Project #1937

MAHONEY ENVIRONMENTAL CONSULTING INC.
[illegible]
GREELEY, COLORADO [illegible]
970-352-5641 Fax 970-356-4564

March 29, 2001

Mr. Randall Ferguson, and
Mr. Ed Dimadio
Colorado Oil and Gas Conservation Commission
Denver, Colorado

Re: Sampling of Keota Oil Field Spill Site, SW1/4, Sec4, 9N, 61W . Area #2, MEC 2001.023

Dear Mr. Ferguson and Mr. Dimadio

MAHONEY ENVIRONMENTAL CONSULTING INC., was contracted to sample an area associated with historical oil field activity in northern Weld County in SW1/4, Sec 4, 9N, 61W. The site (Area 2) is located approximately 1500 feet east of Weld County Road (WCR) 89 nine miles north of Highway 14 (Figure 1). Access to the site is via a gravel road which intersects WCR 89. The site is situated approximately 15 miles northeast from the town of Brigsdale.

The vicinity is used predominantly for cattle grazing activities. Vegetation in the area is characterized by wild grasses and cacti. Two stock ponds are located at the northern end of the study area. Water wells and livestock water troughs are present.

The Weld County Soil Survey identifies the surface soils as units 40 and 44 on sheet #19. Surface soil unit 40 identified as the Nunn loam is situated on the west side of the hill and is described as: "This deep well drained soil is on slightly dissected plains and stream terraces. It formed in calcareous loamy alluvium. Typically, the surface layer is grayish brown loam 7 inches thick. The subsoil is clay loam 25 inches thick. The substratum to a depth of 60 inches or more is calcareous clay loam. In some areas the surface layer is clay loam. Permeability of this Nunn soil is slow. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is slight to moderate. The hazard of soil blowing is slight. Range seeding is suitable if the range is in poor condition. This unit is well suited to windbreaks and environmental plantings".

Surface soil unit 44 identified as the Olney fine sandy loam is situated on the top and east side of the hill and is described as: "This deep, well drained soil is on smooth to moderate dissected plains. It formed in calcareous loamy alluvium. Typically the surface layer is brown fine sandy loam 6 inches thick. The upper 12 inches of the subsoil is sandy clay loam or loam, and the lower 10 inches is calcareous sandy loam. The substratum to a depth of 60 inches or more is calcareous sandy loam. Permeability of this Olney soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow to medium, and the hazard of water erosion is slight to moderate. The hazard of soil blowing is slight. Range seeding is suitable if the range is in poor condition. This unit is well suited to windbreaks and environmental plantings".

The Weld County Soil Survey report, Photo Sheet #19, 1978, shows a distinct variation in the surface conditions (Figure 4). The photo symbol indicates that the area is a severely eroded.

The project objective was to evaluate the ground surface condition and to provide information that will be used to determine the necessary vegetation reclamation activities. The majority of the impacted area is recognized by the distinct non-vegetative ground surface. In some areas stressed or decaying vegetation was present. A limited distribution pattern of native grass patches were beginning to sprout in areas which appear to have a higher ground moisture content associated with spring seasonal conditions.

The majority of the groundsurface soils present were fine grain slightly sandy clays. The texture of the groundsurface soils varied from unconsolidated dry or moist sandy clay to dry hard pack materials (possibly weathered bedrock). For much of the site, the upper soil layer had been eroded away. Figure 2 illustrates the approximate boundaries of the impacted area (ie vegetation denuded).

The visibly impacted area extends southward from the large stock pond an approximate distance of 1500 feet. The denuded area follows the surface drainage pattern to the south. The denuded area is narrow, ranging in width from 15 to 40 feet with two extensions to the west. At the fence line, approximately 600 feet from the hill top the denuded (impacted area) widens and forms a 'U' shaped feature.

The majority of this visibly impacted area is characterized by the absence of vegetation. In addition areas of stressed vegetation are present, as indicated by dead and decaying vegetation. In the upper, northern portion of the sampling area manure had been added to the surface soils. Within the drainage low areas, limited amounts of native grasses were starting to grow with the seasonal spring conditions. All of the above areas were sampled as part of this investigation.

In some areas, it was observed that the surface soil cover was thin with a hard resistant layer less than 4 inches below the surface.

Sample #44 was collected from the upper small stockpond located west of the top of the drainage impact area. The sample was collected from a non-vegetative area. The larger stock pond area was not sampled because of the extensive amount of water present.

SCOPE OF WORK

Per instructions from the COGCC, it was estimated that 35 or more samples would be necessary to evaluate the length of the site from north to south. The sampling pattern required collecting a surface soil sample at approximately 50 foot intervals extending from the north to the south. Additional samples were also collected from impact area that extended to the west.

