



Facilities Master Planning - Knott Dairy Center

FEASIBILITY STUDY



WASHINGTON STATE UNIVERSITY
College of Agricultural, Human,
and Natural Resource Sciences



Pullman, WA
August 2022

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EXECUTIVE SUMMARY

INTRODUCTION

The WSU Animal Sciences Department (AS) has an obligation to train the next generation of livestock producers and industry leaders and conduct research that is relevant to the sustainability and growth of the livestock industry in Washington State, the Pacific Northwest, and the greater US. This study is the culmination of collaborative efforts between stakeholders, faculty, staff, and students to begin the fulfillment of that obligation. Through the process of this study, a strategic investment has been identified, that once executed, will offer better and more relevant hands-on learning opportunities for students and perform essential research for the livestock industry to address efficiency, sustainability and profitability moving forward.

SCOPE OF STUDY

The premise of this study was to identify a project scope and probable cost for development of the existing Knott Dairy Center (KDC) for the College of Agricultural, Human, and Natural Resource Sciences (CAHNRS) on the Washington State University campus in Pullman, WA. Per the Animal Sciences Department (AS), the KDC is in need of repair and modernization to allow training of conventional and robotic dairy techniques, increase production capacity, improve facilities for the shelter and care of their livestock, and improve utilities including electrical, data, water, and manure handling. There is a strong desire to make the KDC better reflect the professional image of excellence that AS wishes to portray.

This document has been developed by the study team to be used to guide the planning of the proposed master plan for the dairy center. It is expected to be a living document that will evolve over time. Included is scope of work (program and conceptual design), potential cost, and rough schedule expectations.

PROGRAMMED SPACES

The Knott Dairy Center promotes three levels of academia which include teaching, research and a student organized club. The current facilities lack the technology needed to support the modern day research needed and prepare students for what they will encounter in the industry. The Cooperative University Dairy Students (CUDS) is a student led program with academic credits that requires independent control from the rest of the KDC herd to be successful.

In order to meet the current and future academic needs of the dairy, the numerous facilities that make up the KDC are in need of an extensive upgrade and modernization. The following is a summary of facilities / spaces expected to be included in the master plan:

- Calving Barn
- Heifer Barn
- Dry Cow Barn
- Lactating Cow Barn
- Close Up Barn / Pens
- Vet Med Space (main and satellite labs)
- Milking Parlor / new robotic milkers.
- Milk storage (redundant safety system).
- Classroom, Offices, and Residence



EXISTING KDC - LACTATING COW BARN FEED ALLEY

CONCEPTUAL DESIGN

The conceptual design of this study has identified several phases to best implement the needed improvements. A future master plan was developed and then overlayed with top priority items to determine the best order for phasing the work. Each phase builds on work from previous phases required to keep the dairy fully operational during construction.

POSSIBLE COSTS/BUDGET

Possible construction and project costs have been developed for the conceptual design. The project is expected to be administered by WSU Facility Services following established state and institutional requirements. The following is a summary of identified cost allowances for this project:

	<u>PHASE I</u>	<u>PHASE II</u>	<u>PHASE III</u>	<u>PHASE IV</u>
Programmed Construction Costs (construction costs 75% of project costs)	\$7,352,000	\$10,576,482	\$4,712,753	\$17,455,059
Anticipated Project Costs	\$2,426,160	\$3,490,239	\$1,555,208	\$1,446,176
Total Project Budget Range <i>(range for conceptual design unknowns / 3-5 years inflation)</i>	\$9.7M - \$12.2M	\$14M-\$17.6M	\$6.3M-\$7.8M	\$23M-\$29M

POSSIBLE SCHEDULE

A possible project schedule by phase was reviewed as part of this analysis. It is anticipated that Phase 1 and Phase 2 would occur within 5 years of this study with Phase 3 & Phase 4 to follow consecutively afterwards as funding becomes available:

- Phase I: 2023-2025
- Phase II: 2025-2027
- Phase III: TBD
- Phase IV: TBD



EXISTING KDC - MILKING PARLOR ENTRANCE

EXISTING SITE ANALYSIS

EXISTING SITE OVERVIEW

The site analysis portion of the study conducted an in-depth review of the existing site layout and overall proximity of existing structures to one another. A review of the current flow of animals was analyzed to identify areas of concern that need addressed. The team also met with WSU Facilities to review known utilities in the area and potential improvements that need to be considered.

EXISTING FACILITIES

The KDC consists of 13 separate structures spread across the site, with 7 of the structures specifically used for housing of animals. Currently the herd size exceeds the originally designed capacity for the dairy which has resulted in mixed use between several structures and poor flow of animals across the site. Herding and containment of animals utilizes hot-wire electric fence, posing safety concerns for the staff and students working at the center.

EXISTING UTILITIES

The following existing utilities have been reviewed with WSU Facilities.

Domestic Water

- Majority of water piping has been upgraded in the last few years with new HDPE water lines (4" & 2").
- Capacity has been up-sized for additional load including providing water to pasture troughs.
- Holding tank was upgraded from 40 Gallons to 150 gallons in last few years.

Storm / Sanitary Sewer

- Cattle waste management consists of a flume system to separate waste and collect solids to transport to WSU's compost facility on the Pullman campus. Liquids are diverted to settling ponds.
- Human waste (Milking Parlor & Residence) is on septic system.
- Little is known about both systems and may require work.

Electrical

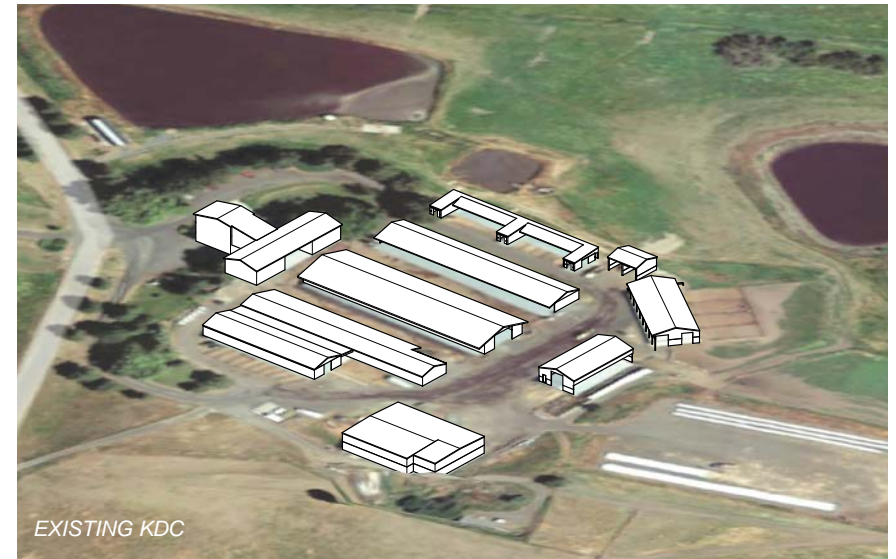
- Infrastructure upgrades currently being processed by WSU facilities for future project.

