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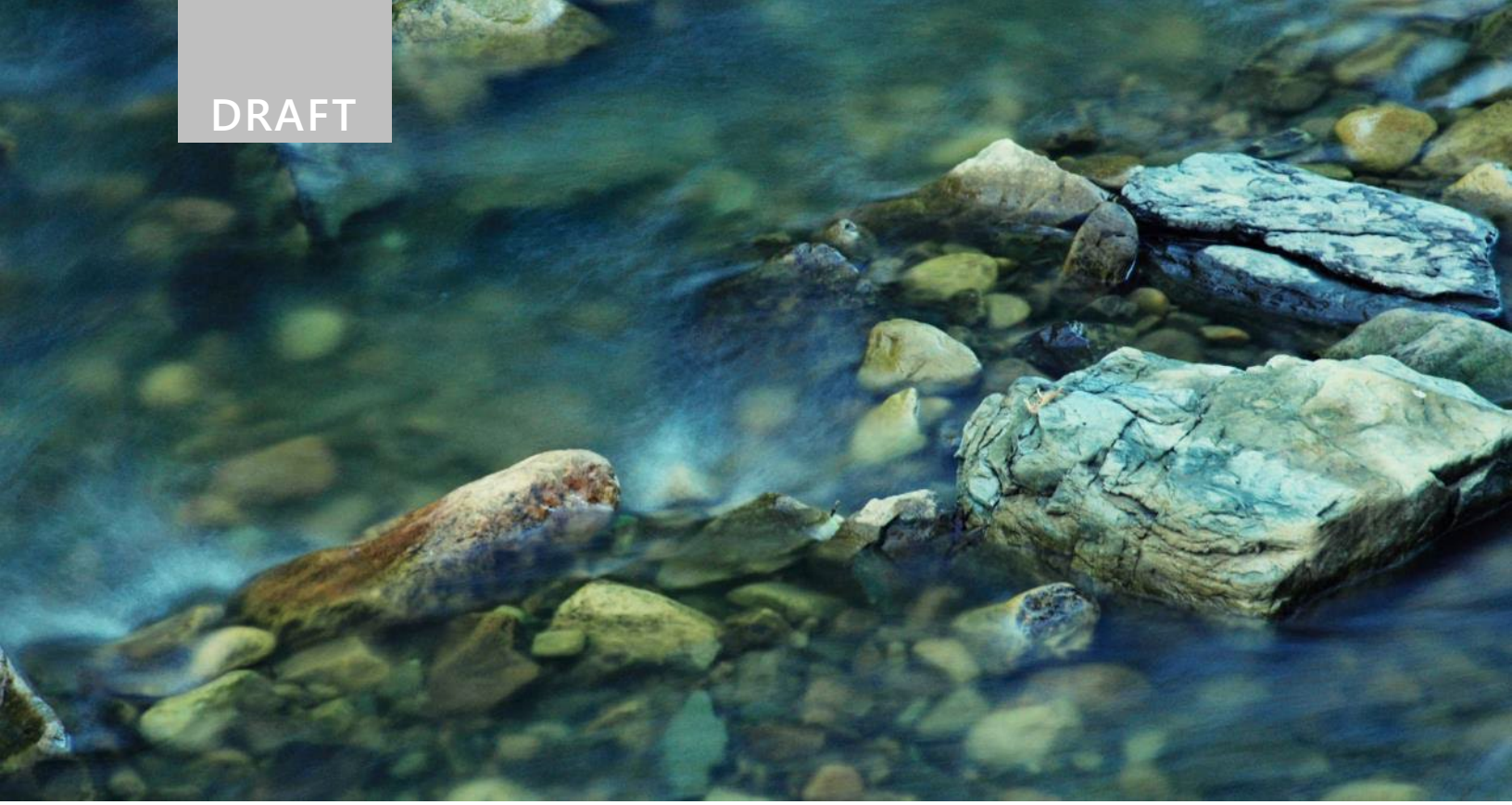

