Attachment F

Kansas Department of Health and Environment
Division of Environment

REGULATORY IMPACT STATEMENT

Pursuant to K.S.A. 77-416

Proposed New Regulations:
K.A.R. 28-16-160 through 28-16-174

May 14, 2004

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DOCUMENTS REFERENCED IN THE REGULATIONS

Federal Water Pollution Control Act (Clean Water Act - 33 U.S.C. 1251 et seq.) as in effect November 27, 2002.

Kansas Sensitive Groundwater Areas for Wastewater Lagoons - November 1, 2003.

Kansas Department of Health and Environment - Minimum Standards of Design for Water Pollution Control Facilities - 1978.

Executive Summary Of Proposed New Regulations

The Kansas Department of Health and Environment (KDHE) is proposing to adopt a series of new regulations specifically targeting municipal, commercial, and industrial wastewater lagoon requirements.

In February 2003, Roderick Bremby, Secretary of the Kansas Department of Health and Environment, announced it was his goal to move forward with development of groundwater-protection practices for the Equus Beds Region as well as other sensitive groundwater areas of the state. Secretary Bremby noted many valid concerns have been raised about the need for additional requirements to contain, treat and dispose of wastewater generated by municipal, commercial, industrial, and livestock facilities in Kansas. KDHE is developing a separate parallel regulation package addressing livestock waste management systems and lagoons. To address these concerns, Secretary Bremby initiated a process within KDHE to develop and finalize draft regulations that would establish requirements covering sources of wastewater from all of these sectors. Secretary Bremby directed the regulations be scientifically and technically sound, utilizing information and approaches shown to be effective. Because the Equus Beds Aquifer serves as a source of water for many residences, businesses and farms, and serves a large portion of the state's population, particular emphasis is directed at protecting this aquifer.

One part of implementing the Secretary's goal is the development and adoption of a series of new regulations specifically targeting municipal, commercial, and industrial wastewater lagoon requirements. The proposed regulations will:

1. Provide for enhanced groundwater protection by addressing the design, construction and operation of wastewater lagoons which serve municipal, commercial, and industrial facilities.

2. Convert, in the case of industrial wastewater lagoon systems, Policy Memorandum #90-2 (September, 1990) titled, "Industrial Wastewater Pond Liner Policy" into regulation and make the requirements an enforceable part of KDHE's Minimum Standards of Design for Water Pollution Control Facilities (1978).

3. Update design and construction requirements in the KDHE Minimum Standards of Design for Water Pollution Control Facilities employed in the design of wastewater treatment systems serving municipal, commercial, and industrial facilities. Specifically, the updates will reflect the research findings of the Kansas State University (KSU) Study regarding the effectiveness of earthen lagoons for the containment and treatment of livestock waste. While the KSU Study specifically targets livestock waste, many of the study findings are directly applicable to municipal, commercial, and industrial waste as well.

4. Provide uniformity in regard to KDHE's approach in the design, construction, and use of wastewater lagoon systems serving municipal, commercial, and industrial facilities. While there are significant differences in the various wastes generated by these facilities, there are areas of common concern to which KDHE desires to provide a uniform approach in addressing.

KDHE's role in the handling, treatment, and disposal of wastewater can be traced back to the formation of the Kansas State Board of Health on April 10, 1885. Over the years, the agency has monitored the research and technical developments associated with the protection of public health

and the treatment and disposal of wastewater. In 1951, the Kansas Legislature enacted K.S.A. 65-171h which authorized the agency to develop minimum standards for sanitary water and sewage systems. Specifically K.S.A. 65-171h states, "The secretary of health and environment in pursuance of his general power of supervision over the interests of the health and life of the citizens of the state, and the sanitary conditions under which they live and in order to protect the quality of the waters of this state for beneficial uses, is hereby authorized and empowered to develop, assemble, compile, approve and publish minimum standards of design, construction, and maintenance of sanitary water and sewage systems, and shall publish and make available such approved minimum standards to municipalities, communities and citizens of this state, and shall from time to time make recommendations to the appropriate committees of the legislature, for any legislation that may be required to adequately protect air and enclosed spaces, and water supply from contamination." In 1957, the Kansas State Board of Health published "Policies Governing The Design Of Sewerage Systems In Kansas". These appear to be the first documented formal design standards addressing municipal, commercial, and industrial wastewater treatment, in Kansas. In 1966, the Kansas State Board of Health adopted K.A.R. 28-16-1 through 28-16-7. These regulations address information required for obtaining sewage discharge permits. Information required to be submitted to the agency to obtain a permit includes an engineering report, construction plans, and construction specifications.

In late 1973 and early 1974, the agency began seeking authorization from the U.S. Environmental Protection Agency (EPA) to administer on behalf of EPA, in Kansas, the National Pollutant Discharge Elimination System (NPDES) program. The NPDES program is a national water pollution permitting program which regulates the discharge of wastewater and pollutants to "Waters of the United States". Authorization to administer the NPDES program in Kansas was granted in 1974. Also in 1974, the Kansas State Board of Health was converted into a cabinet level agency which is now KDHE. KDHE, as a result of implementing the NPDES program and administering a federal construction grant program utilized by municipalities to upgrade their wastewater treatment systems, updated the design standards employed for wastewater treatment systems. In 1978, KDHE published the Minimum Standards of Design for Water Pollution Control Facilities which remains in effect to date. Over the years, the agency has become involved in various groundwater remediation projects. Along with improper handling and disposal of waste by various municipal, commercial, and industrial operations, the agency began noting that a large number of the remediation projects were associated with current or past use of earthen lagoons for handling various types of waste. While the lagoons proved effective in protecting surface waters, their impact on groundwater quality had not been fully understood. As additional information was developed in regard to remediation projects, data from groundwater monitoring wells that KDHE required to be installed at various wastewater lagoon systems, and research work conducted, it became clear that the containment and/or treatment of certain types of waste in earthen lagoon systems did not provide adequate protection of groundwater resources. With the widely varying types of waste industry generates, KDHE took the stance that unless the industrial wastewater was characteristic of non-contact cooling water or conventional domestic-type wastewater, industries utilizing a lagoon system should employ an impermeable synthetic membrane liner system to protect groundwater resources. In September 1990, KDHE published Policy Memorandum #90-2 titled "Industrial Wastewater Pond Liner Policy". A copy of Policy Memorandum #90-2 is provided in the appendices. Because synthetic membrane liner systems are composed of manmade materials which have a limited operational life, and which are exposed directly to the environment, KDHE felt the use of a secondary containment liner with an intermediate leak detection system was necessary. The secondary liner serves two purposes. The secondary liner allows for the installation of a leak detection system between the two liners as well as providing secure secondary

containment in the event the primary lagoon liner fails. While providing effective secondary containment, it also enables the industry and KDHE time to effectively evaluate the reason and scope of the liner failure and to develop, review and approve an effective game plan for the liner repair or replacement. The secondary liner, because of the varied nature of the wastes directed to and contained by industrial wastewater lagoons, would enable an industry to find a means by which they can dispose of the lagoon contents in an environmentally safe and legal manner. The proposed regulations convert the current industrial wastewater pond liner policy into enforceable regulatory requirements.

In 1994, Seaboard began developing large swine operations in Kansas. Significant public interest was generated as a result of the large swine operations being developed by Seaboard and others. One aspect of the public concern was directed at protecting groundwater resources. As Seaboard and others continued to develop large swine operations in Kansas, public interest and concern continued to grow to the point where in late 1996 or early 1997 Governor Graves and KDHE Secretary O'Connell retained Kansas State University to determine if KDHE's design standards for livestock waste facilities were adequately protecting groundwater. During the 1998 Legislative Session, the Legislature passed into law House Bill 2950 which modified a number of water pollution control statutes specifically addressing groundwater protection requirements and the use of lagoons at swine facilities. Kansas State University completed a number of reports regarding their research on the use of earthen lagoons for the handling and treatment of livestock waste. Four reports have been generated to date with the first being published April 28, 1998, the second being published June 23, 1999, the third being published June 30, 2000, and the most recent being published February 2001 which summarized study results to date and provided recommendations for further study. Key findings from the various Kansas State University studies include:

- Data suggests that KDHE's design maximum allowable seepage rate criteria of 1/4-inch per day can be achieved typically with the soils encountered when adequate field compaction is provided. Compaction characteristics of the samples showed that construction practices may strongly influence liner permeability.

- Seepage (permeability) of the soil liner decreased with time as some degree of sealing resulted from organic sludge on the bottom of the lagoons clogging pore spaces between soil particles.

- KSU's review of 200 scientific reports and documents found seepage losses from lagoons typically decrease rapidly during the first six months following the initial introduction of livestock waste as a result of the organic sludge physically clogging soil pores.

- The potential for groundwater contamination decreases when the separation distance between the bottom of the wastewater lagoon and the top of the groundwater table increases.

- With livestock waste lagoons, ammonia accounted for over 99% of the soluble nitrogen in the wastewater. Data from the soil samples collected beneath the lagoons found that ammonia was being adsorbed by negatively charged soil particles (clay minerals) retarding the movement of ammonia and decreasing the risk of groundwater contamination. The rate at which nitrogen is adsorbed and retarded beneath the lagoon is highly dependent upon the soil cation exchange capacity (CEC). The CEC of the compacted soil liner and the underlying native soil should be considered when siting and designing a livestock waste lagoon. Increasing the thickness of the soil liners with high-CEC clays could help trap

ammonia, prevent it's downward migration, and simplify closure and remediation procedures.

- Lagoon soil liners can typically be constructed of Kansas soils so as to achieve seepage rates less than 1/10-inch per day. Constructed soil liners typically 12-18 inches thick can achieve a seepage rate less than 1/10-inch per day if both soil moisture and compaction are adequately controlled and monitored throughout construction.

While municipal, commercial, and industrial waste can vary greatly from livestock waste, many of the concerns associated with the release of nitrogen compounds from the livestock waste are applicable to municipal, commercial, and industrial waste when employing an earthen lagoon system. Many industrial wastes such as brines generated by industries in water softening activities, the processing of animal hides, salt production, and chemical production are not amenable for containment in earthen lagoons as the negatively charged anions in the soil (clay minerals) do not adsorb or retard the movement of the negatively charged anions such as chlorides. For certain types of industrial wastes, a constructed soil liner or existing soils will not provide an effective pollution barrier.

Environmental Benefit Statement

1. Need for proposed amendments and environmental benefit likely to accrue.

a. Need

K.A.R. 28-16-160. Definitions.

The purpose of K.A.R. 28-16-160 is to provide a listing of terms and their definitions which are currently utilized in implementing state water pollution control activities, consolidate and reference the source of terms and their definitions utilized from other KDHE water pollution control statutes and regulations specifically applicable to lagoons, and to provide new terms and their definitions required to implement the proposed liner regulations.

Key terms defined in this regulation include "Equus beds", "Groundwater", "Impermeable synthetic membrane liner", "In existence", "Liner", "Maximum soil liner seepage rate" or "specific discharge", "Maximum synthetic membrane liner leakage rate", and "Sensitive groundwater areas".

K.A.R. 28-16-161. Municipal and commercial lagoons: general provisions.

K.A.R. 28-16-161 establishes general provisions applicable to all municipal and commercial wastewater lagoons. The regulation prohibits siting new lagoons where a minimum of 10 feet of separation between the lagoon bottom and groundwater cannot be provided. The regulation establishes a three tier protection program centered around the Equus Beds Aquifer, sensitive groundwater areas, and the remainder of the state. For the Equus Beds, the regulation mandates the use of a single impermeable synthetic membrane liner. The regulation establishes provisions under which an alternative soil liner may be employed within the Equus Beds if more than 10 foot of separation is provided between the lagoon bottom and groundwater, insitu soils can provide an effective pollution barrier, a maximum soil liner seepage rate less than 1/10-inch per day can be achieved, and a groundwater monitoring well program is established and implemented. Lagoons to be constructed over sensitive groundwater areas, excluding the Equus Beds, may employ a soil liner system so long as the maximum soil liner seepage rate is less than 1/10-inch per day. The remainder of the state which is neither in a sensitive groundwater area nor the Equus Beds may employ a soil liner system so long as the maximum soil liner seepage rate is less than 1/4-inch per day. In lieu of a soil liner system, the use of a single impermeable synthetic membrane liner may be employed. The regulation provides a grandfathering provision for existing lagoons so long as they pose no human health or environmental threat. The regulation requires a permit to construct, operate, or maintain a wastewater lagoon.

K.A.R. 28-16-162. Industrial lagoons: general provisions.

K.A.R. 28-16-162 prohibits the siting of new wastewater lagoons where a minimum of 10 feet of separation between the lagoon bottom and the top of the groundwater table cannot be provided. The regulation establishes a three tier protection program. It establishes specific provisions for wastewater lagoons employed to treat or contain domestic wastewater only, it addresses lagoons containing process wastewater with a low pollution potential, and establishes requirements for lagoons containing process wastewater. As with the general provisions for the municipal and commercial lagoons, industrial lagoons utilized solely for the containment or treatment of domestic

sewage may employ a soil liner system with requirements specifically targeted to whether the lagoon is located within the Equus Beds, a sensitive groundwater area, or the remainder of the state. Wastewater lagoons utilized solely for domestic wastewater constructed over the Equus Beds are required to employ a single impermeable synthetic membrane liner. An alternative soil liner system may be employed if a minimum of 10 feet of separation between the lagoon bottom and the top of the groundwater exist, insitu soils can provide a sufficient and effective pollution barrier to protect groundwater, a maximum soil liner seepage rate less than 1/10-inch per day can be achieved, and a groundwater monitoring well program is established and implemented. Lagoons utilized solely for the containment or treatment of domestic wastewater constructed over sensitive groundwater areas, other than the Equus Beds, may employ a soil liner system so long as the maximum soil liner seepage rate is less than 1/10-inch per day. Lagoons utilized solely for the containment or treatment of domestic wastewater and which are located over neither a sensitive groundwater area nor the Equus Beds may employ a soil liner so long as the maximum soil liner seepage rate is less than 1/4-inch per day. The regulation categorizes industrial wastewater, excluding domestic sewage, as either being process wastewater or low pollution potential process wastewater. Low pollution potential process wastewater is considered to be relatively innocuous and is not considered to pose either a significant human health or environmental threat to groundwater. As such, the regulations enable the use of a soil liner system for the containment or treatment of process generated wastewater from specific industrial activities listed in the regulation. In general, the types of pollutants being addressed are inert solids or cooling water to which chemicals have not been added. A soil liner system may be employed statewide so long as the maximum soil liner seepage rate is less than 1/4-inch per day. A single impermeable synthetic membrane liner may be employed in lieu of a soil liner system for lagoons utilized to contain or treat either domestic wastewater or low pollution potential process wastewater. For industrial process wastewater, the regulations require a dual impermeable synthetic membrane liner system which employs a leak detection system between the two liners and establishes maximum synthetic membrane liner leakage rate to be the more stringent of either 1/64 inch per day or the liner manufacturer's criteria. The regulation provides a grandfathering provision for existing lagoons so long as they pose neither human health nor an environmental threat. The regulation requires a permit to construct, operate, or maintain an industrial wastewater lagoon.

K.A.R. 28-16-163. Required hydrogeologic information for new or modified municipal, commercial, or industrial wastewater lagoons.

The proposed regulation establishes provisions addressing specific hydrogeologic information that municipal, commercial, and industrial facilities are required to submit when proposing to utilize a wastewater lagoon. The regulation requires soil borings or excavations to a depth of at least 10 feet below the proposed lagoon bottom be provided or to impenetrable bedrock, if it is encountered before reaching the 10 foot depth. The boring or excavation will enable the lagoon designer to obtain information regarding the geology of the proposed lagoon site, obtain soil samples for analysis, to log the various soil types encountered, and to confirm whether the 10 foot lagoon/groundwater separation requirement can be met. Excavations or borings less than 10 feet below the proposed lagoon bottom may be allowed if impenetrable rock is encountered. The proposed regulation establishes the number of borings or excavations that are required which are based upon the lagoon size with a minimum of one boring or excavation required for a lagoon. The regulation establishes minimum requirements for the hydrogeologic site investigation which includes the logging of all borings or excavations, identifying soil type(s) encountered, recording the ground surface elevation and location of each boring or excavation, and measuring the static

groundwater level if groundwater is encountered. The regulation also requires the development and submission of a summary, along with or as a part of the engineering report, evaluating the hydrogeologic information. The regulation requires the applicant to advise KDHE a minimum of two days prior to performing any hydrogeologic investigation field work activities to enable agency staff to be on site and witness those activities, if desired by KDHE. Hydrogeologic information is to be obtained by or under the direct supervision of either a professional engineer or geologist licensed to practice in Kansas.

K.A.R. 28-16-164. Municipal, commercial, and industrial wastewater treatment system lagoons: soil liner design.

K.A.R. 28-16-164 establishes provisions addressing the submission with the construction plans and specifications sufficient hydrogeologic information, soil testing data, and calculations to document the use of insitu soils or a constructed soil liner, whether soil amendments are utilized or not, in a manner which will comply with the required maximum allowable soil liner seepage rate criteria. It also requires that a minimum of one foot of natural soil or compacted soil, be provided for the lagoon system. In the case of an impermeable synthetic membrane liner, the one foot of soil will provide the foundation on which the impermeable synthetic membrane liner will be installed.

K.A.R. 28-16-165. Municipal, commercial, and industrial soil liners: postconstruction testing.

K.A.R. 28-16-165 establishes provisions requiring that with the submission of the construction plans and specifications for a proposed lagoon that will employ a soil liner system, that information regarding the method(s) to be employed for postconstruction testing of the soil liner system, to ensure compliance with the maximum allowable soil liner seepage rate provisions, be provided for the Department's review and approval. The regulation establishes requirements for the submission of a certification by a professional engineer, licensed to practice in Kansas, who monitored the construction activities and installation of the soil liner system that the wastewater lagoon and wastewater lagoon soil liner system were constructed in accordance with the plans and specifications approved by the Department. The regulations require that along with the certification that, when requested by KDHE, any supporting documentation regarding the construction of the lagoon and soil liner system be submitted for KDHE review. The regulation requires that within eight months following approval by KDHE to initiate use of the lagoon, or an alternative time period approved by KDHE, the permittee is required to conduct and report post construction testing of the soil liner for compliance with the maximum allowable soil liner seepage rate criteria. The regulation establishes procedures to be followed in the event the criteria was not met. The regulation requires the Department be notified a minimum of two days in advance of any soil liner seepage testing to enable staff an opportunity to witness the test.

K.A.R. 28-16-166. Requirements for impermeable synthetic membrane liners in municipal or commercial wastewater treatment system lagoons.

K.A.R. 28-16-166 establishes general provisions applicable to all impermeable synthetic membrane liners proposed to be employed for municipal or commercial wastewater lagoons. The proposed regulation incorporates numerous provisions that had been previously addressed in Policy Memorandum #90-2 (September 1990) titled "Industrial Wastewater Pond Liner Policy". The regulation establishes a minimum liner thickness to be employed, it requires information to be

submitted by the liner manufacturer confirming compatibility for use of the liner with the proposed wastewater to be retained or treated and that the specified liner is ultraviolet resistant. It requires the liner manufacturer to provide a liner transmissivity rate which reflects the expected rate of movement of fluids through the synthetic membrane liner under "normal" conditions. The regulation addresses embankment compaction requirements to provide a stable foundation on which the liner will be installed. The regulation addresses provisions to ensure the liner is adequately anchored to the top of the wastewater lagoon dike in a manner that will prevent the liner from moving and preventing undue stress being placed on the membrane liner. The regulation requires the liner be installed in accordance with the liner manufacturer's instructions and by a contractor experienced in the installation of impermeable synthetic membrane liners or that the contractor provide for on-site supervision of the liner installation by an individual that has experience in liner installation practices. The regulation requires the plans and specifications identify provisions for use of a reliable seam testing method to monitor installation of the liner. In addition, it is required that all field seams be subjected to non-destructive testing to ensure the liner is installed properly. Provisions addressing the construction of the lagoon system or the installation of the liner not addressed in the proposed regulations are to conform with provisions contained in the Kansas Minimum Standards of Design for Water Pollution Control Facilities (September 1978). The regulations require that a minimum of two feet of insitu soil or compacted soil be provided beneath the liner or bedding material. The regulation requires the development and submission with the construction plans and specifications of a contingency plan, for KDHE review and approval, that outlines procedures for operation of the lagoon and containment of the waste in the event routine maintenance or dewatering is required due to a liner failure or the need to replace the liner. The regulation also requires the permittee to cease operations upon the direction of KDHE in the event of an actual or potential imminent threat to public health or the environment.

K.A.R. 28-16-167. Requirements for impermeable synthetic membrane liners in industrial wastewater treatment system lagoons.

