Warden Hutterian Brethren Headquarters Wastewater System Warden, Washington

Engineering Report

For the Permitting of an Existing Center Pivot Irrigation System for Land Treatment

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1 Introduction

The Warden Hutterian Brethren (WHB) own and operate a simple community wastewater system. Wastewater is collected and flows by gravity to a community septic tank. Septic tank effluent flows by gravity to a two-cell lagoon system for facultative treatment, storage and evaporation. The evaporation lagoons were constructed next to a center pivot irrigated pasture with the intent of increasing the capacity of the wastewater system by means of irrigating the pasture land for effluent disposal via land treatment. In recent years, the WHB community has been pushing the evaporative limit of the lagoons and therefore need to increase effluent disposal capacity. The WHB intend to irrigate lagoon effluent wastewater on the pasture land and therefore need a Land Treatment Permit.

Implementation of the WHB's plan will not require the construction any new facilities or unit processes since the needed infrastructure was constructed initially. A few minor improvements will be needed; such as, outfitting pumps, retrofitting the existing center pivot irrigation equipment, updating O&M manuals and starting a monitoring program.

1.1 General

The land treatment of wastewater uses the physical, chemical and microbial properties of the soil and vegetation to remove contaminants from the applied wastewater. The upper soil-plant zone is used to stabilize, transform, or immobilize wastewater constituents and support crop growth, leading to an environmentally acceptable assimilation of the water. When proper design principles are used, land treatment by irrigation is a desirable method of wastewater treatment.

This Engineering Report is for the WHB Headquarters Wastewater System, located near Warden, Washington between Moses Lake, Washington and Ritzville, Washington. This report outlines the proposed implementation of land treatment by pasture irrigation from an existing wastewater evaporative lagoon facility.

1.2 Facility History

Prior to 2009, the WHB Headquarters wastewater system consisted of two unlined facultative lagoons constructed in the 1980's with a gravity flow collection system.

J-U-B ENGINEERS, Inc. (J-U-B) was retained in 2009 to replace the previous facility in order to increase capacity, improve environmental performance and move the facility away from living areas. Improvements in 2011 included the construction of a new two-cell, double lined facultative/evaporation lagoon system to replace the unlined lagoons. A new septic tank, transfer structure, and wetwell were constructed in addition to site grading, fencing, and drainage improvements. The operating capacity of the two-cell lagoon liner system is approximately 6.4 million gallons per year.

The proposed improvements will allow effluent disposal via land treatment by irrigating nearby pasture land. Necessary modifications to the existing facility include retrofitting an existing irrigation pivot with piping and drag tubes and the lagoon effluent vault with a pump to apply wastewater for land treatment by irrigation. This transition to land treatment irrigation effort will increase capacity, supplement the existing evaporative functions of the wastewater facility and provide operational flexibility of the wastewater facility.

Additionally, the proposed improvements will provide nutrient benefit to the grazing field through the land treatment of the lagoon wastewater.

2 General Design Considerations

This chapter discusses the general design considerations for the proposed land treatment system.

2.1 General

This chapter presents some of the design elements considered for the proposed land treatment system at the WHB Headquarters near Warden, Washington. The region between Moses Lake and Ritzville, which includes WHB Headquarters, is primarily used for agricultural purposes.

2.2 Climate Data

The climate data used to design the site and the initial irrigation plan are shown in Table 2-1 through Table 2-4. The average high temperature for the area is 61 degrees F, with an average low of 36 degrees F. Average precipitation was recorded at approximately 11.3 inches per year for Ritzville, Washington. Pan evaporation rates average 51 inches per year. Average wind speed is 7 miles per hour (mph), with average of 20 mph.

Table 2-1 General Climate Summary, Temperature (Ritzville, WA)

	Monthly Averages, degrees F		
	Max.	**Min.**	**Mean**
January	34.1	21.1	27.6
February	41	25.3	33.2
March	51.1	30	40.5
April	60.9	34.3	47.6
May	69.9	40.7	55.3
June	77.7	47.1	62.4
July	87.6	52.9	70.2
August	86.2	52.2	69.2
September	76.7	45.5	61.1
October	62.6	36.4	49.5
November	45	28.6	36.8
December	35.6	23.2	29.4

Table 2-2 General Climate Summary, Precipitation (Ritzville, WA)

	Mean, in.
January	1.37
February	1.09
March	1.01
April	0.81
May	0.9
June	0.81
July	0.34
August	0.38
September	0.52
October	0.92
November	1.54
December	1.66
Annual	11.34

Table 2-3 Pan Evaporation (Othello, WA)

	Pan Evaporation, in.
January	0
February	0
March	0
April	5.4
May	7.6
June	9
July	10.77
August	9.14
September	6.12
October	2.92
November	0
December	0
Year	50.95

Table 2-4 Wind Climate Data (Moses Lake, WA)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Daily Avg Wind Speed	6.3	6.9	8	8	8.3	8.4	7.6	7	6.8	6.8	6.3	5.9
Daily Avg Max 2-Min	14.4	15.3	18.6	18.5	19.4	19.1	17.1	16.4	15.8	15.7	14.4	14
Daily Avg Peak Gust	17	18.3	22.5	22.8	23.9	23.6	21.3	20	19.3	19.1	17.2	16.6
Maximum Daily Avg	20.6	20.6	21.1	19.1	17.6	17.1	16.1	17.3	21.1	19.5	20.8	20.5
Maximum 2-Minute Avg	44	41	54	46	40	36	37	41	37	41	44	43

2.3 Topography

The site is generally flat with gentle slopes less than 5 percent across the existing irrigation site, encompassing 23.9 acres. This site is an established agricultural and cattle grazing area, with repeat harvesting cycles through the year, with an existing, operating irrigation pivot.

2.4 Soils

The land treatment site primarily contains Shano silt loam, with varying slopes in the surrounding area. This area is an established agricultural and livestock grazing area and is well suited for crop production for harvest and/or pasture.

Soil quality sample testing results are discussed in Section 3.5.

2.5 Crops and Grazing

The WHB currently grows forage pasture grasses for the purposes of livestock grazing within the proposed land treatment site. The proposed land treatment site is currently being irrigated with groundwater and fertilized with chemical nitrogen, phosphorus, and other essential nutrients as needed for crop yields.