January 18, 2022
H&S Bosma Dairy Lagoon No. 3
Administrative Order on Consent Docket No. SDWA-10-2013-0080

ANCHOR QEA

H&S Bosma Dairy
Lagoon No. 3 Abandonment Plan

Prepared for H&S Bosma Dairy

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Lagoon No. 3 Abandonment Plan

Prepared for
H&S Bosma Dairy
5860 East Zillah Drive Road
Granger, Washington 98953

Prepared by
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Project Number: 210996-01.01

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ABBREVIATIONS

Consent Order	Administrative Order on Consent SDWA-10-2013-0080
Dairy	H&S Bosma Dairy
EPA	U.S. Environmental Protection Agency
H:V	horizontal to vertical (ratio)
mg N/kg	milligrams nitrogen per kilogram
Plan	Lagoon Abandonment Plan
SVID	Sunnyside Valley Irrigation District
WA NRCS	Washington State Natural Resources Conservation Service

1 Introduction

This Lagoon Abandonment Plan (Plan) was prepared by Anchor QEA, LLC, on behalf of H&S Bosma Dairy (the Dairy) as required by the U.S. Environmental Protection Agency (EPA) Region 10 Administrative Order on Consent SDWA-10-2013-0080 (Consent Order). The abandonment work described in this plan has been initiated in 2021 and will be completed according to the schedule described in this Plan.

The Dairy is completing the abandonment of Lagoon No. 3 as part of a larger group of lagoon lining and abandonment projects outlined in the *Final Modified Lagoon Work Plan* (Anchor QEA 2016). Lagoon No. 3 was previously used to collect and store stormwater and manure generated from the Dairy's operations. However, the use of the lagoon has been terminated and it has been emptied of manure and associated liquids. The lagoon will no longer be required due to implemented storage and waste management improvements.

As part of lagoon abandonment, the lagoon will be regraded to support crop production. Two active lagoons (Lagoon Nos. 1 and 2) remain to the south of Lagoon No. 3. The abandonment and regrading of Lagoon Nos. 1 and 2 will be addressed in a separate abandonment plan to be prepared during 2022.

This Plan implements the requirements of the *Final Modified Lagoon Work Plan* (Anchor QEA 2016) as approved by EPA. It also exceeds the requirements of Washington State Natural Resources Conservation Service (WA NRCS) *Conservation Practice Standard 360 – Waste Facility Closure* (WA NRCS 2013a) and demonstrates compliance with nutrient management requirements of WA NRCS *Conservation Practice Standard No. 590 – Nutrient Management* (WA NRCS 2013b).

1.1 Report Organization

The remaining sections of this Plan are organized as follows:

- **Section 2 – Existing Conditions.** This section reviews the current conditions of the Dairy and presents the approximate pre-abandonment dimensions of Lagoon No. 3.
- **Section 3 – Abandonment Procedures.** This section discusses the removal of liquids and organic solids and initial soil testing procedures, both of which have been completed. The section also discusses the proposed treatment of elevated soil nutrient levels, confirmation soil testing, and submission of the final completion report.
- **Section 4 –Schedule.** This section outlines the abandonment timeline.
- **Section 5 – References.** This section provides references for the materials cited in this Plan.

2 Existing Conditions

The Dairy is located at 5860 East Zillah Drive Road in Granger, Washington. Figure 1 shows the location of Lagoon No. 3. The estimated dimension and capacity of the lagoon prior to abandonment are provided in Table 1.

The lagoon was originally created within a natural depression in the topography, bounded by Kirks Road and the Sunnyside Canal (owned by the Sunnyside Valley Irrigation District [SVID]), with the addition of earthen berms at the southern ends of what would become Lagoon No. 3. The lagoon is constrained by SVID drainage easement to the west, cropland to the east, Kirks Road to the north, and Lagoon No. 2 to the south.

