April 6, 2015 DRAFT
10 CSR 20-8.200 Wastewater Treatment *[Ponds (Lagoons)]* Lagoons and Land Application

Leasue and Emily,

Here are my comments. Numbers refer to those on the attached scan of the draft regulation. Thank you for the opportunity to comment.

Elke, 4/16/2015

1. Sulfate content of the primary water supply: I assume this relates to the effect of sulfate on the toxicity of chlorides. As far as I know, the related revision of the Chapter 7 Water Quality Standards was not approved by the EPA. This requirement should also not be incorporated here. Most land application systems are used by small or very small dischargers with very limited budgets, both public and private, and land application is the treatment system of last resort. The vast majority of these facilities only process domestic wastewater, very little commercial no industrial wastewater. It would be a overly costly to add this requirement in relation to the possible benefit, if any.

2. Direction of groundwater movement and chemical analyses: This would require extensive and expensive testing with little to no comparable benefit in the vast majority of cases. In many cases there are no drinking water supplies nearby due to rural water districts. This requirement should be limited to cases where there is indication through geologic and soil testing (as required in other sections) that contamination of a drinking water supply is a possibility.

3. Existing well information: In the case of private wells, this information would be hard to come by. Add "where available" to D.2.

4. Monitoring wells: "between" could cover a very large distance. To limit the scope to relevant cases, should state maximum distance or time of travel to existing wells this applies to.

5. Proportioned samples from mechanical plants: Most land application systems are used by small or very small dischargers. These may use mechanical plants, but have very limited monitoring equipment and capabilities. A flow-proportioning sampler would have to be acquired specifically for this test and represents an unnecessary burden without comparable benefit. Allow a composite sample consisting of at least 6 grab samples as an alternative.

6. Required analyses: Both last sentences, especially the sodium absorption rate, are expensive overkill for most small systems. Limit the requirements to WWTPs receiving industrial flows. (Same paragraph "TSS"" misspelled). See paragraph 8 on page 16 to this effect.

7. Qualified agronomist: Does this mean a certified professional agronomist? Except in unusual cases, there is no need for this requirement. Again it would greatly increase cost without appreciable benefit. Cropping and harvesting should be outlined in general terms with the property owner / farmer of the land application site. Permanent cover crops should be excluded from this requirement.

8. Controlled discharge ponds: Primary and secondary cell and storage cell water depths: specify "above 2' level".

9. Aeration requirements: Add O_2 demand for ammonia removal. Allow re-oxygenation credit.

10. Number of aerator: For conventional aerators (several aerators of the same type, perhaps in more than one pond), allow having one spare unit on hand instead. However, some new technologies have very specific aerators and use different types of aerators in the same pond at specific locations. The biological/chemical components of their designs and the extra costs would make these technologies infeasible. Under consideration of the buffering capacity of the lagoon, should allow exceptions or change "shall" to "should".

11. Percolation losses and industrial wastewater: Allow more stringent limits due to flow or loading, rather than just flow.

12. Investigations required under 17(B): Where and what is 17(B)?

13. Membrane covers for manure storage systems: I assume this is supposed to apply to wastewater, not manure?

14: Application field slopes on pages 4 and 15 contradict each other.

15: Submittal of O&M plan: Submittal with facility plan is too early, since many parameters are still unknown. This is not required for any other type of treatment system and should not be required here. The outline could be submitted with the plans, but again, this is not required for any other treatment system and should not be required here. Many components of the O&M manual will not be known, especially the product specific portions like pump maintenance, control panel components, etc. Since most funding agencies require competitive bidding, exact products will not be known until the construction phase. This requirement increases the cost of engineering with no real benefit. The only portion that makes sense to review at this stage would be the application regime, i.e. how many days are between application periods, how many periods per year, how many days to empty the pond, etc. This would be better included in the Design Memo. Could require O&M manual submittal with/prior to Certificate of Completion.

16. Monitoring system for runoff and surface/groundwater intrusion: Any of these cases would be a violation of the permit, since no discharge of intrusion is allowed. There is no practical way to monitor the water leaving the site, since there is no defined outfall - this would be akin to a city monitoring all its stormwater runoff, which has been proven reasonably undoable. Monitoring intrusion to groundwater water would require monitoring wells with sophisticated equipment. The paragraph refers entirely to situations outside the design and NPDES permit parameters and should be deleted.

17. Exclusion of compacted sites for drip irrigation: Should allow remediation of site.

18. Area requirements formula: Define LPP.

This rule shall apply to all wastewater treatment facilities. This rule shall supersede when there is a conflict with 10 CSR 20-8.020.

(3) General. This rule deals with generally used variations of treatment *[ponds]* **lagoons** to achieve secondary treatment including controlled discharge pond systems, flow-through pond systems, *[and]* aerate pond systems, **lagoon retrofits and land application**.

(A) *[Ponds]***Lagoons** utilized for equalization*[, percolation, evaporation]* and sludge storage will *[not be discussed in this rule]* **be discussed in 10 CSR 20-8.150 and 10 CSR 20-8.170. Wastewater reuse beyond land application and subsurface discharge is not discussed in this rule.**

(B) Industrial Wastes. Consideration shall be given to the type and effects of industrial wastes on the treatment process. It may be necessary to pretreat industrial discharges. Industrial wastes shall not be discharged to lagoons or to land application system without assessment of the effects the substances may have upon the treatment processor requirements in accordance with state and federal laws. Whenever industrial wastes are a significant part of the wastewater flow, the department may require more stringent seepage limitations and liner design considerations.

(4) Supplement to *[Engineer's Report]* **Facility Plan**. The [engineer's report] **facility plan** shall contain pertinent information on location, geology, soil conditions, area for expansion and any other factors that will affect the feasibility and acceptability of the proposed project. The following information must be submitted in addition to that required in 10 CSR 20-8.110.

(A) *[Supplementary]* **Lagoon** Field Survey Data.

