REMODELING DAIRY BARNS FOR DAIRY BEEF HOUSING

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Introduction

There are a large number of dairy farms in the Midwest that are not milking cows, but might like to continue to raise dairy beef animals on the farm. The existing dairy barn or other sheds on the farm with some remodeling could accommodate that need. New functional designs for dairy beef housing and feeding or cattle handling could adopt the use of new appropriate technology.

In particular the one or two story dairy barn on the farm may still be standing and in good condition. The building shell may still have some useful life for a different housing and feeding system for dairy beef. This paper was developed to address some of the possible uses for the dairy barn and other sheds that might be on a farmstead to raise or handle dairy beef of various stages of growth.

There are several options for using the barn in a new type of system for housing, feeding, or handling dairy beef cattle. These uses might include:

Weaned Calf Housing
Growing Cattle Housing
Finishing Cattle Housing
Cattle Handling Facility

Typical Dairy Barn Construction

Many older two story barns were designed as timber frames structures with posts and beams supporting the building shell walls, hay mow floor, and roof system. The barn foundation walls were usually constructed with stone or concrete block. The timber frame or wood stud frame second story was placed on top of the foundation wall and was typically used for hay storage. Figure 1 shows a plan and cross section view of a two story barn with two rows of posts, longitudinal beams and ceiling (hay mow floor). Figure 2 shows a photo of the interior lower level of a two story barn.

