INL/EXT-14-33307

Lagoon Seepage Testing Report

Bridger Morrison

September 2014

The INL is a U.S. Department of Energy National Laboratory
operated by Battelle Energy Alliance

INL/EXT-15-33307

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Idaho National Laboratory

Idaho Falls, Idaho 83415

http://www.inl.gov

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

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Lagoon Seepage Testing Report

for

Central Facilities Area (CFA)
Sewage Lagoons

at

Idaho National Laboratory
Butte County, Idaho

September 2014

Prepared by

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Contents

Page

Central Facilities Area (CFA) Sewage Lagoons 1

Executive Summary 1

Introduction 1

Equipment Setup 2

Groundwater 2

Lagoon Depths 2

Daily Observation 2

Data Collection 3

Equipment Manipulation 3

Data Analysis 4

Conclusion 10

Appendix A Photos of the Equipment Setups and Lagoons
Appendix B Daily Log Sheets
Appendix C DEQ Seepage Calculation Spreadsheets

Lagoon Seepage Testing Report
for
Central Facilities Area (CFA) Sewage Lagoons

Executive Summary

J-U-B ENGINEERS, Inc. (J-U-B) performed seepage tests on the CFA Wastewater Lagoons 1, 2, and 3 between August 26th and September 22nd, 2014. The lagoons were tested to satisfy the Idaho Department of Environmental Quality (DEQ) Rules (IDAPA 58.01.16) that require all lagoons be tested at a frequency of every 10 years and the Compliance Activity CA-141-03 in the DEQ Wastewater Reuse Permit for the CFA Sewage Treatment Plant (LA-000141-03). The lagoons were tested to determine if the average seepage rates are less than 0.25 in/day, the maximum seepage rate allowed for lagoons built prior to April 15, 2007. The average seepage rates were estimated for each lagoon and are given in **Table-ES1**. The average seepage rates for Lagoons 1 and 2 are less than the allowable seepage rate of 0.25 in/day. Lagoon 1 and 2 passed the seepage test and will not have to be tested again until the year 2024[1]. However, the average seepage rate for Lagoon 3 appears to exceed the allowable seepage rate of 0.25 in/day which means the potential source for the excessive leakage should be investigated further.

Table ES1: Average Seepage Rates

	Seepage Rate (in/day)					
Lagoon	Average	Error (+/-)	Allowable	Standard Deviation	n (α= 5%, β= 5%)	Test Duration
Lagoon 1	0.083	0.010	0.25	0.017	2	3 days
Lagoon 2	0.055	0.011	0.25	0.009	2	4 days
Lagoon 3	0.455	0.030	0.25	0.034	2	6 days

Introduction

Battelle Energy Alliance, LLC (BEA) operates the Central Facilities Area (CFA) located in Butte County, Idaho at Idaho National Laboratory (INL). The CFA 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 lagoons: Lagoon 1 has a surface area of 1.7 acres, Lagoon 2 has a surface area of 10.3 acres, and Lagoon 3 has a surface area of 0.5 acres. The three lagoons are lined with bentonite-treated soil and riprap. If flows exceed the evaporative capacity of the lagoons, wastewater is discharged to a 73.5 acre land application site that utilizes a center-pivot irrigation sprinkler system.

The Lagoon Seepage Testing Procedure was approved by DEQ on 5/14/2014. Brett M. Converse, Ph.D./P.E., Bridger Morrison, P.E., and Kassidie Lampe, E.I. of J-U-B performed the seepage tests on the

[1] Testing may be required if the lagoons are damaged, signs of leaking are apparent, or regulations change.

lagoons between August 26th and September 22nd, 2014, in accordance with the DEQ-approved Lagoon Seepage Testing Procedure. The testing procedure documents the methods used to complete the seepage test and the equipment used.

Equipment Setup

The equipment was set up in accordance with the testing procedure document. For all three seepage tests, photos were taken of the equipment installation and are included in **Appendix A**.

Groundwater

In September, 2014 the groundwater depth was approximated using an aquifer monitoring well (USGS-130) located less than a quarter of a mile west of the lagoons. The depth to ground water as reported by BEA staff was 487.17 feet.

Lagoon Depths

For each test, the initial lagoon depth was recorded in the daily log by measuring the depth with a staff gauge. For Lagoon 2, the staff gauge was located on the opposite side of a weir, so a measurement down to the water surface was made with a tape measure and compared to the staff gauge in the transfer structure. Photographs showing the staff gauge and general water levels in each lagoon at the time of the test are included in **Appendix A**. Lagoon 1 was tested at 8.0 feet and Lagoons 2 and 3 were tested at 5.5 and 4.75 feet deep, respectively.

Both Lagoon 2 and Lagoon 3 could operate at levels higher than the level at which they were seepage tested. If the lagoons ever have to operate at depths greater than the depths at which they were seepage tested, another seepage test will be required at the greater depth.

Daily Observation

The equipment was observed daily. On weekdays, the equipment was observed once per day by J-U-B Engineers staff (Refer to **Appendix B** for a copy of the daily log sheets). For weekends and holidays, a time lapse camera was set up to photograph the equipment every thirty minutes. The time lapse photos were reviewed by J-U-B staff as well as the logged data to ensure the equipment was not disturbed. The equipment was not disturbed during the duration of the tests. The changes in evaporation pan and lagoon water surface elevations over the weekends did not warrant an adjustment nor invalidate any of the data collected.

Data Collection

Data used to analyze the lagoons were collected over the following timeframes[2]:

- Lagoon 1 8/26/2014 7:00 to 8/29/2014 12:00
- Lagoon 2 9/4/2014 7:00 to 9/8/2014 9:00
- Lagoon 3 9/15/2014 10:32 to 9/21/2014 13:00

Data collected prior to or between the periods listed above was not used because the lagoons were not isolated during those times.