Samples were collected to evaluate the surface soil conditions (0-4 inches). The samples were analyzed for Sodium Absorption Ratio (SAR).

SAMPLING ACTIVITY

MEC Inc. commenced field activity on March 23, 2001. The sample collection pattern extended southward at 50 foot intervals down the central portion of the impact area. Each soil sampling location was marked with a wire stake orange marker flag. The sample number was written on each flag.

Two samples were collected at location #5. The samples were collected from the first area where within a close proximity native grassy vegetation and denuded vegetation was present. Sample #5A was from No Veg surface soils and #5B was from the grassy area within 3 feet of #5A. Both samples were collected for comparison of the surface conditions at essentially the same location. It was noted that the 5B sample was more moist than the 5A sample. The sampling results did not show a distinct difference in the results.

It is MEC Inc. understanding that the COGCC may utilize a Global Position System (GPS) to accurately record the sampling locations. MEC Inc. has prepared a site schematic to illustrate the approximate location of the sampling locations (Figure 2).

Each soil sample was collected as a grab sample. A clean stainless steel scoop was used for extracting the sample. The scoop was cleaned after each sample was collected. The sample was placed in a clean container.

SAMPLE DESCRIPTIONS

Materials sampled included areas of visibly stressed vegetation, semi-stressed vegetation, and no visible vegetation present. The stressed vegetation areas showed signs of dead or decaying vegetation. Semi-stressed vegetation areas had a reduced amount of living grasses which showed obvious stunted growth. No vegetation areas had no signs of live or dead vegetation. In these areas the main soil horizon appeared to be completely eroded. The sample collection data table (Table 1) shows the observed vegetation condition of each sample.

The majority of the surface soils in the area are loam (sandy clay) deposits consisting of fine grain sediments and a limited amount of sand. The amount or thickness of loose soil/regolith varied at sampling locations throughout the site. The soil/regolith thickness varied from more than a few inches to none (0 inches). Where no soil was present the groundsurface was essentially hard pack material, possibly weathered bedrock. Due to the surface drainage patterns, the moisture condition of the samples varied from dry to moist. Recent snow fall in the area was at the final stages of snow melt which provided additional moisture. In areas with moisture retention in the soil native grasses were sprouting, with the current seasonal spring time weather conditions. Overall the amount of grass growth within the area is minimal, an estimated less than 5 percent of the area.

LABORATORY RESULTS

A total of forty-five (45) surface soil samples were collected from 44 locations in Area 2. The samples were analyzed at Weld Laboratories in Greeley, Colorado.

The SAR values ranged from 2.68 to 44.38. Overall, twenty four (24) samples had SAR values above the COGCC regulatory SAR 12 value acceptable level and four (4) samples had SAR values between 10-12 units. The sampling results including sample location rationale and soil description are included in Table 1.

Thirty three (33) samples were collected from areas described as 'No Vegetation present'. Twenty one (21) of the No Veg samples have SAR values greater than 12 and four (4) had SAR values between 10-12.

Two of eight stressed vegetation samples had SAR values > 12.

Overall 13 of the 45 samples collected at the site had Electric Conductivity (EC) readings greater than 4. No distinct trend was determined between the EC, pH, and SAR values.

DELINEATED AREA OF IMPACT

The determination of the impact area can be based on the following factors:

1) Visible observations. The impacted area(s) are easily recognized by the distinct pattern of denuded vegetation. The sampling pattern was selected using the visual impacted area as a guide. A majority of the samples were collected from within the stressed/denuded vegetation area including areas with remnant dead vegetation present and areas devoid of plants or grasses. Samples were also collected around the perimeter of this area.

The visual impacted area as illustrated on Figures 2 includes an estimated 270,000 square foot area.

2) SAR Values. SAR values above and below the regulatory SAR value 12 guideline level were measured in the sampling area. The SAR value distribution pattern is illustrated on Figures 2. Figure 3 illustrates the distribution pattern of SAR values greater than 12 and between 10-12. Based on the sampling results, it is estimated that a 200,000 square foot area have SAR values greater than 12, and an additional 35,000 square foot area have SAR values between 10 and 12.

The above impacted area square footage determinations are estimates. The application of the GPS will provide a more reliable estimate of the actual size of the impacted areas.

RESULTS SUMMARY

Based on the field investigation, the primary impacted areas are recognized by the visible denuded area. The sampling confirms that SAR values in the area exceed the COGCC guideline.

Twenty four (24) samples have SAR value > 12 with an average value of 26.4. The estimated area with SAR > 12 is 200,000. Overall the average SAR is 17.46.