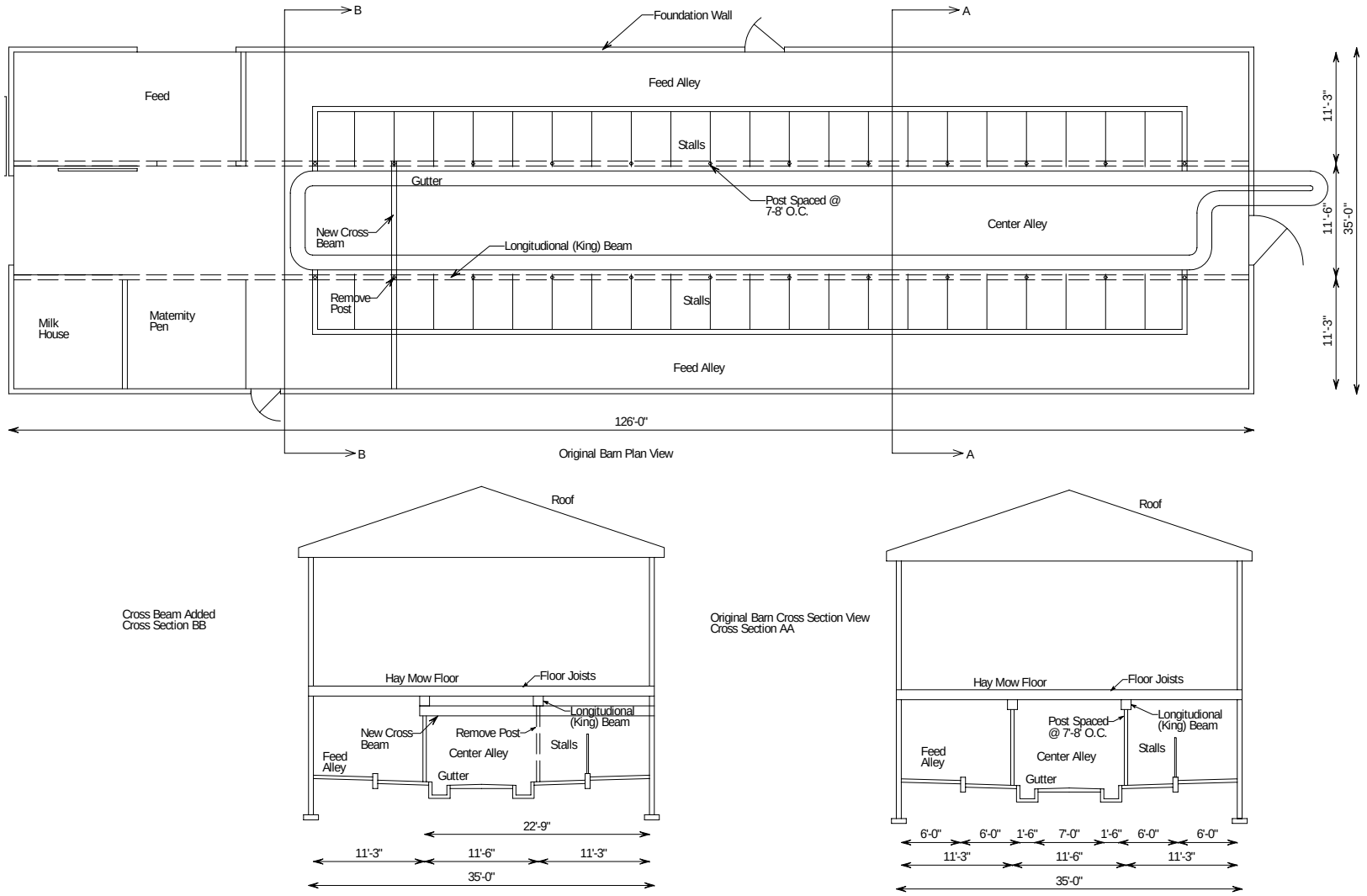


Figure 1. Typical Tie / Stanchion Stall Dairy Barn Design

Two story dairy barns are typically 28’-32’ wide. The outside walls and two longitudinal (king) beams divide the barn width into approximately thirds. Each king beam is supported by a row of posts spaced approximately 7’-8’ on center within the row. Wood ceiling joists are supported by the king beams and walls which in turn support the hay mow floor deck. Hay was usually stored in the second story above the cows housing space. The hay mow floor is also the ceiling of the lower level of the barn which was housed the cows.

Figure 2. Interior Photo of Two Story Dairy barn with two rows of posts and beams.

In the case of a timber frame structure, the posts, king beams, and mow floor are an integral part of the structure of the barn. Removing or changing the arrangement of these components may compromise the entire structural integrity of the building. Newer two story barns have posts and beams supporting the mow floor, but the second story walls and building roof may be supported on the perimeter walls and foundation.

Since many two story barns no longer use the second floor or hay mow space for hay storage, the hay mow floor may not need to carry the load it once did. In this case moving a few posts a short distance within the row to accommodate a new interior layout may be possible assuming the beam and mow floor can carry the intended loads. On the other hand moving posts too far apart or removing posts effectively increases the span of the king beam. This may not be reasonable and/or require engineering analysis to determine the new loading conditions and determine if the king beam can handle the new loading conditions and increased span.

Moving the king beam and increasing the span of floor joists also may not reasonable and/or require engineering analysis. Floor joist may not be long enough to span the distance or may not be the correct size to carry the intended loading. An engineer or company that straightens or raises old barns should be consulted if any major structural changes are planned for the barn. In some cases cross beams can be used to span the barn width to carry the load of removed post that supported the king beam. See Figure 1. This option can span areas where the functional layout requires additional width or the existing posts are in the way of the desired layout.

Single story dairy barns are typically slightly wider (32'-36') with a concrete block, wood post or stud wall foundation walls which in turn support a clear span truss. This type of construction eliminated interior posts and provides much more design flexibility. The lower chord of the truss was usually lined with steel or plywood and insulated to provide a ceiling for the cow housing. There was usually no storage above the ceiling.

First floor ceiling heights range from 8'-9' in most barns and may be less than that in some older barns. Sidewall openings in dairy barns usually included 7-8' wide end wall doors in the center ally, window openings in the sidewall, and several walk doors for cattle access out the side of the barn. Each of these openings uses a header to support the opening below it. It may be possible to increase the opening width but that would require a larger header to be placed above the opening.

Evaluating the Barn for a New Use

Consider objectively if the new use of the barn can provide suitable ventilation, manure handling, feed handling, and animal handling systems in the design. Just because it was well suited as a dairy barn does not necessarily mean it is going to function well as a dairy beef cattle barn. The barn site, orientation, building dimensions, and ability to adopt new technology should be considered. The location of the barn should provide access for cattle loading and unloading if that will be one of its primary uses.

Additional improvements in the area around the building may also be required to provide convenient manure collection and handling, feed equipment access, or cattle loading access. Outside lots should also be evaluated to determine how best to handle barn yard lot runoff from rain and snow fall adequately and in an environmentally friendly way. In some cases the existing barnyard lot runoff system may be suitable, but it may require some redesign to meet a larger animal capacity from what it was originally designed to handle.

