§OH651.0606 Nutrient Removal by Harvesting of Crops

(b) Nutrient uptake example.

Table 6-6

Approximate Amounts of Plant Nutrients Removed in Harvested Crops

Crop	Nutrients Removed for Given Yield[a]			Nutrients Removed for Unit Yield[b]		
	N	**P_2O_5**	**K_2O**	**N**	**P_2O_5**	**K_2O**
	-------------lb/acre----------			----------------lb/bu or ton----------------		
Alfalfa (6 T)	340	80	360	56.6	13.3 lb/T	60 lb/T
Corn (150 Bu)						
Grain	135	55	40	.9	0.37 lb/bu	0.27 lb/bu
Stover	100	25	160	0.66		
Corn-Silage (26 T)	235	80	235	9.0	3.1 lb/T	9.0 lb/T
Grass-Cool Season (3.5 T)	140	45	175	40.0		
Tall Grasses and/or Forage Legumes (established)						
Oats (100 Bu)					13.0 lb/T	60.0 lb/T
Grain	65	25	20	0.65	0.25 lb/bu	0.20 lb/bu
Straw	35	15	100	0.35	0.15 lb/bu	1.0 lb/bu
Surghum-Grain (3.8 T)						
Grain	105	30	30	27.6	0.39 lb/100 lb	0.39 lb/100 lb
Stover	80	50	230	21.0		
Soybean (50 bu)	190	40	70	3.8	0.80 lb/bu	1.4 b/bu
Sugar Beets-Roots (25 T)	100	50	250	4.0	2.0 lb/T	10.0 lb/T
Tobacco-Burley and Cigar Filler						
Leaf (1.5 T)	105	25	185	70		
Stems and Suckers (1 T)	55	15	65	55		
Leaves and Stalks					1.3 lb/100 lb	8.3 lb/100 lb
Wheat (55 bu)						
Grain	70	35	20	1.27	0.64 lb/bu	0.36 lb/bu
Straw	30	5	50	54	0.09 lb/bu	0.91 lb/bu

[a] Source: National Plant Food Institute and others.

[b] Source: *Ohio Agronomy Guide*, 12th Edition.

[c] Inoculated legumes fix nitrogen from the air.

OH651.0606 (b) Nutrient uptake example.

Table 6-6

Recommended Annual Nitrogen Rates (lbs acre)

CROP	**CORN**		
YIELD GOAL	**120BU**	**150BU**	**180BU**
<u>Previous Crop</u>			
Forage Legume	60	110	150
Grass Crop	65	170	200
Soybeans	85	190	200
Con't Corn	115	200	200

CROP			
YIELD GOAL	**50BU**	**70BU**	**90BU**
Wheat (Spring Application)	40	75	110

CROP			
YIELD GOAL	**100BU**	**130BU**	**160BU**
Oats	60	90	125

CROP			
YIELD GOAL	**<3.5T**		**>3.5T**
<u>Forages</u>			
>35% Legume	0		0
20-35% Legume	75		125
<20% Legume	125		175

§OH651.0704 Site Investigations for Planning and Design

General Requirements

All sites for animal waste storage (AWS) facilities shall have a subsurface (geologic) exploration. A geologist or registered professional engineer competent to perform the work should explore sites having complex subsurface conditions or sites within a designated sole-source aquifer area, and when the vertical distance between the bottom of the structure or facility and an aquifer is less than 25 feet. The number of test pits in any exploration shall be adequate to determine the variety of soil types and conditions that could affect the location, design, and operation of the facility. It is important to prevent ground water contamination, and the subsurface findings may make it necessary to change the facility's location or method of handling animal waste to prevent this from happening.

Assistance for facilities on farms requires a thorough subsurface exploration by a competent individual, particularly those that require a permit from Ohio Environmental Protection Agency (OEPA) (Ohio Department of Agriculture (ODA) in the future). It is probable that the number of animal-units that require permitting will be lowered sometime in the future from 1,000 to a lower number. State standards must be followed for permitted jobs. It is recommended that farms that presently have less than 1,000 animal-units, but will surpass that number in the future, be explored as if they were already permitted. Subsurface exploration on permitted sites will require the taking of samples for laboratory testing. The exploration may also require the use of a soils-exploration type of drill rig to ensure that a 100 gpm aquifer does not lie within 25 feet below the bottom of the proposed AWS facility.