Sincerely

John Mahoney

TABLE 1

KEOTA OIL FIELD - Area 2

PRIMARY SPILL IMPACTED AREA INVESTIGATION

Location: WCR 89, 9 miles north of Highway 14, Weld

SOIL LABORATORY ANALYTICAL RESULTS

Analysis	SAR	pH	EC	Sample Location and Rationale	Sample Description
1	10.89	8.5	4	At north end, near stock pond, No Veg.*	Light- Med brown sandy clay
2	3.6	9.2	4.8	40 feet south from # 1 in central portion of impact area, Stressed/Decay Veg, w manure mix	Medium brown sandy clay
3	8.57	8.3	6.4	50 feet south from # 2, Semi Stressed	Light brown sandy clay
4	10.24	8.5	3.9	No veg	Lt brown sandy clay
5A	3.07	7.8	1.3	south side of gravel road, No Veg sample, Area begins trend of patchy native live grass present in the low moist portion of drainage impact area. Sample is split at location to include No Veg and a Veg sample.	Lt brown
5B	6.86	7.9	1.7	sample from low area 3 feet from 5A in grassy area.	Lt- Med Brown Moist
6	2.68	8.4	2.9	Stressed Veg	Med brown sandy clay
7	3.91	8.1	5.4	Stressed Veg	Med brown sandy clay
8	4.7	8.7	2.7	No Veg, some decay/stressed within 1 foot	Lt-Md brown clay,hard pack
9	18.68	9	4.4	No Veg, some decay/stressed within 1 foot	Lt-Md brown Clay
10	20.82	8.9	2.3	No Veg, barren	Lt Brown Sandy Clay
11	3.28	8.4	3.4	No Veg, barren	Lt Brown Sandy Clay
12	35.77	9	6.2	50 feet west of #11 extending up impact extension arm #1, No Veg, barren	Lt Brown Sandy Clay, hard pack
13	41.43	8.9	9	50 feet west of #12 extending up impact extension arm #1, 15 feet north of stock well, No Veg, barren	Lt Brown Sandy Clay
14	13.34	8.7	3.3	No veg	Light brown clay, slightly moist
15	13.77	8.6	2.6	No veg	Light-Medium Brown Clay
16	6.48	6	3.3	No veg and some stressed veg	Light-Medium Brown Clay
17	6.88	8	1.2	No veg and some stressed veg	Light-Medium Brown Clay
18	7.03	8.2	1.3	No Veg, near end of north portion of extension arm	Light brown clay
19	5.91	8	1.3	Semi stress, some grass and dead veg present, near end of south portion of extension arm	Med Brown Sandy Clay
20	43.98	8.3	6.5	50 feet south of #11 in main drainage impact area, No veg, some grass low area within 3 feet	Light Brown

* Vegetation Conditions Observed (Note the following observations were done in February during winter conditions.
The table indicates a variety of observed conditions with respect to vegetation:
No Veg: pertains to no indication of plant growth at sampling location.
Stressed Veg: pertains to visible indication of former plant growth such as wild grasses, but all the vegetation is dead
Semi Stressed Veg: pertains to locations observed with dead and some live vegetation
Some locations were collected in areas with wild grasses and cactus growing similar to surrounding area.
**The irregular landsurface currecntly has developed drainage pathways that appear to be more active than others, consequently some sample areas are wet and others are dry.
***Veg Residue: Some sampling areas had a higher content of dead decaying veg debris in the samples.

TABLE 1 cont
KEOTA OIL FIELD - AREA 2
SPILL IMPACTED AREA INVESTIGATION
Location: WCR 89, 9 miles north of Highway 14, Weld County
SOIL LABORATORY ANALYTICAL RESULTS

