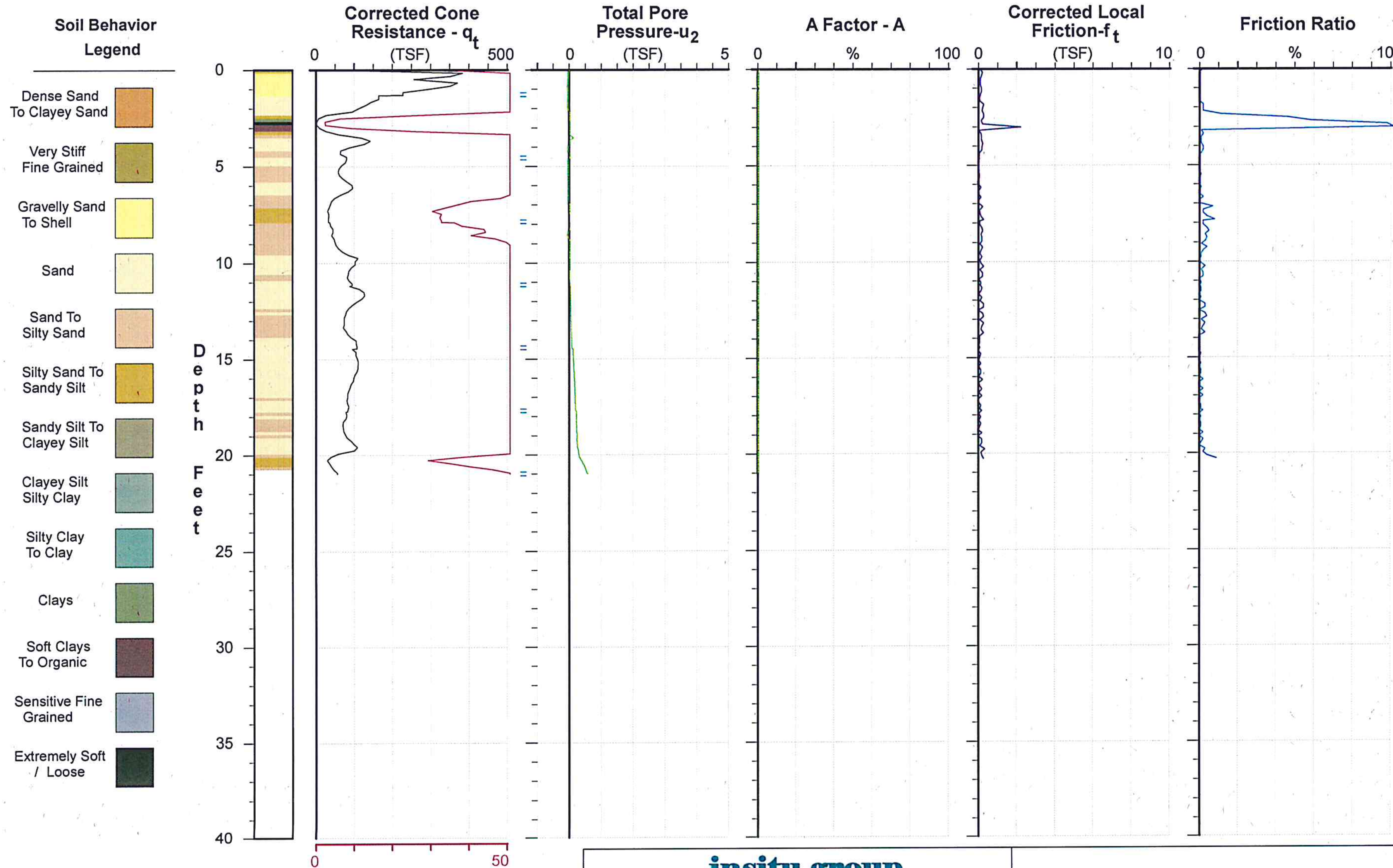
REV: 04-52.22 - 0

PIEZOCONE SOUNDING CPT 15: 134+15



Coarse Scale
Fine Scale
' = ' Push Interrupted To Add Rod
Static Data May Be Available

insitu group

Blue Marlin Engineering
OCLF
Sounding CPT 134+15
Test Date 06-01-2018 17:28:59

REV: 04-52.22 - 0

STANDARD SOIL BEHAVIOR TABLE

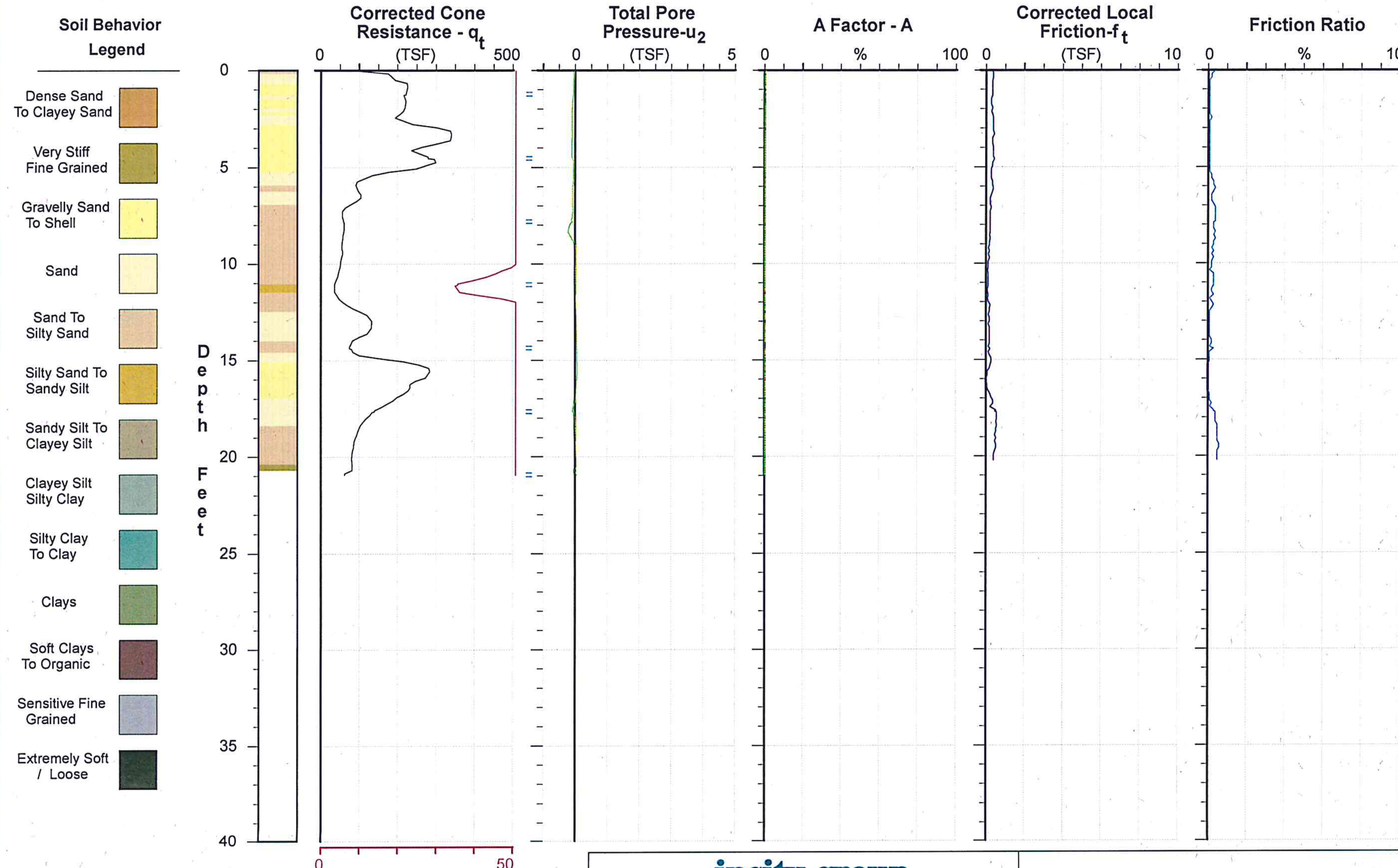
Depth (Feet)	Soil Behavior Type	Qt (TSF)	Corrected Local Friction Lf (TSF)	CPT N (#)	Vertical Effective Stress (TSF)	Relative Density (%)	Friction Angle (Degrees)	Constrained Modulus (TSF)	Undrained Shear Strength (TSF)	Sens.	Comp.	OCR
1	GRAVELLY SAND TO SAND	268.47	0.13	56	0.047	>85%	>43	767.016	--	--	--	--
2	SAND	111.51	0.19	21	0.11	65%-85%	>43	243.415	--	--	--	--
3	SOFT CLAYS TO ORGANIC	17.4	0.5	8	0.157	--	--	--	.593	.5	.02	6
4	SAND	100.44	0.17	17	0.212	58%-65%	41-43	194.754	--	--	--	--
5	SAND TO SILTY SAND	70.42	0.03	16	0.264	58%-65%	39-41	146.083	--	--	--	--
6	SAND	81.37	0.04	18	0.328	58%-65%	39-41	210.606	--	--	--	--
7	SILTY SAND TO SANDY SILT	37.05	0.1	10	0.384	42%-50%	35-37	74.137	--	--	--	--
8	SAND TO SILTY SAND	37.12	0.15	8	0.424	42%-50%	35-37	79.411	--	--	--	--
9	SAND TO SILTY SAND	52.68	0.16	12	0.489	50%-58%	35-37	115.394	--	--	--	--
10	SAND	95.63	0.14	19	0.544	58%-65%	37-39	223.283	--	--	--	--
11	SAND	91.44	0.15	18	0.604	50%-58%	37-39	207.411	--	--	--	--
12	SAND	109.16	0.17	20	0.651	50%-58%	37-39	231.72	--	--	--	--
13	SAND TO SILTY SAND	74.3	0.18	17	0.706	50%-58%	35-37	160.839	--	--	--	--
14	SAND	95.87	0.11	20	0.771	50%-58%	37-39	230.635	--	--	--	--
15	SAND	107.14	0.07	21	0.822	50%-58%	37-39	242.247	--	--	--	--
16	SAND	97.03	0.11	18	0.877	50%-58%	35-37	212.602	--	--	--	--
17	SAND	82.92	0.1	15	0.932	50%-58%	35-37	176.629	--	--	--	--
18	SAND	77.31	0.1	15	0.973	50%-58%	35-37	175.554	--	--	--	--
19	SAND	81.7	0.11	15	1.038	50%-58%	33-35	177.653	--	--	--	--
20	SILTY SAND TO SANDY SILT	61.33	0.18	12	1.093	35-42%	29-31	84.531	--	--	--	--
21	---------- END OF SOUNDING ----------	47.33										

insitu group

Blue Marlin Engineering
OCLF
Sounding # CPT 134+15
Test Date 06-01-2018 17:28:59

REV: 04-52.22 - 0

PIEZOCONE SOUNDING CPT 16: 135



Coarse Scale
Fine Scale
' = ' Push Interrupted To Add Rod
Static Data May Be Available

insitu group

Blue Marlin Engineering
OCLF
Sounding CPT 135
Test Date 06-01-2018 16:46:24

REV: 04-52.22 - 0

STANDARD SOIL BEHAVIOR TABLE

Depth (Feet)	Soil Behavior Type	Qt (TSF)	Corrected Local Friction Lf (TSF)	CPT N (#)	Vertical Effective Stress (TSF)	Relative Density (%)	Friction Angle (Degrees)	Constrained Modulus (TSF)	Undrained Shear Strength (TSF)	Sens.	Comp.	OCR
1	GRAVELLY SAND TO SAND	217.33	0.33	36	0.046	>85%	>43	494.684	--	--	--	--
2	GRAVELLY SAND TO SAND	211.43	0.32	34	0.113	>85%	>43	469.903	--	--	--	--
3	GRAVELLY SAND TO SAND	294.54	0.39	54	0.166	>85%	>43	738.037	--	--	--	--
4	GRAVELLY SAND TO SAND	277.77	0.37	38	0.221	>85%	>43	516.362	--	--	--	--
5	GRAVELLY SAND TO SAND	242.77	0.34	40	0.27	>85%	>43	544.839	--	--	--	--
6	SAND TO SILTY SAND	98.88	0.33	22	0.324	58%-65%	39-41	206.254	--	--	--	--
7	SAND TO SILTY SAND	74.98	0.24	15	0.378	50%-58%	37-39	140.523	--	--	--	--
8	SAND TO SILTY SAND	59.06	0.23	14	0.42	50%-58%	37-39	133.191	--	--	--	--
9	SAND TO SILTY SAND	55.71	0.18	13	0.485	50%-58%	35-37	120.432	--	--	--	--
10	SAND TO SILTY SAND	51.38	0.13	12	0.54	50%-58%	35-37	111.984	--	--	--	--
11	SILTY SAND TO SANDY SILT	38.07	0.12	11	0.6	35-42%	33-35	78.213	--	--	--	--
12	SAND TO SILTY SAND	65.77	0.16	16	0.656	50%-58%	35-37	149.985	--	--	--	--
13	SAND	127.62	0.17	25	0.709	58%-65%	37-39	289.843	--	--	--	--
14	SAND TO SILTY SAND	86.67	0.18	18	0.773	50%-58%	35-37	163.686	--	--	--	--
15	GRAVELLY SAND TO SAND	180.51	0.22	35	0.814	>85%	39-41	474.03	--	--	--	--
16	GRAVELLY SAND TO SAND	256.75	0.05	39	0.867	>85%	39-41	540.559	--	--	--	--
17	SAND	192.77	0.26	36	0.921	65%-85%	39-41	412.866	--	--	--	--
18	SAND	123.84	0.54	24	0.96	50%-58%	37-39	278.804	--	--	--	--
19	SAND TO SILTY SAND	91.52	0.5	21	1.025	50%-58%	35-37	196.444	--	--	--	--
20	SAND TO SILTY SAND	81.2	1.1	19	1.08	42%-50%	33-35	175.308	--	--	--	--
20.9	----------- END OF SOUNDING ----------	74.57										

insitu group

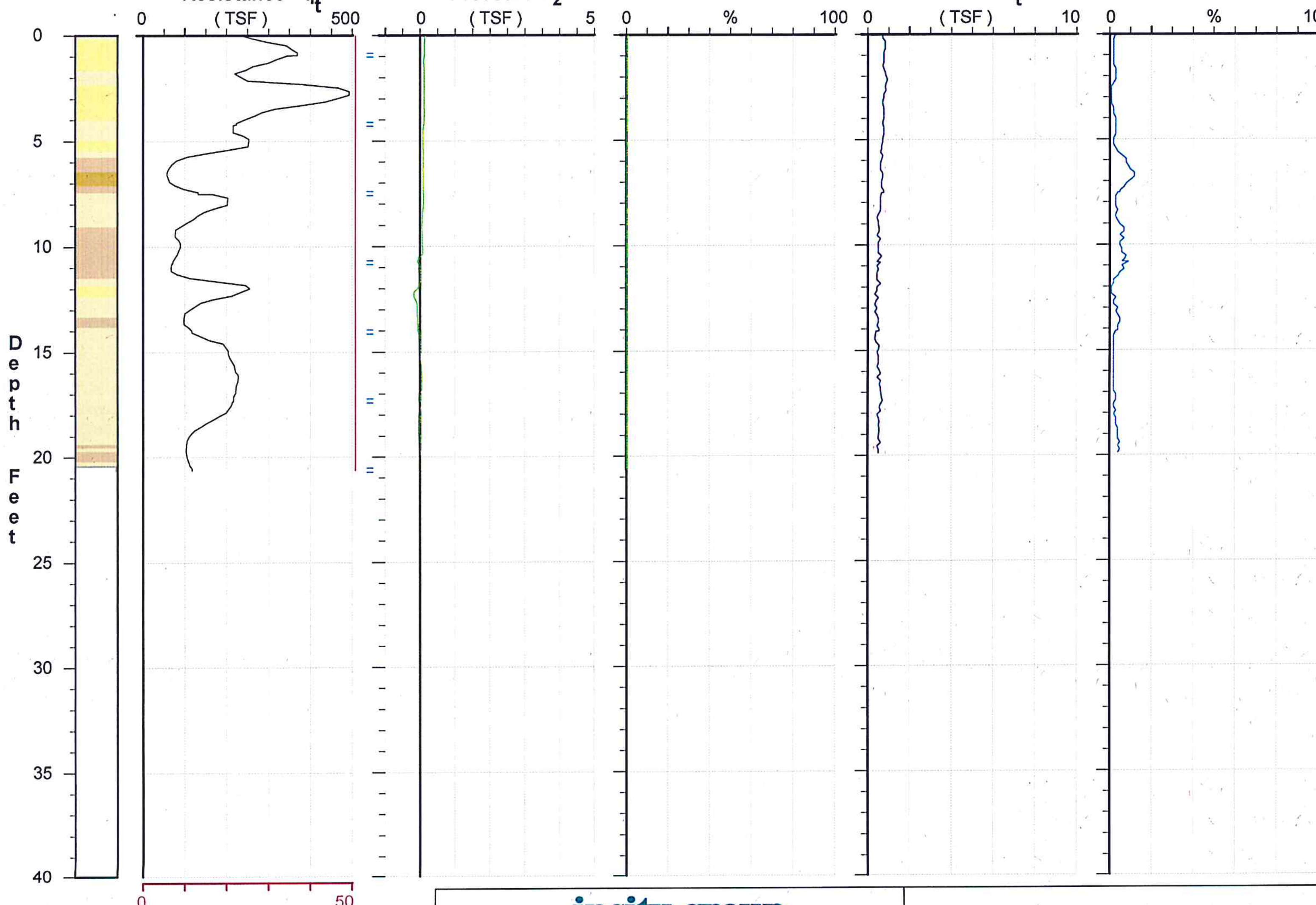
Blue Marlin Engineering
OCLF
Sounding # CPT 135
Test Date 06-01-2018 16:46:24

