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Revision 0

Central Facilities Area Sewage Lagoon Evaluation

J·U·B ENGINEERS, INC.

December 2013

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EXECUTIVE SUMMARY

The Central Facilities Area (CFA), located in Butte County, Idaho, at the Idaho National Laboratory has an existing wastewater system to collect and treat sanitary wastewater and non-contact cooling water from the facility. The existing treatment facility consists of three cells: Cell #1 has a surface area of 1.7 acres, Cell #2 has a surface area of 10.3 acres, and Cell #3 has a surface area of 0.5 acres. If flows exceed the evaporative capacity of the cells, wastewater is discharged to a 73.5-acre land application site that uses a center-pivot irrigation sprinkler system.

As flows at CFA have decreased in recent years, the amount of wastewater discharged to the land application site has decreased from 13.64 million gallons in 2004 to no discharge in 2012 and 2013. In addition to the decreasing need for land application, approximately 7.7 MG of supplemental water was added to the system in 2013 to maintain a water level and prevent the clay soil liners in the cells from drying out and "cracking."

The Idaho National Laboratory is concerned that the sewage lagoons and land application site may be oversized for current and future flows. A further concern is the sustainability of the large volumes of supplemental water that are added to the system according to current operational practices. Therefore, this study was initiated to evaluate the system capacity, operational practices, and potential improvement alternatives, as warranted.

Based on conversations with Battelle Energy Alliance, LLC staff, it was assumed that the average monthly flow for the most recent 3 years, October 2010 through September 2013, excluding the supplemental water, would be representative of current and future flows. Using data from the influent lift station flow meter for this period of time, the following flow estimates were made:

- Sanitary wastewater and non-contact cooling water flow:
  - Average daily = 44,223 gallons per day
  - Average annual = 16,141,216 gallons per year.

Based on these flows, a water balance analysis was performed under both "wet" and "dry" conditions. Initially, the analysis was performed using the assumed seepage rates obtained from the lagoon seepage rate study that was completed in 2006. The results of this analysis show that the lagoons are not oversized and discharge to the land application system should be needed each year with no supplemental water addition. However, because the results of this analysis do not match recent operations and observations, the impacts of two key variables were investigated: seepage and influent flow volumes.

First, an analysis was conducted for various seepage rates. This analysis showed that a small change in the seepage rate can have a significant impact on the water balance of the facility.

Second, an analysis was conducted for the amount of influent flow. It was reported by the facility operator that there may be some question as to the accuracy of the influent flows as measured and recorded by the flow meter. For this reason, two additional scenarios were analyzed based on different influent flow values. This analysis showed that if the seepage rate has not changed since 2006, the influent flow values recorded by the influent flow meter are likely incorrect and substantially higher than actual influent flow values.

The results obtained from the additional modeling of seepage rates and influent flow values emphasize the need to perform an updated seepage rate test and to verify the accuracy of the influent flow measurements. After these tasks are completed, the calculations performed for this study should be repeated with the new seepage rate and influent flow values.

The needs and deficiencies of the existing system were identified based on the results of the water balance analyses and discussions with operations personnel. In total, the following eight key elements were identified in the report:

1. **Addition of Supplemental Water**. One of the primary concerns is the large volume of supplemental water that has been added to the lagoon system in recent times to maintain a minimum water level in the lagoons. Because control of seepage from the lagoons relies on the integrity of the clay liners, a water cap must be maintained in the lagoons to prevent drying out and cracking. The addition of supplemental water should be continued as needed to maintain the water cap until influent flows increase to maintain the water cap or modifications are made to the lagoons to address the problem. If the seepage rate increases to the maximum allowable rate of 0.25 in./day, at current influent flows, as much as 19.2 million gallons may be needed annually to maintain the water level in the lagoons.

2. **Seepage Testing.** As discussed previously, the most recent seepage tests for the lagoons were completed in 2006. The Idaho Department of Environmental Quality (IDEQ) is requiring that the seepage tests at CFA be repeated prior to August 31, 2014. An updated seepage test is recommended for each of the lagoons, and a subsequent update of the water balance model and reassessment of the analyses presented in this report using the new data.

3. **Influent Flow Monitoring.** The accuracy of the influent flow measurements has been questioned due to concern that the check valves in the influent lift station are not sealing properly. Failure of the check valves to function properly will result in additional pumping and flows recorded by the flow meter. Under this scenario, the flows reported by the flow monitor will not be representative of actual influent flows to the lagoons. The check valves should either be serviced or replaced to ensure that influent flow monitoring is accurate. Additional investigation or/or monitoring could be completed to help determine if the check valves are operating properly. If it is determined that actual influent flows vary from those used in this report, updates to the analyses should be completed.

4. **Influent Lift Station.** In addition to the questionable check valves at the influent lift station, facility operators reported that the pump guide rail system in the influent lift station appears to be deteriorating and will likely need to be replaced within approximately 5 years. The condition of the guide rail system and other components of the influent lift station should be monitored and replaced when their conditions warrant replacement.

5. **Collection System.** The Sewage Treatment Plant operators report that the collection system consists of a combination of concrete pipe and PVC pipe and is in fairly good condition, with no known deficiencies. The collection system should continue to be cleaned and maintained in accordance with the established maintenance schedule.

6. **Land Application System.** Facility operators have reported that the irrigation pump, pivot, and other components of the land application system are in good condition and operate as intended. Although the land application system has not been used in recent years, the system and the associated wastewater reuse permit should be maintained until it can be confirmed with new seepage rate test data and an updated water balance model that reuse will no longer be required for future flows. The current Wastewater Reuse Permit from IDEQ will expire on March 16, 2015. If it has not been determined that the land application system is no longer needed, the permit should be renewed.

7. **Transfer Structures.** Facility operators have reported that the weirs and gate valves located in the transfer structures between the lagoons appear to be aging and showing signs of wear-and-tear. They have estimated that the components inside the transfer structures will likely need to be replaced within approximately 10 years. The weirs and valves should continue to be serviced and maintained in accordance with the manufacturer's recommendations to maximize the remaining service life.

8. **Fencing and Signage.** IDEQ requires lagoons to be fenced to prevent entering of livestock and discourage trespassing. Because only the west and south sides of the lagoons are fenced, it is recommended that additional fencing be installed to meet this IDEQ requirement. IDEQ also requires signs to be installed around the lagoons and land application site to signify their uses. It is recommended that operators verify that the existing signage meets the IDEQ requirements.

To address the primary concern of the need for supplemental water, a number of alternatives were considered. The addition of large amounts of supplemental water is in conflict with the site's sustainability goals and should not be relied on as a long-term practice. Therefore, assuming that recently observed conditions are representative of future conditions, the "do nothing" Alternative 1 is not recommended.

Although additional investigation is needed related to the seepage rate and influent flow values prior to implementing any long-term alternative, two long-term alternatives were considered based on the assumption that supplemental water will be needed in future years to maintain the necessary water cap in the lagoons without modifications to the facility.

Long-term Alternative 2 would include replacing the existing clay lining system in the storage cells (Cell #2 and Cell #3) with a synthetic liner system (such as high-density polyethylene). With implementation of this alternative, Cell #2 and Cell #3 could be allowed to go dry without causing damage to the new liner, thus eliminating the need for supplemental water.

The implementation of this lining system would include the following:

- Removal and disposal of accumulated biosolids in Cell #2 and Cell #3
- Reshaping of the bottom of Cell #2 and Cell #3
- Installing the new synthetic liner system.

Long-term Alternative 3 would include reducing the size of the storage volume in Cell #2 enough to ensure that no supplemental water would be needed to maintain a water level throughout most years. This alternative also would require increased flows to the land application system during most years. The implementation of this alternative would include the following:

- Removal and disposal of accumulated biosolids in Cell #2
- Installing a new dike across the center of Cell #2
- Modifying the site piping and transfer structures.

Ultimate selection of the preferred, long-term alternative should be made after conditions are monitored and verification is made regarding the seepage rate and influent flow values. When this information is available, the analyses in this report should be updated and a detailed comparison of the available alternatives should be undertaken with consideration of life-cycle cost, regulatory requirements, schedule, implementability, operation and maintenance requirements, and day-to-day reliability.

Implementation of any long-term alternative will require a number of submittals to IDEQ, including the following:

- A facility planning study
- A preliminary engineering report
- Construction drawings and specifications
- Record drawings and specifications
- Operation and maintenance manual.

The resulting recommended alternative should provide a long-term solution to wastewater treatment and disposal at CFA and eliminate, or at least significantly reduce, the need to add supplemental water.

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Central Facilities Area Sewage Lagoon Evaluation

1. INTRODUCTION

1.1 Study Background

The Central Facilities Area (CFA), located in Butte County, Idaho, at the Idaho National Laboratory (INL) has an existing wastewater system to collect and treat sanitary wastewater and non-contact cooling water from the facility. INL is concerned that the sewage lagoons and land application site, which are part of the wastewater system, may be oversized for current and known future population. Also, there is concern about the sustainability of the large volumes of supplemental water that are added to the system according to current operational practices. Therefore, this study was initiated to evaluate the system capacity, operational practices, and potential improvement alternatives, as warranted.

CFA is operated for the United States Department of Energy by Battelle Energy Alliance, LLC (BEA). Walsh Engineering Services, PC is contracted by BEA to provide facility engineering services for CFA. J-U-B ENGINEERS, Inc. has been subcontracted by Walsh Engineering Service, PC to develop this evaluation study.

1.2 System History

Prior to 1995, sanitary wastewater from CFA was collected and treated at a mechanical wastewater treatment plant, which consisted of a digester and trickling filter. Deterioration of this wastewater treatment plant led to its replacement.

The new Sewage Treatment Plant (STP) was constructed in 1994 and put into service on February 6, 1995. The STP consists of the following:

- 1.7-acre partially mixed/aerated lagoon (Cell #1)
- 10.3-acre non-mixed/aerated facultative lagoon (Cell #2)
- 0.5-acre non-mixed/aerated polishing pond (Cell #3)
- 73.5-acre wastewater land application area consisting of desert steppe and crested wheatgrass vegetative communities
- Computerized center-pivot sprinkler irrigation system.

A 350-gallon per minute pump moves wastewater from the lagoons to the center-pivot sprinkler system, which irrigates the land application area at low pressures (about 30 pounds per square inch).

The CFA STP is managed and operated by the Facilities and Site Services organization located at CFA.

Figure 1, taken from a previous annual wastewater reuse report, shows the location and layout of STP at CFA.

Because clay material cracks when it dries out, lagoons that rely on a clay liner to prevent seepage are typically operated to maintain a minimum depth of water at all times. For this reason and because of the presence of the clay liner material in the CFA lagoons, the Facilities and Site Services staff operate the system to continuously maintain a minimum depth of water in all three lagoons. Recently, this has required the addition of large amounts of supplemental water in the summer months when evaporation rates are peaking. The supplemental water is added within the collection system upstream of the influent lift station.

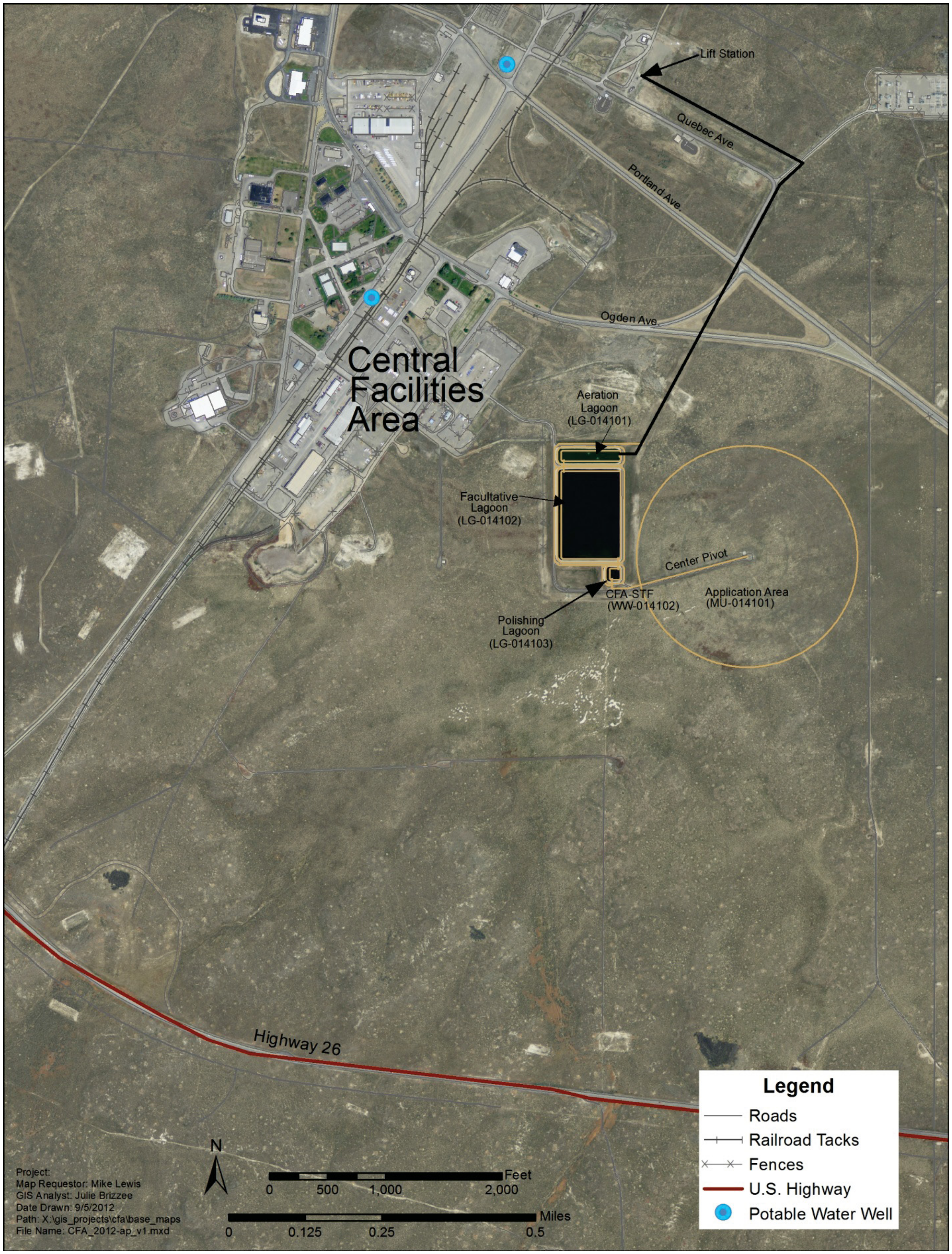

Figure 1. Area map showing the location of the Sewage Treatment Plant at the Central Facilities Area.

In 2006, INL conducted a seepage test of the sewage lagoons. All three passed the test with seepage rates below the maximum allowable seepage rate of 0.25 inches per day (in./day) for lagoons constructed prior to April 15, 2007. The maximum allowable seepage rate is established by Idaho Administrative Code IDAPA 58.01.16. The seepage test results were as follows:

- Cell #1 – 0.028 in./day
- Cell #2 – 0.046 in./day
- Cell #3 – 0.054 in./day.

1.3 Study Objectives

In general, the objectives for this study include the following:

- Describe the climatic conditions relevant to assess the capacity of the lagoons
- Calculate flows and a water balance for the system for existing and anticipated future conditions
- Assess the capacity of the STP
- Identify general needs and deficiencies
- Identify operational changes to reduce the volume of supplemental water added to the system
- Screen and evaluate alternatives needed to address the needs and deficiencies
- Describe key issues to consider for implementation of the preferred alternative.

This study is intended to be a cursory assessment and tool to assist with long-term decision making. If a project is implemented, the preparation of additional documents will be needed, including those required to meet Idaho Department of Environmental Quality (IDEQ) requirements, such as a facilities plan, preliminary engineering report, and detailed plans and specifications for construction.

2. CLIMATIC DATA

2.1 Precipitation

Precipitation data were obtained from the Western Regional Climate Center (WRCC). Approximately 59 years of monthly precipitation data for CFA for the period between April 1954 and March 2013 were analyzed to determine the annual precipitation value that corresponded to both the 10-year high and 10-year low precipitation years, as well as average precipitation over this period.

The 10-year high precipitation value is considered a reasonable value to use in analyzing the capacity of the lagoon system during a “wet” year, whereas the 10-year low value is reasonable for a “dry” year. For example, the 10-year high is the highest amount of annual precipitation that would statistically occur every 10 years. The annual precipitation amount was then allocated to each month proportional to the average monthly precipitation. The resulting monthly 10-year high and low precipitation values are summarized in Table 1.

For comparison, in this 59-year period, the median annual precipitation was 8.67 in. with a high of 14.4 in. and a low of 4.42 in. In 2009, which was considered a relatively wet year, the annual precipitation was 10.4 in. (the thirteenth wettest year in the past 59 years).

Table 1. Monthly precipitation data.

Month	Average Precipitation (in.)[1]	10-Year High Precipitation (in.)	10-Year Low Precipitation (in.)
January	0.7	0.94	0.47
February	0.58	0.78	0.39
March	0.61	0.82	0.41
April	0.83	1.11	0.56
May	1.22	1.64	0.82
June	1.17	1.57	0.78
July	0.49	0.66	0.33
August	0.47	0.63	0.31
September	0.65	0.87	0.44
October	0.58	0.78	0.39
November	0.63	0.84	0.42
December	0.74	0.99	0.50
Annual	8.67	11.62	5.81

[1]Source: Data provided by WRCC for CFA (Idaho Falls 46 W Station) for April 1, 1954, to March 31, 2013.