With the proposed land treatment, the field will continue to be used to grow pasture grasses and used for livestock grazing; however, nutrients will be limited to agronomic rates for nitrogen and water. The crop will be harvested if the grazing demand is less than the supply of forage pasture grasses.

Annual nitrogen application on irrigated pasture orchard grasses can range between 250 and 350 pounds per acre (lb/ac)[1]. However, 250 lb/ac is higher than the recommended loading for seasonal pasture of 75 lb/ac[2]. Therefore, the initial land treatment site allowable nitrogen load will be limited to ~75 lb/ac. Should tissue samples and/or soil samples indicate an abundance or shortage of plant available nitrogen, loading rates may be adjusted.

[1] Kugler, J.l., (2006) Orchardgrass Hay Production Guide for the Columbia Basin of Washington, Washington State University Extension

[2] Kellogg, R.L., *etal*, (2000) Manure Nutrients Relative to the Capacity of Cropland and Pastureland to Assimilate Nutrients, USDA. Publication No. nps00-0579.

Should the nutrient limit be met before the hydraulic demand is satisfied, supplemental irrigation will be provided from the groundwater well supply. Should the hydraulic demand routinely be met before the nutrient demand (as provided by the wastewater), chemical fertilizer will be carefully applied up to agronomic rates to ensure adequate crop yield and crop survival.

The proposed irrigation plan will restrict access for grazing in the field during active irrigation operations and resume livestock grazing after evaporation or absorption of the irrigated wastewater. There are existing fences that will be used to keep the livestock separated from the areas being actively irrigated with wastewater. Concerns over soil compaction can be mitigated by tilling and replanting the pasture as the site is accessible, arable, and farmable.

2.6 Wetlands

There are no current wetlands within or adjacent to the proposed land treatment site.

The decommissioned unlined facultative lagoons were located approximately 700 feet from the center of the proposed irrigation pivot. The National Wetland Inventory classifies this area as a “freshwater pond”, approximately 0.55 acres in size. The decommissioned lagoons have not been used since 2011 and the area was restored to agricultural land after the new lined lagoon system was constructed.

2.7 Land Use

Adams County identifies the WHB Headquarters as a Rural Settlement, surrounded by Prime Agriculture land. The land treatment site is located within Prime Agriculture land, approximately 750 feet from the closest residence within the Rural Settlement zone.

2.8 Land Ownership/Agreements

The land is owned and operated by the WHB (Adams County parcel 2831080330001). The irrigation pivots and agricultural land on site are owned and operated by the WHB. No additional covenants or agreements are in place for the proposed land treatment site.

The possible edges of the proposed land treatment area are within 100 and 150 feet of neighboring parcels. Drag tubes are planned for effluent application, to eliminate aerosols and drift into public roadways and adjacent properties.

2.9 Treatment Processes Prior to Land Treatment

Treatment prior to land treatment is as follows:

- Primary treatment is provided by septic tanks (solids separation and solids decomposition).
- Secondary biological treatment is provided by a facultative lagoon.
- Secondary solids settling is provided by a lagoon which also serves as a storage lagoon.

Wastewater drawn for land treatment will be pumped from an existing irrigation vault to the nearby irrigation pivot with a new pump and controls. A new flow meter will measure the amount of water discharged to the nearby irrigation pivot.

No additional treatment of the wastewater is anticipated, as the nutrients in the water will be used for crop application and the soil will act as a treatment process.

No disinfection is proposed at this time. Disinfection requirements are proposed to be waived by meeting the following operational conditions:

- Low trajectory irrigation methods (drag tubes) that mitigate public health concerns.
- Limiting wastewater treatment application to appropriate periods to mitigate public health concerns.
- Site buffers that mitigate the potential exposure to aerosols.

2.10 Impoundments

The facility has two impoundments; the treatment lagoon and settling/storage lagoon.

The two-cell lagoon system holds approximately 6.4 million gallons of wastewater when at capacity. The two-cell lagoon system will store and evaporate the wastewater between irrigation land treatment seasons. The lagoons have an emergency overflow channel to control and direct the water flow in the case of an overflow emergency.

2.11 Monitoring

Monitoring will be implemented at the wastewater lagoons and land treatment site to record facility operations, document effluent variables, monitor treatment effectiveness, evaluate soil and crop treatment effectiveness, and determine compliance to water quality standards. Monitoring will be in accordance with the permit, which could require the following (Table 2-5):

Table 2-5 Possible Monitoring Elements

Wastewater Applied	Land Treatment Site:	Ground Water
Flow Temperature Conductivity pH BOD5 or COD TDS Nitrogen, Nitrate/Nitrite Total Kjeldahl Nitrogen Chloride	Exchangeable Sodium Percentage of Cation Exchange Capacity Cation Exchange Capacity Sodium Potassium Calcium Magnesium Other Cations	Water level Temperature Conductivity pH Nitrate (as N)

Pollutant assimilative capacity and design limiting constituents are discussed later in the text.

Future wastewater and soil monitoring schedules and criteria are discussed in Section 3.8. Due to the depth to groundwater (several hundred feet and the distance to the nearest well (over 2,000 feet), additional testing of the potable, raw water source will not be required.

2.12 System Operations

The current wastewater lagoons operation is documented in the 2011 Operation and Maintenance (O&M) Manual. Generally, the septic tank is pumped of sludge twice per year. The lagoon embankment is inspected regularly for distresses or other problems that need to be addressed. Flow readings for wastewater going into the lagoons are read monthly.

With the proposed improvements, the leading components will be operated much the same way with increased monitoring per the expected permit. The irrigation pivot will be fitted with separate irrigation lines, so that potable groundwater and wastewater can be kept separate and both can be used for irrigation. The wastewater will be applied by drag tubes in order to eliminate aerosols. The wastewater irrigation is proposed to be applied within the inner 400 foot radius of the irrigation pivot (approximately 9.2 acres), providing a 240 foot buffer to the edge of the existing field. Flow readings to the irrigation spray farm will be taken monthly for both sources, at the same time the inflow data is recorded.