REV: 04-52.22 - 0

PIEZOCONE SOUNDING CPT 17: 135+59.03

Soil Behavior Legend

- Dense Sand To Clayey Sand
- Very Stiff Fine Grained
- Gravelly Sand To Shell
- Sand
- Sand To Silty Sand
- Silty Sand To Sandy Silt
- Sandy Silt To Clayey Silt
- Clayey Silt Silty Clay
- Silty Clay To Clay
- Clays
- Soft Clays To Organic
- Sensitive Fine Grained
- Extremely Soft / Loose



Coarse Scale
Fine Scale
' = ' Push Interrupted To Add Rod Static Data May Be Available

insitu group

Blue Marlin Engineering
OCLF
Sounding CPT 135+59.03
Test Date 06-01-2018 17:04:53

REV: 04-52.22 - 0

STANDARD SOIL BEHAVIOR TABLE

Depth (Feet)	Soil Behavior Type	Qt (TSF)	Corrected Local Friction Lf (TSF)	CPT N (#)	Vertical Effective Stress (TSF)	Relative Density (%)	Friction Angle (Degrees)	Constrained Modulus (TSF)	Undrained Shear Strength (TSF)	Sens.	Comp.	OCR
1	GRAVELLY SAND TO SAND	331.39	0.79	59	0.045	>85%	>43	807.936	--	--	--	--
2	SAND	298.5	0.86	48	0.115	>85%	>43	545.986	--	--	--	--
3	GRAVELLY SAND TO SAND	427.35	0.78	70	0.168	>85%	>43	952.821	--	--	--	--
4	SAND	237.97	0.76	43	0.226	>85%	>43	490.25	--	--	--	--
5	GRAVELLY SAND TO SAND	234.67	0.73	40	0.271	>85%	>43	552.673	--	--	--	--
6	SAND TO SILTY SAND	87.07	0.64	16	0.326	50%-58%	39-41	152.555	--	--	--	--
7	SAND TO SILTY SAND	80.43	0.71	18	0.381	58%-65%	37-39	165.918	--	--	--	--
8	SAND	173.73	0.65	39	0.422	>85%	41-43	442.337	--	--	--	--
9	SAND TO SILTY SAND	99.69	0.52	22	0.485	58%-65%	37-39	198.266	--	--	--	--
10	SAND TO SILTY SAND	84.37	0.52	21	0.54	50%-58%	37-39	194.908	--	--	--	--
11	SAND TO SILTY SAND	76.43	0.52	16	0.591	50%-58%	35-37	145.909	--	--	--	--
12	GRAVELLY SAND TO SAND	214.12	0.47	37	0.655	>85%	41-43	511.58	--	--	--	--
13	SAND	111.24	0.42	19	0.708	50%-58%	37-39	218.408	--	--	--	--
14	SAND	122.06	0.46	23	0.757	58%-65%	37-39	261.836	--	--	--	--
15	SAND	201.59	0.49	39	0.811	65%-85%	39-41	445.736	--	--	--	--
16	SAND	222.23	0.54	44	0.865	>85%	39-41	500.346	--	--	--	--
17	SAND	217.47	0.65	42	0.918	65%-85%	39-41	474.726	--	--	--	--
18	SAND	185.21	0.55	35	0.968	65%-85%	37-39	398.94	--	--	--	--
19	SAND	115.55	0.55	21	1.021	50%-58%	35-37	239.554	--	--	--	--
20	SAND TO SILTY SAND	105.43	-171.33	25	1.076	50%-58%	35-37	231.72	--	--	--	--
20.6	----------- END OF SOUNDING ----------	116.98										

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Blue Marlin Engineering
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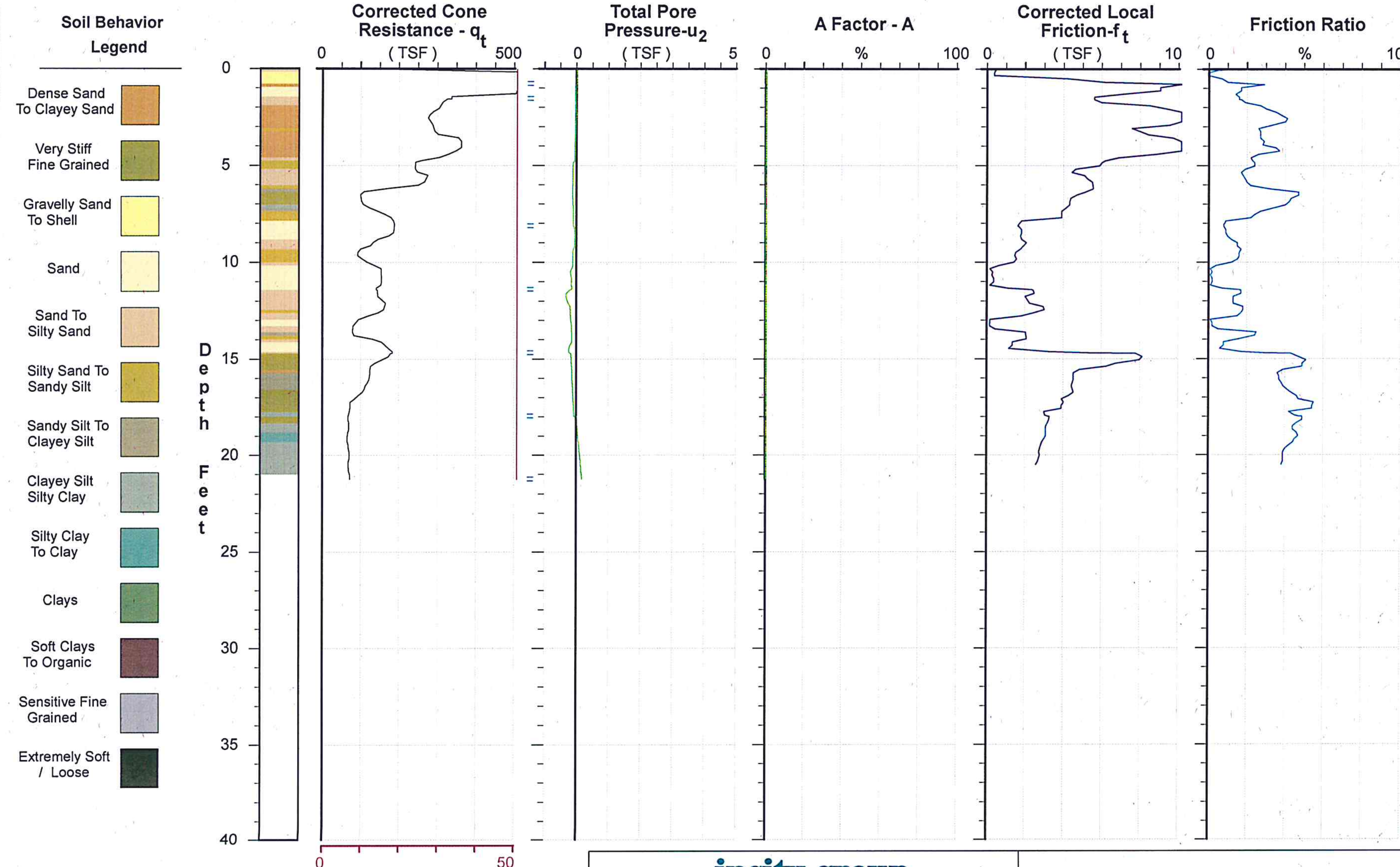
Sounding # CPT 135+59.03
Test Date 06-01-2018 17:04:53

REV: 04-52.22 - 0

PIEZOCONE SOUNDING CPT 18: 139



Coarse Scale
Fine Scale
' = ' Push Interrupted To Add Rod
Static Data May Be Available

insitu group

Blue Marlin Engineering
OCLF
Sounding CPT 139
Test Date 06-02-2018 08:12:22

REV: 04-52.22 - 0

STANDARD SOIL BEHAVIOR TABLE

Depth (Feet)	Soil Behavior Type	Qt (TSF)	Corrected Local Friction Lf (TSF)	CPT N (#)	Vertical Effective Stress (TSF)	Relative Density (%)	Friction Angle (Degrees)	Constrained Modulus (TSF)	Undrained Shear Strength (TSF)	Sens.	Comp.	OCR
1	DENSE SAND TO CLAYEY SAND	520.36	9	291	0.043	>85%	>43	1313.536	--	--	--	--
2	DENSE SAND TO CLAYEY SAND	307.08	8	147	0.111	>85%	>43	666.173	--	--	--	--
3	SILTY SAND TO SANDY SILT	287.11	9.4	94	0.166	>85%	>43	635.781	--	--	--	--
4	DENSE SAND TO CLAYEY SAND	352.17	10.92	176	0.222	>85%	>43	794.173	--	--	--	--
5	SILTY SAND TO SANDY SILT	255.51	5.65	78	0.273	>85%	>43	531.066	--	--	--	--
6	SILTY SAND TO SANDY SILT	222.73	5.34	81	0.328	>85%	>43	547.768	--	--	--	--
7	CLAYEY SILT TO SILTY CLAY	111.77	4.28	51	0.39	--	--	--	7.045	2.4	0	>6
8	SAND	181.77	2.27	36	0.45	>85%	41-43	411.289	--	--	--	--
9	SAND TO SILTY SAND	127.8	1.8	30	0.506	58%-65%	39-41	274.81	--	--	--	--
10	SAND	119.2	1.04	26	0.562	58%-65%	39-41	296.017	--	--	--	--
11	SAND	148.27	0.92	29	0.616	65%-85%	39-41	333.025	--	--	--	--
12	SAND TO SILTY SAND	154.18	2.46	40	0.666	65%-85%	39-41	361.656	--	--	--	--
13	SAND	100.26	0.88	16	0.721	50%-58%	35-37	190.269	--	--	--	--
14	SAND	129.75	1.67	30	0.777	58%-65%	37-39	338.319	--	--	--	--
15	VERY STIFF FINE GRAINED	160.98	6.46	150	0.829	--	--	--	10.219	1.9	0	>6
16	SANDY SILT TO CLAYEY SILT	119.84	4.55	47	0.889	50%-58%	37-39	266.393	--	--	--	--
17	VERY STIFF FINE GRAINED	88.78	4.18	81	0.951	--	--	--	5.468	2.1	0	>6
18	VERY STIFF FINE GRAINED	68.47	3.24	65	1.005	--	--	--	4.372	2	0	>6
19	SILTY CLAY to CLAY	66.26	2.99	42	1.077	--	--	--	4.259	2.1	0	6
20	CLAYEY SILT TO SILTY CLAY	68.93	2.71	34	1.138	--	--	--	4.587	2.5	0	>6
21.2	----------- END OF SOUNDING ----------	69.56										

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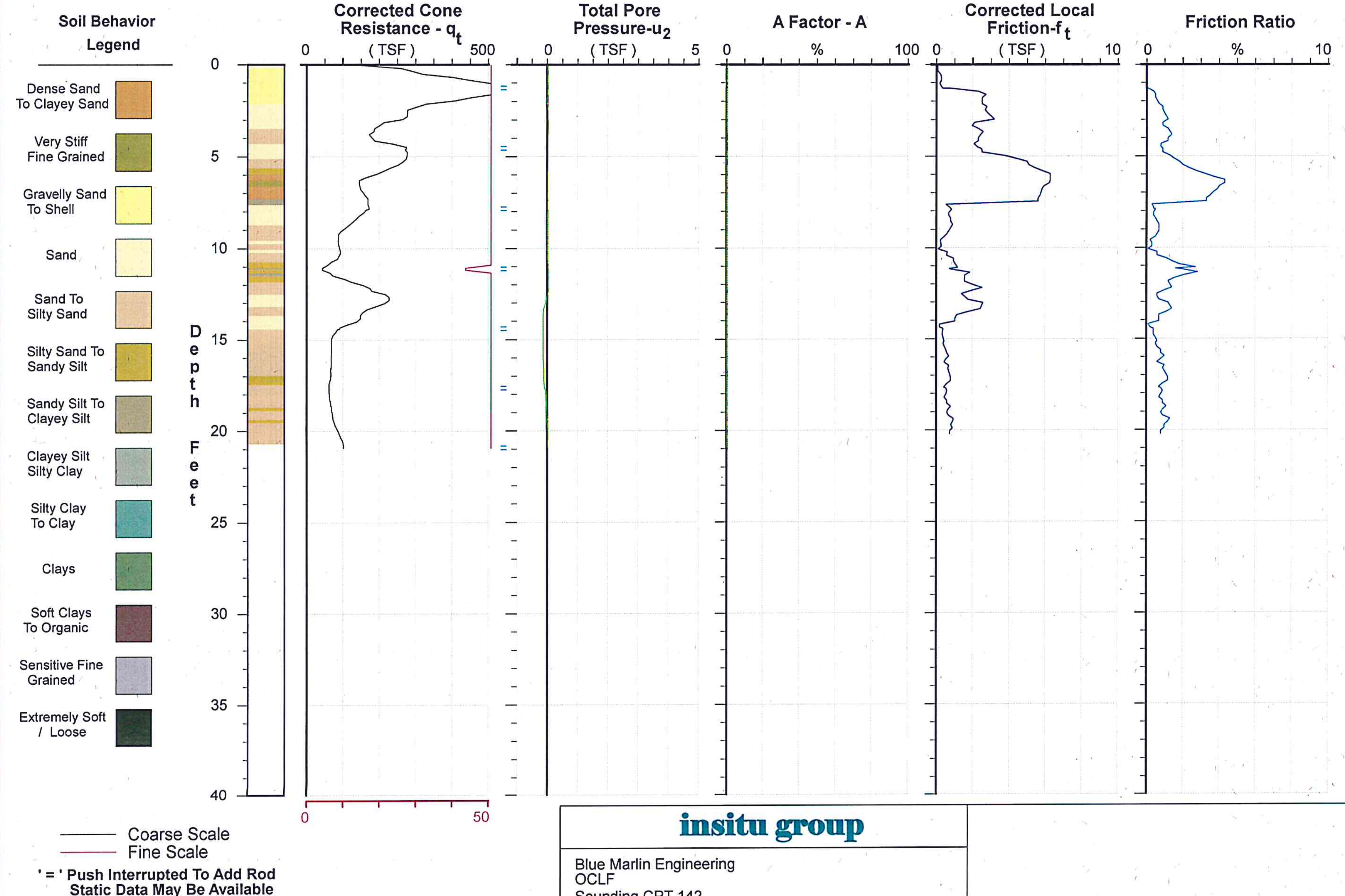
Blue Marlin Engineering
OCLF
Sounding # CPT 139
Test Date 06-02-2018 08:12:22

