Producers’ and Hawai‘i Meat’s plants. This plant is currently leased by Frank Vandersloot and is run as a private business. The state government of Alaska owned Mt. McKinley Meat and Sausage until 2016, when it was sold to a private party. Private business ownership by government agencies is uncommon and is usually only done to ensure a service is available to specific producers that otherwise wouldn’t have access to such service.

There is also the possibility for private ownership of the plant and leasing it to an operator. A design/build firm in South Dakota is in the process of building a beef plant in Sioux Falls, with the builder planning to lease the operations to a beef producer-owned limited liability company (LLC). The operational LLC will be organized as that described in “producer-owned company without rights,” above. The incentive for the builder is both locking in the construction contract to build the plant and also receiving steady long-term income from the operator. Other business leases exist between investors and operators in the U.S. meat processing industry but are not common. Typically, these are lease-to-buy relationships in which the owner is financing the operator with principal and interest handled as a capital lease.

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CHAPTER 7
BRANDING DEFINITION AND ITS IMPACT

The eminent marketing guru Peter Drucker said, "The purpose of a business is to create a customer. Business has only two functions — marketing and innovation. All the rest are costs. The aim of marketing is to know and understand the customer so well the product or service fits him and sells itself."[74] Northwestern University's famous marketing professor and marketing authority Phil Kotler defines marketing as "the science and art of exploring, creating and delivering value to satisfy the needs of a target market at a profit."[75]

Livestock branding was first discovered in an ancient Egyptian tomb, and "brand" emerged as a way for cattle ranchers to identify their animals. In the late 1880s, packaged goods like Coca-Cola started taking off, and brands were used to differentiate them from the generic/commodity competition.

David Ogilvy, the "Father of Advertising," defined brand as "the intangible sum of a product's attributes." A brand is an intangible asset that helps people identify a specific product or range of products as ***unique*** within a complex and sometimes confusing marketplace.

A brand is the foundation on which a company's unique values and beliefs are built. It is a fundamental element of the strategic infrastructure that defines why a potential customer should consider one product over another, while also setting expectations of value in the consumers' minds.

In order to build a brand, it is critically important to think about how the brand should look, how it should make customers feel and what can be done to make it resonate with the target audience. A strong brand requires an identity, image, culture and personality. Developing these components increases brand trust, loyalty and awareness.

The key benefits of branding include, but are not limited to, the following:

- Customer loyalty – thus continues long-term demand;
- Higher price/value acceptance;
- Increase producers/processors confidence; and
- Increase consumer communication/advertising efficiencies.

Therefore, a brand ***must*** understand the customer and the product. Customers hold two distinct sets of beliefs about shopping activities: Positive beliefs regarding the degree to which shopping contributes to their quality of life (shopper well-being), and negative beliefs related to the degree to which shopping activities result in overspending time, effort and money (shopper ill-being). Shopper well-being is a positive predictor of life satisfaction. In other words, the more satisfied a consumer is with a product, the more satisfied they are in general and the more likely it is that

[74] Drucker, Peter, *Peter Drucker on Marketing, Forbes Magazine*, July 3, 2006.
[75] Kolter Marketing, Why Marketing is a Science and Not an Art – Boost Results, 2019. https://www.think-beyond.co.uk

they will be loyal to the brand. Shopper ill-being negatively impacts branding, loyalty and shopper satisfaction.

The following are questions and recommendations that **must** be answered and clearly thought through when creating a brand:

- A clear understanding of the customer:
  - Who are they?
  - Where are they?
  - What are they seeking in our product?
  - Why would they buy our product?

- A clear understanding of our product:
  - What are our product's ***unique*** benefits?
  - What will help ensure customer purchase/retention/loyalty?
- Differentiation from competition in a recognizable and impactful manner.
- Be visibly different from competition in all marketing elements from packaging to advertising, etc.

A good brand has six different elements: brand voice, identity, promise, values, targeting and position.[76]

- Brand voice: the brand's personality and the unique way it is consistently presented. It helps consumers identify the brand across all platforms. It is how consumers perceive the company.
- Brand identity: a brand's visible elements (e.g., color, design, logo, packaging, website, social media graphics, etc.). Any brand asset is a component of brand identity, so consistent marketing and messaging lead to consistent brand identity.
- Brand promise: the brand's value or experience that customers can expect to receive every time they interact with that company. The more a company can deliver on the promise, the stronger the brand value.
- Brand value: the financial significance the brand carries. It determines the brand identity, message and personality. These principles guide story, actions, behaviors and decision-making processes. These are what keep the product/business unique.
- Brand targeting: the strategy that involves identifying specific personas or markets that the brand's products or services are most likely to appeal.
- Brand position: the process of placing the brand in a distinctive place in the mind of the target consumers. It describes how the brand is different from its competitors and where/how it sits in customers' minds.

[76] J. Scott Marketing, Ready for Marketing to Support Your Business Dreams?, 2022. https://jscottmarketing.com/the-six-elements-of-a-brand/#:~:text=We%20break%20down%20your%20brand%20into%20the%20following,Brand%20values%205%20Brand%20targeting%206%20Brand%20positioning

7.1 BRANDING AND TRADEMARK UMBRELLA

The Hawai‘i livestock industry includes multiple ranchers and harvesting facilities, each marketing their own products. Ranchers (producers) and processors are entrepreneurs who are likely to be protective of their brand identity.

There is significant data supporting the benefits of “branding an industry.” Whether it is called a trademark, an umbrella identification or a corporate identity, the benefits are significant both for the industry and the ranchers/processors under the ***trademark umbrella*** (working name).

7.1.1 Objectives

The main objective is to have the industry develop an overall brand/trademark for Hawai‘i’s grass-fed beef industry in order to:

- Provide investment and growth inducement to Hawai‘i ranchers and producers by
    - Increasing Hawai‘i resident consumption/demand of Hawai‘i Grass-Fed Beef from a current 7%-9%) (seven to nine percent) to 18% (eighteen percent) of total beef consumption within five years; and
    - Provide market expansion opportunity for Hawai‘i Grass-Fed Beef in out-of-state markets; and
- Ensure the Hawai‘i livestock stock industry’s sustainability.

