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COWLEY COUNTY
WASTEWATER LAGOON INSTALLATION & USE

INTRODUCTION

A septic tank followed by an in-ground soil absorption system is the preferred on-site wastewater treatment system when site and soil conditions are suitable. However, when the soil is too impermeable for an in-ground system and adequate area exists, a lagoon may be an option. Soils with high clay; poor drainage; seasonal perched water table; or platy, very weak, or massive structure are typically poorly suited to soil absorption but often well suited to lagoons.

A properly designed, constructed, and maintained lagoon will treat wastewater, protect human health and the environment, and can be inconspicuous. It is important to remember, however, that a wastewater lagoon treats raw sewage. Raw sewage is a health hazard. The lagoon must be properly maintained in order to function as it should and protect human health & the fresh waters of the state. This document addresses all aspects of construction, operation, and maintenance of a lagoon. It should be diligently followed.

This document has been prepared to provide guidelines for the design, construction, operation, maintenance, and repair of small (less than 2,500 gallons per day) non-discharging wastewater lagoons. Guidelines in this chapter are intended primarily for private wastewater facilities for individual homes.

How Treatment Occurs in a Wastewater Lagoon

Lagoons support physical, biological, and chemical processes that result in treatment of wastewater. Natural conditions in a properly operating lagoon result in three layers: aerobic on top, anaerobic on the bottom, and an intermediate or mixed layer. Treatment and conditions are different in each of the three layers. Wind on the surface of the lagoon is important to introduce oxygen into the water, supporting aerobic bacteria in the top layer. Sunlight supports algae growth in this layer. Algae produce oxygen through photosynthesis, supporting the aerobic bacteria. The bacteria release carbon dioxide used by the algae. To ensure wind and sun exposure to the lagoon, trees and shrubs must be sufficiently distant so as not to shade the lagoon or inhibit wind contact.

When functioning stably, this symbiotic relationship results in a bright green color at certain times of the year. When wastes are broken down, some gases are released into the air and small amounts of solids settle to the bottom. In a properly constructed and managed lagoon, household wastewater can be treated for up to 30 years and solids will not likely build up to the point they need to be removed. It is essential to maintain the lagoon in a properly functioning state. The ***Use and Maintenance*** portion of this document summarizes ongoing, required maintenance.

City-Cowley County Health Department Responsibilities and Jurisdiction

Legal Authority is granted to the Board of County Commissioners by K.S.A. 19-301 through 19-3708 as amended. All requirements are detailed in the "Cowley Sanitary Code" effective March 21, 2006, and approved by KDHE October 23, 2009. Wastewater stabilization ponds are specifically detailed in Section 2-6 of the Code.

WASTEWATER LAGOON SITE PLANNING

Site Considerations

Due to space requirements and access for maintenance and repair, many factors must be considered in deciding on a lagoon for sewage treatment. These factors include the following:

1) **Adequate space** – the footprint area required by a lagoon may be 10,000 square feet or more, for an individual home. In additional to the initial lagoon location, planning for a replacement must also be considered.
2) **Separation and setback** – distances from property lines, wells, surface water and drainage, easements, buildings, and flood plain are determined by local code and state minimum standards. Contact the Health Department Environmental Health Officer for minimum required and recommended setback requirements. All buried gas, electrical, or other utility lines must be located prior to excavation.
3) **Separation of tall vegetation** – the site should have adequate separation distances from trees and other vegetation that could impair functioning, especially shading, air-flow restriction, and leaf drop.
4) **Ease of maintenance** – routine care of berms, fences, and vegetation is required on a regular schedule.
5) **Site conditions** – slope of land and restrictive soil conditions within 5 feet of the ground surface. A high-water table or a saturated zone near ground surface may prohibit a lagoon.
6) **Adequate area** – a minimum lot size of 5 acres is needed to accommodate a private well and lagoon with all required setback and/or appropriate separation distances.
7) For more specific information, see the ***Installation and Construction*** section of this document.

Site Evaluation

Conducting a proper site evaluation for a lagoon includes the following specific steps:

1) The City Cowley County Health Department environmental program is the local agency responsible for permitting. Contact the health department and complete the application to construct a wastewater system to begin the process.
2) A preliminary site evaluation will be performed to select the most suitable location. Note all conditions that could adversely affect location and construction, such as private or public water wells or pipelines, sandy or rocky soil, utilities, easements, property lines, topography, and geology. Utilize all available site-specific information such as site history, soil profiles, and county soil survey book available from the local USDA NRCS office or the NRCS Web Soil Survey.
3) Evaluate potential effects of unexpected overflow or release, and resultant contamination to surrounding property and environment.
4) Based on a soil profile evaluation, obtain the estimated design loading rate (DLR). Textures and structures with no suitable DLR are frequently acceptable for a wastewater lagoon with adequate compaction.
5) Compare results with permeability of the soil on the site in the SCS/NRCS county soil survey to see if general agreement exists. Large discrepancies in results should be reconciled by further testing, done by someone experienced with soil texture, structure, and permeability.

A lagoon location downslope and downwind from the source is preferred so sewage will flow by gravity at the correct slope. The site should be downwind of the residence or facility to minimize possible nuisance conditions such as odor, in Kansas usually to the east or northeast. Only rarely do objectionable odors occur from a properly operated and maintained lagoon. However, odors may be noticed for a brief period in the spring or fall when a stratified lagoon turns over or when there are several consecutive overcast days.

Separation distances from surface water, wells, property lines, and public water lines must be in compliance with local codes and/or KDHE Bulletin 4-2.

A detailed site plan showing all physical features, surface and buried, and contour elevations will be a great help to locate and design a wastewater lagoon. The bottom of the lagoon should be at least 4 feet above the highest groundwater level or other limiting conditions.

To ensure adequate drainage and to avoid the risk of a backup in the residence or facility, the top of a lagoon berm should be below the lowest drain or cleanout in the house.

