#

Preliminary Investigation Report

Sylvan Grove Farmers Elevator

GENAG582- Soil Investigation Team
Kansas State University
Submitted December 14, 2011

PRELIMINARY INVESTIGATIVE FINDINGS

Sample Collection

Sample collections took place in accordance to the Comprehensive Investigation Plan proposed to KDHE on November 3, 2011 (attached at back of report). A Giddings truck-mounted direct-push probe was used to collect soil samples at the Sylvan Grove contamination site on November 10, 2011 and November 18, 2011. In attendance were: Professor Nathan Nelson, Kansas State University; undergraduate students Laura Kemp, Jeanna Walters-Fancella, Amy Vu, Maggie Stephens, Noortje Crabtree, and graduate student Arthur Fink; Kelsee Wheeler, KDHE; and Chris Stiencamp, environmental lawyer.

All investigators involved with the collection of soil samples used appropriate personal protective equipment including ear plugs, eye protection, closed-toe shoes, and disposable gloves. Dr. Nelson, who operated the probe, wore a hard hat, eye protection, ear plugs and closed-toe shoes throughout the duration of the procedure. A safety radius of 16 feet from the probe was observed all those not operating the machinery. A first aid kit was available at the site. Bottled water was also brought for investigators to prevent dehydration.

All equipment used for soil sampling was thoroughly cleaned between probe sites using a phosphate-free detergent and distilled water.

Processing of soil sampling

After soil samples were extracted from the probe site, they were placed onto a collection trough, measured for the appropriate depth, and scooped into a plastic zip lock bag. Each sample was thoroughly blended. The soil was carefully transferred to glass jars and labeled with sample identification code, probe location, depth, and corresponding analytical laboratory. Each jar was placed in a plastic ziplock bag to protect the identification label and stored in a cooler, chilled to 4^{o} C. Soil left over in the ziplock bag was then field tested for nitrate. Field screen tests were taken by using 30mm of potassium-chloride solution with a soil sample added bringing the level to 40mm measurement. A test strip was used as directed to indicate possible contaminants. Remaining soil was then transferred to a waste pile on site. This waste pile will be properly disgarded after a composite nitrate analysis is made.

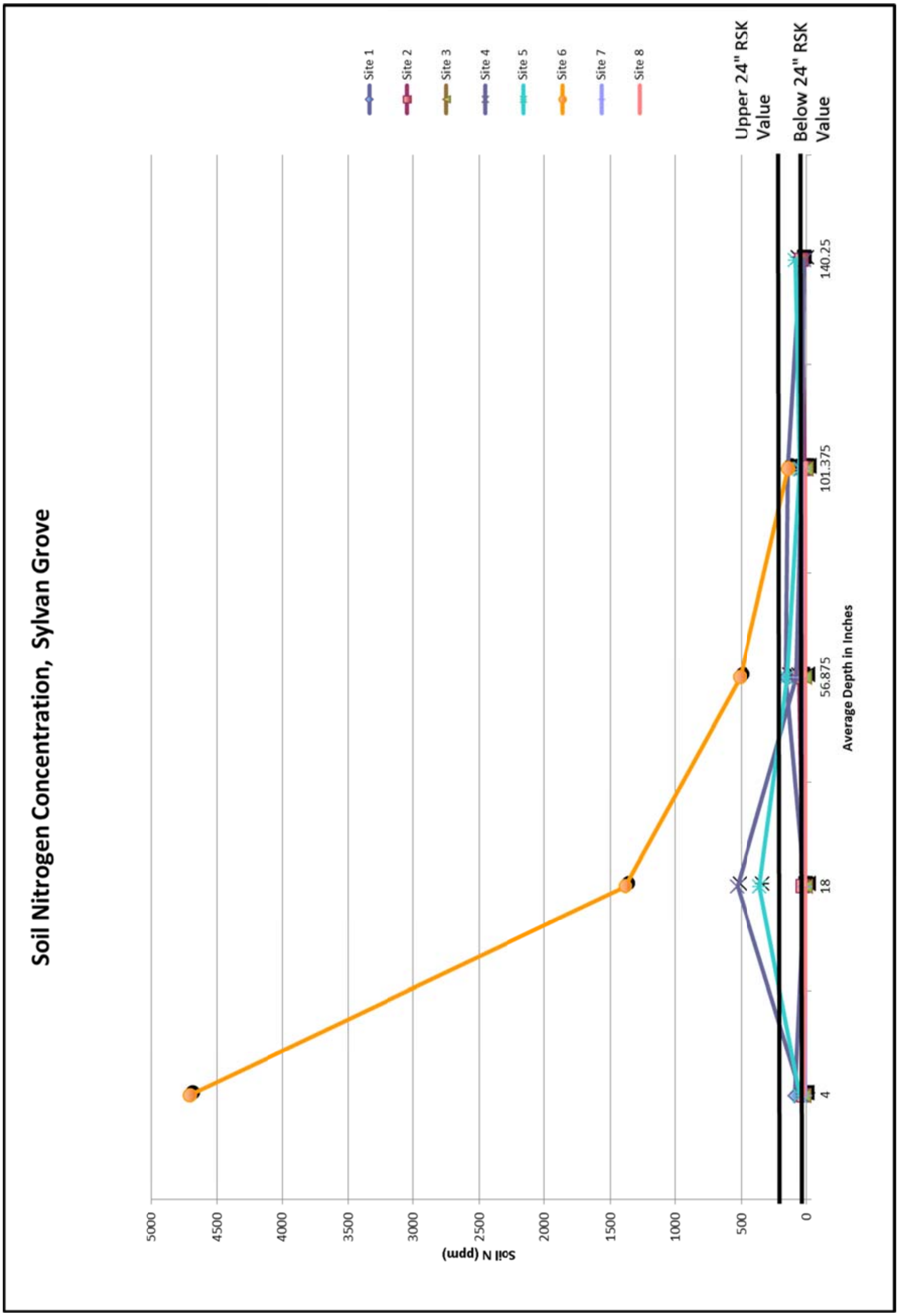
Any deviations from the initial comprehensive investigation plan were made either based on the results of the field screening or because, in the case of probe sites 3 and 4, the underlying media lead to difficult probe penetration and depth inaccuracies.