7.1.2 Proposed Strategy

It is recommended that a ***trademark umbrella*** be developed and managed by the Hawai‘i Cattlemen’s Council, Inc. or similar organization representing beef producers (ranchers). The organization would provide the added marketing support to locally approved ranchers and processors. The ***trademark umbrella*** would not infringe on the unique brands of local ranchers or producers, but rather enhance their brand perception/value. This type of umbrella trademark has been employed by other sectors of the Hawai‘i agriculture industry or different growing regions (e.g., Hawai‘i Neotropica, Kona Coffee, Kaua‘i Grown, etc.).

The organization should consider:

- Legally registering the trademark “Hawai‘i Grass-Fed Beef”;
- Legally registering the logo and other related trademarks associated with Hawai‘i-grown livestock; and
- Undertake the marketing and promotion of Hawai‘i Grass-Fed Beef and related products.

The organization would encourage local ranchers and producers to support marketing and branding efforts through membership that will recognize the ***trademark umbrella*** branded product as unique and superior.

7.1.3 Rationale

A best practice review was performed, as part of this study, of industry trademarks of agricultural products. The following are the conclusions of the review.

- The formulation of strong state-backed regulatory product boards and commissions greatly enhances an industries' ability to protect its place of origin brand. The most successful groups mandate enrollment by all producers, distributors and sellers, while engaging in advocacy, enforcement, marketing, networking, legal issues and research.

- States that have worked in partnership with industry groups to enact strict regulatory frameworks have seen more success in protecting regional brands within those industries. Building on existing federal origin programs can strengthen support and reduce administrative challenges.

- Multi-sourced funding is often necessary to successfully execute origin programs and demonstrate enforcement intent, especially at program onset. Options for federal funding support are available for many purposes through USDA Market Access Program (MAP) and Federal/State Marketing Improvement Program (FSMIP), but additional funding from state and membership sources is often required.

7.2 LABELING/BRANDING ENVIRONMENT

The positioning of beef in the marketplace is confusing and, in many cases, misleading. Under the December 2019 issuance by the Food Safety and Inspection Service (FSIS), beef ***cannot*** be labeled "grass-fed" unless the cattle were fed grass or foraged 100% (one hundred percent) of the time after being weaned.

FSIS does require documentation for labeling claims and when animals have less than 100% (100 percent) access to grass, and therefore, partial "grass-fed" claims must accurately reflect the circumstances. As an alternative, processors may also define their own parameters for labeling that is verifiable by third parties or through the voluntary USDA Process Verified Program. These programs exist to ensure consumer truth-in-labeling.

Technically ***all*** cattle are ***"grass-fed,"*** but it's how they're ***finished*** that makes the difference. When cows have calves and those calves begin to grow, they all eat grass. When calves are at the age of weaning, they can be grass-finished, grain-finished or a combination of both. It is estimated that 95% (ninety-five percent) of cattle in the U.S. are grain-finished versus 5% (five percent) that are grass-fed.

The following are examples of labels from Hawai'i beef companies, followed by examples of labels from non-Hawai'i companies. Unbranded Hawai'i-grown meat is also found in Hawai'i's grocery stores.

Exhibit 29. Grass-Fed Beef Hawai‘i-based Companies

7.3 CONSUMER RESEARCH

Understanding how consumers relate to brands is important. Consumers are not passive purchasers. Rather, consumers purchase products as they relate to self-perceptions of who they are as shoppers. Certain products need only meet pricing requirements (e.g., commodities such as flour, sugar, etc.), while others must meet a host of qualities. As seen below satisfaction with Grass-Fed Beef is relatively high (Top-2-box > 90% for both locations). This is important because satisfaction in this case is an amalgam of attributes (quality, ease of use, etc.) and price does not appear to have a negative impact.

This study undertook a consumer livestock demand and perception survey to define the primary market segment for Hawai‘i Livestock Grass-Fed Beef and their attitudes and desired benefits towards the product range (Appendix F). When asked about the reasons why they prefer specific brands or sources of beef, Hawai‘i respondents show a different pattern in reasons compared to Mainland respondents (Table 28). The top three reasons among Hawai‘i respondents are:

1. Grass-fed beef is better and more organic (52%)
2. Supporting local businesses/farms (13%)
3. Good quality and high standard (13%)

Exhibit 30. Grass-Fed Beef Mainland Companies

Compared to Hawai'i respondents, Mainland respondents are more quality-driven (Table 28). They prefer specific brands or sources of beef that have good quality (32%) or have better flavor (22%). Close to 30% (thirty percent) also think that grass-fed beef is better and more organic.

When asked about important attributes they seek in beef, 88% (eighty-eight percent) of all respondents stated that the appearance of meat and meat safety are most important. When respondents were asked which types of beef they usually purchase, about 47%-48% (forty-seven to forty-eight percent) of Hawai'i and Mainland respondents said they usually purchase grass-fed beef. When asked to describe the quality of the beef the following responses were provided:

- Described the grass-fed beef to be tastier or have better flavor. Hawai'i respondents rated this almost 10% (ten percent) points higher than the Mainland respondents.
- Approximately 18%-21% (eighteen to twenty-one percent) of respondents described grass-fed beef as a cleaner product referring to the way livestock was raised, naturally, healthier and antibiotic- or growth hormone-free.

Hawai'i Grass-Fed Beef awareness is low on the Mainland as compared to Hawai'i residents' level of awareness as shown on Exhibit 31. The level of satisfaction with Hawai'i Grass-Fed Beef is high among both Mainland and Hawai'i consumers as shown in Exhibit 32.

The most common reason for not purchasing Hawai'i Grass-Fed Beef is the higher price. This is a primary reason for enhancing the brand image and quality perception to overcome the price barrier.

Eighty-nine percent (89%) of respondents think confirmation that Hawai'i Grass-Fed Beef is genuinely Hawai'i grown is important. Furthermore, when asked how important specific attributes of Hawai'i Grass-Fed Beef are, they stated food safety was very important (70%), knowing that

the beef is wholesome and free of disease-causing agents. Hawai‘i-grown is also important, especially to Hawai‘i residents.

