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**FOOD AND AGRICULTURAL
PRODUCTS CENTER**

Development of Food
Business Case Studies and
Decision Aids for AgMRC

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EXECUTIVE SUMMARY

The PIs have completed their efforts to generate a multi-use spreadsheet template that can model the feasibility of building and operating inspected, value-added processing facilities as an incubator kitchen or owned/operated production facility. An examination of the facilities and equipment needed for various processing operations constituted the greatest amount of time for this effort.

A summary of the major points in this report are:

- Product possibilities for both smaller and larger facilities could include hot-pack canned items, pickled items, dried/dehydrated items, freeze-dried items, and baked goods.
- Many technology options exist for these food processing possibilities, so this report focuses on those technologies and processing steps that would be both technically appropriate and economically feasible for the widest array of product possibilities.
- The report assumes that any entity deciding to establish an incubator kitchen or for-profit processing venture may utilize grants, private investment and low-interest financing options to raise the necessary capital for the processing facilities.
- The spreadsheet-based model resulting from this effort is designed to include flexibility, allowing AgMRC staff or any approved user to change the facilities, processing equipment and costs, product possibilities, other input costs, and output prices.
- Several facility designs for various types of food processing activities have also been created and included, both in the spreadsheet template and as stand-alone PDF documents.

As with most food processing ventures, the economic viability of a food processing business greatly increases with the use of existing facilities (purchased/renovated or leased) and used/refurbished equipment. However, it is not possible to address the availability or prices of facilities/equipment for such circumstances.

The original intent of this effort was to include some case studies of incubator kitchens. In this regard, we failed. Three such kitchens were identified for these purposes. Unfortunately, one incubator kitchen shut down during the study, one closed for renovation to eventually become less of a shared facility and more of a full-time controlled-production facility, and one simply was not in good enough operating order to serve as an example. To pivot from these expectations, the PIs are using collected video footage from various facilities to serve as examples of purpose/functionality for users of the template. These will be included as links in the template and stand-alone YouTube videos for users and AgMRC links.

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BASIC FOOD PROCESSING: CANNED, DEHYDRATED, FREEZE-DRIED, AND BAKED FOODS

Regardless of the location, size, and scope of food processing venture, some issues related to food safety are consistent. For all processing options, food safety and shelf life of canned goods and dehydrated foods are paramount to manufacturing considerations.

Shelf Life of Canned Goods

Canned foods are generally identified by their shelf-stable containers and the expectation of years of shelf life. However, shelf life depends on many factors including storage temperature, container type, seal type and quality, initial food quality, exposure to sunlight, and exposure to pests. Products may be perfectly safe after prolonged storage but may have sensory issues (e.g. bad color) that make it undesirable to eat. The following are basic (but not necessarily applicable in all situations) shelf-life recommendations/considerations for canned foods that may be produced using the systems outlined in this report:

- Jams and jellies can be expected to have a shelf life of about 6 months to 1 year in the pantry if unopened. If refrigerated (opened) the shelf life is up to 9 months.
- Pickled products have an expected shelf life of about 1 to 2 years in the pantry if unopened. If refrigerated (opened) the expected shelf life is about the same (1 to 2 years).
- Salsa can last up to 12 or 18 months in the pantry if unopened. If refrigerated (opened) the expected shelf life of salsa is about 1 to 2 months.

The production process for any canned food item should be reviewed by an inspector (county health department, state health department, FDA process authority, etc.) prior to mass production and marketing. For more information regarding shelf life, readers are recommended to examine multiple sources of information on the subject for each type of food product. Example websites containing canned food shelf-life information include:

- Shelflifeadvice.com
- Stilltasty.com
- Eatbydate.com

Dehydration: Process Explanation, Food Safety, and Shelf Life

Dehydration, in this report, refers to the process of removing water or moisture from food. There are three main purposes for dehydration:

1. Increase storage life of foods.
2. Reduce shipping weight.
3. Change product quality.

The first purpose is the most important because no refrigeration or canning is required for the product once it is dehydrated. Bacteria cannot grow under the low-moisture conditions and the nutritional value of the product is stable. A barrier package, like a plastic bag or a jar, to keep moisture and pests away from the product is the only requirement for long-term storage. In some cases, a reduced oxygen environment will extend shelf life further.

For some products (e.g. potatoes and yams), blanching is required prior to dehydration. Blanching is the process of quickly heating food to inactivate enzymes and soften flesh. Blanching helps to maintain physical properties like color, flavor and texture throughout the dehydration process. Blanching also kills bacteria. For many vegetables like asparagus, beans, beets, corn, okra, squash and turnips, blanching is optional. The following vegetables should not be blanched: cucumber, mushroom, onion, pepper, and tomato. Blanching is accomplished using steam or hot water to uniformly heat the product. Blanch the product until it is firm, yet tender, barely heated through, then cool it quickly with tap water, ice, or air.

After blanching (if required), the next step in dehydration is to cut the product into thin sections, slices or pieces. The thickness of the cut pieces has a direct bearing on the drying time. Thinner pieces will dry faster, because the moisture inside the product has less distance to travel through the product before it can escape into the air.

Next, the cut pieces are arranged on a perforated drying tray, normally in a single thickness. Some “fluffy” products, like herbs, may be piled onto the tray in a layer as long as air can penetrate the mass for good drying. Contact with warm air, that is preferably moving, is required for dehydration. The moisture in the product will migrate to the surface where it evaporates and is carried off by the air. The air must be warm enough to provide the energy required for evaporation and be dry enough to accept the moisture from the product.

Drying trays, filled with products, are placed into a dehydrator for processing. Depending on the air temperature, humidity, product thickness, product amount, and other factors, the dehydration process can take from six to twelve hours. Normally the temperature in the dehydrator should not exceed 180°F to maintain good quality products. At temperatures above 180°, the product is cooking, not dehydrating. Drying temperatures well below 130° F may be specified to help retain color, flavor, enzymes, and other desirable characteristics of the product.

Products are normally considered “dried” after they reach a moisture content that prevents bacterial growth. Often the target moisture content is about 12% or less (calculated on a wet basis). For many foods, a good rule of thumb is a ratio of 1:3 for final (dried) weight to initial weight. Dried products should be allowed to cool completely to room temperature and should be immediately packaged for storage. Shelf life for dehydrated products varies considerably depending on the product and packaging materials, but may range from 6 months to many years. Hard grains are considered one of the most stable food products after dehydration and have a shelf life of up to 12 years. Dehydrated beans and vegetables can last up to 10 years.

Freeze-Dried

Freeze-drying (lyophilization) is a low-temperature dehydration process that preserves items by freezing them and then removing water as ice vapor through sublimation, bypassing the liquid stage. This relatively “gentle” method retains the product's shape, color, taste, nutrients, and structure, creating lightweight, shelf-stable goods like astronaut food, instant coffee, and pharmaceuticals, by eliminating moisture to prevent spoilage.

