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2010 Annual Wastewater Reuse Report for the Idaho National Laboratory Site's Central Facilities Area Sewage Treatment Plant

February 2011

Idaho National Laboratory

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Idaho National Laboratory
Idaho Falls, Idaho 83415

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ABSTRACT

This report describes conditions, as required by the state of Idaho Wastewater Reuse Permit (#LA-000141-03), for the wastewater land application site at Idaho National Laboratory Site's Central Facilities Area Sewage Treatment Plant from November 1, 2009, through October 31, 2010. The report contains the following information:

- Site description
- Facility and system description
- Permit required monitoring data and loading rates
- Status of special compliance conditions
- Discussion of the facility's environmental impacts.

During the 2010 permit year, approximately 2.2 million gallons of treated wastewater was land-applied to the irrigation area at Central Facilities Area Sewage Treatment plant.

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ACRONYMS

CFA	Central Facilities Area
CFR	Code of Federal Regulations
CES	Cascade Earth Sciences, Ltd.
COD	chemical oxygen demand
DEQ	Idaho Department of Environmental Quality
gpd	gallons per day
INL	Idaho National Laboratory
MS	Monitoring Services
SAR	sodium adsorption ratio
STP	Sewage Treatment Plant
SwRI	Southwest Research Institute
TDS	total dissolved solids
TKN	total Kjeldahl nitrogen
TN	total nitrogen
WRP	Wastewater Reuse Permit

2010 Annual Wastewater Reuse Report for the Idaho National Laboratory Site's Central Facilities Area Sewage Treatment Plant

1. INTRODUCTION

The Central Facilities Area (CFA) Sewage Treatment Plant (STP) is a wastewater land application facility operated by Battelle Energy Alliance, LLC under Wastewater Reuse Permit (WRP) LA-000141-03 issued by the state of Idaho, Department of Environmental Quality (DEQ). The permit was re-issued on March 17, 2010 (Neher 2010). During the permit handoff meeting on March 31, 2010, it was agreed that only information required by the new permit would be included in the annual report (Stanley 2010), although the reporting year is November 1, 2009 through October 31, 2010.

Because of the changes to the permit, information that was previously reported but will not be reported in this and/or future annual reports includes:

Influent water quality data

Influent flow volume to the lagoons

Effluent parameters- biochemical oxygen demand, total suspended solids, and fecal coliform

Removal efficiencies.

Following a description of the STP site, facility, and system, this report presents the status of monitoring data, special compliance conditions, noncompliances, and environmental impacts that occurred at the CFA STP during the 2010 reporting year.

2. SITE, FACILITY, AND SYSTEM DESCRIPTION

The STP is located approximately 5 miles north of the Idaho National Laboratory (INL) Site's southern boundary and southeast of the Central Facilities Area (CFA), which is about 50 miles west of Idaho Falls, Idaho in Butte County, Idaho (see Figure 1). The STP is approximately 2,200 ft down gradient of the nearest drinking water well and 4,000 ft north of Highway 26. The wastewater land application area is approximately 2,200 ft from the nearest inhabited building.

As shown in Figure 1, the STP consists of a:

- 1.7-acre partial-mix, aerated lagoon (Lagoon No. 1)
- 10.3-acre facultative lagoon (Lagoon No. 2)
- 0.5-acre polishing pond (Lagoon No. 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-gpm (gallon per minute) pump moves wastewater from the lagoons to the center-pivot sprinkler system, which waters the land application area at low pressures (about 30 lbs/in^2) to minimize aerosols and spray drift.

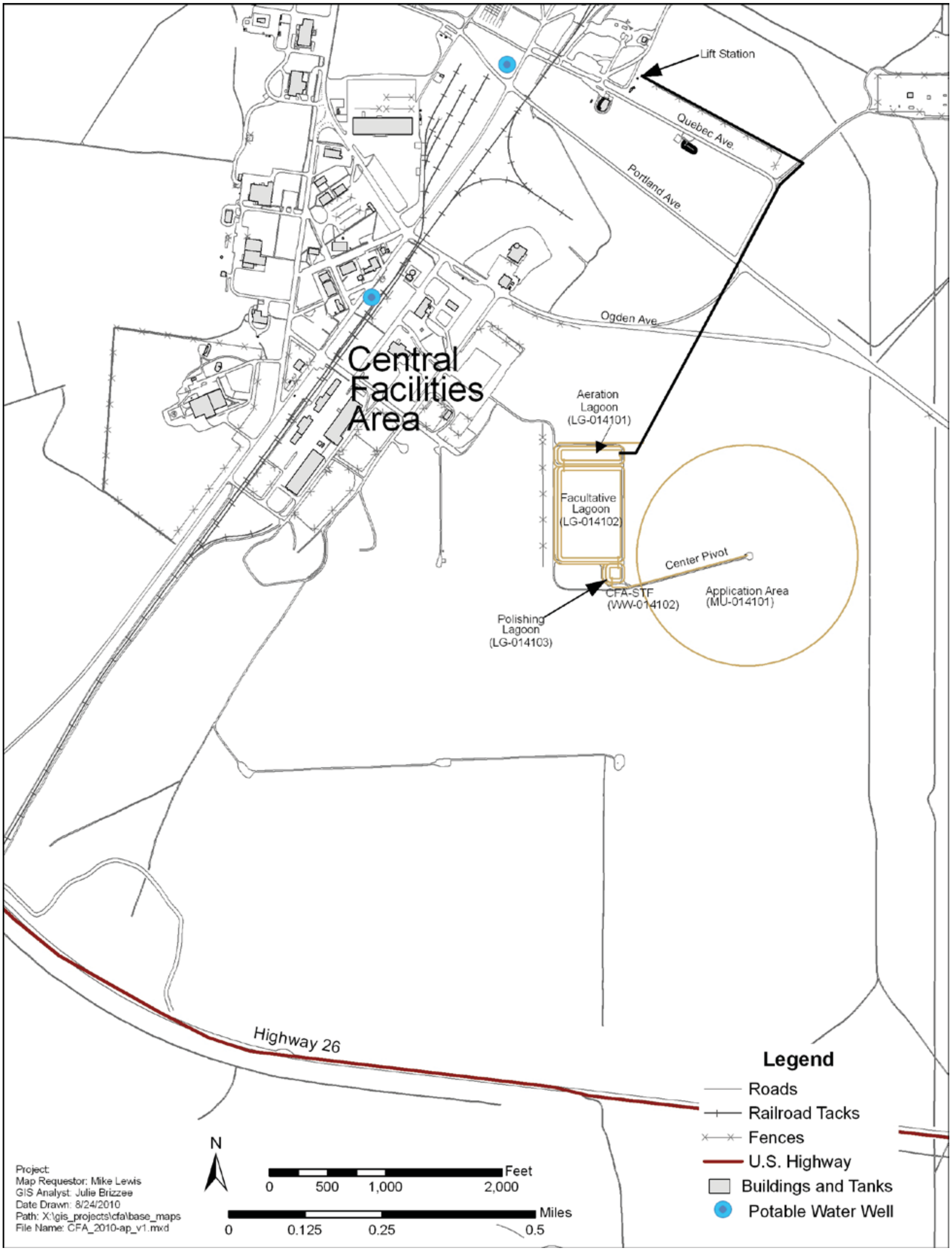

Figure 1. Area map showing the location of the STP at CFA.