Planning for the Subsurface Exploration

Although soil surveys provide a general idea of shallow subsurface conditions at a site, they do not eliminate the need for a subsurface exploration because data in them is generally limited to depths of 5 feet. It is impossible to look at the surface of a flat or rolling field of glacial till and know what lies at depths of 8 or 10 feet below the surface.

The type of facility should be decided upon before starting the exploration. There is no difference in conducting an exploration for a holding pond or a lagoon, except that the former is generally smaller and requires fewer test pits. The location and approximate dimensions (including depth) of the facility will be needed.

Many counties have Ground-Water Pollution Potential reports published by ODNR, Division of Water. They contain DRASTIC maps, which indicate the relative potential for pollution of ground water. Areas of sand and gravel outwash are shown in yellow, orange, and red on the maps. Areas designated as sole-source aquifers (not shown on the maps) may require special designs for the facility. Ground water resource maps, published by ODNR, Division of Water, are available for each county.

OH651.0704

Subsurface Geology

Soil Types

Most Ohio soils are lean clay (CL). This type of soil is normally “impermeable” to water movement unless it contains cracks or sand lenses. (Even “impermeable” soils (and rock) are permeable over geologic time!) Compacted lean clay (CL) blankets will normally meet OEPA permeability requirements of 1 x 10^{-7} cm/sec. Lean clay (CL) provides good bearing strength and has lower landslide and shrink-swell potential than fat clay (CH), which is also impermeable. Sand and gravel soils are highly permeable and will produce leakage problems; manure-contaminated water will readily move through them. Silts (ML) are permeable, as are organic soils (OL/OH) and peat (PT).

Glacial Area

Soil deposited by the glaciers is known as till. Till above bedrock can vary from several tens of feet to 200 feet thick. Within the glaciated area where till is thick, a wide flat ground surface will not provide information about the types of soil and geological conditions that occur at depths of 8 or more feet. In areas close to the limits of the glacial advance, the till is thinner and a rolling ground surface may be due more to the uppermost eroded rock surface, than the thickness of the till.

Glacial till is generally lean clay (CL), containing some sand, gravel, cobbles, and boulders. It can be considered impermeable unless it contains lenses of sand and gravel or cracks. The cracks are geologically old and are evident at depths of 10 to 15 feet. They are frequently marked by the presence of brown iron staining in a gray matrix. The cracks normally die out with depth, frequently between 18 to 20 feet. With increasing depth, till normally changes in color from brown to gray (the so-called “blue clay”). The brown color is due to oxidation of iron within the soil. Till generally has a permeability of 1 x 10^{-7} cm/sec or less. Till below 15 feet of depth is preconsolidated in many areas, which means it was squeezed by the overlying weight of ½ to 1-mile thick glacial ice and made dense. Preconsolidation can reduce the soil’s permeability.

The thickest sand and gravel deposits are usually found in old buried valleys. These stream-cut valleys existed before the glacial epoch. When the glaciers retreated by melting, the sands and gravels were washed downstream out of the till and filled in the old valleys. Most outwash fills present-day valleys and frequently extends far beyond the limits of the glacial advance. Some of these outwash deposits are used as aquifers.

Sand and gravel deposits are generally deposited in and by water. They frequently contain perched ground water zones. The method of deposition of a sand and gravel deposit can suggest the location for test pits. It may be possible to move beyond the banks of sand and gravel deposited in a subglacial stream, by placing a pit to one side and thus delineate the banks of that stream. Some sand and gravel areas are long and thin because they were deposited in streambeds (alluvial deposit) under glacial ice. Streambed soils frequently contain rounded medium sands to coarse gravels. Test pits should be dug to delineate the areas beyond the banks of the stream. This will indicate where to place the animal waste facility to avoid the stream deposit. Sands deposited in lakes are fine to medium grained, horizontally layered, and are frequently interlayered with silts. This type of deposit can be widespread, extending over ¼ mile, making a site having this type of deposit unsuitable for an animal waste facility. Small sand or gravel lenses are frequently not a cause of concern; they can be removed and refilled during construction of the facility.