Key benefits of freeze-drying included preserved quality, extended shelf-life, lightweight end products, and easy rehydration to near-original consistency. For these reasons, freeze-dried foods (including meats, fruits/vegetables, coffee, and even pet foods) are commonly preferred items for outdoor trips such as camping/hiking ventures. This food preservation method is also used for various medical/pharmaceutical products such as vaccines, antibiotics, and heat-sensitive drugs.

The freeze-drying process involves the following steps:

1. Freezing: The product is frozen solid, typically to sub-zero temperatures.
2. Primary Drying (sublimation): A vacuum is applied, lowering the pressure so the frozen water (ice) turns directly into vapor (gas) without melting.
3. Secondary Drying (desorption): Gentle heat is added to remove any remaining moisture, reaching very low water content (around 1-2%).

Baking

Given the demand for home-baked items and the potential for co-packing business by a commercial kitchen, this report includes a brief assessment of baking possibilities. Baking is relatively straight-forward process, and properly baked products are relatively shelf-stable for a period of days. Assuming no meat, high-moisture dairy products, or high-moisture fruits or vegetables are part of the final product, baked goods have a very low food safety risk.

CONSTRUCTING & EQUIPPING A COMMERCIAL KITCHEN

Options for buying an existing food processing facility are limited and may not present themselves when desired. Thus, constructing and equipping a commercial kitchen may be the most viable off-farm processing option. A supplemental spreadsheet file – “Commercial Kitchen Template – Jan 2017.xlsx” – has been created to help AgMRC staff and site users identify the costs of building, equipping, and operating a licensed commercial food processing establishment. All aspects of facility ownership/operations, including operating assumptions, debt management, and several measures of return on investment, are included.

Facilities and Equipment

Because the size and scope of processing options can change, the authors of this report created the accompanying template to allow variation for “what if” assessments. This template considers a variety of facility sizes and capabilities to encompass an array of processing options. The following figure illustrates the templates ability to incorporate various sizes and capabilities to accommodate different combinations of processing options.

	ALL ITEMS	DRYING "D"	CANNING "C"	BAKING "B"	BEVERAGE "V"	CONFEC-TION "F"	FREEZE-DRY "R"	DRY & CAN "DC"	DRY & BAKE "DB"	DRY & CONF "DF"	DRY & FREEZE "DR"	BAKE & CONF "BF"	CAN & BEV "CV"
SUBTOTAL	\$203,894	\$101,573	\$123,594	\$91,856	\$64,288	\$81,497	\$78,334	\$150,890	\$134,254	\$119,604	\$118,857	\$105,931	\$123,594
Freight estimate	20,389	10,157	12,359	9,186	6,429	8,150	7,833	15,089	13,425	11,960	11,886	10,593	12,359
Installation & contingency estimate	30,584	15,236	18,539	13,778	9,643	12,225	11,750	22,634	20,138	17,941	17,829	15,890	18,539
TOTALS	\$254,868	\$126,966	\$154,492	\$114,820	\$80,360	\$101,871	\$97,918	\$188,613	\$167,817	\$149,505	\$148,571	\$132,414	\$154,492

FACILITY	ALL ITEMS	DRYING "D"	CANNING "C"	BAKING "B"	BEVERAGE "V"	CONFEC-TION "F"	FREEZE-DRY "R"	DRY & CAN "DC"	DRY & BAKE "DB"	DRY & CONF "DF"	DRY & FREEZE "DR"	BAKE & CONF "BF"	CAN & BEV "CV"
New building shell (per sq ft)	1,050,000	525,000	700,000	525,000	525,000	525,000	437,500	875,000	787,500	787,500	612,500	700,000	787,500
Upcharge for process area	100,000	60,000	80,000	60,000	60,000	60,000	75,000	100,000	100,000	100,000	85,000	80,000	90,000
Utilities piping and installation	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000
Sewage connection	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000
Site improvements (paving, landscaping, etc.)	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500
Ventilation upgrades	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Contingency, decimal	178,325	91,575	120,825	91,575	91,575	91,575	80,700	150,075	136,950	136,950	108,450	120,825	135,450
TOTALS	\$1,351,825	\$702,075	\$926,325	\$702,075	\$702,075	\$702,075	\$618,700	\$1,150,575	\$1,049,950	\$1,049,950	\$831,450	\$926,325	\$1,038,450

Figure 1: Cost Calculations for Various Food Processing Facility Sizes/Capabilities.

Equipment needs and costs vary by type and size/scope of processing intended for the facility. The following table lays out a suggested list of equipment for a commercial food processing facility. The template includes details for each item, along with the source for the price quote and a link to its description. Approximate prices in the template are new MSRP price quotes, but capital expenditures can be minimized by finding and purchasing lower-priced good-condition used and refurbished equipment. Additional equipment items can be added to the template as needed by the user.

Table 1: Suggested List of Processing Equipment in the Template. (users can add items)

Equipment Items Included for Various Processing Needs	MSRP Prices per Item
3-compartment sink	\$5,427
Air compressor (for piston filler)	\$999
Bread pans	\$750
Bread slicer	\$1,799
Bulk Bag flexible dispenser	\$229
Bulk Bag Rack for unloading	\$1,599
Bun pan racks (3)	\$801
Bun pans (60)	\$872
Case taper, semi-automatic	\$2,399
Centrifugal pump, cleanable	\$239
Chemical storage cabinet	\$1,921
Coder for cases, inkjet	\$1,995
Dehydrator, 28-tray, electric (2)	\$11,990
Dishwasher, commercial	\$5,345
Dough sheeter	\$3,582
Drum cradle	\$1,295
Filler, piston	\$5,612
Freeze dryer	\$9,790
Freezer with temp. indicator	\$7,494
Furniture and accessories for office	\$3,500
Garbage disposal (in sink)	\$2,527
Grease Trap	\$749
Grinder, fruit and veg.	\$3,000
Hood, ventilation	\$6,342
Ice machine	\$4,804
Ingredient bins (3)	\$447
Instrumentation allowance	\$1,500
Kettle, steam, 30 gal, self contained	\$19,863
Label applicator (bottle)	\$1,900
Label dispenser	\$74
Mat, kitchen, anti-fatigue, anti-slip (2)	\$322
Mixer (10 qt), planetary, stand	\$1,594
Oven, continuous belt	\$9,784
Oven, double deck for baking	\$8,519
Pallet jack	\$699
Peeler, countertop	\$2,532
pH meter	\$114
Pickling/fermentation tank, 30 gal (4)	\$876
Pickling/fermentation tank, 45 liters (3)	\$270
Printer, color label for products	\$2,369
Printer, label for cases	\$349