REV: 04-52.22 - 0

PIEZOCONE SOUNDING CPT 19: 142



insitu group

Blue Marlin Engineering
OCLF
Sounding CPT 142
Test Date 06-02-2018 12:30:03

REV: 04-52.22 - 0

STANDARD SOIL BEHAVIOR TABLE

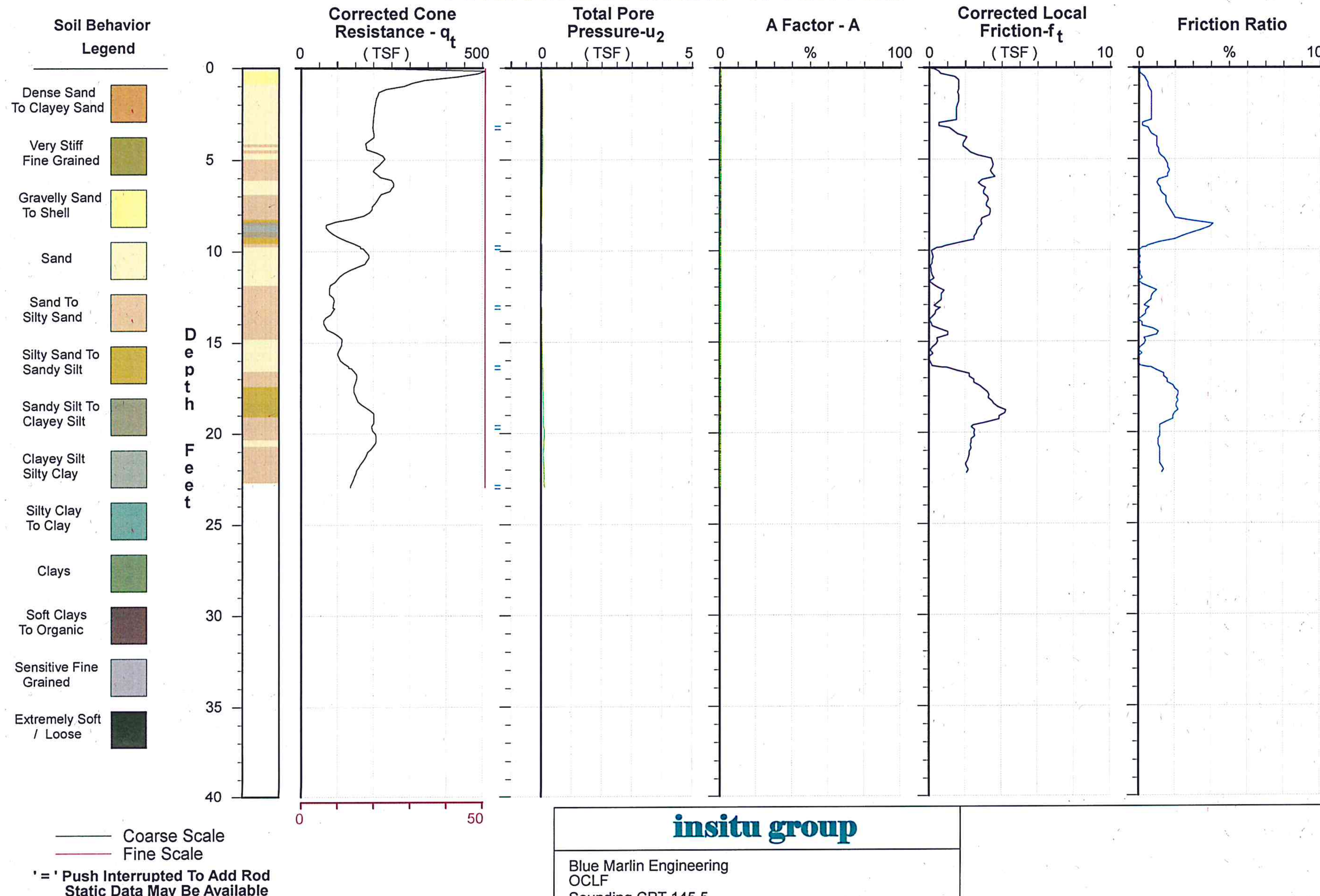
Depth (Feet)	Soil Behavior Type	Qt (TSF)	Corrected Local Friction Lf (TSF)	CPT N (#)	Vertical Effective Stress (TSF)	Relative Density (%)	Friction Angle (Degrees)	Constrained Modulus (TSF)	Undrained Shear Strength (TSF)	Sens.	Comp.	OCR
1	GRAVELLY SAND TO SAND	491.23	0.59	72	0.045	>85%	>43	982.446	--	--	--	--
2	SAND	378.43	2.62	64	0.112	>85%	>43	722.247	--	--	--	--
3	SAND	235.87	2.57	41	0.165	>85%	>43	467.271	--	--	--	--
4	SAND TO SILTY SAND	205.35	2.33	45	0.221	>85%	>43	413.337	--	--	--	--
5	SAND TO SILTY SAND	269.09	3.66	66	0.272	>85%	>43	602.685	--	--	--	--
6	DENSE SAND TO CLAYEY SAND	181.83	6.03	80	0.327	>85%	41-43	364.677	--	--	--	--
7	DENSE SAND TO CLAYEY SAND	158.05	5.72	78	0.385	>85%	41-43	355.174	--	--	--	--
8	SAND	158.96	0.73	31	0.428	>85%	41-43	360.427	--	--	--	--
9	SAND TO SILTY SAND	103.5	0.7	23	0.491	58%-65%	37-39	209.213	--	--	--	--
10	SAND	89.7	0.35	17	0.545	50%-58%	37-39	200.744	--	--	--	--
11	SILTY SAND TO SANDY SILT	57.92	1.08	14	0.605	42%-50%	33-35	96.03	--	--	--	--
12	SAND TO SILTY SAND	134.17	1.86	37	0.654	65%-85%	39-41	340.326	--	--	--	--
13	SAND	206.49	2.02	41	0.708	>85%	39-41	471.572	--	--	--	--
14	SAND	120.18	0.75	21	0.772	50%-58%	37-39	243.138	--	--	--	--
15	SAND TO SILTY SAND	70.84	0.39	16	0.821	50%-58%	35-37	148.992	--	--	--	--
16	SAND TO SILTY SAND	67.51	0.59	16	0.876	42%-50%	33-35	147.937	--	--	--	--
17	SILTY SAND TO SANDY SILT	64.98	0.71	21	0.931	42%-50%	33-35	143.677	--	--	--	--
18	SAND TO SILTY SAND	62.37	0.51	15	0.971	42%-50%	33-35	135.188	--	--	--	--
19	SAND TO SILTY SAND	69.33	0.71	17	1.036	42%-50%	33-35	154.224	--	--	--	--
20	SAND TO SILTY SAND	84.43	0.85	21	1.091	50%-58%	33-35	190.177	--	--	--	--
20.9	----------- END OF SOUNDING ----------	99.89										

insitu group

Blue Marlin Engineering
OCLF
Sounding # CPT 142
Test Date 06-02-2018 12:30:03

REV: 04-52.22 - 0

PIEZOCONE SOUNDING CPT 20: 145.5



insitu group

Blue Marlin Engineering
OCLF
Sounding CPT 145.5
Test Date 06-02-2018 10:26:18

REV: 04-52.22 - 0

STANDARD SOIL BEHAVIOR TABLE

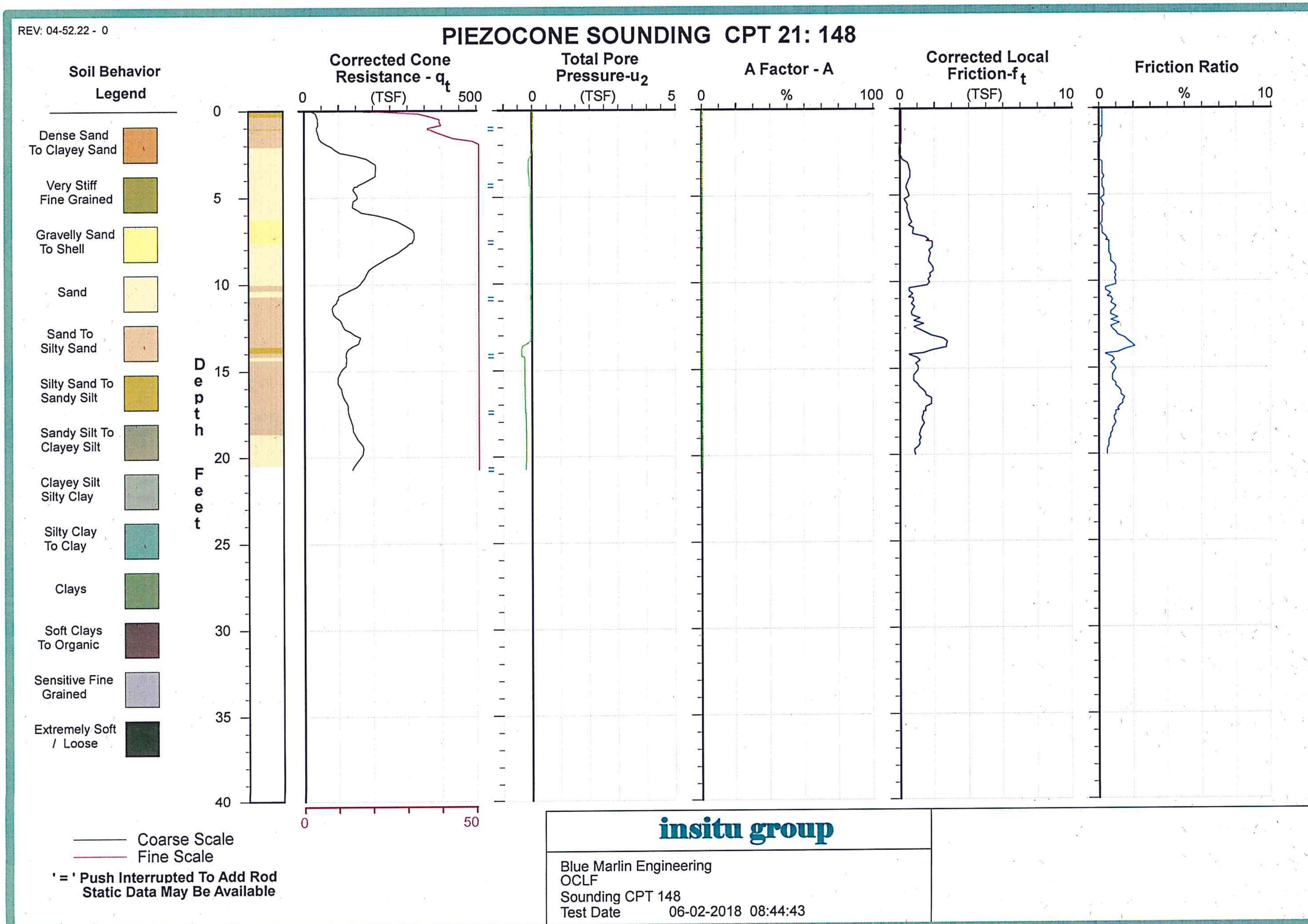
Depth (Feet)	Soil Behavior Type	Qt (TSF)	Corrected Local Friction Lf (TSF)	CPT N (#)	Vertical Effective Stress (TSF)	Relative Density (%)	Friction Angle (Degrees)	Constrained Modulus (TSF)	Undrained Shear Strength (TSF)	Sens.	Comp.	OCR
1	SAND	287.34	1.58	59	0.045	>85%	>43	670.402	--	--	--	--
2	SAND	203.93	1.56	39	0.117	>85%	>43	444.2	--	--	--	--
3	SAND	198.34	1.14	38	0.171	>85%	>43	433.571	--	--	--	--
4	SAND TO SILTY SAND	187.29	1.9	43	0.221	>85%	>43	388.966	--	--	--	--
5	SAND TO SILTY SAND	217.34	3.14	54	0.275	>85%	>43	489.85	--	--	--	--
6	SAND	230.18	3.16	48	0.329	>85%	>43	547.225	--	--	--	--
7	SAND TO SILTY SAND	223.11	3.12	52	0.38	>85%	>43	470.763	--	--	--	--
8	SAND TO SILTY SAND	163.77	3.16	41	0.436	>85%	41-43	378.378	--	--	--	--
9	SANDY SILT TO CLAYEY SILT	88.07	2.64	34	0.495	58%-65%	37-39	193.576	--	--	--	--
10	SAND	169.88	0.6	33	0.537	65%-85%	39-41	374.661	--	--	--	--
11	SAND	145.35	0.14	26	0.6	58%-65%	39-41	297.656	--	--	--	--
12	SAND TO SILTY SAND	84.73	0.42	19	0.654	50%-58%	35-37	171.284	--	--	--	--
13	SAND TO SILTY SAND	87.82	0.5	21	0.713	50%-58%	35-37	192.522	--	--	--	--
14	SAND TO SILTY SAND	70.04	0.35	16	0.77	50%-58%	35-37	146.831	--	--	--	--
15	SAND	108.01	0.43	21	0.824	50%-58%	37-39	244.541	--	--	--	--
16	SAND	118.7	0.32	25	0.886	58%-65%	37-39	289.146	--	--	--	--
17	SAND TO SILTY SAND	149.41	2.29	36	0.927	58%-65%	37-39	332.933	--	--	--	--
18	SILTY SAND TO SANDY SILT	152.65	3.3	49	0.983	58%-65%	37-39	335.841	--	--	--	--
19	SAND TO SILTY SAND	195.19	3.86	48	1.038	65%-85%	37-39	441.518	--	--	--	--
20	SAND TO SILTY SAND	200.47	2.44	49	1.089	65%-85%	37-39	449.474	--	--	--	--
21	SAND TO SILTY SAND	188.93	2.25	44	1.143	58%-65%	37-39	402.749	--	--	--	--
22	SAND TO SILTY SAND	156.43	2.08	37	1.199	58%-65%	37-39	334.786	--	--	--	--
22.9	---------- END OF SOUNDING ----------	139.78										