Lagoon No. 3 has historically been used to store stormwater runoff and manure waste generated from Dairy operations. Liquid collected within the lagoons is stored and then pumped to application fields or to the existing lagoon system.

Table 1
Lagoon No. 3 Approximate Dimensions and Capacity

Lagoon	Length (feet)	Width (feet)	Depth (feet)	Capacity (million gallons)	Capacity (acre-feet)	Approximate Interior Side Slope
3	580	120	10	2.3	7.2	3H:1V

3 Abandonment Procedures

This section describes the lagoon abandonment procedures, including the following:

- Liquids and organic solids removal (completed 2021)
- Initial soil testing (completed 2021)
- In situ soil treatment and testing
- Interim reporting
- Completion report submittal

Most of the lagoon abandonment activities will be performed by Dairy personnel and equipment. Soil confirmation testing, irrigation sensor maintenance, interim reporting, and completion report submittal will be performed by Anchor QEA and Agrimanagement, Inc. The abandonment efforts will be completed consistent with the schedule presented in Section 4.

3.1 Liquids and Organic Solids Removal

Prior to sampling, the liquids and organic solids were removed from the lagoon. Liquids contained within the lagoon were transferred to an in-service, lined lagoon. After liquid removal, organic solids were removed and placed in the composting area. Solids were removed down to the current lagoon soil foundation material. The condition of the lagoon after manure removal is shown in Photograph 1.

Photograph 1
Condition of Lagoon No. 3 in December 2021 Following Manure and Liquids Removal

3.2 Initial Soil Testing

Following removal of the manure, soil testing was conducted within the lagoon to document the ammonia and nitrate concentrations in the subsurface soil. Confirmation testing was conducted at six locations within Lagoon No. 3, including one sample from the lower portion of each sidewall and two samples from the lagoon bottom. Figure 2 shows the actual sampling locations.

Soil sampling from the lagoon interior was performed using the following methods:

1. A backhoe was used to excavate test pits to a depth of 10 feet deep at each testing location. Soil samples were removed with the backhoe bucket at each sampling interval for sampling.
2. Initial soil samples were collected from a depth interval of 0 to 12 inches below ground surface.
3. Subsequent samples were collected at each of nine 1-foot intervals to a depth of 10 feet below ground surface.
4. Sampling personnel recorded the location and depth of each soil sample.
5. After samples were collected, the samples were placed in appropriate containers, and a custody seal bearing the sampler's name or initials and date were placed on the container.

Laboratory analysis of the soil samples was performed by SoilTest Farm Consultants, Inc., a State of Washington-certified analytical laboratory and a North American Proficiency Testing-accredited laboratory located at 2925 Driggs Drive, Moses Lake, Washington. Sample management, packing, shipment, analytical testing, and quality assurance/quality control were consistent with those defined in the *Dairy Facility Application Field Management Plan* (Anchor QEA 2018) as follows:

- Ammonium (as nitrogen) by Western Coordinating Committee S-3.50
- Nitrate (as nitrogen) by Western Coordinating Committee S-3.10

Soil samples were analyzed in a single phase. Results of testing are summarized in Table 2. Results of soil testing demonstrated that ammonia and/or nitrate concentrations in excess of the target level (45 milligrams nitrogen per kilogram [mg N/kg]) were present at depths between 3 and at least 10 feet below ground surface, with an average depth of just over 6 feet. Depths exceeding the target level were greatest for the east and west sidewalls, both of which exceeded the target level at the deepest depths (10 feet below ground surface) sampled.