Produce dryer (spinner)	\$3,533
Produce wash sink and faucet	\$1,111
Proofing cabinet	\$1,249
Pump, PD, 2 HP flexible impeller	\$3,425
Range (6 burners, griddle, two ovens)	\$7,326
Refrigerator, reach-in	\$5,784
Scale, ingredient, legal for trade	\$297
Scale, platform legal for trade	\$2,891
Sink, hand wash	\$1,317
Sink, mop	\$1,724
Slicer, food processor	\$2,307
Stock pot, 60 qt stainless (4)	\$1,520
Storage racks, heavy (1)	\$840
Storage racks, wire, stainless (2)	\$1,158
Tables, work, stainless (4)	\$4,156
Tools, hand, allowance	\$1,500
Trash cans (4) with wheels & lid	\$360
Utensils for kitchen, allowance	\$750
Vacuum packer, double chamber, 16"	\$3,849
Walk-in cooler	\$14,075
Water bath (for hot-process products)	\$322
Water heater, continuous	\$2,029
Water treatment (softener)	\$6,099

Any facility will also be subject to annual expenses for maintenance, insurance, and property taxes. Users of the template can build these expenses into the annual operating budget by accounting for these costs as a percent of the costs of plant, property, and equipment. Depreciation schedules and annual expenses for facilities and equipment are also calculated, using a straight-line depreciation method for the facility and a modified accelerated cost recovery system (MACRS) schedule for equipment.

Borrowing and Debt Management

It is expected that the purchase/construction of any proposed facility will require some level of debt financing. Additionally, a food processing facility may require a seasonal operating loan to pay producers for perishable produce items (presumably these loans would be paid off during the operating year). Business structure can also impact the capital-raising capabilities and debt load of a venture. The template allows users to set the amount and terms of long-term financing for PP&E, and to set an amount and interest rate for operational loans. Interest expenses are included in all annual expense projections, and loan principal payments for capital loans are included in annual measures of cash flow.

Operational Assumptions

For the commercial kitchen template, owners/operators of the facility are provided the options of either renting out the facility at an hourly rate or operating the facility to manufacture 10 chosen products or product categories. These can include products produced by facility owners from locally-sourced commodities and products co-packed for other food businesses. Depending on the nature of production, organic certification by the facility may be desired.

Users can input batch-level recipes/ingredient costs, number of batches produced per day (based on processing facility and equipment assumptions), number of final product units per batch, packaging costs per unit, and output prices as with the on-farm template. Users can also input information on the anticipated share of production that will be lost – whether to shrink, wasted product, or even give-aways such samples and donated production.

Personnel needs are separated into hourly production staff and salaried management/operational employees. Users can identify the number of persons, set the hourly wage rates and annual salaries, set benefits and payroll taxes, and even budget for expected overtime/bonus pay. Additional operating expenses can be included for supplies and anything that may be aggregated into miscellaneous expenses, both for the startup phase and for annual production.

Utilities expenses are highly variable based on production conditions, processing methods, efficiency of production and facility heat recapture and cooling, and arrangement made with utility providers. Users of the template can generate their own estimates to include in the financial calculations, although one tab of the template has a series of input cells and notes boxes to help users arrive at these estimates.

Additional operational concerns over time are expected changes in the costs for inputs and the market price for outputs. Users of the template can set inflation rates for both input costs and output prices separately. These inflation factors affect operational costs and product output prices for the 10-year projections of annual profit/loss.

Return on Investment

The template uses annual profit/loss projections to determine multiple types of return measures. Using a discount rate provided by the template's user, the model estimates net present value (NPV) over a 10-year production period. Across the same time period, the model also estimates internal rate of return (IRR), return on assets (ROA), and return on initial owners' equity (ROE). The model can also estimate a payback period (years of aggregated cash flows needed to recoup the initial PP&E investment). If the payback period is less than 10 years, the number of years is shown. Otherwise, if the annual cash flows do not recoup the PP&E costs in the 10-year timeframe, no payback period is shown.

FACILITY DESIGNS

Throughout this report, multiple references were made to several types of processing facility layouts. The following are examples of the layouts that will be included as supplemental materials in the template. They will also be provided as stand-alone PDF files for use with other AgMRC materials.

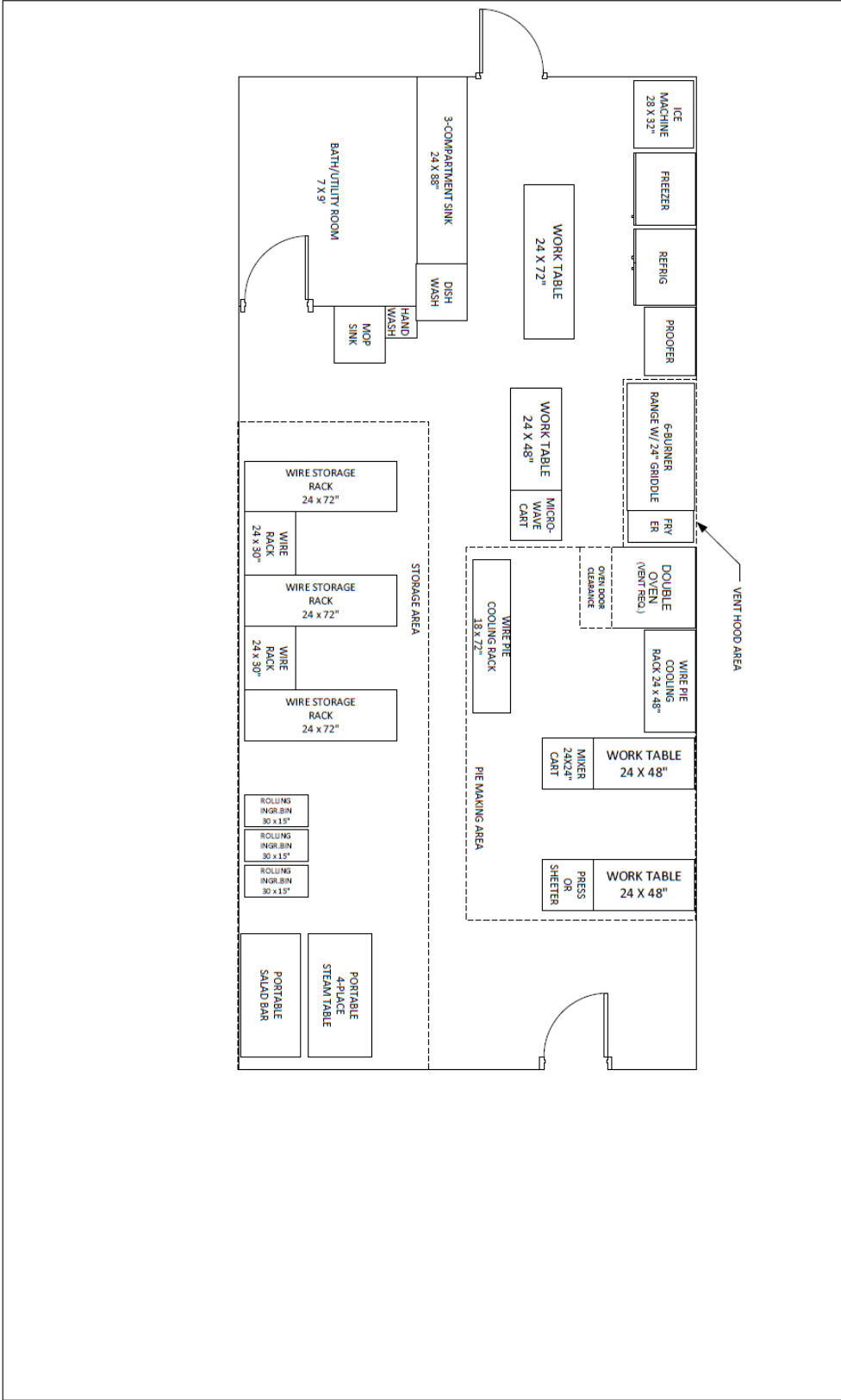


Figure 2: Baking Confection Kitchen.