Signs will be placed along the public roadway and private roadways to indicate the use of wastewater for irrigation in the field, with instructions for residents to not use the field for recreation.

Livestock grazing will be restricted to several days after land treatment of the field, in order to protect the field from over compaction.

2.13 Emergency Plans

The 2011 O&M Manual outlines emergency actions for the lagoon facility system. Generally, flow is directed into the northerly lagoon, then flows to the southerly lagoon. Valving is available to direct the flow after the meter into the southerly lagoon if the northerly lagoon is inoperable. An overflow spillway is only to be used in an absolute emergency when the integrity of the entire lagoon system is in jeopardy and no other alternatives for maintaining impoundment is available.

With the proposed improvements, if there are problems with the wastewater irrigation system, the discharge to the field will cease until corrective action can be taken.

Although drag tubes mitigate the concern associated with aerosols, the operator will shut off irrigation of the wastewater if a leak causes wastewater to spray in a mist or aerosolize. This will reduce the likelihood of exposing the public or adjacent parcels to the wastewater.

3 Evaluation of Proposed Land Treatment Site

This chapter discusses the proposed land treatment processes and an evaluation of the impacts.

3.1 Project Summary

This project includes the land treatment of wastewater to pasture crops at the WHB Headquarters. The WHB Headquarters wastewater system is managed by Paul Wollman (ph. 509-349-8405). The WHB Headquarters is a mix of agriculture, maintenance, and woodworking facility, located at 1054 W. Harder Road in Warden, Adams County, Washington (Section 8, Township 18N, Range 31E, Willamette Meridian).

The proposed improvements include retrofitting an existing irrigation pivot to provide separate lines for the application of either groundwater well supply and/or lagoon effluent. Proposed improvements also include a new manhole to draw wastewater from lagoon 2 (southern lagoon) for irrigation purposes. This irrigation effort will be used to supplement the existing evaporative functions of the wastewater facility and provide operational flexibility to the capacity of their wastewater facility and provide nutrient benefit to the grazing field.

3.2 Wastewater Sources

The WHB Headwaters wastewater system treats residential/commercial wastewater from the headquarters site. Approximately 106 residents are on site, which includes 28 teachers and students. Sources of wastewater within the headquarters are summarized in Table 3-1. Mean average flow rate was 13,193 gallons per day (gpd) in 2016 and 14,644 gpd in 2017. The flow meter readings are taken monthly, with variable number of days between readings. Flow data from 2016 and 2017 are shown in Table 3-2.

Table 3-1 Summary of Wastewater Sources, Warden Hutterian Brethren Headquarters

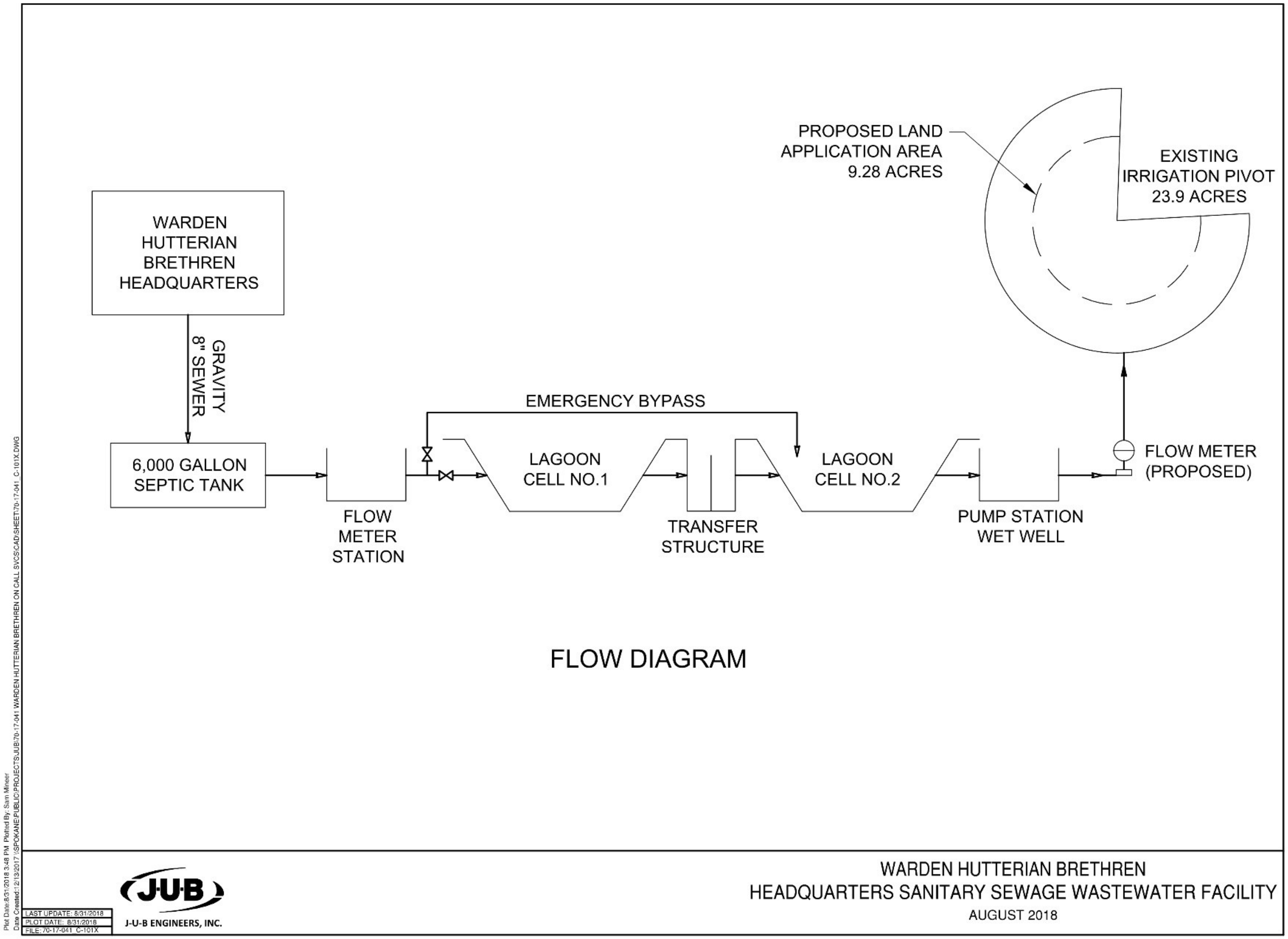
Wastewater Source	Percentage
Residential Units	39%
Cooling for Refrigeration	32%
Central Laundry	10%
Central Kitchen	9%
Central Canning Facility	3%
School	3%
Agricultural Shop	1%
Livestock Barn	1%
Woodworking Shop	1%
Offices	Less than 1%