Table 28
Reasons for Preferring Specific Brand of Beef or Source of Beef

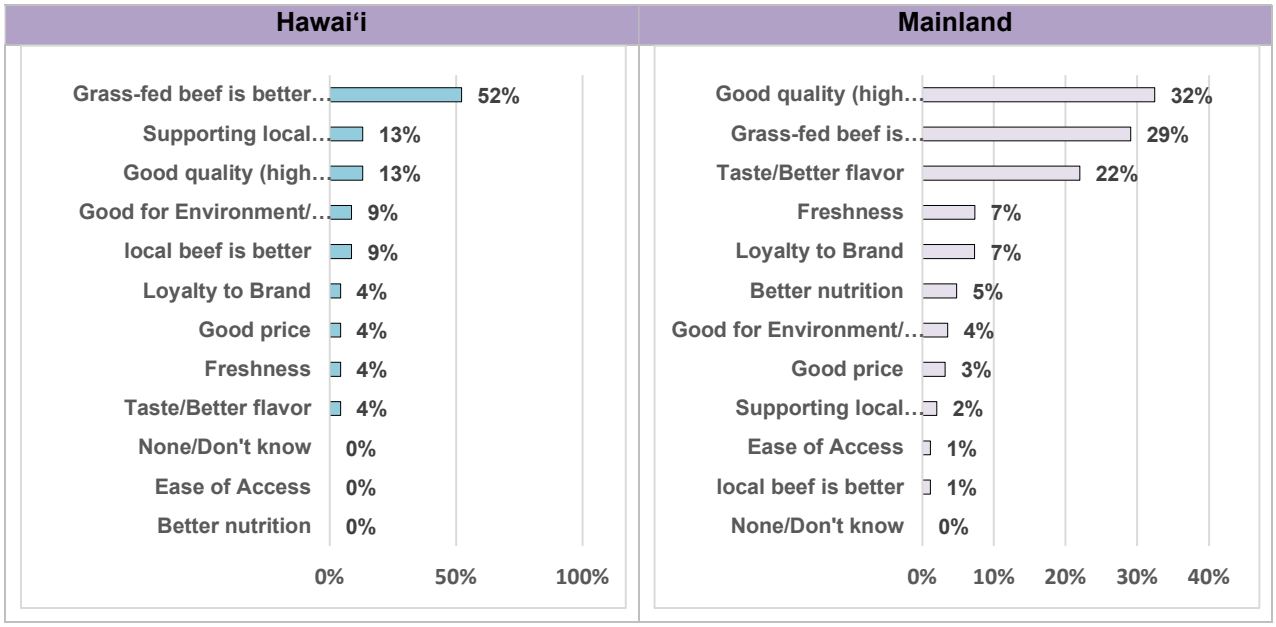
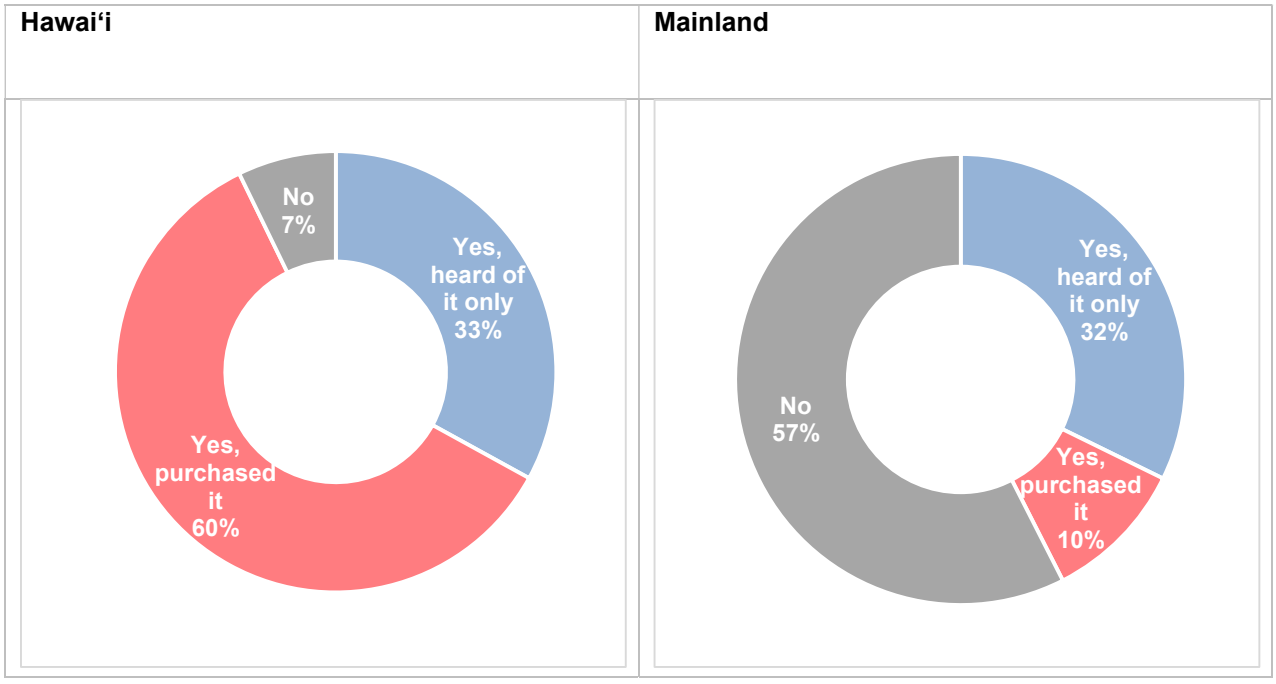