The ventilation system can be evaluated and or redesigned to meet the needs for larger or different animal group requirements. Both the inlet system and fan capacity and placement may need some redesign. Mechanical ventilation will likely be needed to provide reasonable air quality in the barn. Either positive or negative pressure systems with designed inlets or outlets can be used. In many situations a positive pressure system may be more appropriate to allow the space design desired. Table 2 has design information to determine ventilation capacity.

The building structural features should be assessed to determine if they will suit the needs of the new design. These include the:

- Foundation and Walls
- Structural Frame
- Post Spacing
- Headers over openings
- Electrical and Plumbing

The foundation walls should be evaluated to determine if they are in good condition. Repairing cracked, leaning or otherwise damaged foundation walls can be an expensive proposition and should be considered carefully. The structural components such as purlins, joists, headers, posts, beams, and walls should be evaluated to determine if they are of suitable size and condition to serve a new use.

The ceiling height should allow for equipment access for manure handling, and feeding if desired. Door and window openings can potentially be easily increased in width with new headers. But if the ceiling is too low to get the skid steer into the barn for cleaning pens, the alternative of raising the ceiling may be cost prohibitive.

Interior concrete floors will not likely be used in their current condition or layout. A skid steer with a jack hammer can make short work of old concrete. When in doubt it is probably better to tear concrete out than to try and save it. Many farms live with inadequate slopes and poor drainage for the life of the building because they thought they could save some of the old concrete that should have been removed.

The electrical service capacity should be evaluated to determine if it will meet the needs of the new use. Plumbing and drain lines should be evaluated to determine if they can handle the water flows and allow the use of frost free water systems. While the old concrete is removed, it may be simpler to bury water lines underground rather than to try and protect above ground water lines from freezing.

It is assumed in this discussion that the dairy barn or shed:

- Is structurally sound
- Is in a suitable location
- Has an adequate space (width, length, height) to accommodate the new design
- Will require minimal structural changes

Economics of Remodeling the Structure

As a general rule if the cost of remodeling a dairy barn or shed exceeds two thirds to three quarters of the cost of a new building for the same use, it may be wiser to consider the new building over the remodeling. Obtain an estimate for the cost of a new building to serve a similar function using a similar footprint plan to help make the decision to remodel or build new.

Planning the space

The new facility plan should consider:

Environmental needs of the animal group
Animal traffic patterns
Labor Savings
Adoption of new modern technology
Convenient materials handling (manure, bedding, and feed)
Capital cost

Functional space planning should account for the space and environmental needs of the animal and the labor saving systems for the owner. The design should allow the adoption of appropriate technology for feeding, ventilation, cattle handling, manure handling and storage. The space plan will determine the capacity of the barn for a particular use. Table 1 has summary design information to develop the space needs for various sizes of cattle. Table 2 is used to develop a ventilation system design for the animal groups housed in the barn. Table 3 has summary design information to develop the space plan for cattle handling systems. The following discussion show several examples of how a barn can be remodeled for various uses.

Table 1. Summary Design Information (MWPS-6 Beef Cattle Handbook, 1987)

	Animal	
	Calves 400-800 lb	**Finishing 800-1200 lb**
Open Lot Resting Space		
Unpaved lot without Mound Space	300-600 ft^2/animal	400-800 ft^2/animal
Unpaved Lot with Mound Space (includes mound space)	150-300 ft^2/animal	250-500 ft^2/animal
Mound Space	20-25 ft^2/animal	30-35 ft^2/animal
Paved Lot	40-50 ft^2/animal	50-60 ft^2/animal
Sheltered Resting Space		
Bedded Resting Space with lot	15-20 ft^2/animal	20-25 ft^2/animal
Bedded resting space without lot	20-25 ft^2/animal	30-35 ft^2/animal
Feeding Space		
Self Fed (grain)	3-4 in./ animal	4-6 in./animal
Self Fed (roughage)	9-10 in./ animal	10-11 in./ animal
Once per day ration	18-22in./ animal	22-26 in./ animal
Twice per day ration	9-11 in./animal	11-13 in./ animal
Bunk wall Throat Height	18 inches	20 inches
Water Space		
Perimeter length per animal	¾ inches per animal	
Number of animals per water location	25	20
Gallons capacity per animal-day		
Hot weather	8-15	15-22
Cold weather	4-7	8-11
Daily Manure production	0.4-0.8 ft^3/ animal	0.8-1.2 ft^3/ animal