Data

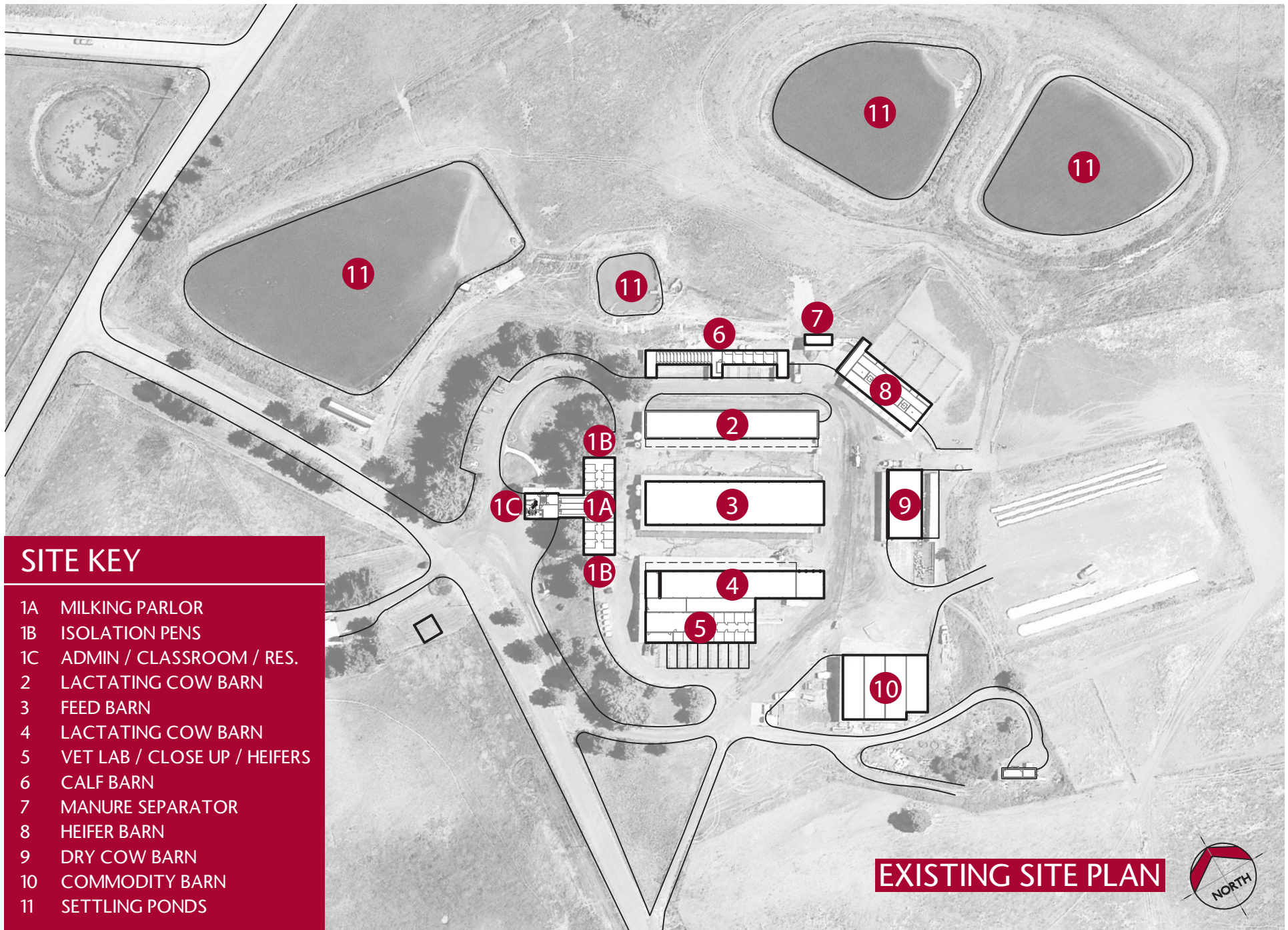
- Upgraded data infrastructure is top priority for KDC.
- Current system is all wireless and not reliable.
- Running fiber optic to site or mix of hardwire and wireless system is needed in order to achieve desired modernization of dairy.

Gas Service

- No gas service available for this area.



EXISTING KDC



PROGRAM REQUIREMENTS

HERD DISTRIBUTION

The following herd size distribution has been closely coordinated with WSU Animal Sciences Department administration and staff to identify facility needs based on the desired herd size of the Knott Dairy Center. As basis-of-design, the faculty shared distribution numbers for a 1000 cow dairy that was then converted to meet the current and projected herd sizes. Currently, the KDC herd is approximately 425 head with 180 lactating cows. It is desired to reach a herd size of 220 lactating cows which meets the milk demand of the WSU creamery. Although it may be impractical for the KDC, the industry design standard advises facilities be designed to 140% of the desired herd size to account for variations in the calving rate of the herd. This has been taken into account for the long term master by providing ample space on site for future growth with initial phases aimed at providing closer to the actual desired herd size.

Item	Current Herd Size	Desired Herd Size	140% of Desired Size
Female Calves			
Birth to 2 mo	17	21	30
3-5 mo	26	32	45
Total Calves	43	53	75
Heifers			
6-8 mo	26	32	45
9-12 mo	35	42	59
13-15 mo	26	32	45
16-22 mo	61	74	104
60 -22 d before calving	11	13	19
close-up heifers (21 d before calving)	7	8	11
Total Heifers	166	201	283
Cows			
Dry cows (60-22 d before calving)	23	28	39
Close-up cows (21 d before calving)	14	17	24
Total Dry cows	37	45	63
First-lactation cows	61	74	104
Lactating cows (\geq second lactation)	119	146	204
Total Lactating cows	180	220	308
Total Cows	217	265	371
Total Head	426	519	729

CALF BARN

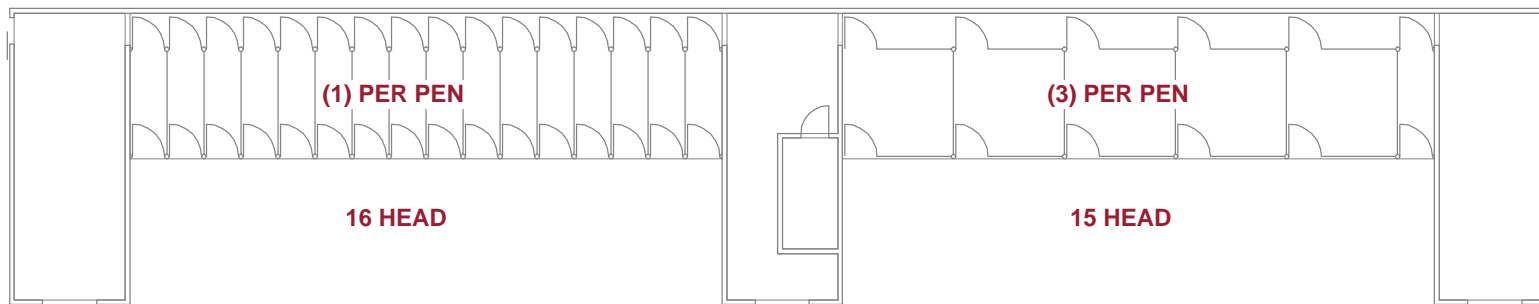
Programmed SF: 3,360 SF

Existing Space SF: 3,328 SF

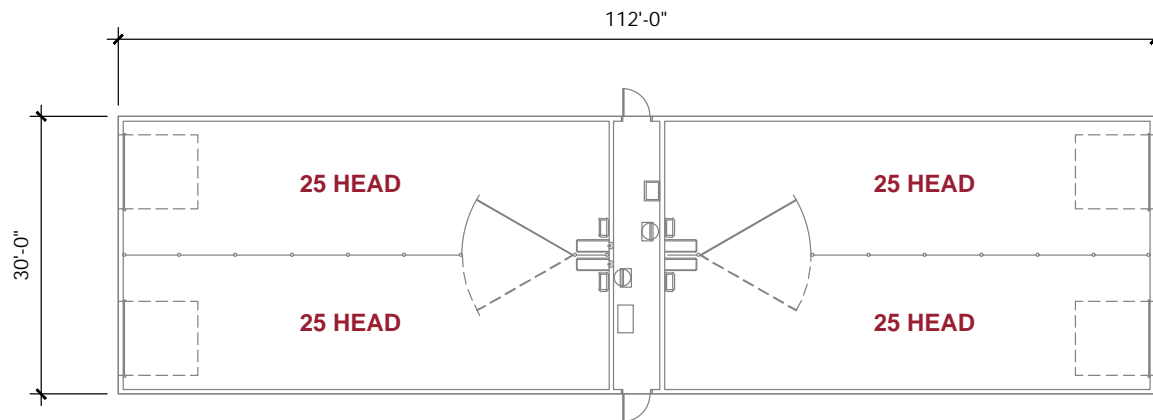
Notes

- Current arrangement houses 1-3 calves per pen with individual manual feeding.
- Anticipated design to implement automatic group feeding with 25 head per pen.
- Projected design size to be 30 heifer calves, a preferred grouping by IACUC and AAALAC.
- Additional space accounted for separate CUDS pens, potential research trials, and possible bull calves program.