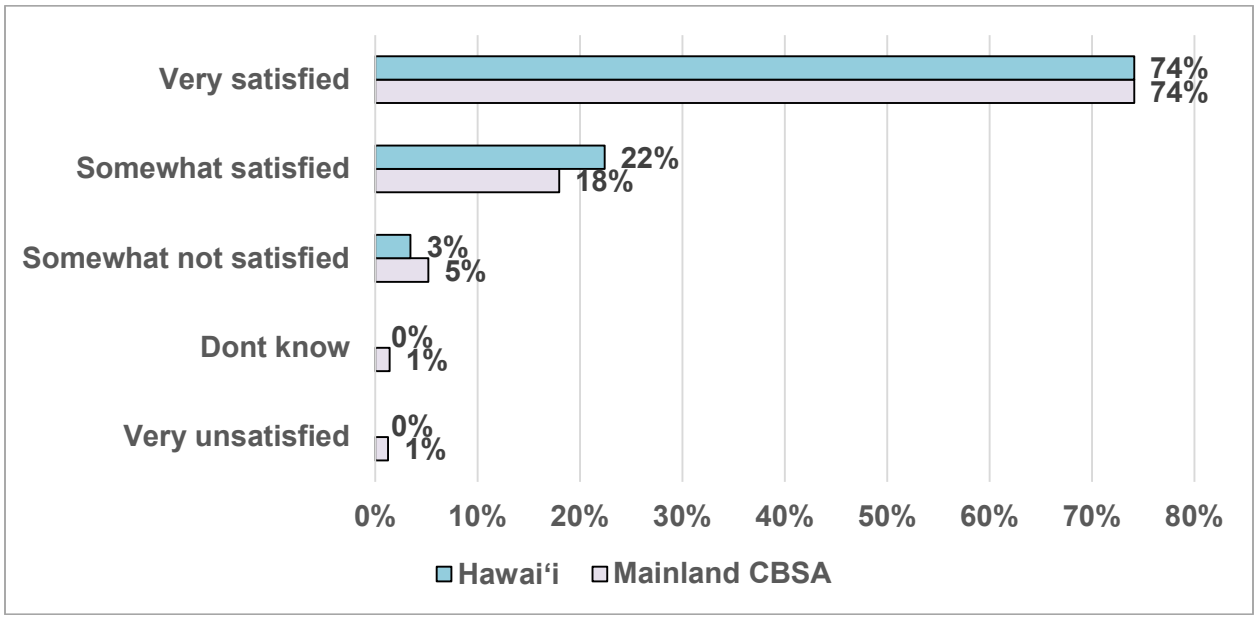
Exhibit 31. General Awareness of Hawai‘i Grass-Fed Beef



Question: Have you heard of or purchased Hawai‘i Grass-Fed Beef?

Source: Beef Survey 2021
Note: The base is those who selected grass-fed beef in the previous question.

Exhibit 32. Satisfaction with Hawai‘i Grass-Fed Beef



Question: How satisfied were you with the Hawai‘i Grass-Fed Beef?

Source: Beef Survey 2021
Note: The base is those who have purchased Hawai‘i Grass-Fed Beef.

7.3.1 Driver Analysis

A driver analysis is a marketing tool utilized to identify what brand benefits should be promoted more strongly. This study did a driver analysis using multiple regression and other statistical tools to measure the relationship between the likelihood of consumers that would buy Hawai‘i Grass-Fed Beef in the future and what attributes of beef appealed to them.

Our objective was to identify beef characteristics that had the strongest positive correlation to the likelihood of buying in the future. A successful branding campaign could then focus on these attributes, which would then result in an increased positive response toward buying Hawai‘i Grass-Fed Beef.

Analysis showed that for those who are ***most likely to buy Hawai‘i Grass-Fed Beef in the future*** also had a high positive association with the following characteristics (Table 29):

1. Placed high importance on the beef’s quality.
2. Placed high importance in the ease of preparation.
3. Believed that Hawai‘i Grass-Fed Beef is generally better.
4. Believed that Hawai‘i Grass-Fed Beef is of better quality.

Table 29
Drivers of Increasing Likelihood to Buy Hawai‘i Grass-Fed Beef

Regression		
Drivers of Increasing Support	**Value**	**p-value**
Quality	0.050	0.000
Ease of preparation	0.045	0.000
Hawai‘i Grass-Fed Beef generally better	0.238	0.000
Hawai‘i Grass-Fed Beef better quality	0.121	0.000

An important result of the analysis is the fact that consumers selected Hawai‘i Grass-Fed Beef because of its association with Hawai‘i. They saw Hawai‘i Grass-Fed Beef as a unique subset of grass-fed beef in general.

7.3.2. Proposed Trademark Umbrella Branding

As mentioned above, a brand is the collective impact or lasting impression from all that is seen, heard or experienced by customers who encounter a company and its products/services. The purpose of a brand is to define the business and provide focus for long-term marketing goals. It also sets a benchmark for measuring progress.

The business entity should manage/assess the effect of the product/service on consumers. The intent is to create customers that continue to purchase the branded products. Good branding enables the brand to have a human side that people can relate to easily.

The grass-fed beef attributes identified in the survey appear to provide a meaningful foundation for developing an umbrella brand for the category. It is important to note, however, that developing a brand is not a simple/easy process. It requires continuously defining, refining and testing the overall brand strategy in the marketplace. This is a long-term plan designed to meet a series of long-term goals that should result in the identification and preference of the brand by consumers. Without a good brand strategy there is no way to ascertain whether the brand is moving in the desired direction.

To differentiate Hawai‘i’s grass-fed beef and assure buyers that the beef products they buy are raised by ranchers in Hawai‘i on grass that produces high quality, tasty, easy-to-prepare beef. it is recommended that an **umbrella** brand should be developed and implemented for the industry.

It is recommended that the Hawai‘i grass-fed beef industry create an umbrella brand that qualified Hawai‘i ranchers can share to give their products more credibility and higher awareness. The branding plan would provide major benefits to the livestock industry in Hawai‘i, including, but not limited to:

- Increasing awareness of the unique qualities of Hawai‘i Grass-Fed Beef will increase demand, and thus encourage local ranchers to maximize product availability;
- Increased consumption of Hawai‘i Grass-Fed Beef will improve Hawai‘i’s food sustainability; and
- With adequate supply, the Hawai‘i livestock community may develop export opportunities, starting with the U.S. Mainland market.

To achieve a successful branding program, some key elements should be considered. To succeed, consumers must become aware of the brand and its benefits. This requires advertising, public relations, point-of-sale programs and more.

The proposed ***trademark umbrella*** should convey the following attributes:

- Food safety assurance
- Superior, assured quality
- Be unique, special and cannot be duplicated.

The proposed umbrella brand would be a ***Seal of Assurance*** that the livestock was grown and raised in Hawai‘i. Only qualified Hawai‘i grass-fed beef would be allowed to use the brand. Preliminary thoughts are that the Seal of Assurance will include words such as “Hawai‘i Grass-Fed Beef,” “Hawai‘i Grazed” or “Grazed in Hawai‘i Beef.” The image could be a cow on grasslands on Hawai‘i Island or a paniolo/cattle picture. It should convey uniqueness, quality and the aloha spirit.

It is proposed that the HCC or the organization register **“**Hawaii Grass-Fed Beef**”** and the specific Seal of Assurance wording and trademark. Identifying the criteria for products that can use the trademark is very important to ensure that once the product is purchased, consumers will taste the quality and buy it again. Building awareness of what the brand and trademark conveys should also be managed by registering organization.