2.2 Evaporation

Evaporation data were obtained from the WRCC for the Aberdeen Experiment Station. The Aberdeen Experiment Station was chosen out of the 14 stations in Idaho where evaporation data has been recorded over several decades because it is believed to be the best representation for the evaporation conditions at CFA. The evaporation data provided by WRCC are reported as the monthly average pan evaporation. The average monthly pan evaporation was then adjusted using factors based on temperature to more closely estimate the average evaporation from the lagoons. Using the pan coefficients, it was determined that the annual evaporation for the CFA area is 33.58 in. "pond" evaporation rate (not "pan" evaporation rate). The resulting monthly evaporation rates are summarized in Table 2.

High salt concentrations in wastewater warrant further reduction of the evaporation rate with a "salinity correction factor." Results from wastewater samples taken at CFA indicated a total dissolved solids concentration of 1,460 milligrams per liter in August 2011 and 1,203 milligrams per liter (average) in 2007. These concentrations are the highest concentrations reported in the annual wastewater reuse reports completed for CFA since 2005 and are not high enough to warrant correction for salinity.

Based on these data, the annual net evaporation for the INL area during a "wet" year is estimated to be approximately 22 in. (33.58 in. evaporation – 11.62 in. precipitation).

Table 2. Monthly temperature and evaporation data.

Month	Average Temperature (°F)[1]	Average "Pan" Evaporation (in.)[2]	Evaporation Pan Coefficient	Adjusted Average "Pond" Evaporation (in.)[3]
January	16.2	0.0	-	0
February	21.3	0.0	-	0
March	31.9	0.0	0.991	0
April	42.1	0.0	0.888	0
May	51.5	7.46	0.805	6.00

Month	Average Temperature (°F)[1]	Average "Pan" Evaporation (in.)[2]	Evaporation Pan Coefficient	Adjusted Average "Pond" Evaporation (in.)[3]
June	60.0	8.95	0.721	6.45
July	68.5	10.28	0.646	6.64
August	66.5	9.40	0.665	6.25
September	56.1	6.41	0.758	4.86
October	43.8	3.85	0.879	3.38
November	29.6	0.0	-	0
December	18.4	0.0	-	0
Annual		46.35		33.58

[1]Source: *WRCC for the CFA (period of record 1954 through 2012)*
[2]Source: *WRCC for the Aberdeen Experiment Station (period of record 1914 through 2005)*
[3]Adjusted values used for evaporative lagoons based on standard pan coefficients for average monthly temperatures.

3. SYSTEM EVALUATION

3.1 Existing System Drawings

Available drawings of the existing STP are included in Attachment A. Also, Figure 2 shows an overall view of the lagoon system site.

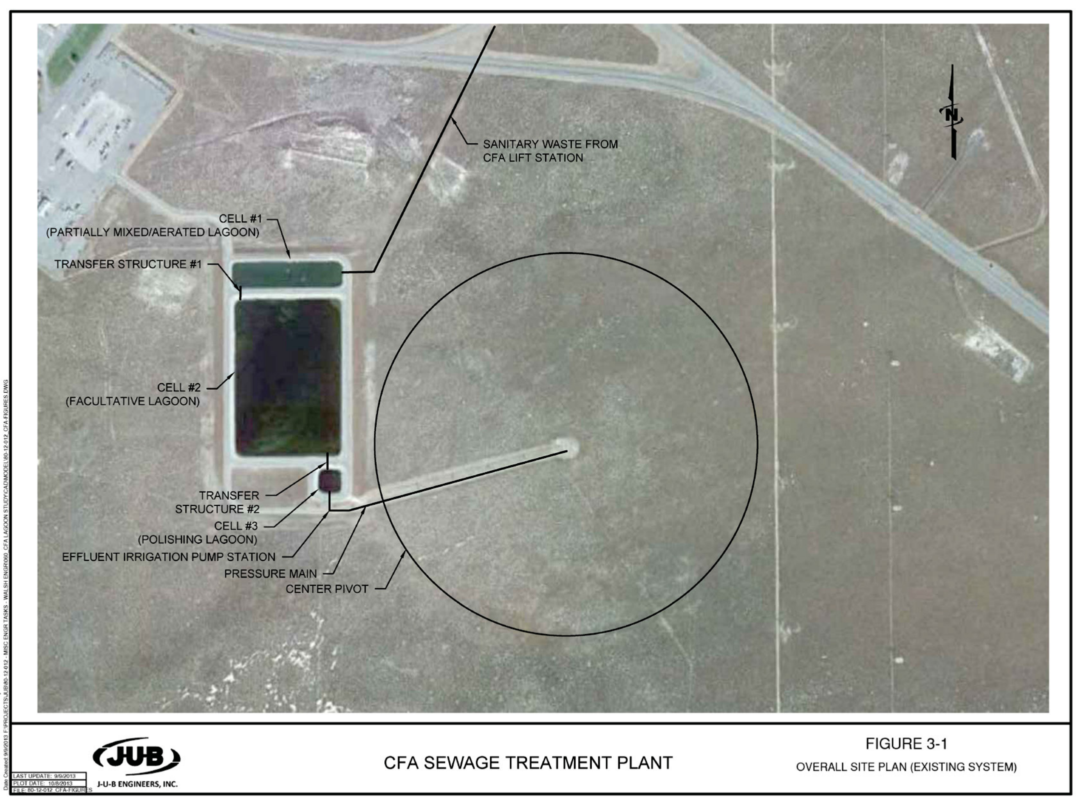

Figure 2. Overall site plan (existing system).

3.2 Existing System Description

Sanitary wastewater from CFA is collected and conveyed through gravity lines to the influent lift station. The duplex submersible pump lift station then pumps the wastewater through a 4-in. pressure main to the lagoons for treatment and disposal via evaporation and the land application system. The discharge of the lift station has an ultrasonic flow meter. Table 3 summarizes the details of the three lagoons.

Table 3. Central Facilities Area existing lagoons.

Lagoon Cell #	Year Constructed	Approximate Average Water Surface Area (acres)	Liner	Maximum Water Depth (ft)[1]	Freeboard Above Max Water Depth (ft)
1	1994	1.7	Bentonite-treated soil with riprapped sides	8	2
2	1994	10.3	Bentonite-treated soil with riprapped sides	8	2
3	1994	0.5	Bentonite-treated soil with riprapped sides	8	2
Total		12.5			

[1]Design depth. Typical maximum operating depth is approximately 7.5 ft.

Figures 3 and 4 are photos of the existing lagoons.

Figure 3. Photo of existing lagoons (Cell #1 in the forefront, Cell #2 behind).

Figure 4. Photo of existing lagoons (Cell #3 in the forefront, Cell #2 behind).

Wastewater from the influent lift station normally enters Cell #1 and flows out the southwest corner through in-dike Transfer Structure #1 into the adjacent Cell #2. The wastewater then flows from Cell #2 to Cell #3 near the southeast corner of Cell #2 through in-dike Transfer Structure #2. These transfer structures consist of valves and overflow weirs. The weirs are typically set to maintain an operating depth in the lagoons of between 3 and 8 ft. Occasionally, the water levels may be lowered for operational and maintenance reasons.

Figures 5 and 6 are photos of both transfer structures.

Need to provide image that works

Figure 5. Photo of existing Transfer Structure #1between Cells #1 and #2.

Figure 6. Photo of existing Transfer Structure #2 between Cells #2 and #3.

Following treatment in the lagoons, the wastewater can be pumped out of Cell #3 to the land application center pivot. Figure 7 is a photo of the effluent irrigation pump station that is used to pump the wastewater to the land application site.

Figure 7. Photo of effluent irrigation pump station.

The lagoon dikes include a 10-ft wide section of gravel road around the perimeters. The exterior and interior slopes are 3:1 (horizontal:vertical). The lagoon facility is fenced only on the west and south side, with a smooth-wire fence; however, the fence is not able to keep all animals out of the facility.

3.3 Service Area Limits and Population

The service area boundary of STP is limited to the CFA boundary. However, additional wastewater is transported from other area septic tanks, portable toilets, and temporary office/laboratory trailers with holding tanks to the CFA STP for treatment. The following information regarding existing and future population at CFA was provided by BEA. According to current plans, no significant future growth is planned for the population served by STP. Therefore, future growth projections of population were not considered in this evaluation, and subsequent analyses of the system were based only on the existing CFA population estimates. It was assumed that the existing population and flows also are representative of future population and flows.

Currently, BEA estimates that there are a total of 438 employees who work at CFA. Of those 438 employees, 324 work 10 or 12-hour shifts, 4 days per week. Less than 50 employees are expected to work at the facility on weekends or night shifts. This represents a total monthly workforce of approximately 9,490 worker-days per month, based on a standard 8-hour workday and assuming an average work week consists of 40 hours *(52 weeks*40 hours/week*438 employees/12 months/year/8 hours/day)*.

3.4 Flows

Flow data for STP were reviewed for the past several years. The influent, effluent, and supplemental water flows at STP for the permit years of 2003 through 2013 are shown graphically in Figure 8.

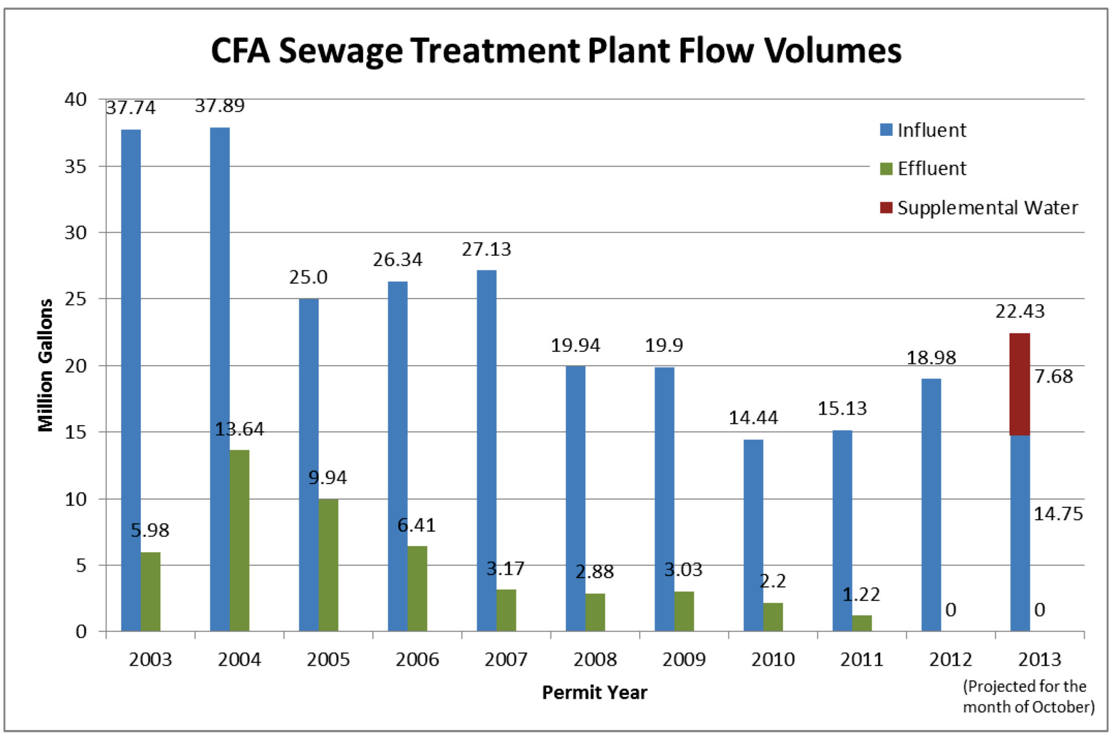

Figure 8. Central Facilities Area Sewage Treatment Plant flow volumes.[a]

[a] The facility's permit year is from November 1 of the previous year to October 31 of the current year. Annual influent and effluent flows for 2003 and 2004 were reported by BEA staff. Influent and effluent flows for 2005 through 2009, and effluent flows for 2010 and 2011 were obtained from the daily flow data reported in the appendix of the annual Wastewater Land Application Site Performance Reports submitted to IDEQ. Influent flows for 2010 through 2013 were obtained from daily flow records provided by BEA staff; missing data were filled in using average values. Influent flow for October 2013 was estimated because flow data were not available prior to completion of this report. Supplemental flow for 2013 was estimated based on information reported by BEA staff.

Monthly influent flows for the period of November 2007 through October 2013 are shown graphically in Figure 9.

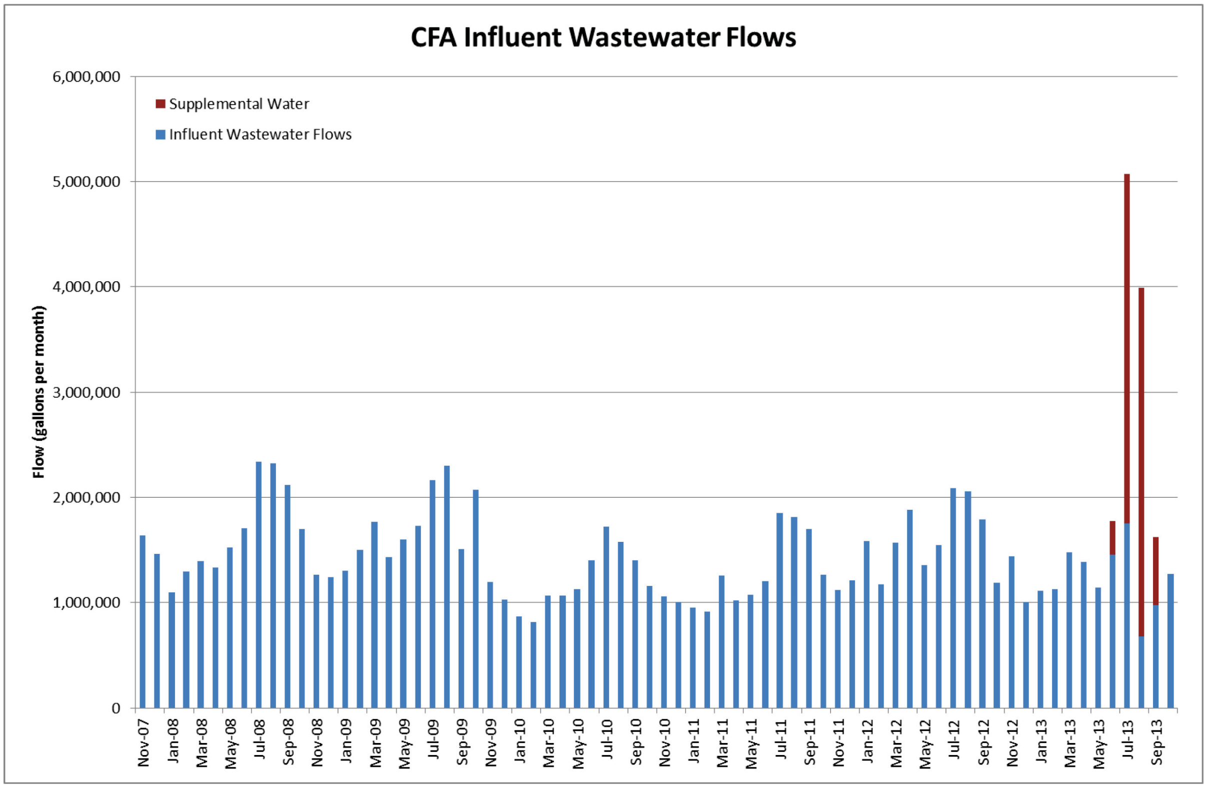

Figure 9. Monthly influent flow data.

As shown in Figures 8 and 9, supplemental water has been discharged to STP in recent months to maintain a minimum water level to keep the clay liners from drying out.

For calculations and analysis discussed later in this report, estimates were made of flows to represent current and future conditions. Based on conversations with BEA staff, it was assumed that the average monthly flow for the most recent 3 years, October 2010 through September 2013, excluding the supplemental water, would be representative of current and future flows. The results of this analysis are as follows:

- Sanitary wastewater and non-contact cooling water flow
  - Average daily = 44,223 gallons per day
  - Average annual = 16,141,216 gallons per year.

Based on the average influent flow and the existing population, the average sanitary flow per worker based on a standard 8-hour workday is 142 gallons per worker-day. For comparison, literature indicates an “office” facility typically uses about 13 gallons per day per worker (Metcalf and Eddy 2003). The higher flows at CFA could partially be a result of the additional non-contact cooling water that is discharged to STP. In addition to the sanitary wastewater and the non-contact cooling water flows at CFA, STP also receives additional flow from septic tanks, portable toilets, and temporary office/laboratory trailers with holding tanks that effectively increases the actual population served by STP.

Another potential reason for the higher flow values was reported by the STP operator who indicated that the check valves in the influent lift station may not be functioning properly, allowing wastewater in the force main to flow back into the influent lift station when the pump turns off. If this is the case, the same wastewater is pumped multiple times and the flows recorded by the flow meter on the force main will be greater than the volume of wastewater actually discharged to the lagoons. For the purpose of this study, it was assumed that the reported influent flows are accurate. If it is determined that the reported influent flows are not representative of actual flows discharged to the lagoons, the calculations discussed later in this report should be updated.