K.A.R. 28-16-167 establishes provisions addressing requirements for industrial facilities that will utilize wastewater treatment lagoons employing impermeable synthetic membrane liners. The major difference between K.A.R. 28-16-167 and K.A.R. 28-16-166 is that a single impermeable synthetic membrane liner may be employed when used for municipal or commercial wastewater lagoons. Because of the highly varied nature of industrial waste generated during production activities, industrial operations proposing to utilize a lagoon system to retain or treat industrial waste shall utilize an impermeable synthetic membrane liner system employing a primary and secondary membrane liner between which an intermediate leak detection system is to be provided. Requirements regarding liner thickness, certifications and information to be obtained from the liner manufacturer, compaction requirements, anchoring the liner at the top of the embankment, installation of the liner in accordance with the liner manufacturer's instructions and by a person knowledgeable with liner installation practices, specifications regarding seam testing methods, the testing of all field seams using non-destructive test methods, and conforming with the Kansas Minimum Standards of Design for Water Pollution Control Facilities (September 1978) are identical to the provisions of K.A.R. 28-16-166. The primary differences with the provisions of K.A.R. 28-16-166 include the use of a double membrane liner system with an intermediate leak detection system, providing a minimum of two cells to allow for flexibility of operation and maintenance which could be waived by the Department if an approved alternative wastewater disposal option is available, providing for an intermediate leak detection system that will ensure that any fluid collected between the two liners can be adequately directed to the leak detection monitoring location for detection and

removal, and providing for a minimum of two feet of insitu or compacted soil beneath the bottom of the secondary liner and/or liner bedding material. The intermediate leak detection system is to be designed such that fluids penetrating the primary liner will have a maximum travel time to reach the leak detection monitoring location in less than 24 hours. The regulation requires the intermediate leak detection system be able to be dewatered and the dewatering system be capable of handling a minimum of 10 times the maximum allowable impermeable synthetic membrane liner leakage rate.

K.A.R. 28-16-168. Postconstruction testing of municipal, commercial, and industrial impermeable synthetic membrane liners.

K.A.R. 28-16-168 establishes provisions addressing the postconstruction testing of impermeable synthetic membrane liners. The regulation requires the submission of a testing protocol(s) with the submission of construction plans and specifications for KDHE review and approval. The testing protocol is to ensure the liner has been installed properly and the maximum allowable synthetic membrane liner leakage rate is less than the more stringent of either 1/64-inch per day or the liner manufacturer's criteria. Within 45 days of completing construction, the permittee shall provide to KDHE a certification by a licensed professional engineer that construction of the lagoon structure and installation of the membrane liner have been completed in conformance with the KDHE approved plans and specifications. Within two months of KDHE authorizing use of the lagoon, or an alternative time frame approved by KDHE, the permittee shall submit a certification by a licensed professional engineer whether the liner installation complies with the maximum allowable synthetic membrane liner leakage rate criteria. In the event the criteria cannot be met, the test report shall provide a plan and schedule of proposed actions required to achieve compliance. The regulation requires the Department be notified a minimum of two days in advance of any impermeable synthetic membrane liner leak testing to enable Department staff an opportunity to witness the test.

K.A.R. 28-16-169. Minimum standards of design, construction, and maintenance.

K.A.R. 28-16-169 establishes that the design and construction of municipal, commercial, or industrial wastewater treatment facility lagoons are to conform with effluent standards, pretreatment requirements, other performance standards, the Kansas Minimum Standards of Design for Water Pollution Control Facilities, or the specific provisions of these regulations. In the event there is a discrepancy between these regulations and existing regulations or the Kansas Minimum Standards of Design for Water Pollution Control Facilities, these regulations control.

K.A.R. 28-16-170. Water, oil, or gas wells.

The proposed regulation provides consistency with the current Livestock Waste Management Regulations which require that any active, abandoned, or plugged water, oil, or gas well within 600 feet of any proposed location of a wastewater lagoon be identified on the construction plans and specifications. The purpose of this identification is to alert KDHE of the potential so that we can ensure adequate separation is provided from these wells and that the wells, if abandoned, are properly plugged. The regulation also addresses provisions in which an abandoned well may be encountered during the course of construction activities which had not been identified up to that point in time. The regulations require notification of KDHE of the well, and if construction activities could impact the well, those construction activities are to be terminated until such time as KDHE

authorizes the construction to resume. This regulation mirrors requirements in a portion of the H.B. 2950 during the 1998 Legislative Session in regard to oil and gas wells. When KDHE developed more detailed regulations implementing the provisions of H.B. 2950 for the Livestock Waste Management Program, the Department included provisions addressing water wells. The adoption of this regulation will make the municipal, commercial, and industrial lagoon regulations consistent with the Livestock Waste Management Regulations. The purpose of the regulation is to eliminate potential conduits along which waste from a lagoon system could migrate downward and contaminate water bearing formations.

K.A.R. 28-16-171. Monitoring wells.

K.A.R. 28-16-171 notes the Department may require the installation and sampling of groundwater monitoring wells in the vicinity of any municipal, commercial, or industrial wastewater lagoon. Depending upon site-specific situations, KDHE may determine that conditions exist which warrant the installation of groundwater monitoring wells to ensure that groundwater resources are being adequately protected. The regulation, because of ongoing research and improvements in technology and product development, enables KDHE to allow use of equivalent technologies in lieu of groundwater monitoring wells, if the technology is approved by the Department. To ensure groundwater monitoring wells are located and constructed properly, the regulation requires the approval of the proposed location, design, and construction of any monitoring well or equivalent technology prior to it being installed. Consistent with current statutes and regulations, the regulation requires the installation of monitoring wells by KDHE licensed water well contractors. If monitoring wells or an alternative equivalent technology is required by KDHE, the regulations require the development and submission for KDHE review and approval of a groundwater sampling and monitoring plan. The regulation also stipulates the minimum requirements for a groundwater sampling and monitoring plan.

K.A.R. 28-16-172. Plan and specification approval; permit issuance.

K.A.R. 28-16-172 provides that regardless of KDHE approval of any engineering report, hydrogeologic report, construction plans, specifications, or the issuance of a permit, these actions will not constitute a defense by the permit applicant or permittee regarding any violation of any statute, regulation, permit condition, or requirement. The regulation also addresses the fact there are to be no deviations from the plans and specifications submitted to and approved by KDHE unless the amended plans have been reviewed and approved by the Department.

K.A.R. 28-16-173. Municipal, commercial, and industrial wastewater lagoons: closure requirements.

K.A.R. 28-16-173 establishes requirements which address wastewater lagoon closure. The regulation requires that KDHE be notified whenever an operator decides to cease operation of, close, or abandon a municipal, commercial, or industrial wastewater lagoon. The intent is to require the development of a formal closure plan which KDHE would review and approve prior to the operator formally closing and abandoning the wastewater lagoon. The regulation requires that each operator is to maintain and comply with a valid and effective Kansas water pollution control permit until such time as KDHE approves the closure of the wastewater lagoon(s). For any new or modified wastewater lagoon, the permit applicant is to develop and submit with the construction plans and specifications a closure plan for review and approval by KDHE. Closure plans are not

to be implemented until authorized by the Department. The regulation specifies minimum requirements to be included in the wastewater lagoon closure plan. These minimum requirements include the means by which the operator proposes to deactivate the various wastewater collection and treatment units employed at the facility, procedures to clean out the lagoon and to remediate any contaminated soils or groundwater, a description as to what the lagoon operator proposes to do with the wastewater lagoon structure, procedures addressing the plugging of any water wells or groundwater monitoring wells associated with the facility, and an estimate of the design life of an impermeable synthetic membrane liner if utilized at the lagoon. The regulation requires the permittee update the wastewater lagoon closure plan or to prepare a closure plan when directed by the Department. The regulation establishes a time frame for the completion of the lagoon closure which is not to exceed more than one year from the date of authorization by the Department to initiate the proposed closure. The regulation also addresses provisions for an extension of time for closure of the wastewater lagoon and the procedures by which the extension is to be requested.

K.A.R. 28-16-174. Variance of specific requirements.

K.A.R. 28-16-174 addresses provisions by which a variance to the proposed liner regulations can be requested. Variance requests are to be submitted in writing to the Secretary and shall provide information and data relevant to the variance request. The variance request is to specifically identify why the variance should be considered and how the requested variance addresses the intent of the wastewater lagoon regulations and provides for the protection of public health and the environment.

b. Environmental Benefit

K.A.R. 28-16-160. Definitions.

Not applicable. Within the context of the regulatory impact statement, this regulation will not have a direct impact on public health or the environment. The proposed regulation addresses current definitions utilized in the administration of KDHE's municipal, commercial, and industrial water pollution control program activities. The regulation also includes the addition of new terms and definitions required to administer the provisions of the proposed wastewater lagoon regulations.

K.A.R. 28-16-161. Municipal and commercial lagoons: general provisions.

This regulation contains four major provisions which would provide for an environmental benefit. While the proposed regulation does not promulgate or amend contaminant specific standards or program requirements for which a risk analysis might be completed, the four provisions do provide for an environmental benefit.

The proposed regulation prohibits the construction of a lagoon at a site where the separation distance between the bottom of the lagoon and the top of the groundwater table is 10 feet or less. This provision is more stringent than the current Minimum Standards of Design for Water Pollution Control Facilities currently utilized by KDHE, as the current design standards automatically allow use of an artificial liner or the installation of a 1½ foot clay blanket to provide groundwater protection. The intent of the regulation is to prohibit the construction of any proposed new wastewater lagoon or the expansion of an existing wastewater lagoon where the lagoon

bottom/groundwater separation distance of 10 feet or more cannot be met. The intent is to recognize the findings of the KSU Lagoon Studies which identified a correlation between lagoon/groundwater separation and groundwater contamination from wastewater lagoons. The regulation allows for consideration of alternatives to the prohibition if scientific and engineering data can be provided to support such an alternative.

The regulation provides for three tiers of groundwater protection depending upon whether the proposed wastewater lagoon site is located over the Equus Beds Aquifer or over some other sensitive groundwater area within the state. The Equus Beds area has been defined as the area within the boundary of Groundwater Management District No. 2 which comprises approximately 1.68% of the total state area. The regulations define Sensitive Groundwater Areas as areas composed of alluvial aquifers, the Dune Sand Area located south of the Great Bend of the Arkansas River, and the Equus Beds. The Sensitive Groundwater Areas (including the Equus Beds) comprises an area of approximately 20.82% of the entire state.

For the majority of the state which does not include either Sensitive Groundwater Areas or the Equus Beds, new or modified wastewater lagoon systems may employ the use of a soil liner system with a maximum soil liner seepage rate less than 1/4-inch per day. The soil liner seepage requirements are unchanged for approximately 79.18% of the state due to the lack of groundwater or limited vulnerability due to local geology and/or groundwater depth.

Sensitive Groundwater Areas include alluvial aquifers, the Dune Sands located south of the Great Bend of the Arkansas River, and the Equus Beds as defined by the boundary of GMD #2. The proposed regulation reduces the maximum allowable soil liner seepage rate criteria from less than 1/4-inch per day to less than 1/10-inch per day. Achieving the proposed maximum soil liner seepage rate criteria will require more control and monitoring on the part of the contractors during construction to ensure adequate compaction is provided, soil moisture is controlled, as well as possibly requiring the amendment of the soil liner system with some type of sealing material such as bentonite clay. The increased compaction, control of the soil moisture, and possible amendment of the soils with bentonite will reduce the seepage rate of the lagoon by more than 50% over the current soil liner standard. Adequate compaction of the soils, control of the soil moisture, and use of soil amendments can reduce the movement of wastewater through the lagoon bottom and side slopes which could potentially impact groundwater quality.

For the Equus Beds (GMD #2) area, the regulation proposes that a single impermeable synthetic membrane liner be employed whenever a municipal or commercial wastewater lagoon or an industrial wastewater lagoon utilized solely for the treatment of domestic wastewater is proposed to be constructed. The use of the impermeable synthetic membrane liner would provide for a maximum leakage rate of less than 1/64-inch per day which is significantly more protective than the current 1/4-inch per day soil liner requirement. The impermeable synthetic membrane liner provides enhanced protection of the Equus Beds Aquifer which is typically shallow, composed of porous soils, and is utilized by a large portion of the state's population as their source of public water supply. Because of the varying geology within the Equus Beds Aquifer, the regulation allows for the consideration of alternatives to the mandated impermeable synthetic membrane liner which will be considered only if scientific and engineering information can be provided to support use of the alternative and that it will ensure protection of public health and the environment.

While the regulation does not promulgate or amend a contaminant specific standard, two pollutant concerns typically associated with municipal and commercial operations and industrial lagoons

utilized solely for the treatment of domestic wastewater, are the nitrogen components of the wastewater, existing primarily in the forms of ammonia and nitrates, and pathogenic organisms. By reducing the seepage rate of the lagoon liner, the potential transmission of pathogenic organisms to the groundwater table is significantly reduced. Enhanced construction requirements reducing the seepage through the bottom and side slopes of the lagoon and employing materials such as clay possessing a high cation exchange capacity not only helps retard the movement of ammonia through the soil liner by physically restricting fluid movement but also serves as a material onto which the positively charged cations of ammonia can be adsorbed. Ammonia can be converted into nitrates which are very mobile and move through soils into the groundwater. Nitrates, in sufficient concentrations, in foods and water consumed by infants may result in infant methemoglobinemia (blue baby disease). The maximum contaminant level for drinking water set by the U.S. Environmental Protection Agency for nitrate is 10 mg/l. The proposed regulation will further restrict the vertical movement of pollutants from the wastewater lagoons to the groundwater. Continued research will further our understanding of the various mechanisms employed and how design and construction practices can be modified to further enhance groundwater protection.

K.A.R. 28-16-162. Industrial lagoons: general provisions.

The proposed regulation does not promulgate or amend contaminant specific standards for which a risk analysis might be completed. The regulation establishes three general classes of industrial wastewater lagoons i.e., domestic wastewater, low pollution potential industrial wastewater, and industrial process wastewater. The first category of industrial lagoons are those which are utilized solely for the containment or treatment of domestic sewage. The wastewater lagoons can be directly compared to the types of wastewater lagoons used to retain and treat domestic wastewater by municipal and commercial wastewater treatment facilities. The second category includes wastewater lagoons associated with various industrial activities which typically generate wastewater or stormwater runoff containing inert solids such as rock dust, clay solids, lime sludge, concrete, or heat from cooling water systems. The third category of industrial lagoons would include any wastewater lagoon used to retain or treat process wastewater or a combination of process wastewater and domestic sewage or cooling water.

The first category of industrial wastewater lagoons would be utilized solely for the containment or treatment of domestic sewage. The proposed regulation would allow use of a soil liner system with the same provisions and maximum allowable soil liner seepage criteria as previously detailed in K.A.R. 28-16-161 for municipal and commercial wastewater lagoons.

The second category of industrial wastewater lagoons are employed to address sediment control associated with aggregate wash water and quarrying operations at limestone quarries, stormwater runoff from clay pit operations, classification and aggregate washing operations associated with sand and gravel dredging, erosion control ponds associated with construction activities, lime sludge ponds associated with water softening operations, concrete washed off of and from concrete delivery trucks, heat associated with cooling water systems, and irrigation tailwater control ponds utilized at industrial wastewater land application sites, which are dewatered at the completion of each irrigation cycle. They may employ wastewater lagoons with soil liner systems with maximum allowable soil liner seepage rates less than 1/4-inch per day. These industrial activities represent only a limited pollution threat to groundwater. Utilization of the maximum allowable soil liner seepage rate of less than 1/4-inch per day conforms to current wastewater lagoon soil liner sealing criteria. While the majority of the waste being addressed by these wastewater lagoons represent

inert suspended solids such as dirt, rock dust, and concrete, use of the soil liner and the 1/4-inch per day seepage criteria will help ensure the construction of the lagoon does not create or enhance the potential for contaminating groundwater by exposing conduits such as fractured bedrock or highly permeable soils such as sand and gravel formations which could allow pollutants on the ground surface to move unabated to the groundwater.

The third category of industrial wastewater lagoons implements the provisions of KDHE's Policy Memorandum #90-2 (September, 1990) titled "Industrial Wastewater Pond Liner Policy". The intent of the policy is to provide a mechanism by which KDHE can address the highly varied types and nature of industrial process wastewater being generated by manufacturing processes throughout the state. The process wastewater being generated varies significantly in both quantity and quality and is dependent upon the specific industry type and manufacturing operations employed. While Kansas is primarily an agricultural state, there are a number of widely varying and diverse types of industrial manufacturing operations located throughout the state. Refinery operations typically generate hydrocarbon type product wastes which include volatile organic compounds such as benzene which is a known carcinogen. Several industries repackage or formulate pesticide and herbicide materials. Inorganic chemical manufacturing includes operations which produce phosphoric acid and generate arsenic waste as a byproduct. Several industries produce explosives and firearm propellants containing perchlorate. Federal facilities manufacture military munitions and propellants. The aircraft industry and machinery production operations throughout state employ metal finishing operations which generate waste containing solvents as well as heavy metals which may be toxic and carcinogenic to humans. Certain types of food processing operations such as meat packing plants generate high strength organic waste which can generate high concentrations of ammonia. Fertilizer manufacturing operations typically create various types of nitrogen compounds which end up in the wastewater. The formation of nitrates from these nitrogen sources can cause methemoglobinmia (blue baby disease) in infants. Some cooling water systems recycle water numerous times concentrating the salts in the water. To maintain an acceptable water quality for use in the cooling water system, chemicals are added to stabilize the water to prevent scaling as well as to control biological growth in the cooling water system. Coal fired power plants control stormwater runoff from coal piles and coal ash which contain concentrations of heavy metals. As seen with the research conducted at Kansas State University in regard to the use of earthen wastewater lagoons for livestock wastes, which primarily targeted pathogenic organisms, ammonia, and nitrates, the use of soil liner systems can be very technically challenging. For KDHE to evaluate and develop specific criteria for each type of industrial waste being generated and determine whether use of a soil liner system is acceptable, would both be administratively overwhelming and technically impractical. The proposed regulation requires industrial process wastewater to be contained in a lagoon system employing two impermeable synthetic membrane liners which are separated by an intermediate leak detection system. The impermeable synthetic membrane liner system is to provide a maximum allowable synthetic membrane liner seepage rate which is the more stringent of either 1/64-inch per day or the liner manufacturer's criteria for the material and the installation of their synthetic membrane liner product. The proposed impermeable synthetic membrane liner system, at this time would be considered "state or the art" and provides a number of environmental benefits including the enhanced "seepage" rate control criteria. Because impermeable synthetic membrane liner systems are constructed of manmade materials and the liners are exposed to the environment, the use of a dual liner system provides for total containment in the event a leak or other failure occurs in the primary liner. Many of the materials contained in industrial wastewater lagoons could potentially be considered hazardous waste or a waste for which it may be hard to find an alternative means for treatment and disposal in a short time frame. The use of a secondary liner system

would prevent a potential release into the environment if the primary liner is breached and provides a means by which the lagoon operator and KDHE can evaluate the problem, develop and implement a disposal plan to allow the dewatering and repair of the lagoon, and a method for monitoring to detect when the primary liner containment fails. Use of the double liner system would allow KDHE to work with the lagoon operator in a manner which is not a "crisis situation". The secondary liner provides a mechanism by which KDHE and the lagoon operator can address the situation in a measured and controlled manner as opposed to a "crisis situation". The secondary containment system would prevent and eliminate the need for possible soil and groundwater remediation activities as no release to the environment would take place. As with any manmade material, at some point in time the useful life of the liner will be reached and the liner system will have to be replaced. Situations also can occur as a result of the liner being exposed to the environment in which "Acts of God", vandalism, and other situations which impact the structural integrity of the primary liner may occur. Because of the highly variable nature of the industrial process wastewater generated by industrial activities, certain types of materials such as highly concentrated brines utilized in the tanning of hides at meat packing plants, salt production, or the use of brine in moving liquified petroleum gas (LPG) into and from large underground salt storage caverns create situations in which the use of earthen lagoons employing soil liner systems are ineffective. The chloride ion is highly mobile and clay materials are ineffective in retarding or containing it's movement. Unlike ammonia, which is a cation and is adsorbed by the clay particles, the chloride anion is repelled and moves relatively unimpeded through clay soils and compacted soil liner systems. Because of the large volumes of chlorides employed in the LPG underground storage operations and other industries, the use of tankage is not feasible because of cost and the fact that concentrated brines are very corrosive to metals. Metal tankage also is not feasible for containment or storage of highly acidic wastewater.

The remainder of the regulation essentially mirrors the requirements previously addressed in K.A.R. 28-16-161.

K.A.R. 28-16-163. Required hydrogeologic information for a new or modified municipal, commercial, or industrial wastewater lagoons.