Organic soils are an indication of a basin that was once a post-glacial lake. Over geologic time, lakes become filled with plants and sediment. Lacustrine (lake) deposits are horizontally layered or laminated and permeable along the layering. Lacustrine deposits can consist of silt, clay, or alternating thin layers of silt and clay and frequently contain small snail shells.

Non-glacial Area

In the non-glaciated portion of the state, 3 to 5 feet of soil usually covers bedrock. Lean clay (CL) is the most common soil type. It may grade downward into weathered rock. The top of a very weathered shale can be difficult to distinguish from lean clay (CL).

Bedrock

Ohio is covered by horizontal sedimentary (layered) rock. There are four major types in the state: sandstone, shale, limestone, and coal. (Siltstone is very fine-grained sandstone. Dolomite (or "dolostone") is similar to limestone but has more magnesium content.) Other sedimentary rocks exist in Ohio but have limited distribution.

The depth to bedrock affects the facility's bottom elevation and design. The uppermost part of the bedrock is frequently weathered and fractured. Leakage out of an animal waste facility can easily occur through the uppermost layers of bedrock or along soil-rock contact. Leakage in karst (cave) areas, where the bedrock is limestone or dolomite, can be extremely high, dependent upon the thickness and type of covering soil. Unless it is cracked, shale is normally slightly permeable to water movement. Sandstone is normally very permeable; limestone or dolomite is also permeable. Of the four major types of bedrock, only shale may be relatively easy to excavate for several feet.

Ground Water

Water at shallow depths within the soil is normally flowing along a perched ground water zone. (Do not use the term "ground water table." This zone is not flat.) These are small local water zones that overlie an aquifer and are separated from the aquifer by an impermeable layer such as lean clay (CL) or shale. Water may be flowing along cracks within lean clay (CL). Water within sand or gravel lenses is usually flowing through the entire lens. Not all sand or gravel lenses contain water; they may be surrounded by lean clay (CL) and not be connected to an area feeding water to it.

Sand, gravel, or bedrock aquifers supply potable ground water. Some aquifers occur as glacial outwash that fills old buried valleys. These valleys take the shape of a tree with branches pointing upstream and the trunk downstream (like modern streams). Many Ohio cities such as Dayton get water supplies from these buried valleys. This type of aquifer can produce over 100 gpm. Some aquifers in bedrock can extend horizontally across wide areas.

The ODNR, Division of Water has posted water well logs on the internet. They indicate the depth to the aquifer and type of material comprising it, as well as the type of material overlying it. This type of information is needed on all facilities, particularly those that require an OEPA permit to operate. The bottom of the casing frequently lies at the top of the aquifer. The static water level is the height to which water under natural pressure will rise within the well. Water wells installed under the current State law must have casing that extends to a minimum depth of 25 feet.

All AWS facilities shall be located where they cannot contaminate a water well. A water well log will give an indication of the potential for aquifer contamination. The thicker the natural clay soil over the aquifer, the lower the chance of polluting the aquifer. All water wells should be located a minimum horizontal distance of 100 feet from the animal waste facility.

OH651.0704

The following table gives an approximate indication of the speed for pollution of an aquifer below an AWS facility. The numbers are based on laboratory tests made on lean clay (CL) glacial till soils in western and northwestern Ohio.

Downward Travel Time for Water to Move through Soil

Depth Of Pond Ft.	Thickness of Natural In-Place Soil Below Pond Ft.	Permeability of Soil cm/sec	Time through Soil Years
12	5	1×10^{-7}	4
"	15	"	24
"	50	"	119
"	100	"	282
15	5	"	4
"	15	"	22
"	50	"	113
12	5	1×10^{-8}	43
"	50	"	1,188

Note: The numbers are based on a dry unit weight of 115 pounds per cubic foot for soil (pre-consolidated soil). The number 1×10^{-7} cm/sec is the fastest rate allowed by OEPA and ODA for water movement through soil to prevent pollution on a permitted operation.