Table 3-2 Wastewater Flow Data, Flow Meter Station at Evaporative Lagoons

	Meter Reading Date	Meter Reading, gallons	Difference, gallons	Days between meter readings	Gallons/day (calculated)
2016	January 30, 2016	363,668	363,668	30	12,122
	April 28, 2016	1,505,682	1,142,014	89	12,832
	May 24, 2016	1,819,474	313,792	26	12,069
	June 15, 2016	2,192,476	373,002	22	16,955
	July 23, 2016	2,537,895	345,419	38	9,090
	November 4, 2016	3,297,929	760,034	104	7,308
	December 3, 2016	3,935,205	637,276	29	21,975
				2016 Mean	13,193
2017	February 22, 2017	843,717	843,717	81	10,416
	April 7, 2017	1,306,850	463,133	44	10,526
	May 8, 2017	1,622,975	316,125	31	10,198
	August 1, 2017	2,719,053	1,096,078	85	12,895
	August 26, 2017	3,188,515	469,462	25	18,778
	October 5, 2017	3,948,465	759,950	40	18,999
	October 28, 2017	4,375,591	427,126	23	18,571
	November 30, 2017	4,896,846	521,255	33	15,796
	January 2, 2018	5,412,204	515,358	33	15,617
				2017 Mean	14,644

A schematic of the wastewater facility is illustrated in Figure 3-1. Wastewater from these facilities are collected through the gravity sewer system, pass through the 6,000 gallon septic tank and through the flow meter station into the two cell evaporative lagoon system.

Figure 3-1 WHB Headquaters Wastewater Facility Schematic



3.3 Wastewater Treatment Processes

Wastewater collected from the WHB headquarters is transmitted through piping to their two-cell 6.4 million gallon evaporative lagoon system, located on the easterly edge of the property. The northerly lagoon cell (#1) holds approximately 2.1 million gallons at 5.25 foot depth. The southerly lagoon cell (#2) holds approximately 4.3 million gallons at 6.95 foot depth. This facility was constructed in 2011 to replace a smaller evaporative lagoon system. Raw wastewater from the community enters the system from a single 8" gravity flow conveyance pipe at the inlet manhole and flows through the treatment processes under gravity. Following the inlet manhole is a two compartment 6,000 gallon concrete septic tank. This tank retains floatable debris and settle solids, thereby providing primary treatment before wastewater passes through the trapezoidal flow meter flume. After passing through the flow meter flume, the wastewater is directed into the lagoon cells for facultative biological treatment processes, solids separation and storage for eventual disposal via evaporation and land treatment. The lagoons store the wastewater during seasons where the inflow exceeds the evaporative processes and irrigation demand. The proposed land treatment system will be used to increase the capacity of the lagoons, offer management flexibility and preserve the integrity of the lagoon structure.

As shown in Table 3-2, the mean flow to the evaporative lagoons has been around 14,600 gpd. Historical data illustrates some seasonal variation, with higher flows recorded during the fall in 2017.

Currently, the only effluent disposal is by evaporation from the lagoons. The net evaporative rate (Precipitation minus Evaporation) of the lagoons is estimated to be approximately 2,160,000 gallons per year (5,900 gpd). Table 3-3 summarized the net evaporative rate calculations.

The proposed improvements will include retrofitting the existing irrigation pivot with piping and drag tubes for water from the lagoons to be pumped for land treatment. The existing effluent vault will be upgraded with a pump and flow meter to monitor the land treatment activities. The existing irrigation pivot will continue to have a separate dedicated irrigation water supply line for irrigation when wastewater from the lagoons is not available for land treatment.

Table 3-3 Net Evaporative Rate Analysis

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
AVG PAN EVAP (IN)				5.4	7.6	9.0	10.8	9.1	6.1	2.9			50.9
AVG PRECIP (IN)	1.4	1.1	1.0	0.8	0.9	0.8	0.3	0.4	0.5	0.9	1.5	1.7	11.3
MONTHLY AVE. TEMP. (F)	29.4	33.2	40.5	47.6	55.3	62.4	70.2	69.2	69.2	49.5	36.8	29.4	
PAN COEFFICIENT		1.0	0.9	0.8	0.8	0.7	0.6	0.6	0.6	0.8	0.9		
POND EVAP (IN)				4.5	5.8	6.3	6.8	5.8	3.9	2.4			35.5
LAGOON AREA, CATCHMENT (AC)	4.07	4.07	4.07	4.07	4.07	4.07	4.07	4.07	4.07	4.07	4.07	4.07	
EVAPORATION AREA (AC)	3.7	3.9	4.0	4.1	3.9	3.6	3.3	3.2	3.2	3.2	3.3	3.5	
EVAPORATION VOL (MG)				0.5	0.6	0.6	0.6	0.5	0.3	0.2			3.3
PRECIPITATION (IN)	1.4	1.1	1.0	0.8	0.9	0.8	0.3	0.4	0.5	0.9	1.5	1.7	11.3
PRECIPITATION VOL (MG)	0.15	0.12	0.11	0.09	0.10	0.09	0.04	0.04	0.06	0.10	0.17	0.18	1.25
Net Gain (PRECIP.- EVAP.) (MG)	0.152	0.121	0.112	-0.413	-0.518	-0.535	-0.574	-0.464	-0.282	-0.107	0.170	0.184	-2.154

3.4 Water Quality Data

Water quality sampling was first conducted in March 2018 to establish a baseline of wastewater quality. Samples were taken at the influent flow meter and from the second lagoon. The lagoon system has been evaporating water for many years; therefore, the dissolved solids in the ponds are high. As land treatment operations begin, the dissolved solids in the lagoon is expected to reduce. Water quality results from the March 2018 sampling are summarized in Table 3-4 and Table 3-5 (lab results included in Appendix A).