1. The location and direction of all residences, commercial developments, parks, recreational areas and water supplies, including a log of each well if available within one-half (1/2) mile (0.8 km) of the proposed [pond] **lagoon and land application site** shall be included *[in the engineer's report]*.

2. Land use zoning adjacent to the proposed *[pond]* site shall be included.

3. A description, including maps showing elevations and contours, of the site and adjacent area shall be provided. Due consideration shall be given to additional treatment units and/or increased waste loadings in determining land requirements. Current United States Geological Survey and Soil Conservation Service maps may be considered adequate for preliminary evaluation of the proposed site.

4. The location, depth and discharge point(s) of any field tile in the immediate area of the proposed site shall be identified.

5. A geological evaluation of the proposed lagoon site prepared by the *[Division of Geology and Land Survey (DGLS)]* **Missouri Geological Survey** shall be submitted. To obtain this geological evaluation of the proposed site, the engineer shall submit the following information to the Department of Natural Resources, *[Division of Geology and Land Survey]* **Missouri Geological Survey,** P.O. Box 250, Rolla, MO *[65401]* **65402**:

A. A layout sheet showing the proposed location. The layout shall include the legal description, property boundaries, roads, streams and other geographical landmarks which will assist in locating the site;

B. Size of the lagoon and/or approximate volume of waste to be treated;

C. Maximum cuts to be made in the construction of the lagoon; and

D. Location and depth of cut for borrow area, if any.

(1) → 6. Sulfate content of the primary water supply shall be determined.

7. Data from all soil borings conducted by a professional soil testing laboratory to determine subsurface soil characteristics and groundwater characteristics, including elevation, at the proposed site and their effect on the construction and operation of a pond shall also be provided.

A. All boring holes shall be filled and sealed.

B. The permeability characteristics of the pond bottom and pond seal material shall also be studied.

C. At the facility plan stage particle size analysis, Atterburg limits, standard *[Procter]* **Proctor** density (moisture-density relations) or permeability coefficient may be required on a case-by-case basis to reflect soil characteristics.

D. At the twenty percent (20%) design stage, soil analysis of each representative soil material including particle size analysis, Atterburg limits, standard *[Procter]* **Proctor** density (moisture-density relations) and permeability coefficient of the compacted soil as measured in a falling head permeameter or other test procedure acceptable to the agency may be required.

E. Soil borings may be required in each geological area to determine depth to piezometric surface and to bedrock. Recommendations of the *[DGLS]* **Missouri Geological Survey** will be used to establish the required tests at the facility plan and twenty percent (20%) design stages.

Visual inspection of the area noting topography, wet areas, vegetation and ditching is useful and may be necessary, particularly if maps are not detailed and/or soil maps do not exist. Information gathered from this investigation should be particularly useful in evaluation of the site with regard to estimating possible soil variability and suitability.

(B)Land Application System.

1. Location. A copy of the USGS topographic map of the area (seven and one-half (7 1/2)-minute series where published), similar map or aerial photograph showing the exact boundaries of the spray field.

2. A topographic map of the total area under consideration by the applicant at a scale of approximately one inch to fifty feet (1":50') (2.54:15.2 cm) with appropriate contour interval. It should show all buildings, the waste disposal system, the spray field boundaries and buffer zone. An additional map should show the spray field topography in detail with a contour interval of two feet (2') (61 cm) and include buildings and land use on adjacent lands within one-fourth (1/4) mile of the project boundary.

3. Water supply wells which might be affected shall be located and identified as to uses—for example, potable, industrial, agricultural and class of ownership; for example, public, private, etc.

4. All abandoned wells, shafts, etc., where possible, should be located and identified. Pertinent information thereon shall be furnished.

5. Geology.

A. Geologic formation's name and the rock types at the site.

B. Degree of weathering of the bedrock.

C. Character and thickness of the surficial deposits.

D. Local bedrock structure including the presence of faults, fractures and joints.

E. The presence of any solution openings and sinkholes in carbonate terrain.

F. The source of the information above. must be indicated.

6. Hydrology.

A. The depth to seasonal and permanent highwater tables (perched and/or regional) must be given, including an indication of seasonal variations.

B. The direction of groundwater movement and the point(s) of discharge must be shown on one (1) of the attached maps.

C. Chemical analyses indicating the quality of groundwater at the site must be included.

D. The following information shall be provided from existing wells and from the test wells as may be necessary:

1. Construction details—where available. Depth, well log, pump capacity, static levels, pumping water levels, casing, grout material and the other information as may be pertinent; and

2. Groundwater quality. For example, nitrates, total nitrogen, chlorides, sulfates, pH, alkalinities, total hardness, coliform bacteria and metal ions.

E. A minimum of one (1) groundwater monitoring well, where deemed necessary by the Missouri Geological Survey, must be drilled in each dominant direction of groundwater movement and between the project site and public well(s) and/or high capacity private wells with provision for sampling at the surface of the water table and at five feet (5') (1.5 m) below the water table at each monitoring site. The location and construction of the monitoring well(s) must be approved by the department. These may include one (1) or more of the test wells where appropriate.

7. Evaluation of Effluent to be Applied. Representative samples are essential to properly evaluate the effluent. Where the discharge is from a sewage treatment plant, twenty-four (24)-hour samples proportioned to the rate of flow will be needed to obtain a representative sample. In cases where the effluent is stored for several days or longer, a single sample of the effluent will suffice. Analyses which will be of major importance will be for total suspended solid (TSS), a volatile suspended solid (VSS), sodium, calcium, magnesium, electrical conductivity (EC), nitrogen, phosphorous, metal ions and fluoride. The sodium absorption ratio (SAR) should be calculated from sodium, calcium and magnesium determination.

8. Soils. All soils investigation should be performed by a qualified soil scientist.

A. A soils map should be furnished of the spray field, indicating the various soil types. This may be included on the large-scale topographic map. Soils information can normally be secured through the USDA Soil Conservation Service.