31 TOTAL HEAD + HUTCHES (NOT SHOWN)



EXISTING CALF BARN PLAN
NOT TO SCALE



PROPOSED CALF BARN PLAN
NOT TO SCALE

100 TOTAL HEAD



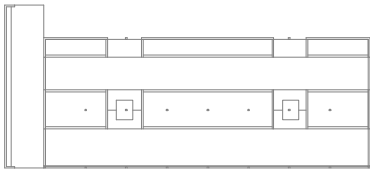
EXISTING KDC CALF BARN

HEIFER / DRY COW BARN

Programmed SF: 38,750 SF
Existing Space SF: 7,200 SF

Notes

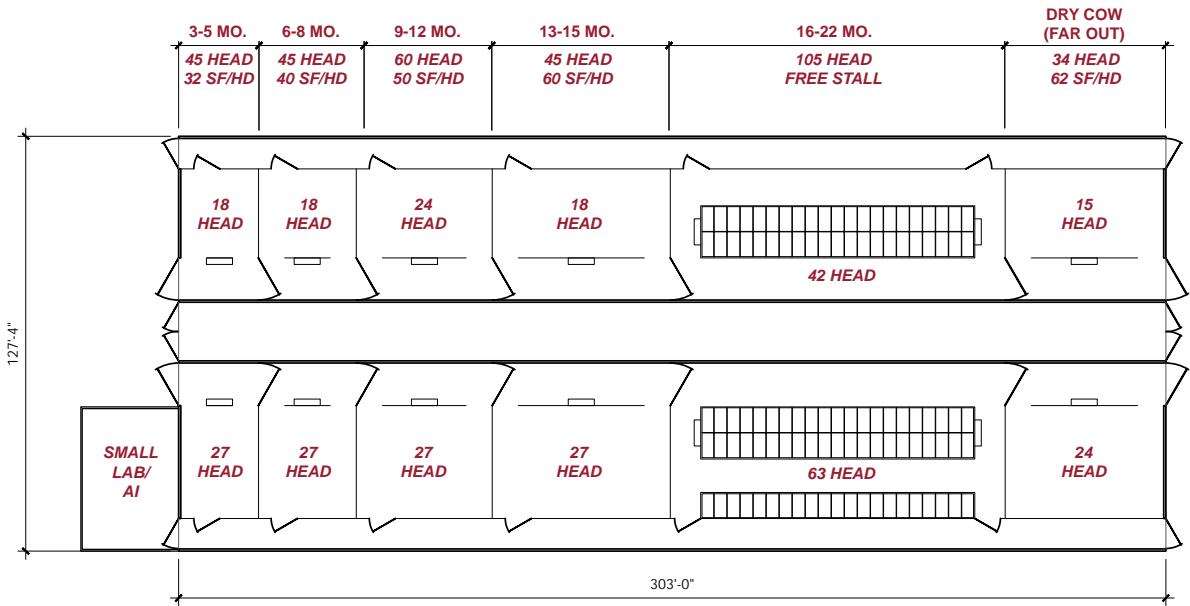
- Heifer barn is undersized for current herd, resulting in heifers being housed in other barns across the site.
- Current dry cow barn failed the most recent AAALAC inspection and requires repairs to regain compliance.



EXISTING HEIFER BARN
NOT TO SCALE



EXISTING DRY COW BARN
NOT TO SCALE



PROPOSED HEIFER / DRY COW BARN
NOT TO SCALE



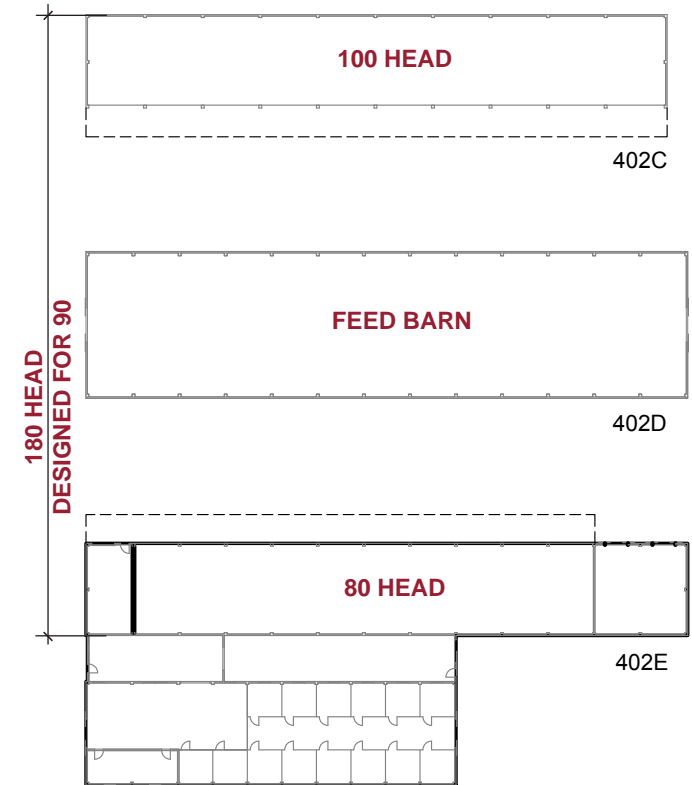
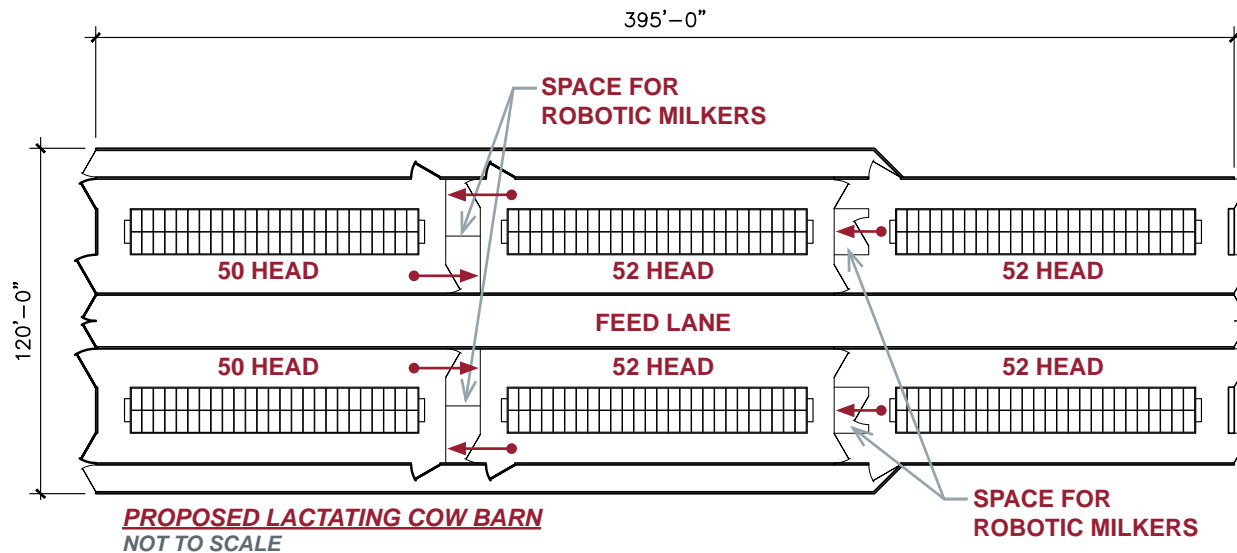
LACTATING COW BARN

Programmed SF: 44,000 SF

Existing Space SF: 46,200 SF (including exterior open space)

Notes

- Current complex of barns were designed for 90 lactating cows but currently hold 180 head.
- Existing covered area is undersized and not properly ventilated.
- Current configuration uses hot-wire for containment of animals which poses a safety concern.
- A teaching space is needed with room for students to gather and view operation.
- Desire to provide robotic milkers in the future does not work with current layout.