3.5 Water Balance

A water balance spreadsheet model of the lagoons and land application system was developed using the influent flow, evaporation, precipitation, and seepage data discussed earlier in this report. Modeling scenarios were developed for both “wet” year and “dry” year conditions using the 10-year high and 10-year low precipitation values, respectively.

The spreadsheet model was prepared assuming that the water level fluctuates simultaneously in all three lagoons as occurs when the valves in the transfer structures are open. In this mode of operation, as water starts to fill the lagoons, all three lagoons rise at the same rate, and, as water is lost to evaporation or land application, the water level in all three lagoons falls the same amount. A 1-year cycle of the lagoon water levels was evaluated to show the water level fluctuation over the course of a complete water cycle season. For this analysis, a water cycle season was assumed to start on October 1, which is when the system should be at its lowest level in the annual cycle.

3.5.1 Assumed Existing Scenarios

The month-to-month water balance for the STP and the land application system, based on the model for existing “wet” and “dry” year conditions, is shown in Figure 10 for the 1-year water cycle period. In this figure, it was assumed that no land application would occu, and an initial storage volume of 20 million gallons (MG) was assumed.

In Figure 10, the accumulated storage volume at the end of the annual cycle is greater than that at the start of the cycle. This indicates that with the assumed seepage, evaporation, precipitation, and influent flow values, land application would be required to prevent the lagoons from eventually overfilling. The model indicates 3.8 MG would need to be land applied annually during a “wet” year and 1.9 MG would need to be land applied annually during a “dry” year.

However, these model results do not correlate with the historical operation of the system during this time period. Effluent discharge records indicate that only 1.22 MG were land applied in 2011 and no land application occurred during 2012 or 2013. In fact, during 2013, approximately 7.7 MG of supplemental water were added to the lagoons to keep a minimum water level. Conversely, the model indicates that more land application should have been required, and there should have been no need for supplemental water. This discrepancy is likely due to a difference between the assumed and actual values for variables such as evaporation, seepage, precipitation, and influent flows.

3.5.2 Variability of Model Input Parameters

Of the contributing variables, evaporation and precipitation data should be reasonably representative of actual conditions because they were derived from actual weather observations during the modeled time period and the range of “dry” and “wet” years should help account for variability. The remaining two variables, seepage rate and influent flows, are likely to have more uncertainty and variability, warranting further analysis.

The seepage rate for the lagoons used in the base water balance model was obtained from the seepage tests that were completed in 2006. The weighted average seepage rate for all three cells from the 2006 seepage tests is 0.044 in./day. Note this value is significantly lower than IDEQ’s allowable seepage rate of 0.25 in./day.

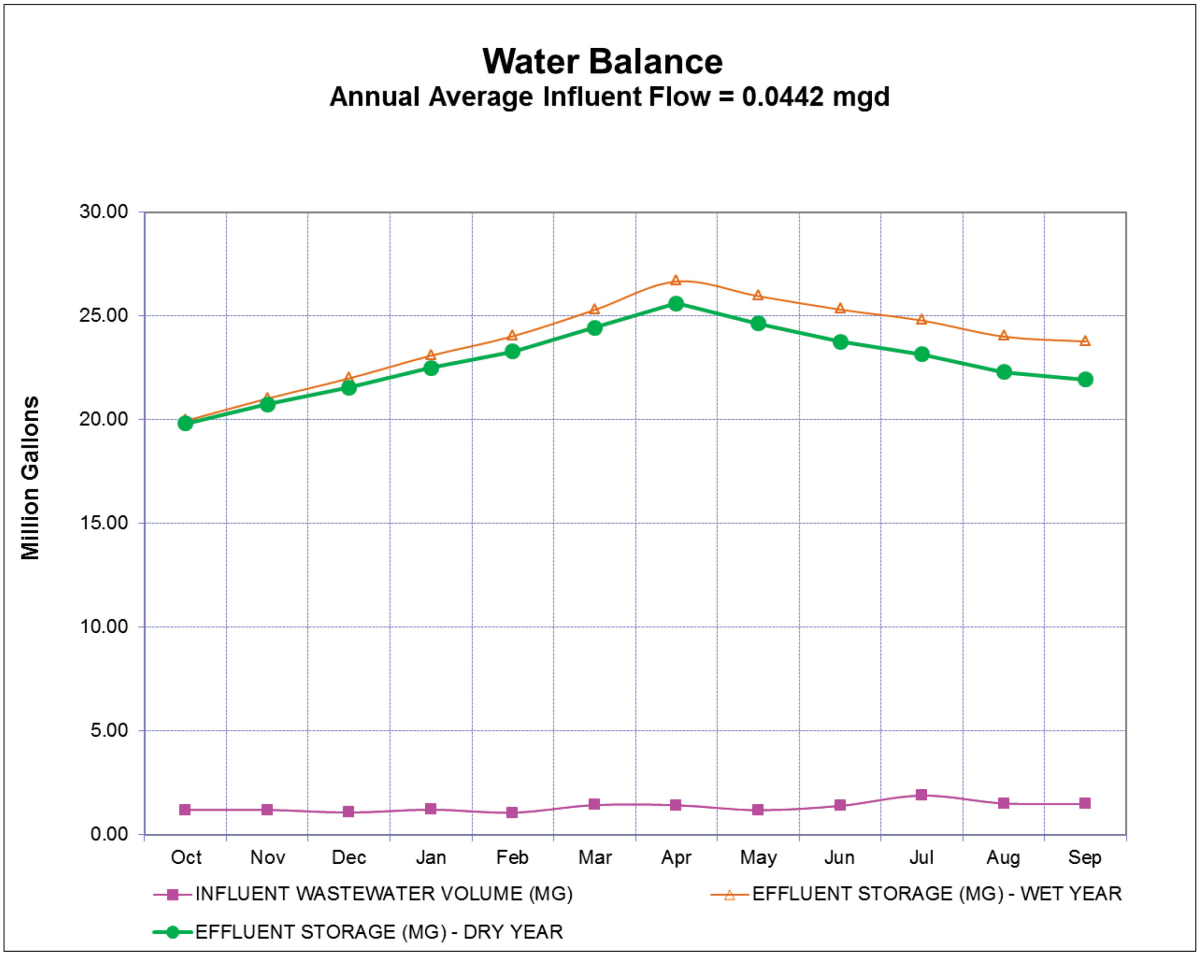

Figure 10. Water balance – with no land application.

To address the uncertainty of the seepage rate, the model was used to compare various scenarios with different seepage rates as shown in Table 4. Scenario 1 in Table 4 shows the results of the water balance model with the seepage rate obtained from the 2006 seepage rate study. Scenario 2 in the table shows what seepage rate would result in a balanced system with no land application and no addition of supplemental water for the assumed influent flows discussed above. As shown for this scenario, the seepage rate would only need to increase from 0.044 in./day to 0.078 in./day for a "wet" year and to 0.062 in./day for a "dry" year in order to achieve a balanced system with no land application or addition of supplemental water. These values are still well below the seepage rate allowed by IDEQ, but indicate that even a minor increase in the seepage rate could have a significant impact on the amount of wastewater that must be land applied or how much supplemental water is required each year.

The model was then used to determine what seepage rate would correspond with the need to add 7.7 MG of supplemental water such as was added during 2013. As shown for Scenario 3 in Table 4, for a balanced scenario under these conditions, the model indicates that the seepage rate would need to increase from the 2006 average value of 0.044 in./day to 0.134 in./day. This assumes precipitation similar to that of a "dry" year, which nearly reflects the weather conditions during 2013. (Note that a seepage rate of 0.134 in./day would still be well below IDEQ's allowable seepage rate of 0.25 in./day.) The final scenario considered was Scenario 4, which shows that 19.2 MG/year of supplemental water would be required if the seepage rate increased to the maximum allowable rate of 0.25 in./day.

Table 4. Water balance model results for various seepage rates.

	Scenario 1		Scenario 2		Scenario 3		Scenario 4	
	Wet Year	Dry Year	Wet Year	Dry Year	Wet Year	Dry Year	Wet Year	Dry Year
Average Daily Flow (gal/day)	44,223	44,223	44,223	44,223	44,223	44,223	44,223	44,223
Seepage Rate (in./day)	0.044	0.044	0.078	0.062	0.141	0.134	0.25	0.25
Amount of Land Application (MG/yr)	3.8	1.9	0	0	0	0	0	0
Amount of Supplemental Water (MG/yr)	0	0	0	0	7.7	7.7	17.5	19.2

The analyses indicate that the current seepage rate of the lagoons may be significantly higher than the values measured during the last seepage test in 2006. IDEQ is requiring that the seepage tests at CFA be repeated prior to August 31, 2014. In addition to fulfilling a requirement of IDEQ, obtaining updated seepage rate data would allow refinement of the water balance model and assist in evaluating the potential need for future addition of supplemental water. If the testing determines that seepage rates have increased significantly, repairs or replacement of the lagoon lining systems and/or other STP modifications may be needed. Therefore, an updated seepage test is recommended for each of the lagoons, and a subsequent update of the water balance model and reassessment of the analyses presented in this report using the new data should be completed.

As stated previously, the accuracy of the influent flow values has been questioned. It is obvious that the results from the water balance model are dependent on the amount of influent flow. To better understand the system capacity and the impact of influent flow values on the water balance, two additional scenarios were modeled. Table 5 shows the results of the modeling of these two additional scenarios where it is assumed that the seepage rate obtained in 2006 is still representative of current conditions. Scenario 1 represents the observed conditions from 2013 and shows what influent flows should be for a balanced system with 7.7 MG being added as supplemental water. For comparison, Scenario 2 shows what the influent flows would need to be for a wet year, where no supplemental water is added and no land application is required.

Table 5. Water balance model results for various flow scenarios.

	Scenario 1	Scenario 2
Seepage Rate (in./day)	0.044 (condition from 2006 seepage test)	0.044 (condition from 2006 seepage test)
Amount of Land Application (MG/year)	0	0
Amount of Supplemental Water (MG/year)	7.7 (amount added in 2013)	0
Modeled Type of Year	Dry	Wet
Average Daily Flow (gal/day)	16,180	33,170
% of Current Average Daily Flow as Reported by Flow Meter	37%	75%

The results from this additional modeling show that if the seepage rate is similar to that obtained in 2006, the influent flow measurements obtained from the flow meter may be incorrect and substantially higher than the actual influent flows. In reality, the discrepancy between the model results and actual observations may be a result of a combination of seepage rate and influent flow uncertainties.

3.6 Needs and Deficiencies

The identified needs and deficiencies of the STP system are summarized in the following subsections.

3.6.1 Addition of Supplemental Water

One of the primary concerns is the large volume of supplemental water that has been added to the lagoon system in recent times to maintain a minimum water level in the lagoons. Providing supplemental water requires significant infrastructure and energy resources and is a conflict with the site's sustainability goals and objectives.

Becasue the control of seepage from the lagoons relies on the integrity of the clay liners, a water cap must be maintained in the lagoons to prevent drying out and cracking. The addition of supplemental water should be continued as needed to maintain the water cap until influent flows increase to maintain the water cap or modifications are made to the STP to address the problem. As shown in Table 4, if the seepage rate increases to the maximum allowable rate of 0.25 in./day, at current influent flows, as much as 19.2 MG may be needed annually to maintain the water level in the lagoons.

3.6.2 Seepage Testing

As discussed previously in Section 3.5 of this report, the most recent seepage tests for the lagoons were completed in 2006. IDEQ is requiring that the seepage tests at CFA be repeated prior to August 31, 2014. An updated seepage test is recommended for each of the lagoons and a subsequent update of the water balance model and reassessment of the analyses presented in this report using the new data.

3.6.3 Influent Flow Monitoring

Accurate influent flow information is important when trying to identify system capacity or deficiencies. As discussed previously in Section 3.4 of this report, STP operators have questioned the integrity of the check valves in the influent lift station. Failure of the check valves to function properly will result in additional pumping and flows recorded by the flow meter. Under this scenario, the flows reported by the flow monitor will not be representative of actual influent flows to the STP. The check valves should either be serviced or replaced to ensure that the influent flow monitoring is accurate.

The flow meter may be capable of measuring reverse flow and distinguishing that from the normal directional flow. If this is the case, data from the flow meter should be collected and reviewed to determine if reverse flow is occurring in the force main due to the failure of the check valves. If the flow meter is not capable of measuring reverse flow, a flow direction sensor could be installed on the influent force main that would determine if the flow direction in the force main reverses when the pump turns off, indicating a failure of the check valves to seal properly. One of these two options could be utilized to determine whether replacing the check valves is necessary.

In addition to influent flow monitoring at the lift station, the flow and volume of any future supplemental water added should be carefully monitored and recorded for use in future analyses.

3.6.4 Influent Lift Station

In addition to the questionable check valves at the influent lift station, STP operators reported that the pump guide rail system in the influent lift station appears to be deteriorating and will likely need to be replaced within approximately 5 years. The condition of the guide rail system and other components of the influent lift station should be monitored and replaced when their conditions warrant replacement.

3.6.5 Collection System

The STP operators report that the collection system consists of a combination of concrete pipe and PVC pipe and is in fairly good condition with no known deficiencies. The collection system should continue to be cleaned and maintained in accordance with the established maintenance schedule.

3.6.6 Land Application System

STP operators have reported that the irrigation pump, pivot, and other components of the land application system are in good condition and operate as intended. Although the land application system has not been used in recent years, the system and the associated wastewater reuse permit should be maintained until it can be confirmed with new seepage rate test data and an updated water balance model that reuse will no longer be required for future flows. The current Wastewater Reuse Permit from IDEQ will expire on March 16, 2015. If it has not been determined that the land application system is no longer needed, the permit should be renewed.

3.6.7 Transfer Structures

STP operators have reported that the weirs and gate valves located in the transfer structures between the lagoons appear to be aging and showing signs of wear-and-tear. They have estimated that the components inside the transfer structures will likely need to be replaced within approximately 10 years. The weirs and valves should continue to be serviced and maintained in accordance with the manufacturer's recommendations to maximize the remaining service life.

3.6.8 Fencing and Signage

3.6.8.1 Lagoons. The IDEQ requirements for wastewater lagoons state:

> *Fencing. The pond area shall be enclosed with an adequate fence to prevent entering of livestock and discourage trespassing. This requirement does not apply to pond areas which store or impound Class A municipal reclaimed effluent. IDAPA 58.01.16.493.09.c.i*
>
> *Warning Signs. Appropriate permanent signs shall be provided along the fence around the pond to designate the nature of the facility and advise against trespassing. At least one (1) sign shall be provided on each side of the site and one (1) for every five hundred (500) feet of its perimeter. IDAPA 58.01.16.493.09.c.iii*

Currently, the lagoons are only fenced on the west and south sides with a smooth wire fence. It is recommended that additional fencing be installed to enclose the lagoons on all sides to meet the requirements of the above referenced requirements. If completed, the existing smooth-wire fence may be sufficient to keep livestock out, but may not be sufficient to reliably keep wildlife out. If livestock or wildlife intrusion in the lagoons is regularly observed, replacement of the fence around the lagoons to provide a more substantial barrier is recommended to help protect the integrity of the lagoon liners when the water level is low. In addition, it is recommended that STP operators verify that the signs are installed to meet the requirements and add additional signs where necessary.

3.6.8.2 Land Application Site. The current Municipal Wastewater Reuse Permit (LA-000141-03) issued by IDEQ does not state that the land application site has to be fenced.

The Reuse Permit does require posting of signs, reading "Sewage Effluent Application – Keep Out" or equivalent, every 500 ft and at each corner of the outer perimeter of the buffer zones. It is recommended that STP operators verify that sufficient signs are installed, and if not, that additional signs are installed to meet this requirement.

4. ALTERNATIVES EVALUATION

4.1 Screening of Alternatives for Further Evaluation

To address the primary issue of eliminating the need to add supplemental water to the lagoons, the following alternatives were developed for consideration and screening.

- Alternative 1: Do Nothing
- Alternative 2: Re-Line Storage Cells – Replace the existing clay liners so that they can be operated in an empty condition.
- Alternative 3: Reduce Size of Storage Cells – Reduce the volume of the storage cells so water is retained throughout most years.

4.1.1 Alternative 1: Do Nothing

As discussed earlier, the water balance model with values based on currently available data for seepage and other inputs indicates that land application should be required each year and the addition of supplemental water should not be needed. However, this conclusion does not match recent experience as nearly 8 MG of supplemental water was needed in 2013 to keep sufficient water in the lagoons, and no land application has been required since 2011.

Assuming that recently observed conditions are representative of future conditions, the "do nothing" alternative is not recommended. The addition of large amounts of supplemental water is in conflict with the site's sustainability goals and should not be relied on as a long-term practice.

4.1.2 Alternative 2: Re-Line Storage Cells

For this alternative, the existing clay lining system in the cells that are used for storage, Cell #2 and Cell #3, would be replaced with a new synthetic liner system (such as high-density polyethylene). Replacing the existing clay lining system with a new synthetic lining system would eliminate the need to add supplemental water because the lagoons could be allowed to go dry without damaging the integrity of the clay material. An added benefit is that the existing clay lining system, which is nearly 20 years old and may be compromised with excessive seepage rates based on the results of the water balance model, would be replaced with a new lining system.