During each test, the following data (with the listed units) were collected every 4 minutes [3]:

- Time Stamp .....Date and time
- Record Number .....Numeric value
- Lagoon Surface Elevation .....Inches
- Evaporation Pan Surface Elevation .....Inches
- Rain .....Inches
- Air Temperature .....Degrees F
- Wind Direction .....Degrees (azimuth)
- Wind Speed .....m/s
- Evaporation Pan Temperature .....Degrees F

Equipment Manipulation

Data collected during each test was adjusted whenever equipment was manipulated. This includes when water was added to the evaporation pan, the lagoon liquid level sensor was lowered, or other adjustments to the equipment. The time/date for each manipulation are given in **Table 1** below. Refer to **Appendix B** for a copy of the daily log sheets.

[2] Time recorded by the data collector for Lagoons 1 and 3 was in Pacific Daylight Time. It was determined that for Lagoon 2, the time recorded by the data collector was 1 hour earlier than the computer time which was set at Pacific Daylight Time, making the recorded time stamp 2 hours earlier than local time. This only affects the comparison of times between the daily logs and the data.

[3] The electronic Excel file, containing the raw data, is on the compact disc memory storage device included as part of this report.

Table 1: Equipment Manipulation

Lagoon	Date/Time[4]	Description
Lagoon 1	8/27/14 7:32	Water added to evaporation pan
	8/28/14 7:24	Water added to evaporation pan
	8/29/14 9:08-9:16	Water added to evaporation pan and lagoon level sensor lowered
Lagoon 2	9/4/14 7:00-7:08	Water added to evaporation pan and lagoon level sensor lowered
	9/5/14 6:40	Water added to evaporation pan and lagoon level sensor lowered
	9/8/14 6:44	Water added to evaporation pan
Lagoon 3	9/16/14 7:24-7:44	Water added to evaporation pan and lagoon level sensor adjusted and lowered
	9/18/14 15:20-15:24	Water added to evaporation pan and lagoon level sensor lowered

Data Analysis

The data collected during each lagoon seepage test are discussed below.

Lagoon 1

Data collected every 4 minutes were averaged to determine the water levels of the lagoon and evaporation pan (Epan). For each day, an averaging period time of 12:00 p.m. was selected and the prior 21 points were averaged to determine the water level for the lagoon and Epan. Therefore, the average water levels from 10:36 to 12:00 on 8/26/2014 were used to determine the starting water levels. After the initial water levels were determined, an additional 72 hours of data was collected. The resulting average water levels, 24-hour median temperatures, and total precipitation were entered into the DEQ Seepage Calculation Spreadsheet. The results are summarized in **Table 2**. A copy of the spreadsheet is included in **Appendix C**[5].

[4] Time recorded by the data collector for Lagoons 1 and 3 was in Pacific Daylight Time. It was determined that for Lagoon 2, the time recorded by the data collector was 1 hour earlier than the computer time which was set at Pacific Daylight Time, making the recorded time stamp 2 hours earlier than local time. This only affects the comparison of times between the daily logs and the data

[5] The electronic Excel file is on the compact disc memory storage device included as part of this report.

Table 2: Lagoon 1 Seepage Rate

Date	Testing Day	S_{r1}	S_{r1} Equipment Error	+ 20% of Previous Readings	- 20% of Previous Readings
		in./day	+/- in./day	in. per day	in. per day
27-Aug-14	1.00	0.0725	0.0105		
28-Aug-14	2.00	0.1060	0.0102	0.0870	0.0580
29-Aug-14	3.00	0.0695	0.0101	0.1071	0.0714
	Standard Deviation =	0.0166			

Daily Seepage Rate Average	Equipment Error Average	Upper Uncertainty Interval	Lower Uncertainty Interval	Seepage Rate over interval end-start
in. per day	+/- in./day	+/- in./day	+/- in./day	in. per day
0.083	0.010	0.093	0.072	0.084

The following statements support the validity of the test:

- During the 24-hour averaging periods used to calculate the seepage rate the water temperature did not drop below freezing. The minimum sampled temperature of the pan during the included averaging periods was 50.06 °F.
- There were no gaps in data collection during this test.

Statistical Evaluation

The statistical evaluation to determine if the data collected was sufficient to provide a 95% confidence level that the true seepage rate was less than the allowable seepage rate only requires 2 sample points to achieve a 95% confidence level as shown in **Figure 1**. The data used for the seepage evaluation contained 3 days of data further validating that the lagoon passed the seepage test and the true rate is likely near 0.083 inches per day.