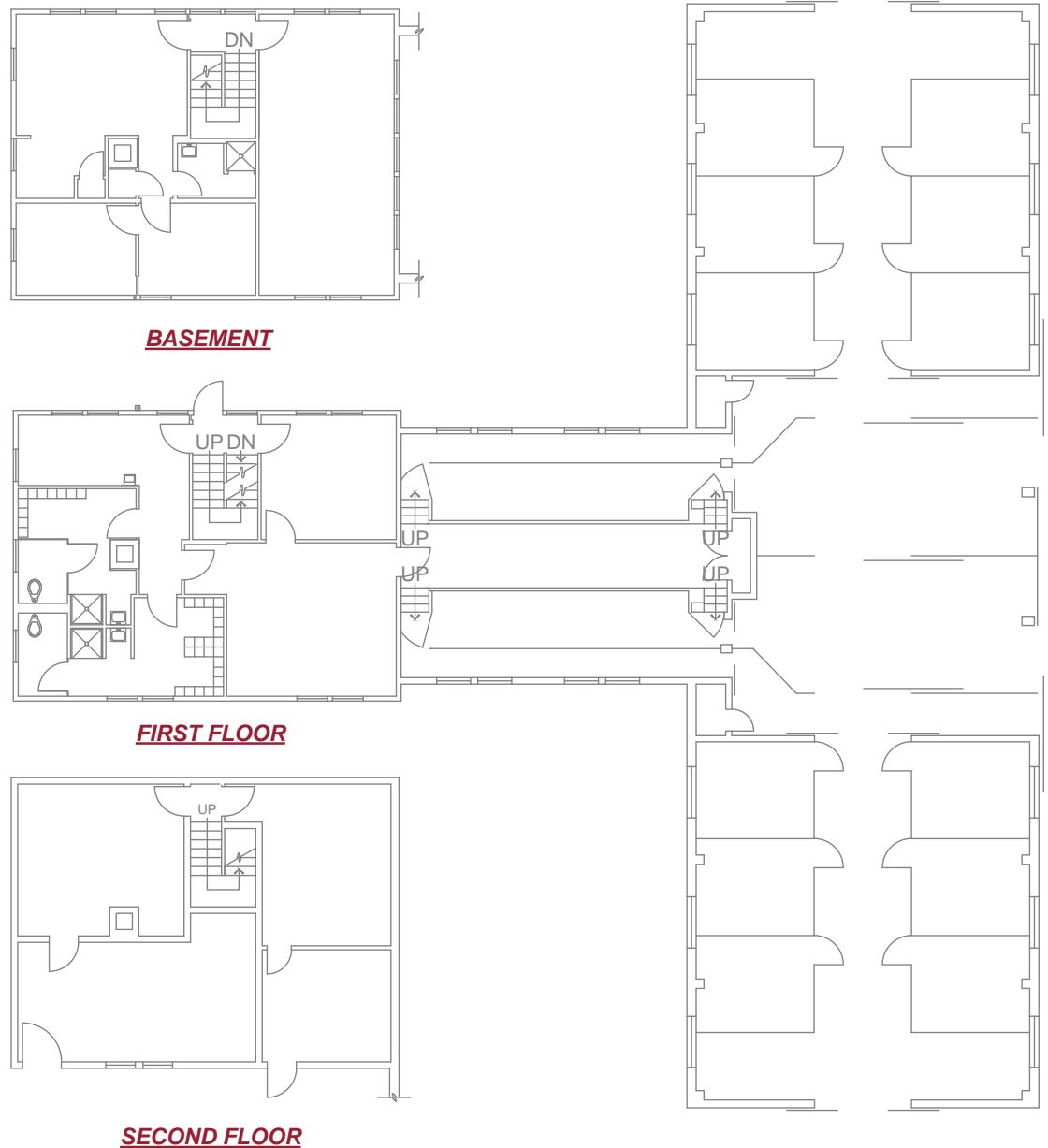


OFFICE AND MILK PARLOR

Existing Space SF: 8,500 SF

Notes

- Existing building consists of milking parlor, milk storage, office / admin space, locker rooms, classroom and residence.
- Parlor only allows for twice a day milking (most dairies are 3x) due to limitations in both space and equipment.
- Parlor access for both people and animals is a concern. Hot wire electric fence is used to guide cows into parlor with no separate space for entering and existing. Staff entrance passes through pens which poses a danger and should be independent.
- Sick pens located adjacent to milking parlor show potential structural issues and programatically should not be located in this close proximity of healthy animals.
- Milk storage is down to a single tank with no redundancy



EXISTING OFFICE AND MILK PARLOR
NOT TO SCALE

CODE CONSIDERATIONS

An initial code analysis of the 2018 International Building Code (IBC) has identified a number of code considerations that should be further examined during project development. Building codes that have been adopted by the State of Washington at the time of building permit review will need to be the basis of project design. Type of construction, allowable building area, adjacent structures separation, fire sprinklers, fire flow, and exiting all appear to be issues that will require close examination as the project design is further developed. Building code requirements for construction change over time. This document provides for master planning considerations. It will be important to provide an updated code analysis prior to each phase of work. The following is a summary of code limitations identified at this time for future consideration:

AUTHORITY HAVING JURISDICTION (AHJ)

Early coordination with the Authority Having Jurisdiction should occur during the design process to fully identify building classifications and code requirements that will be required on the project (each phase & final completion).



OCCUPANCY CLASSIFICATION

The obvious classification of the buildings at the WSU Knott Dairy would be a U Occupancy (barns, livestock shelters, stables). Often an AHJ will classify university ag research buildings as a B Occupancy due to the higher education activities provided by the facility. Additionally, the International Building Code includes 'Appendix C, Group U Agriculture Buildings'. Use of an appendix to the IBC is not mandatory unless specifically adopted by the AHJ. It appears that Washington State has currently not adopted Appendix C. Some AHJ officials will still consult an appendix to the code that has not been adopted to provide direction.

TYPE OF CONSTRUCTION

It appears that a number of Types of Construction could be used for the facility depending on the AHJ occupancy classification and use of Appendix C. Type VB (combustible construction) might be considered if Appendix C is used for direction due to the possibility of 'unlimited building area'. Other construction types to consider per the IBC are Type IB and IIB (non-combustible construction).

BUILDING SEPARATION

Building placement on site is required to follow the code minimum distance between buildings based on occupancy and construction classification. The required building separation also could vary considerably depending on AHJ determinations. This could vary between no required separation to 30 or 60 feet of separation being required. It appears that there are a number of code gymnastics that can be considered by the designer to meet building code limitations.

AUTOMATIC FIRE SPRINKLERS

The use of an automatic fire sprinkler system (AFSS) has the advantage of allowing the basic allowable area per floor to be increased significantly over 300% in a single-story building.

Large area non-fire sprinklered building(s) appear to be allowed by the IBC depending on roof height selected, building classification, type of construction, fire protection and whether or not Appendix C is used for code determination direction.

If automatic fire sprinklers are to be considered as a part of the project design, well pressures and water storage options will need to be considered as an effective system is designed.

NFPA CONSIDERATIONS

In addition to the International Code Council family of building codes, National Fire Protection Association (NFPA) requirements will need to be considered. Based on the contents of the buildings the NFPA should classify these buildings as a moderate hazard. Additionally, the NFPA does not have a corresponding classification to the IBC U Occupancy which indicates close coordination with the fire marshal will be critical to project success.

ALLOWABLE BUILDING AREA

Based on building classification, type of construction, roof height, fire protection and whether Appendix C is used, the allowable area will be identified. There appear to be a number of alternative code paths for the designer to pursue.