To implement this alternative, the following improvements would be needed:

- Remove and dispose of accumulated biosolids in accordance with a sludge management plan approved by the state and following Environmental Protection Agency (EPA) 40 CFR 503 rules. A Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) evaluation would likely be needed to assess whether disposal or land application can be used.
- Replace the clay liner system. (Note: If testing indicates that the seepage rate in Cell #1 exceeds IDEQ's allowable limits, the liner in Cell #1 should be replaced as well.)
- Reconfigure the lagoon bottom to provide a bottom slope. Replacing the entire liner system will require removal of settled solids and reconstruction of the lagoon bottom to provide a suitable base for the new liner. While these disturbances are occurring, it is recommended to reconfigure the bottom of the cells to allow any gas that is generated under the new liner to migrate to the lagoon perimeter where it can safely escape. Gas can be generated by decomposing organic matter present in the native soils or from wastewater collecting under the liner from leaks.

With a new lining system, the seepage rates in the lagoon would likely change significantly. IDEQ would likely consider reconstruction of the lagoons with a new liner to be a significant improvement and reduce the allowable seepage rate to the newer standard of 0.125 in./day.

The water model indicates that if the new seepage rates are less than 0.078 in./day, land application would be required at some point during the summer to maintain the water balance. A new lining system with quality construction can often reduce seepage to negligible levels, in which case the model indicates that 8.8 MG per year would need to be discharged to land application. However, this is still well below the 37 MG per year allowed by the facility's existing wastewater reuse permit.

If the new seepage rates are consistently over 0.078 in./day, the water model indicates that the system could be operated as a total containment system. However, because of the variable nature of the influent flows, weather, and seepage, a number of successful years of operation in this mode would be needed before the facility should consider abandoning the land application system.

As long as the land application system is in use, Cell #1 should continue to be aerated and operated in an overflow mode to provide adequate oxygen, mixing, and detention time for treatment to occur prior to discharge to land application. If the land application system is abandoned, Cell #1 can be converted to use as a storage cell.

4.1.3 Alternative 3: Reduce Size of Storage Cells

For this alternative, the size of the large storage cell (Cell #2) would be reduced such that the storage cells (Cells #2 and #3) would retain water throughout the entire year without the need to add supplemental water.

To implement this alternative, the following improvements would be needed:

- Remove and dispose of accumulated biosolids in accordance with a sludge management plan approved by the state and following EPA's 40 CFR 503 rules. A CERCLA evaluation would likely be needed to assess whether disposal or land application can be used.
- Install a new dike across the center of Cell #2. The dike would need to be located to reduce the overall storage volume (total available in Cells #2 and #3) by the annual volume of supplemental water that an updated water balance model indicates would be required during a worst-case year.
- Modify the site piping and transfer structures to retain the ability to control water level in the lagoons and transfer flow between the lagoons as needed.

One drawback of this alternative is that there would be significantly increased flows to the land application system and reliance on that method of disposal during most years. This is due to the design needing to account for the variable nature of the weather and influent flow volumes. Also, with clay liners, seepage rates can be quite variable and either increase or decrease over a relatively short period of time as cracks in the clay layer occur, heal, or plug. The size of the storage volume would need to be reduced so that water would be retained throughout an entire year, even during worst-case conditions (i.e., hot, dry weather patterns with low influent volumes and high seepage rates). However, the result would be that for other years with average weather, flows, and seepage, excess water would be present and need to be land applied to prevent the lagoons from overfilling.

If this alternative is selected for implementation, more detailed evaluation and updated seepage and influent flow rates would be needed to determine the appropriate reduction in volume. However, the volume could not be reduced below what would be required to store the influent flow throughout the entire non-growing season (November 1 through March 31), when the reuse permit does not allow land application. The existing volume of Cells #2 and #3 is approximately 26 MG. For an average flow of 44,223 gallons per day, the minimum required volume would be 7.6 MG to also accommodate precipitation and assuming no seepage. For this volume, the water model indicates that approximately 14.7 MG would need to be discharged to land application during a wet weather year with zero seepage. This volume is still well below the 37 MG per year allowed by the existing permit.

A second drawback of this alternative is that constructing the new dike without damaging the existing clay liner and connecting the clay liner of the new dike to the existing liner while still passing the post-construction seepage test within IDEQ's allowable limits may be difficult. Also, a thick layer of clay with strict construction tolerances will be necessary to meet IDEQ's requirement for a maximum design seepage rate of 500 gallons per day per acre. (This is 8 times more stringent than IDEQ's maximum operating design seepage rate of 3,400 gallons per day per acre [0.125 in./day]).

4.2 Selection of Preferred Alternative

4.2.1 Engineer's Opinions of Probable Cost

Cost is an important consideration in the comparison of alternatives and selection of a preferred alternative for implementation. When implementation of an alternative is required, engineer's opinions of probable cost will be prepared for comparison.

4.2.2 Comparison of Alternatives

When implementation of an alternative is required, a detailed comparison of the available alternatives should be undertaken, with consideration of a number of criteria such as life-cycle cost, regulatory requirements, schedule, implementability, operation and maintenance requirements, and day-to-day reliability.

One other important consideration is the condition of the liner in the existing cells. As discussed in Section 3.5, a seepage test will need to be completed on all of the lagoons before August 31, 2014. If the results of this seepage test indicate that the existing clay liners have failed or are approaching the end of their useful life, then preference should be given to Alternative 2, which is the only alternative evaluated in Section 4.1 that would include replacement of the lagoon liners.

5. IMPLEMENTATION OF PREFERRED ALTERNATIVE

5.1 Regulatory Requirements

Implementation of Alternative 2 or 3 would constitute a "material modification" to the facility and trigger a number of required submittals to IDEQ for review and approval (see IDAPA 58.01.16.410 through 425):

- A facility planning study
- A preliminary engineering report (with prior IDEQ concurrence, this report may be incorporated into the facility planning study to satisfy this requirement)
- Construction drawings and specifications
- Record drawings and specifications
- Operation and maintenance manual.

Ongoing regulatory EPA/IDEQ requirements will be similar to those required for the existing facility. The facility will likely continue to operate with the land application system; therefore, a wastewater reuse permit for discharge to land application will continue to be required.

Windblown dirt and settled solids from the wastewater will accumulate in the bottom of the lagoons. If solids accumulate in the lagoons to the point where they are using up excessive volume, they should be removed. The removed solids can be land applied with permitting through IDEQ.

Post-construction and periodic seepage testing will continue to be needed in accordance with IDEQ requirements as required by IDAPA 58.01.16.493.02. Every 10 years, seepage testing must be repeated.

If an existing lagoon is abandoned, it must be abandoned in accordance with an IDEQ-approved closure plan, meeting the requirements of IDAPA 58.01.16.493.10. Abandonment would include removal and proper disposal of accumulated solids, the embankment liner, piping, and structures and smooth grading of the site.

5.2 Summary of Implementation Steps

To proceed with operation and monitoring of the existing system and eventual implementation of the preferred alternative, the following steps are recommended:

1. Perform seepage rate testing of all three cells to comply with IDEQ requirements and update the water balance and evaluation provided in this study. Note any trends that show an increasing seepage rate that may indicate that the existing liners have failed or are reaching the end of their useful life.
2. Continue monitoring and tracking flows at the influent lift station flow meter. Note any trends that show increasing or decreasing sanitary wastewater flow that may affect the conclusions in this study.
3. To confirm the reliability of the influent flow meter data, verify that the check valves in the influent lift station are functioning properly. The check valves should be repaired or replaced or a flow direction sensor should be installed on the force main to verify the direction of flow in the force main.
4. Continue monitoring and tracking the addition of any supplemental water required to maintain a water cap in the lagoons. Note any trends that show an increasing seepage rate that may indicate a failing liner.
5. When conditions are apparent that indicate regular addition of supplemental water will be required, secure funding to implement the preferred long-term alternative.
6. Initiate engineering tasks to prepare the documentation discussed in Section 5.1 to satisfy IDEQ requirements and to enable procurement of a contractor for construction of the necessary improvements.
7. Construct the necessary improvements.
8. Perform post-construction seepage testing of the upgraded lagoons in accordance with IDEQ requirements to verify compliance with allowable limits.
9. Prepare record drawings and update the operation and maintenance manual.
10. Close out the project.

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7. ATTACHMENTS

The following items are attached to this report:

- Attachment A, Record Drawings for the ATR Sanitary Wastewater Lagoons

  [needed from BEA for inclusion as an attachment]

- Attachment B, 2006 Seepage Test Results

Attachment A

Record Drawings for the CFA STP

Attachment A
Record Drawings for the CFA STP

Attachment B

2006 Seepage Testing Results

Attachment B
2006 Seepage Testing Results

STATE OF IDAHO
DEPARTMENT OF
ENVIRONMENTAL QUALITY

CCN 208358

900 NORTH SKYLINE DRIVE, SUITE B • IDAHO FALLS, IDAHO 83402 • (208) 528-2650

JAMES E. RISCH, GOVERNOR
TONI HARDESTY, DIRECTOR

January 16, 2007

Carolyn Mascarenas, Director
Environmental Compliance
Battelle Energy Alliance, LLC
Mail Stop 3710
1955 Fremont Avenue
Idaho Falls, ID 83415-3710

RE: 1) Approval of the Seepage Rate Testing for the Central Facilities Area Sewage Treatment Plant, Compliance Activity CA-141-02, Wastewater Land Application Permit LA-000141-02.
2) Termination of Compliance Activity CA-141-03 (lagoon repair or replacement).

Dear Ms. Mascarenas:

I have reviewed the June 30, 2006 Seepage Rate Testing report identified above. The results indicate seepage rates of 0.028, 0.046, and 0.054 inches/day for lagoons 1, 2, and 3, respectively. These seepage rates are less than the maximum limit of 0.125 inches/day. Therefore, the 3 lagoons have passed and Compliance Activity CA-141-02 is approved.

Because all 3 lagoons have passed, there is no need to submit a lagoon repair/replacement plan. Therefore, Compliance Activity CA-141-03 is also terminated.

If you have any questions, please call me at 528-2650.

Sincerely,

Thomas A. Rackow

Thomas A. Rackow, P.E.
Staff Engineer
Idaho Falls Regional Office

c: Norm Stanley, Battelle Energy Alliance, INL
Richard Kauffman, Environmental Technical Support, DOE
Richard Huddleston, Wastewater Program Manager, DEQ Boise

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Printed on Recycled Paper

June 30, 2006 CCN 205989

Mr. Thomas A. Rackow
Staff Engineer
Idaho Department of Environmental Quality
900 N. Skyline, Suite B
Idaho Falls, ID 83402

SUBJECT: Transmittal of Seepage Rate Test Report for the Central Facilities Area Sewage Treatment Lagoons

Dear Mr. Rackow:

The Central Facilities Area (CFA) Sewage Treatment Plant (STP) Wastewater Land Application Permit (WLAP # LA-000141-02) required the Idaho National Laboratory Site to perform seepage tests on each of the sewage treatment lagoons (Compliance Activity 141-02). The attached report contains a description of the seepage tests and the results. The tests demonstrated compliance with the 0.125 inches/day performance standard.

If you have any questions regarding this report, please contact either Keith Hendrickson at (208) 526-3246 or Norm Stanley at (208) 526-5901.

Sincerely,

Carolyn S. Mascareñas, P.E.

Carolyn S. Mascareñas, P.E.
Environmental Compliance Director

NOR:at

cc: M. L. Adams, DOE-ID, MS 1221
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DWW D. W. Wagoner, MS 3428
INL Correspondence Control, MS 3108
Environmental Correspondence, MS 3428
C. S. Mascarenas Letter File (CSM-93-06

Uniform File Code: 6108
Disposition Authority: ENV3-a-2
Retention Schedule: Destroy 5 years after permit expires.

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INL/EXT-06-11520
CCN -205989

Central Facilities Area Sewage Treatment Lagoons Seepage Rate Test Report

Norm Stanley and Keith Hendrickson

June 2006

Idaho National Laboratory
Environmental Compliance
Idaho Falls, Idaho 83415

Prepared for the
U.S. Department of Energy
Office of Nuclear Energy, Science and Technology
Under DOE Idaho Operations Office
Contract DE-AC07-05ID14517

Central Facilities Area Sewage Treatment Lagoons Seepage Rate Test Report

INL/EXT-06-11520

June 2006

Approved by.

Steven L. Winn, Manager, Facility Mgmt. Services — Date 6/29/06

Keith D. Hendrickson, P.E. — Date 29 June 06

Date

PROFESSIONAL ENGINEER
REGISTERED
7765
STATE OF IDAHO
KEITH D HENDRICKSON
29 June 06

CONTENTS

FIGURES

TABLES

APPENDICIES

ACRONYMS

CA	Compliance Activity
CFA	Central Facilities Area
DEQ	Idaho Department of Environmental Quality
gpd	Gallons per day
INL	Idaho National Laboratory
STP	Sewage Treatment Plant
WLAP	Wastewater Land Application Permit

Central Facilities Area Sewage Treatment Lagoons Seepage Rate Test Report

1. PURPOSE

The January 26, 2005 Wastewater-Land Application Permit (WLAP) #LA-00141-02 for the Idaho National Laboratory's Central Facilities Area (CFA) Sewage Treatment Plant (STP) established a seepage rate performance standard for the STP lagoons of 0.125 inches/day (CA-141-02). A seepage test was required to demonstrate compliance with the performance standard. The test was to be performed by February 16, 2006. However, an extension of the testing schedule until June 30, 2006 was requested and approved by the Idaho Department of Environmental Quality (DEQ) to allow for the seepage testing to be performed when the water volume in the lagoons was at or near the design operating depth (Appendix A). This report presents the results of seepage testing performed on the CFA STP Lagoons 1, 2 and 3 during April and May 2006.

2. INTRODUCTION

The Central Facilities Area (CFA) at the Idaho National Laboratory (INL) uses a lagoon and land application process to treat and dispose of wastewater. An aerial view of the lagoon and pivot irrigation system is shown in Figure 1. The CFA sewage treatment plant (STP) process consists of the following major components:

- A gravity flow collection system
- A wet well/lift station that pumps wastewater to the treatment lagoons
- A 1.7 acre partial-mix aerated lagoon (Lagoon 1), at an 8 ft. depth
- A 10.3 acre facultative lagoon (Lagoon 2) at an 8 ft depth
- A 0.5 acre polishing lagoon (Lagoon 3) at an 8 ft depth
- A center pivot irrigation system that applies the treated wastewater to 73.5 acres of native desert soil and vegetation.

The sewage treatment plant (STP) was designed to treat up to 250,000 gallons per day (gpd) with current flows averaging around 70,000 gpd. The lagoons are lined with bentonite and have enough capacity to store the wastewater generated during the non-growing season when the pivot irrigation system is not operating. Wastewater flows by gravity from Lagoon 1 to Lagoons 2 and 3. Water depth is determined by discharge volumes, valve/gate settings in the piping and transfer boxes, and by operation of the pivot irrigation system.

Lagoon 1 seepage testing was performed during April 18 – May 3, 2006 and Lagoons 2 and 3 were tested concurrently during May 22 – June 6, 2006.

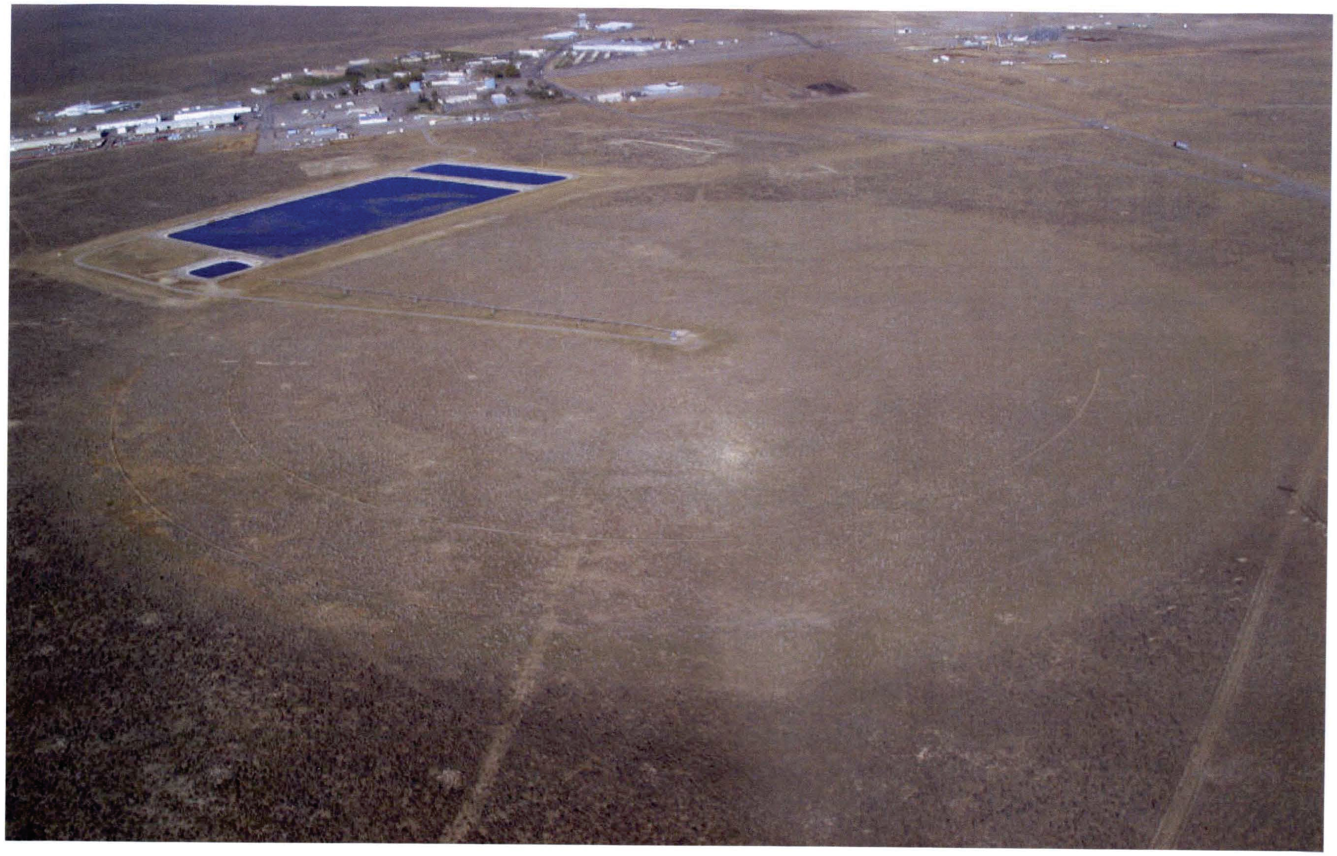

Figure 1. Aerial view of the CFA sewage treatment lagoons and wastewater application area

3. PROCEDURE

The seepage tests were performed using the method approved by the DEQ in the Procedure for Evaluating Wastewater Treatment Lagoon Seepage Rates [(Appendix B) memorandum from David Mabe, State Water Quality Programs Administrator to DEQ Wastewater Staff and Regional Administrators, January 22, 2002] with minor deviations discussed below. Wastewater discharges were diverted directly into Lagoon 2 while seepage testing was performed on Lagoon 1. The wastewater was then routed back into Lagoon 1 while seepage tests were performed on Lagoons 2 and 3. Each of the lagoons was isolated during seepage testing by positioning valves and slide gates. All of the lagoons had operated continuously since 1995 and the water depth in the lagoons was approximately 7 ft (≈88% of design capacity) during the seepage testing. No land application pumping occurred during the seepage testing periods.