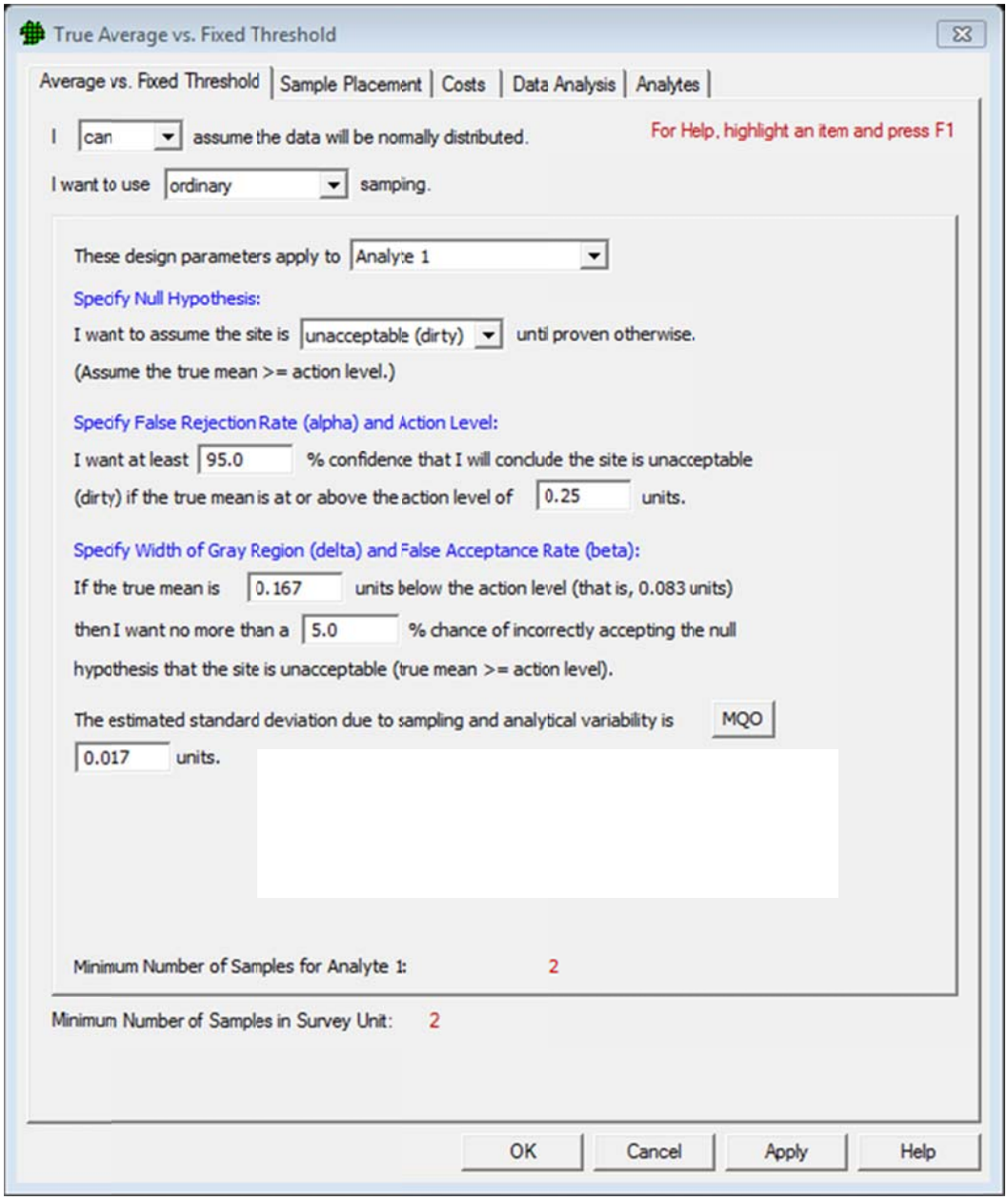

Figure 1: Lagoon 1 - Statistical Evaluation Data Analysis

Lagoon 2

Data collected every 4 minutes were averaged to determine the water levels of the lagoon and Epan. For each day, an averaging period time of 9:00 a.m. was selected and the prior 21 points were averaged to determine the water level for the lagoon and Epan. Therefore, the average water levels from 7:36 to 9:00 on 9/4/2014 were used to determine the starting water levels. After the initial water levels were determined, an additional 96 hours of data was collected. The resulting average water levels, 24-hour median temperatures, and total precipitation were entered into the DEQ Seepage Calculation

Spreadsheet. The results are summarized in **Table 3**. A copy of the spreadsheet is included in **Appendix C**[6].

Table 3: Lagoon 2 Seepage Rate

Date	Testing Day	S_{r1}	S_{r1} Equipment Error	+ 20% of Previous Readings	- 20% of Previous Readings
		in./day	+/- in./day	in. per day	in. per day
5-Sep-14	1.00	0.0395	0.0108		
6-Sep-14	2.00	0.0632	0.0107	0.0474	0.0316
7-Sep-14	3.00	0.0594	0.0104	0.0616	0.0411
8-Sep-14	4.00	0.0590	0.0105	0.0648	0.0432

	Standard Deviation =	0.0092		
Daily Seepage Rate Average	Equipment Error Average	Upper Uncertainty Interval	Lower Uncertainty Interval	Seepage Rate over interval end-start
in. per day	+/- in./day	+/- in./day	+/- in./day	in. per day
0.055	0.011	0.066	0.045	0.058

The following statements support the validity of the test:

- During the 24-hour averaging periods used to calculate the seepage rate the water temperature did not drop below freezing. The minimum sampled temperature of the pan during the included averaging periods was 43.82 °F.
- There were no gaps in data collection during this test.

Statistical Evaluation

The statistical evaluation to determine if the data collected was sufficient to provide a 95% confidence level that the true seepage rate was less than the allowable seepage rate only requires 2 sample points to achieve a 95% confidence level as shown in **Figure 2**. The data used for the seepage evaluation contained 4 days of data further validating that the lagoon passed the seepage test and the true rate is likely near 0.055 inches per day.

[6] The electronic Excel file is on the compact disk memory storage device included as part of this report.