EGRESS

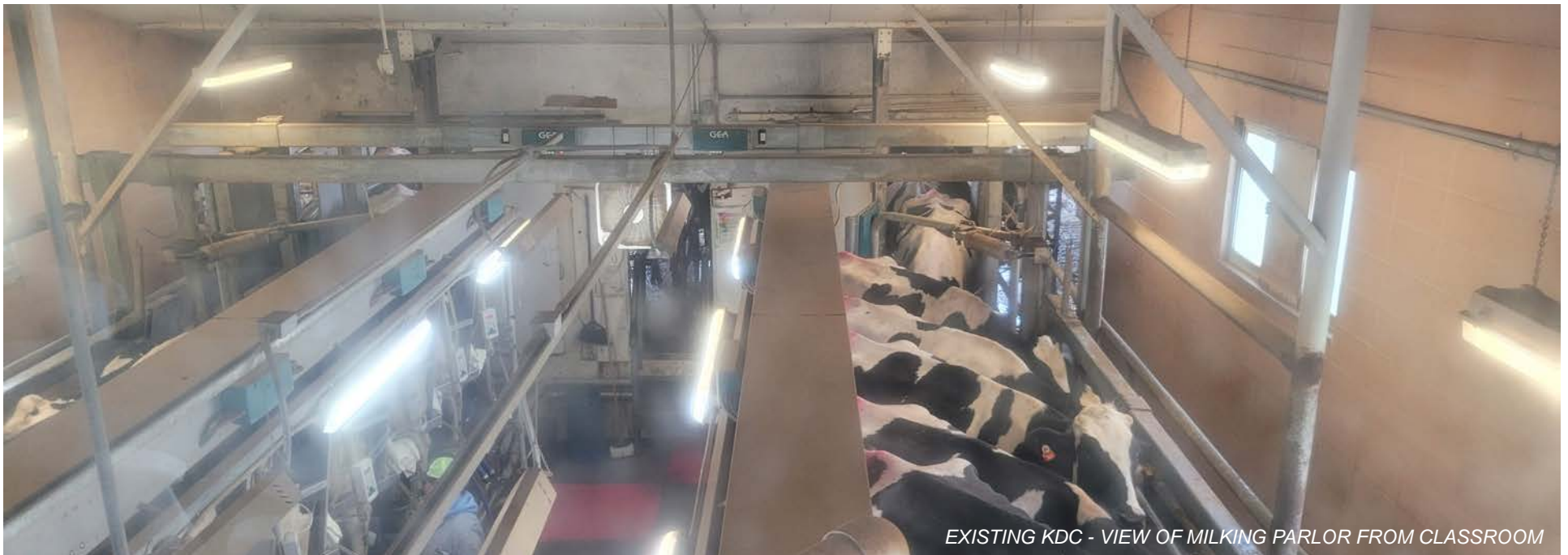
Due to the low egress occupant load of agricultural buildings (300 sf per occupant), it appears that only 2 exits would be required from any building. The conceptual design has taken this into account and has also provided for the required remoteness of exits.

ACCESSIBILITY

IBC Chapter 11 and the Americans with Disabilities Accessible Guidelines (ADA-AG) require that the facility includes accessible features. It should be noted that U Occupancies require accessibility as follows: 1) In ag buildings, access is required to paved work areas and areas open to the public, and 2) areas that contain required accessible parking. The conceptual design included in the study has taken into account specific accessible requirements.

FUTURE ADDITION(S)

Master planning, phasing and future improvements anticipated should be considered when initial improvements are made so that future needs can be easily met. This approach would provide the college with future growth opportunities with little redesign of improvements previously completed.



EXISTING KDC - VIEW OF MILKING PARLOR FROM CLASSROOM

CONCEPTUAL DESIGN

PHASING INFORMATION

PHASE 1

- Construct a new heifer and dry cow barn at the northeast side of the site. Barn is to be positioned in a manner that allows for the construction of future addition(s) under later phases. New barn to house overflow of heifers located elsewhere on site (not in current heifer barn) and relocation of dry cows from current barn. The existing dry cow barn is to be abandoned due to non-compliance with current AAALAC regulations. Barn design to follow a freestall and compost bedded pack housing module.
- Construct system of corral fencing at current lactating cow barn to replace hot-wire used for herding animals to milking parlor.
- Expand parlor by constructing corrals outside of building to increase holding pen size and provide safer human access.
- Upgrade data infrastructure to provide more reliable internet on site. Upgrades may include installing fiber optic to site or a mix of improved exterior wireless access points and hardline cabling from tower to site.

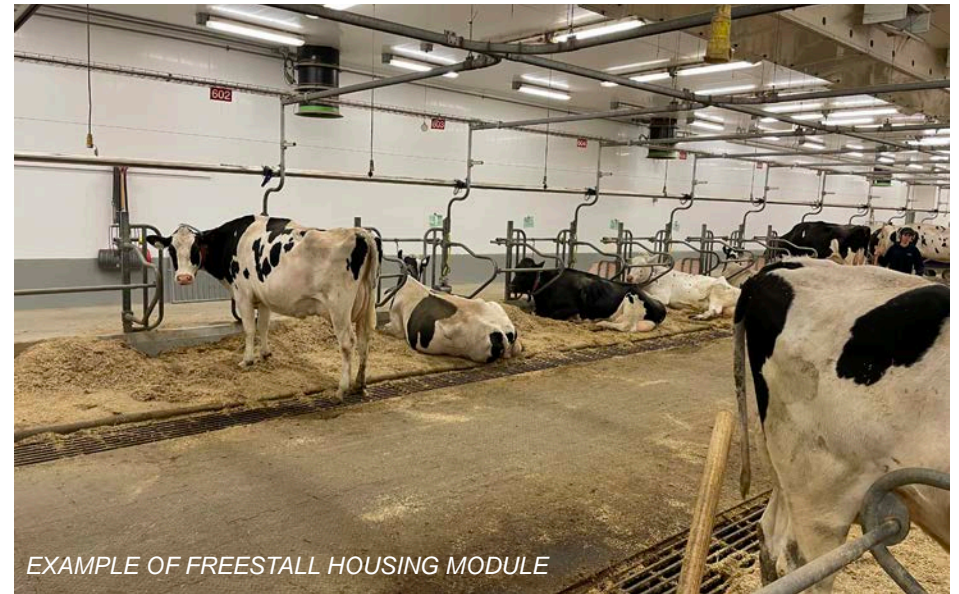


EXISTING KDC - CALF BARN AND
LACTATING COW BARN MODULE

CONCEPT DEVELOPMENT

The conceptual design has been developed to be responsive to the Washington State livestock agricultural community. The Animal Sciences Department (AS) is committed to building their reputation for excellence by modernizing the Knott Dairy Center to meet the research and educational needs of the industry. It is desired to reconfigure the current layout to create a more efficient flow of animals and provide a safer environment for the staff, researchers, and students running the center.

The future vision of the KDC includes modernized barns with robotic feeders and milkers that will provide the precision required for collecting research data. In order to accomplish the much needed improvements, a long term master plan has been established with a phased approach guided by the priorities identified during this study. The enclosed concept includes a mixture of new and remodeled buildings that will be sequenced in a manner that allows the KDC to remain operational during the construction phases.



EXAMPLE OF FREESTALL HOUSING MODULE

PHASE 2

- Demo existing feed barn and dry cow barn.
- Construct new lactating cow barn after demolition of buildings indicated above. Barn to be designed following the freestall housing module. Included shall be space for robotic milking stations (for future install or during this phase pending available funding sources). New underground stainless steel piping should be installed running towards milk storage tanks in existing parlor and also plumbed to the north for future relocation of tanks. An elevated observation walkway is desired above the pens to allow for a safe teaching environment.
- Construct new feed storage on east side of site. Location of new feed storage should be positioned to allow for future growth of the lactating cow barn.
- Temporary feed aisle for existing lactating cow barns to be constructed for use during Phase 2 construction.