While the proposed regulation does not promulgate contaminant specific standards or program requirements for which a risk analysis might be completed, it does provide an environmental benefit. The proposed regulation details specifically what information KDHE expects to see when a hydrogeologic investigation is conducted for a proposed lagoon site. The proposed regulation addresses the administrative criteria as to how the hydrogeologic investigation is to be implemented addressing such things as confirmation of the 10 foot separation criteria between the proposed lagoon bottom and groundwater table, specifying the use of borings or excavations in obtaining hydrogeologic information, the extent to which borings and excavations are required based on the size of the proposed lagoon(s), collection of samples for laboratory analysis to aid in design and construction, and the summarizing of findings and data obtained and submitted as a part of the engineering report. Requires KDHE notification prior to conducting field work to enable staff to witness the soil borings or excavations. The hydrogeologic work is to be conducted by either a professional engineer or geologist licensed to practice in Kansas.

K.A.R. 28-16-164. Municipal, commercial, and industrial wastewater treatment system lagoons: soil liner design.

Not applicable. The proposed regulation does not promulgate or amend contaminant specific standards or program requirements for which a risk analysis might be completed. The regulation requires that with the submission of the construction plans and specifications that detailed hydrogeologic information be submitted addressing the proposed design and use of the lagoon soil liner system and documenting the capability of meeting the maximum allowable soil liner seepage criteria.

K.A.R. 28-16-165. Municipal, commercial, and industrial soil liners: postconstruction testing.

Not applicable. While the proposed amendment does not promulgate or amend contaminant specific standards or program requirements for which a risk analysis might be completed, the proposed regulation does provide an environmental benefit by monitoring the construction of the soil liner and assuring that construction of the soil liner system was completed in a manner that complied with the construction plans and specifications approved by KDHE. The regulation requires an inspector be on site and witness construction activities and construction monitoring practices. It requires a licensed professional engineer to certify the construction. The regulation requires the development and submission for KDHE review and approval a soil liner postconstruction testing protocol. The regulation requires a licensed professional engineer to certify postconstruction seepage testing results within eight months of KDHE authorizing use of the lagoon. The environmental benefit this will provide is to ensure the groundwater protection provisions of the designed soil liner system have been provided during construction.

K.A.R. 28-16-166. Requirements for impermeable synthetic membrane liners in municipal or commercial wastewater treatment system lagoons.

Not applicable. Within the context of the regulatory impact statement, this regulation will not have a direct impact on public health or the environment. Rather, the regulation addresses procedures and criteria specifically addressing impermeable synthetic membrane liners and their installation. The regulation does have an environmental benefit in that it will help ensure the installation of an impermeable synthetic membrane liner system is done in a manner consistent with practices acceptable to the liner manufacturer and utilizes materials appropriate for the containment and treatment of municipal or commercial wastewater.

K.A.R. 28-16-167. Requirements for impermeable synthetic membrane liners in industrial wastewater treatment system lagoons.

Not applicable. Within the context of the regulatory impact statement, this regulation will not have a direct impact on the environment as it adopts procedures and requirements related to impermeable synthetic membrane liners. As with K.A.R. 28-16-166, the proposed regulation establishes requirements assuring the impermeable synthetic membrane liner system is installed in a manner consistent with the liner manufacturer's requirements as well as addressing the intermediate leak detection system installation to ensure that leakage from the primary liner can be detected in an appropriate and timely manner. The requirements are identical to those in K.A.R. 28-16-166 in regard to liner thickness, certifications to be obtained from the liner manufacturer,

compaction of the wastewater lagoon bottom and embankments, and liner installation and seam testing. Because of the enhanced requirements for the use of impermeable synthetic membrane liners when employed to retain or treat industrial process wastewater, additional provisions specifically targeting the secondary liner and intermediate leak detection system are also provided. The intermediate leak detection system provides an early warning mechanism by which failure of the primary liner containment can be detected and wastewater in the lagoon can be contained and prevented from being released directly into the environment. The environmental benefits of the dual liner-intermediate leak detection system include 100% secondary containment, prevention of soil or groundwater contamination if the primary liner fails, and a positive means to detect, in a timely manner, when a primary liner failure occurs.

K.A.R. 28-16-168. Postconstruction testing of municipal, commercial, and industrial impermeable synthetic membrane liners.

Not applicable. Within the context of the regulatory impact statement, this regulation will not have a direct impact on public health or the environment. The proposed regulation will have an environmental benefit in ensuring the installation of the impermeable synthetic membrane liner is conducted in an acceptable manner and that upon initiation of use complies with the maximum allowable synthetic membrane liner leakage criteria. The regulation also requires the submission of a certification by a professional engineer licensed to practice in Kansas the lagoon was constructed and the liner installed in a manner approved by KDHE.

K.A.R. 28-16-169. Minimum standards of design, construction, and maintenance.

Not applicable. Within the context of the regulatory impact statement, this regulation will not have a direct impact on public health or the environment. The regulation addresses current procedures utilized in administering the design and review of water pollution control facilities associated with municipal, commercial, and industrial facilities.

K.A.R. 28-16-170. Water, oil, or gas wells.

Within the context of the regulatory impact statement, this regulation will not have a direct impact on public health or the environment. The proposed regulation will have an environmental benefit. The proposed regulation addresses provisions regarding notification of KDHE in the event an active or abandoned water, oil, or gas well is found to be located in the vicinity of the proposed lagoon site. Existing or abandoned water, oil, or gas wells provide a potential conduit along or through which contaminants from the surface can be introduced into a groundwater aquifer. This requirement was added for a number of reasons. Existing water, oil, or gas wells need to be located sufficiently far enough away from a proposed lagoon system such that any mounding of wastewater beneath the lagoon does not come into contact with the well casing or borehole which could potentially serve as a conduit for movement of fluid which has seeped from the bottom of the lagoon. Abandoned water, oil, or gas wells may provide a direct unobstructed conduit if the interior well casing has not been properly plugged. By identifying active and abandoned wells in the immediate vicinity of a proposed lagoon site, KDHE staff can evaluate the potential for groundwater contamination and require that necessary steps are taken to minimize and/or eliminate this potential. Abandoned water supply wells will be required to be plugged by KDHE. Abandoned oil and gas wells identified will be brought to the attention of the Kansas Corporation Commission for proper plugging. The construction of a lagoon over an existing or abandoned water, oil, or gas well

represents a high potential for groundwater contamination. If such a well is encountered during construction because it was unknown to exist or could not be located, the regulation requires that KDHE be notified and that construction activities either be diverted around this area or construction activities be terminated until such time as KDHE authorizes construction to resume. The environmental benefit drive here is the potential elimination of a direct conduit through which pollutants can be introduced to a groundwater aquifer.

K.A.R. 28-16-171. Monitoring wells.

Within the context of the regulatory impact statement, this regulation will not have a direct impact on public health or the environment as it implements KDHE's current authority to require the installation of monitoring wells when deemed appropriate at municipal, commercial, or industrial wastewater treatment facility lagoons. The regulation does acknowledge that with the change in research and technology associated with groundwater monitoring activities, that an equivalent technology, in lieu of the installation and sampling of groundwater monitoring wells may be employed, if approved by KDHE. The regulation also requires the development and submission for review and approval of a groundwater sampling and monitoring protocol. The protocol will help ensure the quality of the groundwater data generated from the monitoring well system.

K.A.R. 28-16-172. Plan and specification approval; permit issuance.

Within the context of the regulatory impact statement, this regulation will not have a direct impact on public health or the environment. The regulation is intended to advise the design engineer and permittee that regardless of KDHE approvals, any engineering report, hydrogeologic report, construction plans, construction specifications or the issuance of a water pollution control permit shall not constitute a defense by the permittee regarding violation of any statute, regulation, permit condition, or requirement. The regulation also provides administrative details addressing the fact that no deviation from construction plans and specifications are allowed unless KDHE has approved the proposed modifications prior to their implementation.

K.A.R. 28-16-173. Municipal, commercial, and industrial wastewater lagoons: closure requirements.

This regulation will have an environmental benefit. While the regulation primarily addresses the implementation of current practices and procedures employed by KDHE regarding lagoon closures, there are a number of new provisions the regulation would implement. Any new lagoon system or an expansion of an existing lagoon system would require the development of a formal closure plan for the entire facility to be submitted at the time the construction plans and specifications are submitted to KDHE for review and approval. The regulation details minimum requirements to be addressed by the lagoon closure plan. Based on information provided in the Kansas State University Lagoon Studies, there may be situations in which a remediation of contaminated soils and/or groundwater may prove sufficiently costly to warrant utilization of impermeable synthetic membrane liners. The intent is to have the design engineer and permit applicant consider and compare the short term capital costs of installing the soil liner vs. the potential long term operational costs involved in ultimately closing out the lagoon system. The regulation stipulates a time frame for the completion of the lagoon closure which is an attempt to eliminate a potential pollution source and to address situations which appear from the KSU Lagoon Study which could potentially allow the conversion of adsorbed ammonia to a more mobile nitrate form which could move to the

groundwater table once the lagoon is dewatered. More detailed research is required to fully understand the fate of the ammonia tied to the clay particles in the lagoon liner and soils beneath the lagoon once the lagoon has been emptied and becomes deactivated.

K.A.R. 28-16-174. Variance of specific requirements.

Within the context of the regulatory impact statement, this regulation will not have a direct impact on public health or the environment. This regulation provides a mean by which a variance to the regulatory requirements can be requested. Recognizing that technology continues to advance in regard to monitoring and construction practices as well as materials employed in the use of impermeable synthetic membrane liners, this regulation was added to allow the agency flexibility to consider alternatives to the regulation requirements if the design engineer or permit applicant can document, to KDHE's satisfaction, that the intent of the regulation is being met and adequate public health and environmental protection would be provided.

2. When applicable, a summary of the research or data indicating the level of risk to the public health or the environment being removed or controlled by the proposed regulations or amendments.

As discussed in the Executive Summary, significant interest in the design and construction of wastewater lagoons employed by the livestock industry started around 1994 with several large swine operations being constructed in Kansas. As a result of public concern over potential impacts these facilities may have on the groundwater resources of the state, Governor Graves and KDHE Secretary O'Connell consulted with and retained Kansas State University (KSU) to determine if KDHE's design standards for livestock waste control facilities were adequately protecting groundwater. House Bill 2950 during the 1998 Legislative Session modified a number of water pollution control statutes specifically addressing groundwater protection requirements and the use of wastewater lagoons with soil liner systems at swine facilities. During the course of the debate regarding livestock waste management practices and the use of wastewater lagoons, similar concerns were directed at whether municipal, commercial, and industrial wastewater lagoons were also providing adequate groundwater protection. Kansas State University released the first of four reports they developed on August 28, 1998. This report is titled "Evaluation Of Lagoons For Containment Of Animal Wastes". The second report by KSU dated June 23, 1999 is titled "Animal Waste Lagoon Water Quality Study". The third report released dated June 30, 2000 is titled "Animal Waste Lagoon Water Quality Study". A fourth report was published in February, 2001 and is titled "Animal Waste Management And Utilization" which summarizes the findings of the KSU four year study of the impacts of earthen lagoons used for livestock wastes. While KSU's four reports are primarily targeted at the use of earthen lagoons for controlling livestock waste and their impact on soil and groundwater resources, many of the findings and recommendations are directly applicable to and warrant consideration by KDHE in regard to design and construction practices associated with wastewater lagoons utilized to treat municipal, commercial, and industrial wastewater. The following paragraphs summarize some of KSU's findings which have applicability in regard to the proposed municipal, commercial, and industrial wastewater lagoon liner requirements being proposed by the regulation package.

KSU found KDHE's current 1/4-inch per day seepage (permeability) rate can typically be achieved using a wide range of soils, collected throughout the state, which had varied textures and properties provided that field compaction is adequate and a soil liner greater than 12 inches is utilized. KSU

also found that seepage could be controlled to less than 1/10-inch per day utilizing standard construction practices so long as 12-18 inches of compacted soil liner is utilized and built from appropriate soils. Construction practices controlling soil moisture and compaction are key to achieving a seal resulting in seepage less than the 1/10-inch per day rate.

As a part of the research work conducted by KSU, they developed equipment which could monitor with great sensitivity, over relatively short periods of time, seepage rates of wastewater lagoon systems. KSU's equipment was found to have an accuracy of ±0.02 inches per day over a brief 5-10 day period when evaporation was small (less than 0.23 inches per day). The cost of the testing is relatively inexpensive and provides a field test of the actual lagoon seepage rate as opposed to laboratory testing of soil/liner samples. In their report, KSU found there was a difference in results between whole pond seepage testing and results obtained from laboratory testing of the soils/liner which can vary significantly.

KSU's research found that compaction characteristics of the soil samples analyzed indicate construction practices may strongly influence liner permeability.

Testing the soil's hydraulic properties found that some degree of sealing resulted from organic sludge accumulating on the bottom of the lagoons. KSU found that whole pond seepage test results of lagoons that were placed into service and being used were approximately five times less than those seepage rates measured and calculated from soil cores collected prior to the addition of waste to the lagoon system. KSU conducted reviews of over 200 scientific papers and determined that seepage losses decrease rapidly during the first six months following the introduction of waste into a lagoon. The reduction in lagoon seepage appears to be the result of a sludge mat being created on the bottom of the lagoon which reduces the liner permeability by physically clogging the soil pores. Additionally, but to a much lesser extent, biological factors play a minor role in the apparent sealing process. Evidence from both the literature and KSU's research indicates that most of the seepage from a lagoon originates from the sides of the lagoon where the liquid surface meets the side-embankment. A lack of a sludge layer on the side slopes of the lagoon system coupled with erosion, freezing-thawing, wetting-drying, and biological processes such as root intrusion from deep rooted vegetation and burrowing activities of earthworms can significantly increase the permeability of the side slope embankments of an earthen lagoon.

KSU believes that a comprehensive environmental assessment or design of lagoons requires consideration of three focus areas:

a. Toxicity - What are the constituents in the lagoon waste that pose a threat to water quality and public health?

b. Input loading - At what rate does the waste seep from the lagoon under field conditions?

c. Aquifer vulnerability - How do soil properties, geology, and water table depth affect the risk of waste movement from a lagoon to the groundwater?

KSU studies have primarily concentrated on livestock waste lagoon systems. One of the primary concerns evaluated by KSU is the movement of various forms of nitrogen through the lagoon liner which could ultimately reach the groundwater table. Livestock waste lagoons may contain high concentrations of ammonia. KSU found that with livestock lagoons, approximately 99% of all the

soluble nitrogen in the wastewater was in the form of ammonia. The ammonia concentrations varied widely from facility to facility as well as species of livestock involved. Ammonia concentrations ranged from 550 - 900 mg/l for swine facilities and 20 - 200 mg/l for cattle facilities. In monitoring the livestock wastewater lagoons for nitrates, KSU found that in all cases the nitrates were less than 3 mg/l. Other waste parameters monitored by KSU included sodium which ranged from 148 - 270 mg/l at swine operations and chlorides which ranged from 275 - 569 mg/l at both swine and cattle operations. For comparison purposes, typical raw untreated municipal wastewater ammonia concentrations will range from 15 - 25 mg/l. The reduction of ammonia through biological, physical, and chemical means within municipal wastewater lagoons typically results in concentrations in the final lagoon cell of ammonia less than 2 mg/l and nitrates less than 1 mg/l.

KSU's review of various scientific papers and data collected as a part of their research work found significant quantities of ammonia were being tied up or retained within the soils comprising the lagoon liner and soils immediately beneath the lagoon system. KSU found ammonia losses to the soils comprising the lagoon liner and those immediately beneath the lagoon could exceed 100,000 lbs of nitrogen per acre, at livestock facilities, over a 20-30 year operational period for the lagoon system. In one case, KSU estimated ammonia subsurface losses could exceed 2,640 lbs per acre per year and that over a 20 year operational life of the lagoon system 250,000 lbs of ammonia would be "captured" in the soils immediately beneath the lagoon system. KSU found the positive charged ammonium cation is readily adsorbed by the negatively charged clay particles comprising the lagoon soil liner and soils beneath the lagoon. Up to a point, depending upon the cation exchange capacity (CEC), the clay particles would continue to attract and retain the ammonia until the clay particles become "saturated". In reviewing scientific literature, KSU determined the majority of studies involving medium to fine textured soils found no appreciable nitrogen contamination in the groundwater within 100 feet of the lagoons. The studies did show that in coarse-textured soils, appreciable nitrogen contamination in the groundwater did occur. The literature also indicated that when groundwater depth was greater than 100-130 feet, few cases of groundwater contamination were documented. The nitrogen (ammonia) is adsorbed by the soil directly beneath the lagoon. The highest soil ammonium concentrations found by KSU range from 800 - 1,100 mg/l and were found immediately beneath the lagoon floor. Sampling of the soil at different depths found the ammonium concentration to decrease rapidly with depth. It appears that approximately 90% of the ammonia is trapped in the first 12 feet of soil located immediately beneath the lagoon bottom.

KSU found the movement of ammonia beneath the lagoons to be dependent upon liner thickness, CEC of the soil liner material, liner soil hydraulic properties (seepage), the type of soil composition beneath the lagoon liner (clay content), and soil mixture CEC, which all have a dramatic effect on how fast the nitrogen would move beneath the constructed soil liner of a lagoon. The KSU study noted an increase in liner thickness from ½ foot to 3 feet caused a nine fold reduction in the ammonia concentration exiting the bottom of the soil liner and increased the time for the ammonia to penetrate the soil liner from five years to 65 years.

The KSU study notes a concern regarding the potential for a significant fraction of the "stored" nitrogen in the soils of the liner and beneath the lagoon being converted to the more mobile form as nitrate when the lagoons are deactivated and allowed to dry. KSU notes the need for additional research as to the long term fate of ammonia adsorbed by the soil directly beneath the lagoon system once a lagoon is taken out of service. The potential of the "trapped" ammonia being converted into a more mobile form, nitrate, highlights the importance of developing a plan to reclaim the nitrogen beneath the lagoons after the lagoon is dewatered and closed.

Based upon the research conducted to date, KSU notes that proposed lagoon locations with coarse-textured soils, low soil cation exchange capacities, and shallow groundwater may require low permeability soil liners or the use of impermeable synthetic membrane liners to protect groundwater.

In 2000, KSU monitored seepage from several lagoons in the Equus Beds Region. Their findings indicate that, like other areas in Kansas, there are good and bad places to build lagoons in that region. KSU noted there are places in the Equus Beds that had clay soils and a water table 30-40 feet from the surface and would be a safe place to build a wastewater lagoon. KSU also noted there are numerous locations in the Equus Beds Region that have shallow groundwater and very sandy soils.

In regard to the nitrogen component of livestock waste, KSU is proposing the use of a "logical framework" (decision tree) to be used to customize lagoon requirements for new facilities on a site-specific basis. KSU contends the approach will encourage producers to build new lagoons in areas with a lower risk. While the logical framework process, as proposed by KSU, appears to potentially be a valuable tool when considering nitrogen compounds, use of the KSU tool for the numerous and varied pollutants generated by industrial activities is not practical, at this time. Many of the industrial pollutants have human health criteria with extremely low concentrations. In addition, many of the industrial pollutants of concern produce negatively charged anion components (chlorides) in the wastewater which can be retarded somewhat by limiting the physical movement of fluid through the soil liner but will not have the same adsorption benefit as documented by KSU's research data with ammonia. Further documentation regarding potential pollutants of concern and their public health impact criteria are provided in the following section.

3. If specific contaminants are to be controlled by the proposed regulations or amendment, a description indicating the level at which the contaminants are considered harmful according to current available research.

The proposed regulations do not target a specific contaminant or contaminants. The intent of the regulation package is to provide for enhanced groundwater protection by reducing or eliminating the release of various contaminants which could potentially impact public health or the environment. KSU's recommendations regarding lagoon construction should prove an effective means by which to control pathogenic organisms and nitrogen compounds from livestock, municipal, commercial, and industrial waste lagoons. Because of the highly varied nature of the waste generated by industrial processing activities in Kansas, a "one size that fits all" scenario is impractical. Much of the information developed during the course of the KSU studies regarding fate and transport of wastewater pollutants as well as the "retarding" effect the soil liner has on contaminant movement has yet to be established for many other chemical compounds and contaminants of concern which are associated with industrial wastewater. Recognizing that groundwater contamination has occurred in the past from improper handling and disposal of industrial waste throughout the state, it is very apparent that many of the chemical contaminants of concern are very mobile and easily find their way into the groundwater, potentially impacting the environment and public health. In recognizing this situation, KDHE has chosen to be proactive by requiring the use of impermeable synthetic membrane liners for lagoons which will be utilized to retain or treat industrial process wastewater. While the regulations do not directly target specific contaminants to be controlled, the following table has been developed in an attempt to provide a sense of the magnitude a contaminant release to groundwater could potentially have on impacting

water supplies from a public health prospective. The parameters listed in the table reflect Maximum Contaminant Levels (MCLs) established by the U.S. Environmental Protection Agency and represent the maximum level of a contaminant in drinking water at which no known or anticipated adverse affect on the health of persons would occur. In addition, where an applicable MCL may not exist but where known human health cancer risk levels have been established, those values have been provided. The values listed in the table, unless otherwise noted, are expressed in micrograms per liter (ug/l) which represents one part in one billion. Another typical unit of measure employed when referencing concentrations is milligrams per liter (mg/l) representing one part in one million. There are 1,000 ug/l in 1 mg/l. To put this into perspective, 1 mg/l would be equivalent to 1 inch in 15.8 miles while 1 ug/l would be equivalent to 1 inch in 15,780 miles. Another example would be 1 mg/l would be 1 minute in 23 months while 1 ug/l would be 1 minute in 1,901 years. In reviewing the accompanying table one can observe that public health criteria for water supplies contains very low concentrations for various contaminants. This is one of the major reasons why, in addition to the lack of contaminant specific information on which to design lagoon soil liner systems, KDHE has chosen to employ the use of impermeable synthetic membrane liners. The cancer risk levels provided in the table represent a cancer risk level of 10^{-6} or one additional case of cancer in a population of one million.