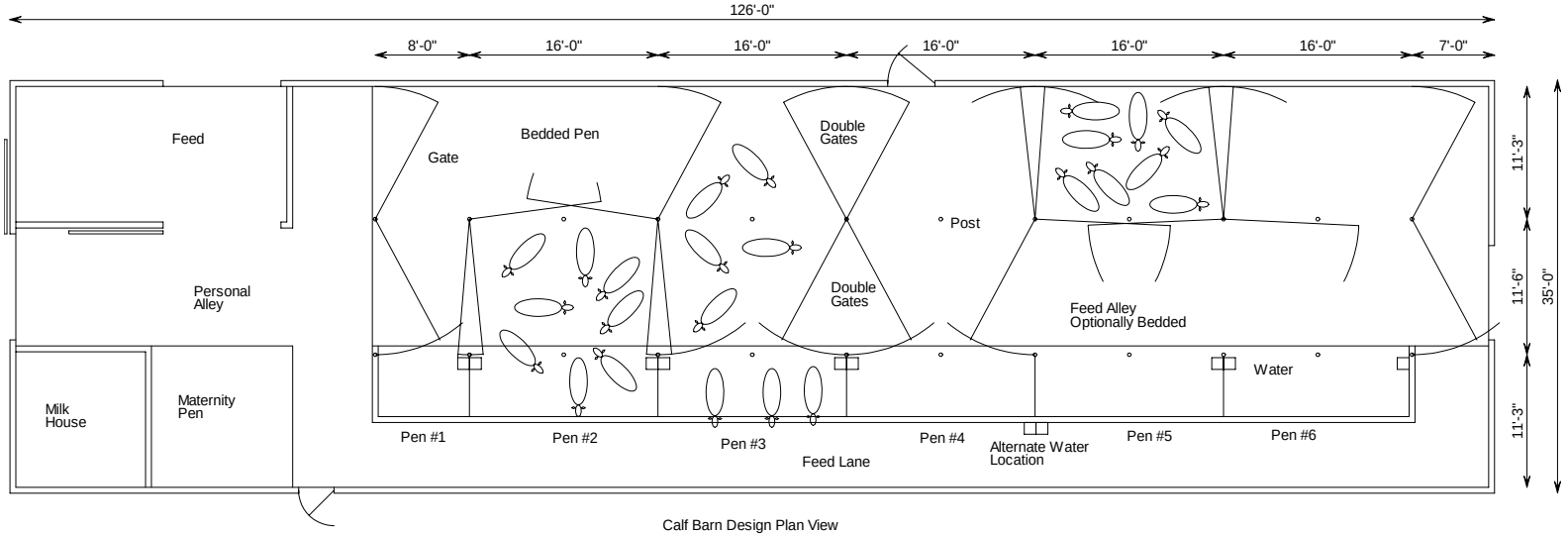
Table 2. Ventilation Design for Dairy Beef (MWPS-6 Beef Housing Handbook, 1987)

	Cold Weather	Mild Weather	Hot Weather
	---------- cfm/ animal----------		
Calves, 0-2 months	15	+35 = 50	+50 = 100
Feeder calves, 2-12 months	20	+40 = 60	+70 = 130
Yearlings, 12-24 months	30	+50 = 80	+100 = 180

Table 3. Cattle Handling Design Information.

	Animal	
	Calves 400-800 lb	Finishing 800-1200 lb
Holding Pen Space		
Overnight	45 ft^2 / head	50 ft^2 / head
2-4 hours	14 ft^2 / head	17 ft^2 / head
Crowd Tub	6 ft^2 head	10 ft^2 / head
Collecting Alley width	12’	
Working Chute length	20-24’	
Working Chute Width	18”	22” (20-24”)
Loading Ramp Width	26”	
Loading Ramp Length	12’	
Loading Ramp Rise / foot	3-1/2” to 4”/ foot	
Loading Ramp Height		
Stock Trailer	15”	
Pickup Truck	28”	
Stock Truck	40”	
Tractor Trailer	48”	

***Calf Barn Design*.** Figure 3 shows a remodel for a calf barn with several small group bedded pens. This would be appropriate for calves after weaning. The interior posts of the barn are not moved. The old concrete floor and curbs that don’t fit into the new floor plan are removed. A new concrete floor with the correct slope and configuration is replaced. New water lines to the water locations should be placed underground before the new floor is placed. A series of double gates separate each pen and can be placed to vary pen size according to need. A small fence or gate can be used to separate pens near the feed lane. The area near the feeding fence may require hand scraping into the adjacent alley. The gates are hinged to swing and lock calves into different parts of the pen. This allows a calf group to be moved and locked into the bedded pen area (See Figure 3 pen # 5) while the manure is removed from the feed alley. Calves can then be moved and locked into the clean feed alley of the pen while the adjacent bedded pen area is cleaned (See Figure 3 pen #2). The 16’-0” x 11’-3” resting area of a pen has a capacity of 7 calves @ 25 ft^2/ calf (Table 1).