B. The soils should be named and their texture described.

C. Slopes and agricultural practice on the spray field are closely related. Slopes on cultivated fields should be limited to four percent (4%) or less. Slopes on sodded fields should be limited to eight percent (8%) or less. Forested slopes should be limited to eight percent (8%) for year-round operation but some seasonal operation slopes up to fourteen percent (14%) may be acceptable.

D. The thickness of soils should be indicated. Indicate how determined.

E. Data should be furnished on the exchange capacity of the soils. In cases of industrial wastes particularly, this information must be related to special characteristics of the wastes.

F. Information must be furnished on the internal and surface drainage characteristics of the soil materials. Location and depths to impermeable or restricted horizons should be indicated.

G. Proposed application rates should take into consideration the drainage and permeability of the soils and the distance to the water table.

9. Agricultural Practice.

A. The present and intended soil-crop management practices, including forestation, shall be stated.

B. Pertinent information shall be furnished on existing drainage systems.

C. When cultivated crops are anticipated, a cropping and harvesting program by a qualified agronomist shall be included.

10. Adjacent Land Use.

A. Present and anticipated use of the adjoining lands must be indicated. This information can be provided on one (1) of the maps and may be supplemented with notes.

B. The plan shall show existing and proposed screens, barriers or buffer zones to prevent blowing spray from entering adjacent land areas.

C. If expansion of the facility is anticipated, the lands which are likely to be used must be shown on the map

[(B)] (C) Site Information.

1. Distance from habitation. Lagoon sites should be as far as practicable from habitation or any area which may be built up within a reasonable future period. The agency does not attempt to set any minimum distance from habitation since each case must be judged upon its own merits.

2. Prevailing winds. If practicable, *[ponds]* **lagoons and spray land application sites** should be located so that local prevailing winds will be in the direction of uninhabited areas.

3. Surface runoff. Location of [ponds] **lagoons** in watersheds receiving significant amounts of stormwater runoff is discouraged. Adequate provisions must be made to divert stormwater runoff around the ponds and protect embankments from erosion.

4. Hydrology. Construction of *[ponds]* **lagoons** in close proximity to water supplies and other facilities subject to contamination should be avoided. A minimum separation of four feet (4') (1.2 m) between the bottom of the pond and the maximum groundwater elevation should be maintained where feasible.

5. Groundwater pollution. Proximity of lagoons to water supply located in areas of porous soils and fissured rock formation shall be elevated to avoid creation of health hazards or other undesirable conditions. If the geological report from *[DGLS]* **Missouri Geological Survey** makes suggestions for remedial treatment of the site, the engineer shall comply with the suggestions. In some cases, the engineering geologist requests to visit the site during or after construction. When a request is made, the consulting engineer shall comply with the request.

(5) Basis of Design.

(A) Quality of Effluent. A controlled discharge stabilization *[pond]* **lagoon** (four (4)-cell) will be considered capable of meeting effluent limitations of thirty (30) mg/l biochemical oxygen demand (BOD_5) and thirty (30) mg/l suspended solids. Flow-through stabilization *[ponds]* **lagoons** (three (3)-cell), and aerated lagoon systems will be considered capable of meeting effluent limitations of thirty (30) mg/l BOD_5 and eighty (80) mg/l suspended solids. Flow-through lagoon systems and aerated lagoon systems followed by submerged sand filters will be considered capable of meeting effluent limitations of twenty (20) mg/l BOD_5 and twenty (20) mg/l suspended solids. Lagoons may be incorporated into irrigation systems or systems utilizing chemical coagulation and filtration to meet the requirements of 10 CSR 20-7.015(3)(A)3. Please refer to 10 CSR 20-7.015 Effluent Regulation for discharge requirements.

(B) Area and Loadings for Controlled Discharge Stabilization *[Ponds]* **Lagoons** (four (4)-cell). *[Pond]* **Lagoon** design for BOD_5 loadings shall not exceed thirty-four (34) lbs./acre/day (38 km per hectare per day) at the three-foot (3') (1.9 m) operating depth in the primary cells. The primary cell shall be followed by a secondary cell having 0.3 the area of the primary cell and by two (2) storage cells. The two (2) storage cells shall have a volume above the two-foot (2') (0.6 m) level for one (1) month's storage of average daily flow in each cell. At least one hundred twenty (120) days' detention time between the two-foot (2') level (0.6 m) and the maximum operating depth shall be provided in the entire pond system. Flow can be based on one hundred (100) gallons per capita per day (38 m^3/cap/d) or other values if data is presented to justify the rate. Primary and secondary cells shall be designed for water depths up to a maximum of five feet (5') (1.5 m). The storage cell should be made as deep as possible up to a maximum depth of eight feet (8') (2.4 m).

(C) Area and Loadings for Flow-through Stabilization *[Ponds]* **Lagoons** (three (3)-cell). *[Pond]* **Lagoon** design for BOD_5 loadings shall not exceed thirty-four (34) pounds per acre per day (38 km per hectare per day). The second cell must be at least 0.3 the area of the first cell and the third cell 0.1 the area of the first cell. The first and second cells must have a variable operating level of between two feet (2') (0.6 m) and five feet (5') (1.5 m). The third cell must have a variable operating level of between two feet (2') (0.6 m) and eight feet (8') (2.4 m). Detention time of at least one hundred twenty (120) days must be provided. Flows of less than one hundred (100) gallons per capita per day (.38 m^3/cap/d) may be used if data is presented to justify the lower rate.

(D) Aerated Lagoons. For the development of final design parameters it is recommended that actual experimental data be developed; however, the aerated lagoon design for minimum detention time may be estimated using the following formula:

$$t = \frac{E}{2.3\ K_1 \times (100\text{-}E)}$$

where:
t = detention time in the aeration cell in days;
E = percent of BOD_5 to be removed in an aerated pond; and
K_1 = reaction coefficient aerated lagoon, base 10.