insitu group

Blue Marlin Engineering
OCLF
Sounding # CPT 145.5
Test Date 06-02-2018 10:26:18

REV: 04-52.22 - 0

PIEZOCONE SOUNDING CPT 21: 148



insitu group

Blue Marlin Engineering
OCLF
Sounding CPT 148
Test Date 06-02-2018 08:44:43

REV: 04-52.22 - 0

STANDARD SOIL BEHAVIOR TABLE

Depth (Feet)	Soil Behavior Type	Qt (TSF)	Corrected Local Friction Lf (TSF)	CPT N (#)	Vertical Effective Stress (TSF)	Relative Density (%)	Friction Angle (Degrees)	Constrained Modulus (TSF)	Undrained Shear Strength (TSF)	Sens.	Comp.	OCR
1	SAND TO SILTY SAND	38.11	0.08	9	0.047	50%-58%	>43	87.244	--	--	--	--
2	SAND	70.98	0.05	15	0.114	58%-65%	>43	172.922	--	--	--	--
3	SAND	190.75	0.28	40	0.168	>85%	>43	454.359	--	--	--	--
4	SAND	176.84	0.5	30	0.232	>85%	>43	344.34	--	--	--	--
5	SAND	146.24	0.4	30	0.272	>85%	>43	339.015	--	--	--	--
6	SAND	197.93	0.49	41	0.326	>85%	>43	469.145	--	--	--	--
7	GRAVELLY SAND TO SAND	309.07	0.83	51	0.38	>85%	>43	701.829	--	--	--	--
8	SAND	292.29	1.75	57	0.421	>85%	>43	652.113	--	--	--	--
9	SAND	208.18	1.79	38	0.484	>85%	41-43	437.401	--	--	--	--
10	SAND TO SILTY SAND	160.58	1.49	39	0.538	65%-85%	39-41	354.877	--	--	--	--
11	SAND TO SILTY SAND	95.26	0.68	23	0.585	50%-58%	37-39	209.981	--	--	--	--
12	SAND TO SILTY SAND	97.15	0.91	25	0.65	50%-58%	37-39	229.017	--	--	--	--
13	SAND TO SILTY SAND	145.84	1.76	39	0.705	65%-85%	39-41	356.997	--	--	--	--
14	SAND	124.29	1.53	23	0.763	58%-65%	37-39	264.11	--	--	--	--
15	SAND TO SILTY SAND	109.2	0.99	25	0.811	50%-58%	37-39	230.184	--	--	--	--
16	SAND TO SILTY SAND	102.98	1.08	26	0.866	50%-58%	35-37	234.424	--	--	--	--
17	SAND TO SILTY SAND	123.41	1.61	30	0.93	50%-58%	37-39	276.725	--	--	--	--
18	SAND TO SILTY SAND	136.43	1.32	33	0.983	58%-65%	37-39	305.274	--	--	--	--
19	SAND	158.46	1.13	31	1.037	58%-65%	37-39	356.024	--	--	--	--
20	SAND	158.82	0.89	30	1.091	58%-65%	37-39	345.466	--	--	--	--
20.7	---------- END OF SOUNDING ----------	139.24										

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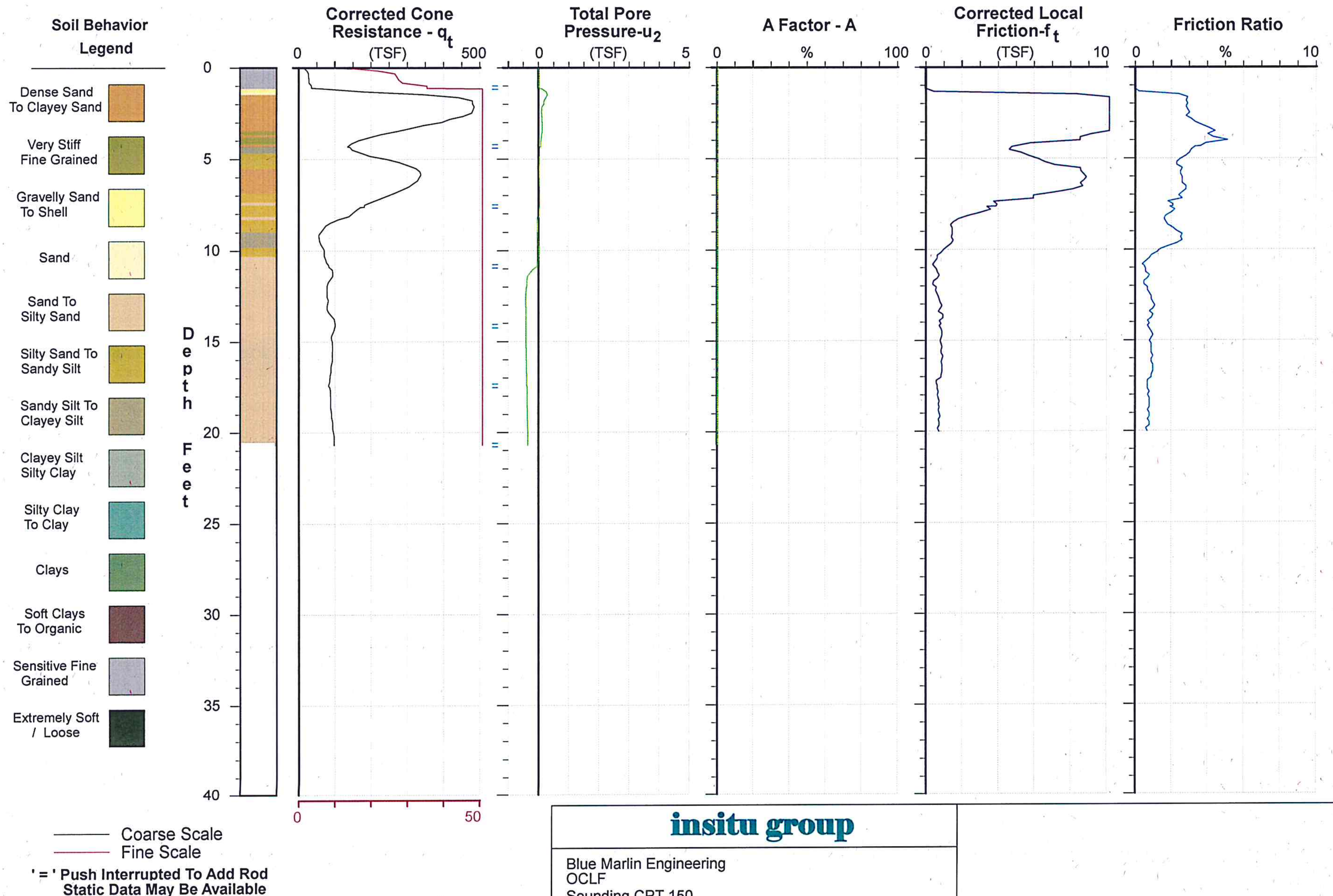

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STANDARD SOIL BEHAVIOR TABLE

Depth (Feet)	Soil Behavior Type	Qt (TSF)	Corrected Local Friction Lf (TSF)	CPT N (#)	Vertical Effective Stress (TSF)	Relative Density (%)	Friction Angle (Degrees)	Constrained Modulus (TSF)	Undrained Shear Strength (TSF)	Sens.	Comp.	OCR
1	SENSITIVE FINE GRAINED	92.77	-0.4	13	0.034	--	--	--	1.894	1000	0	>6
2	DENSE SAND TO CLAYEY SAND	472.41	13.87	235	0.103	>85%	>43	1062.215	--	--	--	--
3	DENSE SAND TO CLAYEY SAND	363.59	12.91	167	0.158	>85%	>43	755.927	--	--	--	--
4	DENSE SAND TO CLAYEY SAND	167.96	6.91	71	0.217	>85%	>43	320.348	--	--	--	--
5	SILTY SAND TO SANDY SILT	222.46	5.89	78	0.265	>85%	>43	532.357	--	--	--	--
6	DENSE SAND TO CLAYEY SAND	327.44	8.63	161	0.32	>85%	>43	728.954	--	--	--	--
7	SILTY SAND TO SANDY SILT	252.89	6.57	79	0.375	>85%	>43	535.531	--	--	--	--
8	SILTY SAND TO SANDY SILT	146.31	2.93	48	0.428	>85%	41-43	324.628	--	--	--	--
9	SANDY SILT TO CLAYEY SILT	61.97	1.45	21	0.494	50%-58%	35-37	121.149	--	--	--	--
10	SILTY SAND TO SANDY SILT	68.38	0.96	22	0.551	50%-58%	37-39	153.999	--	--	--	--
11	SAND TO SILTY SAND	86.65	0.55	22	0.602	50%-58%	37-39	202.864	--	--	--	--
12	SAND TO SILTY SAND	80.05	0.54	19	0.657	50%-58%	35-37	172.247	--	--	--	--
13	SAND TO SILTY SAND	79.25	0.77	18	0.712	50%-58%	35-37	170.127	--	--	--	--
14	SAND TO SILTY SAND	97.07	0.83	24	0.773	50%-58%	37-39	219.934	--	--	--	--
15	SAND TO SILTY SAND	92.01	0.87	22	0.82	50%-58%	35-37	202.977	--	--	--	--
16	SAND TO SILTY SAND	91.41	0.88	22	0.875	50%-58%	35-37	202.977	--	--	--	--
17	SAND TO SILTY SAND	85.17	0.75	20	0.94	50%-58%	35-37	188.129	--	--	--	--
18	SAND TO SILTY SAND	87.15	0.69	21	0.993	50%-58%	35-37	192.358	--	--	--	--
19	SAND TO SILTY SAND	90.72	0.74	22	1.048	50%-58%	35-37	198.717	--	--	--	--
20	SAND TO SILTY SAND	95.52	0.71	23	1.103	50%-58%	35-37	213.534	--	--	--	--
20.7	----------- END OF SOUNDING ----------	97.54										

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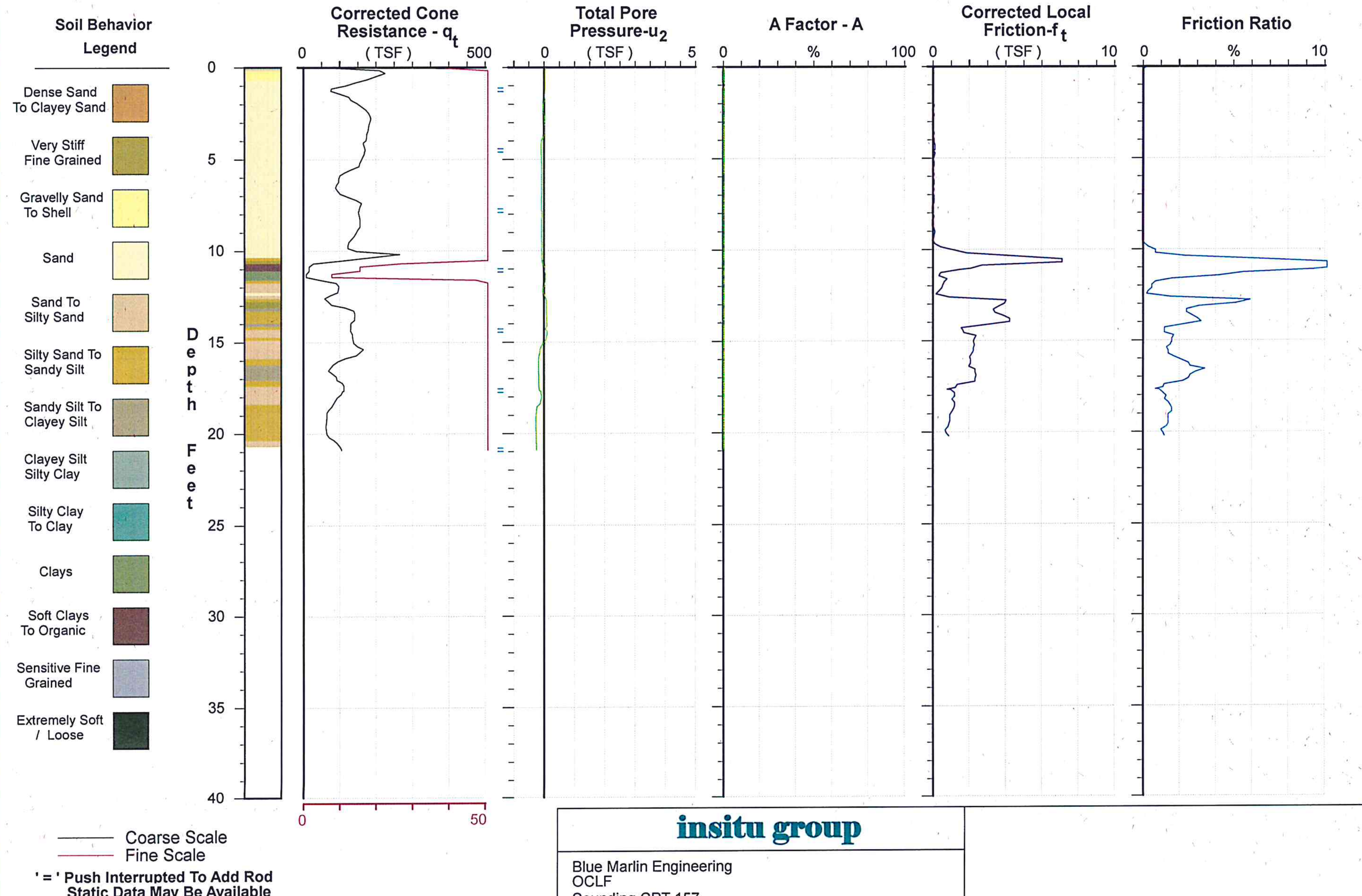

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Test Date 06-02-2018 09:39:20

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STANDARD SOIL BEHAVIOR TABLE

Depth (Feet)	Soil Behavior Type	Qt (TSF)	Corrected Local Friction Lf (TSF)	CPT N (#)	Vertical Effective Stress (TSF)	Relative Density (%)	Friction Angle (Degrees)	Constrained Modulus (TSF)	Undrained Shear Strength (TSF)	Sens.	Comp.	OCR
1	SAND	119.39	0.02	27	0.045	>85%	>43	313.272	--	--	--	--
2	SAND	151.16	0.03	30	0.113	>85%	>43	348.323	--	--	--	--
3	SAND	180.65	0.03	35	0.167	>85%	>43	396.042	--	--	--	--
4	SAND	169.83	0.08	31	0.221	>85%	>43	360.017	--	--	--	--
5	SAND	161.43	0.07	30	0.27	>85%	>43	347.279	--	--	--	--
6	SAND	105.04	0.05	18	0.323	58%-65%	39-41	213.606	--	--	--	--
7	SAND	118.46	0.05	24	0.377	65%-85%	41-43	274.073	--	--	--	--
8	SAND	153.35	0.03	29	0.417	>85%	41-43	330.833	--	--	--	--
9	SAND	145.95	0.06	28	0.481	65%-85%	39-41	317.573	--	--	--	--
10	SAND	161.1	1.35	28	0.534	65%-85%	39-41	320.747	--	--	--	--
11	CLAYS	28.51	3.03	15	0.584	--	--	--	.993	1	.01	6
12	SAND TO SILTY SAND	82.71	0.49	23	0.642	50%-58%	37-39	209.858	--	--	--	--
13	SANDY SILT TO CLAYEY SILT	99.29	3.2	44	0.699	58%-65%	37-39	252.764	--	--	--	--
14	SILTY SAND TO SANDY SILT	133.36	3.07	42	0.755	58%-65%	37-39	285.665	--	--	--	--
15	SAND TO SILTY SAND	142.66	2.19	33	0.806	58%-65%	37-39	303.81	--	--	--	--
16	SILTY SAND TO SANDY SILT	110.73	2.08	30	0.862	50%-58%	35-37	208.353	--	--	--	--
17	SILTY SAND TO SANDY SILT	91.08	2.18	29	0.921	50%-58%	35-37	201.984	--	--	--	--
18	SAND TO SILTY SAND	99.33	1.1	25	0.964	50%-58%	35-37	227.368	--	--	--	--
19	SILTY SAND TO SANDY SILT	67.07	1.04	20	1.029	42%-50%	33-35	141.557	--	--	--	--
20	SILTY SAND TO SANDY SILT	67.71	0.85	20	1.084	42%-50%	33-35	141.557	--	--	--	--
20.9	----------- END OF SOUNDING ----------	99.06										

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Appendix I

Ardaman & Associates, Inc. Report

"Evaluation of Groundwater Elevations and Flow Patterns beneath Cells 9 through 12 at Orange County Landfill Southern Expansion Site, Orlando, Florida"

Ardaman & Associates, Inc.