As stipulated in the permit (Section F, Table 4), no grazing of domesticated animals or cultivation of crops for human consumption occurred on the application area during the 2010 permit year.

The STP serves all major CFA facilities. The wastewater is derived from: bus and vehicle maintenance areas; boiler blowdown; heating, ventilation, and air conditioning systems; employee showers and restrooms; laboratories; craft shops; a fire station; and a medical dispensary. Additional wastewater is transported from other area septic tanks and portable toilets.

3. EFFLUENT MONITORING

This section describes the sampling and analytical methods used in the effluent monitoring program. It provides the effluent monitoring data, the effluent flow data, and a summary of the truck-hauled wastewater that is discharged to the CFA STP. The section also includes the calculated hydraulic and nutrient loading rates as required by the permit.

3.1 Sampling Program and Analytical Methods

Monitoring Services (MS) at the INL monitors effluent discharges at the CFA STP. This program involves sampling, analysis, and data interpretation carried out under a quality assurance program. During the 2010 permit year, MS conducted monthly effluent monitoring as required in Section G of the permit for the CFA STP. Effluent samples were collected from the pump pit (sampling location WW-014102) prior to discharge to the pivot. All samples were collected according to established programmatic sampling procedures.

Effluent samples were taken during a preselected week each month following a randomly generated sampling schedule to represent normal operating conditions. All samples were analyzed using methods identified in 40 CFR 136, “Guidelines Establishing Test Procedures for the Analysis of Pollutants”, 40 CFR 141, “National Primary Drinking Water Regulations”, 40 CFR 143, “National Secondary Drinking Water Regulations”, or as approved by the DEQ. The pH and total coliform samples were collected as grab samples. The other WRP required samples were collected as flow proportional composite samples.

As required by Section G of the WRP, daily effluent flow readings were taken from the sprinkler pivot flow meter when irrigation occurred.

CH2M-WG Idaho, LLC (CWI) wastewater operators were subcontracted to perform the monthly effluent total coliform analyses. The CWI, State of Idaho licensed wastewater operators performed the monthly total coliform analysis using *Standard Methods for Examination of Water and Wastewater* (2005). The total coliform sample was collected from the CFA STP pump pit (WW-014102) prior to discharge to the sprinkler pivot.

The pH analysis was performed by MS personnel on a grab sample collected at the effluent location.

All other effluent and soil samples were submitted to and analyzed by Southwest Research Institute’s (SwRI) Analytical and Environmental Chemistry Department located in San Antonio, Texas.

3.2 Effluent Monitoring Results

The permit year covered in this report is November 1, 2009, through October 31, 2010.

Effluent samples are collected from the pump pit (prior to the pivot) during pivot operation. The pivot was only operated in August 2010. The effluent samples collected were flow proportional composite samples during pivot operation except for pH and total coliform. These samples were collected as grab samples. All samples were collected and analyzed as required by the permit. Table 1 summarizes the effluent results.

Table 1. CFA STP effluent water quality data (to pivot, WW-014102).

Sample Month	Sample Date	TKN[a] (mg/L)	NNN[b] (mg/L)	TN[c] (mg/L)	COD[d] (mg/L)	TDS[e] (mg/L)	pH	Total Phosphorus (mg/L)	Total Coliform (100 mL)
August	08/10/10	4.58	0.151	4.73	47.6	1,200	9.11	0.888	3

a. TKN—total Kjeldahl nitrogen.

b. NNN—nitrate+nitrite as nitrogen.

c. TN—total nitrogen.

d. COD—chemical oxygen demand.

e. TDS—total dissolved solids.

For comparison of the 2010 effluent data, Table 2 shows the 2000 through 2009 (historical) effluent annual averages. With the exception of total Kjeldahl nitrogen (TKN) and total nitrogen (TN), the August 2010 effluent data were within their historical annual average ranges. The 2010 concentrations for TKN of 4.58 mg/L and TN of 4.73 mg/L were greater than the previous high shown in Table 2 of 3.95 mg/L for TKN and 4.13 mg/L for TN for reporting year 2000.

Table 2. CFA STP 2000 through 2009 effluent annual averages.

Annual Averages	TKN (mg/L)	NNN (mg/L)	TN (mg/L)	COD (mg/L)	TDS (mg/L)	pH	Total Phosphorus (mg/L)	Total Coliform (100 mL)
2000	3.95	0.183	4.13	62.34	NS[a]	8.50	2.05	48
2001	1.38	0.009	1.39	34.09	NS	9.79	0.14	15
2002	1.58	0.026	1.61	29.00	NS	9.85	0.23	6
2003	3.92	0.032	3.95	37.90	NS	9.52	0.29	24
2004	0.63	0.006	0.64	27.10	NS	9.74	0.17	7
2005	2.03	0.025	2.06	39.24	992	8.78	0.60	23
2006	2.48	0.076	2.56	45.60	1,071	8.81	1.32	7
2007	2.19	0.239	2.43	38.7	1,203	9.16	0.188	3
2008	2.78	0.212	2.99	53.45	1,040	9.38	0.528	3
2009	2.25	0.183	2.43	46.6	1,160	9.33	0.293	1

a. NS—Not sampled. Previous permit did not require this parameter to be sampled.

3.3 Flow Volumes and Hydraulic Loading Rates

Daily effluent flow readings were recorded at the pivot control panel when the pivot was operating. All flow readings were recorded in gallons per day (gpd). The pivot was only operated for 14 days during the month of August. As required, all wastewater was applied to the land application area (MU-014101). Table 3 summarizes monthly and annual flow data. Daily effluent flow data is provided in Appendix A.

Approximately 9,800 gallons of truck-hauled wastewater was discharged into the CFA STP during the 2010 permit year (see Section 3.3.1).

Table 3. CFA STP effluent to the pivot (WW-014102) flow summaries.