Sample Analysis

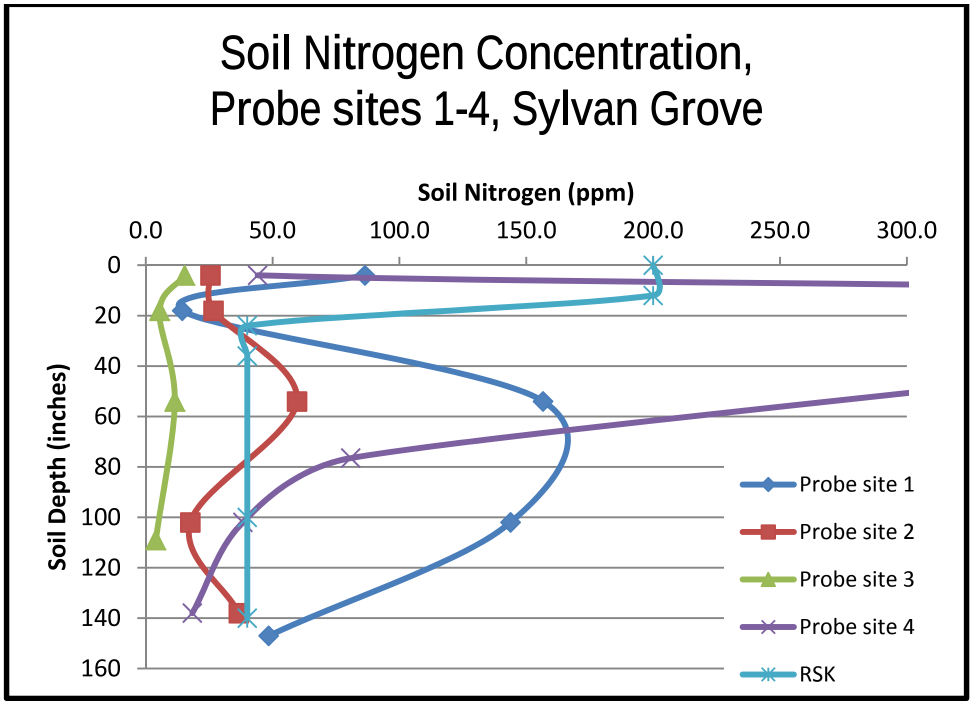
Official nitrate analyses were carried out by the Soil Testing Laboratory of Kansas State University. Additionally, eight duplicate samples collected from probe sites 4 and 6 were analyzed by Continental Analytical Services of Salina, Kansas, for purposes of quality assurance.