Geotechnical, Environmental and Materials Consultants

June 14, 2018
File Number 17-13-0115

Blue Marling Engineering
102 Drennan Road
Suite B-10
Orlando, FL 32806

Attention: Mr. Osciel F. Plaza, P.E.

Subject: Evaluation of Groundwater Elevations and Flow Patterns beneath Cells 9 through 12 at Orange County Landfill Southern Expansion Site, Orlando, Florida

Gentlemen/Ladies:

As requested by Neel Schaffer, Inc. (NSI) and Jacobs Engineering Group (Jacobs) and authorized by Blue Marlin Engineering (BME), Ardaman & Associates, Inc., (Ardaman) has completed an engineering evaluation of groundwater elevations and flow patterns beneath the existing Cells 9 and 10 and the proposed Cells 11 and 12 at the Orange County Landfill Southern Expansion Site. The primary objective of our study was to evaluate and predict groundwater elevations and flow patterns beneath the footprints of these four landfill cells before, during, and after construction of Cells 11 and 12. The information will be used to aid in design of the bottom liner and leachate collection systems for Cells 11 and 12 by NSI and Jacobs.

At the beginning of this study, Messrs. Francis K. Cheung, P.E., and Jeyisanker Mathiyaparanam, P.E., of Ardaman visited the Southern Expansion Site and met with Mr. Dan Courcy, P.E., of Orange County Solid Waste Division on August 18, 2017 to observe the topographic and drainage conditions at and in the vicinity of the proposed Cells 11 and 12. Following the site visit, Ardaman accompanied NSI, Jacobs, GAI Consultants, and Orange County to attend the pre-permit application meeting with the Florida Department of Environmental Protection (FDEP) on August 24, 2017. After the FDEP meeting, Ardaman attended a team meeting with NSI, Jacobs, and BME on September 27, 2017 to review available soil and groundwater data, and to explain the need to document aquifer properties to support our groundwater evaluation effort. On February 1, 2018, Ardaman attended another meeting with NSI and Jacobs to reiterate the data that would be required for Ardaman to complete the work, and agreed to perform field permeability tests using existing monitor wells at the Southern Expansion Site.

This report provides a description of the Southern Expansion Site, the subsurface soil profile developed by BME for the proposed Cell 11 and 12 footprints, the monthly groundwater elevations recorded by BME between October 2016 and August 2017, results of field permeability testing performed by Ardaman, findings from our groundwater modeling efforts, and recommendations for design against hydrostatic uplift of the bottom liner system for the proposed Cells 11 and 12.

Site Description

An annotated March 2017 aerial photograph of the Orange County Landfill Southern Expansion Site, which lies south of the original Orange County Landfill Facility, is presented in Figure 1. As shown, the landfill cells at the Southern Expansion Site consist of, from north to south, the existing Cells 9 and 10, and the proposed Cells 11 and 12. Cells 9 and 10 have a combined footprint area of approximately 150 acres. The proposed Cells 11 and 12 also have a comparable footprint area, and span approximately 4,700 feet in the north-south direction and approximately 1,400 feet in the east-west direction.

Since 2004, Orange County has been conducting the waste disposal operation in Cells 9 and 10. Construction of Cell 11 is currently scheduled to begin in 2020. It is our understanding that each of the existing and proposed landfill cells at the Southern Expansion Site was or will be provided with a bottom liner and leachate collection system that complies with Chapter 62-701 of the Florida Administrative Code (F.A.C.) titled “Solid Waste Management Facilities”.

Four existing ponds, designated Ponds 5 through 8, were excavated at the Southern Expansion Site to provide borrow materials for construction of the landfill cells and stormwater management for runoff from the landfill cells after closure. These ponds were permitted as wet detention ponds for stormwater management. As shown in Figure 1, Ponds 5 and 7 are located to the west and Pond 6 is located to the east of Cells 9 and 10. Pond 8 is located to the east of the proposed Cell 11 and 12 footprints. We understand that an additional wet detention pond, designated Pond 9A, will be excavated to the west of the proposed expansion area, prior to construction of Cells 11 and 12. Outlet structures were or will be provided in these wet detention ponds to establish the control pond water elevations (control elevations) during normal operation and to allow the controlled release of pond water through the weirs of the outlet structures after the design storm event.

The control elevations and the weir elevations of the existing and proposed wet detention ponds are shown in Table 1. The elevations for Ponds 5 through 8 were obtained from the record drawings, whereas the elevations for Pond 9A were obtained from the Environmental Resource Permit (ERP) application. As shown, the control elevations for Ponds 5 through 8 were established at +81.88, +80.58, +82.33, and +82.11 feet (NGVD), and the weir elevations were constructed at +82.40, +80.96, +82.86, and +82.47 feet (NGVD), respectively. Pond 9A has a design control elevation of +82.50 feet (NGVD), and a design weir elevation of +83.07 feet (NGVD). The wet detention ponds on the west side of the landfill cells have slightly higher control elevations than those on the east side. Also, the ponds to the south have slightly higher control elevations than those to the north. The proposed Pond 9A has the highest control elevation at +82.50 feet (NGVD), whereas the existing Pond 6 has the lowest control elevation at +80.58 feet (NGVD).

We understand that Orange County is currently operating a borrow pit that lies as close as 800 feet west of the western boundary of the proposed Cells 11 and 12, and plan to operate an additional borrow pit immediately south of the proposed Cell 12. According to NSI, excavation of the southern borrow pit will begin after completion of lining of Cell 11, continue through lining of Cell 12, and terminate before Cell 12 reaches the final design elevations. Orange County is operating and presumably will continue to operate borrow pits “in-the-dry” using perimeter toe ditches at the pit bottoms for dewatering.

Subsurface Exploration and Groundwater Elevations Monitoring

BME was retained by NSI and Jacobs to perform a subsurface soil exploration and to monitor groundwater levels within the proposed Cell 11 and 12 footprints. The subsurface soil exploration involved drilling of 18 standard penetration test (SPT) soil borings to depths varying from 100 to 150 feet below land surface, and performance of index and classification tests on the recovered soil samples. The groundwater level monitoring program consisted of installation of 12 piezometers, and measurements of piezometric water levels for an 11-month period between October 2016 and August 2017.

BME documented their subsurface exploration in a technical memorandum titled "Geotechnical Exploration for Permitting & Construction of Cells 11 and 12 of the Southern Expansion Site", dated March 13, 2017. A generalized subsurface soil profile developed by BME, along with the assigned density and shear strength for each soil layer, is provided in Table 2. As shown, the subsurface soil profile, as reported by BME, consists of a medium dense sand layer from land surface to a depth of approximately 34 feet, which is underlain by a 15-foot thick soft clay layer. Below the soft clay layer is a medium dense to very dense sand layer that occurs to a depth of 93 feet, followed by a loose clayey sand layer that occurs to a depth of 110 feet. Between 110 feet below land surface and the maximum exploration depth (150 feet) of the soil borings is a very dense sand layer.

BME installed 12 piezometers, designated PZ-1, PZ-2, PZ-3, PZ-5, PZ-7, PZ-9, PZ-11, PZ-12, PZ-13, PZ-14, PZ-17, and PZ-18, within the proposed Cell 11 and 12 footprints, and recorded groundwater levels in these piezometers monthly between October 2016 and August 2017. These piezometer locations are shown on a site plan in Figure 2. As reported by BME, the maximum, average, and minimum groundwater elevations at each piezometer location are shown in Table 3, and the ranges of groundwater level fluctuations during the monitoring period are shown in Table 4. Based on the groundwater elevations reported by BME, Ardaman estimated the high, average, and low groundwater elevations along the east side, west side, and north-south centerline of the proposed Cell 11 and 12 footprints, which are shown in Table 5.

As shown in Table 4, groundwater level fluctuations were typically in the range of 3 to 5 feet, with the low groundwater elevations mostly occurring in May 2017 and the high groundwater elevations typically occurring in August 2017. Along the west side of the proposed Cell 11 and 12 footprints, the high, average, and low groundwater elevations were estimated to be +85, +83, and +81 feet (NGVD). Along the east side, the high, average, and low groundwater elevations were judged to be +84, +82, and +80 feet (NGVD). Along the north-south centerline, the high, average, and low groundwater elevations were estimated to be +86, +83, and +81 feet (NGVD).

Based on the groundwater elevations reported by BME, the water table beneath the proposed Cell 11 and 12 footprints was relatively flat, especially in the western part, with groundwater flow typically occurring from west to east towards Pond 8. However, under high water table condition during the wet season, groundwater could mound beneath the north-south centerline, inducing flow to both east and west. The highest groundwater elevation of +86.4 feet (NGVD) was documented in PZ-14 on August 9, 2017, and the lowest groundwater elevation of +78.9 feet (NGVD) was documented in PZ-5 on May 12, 2017. PZ-14 is located near the northwestern corner of the proposed Cell 11, and PZ-5 is located near the northeastern corner. The groundwater elevations near the southwestern corner appeared to have been slightly depressed, apparently by the dewatering operation in the adjacent borrow area to the west.

To evaluate whether the measured groundwater elevations between October 2016 and August 2017 were representative of those in a normal, wet, or dry year, Ardaman has reviewed the rainfall data at two climatological stations located near the Orange County Landfill property. The monthly rainfall data recorded at the South Florida Water Management District (SFWMD) Beeline Climatological Station and the Orlando International Airport Climatological Station between January 2016 and August 2017, as well as the monthly rainfall in a normal rainfall year at the Orlando International Airport Climatological Station, are summarized in Table 6.

As shown in Table 6, the four wet months (i.e., June through September 2016) that preceded the groundwater level monitoring period had total rainfalls of 26.19 inches at the SFWMD Beeline Climatological Station and 28.86 inches at the Orlando International Airport Climatological Station, compared to a total rainfall of 28.04 inches for these four months in a normal rainfall year at the Orlando International Airport Climatological Station. For the entire groundwater level monitoring period (i.e., from October 2016 through August 2017), the total rainfalls were 34.91 inches at the SFWMD Beeline Climatological Station and 33.77 inches at the Orlando International Airport Climatological Station, which are approximately 10 to 11 inches below the total rainfall for these months in a normal rainfall year. However, the last three months (i.e., June through August 2017) of the groundwater level monitoring period had total rainfalls of 24.45 inches at the SFWMD Beeline Climatological Station and 22.03 inches at the Orlando International Airport Climatological Station, which were 0 to 2.5 inches above the total normal rainfall for these months. In our judgment, the high groundwater elevations documented by BME between October 2016 and August 2017 should be representative of those in a normal rainfall year. The low groundwater elevations, however, were probably slightly lower than the seasonal low groundwater elevations in a normal rainfall year.

Field Permeability Tests

Based on discussions with NSI and Jacobs at the February 2, 2018 meeting, Ardaman agreed to perform field permeability tests using existing monitor wells to ascertain the transmissivity of the approximately 34-foot thick surficial sand layer, which forms the shallow part of the surficial aquifer system. The monitor wells selected by NSI, Jacobs, and Ardaman for field permeability testing were the four shallow wells designated MW-420S, MW-425S, MW-490S, and MW-495S. MW-420 and MW-425 are located west of Cell 10, whereas MW-490 and MW-495 are located outside the southeastern corner of Cell 10. The locations of these monitor wells are shown in Figure 2.

The field permeability tests were performed by Ardaman on February 9, 2018 in general accordance with the falling head and rising head methods described in ASTM D4044 by inserting a solid slug of known volume into the well casing. In the falling head test method, the solid slug was submerged to raise the water level inside the well casing, and the rate of decline of piezometric head was monitored with time. In the rising head test method, the submerged solid slug was removed and the rate of rise of piezometric head was monitored with time. The rate of change in piezometric head, as measured using a transducer, was used to compute the hydraulic conductivity of the soil deposits around the well screen. Our field representative cleaned and washed the solid slug each time before it was inserted into the well casing.

Results from the field permeability tests are included in Appendix 1 and summarized in Table 7. As shown, the hydraulic conductivity of the surficial sand ranged from 3 to 17 feet per day, and averaged 9 feet per day from the falling head tests. In the rising head tests, the hydraulic conductivity ranged from 3 to 13 feet per day, and averaged 8 feet per day. These values are generally consistent with the data reported by CDM for the original Orange County Landfill Facility and those obtained by Ardaman at project sites near the Orange County Landfill property. A hydraulic conductivity value on the order of 10 feet per day ($3.5x10^{-3}$ cm/sec) is judged to be representative of the 34-foot thick surficial sand layer. The soft clay layer beneath the surficial sand was considered to be impervious.

Setup of Groundwater Model

Ardaman evaluated groundwater elevations and flow patterns beneath the Southern Expansion Site using the MODFLOW groundwater flow model, with the GMS software as the graphical user interface. MODFLOW is an open-source computer program distributed by the United States Geological Survey (USGS). GMS is a pre- and post-processor to the MODFLOW input and output files, and is available commercially.

MODFLOW is a modular three-dimensional finite-difference numerical model capable of simulating groundwater flow in an aquifer system under either steady-state or transient condition. It was originally developed by the USGS[1], and has been improved and updated by the USGS and other software developers over the years. The MODFLOW model is very versatile. It can handle a variety of boundary conditions, and utilizes various modules to represent rivers, drains, wells, streams, recharge, etc. in a hydrogeologic system. MODFLOW computes the hydraulic head in each grid cell by iterating inflow, outflow, head, and storage requirements until both Darcy's Law, which governs groundwater flow in an aquifer, and the continuity equation are satisfied for each grid cell at the specified time steps. Inputs to the model include geometric and hydraulic properties of the aquifer system, recharge rates, hydrogeologic boundary conditions, etc. Outputs from the model include piezometric heads, water level drawdowns, cell-to-cell flow rates, etc.

The model boundaries selected by Ardaman for simulations of groundwater flow beneath the Southern Expansion Site extend approximately 12,000 feet in the north-south direction and approximately 8,000 feet in the east-west direction. The model area covers approximately 2,200 acres, which includes the existing Cells 9 and 10, the proposed Cells 11 and 12, the existing Ponds 5 through 8, and the proposed Pond 9A. It was discretized by a 100-foot square grid, and assigned a single layer that represents the surficial sand which forms the shallow part of the surficial aquifer system. The model boundaries and grid system are depicted in Figure 3. The pond water elevations were specified to be the control elevations. An average annual rainfall recharge rate of 5 inches per year was applied to the model area, except for grids that were within the footprints of lined landfill cells, where zero rainfall recharge was used.

Before the computer model was used for predictive simulations of groundwater flow under various scenarios, it was calibrated to replicate known groundwater elevations with a reasonable degree of accuracy. Model calibration is a process in which numerical simulations are performed using a trial-and-error procedure to match simulated results to field observations.