Locations for the transfer box stilling wells, evaporation pan, rain gauge and temperature data logger used for the seepage tests are shown in Figure 2.

An evaporation station was set up on the south side of Lagoon 2 just west of Lagoon 3. The station consisted of a Class-A stainless steel evaporation pan, with a stilling well and a hook gauge. The pan was positioned on a level pallet located on the berm south of Lagoon #2 and west of Lagoon #3. Fencing panels were installed around the pan to prevent deer and antelope from drinking during the testing periods.

A rain gauge and temperature data logger were installed on one of the aerator anchor posts located in the berm between Lagoons 1 and 2. Precipitation was monitored using a Productive Alternatives All-Weather Rain Gauge. The gauge was a standard 4-inch orifice, funnel type unit that was installed about 5-ft above the ground with the top orifice being several inches above the mounting post. The gauge measuring tube had a 1.00 inch capacity with readout increments of 0.01 inch. The gauge was read, recorded and emptied (if precipitation was collected) at approximately 1:30 pm daily during the testing periods. Temperature data was collected using a HOBO® H8 Pro Series logger. The temperature was recorded to the nearest 0.01°F at 5 minute intervals. Seventy-two hour means were calculated for each water measurement period during the 15-day testing cycles.

Hook gauges were used to measure water surface levels at approximately 1:30 pm on days 0, 3, 6, 9, 12 and 15 of each seepage test. Seven hook gauge measurements were taken and recorded at the evaporation pan and the lagoon(s) during each measurement cycle. Hook gauge readings were made to the nearest 0.001 inch. Baseline and corrected measurements were taken when water was added to the evaporation pan or when hook gauge extensions were added to reach the lagoon surfaces.

Seepage tests performed at the CFA STP deviated from the approved DEQ procedure in the following areas.

- The procedure specifies that stilling wells should be installed as near to the center of the cell as possible. A request was submitted to the DEQ to use the concrete transfer structures located in the lagoon berms between Lagoons 1 and 2, and Lagoons 2 and 3 as stilling wells for the water level measurements. The request was approved by DEQ (letter from Thomas A. Rackow to Carolyn S. Mascarenas, Request for Alternative Stilling Well Location for Seepage Rate Testing at the Central Facilities Area Sewage Treatment Lagoons, Compliance Activity CA-141-03, Wastewater Land Application Permit No. LA-000141-2, April 13, 2006. (Appendix C)

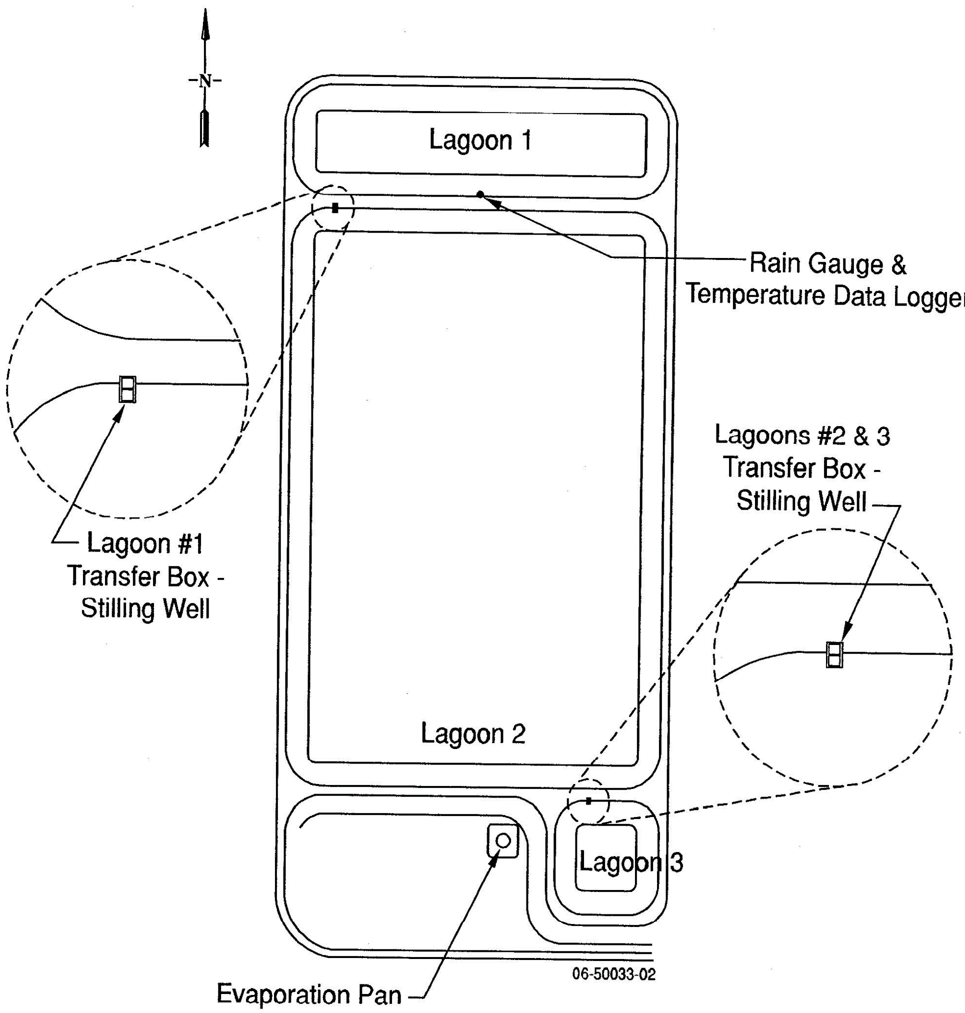

Figure 2. Instrument and measurement locations for the CFA STP seepage tests

Lagoon water elevation measurements were taken from reference points on the transfer box cover grates using an extended hook gauge. Hook gauge extensions or wooden spacers between the hook gauge and the grate were used as needed to keep the water surface elevation within the travel distance of the hook gauge. The distance between the reference point and the water surface was re-baselined each time an extension or spacer was added or removed.

- The procedure specifies that one individual is to be responsible for all measurements. Work scheduling required two individuals to perform the hook gauge measurements and additional support from CFA utilities personnel in performing daily rain gauge measurements.

4. LAGOON SEEPAGE RATES

Seepage rates for each of the lagoons were determined by solving the following equation from the DEQ approved seepage test procedure (Appendix B).

$$Sr = \frac{ES - I_L}{n}$$

where:

Sr = Seepage rate (inches/day)
ES = Change in lagoon surface elevation based on hook gauge readings (inches)
n = Time (days)
I_L = Net pond evaporation (inches) where
I = pan coefficient x (precipitation + measured pan evaporation)-precipitation

Fifteen-day average seepage rates for the three CFA STP lagoons are summarized in Table 1. More detailed information is shown in Tables 2 and 3. Field-collected information is shown in Appendix E.

Table 1 CFA STP Seepage Test 15-Day Summary

	Lagoon 1	Lagoon 2	Lagoon 3
Seepage Test Period	4/18/2006 - 5/3/06	5/22/06 - 6/6/06	5/22/06 - 6/6/06
Total Pan Evaporation (in)	3.415	3.929	3.929
Precipitation (in)	0.09	0.5	0.5
Mean Temperature °F	48	57	57
Temperature Corrected Pan Evap. (in)	2.827	2.805	2.805
Measured Water Surface Change (in)	3.243	3.499	3.609
Calculated Seepage/Day (in)	0.028	0.046	0.054

Table 2. CFA STP Lagoon 1 seepage rate calculation.

Date	Measured Mean Evap Pan Water Surface (in)	Precip (in) (R)	Mean Pan Evap (in)	Mean Temp. (°F)	Pan Temp. Coef. (P)	Net Corrected Pan Evap (in) (I_L)	Lagoon Influent-Effluent (in) (Q)	Measured Mean Lagoon 1 Surface (in)	Mean Lagoon 1 Surface Change (in) (ES)	Time (days)	Seepage (in/day)
18-Apr-06	3.651							4.361			
21-Apr-06	3.232	0.00	0.419	40	0.9070	0.380	0	3.952	0.409	3	0.010
24-Apr-06	2.354	0.00	0.878	51	0.8046	0.706	0	3.258	0.694	3	-0.004
27-Apr-06	1.915	0.09	0.529	47	0.8416	0.355	0	2.773	0.485	3	0.043
30-Apr-06	1.041	0.00	0.874	56	0.7857	0.687	0	1.993	0.780	3	0.031
3-May-06	0.236	0.00	0.805	48	0.8324	0.670	0	1.118	0.875	3	0.068
15-day Average	3.415	0.09	3.505	48.4	0.8324	2.827	0	3.243	3.243	15	0.028

Table 3. CFA STP Lagoon 2 seepage rate calculation.

Date	Measured Mean Evap Pan Water Surface (in)	Precip (in)	Adjusted Pan Evap (in)	Mean Temp. (°F)	Pan Temp. Coef. (P)	Net Corrected Pan Evap (in) (I_L)	Lagoon Influent-Effluent (in) (Q)	Measured Mean Lagoon 2 Surface (in)	Mean Lagoon 2 Surface Change (in) (ES)	Time (days)	Seepage (in/day)
22-May-06	4.663							3.551			
25-May-06	3.519	0.00	1.144	59	0.7302	0.835	0	2.491	1.06	3	0.075
28-May-06	3.469	0.50	0.550	50	0.8140	-0.052	0	2.077	0.414	3	0.155
31-May-06	2.975	0.04	0.534	48	0.8324	0.405	0	1.462	0.615	3	0.070
3-Jun-06	1.950	0.00	1.025	64	0.6834	0.700	0	1.081	0.381	3	-0.106
6-Jun-06	0.734	0.00	1.216	65	0.6740	0.820	0	0.052	1.029	3	0.070
15-cay Average/Total	3.929	0.54	4.469	57.2	0.7486	2.805	0	3.499	3.499	15	0.046

Table 4. CFA STP Lagoon 3 seepage rate calculation.

Date	Measured Mean Evap Pan Water Surface (in)	Precip (in)	Adjusted Pan Evap (in)	Mean Temp. (°F)	Pan Temp. Coef. (P)	Net Corrected Pan Evap (in) (I_L)	Lagoon Influent-Effluent (in) (Q)	Measured Mean Lagoon 3 Surface (in)	Mean Lagoon 3 Surface Change (in) (ES)	Time (days)	Seepage (in/day)
22-May-06	4.663							3.426			
25-May-06	3.519	0.00	1.144	59	0.7302	0.835	0	2.486	0.940	3	0.035
28-May-06	3.469	0.50	0.550	50	0.8140	-0.052	0	2.012	0.474	3	0.175
31-May-06	2.975	0.04	0.534	48	0.8324	0.405	0	1.421	0.591	3	0.062
3-Jun-06	1.950	0.00	1.025	64	0.6834	0.700	0	0.790	0.631	3	-0.023
6-Jun-06	0.734	0.00	1.216	65	0.6740	0.820	0	-0.183	0.973	3	0.051
15-day Average	3.929	0.54	4.469	57.2	0.7486	2.805	0	3.609	3.609	15	0.054

5. SUMMARY AND CONCLUSIONS

Lagoon seepage tests were performed at the CFA STP lagoons during April and May of 2006. The water level in the lagoons was near the design capacity and each lagoon was hydraulically isolated during the testing periods. Monitoring equipment and measurements were applied in compliance with DEQ guidance or approved deviations. The calculated seepage rates for each of the Lagoons was less than the 0.125 inches/day allowable by the WLAP permit.

The 15-day average seepage rate for Lagoon #1 was 0.028 inches/day.
The 15-day average seepage rate for Lagoon #2 was 0.046 inches/day
The 15-day average seepage rate for Lagoon #3 was 0.054 inches/day

Central Facilities Area Sewage Treatment Lagoons

Seepage Rate Test Report

APPENDIX A

Idaho Department of Environmental Quality

Approval for CFA STP Seepage Rate Test Schedule Extension

Idaho National Laboratory INL

October 27, 2005

CCN 203067

Mr. Thomas A. Rackow
Staff Engineer
Idaho Department of Environmental Quality
900 N. Skyline, Suite B
Idaho Falls, ID 83402

SUBJECT: Request for Extension of the due Date for Seepage Rate Testing at the Central Facilities Area Sewage Treatment Lagoons

Dear Mr. Rackow:

The Central Facilities Area (CFA) Sewage Treatment Plant (STP) Wastewater Land Application Permit (WLAP # LA-000141-02) requires the Idaho National Laboratory Site to perform seepage tests on each of the sewage treatment lagoons by January 26, 2006. During our seepage test plan meeting on October 3, 2005 you indicated that the testing should be performed when the lagoons are filled to their design capacity to account for potential seepage into the berms and for maximum hydrostatic head. You also indicated that it would be acceptable to request an extension for completion of the compliance activity to allow time for the lagoons to refill. Currently, the water level in the lagoons has been drawn down to provide storage space for the winter months. The ponds will not be filled to their approximate design capacity until the beginning of the next land application season (April 2006).

This letter requests an extension of the permit seepage rate test completion date until June 30, 2006 to allow for seepage testing when the ponds are filled to their approximate design capacity. The tentative schedule for performing the tests follows:

- October - November 2005. Develop and test modified hook gauge for measuring the water surface in control box stilling wells.
- March 14-31, 2006. Install, evaporation pan, precipitation gauge and temperature data logger. Test equipment and train on measurement and recording procedures. Pump down lagoon 1 if necessary to accept discharge during lagoon 2 & 3 testing.
- April 3-18, 2006. Isolate Lagoons 2&3; perform concurrent seepage test measurements per approved procedure (the testing period may be extended if needed to demonstrate a consistent seepage pattern).
- April 19-24. Allow water levels in the 3 lagoons to equilibrate.
- April 25-May 9. Isolate Lagoon 1; perform seepage test measurements per approved procedure (the testing period may be extended if needed to demonstrate a consistent seepage pattern).
- May 10-31. Evaluate data and prepare report
- June 1-15. Internal report reviews, approvals and transmittal
- June 16-30. Contingency

If you have any questions regarding this request, please contact either Norm Stanley at (208) 526-5901 or Mike Lewis at (208) 526-0623.

Sincerely,

Carolyn S. Mascareñas, P.E.

Carolyn S. Mascareñas, P. E.
Environmental Compliance Director

NOR:sdh

cc: M. R. Gray, CWI, MS 4144
J. J. Grossenbacher, INL, MS 3695
R. M. Kauffman, DOE-ID, MS 1216
F. B. Williams, INL, MS 3405

STATE OF IDAHO
DEPARTMENT OF
ENVIRONMENTAL QUALITY

CCN 203781

900 North Skyline Dr., Suite B • Idaho Falls, Idaho 83402-1718 • (208) 528-2650

Dirk Kempthorne, Governor
Toni Hardesty, Director

December 19, 2005

Carolyn Mascareñas
Environmental Compliance Director
Battelle Energy Alliance, LLC
Mail Stop 3710
1955 Fremont Avenue
Idaho Falls, Idaho 83401-3710

SUBJECT: Seepage Rate Testing Extension Request, Central Facilities Area Sewage Treatment Plant, Compliance Activity CA-141-02, WLAP Permit LA-000141-02.