Analytical results indicate that nitrate contamination levels on the Sylvan Grove site range from minuscule to severe. Highest contaminate levels were recorded at probe sites 5 and 6. It should be noted that these sites were located in the area displaying the most visual surface scarring. Analytical results of probe site 6 indicated nitrate levels of approximately 3,990 mg/kg in the upper eight inches of soil, far in exceedence of the risk-based standard of 85 mg/kg set by the state of Kansas. Probe site 5 is also significantly high in nitrate concentration. High nitrates were indicated during the field tests performed onsite, and an additional sample was collected from probe site 5 at a depth of 11-12 feet. The deepest samples collected at these two sites were above RSK, indicating that contamination extends beyond the scope of the plan and capability of the available equipment.

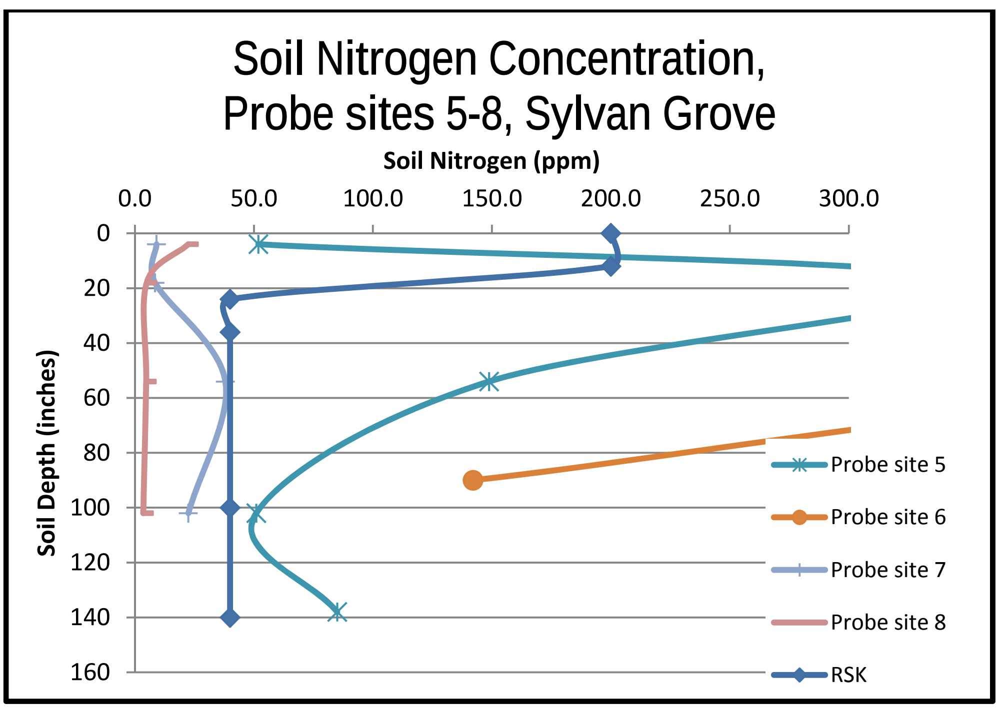
Additionally, soils below twenty-four inches have an risk-based standard (RSK) limit of 40 mg/kg nitrogen; samples from all but three of the probe sites were in exceedence of the risk based standards for soils below twenty-four inches. Based on the soil analyses, probe site 3, located to the east of the sump, appears to be below RSK. Also, samples from probe site 7 and 8, located on the north side of the property and east side of the sump, respectively, were negligible in soil nitrogen levels. Please see Table 1and Graphs 1-3, for a summary of the soil nitrogen results from Kansas State Univeristy. Currently, the results from Continental Analytical Services have not yet been received, and comparisons cannot be made at this time.