Test Pits or Borings

Equipment

Explorations shall be made using a backhoe or trackhoe; the use of hand augers is normally unacceptable. Good horizontal exposure of soil and rock types and conditions is obtained in test pits, but depth control (upper and lower contacts of soil and rock layers) can be difficult to determine. Subsurface explorations are occasionally made using a soil-probe truck (used by soil scientists) or a soil-exploration type of drill rig, which can drill deeper. Soil-exploration drill rigs employ a steel tube that is driven into the ground to recover samples and an auger to clean out and advance the hole. (Water-well drill rigs are undesirable for subsurface exploration, because their use of water to advance the hole.) Soil samples obtained through the use of drill rigs allow for good depth control, but there is limited horizontal exposure of subsurface layers.

Placement of Test Pits

Test pits should be dug at the perimeter of the facility in soil that will be outside the excavation, not at the inside toe of the sideslopes. Leakage of manure-contaminated water can only move through soil outside of the facility. It may be useful to know the type of soil that will be excavated if it is to be used as a building foundation, but this material will not affect leakage since it will be removed during construction.

Number and Depths of Test Pits

The number of test pits is always based on the size of the facility, variety of soil types, and complexity of subsurface conditions. The exact number of pits is determined during the exploration. It is recommended that a minimum of 4 test pits be made at the corners of a 200 by 200 foot square (40,000 square foot), or smaller facility. Larger facilities, such as 400 x 600 feet or even 500 x 600 feet lagoons could be adequately covered by 10 test pits (8 pits around the perimeter and 2 others in the middle), providing soils are primarily clay, the subsurface geology is simple, and the probability of leakage is extremely low.

The proposed design of the bottom elevation (depth below the original ground surface) should be estimated before the time of exploration, and test pits should extend a minimum of 5 feet below it. Test pits on regulated facilities should extend a minimum of 5 feet below the bottom of the pond or lagoon. Test pits should extend a minimum of 5 feet below all permeable layers (sand or gravel), or until the observed geological problem conditions make it necessary to relocate the facility. In some cases, a geological problem condition may be overcome by a special design and construction. Geological conditions at a site may be so poor that an 8 foot deep test pit can indicate the difficulty or impossibility of installing an AWS pond or lagoon. The bottom depth of a test pit may also be controlled by refusal (inability to dig deeper within a hard layer).

Test pits to locate borrow for blanketing will normally be spaced at distances of 200 feet between pits; the spacing again being dependent upon what is found during the exploration. The bottom depths of these pits should be approximately 2 feet below the lowest elevations of the borrow area.

Logging

The best logging can produce enough information to correlate (connect) soil layers from one test pit to another. This allows the prediction of subsurface conditions between pits and delineates the approximate horizontal and vertical limits of a particular layer. It is useful to locate the approximate edge of subsurface deposits, particularly those that are highly permeable.

Soils

Soils should be identified and logged, using the Unified Soil Classification System and recorded on form OH-ENG-138. Sample descriptions of soils are found on the back of this form. Soil colors will normally not affect the engineering characteristics of the soil. The presence of cracks frequently marked by brown iron staining shall be recorded. RECORD ALL IMPORTANT FINDINGS. It may be useful to record what would be expected but not found.

Groundwater

Record the depth to water, as well as the strength of flow. It may be possible to estimate the rate of inflow, such as ½ or 5 gallons per minute. The strength of flow affects: 1) the design bottom elevation of the facility, 2) whether it is economically feasible to stop any inflow into the site (by a core trench or pumped subsurface drain), or 3) whether over-excavation and blanketing (or some other method of preventing leakage) will be needed. It may be useful to record the lack of water or direction of water flow. Water moving upwards into the pit bottom may be an indication that water at a greater depth is under hydrostatic pressure. This is an indication that the exploration pit should be made deeper.

Bedrock
The type of and depth to bedrock shall be recorded. The depth affects the facility's bottom elevation and its design. Record the ease of bedrock excavation. Shale that is weathered and soft should be given a dual logging classification, i.e., "shale, clay-like (CL)."