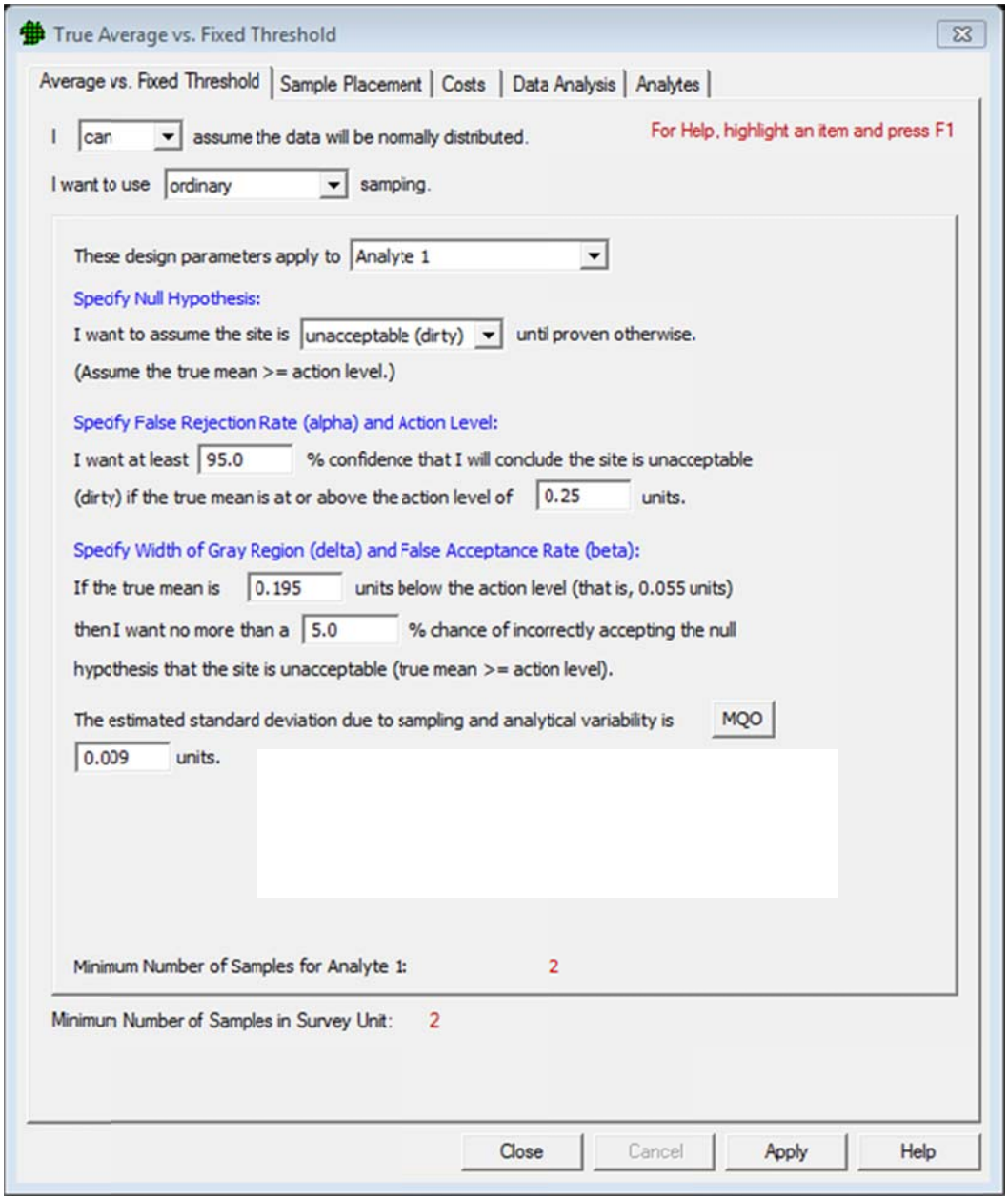

Figure 2: Lagoon 2 - Statistical Evaluation Data Analysis

Lagoon 3

Data collected every 4 minutes were averaged to determine the water levels of the lagoon and Epan. For each day, an averaging period time of 13:00 (1:00 p.m.) was selected and the prior 21 points were averaged to determine the water level for the lagoon and Epan. Therefore, the average water levels from 11:36 to 13:00 on 9/15/2014 were used to determine the starting water levels. After the initial water levels were determined, an additional 144 hours of data was collected. The resulting average water levels, 24-hour median temperatures, and total precipitation were entered into the DEQ Seepage

Calculation Spreadsheet. The results are summarized in **Table 4**. A copy of the spreadsheet is included in **Appendix C**[7].

Table 4: Lagoon 3 Seepage Rate

Date	Testing Day	S_{r1}	S_{r1} Equipment Error	+ 20% of Previous Readings	- 20% of Previous Readings
		in./day	+/- in./day	in. per day	in. per day
16-Sep-14	1.00	0.3960	0.0103		
17-Sep-14	2.00	0.4699	0.0102	0.4752	0.3168
18-Sep-14	3.00	0.4251	0.0645	0.5195	0.3463
19-Sep-14	4.00	0.4727	0.0729	0.5164	0.3443
20-Sep-14	5.00	0.5004	0.0104	0.5291	0.3527
21-Sep-14	6.00	0.4667	0.0103	0.5434	0.3622
	Standard Deviation =	0.034			

Daily Seepage Rate Average	Equipment Error Average	Upper Uncertainty Interval	Lower Uncertainty Interval	Seepage Rate over interval end-start
in. per day	+/- in./day	+/- in./day	+/- in./day	in. per day
0.455	0.030	0.485	0.425	0.456

The following statements support the validity of the test:

- During the 24-hour averaging periods used to calculate the seepage rate the water temperature did not drop below freezing. The minimum sampled temperature of the pan during the included averaging periods was 38.43 °F.
- There were no gaps in data collection during this test.

On September 19th, the facility Operator and other BEA staff were notified of the preliminary results indicating an excessive seepage rate. Attempts were made by the Operator to identify a source of leaking or an indication that the lagoon was not isolated. As the results of the seepage test calculations indicate for the following two days, no changes were made that had a noticeable effect on the seepage rate. Additional effort may be needed to identify the source of the leak or to verify the integrity of the components used for isolating the lagoon.

Statistical Evaluation

The statistical evaluation to determine if the data collected was sufficient to provide a 95% confidence level that the true seepage rate was greater than the allowable seepage rate only requires 2 sample points to achieve a 95% confidence level as shown in **Figure 3**. The data used for the seepage evaluation contained 6 days of data.

[7] The electronic Excel file is on the compact disc memory storage device included as part of this report.