Sometimes the lagoon must be located upgrade from the house, which necessitates a pump tank and pump. Pumps are subject to failure, require an energy source and maintenance, and will increase costs. When pumping is required, it is advisable to add a septic tank and use an effluent pump. To ensure good hydraulic operation, use a high-quality sewage or grinder pump and have the system designed by an experienced person. Adherence to hydraulic principals including pump selection and backflow prevention from the lagoon are essential.

The findings of site investigation and pertinent preliminary information should be reviewed with both parties. An original, and at least two additional sets of construction plans and specifications should be prepared. The contractor and homeowner should receive the copies and the original should be retained in the office permit files.

Applicants need to be informed that single-family wastewater lagoons are to be constructed, operated, and maintained according to county or city/county requirements. Failure to do so can result in a declaration of a public health nuisance by the local board of health (KSA 65-159) and prosecution by the county attorney (KSA 65-160).

Additionally, applicants should be informed that if a central collection system becomes available, within 400 feet of the property, connection to the central collection system may be required as defined by county code. If connection occurs, proper abandonment of the wastewater lagoon must occur.

When the site evaluation indicates a lagoon is the most appropriate and acceptable option, sizing, design, specifications, and construction plans are the next step.

Sizing the Wastewater Lagoon

The primary objective of sizing the lagoon is to provide adequate depth & wastewater treatment and to prevent overflow. Optimum lagoon water depth is 5 feet measured from the bottom of the lagoon to the water surface. Satisfactory operation occurs with water depths of 3 to 5 feet. Water levels may drop as low as 2½ feet for short periods without adversely affecting the lagoon's operation. However, sunlight may penetrate a shallower depth and plant growth across the lagoon bottom with depths less than 2½ feet will impair a lagoon's operation.

Estimating wastewater retention in a lagoon is achieved by identifying the amount of wastewater flow minus net water loss. Water loss occurs through evaporation and seepage. Evaporation plus seepage can range up to 14 feet in annual loss in Southwestern Kansas, to 10 feet or less in Eastern Kansas. Seepage varies with the soil and compaction from very low to the maximum allowable of 0.25 inches per day (few inches to 7.6 feet per year). Preferably, seepage should be no more than 1/8-inch per day. Precipitation and evaporation data are collected only at certain sites across the state and have been extrapolated to include areas where data were not available.

Wastewater flow for sizing a lagoon is based on average flow rather than peak flow, which is used for sizing an in-ground wastewater system. Lagoons easily handle temporary high flows with a rise in water level, which results in an increase in losses. Conversely, in-ground systems must be able to handle these peak flows to avoid malfunction or failure.

Actual water records, when available, are a preferable source of determining expected average flow. Factors to consider when estimating wastewater flow to size of lagoon follow:

1) Wastewater design flows are based on average number of persons expected to reside in the house. This is certainly less than full occupancy of two persons per number of bedrooms. Use a wastewater flow rate of typically 40 to 50 gallons per person per day. Use two- to five-person average occupancy for a three-bedroom house with corresponding flows of 100 to 250 gpd.
2) Assess lifestyle factors for a deviation above or below the average wastewater flow. Low wastewater flow may result in lower average water depths, which allow rooted vegetation, rodent and disease-transmitting insect habitats, poor operation, and excessive odor. For example, a couple living in a four-bedroom home might better utilize a lagoon dug deeper to a smaller base, requiring less water to maintain adequate depth. The deep part of the lagoon would be sized for a home with two occupants. The overall size would be adequate for eight occupants.
3) Additional water may need to be added, especially during dry periods. Ways to do this are from roof guttering and downspouts, sump pump that includes or diverts drainage, or the household water supply, especially from a private well. Construct all such diversions so they are easily disconnected during periods of excess rainfall because they may add too much water to the pond.
4) Avoid discharging large doses of chemicals to a lagoon to protect its chemical balance. Large doses of disinfectants from water well disinfection, swimming pools, or hot tubs, among other chemicals, can upset the lagoon's biological balance.

Table 1. Recommended sizes for square and round wastewater lagoons

Table 1 lists guidelines for three household sizes in South Central Kansas. Experience and advice from agencies and contractors will help determine the most suitable size. **Table 1** shows the side length for square lagoons and diameter for round lagoons. Other shapes may be used but length should not exceed twice the width.

	Square-side length ft[a]	Round diameter ft[a]	Surface area square ft[a]	Volume 100s gal[a]	Minimum flow per month[b]
Small	35	40	1225	18	4
Medium	40	45	1600	26	5.5
Large	45	51	2025	32	7

These sizings are based on an assumed ¼ in/day seepage loss.
***Small** = 3 or less people; **Medium** = 3-5 people; **Large** = 6 or more;*
[a] contents at 5-ft depth; [b] minimum flow (1,000 gallons/month) to maintain a 3-ft depth

All city and county code requirements shall be met prior to construction. Construction of a wastewater lagoon may be considered if soil properties at the bottom of the lagoon are satisfactory as indicated by slow percolation rates, minimal porosity, and fine soil texture. Soil profiles can be used to determine texture giving percentages of sand, silt, and clay. A soil profile evaluation is required because permeability rates obtained from a perc test vary in accuracy depending on soil moisture content at the time of testing.

Separation distance requirements: *These measurements are from the inside of the berm at the 5- foot operational water level as measured vertically from the bottom of the lagoon.*

1) A minimum of 50 feet (200 ft recommended) from property boundaries. Sometimes adjacent property owners are willing to agree to a legal easement in which a wastewater lagoon may be constructed closer. An adjacent property owner needs to be made aware that construction of a private water well requires a 50-foot distance from a wastewater lagoon. If a legal easement is obtained, a wastewater lagoon may be constructed closer than 50 feet from adjacent property. Legal easements must be filed with the register of deeds to protect the interests of all present or future parties.
2) Public roadways (total right-of-way) may be considered part of the separation distance; however, no part of a wastewater lagoon may be placed on a public access or utility easement.
3) Any potable public water supply or suction line must be 100 feet from the lagoon's operational water level.