Other states and industries that have used an umbrella brand generate funding by collecting a fee for use of the brand/trademark. The fee is used to build awareness of the brand and, if needed, protect the brand from being used by products that have not been approved. The study recommends that funding sources be developed in conjunction with local ranchers and processors. Initially there may be state funding available to establish the brand. However, for the brand to have significant impact, ongoing promotion, expansion, and protection of the brand will be needed, and those funds will have to be generated over time.

Funding of the program can be undertaken in multiple ways. An initial approach to be considered is generating a marketing fund of 1% (one percent) of gross wholesale livestock product sales from participating ranchers and processors. Based on estimated 2020 wholesale livestock revenues in Hawai‘i that generated $42 million plus per annum, the marketing fund may reach $420,000. This level of funding for the year one marketing effort to be concentrated in Hawai‘i is adequate to commence building a sound brand image.

The plan should ensure the livestock ranchers (producers) and processors that the ***trademark umbrella*** will not infringe on their unique brands, but rather provide enhancement. In addition, the brand should only be available to ranchers and processors that meet the quality benchmarks for Hawai‘i Grass-Fed Beef established by the registering organization. Also, promoting the umbrella brand means that all participants get a boost in awareness and association with high quality much more than any one brand can hope to invest in individually. It is proposed that additional funding sources be developed through USDA, HDOA and grants from the state legislature.

CHAPTER 8
FINANCIAL FEASIBILITY

The economic feasibility will depend on the business plan for the facility, elements of which are detailed in previous chapters and in the appendices. The financial feasibility of the facility needs to evaluate the bottom line of the business and to assist in determining whether it can sustain itself; pay its employees, investors and creditors; reinvest into the facility and, obviously, make a profit.

To accomplish the above, the evaluation of financial feasibility is provided in basic terms. The basics are used intentionally, as individual investors will identify their own site of operation and business models. As such, this scalable and replicable model of this facility is **not:**

- Site specific,
- Cost constrained;
- Developed for a specific operator; and/or
- Planned or designed for a specific business model, but closely resembles a facility that is under an individual owner independent of the supply model.

The feasibility of the project will depend on many factors, most of which have been discussed in previous chapters of this report and should not only be based on the following financial analysis. One must also view the facility from the livestock industry perspective, and as part of their food-security objective.

Currently, the calf-export model provides stable revenue for ranchers, and over the years complex distribution networks have been developed. The shift to provide an additional 5,000 to 10,000 cattle per year for Hawai‘i-based harvesting facilities will be a significant shift in pasture management, risks, logistics and production. Therefore, it’s up to the ranchers and harvesting facility owners/operators to determine the feasibility of this model within the livestock system.

It should be noted that the information provided is based on publicly available data and not specific to one or any operator in the state of Hawai‘i. The existing operator’s financial information is considered CONFIDENTIAL BUSINESS INFORMATION and, therefore, is not used in this analysis. In addition, due to the limited number of harvesting facilities in Hawai‘i, the use of an average or a specific value would not be statistically accurate, may provide a bias, and may unintentionally reveal confidential business information.

This financial feasibility analysis shows an expense and revenue timeline to reflect, how the investor will recoup the initial startup costs and when the long-term profits may be realized. This analysis is based on a fixed profit percentage to show the dependency of the finished product price to the overall expenses borne by the harvesting facility operator.

The analysis also provides a Return on Investment (ROI) computation using industry standard methodology for financial analysis. The ROI is expressed as a percentage and is calculated by dividing an investment’s net profit (or loss) by its initial cost or outlay. The ROI analysis does not include a fixed profit margin as it would bias the results of the analysis. This methodology is

similar to the methodology developed by Oklahoma State University faculty Holcomb and Kenkel. A brief summary of the model, and a link to the model is presented below.

The facility is a multi-species harvesting facility, but beef production currently provides the majority of income to the facility. As seen in the inventory, the hog market has potential if the gray market processing shifts to commercial harvesting.

One of the objectives was to provide a sustainable system for livestock harvesting — however, this can't exist in a vacuum. For the harvesting facility to be sustainable, the livestock industry needs to be sustainable. The economic sustainability depends on the rancher's profit to be equal or higher than the current calf-export model. Therefore, financial feasibility of the livestock system is dependent on: 1) the "cost for goods sold" (the input AU price and the price paid to the rancher) which will determine the rancher's profitability; and 2) the "market price" that the harvesting facility sells the finished beef to be competitive and meet consumer demand. The feasibility of the harvesting facility will also be dependent on less variable costs, such as the operating costs and debt service. The overall analysis of the livestock system is beyond the scope of this study therefore, the analysis uses assumptions for the two important variables to determine the feasibility of this studied facility.

The cost of goods sold, and the market price are dynamic and depend on various factors. The variability of the first is based on breed, age, quality of beef, etc. The second is based on consumer pricing, market demand, buyer (e.g., DOE) contracts, branding, marketing, quality of beef, consumer acceptance, etc. In addition, as Hawai'i's cost of living is high, the general population will tend to purchase cheaper products for everyday needs.

In this analysis, the following assumptions are made:

- There are 10,000 head of cattle per year for harvesting on a consistent basis;
- The facility was designed with no site-specific constraints;
- The facility was designed with no budgetary constraints;
- The majority of the cattle will be at the optimal harvesting age for a quality product;
- Cull cattle or older cattle will make up a small percentage of AU harvested;
- Wet-aging will be employed to increase the value of the beef;
- Cattle is sold to the harvesting facility at an average cost of $1.40 per pound based on live weight;
- Finished beef is sold at an average of $5.66 per pound to the wholesaler; and
- The analysis does not account for planning, permitting and other pre-development costs, time and analysis.

8.1. FEASIBILITY ELEMENTS

A potential investor and owner will perform their own due diligence, research, financial analysis and investigation regarding the actual feasibility of the project. The basic components are:

- Company Expenses;
- Revenue;

- Assets; and
- Liabilities.

The business plan will need to be developed by the investor(s)/owner(s) to determine the actual feasibility of the project. The business plan will evaluate and understand detailed data and statistics such as, but not limited to, the following.

- Demographics.
- Real estate, land value and site characteristics.
- Construction and development costs.
- Market factors:
  - Product and neighborhood analysis,
  - Labor supply,
  - Government incentives,
  - Similar facilities and products,
  - National and regional comparisons,
  - Competitive market analysis and competition analysis,
  - Projected market and gross revenue,
  - Cost of supplies,
  - Cost of utilities and operational requirements, and
  - USDA inspection availability.
- Financial information:
  - Profit and loss,
  - Income statement,
  - Pro forma; and
  - Balance sheets.