Graph 1*: Total Soil Nitrogen Concentrationsof all probe sites.*



Graph 2: *Total soil nitrogen at probe sites 1-4.*



Graph 3: *Soil nitrogen concentration at probe sites 5-8.*

Sample ID	Probe Site	Depth of Sample (inches)	NH_4-N (ppm)	$N0_3$-N (ppm)	Soil N (ppm)
1-N1-K	Site 1	0-8	43.1	43.4	86.5
1-N2-K		12-24	6.5	7.9	14.5
1-N3-K		48-60	4.9	151.8	156.7
1-N4-K		96-108	6.3	137.5	143.8
1-N5-K*		144-150	5.5	43.0	48.5
2-N1-K	Site 2	0-8	14.5	11.0	25.5
2-N2-K		12-24	5.9	20.9	26.7
2-N3-K		48-60	4.1	55.6	59.6
2-N4-K		96-108	2.4	15.2	17.6
2-N5-K*		120-156	2.8	33.9	36.7
3-N1-K	Site 3	0-8	8.1	7.2	15.4
3-N2-K		12-24	2.6	2.8	5.5
3-N3-K		48-60	2.5	9.0	11.5
3-N4-K*		104-114	2.2	1.8	4.0
4-N1-K	Site 4	0-8	18.4	25.8	44.1
4-N2-K		12-24	5.0	524.4	529.4
4-N3-K*		72-81	2.6	78.3	80.9
4-N4-K		96-108	1.8	36.6	38.3
4-N5-K*		132-144	1.9	16.4	18.4
5-N1-K	Site 5	0-8	6.8	45.1	51.9
5-N2-K		12-24	3.5	354.0	357.4
5-N3-K		48-60	3.3	145.6	148.9
5-N4-K		96-108	1.8	49.1	51.0
5-N5-K*		132-144	2.0	83.0	85.0
6-N1-K	Site 6	0-8	713.2	3991.9	4705.1
6-N2-K		12-24	149.6	1233.4	1382.9
6-N3-K		48-60	3.4	506.0	509.4
6-N4-K*		84-96	4.4	137.6	142.0
7-N1-K	Site 7	0-8	6.2	2.9	9.1
7-N2-K		12-24	6.0	2.5	8.4
7-N3-K		48-60	3.9	34.1	38.0
7-N4-K		96-108	8.0	14.5	22.5
8-N1-K	Site 8	0-8	9.3	13.1	22.4
8-N2-K		12-24	2.0	2.9	5.0
8-N3-K		48-60	3.1	1.7	4.7
8-N4-K		96-108	2.2	1.3	3.5

Table 1: *Results from Soil Testing Lab, Kansas State University. Highlighted cells indicate exceedence of RSK limits.*

Discussion of potential impacts

While Nitrate-nitrogen is essential in the growth and production of plants and crops, it could potentially be classified as a pollutant. The nitrate itself is not the specific concern, but the conversion of nitrate to nitrite. Although nitrate is beneficial to our agricultural systems, it is important to understand the potentail negative impacts that nitrate contamination may impose on both the environment and human health.

Excess nitrate in the soil may come from improper timing or amounts of nitrogen fertilizer, which causes nitrogen loss from the system and environmental problems. With the storage of dry fertilizer at the Sylvan Grove site, it is possible that transportation from the storage unit to the soil may be responsible for the nitrate contamination of the area. A potential loss of nitrates in soils is leaching potential, where depending on the type of soil textures present, may have a significant affect on the speed with which nitrate leaches into groundwater and streams. Soil texture will have an impact on the rate of leaching; the texture affects percolation, or the downward movement of free water. The finer the soil, the slower the rate of percolation will be. Consequently, the coarser the soil, the faster the rate of movement through the soil profile. The soils at the site are a silt-loam, which indicates that the percolation of water will be slower, compared to a few areas onsite with sandy soils. But we also know that the texture readily transmits water through the profile and is well-draining, which results in higher leaching potential of nitrate.

There is much variability surrounding factors affecting nitrate leaching, such as fertilizer application rates (or uncalculated spill events), precipitation levels, and organic cover. Another potential loss of nitrate in the ground is through the process of denitrification. Denitrification results from a biochemical processes, and leads to the emission of nitrogen gases into the atmosphere. Denitrification is also heavily influenced by precipitation. Figure 1 shows the Sylvan Grove precipitation average in a year compared to the US average.