Contaminants and Public Health Criteria	
Parameter	Public Health Criteria for Water Supplies ug/l (Part Per Billion) unless otherwise noted
RADIONUCLIDES (pCi/L)	
gross beta radioactivity	50 (pCI/L)
gross alpha particles including radium-226, but not radon or uranium	15 (pCi/L)
radium 226 and 228 combined	5 (pCi/L)
strontium 90	8(pCi/L)
tritium	20,000 (pCi/L)
METALS	
antimony, total	6
arsenic, total	10
barium	2,000
beryllium, total	4
cadmium, total	5
chromium, total	100
chromium (III)	50
chromium (VI)	50
copper, total	1,300
lead, total	15
mercury, inorganic	2
nickel, total	100
selenium, total	50
silver, total	100
thallium, total	2

Contaminants and Public Health Criteria	
Parameter	Public Health Criteria for Water Supplies ug/l (Part Per Billion) unless otherwise noted
OTHER INORGANIC SUBSTANCES	
asbestos (µfibers/L)	7,000,000
chloride	250,000
cyanide (free)	200
fluoride	4,000
nitrate (as N)	10,000
nitrite (as N)	1,000
sulfate	250,000
ORGANIC SUBSTANCES	
Benzenes	
benzene	5
chlorobenzene	100
o-dichlorobenzene	600
m-dichlorobenzene	400
p-dichlorobenzene	75
1,2,4-trichlorobenzene	70
hexachlorobenzene	1
ethylbenzene	700
nitrobenzene	17
vinylbenzene (styrene)	100
Ethers	
bis(2-chloroethyl)ether	0.031
bis(2-chloroisopropyl)ether	1,400
Halogenated Hydrocarbons	
1,2-dichloroethane	5
1,1,1-trichloroethane	200
1,1,2-trichloroethane	5
1,1,2,2-tetrachloroethane	0.17
hexachloroethane	1.9
1,1-dichloroethylene	7
cis-1,2-dichloroethylene	70
trans-1,2-dichloroethylene	100
trichloroethylene	5
tetrachloroethylene	5
Chlorinated Propanes/Propenes	
1,2-dichloropropane	5
1,3-dichloropropene	10

Contaminants and Public Health Criteria	
Parameter	Public Health Criteria for Water Supplies ug/l (Part Per Billion) unless otherwise noted
Other Halogenated Hydrocarbons	
halogenated methanes, total	100
1,2-dibromoethane	0.05
tribromomethane (bromoform)	4.3
bromodichloromethane	0.27
dibromochloromethane	0.41
dichloromethane (methylene chloride)	5
trichloromethane (chloroform)	5.7
tetrachloromethane (carbon tetrachloride)	5
di(2-ethylhexyl)adipate	400
hexachlorobutadiene	0.44
hexachlorocyclopentadiene	50
vinyl chloride	2
Miscellaneous Organics	
dioxin (2,3,7,8 TCDD)	0.00003
isophorone	8.4
polychlorinated biphenyls, total	5
Nitrogen Compounds	
N-nitrosodimethylamine	0.00069
N-nitrosodiphenylamine	5
acrylonitrile	0.059
benzidene	0.00012
3,3'-dichlorobenzidine	0.04
1,2-diphenyl hydrazine	0.04
Polynuclear Aromatic Hydrocarbons, total	0.2
acenaphthhene	1200
anthracene	9,600
benzo(a)anthracene	0.0028
benzo(a)pyrene	0.2
benzo(b)fluoranthene	0.0028
benzo(k)fluoranthene	0.0028
chrysene	0.0028
dibenzo(a,h)anthracene	0.0028
fluoranthene	300
fluorene	1,300
ideno(1,2,3-cd)pyrene	0.0028
pyrene	960

Contaminants and Public Health Criteria	
Parameter	Public Health Criteria for Water Supplies ug/l (Part Per Billion) unless otherwise noted
Phthalate Esters	
butylbenzyl phthalate	100
di(2-ethylhexyl)phthalate	6
dibutyl phthalate	2,700
diethyl phthalate	5
Phenolic Compounds	
phenol	21,000
2,4-dimethyl phenol	540
chlorinated phenols	
2-chlorophenol	120
2,4-dichlorophenol	93
2,4,6-trichlorophenol	2.1
pentachlorophenol	1
2,4-dinitrophenol	70
4,6-dinitro-o-cresol	13.4
Toluenes	
toluene	1,000
2,4-dinitrotoluene	0.11
xylene	10,000
PESTICIDES	
acrolein	320
acrylamide	0.01
alachlor (lasso)	2
aldicarb	3
aldicarb sulfone	2
aldicarb sulfoxide	3
aldrin	0.00013
atrazine (aatrex)	3
barbofuran (furadan)	40
chlordane	2
2,4-D	70
dalapon	200

Contaminants and Public Health Criteria	
Parameter	Public Health Criteria for Water Supplies ug/l (Part Per Billion) unless otherwise noted
DDT and Metabolites	
4,4'-DDE (p,p'-DDE)	0.00059
4,4'-DDD (p,p'-DDD)	0.00083
DDT, total	0.00059
dieldrin	0.00014
dinoseb (DNBP)	7
diquat	20
alpha-endosulfan	0.93
beta-endosulfan	0.93
endosulfan sulfate	0.93
endothall	100
endrin	2
endrin aldehyde	0.76
epichlorohydrin	4
ethylene dibromide	0.05
glyphosate (roundup)	700
heptachlor	4
heptachlor epoxide	2
alpha-HHC	0.0039
beta-HHC	0.014
gamma-HCH (lindane)	2
methoxychlor	40
oxamyl (vydate)	200
picloram (tordon)	500
simazine (princep)	4
toxaphene	3
2,4,5-TP (silvex)	50

Economic Impact Statement

1. Are the proposed regulations or amendments mandated by federal law as a requirement for participating in or implementing a federally subsidized or assisted program?

The proposed regulations are not mandated by federal law as a requirement for participating in or implementing a federally subsidized or assisted program.

2. Do the proposed regulations or amendments exceed the requirements of applicable federal law?

The proposed regulations exceed the requirements of applicable federal law. Federal law, as administered by the U.S. Environmental Protection Agency, currently does not address minimum standards of design for water pollution controls for municipal, commercial or industrial facilities nor does the federal law establish groundwater quality standards in a similar manner in which they have adopted nationwide minimum standards for surface water quality criteria.

3. Description of cost to agencies, to the general public and to persons who are affected by, or are subject to, the regulations:

a. Capital and annual costs of compliance with the proposed regulations or amendments and the persons who will bear those costs.

K.A.R. 28-16-160. Definitions.

None. The proposed regulation does not subject the affected parties to additional cost of compliance. The regulation provides definitions used to administer the proposed regulations.

K.A.R. 28-16-161. Municipal and commercial lagoons: general provisions.

The projected increased capital and annual costs associated with the implementation of this regulation is expected to be less than $2,452,000 per year to municipal and commercial facilities.

K.A.R. 28-16-162. Industrial lagoons: general provisions.

The projected increased capital and annual costs associated with the implementation of this regulation is expected to range from $893,238 - $658,050 per year for industrial facilities.

K.A.R. 28-16-163. Required hydrogeologic information for new or modified municipal, commercial, or industrial wastewater lagoons.

The projected increased capital and annual costs associated with the implementation of this regulation is expected to be $56,121 per year for approximately 13 proposed municipal, commercial and industrial, lagoon sites.

K.A.R. 28-16-164. Municipal, commercial, and industrial wastewater treatment system lagoons: soil liner design.

None. The costs associated with this regulation have been previously summarized in K.A.R. 28-16-163 above.

K.A.R. 28-16-165. Municipal, commercial, and industrial soil liners: postconstruction testing.

The projected increased capital and annual costs associated with the implementation of this regulation is expected to be $231,280 per year for approximately 28 municipal, commercial, and industrial sites which will employ a soil liner system.

K.A.R. 28-16-166. Requirements impermeable synthetic membrane liners in municipal or commercial wastewater treatment system lagoons.

Refer to the fiscal impact related to synthetic membrane liners summarized in K.A.R. 28-16-161.

If a synthetic membrane liner were to be employed, an additional $110.00 per site would be required to specify postconstruction testing protocols to be employed.

K.A.R. 28-16-167. Requirements for impermeable synthetic membrane liners in industrial wastewater treatment system lagoons.

Refer to the fiscal impact related to synthetic membrane liners summarized in K.A.R. 28-16-162.

An additional $110.00 per site would be required to specify postconstruction testing protocols to be employed.

K.A.R. 28-16-168. Postconstruction testing of municipal, commercial, and industrial impermeable synthetic membrane liners.

The projected increased capital and annual costs associated with the implementation of this regulation is expected to be $10,060 per lagoon. Total estimated annual cost is $70,420 for approximately 7 municipal, commercial, and industrial sites which will employ an impermeable synthetic membrane liner system.

K.A.R. 28-16-169. Minimum standards of design, construction, and maintenance.

None. The proposed regulation does not subject the affected parties to additional costs of compliance. The regulation is used to administer the proposed wastewater lagoon regulations. Requirements for the compliance with the Minimum Standards of Design for Water Pollution Control Facilities can be found in K.A.R. 28-16-62 as well as requirements for treatment over and above minimum standards. Compliance with effluent standards, effluent limitations, pretreatment requirements, and other performance standards are also addressed in K.A.R. 28-16-57 and K.A.R. 28-16-57a.

K.A.R. 28-16-170. Water, oil, or gas wells.

None. There are no capital or annual costs expected. At most, a one time cost of between $6.00 to $25.74 would be expected to obtain information regarding any active, plugged or abandoned water, oil or gas wells located in the immediate vicinity of the proposed wastewater lagoon.

K.A.R. 28-16-171. Monitoring wells.

KDHE currently has authority to require groundwater monitoring at water pollution control facilities. The regulation is primarily administrative in nature implementing these provisions. If KDHE requires groundwater monitoring, it is expected that the affected parties would be subjected to additional costs of compliance requiring the installation of monitoring wells, periodic sampling and analysis of the groundwater, and reporting the results to KDHE. The cost to install a three well monitoring system is estimated at $4,597.60 for shallow wells (50 ft.) and $10,132.50 for deep (150 ft.) wells. Annual sampling and analysis of the three well monitoring system is estimated at $205.75. Annual reporting to KDHE is estimated at $20.37 which involves the submission of the lab analysis results.

K.A.R. 28-16-172. Plan and specification approval; permit issuance.

None. The proposed regulation does not subject the affected parties to additional costs of compliance. The regulation provides a notification to the permit applicant that KDHE's approval of any report, construction plans, or construction specifications will not constitute a defense by the

applicant if any statute, regulation, permit condition, or requirement is violated. The regulation also provides a notice that there shall be no deviation from the plans and specifications submitted to and approved by KDHE unless KDHE approves the proposed changes. This is consistent with requirements of III.C. of the Minimum Standards of Design for Water Pollution Control Facilities (September, 1978) and K.A.R. 28-16-7.

K.A.R. 28-16-173. Municipal, commercial, and industrial wastewater lagoons: closure requirements.

There are no expected capital or annual costs associated with the regulation. It is a one-time cost to develop a closure plan. Notification of KDHE regarding a proposed lagoon closure, possible permit annual fee required until KDHE approves the lagoon closure and development of a closure plan are associated with the one time cost. Notification costs could range from $3.00 to $15.37. Maintenance of a viable water pollution control permit and associated annual permit fee cost varies with the type of wastewater treatment system i.e., municipal and commercial permits $125.00, industrial permits $320.00, and quarry or stormwater construction runoff permits at $60.00. Development of a closure plan for municipal or commercial facilities is $550.00 and for industrial facilities is $500.00.

K.A.R. 28-16-174. Variance of specific requirements.

None. The proposed regulation is primarily administrative addressing the implementation of the wastewater lagoon liner requirements. The proposal does not entail any additional capital or annual costs.

b. Initial and annual costs of implementing and enforcing the proposed regulations or amendments, including the estimated amount of paperwork, in the state agencies, other governmental agencies or other persons or entities who will bear the costs.

K.A.R. 28-16-160 Definitions.

None. The proposed regulation does not subject KDHE or other agencies to additional cost of compliance. The regulation provides definitions used to administer the proposed regulations.

K.A.R. 28-16-161 Municipal and commercial lagoons: general provisions.

None. The initial and annual cost and increased paperwork of implementing the proposed regulation is expected to be minimal to KDHE.

K.A.R. 28-16-162 Industrial lagoons: general provisions.

None. The initial and annual cost and increased paperwork of implementing the proposed regulation is expected to be minimal to KDHE.

K.A.R. 28-16-163 Required hydrogeologic information for new or modified municipal, commercial, or industrial wastewater lagoons.

None. The initial and annual cost and increased paperwork of implementing the proposed regulation is expected to be minimal to KDHE.

K.A.R. 28-16-164 Municipal, commercial, and industrial wastewater treatment system lagoons: soil liner design.

None. The initial and annual cost and increased paperwork of implementing the proposed regulation is expected to be minimal to KDHE.

K.A.R. 28-16-165 Municipal, commercial, and industrial soil liners: postconstruction testing.

None. The initial and annual cost and increased paperwork of implementing the proposed regulation is expected to be minimal to KDHE.

K.A.R. 28-16-166 Requirements for impermeable synthetic membrane liners in municipal or commercial wastewater treatment system lagoons.

None. The initial and annual cost and increased paperwork of implementing the proposed regulation is expected to be minimal to KDHE.

K.A.R. 28-16-167 Requirements for impermeable synthetic membrane liners in industrial wastewater treatment system lagoons.

None. The initial and annual cost and increased paperwork of implementing the proposed regulation is expected to be minimal to KDHE.

K.A.R. 28-16-168 Postconstruction testing of municipal, commercial and industrial impermeable synthetic membrane liners.

None. The initial and annual cost and increased paperwork of implementing the proposed regulation is expected to be minimal to KDHE.

K.A.R. 28-16-169 Minimum standards of design, construction, and maintenance.

None. There are no initial or annual costs associated with this regulation. KDHE expects no additional paperwork or impact to KDHE resources regarding this regulation.

K.A.R. 28-16-170 Water, oil, or gas wells.

No initial or annual costs are expected. KDHE may see a very slight increase in paperwork in administering this provision but it is not expected to be significant.

K.A.R. 28-16-171 Monitoring wells.

KDHE will experience additional paperwork and processing but expects this to be a minor impact on the agency.

K.A.R. 28-16-172 Plan and specification approval; permit issuance.

None. There is no expected initial or annual cost. There is no expected increase in paperwork or impact on KDHE resources.

K.A.R. 28-16-173 Municipal, commercial, and industrial wastewater lagoons: closure requirements.

The regulation provides no additional paperwork or resource requirement by the agency.

K.A.R. 28-16-174 Variance of specific requirements.

KDHE will experience additional paperwork and processing to evaluate a variance request. It is expected the majority of the variance requests will take place during the design phase of a project and as such, the expected additional paperwork and processing should be minimal and have little, if any, impact on program resources or staffing.

c. Costs which would likely accrue if the proposed regulations or amendments are not adopted, the persons who will bear the cost and those who will be affected by the failure to adopt the regulations.

K.A.R. 28-16-160 Definitions.

None. The regulation provides definitions used to administer the proposed regulations.

K.A.R. 28-16-161 Municipal and commercial lagoons: general provisions.

None, if groundwater contamination does not take place. The lagoon owner would be liable for any cost of remediating contaminated soils or groundwater.

K.A.R. 28-16-162 Industrial lagoons: general provisions.

None, if groundwater contamination does not take place. The lagoon owner would be liable for any cost of remediating contaminated soils or groundwater.

K.A.R. 28-16-163 Required hydrogeologic information for new or modified municipal, commercial, or industrial wastewater lagoons.

None, if groundwater contamination does not take place. The lagoon owner would be liable for any cost of remediating contaminated soils or groundwater.

K.A.R. 28-16-164 Municipal, commercial, and industrial wastewater treatment system lagoons: soil liner design.

None.

K.A.R. 28-16-165 Municipal, commercial, and industrial soil liners: postconstruction testing.

None, if groundwater contamination does not take place. The lagoon owner would be liable for any cost of remediating contaminated soils or groundwater.

K.A.R. 28-16-166 Requirements for impermeable synthetic membrane liners in municipal or commercial wastewater treatment system lagoons.

None, if groundwater contamination does not take place. The lagoon owner would be liable for any cost of remediating contaminated soils or groundwater.

K.A.R. 28-16-167 Requirements for impermeable synthetic membrane liners in industrial wastewater treatment system lagoons.

None, if groundwater contamination does not take place. The lagoon owner would be liable for any cost of remediating contaminated soils or groundwater.

K.A.R. 28-16-168 Postconstruction testing of municipal, commercial, and industrial impermeable synthetic membrane liners.

None, if groundwater contamination does not take place. The lagoon owner would be liable for any cost of remediating contaminated soils or groundwater.

K.A.R. 28-16-169 Minimum standards of design, construction, and maintenance.

None.

K.A.R. 28-16-170 Water, oil, or gas wells.

No cost would accrue if the proposed regulation is not adopted unless the earthen wastewater lagoon is constructed over or near the well and groundwater contamination occurs. The cost to the regulated party would be the cost required to remediate contaminated soils and groundwater. Estimated cost cannot be provided due to the numerous variables involved.

K.A.R. 28-16-171 Monitoring wells.

None.

K.A.R. 28-16-172 Plan and specification approval; permit issuance.

None.

K.A.R. 28-16-173 Municipal, commercial, and industrial wastewater lagoons: closure requirements.

None. The facility either has to properly close out a facility to eliminate a potential water pollution threat or maintain an effective and viable water pollution control permit for the wastewater lagoon.

K.A.R. 28-16-174 Variance of specific requirements.

None.

d. A detailed statement of the data and methodology used in estimating the cost used in the statement.

K.A.R. 28-16-160. Definitions.

None. The regulation provides definitions used to administer the proposed regulations.

K.A.R. 28-16-161. Municipal and commercial lagoons: general provisions.

The regulation establishes general provisions applicable to municipal and commercial wastewater lagoons. The regulation grandfathers existing municipal and commercial wastewater lagoons so long as they do not pose an actual or imminent public health or environmental threat. As such, the regulation targets proposed new wastewater lagoons or expansions of existing wastewater lagoons. The regulation establishes three tiers of criteria addressing the level of protection to be provided by the wastewater lagoon liner and a fourth tier establishing a prohibition for siting a proposed new wastewater lagoons or an expansion of an existing wastewater lagoon if a minimum of 10 feet of separation between the bottom of the lagoon and groundwater can not be provided. The three tiers of criteria addressing the level of protection to be provided by the wastewater lagoon liner include a maximum soil liner seepage rate of 1/4-inch per day or less statewide (KDHE's current criteria); 1/10-inch per day or less for sensitive groundwater areas, excluding the Equus Beds; and the mandatory use of an impermeable synthetic membrane liner system for the Equus Beds area. Complicating things further in considering the capital and annual cost associated with implementing this regulation is the size of the proposed new lagoon or expansion being considered.

To provide a means to compare the potential fiscal impact these variables may have, a table has been provided which summarizes the estimated capital and annual costs for a given design size and potential alternative available to the regulated public. The table is presented on the following page.

