USDA
NATURAL RESOURCES
CONSERVATION SERVICE

DELAWARE CONSERVATION
PRACTICE STANDARD

MANURE TRANSFER

CODE 634
(Reported by No.)

DEFINITION

A manure conveyance system using structures, conduits, or equipment.

PURPOSES

To transfer animal manure (bedding material, spilled feed, process and wash water, and other residues associated with animal production may be included) through a hopper or reception pit, a pump (if applicable), a conduit, or hauling equipment to a manure storage/treatment facility, a loading area, or to agricultural land for final utilization.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where:

- The manure transfer component is a part of a planned manure management or comprehensive nutrient management system.
- Where manure is generated by livestock production or processing and a conveyance system is necessary to transfer manure from the source to a storage/treatment facility and/or a loading area, and/or from storage/treatment to an area for utilization. This includes hauling manure from one geographical area with excess manure to a geographical area that can utilize the manure in an acceptable manner.

This practice does not include land application or other use of manure. Criteria for land application of manure are included in NRCS Conservation Practice Standard 590, Nutrient Management, or Standard 633, Waste Utilization.

CONSIDERATIONS

Consider economics (including design life), overall manure management system plans, and health and safety factors.

On Farm Transfer. In locating structures, utilize existing topography to the greatest extent possible to generate head on structures and reduce pumping requirements.

Consider the operating space requirements of loading and unloading of equipment in the vicinity of the manure transfer components.

Consider the subsurface conditions, i.e., depth to bedrock, water table, etc., when locating and designing structures.

Pipelines used for transferring manure should be flushed with clean water after use.

When applicable and compatible, consider the joint use of manure transfer pipelines with irrigation system design requirements.

The pipe pressure rating required may need adjustment based on manure temperature.

Consider corrosion resistance and water tightness in the selection of pipe material and joints.

Consider the potential for salt (struvite) deposits in smaller diameter pipes.

Consider the need for appropriate check valves, anti-siphon protection, and open air breaks in all pipelines.

Provisions should be made for removing solids

from conveyance conduits such as concrete lined ditches, etc.

Off Farm Transfer/Transport. Consider route selection and timing of manure transfer to minimize impact of nuisance odors on others.

Consider equipment type and covering of manure to minimize particulate matter generation during transport of manure.

Vehicles used to transfer manure should be sized to reduce the danger of rollover.

CRITERIA

Criteria Applicable to All Purposes

Manure transfer components shall comply with all federal, state, and local laws, rules, and regulations.

Structures. All structures, including those that provide a work area around pumps, shall be designed to withstand the anticipated static and dynamic loading. Structures shall be designed to withstand earth and hydrostatic loading in accordance with Conservation Practice Standard 313, Waste Storage Facility. Covers, when needed, shall be designed to support the anticipated dead and live loads.

Reception pits shall be sized to contain a minimum of one full day's manure production. For reception pits collecting runoff, the reception pit shall be sized to also contain at least the volume of runoff from the 25-year, 24-hour storm. Additional capacity shall be added as needed for freeboard and emergency storage.

For existing CAFOs, reception pits collecting runoff shall be sized to contain at least the volume of runoff from the 25-year, 24-hour storm. For new CAFO facilities, reception pits collecting runoff shall be sized to contain at least the volume of runoff from the 25-year, 24-hour storm for horse, sheep, duck, dairy, and beef (other than veal). The reception pits collecting runoff for swine, veal calf, turkey, and chickens shall be sized to contain at least the volume of runoff from the 100-year, 24-hour storm.

Openings to structures to receive manure from alley scrape collection shall be a minimum of 9 square feet with one dimension no smaller than 4 feet. The opening shall be equipped with a grate designed to support the anticipated loads.

When curbs are needed in conjunction with structures, they shall be constructed of either concrete or wood. Curbs shall be of sufficient height to ensure total manure flow into the structure and be adequately anchored.

Pipelines. Design of pipelines shall be in accordance with sound engineering principles considering the type of load on the pipe, exposure, etc. The minimum pipeline capacity from collection facilities to storage/treatment facilities shall be the maximum peak flow anticipated on a daily basis.

The minimum pipeline capacity from storage/treatment facilities to utilization areas shall ensure the storage/treatment facilities can be emptied within the time limits stated in the management plan for manure utilization.

Pipelines used for transferring waste to an irrigation system shall meet the requirements of NRCS Conservation Practice Standard 430, Irrigation Water Conveyance, Pipeline.