Table 3-4 Results of Influent Water Quality Sampling

	Method	MDL	PQL	Units	Result
Electrical Conductivity	SM 2510 B	0.03	0.12	micro-S	1144
Total Kjeldahl Nitrogen (TKN)	SM 4500 Norg	0.07	2.80	mg/L	60
Total Dissolved Solids (TDS)	Sm 2540 CD	1.00	4.00	mg/L	702
Fixed Dissolved Solids (FDS)	SM 2540 CD	1.00	4.00	mg/L	507
Total Suspended Solids (TSS)	SM 2540 CD	1.00	4.00	mg/L	99
BOD-5	SM 5210 B	0.50	2.00	mg/L	291
Fecal Coliform	SM 9222 D/MF		10.00	CFU/100mL	>200000

Table 3-5 Results of Pond Water Quality Sampling

	Method	MDL	PQL	Units	Result
Electrical Conductivity	SM 2510 B	0.03	0.12	micro-S	2990
Total Kjeldahl Nitrogen (TKN)	SM 4500 Norg	0.07	2.80	mg/L	12.6
Total Dissolved Solids (TDS)	Sm 2540 CD	1.00	4.00	mg/L	2150
Fixed Dissolved Solids (FDS)	SM 2540 CD	1.00	4.00	mg/L	1950
Total Suspended Solids (TSS)	SM 2540 CD	1.00	4.00	mg/L	27
BOD-5	SM 5210 B	0.50	2.00	mg/L	47
Fecal Coliform	SM 9222 D/MF		10.00	CFU/100mL	38900

3.5 Soil Quality Data

The proposed land treatment site is high quality agricultural land ideally suited to grow fodder/grass crops as well as many other crops. The field soils were recently sampled and the results are shown in Table 3-6 (lab results in Appendix B). Hydraulic, nutrient, and organic loadings are discussed in Section 3.7.

Table 3-6 Results of Soil Quality Sampling

SAMPLE DEPTH	1FT	2FT	5FT
LAB NO	3318	3319	3320
NO3-N mg/kg	5.3	4	4.1
E.C. mmhos/cm	0.36	0.59	0.67
SOLUBLE SALTS mmhos/cm	0.9	1.53	1.74
TOTAL N mg/kg	790	582	373
Na mg/kg	2.63	3.09	1.72
CEC meq/100g	11.2	11.6	8.6
ESP %	23.4	26.7	20
Ca meq/L	0.72	2.43	1.85
Mg meq/L	0.33	0.9	3.51
Na meq/L	6.28	14.61	10.07
SAR	8.67	11.32	6.15
MOISTURE %	18.5	13.5	13.1

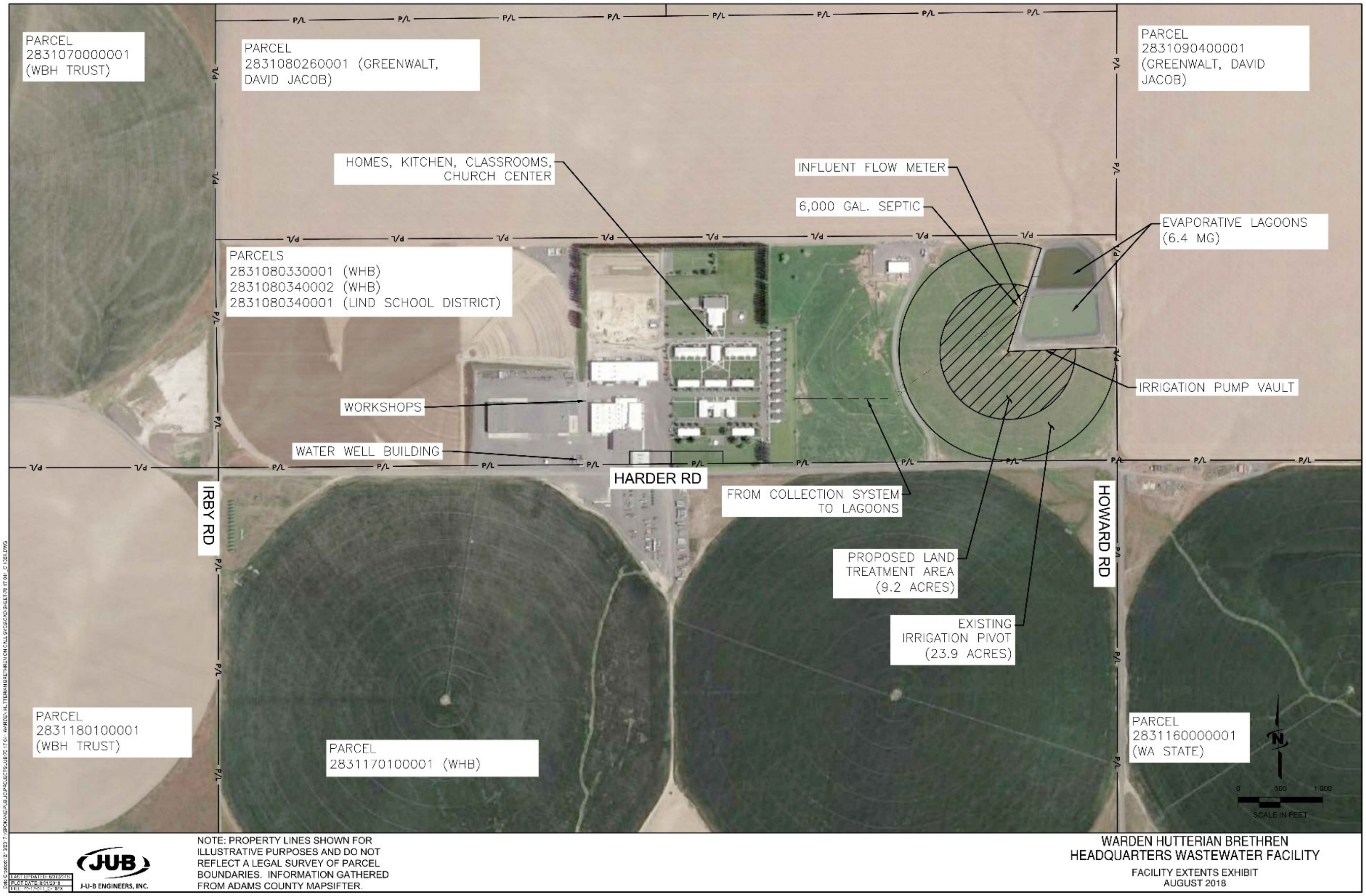
3.6 Site Description

The proposed land treatment site is on the easterly edge of the WHB property, shown in Figure 3-2. The irrigation pivot operates in a 290-degree swing arc and is approximately 600 feet long. Average slopes on the land treatment site vary from flat to approximately 5-percent slope, generally sloping to the south. The soils are primarily Shano silt loam.