Municipal and Commercial Lagoon Costs

Population Equivalent (PE)	Incremental Cost Alternative Site	Incremental Cost Enhanced Soil Liner	Incremental Cost Single Synthetic Liner	Total Cost - New Mechanical / Lagoon
28	- - -	$27,347	$11,659	
250	$320,152	$27,155	$53,956	$677,296 / $332,970
500	$358,074	$41,043	$95,703	
1000	$455,336	$73,124	$149,035	
1500	$537,638	$107,965	$218,094	
2000	$634,038	$142,583	$286,286	$2,136,560 / $1,258,910

Municipal and Commercial Lagoon Costs

Population Equivalent (PE)	Incremental Cost Alternative Site	Incremental Cost Enhanced Soil Liner	Incremental Cost Single Synthetic Liner	Total Cost - New Mechanical / Lagoon
2500	$742,622	$177,167	$353,816	
3000	$821,090	$211,176	$420,496	$2,964,830 / $1,733,068

The table provides for the consideration of various size facilities. The left hand column addresses facility size and is labeled "Population Equivalent (PE)". Municipal and commercial designs are based on the number of people served per day or population equivalent (PE). The left hand column ranges from the very small (28 PE) which would be indicative of a commercial facility or a small manufacturing operation. The 250 - 3,000 PE spans the range of a small municipality to a large municipality which may employ a wastewater treatment lagoon system. The next three columns address the incremental costs associated with providing an alternative site, providing an enhanced soil liner, and installing a single impermeable synthetic membrane liner. The incremental costs in these three columns represent the estimated "added" cost to a project as a result of the new regulation requirements, not the total project cost. For comparison purposes in evaluating the magnitude of the "incremental costs", a fifth column is provided which summarizes the total estimated project cost for a complete new mechanical wastewater treatment system or wastewater lagoon.

The second column addressing the "Incremental Cost - Alternative Site" addresses the option where the proposed site would be prohibited because the separation distance between the lagoon bottom and groundwater would be less than 10 feet or the site is located in a sensitive groundwater area and soils at the site can not be amended with bentonite to achieve the 1/10-inch per day or less criteria. This alternative considers the need to move the proposed lagoon site to an acceptable location. The incremental "added" costs associated with this alternative include a pump station, excavation and 4,000 feet of force main to the new site, an emergency generator for the pump station, air relief valves and stream/river crossings, additional power and operation & maintenance costs for a 20 year period, and an additional 6-inches of liner with the addition of bentonite to amend the liner soils. The estimated costs do not address an allowance for groundwater monitoring wells if required for the project. Costs associated with the installation of monitoring wells and sampling are address in the summary for K.A.R. 28-16-171.

The third column addressing the "Incremental Costs - Enhanced Soil Liner" addresses the option where the required sealing criteria of 1/10-inch per day or less can not be met with the soils at the site or provided for construction of the soil liner. This alternative considers having to increase the liner thickness by 6 inches and using bentonite to amend the soils at a rate of 2 pounds per square foot. The unit cost of the bentonite varies as to the size of the project with lower unit costs for greater quantities ordered. The unit cost for the bentonite rages from $200 to $140 per ton delivered. The estimated costs do not address an allowance for groundwater monitoring wells if required for the project. Costs associated with the installation of monitoring wells and sampling are address in the summary for K.A.R. 28-16-171.

The fourth column addressing the "Incremental Costs - Single Synthetic Liner" addresses the situation where a proposed new or expanded wastewater lagoon will be located in the Equus Beds area which mandates the use of an impermeable synthetic membrane liner or in sensitive groundwater areas where a soil liner system can not achieve the 1/10-inch per day or less sealing criteria. For municipal and commercial wastewater treatment lagoons, the regulations allow for the use of a single impermeable synthetic membrane liner. As with bentonite, liner costs vary with the size of the project. The table below summarizes a cost schedule obtained from a consulting/contracting firm that installs impermeable synthetic membrane liners. The costs summarized in the table do not address excavation or other earthwork, leak collection or return equipment, or whole pond leak testing. The cost does include material, installation, and quality assurance testing during the installation process.

Impermeable Synthetic Membrane Liner Cost Schedule

Material	50,000 - 100,000 SF ($/SF)	300,000 or greater SF ($/SF)
36-mil Hypalon ® liner	0.85	0.75
60-mil HDPE smooth liner	0.53	0.45
60-mil HDPE textured liner	0.51	0.43
40-mil HDPE liner	0.41	0.33
200-mil drainage net	0.25	0.24

Note: SF - square feet
HDPE - high density polyethylene
mil - 1/1000-inch thickness

Also for the sake of limiting the number of variables being considered, the incremental cost for the single impermeable synthetic membrane liner does not take into account the increased pond size required to address enhanced evaporation (more surface area), to maintain a non-discharge status if a total retention evaporative lagoon is utilized, since there will be no "seepage" losses as with a soil liner. The estimated costs do not address an allowance for groundwater monitoring wells if required for the project. Costs associated with the installation of monitoring wells and sampling are addressed in the summary for K.A.R. 28-16-171.

The fifth column provides a total cost estimate for the construction of a complete new mechanical wastewater treatment plant or a complete new wastewater treatment lagoon for comparison with the incremental costs of the various alternatives evaluated.

A review of the Municipal and Commercial Lagoon Costs table finds that with the exception of very small lagoons (28 PE - Commercial) the incremental capital and annual cost is the least for providing an enhanced soil liner system. Providing a single impermeable synthetic membrane liner is still significantly less costly than having to utilize an alternative site. Based on the KSU Lagoon Study, we believe municipal and commercial facilities will be typically able to utilize a soil liner or an enhance soil liner in lieu of a single impermeable synthetic membrane liner, when not within the Equus Beds area.

To estimate the capital and annual cost associated with this regulation, staff evaluated the number and types of projects processed for the last several years. A typical year will result in 13 projects which involve a new or expanded municipal or commercial wastewater lagoon. In calculating the projected fiscal impact, we assumed 3 new and 10 expanded lagoon projects. A total of 8 projects involved expansions of 250 PEs and 2 involved expansions of 500 PE's. Three new projects include a small commercial facility (28 PE), a 1,000 PE lagoon, and a 2,000 PE facility. For a worst case scenario, we assumed that all of the lagoon projects required the use of an enhanced soil liner, the use of an alternative site, a single synthetic liner, or in one case the use of a mechanical wastewater treatment plant in lieu of a wastewater treatment lagoon. Under these extremely conservative assumptions the cost is estimated at $2,452,000.

Please refer to Appendix A for the detailed calculations utilized for the above evaluations.

K.A.R. 28-16-162. Industrial lagoons: general provisions.

The regulation establishes general provisions applicable to industrial wastewater lagoons. The regulation grandfathers existing industrial wastewater lagoons so long as they do not pose an actual or imminent public health or environmental threat. The regulation targets proposed new wastewater lagoons or expansions of existing wastewater lagoons. The regulation addresses three major classes of wastewater to be regulated i.e., domestic wastewater, low pollution potential industrial wastewater, and process wastewater. The regulation establishes, for domestic wastewater, three tiers of criteria addressing the level of protection to be provided by the wastewater lagoon liner and a fourth tier establishing a prohibition for siting a proposed new wastewater lagoon or an expansion of an existing wastewater lagoon if a minimum of 10 feet of separation between the bottom of the lagoon and groundwater can not be provided. The three tiers of criteria addressing the level of protection to be provided by the domestic wastewater lagoon liner include a maximum soil liner seepage rate of 1/4-inch per day or less statewide (KDHE's current criteria); 1/10-inch per day or less for sensitive groundwater areas, excluding the Equus Beds; and the mandatory use of an impermeable synthetic membrane liner system for the Equus Beds area. Complicating things further in considering the capital and annual cost associated with implementing this regulation is the size of the proposed new lagoon or expansion being considered. Low pollution potential industrial wastewater can utilize a soil liner system which meets the 1/4-inch per day criteria which is KDHE's current criteria. Industrial process wastewater will require the use of an impermeable synthetic membrane liner system which employs a primary and secondary liner with an intermediate leak detection system.

The requirements of K.A.R. 28-16-162(a) and (e) are identical to the requirements for municipal and commercial wastewater lagoons in K.A.R. 28-16-161. Very few industrial facilities that employ on-site wastewater treatment systems utilize a separate wastewater lagoon system to treat and dispose of domestic wastes from the facility. Assuming we would receive at most 1 such proposal per year and the facility employs 28 people or less, then the fiscal impact estimated for municipal and commercial operations of the same size would be directly applicable. Assuming the 1/10-inch per day criteria could be met with an additional 6 inches of compacted soil liner and the addition of 2 pounds of bentonite per square foot is utilized, the total annual estimated incremental cost is:

1 X [$13,400 (bentonite) + $1,833 (additional 6-inch liner)] = $15,233

Industrial facilities do not have the ability to condemn land as do municipalities. As such pumping to an alternate site and employing a lagoon system was not considered feasible. If it were, the

estimated cost would be $237,963 which includes provisions for pumping costs for a 20 year period.

K.A.R. 28-16-162(f) addresses low pollution potential industrial wastewater lagoons employed primarily to remove inert suspended solids or heat from wastewater. The specific industrial activities referenced in the regulation generate inert suspended solids such as rock dust from limestone quarrying, clay particles from clay pit mining, dirt and stream sediment from sand and gravel dredging, eroded soil from construction sites, lime sludge from water softening operations, and concrete from batch plant delivery trucks. Dissipation of heat from once through or cooling tower operations is also addressed infrequently. The proposed 1/4-inch per day criteria is consistent with current KDHE lagoon sealing requirements. We receive approximately 15 new quarry, clay pit, or sand and gravel dredging operations per year. Most of the quarry ponds are total recycle except in heavy rains and are typically less than 1 acre in size. New lagoons constructed solely for cooling water purposes are very rare. They would have to be for relatively small operations on a potentially water quality impacted stream segment. Very few tailwater control ponds are constructed at land application sites as wastewater application is typically controlled to prevent runoff during application. The only new lime sludge ponds constructed over the last 5-10 years have been associated with public water supply systems employing lime sludge softening practices for controlling the hardness of the finished water. The cost varies greatly with the size of the public water supply system, the amount of water produced, the amount of hardness to be removed, and the design life (storage capacity) of the lagoon. KDHE receives annually, approximately 375 applications for NPDES permits associated with the control of stormwater runoff from construction sites. Approximately 20% of these applications propose to employ sediment control ponds. Most of the sediment control ponds are 1/3 acre or less in size. The proposed regulatory requirements are not expected to impose any additional requirements as the current lagoon sealing requirements are 1/4-inch per day or less. Additionally we do not project that additional costs would be incurred regardless of whether the lagoon would be constructed over a sensitive groundwater area or the Equus Bed because of the relatively low pollution potential of the waste to be contained.

To implement K.A.R. 28-16-162(g) as detailed in K.A.R. 28-16-167, industries would be required to provide a dual impermeable synthetic membrane liner with an intermediate leak detection system. This provision has been implemented by KDHE since 1992 through Policy #92-2 "Industrial Wastewater Pond Liner Policy". The adoption of this regulation will enable KDHE to enforce this provision. Liner costs vary with the size of the project. The table below summarizes a cost schedule obtained from a consulting/contracting firm that installs impermeable synthetic membrane liners. The costs summarized in the table do not address excavation or other earthwork, leak collection or return equipment, or whole pond leak testing. The cost does include material, installation, and quality assurance testing during the installation process.

Impermeable Synthetic Membrane Liner Cost Schedule

Material	50,000 - 100,000 SF ($/SF)	300,000 or greater SF ($/SF)
36-mil Hypalon ® liner	0.85	0.75
60-mil HDPE smooth liner	0.53	0.45
60-mil HDPE textured liner	0.51	0.43
40-mil HDPE liner	0.41	0.33
200-mil drainage net	0.25	0.24

Note: SF - square feet
HDPE - high density polyethylene
mil - 1/1000-inch thickness

Hypalon is more chemically resistant than HDPE. Where chemical compatibility is not an issue then HDPE will probably be the material of choice.

KDHE estimates that piping, a collection sump, pump and flow meter would add an additional $12,000 to the cost of the dual liner system.

For industrial projects, the lined lagoon systems are typically either very small or very large. For comparison purposes only, assuming an 8 foot total pond depth with a 5 foot operating depth for the wastewater:

Acres	Top Dimension (ft.)	Bottom Dimension (ft.)	Volume @ 5 ft. (gal.)
1/2	148 x 148	100 x 100	497,420
1	209 x 209	161 x 161	1,161,307
5	467 X 467	419 x 419	7,047,319
10	660 x 660	612 x 612	14,705,830

Estimated additional costs associated with providing a dual liner with an intermediate leak detection system for the four size categories listed above using an estimated cost of $1.85 per square foot for Hypalon and $1.25 for HDPE are:

Acres / (Square Feet)	Incremental Cost For Dual Liner System	
	Hypalon	HDPE
½ (21,780)	$52,293	$39,225
1 (43,560)	$92,568	$66,450
5 (217,800)	$414,930	$284,250
10 (435,600)	$817,860	$556,500

Most lined lagoons are 1 acre or less in size. Large brine ponds are used in the liquid petroleum gas (LPG) storage operations and have a number of brine ponds, some of which are 5 acres or more in size. Anaerobic lagoon basins employed at new large meat packing operations run approximately 4 to 6 acres in size assuming 3 MGD waste flows, 10 day detection, and 15 ft. operating depths. For the purpose of estimating annual costs associated with the dual liner and intermediate leak detection system assume 4 projects per year at ½ acre, 2 projects per year at 1 acre, and 1 project per year at 5 acres. Total annual estimated incremental cost:

Hypalon

(4)(52,293 + 12,000) + (2)(92,568 + 12,000) + (1)(414,930 + 12,000) = $893,238

HDPE

(4)(39,225 + 12,000) + (2)(66,450 + 12,000) + (1)(284,250 + 12,000) = $658,050

The estimated annual costs for the dual liner requirements would rage from $893,238 to $658,050 depending on whether Hypalon or HDPE is utilized.

K.A.R. 28-16-163. Required hydrogeologic information for new or modified municipal, commercial, or industrial wastewater lagoons.

Based on the lagoon projections from K.A.R. 28-16-161 and K.A.R. 28-16-162 there will be approximately 20 sites requiring some form of hydrogeologic investigation per year. Based on the projected lagoon sizes and a requirement of 1 borehole or excavation per surface acre of lagoon proposed, there will be approximately 72 boreholes or excavations required. Eliminating the need for extensive soils work required for designing a soil liner for the industrial lagoons employing a dual impermeable synthetic membrane liner system and the fact that costs associated with determining groundwater depth and soils information for dike construction already exist as a requirement of KDHE's current Minimum Standards of Design for Water Pollution Control Facilities, there will be 61 sets of soil samples collected per year for designing a soil liner system that will be impacted by the new regulations.

Estimated costs for the borings/excavations are:
Wastewater lagoons typically have an 8 foot total depth with a 5 foot maximum operating depth. To check for groundwater, a boring or excavation would need to be a depth of 18 to 20 feet. An auger or a tractor mounted backhoe can be used to check for groundwater, log soils types, and collect soil samples.

Mobilization Costs:		
Rig (auger or backhoe) and crew (300 mile round trip @ $2.50/mile) =	$ 750.00	
Assume 2 days for travel and boring.		
Assume a crew of 2.		
Travel Expense:		
2 people x 1 night x $60.00 member =	$ 120.00	Hotel
Salary Expense		
1 crew (Engineer, Geologist, Soil Scientist) @ $55/hr. for 16 hrs:		
16 hrs x $55 =	$ 880.00	
1 crew (laborer or technician) @ $40/hr for 16 hours:		
16 hours x $40/hr. =	$ 640.00	
Total for Travel & Salary Expense =	$1520.00	

Soil Tests:	Standard Proctor Density	$ 100 / sample
	USCS Soil Classification	$ 8 / sample
	Atterberg Limits (LL, PL, SL)	$ 50 / sample
	Permeability	$250-300 / sample
Total for Soil Tests Per Sample =		$ 458 / sample

Soils Report Development:
Assume 10 hours at $55/hour = $ 550.00

Pre-test notification of KDHE by telephone = $ 3.00

Liner design costs have not been included as this is a current design cost and would not vary regardless of whether the 1/4- or 1/10-inch per day liner criteria is used.

Summation of hydrogeology costs (per site) for soil liner systems:

Mobilization	$ 750.00
Travel	$ 120.00
Salaries (Drilling)	$1,520.00
Soils Tests (Assume 3 per site average)	$1,374.00
Soils Report	$ 550.00
Pre-test notification of KDHE	$ 3.00
Total cost per site =	$4,317.00

Total annual cost:
13 sites x $4317.00 / site = $56,121 annually.

K.A.R. 28-16-164. Municipal, commercial, and industrial wastewater treatment system lagoons: soil liner design.

Costs associated with the hydrogeologic information and its use in designing wastewater lagoon soil liner systems have been summarized in K.A.R. 28-16-163 above.

K.A.R. 28-16-165. Municipal, commercial, and industrial soil liners: postconstruction testing.

Submission of the post-construction testing protocol is considered a part of the construction plan and specifications development. KDHE expects consultants will develop and submit a standardized testing protocol. Inclusion into the construction specifications is estimated at 2 hours of time at $55/hour i.e., $110.00.

Postconstruction certification report estimated at 10 hours at $55/hour i.e., $550.00.

Inspection costs on which the certification is based is estimated at:
80 hours per project at $45/hour i.e., $3600.00.

Submission of observations and data from inspections and whole pond testing is covered in the certification cost.

Two types of whole pond seepage tests are considered for cost comparison.

Barrel test method is estimated at $2,500 per test per lagoon cell.

Using equipment similar to the KSU lagoon seepage monitoring equipment, the cost of testing is estimated at $1,000 for mobilization and $3,000 for the test i.e., $4,000 per lagoon. If the testing equipment needs to be constructed/purchased, KSU estimates the monitoring equipment costs approximately $2,000.

Use $4,000 per lagoon per test. The per lagoon test cost would be reduced if more than one test is conducted at a site.

Total cost per site is: $110.00 + $550.00 + $3,600.00 + $4,000.00 = $8,260.00 / lagoon

For 28 sites (12 municipal/commercial and 16 industrial) per year employing soil liner systems:

Total annual costs = 28 x $8,260 = $231,280

K.A.R. 28-16-166. Requirements for impermeable synthetic membrane liners in municipal or commercial wastewater treatment system lagoons.

Refer to the fiscal impact related to impermeable synthetic membrane liners summarized in K.A.R. 28-16-161.

Development and submission of the postconstruction testing protocol is considered a part of the construction plan and specifications development. KDHE expects consultants will develop and submit a standardized testing protocol. It is estimated at 2 hours of time at $55/hour i.e., $110. Postconstruction liner testing protocol development is estimated at $110.00 per site.

K.A.R. 28-16-167. Requirements for impermeable synthetic membrane liners in industrial wastewater treatment system lagoons.

Refer to the fiscal impact related to impermeable synthetic membrane liners summarized in K.A.R. 28-16-162.

Development and submission of the postconstruction testing protocol is considered a part of the construction plan and specification development. KDHE expects consultants will develop and submit a standardized testing protocol. It is estimated at 2 hours of time at $55/hour i.e., $110. Postconstruction liner testing protocol development is estimated at $110.00 per site.

K.A.R. 28-16-168. Postconstruction testing of municipal, commercial, and industrial impermeable synthetic membrane liners.

Submission of the postconstruction testing protocol is considered a part of the construction plan and specification development. KDHE expects consultants will develop and submit a standardized testing protocol. Inclusion into the construction specifications is estimated at 2 hours of time at $55/hour i.e., $110.00

Postconstruction certification report estimated at 10 hours at $55/hour i.e., $550.00.

Inspection costs on which the certification is based is estimated at:
120 hours per project at $45/hour i.e., $5,400.00

Submission of observations and data from inspections and whole pond testing is covered in the certification cost.

One method which could be employed is to monitor the leakage collected and pumped out of the intermediate leak detection system. For small ponds this may not be very accurate unless a lengthy period of time is monitored. Use of the KSU monitoring system can determine whether seepage (leakage) requirements have been met. The KSU method could be employed for $4,000 per lagoon while a whole pond barrel test could be run for $2,500 per lagoon.
Use an estimated cost of $4,000 per lagoon cell.

Total cost per lagoon is: $110.00 + $550.00 + $5,400.00 + $4,000.00 = $10,060.00 / lagoon

For 7 sites per year employing impermeable synthetic membrane liner systems:

Total estimated annual costs = 7 x $10,060 = $70,420.00

K.A.R. 28-16-169. Minimum standards of design, construction, and maintenance.

Not applicable.

K.A.R. 28-16-170. Water, oil, or gas wells.

Requirements considered in the cost of developing the construction plans, specifications, and documentation. Visual inspection can be conducted in conjunction with other preliminary site work conducted at the facility i.e., preliminary site inspection, hydrogeologic work, surveying, etc. Information regarding existing, plugged or abandoned water wells can be obtained by contacting KDHE and for oil and gas wells by contacting the Kansas Corporation Commission (KCC). Costs for obtaining this information from KDHE and KCC are estimated at $6.00 if done by phone or $25.74 if done by letter.

2 Phone Calls:	$3.00 per call =	$ 6.00
2 Letters:	½ hr. @ $50.00 plus $0.37 stamp: (½ X $50) + $0.74 =	$25.74

K.A.R. 28-16-171. Monitoring wells.

Monitoring Well Installation Costs
Estimates from bids received by KDHE for monitoring well installation for the Bureau of Environmental Remediation.
Assume 100 feet per day of well installation.
Hollow stem auger drilling.
Minimum of 3 wells required. Costs developed for 50 ft. deep wells and 150 ft. deep wells.