Dear Ms. Mascareñas:

The Department is in receipt of your October 27, 2005 request (CCN 203067) to extend the deadline for the seepage rate testing required by Compliance Activity CA-141-02 in the permit specified above.

Pursuant to your October 27th letter and follow up discussions with your staff, the Department hereby grants the seepage rate testing extension request. Compliance Activity CA-141-02 shall be completed, and the report shall be submitted to this office no later than June 30, 2006.

If you have any questions, please contact me at 208-528-2650.

Sincerely,

Thomas A. Rackow

Thomas Rackow, P.E.
Staff Engineer
Idaho Falls Regional Office

C: Greg Eager, P.E., Regional Engineering Manager, DEQ Idaho Falls
Richard Huddleston, P.E., Wastewater Program Manager, DEQ Boise
Richard Kauffman, DOE-ID
Norm Stanley, BEA
Mike Lewis, BEA

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Central Facilities Area Sewage Treatment Lagoons

Seepage Rate Test Report

APPENDIX B

Idaho Department of Environmental Quality

Procedure for Evaluating Wastewater Treatment Lagoon Seepage Rates

STATE OF IDAHO
DEPARTMENT OF
ENVIRONMENTAL QUALITY

1410 North Hilton • Boise, ID 83706-1255• (208) 373-0502

January 22, 2002

Final

MEMORANDUM

TO: DEQ Wastewater Staff

Regional Administrators

FROM: David Mabe, State Water Quality Programs Administrator

SUBJECT: DEQ Wastewater Program Guidance -

Procedure for Evaluating Wastewater Treatment Lagoon Seepage Rates.

1.0 INTRODUCTION

This procedure has been revised from a previous procedure. The revisions include changing Division to Department, an expanded pan coefficient table, a recommended use of a temperature recorder, such as a "Hobotemp" weatherproof data logger, and a new definition of "mean air temperature".

2.0 PURPOSE

To establish a uniform standard procedure by which new and existing wastewater treatment lagoons can be evaluated to determine status of compliance with State seepage rate requirements.

3.0 DISCUSSION

Wastewater treatment lagoons constructed in the State of Idaho are required to meet a site-specific seepage rate as prescribed by the Department of Environmental Quality. In the past, measurements to determine compliance with the required seepage rate have been performed utilizing a wide variety of instruments and procedures. Adoption of a standard testing procedure will ensure consistent seepage measurement techniques.

4.0 GUIDANCE

1. The staff of the Department of Environmental Quality will provide seepage rate allowances to the entity proposing to construct wastewater treatment lagoons. The maximum allowance is 1/8" per day, which equals 3,395 gallons/day/acre.

2. Wastewater treatment lagoon plans and specifications submitted to the Department of Environmental Quality for review and approval should contain the following standard procedure.

3. Seepage test data shall be submitted for review and approval.

The following guidance material contains two main sections. The first section is a description of DEQ's standard seepage testing procedure. The last section is a suggested specification insert that may be used as guidance when developing a seepage testing procedure for a lagoon liner specification.

5.0 SEEPAGE TESTING PROCEDURES

Lagoons to be tested should be filled and maintained at design operational depth for at least two weeks prior to the beginning of the test period to allow for initial saturation (saturation period not required for synthetic lined lagoons). Measurements are to be taken at least every three days over a period of fifteen (15) days (0, 3, 6, 9, 12, 15) or longer until a consistent pattern is evident. One individual is to be responsible for all measurements and the measurements should be taken at the same hour of each test day.

Equipment[1]

1. Precipitation gauge
2. Temperature recorder, such as a Hobotemp weatherproof data logger
3. Class A evaporation pan and pan stilling well
4. Hook gauge with Vernier scale accurate to 0.001 ft.
5. Appropriate length of six (6) inch PVC pipe (Class 150 for stability) with suitable anchor support base for use as lagoon stilling well
6. Platform with support or boat for access to lagoon stilling well
7. Any necessary flow monitoring equipment

5.1 Evaporation/Precipitation

A precipitation gauge is to be set up and monitored daily. The evaporation pan should be located on a level area as close to the lagoon as possible. If necessary, shims should be used to level the pan. The obvious objective is to duplicate lagoon exposure as nearly as possible (sun, wind, rain, etc.). The pan stilling well should be anchored in the pan and not moved once the test period begins. Initial water level in the pan should be about two (2) inches below the lip. Air temperature is monitored to obtain the mean air temperature during the test period that in turn establishes the appropriate pan coefficient. Mean air temperature shall be defined as the mean of a minimum of 24 hourly temperature recordings in a twenty-four hour period. The measured pan evaporation is multiplied by the pan coefficient (Table 1) to obtain the lagoon evaporation.

5.2 Lagoon Seal

The lagoon stilling well should be installed as near to the center of the cell as possible. The stilling well must be installed at 90 degrees to the water surface for accurate measurements. Access to the stilling well is by boat or by installing a temporary platform. (DO NOT impinge upon the stilling well). Mark a spot on top of the stilling well to be used as a position indicator for the hook gage. All measurements must be taken with the hook gauge in the same position.

Each time a water surface is measured, hook gauge readings shall be repeated a minimum of seven (7) times and numerically averaged.

[1]Items 2, 3, and 4 are available through Forestry Suppliers Inc., P.O. Box 8397, Jackson, MS 39284-8397, (800) 647-5368 Internet www.forestry-suppliers.com; Fax (800) 543-4203

If possible, influent/effluent flows should be blocked to avoid unnecessary complications due to flow measurement errors.

Alternative lagoon stilling well locations will be reviewed/approved by the Department on a site-specific basis.

5.3 General Notes

A water source will be necessary for both the lagoon and the evaporation pan.

When constructing new lagoons, it may be more practical to install a permanent stilling well before filling the lagoon, rather than to use a temporary set-up.

A construction level will help in setting up the equipment properly.

On cloudy days, a flashlight may be helpful in seeing the hook gauge inside the stilling well.

Mean air temperature may be recorded using a HOBO temperature data logger.

5.4 Definitions

S_{r1} is the seepage rate in inches per day.

S_{r2} is the seepage rate in gallons per acre per day.

E_{s0} is the lagoon surface elevation, day 0 inches.

E_{sn} is the lagoon surface elevation, day n in inches.

ES is the lagoon surface elevation change in inches (Es0 – Esn). Positive if the n day surface is lower than day 0; negative if the n day surface is higher than day 0.

IL is the net lagoon evaporation which is calculated from the net corrected pan evaporation in inches (may be a positive or negative number).

Q is the net effluent flow in inches. May be positive (effluent > the influent flow) or negative (effluent < than influent flow). Value is zero if influent and effluent flows are blocked. (See equation on the next page).

n is time in days.

P is pan coefficient from Table 1.

E_{pan0} is the evaporation pan surface elevation, day 0 in inches.

$E_{pan\,n}$ is the evaporation pan surface elevation, day n in inches.

NOTE: *All hook gauge readings must be subtracted from a datum elevation and multiplied by 12 to give water surface elevations in inches. The datum elevation may be assumed.*

At a minimum, the following information should be recorded each time measurements are taken: date, time, air temperature, lagoon surface elevation (Es), pan surface elevation (Epan), precipitation, influent flow, and effluent flow. Then, the overall seepage rate for the testing period can be calculated using the following equations:

5.5 Seepage Rate Calculations

Seepage Equation 1: $S_{r1} = \dfrac{ES - I_L - Q}{n} = \dfrac{inches}{day}$

Seepage Equation 2: $S_{r1} = S_{r2}\dfrac{[in][1ft][43{,}560ft^2][7.48gal]}{[day][12in][1acre][ft^3]} = \dfrac{gallons}{acre/day}$

Where

$$ES = E_{s0} - E_{sn} = inches$$

$$IL = P[precipitation + E_{pan0} - E_{pann}] - precipitation$$

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$$Q = \frac{(efflent\ flow - influent\ flow\ in\ gallons)(ft^3)(12in)}{(lagoon\ surface\ area\ ft^2)(7.48gal)(ft)} = inches$$

5.6 Pan Evaporation (Ip)

$$I_p = P[precipitation + E_{pan0} - E_{pan\,n}] - precipitation$$

NOTE: *Solving for Ip in the above equation assumes that the precipitation event was short duration. If a precipitation event during a seepage test is of extended duration, P should be multiplied by the factor:*

$$\frac{n\ hours - precipitation\ hours}{n\ hours}$$

Definitions

Ip = *Net pan evaporation*

P = *pan coefficient from Table 1*

N = *time of seepage test*

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Table 1

Evaporation Pan Coefficient, P

Mean Air Temperature F	Pan Coefficient P	Mean Air Temperature F	Pan Coefficient P	Mean Air Temperature F	Pan Coefficient P
30	1.0000	49	0.8232	68	0.6464
31	0.9906	50	0.8140	69	0.6372
32	0.9812	51	0.8046	70	0.6280
33	0.9718	52	0.7952	71	0.6186
34	0.9624	53	0.7858	72	0.6092
35	0.9530	54	0.7764	73	0.5998
36	0.9438	55	0.7670	74	0.5904
37	0.9346	56	0.7578	75	0.5810
38	0.9254	57	0.7486	76	0.5720
39	0.9162	58	0.7394	77	0.5630
40	0.9070	59	0.7302	78	0.5540
41	0.8976	60	0.7210	79	0.5450
42	0.8882	61	0.7116	80	0.5360
43	0.8788	62	0.7022	81	0.5264
44	0.8694	63	0.6928	82	0.5168
45	0.8600	64	0.6834	83	0.5072
46	0.8508	65	0.6740	84	0.4976
47	0.8416	66	0.6648	85	0.4880
48	0.8324	67	0.6556		

6.0 SUGGESTED LAGOON SEEPAGE TESTING SPECIFICATION INSERT

Lagoon Liner – Liner integrity of each individual cell shall be evaluated in the following manner:

a. Evaporation – Shall be measured utilizing a Class A evaporation pan and pan stilling well arrangement. Pan measurements accurate to 0.012 inch (0.001 foot) shall be taken six (6) times over a period of fifteen (15) days (day 0, 3, 6, 9, 12, 15,). The pan coefficient for comparison is dependent on the mean air temperature (F□) over the test period and shall be taken from Table 1.

b. Precipitation/Air Temperature – Precipitation shall be measured using a standard precipitation gauge accurate to the nearest 0.01 inch. Measurements shall be recorded following each precipitation event. Air temperature (F□) shall be monitored and recorded, using a recording data logger such as a HOBO.

c. Lagoon – New or Existing Cells – Shall be filled and maintained at design operating level for at least two weeks prior to testing (not required for synthetic liners). During the test period, influent/effluent flows shall be blocked. A level, fixed stilling well located as near to the center of the lagoon as possible shall be used at the point for measurement. Measurements accurate to 0.012 inch (0.001 foot) shall be taken six (6) times over a period of fifteen (15) days (day 0, 3, 6, 9, 12, 15).

6.0 Definitions

S_{r1} is the seepage rate in inches per day.

S_{r2} is the seepage rate in gallons per acre per day.

E_{s0} is the lagoon surface elevation, day 0 inches.

E_{sn} is the lagoon surface elevation, day n in inches.

ES is the lagoon surface elevation change in inches ($E_{s0} - E_{sn}$). Positive if the n day surface is lower than day 0; negative if the n day surface is higher than day 0.

I_L is the net lagoon evaporation which is calculated from the net corrected pan evaporation in inches (may be a positive or negative number).

Q is the net effluent flow in inches. May be positive (effluent > the influent flow) or negative (effluent < than influent flow). Value is zero if influent and effluent flows are blocked. (See equation on the next page).

n is time in days.

P is pan coefficient from Table 1.

E_{pan0} is the evaporation pan surface elevation, day 0 in inches.

$E_{pan\,n}$ is the evaporation pan surface elevation, day n in inches.

NOTE: *All hook gauge readings must be subtracted from a datum elevation and multiplied by 12 to give water surface elevations in inches. The datum elevation may be assumed.*

At a minimum, the following information should be recorded each time measurements are taken: date, time, air temp., lagoon surface elevation (Es), pan surface elevation (Epan), precipitation, influent flow, and effluent flow. Air temperature shall be recorded minimally at hour intervals. Then, the overall seepage rate for the testing period can be calculated using the following equations:

6.2 Seepage Rate Calculations

Seepage Equation 1: $S_{r1} = \dfrac{ES - I_L - Q}{n} = \dfrac{inches}{day}$

Seepage Equation 2: $S_{r2} = S_{r1}\dfrac{[in][1ft][43.560ft^2][7.48gal]}{[day][12in][1acre][ft^3]} = \dfrac{gallons}{acre/day}$

Where

ES = $E_{s0} - E_{sn} = inches$

IL = $P[precipitation + E_{pan0} - E_{pann}] - precipitation$

Q = $\dfrac{(effluent\ flow - influent\ flow\ in\ gallons)(ft^3)(12in)}{lagoon\ surface\ area\ ft^2)(7.48gals)(ft)} = inches$

6.3 Pan Evaporation (I_p)

Ip = $P[precipitation + E_{pan0} - E_{pann}] - precipitation$

NOTE: *Solving for Ip in the above equation assumes that the precipitation event was short duration. If a precipitation event during a seepage test is of extended duration, P should be multiplied by the factor:*

$$\frac{n\,hours - precipitation\,hours}{n\,hours}$$

Definitions

Ip = *New pan evaporation*

P = *pan coefficient from Table 1*

N = *time of seepage test*

Table 1

Evaporation Pan Coefficient, P

Mean Air Temperature F	Pan Coefficient P	Mean Air Temperature F	Pan Coefficient P	Mean Air Temperature F	Pan Coefficient P
30	1.0000	49	0.8232	68	0.6464
31	0.9906	50	0.8140	69	0.6372
32	0.9812	51	0.8046	70	0.6280
33	0.9718	52	0.7952	71	0.6186
34	0.9624	53	0.7858	72	0.6092
35	0.9530	54	0.7764	73	0.5998
36	0.9438	55	0.7670	74	0.5904
37	0.9346	56	0.7578	75	0.5810
38	0.9254	57	0.7486	76	0.5720
39	0.9162	58	0.7394	77	0.5630
40	0.9070	59	0.7302	78	0.5540
41	0.8976	60	0.7210	79	0.5450
42	0.8882	61	0.7116	80	0.5360
43	0.8788	62	0.7022	81	0.5264
44	0.8694	63	0.6928	82	0.5168
45	0.8600	64	0.6834	83	0.5072
46	0.8508	65	0.6740	84	0.4976
47	0.8416	66	0.6648	85	0.4880
48	0.8324	67	0.6556		

7.0 CONCLUSION

These guidelines should be followed to be protective of public health and the environment. This guidance document becomes effective today.

Central Facilities Area Sewage Treatment Lagoons

Seepage Rate Test Report

APPENDIX C

Idaho Department of environmental Quality

Approval for CFA STP Seepage Rate Test Alternative Stilling Well Location

21

Idaho National Laboratory INL

March 14, 2006

CCN 204686

Mr. Thomas A. Rackow, P.E.
Idaho Department of Environmental Quality
900 N. Skyline, Suite B
Idaho Falls, ID 83402

SUBJECT: Request for Alternative Stilling Well Location for Seepage Rate Testing at the Central Facilities Area Sewage Treatment Lagoons

Dear Mr. Rackow:

The Central Facilities Area (CFA) Sewage Treatment Plant (STP) Wastewater Land Application Permit (WLAP # LA-000141-02) compliance activity CA-141-03 requires the Idaho National Laboratory to perform seepage tests on each of the sewage treatment lagoons per the Idaho Department of Environmental Quality (DEQ) approved procedure issued January 22, 2002. The procedure specifies that lagoon stilling wells should be installed as near to the center of the cells as possible. Alternative locations must be reviewed and approved by the DEQ on a site-specific basis.

This letter requests DEQ approval to use concrete transfer structures located in the berms between lagoons 1 & 2, and 2 & 3 as stilling wells for the seepage rate tests. We discussed the concept of using the transfer structures as stilling wells with you in a meeting on October 3, 2005. During the seepage testing periods, valves in the transfer structures will be positioned to isolate the test lagoon and to establish equilibrium between the water level in the transfer structure and the lagoon. The repeated water level measurements will be taken from selected locations on the grates covering the transfer structures. Measurements will be taken using an extended hook gauge. The water surface is expected to be 4-5 feet below the grates. Photos and a drawing of the transfer structures are attached.

If you have any questions regarding this request, please contact either Norm Stanley at (208) 526-5901 or Mike Lewis at (208) 526-0623.

Sincerely,

Carolyn S. Mascareñas, P.E.

Carolyn S. Mascareñas, P.E
Environmental Compliance Director

NS:at

Attachment

cc: M. L. Adams, DOE-ID, MS 1221
M. R. Gray, CWI, MS 4144
J. J. Grossenbacher, INL, MS 3695
D. C. Long, DOE-ID, MS 1240
R. M. Kauffman, DOE-ID, MS 1216
L. A. Sehlke, INL, MS 3810 (w/o Enc.)
F. B. Williams, INL, MS 3405

STATE OF IDAHO
DEPARTMENT OF
ENVIRONMENTAL QUALITY

CCN 205173

900 North Skyline Dr., Suite B • Idaho Falls, Idaho 83402-1718 • (208) 528-2650

Dirk Kempthorne, Governor
Toni Hardesty, Director

April 13, 2006

Carolyn S. Mascareñas
Environmental Compliance Director
Mail Stop 3710
1955 Fremont Avenue
Idaho Falls, ID 83415-3710

RE: Request for Alternative Stilling Well Location for Seepage Rate Testing at the Central Facilities Area Sewage Treatment Lagoons, Compliance Activity CA-141-03, Wastewater Land Application Permit No. LA-000141-02.