Sample Month	Average (gpd[a])	Minimum (gpd)	Maximum (gpd)	Total to Land Application Site (MU-014101) (MG[b])
April 2010	NF[c]	NF	NF	NF
May 2010	NF	NF	NF	NF
June 2010	NF	NF	NF	NF
July 2010	NF	NF	NF	NF
August 2010	156,914	136,200	189,500	2.20
September 2010	NF	NF	NF	NF
October 2010	NF	NF	NF	NF
Yearly summary	156,914	136,200	189,500	2.20

a. gpd—gallons per day.
b. MG—million gallons.
c. NF—no flow.

The permit (Section F, Table 4) specifies the following:

- Application season (growing season) is April 1 through October 31. Application to frozen or snow-covered ground is prohibited.
- Application of supplemental (fresh) irrigation water is prohibited.
- Wastewater shall not exceed 37 MG annually or 18.5 in./acre.
- Wastewater may be applied on a maximum of 73.5 acres.

Wastewater was not applied to frozen or snow-covered ground. No supplemental irrigation water was applied to the application area. When applied, discharge to the application area averaged 156,914 gpd. The end gun was used during the 2010 application period and wastewater was applied evenly to the entire 73.5 acres.

The volume of wastewater that can be land applied was reduced from 46 MG (23.0 in./acre) annually in the previous permit to 37 MG annually (18.5 in./acre) annually in the current permit. The 2010 hydraulic loading rates to the application area are presented in Table 4. A total of 2.20 MG (1.1 acre-in./acre/year) were applied to the land application area. This was significantly less than the current WRP limit of 37 MG (18.5 acre-in./acre/year).

Table 4. 2010 hydraulic loading rates.[a]

Month	Applied Wastewater (MG/acre)	Applied Wastewater (in./acre)	Total (MG[b])
August	0.03	1.1	2.20
Yearly total	0.03	1.1	2.20

a. Loading rates are calculated for wastewater application on 73.5 acres (hydraulic management unit MU-014101).
b. MG—million gallons.

Figure 2 shows the effluent flow volumes to the CFA STP pivot from permit year 2000 through the current permit year. Volumes decreased significantly from 2004 through 2007 and have remained relatively stable from 2007 through 2010. Reduction in personnel and operations is expected to have resulted in a reduction in the wastewater flow.

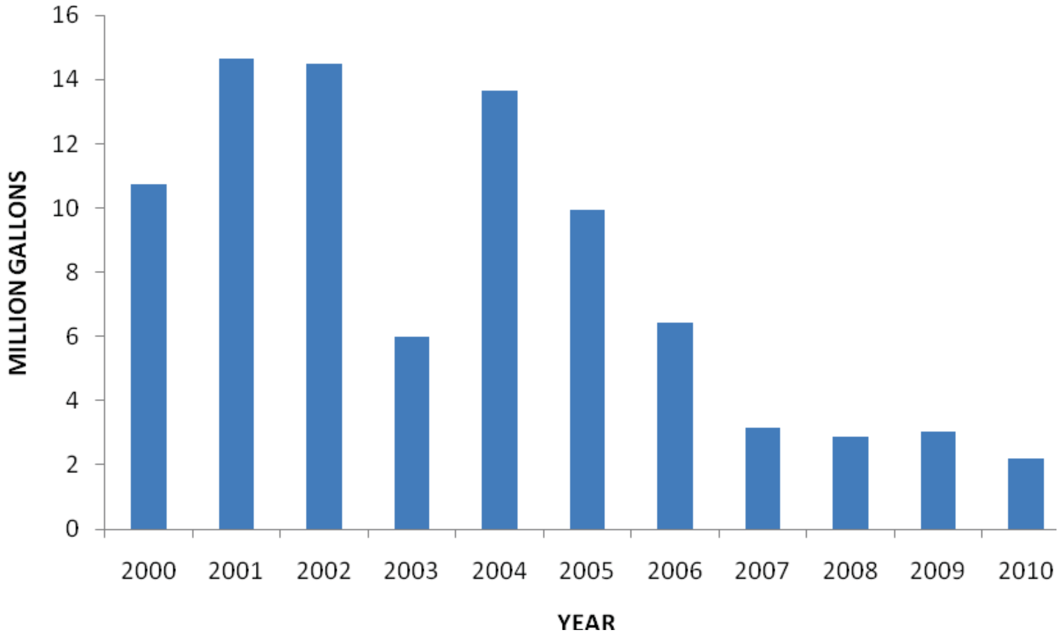

Figure 2. Annual effluent flow to the CFA STP pivot.

3.3.1 Truck-hauled Wastewater Discharges

Truck-hauled wastewater consists of wastewater pumped from portable toilets, septic tanks, and comfort stations. These wastewater systems are pumped by septic system pumping companies licensed in the State of Idaho. Prior to discharge, CFA STP personnel are contacted by the pumping company. A form is filled out documenting the date and estimated volume of wastewater discharged. The wastewater is then discharged into a manhole upstream of the influent flow meter. For the 2010 permit year, approximately 9,800 gallons of truck-hauled wastewater was discharged to the CFA STP.

3.4 Nutrient Loading Rates

The permit requires loading rate calculations for total dissolved solids (TDS), total nitrogen, chemical oxygen demand (COD), and total phosphorus. However, the permit does not specify any limits for loading rates. The 2010 monthly and annual effluent nutrient-loading rates to the application area are presented in Table 5. Wastewater was applied to the entire 73.5 acres of the application area during 2010.

Table 5. 2010 nutrient-loading rates.[a]

Month	TDS (lbs/acre)	Total Nitrogen[b] (lbs/acre)	COD (lbs/acre)	Total Phosphorus (lbs/acre)
August	300.42	1.18	11.92	0.22
Yearly total	300.42	1.18	11.92	0.22

a. Loading rates calculated for wastewater application on 73.5 acres (hydraulic management unit MU-014101).

b. Total nitrogen is determined from the sum of the TKN and NNN results.

Sampling and analysis of TDS in the wastewater became a requirement with the issuance of a new permit in 2005 (Johnston 2005). The total annual TDS loading rate for 2005 was 1,079 lbs/acre, the total annual loading rates then decreased each year to a low of 335 lbs/acre in 2008. In 2009, the loading rate increased to 399.06 lbs/acre. For permit year 2010, the loading rate dropped to 300.42 lbs/acre.

Total nitrogen loading rate for 2010 from the wastewater was only 1.18 lbs/acre/year. Figure 3 shows the total annual loading rates from 2000 through 2010. As a general rule, nitrogen loading should not exceed the amount necessary for crop utilization plus 50%. However, wastewater is applied to desert steppe and crested wheat grass communities without nitrogen removal via crop harvest. To estimate nitrogen buildup in the soil under this condition, a nitrogen balance was prepared by Cascade Earth Science, Ltd.(CES), which estimated it would take 20 to 30 years to reach normal nitrogen agricultural levels in the soil (based on a loading rate of 32 lbs/acre/year) (CES 1993). The extremely low nitrogen-loading rates are expected to have an insignificant effect on nitrogen accumulation in the soil.