Table 2
Results of Initial Soil Testing

Station ID	Depth Range (inches)	Nitrate-N (mg N/kg)	Ammonia-N (mg N/kg)	Available N (mg N/kg)	Exceeds 45 mg N/kg?
S-01 (North Sidewall)	**0–12**	147.7	1.7	**149.4**	**Yes**
	12–24	89.5	ND (u)	**89.5**	**Yes**
	24–36	47.7	2.6	**50.3**	**Yes**
	36–48	93.8	3.1	**96.9**	**Yes**
	48–60	18.3	3.6	21.9	No
	60–72	17.3	2.9	20.2	No
	72–84	14.2	3.1	17.3	No
	84–96	28.8	2.6	31.4	No
	96–108	20.3	3.5	23.8	No
	108–120	30.4	3.6	34	No
S-02 (West Sidewall)	**0–12**	26.8	97.5	**124.3**	**Yes**
	12–24	1.0	30.8	31.8	No
	24–36	1.0	23.1	24.1	No
	36–48	1.8	25.0	26.8	No
	48–60	28.5	25.2	**53.7**	**Yes**
	60–72	39.9	1.9	41.8	No
	72–84	51.6	3.3	**54.9**	**Yes**
	84–96	67.0	8.5	**75.5**	**Yes**
	96–108	41.7	ND (u)	41.7	No
	108–120	45.6	7.2	**52.8**	**Yes**
S-03 (East Sidewall)	**0–12**	83.3	ND (u)	**83.3**	**Yes**
	12–24	188.2	ND (u)	**188.2**	**Yes**
	24–36	103.1	ND (u)	**103.1**	**Yes**
	36–48	85.5	ND (u)	**85.5**	**Yes**
	48–60	131.3	4.2	**135.5**	**Yes**
	60–72	56.6	ND (u)	**56.6**	**Yes**
	72–84	44.6	2.3	**46.9**	**Yes**
	84–96	69.5	ND (u)	**69.5**	**Yes**
	96–108	76.7	1.8	**78.5**	**Yes**
	108–120	113.1	2.7	**115.8**	**Yes**

Station ID	Depth Range (inches)	Nitrate-N (mg N/kg)	Ammonia-N (mg N/kg)	Available N (mg N/kg)	Exceeds 45 mg N/kg?
S-04 (South Sidewall)	**0–12**	5.9	67.9	**73.8**	**Yes**
	12–24	ND (u)	81.7	**81.7**	**Yes**
	24–36	ND (u)	61.6	**61.6**	**Yes**
	36–48	2.9	10.7	13.6	No
	48–60	21	21.6	42.6	No
	60–72	1.8	6.0	7.8	No
	72–84	6.6	5.0	11.6	No
	84–96	6.8	6.1	12.9	No
	96–108	3.4	4.5	7.9	No
	108–120	6.9	2.4	9.3	No
B-N (North Bottom Sample)	**0–12**	23.7	251.3	**275**	**Yes**
	12–24	1.9	139.7	**141.6**	**Yes**
	24–36	15.4	128.6	**144**	**Yes**
	36–48	0.8	208	**208.8**	**Yes**
	48–60	ND (u)	20.5	20.5	No
	60–72	4.8	18.5	23.3	No
	72–84	1.1	32.6	33.7	No
	84–96	ND (u)	14.3	14.3	No
	96–108	1.4	10.1	11.5	No
	108–120	0.7	8.2	8.9	No
B-S (South Bottom Sample)	**0–12**	176.8	109.5	**286.3**	**Yes**
	12–24	6.0	92.8	**98.8**	**Yes**
	24–36	24.4	6.6	**31.0**	**Yes**
	36–48	11.2	65.2	**76.4**	**Yes**
	48–60	11.8	118.7	**130.5**	**Yes**
	60–72	45.6	10.3	**55.9**	**Yes**
	72–84	19.8	5.7	25.5	No
	84–96	9.8	5.6	15.4	No
	96–108	21.0	7.8	28.8	No
	108–120	15.4	10.1	25.5	No

Notes:

ND: Not detected

Bolded available nitrogen values exceed the target value of 45 mg N/kg.