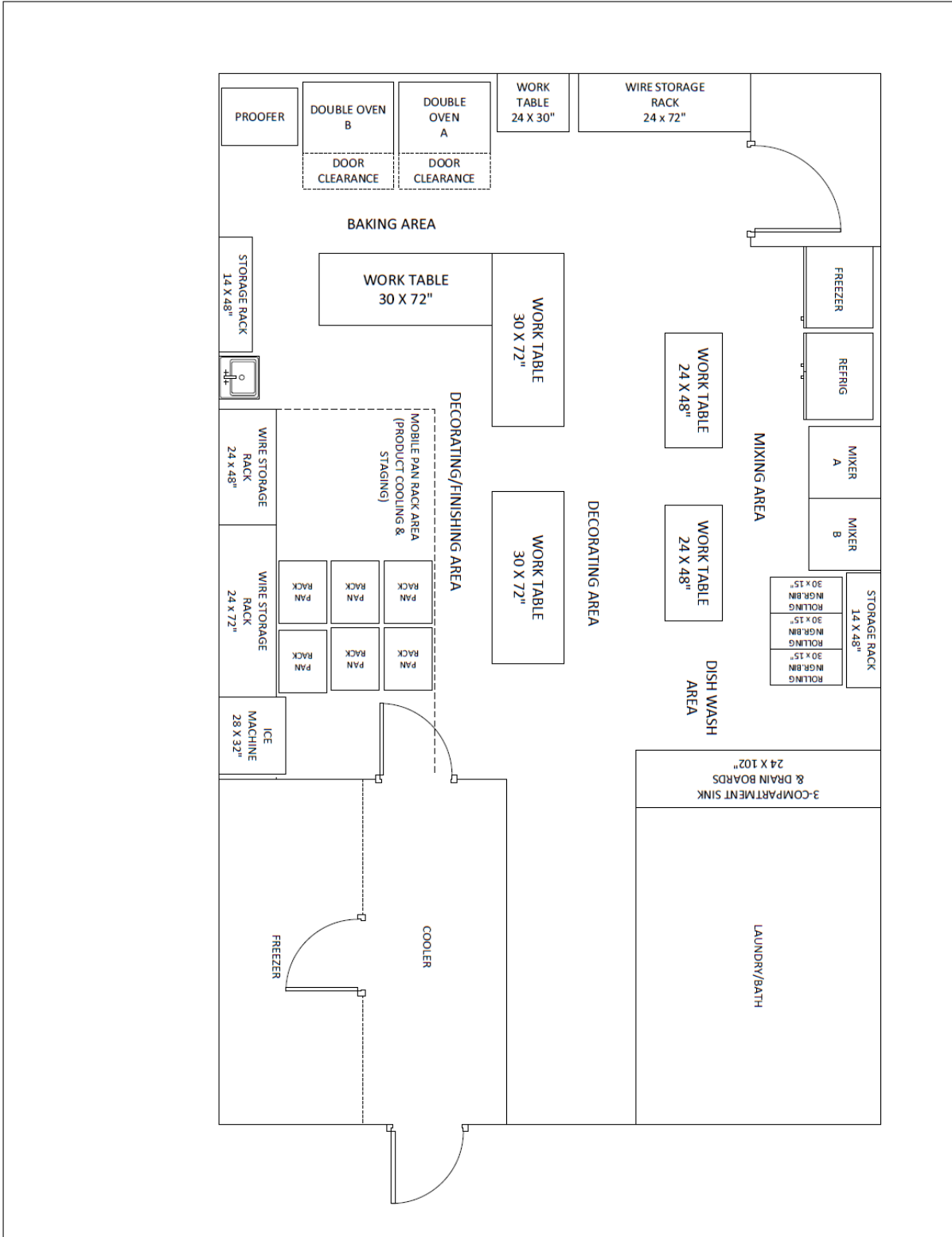


Figure 3: Baking Confection Kitchen (alternative version).