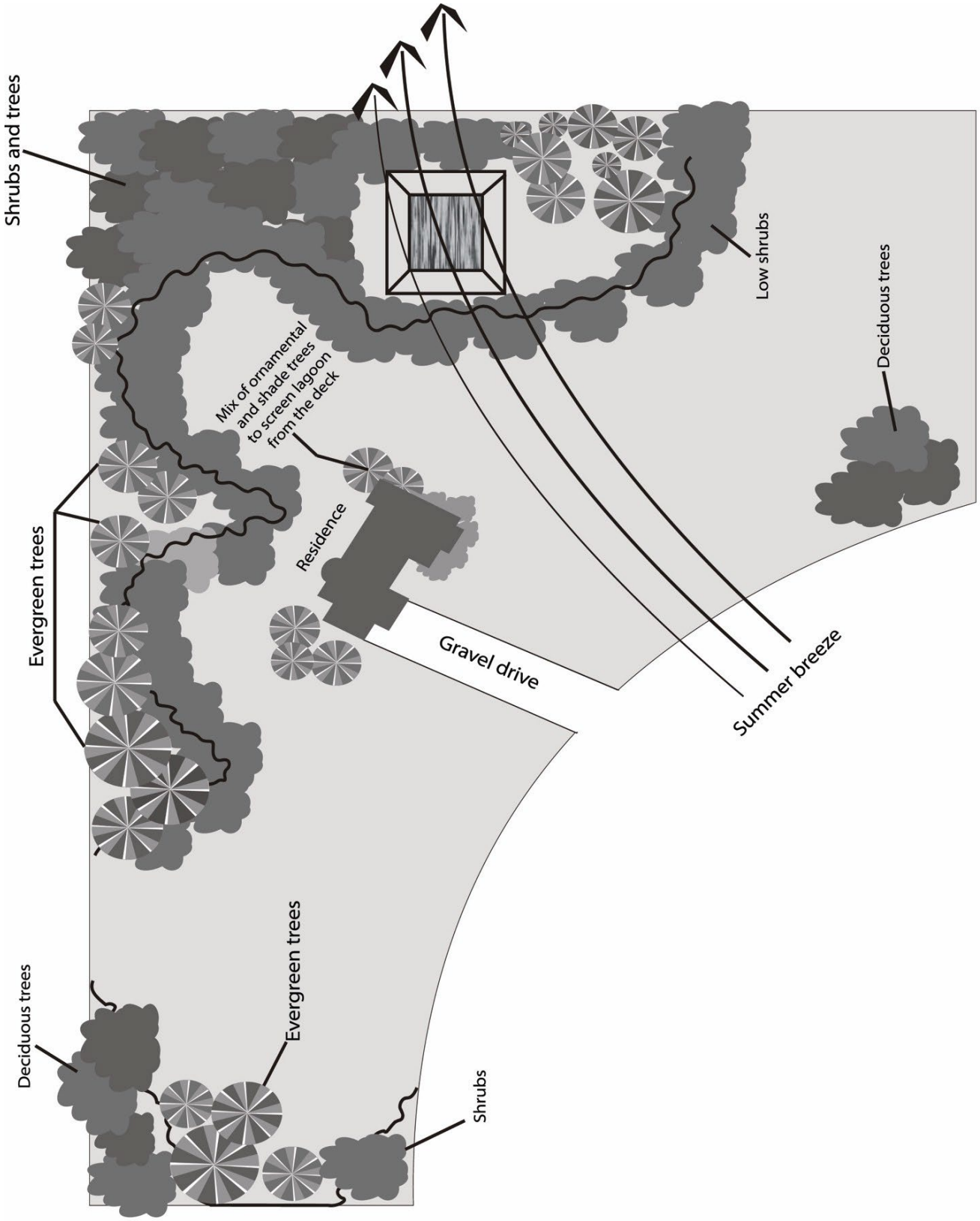
Pretreatment Options for Wastewater Lagoons

In most cases a lagoon will work fine with no pretreatment of normal household wastewater before it enters the lagoon. The ideal sewer grade is 1/8- to 1/4-inch of drop per foot of sewer pipe or 1 to 3 percent grade of the sewer line. Slopes substantially greater or flatter than this can lead to problems of solids separation from the wastewater.

A septic tank can be added ahead of the lagoon to remove solids and reduce problems resulting from a substantially flatter or greater grade on the line leading to the lagoon. A septic tank has the advantages of removing solids (this expands the range of suitable sewer grade slope), reducing organic load (aids lagoon function), minimizing the chance of odor as long as the discharge line is under the water surface, and reducing rate of solids accumulation.

Other advantages include allowing use of a smaller-diameter effluent line and effluent pump, increased distance between cleanouts, greater variability in sewer grade, and greater flexibility for placement. Disadvantages include increased construction cost overall, anaerobic wastewater discharge to a pond, and maintenance for the tank. When a tank is used, it must be pumped regularly to avoid solids carryover that could block the effluent line. Outflow from the septic tank is still sewage and because of bacteria and safety issues, the lagoon must still be fenced.