Dear Ms. Mascareñas:

I have reviewed your March 14, 2006 letter requesting an alternative stilling well location for the seepage rate testing referenced above. You have requested to use the concrete transfer structures between the lagoons as the stilling wells, and make water level measurements from the grates covering the structures. Your letter also indicates that the valves in the transfer structures can be positioned to isolate each lagoon for individual testing.

The intent of the seepage testing procedure is to use stilling wells that accurately represent the independent water levels in each lagoon. It appears that your proposal will meet the intent of the procedure; therefore, your request is approved. Please ensure that the valves are positioned such that each cell can be individually isolated for the duration of the testing periods.

If you have any questions, please let me know.

Sincerely,

Thomas A. Rackow

Thomas A. Rackow, P.E.
Staff Engineer
Idaho Falls Regional Office

c: Richard Kauffman – DOE
Greg Eager, P.E. – DEQ Idaho Falls

34075

Central Facilities Area Sewage Treatment Lagoons

Seepage Rate Test Report

APPENDIX D

CFA STP Lagoons Seepage Rate Test Air Temperature Log Hourly Summaries

Temperatures were logged to 0.01 °F at 5-minute intervals during each of the lagoon seepage testing periods. The average of the 5-minute temperatures used to select the coefficients for calculating the incremental 3-day and the total 15-day seepage rates were based on the 5-minute logs. The 5-minute readings taken nearest to beginning of each hour are shown in this appendix. The detailed temperature log data is documented in the project file.

CFA STP Lagoon 1Seepage Test Hourly Temperature Measurements

DATE/TIME	Temp. *F	DATE/TIME	Temp. *F	DATE/TIME	Temp. *F	DATE/TIME	Temp. *F	DATE/TIME	Temp. *F
4/18/06 13:02	44.65	4/21/06 13:02	63.54	4/24/06 13:02	40.23	4/27/06 13:02	65.59	4/30/06 13:02	61.48
4/18/06 14:02	44.65	4/21/06 14:02	64.91	4/24/06 14:02	39.48	4/27/06 14:02	66.96	4/30/06 14:02	62.85
4/18/06 15:02	42.46	4/21/06 15:02	66.28	4/24/06 15:02	40.23	4/27/06 15:02	69.71	4/30/06 15:02	66.28
4/18/06 16:02	43.19	4/21/06 16:02	66.96	4/24/06 16:02	42.46	4/27/06 16:02	70.39	4/30/06 16:02	66.96
4/18/06 17:02	40.23	4/21/06 17:02	66.28	4/24/06 17:02	44.65	4/27/06 17:02	67.65	4/30/06 17:02	66.28
4/18/06 18:02	40.23	4/21/06 18:02	64.91	4/24/06 18:02	46.82	4/27/06 18:02	66.96	4/30/06 18:02	64.22
4/18/06 19:02	40.97	4/21/06 19:02	64.22	4/24/06 19:02	46.1	4/27/06 19:02	65.59	4/30/06 19:02	61.48
4/18/06 20:02	37.2	4/21/06 20:02	59.42	4/24/06 20:02	45.38	4/27/06 20:02	62.17	4/30/06 20:02	56.66
4/18/06 21:02	34.1	4/21/06 21:02	49.67	4/24/06 21:02	43.92	4/27/06 21:02	55.97	4/30/06 21:02	53.19
4/18/06 22:02	30.91	4/21/06 22:02	44.65	4/24/06 22:02	43.19	4/27/06 22:02	51.08	4/30/06 22:02	50.38
4/18/06 23:02	31.72	4/21/06 23:02	44.65	4/24/06 23:02	42.46	4/27/06 23:02	49.67	4/30/06 23:02	46.1
4/19/06 0:02	31.72	4/22/06 0:02	39.48	4/25/06 0:02	40.97	4/28/06 0:02	46.82	5/1/06 0:02	43.92
4/19/06 1:02	29.28	4/22/06 1:02	37.97	4/25/06 1:02	39.48	4/28/06 1:02	44.65	5/1/06 1:02	38.72
4/19/06 2:02	28.45	4/22/06 2:02	36.43	4/25/06 2:02	39.48	4/28/06 2:02	45.38	5/1/06 2:02	37.2
4/19/06 3:02	26.77	4/22/06 3:02	36.43	4/25/06 3:02	38.72	4/28/06 3:02	45.38	5/1/06 3:02	34.1
4/19/06 4:02	24.2	4/22/06 4:02	34.1	4/25/06 4:02	38.72	4/28/06 4:02	42.46	5/1/06 4:02	32.52
4/19/06 5:02	24.2	4/22/06 5:02	33.31	4/25/06 5:02	37.97	4/28/06 5:02	40.23	5/1/06 5:02	30.91
4/19/06 6:02	23.33	4/22/06 6:02	34.1	4/25/06 6:02	38.72	4/28/06 6:02	39.48	5/1/06 6:02	28.45
4/19/06 7:02	23.33	4/22/06 7:02	32.52	4/25/06 7:02	37.2	4/28/06 7:02	38.72	5/1/06 7:02	29.28
4/19/06 8:02	26.77	4/22/06 8:02	39.48	4/25/06 8:02	39.48	4/28/06 8:02	48.25	5/1/06 8:02	35.66
4/19/06 9:02	32.52	4/22/06 9:02	47.53	4/25/06 9:02	43.19	4/28/06 9:02	51.08	5/1/06 9:02	44.65
4/19/06 10:02	37.2	4/22/06 10:02	55.28	4/25/06 10:02	47.53	4/28/06 10:02	53.89	5/1/06 10:02	51.79
4/19/06 11:02	44.65	4/22/06 11:02	60.8	4/25/06 11:02	50.38	4/28/06 11:02	56.66	5/1/06 11:02	56.66
4/19/06 12:02	50.38	4/22/06 12:02	67.65	4/25/06 12:02	53.89	4/28/06 12:02	58.73	5/1/06 12:02	58.04
4/19/06 13:02	51.08	4/22/06 13:02	72.46	4/25/06 13:02	56.66	4/28/06 13:02	60.11	5/1/06 13:02	59.42
4/19/06 14:02	51.79	4/22/06 14:02	74.53	4/25/06 14:02	58.04	4/28/06 14:02	62.17	5/1/06 14:02	62.85
4/19/06 15:02	53.89	4/22/06 15:02	73.15	4/25/06 15:02	58.73	4/28/06 15:02	64.91	5/1/06 15:02	64.22
4/19/06 16:02	53.19	4/22/06 16:02	71.08	4/25/06 16:02	56.66	4/28/06 16:02	66.96	5/1/06 16:02	64.91
4/19/06 17:02	55.28	4/22/06 17:02	70.39	4/25/06 17:02	55.97	4/28/06 17:02	66.96	5/1/06 17:02	64.91
4/19/06 18:02	54.58	4/22/06 18:02	70.39	4/25/06 18:02	55.97	4/28/06 18:02	68.33	5/1/06 18:02	64.91
4/19/06 19:02	51.79	4/22/06 19:02	68.33	4/25/06 19:02	55.28	4/28/06 19:02	65.59	5/1/06 19:02	62.85
4/19/06 20:02	46.82	4/22/06 20:02	61.48	4/25/06 20:02	53.89	4/28/06 20:02	62.85	5/1/06 20:02	60.11
4/19/06 21:02	40.23	4/22/06 21:02	53.19	4/25/06 21:02	46.82	4/28/06 21:02	54.58	5/1/06 21:02	55.28
4/19/06 22:02	36.43	4/22/06 22:02	49.67	4/25/06 22:02	41.72	4/28/06 22:02	46.82	5/1/06 22:02	51.08
4/19/06 23:02	34.1	4/22/06 23:02	49.67	4/25/06 23:02	43.92	4/28/06 23:02	46.1	5/1/06 23:02	48.96
4/20/06 0:02	32.52	4/23/06 0:02	50.38	4/26/06 0:02	40.97	4/29/06 0:02	44.65	5/2/06 0:02	46.1
4/20/06 1:02	31.72	4/23/06 1:02	52.49	4/26/06 1:02	35.66	4/29/06 1:02	42.46	5/2/06 1:02	43.92
4/20/06 2:02	28.45	4/23/06 2:02	53.19	4/26/06 2:02	41.72	4/29/06 2:02	40.97	5/2/06 2:02	41.72
4/20/06 3:02	28.45	4/23/06 3:02	52.49	4/26/06 3:02	37.2	4/29/06 3:02	38.72	5/2/06 3:02	40.23
4/20/06 4:02	27.62	4/23/06 4:02	52.49	4/26/06 4:02	34.88	4/29/06 4:02	37.2	5/2/06 4:02	37.97
4/20/06 5:02	25.07	4/23/06 5:02	51.79	4/26/06 5:02	30.91	4/29/06 5:02	34.88	5/2/06 5:02	36.43
4/20/06 6:02	25.93	4/23/06 6:02	48.25	4/26/06 6:02	30.1	4/29/06 6:02	34.1	5/2/06 6:02	30.1
4/20/06 7:02	25.93	4/23/06 7:02	46.82	4/26/06 7:02	29.28	4/29/06 7:02	37.2	5/2/06 7:02	32.52
4/20/06 8:02	30.1	4/23/06 8:02	48.25	4/26/06 8:02	36.43	4/29/06 8:02	43.19	5/2/06 8:02	38.72
4/20/06 9:02	35.66	4/23/06 9:02	51.79	4/26/06 9:02	45.38	4/29/06 9:02	49.67	5/2/06 9:02	41.72
4/20/06 10:02	42.46	4/23/06 10:02	54.58	4/26/06 10:02	51.08	4/29/06 10:02	55.97	5/2/06 10:02	46.1
4/20/06 11:02	47.53	4/23/06 11:02	57.35	4/26/06 11:02	57.35	4/29/06 11:02	63.54	5/2/06 11:02	48.25
4/20/06 12:02	55.28	4/23/06 12:02	56.66	4/26/06 12:02	60.8	4/29/06 12:02	69.02	5/2/06 12:02	51.79
4/20/06 13:02	58.04	4/23/06 13:02	58.04	4/26/06 13:02	60.11	4/29/06 13:02	70.39	5/2/06 13:02	51.79
4/20/06 14:02	60.11	4/23/06 14:02	59.42	4/26/06 14:02	62.17	4/29/06 14:02	71.08	5/2/06 14:02	53.89
4/20/06 15:02	61.48	4/23/06 15:02	59.42	4/26/06 15:02	64.22	4/29/06 15:02	72.46	5/2/06 15:02	54.58
4/20/06 16:02	62.85	4/23/06 16:02	58.73	4/26/06 16:02	64.91	4/29/06 16:02	71.77	5/2/06 16:02	55.97
4/20/06 17:02	63.54	4/23/06 17:02	56.66	4/26/06 17:02	64.22	4/29/06 17:02	72.46	5/2/06 17:02	58.73
4/20/06 18:02	59.42	4/23/06 18:02	53.19	4/26/06 18:02	63.54	4/29/06 18:02	71.08	5/2/06 18:02	56.66
4/20/06 19:02	57.35	4/23/06 19:02	49.67	4/26/06 19:02	61.48	4/29/06 19:02	69.71	5/2/06 19:02	54.58
4/20/06 20:02	53.19	4/23/06 20:02	47.53	4/26/06 20:02	57.35	4/29/06 20:02	66.28	5/2/06 20:02	52.49
4/20/06 21:02	45.38	4/23/06 21:02	44.65	4/26/06 21:02	52.49	4/29/06 21:02	60.8	5/2/06 21:02	47.53
4/20/06 22:02	40.97	4/23/06 22:02	44.65	4/26/06 22:02	53.19	4/29/06 22:02	59.42	5/2/06 22:02	42.46
4/20/06 23:02	39.48	4/23/06 23:02	40.97	4/26/06 23:02	49.67	4/29/06 23:02	58.04	5/2/06 23:02	37.2
4/21/06 0:02	37.2	4/24/06 0:02	37.97	4/27/06 0:02	46.82	4/30/06 0:02	55.97	5/3/06 0:02	38.72
4/21/06 1:02	33.31	4/24/06 1:02	37.2	4/27/06 1:02	43.19	4/30/06 1:02	55.97	5/3/06 1:02	38.72
4/21/06 2:02	32.52	4/24/06 2:02	37.2	4/27/06 2:02	43.19	4/30/06 2:02	56.66	5/3/06 2:02	36.43
4/21/06 3:02	31.72	4/24/06 3:02	37.2	4/27/06 3:02	39.48	4/30/06 3:02	55.97	5/3/06 3:02	33.31
4/21/06 4:02	30.91	4/24/06 4:02	37.97	4/27/06 4:02	40.97	4/30/06 4:02	54.58	5/3/06 4:02	30.1
4/21/06 5:02	28.45	4/24/06 5:02	37.97	4/27/06 5:02	37.97	4/30/06 5:02	52.49	5/3/06 5:02	30.1
4/21/06 6:02	28.45	4/24/06 6:02	38.72	4/27/06 6:02	34.88	4/30/06 6:02	47.53	5/3/06 6:02	27.62
4/21/06 7:02	29.28	4/24/06 7:02	38.72	4/27/06 7:02	33.31	4/30/06 7:02	47.53	5/3/06 7:02	28.45
4/21/06 8:02	34.1	4/24/06 8:02	38.72	4/27/06 8:02	43.19	4/30/06 8:02	54.58	5/3/06 8:02	36.43
4/21/06 9:02	40.97	4/24/06 9:02	38.72	4/27/06 9:02	51.79	4/30/06 9:02	59.42	5/3/06 9:02	43.92
4/21/06 10:02	48.25	4/24/06 10:02	40.23	4/27/06 10:02	58.73	4/30/06 10:02	60.8	5/3/06 10:02	48.25
4/21/06 11:02	53.19	4/24/06 11:02	40.97	4/27/06 11:02	61.48	4/30/06 11:02	62.85	5/3/06 11:02	51.79
4/21/06 12:02	58.73	4/24/06 12:02	39.48	4/27/06 12:02	63.54	4/30/06 12:02	62.85	5/3/06 12:02	54.58
72 hour mean	**41.0**	**72 hour mean**	**50.9**	**72 hour mean**	**47.1**	**72 hour mean**	**55.9**	**72 hour mean**	**48.0**
15-day mean	**47.9**								