3.3 In Situ Soil Treatment

This section describes how nutrients will be extracted from the soils beneath the lagoon using in situ treatment. Soil treatment will be performed agronomically using a combined forage crop including alfalfa and chicory. Alfalfa and chicory were selected to maximize nitrogen extraction rates, particularly from deep soil horizons, and details are provided as follows:

- **Alfalfa:** Alfalfa is a perennial forage crop that is well suited to deep rooting and high dry matter production (resulting in high nitrogen extraction rates). Research has shown that alfalfa can extract nutrients up to a depth of 120 centimeters (approximately 4 feet) within the first year after establishment. Roots can continue to push deeper through Years 2–4 until extraction has been observed up to a depth of 270 centimeters (over 8 feet) (Entz et al. 2001). In addition to crop age, soil and irrigation conditions can affect the depth of rooting. Even though alfalfa can obtain nitrogen for growth via symbiotic nitrogen fixation, it is also very effective in removing inorganic nitrogen from the soil (Russelle 1991). Research shows that alfalfa is an excellent crop for extraction of inorganic nitrogen from soil (Russelle et al. 2001). At a mono-crop yield of 9 tons/acre per year, alfalfa can typically extract nitrogen at a rate of up to 585 pounds nitrogen/acre per year.
- **Chicory:** Chicory is a deep-rooted, broad-leafed perennial that is very drought tolerant and hardy and responds well to higher levels of nitrogen within the soil. It can send roots over 3 meters (over 9 feet) deep within the first 3 months of growth and extend to 4 meters deep (over 13 feet) by Year 2 (Rasmussen 2020). At a mono-crop yield of 5.5 tons/acre per year, chicory can typically extract nitrogen at a rate of up to 185 pounds nitrogen/acre per year (Ditsch and Sears 2007).

As a mixed crop, the nitrogen extraction rate will likely be between 525 and 585 pounds per year. The mixed crop can be managed and harvested together efficiently. The mixing of the two crops is intended not to drive up overall nitrogen extraction, but rather to optimize the following: 1) the rate of extraction throughout the lagoon area; and 2) the removal of nitrogen from deeper soil horizons. The mixed crop can be expected to recover available nitrogen from depths at and below 10 feet. Removal rates can be expected to be highest in the upper soil horizon. Deeper soil extraction will likely increase over time as shallow soil reservoirs are exhausted.

Advantages of the soil treatment approach in comparison to other methods (e.g., soil excavation, export and backfill with clean soil) include the following:

- **Ability to treat all lagoon areas:** The western portion of Lagoon No. 3 is located adjacent to SVID irrigation infrastructure located within an SVID easement. Excavation of nutrient-rich soils would be precluded within this area, whereas in situ treatment is not.

- **Soil conservation:** The in situ treatment approach will not damage the food production value of the existing soils in comparison to an excavation approach and will not require import of clean soil.
- **Lower fuel consumption:** Overall fuel consumption (and associated production of greenhouse gas emissions) will be much lower for the in situ treatment approach in comparison to an excavation and backfill approach.
- **Incidental treatment of soils below the treatment target:** Though not required to complete lagoon abandonment, the in situ treatment approach will be applied throughout the Lagoon No. 3 footprint with the same deep-penetrating crop mix. This means that nutrient extraction will occur in all lagoon areas, even those that currently are below treatment objectives.

The treatment crop will be planted throughout the former lagoon footprint. Agrimanagement will install an irrigation sensor within the former lagoon bottom to help optimize both yields and deep root penetration while minimizing potential downward flux of nitrogen through soil leaching. Deep root penetration is achieved best by establishing a healthy crop and then restricting its moisture to drive roots deeper in a search for water. This restriction must not, however, be excessive or nutrient extraction rates will fall off.

The irrigation sensor will be consistent with those used to monitor shallow soil moisture levels in the existing nutrient application fields at the Dairy. However, the soil sensors will be installed at the following adjusted depths: 1 foot, 3 feet, and 5 feet below ground surface.

Irrigation will be provided as necessary to support optimal crop growth and root penetration. The irrigation will be provided using solid sets or equivalent. Irrigation will follow irrigation needs estimates provided by Agrimanagement. Irrigation records will be maintained to document the dates and duration of irrigation, and these will be summarized in interim annual reports and in the completion report.