Figure 1. Lagoon Siting and Design



WASTEWATER LAGOON INSTALLATION & CONSTRUCTION

Guidelines for Construction of Wastewater Lagoons

1) **Rock or porous strata.** Excavation that penetrates or terminates in rock or porous strata should be over-excavated a minimum depth of 2 feet on both side slopes and bottom. The entire excavation area must be filled with nonpermeable earthen material to limit seepage from the lagoon to a maximum value of 1/4-inch per day (0.01 inch per hour). Use high clay subsoil that is free of rocks, or fill soil that is mixed with bentonite clay and applied at the manufacturer's recommended rate and then compacted.
2) **Compact to avoid excessive water loss.** Compaction is essential to achieve consistent low water loss from lagoons. A sheepsfoot roller compacted lining built in three- to six- inch lifts to make a lining of at least 1½ feet thick is strongly recommended.
3) **Prevent surface water entry.** Divert surface runoff to prevent sediment entry and lagoon overfill/overflow. Construct the berm above the surrounding soil level or make an interception terrace (trench and ridge) to carry runoff away from the upslope side to accomplish this.
4) **Prevent berm erosion with vegetation.** Following the final grading, establish a perennial or temporary annual groundcover on the berm as soon as feasible; mulching until vegetation is established helps prevent erosion.
5) **Ensure adequate air flow and avoid shading.** Sunlight and air circulation over the lagoon are essential for good lagoon operation. Trees need to be located at least 30 feet outside the embankment and shrubs should be at least 15 feet outside the embankment. Because sunlight is essential for algae to produce oxygen, a lagoon's east, south, and west sides should not be shaded. It is recommended that no plants grow taller than a 22- degree angle (approximately 2½ horizontal to 1 vertical ratio) from the top outer edge of the berm.
6) **Fence for human and animal safety.** These lagoons contain raw sewage that can easily spread disease. If unfenced, they can create both a hazard and liability, especially with drowning, which is the second leading cause of accidental death in children. State and county codes require all wastewater lagoons be fenced. Fencing should preferably be located 3 feet outside the berm toe. A 4-foot-wide, rigid-frame hinged gate can allow easy access to mowing equipment. Gating must provide the same degree of resistance to entry as fencing and requires a padlock. Fencing diagrams are provided in this document.

Specifications for lagoon fence

a) **Height:** 4 feet minimum. If the fence will also be accessible to livestock, a double strand of barbed wire placed above the fence top or an electrical fence placed outside the inner fence may also be installed.

b) **Size:** 12.5-gauge wire.

c) **Open space:** 8 square inches or smaller; example 2" x 4."

d) **Warning signs:** A sign stating, "WASTEWATER TREATMENT LAGOON" or "RAW SEWAGE, KEEP OUT," shall be posted on the gate or fence adjacent to the gate.

Construction

1) **Soil condition.** Soil moist enough to compact into a firm ball is most suitable. Muddy soil is not only difficult to work but also forms clods that can be difficult to smooth out. Soil too dry for compaction into a firm ball can have moisture added. Topsoil needs to be removed and stockpiled for later use on the berm. Once the lagoon construction is completed, the topsoil may then be placed on the berm surface to support groundcover growth. Berm compaction needs to be done in layers, preferably by sheepsfoot roller, rather than by machine traffic or

other provision. This practice is critical if the soil is borderline acceptable for a wastewater lagoon. Fill layers shall be no more than 6 inches thick.

2) **Lagoon depth.** Lagoons are normally excavated to a depth no greater than 8 feet below the surface of the surrounding ground. Greater depth may contribute to problems of inadequate sunlight and/or air transfer. Surfaces of the berm and lagoon bottom should have uniform slope. They need to be free of rocks, debris, ruts, and ridges. When rock is encountered in excavation, the hole must be over-excavated by at least one foot to remove rock, then filled and compacted with at least one foot of clay material. The bottom of the lagoon must be at least four feet above the highest expected groundwater level or fractured bedrock.

3) **Berms.** Wastewater lagoons must be completely enclosed by berms 3 feet higher than the surface of the surrounding ground. Both the interior and exterior slope should be no less than 3 feet of lateral movement for each foot of vertical drop; 3.5 ft is better when space allows. The top width of the berm should be at least five feet to allow for easier mowing.

4) **Linings.** Where soil percolation rates exceed one-inch fall per hour, the bottom and interior sides of the wastewater lagoon need to be lined with a compacted clay of sufficient thickness to reduce the soil absorption rate to 1/4-inch per day or less, preferably 1/8-inch per day. See Protocol - Compacted Lining at the end of this chapter. Refer to manufacturer's recommended rate when using bentonite clay, asphalt cement, or membrane application.

5) **Sewage inflow.** The pipe carrying wastewater from the house to the lagoon must be at least 4 inches in diameter. Schedule 40 thermoplastic sewer pipe with solvent-welded joints is recommended. Slope can vary between 1/8- and 3/8-inch per foot. A 1/4-inch slope per foot, or 2-foot slope per 100 feet is recommended to avoid solids accumulation in the line. Pipe entry needs to be located below the water surface and extend nearly to the lagoon center, ideally located at 18 to 20 inches off the bottom. Beneath the pipe ending, at the lagoon center bottom, place a concrete pad of 2 feet x 2 feet x 4 inches thick. This pad can protect the lagoon lining from effluent damage. Supporting the end pipe can be done by anchoring it above concrete blocks with posts and/or steel support.

6) **Monitoring lagoon-water depth.** Installation of a post with clear markings in one-foot increments, located near the center, is recommended for ease in observation of water depth. Bentonite or clay soil can be packed around the base of the marker.

7) **Install at least two cleanouts.** One located near the outside of the house and the second one near the lagoon where the ground surface is approximately 6 inches higher than the berm, are favorable locations. Additional cleanouts are recommended with any change in pipe direction or distance of greater than 100 feet. A Tee or Y design may be used. However, a Y- shaped design allows easier access and double cleanouts allow for easier cleaning in both directions.

8) **Topsoil replacement to berm.** Application of topsoil is for the purpose of supporting groundcover growth. Reapplying topsoil by spreading in a loose manner is desirable, or if packed too firmly, it can be tilled prior to planting groundcover. Perennial groundcover, for preventing erosion, needs to be seeded as promptly as possible following construction. Natural Resources Conservation Service or Extension may provide recommendations for groundcover most suitable to one's specific location. Protective covering of straw or hay mulch may be beneficial in holding the soil and seeding during the process of establishing groundcover growth.

9) **Fencing installation.** Fencing must be completed as soon as possible for public safety. Posts need to be placed 2½ to 3 feet deep and backfilled with tightly compacted soil. Placing cemented posts at a 2½-foot depth is an alternative option. Wire needs to be stretched tightly using a come-along (wire stretcher), tractor, or other method. Figures 2 through 7 illustrate gate and fencing specifications.