The groundwater flow model was calibrated using varying hydraulic conductivities and recharge rates to replicate the groundwater elevations obtained between October 2016 to August 2017, which were judged to be representative of a normal rainfall year. Based on model calibration, Ardaman confirmed that a hydraulic conductivity of 10 feet per day for the surficial sand layer and an average rainfall recharge rate of 5 inches per year would produce simulated groundwater elevations that match reasonably well with the average groundwater elevations obtained between October 2016 and August 2017. A higher rainfall recharge rate of 15 inches per year would

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1 McDonald, M. G. and Harbaugh, A. W. (1988). A Modular Three-Dimensional Finite-Difference Ground-Water Flow Model. Techniques of Water-Resources Investigations of the U.S. Geological Survey, Modeling Techniques, Chapter A1, Book 6.

produce simulated groundwater elevations that match reasonably well with the high groundwater elevations recorded during the same period.

Numerical simulations were performed to evaluate groundwater elevations and flow patterns for the following five scenarios that occur before, during, and after construction of Pond 9A, Cell 11, and Cell 12:

- Under existing condition
- During construction for Pond 9A
- After construction of Pond 9A
- After lining of Cell 11
- After lining of Cell 12

For each of the above scenarios, the average and seasonal high groundwater elevations in a normal rainfall year were obtained using the calibrated MODFLOW model, for a total of ten simulations. Results from the groundwater simulations are presented in the following sections. The simulations assumed that excavation of Pond 9A and installation of the outlet structure in the pond would be completed prior to lining of Cell 11. Therefore, operation and dewatering of the western borrow pit should not affect groundwater levels beneath the proposed Cells 11 and 12. Because excavation and dewatering of the southern borrow pit will not occur until after completion of lining of Cell 11, the southern borrow pit will not affect the design and construction of the Cell 11 bottom liner system. Operation and dewatering of the southern borrow pit will lower the groundwater level near the southern end of Cell 12, but the groundwater elevations at the sump locations should not be affected.

<u>Groundwater Elevations under Existing Condition</u>

The simulated average and seasonal high groundwater elevations at the Southern Expansion Site in a normal rainfall year under the existing condition (i.e., Cells 9 and 10 are lined, and Ponds 5 through 8 are in operation) are displayed in Figures 4 and 5, respectively.

Because Cells 9 and 10 are lined, there would not be any significant fluctuations of groundwater levels beneath these two landfill cells. As shown in Figures 4 and 5, under existing condition, most of the Cell 9 and 10 footprints would have average and seasonal high groundwater elevations between +81 and +82 feet (NGVD). The highest groundwater elevation would occur in the southwestern part of Cell 10, with the seasonal high groundwater elevation close to +82.3 feet (NGVD), which corresponds to the control elevation of Pond 7. The simulations indicated that groundwater flow would generally occur from west to east (i.e., from Ponds 5 and 7 towards Pond 6), under an average flow gradient on the order of 0.001.

As shown in Figure 5, under existing condition, most of the proposed Cell 11 and 12 footprints would have seasonal high groundwater elevations between +83 and +86 feet (NGVD), with the higher groundwater elevations occurring along the west side and near the southwestern corner. The dewatering operation in the adjacent borrow area would depress the groundwater elevations in the western and southwestern portions of the site. The simulations indicated that groundwater flow would generally occur from west-southwest to east-northeast towards Pond 8, under an average flow gradient on the order of 0.003. A comparison between Figures 4 and 5 indicated that the seasonal high groundwater elevations would generally be 1 to 2 feet higher than the average groundwater elevations.

At approximately 130 feet from the edge of Pond 8, where the leachate collection sumps for Cells 11 and 12 are proposed to be constructed, the seasonal high groundwater elevation under existing condition was simulated to be close to +83 feet (NGVD).

Groundwater Elevations during Construction of Pond 9A

The simulated average and seasonal high groundwater elevations at the Southern Expansion Site in a normal rainfall year during construction of Pond 9A (i.e., Cells 9 and 10 are lined, Ponds 5 through 8 are in operation, and Pond 9A is being excavated and dewatered) are displayed in Figures 6 and 7, respectively. We assumed that during excavation of Pond 9A, dewatering would be conducted using a perimeter toe ditch to lower groundwater to an elevation of +72 feet (NGVD), which corresponds to 2 feet below the design pond bottom elevation.

As shown in Figure 7, during construction of Pond 9A, most of the Cell 9 and 10 footprints would have seasonal high groundwater elevations between +81 and +82 feet (NGVD). The highest groundwater elevation would occur along the north side of Cell 9, with a seasonal high groundwater elevation of approximately +82.3 feet (NGVD). The simulations indicated that groundwater flow would generally occur from north-northwest to east-southeast, under an average flow gradient on the order of 0.001. Construction dewatering for Pond 9A would not significantly alter the groundwater elevations beneath Cells 9 and 10, but would alter the groundwater elevation contours and induce groundwater flow towards the dewatered pit, especially beneath the southwestern part and southern end of Cell 10.

As shown in Figures 6 and 7, during construction of Pond 9A, the proposed Cell 11 and 12 footprints would have average and seasonal high groundwater elevations that vary from slightly below +82 feet (NGVD) along the east side where Pond 8 is located to slightly above +72 feet (NGVD) along the west side where Pond 9A is being excavated and dewatered. The simulations indicated that groundwater flow would occur from east to west towards the dewatered pit of Pond 9A, under an average flow gradient on the order of 0.007. With an average rainfall recharge rate of 5 inches per year, groundwater seepage into the dewatered pit of Pond 9A was calculated to be on the order of 200 to 300 gallons per minute.

Groundwater Elevations after Construction of Pond 9A

The simulated average and seasonal high groundwater elevations at the Southern Expansion Site in a normal rainfall year after construction of Pond 9A (i.e., Cells 9 and 10 are lined, Ponds 5 through 9A are in operation) are displayed in Figures 8 and 9, respectively. With operation of Pond 9A, the pond water was considered to be at the control elevation of +82.50 feet (NGVD).

As shown in Figure 9, with operation of Pond 9A, most of the Cell 9 and 10 footprints would have seasonal high groundwater elevations between +81 and +82 feet (NGVD). A comparison between Figures 5 and 9 indicated that operation of Pond 9A would not significantly alter groundwater elevations and flow pattern beneath the Cell 9 and 10 footprints from those under the existing condition.

As shown in Figure 9, with operation of Pond 9A, most of the proposed Cell 11 and 12 footprints would have seasonal high groundwater elevations that vary from approximately +82.5 feet (NGVD) along the west side where Pond 9A would be constructed to approximately +82 feet (NGVD) along the east side where Pond 8 is located. The simulations indicated that groundwater flow would generally occur from west to east, under average flow gradients on the order of 0.0003 across the site and 0.0007 in the eastern half of the site (i.e., the western half of the site would have a relatively flat water table). The seasonal high groundwater elevations shown in Figure 9 are only slightly higher the average groundwater elevations shown in Figure 8, with no indication of a groundwater mound beneath the north-south centerline even during the wet season. A comparison of Figures 8 and 9 to Figures 4 and 5 indicated that operation of Pond 9A would lower groundwater elevations and reduce groundwater level fluctuations beneath the proposed Cell 11 and 12 footprints as compared to those under the existing condition. Nevertheless, temporary groundwater mound could occur beneath the north-south centerline under extreme weather conditions or prolonged periods of wet weather condition.

At approximately 130 feet from the edge of Pond 8, where the leachate collection sumps for Cells 11 and 12 will be located, the seasonal high groundwater elevation with operation of Pond 9A is expected to be between +82.0 and +82.5 feet (NGVD).

Groundwater Elevations after Lining of Cell 11

The simulated average and seasonal high groundwater elevations at the Southern Expansion Site in a normal rainfall year after lining of Cell 11 (i.e., Cells 9 through 11 are lined, and Ponds 5 through 9A are in operation) are displayed in Figures 10 and 11, respectively.

As shown in Figure 11, after lining of Cell 11, most of the Cell 9 and 10 footprints would have seasonal high groundwater elevations between +81 and +82 feet (NGVD). A comparison of Figure 11 to Figures 5 and 9 indicated that lining of Cell 11 would not have any significant effects on groundwater elevations and flow pattern beneath the Cell 9 and 10 footprints as compared to those under the existing condition and after construction of Pond 9A.

As shown in Figure 11, after lining of Cell 11, most of the proposed Cell 11 and 12 footprints would have seasonal high groundwater elevations that vary from approximately +82.5 feet (NGVD) along the west and southwestern parts of Cell 12 to +82.0 feet (NGVD) along the east side of Cells 11 and 12. A comparison between Figures 9 and 11 indicated that lining of Cell 11 would slightly lower the groundwater elevations beneath the proposed Cell 11 footprint as compared to the condition after construction of Pond 9A, but the groundwater flow pattern would practically remain the same.

Groundwater Elevations after Lining of Cell 12

The simulated average and seasonal high groundwater elevations at the Southern Expansion Site in a normal rainfall year after lining of Cell 12 (i.e., Cells 9 through 12 are lined, and Ponds 5 through 9A are in operation) are displayed in Figures 12 and 13, respectively.

As shown in Figure 13, after lining of Cell 12, most of the Cell 9 and 10 footprints would have seasonal high groundwater elevations between +81 and +82 feet (NGVD). A comparison of Figure 13 to Figures 5, 9, and 11 indicated that lining of Cell 12 would not have any significant effects on groundwater elevations and flow pattern beneath the Cell 9 and 10 footprints as compared to those under the existing condition, after construction of Pond 9A, and after lining of Cell 11.

As shown in Figure 13, after lining of Cell 12, most of the proposed Cell 11 and 12 footprints would have seasonal high groundwater elevations that vary from approximately +82.5 feet (NGVD) along the west and southern end of Cell 12 to +82.0 feet (NGVD) along the east side of Cells 11 and 12. A comparison between Figures 11 and 13 indicated that lining of Cell 12 would slightly lower the groundwater elevations beneath the proposed Cell 12 footprint as compared to the condition after lining of Cell 11, but the groundwater flow pattern would practically remain the same.

Summary of Findings

Below is a summary of key findings from our groundwater evaluation for the Southern Expansion Site:

- Ponds 5, 7, and 9A, which are or will be located on the west side of the landfill cells, have slightly higher control elevations than Ponds 6 and 8, which are located on the east side. The proposed Pond 9A has the highest control elevation at +82.50 feet (NGVD), whereas the existing Pond 6 has the lowest control elevation at +80.58 feet (NGVD).

- The shallow part of the surficial aquifer system has a thickness of 34 feet and a hydraulic conductivity on the order of 10 feet per day.

- Under existing condition, groundwater level fluctuations beneath the proposed Cell 11 and 12 footprints, from seasonal low to seasonal high, are in the typical range of 3 to 5 feet.

- Under existing condition, most of the Cell 9 and 10 footprints would have average and seasonal high groundwater elevations between +81 and +82 feet (NGVD), with groundwater flow generally occurring from west to east under an average flow gradient on the order of 0.001.

- Under existing condition, most of the proposed Cell 11 and 12 footprints would have seasonal high groundwater elevations between +83 and +86 feet (NGVD), which are generally 1 to 2 feet above the average groundwater elevations. Groundwater flow would generally occur from west to east towards Pond 8, under an average flow gradient on the order of 0.003. However, during the wet season, groundwater could mound beneath the north-south centerline, inducing flow to both east and west.

- The dewatering operation in the adjacent borrow area to the west has depressed and will continue to depress the groundwater levels along the western and southwestern parts of the proposed Cell 11 and 12 footprints.

- At approximately 130 feet from the edge of Pond 8, where the leachate collection sumps for Cells 11 and 12 will be located, the seasonal high groundwater elevation under existing condition was simulated to be close to +83 feet (NGVD).

- Construction dewatering for Pond 9A would not significantly alter the groundwater elevations beneath Cells 9 and 10, but would alter the groundwater elevation contours and induce groundwater flow towards the dewatered pit, especially beneath the southwestern part and southern end of Cell 10.

- During excavation of Pond 9A with associated construction dewatering, the proposed Cell 11 and 12 footprints would have average and seasonal high groundwater elevations that vary from slightly below +82 feet (NGVD) along the east side to slightly above +72 feet (NGVD) along the west side, with an average flow gradient on the order of 0.007.

- During construction of Pond 9A, the groundwater seepage rate into the dewatered pit could be on the order of 200 to 300 gallons per minute.

- Operation of Pond 9A would not significantly alter groundwater elevations and flow pattern beneath the Cell 9 and 10 footprints from those under the existing condition.

- Operation of Pond 9A would significantly lower groundwater elevations and reduce groundwater level fluctuations beneath the proposed Cell 11 and 12 footprints as compared to those under the existing condition.

- At approximately 130 feet from the edge of Pond 8, where the leachate collection sumps for Cells 11 and 12 will be located, the seasonal high groundwater elevation after construction of Pond 9A is expected to be between +82.0 and +82.5 feet (NGVD).

- Lining of Cells 11 and 12 would lower the groundwater elevations and reduce groundwater level fluctuations slightly as compared to the condition after construction of Pond 9A, but the groundwater flow patterns would remain practically the same.

- Because excavation and dewatering of the southern borrow pit will not occur until after completion of lining of Cell 11, the southern borrow pit will not affect the design and construction of the Cell 11 bottom liner system.

- Operation and dewatering of the southern borrow pit will lower the groundwater level near the southern end of Cell 12, but the groundwater elevations at the sump locations should not be affected.

Design for Uplift Resistance for Bottom Liner System

According to NSI, the leachate collection sumps for the proposed Cells 11 and 12 will be constructed at approximately 130 feet from the edge of Pond 8. The depressed sumps will have a design bottom elevation of +77 feet (NGVD), and will meet the adjoining bottom liner at an elevation of +79.2 feet (NGVD), i.e., the sump will be depressed 2.2 feet below the bottom liner design grade.

At the proposed leachate collection sump locations, the seasonal high groundwater elevation in a normal rainfall year are expected to be close to +83.0 (NGVD) under existing condition, and between +82.0 and +82.5 feet (NGVD) with operation of Pond 9A. Accordingly, the proposed leachate collection sump bottom could be as much as 6 feet below the seasonal high groundwater elevation in a normal rainfall year. During construction of the leachate collection sumps, we recommend lowering the groundwater level to at least 18 inches below sump bottoms to facilitate compaction of the subgrade soils beneath.

We recommend the bottom liner system within and around the leachate collection sumps be designed based on a minimum groundwater elevation of +83.0 feet (NGVD). We further recommend a minimum design factor of safety of 1.25 be used to prevent hydrostatic uplift of the bottom liners. The ballast should be designed such that, after construction dewatering is terminated, the weight of the soil and gravel above the bottom liner system remains sufficient to provide the required uplift resistance.

Ardaman appreciates the opportunity of being of service to NSI, Jacobs, BME, and Orange County. If you have any questions or need additional information, please contact us.

Very truly yours,
ARDAMAN & ASSOCIATES, INC.
Certificate of Authorization No. 5950

M. J

Jeyisanker Mathiyaparanam, P.E.
Senior Project Engineer

Francis K. Cheung, P.E.
Principal Engineer 06/14/18
Florida License No. 36382

FRANCIS K. CHEUNG
LICENSE
No 36382
STATE OF FLORIDA
PROFESSIONAL ENGINEER

Enclosures

cc: Mr. R.J. "Bo" Bruner III, P.E. (Jacobs)
Mr. Ron Beladi, P.E. (NSI)

LIST OF TABLES

Table 1

Control and Weir Elevations of Wet Detention Ponds

Pond	Control Elevation (feet, NGVD)	Weir Elevation (feet, NGVD)
5	+81.88	+82.40
6	+80.58	+80.96
7	+82.33	+82.86
8	+82.11	+82.47
9A	+82.50	+83.07

Notes:

(1) The elevations for the existing Ponds 5, 6, 7, and 8 are based on record drawings.

(2) The elevations for the proposed Pond 9A are based on the ERP application.