All pipes shall be designed based on the type of material and total solids content and shall convey the required flow without plugging. Flow velocities shall be sufficient to minimize settling of solids in the pipeline.

Clean-out access shall be provided for gravity pipelines at a maximum interval of 200 feet for lines carrying non-bedded manure. For pipelines carrying bedded manure the maximum interval shall be 150 feet. Gravity pipelines shall not have horizontal curves or bends except minor deflections (less than 10 degrees) in the pipe joints unless special design considerations are used.

Where slurry manure is transferred in a gravity system, a minimum of 4 feet of head is required on the pipe system.

Gravity discharge pipes used for emptying a storage/treatment facility shall have a minimum of two gates or valves, one of which shall be manually operated.

Pipelines shall be installed with appropriate connection devices to prevent contamination of private or public water supply distribution systems and ground water.

Other Conduits. Concrete lined ditches shall be designed in accordance with Practice Standard 468, Lined Waterway or Outlet. A minimum design velocity of 1.5 feet per second shall be used.

Pipe. The pipe must meet or exceed the applicable specification rating listed in Table 1. The manufacturer's recommendations for deflection in the joints must be followed.

All pipe for pump or direct transfer systems must meet the pressures and dynamic loads generated by the system and installation as specified by the pump manufacturer. All pipes must withstand the earth, live load, and dead load pressures. All pipes shall have a minimum internal pressure rating as shown in Table 1 or two times the maximum operating pressure, whichever is less.

Valves. Valves shall be installed in pipelines where there is a positive working head for emergencies and to service the system. As a minimum, a valve shall be located immediately before entering the storage facility.

A second valve shall be required near the pump if the storage facility is not readily accessible for emergency operation, or if it is needed to service the pump without emptying the pipeline. All the valves shall be positive seating, guillotine valves, that can be operated by hand and are readily accessible for operation and service.

Pumps. Pumps installed for a manure transfer shall meet the requirements of NRCS Conservation Practice Standard 533, Pumping Plant. Pumps shall be sized to transfer manure at the required system head and volume. Type of pump shall be based on the consistency of the manure and the type of bedding used. Requirements for pump installation shall be based on manufacturer's recommendations.

Safety. The system design will include measures to protect the safety of humans and animals during construction and operation.

Open structures shall be provided with covers or barriers such as gates, fences, etc. Ventilation and warning signs shall be provided for manure transfer systems as necessary to warn of the danger of entry and to reduce the risk of explosion, poisoning, or asphyxiation.

Pipelines from enclosed buildings shall be provided with a water-sealed trap and vent or similar devices where necessary to control gas entry into buildings.

Barriers shall be placed on push-off ramps to prevent tractors or other equipment from slipping into waste collection, storage, or treatment facilities.

Odors. A transfer system pipe shall enter a storage facility at or near the bottom of the storage facility unless precluded by the site conditions. This will minimize the surface disturbance and allow a crust to form where possible to further minimize odors.

Biosecurity. Manure from diseased animals shall be handled in accordance with the recommendations of the state veterinarian.

Equipment leaving the farm shall be sanitized as appropriate to prevent the spread of disease.

Gravity Transfer Systems. The operation of a gravity transfer system depends on the consistency of the manure and the overall hydraulics of the system. Consistency is affected by the type of manure, bedding, or other materials, and the amount of water or other liquids present. Table 2 gives criteria for gravity systems.

Gravity systems should have a source of water or waste liquids available to flush the system if needed.

Systems for Dairy and Veal Operations. Wastes from lactating dairy herds are generally suitable for gravity pipeline systems. The amount and type of bedding used could affect the performance of the system. Bedding amounts up to 3 lb. per head, per day, of chopped hay or straw, sawdust, or newspapers can be used. Bedding amounts beyond this level could result in a consistency problem with the waste in the gravity transfer system. Long stem hay or straw

and frozen materials should be avoided. The addition of water could overcome these problems, provided it was added in a gutter chain or other mixing system prior to entering the gravity transfer system.

Unless special provisions are made, the use of ground rock or sand as bedding should be avoided with gravity transfer systems.