Figure 2. Lagoon Design

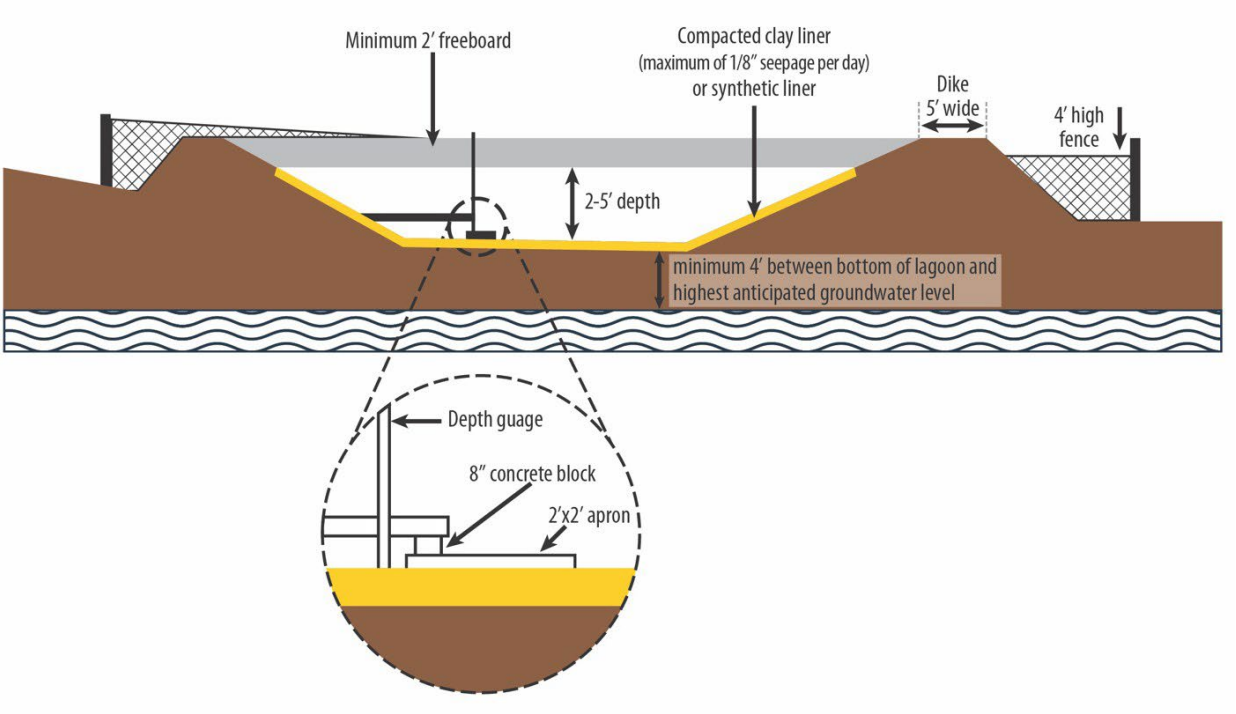


Figure 3. Gate and Fencing

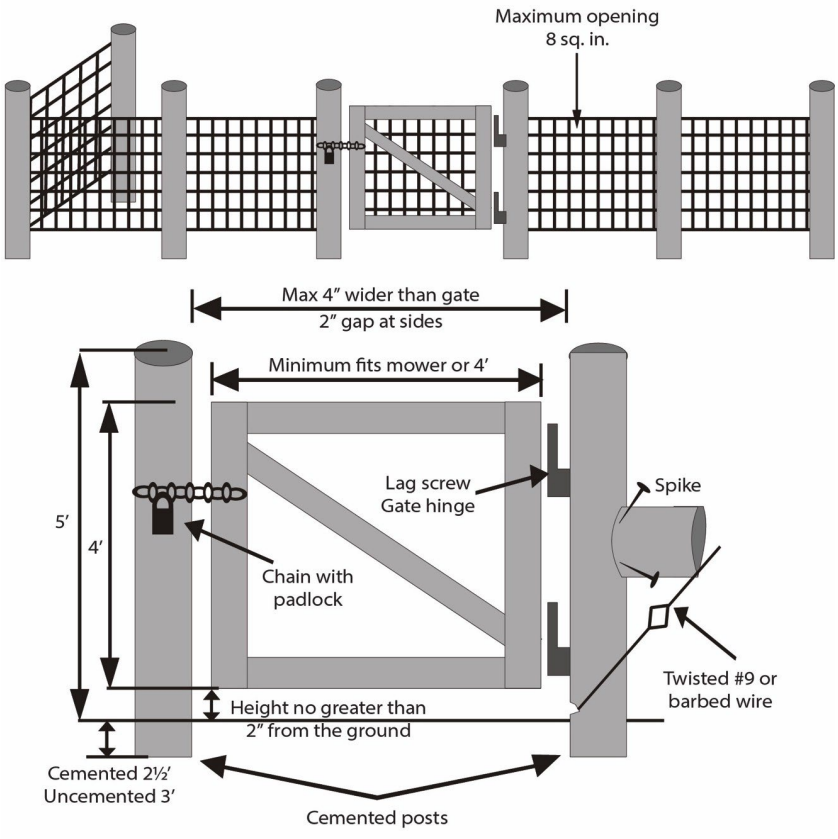
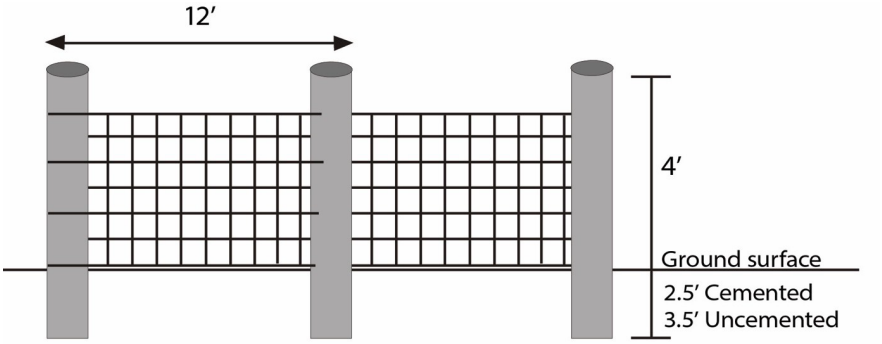


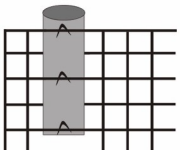
Figure 4. Fencing: The Standard Fencing



Avoid driving staple in too far to prevent damage to wire.