The planned crop for this irrigation pivot includes various grasses for pasture. Livestock grazing will continue within the proposed land treatment site. Excess grazing crop will be harvested for winter storage when the grazing demand is less than the supply of forage pasture grasses.

The nearest water supply is located approximately 2,000 feet from the edge of the irrigation pivot. This well supplies water to the WHB community (Well Tag ALF246, Water System ID 92829). The depth to first open interval for this well is 560 feet and the water level is known to be several hundred feet below ground surface.

Figure 3-2 Site Layout and Description of Land Treatment Site



3.7 Irrigation Management Plan

An initial irrigation and crop management plan was created using Western Regional Climate Center data and US Bureau of Reclamation AgriMet data.

The data for precipitation, evaporation, temperature and irrigation deficit (pasture) are summarized in the Table 3-7.

Table 3-7 Irrigation Demand Analysis

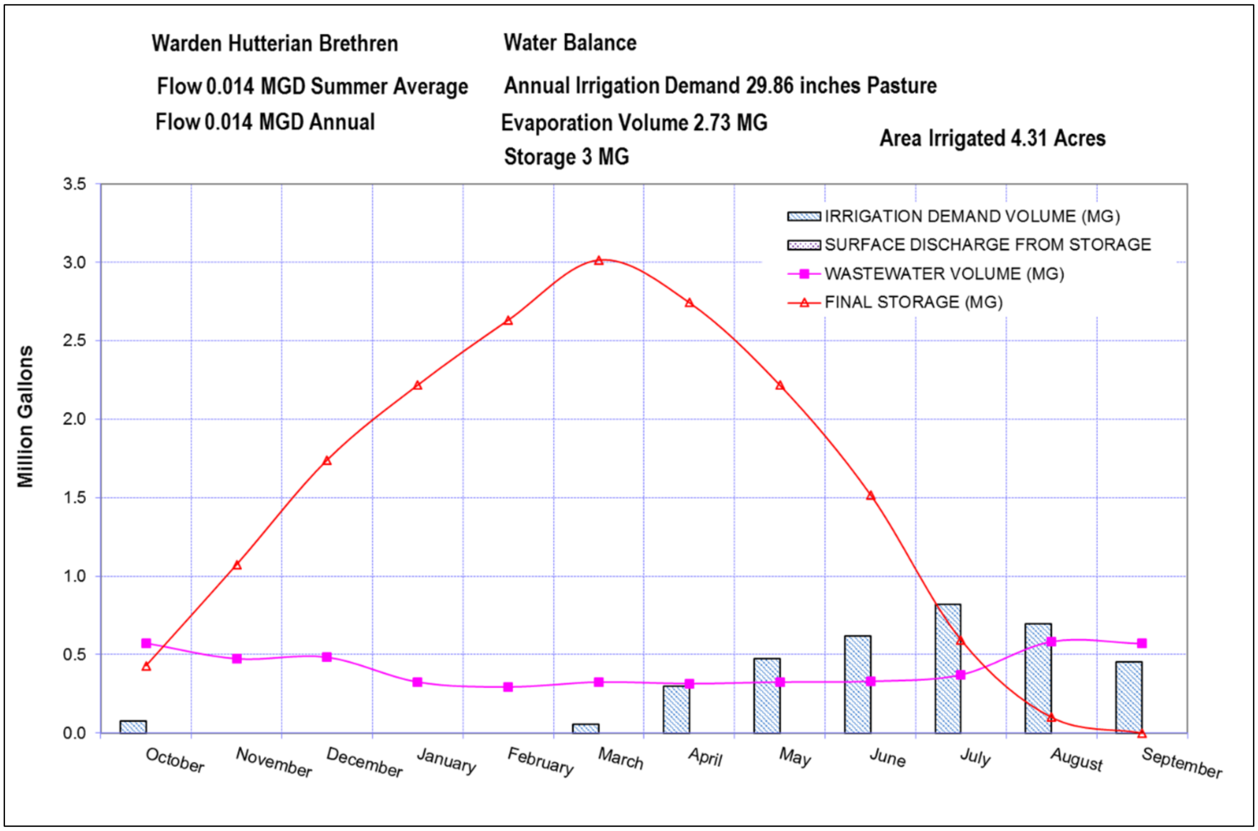
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	TOTAL
AVG PRECIP (IN)	1.4	1.1	1.0	0.8	0.9	0.8	0.3	0.4	0.5	0.9	1.5	1.7	11.3
AVG PAN EVAP (IN)	0	0	0	5.4	7.6	9.0	10.8	9.1	6.1	2.9	0	0	50.9
MONTHLY AVE. TEMP. (F)	29.4	33.2	40.5	47.6	55.3	62.4	70.2	69.2	69.2	49.5	36.8	29.4	
IRRIGATION DEMAND (IN)	0	0	0.58	3.21	5.08	6.58	8.75	7.44	4.85	0.83	0	0	37.32

The environmental data and irrigation deficit data were used in a water balance to estimate the number of acres needed for land treatment. As a factor of safety, the irrigating demand and the evaporation rate were reduced 20% and the irrigation efficiency was set to 100%. WHB can hydraulically manage the current annual flow of ~5 million gallons on approximately 4.5 acres of pasture land as depicted in the water balance chart shown in Figure 3-3.