Analysis	SAR	pH	EC	Sample Location and Rationale	Sample Description
21	13.95	9.1	2.3	In grassy area, moist	Light - Med Brown Sandy Clay
22	23.95	8	1.1	Extending up small west central arm 50 feet from #21, No Veg	Light brown
23	5.91	8	1.4	At west end of central arm, 50 feet from #22 , No Veg	Light to Med Brown Clay
24	10.18	8.7	1.7	Skipped 100 feet south of #21. Skipped narrow drainage (3 feet wide), mostly veg grass surface cover. Collected #24 in No Veg area at end.	Medium brown moist
25	37	9.1	5.1	At end of narrow area where it opens up to a 'U' shaped loop area near the south fence line. No veg	Dry hard
26	27.09	8.3	7.8	50 feet south of #25, in open area, No Veg,	Light brown sandy clay
27	22.61	8.5	5.3	No Veg	Light brown clay, dry
28	28.79	8.7	0.9	No Veg, 15 feet west of electric pole	Light brown clay, dry
29	19.69	8.3	4.5	No Veg	Light brown clay, dry, hard pack
30	9.03	8.6	1.9	Stress Veg	Light brown clay, dry,
31	12.21	8.8	1.8	Stress Veg	Light brown clay, dry
32	27.09	9	3.7	Stress Veg, 30 feet north of fence line	Light brown clay, dry
33	22.6	9	4.2	70 feet south of #32, sampled on south side of fence line road (40 feet south of fence line), Area to south has patchy veg and no Veg	Med brown sandy clay
34	9.07	8.2	1.8	100 feet south of #33, Patchy veg, No Veg and some stressed veg	Lt -Med brown clay
35	7.86	8	1.2	100 feet south of #34, Stressed Veg and No Veg	Medium Brown Clay
36	10.88	8.3	2	50 feet south of #35, Stressed Veg and No Veg	Med Brown Sandy Clay
37	18.88	9.3	2.4	South side of 'U' shaped area, 15 feet from fence line, No Veg	Light Brown Sandy Clay
38	25.48	8.9	0.9	In 'U' shape area, No Veg,	Lt-Med brown sandy clay
39	39.63	9.4	0.8	In 'U' shape area, No Veg,	Lt-Med Brown Sandy Clay, possible residual old petroleum stain on surface.
40	10.09	7.8	1.2	On narrow 15 foot extension to the west off of 'U' shaped area, No Veg, Road goes approximately 300 feet more to the west	Light Brown
41	26.28	8.3	3.4	In 'U' shaped area, No Veg	Light brown sandy clay
42	40.22	9.3	5.6	In 'U' shaped area, No Veg	Light brown sandy clay
43	44.38	9.5	6.3	In 'U' shaped area, No Veg, Near COGCC sample location	Light brown sandy clay
44	22.02	8.6	3.4	Adjacent to small stock pond at north end of area near former tank battery location, Water present in pond. No Veg sample	MD brown sandy clay

TABLE 2

KEOTA OIL FIELD

PRIMARY SPILL IMPACTED AREA INVESTIGATION

Location: WCR 89, 9 miles north of Highway 14, Weld

SOIL SAMPLING RESULTS BY SURFACE SOIL CONDITIONS

	Stressed Vegetation	Semi-Stressed Vegetation	No Vegetation	Native Living Vegetation	TOTALS
Number of total samples	8	2	33	2	45
SAR > 12	2		21	1	24
SAR 10-12			4		4
SAR < 10	6	2	8	1	17
EC = or > 4	2	1	13		16
pH = or < 6			1		1
pH = or > 9	1	1	8		10

* Vegetation Conditions Observed (Note the following observations were done in February during winter conditions.

The table indicates a variety of observed conditions with respect to vegetation:

No Veg: pertains to no indication of plant growth at sampling location.

Stressed Veg: pertains to visible indication of former plant growth such as wild grasses, but all the vegetation is dead

Semi Stressed Veg: pertains to locations observed with dead and some live vegetation

Some locations were collected in areas with wild grasses and cactus growing similar to surrounding area.

**The irregular landsurface currently has developed drainage pathways that appear to be more active than others, consequently some sample areas are wet and others are dry.

***Veg Residue: Some sampling areas had a higher content of dead decaying veg debris in the samples

WELD LABORATORIES, INC.

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Phone: (970) 353-8118 • Fax: (970) 353-1671

March 27, 2001

Mahoney Environmental Consulting, Inc.
1601 10th Ave.
Greeley, CO 80631

Laboratory No. 4419
Project ID: North Weld County - Keota Oilfield
Date Sampled: 3/22/01
Date Rec'd: 3/22/01
Date Prepared: 3/23-26/01
Date Analyzed: 3/27/01

Sample ID	pH (SI Units)	Conductivity (mmhos/cm)	Calcium (mg/kg)	Magnesium (mg/kg)	Sodium (mg/kg)	SAR
1	8.5	4.0	3325	163	2375	10.89
2	9.2	4.8	5525	530	1048	3.60
3	8.3	6.4	4600	270	2215	8.57
4	8.5	3.9	4050	117	2425	10.24
5A	7.8	1.3	2295	143	563	3.07
6	8.4	2.9	5050	489	748	2.68
7	8.1	5.4	5600	498	1140	3.91
8	8.7	2.7	3250	189	1020	4.70
9	9.0	4.4	2468	253	3650	18.68
10	8.9	2.3	2238	129	3750	20.82
11	8.4	3.4	1895	96	3225	19.56
12	9.0	6.2	2163	121	6325	35.77
13	8.9	9.0	2158	114	7300	41.43
14	8.7	3.3	2850	116	2675	13.34
15	8.6	2.6	3025	95	2825	13.77
16	6.0	3.3	2850	598	1463	6.48
17	8.0	1.2	2850	222	1420	6.88
18	8.2	1.3	3450	212	1578	7.03
19	8.0	1.3	4375	315	1505	5.91
20	8.3	6.5	1903	169	7475	43.98
21	9.1	2.3	3700	94	3150	13.95
22	8.0	1.1	1630	90	3675	23.95
23	8.0	1.4	3600	224	1355	5.91