PHASE 3

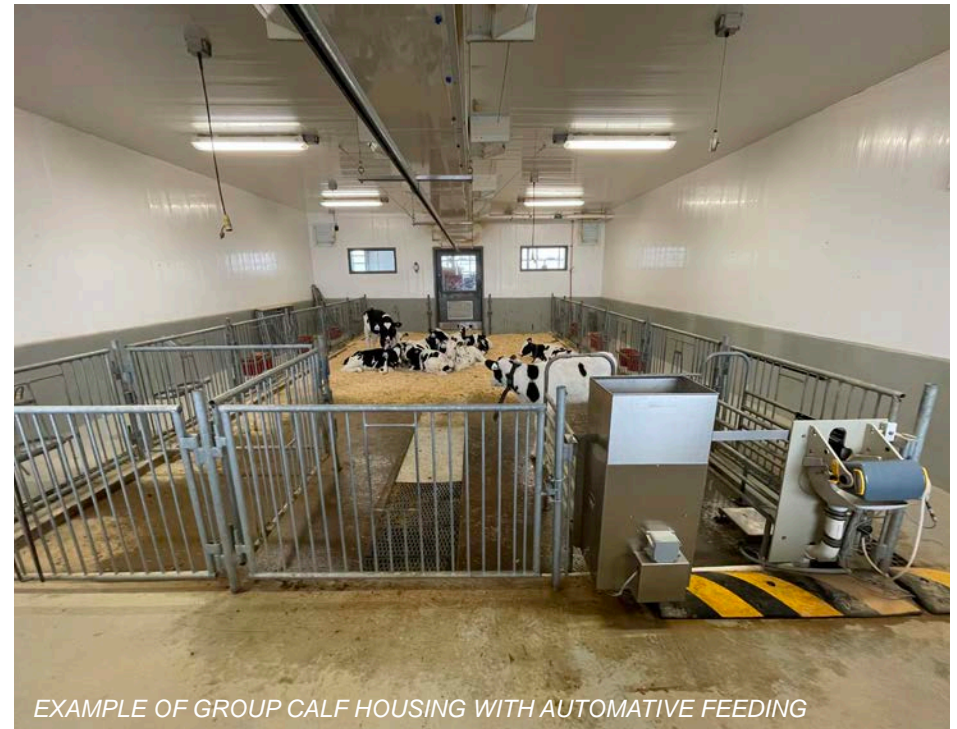
- Remodel / reconstruct existing lactating cow barns.
- South barn location to become new updated veterinary medical lab, pens for up close heifers and cows, storage, and teaching classroom lab.
- North barn location to become new ambulatory care (relocated from milking parlor building) and new calf barn. A small lab is to be constructed as separation between the two functions. Calf barn to provide group feeding with automative feeding.

PHASE 4

- Demo existing heifer barn and expand new heifer / dry cow barn. Expansion to follow a freestall and compost bedded pack housing module. A small lab shall be constructed including set up to conduct artificial insemination (AI).
- Expand lactating cow barn to the east following the same freestyle housing module.
- Remodel existing parlor, residence, and administrative building. Milking parlor to remain as teaching tool and emergency milking with anticipation that majority of milking to take place by new robotic milkers located in lactating cow barn.
- Demo existing calf barn for new milk storage building.

ADDITIONAL SITE DEVELOPMENT CONSIDERATIONS

It is expected that the existing site directly related to each phase will be developed for the needs under that phase. In addition, other site improvements which may be independent of the above listed phases include road and parking lot improvements, pasture watering system, and improvements / modifications to the current waste management system. There are many decisions left to be made regarding the direction of the waste management system which may include improvements to waste flume and settlement ponds, addition of on-site composting, or implementation of a dairy digester system.