However, with a total nitrogen concentration near 15 mg/l, the annual nitrogen load would be 145 pounds per acre per year if irrigation demand is met with 100% wastewater. This is higher than the recommended loading for seasonal pasture of 75 pounds per acre[3]. Therefore, the land treatment area will have to be at least 8.5 acres in size with about 3.5 million gallons of supplemental irrigation. The proposed land treatment area is 9.2 acres (400 feet radius from center of irrigation pivot).

[3] Kellogg, R.L., *etal*, (2000) Manure Nutrients Relative to the Capacity of Cropland and Pastureland to Assimilate Nutrients, USDA. Publication No. nps00-0579.

Figure 3-3 Water Balance Analysis for Irrigation Loading



The proposed land treatment will allow the WHB community to maintain a reasonable level in their evaporative ponds and to supplement water treatment by land when evaporation is unable to handle the influent.

The proposed irrigation plan will restrict access for grazing in the field during irrigation operations and resume livestock grazing after evaporation or absorption of the irrigated wastewater. Concerns over soil compaction can be mitigated by tilling and replanting the pasture as the site is accessible, arable, and farmable.

The organic loading is expected to be less than 5 pounds per acre pre day based on the maximum expected daily irrigation rate of 0.4 inches per day and the expected BOD_5 concentration of 50 mg/l.

3.8 Monitoring Plan

Water quality and soil characteristics will be monitored as wastewater is applied to the crop. During an recent emergency land application from the lagoons (approved by Ecology), it was observed that the resulting pasture grass flourished from the nutrients from the lagoons. It is anticipated that the pasture grass will continue to flourish from the nutrients. If the pasture grass is observed to be adversely affected by the lagoon water, then irrigation water will be applied. The WHB will be prepared to mitigate negative effects from the wastewater as they are identified. For example, if the salt content is too high, then lime or gypsum can be tilled into the ground to break down the salts. Other in-line injection treatment methods can also be investigated to treat the effluent before it reaches the irrigation pivot.

Water quality testing, as expected in the permit, include the constituents listed in Table 3-8. Water will be sampled from the lagoon effluent line. A flow monitor will record the volume of wastewater used for irrigation. Water quality samples will be collected.

Table 3-8 Irrigated Wastewater Effluent Water Quality Sampling

Parameter	Units & Speciation	Minimum Sampling Frequency	Sampling Type
Flow (Daily Average and Max)	GPD	Continuous	Metered
Application/Loading Rate	inches/ month; inches/year	Recorded	Calculated
Total Water Irrigated Volume	gallons/month and million gallons per year	Recorded	Calculated
BOD-5	mg/L	1/month	Grab or composite
BOD-5	lbs/day	1/month	Calculated
BOD-5	% removal	1/month	Calculated
TSS	mg/L	1/month	Grab or composite
TSS	lbs/day	1/month	Calculated
TSS	% removal	1/month	Calculated
Fecal Coliform	#Organisms /100 mL	1/month	Grab
Total Kjeldahl Nitrogen (TKN)	mg/L as N	1/month	Grab
TKN	lbs/acre	1/month	Calculated
TKN (cumulative)	lbs/acre/year	Recorded	Calculated
Fixed Dissolved Solids (FDS)	mg/L	1/month	Grab or 24-Hour Composite
FDS	lbs/acre	1/month	Calculated
FDS (cumulative)	lbs/acre/year	Recorded	Calculated
Electric Conductivity	millimhos/cm	1/month	Grab

Soil testing will include the constituents listed in Table 3-9, as well as the following instructions:

1. Monitor once per year at the end of the growing season, at a time that best represents crop soil conditions.
2. Locate sampling sites so they represent each land treatment site or as identified in the crop management plan.
3. If possible, locate sampling sites in the same vicinity each year.
4. Test soil at each sampling site at the required depth increments as defined in the table below or until auger refusal.
5. Each depth sample must have a minimum of four (4) core samples, and the samples at that depth may be combined into one composite sample for that depth.
6. Submit results annually with the annual Irrigation and Crop Management Plan.

Table 3-9 Soil Testing Parameters

Parameter	Units & Speciation	Sample Point	Depth Increments [a]
Sodium Adsorption Ratio (SAR)	unitless	Each field	1, 2, 5
Exchangeable Sodium Percentage	%	Each field	1, 2, 5
Moisture Content	%	Each field	1, 2, 5
Total Kjeldahl Nitrogen (TKN)	mg/Kg as N	Each field	1, 2, 5
Nitrate - Nitrite(as N)	mg/Kg as N	Each field	1, 2, 5
Soluble Salts	mg/L	Each field	1, 2, 5

[a] Sample ID	Depth increment (inches) for composite samples:
1	0 -12 inches below ground surface
2	12-24 inches below ground surface
3	24-36 inches below ground surface
4	36-48 inches below ground surface
5	48-60 inches below ground surface

Due to the depth to groundwater (several hundred feet and the distance to the nearest well (over 2,000 feet), additional testing of the raw water source will not be required.

3.9 Adjacent Land and Land Uses

The current land use is agricultural. The residential community within the WHB Headquarters is located approximately 600 feet from the edge of the irrigation pivot. Adjacent land uses are also agricultural, located between 100 and 150 feet from the proposed land treatment area.

3.10 Site Geology and Regional Hydrogeology

The site is primarily agricultural, with Shano silt loam, with a maximum slope of 5% for the area (Section 2.4). Annual precipitation in the region is 11.34 inches (Table 2-2). The depth to ground water is several hundred feet. The WHB Headquarters is located with Water Resource Inventory Area 41, Lower Crab watershed.