1. For normal domestic sewage the K_1 value may be assumed to be .15 per day for Missouri conditions. The reaction rate coefficient for domestic sewage which includes some industrial waste, other waste or partially treated sewage must be determined experimentally for various conditions which might be encountered in the aerated ponds. Conversion of the reaction coefficient at other temperatures shall be based on experimental data. Raw sewage strength should also consider the effect of any return sludges.

2. *[Also, additional]* **Additional storage** volume should be considered for sludge and in northern [climates] **Missouri**, ice cover.

3. Oxygen requirements generally will depend on the BOD_5 loading, the degree of treatment and the concentration of suspended solids to be maintained. Aeration equipment shall be capable of maintaining a minimum dissolved oxygen level of two (2) mg/l in the *[ponds]* lagoons at all times. **The aeration equipment shall be capable of providing 1.3 pounds of oxygen per pound of BOD_5 (1.3 kg/kg BOD_5) removed. BOD_5 removal shall be based on warm weather rates.** Add NH_3 O_2 req't.

4. Suitable protection from weather shall be provided for electrical controls. *[The aeration equipment shall be capable of providing 1.3 pounds of oxygen per pound of BOD_5 (1.3 kg/kg BOD_5) removed. BOD_5 removal shall be based on warm weather rates. Aerated cells shall be followed by a polishing cell with a volume of 0.3 of the volume of the aerated cell (see 10 CSR 20-8.180 for details on aeration equipment).]*

5. A sufficient number of aerators shall be provided so that a design level of dissolved oxygen within a particular cell shall be maintained with the largest capacity aerator in that cell out of service.

A. Floating surface aerators should be anchored in at least three and preferably four directions. Interconnection of floating aerators is discouraged. Flexible cables are preferred over rigid ones.

B. Surface aerators should be designed to prevent icing. Consideration should be given to the installation of splash plates for control of misting. For platform mounted aerators, the platform legs should be spaced at a sufficient distance from the aerator to minimize the effect of ice build-up caused by splashing.

1. Aerator design should provide for periodic and major maintenance and repairs and shall provide for removal of the aerators for replacement if necessary.

2. Provisions shall be made for independent operation of each aerator by on/off switches, time clocks, etc.

C. Diffused aeration. The design for compressed air volume requirements shall include the basin aeration requirements together with air used in other channels, pumps, or other air-use demands. The air diffusion equipment shall be capable of maintaining sufficient mixing and oxygen concentration in the aerated volume under maximum seasonal demand conditions. Provisions shall be made for removal of deposits for

D. If measurement of percolation losses is required by the department. In no case shall measured percolation losses exceed thirty-five hundred (3500) gallons per acre per day. In areas where there is a significant potential for groundwater contamination, justification shall be provided before measured percolation losses will be allowed to exceed five hundred (500) gallons per acre per day and in no case shall percolation losses exceed seventeen hundred (1700) gallons per acre per day. Whenever industrial wastes are a significant part of the wastewater flow, the department may require more stringent seepage limitations and liner design considerations. Measured percolation losses in excess of one-sixteenth inch (1/16") (1.6 mm) per day will be considered excessive.

(C) **Lagoon** Seal **and Liner**.

[1. Design. Ponds shall be sealed so that seepage loss through the seal is as low as practicably possible. Seals consisting of soils or synthetic liners may be used provided the permeability, durability, integrity and cost effectiveness of the proposed materials can be satisfactorily demonstrated for anticipated conditions. Bentonite, soda ash or other sealing aids may be used to achieve an adequate seal in systems using soil. Results of a testing program which substantiates the adequacy of the proposed seal must be incorporated into and/or accompany the engineering report. Standard ASTM procedures or other acceptable methods shall be used for all tests. Soils having a permeability coefficient of 10- cm/sec or less with a compacted thickness of twelve inches (12") (30.5 cm) will be acceptable as a lagoon seal for water depths up to five feet (5') (1.5 m). For permeability coefficients greater than $10^{-7\ cm/sec}$ or for heads over five feet (5') (1.5 m) such as an aerated lagoon system, the following formula shall be used to determine minimum seal thickness:

$$t = \frac{H \times K}{5.4 \times 10^{-7\ cm/sec}}$$

where:
K = the permeability coefficient of the soil in question;
H = the head of water in the lagoon; and
t = the thickness of the soil seal.

2. Normal construction methods will include over-excavation below grade level of twelve inches (12") (30.5 cm), scarification and compaction of base material to ninety-five percent (95%) standard Procter density at moisture content between two percent (2%) below and four percent (4%) above optimum, and compaction of lifts generally not exceeding six inches (6") (15.2 cm) to ninety-five percent (95%) standard Procter density at moisture content between two percent (2%) below and four percent (4%) above optimum. Maximum rock size should not exceed one-half (1/2) of the thickness of the compacted lift. The cut face of dikes must also be over-excavated and compacted in lifts not to exceed six inches (6") (15.2 cm) per lift. Soils containing plastic clay may be excluded from this construction requirement on a case-by-case basis based on particle size analysis and Atterburg limits. In fact, with some clay soils, satisfactory construction cannot be obtained by over-excavation and recompaction. Construction control must include field density. A minimum of two (2) density tests per acre or not less than three (3) tests must be performed for the base and each lift. Permeability tests of field compacted material may be performed at the option of the consulting engineer.

3. Prefilling. The pond shall be prefilled in order to protect the liner, to prevent weed growth, to reduce odor, to allow measurement of percolation losses and to maintain moisture content of the seal. However, the dikes must be completely prepared as described in subparagraphs (6)(A)7.A. and/or B. of this rule before the introduction of water. If the lagoon bottom is allowed to dry, the seal must be recompacted as required in paragraph (6)(C)2.