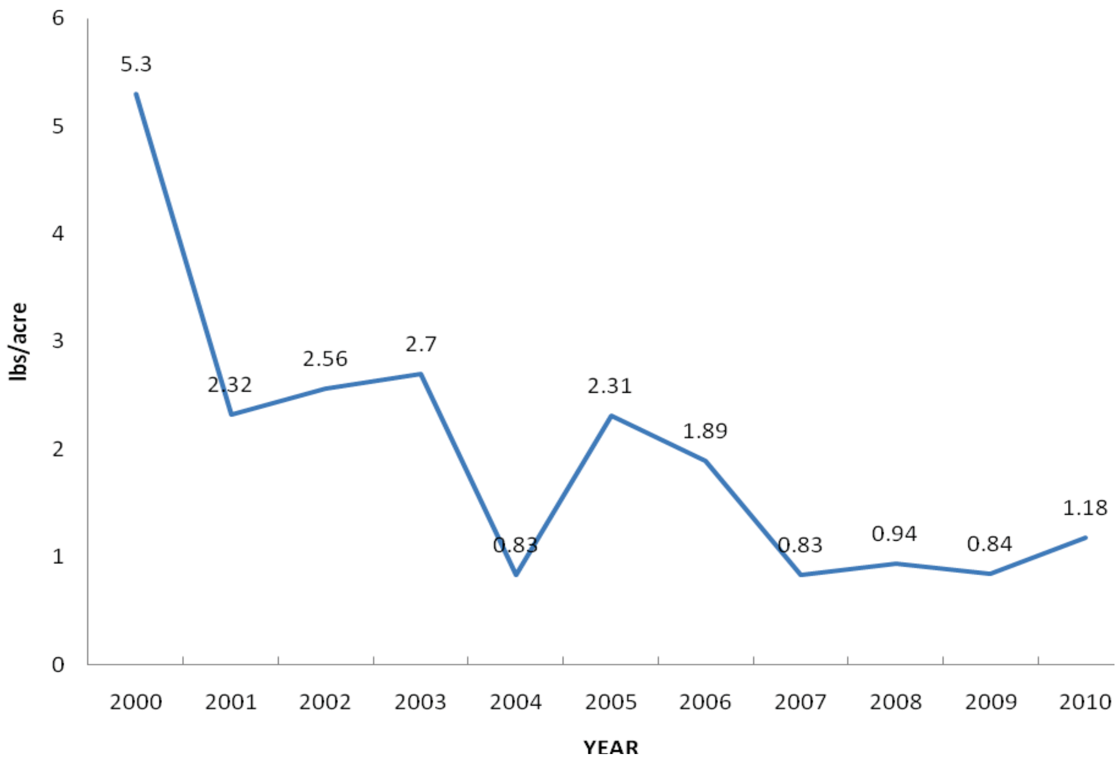

Figure 3. Total nitrogen annual loading rates for permit years 2000 through 2010.

Total annual COD loading of 11.92 lbs/acre/year for 2010 was lower than the COD loading rate for the 2009 permit year of 16.03 lbs/acre/year. The 2010 COD loading rate was also significantly lower than the rate specified in the DEQ guidance (DEQ 2007) of 50.0 lbs/acre/day for the growing season.

The 2010 annual total phosphorus loading rate of 0.22 lbs/acre/year was well below the projected maximum loading rate of 4.5 lbs/acre/year (CES 1993). Figure 4 shows the total phosphorus loading rates for permit years 2000 through 2010. The small amount of phosphorus applied is expected to be removed by sorption reactions in the soil and used by vegetation, rather than lost to ground water.

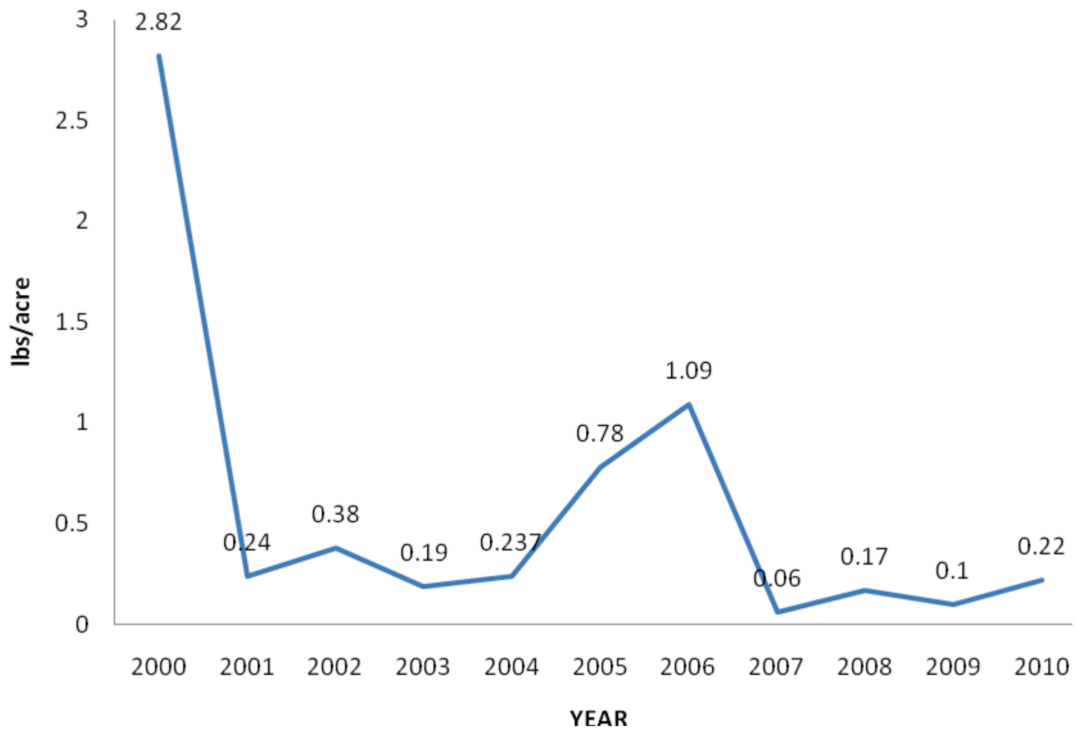

Figure 4. Total phosphorous annual loading rates for permit years 2000 through 2010.

4. SOIL MONITORING

This section briefly describes the soil sampling and analytical methods used in the soils sampling program. It also provides the historical and current soil sampling data from the CFA STP application area.