Mobilization Costs:

Drill rig & crew (300 miles round trip @ $2.50/miles) =	$ 750.00
Geologist (300 miles @ $.40/miles) =	120.00
Geologist Time (travel - 5.5 hrs. @ $30.00/hour) =	165.00
Total	$1,035.00

Travel Expense:
Assume 2 days for travel/installation of 50 ft. wells.
3 people/crew X 1 night x $55.00/crew member = $ 165.00
Assume 3 days for travel/installation of 150 ft. wells.
3 people/crew X 2 nights X $55.00/crew member = $ 330.00

Drilling, Installation, Development and Decontamination:
Costs for drilling, installation and decontamination range from:
Shallow wells (less than 50 ft.) @ $5.00 - $10.00/ft.
Assume $8.00/ft. for shallow wells.
Assume $10.00/ft. for deep wells.
Assume shallow wells to be installed 50 feet deep.
Assume deep wells to be installed 150 feet deep.

Cost of drilling, installation and decontamination:
Shallow wells @ 3 X 50 ft. X $8.00/ft. = $1,200.00
Deep wells @ 3 X 150 ft. X $10.00/ft. = $4,500.00

Well Construction Materials:
Assumes 10 ft. of 2-inch PVC well screen, PVC Schedule 40 pipe, PVC riser, gravel pack and grout @ $6.15/ft.
Shallow wells @ 3 X 50 ft. = $ 922.50
Deep wells @ 3 X 150 ft. = $2,767.50

Surface Completion:
Assumes an above ground completion, above grade steel well cover, 2 ft. X 2 ft. concrete pad, expandable well cap and lock @ $150.00/well.
Shallow wells 3 X $150.00 = $ 450.00
Deep wells 3 X $150.00 = $ 450.00

Well Development:
Includes the removal of 5 well volumes of water @ $50.00/well.
Shallow wells 3 X $50.00 = $ 150.00
Deep wells 3 X $50.00 = $ 150.00

Geologist Time:
Assume 9 hr. days.
Assume 1½ days for the shallow wells.
Assume 2 days for the deep wells.
Consulting costs @ $50.00/hr.
Shallow wells @ 1½ days X 9 hrs/day X $50/hr. = $ 675.00
Deep wells @ 2 days X 9 hrs/day X $50/hr = $ 900.00

Total monitoring well system (3 wells) installation costs:

	Shallow Wells	Deep Wells
Mobilization	$1,035.00	$ 1,035.00
Travel	165.00	330.00
Drilling/installation	1,200.00	4,500.00

Well materials	922.50	2,767.50
Surface completion	450.00	450.00
Well development	150.00	150.00
Geologist time	675.00	900.00
Total (3 well system)	$4,597.60	$10,132.50

Sampling Costs

Sampling procedure requires removal of 3 well volumes prior to sampling.
Equipment for pre-sampling well purging and sampling:
Manual well bailers (3 ft.) $110.00 Utility Supply of America
Manual well bailers (3 ft.) $ 50.00 Cole-Parmer
Battery powered disposable pump $120.00 (KDHE purchases).
Assume portable battery powered pump to be utilized.
Initial pump costs = $120.00
Sample bottles/containers typically provided by commercial laboratory.
Sample shipping costs assuming one sample per year for each well system, container approximately 8 pounds in weight, shipped Federal Express Overnight $25.75 (Estimate from Federal Express).
Operator time to collect sample estimated at 20 minutes per well @ $10.00/hr. for the operator:
3 X 1/3 hr. X $20.00/hr. = $20.00

Laboratory analysis of the water samples:
Assume samples collected for 3 monitoring wells annually.
Assume sample parameters to be analyzed by the lab include: ammonia, nitrate, and chloride.
Costs of analysis derived from price lists obtained from commercial labs.

Lab	Cost per well for analysis set
M.D. Chemical & Testing, Inc.	$ 40.00

Analysis and Shipping Costs (3 Samples):
M.D. Chemical (3 X $40.00) + $25.75 = $145.75

Annual sampling costs (3 well system):

Sample collection pump (3 yr. life) =	$ 40.00
Operators time =	$ 20.00
Lab & Shipping =	$145.75
Total	$205.75 / year

Reporting Cost To KDHE

Assume 1 hr. of operator's time @ $20.00/hr. =	$ 20.00
Postage =	.37
	$ 20.37

K.A.R. 28-16-172. Plan and specification approval; permit issuance.

Not applicable.

K.A.R. 28-16-173. Municipal, commercial, and industrial wastewater lagoons: closure requirements.

Notification to KDHE of plans to cease operation, close, or abandon a wastewater treatment lagoon is estimated at ½ hour of a facility operators time to draft a letter at $30 per hour plus a $0.37 stamp for an estimated cost of $15.37 if the notification is by mail or $3.00 if the notification is made by telephone.

Maintenance of a viable water pollution control permit may require the submission of an annual fee until the facility is closed per KDHE approval. Annual fees for municipal and commercial operations would be $185.00 and for industries typically $320.00. For quarries, sand and gravel dredging operations, clay pits and erosion control ponds used for stormwater runoff from construction sites, the annual fee is $60.00.

The fiscal cost estimates do not address the actual closure costs as KDHE currently requires closure and removal of all wastes prior to terminating a water pollution control permit or abandoning a water pollution control facility. Until all wastes are removed or controlled, KDHE would consider a pollution potential to exist and require either remediation or acquiring the necessary permits.

Assuming a consultant will be utilized to develop a closure plan and consultants charge from $50 to $75 per hour with $50 per hour being representative, the following is estimated for developing a closure plan:

Municipal, commercial, and industrial wastewater lagoons treating domestic wastewater may typically be closed out by dewatering the lagoon, removal or incorporation of the wastewater sludge, and backfilling the lagoon and contouring the site. Dewatering the lagoon can be done through discharge via an NPDES permit, land application of the wastewater at agronomic application rates, or pumping/hauling the water to a municipal wastewater treatment plant for treatment and disposal. The sludge may be removed and land applied or dried and buried within the lagoon being backfilled. There is minimal work required other than the logistics of the dewatering, sludge removal or backfilling work. Soil sampling may be required to determine if soil removal is required which can be spread onto agricultural cropland for dispersal of the nitrogen or phosphorous.

Assume 10 hours to develop the closure plan = 10 hr X $50 per hr =	$500.00
Assume 2 soil samples at $25 per sample = 2 x $25 =	50.00
Cost for the closure plan is estimated at:	$550.00

For industrial lagoons addressed by K.A.R. 28-16-162(b), the closure plan is expected to be nothing more than addressing the method of dewatering and whether/or the extent to which the solids/soil needs to be removed prior to backfilling the lagoon. The exception to this would be those ponds designed to contain lime sludge where the wastewater lagoon was designed to be the final disposal site, once capped. Such facilities would have dual permits as being a wastewater lagoon and possessing a solid waste permit which already addresses closure and post closure requirements per solid waste program regulations.

The disposal plan required to address industrial wastewater lagoons which employ an impermeable synthetic liner consist of addressing the disposal of the lagoon contents (wastewater and sludge) and the method to dispose of the liner. Depending on the type of wastes involved, disposal methods may include use of disposal wells, directing the wastewater to a municipal wastewater

treatment plant, directing wastewater to a commercial waste disposal facility, etc. Wastewater sludges would be handled in a similar manner. Disposal costs are not considered as a part of the economic impact statement as the removal and proper disposal are currently required and would be independent of whether an earthen lagoon is currently utilized or a synthetic membrane liner is used. Disposal of the liner on-site (burial) can be authorized by the KDHE Bureau of Waste Management as a solid waste disposal or an authorization could be granted for disposal of the liner at a solid waste landfill. Assume the cost of developing a closure plan is the same for the domestic wastewater lagoons with the exception of the soil testing as there should be no soil contamination due to the secondary liner. The estimated cost would be $500.00

K.A.R. 28-16-174. Variance of specific requirements.

Not applicable.

e. Description of any less costly or less intrusive methods that were considered by the agency and why such methods were rejected in favor of the proposed regulations.

KDHE was unable to identify any less costly or less intrusive methods available to the agency to address an equivalent level of groundwater protection.

f. Consultation with League of Kansas Municipalities, Kansas Association of Counties, and Kansas Association of School Boards.

Copies of the draft regulations and draft regulatory impact statements have been forwarded to the Kansas League of Municipalities, Kansas Association of Counties, and Kansas Association of School Boards on May 12, 2004. As of the date of this document, we have not received a response from these parties regarding any questions, comments, or concerns they may have regarding the proposed regulations.

g. Public outreach.

On March 21, 2003 KDHE Secretary Bremby hosted two meetings in the KDHE Topeka office in which KDHE provided briefing presentations to representatives of the agricultural community and to legislators regarding his Equus Beds / sensitive groundwater area protection proposal. Secretary Bremby and KDHE staff conducted a similar presentation, on March 26, 2003, in Newton, Kansas directed at governmental representatives located within the Equus Beds Aquifer area. Following the three introductory meetings conducted by Secretary Bremby, KDHE staff conducted a number of public outreach and information meetings throughout the state in which an overview of the Secretary's goal of providing enhanced protection of both the Equus Beds and sensitive groundwater areas in the state and regulatory concepts being considered by KDHE. The public outreach meetings were intended to inform the public of Secretary Bremby's goals and to present various technical considerations and concerns which KDHE feels need to be addressed in the form of regulations. The outreach meetings were also intended as a forum in which KDHE could solicit concepts, issues, and concerns the public may have regarding groundwater protection and to offer ideas or direction for KDHE's consideration at the time we began developing and formulating draft regulation concepts. Three public outreach meetings were conducted to address the proposed municipal, commercial, and industrial lagoon regulations. A meeting was conducted April 16, 2003 in the evening at the Kansas Historical Center Museum Education Classroom in Topeka, Kansas. An April 22, 2003 evening meeting was conducted at the Fort Hays State

University Memorial Union in Hays, Kansas. The third public outreach meeting was conducted on the evening of April 23, 2003 at the Sedgwick County Education Extension Center in Wichita, Kansas. In an attempt to receive as much input and direction regarding the proposed regulatory concepts under consideration as possible, KDHE provided statewide press releases to newspapers, radio stations, and television stations. The notices also advised additional information was available via the internet at KDHE's website. KDHE placed upon our homepage links to which the public could access background information regarding the proposed regulatory concepts, information regarding the public outreach meetings, and a copy of the KDHE staff presentation provided at each of the public outreach meetings. The presentation material provided details regarding the various regulatory concepts KDHE placed on the table hoping to solicit comments and input and to spark discussions at the public outreach meetings. An opportunity was also made available for individuals who could not attend the public outreach meetings to provide written comments directly to KDHE for our review and use.

Appendix A

Cost Analysis for

Municipal and Commercial Lagoon

General Provisions

ESTIMATED ADDITIONAL ANNUAL COST OF PROPOSED LAGOON REGULATIONS

ENTITY	POPULATION PE	NEW / EXP.	CAPACITY EXPANSION PE	GROUNDWATER LESS THAN 10'	PRESENT COST	NOTE
City	500	E	250	X	$320,000	* Pump to alternate site with additional clay and compaction
City	500	E	250	X	$320,000	* Pump to alternate site with additional clay and compaction
City	500	E	250		$27,000	Additional clay and compaction
City	500	E	250		$27,000	Additional clay and compaction
City	1000	E	250	X	$320,000	* Pump to alternate site with additional clay and compaction
City	1000	E	250		$27,000	Additional clay and compaction
City	1000	E	250		$27,000	Additional clay and compaction
City	1000	N			$73,000	Additional clay and compaction
City	1500	E	500	X	$358,000	* Pump to alternate site with additional clay and compaction
City	1500	E	250		$27,000	Additional clay and compaction
City	2000	E	500		$41,000	Additional clay and compaction
City	2000	N			$873,000	** Mechanical plant
Commercial	28	N		X	$12,000	Small discharging lagoon system

TOTAL ANNUAL PRESENT COST *** $2,452,000

* Includes 20 years of pumping costs

** Includes 20 years of additional pumping and operation cost

*** Includes capital cost, engineering and 20 years of operation cost

Additional clay = 2 lbs. bentonite/sq. ft.

Additional compaction = 6 inch additional compacted soil liner (18' vs. 12")

KDHE NOVEMBER 2003

Municipal Programs Section

Cost estimate prepared by R. Walker

ALTERNATIVE FOR SITE WITH SHALLOW GROUNDWATER < 10 FEET
INCREMENTAL COST
PUMP STATION AND REMOTE LAGOON AT SITE WITH GROUNDWATER > 10 BELOW FLOOR OF LAGOON
POPULATION = 250

	CELL 1		CELL 2		CELL 3		TOTALS	
WATER SURFACE LENGTH	220	feet	220	feet	190	feet		
WATER SURFACE WIDTH	190	feet	110	feet	160	feet		
WATER DEPTH	5	feet	5	feet	5	feet		
SIDE SLOPE	3	horz./vert	3	horz./vert	3	horz./vert		
WATER SURFACE AREA	41,800	sq. ft	24,200	sq. ft	30,400	sq. ft	96,400	sq. ft
	0.96	acres	0.56	acres	0.70	acres	2.21	acres
WATER VOLUME	179,750	cubic feet	97,750	cubic feet	127,250	cubic feet	404,750	cubic feet
	1,344,530	gallons	731,170	gallons	951,830	gallons	3,027,530	gallons

	AMOUNT	UNIT	COST/UNIT	COST
6" PVC FORCE MAIN (NO ROCK EXC.)	4000	LF	$12.00	$48,000
6" PVC FORCE MAIN (ROCK EXC.)	4000	LF	$24.00	$96,000
PUMP STATION	1	L.S.	$20,000.00	$20,000
GENERATOR	1	L.S.	$22,000.00	$22,000
EXTRA BENTONITE @ 2 lb./sq. ft.	97	TON	$200.00	$19,400
EXTRA LINER EXC. & COMPACT. (18" vs. 12")	1785	CY	$1.50	$2,678
AIR RELEASE VALVE	4	EACH	$2,500.00	$10,000
STREAM CROSSINGS	2	EACH	$2,000.00	$4,000
RIVER CROSSING	1	EACH	$20,000.00	$20,000
SUBTOTAL				$242,078
CONTINGENCIES				$24,208
ENGINEERING				$19,366
INSPECTION				$12,104
EASEMENT - R/W LEGAL & ACQUISITION				$12,000
TOTAL				$309,755

PUMP STATION AND REMOTE LAGOON AT SITE WITH GROUNDWATER > 10 BELOW FLOOR OF LAGOON

POPULATION = 250

ADDITIONAL OPERATION COSTS	ANNUAL COSTS
ADDITIONAL POWER COST	$281
ADDITIONAL O,M & R COST	$700
	$981

PRESENT COST

DESIGN PE = 250

ITEMS	YEARLY	PRESENT COST*
CAPITAL		$309,755
OM & R	$981	$10,397
TOTAL		$320,152

* PW factor = 10.594 (7% for 20 years)

PUMP STATION AND REMOTE LAGOON AT SITE WITH GROUNDWATER > 10 BELOW FLOOR OF LAGOON

POPULATION = 250

POWER COST

PIPE DIAMETER	6	INCHES
STATIC HEAD	50	FEET
DYNAMIC HEAD	7.2	FEET
PUMP RATE	100	GPM
POWER COST	0.085	$/KWH
PEAKING FACTOR	5	PEAK FLOW / AVERAGE DAILY FLOW
PUMP EFFICIENCY	0.55	%
MOTOR EFFICIENCY	0.9	%
DAILY ON TIME	4.17	Hr / DAY
ANNUAL POWER COST	$281	

ADDITIONAL O,M & R COST $700

ALTERNATIVE FOR SITE WITH SHALLOW GROUNDWATER < 10 FEET
INCREMENTAL COST
PUMP STATION AND REMOTE LAGOON AT SITE WITH GROUNDWATER > 10 BELOW FLOOR OF LAGOON
POPULATION = 500

	CELL 1		CELL 2		CELL 3		TOTALS	
WATER SURFACE LENGTH	220	feet	220	feet	220	feet		
WATER SURFACE WIDTH	300	feet	200	feet	300	feet		
WATER DEPTH	5	feet	5	feet	5	feet		
SIDE SLOPE	3	horz./vert	3	horz./vert	3	horz./vert		
WATER SURFACE AREA	66,000	sq. ft	44,000	sq. ft	66,000	sq. ft	176,000	sq. ft
	1.52	acres	1.01	acres	1.52	acres	4.04	acres
WATER VOLUME	292,500	cubic feet	190,000	cubic feet	292,500	cubic feet	775,000	cubic feet
	2,187,900	gallons	1,421,200	gallons	2,187,900	gallons	5,797,000	gallons

	AMOUNT	UNIT	COST/UNIT	COST
6" PVC FORCE MAIN (NO ROCK EXC.)	4000	LF	$12.00	$48,000
6" PVC FORCE MAIN (ROCK EXC.)	4000	LF	$24.00	$96,000
PUMP STATION	1	L.S.	$28,000.00	$28,000
GENERATOR	1	L.S.	$26,000.00	$26,000
EXTRA BENTONITE @ 2 lb./sq. ft.	178	TON	$160.00	$28,480
EXTRA LINER EXC. & COMPACT. (18" vs. 12")	3259	CY	$1.50	$4,889
AIR RELEASE VALVE	4	EACH	$2,500.00	$10,000
STREAM CROSSINGS	2	EACH	$2,000.00	$4,000
RIVER CROSSING	1	EACH	$20,000.00	$20,000
SUBTOTAL				$265,369
CONTINGENCIES				$26,537
ENGINEERING				$21,229
INSPECTION				$13,268
EASEMENT - R/W LEGAL & ACQUISITION				$12,000
TOTAL				$338,403

PUMP STATION AND REMOTE LAGOON AT SITE WITH GROUNDWATER > 10 BELOW FLOOR OF LAGOON

POPULATION = 500

ADDITIONAL OPERATION COSTS	ANNUAL COSTS
ADDITIONAL POWER COST	$642
ADDITIONAL O,M & R COST	$1,200
	$1,842

PRESENT COST

DESIGN PE = 500

ITEMS	YEARLY	PRESENT COST*
CAPITAL		$338,403
OM & R	$1,857	$19,671
TOTAL		$358,074

* PW factor = 10.594 (7% for 20 years)

PUMP STATION AND REMOTE LAGOON AT SITE WITH GROUNDWATER > 10 BELOW FLOOR OF LAGOON

POPULATION = 500

POWER COST

PIPE DIAMETER	6	INCHES
STATIC HEAD	50	FEET
DYNAMIC HEAD	15.2	FEET
PUMP RATE	174	GPM
POWER COST	0.085	$/KWH
PEAKING FACTOR	5	PEAK FLOW / AVERAGE DAILY FLOW
PUMP EFFICIENCY	0.55	%
MOTOR EFFICIENCY	0.9	%
DAILY ON TIME	4.80	Hr / DAY
ANNUAL POWER COST	$642	

ADDITIONAL O,M & R COST $1,215

ALTERNATIVE FOR SITE WITH SHALLOW GROUNDWATER < 10 FEET
INCREMENTAL COST
PUMP STATION AND REMOTE LAGOON AT SITE WITH GROUNDWATER > 10 BELOW FLOOR OF LAGOON
POPULATION = 1000

	CELL 1		CELL 2		CELL 3	
WATER SURFACE LENGTH	360	feet	420	feet	300	feet
WATER SURFACE WIDTH	300	feet	400	feet	250	feet
WATER DEPTH	5	feet	5	feet	5	feet
SIDE SLOPE	3	horz./vert	3	horz./vert	3	horz./vert

							TOTALS	
WATER SURFACE AREA	108,000	sq. ft	168,000	sq. ft	75,000	sq. ft	351,000	sq. ft
	2.48	acres	3.86	acres	1.72	acres	8.06	acres
WATER VOLUME	492,000	cubic feet	780,000	cubic feet	335,250	cubic feet	1,607,250	cubic feet
	3,680,160	gallons	5,834,400	gallons	2,507,670	gallons	12,022,230	gallons

	AMOUNT	UNIT	COST/UNIT	COST
8" PVC FORCE MAIN (NO ROCK EXC.)	4000	LF	$13.00	$52,000
8" PVC FORCE MAIN (ROCK EXC.)	4000	LF	$26.00	$104,000
PUMP STATION	1	L.S.	$45,000.00	$45,000
GENERATOR	1	L.S.	$34,000.00	$34,000
EXTRA BENTONITE @ 2 lb./sq. ft.	355	TON	$140.00	$49,700
EXTRA LINER EXC. & COMPACT. (18" vs. 12")	6500	CY	$1.50	$9,750
AIR RELEASE VALVE	4	EACH	$2,500.00	$10,000
STREAM CROSSINGS	2	EACH	$2,000.00	$4,000
RIVER CROSSING	1	EACH	$20,000.00	$20,000
SUBTOTAL				$328,450
CONTINGENCIES				$32,845
ENGINEERING				$26,276
INSPECTION				$16,423
EASEMENT - R/W LEGAL & ACQUISITION				$12,000
TOTAL				$415,994