Treatment is expected to require between 3 and 4 years to complete. A single planting with multiple harvests each year is expected to be sufficient for soil treatment. The forage mix will be harvested periodically consistent with standard agronomic practices to remove the extracted nutrients from the treatment area.

At the end of an initial 2-year treatment period, soil confirmation testing will be completed using the same locations, depths, and procedures as described in Section 3.2. Sampling shall be repeated adjacent to each of the six initial testing locations. Testing will document soil ammonia-nitrogen and nitrate-nitrogen to depths of 10 feet at each location and will be used to update the expected treatment duration.

If testing confirms that the target nitrogen concentrations have been reached after 2 years, then treatment will be considered complete. If nitrogen concentrations remain in excess of the treatment target, then treatment will be conducted for an additional 1- or 2-year period. The duration will be estimated based on observed nitrogen extraction rates and soil testing data.

Final confirmation testing will be implemented at the end of the 3- or 4-year treatment period. Final confirmation testing will be completed using the same locations, depths, and procedures as described in Section 3.2. Sampling shall be repeated adjacent to each of the six initial testing locations. Testing will document soil ammonia-nitrogen and nitrate-nitrogen to depths of 10 feet at each location and will be used to update the expected treatment duration.

3.4 Interim Reporting

During the treatment period, an interim treatment report will be submitted to EPA following each calendar year. The report will summarize the following:

- Results of soil moisture monitoring
- Crop yield achieved during the calendar year harvests
- Estimated nitrogen extraction rates
- Results of soil confirmation testing (Year 2 only)
- Recommended final treatment duration (Year 2 only)

3.5 Completion Report

Following completion of soil treatment and final confirmation testing, Anchor QEA will prepare and submit a completion report. That report will include the following information:

- A short narrative describing the lagoon abandonment work completed, including a discussion of crop yields and nutrient extraction accomplished during the treatment period
- Copies of construction photographs showing the lagoon after emptying and during soil treatment
- Results of all soil testing
- Results of soil moisture monitoring
- Statement that the closure followed WA NRCS *Conservation Practice Standard 360 – Waste Facility Closure* (WA NRCS 2013a) practices
- Documentation of site conditions following soil treatment

4 Schedule

The abandonment activities described in this plan are partially complete (manure removal and initial soil testing). Crop planting and soil moisture sensor installation will be completed following EPA approval of this plan. Planting will be conducted during spring or fall months. Planting during the summer months is not recommended for crop health and nutrient extraction performance.

Interim reports will be submitted at the end of each calendar year until treatment is complete. The reports will be submitted to EPA by February 15 following the treatment year.

The completion report will be submitted to EPA by February 15 of the year when treatment targets have been achieved as documented through final confirmation testing. The current expected treatment duration is between 3 and 4 years.

5 References

Anchor QEA (Anchor QEA, LLC), 2016. *Final Modified Lagoon Work Plan*. Prepared for Liberty Dairy, LLC/H&S Bosma Dairy. December 2016.

Anchor QEA, 2018. *Dairy Facility Application Field Management Plan*. Prepared for Cow Palace, LLC, George DeRuyter & Son Dairy, LLC/D&A Dairy, LLC/George & Margaret, LLC, and Liberty Dairy, LLC/H&S Bosma Dairy. February 2018.

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WA NRCS, 2013b. *Conservation Practice Standard No. 590 – Nutrient Management*. December 2013.