APPENDIX A

Wastewater Quality Test Results

soiltest farm consultants, inc.
2925 Driggs Dr., Moses Lake, Wa 98837 · www.soiltestlab.com
Office: (509)765-1622 · Fax:(509)765-0314 · (800)764-1622

WATER ANALYSIS

Lab Number: W18-01297
Sampler: AO
Date Received: *3/21/2018*
Date Reported *4/5/2018*
Date Sampled: *3/21/2018*

WARDEN HUTTERIAN BRETHERN
ATTN: ELI WOOLMAN JR
WARDEN , WA 98857

Field Sample I.D.
INFLUENT

	Method	MDL	PQL	Units	Result
Electrical Conductivity	SM 2510 B	0.03	0.12	µS	**1144**
Total Kjeldahl Nitrogen (TKN)	SM 4500 Norg	0.70	2.80	mg/L	**60.0**
Total Dissolved Solids (TDS)	SM 2540 CD	1.00	4.00	mg/L	**702**
Fixed Dissolved Solids (FDS)	SM 2540 CD	1.00	4.00	mg/L	**507**
Total Suspended Solids (TSS)	SM 2540 CD	1.00	4.00	mg/L	**99**
BOD-5	SM 5210 B	0.50	2.00	mg/L	**291**

Note: "u" indicates that the element was analyzed for but not detected

ALL LABORATORY TESTING COMPLIES WITH THE PROVISIONS SET FORTH IN CHAPTER 173-50 WAC. DOE ACCREDITATION #C157

This is your Invoice W18-01297 Account #: 320600 Reviewed by: KEB List Cost:

soiltest farm consultants, inc.
2925 Driggs Dr., Moses Lake, Wa 98837 - www.soiltestlab.com
Office: (509)765-1622 - Fax:(509)765-0314 - (800)764-1622

WATER ANALYSIS

Lab Number: W18-01298
Sampler: AO
Date Received: *3/21/2018*
Date Reported *4/5/2018*
Date Sampled: *3/21/2018*

WARDEN HUTTERIAN BRETHERN
ATTN: ELI WOOLMAN JR
WARDEN , WA 98857

Field Sample I.D.
POND

	Method	MDL	PQL	Units	Result
Electrical Conductivity	SM 2510 B	0.03	0.12	µS	**2990**
Total Kjeldahl Nitrogen (TKN)	SM 4500 Norg	0.70	2.80	mg/L	**12.6**
Total Dissolved Solids (TDS)	SM 2540 CD	1.00	4.00	mg/L	**2150**
Fixed Dissolved Solids (FDS)	SM 2540 CD	1.00	4.00	mg/L	**1950**
Total Suspended Solids (TSS)	SM 2540 CD	1.00	4.00	mg/L	**27**
BOD-5	SM 5210 B	0.50	2.00	mg/L	**47**

Note: "u" indicates that the element was analyzed for but not detected

ALL LABORATORY TESTING COMPLIES WITH THE PROVISIONS SET FORTH IN CHAPTER 173-50 WAC. DOE ACCREDITATION #C157

This is your Invoice W18-01298 Account #: 320600 Reviewed by: KEB List Cost:

EDGE ANALYTICAL

Burlington, WA *Corporate Laboratory (a)*
1620 S Walnut St - Burlington, WA 98233 - **800.755.9295** • 360.757.1400

Bellingham, WA *Microbiology (b)*
805 Orchard Dr Ste 4 - Bellingham, WA 98225 - 360.715.1212

Portland, OR *Microbiology/Chemistry (c)*
9150 SW Pioneer Ct Ste W - Wilsonville, OR 97070 - 503.682.7802

Corvallis, OR *Microbiology/Chemistry (d)*
540 SW Third Street - Corvallis, OR 97333 - 541.753.4946

Bend, OR *Microbiology (e)*
20332 Empire Blvd Ste 4 - Bend, OR 97701 - 541.639.8425

Data Report

Client Name: Soiltest Farm Consultants, Inc.
2925 Driggs Drive
Moses Lake, WA 98837

Reference Number: **18-09569**
Project: WARDEN HUTTERIAN

Report Date: 4/2/18

Date Received: 3/22/18
Approved by: clh
Authorized by: C. K. Knox

Ceann K Knox
Lab Manager, Bellingham

Sample Description: INFLUENT — Sample Date: 3/21/18 11:30 am
Lab Number: 20068 — Sample Comment: — Collected By:

CAS ID#	Parameter	Result	PQL	MDL	Units	DF	Method	Lab	Analyzed	Analyst	Batch	Comment
E-14551	**FECAL COLIFORM**	>200000 A1	10		CFU/100mL	1.0	SM9222 D/MF	b	3/23/18	jma	MFC_180322s	

Sample Description: POND — Sample Date: 3/21/18 11:30 am
Lab Number: 20069 — Sample Comment: — Collected By:

CAS ID#	Parameter	Result	PQL	MDL	Units	DF	Method	Lab	Analyzed	Analyst	Batch	Comment
E-14551	**FECAL COLIFORM**	38900 A8	2		CFU/100mL	1.0	SM9222 D/MF	b	3/23/18	jma	MFC_180322s	

Notes:
ND = Not detected above the listed practical quantitation limit (PQL) or not above the Method Detection Limit (MDL), if requested.
PQL = Practical Quantitation Limit is the lowest level that can be achieved within specified limits of precision and accuracy during routine laboratory operating conditions.
D.F. - Dilution Factor

If you have any questions concerning this report contact us at the above phone number.

APPENDIX B

Soil Quality Test Results

soiltest farm consultants, inc.
2925 Driggs Dr., Moses Lake, Wa 98837 - www.soiltestlab.com
Office: (509)765-1622 - Fax:(509)765-0314 - (800)764-1622

WARDEN HUTTERIAN BRETHREN
1054 W HARDER RD
WARDEN, WA 98857

DATE REC 3/21/2018
INVOICE # 3318

SAMPLE DEPTH	LAB NO	NO3-N mg/kg	E.C. mmhos/cm	SOLUBLE SALTS mmhos/cm	TOTAL N mg/kg	Na mg/kg	CEC meq/100g	ESP %
1FT	3318	5.3	0.36	0.9	790	2.63	11.2	23.4
2FT	3319	4	0.59	1.53	582	3.09	11.6	26.7
5FT	3320	4.1	0.67	1.74	373	1.72	8.6	20.0

SAMPLE DEPTH	LAB NO	Ca meq/L	Mg meq/L	Na meq/L	SAR	MOISTURE %
1FT	3318	0.72	0.33	6.28	8.67	18.5
2FT	3319	2.43	0.90	14.61	11.32	13.5
5FT	3320	1.85	3.51	10.07	6.15	13.1

REVIEWED BY _____ KEB