Table 2

Generalized Soil Profile Developed by BME

Depth Below Existing Grade (feet)	Material Description	Saturated Unit Weight (pcf)	Internal Friction Angle (degrees)	Cohesion (psf)
0 to 34	Medium Dense Sand	115	34	---
34 to 49	Soft Clay	120	---	1000
49 to 73	Dense to Very Dense Sand	125	39	---
73 to 85	Medium Dense Sand	115	34	---
85 to 93	Medium Dense Cemented Sand	120	36	---
93 to 110	Loose Clayey Sand	115	32	---
110 to 150	Very Dense Sand	125	34	---

Source: BME's technical memorandum titled "Geotechnical Exploration for Permitting & Construction of Cells 11 and 12 of the Southern Expansion Site," dated March 13, 2017.

Table 3

Groundwater Level Monitoring between October 2016 and August 2017 by BME

Piezometer	Ground Surface Elevation (feet, NGVD)	Maximum Groundwater Elevation (feet, NGVD)	Average Groundwater Elevation (feet, NGVD)	Minimum Groundwater Elevation (feet, NGVD)
PZ-1	+85.7	+84.7	+82.5	+80.2
PZ-2	+86.2	+85.2	+82.8	+80.8
PZ-3	+86.2	+84.4	+83.0	+80.5
PZ-5	+84.8	+84.8	+81.9	+78.9
PZ-7	+86.2	+83.2	+81.8	+80.1
PZ-9	+86.9	+85.6	+83.3	+80.2
PZ-11	+86.0	+86.0	+83.2	+80.7
PZ-12	+87.3	+84.9	+82.8	+81.0
PZ-13	+83.9	+83.9	+81.7	+79.2
PZ-14	+89.2	+86.4	+85.4	+84.3
PZ-17	+86.7	+84.3	+82.3	+80.6
PZ-18	+86.5	+83.5	+82.7	+81.3

Table 4

Groundwater Level Fluctuation between October 2016 and August 2017

Piezometer	Maximum Groundwater Elevation (feet, NGVD)	Minimum Groundwater Elevation (feet, NGVD)	Maximum Groundwater Level Fluctuation (feet)
PZ-1	+84.7	+80.2	4.5
PZ-2	+85.2	+80.8	4.4
PZ-3	+84.4	+80.5	3.9
PZ-5	+84.8	+78.9	5.9
PZ-7	+83.2	+80.1	3.1
PZ-9	+85.6	+80.2	5.4
PZ-11	+86.0	+80.7	5.3
PZ-12	+84.9	+81.0	3.9
PZ-13	+83.9	+79.2	4.7
PZ-14	+86.4	+84.3	2.1
PZ-17	+84.3	+80.6	3.7
PZ-18	+83.5	+81.3	2.2

Table 5

Groundwater Elevations beneath Cells 11 and 12

Water Table Condition	Groundwater Elevations (feet, NGVD)		
	West Side	N-S Centerline	East Side
Seasonal High	+85	+86	+84
Seasonal Average	+83	+83	+82
Seasonal Low	+81	+81	+80

Note: The groundwater elevations were based on groundwater level readings obtained by BME between October 2016 and August 2017.

Table 6

Monthly Rainfall

Year	Month	Rainfall at SFWMD Beeline Station (inches)	Rainfall at Orlando International Airport Station (inches)	Normal Rainfall at Orlando International Airport Station* (inches)
2016	Jan	5.29	5.65	2.35
	Feb	2.04	1.69	2.38
	Mar	4.71	5.31	3.77
	Apr	1.24	1.27	2.68
	May	7.09	6.17	3.45
	Jun	8.00	7.71	7.58
	Jul	5.90	3.99	7.27
	Aug	6.28	9.90	7.13
	Sep	6.01	7.26	6.06
	Oct	4.09	2.77	3.31
	Nov	0.10	0.06	2.17
	Dec	0.88	2.52	2.58
2017	Jan	1.28	1.98	2.35
	Feb	1.62	0.95	2.38
	Mar	0.25	0.10	3.77
	Apr	0.01	0.00	2.68
	May	2.23	3.36	3.45
	Jun	10.64	5.44	7.58
	Jul	10.26	10.60	7.27
	Aug	3.55	5.99	7.13
Jan 16 – Sep 16		46.56	48.95	42.67
Jun 16 – Sep 16		26.19	28.86	28.04
Jan 16 – Dec 16		51.63	54.30	50.73**
Jun 17 – Aug 17		24.45	22.03	21.98
Oct 16 – Aug 17		34.91	33.77	44.67

* Represents average rainfall between 1981 and 2010 from the National Climatic Data Center.
** Represents annual rainfall in a normal year.

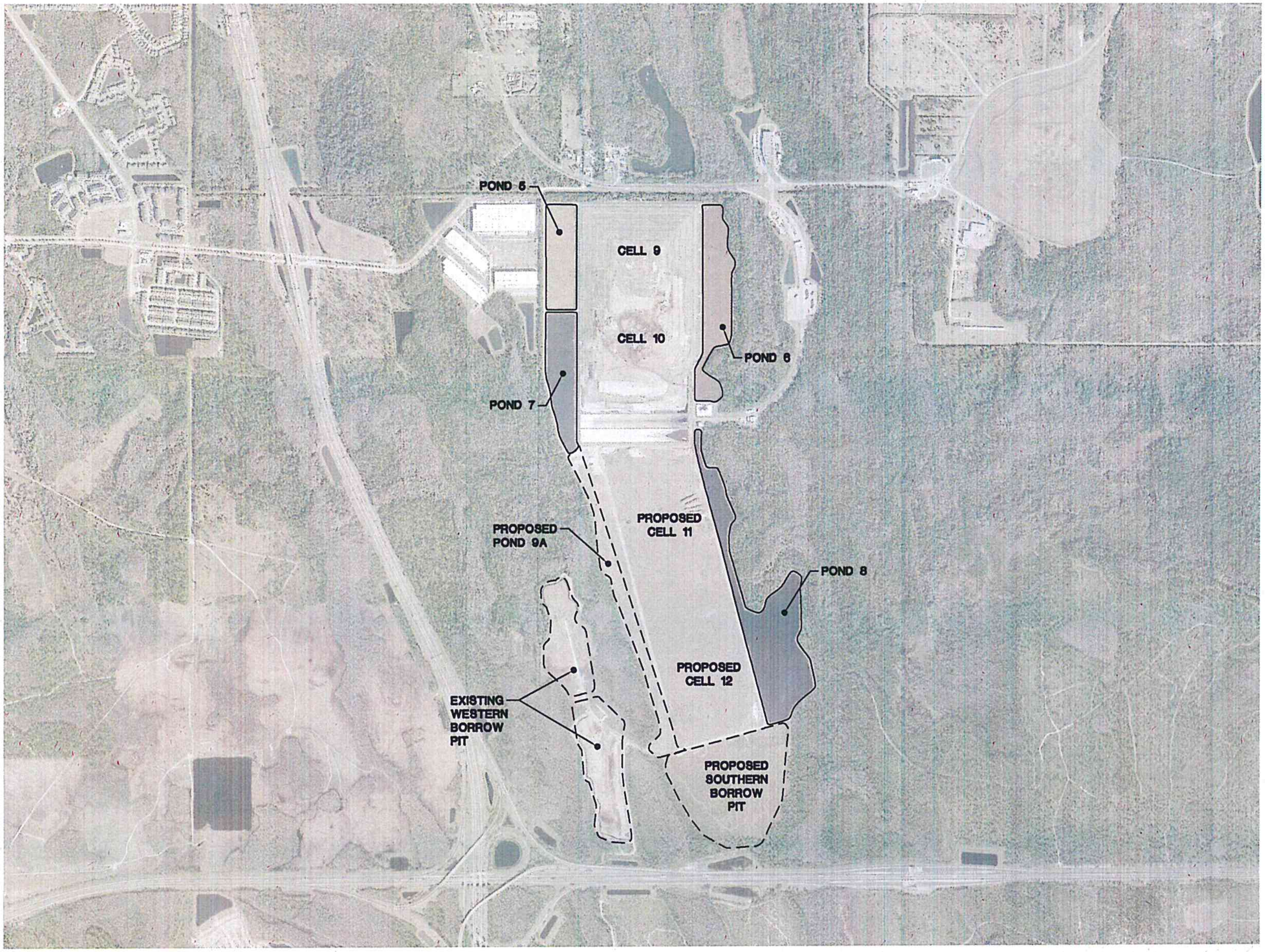
Table 7

Results of Field Permeability Testing

Monitor Well	Hydraulic Conductivity (feet/day)	
	Falling Head	Rising Head
MW-420S	3.4	3.2
MW-425S	4.7	4.1
MW-490S	12.3	13.2
MW-495S	17.2	10.1
Average	9.4	7.7

Note: The field permeability tests were performed using a solid slug and in general accordance with ASTM D4044.

LIST OF FIGURES



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AERIAL PHOTOGRAPH PROVIDED BY ORANGE COUNTY PROPERTY APPRAISER

DATE OF AERIAL SURVEY: 2017

SITE LOCATION PLAN

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

ENGINEERING EVALUATION OF GROUNDWATER LEVELS
CELLS 11 AND 12
ORANGE COUNTY LANDFILL
SOUTHERN EXPANSION SITE

DRAWN BY: CCS	CHECKED BY: JM	DATE: 03/29/18
FILE NO. 17-13-0115	APPROVED BY: FKC	FIGURE: 1

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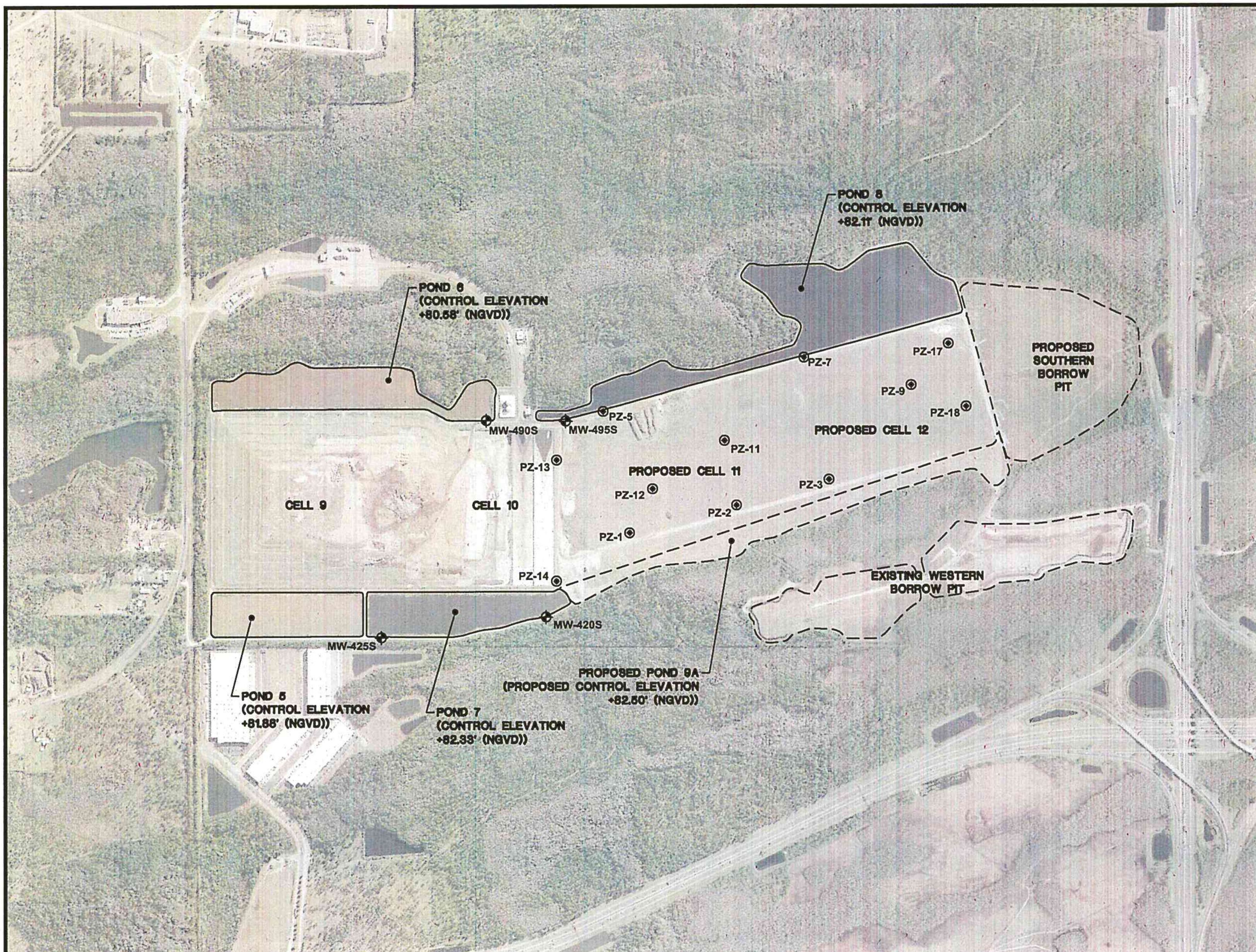

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AERIAL PHOTOGRAPH PROVIDED BY ORANGE COUNTY PROPERTY APPRAISER

DATE OF AERIAL SURVEY: 2017

LEGEND

PZ-1 PIEZOMETERS

MW-485S MONITOR WELL

PIEZOMETER AND MONITOR WELL LOCATION PLAN

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

ENGINEERING EVALUATION OF GROUNDWATER LEVELS
CELLS 11 AND 12
ORANGE COUNTY LANDFILL
SOUTHERN EXPANSION SITE

DRAWN BY: CCS	CHECKED BY: JM	DATE: 03/29/18
FILE NO. 17-13-0115	APPROVED BY: FKC	FIGURE: 2

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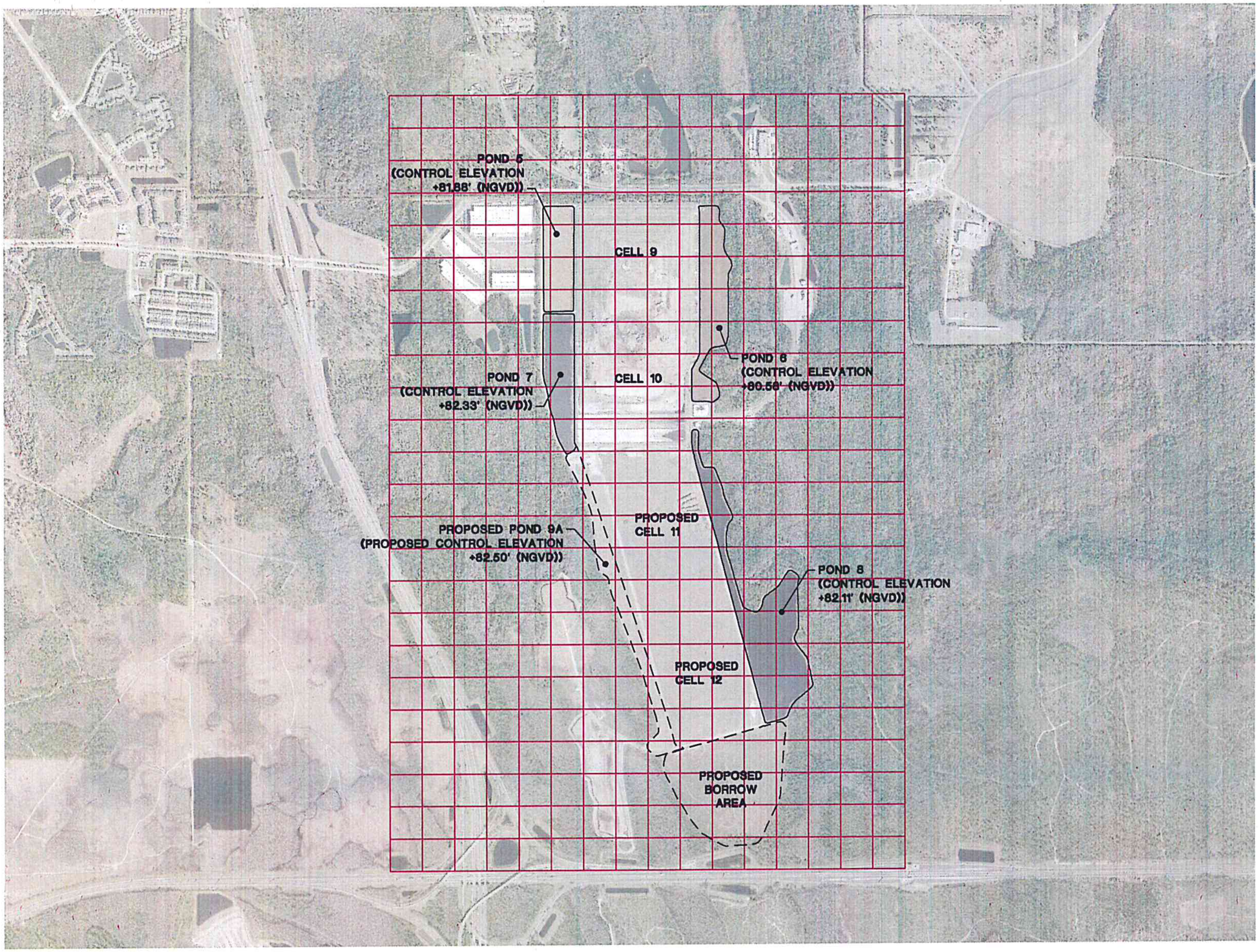

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AERIAL PHOTOGRAPH PROVIDED BY ORANGE COUNTY PROPERTY APPRAISER

DATE OF AERIAL SURVEY: 2017

NOTE:
GROUNDWATER SIMULATION WAS PERFORMED USING 100-FOOT SQUARE GRID. FIGURE ONLY SHOWS 500-FOOT SQUARE GRID FOR CLARITY.