4.1 Sampling Program and Analytical Methods

The CFA STP permit requires that the soil within the land application area be sampled in October of 2010 and then in October 2013. These soil samples are collected by MS personnel. The program sampling and data interpretation are carried out under a quality assurance program. For October 2010, ten soil samples were collected from the land application area at three depths and then composited in accordance with INL procedures and as specified in the permit. The samples are analyzed using *Methods of Soil Analysis*.

4.2 Soil-Monitoring Results

Cascade Earth Science, Ltd. (CES 1993) characterized soils at the CFA STP prior to construction. Soils in the upper 6 in. are predominantly silty clay loam. Soils from 6 to 52 in. are predominantly silt loam. Soils at CFA were determined to be suitable for slow-rate wastewater application (EG&G 1993).

For the period of 1995 through 2004, the permit required that samples be collected from five sampling locations on the application area at the 0–12 and 12–24 in. depths. Beginning with the October 2005 soil sampling event, samples have been collected at 10 locations (see Figure 5) in the land application area as required by the permit. Subsamples are taken from the 0–12, 12–24, and 24–36 in. depths at each location and composited, yielding three composite samples, one from each depth. The 24–36 in. depth interval was a new permit requirement for 2005; soil samples were not collected at this interval prior to 2005.

During the 2010 sampling event, refusal was met at the 18 in. depth at location #4 (see Figure 4). The auger was moved and additional sample was collected from 18–24 in. to complete the 12–24 in. sample. Refusal was hit again at the 30 in. depth, resulting in a 24–30 in. sample being collected. The 2005 through 2010 sample results are listed in Table 6.

The 2010 pH levels ranged from 7.85 to 7.97 at the three depth ranges (see Table 6). A pH between 5.5 and 8.4 is suitable for most crops (DEQ 2007).

The percent organic matter was within the 1995 through 2009 historical levels at all three soil depths (see Table 6).

Excessive salts can adversely affect soil and plant health. Conversely, low to moderate salinity, indirectly measured as electrical conductivity, may actually improve the physical conditions of some soils. Soil conductivity levels of 0–2 millimhos per centimeter (mmhos/cm) are generally accepted to have negligible effects on plant growth. Soils with a conductivity of 2–4 millimhos are considered to have a moderately high soil salinity (DEQ 2007). The soil conductivity level found in the 0–12 in. depth from the 2010 sample, was below the 2 mmhos/cm level. The 2010 soil conductivity levels in the 12–24 in. and 24–36 in. were above the 2 mmhos/cm level at 2.660 mmhos/cm and 2.590 mmhos/cm, respectively. However, the 2010 conductivity levels at the 12–24 in. and 24–36 in. depth were within the 2005 through 2009 historical range (see Table 6).

Poor drainage is the most common cause of salt buildup in soils (Blaylock 1994). This can be expected due to the low volume of water applied to the CFA STP pivot application area. Currently, the soil salinity in the application area is below the 6 mmhos/cm level expected to result in a decrease in relative growth of crested wheat grass (Blaylock 1994) and sagebrush (Swift 1997).

Soils with sodium adsorption ratios (SARs) below 15 and electrical conductivity levels below 2 mmhos/cm are generally classified as not having sodium or salinity problems (Bohn, McNeal, and O'Connor 1985). The SAR indicates the exchangeable sodium levels in the soil. Soils with high exchangeable sodium levels tend to crust badly or disperse, which greatly decreases soil hydraulic conductivity. DEQ guidance (DEQ 2007) states that "SAR values above thirteen (13) classify soils as sodic or alkali, have sodium as the dominant cation, and may possibly experience infiltration problems due to deflocculation of soil colloids." The SARs for 2010 were all less than 5.5 (see Table 6).

The nitrogen data in Table 6 suggest negligible nitrogen accumulation from wastewater application. Nitrate as nitrogen was detected above the laboratory instrument detection threshold in the upper soil layer (0–12 in.) at a concentration of 1.41 ppm. All other nitrate and ammonium soil samples were below the detection thresholds. The low soil-available nitrogen (NH_4-N and NO_3-N) concentrations suggest that the sagebrush and grass vegetation use all of the plant-available nitrogen and that the total nitrogen application is low. Increased nutrients and water from wastewater application may be stimulating plant growth, which in turn rapidly uses plant-available nitrogen. The NH_4-N and NO_3-N concentrations are comparable to those of nonfertilized agricultural soils.