PUMP STATION AND REMOTE LAGOON AT SITE WITH GROUNDWATER > 10 BELOW FLOOR OF LAGOON

POPULATION = 1000

ADDITIONAL OPERATION COSTS	ANNUAL COSTS
ADDITIONAL POWER COST	$1,283
ADDITIONAL O,M & R COST	$2,450
	$3,733

PRESENT COST

DESIGN PE = 1000

ITEMS	YEARLY	PRESENT COST*
CAPITAL		$415,994
OM & R	$3,714	$39,342
TOTAL		$455,336

* PW factor = 10.594 (7% for 20 years)

PUMP STATION AND REMOTE LAGOON AT SITE WITH GROUNDWATER > 10 BELOW FLOOR OF LAGOON

POPULATION = 1000

POWER COST

PIPE DIAMETER	8	INCHES
STATIC HEAD	50	FEET
DYNAMIC HEAD	15.2	FEET
PUMP RATE	347	GPM
POWER COST	0.085	$/KWH
PEAKING FACTOR	5	PEAK FLOW / AVERAGE DAILY FLOW
PUMP EFFICIENCY	0.55	%
MOTOR EFFICIENCY	0.9	%
DAILY ON TIME	4.80	Hr / DAY
ANNUAL POWER COST	$1,283	

ADDITIONAL O,M & R COST $2,431

ALTERNATIVE FOR SITE WITH SHALLOW GROUNDWATER < 10 FEET
INCREMENTAL COST
PUMP STATION AND REMOTE LAGOON AT SITE WITH GROUNDWATER > 10 BELOW FLOOR OF LAGOON
POPULATION = 1500

	CELL 1		CELL 2		CELL 3	
WATER SURFACE LENGTH	500	feet	500	feet	330	feet
WATER SURFACE WIDTH	330	feet	510	feet	300	feet
WATER DEPTH	5	feet	5	feet	5	feet
SIDE SLOPE	3	horz./vert	3	horz./vert	3	horz./vert

							TOTALS
WATER SURFACE AREA	165,000	sq. ft	255,000	sq. ft	99,000	sq. ft	519,000
	3.79	acres	5.85	acres	2.27	acres	11.91
WATER VOLUME	764,250	cubic feet	1,200,750	cubic feet	449,250	cubic feet	2,414,250
	5,716,590	gallons	8,981,610	gallons	3,360,390	gallons	18,058,590

	AMOUNT	UNIT	COST/UNIT	COST
10" PVC FORCE MAIN (NO ROCK EXC.)	4000	LF	$14.00	$56,000
10" PVC FORCE MAIN (ROCK EXC.)	4000	LF	$28.00	$112,000
PUMP STATION	1	L.S.	$54,000.00	$54,000
GENERATOR	1	L.S.	$36,000.00	$36,000
EXTRA BENTONITE @ 2 lb./sq. ft.	524	TON	$140.00	$73,360
EXTRA LINER EXC. & COMPACT. (18" vs. 12")	9611	CY	$1.50	$14,417
AIR RELEASE VALVE	4	EACH	$2,500.00	$10,000
STREAM CROSSINGS	2	EACH	$2,000.00	$4,000
RIVER CROSSING	1	EACH	$20,000.00	$20,000
SUBTOTAL				$379,777
CONTINGENCIES				$37,978
ENGINEERING				$30,382
INSPECTION				$18,989
EASEMENT - R/W LEGAL & ACQUISITION				$12,000
TOTAL				$479,125

PUMP STATION AND REMOTE LAGOON AT SITE WITH GROUNDWATER > 10 BELOW FLOOR OF LAGOON

POPULATION = 1500

ADDITIONAL OPERATION COSTS	ANNUAL COSTS
ADDITIONAL POWER COST	$1,877
ADDITIONAL O,M & R COST	$3,600
	$5,477

PRESENT COST

DESIGN PE = 1500

ITEMS	YEARLY	PRESENT COST*
CAPITAL		$479,125
OM & R	$5,523	$58,513
TOTAL		$537,638

* PW factor = 10.594 (7% for 20 years)

PUMP STATION AND REMOTE LAGOON AT SITE WITH GROUNDWATER > 10 BELOW FLOOR OF LAGOON

POPULATION = 1500

POWER COST

PIPE DIAMETER	10	INCHES
STATIC HEAD	50	FEET
DYNAMIC HEAD	13.6	FEET
PUMP RATE	521	GPM
POWER COST	0.085	$/KWH
PEAKING FACTOR	5	PEAK FLOW / AVERAGE DAILY FLOW
PUMP EFFICIENCY	0.55	%
MOTOR EFFICIENCY	0.9	%
DAILY ON TIME	4.80	Hr / DAY
ANNUAL POWER COST	$1,877	

ADDITIONAL O,M & R COST $3,646

ALTERNATIVE FOR SITE WITH SHALLOW GROUNDWATER < 10 FEET
INCREMENTAL COST
PUMP STATION AND REMOTE LAGOON AT SITE WITH GROUNDWATER > 10 BELOW FLOOR OF LAGOON
POPULATION = 2000

	CELL 1		CELL 2		CELL 3		TOTALS
WATER SURFACE LENGTH	500	feet	500	feet	350	feet	
WATER SURFACE WIDTH	435	feet	670	feet	380	feet	
WATER DEPTH	5	feet	5	feet	5	feet	
SIDE SLOPE	3	horz./vert	3	horz./vert	3	horz./vert	
WATER SURFACE AREA	217,500	sq. ft	335,000	sq. ft	133,000	sq. ft	685,500
	4.99	acres	7.69	acres	3.05	acres	15.74
WATER VOLUME	1,018,875	cubic feet	1,588,750	cubic feet	611,750	cubic feet	3,219,375
	7,621,185	gallons	11,883,850	gallons	4,575,890	gallons	24,080,925

	AMOUNT	UNIT	COST/UNIT	COST
12" PVC FORCE MAIN (NO ROCK EXC.)	4000	LF	$16.00	$64,000
12" PVC FORCE MAIN (ROCK EXC.)	4000	LF	$32.00	$128,000
PUMP STATION	1	L.S.	$60,000.00	$60,000
GENERATOR	1	L.S.	$42,000.00	$42,000
EXTRA BENTONITE @ 2 lb./sq. ft.	692	TON	$140.00	$96,880
EXTRA LINER EXC. & COMPACT. (18" vs. 12")	12694	CY	$1.50	$19,041
AIR RELEASE VALVE	4	EACH	$2,500.00	$10,000
STREAM CROSSINGS	2	EACH	$2,000.00	$4,000
RIVER CROSSING	1	EACH	$20,000.00	$20,000
SUBTOTAL				$443,921
CONTINGENCIES				$44,392
ENGINEERING				$35,514
INSPECTION				$22,196
EASEMENT - R/W LEGAL & ACQUISITION				$12,000
TOTAL				$558,023

PUMP STATION AND REMOTE LAGOON AT SITE WITH GROUNDWATER > 10 BELOW FLOOR OF LAGOON

POPULATION = 2000

ADDITIONAL OPERATION COSTS	ANNUAL COSTS
ADDITIONAL POWER COST	$2,314
ADDITIONAL O,M & R COST	$4,900
	$7,214

PRESENT COST

DESIGN PE = 2000

ITEMS	YEARLY	PRESENT COST*
CAPITAL		$558,023
OM & R	$7,175	$76,016
TOTAL		$634,038

* PW factor = 10.594 (7% for 20 years)

PUMP STATION AND REMOTE LAGOON AT SITE WITH GROUNDWATER > 10 BELOW FLOOR OF LAGOON

POPULATION = 2000

POWER COST

PIPE DIAMETER	12	INCHES
STATIC HEAD	50	FEET
DYNAMIC HEAD	8.8	FEET
PUMP RATE	694	GPM
POWER COST	0.085	$/KWH
PEAKING FACTOR	5	PEAK FLOW / AVERAGE DAILY FLOW
PUMP EFFICIENCY	0.55	%
MOTOR EFFICIENCY	0.9	%
DAILY ON TIME	4.80	Hr / DAY
ANNUAL POWER COST	$2,314	

ADDITIONAL O,M & R COST $4,861

ALTERNATIVE FOR SITE WITH SHALLOW GROUNDWATER < 10 FEET
INCREMENTAL COST
PUMP STATION AND REMOTE LAGOON AT SITE WITH GROUNDWATER > 10 BELOW FLOOR OF LAGOON
POPULATION = 2500

	CELL 1		CELL 2		CELL 3		TOTALS
WATER SURFACE LENGTH	600	feet	690	feet	460	feet	
WATER SURFACE WIDTH	460	feet	600	feet	350	feet	
WATER DEPTH	5	feet	5	feet	5	feet	
SIDE SLOPE	3	horz./vert	3	horz./vert	3	horz./vert	
WATER SURFACE AREA	276,000	sq. ft	414,000	sq. ft	161,000	sq. ft	851000
	6.34	acres	9.50	acres	3.70	acres	19.54
WATER VOLUME	1,302,000	cubic feet	1,974,750	cubic feet	745,750	cubic feet	4022500
	9,738,960	gallons	14,771,130	gallons	5,578,210	gallons	30,088,300

	AMOUNT	UNIT	COST/UNIT	COST
12" PVC FORCE MAIN (NO ROCK EXC.)	4000	LF	$18.00	$72,000
12" PVC FORCE MAIN (ROCK EXC.)	4000	LF	$36.00	$144,000
PUMP STATION	1	L.S.	$70,000.00	$70,000
GENERATOR	1	L.S.	$50,000.00	$50,000
EXTRA BENTONITE @ 2 lb./sq. ft.	860	TON	$140.00	$120,400
EXTRA LINER EXC. & COMPACT. (18" vs. 12")	15759	CY	$1.50	$23,639
AIR RELEASE VALVE	4	EACH	$2,500.00	$10,000
STREAM CROSSINGS	2	EACH	$2,000.00	$4,000
RIVER CROSSING	1	EACH	$20,000.00	$20,000
SUBTOTAL				$514,039
CONTINGENCIES				$51,404
ENGINEERING				$41,123
INSPECTION				$25,702
EASEMENT - R/W LEGAL & ACQUISITION				$12,000
TOTAL				$644,267

PUMP STATION AND REMOTE LAGOON AT SITE WITH GROUNDWATER > 10 BELOW FLOOR OF LAGOON

POPULATION = 2500

ADDITIONAL OPERATION COSTS	ANNUAL COSTS
ADDITIONAL POWER COST	$3,208
ADDITIONAL O,M & R COST	$6,100
	$9,308

PRESENT COST

DESIGN PE = 2500

ITEMS	YEARLY	PRESENT COST*
CAPITAL		$644,267
OM & R	$9,284	$98,355
TOTAL		$742,622

* PW factor = 10.594 (7% for 20 years)

PUMP STATION AND REMOTE LAGOON AT SITE WITH GROUNDWATER > 10 BELOW FLOOR OF LAGOON

POPULATION = 2500

POWER COST

PIPE DIAMETER	12	INCHES
STATIC HEAD	50	FEET
DYNAMIC HEAD	15.2	FEET
PUMP RATE	868	GPM
POWER COST	0.085	$/KWH
PEAKING FACTOR	5	PEAK FLOW / AVERAGE DAILY FLOW
PUMP EFFICIENCY	0.55	%
MOTOR EFFICIENCY	0.9	%
DAILY ON TIME	4.80	Hr / DAY
ANNUAL POWER COST	$3,208	

ADDITIONAL O,M & R COST $6,076

ALTERNATIVE FOR SITE WITH SHALLOW GROUNDWATER < 10 FEET
INCREMENTAL COST
PUMP STATION AND REMOTE LAGOON AT SITE WITH GROUNDWATER > 10 BELOW FLOOR OF LAGOON
POPULATION = 3000

	CELL 1		CELL 2		CELL 3		TOTALS
WATER SURFACE LENGTH	700	feet	700	feet	475	feet	
WATER SURFACE WIDTH	475	feet	710	feet	390	feet	
WATER DEPTH	5	feet	5	feet	5	feet	
SIDE SLOPE	3	horz./vert	3	horz./vert	3	horz./vert	
WATER SURFACE AREA	332,500	sq. ft	497,000	sq. ft	185,250	sq. ft	1014750
	7.63	acres	11.41	acres	4.25	acres	23.30
WATER VOLUME	1,575,875	cubic feet	2,380,750	cubic feet	862,875	cubic feet	4819500
	11,787,545	gallons	17,808,010	gallons	6,454,305	gallons	36,049,860

	AMOUNT	UNIT	COST/UNIT	COST
14" PVC FORCE MAIN (NO ROCK EXC.)	4000	LF	$18.00	$72,000
14" PVC FORCE MAIN (ROCK EXC.)	4000	LF	$36.00	$144,000
PUMP STATION	1	L.S.	$88,000.00	$88,000
GENERATOR	1	L.S.	$55,000.00	$55,000
EXTRA BENTONITE @ 2 lb./sq. ft.	1025	TON	$140.00	$143,500
EXTRA LINER EXC. & COMPACT. (18" vs. 12")	18792	CY	$1.50	$28,188
AIR RELEASE VALVE	4	EACH	$2,500.00	$10,000
STREAM CROSSINGS	2	EACH	$2,000.00	$4,000
RIVER CROSSING	1	EACH	$20,000.00	$20,000
SUBTOTAL				$564,688
CONTINGENCIES				$56,469
ENGINEERING				$45,175
INSPECTION				$28,234
EASEMENT - R/W LEGAL & ACQUISITION				$12,000
TOTAL				$706,566

PUMP STATION AND REMOTE LAGOON AT SITE WITH GROUNDWATER > 10 BELOW FLOOR OF LAGOON

POPULATION = 3000

ADDITIONAL OPERATION COSTS	ANNUAL COSTS
ADDITIONAL POWER COST	$3,519
ADDITIONAL O,M & R COST	$7,300
	$10,819

PRESENT COST

DESIGN PE = 3000

ITEMS	YEARLY	PRESENT COST*
CAPITAL		$706,566
OM & R	$10,810	$114,524
TOTAL		$821,090

* PW factor = 10.594 (7% for 20 years)

PUMP STATION AND REMOTE LAGOON AT SITE WITH GROUNDWATER > 10 BELOW FLOOR OF LAGOON

POPULATION = 3000

POWER COST

PIPE DIAMETER	14	INCHES
STATIC HEAD	50	FEET
DYNAMIC HEAD	9.6	FEET
PUMP RATE	1042	GPM
POWER COST	0.085	$/KWH
PEAKING FACTOR	5	PEAK FLOW / AVERAGE DAILY FLOW
PUMP EFFICIENCY	0.55	%
MOTOR EFFICIENCY	0.9	%
DAILY ON TIME	4.80	Hr / DAY
ANNUAL POWER COST	$3,519	

ADDITIONAL O,M & R COST $7,292

INCREASED BENTONITE AND 18" COMPACTED SOIL LINER
INCREMENTAL COST
LAGOON AT SITE WITH GROUNDWATER > 10 BELOW FLOOR OF LAGOON
POPULATION = 28
NON-DISCHARGING

	CELL 1		CELL 2		CELL 3		TOTALS	
WATER SURFACE LENGTH	220	feet	220	feet	0	feet		
WATER SURFACE WIDTH	150	feet	150	feet	0	feet		
WATER DEPTH	5	feet	5	feet	0	feet		
SIDE SLOPE	3	horz./vert	3	horz./vert	0	horz./vert		
WATER SURFACE AREA	33,000	sq. ft	33,000	sq. ft	0	sq. ft	66000	sq. ft
	0.76	acres	0.76	acres	0.00	acres	1.52	acres
WATER VOLUME	138,750	cubic feet	138,750	cubic feet	0	cubic feet	277500	cubic feet
	1,037,850	gallons	1,037,850	gallons	0	gallons	2,075,700	gallons

	AMOUNT	UNIT	COST/UNIT	COST
EXTRA BENTONITE @ 2 lb./sq. ft.	67	TON	$200.00	$13,400
EXTRA LINER EXC. & COMPACT. (18" vs. 12")	1222	CY	$1.50	$1,833
INCREASED LAGOON SIZE	1	LS	$7,000	$7,000
SUBTOTAL				$22,233
CONTINGENCIES				$2,223
ENGINEERING				$1,779
INSPECTION				$1,112
TOTAL				$27,347

INCREASED BENTONITE AND 18" COMPACTED SOIL LINER
INCREMENTAL COST
LAGOON AT SITE WITH GROUNDWATER > 10 BELOW FLOOR OF LAGOON
POPULATION = 250

	CELL 1		CELL 2		CELL 3		TOTALS	
WATER SURFACE LENGTH	220	feet	220	feet	190	feet		
WATER SURFACE WIDTH	190	feet	110	feet	160	feet		
WATER DEPTH	5	feet	5	feet	5	feet		
SIDE SLOPE	3	horz./vert	3	horz./vert	3	horz./vert		
WATER SURFACE AREA	41,800	sq. ft	24,200	sq. ft	30,400	sq. ft	96400	sq. ft
	0.96	acres	0.56	acres	0.70	acres	2.21	acres
WATER VOLUME	179,750	cubic feet	97,750	cubic feet	127,250	cubic feet	404750	cubic feet
	1,344,530	gallons	731,170	gallons	951,830	gallons	3,027,530	gallons

	AMOUNT	UNIT	COST/UNIT	COST
EXTRA BENTONITE @ 2 lb./sq. ft.	97	TON	$200.00	$19,400
EXTRA LINER EXC. & COMPACT. (18" vs. 12")	1785	CY	$1.50	$2,678
SUBTOTAL				$22,078
CONTINGENCIES				$2,208
ENGINEERING				$1,766
INSPECTION				$1,104
TOTAL				$27,155

INCREASED BENTONITE AND 18" COMPACTED SOIL LINER
INCREMENTAL COST
LAGOON AT SITE WITH GROUNDWATER > 10 BELOW FLOOR OF LAGOON
POPULATION = 500

	CELL 1		CELL 2		CELL 3		TOTALS	
WATER SURFACE LENGTH	220	feet	220	feet	220	feet		
WATER SURFACE WIDTH	300	feet	200	feet	300	feet		
WATER DEPTH	5	feet	5	feet	5	feet		
SIDE SLOPE	3	horz./vert	3	horz./vert	3	horz./vert		
WATER SURFACE AREA	66,000	sq. ft	44,000	sq. ft	66,000	sq. ft	176000	sq. ft
	1.52	acres	1.01	acres	1.52	acres	4.04	acres
WATER VOLUME	292,500	cubic feet	190,000	cubic feet	292,500	cubic feet	775000	cubic feet
	2,187,900	gallons	1,421,200	gallons	2,187,900	gallons	5,797,000	gallons

	AMOUNT	UNIT	COST/UNIT	COST
EXTRA BENTONITE @ 2 lb./sq. ft.	178	TON	$160.00	$28,480
EXTRA LINER EXC. & COMPACT. (18" vs. 12")	3259	CY	$1.50	$4,889
SUBTOTAL				$33,369
CONTINGENCIES				$3,337
ENGINEERING				$2,669
INSPECTION				$1,668
TOTAL				$41,043

INCREASED BENTONITE AND 18" COMPACTED SOIL LINER
INCREMENTAL COST
LAGOON AT SITE WITH GROUNDWATER > 10 BELOW FLOOR OF LAGOON
POPULATION = 1000

	CELL 1		CELL 2		CELL 3		TOTALS	
WATER SURFACE LENGTH	360	feet	420	feet	300	feet		
WATER SURFACE WIDTH	300	feet	400	feet	250	feet		
WATER DEPTH	5	feet	5	feet	5	feet		
SIDE SLOPE	3	horz./vert	3	horz./vert	3	horz./vert		
WATER SURFACE AREA	108,000	sq. ft	168,000	sq. ft	75,000	sq. ft	351000	sq. ft
	2.48	acres	3.86	acres	1.72	acres	8.06	acres
WATER VOLUME	492,000	cubic feet	780,000	cubic feet	335,250	cubic feet	1607250	cubic feet
	3,680,160	gallons	5,834,400	gallons	2,507,670	gallons	12,022,230	gallons

	AMOUNT	UNIT	COST/UNIT	COST
EXTRA BENTONITE @ 2 lb./sq. ft.	355	TON	$140.00	$49,700
EXTRA LINER EXC. & COMPACT. (18" vs. 12")	6500	CY	$1.50	$9,750
SUBTOTAL				$59,450
CONTINGENCIES				$5,945
ENGINEERING				$4,756
INSPECTION				$2,973
TOTAL				$73,124

INCREASED BENTONITE AND 18" COMPACTED SOIL LINER
INCREMENTAL COST
LAGOON AT SITE WITH GROUNDWATER > 10 BELOW FLOOR OF LAGOON
POPULATION = 1500