4. Percolation losses. Measurement of percolation losses shall consider flow into and out of the lagoon, rainfall and evaporation, and changes in water level. Measured percolation losses in excess of one-sixteenth inch (1/16") (1.6 mm) per day will be considered excessive.]

1. Site Evaluation. A preliminary investigation for a lagoon site should be undertaken to screen a study area for potential sites before a detailed site investigation, if required, is undertaken. The purpose of the investigation is to assemble available information to determine if soil borings and soil tests are required to design a pond which will meet the seepage requirements. The investigation should be done using data such as Soil Conservation Service (SCS) County Soil Surveys, U.S. Geological Survey topographic maps and the required geological evaluation from the Department of Natural Resources, Division of Geology and Land Survey. Visual inspection of the area noting topography, wet areas, vegetation and ditching is useful and may be necessary, particularly if maps are not detailed and/or soil maps do not exist. Information gathered from

this investigation should be particularly useful in evaluation of the site with regard to estimating possible soil variability and suitability.

A. All potential lagoon sites will receive a rating from the geological evaluation. The rating will infer the relative geological limitations for designing and constructing a pond at the site in question. Whenever the geological evaluation indicates that a site has slight limitations, the requirements for additional site investigation as set forth in subsection (17)(B) of this rule, may not be required by the department. The department may require that the results of density tests, taken on the finished pond liner, be submitted and approved prior to putting the pond into operation.

B. Whenever a site has moderate geological limitations, the department may require one (1) or all of the requirements for a detailed site investigation as set forth in subsection (17)(B) of this rule. The department may require density tests, taken on the finished pond liner, be submitted and approved prior to putting the pond into operation.

C. Sites that have severe geological limitations for construction of wastewater stabilization lagoons will be reviewed on a case-by-case basis. The department may require artificial liners in these situations. In general, where there is high collapse potential due to bedrock and soil conditions, the use of ponds will not be allowed. Exceptions may be granted dependent upon the type of liner proposed and where the geological considerations have been thoroughly evaluated so that the risk of groundwater contamination is minimized.

D. Where liners are used in storage or treatment basins for wastewaters of an industrial nature, the summary of design data shall document that the liner or storage structure material is capable of containing the wastewater for at least twenty (20) years and shall specify repair or replacement procedures in the event of leakage or damage to the seal. Secondary containment or leakage detection and collection devices shall be considered for corrosive or reactive wastewaters and for toxic materials. The department may require leakage testing and submittal of density tests and/or coefficient of permeability on the finished liner prior to placing the structure into operation.

2. Detailed Soils Investigation. If a detailed site investigation is needed to substantiate feasibility and design of a project at a selected site with regard to design requirements, the quantity and quality of soil materials on site (and borrow) must be identified and evaluated for use in the pond and/or liner construction. The design concepts and objectives of the investigation should be made clear by the consulting engineer to the qualified soil engineering party doing the field work so that an investigation strategy can be developed and sufficient data collected. Most important, an identification of the volume of the soil needed for the liner must be determined. The department may require the following to be included in the soils investigation:

A. Exploration shall be sufficient to identify and define the quantities and quality of the soil liner materials. The use of test pits, split barrel or thin wall sampling or a combination of these techniques may be used depending on the total area of investigation and the depth to which exploration is needed. The following information, in whole or in part, may be required by the department:

1. Atterburg limits;
2. Standard Proctor density (moisture/density relationships);
3. Coefficient of permeability (undisturbed and remolded);
4. Depth to bedrock;
5. Particle size analysis; and
6. Depth to seasonal high groundwater table.

B. Information gathered from the investigation should be presented on a base map drawn to scale and referenced to U.S. Geological Survey datum. Slope, landscape position and other surface features should also be included. Stratigraphy of soils should be shown using cross sections or fence diagrams when soil liner material is to be identified. Copies of original boring and other soil test logs shall also be included. An interpretation of the collected data shall be incorporated into the report. Any site constraints and how they will be dealt with should be discussed.

3. Design. The following criteria are for design and construction of soil liners. Engineering reports, plans and specifications should address these criteria.

A. The soils used for construction of a wastewater stabilization pond liner should meet the following minimum specifications:

1. Be classified under the Unified Soil Classification Systems as Cl, Ch, Gc or Sc;
2. Allow more than fifty percent (50%) passage through a No. 200 sieve;
3. Have a liquid limit equal to or greater than thirty (30);
4. Have a plasticity index equal to or greater than twenty (20); and
5. Have a coefficient of permeability equal to or less than 1×10^{-7} centimeters per second when compacted to ninety percent (90%) of standard proctor density with the moisture content between two percent (2%) below and four percent (4%) above the optimum moisture content;

2. Clean graded gravel, preferably placed in at least three (3) layers should be placed around the underdrains and to a depth of at least six inches (6") (15 cm) over the top of the underdrains. Suggested gradings for the three (3) layers are: one and one-half inches to three-fourths inch (1 1/2"–3/4") (3.8 cm–1.9 cm), three-fourths inch to one-fourth inch (3/4"–1/4") (1.9 cm–.6 cm) and one-fourth inch to one-eighth inch (1/4"–1/8") (.6 cm–.3 cm).

3. At least twenty-four inches (24") (0.6 m) of clean washed sand should be provided. The sand should have an effective size of 0.3–1.0 mm and a uniformity coefficient of 3.5 or less.

4. Open-joint or perforated pipe underdrains may be used. They should be spaced not to exceed ten-foot (10') (3.0 m) center-to-center.

5. The earth base of the filters should be sloped to the underdrains or the underdrains may simply be placed in the gravel base on the flat bottom of the basin.

6. The depth of liquid above the sand must be adjustable from one to five feet (1–5') (.3 m–1.5 m).

7. At least two (2) cells must be provided with the combined capacity equal to that necessary for the design loading.

8. A vehicle access ramp from the top of the embankment down to the sand surface and running along one (1) side of the filter is a desirable feature for periodic maintenance of the filter.]