Systems for Swine Operations. There tends to be a solid separation with this type of waste. Therefore it is important that gravity systems transferring this type of waste maintain minimum grades to insure that solids and liquids do not separate within the system and are not allowed to accumulate at any point. This can be addressed with collection hoppers that act in support of flush systems, allowing all the wastes to transfer at one time. Also, the pipelines shall be kept at grades no steeper than 1% where the systems will be a continuous flow type. Outlets for such systems should be positioned so that solid accumulations within the storage or near the outlets do not block the pipe. As a minimum, it is recommended that there be at least two feet from the invert of the pipe to the bottom of the storage or other reception pits. Additional clearance may need to be added if more accumulations of solids may be expected.

Systems for Dairy Replacements and Beef. This type of manure does not generally lend itself for gravity pipe transfer systems because of the consistency of the manure itself and the lack of additional liquids. Systems can be planned and designed for use under certain conditions, such as freestalls during the summer months, where limited bedding will be used. Provisions for an alternate system must be planned for when freezing or drying conditions make the waste too solid to transfer in these systems.

Flush Systems. These systems accumulate the waste in a hopper or temporary storage structure at the head of the system. The waste is then transferred through a pipe at one time by opening a valve and releasing the wastes suddenly. These systems tend to move solids more efficiently, especially when the pipelines are on steeper grades.

They can be used to alter the consistency of some waste by adding solids and liquids separately and allowing them to mix naturally in the hopper or temporary storage. An agitator can be added to mechanically agitate the waste before it is transferred, if necessary.

Hoppers. Collection hoppers are needed at the head of all gravity pipe systems to collect and direct the waste into the pipelines. The hopper can consist of an existing storage or tank. Minimum volume of a hopper shall be 100 cubic feet or one-half day's accumulation of waste, whichever is less. The minimum depth of the hopper is (8) eight feet, unless the waste is of a liquid consistency and then the minimum depth should be (4) four feet. All hoppers should have a smooth finish on the inside. Fillets to reduce sharp corners and significant head losses at the pipe inlet are recommended. The bottom of the hopper shall be sloped to match the grade of the pipe exiting the hopper. All hoppers should have a safety grate or shroud to restrict access to the hopper.

A concrete curb which is a minimum of six inches high and five inches wide, or a wooden curb which is 12 inches (nominal) high, is required across from the loading side of the grate to insure total manure flow into the drop structure, when applicable. These curbs must be adequately anchored to the barn floor or the drop structure. Hoppers should be covered to minimize freezing and drying problems. A warning sign should be posted near hoppers and reception pits describing the hazards associated with the hopper and accumulated gases.

Gates. Gates can be installed on gravity transfer systems at the hoppers to convert them to flush type systems. These gates can be ball valves, guillotine slide gates, or globe valves that do not restrict the opening to the pipe when fully opened. The gate action should be smooth and relatively quick. Screw type valve operating mechanisms are not to be used for flush type systems.

Pipelines. All gravity pipes shall have smooth interiors; the pipelines shall be completely and uniformly bedded to one foot over the top of the pipe. The pipe diameters, lengths, and slopes shall be as shown in Table 2.

The diameter of the pipeline should be considered when determining the amount of time

the waste will travel within the system. Waste that enters the pipe should exit within 48 hours. Where sawdust and chopped paper are used for bedding, shorter periods should be considered to avoid the formation of a dry plug.

Wherever possible, milk house wastewater or another source of water should be added at the hopper or reception pit to facilitate manure flow. The transfer pipe should exit into a storage facility at the bottom or through the bottom for freezing protection, unless it is a hog or veal system or sand bedding, and then it should be off the bottom accordingly to allow for solid accumulations.

Vents. A vent should be considered in the gravity transfer system at a location beyond the entrances to the pipeline to alleviate air locking of the system. The minimum size of vents shall be one inch.

Hydraulics. The overall hydraulic components of the system include the working head, the losses due to entrances and friction head, and the size of the collection hoppers and pipelines.

The minimum head between the highest point where the system will be loaded at the top of the hopper and the maximum level of the waste in the storage shall be no less than the values in Table 2. All entrances to the pipes shall be made with a smooth, square edge. Vertical changes in direction in a pipeline should not be made in greater than 45° angles at any one time. All changes in vertical direction should be made with manufactured watertight fittings compatible with the type of pipe being used. Changes in horizontal direction should be made in drop structures or manholes.

Milking Center Wastes. Milking center wastes shall first be collected at the drain exiting the milkhouse, using a manhole or clean-out assembly. If the drains carry wastewater from a milking parlor, a settling tank with at least two days volume shall be provided if the pipe length will exceed 100 feet. The pipe shall enter a storage facility at a location which will be free draining. If outleted below the maximum fill elevations for a storage facility, provisions shall be made to protect the outlet from clogging and facilitate cleanings.