Sampling and Testing

Sampling
Soil samples are obtained as test pits are dug or from adjoining pits after the first ones are dug and logged. HAZARD RECOGNITION: ANY ENTRANCE INTO A PIT FOR THE PURPOSE OF SAMPLING, SHOULD COMPLY WITH ALL SAFETY REGULATIONS. DO NOT ENTER ANY PIT WITH UNSTABLE WALLS OR ONE DEEPER THAN 5 FEET WITH WALLS UNSUPPORTED BY A PROPERLY DESIGNED TRENCH SHIELD. IN THE ABSENCE OF A TRENCH SHIELD, PITS THAT ARE ENTERED SHOULD BE MADE WIDER THAN SINGLE BUCKET WIDTH AND HAVE SEVERAL BENCHES, OR THE WALLS SHOULD BE SLOPED TO 1 ½:1 OR FLATTER. DO NOT ENTER ANY DEEP PIT IN UNSTABLE SOILS EVEN IF THE WALLS ARE BENCHED OR SLOPED BACK. ALL PITS DEEPER THAN 4 FEET SHOULD HAVE A SUITABLE WAY TO EXIT QUICKLY SHOULD IT PROVE NECESSARY. Excavations, OSHA Publication 2226, 1995 (Revised) contains additional information on the subject.

Soil samples are small representations of materials encountered; for example, a lean clay (CL) layer may extend from 5 to 11 feet of depth, but the sample may be taken from 7 to 9 feet of depth. All layers less than ½ foot thick are difficult to sample and are normally not sampled, unless their properties are important or the layer will greatly affect the operation of the facility. It is better to take too many samples and discard some after the exploration is finished than to take too few samples. Soil samples consist of two types: 1) Undisturbed samples represent the subsurface material as it exists *in situ* (in place). Undisturbed samples are normally taken by driving a 4-inch diameter steel cylinder into the soil using specialized equipment. 2) Disturbed samples are taken by shovel from material piled on the ground surface during the excavation or from the walls of a pit. Disturbed samples may also be taken off an auger.

The size of the sample is dependent upon the type of soil (particle size) and type of laboratory test to be run. Soils having large particles require large samples. Classification tests on lean clay (CL) can be run on quart-size samples; those on sands require samples of 2 quarts; those on gravels should be 1 gallon for smaller gravel sizes, up to 5 gallons for largest sizes. Compaction and permeability tests for blanketing material require samples of 3 to 5 gallons. It is better to send too large a sample for testing to a lab than one too small; let the lab discard what it doesn't need. Instructions for testing should be given to a laboratory; particularly, if samples from two or more locations are to be combined for testing as in testing the compaction and permeability of a soil blanket.

AWS facilities will frequently need a clay blanket in areas where there is a high ground water pollution potential. The blankets must have a maximum permeability rate of 1×10^{-7} cm/sec (0.1 ft/yr). Data to design a soil blanket will be obtained after testing soil samples. A synthetic blanket may be used instead of a soil blanket, but these are more expensive and require other design considerations.

Testing

Soil samples are tested in a laboratory. Some samples may be combined there prior to testing.

The most important tests are permeability and dry unit weight tests run on undisturbed samples. The former test indicates whether a blanket is needed, and the latter determines the density of the soil. Test results enter into calculations that estimate the time for an aquifer below an AWS site to be polluted. Classification tests (Atterberg Limits and particle size analysis) can also be run. Proposed material for blanketing is tested by: 1) running a standard compaction test to determine the maximum density and optimum moisture (plotting a "Proctor" curve), 2) recompacting the soil, usually at 90% of maximum density, and 3) testing the permeability of the recompacted soil. These tests will determine if soil compaction alone will produce an acceptable impermeable soil blanket or whether additives (such as a polyphosphate or bentonite) are needed to reduce the soil permeability to a desired level.

The NRCS National Soil Mechanics Laboratory in Lincoln, Nebraska, can perform all testing but there is usually a six-month waiting time before testing is finished. Private labs can perform the tests in a much shorter period but their charges can be $600 per site for undisturbed samples. The testing of one soil sample for blanketing may be adequate for storage ponds, but tests on two or more samples may be needed for lagoons. Testing costs for blanketing can be $500 to $1,000.