[(8) Miscellaneous.

(A) Fencing. The pond area shall be enclosed with an adequate fence to discourage trespassing and prevent entering of livestock. Minimum fence height shall be five feet (5') (1.5 m). The fence may be of the chain link or woven type. Fencing shall not obstruct vehicle traffic or mowing operations on the dike. A vehicle access gate of sufficient width to accommodate mowing equipment shall be provided. All access gates shall be provided with locks.

(B) Access. An all-weather access road shall be provided to the pond site to allow year-round maintenance of the facility.

(C) Warning Signs. Appropriate permanent signs shall be provided along the fence around the pond to designate the nature of the facility and advise against trespassing. At least one (1) sign shall be provided on each side of the site and one (1) for every five hundred feet (500') (150 m) of its perimeter.

(D) Flow Measurement. Refer to 10 CSR 20-8.140(8)(G).

(E) Groundwater Monitoring. An approved system of groundwater monitoring wells or lysimeters may be required around the perimeter of the pond site to facilitate groundwater monitoring. The use of wells and/or lysimeters will be determined on a case-by-case basis.

(F) Laboratory Equipment. Refer to 10 CSR 20-8.140(8)(D).

(G) Pond Level Gauges. Pond level gauges shall be provided.

(H) Service Building. Consideration in design should be given to a service building for laboratory and maintenance equipment.]

(7) Lagoon Retrofits

A. Baffles

B. Covers

(13) 1. Membrane covers, either permeable or impermeable, when used on an earthen basin manure storage system, shall be constructed of high density polyethylene (HDPE) and have a minimum thickness of 2 mil and be ultraviolet and weather resistant.

A. The HDPE cover shall be secured at the lagoon perimeter utilizing an anchor trench.

B. The anchor trench shall be constructed with rounded corners in order to avoid sharp bends.

2. Seams

A. Large rocks and other objects shall be removed from the trench sides.

B. Extrusion and fusion welding shall be used for field seaming.

C. Trial seams shall be used to verify acceptable environmental conditions. Specimens of the trial seam shall be tested in shear and peel using a field tension meter. The seaming equipment shall not be used if the specimens fail the testing.

D. The cover shall include at least six 6" sample ports that will be used to retrieve wastewater and sludge samples from the lagoon's contents. The sample ports shall prevent the escape of biogas while the port is open. Each port shall have a secured cover or cap.

E. The cover shall include at least three manway hatches located along or near the center of the lagoon. Each hatch shall have a secured cover or cap.

3.Biogas. The cover shall include all necessary collections piping and other conducts to collect and convey the generated biogas handling system. Biogas collection within the cover shall include a central collection conduit

B. The pumping system and distribution system shall be sized for the flow and operating pressure requirements of the distribution equipment and the application restrictions of the soils and topography;

C. Provisions shall be made for draining the pipes to prevent freezing if pipes are located above the frost line;

D. A suitable structure shall be provided for either a portable pumping unit or a permanent pump installation. The intake to the pumping system shall provide the capability for varying the withdrawal depth. The intake elevation should be maintained twelve to twenty-four inches (12–24") below the wastewater elevation. The intake shall be screened so as to minimize clogging of the sprinkler nozzle or distribution system orifices. For use of a portable pump, a stable platform and flexible intake line with flotation device to control depth of intake will be acceptable;

E. Thrust blocking of pressure pipes shall be provided. For use of above ground risers for sprinklers, a concrete pad and support bracing should be considered; and

F. Automatic or semi-automatic controls should be considered for shut off of the system after a prescribed wastewater application period. Manual start-up of the application system is recommended.

4. Soil permeability. Soil permeability shall be based on the most restrictive layer in the top five feet (5') of soil. Soils having permeability rates of two-tenths to two inches (0.2–2") per hour are most suitable for irrigation. Values below two-tenths inch (.2") per hour may generally require special application equipment, reduced application rates or overland flow approach. Values above two inches (2") per hour will require reduced application rates to provide adequate residence time within the soil profile or will require additional soils and geologic information for depth to bedrock, depth to water table and recharge areas.

(14) →

5. Slope. The maximum allowable slope of the wetted application area is twenty percent (20%).

6. Application rate. The application rate consists of an hourly application rate in inches per hour and daily, weekly and annual application rates in inches per acre. Application of wastewater will not be allowed during periods of ground frost, frozen soil or during rainfalls. The following shall apply to design application rates:

A. The hourly application rate should not exceed the design sustained permeability rate except for short periods when initial soil moisture is significantly below field capacity. The hourly rate shall not exceed one-half (½) the design sustained permeability for slopes exceeding ten percent (10%). However, in no case should the application rate be greater than one-half inch (1/2") per hour. For soil permeability of less than two-tenths inch (0.2") per hour, the designed maximum application rate should be as low as practicable and shall not exceed two-tenths inch (0.2") per hour;

B. The daily and weekly application rates should be based on soil moisture holding capacity, antecedent rainfall and depth to the most restrictive soil permeability. The application rate shall in no case exceed one inch (1") per day and three inches (3") per week; and

C. The design maximum annual application rate shall not exceed a range from four percent to ten percent (4%–10%) of the design sustained soil permeability rate for the number of days per year when soils are not frozen. The following shall apply to typical domestic wastewater lagoon effluent:

(I) Soil permeability less than two-tenths inch (0.2") per hour. The maximum application rate shall be forty inches (40") of applied wastewater per year. The department may require lower application rates when there is evidence of fragipans, claypans or zones of seasonal saturation within the top two feet (2') of the soil profile;

(II) Soil permeability range from two-tenths inch (0.2") per hour to two inches (2") per hour. The maximum application rate shall be one hundred inches (100") of applied wastewater per year. Lower rates may be required if there is evidence of seasonal saturation in the top five feet (5') of the soil profile or if there is a significant potential for groundwater contamination;

(III) Soil permeability ranges from two inches (2") per hour to six inches (6") per hour. The maximum application rate shall be sixty inches (60") of applied wastewater per year. The department may require lower rates if there is a significant potential for groundwater contamination; and

(IV) Soil permeability over six inches (6") per hour. The maximum application rate shall be twenty-four inches (24") of applied wastewater per year.