Slopes and Chutes. Slopes and chutes to transfer waste shall be 2:1 or steeper. The waste should be dropped on a slope a minimum of 5.0 feet. The waste should be confined in a channel as much as possible to maintain depth and velocity.

Gravity Unload Systems. Due to the potential hazards and management requirements, gravity unload systems are generally not recommended. They are permitted only with pipe diameters eight inches or less and where no bedding is in the storage. If a gravity system is used, it should have a minimum of two (2) independently operated valves which shall be manually operated. The valves must be commercially manufactured and guaranteed to be water tight at twice the maximum operating head. The area where the pipeline is to discharge shall be enclosed to impound a minimum volume equal to twice the size of the receiving system or spreader.

Direct Transfer Systems. These types of systems collect the waste and transfer it directly without temporary storage. These systems are generally furnished and installed by vendors servicing the industry for this type of handling equipment.

Ram Pumps. These systems may include a ram or plunger oscillating in a chamber. There is a hopper to direct the waste to the chamber. The system is power driven, usually with electric motors. The systems are available in various sizes and capacities. The plunger head and pipeline sizes are directly related to capacity. The systems are limited by working head and pipeline distance. A general working guide for these types of installations is shown on Table 3. All manufacturer's recommendations and limitations shall be followed in design and installation.

Elevators and Conveyors. These systems consist of a chain, belt, or auger operating in a chute or housing. The waste is usually dropped or moved directly into the system without a hopper or collection system. These systems may be used to extend present waste handling equipment to transfer the wastes to storage or another transfer system. Working height and distances are limited and exposure to freezing weather may affect their performance and

maintenance requirements. All manufacturer's recommendations and limitations shall be followed in design and installation.

Pump Transfer Systems. These types of systems utilize a temporary storage and pump to transfer the waste. The temporary storage collects and stores the wastes and serves as a pumping port or platform. Pumps are used to agitate and transfer the waste. These systems are limited by working head and pipeline distances, as well as available power sources.

A general working guide for these types of pump systems is shown in Table 3. All manufacturer's recommendations and limitations shall be followed in design and installation.

PTO Driven Pumps. These pumps are driven through the Power Take-Off (PTO) from another power source. Pumps may be mounted on the storage structure or portable. They may operate in a vertical or angled position. They are rated in horsepower and capacity for pumping.

Agitating takes additional power requirements and may be located separately. The minimum available horsepower should be 80 hp on the PTO. These pumps may be used for loading and unloading storage.

The discharge nozzles can be directed for agitating, loading, or transferring wastes to a pipeline.

Waste Water Pumps. These pumps are installed in the temporary storage tank and are powered with electric motors. The equipment must be compatible with the type of wastewater being transferred. Acids, detergent, manure, or other wastes may affect the performance and life span of these pumps. The manufacturer's recommendations will verify the environment and condition for which these pumps are applicable.

Sludge build-up in the reception pits could be a problem and should be eliminated as much as possible by agitating or routine maintenance. The temporary storage size is important to the performance of this type of system in that it dictates the cycle time of the pump.

Effluent type pumps with 3/4-inch solid capacity should only be used in conjunction with a dilute wastewater that has passed through a separate settling facility with a minimum of two days flow volume. If a separate settling facility is not provided, a sewage rated pump with at least 1 1/2-inch solids capacity should be used. A general working guide for these types of pump systems is shown in Table 3. The maximum cycle for these types of pumps shall not be more than one per 12-hour period.

Wastewater pumps shall be selected and specified based on discharge capacity, total head, and solids capacity. The pumps shall be equipped with float switches, an alarm, and be wired directly into a power circuit.

Reception Pits/Temporary Storage. These are temporary storage tanks to accommodate a pump transfer system. They must be sized according to the waste production and the capacity and working requirements of the pumps. Reception pits shall be sized to contain one full days manure production. Openings and access to these reception pits must be located and sized to accommodate the pumps and operational needs of the system. These storage facilities shall meet the requirement of Waste Storage Facility (313).

Sumps. Sumps may be needed in some pumping systems in order to completely empty reception pits or other storages. The sump is recessed below the floor to allow for waste to drain to a low point and for the pump assemblies to reach the floor elevations. The minimum manure sump size shall be 1.0 feet deep and 2.0 feet in diameter or square or as necessary to accommodate the pump.