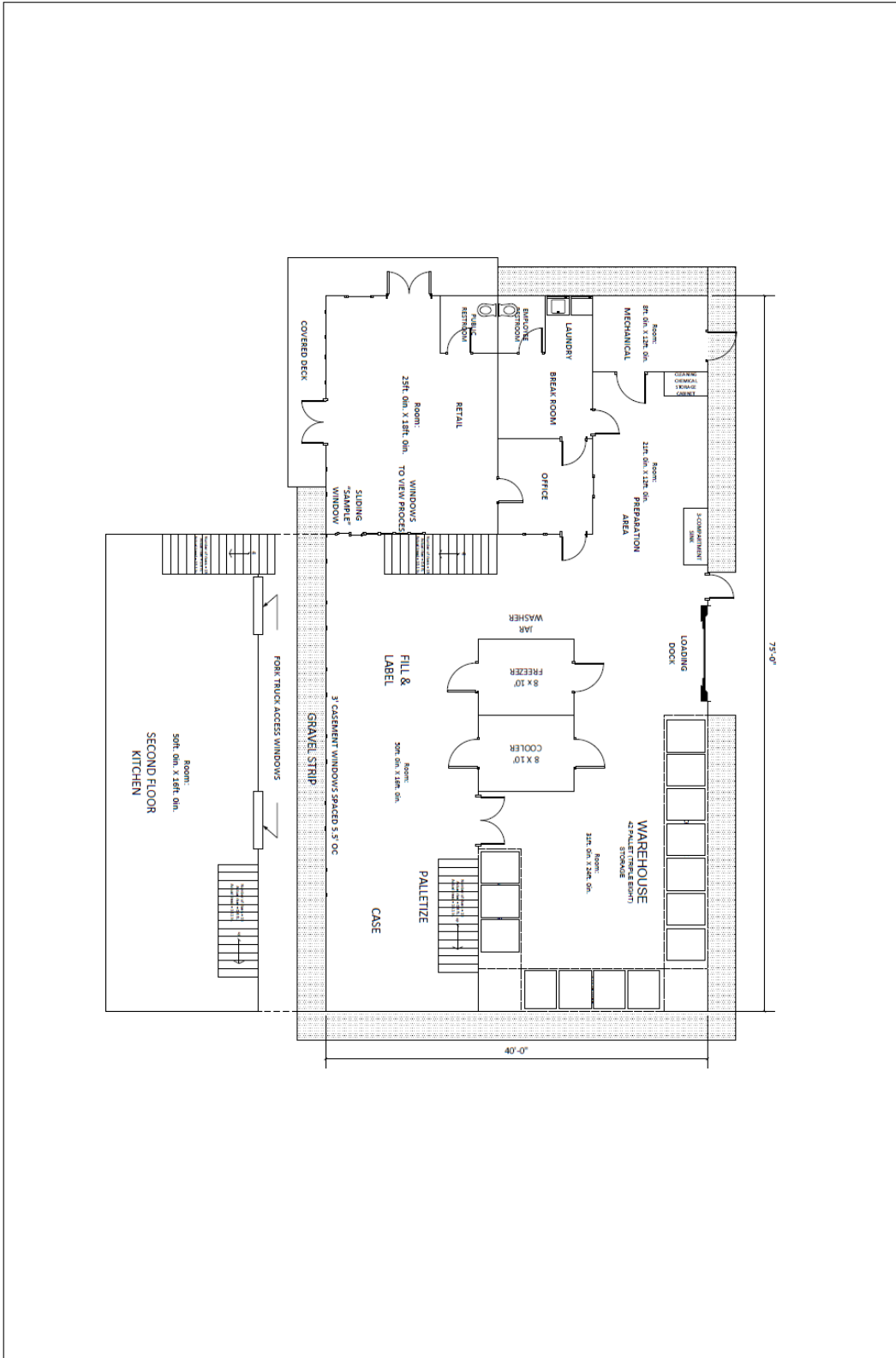


Figure 4: Canning Kitchen Layout.

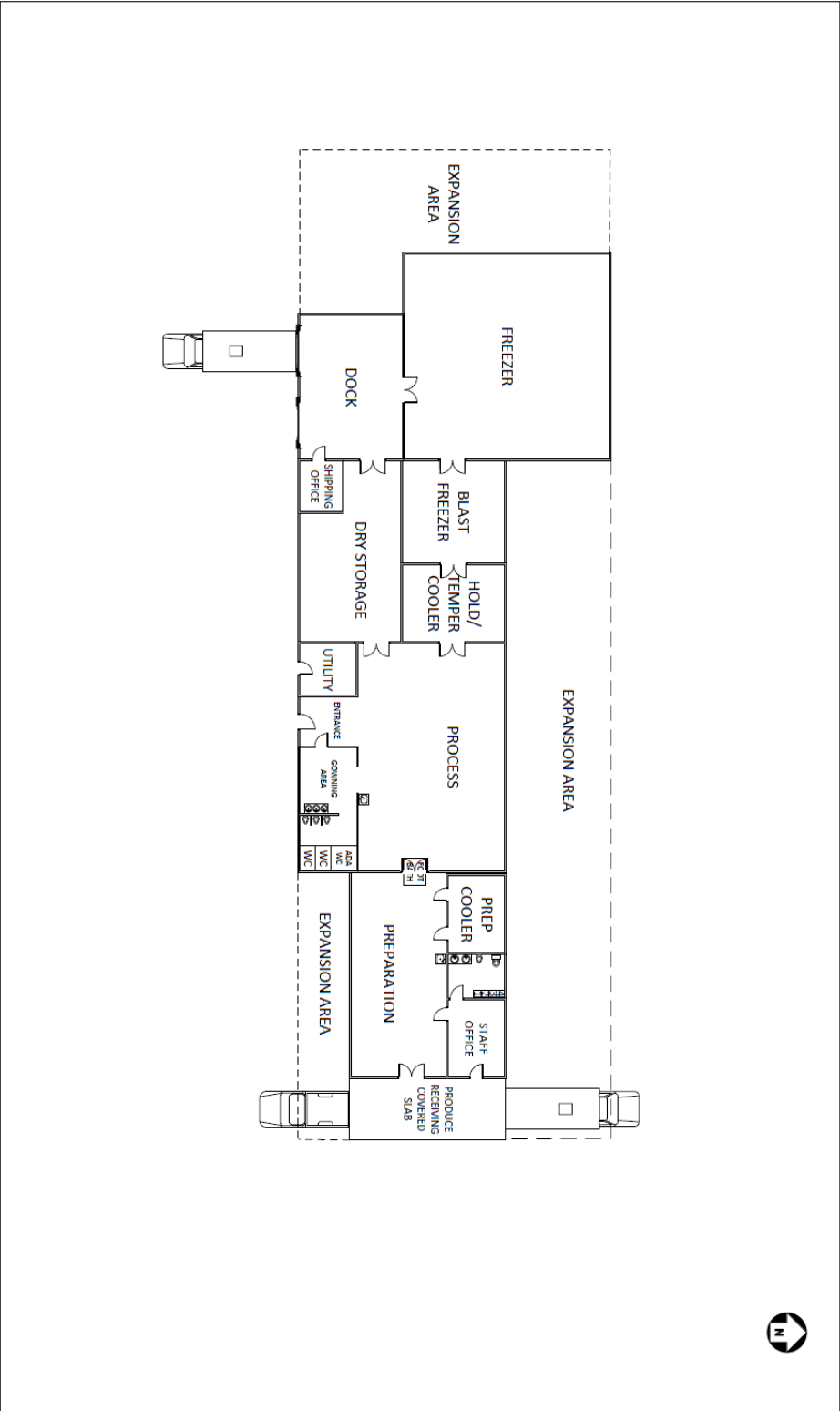


Figure 5: Frozen Produce Facility.