D. In no case shall the application rate result in the runoff of applied wastewater during or immediately following application.

7. Nitrogen Loading. Nitrogen application rates shall not exceed the amount of nitrogen that can be utilized by the vegetation to be grown. Typical domestic wastewater after lagoon storage can be expected to contain from five to eight milligrams per liter (5–8 mg/l) of ammonia nitrogen as N and less than one milligrams per liter (1mg/L) of nitrate nitrogen as N. Ammonia nitrogen can be adsorbed onto soil particles and retained in the soil for later use by plants and microorganisms. However, nitrate nitrogen is mobile and will readily leach through the soil profile if wastewater is applied faster than the vegetation or soil microbes can utilize the nitrates. If the applied wastewater is expected to provide more than one hundred fifty pounds (150 lbs.) of total nitrogen per acre annually or if the applied wastewater exceeds ten (10) mg/l of nitrate nitrogen as N, then calculations shall be submitted to show the amount of plant-available nitrogen provided and the amount of nitrogen that will be utilized by the vegetation to be grown.

8. Trace element loading. Consideration shall be given to the type and influence of any industrial wastes contributed to the wastewater stabilization pond. Typical domestic wastewater does not contain amounts of trace substances which are of concern for land application of wastewater under this rule. However, introduction of substances, such as excess sodium, chlorides, boron or other constituents, can have an adverse impact on soils and vegetation. Wastewater suitable for general land application shall not exceed the trace element concentrations in Table 4-5 of the *U.S. Environmental Protection Agency Process Design Manual for Land Treatment of Municipal Wastewater* (EPA 625-1/81-013).

9. Grazing and harvesting deferment. Grazing of animals or harvesting of forage crops should be deferred for up to thirty (30) days following wastewater irrigation depending upon ambient air temperature and sunlight conditions. The following deferments shall be considered:

A. During the period from May 1 to October 30 of each year, the minimum deferment from grazing or forage harvesting shall be fourteen (14) days;

B. During the period from November 1 to April 30 of each year, the minimum deferment from grazing or forage harvesting shall be thirty (30) days;

C. Grazing of sewage irrigated land is generally not recommended for lactating dairy animals unless there has been a much longer deferment period. The recommendations of the State Milk Board shall be followed; and

D. Deferment may not be required for irrigation water that has been disinfected so that the water contains less than four hundred (400) fecal coliform organisms per one hundred milliliters (100 ml).

(F) Operation and Maintenance. An operation and maintenance plan shall be provided to explain the key operating procedures at a level easily understood by the owner and the operator of the facility. An outline and brief summary of operations shall be provided as part of the facility plan. A detailed operation and maintenance plan shall be included as part of the submitted plans and at a minimum shall address maintenance of mechanical equipment and vegetative cover, monitoring, record keeping, operating procedures, application scheduling and winterization of the system.

1. Public Access Areas. The wastewater shall be disinfected prior to land application (not storage) in accordance with section (5) of this rule.

A. The wastewater shall contain as few of the indicator organisms as possible and in no case shall the irrigated wastewater contain more than one hundred twenty-six (126) Escherichia coliform organisms per one hundred milliliters (100 ml);

B. The public shall not be allowed into an area when application is being conducted; and

C. For golf courses utilizing wastewater, all piping and sprinklers associated with the distribution or transmission of wastewater shall be color-coded and labeled or tagged to warn against the consumptive use of contents.

2. Nighttime Irrigation

A. If land applying in evening or nighttime, an automatic notification alarm system shall be installed. The alarm system shall be installed on each pivot and pump system, and be capable of notifying an on-call operator when a fault occurs in the system. The alarm system shall also include pressure monitoring in case of line break or other malfunctions that causes leaks.

B. The operations and maintenance manual shall include provisions on daily operator checks of the system to ensure that the irrigation pumping and pivot systems are working properly and that there is no runoff from any field where the irrigating pivot is currently located. The manual shall include provisions for stress testing the system at least once per season to ensure the alarm system is operating properly and the system components are in good condition.

3. System Monitoring. An appropriate monitoring system shall be provided to determine the quality of water leaving the land treatment site and entering surface and/or ground water. Analysis of soil and plant tissue samples may be required to monitor the effect of the wastewater on the soil and crop.

(9) Subsurface Irrigation

(A)Subsurface Irrigation systems, also known as drip dispersal systems, are designed and operated to allow the soil to provide final treatment of the wastewater prior to its introduction to groundwater. Dispersal and treatment occurs via physical, chemical and biological processes within the soil and through evapotranspiration and nutrient uptake by plant matter. There are many factors to be considered when designing drip dispersal systems, such as the quality of treated effluent being applied, depth of soils, and retention time in the soils before water returns to either ground water or surface water.

(B) Preliminary Treatment. Subsurface Irrigation shall be preceded by preliminary treatment. Preliminary treatment shall be at a minimum being treated with a septic tank, however secondary treatment technologies should be used.

1. When using septic tank effluent there shall be a minimum of two feet (2') of sand fill material and two feet (2') of naturally occurring soils between the bottom of the trench rock and the highest elevation of the seasonal high groundwater level, bedrock, or other limiting layer; or

2. When using secondary treatment there shall be a minimum of one foot (1') of material and two feet (2') of naturally occurring soils between the bottom of the trench rock and the highest elevation of the seasonal high groundwater level, bedrock, or other limiting layer.

(C) Design.