Vacuum Systems. Some pump systems operate by collecting the waste on the vacuum side of a pump and then transferring it under pressure. These systems are limited to a suction head and should not be used when the bottom of the storage or collection point is more than 12 feet lower than the highest point in the system, before it reaches the pump. A general working guide for these pumps is shown in Table 3.

Safety. Warning signs, ladders, guard rails, shields, and other devices shall be provided, as appropriate, to insure the safety of humans and

livestock. Fences shall comply with Practice Standard 382, Fence.

Ventilation and warning signs must be provided for enclosed waste holding structures, as necessary, to prevent explosion, poisoning, or asphyxiation. No safety shields or devices supplied with equipment shall be removed or altered in any way.

Warning signs should be posted near hoppers and reception pits describing the hazards associated with the hopper and accumulated gases.

Waste Utilization. Manure shall be applied to the utilization area in amounts, uniformity, rates, and at a time consistent with the requirements of NRCS Conservation Practice Standard 590, Nutrient Management, or Standard 633, Waste Utilization.

Liquid or slurry manure shall be adequately agitated prior to transfer for the purpose of land application both on and off the farm.

Hauling Equipment. Equipment used for hauling manure from one geographical area to another area shall be capable of hauling the manure without spillage, leakage, or wind-blown losses during transport. Hauling equipment shall meet all applicable federal, state, and local laws regarding highway transportation.

Weight limits of roads used for hauling waste shall be followed.

SPECIFICATIONS

Plans and specifications for this practice shall be prepared in accordance with the previously listed criteria. Plans and specifications shall contain sufficient detail to ensure successful implementation of this practice. Documentation shall be in accordance with the section "Supporting Data and Documentation" in this standard.

OPERATION AND MAINTENANCE

An Operation and Maintenance (O&M) plan must be prepared and reviewed with the landowner or operator responsible for the application of this practice. The O&M Plan shall provide specific instructions for proper operation and maintenance of each component of this practice and shall detail the level of repairs needed to maintain the effectiveness and useful life of the practice.

The operation and maintenance plan shall describe what actions will be taken to minimize flies and other insects during the transfer of manure.

For the hauling of manure from one geographical area to another, recordkeeping by the producer or his/her designated representative will be required and may include such items as:

1. The type, nutrient content, and amount of manure transferred,
2. The solids percentage of the manure,
3. The date of the transfer,
4. The name and address of the source and destination of the manure, and
5. The condition of the manure as left at the destination (spread, stockpiled and covered, etc.).

SUPPORTING DATA FOR DOCUMENTATION

The following is a list of the minimum data and documentation to be recorded in the case file:

1. Location the practice on the conservation map.
2. Assistance notes. The notes shall include dates of site visits, name or initials of the person who made the visit, specifics as to alternatives discussed, decisions made, and by whom.

Field Data and Survey Notes

The following is a list of the minimum data needed:

1. Plan view sketch.
2. Site access.
3. Location of the collection point.
4. Location of the waste destination.
5. Profile of the existing conditions between the collection point and destination as appropriate.
6. Cross-sections as appropriate.
7. Number and type of animals served by the system as well as the type and volume of bedding.
8. Consistency of the waste.
9. Soil borings with depth to water table identified.
10. Topographic survey as needed for the location and elevation of the manure transfer system components and appurtenances.

Design Data

Record on appropriate engineering paper. For guidance on the preparation of engineering plans see Chapter 5 of the Engineering Field Handbook, Part 650. The following is a list of the minimum required design data:

1. Determine soil type and any special restrictions.
2. Determine runoff volume from the contributing drainage area for the required design storm in accordance with Chapter 2, EFH, Part 650, or by other approved method.
3. Size the manure transfer system components in accordance with the AWMFH, Part 651, or by other approved methods.
4. Show job class on the plan.
5. Include the Miss Utility notification statement.
6. Plan view sketch and final grading plan as required.
7. References to components supplied by others (pumps, etc.).
8. Maximum operating level (elevation) and pressures as appropriate.
9. Structural details of all components with dimensions and special requirements noted.
10. Special safety requirements.
11. Seeding, fertilizing, and mulching requirements.

Utilities Notification

1. Forms ENG-5 and ENG-6 can be used to assist in tracking utility notifications.
2. Document on CPA-6 initial discussion about his or her responsibility to notify Miss Utility.
3. Document on CPA-6 any information from the landowner about the existence and location of known utilities.
4. Document on CPA-6 assurances from the landowner that Miss Utility has been notified, including staking by the utilities.