Figures

SOURCE: Aerial from Microsoft (Bing) 4/11/2018
HORIZONTAL DATUM: Washington State Plane South, NAD83, U.S. ft

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Feet

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Figure 1
H&S Bosma Dairy Lagoon Map

Lagoon No. 3 Abandonment Plan
H&S Bosma Dairy

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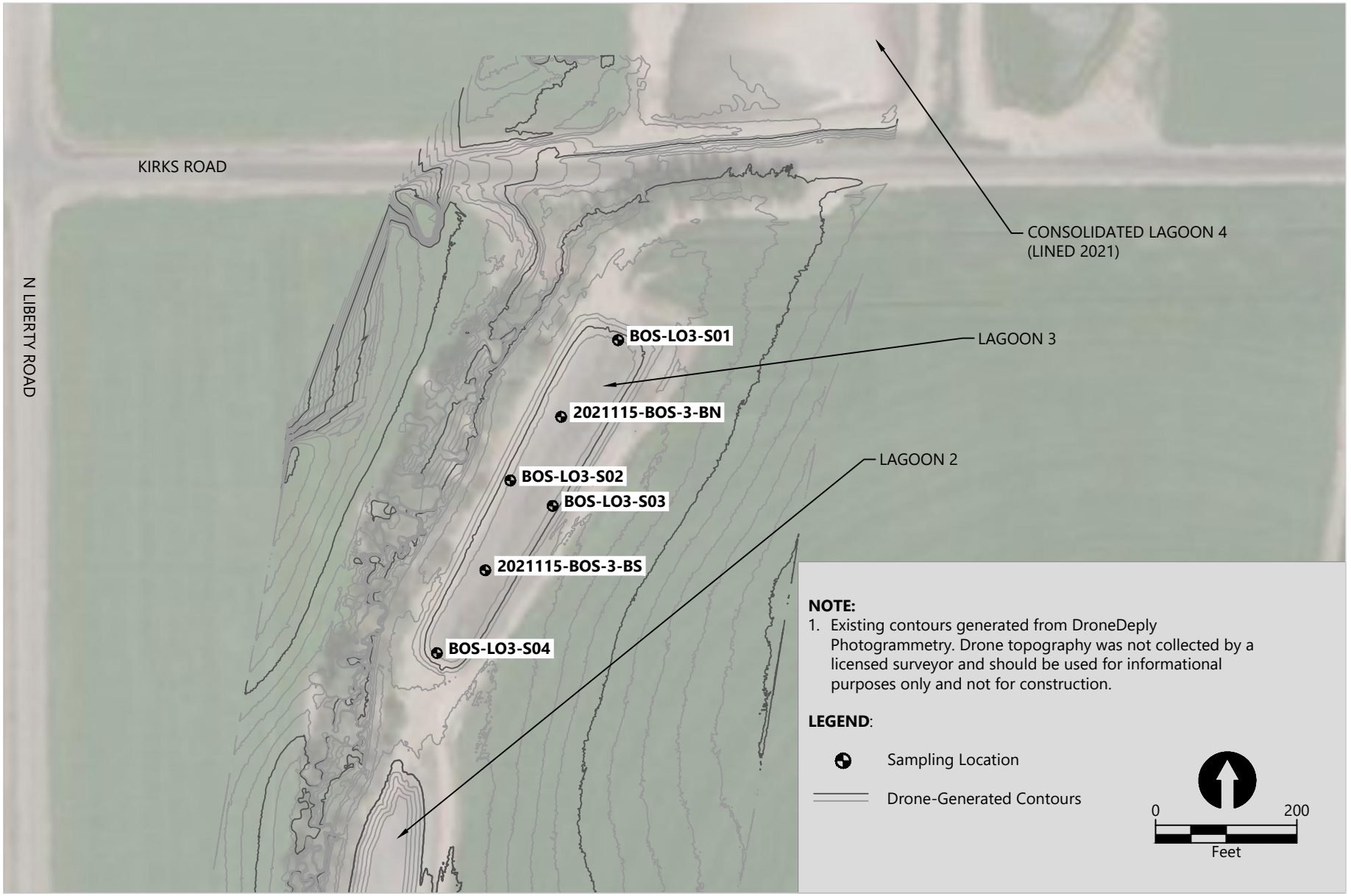

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Figure 2
Sampling Locations

Lagoon No. 3 Abandonment Plan
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