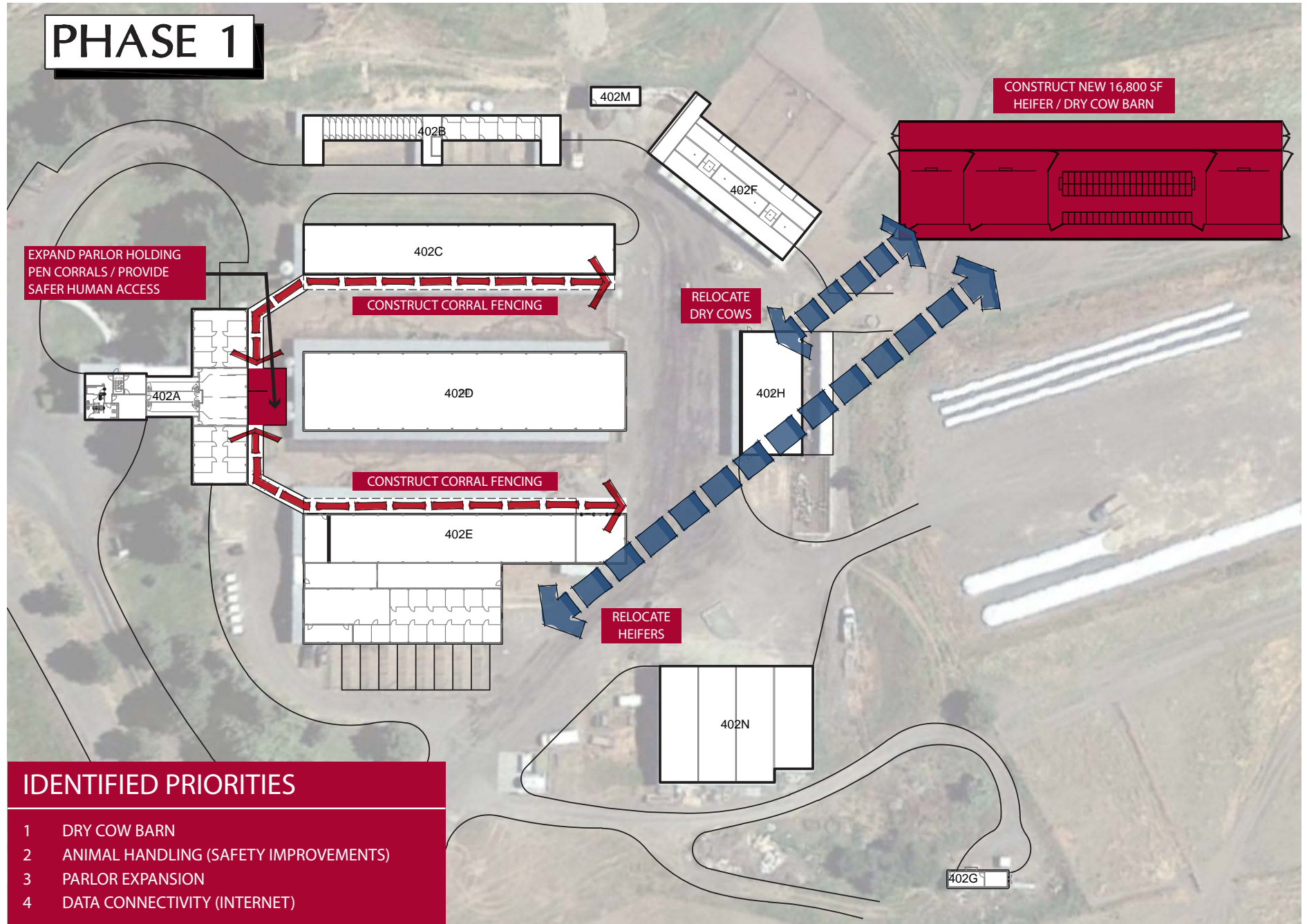


EXAMPLE OF GROUP CALF HOUSING WITH AUTOMATIVE FEEDING



LONG TERM MASTER PLAN

PHASE 1



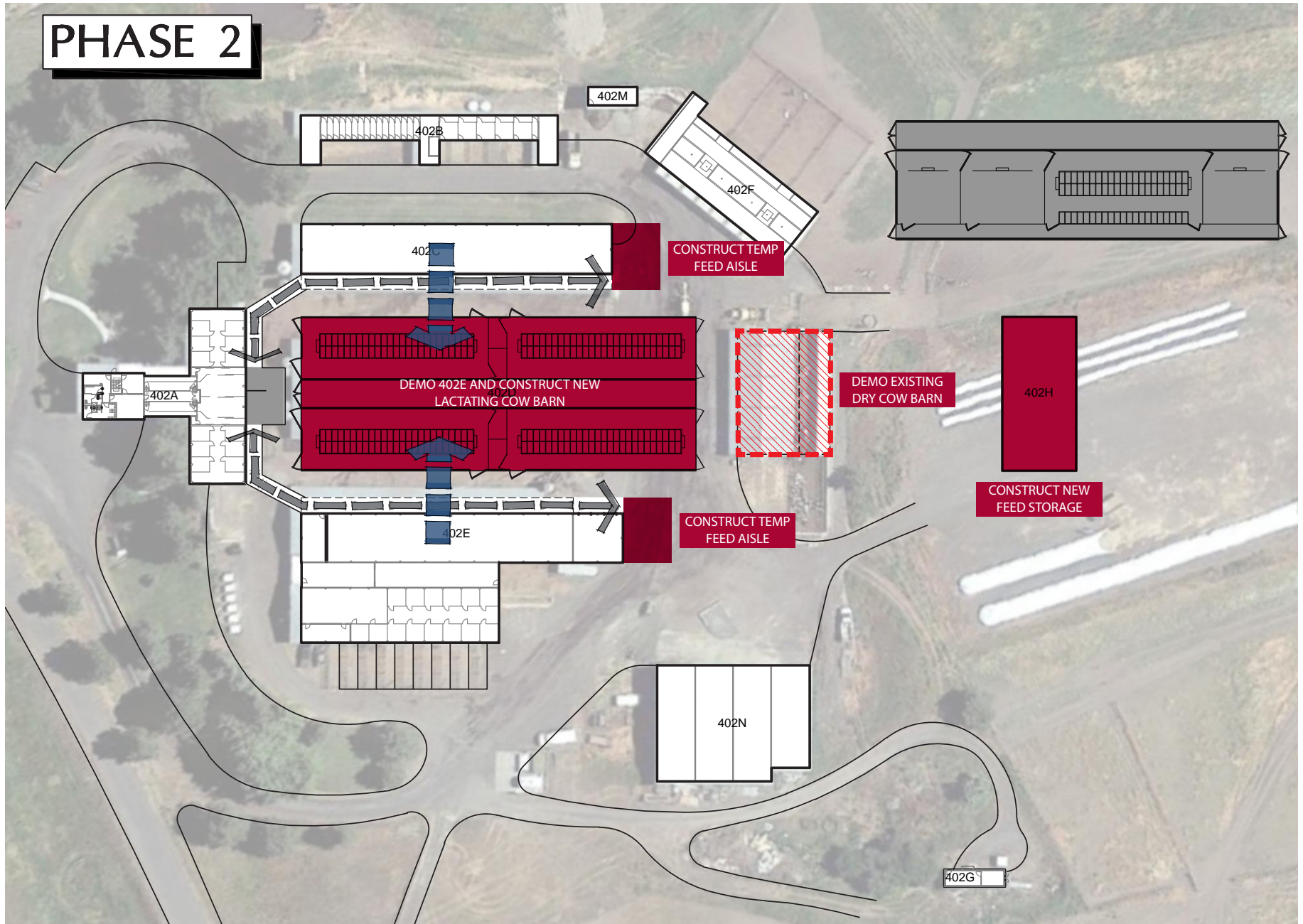
PHASE 1

SCALE: 1" = 80'-0"

NORTH



PHASE 2



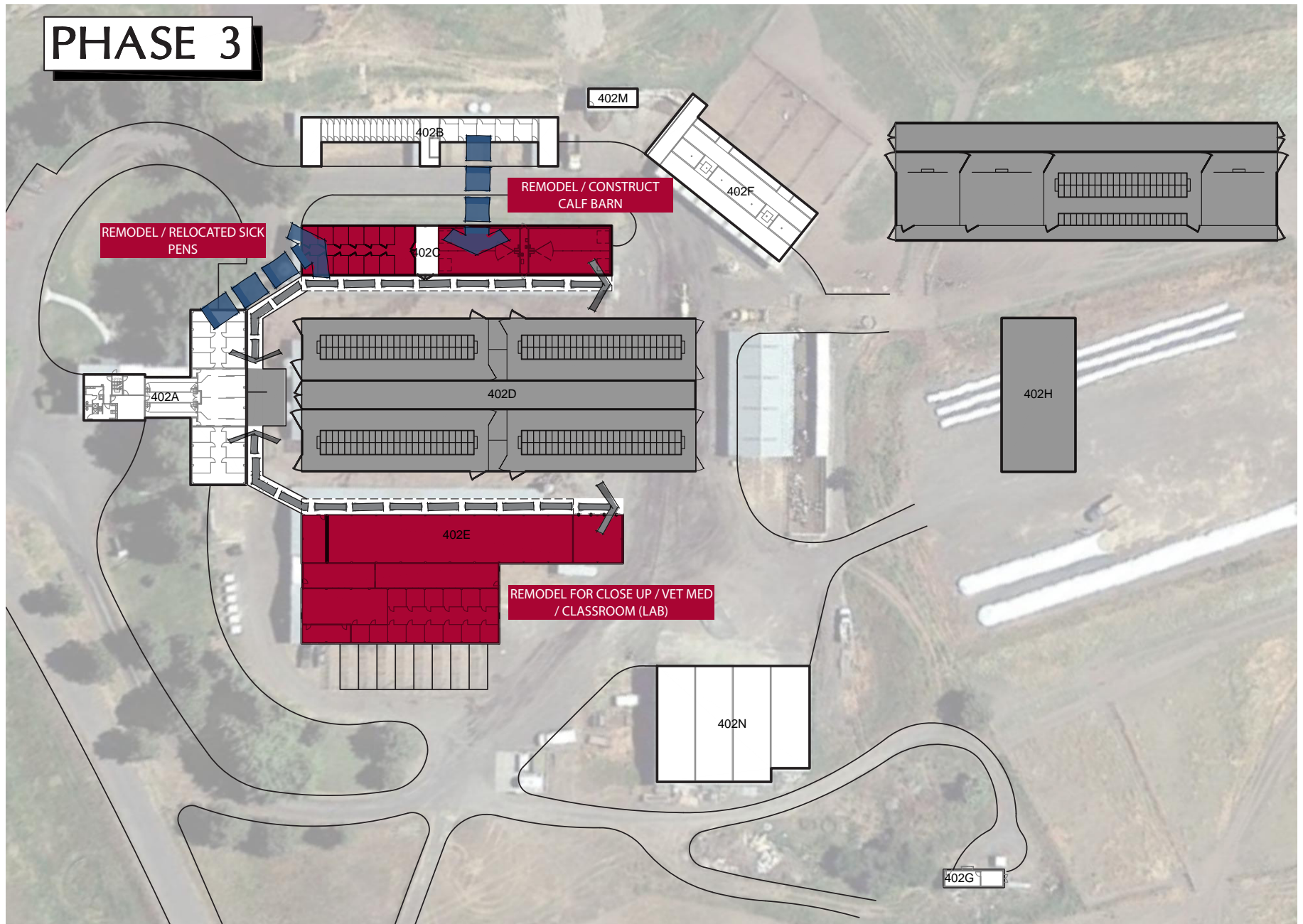
PHASE 2

SCALE: 1" = 80'-0"