Market and branding studies show potential for Hawai‘i-grown beef in the state and abroad, as discussed in Chapter 7 and Appendix F. The branding and ownership model will be critical in determining the financial analysis and potential success of the facility. In addition, actual government funds and incentives to the livestock industry, and agriculture in general, will also assist in profitability and with improving Hawaii’s sustainability and food security.

One issue the facility will have to consider pertains to smaller ranchers that have fewer livestock to harvest. The operator will need to determine how the facility is going to process these AUs through the facility in a cost-effective method as the AU may have greater variability in beef quality, breed, age, etc.

As noted previously, the availability of land, investor budget constraints, construction resources, rules and regulations will alter the cost, size and components of the facility. In addition, the components or concepts of this proposed facility may be used at existing facilities as they renovate or retrofit. Technically the facility is feasible to be constructed and operated as it is based on design principles in the continental United States. A review of the design by the designer-of-record may decide cost-effective modifications or value-added designs which may reduce the cost of the facility.

8.2 FEASIBILITY TEMPLATE–OKLAHOMA STATE UNIVERSITY

Oklahoma State University faculty Holcomb and Kenkel developed a template to determine the feasibility of a Fresh Beef Packing Plan.[77] The template was designed to assist potential owners and operators of livestock harvesting facilities in assessing and comparing costs for alternative plant construction and operation costs, and meat and by-product values. The template allows users, through a series of worksheets, to determine the viability of building and operating small, medium or large facilities. The link for the template is: https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Ffood.okstate.edu%2Ftraining-and-services%2Fsite-files%2Fdocs%2Fmid-large-scale-fresh-beef-packing-plant.xls&wdOrigin=BROWSELINK.

8.3 FINANCIAL FEASIBILITY – INDIVIDUAL OWNER SCENARIO

For this scenario, the facility is operated as an owner who is independent of supply. Therefore, the facility will buy the cattle from the rancher, and sells the finished products to a wholesaler or buyer (e.g., DOE). The analysis methodology follows general principles and practices, equations and worksheets for business financial analysis. This analysis shows the timeline of the estimated expenses and projected revenues on an annual basis. The financial feasibility evaluation will be based on a scenario for a harvesting facility designed to process 70 beef AU/day and have an annual production of approximately 10,000 beef AU. This analysis assumes a fixed 10 percent (10%) profit to each pound of finished goods.

8.3.1 Expenses

The operating costs for the 70 AU/day facility operating at 40 AU/day[78] can be estimated as shown in Table 30. The references for the expenses are provide in the table. For this scenario, the price paid to the rancher by the operator is $1.40 per pound ($1.40/lb) based on the live weight (hoof weight) of the AU and based on past surveys of the industry at the start of the study. The miscellaneous costs are estimated and include smaller expenses such as travel, small equipment, office supplies, etc.

Table 31 presents the amortized Capital Improvement Cost (debt service) on the $51,000,000 (fifty-one million dollars) construction cost estimate from the 60% (sixty percent) design drawing and equipment. The debt service assumes a commercial loan at nine percent (9%) interest.

There was no value engineering performed as there is no site selected. Value engineering for resources available to the contractor may decrease the construction costs, and land fee ownership or lease rent is not included in the analysis. The analysis was based on the worksheet similar to the Holcomb and Kenkal template, and a summary of the information is presented below.

[77] Holcomb, Rodney B. and Phil Kenkel, *Feasibility Template for a Fresh Beef Packing Plant*, Oklahoma State University.
[78] The facility will be designed to meet the 70 AU/day design presented but operate at a 10,000 AU per year as discussed previously. The smaller processing flow accommodates the current labor shortage identified in the research.

Table 30
Estimated Operational Costs for Processing 40 AU/day
In the 70 AU/day Facility
(Annual Costs)

Description	Cost	Reference
Wages & Fringe Benefits	$2,370,000	U.S. Department of Labor and adjusted for Hawaii
Debt Services (Plant and Equipment)	$5,770,000	Proprietary Bank Worksheet
Utilities	$560,000	Hawai'i Rates (Honolulu)
Professional Services (legal, accounting, marketing, etc.)	$610,000	Online review of rates
Boxing and Packaging	$156,000	Oklahoma State worksheet
Miscellaneous Costs (estimated 4%)	363,000	Travel, vehicles, cleaning and office supplies, etc.
TOTAL EXPENSES	$9,829,000	

Note: In personal discussions with other Hawaii agricultural commodity groups, they state that boxing and packaging costs in Hawaii are significantly higher than costs on the Mainland.

The assets and debt service are based on the construction costs and the major equipment costs for the 70 cattle-head/day facility are presented in Table 31. The debt service was computed based on a 30-year commercial loan with an interest rate of nine percent (9%).

Table 31
Debt Service
(annual cost)

Description	Cost
Building	$ 4,950,000
Equipment	$ 820,000

8.3.2 Revenue

The facility needs to sell the finished product at a market price that is competitive with the imported beef being sold in the local market. This variable is dependent on the value of the product to the wholesaler. Typically, locally grown products have higher consumer prices than imported (Mainland) products, which may not translate to a higher value to the harvesting plant owner for the finished product.

As learned from the surveys, consumer purchasing decisions are not always based on price. However, price is one factor consumers use to purchase beef, along with other factors such as but not limited to: quality, taste, and Hawai'i grown label. Therefore, branding, marketing and product consistency play an important role in understanding consumer buying trends and achieving the correct price point.

For this scenario, the assumption is that the wholesale price per pound of the final product is based on a 10% (ten percent) profit margin over expenses (not including depreciation). Therefore, it is a fixed 10% (ten percent) revenue for each pound of finished product.

8.3.3 Assets and Depreciation

For the cashflow analysis, the assets and depreciation are taken into account. The assets are basically the fixed assets such as building value and the value of equipment, cars, etc. The cost of acquiring these assets and their maintenance is reflected in the operating expenses of the facility.

Depreciation is also used in the cashflow analysis and standard accounting methodology (straight line depreciation) was used to compute the depreciation of the assets. The depreciation of the asset was computed using the straight-line depreciation method. Table 32 shows the assets and depreciation of the assets.