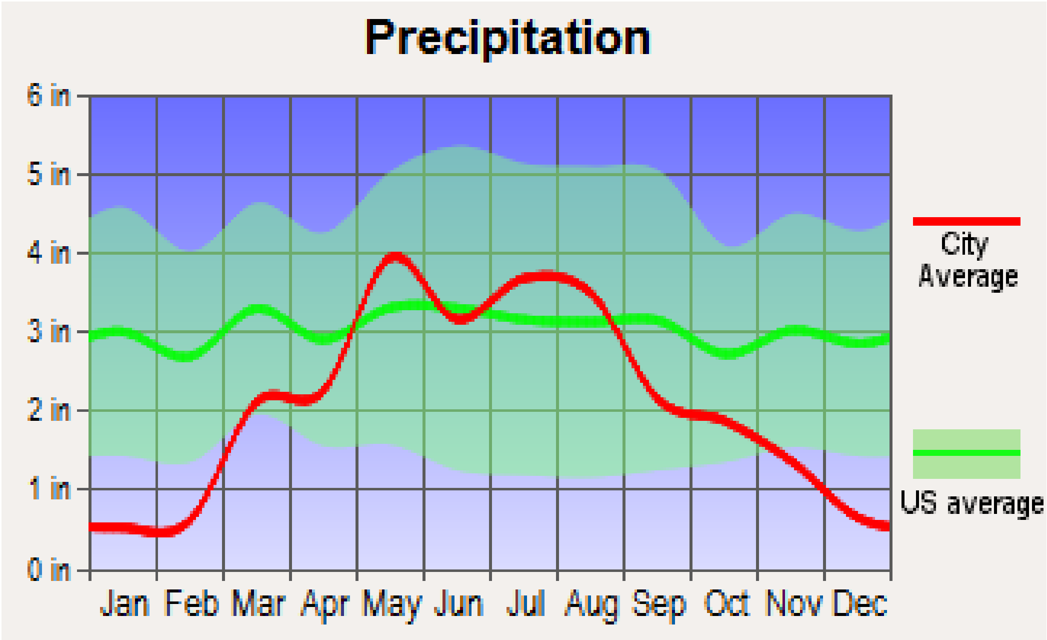


Figure 1: *Annual precipitation at Sylvan Grove, Kansas.*

The city average varies a substantial amount more than the US average. It would be important to understand that both leaching and denitrification potential is highest April-September. As rainfall intensifies, the nitrate is more prone to leaching and will potentially migrate in groundwater to a potential drinking source. This would be the time avoid application of fertilizers, in order to reduce the amount of nitrates in the ground. Also, establishing an organic cover on the site may decrease the amount of nitrogen escape from the area. Bare soils are more susceptible to emission losses because the nitrogen is not able to bind onto an organic matter on the field, and is able to be released more easily. Nitrate leaching and atmospheric losses have a big effect on not only the environment, but human health as well.

Since the nitrate N exceeds the RSK limit at the Sylvan Grove site, it is significant to understand the effects on human health that nitrates may have. Stomach cancer and methemoglobin, also known as baby blue syndrome, are potential health concerns associated by nitrate ingestion. Nitrate ingestion may occur through the drinking of contaminated water, or in rare cases, by direct ingestion of contaminated soil. Of all cancers, stomach cancer is the second largest cause of deaths. Nitrite produced by nitrate reacts in the stomach with a secondary amine and produces a toxic compound which leads to the stomach cancer. Infants and the elderly are most susceptible to methemoglobin. Conversion of nitrate to nitrite inhibits the transportation of oxygen throughout the body. With businesses and residences both north and south of the Sylvan Grove site, residents should have an understanding of the risks associated with the contaminated site. If nearby families have young children, the children should not be allowed to play near the site. The children could ingest the nitrate directly, and be affected by the high levels of nirates. Also, due to the directional flow of groundwater, people wishing to install a well south of the elevator site, for either residential purposes or livestock purposes, should be cautioned of the contamination.