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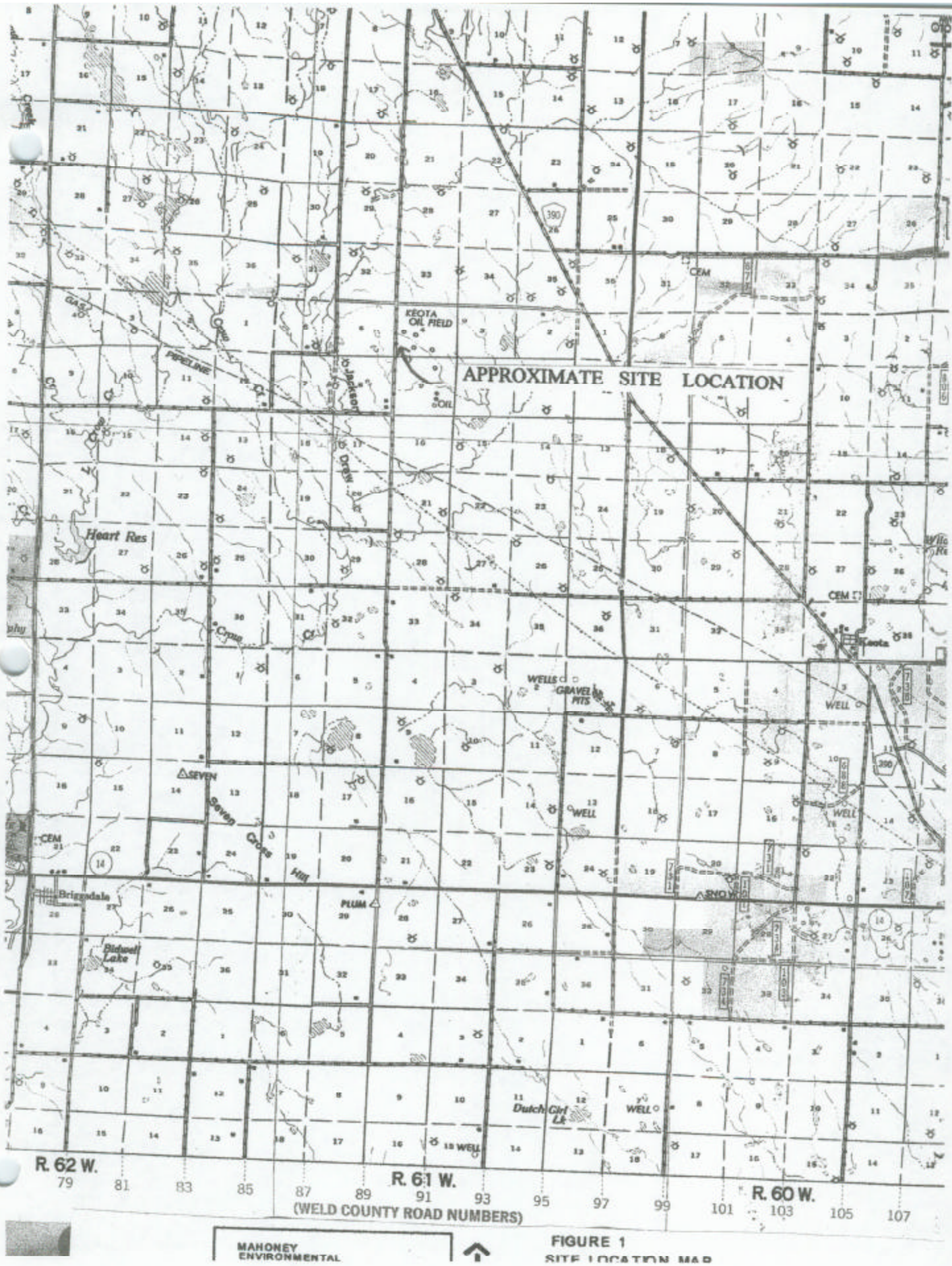
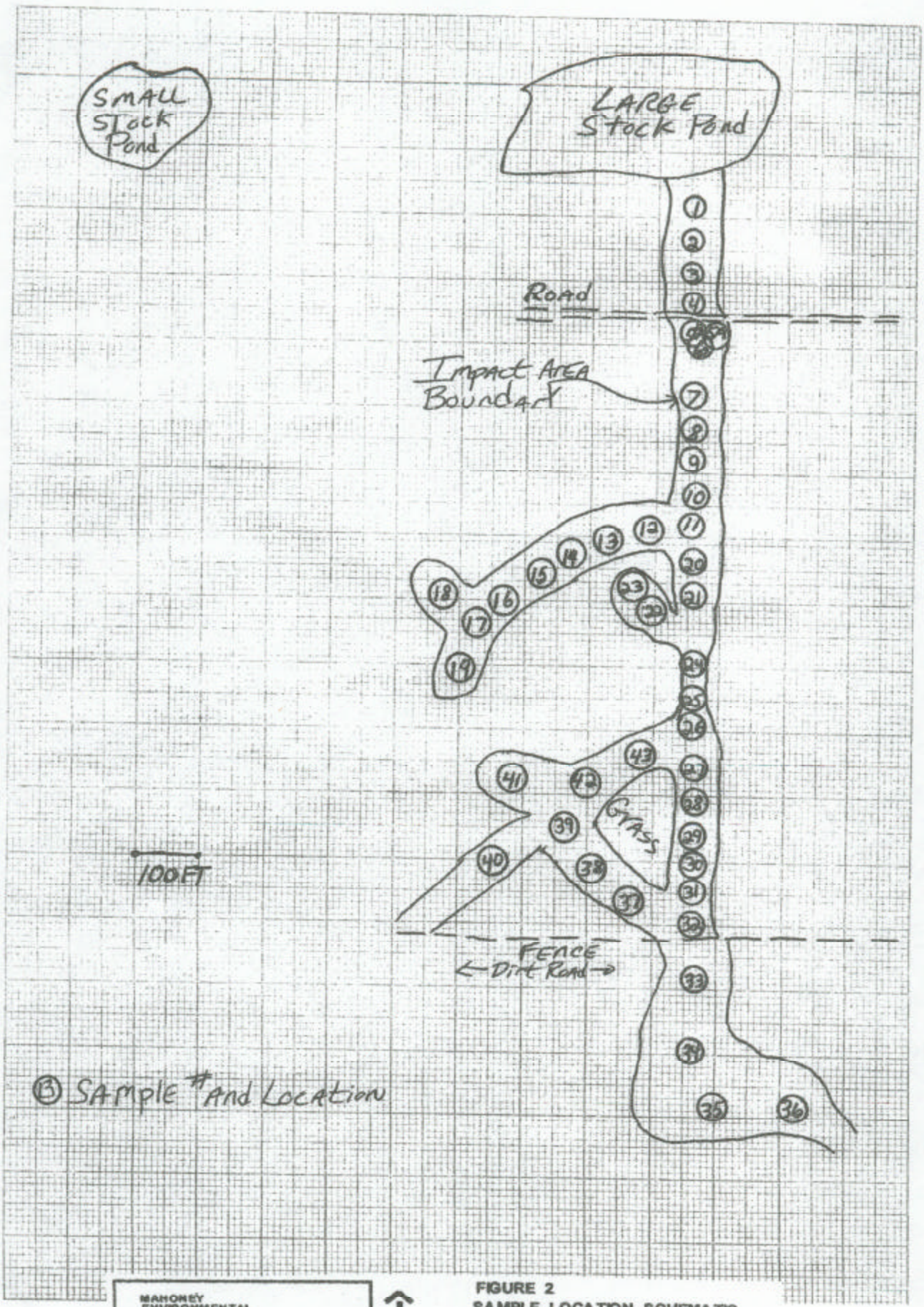
Phone: (970) 353-8118 • Fax: (970) 353-1671