Staple on slant to prevent post from splitting.

Staple top, bottom, and every 12 inches along post.



Use fence staples 1½" long

12½ gauge

2'x4' Welded wire or chain link fencing

Line post material: pressure-treated wood or standard steel fence posts

Figure 5. Fencing: "H" Style Corner Brace

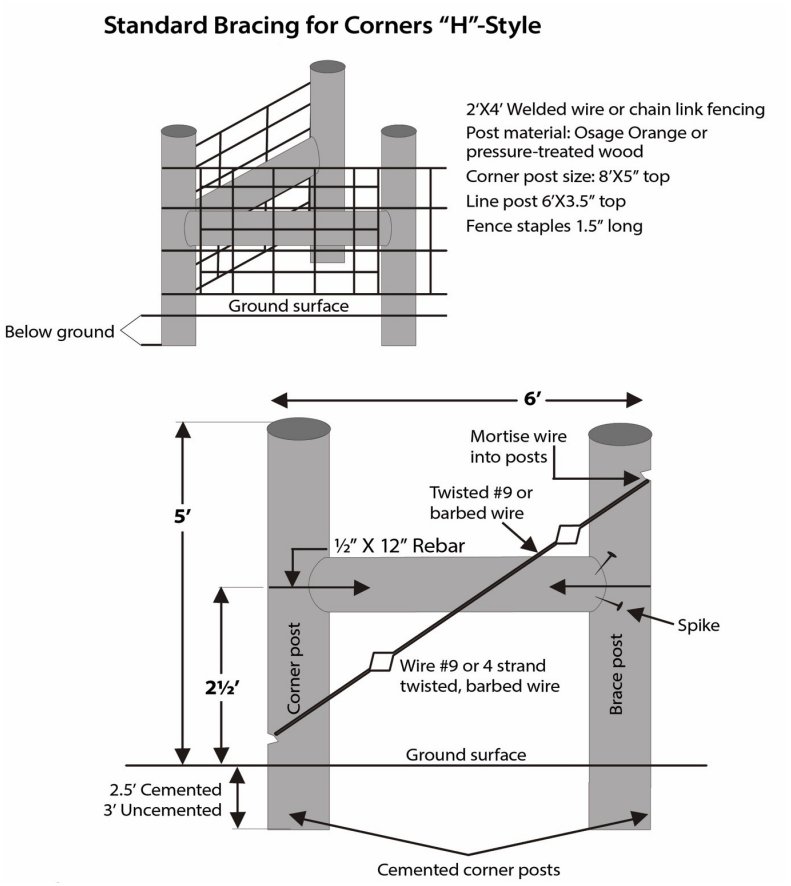


Figure 6. Fencing: "N" Style Corner Brace

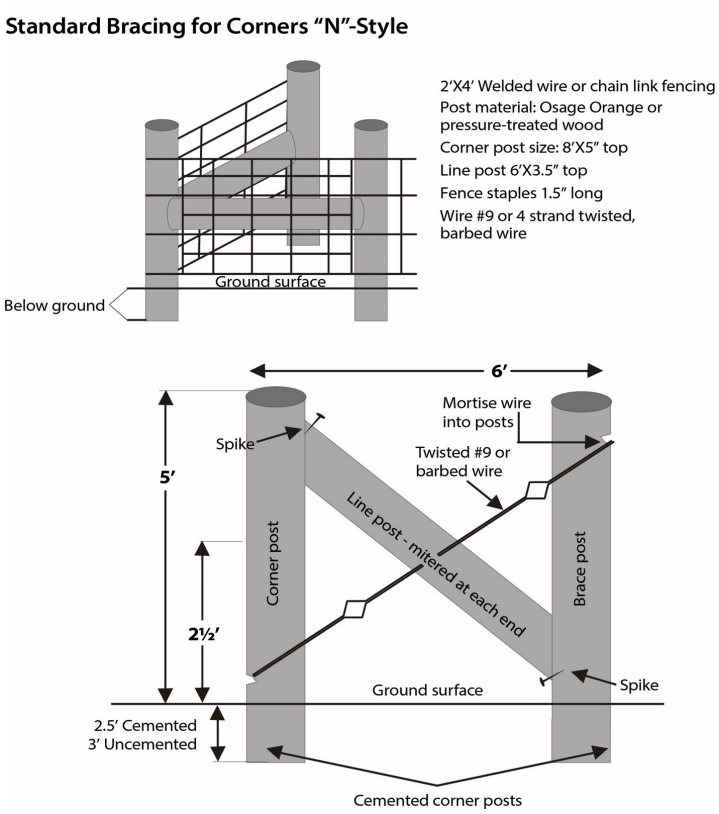
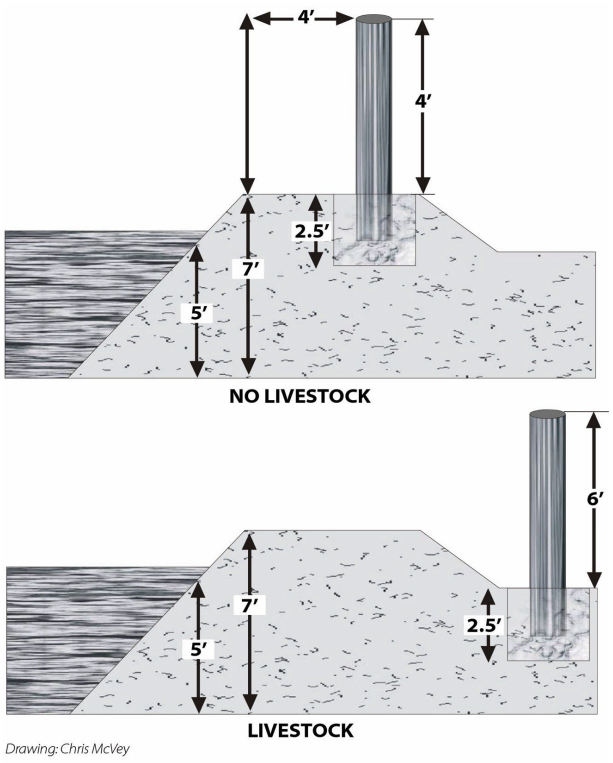