	CELL 1		CELL 2		CELL 3		TOTALS	
WATER SURFACE LENGTH	500	feet	500	feet	330	feet		
WATER SURFACE WIDTH	330	feet	510	feet	300	feet		
WATER DEPTH	5	feet	5	feet	5	feet		
SIDE SLOPE	3	horz./vert	3	horz./vert	3	horz./vert		
WATER SURFACE AREA	165,000	sq. ft	255,000	sq. ft	99,000	sq. ft	519000	sq. ft
	3.79	acres	5.85	acres	2.27	acres	11.91	acres
WATER VOLUME	764,250	cubic feet	1,200,750	cubic feet	449,250	cubic feet	2414250	cubic feet
	5,716,590	gallons	8,981,610	gallons	3,360,390	gallons	18,058,590	gallons

	AMOUNT	UNIT	COST/UNIT	COST
EXTRA BENTONITE @ 2 lb./sq. ft.	524	TON	$140.00	$73,360
EXTRA LINER EXC. & COMPACT. (18" vs. 12")	9611	CY	$1.50	$14,417
SUBTOTAL				$87,777
CONTINGENCIES				$8,778
ENGINEERING				$7,022
INSPECTION				$4,389
TOTAL				$107,965

INCREASED BENTONITE AND 18" COMPACTED SOIL LINER
INCREMENTAL COST
LAGOON AT SITE WITH GROUNDWATER > 10 BELOW FLOOR OF LAGOON
POPULATION = 2000

	CELL 1		CELL 2		CELL 3		TOTALS	
WATER SURFACE LENGTH	500	feet	500	feet	350	feet		
WATER SURFACE WIDTH	435	feet	670	feet	380	feet		
WATER DEPTH	5	feet	5	feet	5	feet		
SIDE SLOPE	3	horz./vert	3	horz./vert	3	horz./vert		
WATER SURFACE AREA	217,500	sq. ft	335,000	sq. ft	133,000	sq. ft	685500	sq. ft
	4.99	acres	7.69	acres	3.05	acres	15.74	acres
WATER VOLUME	1,018,875	cubic feet	1,588,750	cubic feet	611,750	cubic feet	3219375	cubic feet
	7,621,185	gallons	11,883,850	gallons	4,575,890	gallons	24,080,925	gallons

	AMOUNT	UNIT	COST/UNIT	COST
EXTRA BENTONITE @ 2 lb./sq. ft.	692	TON	$140.00	$96,880
EXTRA LINER EXC. & COMPACT. (18" vs. 12")	12694	CY	$1.50	$19,041
SUBTOTAL				$115,921
CONTINGENCIES				$11,592
ENGINEERING				$9,274
INSPECTION				$5,796
TOTAL				$142,583

INCREASED BENTONITE AND 18" COMPACTED SOIL LINER
INCREMENTAL COST
LAGOON AT SITE WITH GROUNDWATER > 10 BELOW FLOOR OF LAGOON
POPULATION = 2500

	CELL 1		CELL 2		CELL 3		TOTALS	
WATER SURFACE LENGTH	600	feet	690	feet	460	feet		
WATER SURFACE WIDTH	460	feet	600	feet	350	feet		
WATER DEPTH	5	feet	5	feet	5	feet		
SIDE SLOPE	3	horz./vert	3	horz./vert	3	horz./vert		
WATER SURFACE AREA	276,000	sq. ft	414,000	sq. ft	161,000	sq. ft	851000	sq. ft
	6.34	acres	9.50	acres	3.70	acres	19.54	acres
WATER VOLUME	1,302,000	cubic feet	1,974,750	cubic feet	745,750	cubic feet	4022500	cubic feet
	9,738,960	gallons	14,771,130	gallons	5,578,210	gallons	30,088,300	gallons

	AMOUNT	UNIT	COST/UNIT	COST
EXTRA BENTONITE @ 2 lb./sq. ft.	860	TON	$140.00	$120,400
EXTRA LINER EXC. & COMPACT. (18" vs. 12")	15759	CY	$1.50	$23,639
SUBTOTAL				$144,039
CONTINGENCIES				$14,404
ENGINEERING				$11,523
INSPECTION				$7,202
TOTAL				$177,167

INCREASED BENTONITE AND 18" COMPACTED SOIL LINER
INCREMENTAL COST
LAGOON AT SITE WITH GROUNDWATER > 10 BELOW FLOOR OF LAGOON
POPULATION = 3000

	CELL 1		CELL 2		CELL 3		TOTALS	
WATER SURFACE LENGTH	700	feet	700	feet	475	feet		
WATER SURFACE WIDTH	475	feet	710	feet	390	feet		
WATER DEPTH	5	feet	5	feet	5	feet		
SIDE SLOPE	3	horz./vert	3	horz./vert	3	horz./vert		
WATER SURFACE AREA	332,500	sq. ft	497,000	sq. ft	185,250	sq. ft	1014750	sq. ft
	7.63	acres	11.41	acres	4.25	acres	23.30	acres
WATER VOLUME	1,575,875	cubic feet	2,380,750	cubic feet	862,875	cubic feet	4819500	cubic feet
	11,787,545	gallons	17,808,010	gallons	6,454,305	gallons	36,049,860	gallons

	AMOUNT	UNIT	COST/UNIT	COST
EXTRA BENTONITE @ 2 lb./sq. ft.	1025	TON	$140.00	$143,500
EXTRA LINER EXC. & COMPACT. (18" vs. 12")	18792	CY	$1.50	$28,188
SUBTOTAL				$171,688
CONTINGENCIES				$17,169
ENGINEERING				$13,735
INSPECTION				$8,584
TOTAL				$211,176

MECHANICAL PLANT

POPULATION = 250

	AMOUNT	UNIT	COST/UNIT	COST
ACTIVATED SLUDGE PLANT	1	LS	$270,000	$270,000
UV DISINFECTION UNIT	1	LS	$35,000	$35,000
SLUDGE STORAGE TANK & WAGON	1	LS	$20,000	$20,000
MISCELLANEOUS / PIPING & SITE WORK	1	LS	$20,000	$20,000
PUMP STATION	1	L.S.	$20,000	$20,000
GENERATOR	1	L.S.	$22,000	$22,000
SUBTOTAL				$387,000
CONTINGENCIES				$38,700
ENGINEERING				$30,960
INSPECTION				$19,350
TOTAL				$476,010

Alternative Cost of Discharging Lagoon System = $280,000

OPERATION COSTS ACTIVATED SLUDGE	ANNUAL COSTS
POWER	$7,000
OTHER O,M & R COSTS	$12,000
Total O, M & R	$19,000

OPERATION COSTS LAGOON	ANNUAL COSTS
O,M & R COST	$5,000

MECHANICAL PLANT

POPULATION = 250

ESENT WORTH COST ACTIVATED SLUDGE DESIGN PE = 250		
ITEMS	YEARLY	PRESENT WORTH COST
CAPITAL		$476,010
OM & R *	$19,000	$201,286
TOTAL		$677,296

* PW factor = 10.594 (7% for 20 years)

PRESENT WORTH COST LAGOON DESIGN PE = 250		
ITEMS	YEARLY	RESENT WORTH COST
CAPITAL		$280,000
OM & R *	$5,000	$52,970
TOTAL		$332,970

* PW factor = 10.594 (7% for 20 years)

PRESENT WORTH COST OF MECHANICAL PLANT SYSTEM MINUS PRESENT COST OF LAGOON SYSTEM = $344,326

MECHANICAL PLANT

POPULATION = 2000

	AMOUNT	UNIT	COST/UNIT	COST
ACTIVATED SLUDGE PLANT	1	LS	$430,000	$430,000
UV DISINFECTION UNIT	1	LS	$85,000	$85,000
SLUDGE STORAGE TANK & PRESS	1	LS	$150,000	$150,000
LAB / OFFICE / SLUDGE / UV BUILDING	1	LS	$60,000	$60,000
MISCELLANEOUS / PIPING & SITE WORK	1	LS	$80,000	$80,000
PUMP STATION	1	L.S.	$60,000	$60,000
GENERATOR	1	L.S.	$42,000	$42,000
HEADWORKS	1	L.S.	$180,000	$180,000
SUBTOTAL				$1,087,000
CONTINGENCIES				$108,700
ENGINEERING				$86,960
INSPECTION				$54,350
TOTAL				$1,337,010

Alternative Cost of Discharging Lagoon System = $1,100,000

OPERATION COSTS ACTIVATED SLUDGE	ANNUAL COSTS
POWER	$45,000
OTHER O,M & R COSTS	$30,000
Total O, M & R	$75,000

OPERATION COSTS LAGOON	ANNUAL COSTS
O,M & R COST	$15,000

MECHANICAL PLANT

POPULATION = 2000

RESENT WORTH COST ACTIVATED SLUDGE DESIGN PE = 2000		
ITEMS	YEARLY	PRESENT WORTH COST
CAPITAL		$1,337,010
OM & R *	$75,000	$794,550
TOTAL		$2,131,560

* PW factor = 10.594 (7% for 20 years)

PRESENT WORTH COST LAGOON DESIGN PE = 2000		
ITEMS	YEARLY	PRESENT WORTH COST
CAPITAL		$1,100,000
OM & R *	$15,000	$158,910
TOTAL		$1,258,910

* PW factor = 10.594 (7% for 20 years)

PRESENT WORTH COST OF MECHANICAL PLANT SYSTEM MINUS PRESENT COST OF LAGOON SYSTEM = $872,650

MECHANICAL PLANT

POPULATION = 3000

	AMOUNT	UNIT	COST/UNIT	COST
ACTIVATED SLUDGE PLANT	1	LS	$590,000	$590,000
UV DISINFECTION UNIT	1	LS	$130,000	$130,000
SLUDGE STORAGE TANK & PRESS	1	LS	$180,000	$180,000
LAB / OFFICE / SLUDGE / UV BUILDING	1	LS	$80,000	$80,000
MISCELLANEOUS / PIPING & SITE WORK	1	LS	$120,000	$120,000
PUMP STATION	1	L.S.	$88,000	$88,000
GENERATOR	1	L.S.	$55,000	$55,000
HEADWORKS	1	L.S.	$220,000	$220,000
SUBTOTAL				$1,463,000
CONTINGENCIES				$146,300
ENGINEERING				$117,040
INSPECTION				$73,150
TOTAL				$1,799,490

Alternative Cost of Discharging Lagoon System = $1,500,000

OPERATION COSTS ACTIVATED SLUDGE	ANNUAL COSTS
POWER	$60,000
OTHER O,M & R COSTS	$50,000
Total O, M & R	$110,000

OPERATION COSTS LAGOON	ANNUAL COSTS
O,M & R COST	$22,000

MECHANICAL PLANT

POPULATION = 3000

RESENT WORTH COST ACTIVATED SLUDGE DESIGN PE = 3000		
ITEMS	YEARLY	PRESENT WORTH COST
CAPITAL		$1,799,490
OM & R *	$110,000	$1,165,340
TOTAL		$2,964,830

* PW factor = 10.594 (7% for 20 years)

PRESENT WORTH COST LAGOON DESIGN PE = 3000		
ITEMS	YEARLY	RESENT WORTH COST
CAPITAL		$1,500,000
OM & R *	$22,000	$233,068
TOTAL		$1,733,068

* PW factor = 10.594 (7% for 20 years)

PRESENT WORTH COST OF MECHANICAL PLANT SYSTEM MINUS PRESENT WORTH COST OF LAGOON SYSTEM = $1,231,762

COMMERCIAL

SITE WITH GROUNDWATER < 10 BELOW FLOOR OF LAGOON
CONSTRUCT SYNTHETIC LINED DICHARGING LAGOON IN LIEU OF
EARTHEN LINED NON-DISCHARGING LAGOON
POPULATION = 28

Non-Discharging Lagoon

	CELL 1		CELL 2		CELL 3	
WATER SURFACE LENGTH	220	feet	220	feet	0	feet
WATER SURFACE WIDTH	150	feet	150	feet	0	feet
WATER DEPTH	5	feet	5	feet	0	feet
SIDE SLOPE	3	horz./vert	3	horz./vert	0	horz./vert

							TOTALS	
WATER SURFACE AREA	33,000	sq. ft	33,000	sq. ft	0	sq. ft	66000	sq. ft
	0.76	acres	0.76	acres	0.00	acres	1.52	acres
WATER VOLUME	138,750	cubic feet	138,750	cubic feet	0	cubic feet	277500	cubic feet
	1,037,850	gallons	1,037,850	gallons	0	gallons	2,075,700	gallons

	AMOUNT	UNIT	COST/UNIT	COST
MOBILIZATION	1	LS	$1,000	$1,000
EARTHWORK	2400	CY	$1.50	$3,600
INLET & TRANSFER VALVES	3	EACH	$200	$600
POND PIPING	150	LF	$12	$1,800
SOIL STERILIZATION	1	LS	$120	$120
SEEDING & GRADING	1	LS	$300	$300
FENCE	1120	LF	$3	$3,360
CLEARING AND GRUBBING	1	LS	$400	$400
MISCELLANEOUS CONCRETE	1	LS	$250	$250
SUBTOTAL				$11,430
CONTINGENCIES				$1,143
ENGINEERING				$1,372
INSPECTION				$1,143
TOTAL				$15,088

Non-Discharging Lagoon

LAGOON OM & R	
	YEARLY COST
LAGOON ROUTINE MAINTENANCE (MOWING ETC.)	$200
TOTAL	$200

PRESENT WORTH COST LAGOON DESIGN PE = 28		
ITEMS	YEARLY	PRESENT WORTH COST
CAPITAL		$15,088
OM & R *	$200	$2,119
TOTAL		$17,206

* PW factor = 10.594 (7% for 20 years)

Discharging Lagoon with Synthetic Liner

	CELL 1		CELL 2		CELL 3		TOTALS	
WATER SURFACE LENGTH	100	feet	100	feet	0	feet		
WATER SURFACE WIDTH	78	feet	78	feet	0	feet		
WATER DEPTH	5	feet	5	feet	0	feet		
SIDE SLOPE	3	horz./vert	3	horz./vert	0	horz./vert		
BASE LENGTH	70		70		0			
BASE WIDTH	48		48		0			
MID-DEPTH LENGTH	85		85		0			
MID-DEPTH WIDTH	63		63		0			
WATER SURFACE AREA	7,800	sq. ft	7,800	sq. ft	0	sq. ft	15600	sq. ft
	0.18	acres	0.18	acres	0.00	acres	0.36	acres
WATER VOLUME	27,150	cubic feet	27,150	cubic feet	0	cubic feet	54300	cubic feet
	203,082	gallons	203,082	gallons	0	gallons	406,164	gallons

	AMOUNT	UNIT	COST/UNIT	COST
MOBILIZATION	1	LS	$1,000	$1,000
EARTHWORK	600	CY	$1.50	$900
Synthetic Liner 60 mil. HDPE	16520	SF	$0.60	$9,912
INLET & TRANSFER VALVES	3	EACH	$200	$600
POND PIPING	150	LF	$12	$1,800
SOIL STERILIZATION	1	LS	$120	$120
SEEDING & GRADING	1	LS	$300	$300
FENCE	800	LF	$3	$2,400
CLEARING AND GRUBBING	1	LS	$400	$400
MISCELLANEOUS CONCRETE	1	LS	$250	$250
SUBTOTAL				$17,682
CONTINGENCIES				$1,768
ENGINEERING				$2,122
INSPECTION				$1,768
TOTAL				$23,340

Discharging Lagoon with Synthetic Liner

LAGOON OM & R	
	YEARLY COST
LAGOON ROUTINE MAINTENANCE (MOWING ETC.)	$150
LAGOON EFFLUENT TESTING (QUARTERLY)	$360
TOTAL	$510

PRESENT WORTH COST LAGOON DESIGN PE = 28		
ITEMS	YEARLY	PRESENT WORTH COST
CAPITAL		$23,340
OM & R *	$510	$5,403
TOTAL		$28,743

* PW factor = 10.594 (7% for 20 years)

PRESENT WORTH COST OF DISCHARGING LAGOON SYSTEM MINUS
PRESENT WORTH COST OF NON-DISCHARGING LAGOON SYSTEM = $11,537

Appendix B

Policy Memorandum #90-2 (September, 1990)

Industrial Wastewater Pond Liner Policy

State of Kansas
Mike Hayden, Governor

Department of Health and Environment
Division of Environment
Forbes Field, Bldg. 740, Topeka, KS 66620-0002

Stanley C. Grant, Ph.D., Secretary

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Policy Memorandum #90-2
September 1990

FROM: Karl W. Mueldener, P.E.
Director, Bureau of Water

SUBJECT: INDUSTRIAL WASTEWATER POND LINER POLICY

PURPOSE:

This document states the Bureau of Water (Bureau) policy for requirements relating to industrial wastewater ponds. This policy is intended to protect the water and soil resources from a significant risk of contamination posed by earthen lagoons utilized for the containment/treatment of industrial wastewater and to provide minimum standards for the design and construction of new industrial wastewater ponds and the retrofitting of existing earthen lagoons.

BACKGROUND:

The Bureau of Water administers the Kansas Water Pollution Control Permit program established by K.S.A. 65-164 and 65-165. Wastewater ponds which discharge to surface waters or total retention through the use of evaporation, irrigation or recycle are addressed by this program. The Department has responsibilities under K.S.A. 65-171d to prevent subsurface water pollution and soil pollution. An increased emphasis, at both the state and federal level, has been placed on addressing source control as a mechanism for preventing or minimizing groundwater contamination. Since groundwater contamination from earthen ponds has been documented, the Bureau concludes construction of new industrial wastewater ponds without impermeable liner/leak detection systems represent an unnecessary risk of polluting groundwater and soils.

POLICY:

Any new or modified wastewater ponds designed and constructed for the containment or treatment of industrial wastewater, for other than non-contact cooling water or conventional domestic-type wastewater shall meet the following requirements:

1. The pond shall have a primary and secondary liner with an intermediate leak detection system.

2. The primary liner shall be at least 30 mil in thickness.

3. The secondary liner shall also be at least 30 mil in thickness, or, depending on the situation, other alternatives may be approved on a case by case basis.

4. Compaction of the pond embankments and upper 12 inches of the interior bottoms below the secondary liner shall be a minimum of 95% of the maximum standard proctor density. The maximum thickness of the layers of material to be compacted shall be 6 inches. The moisture content range shall be optimum moisture to optimum moisture + 3%. The maximum size of dirt clods in the compacted soil shall be less than one inch diameter.

5. A minimum of two cells must be provided to allow flexibility in operation/maintenance of the pond system. This requirement may be waived if approved wastewater disposal options are available when the pond needs to be dewatered.

6. The primary and secondary liners shall be separated by a permeable material (clean sand or pea gravel having a particle size of less than 1/4 inch in diameter). At least ten (10) inches of sand shall separate the liners on the pond bottom and either six (6) inches of sand or a geotextile fabric shall separate the liners on the slopes.

7. A statement from the liner manufacturer shall be submitted stating the liner is UV resistant and compatible with the wastewater to be contained/treated.

8. A statement from the liner manufacturer shall be submitted stating the permeability of the liner in units of volume/area/time, e.g. gallon/square feet/day.

9. The leak detection pipe(s) shall be placed in a trench to enhance collection of leachate. There should be perforations in the pipe(s), preferably between the 4 or 5 o'clock and 7 or 8 o'clock positions. The pipe(s) shall be wrapped in geotextile fabric to prevent plugging of openings in the pipe(s) by the fine granular material placed between the liners.

10. The pond bottom shall have at least a 2.5% slope to the leak detection pipe(s).The leak detection pipe(s) shall have at least a 1.0% slope to an observation pipe, sump, manhole or other similar structure.

11. The primary and secondary liners shall be anchored at the top of the dike. The liners shall overlap the dike in a U or L-shaped fashion and then be backfilled with soil.

12. The liner shall be installed in accordance with the liner manufacturer's recommendations and by a contractor experienced in synthetic liner installation (at least 10 million square feet of liner previously installed by the contractor is recommended). It is recommended the liner installation be supervised by a representative of the liner manufacturer.

13. A reliable seam testing method shall be used to verify there are no leaks in seams or seals. The methods of destructive and non-destructive seam testing shall be specified. The number destructive tests per linear foot of field seam, and the size of the destructive test specimens shall be specified. All field seams shall be subjected to non-destructive testing.

14. The Kansas Minimum Standards of Design for Water Pollution Control Facilities shall be followed for compaction requirements, slopes, embankment top width, freeboard and any other general wastewater pond construction criteria.

These liner requirements are not applicable for the containment/treatment of hazardous wastes. The Department's Bureau of Air and Waste Management-Hazardous Waste Section should be contacted for hazardous waste requirements.

EFFECTIVE DATE:

The above policy will be in effect on September 18, 1990, and will remain in effect until withdrawn, revised, or modified by the Director.