Notes for the Sampling Section: (1) The term of 1 x 10^7 cm/ sec for permeability appears to be a velocity (distance/time) for water moving through soil. It is really a reduction of the term, $cm^3/cm^2/sec$, which measures a volume of water moving through a wall area within a particular amount of time. In a similar way, the English equivalent of ft/yr is really its reduction to customary English units.

(2) Although amounts of soil needed for testing is normally given in pounds, it is easier to visualize the amount needed in liquid quantities, such as the amount of material that will fill a 1 quart container or 5 gallon plastic bucket.

Surveying and Facility Design

The locations of all test pits should be surveyed shortly after the subsurface work is completed. These locations shall be plotted on the engineering plans, and the logs of test pits shall be plotted on the appropriate plan cross-sections and profiles.

§OH651.1004 Treatment

The following are K values to be used for Anaerobic lagoon design in Ohio.

A-1 FINDLAY

County	Kvalue
Allen	0.56
Auglaize	0.57
Crawford	0.56
Defiance	0.55
Fulton	0.54
Hancock	0.56
Hardin	0.57
Henry	0.54
Lucas	0.54
Marion	0.57
Morrow	0.57
Ottawa	0.54
Paulding	0.55
Putnam	0.56
Sandusky	0.54
Seneca	0.55
Van Wert	0.56
Williams	0.54
Wood	0.54
Wyandot	0.56

A-2 MEDINA

County	Kvalue
Ashland	0.56
Ashtabula	0.54
Columbiana	0.57
Cuyahoga	0.54
Erie	0.54
Geauga	0.54
Huron	0.55
Lake	0.53
Lorain	0.54
Mahoning	0.56
Medina	0.55
Portage	0.55
Richland	0.56
Stark	0.56
Summit	0.55
Trumbull	0.55
Wayne	0.56

A-3 ZANESVILLE

County	Kvalue
Belmont	0.56
Carroll	0.57
Coshocton	0.58
Guernsey	..0.59
Harrison	0.58
Holmes	0.57
Jefferson	0.58
Knox	0.58
Licking	0.59
Monroe	0.60
Morgan	0.61
Muskingum	0.59
Noble	0.60
Perry	0.60
Tuscarawas	0.57
Washington	0.61

A-4 ENGLEWOOD

County	Kvalue
Butler	0.61
Champaign	0.59
Clark	0.59
Clermont	0.63
Clinton	0.61
Darke	0.59
Fayette	0.61
Greene	0.60
Hamilton	0.62
Logan	0.58
Madison	0.59
Mercer	0.57
Miami	0.59
Montgomery	0.60
Preble	0.60
Shelby	0.58
Union	0.58
Warren	0.61

A-5 CHILLICOTHE

County	Kvalue
Adams	0.64
Athens	0.62
Brown	0.64
Delaware	0.58
Fairfield	0.60
Franklin	0.59
Gallia	0.64
Highland	0.62
Hocking	0.61
Jackson	0.63
Lawrence	0.75
Meigs	0.63
Pickaway	0.60
Pike	0.63
Ross	0.62
Scioto	0.64
Vinton	0.62

OH651.1004 (a)

Anaerobic Lagoon/Settling Basin (ALSB)

This is a system designed to settle volatile and fixed solids in an earthen settling basin with an overflow to a single stage anaerobic lagoon. The settling basin is designed to contain the manure volume produced between cleanouts, usually 365 days. The anaerobic lagoon volume is designed on the volatile and total solids loading from the settling basin overflow. The system will typically be designed for an operator who wants to utilize the nutrient value of the manure and have recycled water available for flushing. Advantages over a holding pond or lagoon as a single practice include: 1) concentrated nutrients for utilization available in the settling basin, 2) reduced anaerobic lagoon size due to the reduction of total and volatile solids retained in the settling basin, 3) high quality flushwater water is available. Disadvantages include: 1) land availability to spread nutrients are similar to a holding pond, 2) knowledge of irrigation equipment, 3) this system would not be an option in an odor sensitive area, unless measures are taken to prevent odors, i.e. settling basin covers and/or knifing in manure, and 4) management skills include those necessary for both a waste storage pond and an anaerobic lagoon.