1. Drip dispersal design submittals should take into consideration all factors influencing the infiltrative capacity of the soil and the ability of the soil and site to transport ground water away from the application area. It should be noted that the use of historical information from existing systems installed and operated in similar soils, with documented loading rates, landscape positions and design conditions similar to the proposed system may be applicable. Therefore, soils that have been highly compacted and/or disturbed, such as old road beds, foundations, etc., must be excluded when evaluating suitable areas for drip dispersal systems.

(17)

2. Sites with seasonal high groundwater less than twenty-four (24) inches deep may require drainage improvements before they can be utilized for slow rate land treatment. The design hydraulic conductivity at such sites is a function of the design of the drainage system.

3. The design wastewater loading is a function of:

- **a. Precipitation.**
- **b. Evapotranspiration.**
- **c. Design hydraulic conductivity rate.**
- **d. Nitrogen loading limitations.**
- **e. Other constituent loading limitations.**
- **f. Groundwater and drainage conditions.**
- **g. Average and peak design wastewater flows.**
- **h. Soil denitrification rates**
- **i. Rate of nitrogen uptake in site vegetation**

4. The design application rate in gallons per day per square foot (GPD/SF) shall be derived from either the hydraulic (water) loading rate (Lwh) based upon the most restrictive of

A. The NRCS hydraulic conductivity data and the texture and structure

B. The nutrient (nitrogen) loading rate (Lwn). The amount of wastewater that can be applied to a site may be limited by the amount of nitrogen in the wastewater. A particular site may be limited by the nitrogen content of the wastewater during certain months of the year and limited by the infiltration rate during the remainder of the year. The equation below shall be used to calculate, on a monthly basis, the allowable hydraulic loading rate based on nitrogen limits:

$$\mathbf{Lwn} = \frac{Cp\,(Pr - PET) + N(4.413)}{(1 - f)(Cn) - Cp}$$

Where: Lwn = allowable monthly hydraulic loading rate based on nitrogen limits, inches/month
Cp = nitrogen concentration in the percolating wastewater, mg/L. This will usually be 10mg/L Nitrate-Nitrogen
Pr = Five-year return monthly precipitation, inches/month
PET = potential evapotranspiration, inches/month
U = nitrogen uptake by cover, lbs/acre/year
N = nitrogen uptake by cover, lbs/acre/month
Cn = Nitrate-Nitrogen concentration in applied wastewater, mg/L (after losses in preapplication treatment)

f = fraction of applied nitrogen removed by denitrification and volatilization.

The Lwh value is determined by a detailed site evaluation and will be dependent upon the soil characteristics. The values of Lwh and Lwn are compared for each month. The lesser of the two values will be used to determine the amount of acreage needed.

5. Drip field area requirements. The minimum soil treatment area and total length. The system shall be sized in accordance with the following equations:

$$A = \frac{Q}{LTAR} \text{ and } L = \frac{A}{5\,feet}$$

Where:

(18) → A = Minimum LPP soil treatment area (square feet)

Q = Maximum daily sewage flow (gallons per day)

L = Minimum total length (feet)

LTAR = Long term acceptance rate (gallons per day per square foot). LTAR = Long term acceptance rate (gallons per day per square foot). This is the lowest reported conventional soil loading rate between the soil surface and at least twelve inches (12") below the fill.

(D) Soils. Moderately permeable and well-drained soils are desirable. Preliminary soil investigations should be done to identify areas best suited for subsurface wastewater drip dispersal.

1. The proposed drip dispersal area must be mapped at sufficient accuracy to identify each soils series (or lowest possible level of soil classification) present and the boundary location between series. Once those areas are identified, the more detailed procedures outlined below will be employed.

2. It is required that all soil investigations be performed by a qualified soil scientist. Evaluation of a soil area's suitability for drip dispersal should take into consideration limiting aspects of the soil profile.

3. Level sites with shallow restrictive horizons overlain by low permeability soils represent one of the more limited scenarios for drip dispersal and the application rate and/or application area should be suitably modified.

4. The use of any soil is should meet the following four (4) criteria:

A. The applied effluent loading rate does not exceed the applicable hydraulic loading rate in the table below. The applicable hydraulic loading rate is determined by a detailed site evaluation in which the site is mapped utilizing soil borings and pits to determine the physical properties of soil horizons and soil map units.

B. The applied effluent maximum loading rate does not exceed 10% of the minimum NRCS saturated vertical hydraulic conductivity (K_{SAT}) for the soil series, the results of the nutrient loading rate, or 0.20 gallons per day per square foot whichever is least.

C. The soil does not have a restrictive horizon within its top twenty (20) inches.

D. The soil is well drained, or capable of being drained.

5. It is desirable to have a minimum depth of twenty (20) inches of undisturbed soil above a restrictive horizon which may need to be increased as slope increases. This is necessary to provide adequate installation depth and buffer below the drip line.

6. Even if a soil meets the depth requirements it may not be suitable due to the texture and/or structure. If a soil shows signs of wetness within a depth of 20 inches of the soil surface, it will most likely require a soil improvement practice such as an interceptor or drawdown drain. The location and size of the drains and buffers must be factored into the total area required for the drip dispersal system.

(E) Lines and Trenches.

1. Drip dispersal lines should be placed at depths of six (6) to ten (10) inches below the surface. The drip lines should be laid level and should run with the contour.

2. The emitter line spacing and emitter spacing shall be at 2-foot spacing to achieve even distribution of the wastewater and maximum utilization of the soil.

3. The vertical separation between the bottom of the trench and a limiting layer, including but not limited to, bedrock; restrictive horizon; or seasonal high water table, shall be no less than twenty-four inches (24") or shall be no less than twelve inches (12") for systems dispersing secondary or higher quality effluent.

4. Vertical separation shall be no less than forty-eight inches (48") where karst features are present unless the site can be reclassified;

5. Trenches shall be spaced at least five feet (5') apart on centers. When trench spacing is greater than five feet (5'), a maximum effective area of up to five square feet (5 sq.ft.) of soil treatment area per foot of trench may be allowed.