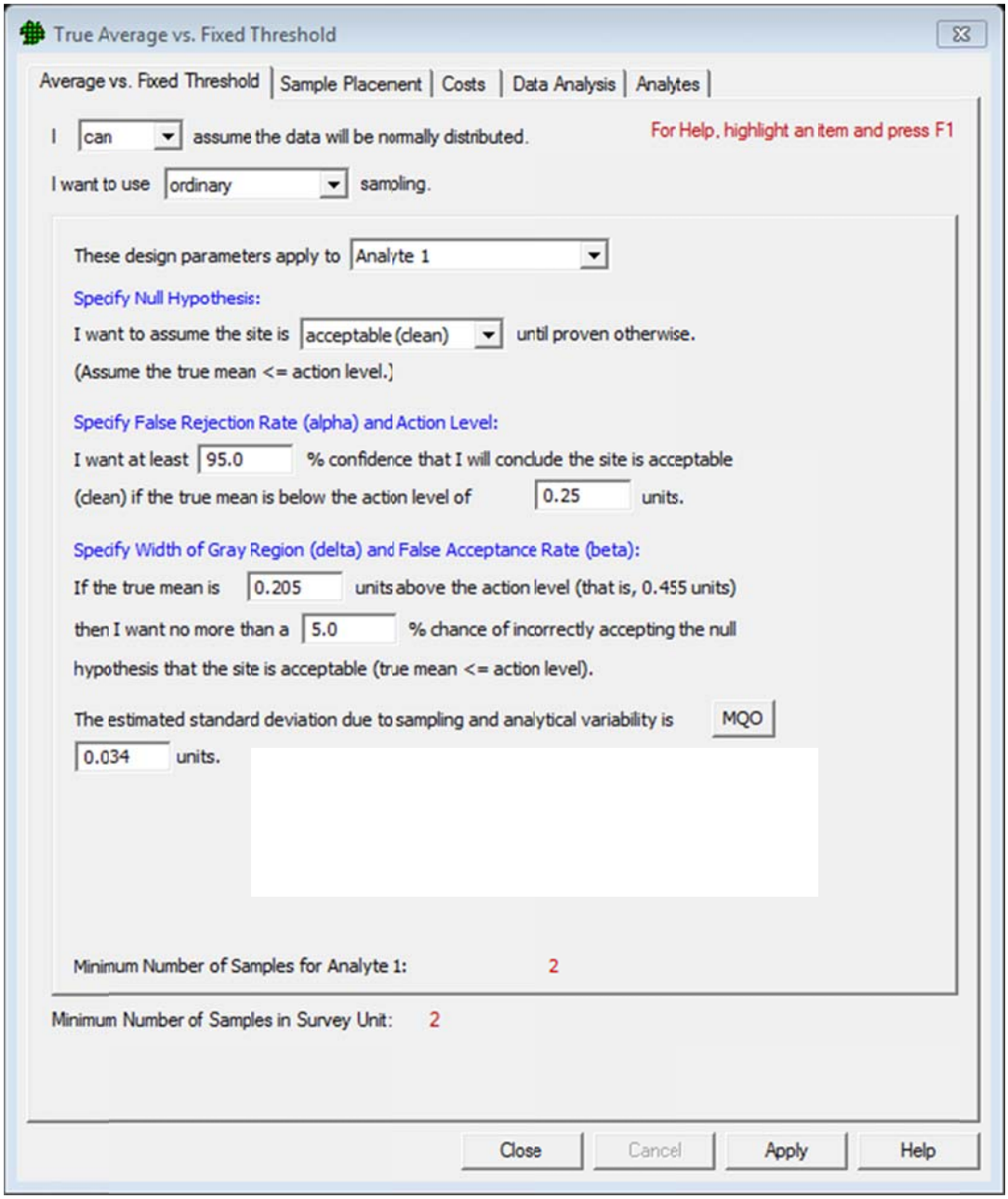

Figure 3: Lagoon 3 - Statistical Evaluation Data Analysis

Conclusion

Using the 24-hour averaged data, the average seepage rates for each lagoon are given in **Table 5**, and are lower than the allowable seepage rate of 0.25 inches per day for Lagoon 1 and Lagoon 2. Those two lagoons passed the seepage tests and should not have to be tested again until the year 2024[8]. However, additional effort is required to identify the cause of the excessive seepage rate obtained for Lagoon 3.

[8] Testing may be required if the lagoon is damaged, signs of leaking are apparent, or regulations change.

Table 5: Average Seepage Rates

Lagoon	Seepage Rate (in/day) Average	Error (+/-)	Allowable	Standard Deviation	n (α= 5%, β= 5%)	Test Duration
Lagoon 1	0.083	0.010	0.25	0.017	2	3 days
Lagoon 2	0.055	0.011	0.25	0.009	2	4 days
Lagoon 3	0.455	0.030	0.25	0.034	2	6 days

Appendix A

Photos of the Equipment Setups and Lagoons

Equipment set-up for Lagoon 1

Evaporation Pan

Equipment set-up for Lagoon 1

Lagoon Level Sensor

Staff Gauge/Water Level for Lagoon 1

General Water Level in Lagoon 1 at Time of Test

Equipment set-up for Lagoon 2 and Lagoon 3

Staff gauge/water level in Lagoon 2


Equipment set-up for Lagoon 2 and Lagoon 3


Support for Lagoon Level Sensor for Lagoon 2

General Water Level in Lagoon 2 at Time of Test

General water level in Lagoon 3 at time of test

Support for Lagoon Level Sensor for Lagoon 3

Evaporation pan for Lagoon 2 and Lagoon 3

Appendix B

Daily Log Sheets

Daily Log Sheet

Lagoon 1

Day 0, Set Up Equipment

Date 8/25/14

Time 3:30 pm

1. Water surface in Pan
   a. Is water surface within three inches from the top? Yes
   b. Was Water Added Set Up
      i. Date _____
      ii. Time _____
2. Water surface in Lagoon
   a. Is liquid level within range of the buoy? Yes
   b. Was level sensor lowered Set Up
      i. Date _____
      ii. Time _____

Utilities Operator Adjusting Pump & Weir Gate. Water Level may change.

3. Check Equipment
   a. Fence ✓
   b. Wooden instrument box ✓
   c. Solar panel ✓
   d. Battery ✓
   e. Weather proof enclosure ✓
   f. Rain gauge ✓
   g. Wind anemometer ✓
   h. Wind vane ✓
   i. Air temperature sensor and gill shield ✓
   j. Air temperature sensor ✓
   k. Water temperature sensor ✓
   l. Lagoon liquid level sensor ✓
   m. Pan liquid level sensor ✓
   n. Check air pressure in inflatable plugs (if applicable) —

Daily Log Sheet

Lagoon 1

Day 1

Date 8/26/14

Time 9:00 am

1. Water surface in Pan
   a. Is water surface within three inches from the top? Yes
   b. Was Water Added No
      i. Date _____
      ii. Time _____
2. Water surface in Lagoon
   a. Is liquid level within range of the buoy? Yes
   b. Was level sensor lowered No
      i. Date _____
      ii. Time _____
3. Check Equipment
   a. Fence ✓
   b. Wooden instrument box ✓
   c. Solar panel ✓
   d. Battery ✓
   e. Weather proof enclosure ✓
   f. Rain gauge ✓
   g. Wind anemometer ✓
   h. Wind vane ✓
   i. Air temperature sensor and gill shield ✓
   j. Air temperature sensor ✓
   k. Water temperature sensor ✓
   l. Lagoon liquid level sensor ✓
   m. Pan liquid level sensor ✓
   n. Check air pressure in inflatable plugs (if applicable) —

Operator adjusted Weir Gate around 7:30 am.