Sample ID	pH (SI Units)	Conductivity (mmhos/cm)	Calcium (mg/kg)	Magnesium (mg/kg)	Sodium (mg/kg)	SAR
24	8.7	1.7	3925	161	2398	10.18
25	9.1	5.1	1945	107	6200	37.00
26	8.3	7.8	3550	305	6275	27.09
27	8.5	5.3	2675	213	4525	22.61
28	8.7	0.9	2205	215	5300	28.79
29	8.3	4.5	1738	100	3125	19.69
30	8.6	1.9	2600	107	1730	9.03
31	8.8	1.8	2245	86	2170	12.21
32	9.0	3.7	2068	82	4625	27.09
33	9.0	4.2	5350	151	6150	22.60
34	8.2	1.8	2575	129	1743	9.07
35	8.0	1.2	3000	156	1633	7.86
36	8.3	2.0	3050	116	2253	10.88
37	9.3	2.4	2600	67	3575	18.88
38	8.9	0.9	1928	106	4250	25.48
39	9.4	0.8	2975	134	8150	39.63
40	7.8	1.2	2875	168	2060	10.09
41	8.3	3.4	3150	245	5700	26.28
42	9.3	5.6	3475	149	8925	40.22
43	9.5	6.3	1545	123	6750	44.38
44	8.6	3.4	2418	181	4175	22.02
5B	7.9	1.7	4375	189	1708	6.86