Calf Barn Design Plan View

Pen Capacity
16'-0" x 11'-3" pen = 180 square feet
7 head @ 25 s.f. /head = 175 square feet

Calf Barn Design Cross Section View

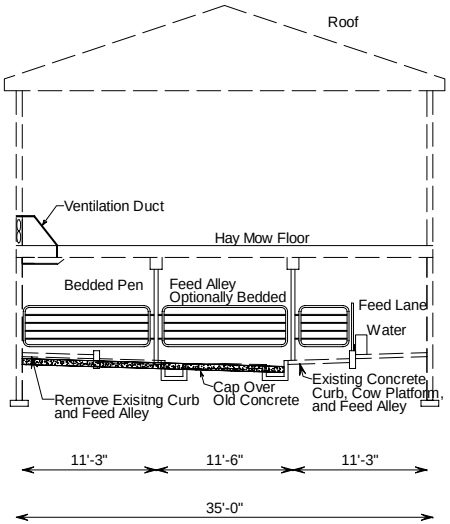


Figure 3. Calf Barn Design Remodeled into a Tie / Stanchion Stall Dairy Bar

Either the bedded resting area of the pen can be bedded or the entire pen can be bedded. Feed can be delivered by hand or motorized cart in the existing feed lane. Frost free waterers are placed near the feed fence to protect them from equipment. A single waterer can be shared between two pens or provided for each en. A positive/negative pressure system could be placed in the barn with a duct providing fresh air into the barn and exiting out the sidewall of the barn. See Table 2 for fan capacity needs. If an existing tunnel ventilation system was in place it could be redesigned and controlled to meet the needs of the animal group housed.

Grower Barn Design

Figure 4 shows a remodel for a grower barn with several group bedded pens. The sidewall of the barn is opened to provide cattle access to the feeding bunk. A flat feeding floor or J bunk can be placed on the outside of the barn wall to allow drive by feeding from the outside. The interior posts of the barn are not moved. The old concrete floor and curbs that don't fit into the new floor plan can be removed. A new floor with the correct slope and configuration is replaced. New water lines should be placed underground before the new floor is placed. Waterers could be placed along the feed line or inside the barn if more convenient. Gates separate each pen and can be placed to vary pen size according to need. A fence between the resting area and alley with gated openings allows cattle to be locked into either area. This allows a group of animals to be moved and locked into the resting space while the alley is cleaned (See Figure 4 pen #2) or locked into the feed alley (See Figure 4 pen #4) while the resting area is cleaned. Frost free waterers are placed near the feed fence. A single waterer can be shared between two pens or provided for each pen. A positive pressure ventilation system can be placed in the barn. See Table 2 for fan capacity needs. The 16'-0" x 22'-9" resting area of a pen has a capacity of 12 head @ 30 ft^2/ head (Table 1).

Finishing Barn Design

Figure 5 shows a remodel for a finishing barn with several group bedded pens and access to an outside lot and drive by feeding platform. The interior posts of the barn are not moved. The old concrete floor and curbs that don't fit into the new floor plan can be removed. A new floor with the correct slope and configuration is replaced. New water lines should be placed underground before the new floor is placed. Waterers could be placed outside along the sidewall of the barn or if more convenient placed along the outside lot feeding fence line. Gates separate each pen and can be placed to vary pen size according to need. Place gated openings in the sidewall to allow cattle access to the outside lots. This allows a group of animals to be locked into the outside lot while the bedded resting area is cleaned (See Figure 5 pen #1) or into the bedded resting space while the outside lot is cleaned (See Figure 5 pen #3).