Construction Check Data/As-Built Plans

Record on survey notepaper, NRCS-ENG-28, or other appropriate engineering paper. Survey data will be plotted in red on the as-built plans. Document approval by the designer of any changes from the drawings or specifications before implementation of the change.

The following is a list of minimum data needed for as-built documentation:

1. Documentation of site visits on CPA-6. The documentation shall include the date, who performed the inspection, specifics as to what was inspected, all alternatives discussed, and decisions made and by whom.

2. Check notes recorded during or after completion of construction showing dimensions and elevations of the components, as appropriate.

3. Statement on seeding and fencing.

4. Final quantities and documentation for quantity changes. Materials certifications as appropriate.

5. Sign and date check-notes and plans by someone with appropriate approval authority. Include statement that the practice was installed as designed, except as noted by redline changes, and meets or exceeds NRCS practice standards.

In addition, the as-built drawings shall include name of the installer, manufacturer, and date of completion of each transfer system and/or component. The as-built records shall also include any applicable "Statement of Conformance" presented or certified by suppliers of structures or equipment. The design folder, as-built drawings, certifications and specifications shall be filed in the case file.

TABLE 1 - MINIMUM PIPE QUALITY FOR VARIOUS SEPERATION DISTANCES TO WELLS, BEDROCK, AND GROUNDWATER

		Pipe Material	Minimum 3/ Pressure Rating (psi)	Applicable Specifications
GRAVITY FLOW SYSTEM		Plastic (PVC)	--	ASTM's: D3033; D3034; F679; F794
		Plastic (PE)	--	ASTM F894
		Steel	--	ASTM's: A53; A134; A135; or A139
PRESSURE FLOW SYSTEM				
Distance From:				
Well (ft)	**Bedrock or Ground Water (ft)**			
25-50	>0.5	PVC	200	ASTM D2241 or D1785
		All Other	200	1/
50-100	0.5 - 3	PVC	125	ASTM, D2241
		All Other		1/
	>3	PVC	80	430-DD 2/
		All Other		1/
>100	0.5 - 3	PVC	80	430-DD 2/
		All Other		1/
	>3	PVC	--	ASTM D3033 or D3034 (Max. SDR=35)
		All Other		Sewer Pipe 1/

1/ Applicable ASTM or AWWA standard for specific material.

2/ NRCS Practice Standard 430, Irrigation Water Conveyance, Pipeline, High-Pressure, Underground, Plastic (Ft.), National Handbook of Conservation Practices.

3/ Pressure ratings for pipe and joints must meet the listed pressure or 2 times the maximum operating pressure, whichever is less. For gravity systems, the pipe joints must meet the requirements of the applicable specification and the specifications referenced therein.

TABLE 2 - GRAVITY SYSTEMS

Type of Waste 1/	Minimum Head (ft) 2/	Minimum and Maximum Slope %	Maximum Length 3/	Minimum and Maximum Pipe Diameter
Dairy	5	1 - 15	200 (ft)	18 - 30 inches
Dairy, Gravity Gutter	1	1 - 20	200 (ft)	12 - 24 inches
Dairy Replacement And Beef	8	1 - 6	150 (ft)	24 - 30 inches
Veal	1	0.5 - 12	200 (ft)	6 - 24 inches
Swine	2	0.5 - 7	200 (ft)	6 - 24 inches
Milking Center Waste Water	1	0.5 - 10	500 (ft) 4/	4 - 6 inches

1/ Maximum amount of bedding is 2 to 3 pounds per day per head of chopped or short hay, straw, sawdust, or similar material.
2/ Head equals the elevation difference from the hopper inlet to the highest elevation waste is stored.
3/ Maximum length for continuous closed conduits.
4/ After settling tank for milking parlors. Maximum length from parlor to settling tank is 100 feet on a continuous grade.

TABLE 3 - PUMP SYSTEMS

Type of System	Maximum Working Head (ft)	Maximum Distance (ft)	Pipe Size
Ram Pump 1/	25	200	12 - 15 inches
Agitator Pumps 2/	50	400	4 - 6 inches
Waste Water Pumps 3/	50	800	1½ - 2 inches
Vacuum	30 4/	200	4 - 6 inches

1/ Mechanical or hydraulic driver plugger type pump.
2/ Centrifugal or vacuum type slurry pumps.
3/ Electric, submersible pumps.
4/ No more than 12 feet can be on the suction side of the pump.