Figure 7. Fencing: Placement



USE AND MAINTENANCE

1) **Establish and maintain groundcover**. All areas bounded by the toe of the berms and within the fence shall have an ample stand of low-growing perennial groundcover. Once the groundcover is established, it needs to be regularly maintained during the growing season at a height of 6 inches or less. Under no circumstances should trees or tall weeds be allowed to develop on the berm area. Near the lagoon edge, it is preferable to cut the vegetation shorter than 6 inches to prevent any drooping into the water. Ideally, grass clippings should be removed from the lagoon area. At a minimum, they must be directed away from the lagoon.

2) **Remove any trees and additional vegetation.** All trees, weeds, cattails, duckweed, floating algae, and other undesirable vegetation need to be removed promptly with the first signs of their development in the water or along the berm. This vegetation is a habitat for mosquito breeding, produces excess organic loading, and degrades oxygen transfer. The best way to keep these plants from growing in the lagoon is to keep three feet or more of water in it. Removing weeds by hand before they become embedded and contribute to the lagoon's organic load is advisable. Take precautions to minimize exposure to wastewater by wearing protective clothing and waterproof gloves. After working with wastewater, thoroughly wash hands, or shower and disinfect any breaks in skin. Excess vegetation can create additional problems including a reduction of air flow, decreased evaporation, lagoon filling, shading, and less sunlight activity over the lagoon. Mosquito production is often directly proportional to the amount of such vegetation. Destruction of the lagoon's seal by root penetration can also occur. To repair a leaking lagoon, see Protocol – Sealing a Leaking Lagoon at the end of this chapter.

3) **Avoid herbicide use.** Improper use of herbicides can cause temporary system failure. If use becomes necessary, consult with the local county Extension Office or environmental health officer for the most recent product advice. Follow the manufacturer's label and avoid spillage or drift that might cause chemical holes or kill groundcover on the berm.

4) **Keep undesirable materials out of the wastewater.** It is important to keep hazardous materials (drain cleaners, paint, varnishes, solvents, fuels, waste oil, photographic solutions, pesticides or other organic chemicals) out of domestic wastewater that enters the lagoon. Also, minimize fats and greases that may clog the pipes as well as feminine hygiene products, coffee grounds, bones, cigarette butts, disposable diapers, paper towels, facial tissues, and other materials that decompose very slowly.

5) **Maintain desirable water depth – as close as feasible to 5 feet.** A short-term water depth of 2.5 feet during drought conditions is acceptable. Adequate treatment can become a problem if the depth becomes less than 2.5 feet. Therefore, a design of directing roof drains and/or sump pump wastewater to the lagoon as a temporary condition is desirable and must include a plan for rerouting the same wastewater elsewhere during prolonged periods of wet weather. Two feet of freeboard (berm height above the water surface) for water storage needs to be maintained to provide for times of exceptional storms. For emergency situations in which wastewater is encroaching on the freeboard and may overflow the lagoon, follow procedures in Protocol - Emergency Dewatering at the end of this chapter.

6) **Repair berm damage.** A certain amount of erosion will occur on the berm after initial construction. Any damage incurred by reasons of weather, animal entry, or other means should be repaired by shaping the area to the original plan and reestablishing perennial groundcover. Among the most common causes of damage are settling, erosion, and rodent burrowing.

7) **Evaluate wastewater lagoon conditions.** Proper operation of a wastewater lagoon can be evaluated by color, odor, and water testing. Generally routine testing is beyond the ability of the owner or user. Thus, one must rely on appearance and odor for operation information. Lagoon color is directly related to pH and dissolved oxygen (DO).

8) **Maintain essential lagoon features.** The fence, gate, vegetation height, and inlet pipe shall also be maintained in the condition called for in the original plans and specifications. Ensure the fence and gate are in good condition at least twice per year. The gap between the gate and post or space at the bottom of the fence to the ground should

not be bigger than 2 inches. Check for loose or damaged posts, loose anchors, sags in wire, and any damage. The fence must keep animals, especially pets, and children away from the lagoon. Any diversions provided to keep surface runoff away shall be maintained in satisfactory condition and at sufficient height to protect the lagoon.

9) **Pay attention to odors.** Properly operating lagoons rarely emit an odor. Odors may indicate the lagoon is not functioning properly. Odors may be due to the following: a) sludge may be filling the lagoon; b) lagoon may be improperly sized; or c) lagoon may be overloaded. Odor that persists longer than two days indicates an operational problem, and the cause must be determined.

10) **Measure and record sludge.** Maintain at least 18 inches of water above the level of sludge. Measure the depth of sludge in the same area of the lagoon, preferably near the center, after 10 years, and then again every three to five years. It is not safe to walk into a lagoon with waders. Rather, use a small pump with an intake suspended from a float at an adjustable depth. Move the intake deeper until solids are first noticed. The depth of the intake below the surface is the depth to the sludge. Keep a record of depths of sludge and the years it was measured.