Recommendations for Sylvan Grove

The nitrate and ammonia levels in the soil are still quite high, especially at Site 6. There are also several other sites present (4 and 6) that still exceed the allowable nitrate limit, even at 9 feet deep. This means that the nitrates are leaching down into the soil, and may or may not have already affected the ground water. The city well is nearby, and this contamination could cause harmful effects to human health if the water were to be used. Cleaning up contaminated water can be expensive and is quite difficult to do, so a soil remediation is recommended in order to protect the soil-to-groundwater pathway. The hydrology at the site shows that the nitrate will move vertically until hitting the groundwater, which is approximately 25 feet in depth. Nitrate in the soil itself does not cause a great health concern but the potential leaching to groundwater is a concern.

When examining the map of sample collection, it sould be noted that the hot spots are right outside of the excavated area. This is perhaps due to the fact that the excavation was not extensive enough. Additionally, it may be due to contamination that occurred after the excavation took place. There is no identified leak in the barrels on site and they no longer contain fertilizer. This plume may have been caused by spills in the past. Not enough data was given for us to determine the exact cause of this contamination. The area does not have much land cover or organic matter so bioremediation could be a potential option since that will deal with the contaminants already present in the soil, as well as prevent some release of nitrogenous gas.

COMPREHENSIVE INVESTIGATION PROPOSAL- Submitted November 3, 2011

Historical Evaluation and Site Description

Description of Location:

The site is located at 129 South Main Street, Sylvan Grove, Lincoln County, Kansas, in the Southwest Quarter of the Northwest Quarter of Section 13, Township 12 South, Range 10 East and Southeast Quarter of the Northeast Quarter of Section 14, Township 12 South, Range 10 East. The site is a total of approximately 6.52 acres and its geographic coordinates are 39.00954º North latitude and 98.39398º West longitude.

The facility consists of a former elevator property and is located on the edge of Sylvan Gove south of the business district. Community shop and residential properties are also north of the facility. Residential property is directly south of the site on the west side of Main Street and a ball field on the east side of Main Street. It is currently being used for grain storage for Glenn Ringler and Gregory Ringler, Jr. of Ringler Farms.

Figure 2.

U.S. Geological Survey (USGS), Sylvan Grove Topographic Map

Map Scale: 1:24,000

Site History:

According to historical Sylvan Grove city maps, grain elevators were present prior to 1901. A 1901 map shows three elevators were located on the site; two were on the west side of Main Street and one on the east of Main Street. Wood-constructed elevators burned down in the 1930's and again in 1977.

In 1997, the Farmers Elevator Company used the site for grain storage, storage of dry fertilizer, and sale of chemicals and farm supplies. Barnard Grain Company and Miller Grain Company operated the facility since 1997. Each company operated the facility for approximately three years before filing for bankruptcy. After the Miller Grain Company ended business on the site, the land was divided into three tracts; Kirk Meyer owned the former office building, and the Ringlers owned the land and other buildings on the site. The property is now owned solely by Ringler Farms.

A sale barn was located just north of the elevator property until the 1950's. After that time it was moved farther north. No known investigations have been carried out to distinguish the contamination on the elevator property as organic or inorganic in origin.

Enviro Tech Services, Inc. of Salina, Kansas executed a Phase I Environmental Assessment for the Barnard Grain Company at the Farmers Elevator Company in May 1996. The assessment concluded that the Farmers Elevator Company seemed to have maintained good housekeeping practices. Enviro Tech Services, Inc. then collected seven soil samples from the site in May of 1997. These samples were tested and analyzed by Continental Analytical Services in Salina, Kansas. Results of the samples showed a maximum detection of nitrate nitrogen at 330 mg/kg. This exceeds the 85 mg/kg maximum in the upper eight inches, as set by the Risk-based Standards for Kansas.

KDHE completed a Site Reconnaissance & Evaluation in May 2008 and suggested the site be more thoroughly investigated for nitrate and pesticide contamination. In July 2008, KDHE encouraged the current landowners to enroll their properties in the Voluntary Cleanup and Property Redevelopment Program in order to further characterize and possibly remediate the contamination. The Sylvan Grove Historical Society responded and applied to the program on August 24, 2010. Other potentially responsible parties are being researched and evaluated.