Table 32
Assets and Depreciation

Asset	Value	Depreciation
Facility	$ 51,333,000	$ 1,711,000
Equipment	$ 4,229,000	$ 604,000

8.3.4 Expenses and Revenue Timeline

This analysis will evaluate the overall cashflow for the first ten years of the facility. Table 33 shows the estimated revenue and costs based on a 2.5% inflation for the first 10 years. The owner's profitability will depend on their business plan, marketing and branding, and other dynamics that are not available at this time. Simple business planning would dictate that if the facility is feasible, the revenue over time needs to be greater than the expenses. The business plan, balance sheets, cash flow and pro forma will need to be developed for each site to determine if the plan will work and if the ROI and long-term cash flow would be achievable. From the surveys, the scenario assumes cost of goods for the plant to be $1.40 per pound ($1.40/lb) of live weight and 1,095 pounds average for cattle.

The first two years will be the construction and hiring of staff for the facility, which will result in no revenue as the facility is not ready for operation. This analysis does not include the design, permitting, and approval time period which occurs prior to construction. In Hawai‘i, this pre-construction timeframe is typically five or more years depending on the number of permits and approvals required, and the level of public controversy and/or associated legal challenges. Typically, in Hawaii, design costs are estimated to be approximately 15 to 20 percent (fifteen to twenty percent) of the construction costs.

The third year is estimated to be the first year of operation and a seventy percent (70%) throughput is assumed. This allows for a "break-in" period for the facility and staff. Operational costs are estimated to be 100 percent (100%) as the facility is operating with a full staff. It is

assumed that an adequate supply of AU is available, and the marketing and branding has been developed and implemented pursuant to the facilities business plan.

From year four (4) to year 10 and longer, the facility is operating at 100% (one hundred percent) and processing 10,000 head per year. Based on a 2.5 percent inflation rate, the operation costs are annually increasing. Based on the cost to acquire cattle and the sold price to market, the facility has made a negative profit or net loss. For these large capital investments, the payout period can be longer.

Table 33
Estimated Annual Expenses and Revenue
(0 to 10 years)

Year	Fixed Cost ($000s)	Operating Costs ($000s)	AU Harvested	Cost of Goods (AU/Year) ($000s)	Gross Revenue ($000s)	Net revenue ($000s)	Average Revenue (lb. of finished product)
1	5,770	0	0	0	0	0	Not Applicable
2	5,770	2,840	0	0	0	0	Not Applicable
3	5,770	4,160	7,000	10,730	22,726	2,066	$6.91
4	5,770	4,260	10,000	15,710	28,314	2,574	$6,02
5	5,770	4,370	10,000	16,110	28,875	2,625	$6.14
6	5,770	4,480	10,000	16,510	29,436	2,676	$6.26
7	5,770	4,590	10,000	16,920	30,008	2,728	$6.38
8	5,770	4,700	10,000	17,340	30,602	2,782	$6.51
9	5,770	4,820	10,000	17,780	31,207	2,837	$6.64
10	5,770	4,940	10,000	18,220	31,834	2,894	$6.77

Note: Values have been rounded.

Based on the above computations, the price of the finished product would need to be in the $6 range. However, stakeholders have stated that an average of $5.70 per pound would be for a high-end finished product. Stakeholders, currently state that a significant portion of the AU harvested are too old to be considered for a high-end market, making the finished product value lower. Note that the stakeholders are basing their input from existing conditions, without wet-aging of the final cut beef products, current calf-export model, and current branding and marketing plans. In this scenario, with an assumed $5.70 per pound paid for the finished product the net revenue will be much less than the assumed 10 percent (10%) profit.

Based on the expenses and revenues in Table 33, the investor will expend $14.380 million for construction costs and partial operating costs in the first two (2) years, without revenue. The net revenue is projected to be realized in year three (3). Therefore, based on the estimated net revenue from year three (3) and beyond, the investor will recover the initial expenses in year seven or eight (7 or 8). The investor will realize the net revenue from year eight (8) (6 years of operation) and beyond. As such, a long-term investor may be interested in the development of the facility, especially if the investor has the same objectives as HCC and/or the livestock industry.

For comparison purposes, an analysis was performed without debt service, as there maybe financing alternatives for the construction portion of the project, such as the use of a construction loan or cash-based funding. For short-term construction loans, only interest is paid on the amount borrowed from the loan. Construction loans are typically only for 12 to 18 months and paid off at the end of the loan period. Table 34 provides the estimated price per pound of the finished product with no debt service to provide a different financial analysis than shown in Table 33. As expected, the price per pound of the finished product is much lower than the price value with the debt service.

Table 34
Estimated Annual Expenses and Revenue with No Debt Service
(0 to 10 years)

Year	Fixed Cost ($000s)	Operating Costs ($000s)	AU Harvested	Cost of goods (AU/Year) ($000s)	Gross Revenue ($000s)	Net Revenue ($000s)	Average Revenue (lb. of finished product
1	0	0	0	0	0	0	Not Applicable
2	0	2,840	0	0	0	0	Not Applicable
3	0	4,160	7,000	10,730	16,378	1,489	$4.98
4	0	4,260	10,000	15,710	21,973	1,998	$4.68
5	0	4,370	10,000	16,110	22,522	2,047	$4.79
6	0	4,480	10,000	16,510	23,085	2,099	$4.91
7	0	4,590	10,000	16,920	23,663	2,151	$5.03
8	0	4,700	10,000	17,340	24,254	2,205	$5.16
9	0	4,820	10,000	17,780	24,860	2,260	$5.29
10	0	4,940	10,000	18,220	25,482	2,317	$5.42

8.5 EXPENSES FOR 20 AU/DAY HARVESTING FACILITY

As part of the study, the facility was required to be scalable. Therefore, the analysis was performed on the 20 AU/day facility which would equate to harvesting 5,000 AU/year. The estimated expenses for the 20 AU/day facility are shown on Table 35. The construction costs for the 20 AU/day facility are estimated to be $38 million based on the unit construction costs from the 70 AU/day facility.

8.6 RETURN ON INVESTMENT

The ROI analysis for the estimated expenses and revenue was based on $5.66 per pound ($5.66/lb) of finished product. The ROI was computed for three scenarios, 1) the 20 hd/day facility processing 5,000 beef AU per year; 2) the 70 hd/day facility operating at 40 hd/day and processing 10,000 beef AU/year, and 3) the 70 hd/day facility processing 18,000 beef AU/yr. As this analysis uses industry standard business investment methodologies, the fixed 10 percent markup on expenses is **NOT** included. The methodology uses similar worksheets as published

by Holcomb and Kenkal of Oklahoma State University. The results for the ROI analysis for the three scenarios are shown on Table 36.