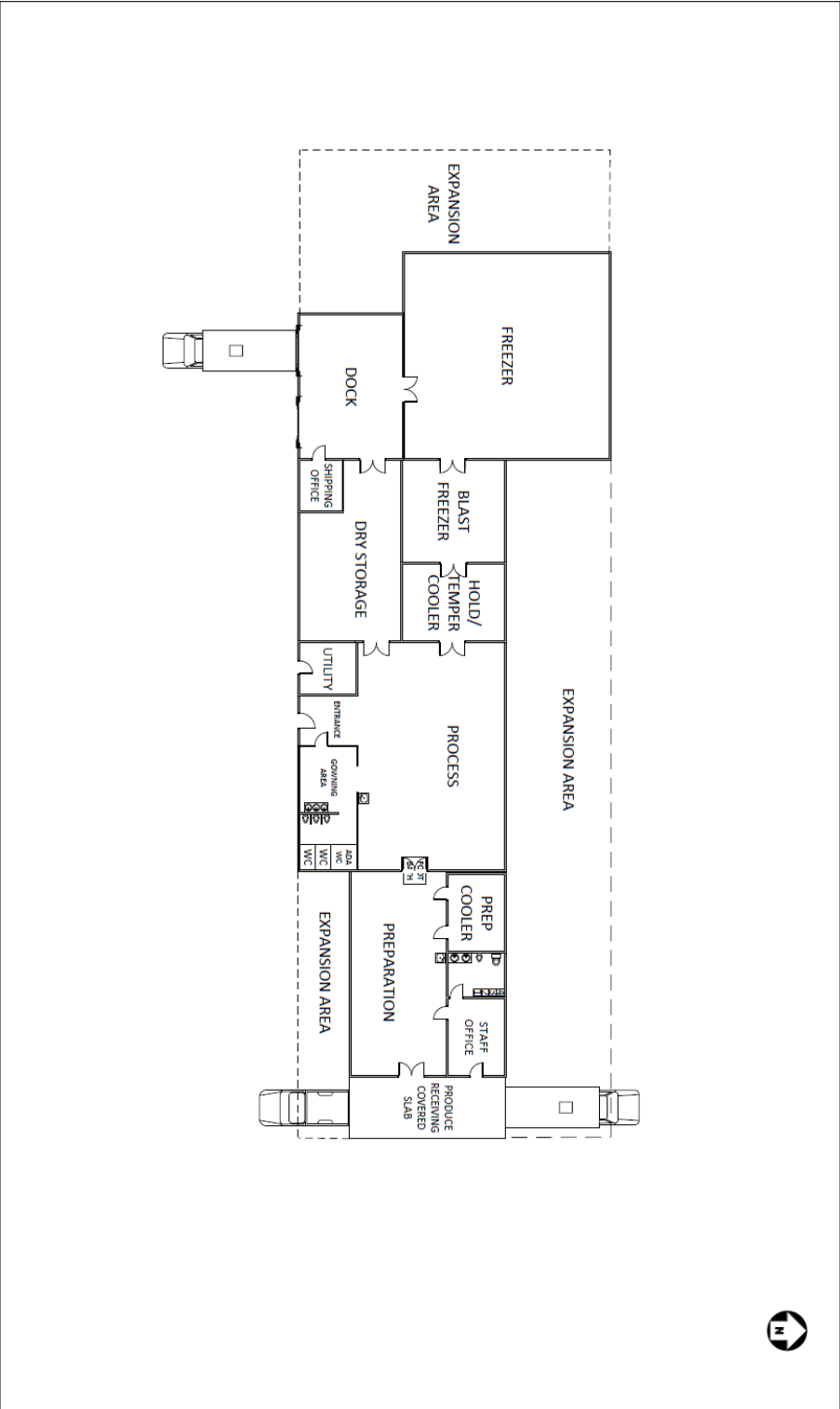


Figure 6: Basic, Comprehensive Incubator Kitchen.

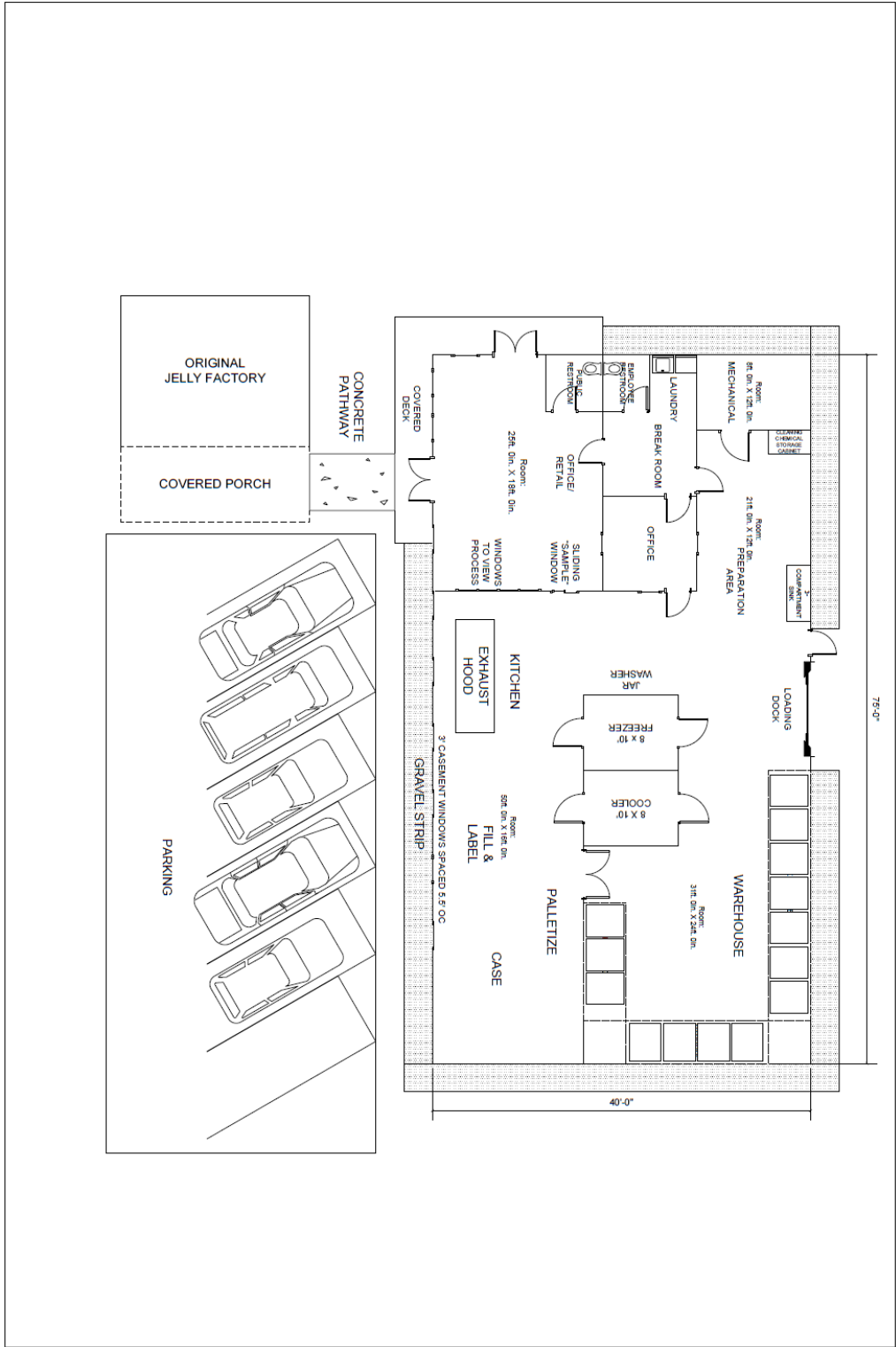


Figure 7: Basic Jam/Jelly Kitchen.