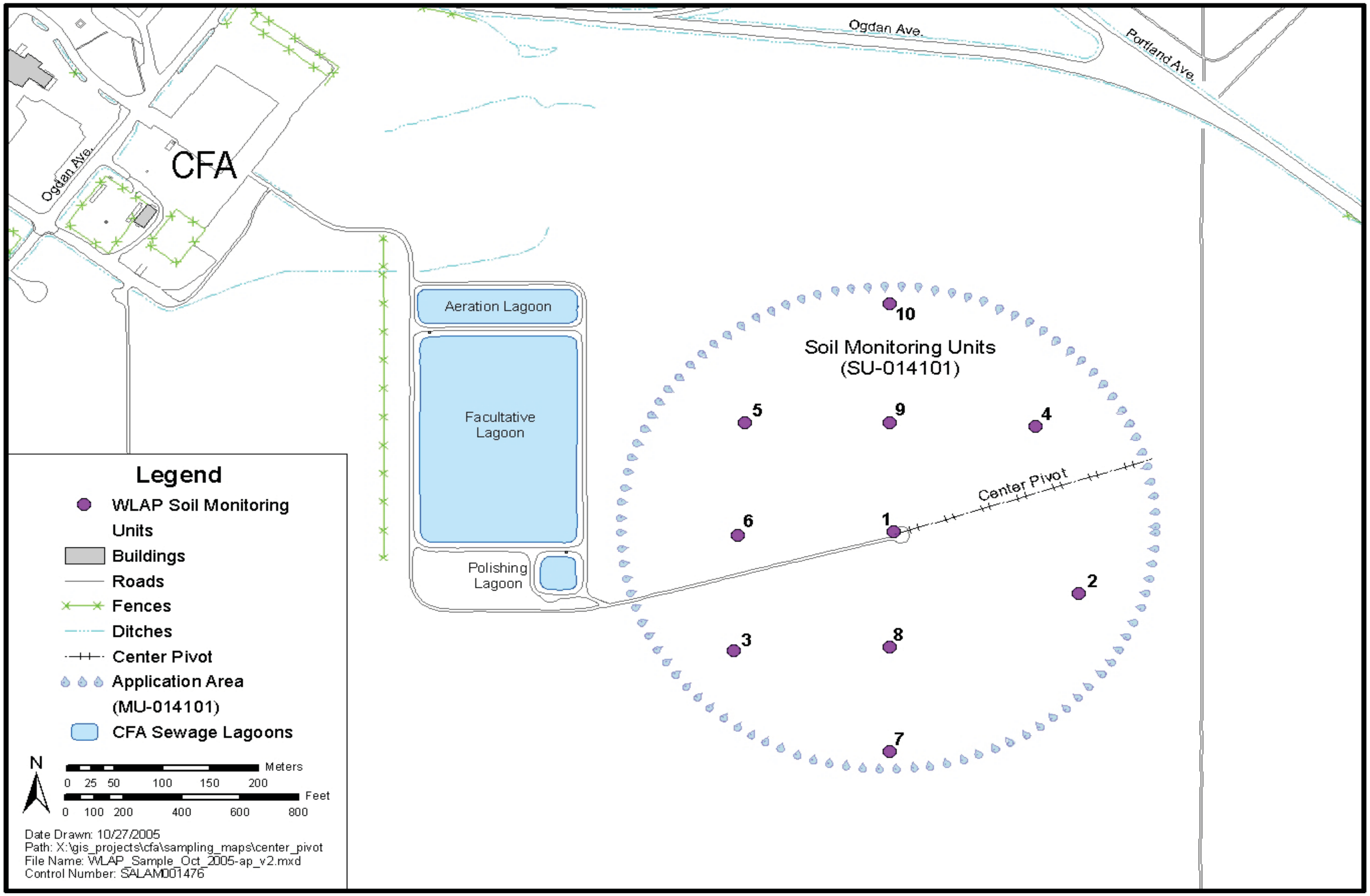

Figure 5. CFA Wastewater Land Application Permit soil-monitoring locations.

Table 6. CFA STP 2005 through 2010 application area soil-monitoring results.

Parameter	Depth (in.)	2005	2006	2007	2008	2009[a]	2010[b]
pH	0–12	8.02	8.29	8.05	8.21	8.26	7.97
	12–24	7.94	8.05	8.00	7.88	7.95	7.85
	24–36	8.03	8.15	8.09	8.00	8.05	7.85
Electrical Conductivity (mmhos/cm)	0–12	1.93	0.86	1.221	0.722	0.675	1.091
	12–24	2.86	3.20	2.03	2.66	2.490	2.660
	24–36	2.10	3.54	1.95	2.20	1.937	2.590
Organic Matter (%)	0–12	1.49	1.76	1.33	1.49	1.51	1.72
	12–24	0.79	0.933	0.774	0.874	0.655	0.828
	24–36	0.46	0.562	0.483	0.867	0.424	0.603
Nitrate as Nitrogen (ppm)	0–12	5.44	3.07	3.18	1.16	1.62	1.41
	12–24	1.66	1.003 U[c]	0.977 U	0.996 U	0.998 U	1.02 U
	24–36	1.73	0.998 U	1.00 U	0.986 U	0.996 U	1.01 U
Ammonium Nitrogen (ppm)	0–12	0.49 U	1.99	0.516	1.46	0.818	0.512 U
	12–24	0.48U	0.501 U	0.489 U	0.498 U	0.499 U	0.508 U
	24–36	0.49 U	0.501 U	0.500 U	0.493 U	0.498 U	0.507 U
Extractable Phosphorus (ppm)	0–12	13.10	10.60	9.05	11.2	7.77	15.4
	12–24	3.26	1.94	1.77	3.98	1.72	3.64
	24–36	1.72	0.99 U	1.19	2.84	1.28	4.34
Sodium Adsorption Ratio	0–12	5.64	9.68	3.79	4.06	3.83	4.32
	12–24	3.94	7.45	4.00	4.73	4.19	5.10
	24–36	3.12	10.00	3.69	3.48	2.5	4.62

a. During the 2009 sampling event, refusal was met at the 23 in. depth at location #1. The auger was moved allowing for the 24–36 in. depth sample to be collected. At sampling location #4, refusal was met at the 30 in. depth.

b. During the 2010 sampling event, refusal was met at 18 in. at location #4. The location was moved and additional sample was collected from 18–24 in., completing the 12–24 in. depth sample. Refusal was again encountered at the 30 in. depth at location #4, resulting in the sample being collected at a depth of 24–30 inches.

c. U flag indicates that the result was reported as below the detection limit.

Extractable (plant available) phosphorus concentrations at the 0–12 in., 12–24 in., and 24–36 in. depths for samples collected in 2010 were 15.4 ppm, 3.64 ppm, and 4.34 ppm, respectively. The phosphorus concentrations in the 0–12 in. and 24–36 in. depths were higher than the concentrations previously reported for the 2005 through 2009 reporting periods (see Table 6). DEQ guidance (DEQ 2007) recommends that to ensure there are no ground water contamination concerns, the phosphorus should be less than 30 ppm (Olsen method used in these analyses) in the 24–36 in. soil depth. As discussed above, the phosphorus concentration at the 24–36 in. depth for 2010 was 4.34 ppm, and well below the level of concern.

5. PERMIT YEAR SUMMARIES

This section provides information and status associated with permit required compliance activities, noncompliance issues, and lagoon weed control.

5.1 Status of Permit Required Compliance Activities

Section H, Paragraph 5, of the permit requires that DEQ be notified within 30 days of completing any work described in Section E, and that the annual report shall provide the status of compliance activities still in progress at the end of the permit year.

Compliance Activity CA-141-01(within 12 months of permit issuance): A final Plan of Operation (O&M Manual) for the wastewater reuse facility, incorporating the requirements of this permit shall be submitted to the Department for review and approval. The Plan shall include a description of approved sample collection methods, appropriate analytical methods and companion QA/QC protocol. The manual may reference other written procedures required for the operation and maintenance of the wastewater reuse facility.

The permit was issued on March 17, 2010 and therefore, the Plan of Operation is required to be submitted to the DEQ by March 17, 2011.

Compliance Activity CA-141-02 (May 31, 2014): Submit a Seepage Testing Procedure to DEQ for review and approval for the three wastewater treatment lagoons. The Procedure shall describe the testing procedures, equipment, measurement methods, and calculation methodology conclusions for DEQ review and approval.

Procedure will be completed by May 31, 2014.

Compliance Activity CA-141-03 (August 31, 2014): Upon DEQ approval of the Seepage Testing Procedure (CA-141-02, above), the permittee shall complete seepage testing of CFA STP lagoons 1 through 3 and submit a Seepage Test Results Report to DEQ no later than August 31, 2014 for review and approval.

The seepage test will be completed by August 31, 2014.

NOTE: The Compliance Activity Description in Section E, Table 3 of the permit, states “no later than August 31, 2015” which contradicts the date of August 31, 2014 given in the Compliance Activity Number Completion Date column in the same section and table. In order to allow the DEQ time to review the seepage test results prior to issuing a new permit, the correct date is August 31, 2014.

5.2 Noncompliance Issues

There were no noncompliance issues identified during the 2010 permit year.