Inventory and Evaluation

Inventory and evaluate the site as you would a waste storage pond. If odor is a concern and you would not recommend a waste storage pond, the ALSB is not an option either. Criteria to take into consideration performing an I&E includes but is not limited to: a) number and type of animals and housing arrangement; b) distance and direction to neighbors, residences, and/or businesses; c) prevailing and seasonal wind direction; d) visibility; 3) location of trees and shrubbery; f) management skills and experience of the operator; g) topography; h) aesthetics; i) local concerns; j) local weather conditions; k) acreage; field location, and crops available for nutrient uptake; l) slopes, drainage, surrounding ponds, lakes, streams, and wells.

(1) Design.

The following volumes should be included for the settling basin and lagoon.

a. Earthen Settling Basin.

1. Manure volume produced between cleanout interval, usually 365 days.
2. 1.5 feet of freeboard above the invert of the high point overflow elevation (see sketch).
3. Except for the rainfall volume requirements, the earthen settling basin shall follow the requirements as for the WASTE STORAGE POND Standard, Code 425.

b. Single Stage Anaerobic Lagoon.

1. Refer to the WASTE TREATMENT LAGOON (ANAEROBIC) standard, Code 359A. The volume design shall be the same as for the second stage of the two-stage lagoon design in standard 359A plus the required sludge volume. All other requirements for the lagoon shall be as listed in standard 359A.

2. Unless specific data is available, lagoon loading of volatile and total solids produced by the animal may be reduced 80% and 70% respectively, to determine the respective treatment (MTV) and sludge (SV) volumes. *These reductions are based on manure tests taken 24 to 30 inches below the surface of existing swine manure holding ponds. Consult the State Environmental Engineer for animals other than swine.*

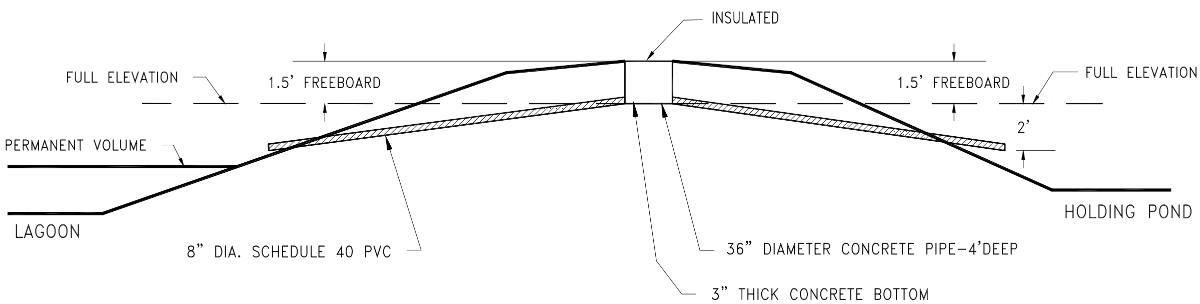
OH10-34 (2)

c. Overflow Pipe.

1. The inlet of the overflow pipe into the lagoon shall be 24 to 30 inches below the settling basin pool elevation.

2. At the top of the embankment, it is recommended to "break" the overflow pipe with a manhole. This is usually a 36 to 48 inch, 3 to 4 foot section of concrete pipe. This pipe also needs to have sufficient cover or insulation to prevent freezing.

3. The outlet into the lagoon should be located at or above the elevation associated with the MTV plus the SV.



TYPICAL SECTION OF TRANSFER PIPE
FOR SWINE FACILITY

Note: The minimum freeboard requirement for lagoons and holding ponds is 1.0 foot. In this example, 1.5 feet of freeboard is shown to maintain cover over the transfer pipe. This cover can be provided by mounding soil over the pipe.

d. Operation and Maintenance.

1. Typical annual operation schedule:

September – Finish construction, precharge settling basin (SB) with fresh water or lagoon effluent to the overflow pipe and the anaerobic lagoon (AL) with the volume required for minimum treatment prior to loading.

October – Begin loading the SB.

November through September – Continue loading the SB.