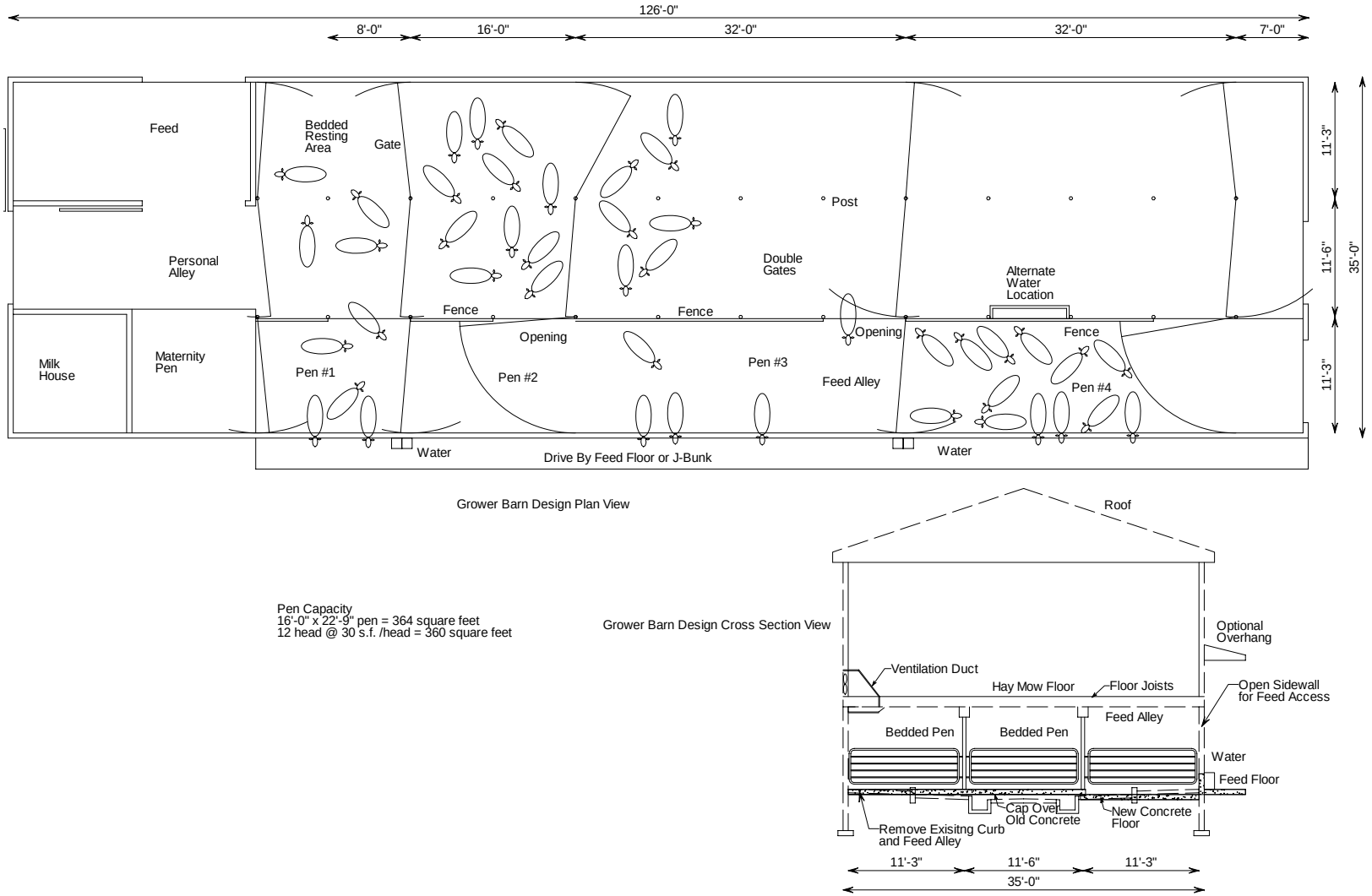


Figure 4. Grower Barn Design Remodeled into a Tie / Stanchion Stall Dairy Barn

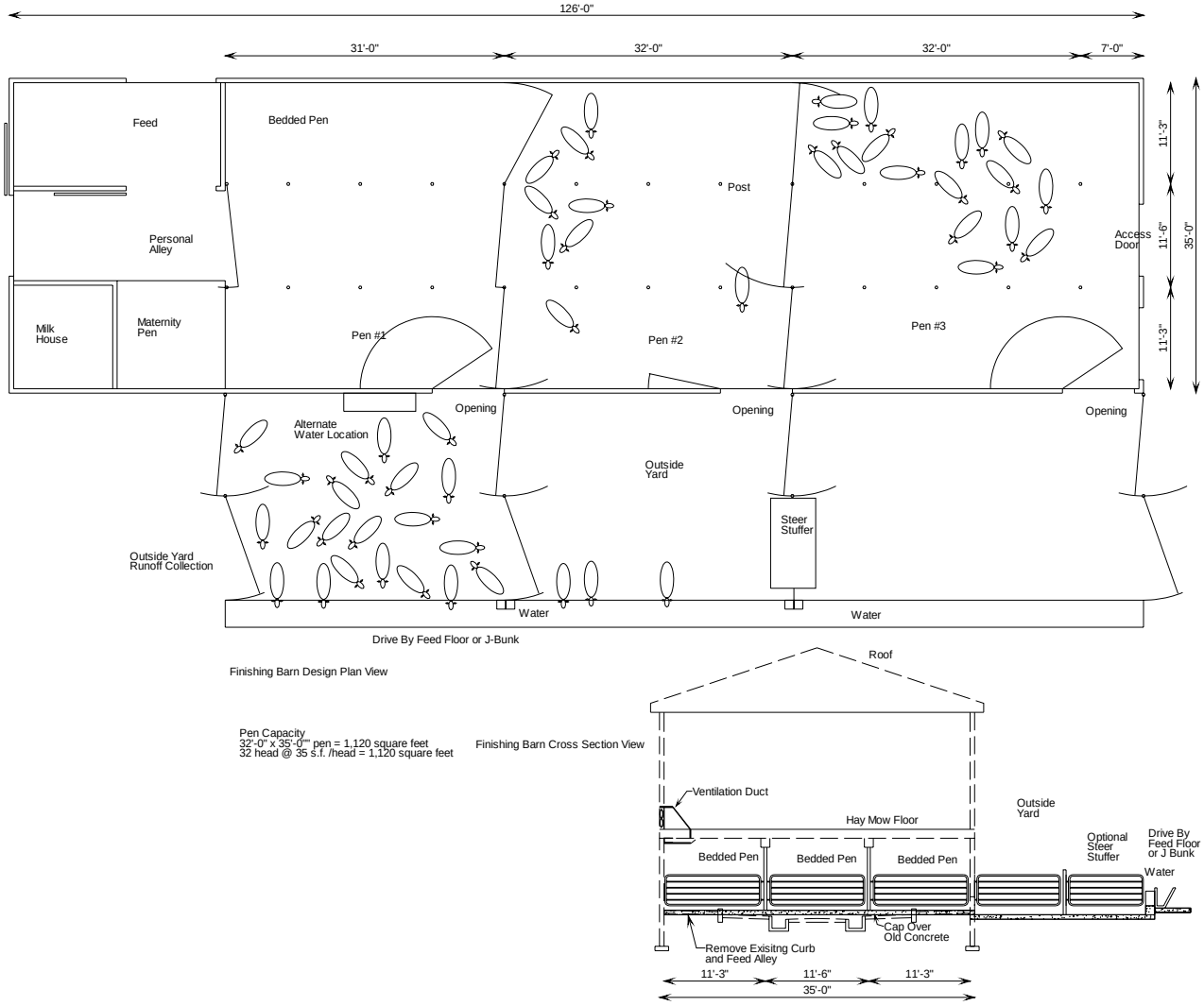


Figure 5. Finisher Barn Design Remodeled into a Tie / Stanchion Stall Dairy Barn

The entire barn can be bedded. A flat feeding floor or J bunk can be placed along the perimeter of the concrete barn yard to allow drive by feeding. In many cases there is more than enough outside lot space for the cattle. Part of the existing barnyard can be also be used for the driveway for feeding equipment. A positive pressure ventilation system can be placed in the barn. Part of the pen gate partition can be replaced with a steer stuffer which is easily accessible from the drive by feeding lane for filling. The
32'-0" x 35'-0" resting area of a pen has capacity of 32 head @ 35 ft^2/ head (Table 1).

Cattle Handling Design

Figure 6 shows a plan design for a cattle handling area developed inside an existing stall barn. The interior posts were not removed. The south side of the barn between the south sidewall and a row of posts is developed as the entrance lane and holding pen. The cattle enter one end of the barn at the southwest corner of the building. Partition gates allow separate groups to be loaded into the entrance lane.