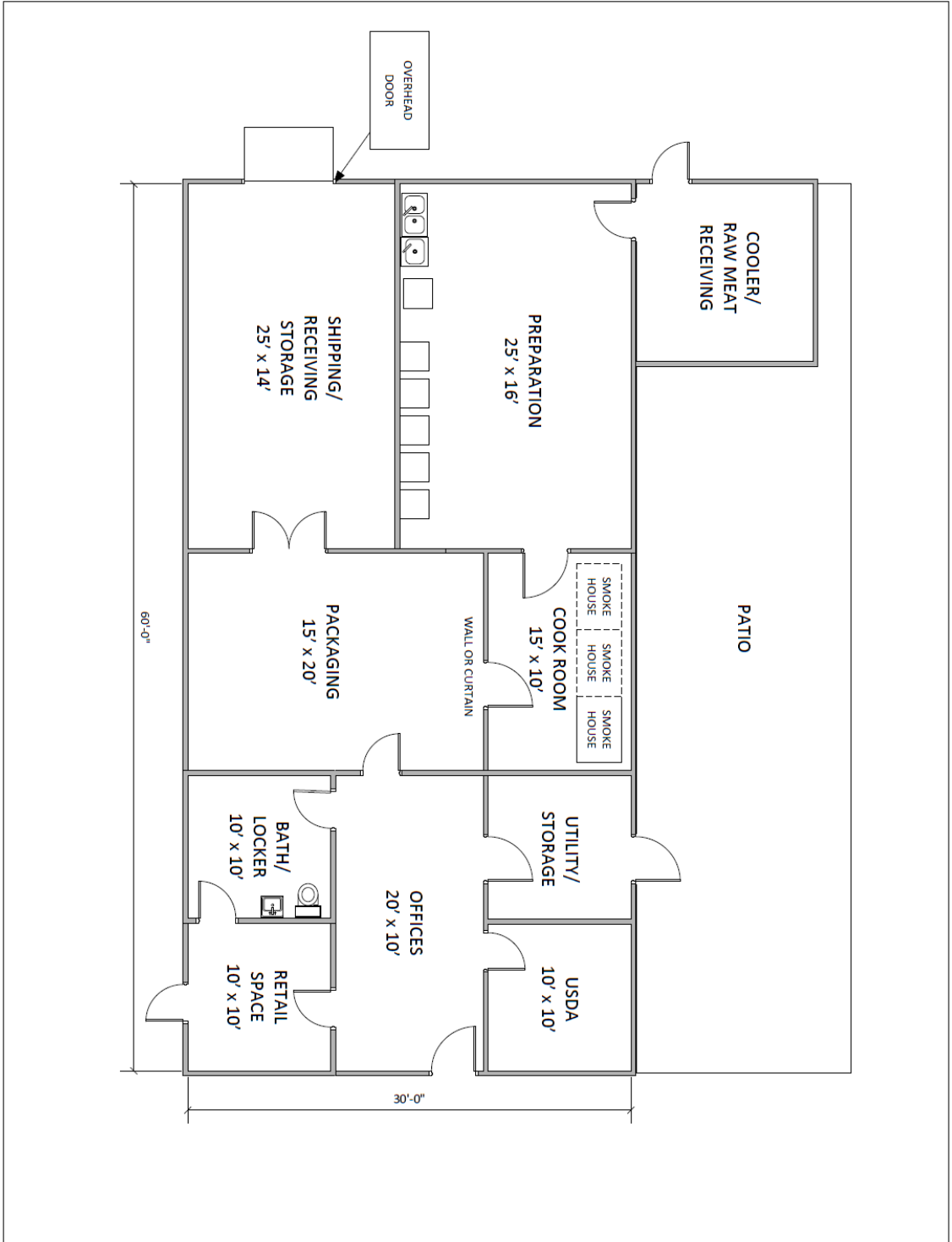


Figure 8: Jerky Processing Facility (basic).

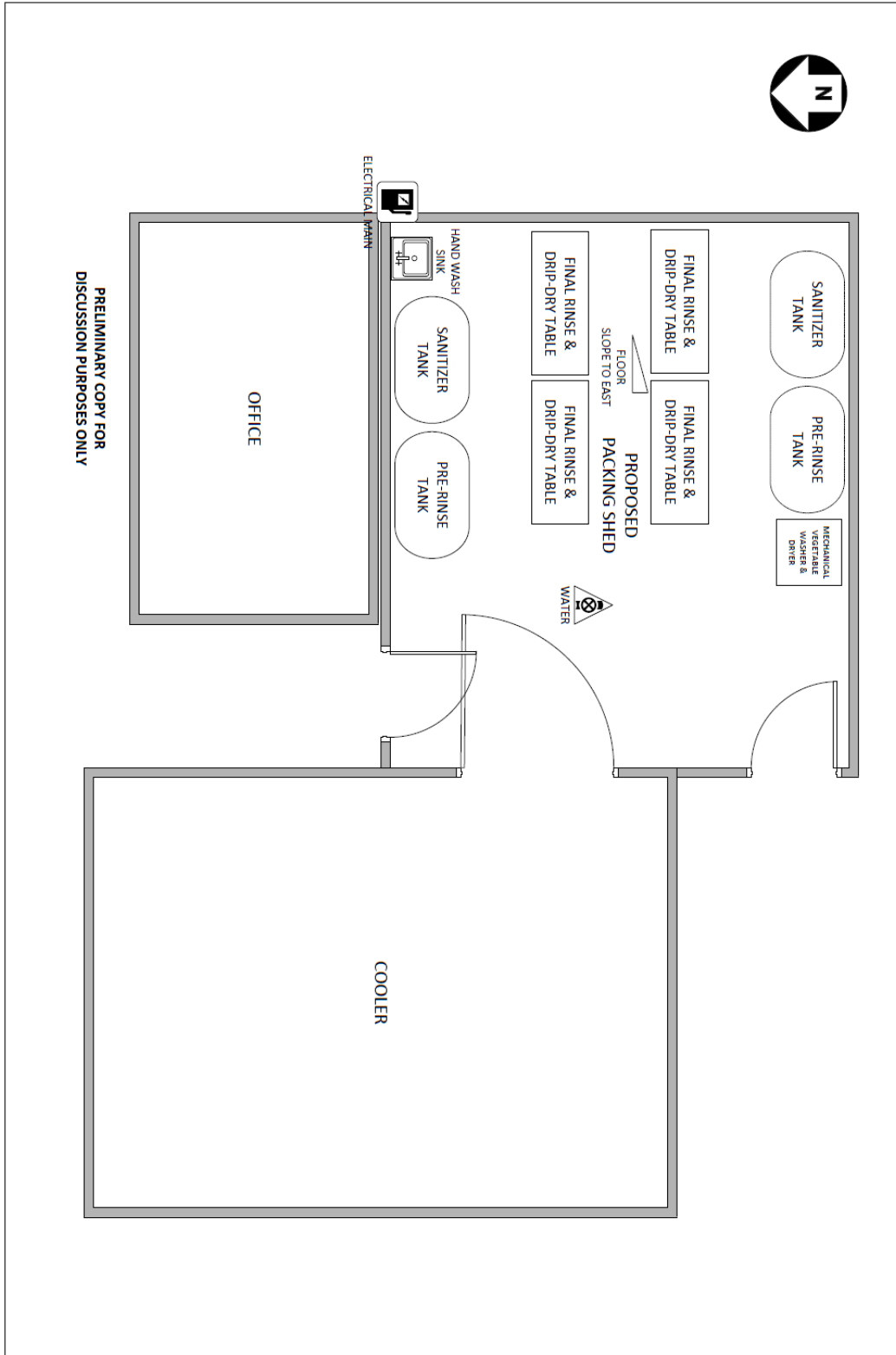


Figure 9: Enclosed Fresh Produce Packing Shed.