Study Area Investigation

Soils Background:

According to the National Cooperative Soil Survey, the soils at the Sylvan Grove contamination site are classified as Hord silt-loam, Geary-Lancaster complex, and Roxbury silt-loam. Roxbury silt-loam is the underlying soil type to the west of the grain elevator and Hord silt-loam is found directly south. At KDHE's Boreholes 1 and 2 (and also between the elevator and the former stockyard), Geary-Lancaster complex is present. These soils are all formed from either calcareous parent material or loess. Typically, these soil types are well-draining, and readily transmit water through the soil profile. Site specific water infiltration rates are not yet determined.

Source Characterization

Site Evaluation and Sampling Plan:

According to KDHE's Site Reconnaissance and Evaluation at the Sylvan Grove site, the area on the eastern most side of the property displayed soil nitrate levels below the RSK values established for the state of Kansas. At Boreholes P-3 and P-5 of KDHE's 2008 investigation, the nitrate concentrations were also below RSK. Additionally, the area immediately surrounding the dry fertilzer storage container has been excavated in the past. Because these areas have either been tested by KDHE and deemed acceptable, or have already been excavated, they will not be included in this sampling program.

This plan's area of focus is that which lies south of the elevator and west of the sump. This general area revealed the highest nitrate contamination in 2008, and appears to have "scarring" typical of a synthetic nitrogen fertilizer spill. To determine the extent to which the nitrogen contamination is dispersed, a sampling plan has been devised as follows:

A. A Giddings truck-mounted direct-push probe (properly decontaminated, according to guidelines in BER-05) will be used to collect samples from suspect areas. Samples will be taken from eight identified locations on the property (please refer to Figure 3). Each location will generate 4 subsamples; one interval sample for soil between 0-8 inches, another for 1-2 feet, a third sample for 4-5 feet, and a final for soil between 8-9 feet. This will allow for analysis of the contamination extent in both width and depth. Thus, the intention of this sampling plan is to determine both the boundaries of the contamination as well as the nitrate concentrations present at various depths.

B. Probe sites 5 and 6 will also have samples collected for texture analysis to help determine the hydraulic properties of the soil. A detailed particle size analysis will be used to estimate the hydraulic conductivity potential of the soil, which will be of aid when assessing future risk.

Figure 3. *Site map detailing soil probe locations 1-8.*

Handling of Soil Samples:

A team of senior undergraduate students from Kansas State will carry out the collection of samples under the supervision of Professor Nathan Nelson and an agent appointed by KDHE. These samples will be collected following KDHE's Standard Operating Procedures as outlined in BER-03 and BER-07. Samples will be stored in coolers chilled to 4°C, and delivered to laboratories within 48 hours. Samples will all be analyzed by the soils lab of Kansas State University for nitrate levels and ammonia levels. A minimum of ten percent of the samples collected will additionally be sent to Continental Analytical Services of Salina, Kansas, for purposes of quality assurance. Please see Table 3 for summary.