5.3 Experimental Weed Control

During permit year 2007, prolific aquatic vegetative growth in Lagoons No.’s 2 and 3 became a potential operational concern. Concerns included the potential for short circuiting, insect breeding, and plugging of the pivot irrigation system pump and spray nozzles. Several vegetative control methods were considered. After discussion with the DEQ (Stanley 2008), it was decided that the INL would purchase grass carp (Ctenopharyngodon idella) and stock them in the two lagoons.

Grass carp can be an economical and effective method for controlling aquatic vegetation. On a daily basis, small grass carp (< 16 inches in length) can consume up to two times their body weight under optimal conditions. This rate decreases to 80% of their body weight as the fish grow. Grass carp may live up to 10 or more years under the right conditions.

Approximately 250 triploid (sterile) 6 inch grass carp were released into the CFA STP lagoons during the summer of 2008. Approximately 240 were released into Lagoon No. 2 and 10 were released into Lagoon No. 3.

The grass carp suffered significant mortality during the first month following stocking evidenced by dead grass carp floating on the lagoon surfaces. The extent of mortality and survival was unknown. The 2008 seasonal aquatic plant growth in the facultative lagoon was similar to prior years but plant growth in the polishing lagoon was significantly below that observed during prior years.

In 2009, plant growth in the lagoons was less than what had been observed in 2008. Whether this can be attributed to the grass carp is unknown. However, a few more dead carp were observed in 2009 indicating some had survived over the winter.

On May 18, 2010 an additional 190 grass carp were released into Lagoon No. 2 and 10 released into Lagoon No. 3. The carp were approximately 6 inches in length. It appeared that survival was good over the spring, summer, and early fall. Aquatic weeds were not an operational issue during the 2010 permit year.

6. ENVIRONMENTAL IMPACTS

When compared to the historical sample results from the CFA STP effluent for the period of 2000 through 2009 (Table 2), the 2010 TKN result of 4.58 mg/L was higher than previous historical annual average maximum of 3.95 mg/L for permit year 2000. The 2010 effluent total phosphorous concentration of 0.888 mg/L was within the 2000 through 2009 annual average historical minimum of 0.14 mg/L and maximum of 2.05 mg/L.

Monitoring of TDS in the effluent began in 2005. The September 2010 TDS concentration was 1,200 mg/L compared to the 2005 low of 992 mg/L and the 2007 high average annual concentration of 1,203 mg/L.

Wastewater was applied to the land application area a total of 14 days during the month of August. Only 2.2 MG (1.1 acre-in./acre/year) of wastewater were applied to the land application area. This is well below the permit limit of 37 MG (18.5 acre-in./acre/year).

The permit requires loading rate calculations for total nitrogen, COD, total phosphorus, and TDS. The total annual 2010 loading rates for these constituents were as follows:

- Total nitrogen was 1.18 lbs/acre/year.
- COD was 11.92 lbs/acre/year.
- Total phosphorus was 0.22 lbs/acre/year, well below the projected maximum loading rate of 4.5 lbs/acre/year (CES 1993).
- Sampling and analysis of TDS in the effluent was a new requirement in the 2005 permit. TDS loading for 2010 was 300.42 lbs/acre/year compared to 399.06 lbs/acre/year in 2009. TDS is a measure of dissolved ions (sodium, chloride, calcium, magnesium, etc.) in ground water and wastewater.

Soils nitrogen data indicates negligible nitrogen accumulation from wastewater application (Figure 3). The low soil-available nitrogen (NH_4-N and NO_3-N) concentrations suggest that the sagebrush and grass vegetation use all of the plant-available nitrogen and that the total nitrogen application is low. Increased nutrients and water from wastewater application may be stimulating plant growth, which in turn rapidly uses the plant-available nitrogen. The NH_4-N and NO_3-N concentrations are comparable to those of nonfertilized agricultural soils.

A pH between 5.5 and 8.4 is suitable for most crops (DEQ 2007). The 2010 soil pH for the three soil depths ranged from 7.85 to 7.97 (see Table 6). Soils with pH greater than nine generally contain sodium at concentrations high enough to be detrimental to soil structure.

Organic matter in mineral soils is usually less than 5 percent. Organic matter in the 2010 soil samples from the application area was highest in the 0–12 in. soil depth at 1.72% and lowest in the 24–36 in. soil depth at 0.603%.

Excessive salts can adversely affect soil and plant health. Conversely, low to moderate salinity, measured as electrical conductivity, may actually improve the physical conditions of some soils. Soil conductivity levels of 0–2 millimhos per centimeter (mmhos/cm) are generally accepted to have negligible effects on plant growth. The 2010 soil conductivity level at the 0–12 in. was 1.091 mmhos/cm. The conductivity levels at the 12–24 and 24–36 depths were 2.660 mmhos/cm and 2.590 mmhos/cm, respectively. Although above the 2 mmhos/cm level at the 12–24 and 24–36 depths, the results were below the historical maximums (Table 6).

Poor drainage is the most common cause of salt buildup in soils (Blaylock 1994). This can be expected due to the low volume of water applied to the CFA STP pivot application area. Currently, the soil salinity in the application area is below the 6 mmhos/cm level expected to result in a decrease in relative growth of crested wheat grass (Blaylock 1994) and sagebrush (Swift 1997).

The SAR indicates the exchangeable sodium levels in the soil. Soils with high exchangeable sodium levels tend to crust badly or disperse, which greatly decreases soil hydraulic conductivity. The 2010 SAR of 4.32 at the 0–12 in. depth was significantly lower than the 2006 historical high of 9.68 but higher than the 2009 level of 3.83. The 2010 SARs of 5.10 at the 12–24 in. depth and 4.62 at the 24–36 in. depth were higher than the 2009 levels but lower than the 2006 results (see Table 6). All SARs remained well below 13 at all depth intervals. DEQ guidance (DEQ 2007) states that “SAR values above thirteen (13) classify soils as sodic or alkali, have sodium as the dominant cation, and may possibly experience infiltration problems due to deflocculation of soil colloids.”

The phosphorus concentration at the 0–12 in. depth interval in 2010 was 15.4 ppm. Phosphorus decreased significantly with depth. The 2010 phosphorus concentrations at the 12–24 in. and 24–36 in. depths were 3.64 ppm and 4.34 ppm, respectively. The DEQ guidance (DEQ 2007) recommends that to ensure there are no ground water contamination concerns, phosphorus should be less than 30 ppm (Olsen method used in these analyses) in the 24–36 in. soil depth. The 2010 concentration at this depth was well below the level of concern.

The low-strength wastewater influent, followed by treatment in the CFA STP lagoons, produced an effluent with very low loading rates. In fact, the nitrogen loading was far less than that needed for optimal plant growth.