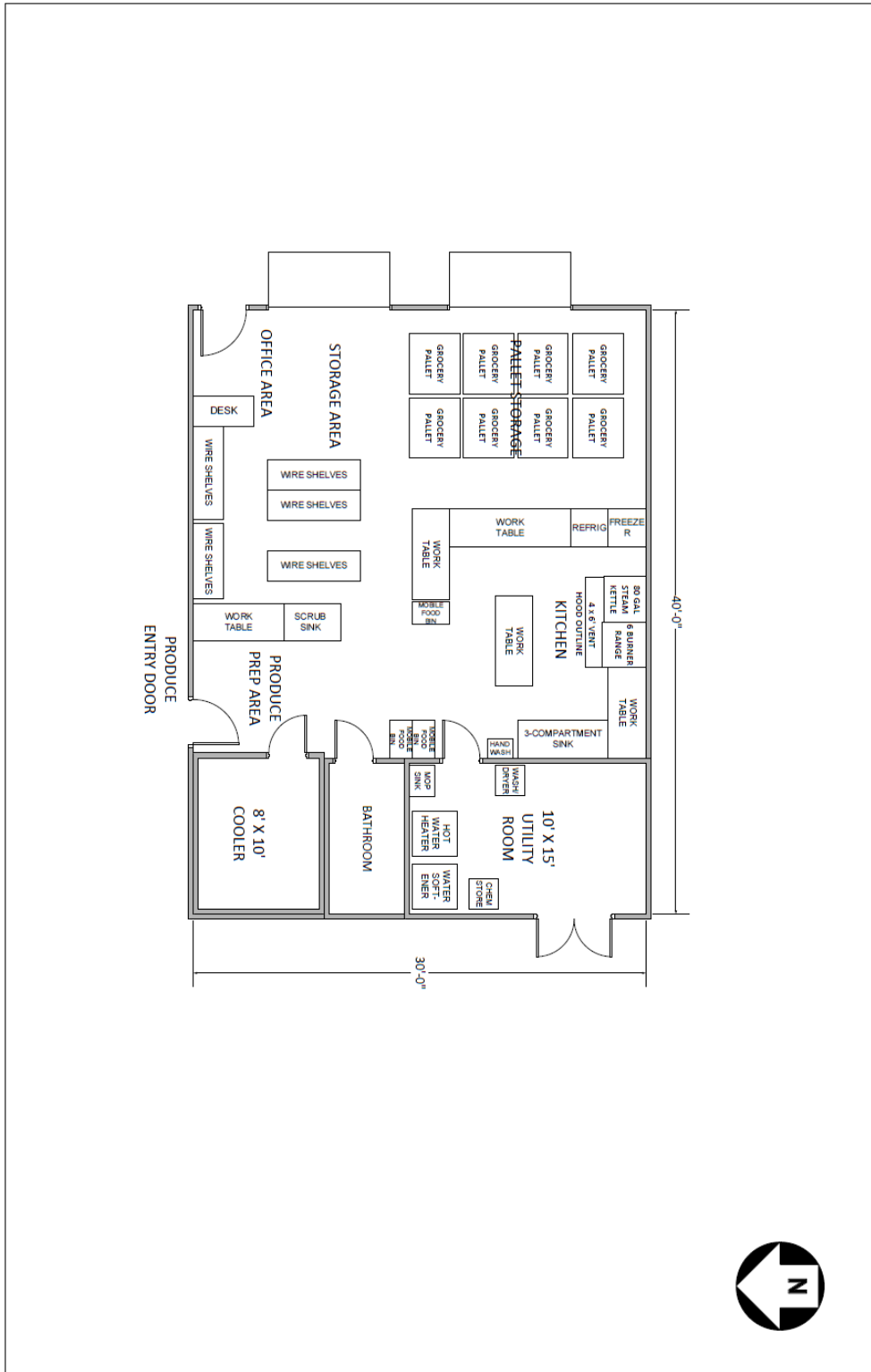
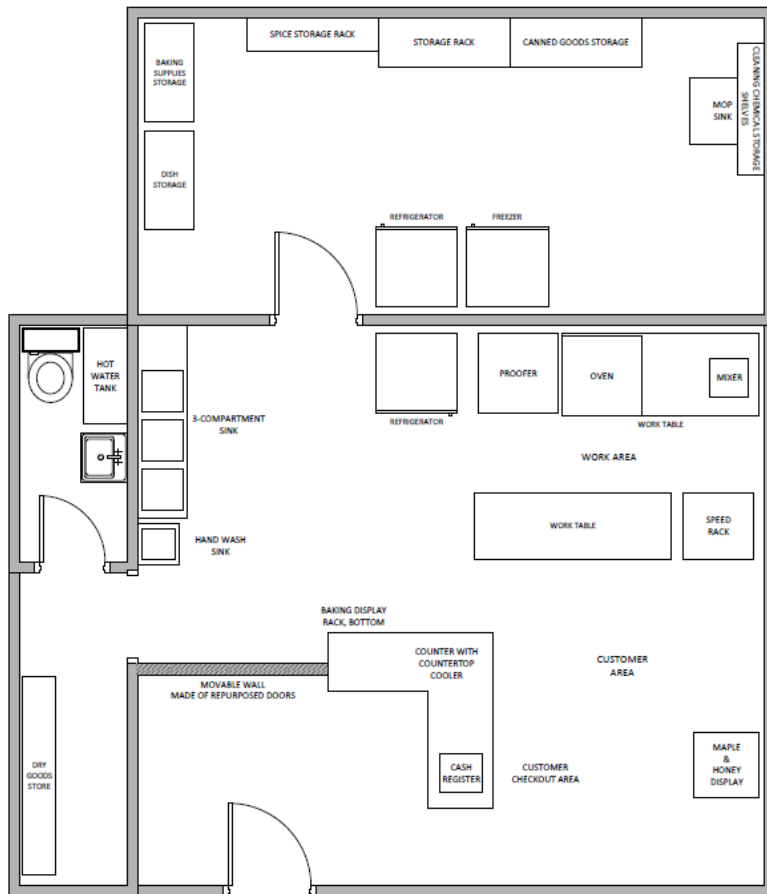


Figure 10: Salsa Processing Facility

DRAFT DOCUMENT FOR DISCUSSION ONLY



PLAN VIEW
VERY SMALL BAKERY

Figure 11: Very Small Bakery (draft).