Cattle move east toward a crowding tub area at the east end of the barn where they begin to turn north through the crowding tub and into a curved chute to the west toward the head gate or working chute area. Personal space is provided on both sides of the working chute and head gate as well as space on the inside of the working tub for moving cattle safely. There should be good footing at the exit from the head gate to prevent cattle from slipping as they leave the chute. At the exit of the head gate there are several options for exiting and or sorting the cattle. Cattle can be released into the exit lane (Option A), directed to a sort pen (Option B), or return to the entrance lane and holding pen (Option C).

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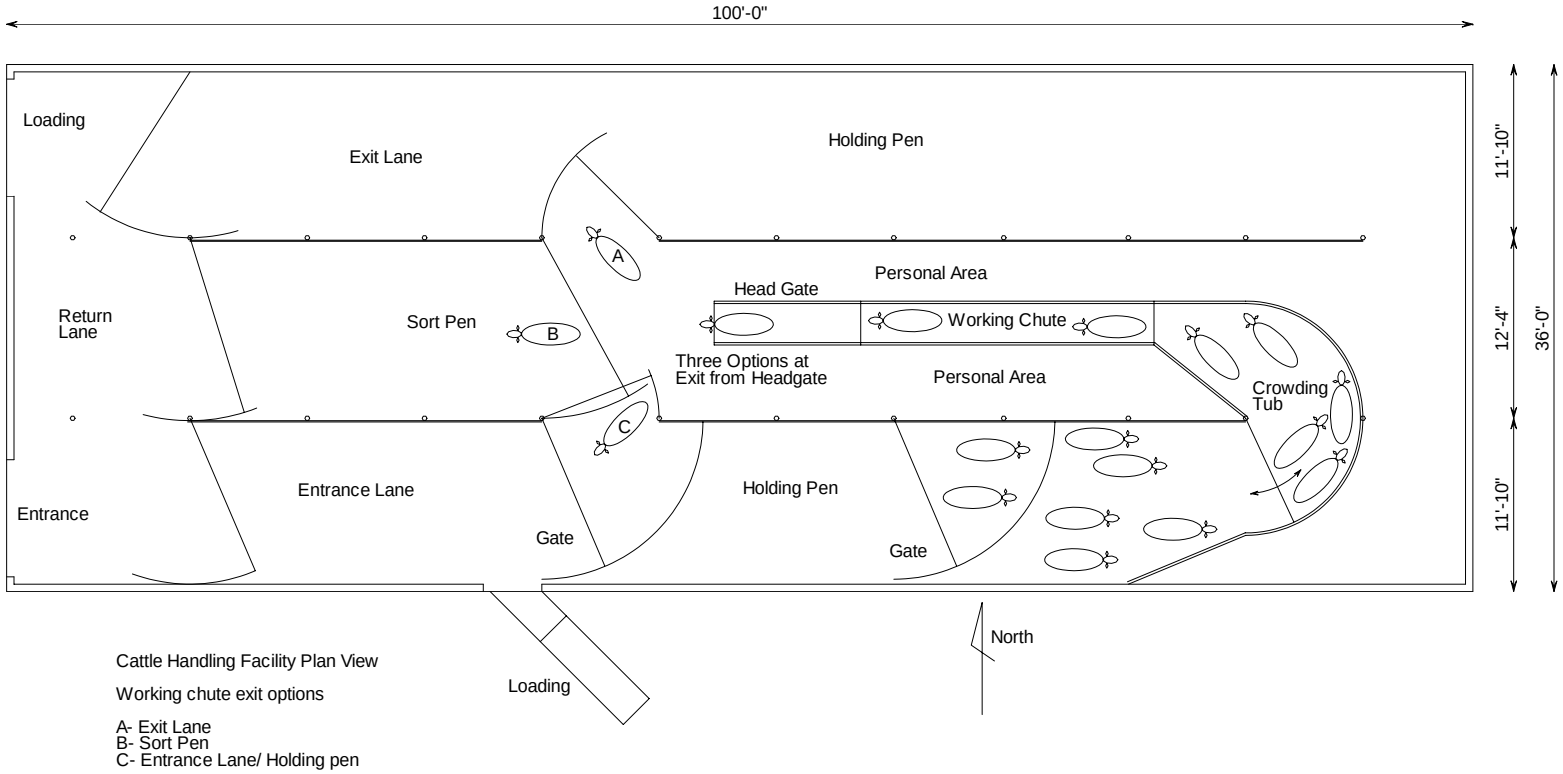

Figure 6. Cattle Handling Design Remodeled into a Tie / Stanchion Stall Dairy Barn