Table 2. Visual Indicators of a Lagoon's Condition

COLOR	CONDITION	SYMPTOM OR CAUSE
Dark sparkling green	Good	High pH and DO
Dull green to yellow	Not as good	pH and DO are dropping Blue-green-type algae are becoming predominant
Gray to black	Very bad	Lagoon is septic with anaerobic conditions prevailing
Tan to brown	Ok if…	Due to predominance of a type of brown algae (not found in KS)
	Not good if…	Due to silt or bank erosion

Source: Stabilization Ponds - Operations Manual. Aug 1977, EPA Office of Water Program Operations, O-15

Troubleshooting

Testing Final Seepage Rate - Use one of three ways to test the final seepage rate of the lagoon to ensure it does not exceed ¼- inch per day. A rate of 1/8-inch per day is preferred. An independent soil lab can take a sample of the soil for testing prior to filling the lagoon. This may be expensive and leave a hole that would compromise the lagoon. The hole can be plugged with bentonite or soil used for the liner and then compacted.

Alternately, the two-barrel method requires two 55-gallon drums. One is the "control" drum, which records water loss due to evaporation or gain due to precipitation. This drum is set on the bottom of the lagoon, closed end down. The second drum has had the top and bottom removed. This is the "seepage" drum. It is placed a few inches into the sealed soil layer on the bottom of the lagoon. A bead of bentonite should be packed around the inside edge of the drum. The seepage drum should be kept filled with water for two days prior to beginning the test. This ensures the soil is saturated. Weights are suspended on the outside of the seepage drum to keep it from popping up during the test; however, the top must remain uncovered so there is no interference with precipitation entering the drum. To conduct the test, fill each drum with an equal amount of water. For at least seven days, measure and record the difference in water levels; refill the barrels to the original levels. The difference between the two levels in the barrels is due to seepage and must not exceed ¼-inch per day. A 1/8-inch seepage rate is preferable.

Another choice for testing seepage is the five-gallon bucket test. To conduct this test, fill the lagoon with fresh water to a depth of two feet. After water sits for two days to achieve soil saturation, mark this level on the permanent depth marker.

Near the lagoon, partially bury a five- gallon bucket filled with water to a line marked near the top. Water-level changes in the bucket will be due to weather. The changes in the lagoon will be the result of weather and seepage.

Record the water levels daily for at least seven days. The difference in the measurements is the seepage. It must not exceed ¼-inch per day and 1/8-inch is preferred.

If seepage exceeds ¼-inch per day, bentonite or soda ash must be added and compacted on the lagoon bottom and sides, or a synthetic liner must be installed.

Sludge Removal

Wastewater lagoons will begin to fill with silt, sludge, and organic debris after a period of extended use. Lack of maintenance will increase the rate of fill. Leaves, uncut grass, grass clippings, waterfowl, animal burrowing, and livestock damage will accelerate the rate of filling occurring in the lagoon. Original lagoon volume must be maintained so that overflow does not occur.

Evidence of filling includes 1) overflow; 2) presence of cattails or other aquatic vegetation toward the center of the lagoon; 3) over-loaded condition indicated by heavy algae growth, dark lagoon water, decreased wave action, slow-flowing toilets, and foul air odor; and 4) water level on the berm near overflow condition during periods of normal rainfall.

Any of the above conditions, by themselves, may be attributed to inadequate lagoon sizing, or unusually heavy or light wastewater flow. Dewatering may be necessary to determine the cause. Consulting the local environmental health officer for assistance in determining whether to clean and reconstruct, abandon, or initiate other corrective action may be beneficial.

Procedure to clean and reconstruct the lagoon:

1) Contact the regulating authority for permit requirements or improvement requirements.
2) Lagoon dewatering must be accomplished with the greatest degree of environmental safety possible. Refer to Protocol - Emergency Dewatering Procedure at the end of this chapter.
3) Sludge may then be removed, utilizing a backhoe, bulldozer, or front-end loader in accordance with guidelines established by the local regulatory agency. The sludge can then be taken to a publicly owned wastewater treatment facility such as a landfill permitted and willing to accept sludge, or it can be tilled into farmland. If the sludge material is applied to farmland, it needs to be tilled into the soil as soon as possible (within 24 hours). (Refer to EPA 40 CFR Part 503 Regulations.)
4) Clay or bentonite layers, or lining originally installed to control seepage losses need to be checked and restored. See Protocol - Sealing a Leaking Lagoon at the end of this chapter.
5) Inlet pipes and cleanouts need to be checked for proper functioning with repairs made if needed.
6) Berm must be reshaped, packed, and smoothed. Reseeding and restoring the fence to an approved condition needs to be done.
7) Water level should be restored to a 2 ½-foot depth before the lagoon is returned to service.

Lagoon Abandonment

Reasons for abandonment of a wastewater lagoon may include the following:

1) Public sewer available to the property within a feasible distance.
2) Lagoon will not retain wastewater.
3) Sludge level is at a depth that impairs proper functioning of the lagoon.
4) Local environmental health officer determines the system cannot be made to function properly; cannot adequately protect health of property owner or health of the public, or the quality of state waters.

Abandoning a wastewater lagoon would normally entail dewatering, sludge removal by a licensed septage hauler, and returning the land area to the contour it held prior to lagoon construction. Kansas Department of Health and Environment issues addendums as new laws and procedures are developed. Wastewater lagoons are subject to these additions. Current guideline procedures for abandoning a wastewater lagoon are as follow:

1) Dewater according to the Protocol – Emergency Dewatering procedure at the end of this chapter.
2) If the dry sludge is more than 18 inches thick, it should be removed and disposed following the local code and EPA 40 CFR Part 503 regulations, then proceed with the steps below.
3) Push berms in to fill lagoon. A slight elevation above the center is desirable to eliminate the possibility of an area holding water once settling occurs.
4) Cover the area with topsoil and reseed with suitable groundcover