With the low hydraulic and nutrient loading rates to the application area and the depth to groundwater (approximately 600 feet below land surface), there are no negative impacts expected to the groundwater resource.

7. REFERENCES

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Appendix A

Central Facilities Area Sewage Treatment Plant Daily Effluent Flow Readings

Appendix A

Central Facilities Area Sewage Treatment Plant Daily Effluent Flow Readings

Table A-1. CFA STP daily effluent flows for the 2010 permit year.

Date	CFA Effluent (gallons)	Date	CFA Effluent (gallons)	Date	CFA Effluent (gallons)
4/1/2010	No flow	5/1/2010	No flow	5/31/2010	No flow
4/2/2010	No flow	5/2/2010	No flow	6/1/2010	No flow
4/3/2010	No flow	5/3/2010	No flow	6/2/2010	No flow
4/4/2010	No flow	5/4/2010	No flow	6/3/2010	No flow
4/5/2010	No flow	5/5/2010	No flow	6/4/2010	No flow
4/6/2010	No flow	5/6/2010	No flow	6/5/2010	No flow
4/7/2010	No flow	5/7/2010	No flow	6/6/2010	No flow
4/8/2010	No flow	5/8/2010	No flow	6/7/2010	No flow
4/9/2010	No flow	5/9/2010	No flow	6/8/2010	No flow
4/10/2010	No flow	5/10/2010	No flow	6/9/2010	No flow
4/11/2010	No flow	5/11/2010	No flow	6/10/2010	No flow
4/12/2010	No flow	5/12/2010	No flow	6/11/2010	No flow
4/13/2010	No flow	5/13/2010	No flow	6/12/2010	No flow
4/14/2010	No flow	5/14/2010	No flow	6/13/2010	No flow
4/15/2010	No flow	5/15/2010	No flow	6/14/2010	No flow
4/16/2010	No flow	5/16/2010	No flow	6/15/2010	No flow
4/17/2010	No flow	5/17/2010	No flow	6/16/2010	No flow
4/18/2010	No flow	5/18/2010	No flow	6/17/2010	No flow
4/19/2010	No flow	5/19/2010	No flow	6/18/2010	No flow
4/20/2010	No flow	5/20/2010	No flow	6/19/2010	No flow
4/21/2010	No flow	5/21/2010	No flow	6/20/2010	No flow
4/22/2010	No flow	5/22/2010	No flow	6/21/2010	No flow
4/23/2010	No flow	5/23/2010	No flow	6/22/2010	No flow
4/24/2010	No flow	5/24/2010	No flow	6/23/2010	No flow
4/25/2010	No flow	5/25/2010	No flow	6/24/2010	No flow
4/26/2010	No flow	5/26/2010	No flow	6/25/2010	No flow
4/27/2010	No flow	5/27/2010	No flow	6/26/2010	No flow
4/28/2010	No flow	5/28/2010	No flow	6/27/2010	No flow
4/29/2010	No flow	5/29/2010	No flow	6/28/2010	No flow
4/30/2010	No flow	5/30/2010	No flow	6/29/2010	No flow

Date	CFA Effluent (gallons)	Date	CFA Effluent (gallons)	Date	CFA Effluent (gallons)
6/30/2010	No flow	8/6/2010	No flow	9/12/2010	No flow
7/1/2010	No flow	8/7/2010	No flow	9/13/2010	No flow
7/2/2010	No flow	8/8/2010	No flow	9/14/2010	No flow
7/3/2010	No flow	8/9/2010	147,200	9/15/2010	No flow
7/4/2010	No flow	8/10/2010	137,000	9/16/2010	No flow
7/5/2010	No flow	8/11/2010	155,700	9/17/2010	No flow
7/6/2010	No flow	8/12/2010	169,000	9/18/2010	No flow
7/7/2010	No flow	8/13/2010	No flow	9/19/2010	No flow
7/8/2010	No flow	8/14/2010	No flow	9/20/2010	No flow
7/9/2010	No flow	8/15/2010	No flow	9/21/2010	No flow
7/10/2010	No flow	8/16/2010	No flow	9/22/2010	No flow
7/11/2010	No flow	8/17/2010	No flow	9/23/2010	No flow
7/12/2010	No flow	8/18/2010	No flow	9/24/2010	No flow
7/13/2010	No flow	8/19/2010	No flow	9/25/2010	No flow
7/14/2010	No flow	8/20/2010	No flow	9/26/2010	No flow
7/15/2010	No flow	8/21/2010	No flow	9/27/2010	No flow
7/16/2010	No flow	8/22/2010	No flow	9/28/2010	No flow
7/17/2010	No flow	8/23/2010	No flow	9/29/2010	No flow
7/18/2010	No flow	8/24/2010	No flow	9/30/2010	No flow
7/19/2010	No flow	8/25/2010	No flow	10/1/2010	No flow
7/20/2010	No flow	8/26/2010	137,600	10/2/2010	No flow
7/21/2010	No flow	8/27/2010	185,800	10/3/2010	No flow
7/22/2010	No flow	8/28/2010	147,200	10/4/2010	No flow
7/23/2010	No flow	8/29/2010	153,700	10/5/2010	No flow
7/24/2010	No flow	8/30/2010	155,800	10/6/2010	No flow
7/25/2010	No flow	8/31/2010	189,500	10/7/2010	No flow
7/26/2010	No flow	9/1/2010	No flow	10/8/2010	No flow
7/27/2010	No flow	9/2/2010	No flow	10/9/2010	No flow
7/28/2010	No flow	9/3/2010	No flow	10/10/2010	No flow
7/29/2010	No flow	9/4/2010	No flow	10/11/2010	No flow
7/30/2010	No flow	9/5/2010	No flow	10/12/2010	No flow
7/31/2010	No flow	9/6/2010	No flow	10/13/2010	No flow
8/1/2010	155,800	9/7/2010	No flow	10/14/2010	No flow
8/2/2010	174,700	9/8/2010	No flow	10/15/2010	No flow
8/3/2010	151,600	9/9/2010	No flow	10/16/2010	No flow
8/4/2010	136,200	9/10/2010	No flow	10/17/2010	No flow
8/5/2010	No flow	9/11/2010	No flow	10/18/2010	No flow

Date	CFA Effluent (gallons)	Date	CFA Effluent (gallons)	Date	CFA Effluent (gallons)
10/19/2010	No flow	10/24/2010	No flow	10/28/2010	No flow
10/20/2010	No flow	10/25/2010	No flow	10/29/2010	No flow
10/21/2010	No flow	10/26/2010	No flow	10/30/2010	No flow
10/22/2010	No flow	10/27/2010	No flow	10/31/2010	No flow
10/23/2010	No flow				