June through September – Irrigate excess annual inputs from the lagoon not to be used to recharge the SB. This volume will vary due to rainfall.

October or November – Agitate the SB and land apply manure. Recharge the SB with fresh water and lagoon effluent. Continue loading.

2. The settling basin shall be precharged with fresh water or lagoon effluent after each clean out and prior to loading; the clean out interval is usually 6 months or 1 year. The settling basin will have a permanent pool, except during cleanout.

3. The anaerobic lagoon shall be precharged with the minimum treatment volume prior to loading. The lagoon shall never be drawn down below the volume required for minimum treatment and sludge unless total cleanout is required. Annual inputs to the lagoon shall be used to recharge the settling basin and irrigate during the summer months.

OH651.1004 (a)

e. Design Considerations.

1. To assist recharge of the settling basin, if possible, install a separate valved gravity drain from the lagoon to the SB to reduce pumping time and power requirements for recharging. The intake from the lagoon should be placed above the volume required for the minimum treatment plus sludge volume.

2. Flush water intake in the lagoon should be located above the MTV plus SV and have a sufficient volume of water available so flush water is available during dewatering. If possible, the return line from the lagoon could be valved for pumping either to the settling basin, into the buildings for flushwater, or land application.

3. Drawdown indicators in the lagoon are critical to maintaining appropriate water levels. As a minimum, the indicator post should be "ruled" to show the following levels:

- Maximum Drawdown (SV plus MTV retained).
- Settling Basin Recharge Volume.
- Full Elevation.

Design Example

Animals	**Number**	**Average Weight (#)**	***** MV/Day (Ft^3/1000#AW)**	**Mv/Day (FT^3)**	***** VS/Day (#/1000#AW)**	**VS/Day (#)**	***** TS/Day (#/1000#AW)**	**TS/Day (#)**
Lactating Sows	288	425	0.96	118	5.4	661	6	734
Gestating Sows	2,070	400	0.44	364	2.13	1,764	2.5	2,070
Boars	64	450	0.33	10	1.7	49	1.9	55
Replacement Guilts	64	300	0.53	10	2.92	56	3.28	63
Nursing Pigs	2,880	8	1.7	39	8.8	203	10.6	244
			Daily Totals	**541**		**2,732**		**3,166**

Legend:
AW – Animal Weight
MV – Manure Volume
VS – Volatile Solids
TS – Total Solids
*** -- Values taken from Table 4-11 of Ag. Waste Mgmt. Field Handbook

Design Values:
Settling Basin storage period = 365 days
Annual Rainfall – Annual Evaporation = 9.3"
25 yr. 24 hr. storm = 4.2" (Delaware County, Ohio)
Annual Manure Volume -= 541 x 365 = 197,465 ft^3
Daily Total Solids Produced – 3,166 lbs./day
Daily Volatile Solids Produced = 2,732 lbs./day
Lagoon activity ratio (K) = 0.58 (Delaware County, Ohio)

OH10-34 (4)

DESIGN

Settling Basin Volume = Annual manure volume = 197,465 ft^3 + 1.5 ft. freeboard. The overflow elevation shall be set at the elevation corresponding to the 197,465 ft^3. volume.

Lagoon Volume

Use 80% reduction is VS and 70% reduction is TS.
VS Loading = (0.2) x (2732) = 546 lbs/day.
TS Loading = (0.3) x (3166) = 950 lbs/day.
MTV = 546 lbs/day / (0.0062 lbs/ft^3-d x 0.58) = 151,835 ft^3.
SV – 950 lbs/d x 365 d x 10 yrs x 0.0485 ft^3/lb = 168,174 ft^3.
7 year min. sludge storage design period (10 year reasonable max. and used in this example).

Annual Inputs

RF – Evap (SB) – (SB surface area) x (9.3/12)
RF – Evap (AL) – (AL surface area) x (9.3/12)
25 yr. storm (SB) – (SB surface area) x (4.2/12)
Manure Volume – 197,465 ft^3.
Waste Water = Unless information is available, use 25% of the manure volume (this is estimated by experience only for 365 days storage).

Total Lagoon Volume = 320,009 ft^3 + Annual Inputs.