NORTH



PHASE 3

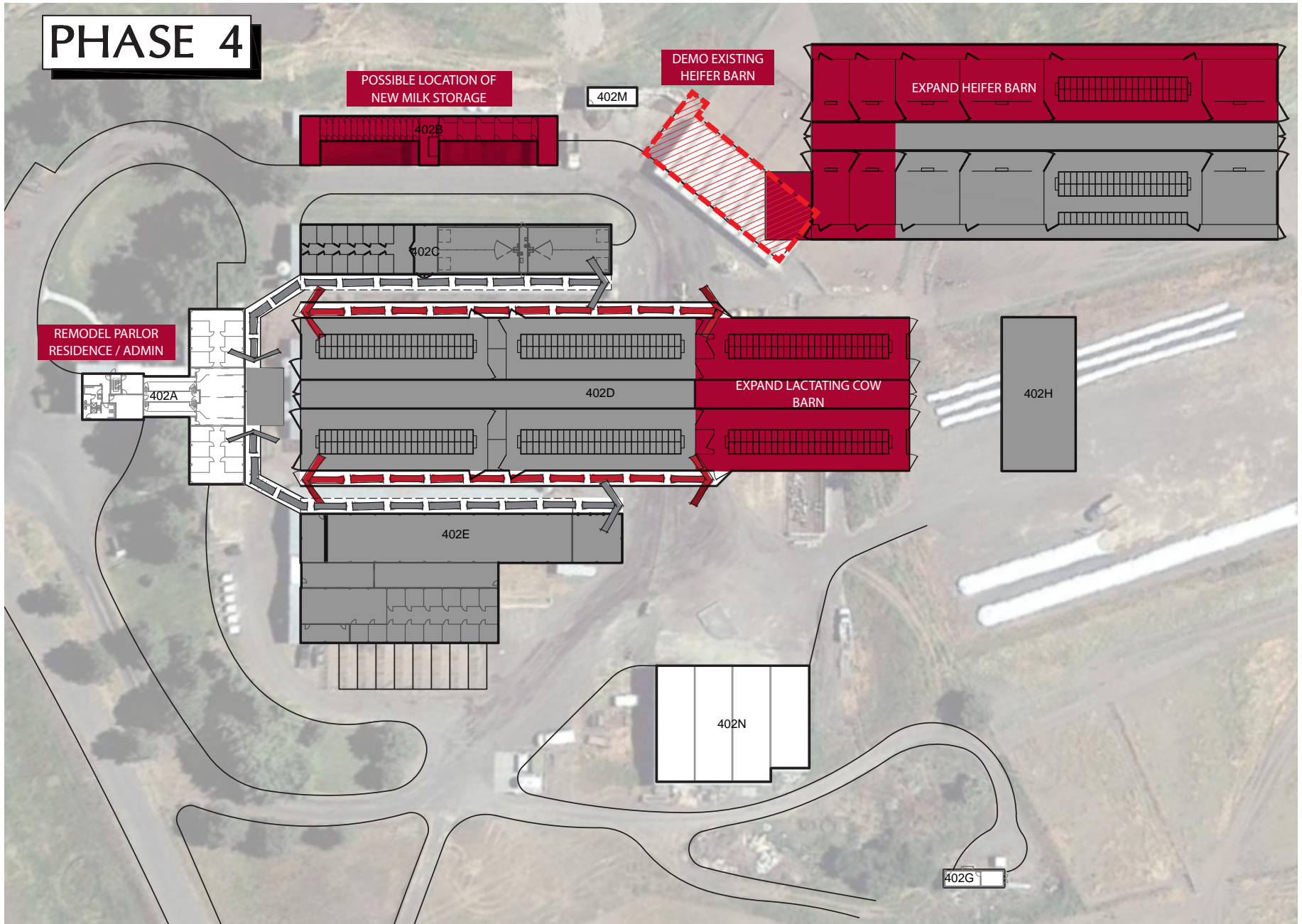


PHASE 3

SCALE: 1" = 80'-0"

NORTH





PHASE 4

SCALE: 1" = 80'-0"

NORTH



POSSIBLE COSTS / BUDGET

The success of any project is founded on quality research and investigation to fully understand applicable issues. This facility study and conceptual design is a step forward in identifying these issues. It is fully expected that adjustments in cost assumptions will need to be coordinated and refined as the design is further developed and actual financing is finalized. The project will be administered by WSU Facility Services and state requirements will need to be followed. Costs will need to be continually updated as more information is obtained, scope is refined, and the design is adjusted.

CONSTRUCTION COSTS ANTICIPATED

The construction costs included for this facility study are a summary of an itemized cost model that was developed for the conceptual design. Anticipated construction costs have been identified per each phase outlined in this document. Included are building construction costs as well as site improvement costs directly related to the development of that structure. Separate from the identified phased work may be additional site improvement costs for road and parking lot improvements, a pasture watering system, and improvements / modifications to the current waste management system. As mentioned previously, the construction cost model will need to be updated at each design phase to monitor whether assumptions made are still valid with changing market conditions.

TOTAL PROJECT COSTS ANTICIPATED

Total project costs include allowances for costs that will be required for the entire project in addition to the assumed construction costs. Included are additional expenditures beyond construction costs such as allowances for administrative, support, FFE (fixtures, furnishings, & equipment), moving, A/E fees, inflation, testing & commissioning, abatement, change orders, and project contingencies. These project costs should be closely examined, identified, amended, and budgeted as required. WSU Facility Services will provide project cost budgeting and administration.

OPINION OF PROBABLE COSTS

	PHASE I	PHASE II	PHASE III	PHASE IV
General Conditions	\$1,393,683	\$1,655,449	\$893,374	\$3,308,872
Calf Barn / Sick Pens			\$572,358	
Heifer Barn / Dry Cows	\$4,452,000			\$5,563,400
Close Up / Vet Med			\$2,632,314	
Lactating Barn		\$6,190,291		\$3,811,000
Feed Barn		\$1,351,200		
Milking Parlor	\$47,360			\$442,880
Admin / Classroom / Residence				\$1,592,000
Milk Storage Facility				\$460,160
Other Infrastructure	(Data) \$500,000			(Other) TBD
Design Contingency (15%)	\$958,957	\$1,379,541	\$614,707	\$2,276,747
Probable Construction Costs	\$7,352,000	\$10,576,482	\$4,712,753	\$17,455,059
Anticipated Project Costs (33% of construction costs)	\$2,426,160	\$3,490,239	\$1,555,208	\$5,760,169
Probable Total Budget Cost (range for conceptual design unknowns / 3-5 years inflation)	\$9,778,160 \$9.7M - \$12.2M	\$14,066,721 \$14M-\$17.6M	\$6,267,961 \$6.3M-\$7.8M	\$23,215,228 \$23M-\$29M

SCHEDULE EXPECTATIONS

The following anticipated project schedule expectations have been processed with the WSU College of Agricultural, Human, and Natural Resource Sciences administration identifying possible milestone expectations for funding of the individual phases. It is anticipated that Phase 1 and Phase 2 will occur within 5 years of this study with Phase 3 & Phase 4 following consecutively afterwards as funding becomes available.

- Phase I: 2023-2025
- Phase II: 2025-2027
- Phase III: TBD
- Phase IV: TBD

PROJECT SCHEDULE MILESTONES ANTICIPATED

A possible project schedule per phase has been approximated below based on a 24 month schedule for design, approval, and construction. Applicable milestones should also include funding finalization, Washington State University Board of Regents approval (planning & design) and WSU Facility Services assignment and set up. A possible schedule of milestones may look like the following:

Finalized Project Design	4 months
Construction Documents	5 months
Plan Review	1 month
Bidding and Contracts	2 months
<u>Construction</u>	<u>12 months</u>
Total Design/Construction	24 months



ACKNOWLEDGMENTS

The following individuals have provided active participation, input, or feedback as a part of this facility study. With much gratitude their efforts have provided for the development of this comprehensive study for the proposed WSU Knott Dairy Center Master Planning.

COLLEGE OF AGRICULTURAL, HUMAN, AND NATURAL RESOURCE SCIENCES

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