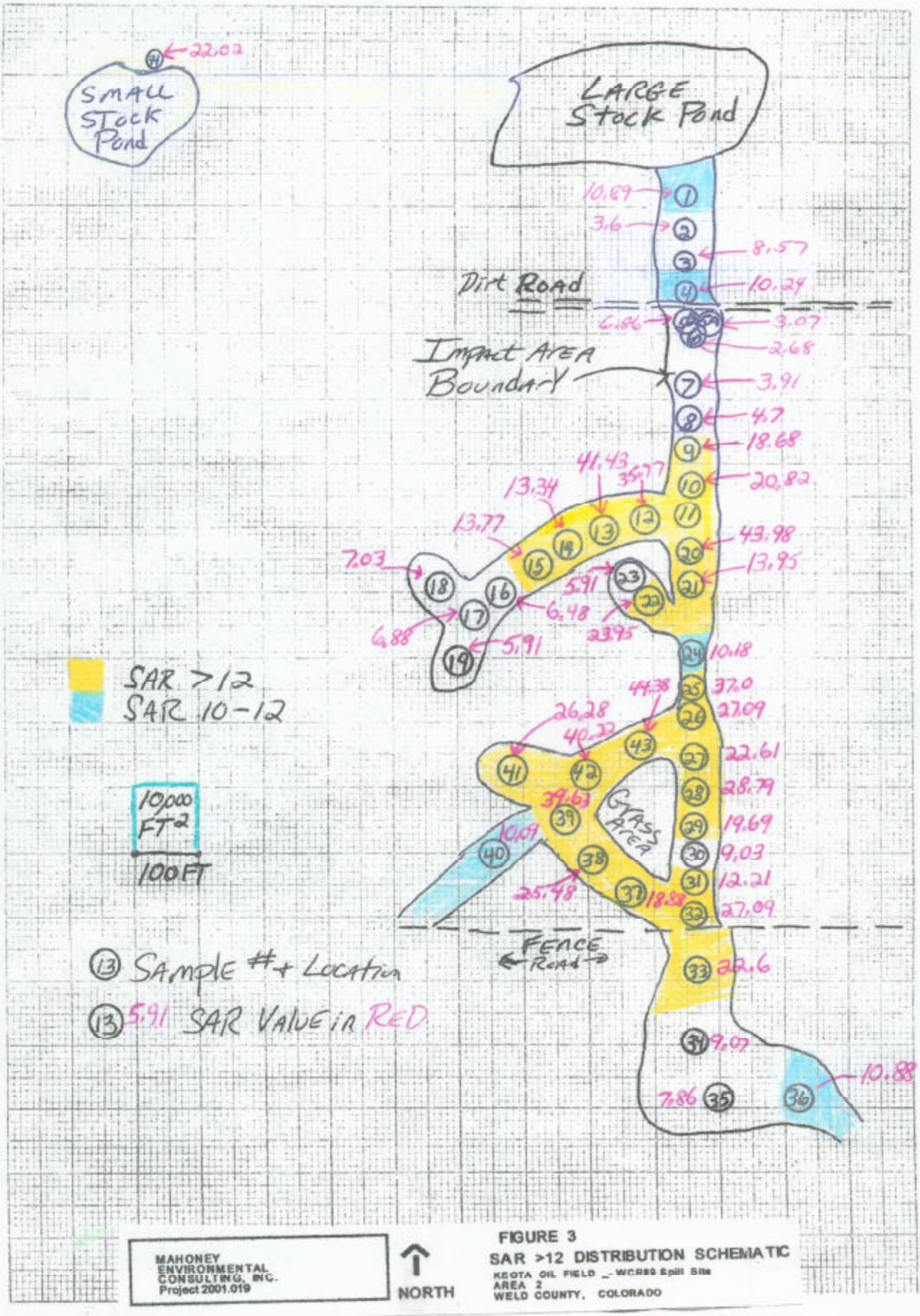
MAHONEY ENVIRONMENTAL

FIGURE 1
SITE LOCATION MAP



MAHONEY ENVIRONMENTAL CONSULTING, INC.
Project 2001.019

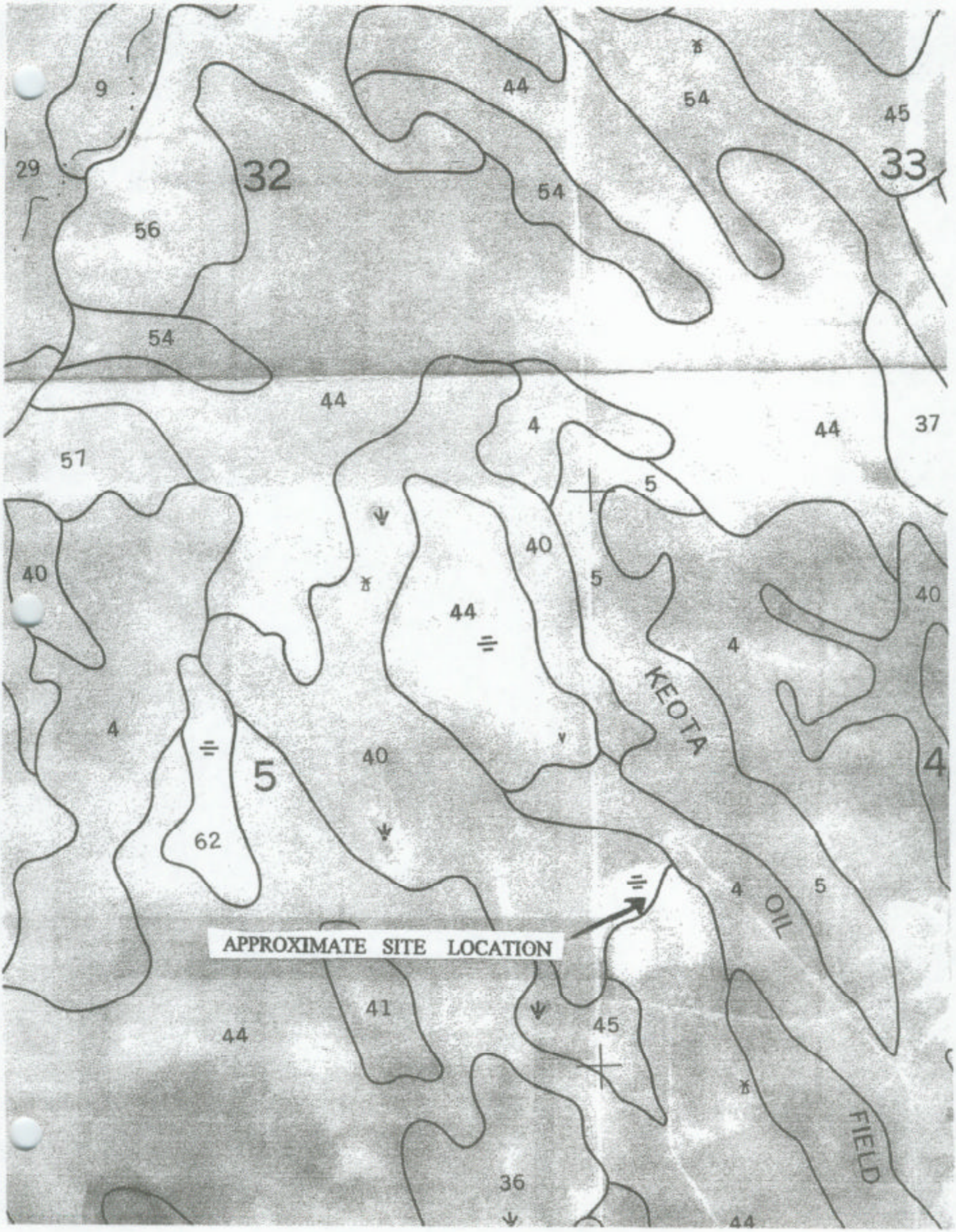
FIGURE 2
SAMPLE LOCATION SCHEMATIC
KEOTA OIL FIELD _- WCR89 Spill Site
AREA 2
WELD COUNTY, COLORADO



MAHONEY ENVIRONMENTAL CONSULTING, INC.
Project 2001.019

NORTH

FIGURE 3
SAR >12 DISTRIBUTION SCHEMATIC
KEOTA OIL FIELD _- WCRSS Spill Site
AREA 2
WELD COUNTY, COLORADO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KEOTA
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APPROXIMATE SITE LOCATION
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OIL
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FIELD
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