Daily Log Sheet

Lagoon 1

Day 2

Date 8/27/14

Time 8:30 am

1. Water surface in Pan
   a. Is water surface within three inches from the top? Yes
   b. Was Water Added Yes
      i. Date 8/27/14
      ii. Time ≈ 8:30 am
2. Water surface in Lagoon
   a. Is liquid level within range of the buoy? Yes
   b. Was level sensor lowered No
      i. Date
      ii. Time
3. Check Equipment
   a. Fence ✓
   b. Wooden instrument box ✓
   c. Solar panel ✓
   d. Battery ✓
   e. Weather proof enclosure ✓
   f. Rain gauge ✓
   g. Wind anemometer ✓
   h. Wind vane ✓
   i. Air temperature sensor and gill shield ✓
   j. Air temperature sensor ✓
   k. Water temperature sensor ✓
   l. Lagoon liquid level sensor ✓
   m. Pan liquid level sensor ✓
   n. Check air pressure in inflatable plugs (if applicable) —

Daily Log Sheet

Lagoon 1

Day 3

Date 8/28/14

Time 8:25 am

1. Water surface in Pan
   a. Is water surface within three inches from the top? Yes
   b. Was Water Added Yes
      i. Date 8/28/14
      ii. Time ~~8~~ 8:25 am
2. Water surface in Lagoon
   a. Is liquid level within range of the buoy? Yes
   b. Was level sensor lowered No
      i. Date
      ii. Time
3. Check Equipment
   a. Fence ✓
   b. Wooden instrument box ✓
   c. Solar panel ✓
   d. Battery ✓
   e. Weather proof enclosure ✓
   f. Rain gauge ✓
   g. Wind anemometer ✓
   h. Wind vane ✓
   i. Air temperature sensor and gill shield ✓
   j. Air temperature sensor ✓
   k. Water temperature sensor ✓
   l. Lagoon liquid level sensor ✓
   m. Pan liquid level sensor ✓
   n. Check air pressure in inflatable plugs (if applicable) —

Daily Log Sheet

Lagoon 1

Day 4

Date 8/29/14

Time 9:45am

1. Water surface in Pan
   a. Is water surface within three inches from the top? Yes
   b. Was Water Added Yes
      i. Date 8/29/14
      ii. Time ≈10:00am
2. Water surface in Lagoon
   a. Is liquid level within range of the buoy? Yes
   b. Was level sensor lowered Yes
      i. Date 8/29/14
      ii. Time ≈10:10am
3. Check Equipment
   a. Fence ✓
   b. Wooden instrument box ✓
   c. Solar panel ✓
   d. Battery ✓
   e. Weather proof enclosure ✓
   f. Rain gauge ✓
   g. Wind anemometer ✓
   h. Wind vane ✓
   i. Air temperature sensor and gill shield ✓
   j. Air temperature sensor ✓
   k. Water temperature sensor ✓
   l. Lagoon liquid level sensor ✓
   m. Pan liquid level sensor ✓
   n. Check air pressure in inflatable plugs (if applicable) —

Daily Log Sheet

Lagoon 2

Day 0

Date 9/2/14

Time 3:00 pm

1. Water surface in Pan
   a. Is water surface within three inches from the top? Yes
   b. Was Water Added Set Up
      i. Date _____
      ii. Time _____
2. Water surface in Lagoon
   a. Is liquid level within range of the buoy? Yes
   b. Was level sensor lowered Set Up
      i. Date _____
      ii. Time _____
3. Check Equipment
   a. Fence ✓
   b. Wooden instrument box ✓
   c. Solar panel ✓
   d. Battery ✓
   e. Weather proof enclosure ✓
   f. Rain gauge ✓
   g. Wind anemometer ✓
   h. Wind vane ✓
   i. Air temperature sensor and gill shield ✓
   j. Air temperature sensor ✓
   k. Water temperature sensor ✓
   l. Lagoon liquid level sensor ✓
   m. Pan liquid level sensor ✓
   n. Check air pressure in inflatable plugs (if applicable) —

Daily Log Sheet

Lagoon 2

Day 1

Date 9/3/14

Time 9am

1. Water surface in Pan
   a. Is water surface within three inches from the top? Yes
   b. Was Water Added No
      i. Date _____
      ii. Time _____
2. Water surface in Lagoon
   a. Is liquid level within range of the buoy? Yes
   b. Was level sensor lowered No
      i. Date _____
      ii. Time _____
3. Check Equipment
   a. Fence ✓
   b. Wooden instrument box ✓
   c. Solar panel ✓
   d. Battery ✓
   e. Weather proof enclosure ✓
   f. Rain gauge ✓
   g. Wind anemometer ✓
   h. Wind vane ✓
   i. Air temperature sensor and gill shield ✓
   j. Air temperature sensor ✓
   k. Water temperature sensor ✓
   l. Lagoon liquid level sensor ✓
   m. Pan liquid level sensor ✓
   n. Check air pressure in inflatable plugs (if applicable) —

Very Windy!