Table 35
Expenses for 20 AU/day Facility

Description	20 AU/day Cost
Wages & Fringe Benefits	$1,470,000
Debt Services (Plant and Equipment)	$2,620,000
Utilities	$510,000
Professional Services (legal, accounting, marketing, etc.)	$610,000
Boxing and Packaging	$80,000
Miscellaneous Costs (estimated 5%)	210,000
TOTAL	$5,500,000

The analysis used a commercial loan term of 30 years, with an interest rate of nine percent (9%). For comparison purposes, the analysis looked at a 20-year loan term for the 70 AU/day facility, and the ROI with debt service decreased as expected. The analysis also computed the plant profitability index. The analysis shows that the 20 AU/day facility may not be feasible, but the 70 AU/day facility has a positive ROI. As the number of AU processed increases to meet the design capacity of 70 AU/day, the ROI increases significantly with debt service included.

Table 36
Return on Investment and Plant Profitability Index

Facility and Annual processing capacity	20-year Loan			30-year Loan		
	ROI	ROI w/o Debt Service	Plant Profitability	ROI	ROI w/o Debt Service	Plant Profitability
20 AU/day facility processing 5,000 AU/year	-4.26	7.10	22.51	-3.15	7.10	22.51
70 AU/day facility processing 10,000 AU/Year (40 AU/day)	2.10	13.54	28.65	3.15	13.54	28.65
70 AU/day facility processing 18,000 AU/Year	14.19	25.64	29.57	15.25	25.64	29.57

8.6 GOVERNMENT INCENTIVES

Government incentives have been used by federal, states, municipalities, and counties to assist in the development of industry, facilities, and resources. Government incentives could improve the feasibility for investors and include, but not limited to: grants, tax breaks, special purpose bonds, and lower land leases for agricultural enterprises.

It should be noted that the two largest harvesting facilities in the Hawaii, are on state lands and in facilities constructed with state funds. Given that, a full privately funded facility would have a difficult time competing against those facilities with state assistance.

The availability of government funding or subsidies for a new or renovated facility and land would improve the feasibility and competitiveness, as the cost for the facility is reduced. From a food security point-of-view, the federal government (USDA) has released funds to increase food security. A recent (2022) grant was provided to University of Hawaii College of Tropical Agriculture for $40 million.[79]

8.7 SUMMARY OF RESULTS

The analysis included specific harvest projections to provide a comparison of revenues and expenses for two plant sizes and operating capacity. The financial projections were developed assuming a consistent and uniform supply of AU. In addition, in performing the analysis, the following assumptions apply:

- Land acquisition was not included in the computation and analysis as no site was selected;
- The surveys performed and the Bureau of Labor Statistics data shows that there is a limited workforce for meatcutters and other skilled labor;
- Producer commitment of an adequate supply of quality cattle to the processor;
- Increase harvesting and potential revenue from other animals such as hogs, goats and deer was not considered in this analysis;
- Actual results will vary greatly and may also be dependent on uncontrollable events and circumstances that may significantly affect the outcome;
- Periodic financial assessments should be performed as future economic conditions may impact the feasibility of this project;
- The ROI was computed on the designed cost for investment in plant and plant equipment;
- This analysis should not be used for investment decisions;
- Each potential investor should perform their due diligence and consult with their professionals or other professional advisors for advice prior to making any investment decision;
- The analysis was not prepared in accordance with the American Institute of Certified Public Accounting's generally accepted accounting principles or accounting or auditing standards; and
- The analysis including the accompanying projections, is intended for the sole use of this study and should not be used for any other purpose.

[79] University of Hawaii News, *UN Lead $40M Grant for Climate-smart food Production*, October 4, 2022.

Although not shown, the analysis showed that harvesting to dress carcasses only does not provide profitable at yields for either the 20 or 70 AU per day facilities. This practice is currently performed on a small scale at certain Hawai‘i facilities to accommodate special requests. Stakeholders have stated that this type of harvesting is not performed on the continental United States as it is typically not profitable.

In the scenario presented, with 10 percent (10%) profit margin, in the long-term, the facility will produce a net positive cashflow and advance the long-term goals of Hawaii's sustainable agricultural and food security needs. However, a long-term investor should be willing to wait over seven (7) years should start to see higher profits. The owner/investor should establish a budgetary limit for the construction of the facility, to increase profitability and ROI. The owner/investor should perform value engineering on the design to find potential costs savings. Should the investor look for a smaller profit margin, the timeframe to recovery on the startup costs will take longer.

The addition of a hog harvest has the potential to increase the revenue. If the owner/investor is able to convince hog (pork) producers to commercially harvest gray-market hogs it would add to the revenue stream of the facility and increase the income to the facility.

The ROI analysis shows that the 20 AU/day facility may not be profitable unless the expenses can be reduced. The capital cost maybe reduced with value engineering or by waiting for lower interest rates on the loans. The 70 AU/day facility operating at 40 hd/day had a positive ROI which maybe adequate for a long-term investor which wants to increase Hawaii's food security and sustainability. As the amount processed increases to 18,000 AU/yr. which is the design capacity of the facility, the ROI increases significantly, especially with debt service. As the purpose of this study was to develop a scalable facility, the investor(s) need to determine what their starting demand is and what future demand they expect and scale the facility to those parameters. The scalability and design decisions will provide a cost-effective design which will improve their ROI.

In general, the feasibility of the facility will be dependent on the economic feasibility of the livestock industry. The rancher and the owner/operator must have a positive cashflow to sustain the livestock industry, regardless of the species to be harvested. Even then, this implies that the supply of AU has consistent quality and quantity to sustain the operation.

Hawaii's agricultural industry must also consider the effects climate change will have on future production. Improvements in genetics, grazing practices, pasture management, drought mitigation and production efficiency will need to be effectively implemented to improve the overall health of the industry. Novel grants and loans that specifically fund climate smart production and food security may be available to support the capital investment.

The development of a cost-effective harvesting facility will add to the viability of the Hawaii's livestock industry and agriculture in general. The facility should target those investors who are aligned with the livestock industry's sustainability and food security goals. The investor should use a budget constrained development to limit the expenses and to provide a feasible revenue stream.

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CHAPTER 9
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