CFA STP Lagoons 2 & 3 Seepage Test Temperature Summary

DATE/TIME	Temp. *F	DATE/TIME	Temp. *F	DATE/TIME	Temp. *F	DATE/TIME	Temp. *F	DATE/TIME	Temp. *F
05/22/06 13:01	66.96	05/25/06 13:01	71.77	05/28/06 13:01	49.67	05/31/06 13:01	68.33	06/03/06 13:01	73.84
05/22/06 14:01	66.28	05/25/06 14:01	73.15	05/28/06 14:01	48.96	05/31/06 14:01	69.02	06/03/06 14:01	75.92
05/22/06 15:01	64.91	05/25/06 15:01	73.84	05/28/06 15:01	46.1	05/31/06 15:01	71.77	06/03/06 15:01	76.62
05/22/06 16:01	67.65	05/25/06 16:01	75.22	05/28/06 16:01	45.38	05/31/06 16:01	73.15	06/03/06 16:01	73.84
05/22/06 17:01	69.71	05/25/06 17:01	75.22	05/28/06 17:01	46.1	05/31/06 17:01	74.53	06/03/06 17:01	73.84
05/22/06 18:01	71.08	05/25/06 18:01	73.84	05/28/06 18:01	42.46	05/31/06 18:01	72.46	06/03/06 18:01	73.15
05/22/06 19:01	69.71	05/25/06 19:01	70.39	05/28/06 19:01	46.1	05/31/06 19:01	70.39	06/03/06 19:01	72.46
05/22/06 20:01	65.59	05/25/06 20:01	67.65	05/28/06 20:01	43.92	05/31/06 20:01	67.65	06/03/06 20:01	70.39
05/22/06 21:01	59.42	05/25/06 21:01	64.22	05/28/06 21:01	45.38	05/31/06 21:01	62.85	06/03/06 21:01	66.28
05/22/06 22:01	57.35	05/25/06 22:01	57.35	05/28/06 22:01	43.19	05/31/06 22:06	55.28	06/03/06 22:01	65.59
05/22/06 23:01	55.28	05/25/06 23:01	54.58	05/28/06 23:01	42.46	05/31/06 23:01	51.08	06/03/06 23:01	64.91
05/23/06 00:01	54.58	05/26/06 00:01	52.49	05/29/06 00:01	41.72	06/01/06 00:01	48.25	06/04/06 00:01	62.85
05/23/06 01:01	53.19	05/26/06 01:01	50.38	05/29/06 01:01	38.72	06/01/06 01:01	48.25	06/04/06 01:11	62.85
05/23/06 02:01	52.49	05/26/06 02:01	51.08	05/29/06 02:01	37.97	06/01/06 02:01	43.92	06/04/06 02:01	60.11
05/23/06 03:01	50.38	05/26/06 03:01	56.66	05/29/06 03:01	37.2	06/01/06 03:01	43.92	06/04/06 03:01	58.04
05/23/06 04:01	48.96	05/26/06 04:01	55.97	05/29/06 04:01	36.43	06/01/06 04:01	43.19	06/04/06 04:01	56.66
05/23/06 05:01	47.53	05/26/06 05:01	53.89	05/29/06 05:01	36.43	06/01/06 05:01	40.23	06/04/06 05:01	53.19
05/23/06 06:01	46.1	05/26/06 06:01	52.49	05/29/06 06:01	35.66	06/01/06 06:01	39.48	06/04/06 06:01	51.79
05/23/06 07:01	46.1	05/26/06 07:01	51.08	05/29/06 07:01	35.66	06/01/06 07:01	42.46	06/04/06 07:01	53.89
05/23/06 08:01	51.08	05/26/06 08:01	48.96	05/29/06 08:01	39.48	06/01/06 08:01	48.25	06/04/06 08:01	58.73
05/23/06 09:01	55.28	05/26/06 09:01	49.67	05/29/06 09:01	43.92	06/01/06 09:01	56.66	06/04/06 09:01	66.96
05/23/06 10:01	58.73	05/26/06 10:01	51.79	05/29/06 10:01	48.96	06/01/06 10:01	62.85	06/04/06 10:01	71.77
05/23/06 11:01	62.17	05/26/06 11:01	56.66	05/29/06 11:01	50.38	06/01/06 11:01	68.33	06/04/06 11:01	73.15
05/23/06 12:01	65.59	05/26/06 12:01	59.42	05/29/06 12:01	51.79	06/01/06 12:01	73.84	06/04/06 12:01	74.53
05/23/06 13:01	66.96	05/26/06 13:01	58.04	05/29/06 13:01	53.89	06/01/06 13:01	78.71	06/04/06 13:01	75.92
05/23/06 14:01	67.65	05/26/06 14:01	58.04	05/29/06 14:01	56.66	06/01/06 14:01	78.71	06/04/06 14:01	76.62
05/23/06 15:01	66.96	05/26/06 15:01	59.42	05/29/06 15:01	57.35	06/01/06 15:01	82.24	06/04/06 15:01	80.12
05/23/06 16:01	67.65	05/26/06 16:01	60.8	05/29/06 16:01	55.97	06/01/06 16:01	80.82	06/04/06 16:01	73.84
05/23/06 17:01	67.65	05/26/06 17:01	61.48	05/29/06 17:01	56.66	06/01/06 17:01	80.82	06/04/06 17:01	78.71
05/23/06 18:01	66.28	05/26/06 18:01	58.73	05/29/06 18:01	55.97	06/01/06 18:01	80.12	06/04/06 18:01	80.12
05/23/06 19:01	65.59	05/26/06 19:01	56.66	05/29/06 19:01	57.35	06/01/06 19:01	79.41	06/04/06 19:01	77.31
05/23/06 20:01	62.85	05/26/06 20:01	56.66	05/29/06 20:01	50.38	06/01/06 20:01	76.62	06/04/06 20:01	75.92
05/23/06 21:01	59.42	05/26/06 21:01	56.66	05/29/06 21:01	48.96	06/01/06 21:01	68.33	06/04/06 21:01	72.46
05/23/06 22:01	55.28	05/26/06 22:01	55.28	05/29/06 22:01	48.25	06/01/06 22:01	61.48	06/04/06 22:01	66.96
05/23/06 23:01	54.58	05/26/06 23:01	53.19	05/29/06 23:01	46.82	06/01/06 23:01	56.66	06/04/06 23:01	62.85
05/24/06 00:01	49.67	05/27/06 00:01	51.08	05/30/06 00:01	44.65	06/02/06 00:01	55.97	06/05/06 00:01	58.04
05/24/06 01:01	47.53	05/27/06 01:01	48.25	05/30/06 01:01	40.97	06/02/06 01:01	56.66	06/05/06 01:01	55.97
05/24/06 02:01	43.19	05/27/06 02:01	43.92	05/30/06 02:01	40.23	06/02/06 02:01	51.79	06/05/06 02:01	55.97
05/24/06 03:01	42.46	05/27/06 03:01	43.92	05/30/06 03:01	37.2	06/02/06 03:01	51.08	06/05/06 03:01	49.67
05/24/06 04:01	42.46	05/27/06 04:01	43.19	05/30/06 04:01	36.43	06/02/06 04:01	49.67	06/05/06 04:01	46.1
05/24/06 05:01	40.23	05/27/06 05:01	42.46	05/30/06 05:01	34.1	06/02/06 05:01	48.25	06/05/06 05:01	43.19
05/24/06 06:01	37.97	05/27/06 06:01	41.72	05/30/06 06:01	33.31	06/02/06 06:01	46.1	06/05/06 06:01	43.92
05/24/06 07:01	43.92	05/27/06 07:01	40.97	05/30/06 07:01	35.66	06/02/06 07:01	47.53	06/05/06 07:01	47.53
05/24/06 08:01	50.38	05/27/06 08:01	40.97	05/30/06 08:01	42.46	06/02/06 08:01	53.19	06/05/06 08:01	57.35
05/24/06 09:01	55.28	05/27/06 09:01	40.97	05/30/06 09:01	47.53	06/02/06 09:01	61.48	06/05/06 09:01	64.22
05/24/06 10:01	61.48	05/27/06 10:01	41.72	05/30/06 10:01	53.19	06/02/06 10:01	70.39	06/05/06 10:01	69.71
05/24/06 11:01	69.71	05/27/06 11:01	41.72	05/30/06 11:01	58.04	06/02/06 11:01	75.92	06/05/06 11:01	73.84
05/24/06 12:01	73.84	05/27/06 12:01	42.46	05/30/06 12:01	61.48	06/02/06 12:01	77.31	06/05/06 12:01	73.15
05/24/06 13:01	73.15	05/27/06 13:01	41.72	05/30/06 13:01	63.54	06/02/06 13:01	78.01	06/05/06 13:01	73.84
05/24/06 14:01	74.53	05/27/06 14:01	41.72	05/30/06 14:01	66.96	06/02/06 14:01	79.41	06/05/06 14:01	76.62
05/24/06 15:01	76.62	05/27/06 15:01	43.92	05/30/06 15:01	64.91	06/02/06 15:01	80.12	06/05/06 15:01	77.31
05/24/06 16:01	77.31	05/27/06 16:01	43.92	05/30/06 16:01	69.02	06/02/06 16:06	79.41	06/05/06 16:01	78.01
05/24/06 17:01	75.92	05/27/06 17:01	42.46	05/30/06 17:01	66.96	06/02/06 17:01	78.01	06/05/06 17:01	78.01
05/24/06 18:01	76.62	05/27/06 18:01	43.92	05/30/06 18:01	63.54	06/02/06 18:01	78.71	06/05/06 18:01	78.01
05/24/06 19:01	73.84	05/27/06 19:01	45.38	05/30/06 19:01	63.54	06/02/06 19:01	75.92	06/05/06 19:01	77.31
05/24/06 20:01	69.71	05/27/06 20:01	45.38	05/30/06 20:01	58.73	06/02/06 20:01	73.84	06/05/06 20:01	75.22
05/24/06 21:01	65.59	05/27/06 21:01	43.19	05/30/06 21:01	53.89	06/02/06 21:01	67.65	06/05/06 21:01	66.28
05/24/06 22:01	62.17	05/27/06 22:01	43.19	05/30/06 22:01	48.25	06/02/06 22:01	64.22	06/05/06 22:01	61.48
05/24/06 23:01	59.42	05/27/06 23:01	40.97	05/30/06 23:01	45.38	06/02/06 23:01	62.17	06/05/06 23:01	59.42
05/25/06 00:01	55.97	05/28/06 00:01	39.48	05/31/06 00:01	43.19	06/03/06 00:01	62.85	06/06/06 00:01	54.58
05/25/06 01:01	51.79	05/28/06 01:01	38.72	05/31/06 01:01	40.23	06/03/06 01:01	64.22	06/06/06 01:01	53.19
05/25/06 02:01	48.96	05/28/06 02:01	38.72	05/31/06 02:01	40.23	06/03/06 02:01	61.48	06/06/06 02:01	51.79
05/25/06 03:01	46.82	05/28/06 03:01	37.97	05/31/06 03:01	37.97	06/03/06 03:01	59.42	06/06/06 03:01	49.67
05/25/06 04:01	48.25	05/28/06 04:01	35.66	05/31/06 04:01	36.43	06/03/06 04:01	57.35	06/06/06 04:01	46.82
05/25/06 05:01	45.38	05/28/06 05:01	35.66	05/31/06 05:01	35.66	06/03/06 05:01	56.66	06/06/06 05:01	45.38
05/25/06 06:01	44.65	05/28/06 06:01	36.43	05/31/06 06:01	34.1	06/03/06 06:01	53.89	06/06/06 06:01	43.19
05/25/06 07:01	48.25	05/28/06 07:01	36.43	05/31/06 07:01	37.97	06/03/06 07:01	53.89	06/06/06 07:01	49.67
05/25/06 08:01	56.66	05/28/06 08:01	37.2	05/31/06 08:01	43.92	06/03/06 08:01	60.11	06/06/06 08:01	55.28
05/25/06 09:01	60.11	05/28/06 09:01	39.48	05/31/06 09:06	51.08	06/03/06 09:01	62.85	06/06/06 09:01	63.54
05/25/06 10:01	66.28	05/28/06 10:01	40.23	05/31/06 10:01	56.66	06/03/06 10:01	67.65	06/06/06 10:01	69.02
05/25/06 11:01	69.02	05/28/06 11:01	41.72	05/31/06 11:01	60.8	06/03/06 11:01	71.08	06/06/06 11:01	74.53
05/25/06 12:01	70.39	05/28/06 12:01	45.38	05/31/06 12:01	66.28	06/03/06 12:01	73.84	06/06/06 12:01	78.71
72 hour mean	59.3	72 hour mean	50.4	72 hour mean	47.7	72 hour mean	63.8	72 hour mean	65.3
15-day mean	57.3								

Central Facilities Area Sewage Treatment Lagoons

Seepage Rate Test Report

APPENDIX E

CFA STP Lagoons Seepage Rate Test Field Data

Field Measurement Adjustments During CFA STP Lagoon Seepage Rate Testing

	Evaporation Pan			Lagoon #1	Rain Gauge	3 day Precip
	Actual Measurement	Adjustments	Adjusted Measurement	Actual Measurement	Precipitation	total
18-Apr	3.651		3.651	4.361	0	0
19-Apr					0	
20-Apr					0	
21-Apr	3.232		3.232	3.952	0	0
22-Apr					0	
23-Apr					0	
24-Apr	2.354		2.354	3.258	0	0
25-Apr					0.09	
26-Apr					0	
27-Apr	1.915		1.915	2.773	0	0.09
28-Apr					0	
29-Apr					0	
30-Apr	1.041		1.041	1.993	0	0
1-May					0	
2-May					0	
3-May	2.753	2.517 water added	0.236	1.118	0	0

Evaporation Pan Initial	Rebaseline
0.856	3.37
0.846	3.362
0.856	3.367
0.848	3.372
0.85	3.37
0.852	3.368
0.854	3.370
0.852	3.368
Difference	2.517

Date	Evaporation Pan			Lagoon #2			Lagoon #3			Rain Gauge	3 day Precip
	Actual Measurement	Adjustments	Adjusted Measurement	Actual Measurement	Adjustments	Adjusted Measurement	Actual Measurement	Adjustments	Adjusted Measurement	Precipitation	total
22-May	4.663		4.663	3.551		3.551	3.426		3.426	0	
23-May										0	
24-May										0	
25-May	3.519		3.519	2.491		2.491	2.486		2.486	0	0
26-May										0	
27-May										0.47	
28-May	3.469		3.469	2.077		2.077	2.012		2.012	0.03	0.5
29-May										0.04	
30-May										0	
31-May	2.975		2.975	1.462		1.462	1.421		1.421	0	0.04
1-Jun										0	
2-Jun										0	
3-Jun	1.950		1.950	1.081		1.081	3.061	2.271 Spacer Removed	0.790	0	0
4-Jun										0	
5-Jun										0	
6-Jun	1.911	1.177 water added	0.734	2.177	2.125 Spacer Removed	0.052	2.088	2.271	-0.183	0	0

	Evaporation Pan Initial	Rebaseline	Lagoon #2 Initial	Rebaseline	Lagoon #3 Initial	Rebaseline
	1.945	3.126	1.069	3.188	1.22	3.488
	1.952	3.128	1.072	3.212	1.23	3.51
	1.95	3.128	1.07	3.214	1.236	3.494
	1.952	3.126	1.073	3.236	1.235	3.496
	1.948	3.128	1.076	3.188	1.226	3.532
	1.95	3.126	1.1	3.182	1.244	3.512
	1.951	3.124	1.110	3.228	1.252	3.506
Average	1.950	3.127	1.081	3.207	1.235	3.505
	Difference	1.177	Difference	2.125	Difference	2.271

Lagoon 1 Evaporation Pan Measurements

Date	4/18/2006	4/21/2006	4/24/2006	4/27/2006	4/30/2006	5/1/2006*	5/1/2006*	5/3/2006
	3.652	3.231	2.352	1.924	1.042	0.856	3.37	2.758
	3.652	3.234	2.356	1.914	1.043	0.846	3.362	2.746
	3.652	3.232	2.354	1.92	1.044	0.856	3.367	2.754
	3.652	3.231	2.354	1.92	1.041	0.848	3.372	2.755
	3.652	3.231	2.351	1.909	1.039	0.85	3.37	2.756
	3.649	3.229	2.357	1.9	1.041	0.852	3.368	2.748
	3.651	3.234	2.354	1.915	1.04	0.854	3.37	2.751
Average	3.651	3.232	2.354	1.915	1.041	0.852	3.368	2.753

*Water was added to the evaporation pan and the surface measurement re-baselined

Lagoon 1 Precip.(in)		0	0.09	0	0			0

Lagoon 1 Water Level Measurements

Date	4/18/2006	4/21/2006	4/24/2006	4/27/2006	4/30/2006			5/3/2006
	4.38	3.981	3.26	2.804	1.993			1.11
	4.38	3.98	3.258	2.7	2.055			1.113
	4.398	3.921	3.252	2.762	1.93			1.125
	4.332	3.924	3.272	2.824	2.055			1.107
	4.346	3.938	3.254	2.706	1.993			1.133
	4.329	3.942	3.254	2.79	1.93			1.111
	4.362	3.978	3.256	2.828	1.993			1.128
Average	4.361	3.952	3.258	2.773	1.993			1.118

Lagoons 2&3 Evaporation Pan Measurements

Date	5/22/2006	5/25/2006	5/28/2006	5/31/2006	6/3/2006	6/3/2006*	6/6/2006
	4.676	3.516	3.464	2.974	1.945	3.126	1.913
	4.662	3.522	3.471	2.974	1.952	3.128	1.912
	4.668	3.518	3.469	2.978	1.95	3.128	1.909
	4.67	3.515	3.468	2.976	1.952	3.126	1.913
	4.668	3.524	3.472	2.978	1.948	3.128	1.91
	4.666	3.516	3.47	2.972	1.95	3.126	1.908
	4.664	3.521	3.47	2.974	1.951	3.124	1.915
Average	4.668	3.519	3.469	2.975	1.950	3.127	1.911

* Approximately 10 gal of water was added to the pan on 6/3/06 and the surface measurement was re-baselined.

Date	5/22/2006	5/25/2006	5/28/2006	5/31/2006	6/3/2006	6/6/2006
Lagoons 2&3 Rain Gauge Precip.(in)		0	0.5	0.04	0	0

Lagoon 2 Water Level Measurements							
Date	5/22/2006	5/25/2006	5/28/2006	5/31/2006	6/3/2006	6/3/2006*	6/6/2006
	3.592	2.504	2.131	1.27	1.069	3.188	2.186
	3.522	2.568	2.04	1.272	1.072	3.212	2.18
	3.521	2.514	2.094	1.258	1.07	3.214	2.158
	3.525	2.446	2.12	1.252	1.073	3.236	2.159
	3.706	2.497	2.024	1.249	1.076	3.188	2.176
	3.516	2.433	2.061	1.262	1.1	3.182	2.196
	3.478	2.476	2.07	1.274	1.11	3.288	2.181
Average	3.551	2.491	2.077	1.262	1.081	3.215	2.177

* Spacers were removed from between the hook gauge and grate on 6/3/06 and the surface measurement was re-baselined

Lagoon 3 Water Level Measurements								
Date	5/22/2006	5/25/2006	5/28/2006	5/31/2006	6/1/2006*	6/1/2006*	6/3/2006	6/6/2006
	3.4	2.498	2.092	1.442	1.22	3.488	3.028	2.088
	3.452	2.498	1.967	1.425	1.23	3.51	3.088	2.078
	3.404	2.461	2.084	1.416	1.236	3.494	3.067	2.121
	3.372	2.486	2.015	1.415	1.235	3.496	3.088	2.07
	3.397	2.491	1.96	1.416	1.226	3.532	3.023	2.086
	3.445	2.477	1.97	1.428	1.244	3.512	3.084	2.096
	3.509	2.498	1.988	1.428	1.252	3.506	3.05	2.08
Average	3.426	2.487	2.011	1.424	1.235	3.505	3.061	2.088

* Spacers were removed from between the hook gauge and grate on 6/1/06 and the surface measurement was re-baselined