Daily Log Sheet

Lagoon 2

Day 2

Date 9/4/14

Time 8:45am

1. Water surface in Pan
   a. Is water surface within three inches from the top? Yes
   b. Was Water Added Yes
      i. Date 9/4/14
      ii. Time ≈9am
2. Water surface in Lagoon
   a. Is liquid level within range of the buoy? Yes
   b. Was level sensor lowered Yes & pulled out & "exercised" sensor hook
      i. Date 9/4/14
      ii. Time ≈9am
3. Check Equipment
   a. Fence ✓
   b. Wooden instrument box ✓
   c. Solar panel ✓
   d. Battery ✓
   e. Weather proof enclosure ✓
   f. Rain gauge ✓
   g. Wind anemometer ✓
   h. Wind vane ✓
   i. Air temperature sensor and gill shield ✓
   j. Air temperature sensor ✓
   k. Water temperature sensor ✓
   l. Lagoon liquid level sensor ✓
   m. Pan liquid level sensor ✓
   n. Check air pressure in inflatable plugs (if applicable) —

Daily Log Sheet

Lagoon 2

Day 3

Date 9/5/14 Friday

Time 8:45am

1. Water surface in Pan
   a. Is water surface within three inches from the top? Yes
   b. Was Water Added Yes
      i. Date 9/5/14
      ii. Time ≈ 8:45am
2. Water surface in Lagoon
   a. Is liquid level within range of the buoy? Yes
   b. Was level sensor lowered Yes
      i. Date 9/5/14
      ii. Time ≈ 8:45am
3. Check Equipment
   a. Fence ✓
   b. Wooden instrument box ✓
   c. Solar panel ✓
   d. Battery ✓
   e. Weather proof enclosure ✓
   f. Rain gauge ✓
   g. Wind anemometer ✓
   h. Wind vane ✓
   i. Air temperature sensor and gill shield ✓
   j. Air temperature sensor ✓
   k. Water temperature sensor ✓
   l. Lagoon liquid level sensor ✓
   m. Pan liquid level sensor ✓
   n. Check air pressure in inflatable plugs (if applicable) —

Daily Log Sheet

Lagoon 2

Day 6

Date 9/8/14 Monday

Time 8:45 am

1. Water surface in Pan
   a. Is water surface within three inches from the top? Yes
   b. Was Water Added Yes
      i. Date 9/8/14
      ii. Time ≈8:45am
2. Water surface in Lagoon
   a. Is liquid level within range of the buoy? Yes
   b. Was level sensor lowered No
      i. Date ~~9/8~~ %
      ii. Time
3. Check Equipment
   a. Fence ✓
   b. Wooden instrument box ✓
   c. Solar panel ✓
   d. Battery ✓
   e. Weather proof enclosure ✓
   f. Rain gauge ✓
   g. Wind anemometer ✓
   h. Wind vane ✓
   i. Air temperature sensor and gill shield ✓
   j. Air temperature sensor ✓
   k. Water temperature sensor ✓
   l. Lagoon liquid level sensor ✓
   m. Pan liquid level sensor ✓
   n. Check air pressure in inflatable plugs (if applicable) —

Daily Log Sheet

Lagoon 2

Day 7

Date 9/9/14 Tuesday

Time 8:30 am

1. Water surface in Pan
   a. Is water surface within three inches from the top? Yes
   b. Was Water Added No
      i. Date _____
      ii. Time _____
2. Water surface in Lagoon
   a. Is liquid level within range of the buoy? Yes
   b. Was level sensor lowered No
      i. Date _____
      ii. Time _____
3. Check Equipment
   a. Fence ✓
   b. Wooden instrument box ✓
   c. Solar panel ✓
   d. Battery ✓
   e. Weather proof enclosure ✓
   f. Rain gauge ✓
   g. Wind anemometer ✓
   h. Wind vane ✓
   i. Air temperature sensor and gill shield ✓
   j. Air temperature sensor ✓
   k. Water temperature sensor ✓
   l. Lagoon liquid level sensor ✓
   m. Pan liquid level sensor ✓
   n. Check air pressure in inflatable plugs (if applicable) —

Daily Log Sheet

Lagoon 3

Day 0 Set Up

Date 9/9/14 Tuesday

Time 9 am

1. Water surface in Pan
   a. Is water surface within three inches from the top? Yes
   b. Was Water Added Set Up
      i. Date _____
      ii. Time _____

Checked Sensors
Operator to change valving to test Lagoon 3.

2. Water surface in Lagoon
   a. Is liquid level within range of the buoy? Yes
   b. Was level sensor lowered Set Up
      i. Date _____
      ii. Time _____

3. Check Equipment
   a. Fence ✓
   b. Wooden instrument box ✓
   c. Solar panel ✓
   d. Battery ✓
   e. Weather proof enclosure ✓
   f. Rain gauge ✓
   g. Wind anemometer ✓
   h. Wind vane ✓
   i. Air temperature sensor and gill shield ✓
   j. Air temperature sensor ✓
   k. Water temperature sensor ✓
   l. Lagoon liquid level sensor ✓
   m. Pan liquid level sensor ✓
   n. Check air pressure in inflatable plugs (if applicable) —

Daily Log Sheet

Lagoon 3

Day 1

Date 9/10/14 Wednesday

Time 8:45am

1. Water surface in Pan
   a. Is water surface within three inches from the top? Yes
   b. Was Water Added Yes
      i. Date 9/10/14
      ii. Time ≈ 8:45am
2. Water surface in Lagoon
   a. Is liquid level within range of the buoy? Yes
   b. Was level sensor lowered No
      i. Date
      ii. Time ≈ 9 am

Pulled Sensor Out & "Exercised" the hook & weight

3. Check Equipment
   a. Fence ✓
   b. Wooden instrument box ✓
   c. Solar panel ✓
   d. Battery ✓
   e. Weather proof enclosure ✓
   f. Rain gauge ✓
   g. Wind anemometer ✓
   h. Wind vane ✓
   i. Air temperature sensor and gill shield ✓
   j. Air temperature sensor ✓
   k. Water temperature sensor ✓
   l. Lagoon liquid level sensor ✓
   m. Pan liquid level sensor ✓
   n. Check air pressure in inflatable plugs (if applicable) —

Equipment looked wind blown.
Re Spread Fishing line & tightened the fence.