Sample Number	Probe site	Depth	Holding Time	Preservation	Parameter	Laboratory
1-N1-K	1	0-8 inches	<48 hours	Cool to <4°C	Nitrate	KSU
1-N2-K	1	1-2 feet	<48 hours	Cool to <4°C	Nitrate	KSU
1-N3-K	1	4-5 feet	<48 hours	Cool to <4°C	Nitrate	KSU
1-N4-K	1	8-9 feet	<48 hours	Cool to <4°C	Nitrate	KSU
2-N1-K	2	0-8 inches	<48 hours	Cool to <4°C	Nitrate	KSU
2-N2-K	2	1-2 feet	<48 hours	Cool to <4°C	Nitrate	KSU
2-N3-K	2	4-5 feet	<48 hours	Cool to <4°C	Nitrate	KSU
2-N4-K	2	8-9 feet	<48 hours	Cool to <4°C	Nitrate	KSU
3-N1-K	3	0-8 inches	<48 hours	Cool to <4°C	Nitrate	KSU
3-N2-K	3	1-2 feet	<48 hours	Cool to <4°C	Nitrate	KSU
3-N3-K	3	4-5 feet	<48 hours	Cool to <4°C	Nitrate	KSU
3-N4-K	3	8-9 feet	<48 hours	Cool to <4°C	Nitrate	KSU
3-N1-C	3	0-8 inches	<48 hours	Cool to <4°C	Nitrate	Continental
3-N2-C	3	1-2 feet	<48 hours	Cool to <4°C	Nitrate	Continental
3-N3-C	3	4-5 feet	<48 hours	Cool to <4°C	Nitrate	Continental
3-N4-C	3	8-9 feet	<48 hours	Cool to <4°C	Nitrate	Continental
4-N1-K	4	0-8 inches	<48 hours	Cool to <4°C	Nitrate	KSU
4-N2-K	4	1-2 feet	<48 hours	Cool to <4°C	Nitrate	KSU
4-N3-K	4	4-5 feet	<48 hours	Cool to <4°C	Nitrate	KSU
4-N4-K	4	8-9 feet	<48 hours	Cool to <4°C	Nitrate	KSU
5-N1-K	5	0-8 inches	<48 hours	Cool to <4°C	Nitrate	KSU
5-N2-K	5	1-2 feet	<48 hours	Cool to <4°C	Nitrate	KSU
5-N3-K	5	4-5 feet	<48 hours	Cool to <4°C	Nitrate	KSU
5-N4-K	5	8-9 feet	<48 hours	Cool to <4°C	Nitrate	KSU
5-T1-K	5	1-2 feet	<48 hours	Cool to <4°C	Texture	KSU
5-T2-K	5	4-5 feet	<48 hours	Cool to <4°C	Texture	KSU
6-N1-K	6	0-8 inches	<48 hours	Cool to <4°C	Nitrate	KSU
6-N2-K	6	1-2 feet	<48 hours	Cool to <4°C	Nitrate	KSU
6-N3-K	6	4-5 feet	<48 hours	Cool to <4°C	Nitrate	KSU
6-N4-K	6	8-9 feet	<48 hours	Cool to <4°C	Nitrate	KSU
6-T1-K	6	1-2 feet	<48 hours	Cool to <4°C	Texture	KSU
6-T2-K	6	4-5 feet	<48 hours	Cool to <4°C	Texture	KSU
7-N1-K	7	0-8 inches	<48 hours	Cool to <4°C	Nitrate	KSU
7-N2-K	7	1-2 feet	<48 hours	Cool to <4°C	Nitrate	KSU
7-N3-K	7	4-5 feet	<48 hours	Cool to <4°C	Nitrate	KSU
7-N4-K	7	8-9 feet	<48 hours	Cool to <4°C	Nitrate	KSU
8-N1-K	8	0-8 inches	<48 hours	Cool to <4°C	Nitrate	KSU
8-N2-K	8	1-2 feet	<48 hours	Cool to <4°C	Nitrate	KSU
8-N3-K	8	4-5 feet	<48 hours	Cool to <4°C	Nitrate	KSU
8-N4-K	8	8-9 feet	<48 hours	Cool to <4°C	Nitrate	KSU

Table 3. *Soil sample summary*

Appendix A: Health and Safety Plan

In order to minimize the potential for injury to site investigators, a health and safety plan has been devised. It includes a list of guidelines that must be followed by members of the sampling team, as well as directions and contact information for the local hospital.

1. All investigators involved in the collecting of samples will use appropriate personal protection equipment (PPE), including :
    a. disposable, latex (or latex substitute) gloves
    b. safety glasses
    c. closed-toed shoes.
2. All personnel working directly with the Giddings probe will be required to use a safety hard hat, and ear protection.
3. A basic first-aid will be kept on site.
4. Water will be provided to prevent dehydration.
5. Site investigators and supervisors will always notify or have someone else notify emergency medical professionals immediately in case of a medical emergency.

EMERGENCY CONTACTS:

- **Lincoln County Hospital**
  624 North Second Street
  Lincoln, Kansas
  785-524-4403

  Directions:

1.	Head north on KS-181 N/S Main St toward W 1st St Continue to follow KS-181 N	1.4 mi
2.	Turn right onto KS-18 E/State Hwy 18	13.4 mi
3.	Turn right onto KS-14 S/N 6th St	1.3 mi
4.	Turn left onto W College Ave	0.4 mi
5.	Take the 3rd left onto S 2nd St Destination will be on the left	400 ft

- **Sylvan Grove Ambulance**
  785-885-4565
- **Lincoln County Sheriff's Office**
  785-524-4479

References

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- Risk-Based Standards for Kansas (RSK Manual) – http://www.kdheks.gov/remedial/rsk_manual_page.htm. October 11, 2011.

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