Daily Log Sheet

Lagoon 3

Day 2

Date 9/11/14

Time 8:30am

1. Water surface in Pan
   a. Is water surface within three inches from the top? Yes
   b. Was Water Added No
      i. Date _____
      ii. Time _____
2. Water surface in Lagoon
   a. Is liquid level within range of the buoy? Yes
   b. Was level sensor lowered No
      i. Date _____
      ii. Time _____
3. Check Equipment
   a. Fence ✓
   b. Wooden instrument box ✓
   c. Solar panel ✓
   d. Battery ✓
   e. Weather proof enclosure ✓
   f. Rain gauge ✓
   g. Wind anemometer ✓
   h. Wind vane ✓
   i. Air temperature sensor and gill shield ✓
   j. Air temperature sensor ✓
   k. Water temperature sensor ✓
   l. Lagoon liquid level sensor ✓
   m. Pan liquid level sensor ✓
   n. Check air pressure in inflatable plugs (if applicable) ~~✓~~

Daily Log Sheet

Lagoon 3

Day 3

Date 9/12/14

Time 8:00 am

1. Water surface in Pan
   a. Is water surface within three inches from the top? Yes
   b. Was Water Added Yes
      i. Date 9/12/14
      ii. Time ≈8 am
2. Water surface in Lagoon
   a. Is liquid level within range of the buoy? Yes
   b. Was level sensor lowered Yes
      i. Date 9/12/14
      ii. Time ≈8 am
3. Check Equipment
   a. Fence ✓
   b. Wooden instrument box ✓
   c. Solar panel ✓
   d. Battery ✓
   e. Weather proof enclosure ✓
   f. Rain gauge ✓
   g. Wind anemometer ✓
   h. Wind vane ✓
   i. Air temperature sensor and gill shield ✓
   j. Air temperature sensor ✓
   k. Water temperature sensor ✓
   l. Lagoon liquid level sensor ✓
   m. Pan liquid level sensor ✓
   n. Check air pressure in inflatable plugs (if applicable) —

Daily Log Sheet

Lagoon 3

Day 6

Date 9/15/14

Time 9:45 am

Due to valving of sensor... the sensor wasn't testing an isolated lagoon 3.

1. Water surface in Pan
   a. Is water surface within three inches from the top? Yes
   b. Was Water Added Yes
      i. Date
      ii. Time
2. Water surface in Lagoon Measured 63" below 10' mark on staff gauge
   a. Is liquid level within range of the buoy?
   b. Was level sensor lowered
      i. Date
      ii. Time

Moved sensor to other side of the weir gate in the transfer structure.

3. Check Equipment
   a. Fence ✓
   b. Wooden instrument box ✓
   c. Solar panel ✓
   d. Battery ✓
   e. Weather proof enclosure ✓
   f. Rain gauge ✓
   g. Wind anemometer ✓
   h. Wind vane ✓
   i. Air temperature sensor and gill shield ✓
   j. Air temperature sensor ✓
   k. Water temperature sensor ✓
   l. Lagoon liquid level sensor ✓
   m. Pan liquid level sensor ✓
   n. Check air pressure in inflatable plugs (if applicable) —

- Stan, Kent, Kenny helped us refigure...
- DEQ was onsite w/ Mr. Griffith in the afternoon & requested permission to take pictures

Daily Log Sheet

Lagoon 3

Day 7

Date 9/16/14

Time 8:30am

1. Water surface in Pan
   a. Is water surface within three inches from the top? Yes
   b. Was Water Added Yes
      i. Date 9/16/14
      ii. Time ~8:30am
2. Water surface in Lagoon
   a. Is liquid level within range of the buoy? Yes
   b. Was level sensor lowered Yes
      i. Date 9/16/14
      ii. Time ~8:30am
3. Check Equipment
   a. Fence ✓
   b. Wooden instrument box ✓
   c. Solar panel ✓
   d. Battery ✓
   e. Weather proof enclosure ✓
   f. Rain gauge ✓
   g. Wind anemometer ✓
   h. Wind vane ✓
   i. Air temperature sensor and gill shield ✓
   j. Air temperature sensor ✓
   k. Water temperature sensor ✓
   l. Lagoon liquid level sensor ✓
   m. Pan liquid level sensor ✓
   n. Check air pressure in inflatable plugs (if applicable) —

Daily Log Sheet

Lagoon 3

Day 9

Date 9/18/14

Time 4:15pm

1. Water surface in Pan
   a. Is water surface within three inches from the top? Yes
   b. Was Water Added Yes
      i. Date 9/18/14
      ii. Time ~4:20pm
2. Water surface in Lagoon
   a. Is liquid level within range of the buoy? Yes
   b. Was level sensor lowered Yes
      i. Date 9/18/14
      ii. Time ~4:20pm
3. Check Equipment
   a. Fence ✓
   b. Wooden instrument box ✓
   c. Solar panel ✓
   d. Battery ✓
   e. Weather proof enclosure ✓
   f. Rain gauge ✓
   g. Wind anemometer ✓
   h. Wind vane ✓
   i. Air temperature sensor and gill shield ✓
   j. Air temperature sensor ✓
   k. Water temperature sensor ✓
   l. Lagoon liquid level sensor ✓
   m. Pan liquid level sensor ✓
   n. Check air pressure in inflatable plugs (if applicable) —

Strung more fishing line & flourescent flagging for bird protection maintenance.

Daily Log Sheet

Lagoon 3

Day 13

Date 9/22/14

Time 7:30 am

1. Water surface in Pan
   a. Is water surface within three inches from the top? Yes
   b. Was Water Added No
      i. Date _____
      ii. Time _____
2. Water surface in Lagoon
   a. Is liquid level within range of the buoy? Yes
   b. Was level sensor lowered No
      i. Date _____
      ii. Time _____
3. Check Equipment
   a. Fence ✓
   b. Wooden instrument box ✓
   c. Solar panel ✓
   d. Battery ✓
   e. Weather proof enclosure ✓
   f. Rain gauge ✓
   g. Wind anemometer ✓
   h. Wind vane ✓
   i. Air temperature sensor and gill shield ✓
   j. Air temperature sensor ✓
   k. Water temperature sensor ✓
   l. Lagoon liquid level sensor ✓
   m. Pan liquid level sensor ✓
   n. Check air pressure in inflatable plugs (if applicable) —

Took down equipment.

Appendix C

DEQ Seepage Calculation Spreadsheets

See Enclosed Compact Disc Containing Electronic Excel Spreadsheets