MODEL BOUNDARY AND GRID SYSTEM

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

ENGINEERING EVALUATION OF GROUNDWATER LEVELS CELLS 11 AND 12 ORANGE COUNTY LANDFILL SOUTHERN EXPANSION SITE

DRAWN BY: CCS	CHECKED BY: JM	DATE: 03/29/18
FILE NO. 17-13-0115	APPROVED BY: FKC	FIGURE: 3

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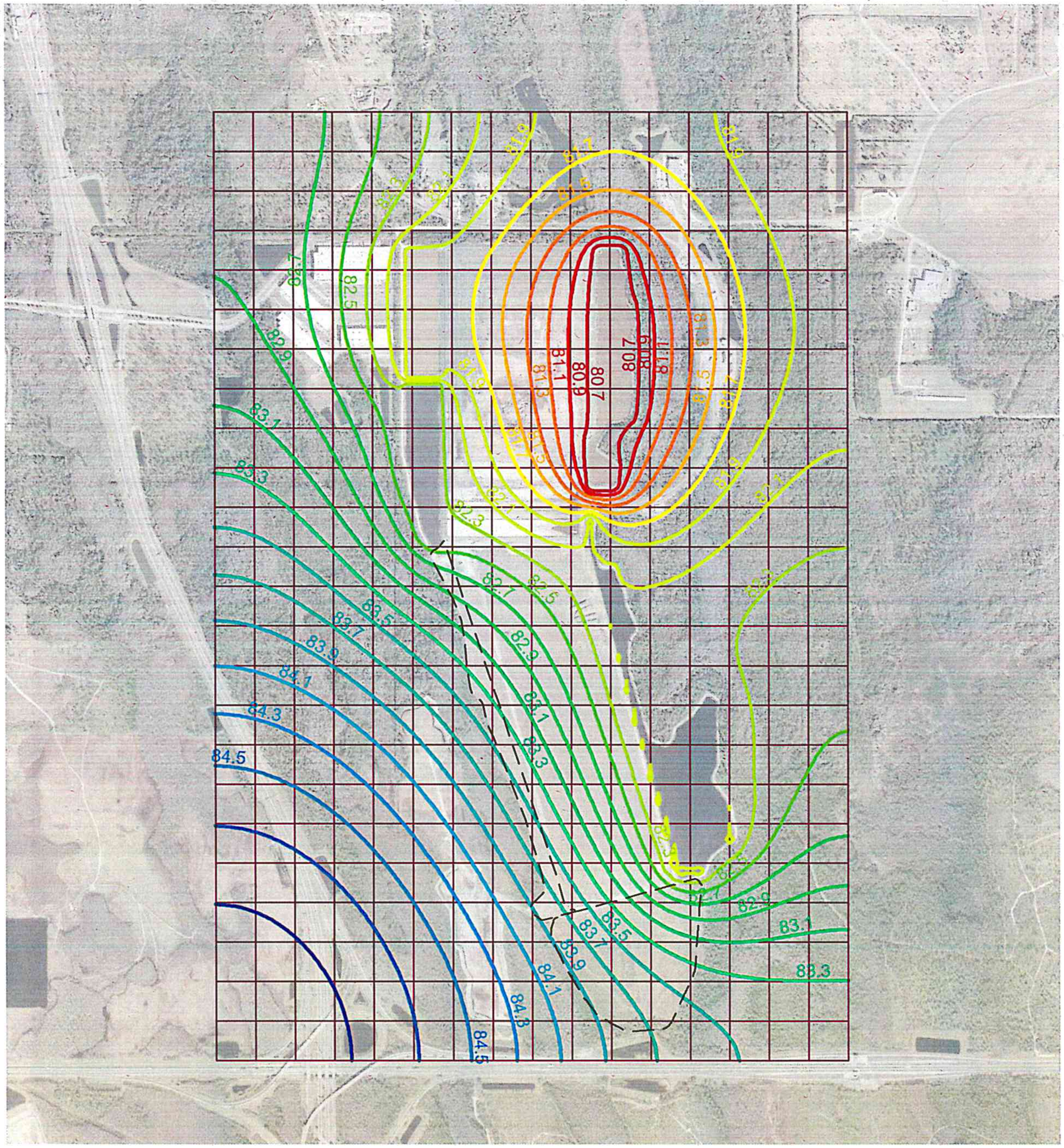

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SCALE: 1"=1,500'

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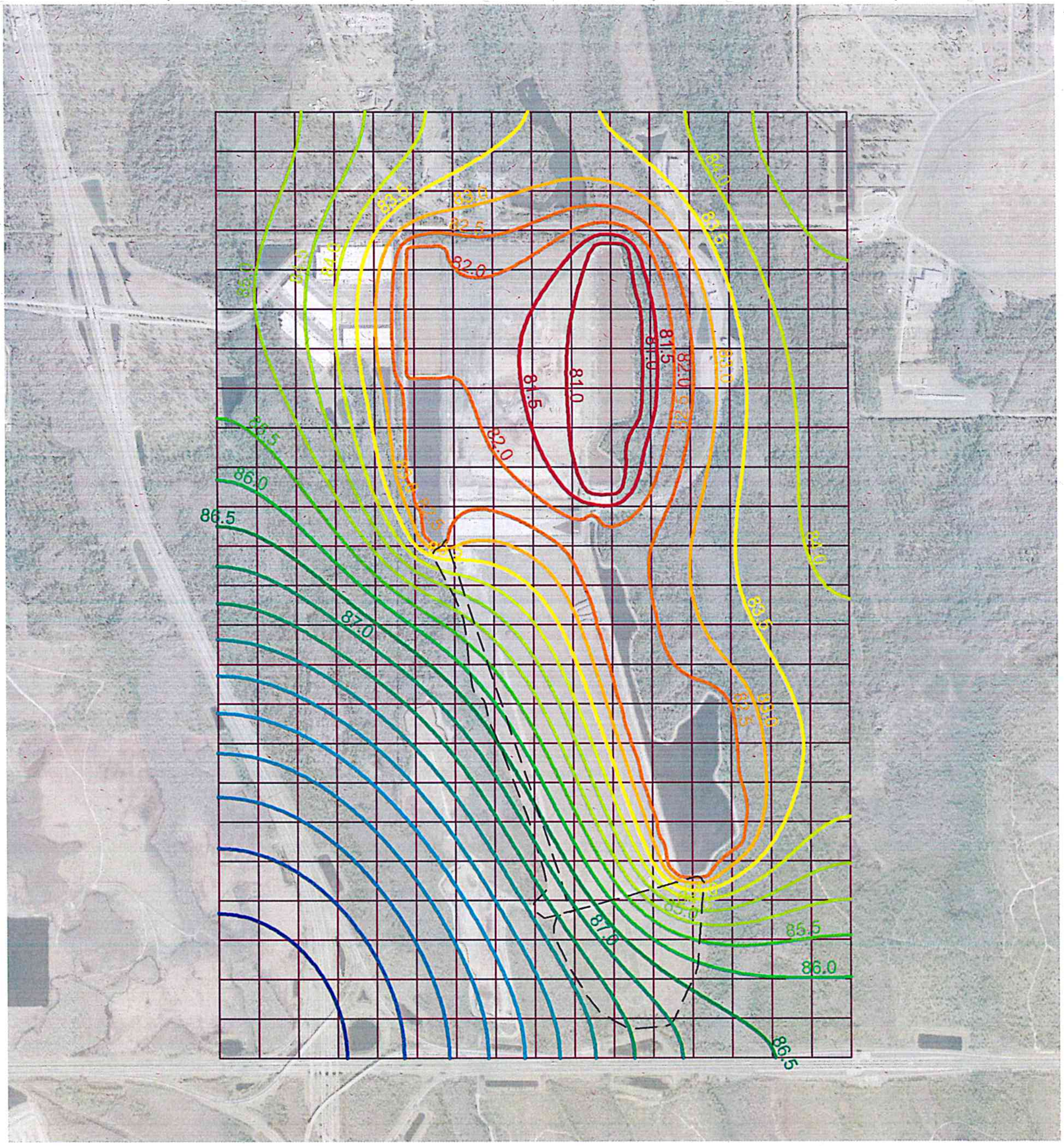
DATE OF AERIAL SURVEY: 2017

AVERAGE GROUNDWATER ELEVATION IN A NORMAL RAINFALL YEAR UNDER EXISTING CONDITION

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

ENGINEERING EVALUATION OF GROUNDWATER LEVELS CELLS 11 AND 12 ORANGE COUNTY LANDFILL SOUTHERN EXPANSION SITE

DRAWN BY: RDH	CHECKED BY: JM	DATE: 03/29/18
FILE NO. 17-13-0115	APPROVED BY: FKC	FIGURE: 4



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SCALE: 1"=1,500'

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DATE OF AERIAL SURVEY: 2017

SEASONAL HIGH GROUNDWATER ELEVATION IN A NORMAL RAINFALL YEAR UNDER EXISTING CONDITION

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

ENGINEERING EVALUATION OF GROUNDWATER LEVELS CELLS 11 AND 12 ORANGE COUNTY LANDFILL SOUTHERN EXPANSION SITE

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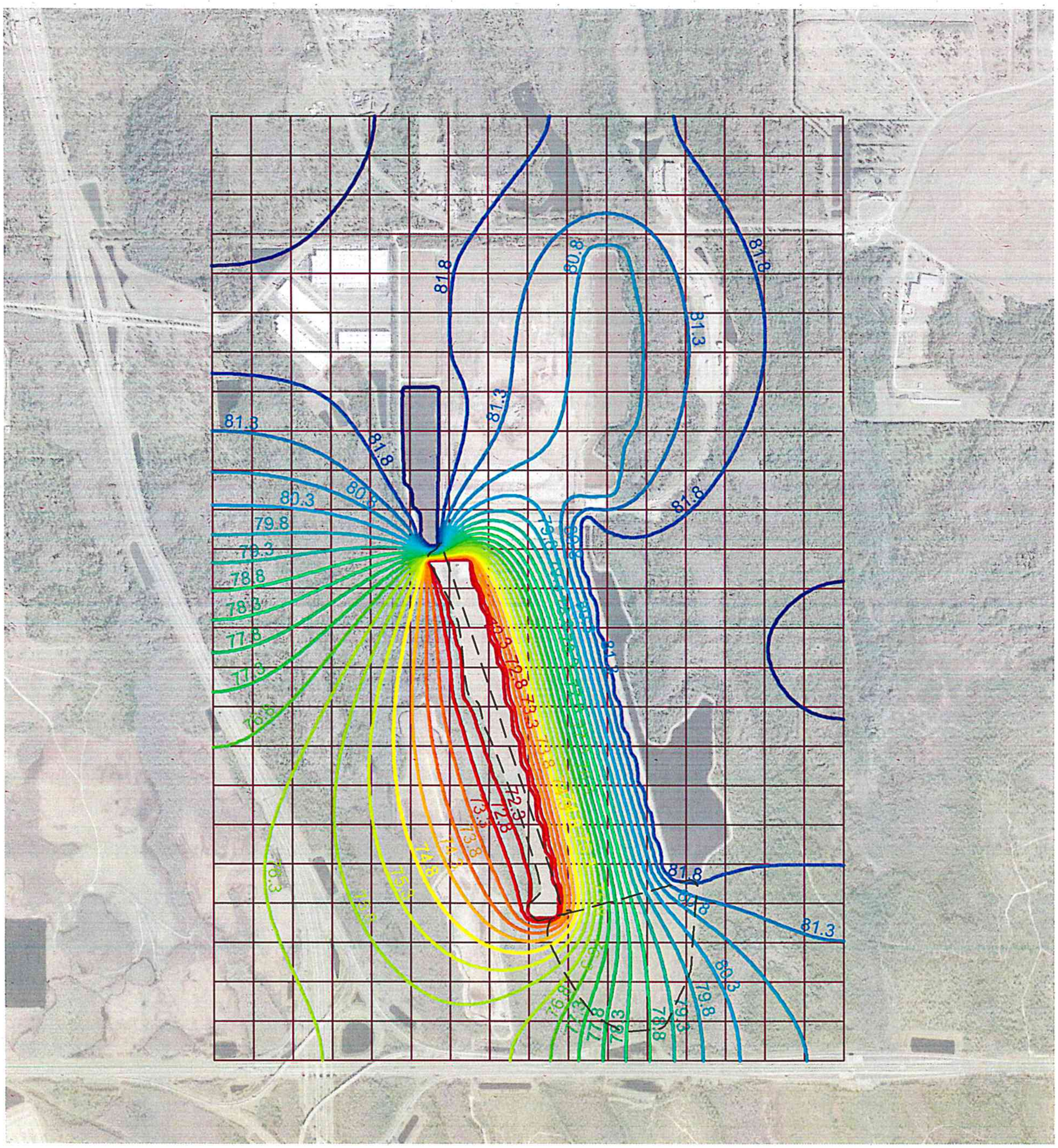

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AERIAL PHOTOGRAPH PROVIDED BY ORANGE COUNTY PROPERTY APPRAISER

DATE OF AERIAL SURVEY: 2017

AVERAGE GROUNDWATER ELEVATION IN A NORMAL RAINFALL YEAR DURING POND 9A CONSTRUCTION

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

ENGINEERING EVALUATION OF GROUNDWATER LEVELS CELLS 11 AND 12 ORANGE COUNTY LANDFILL SOUTHERN EXPANSION SITE

DRAWN BY: RDH	CHECKED BY: JM	DATE: 03/29/18
FILE NO. 17-13-0115	APPROVED BY: FKC	FIGURE: 6

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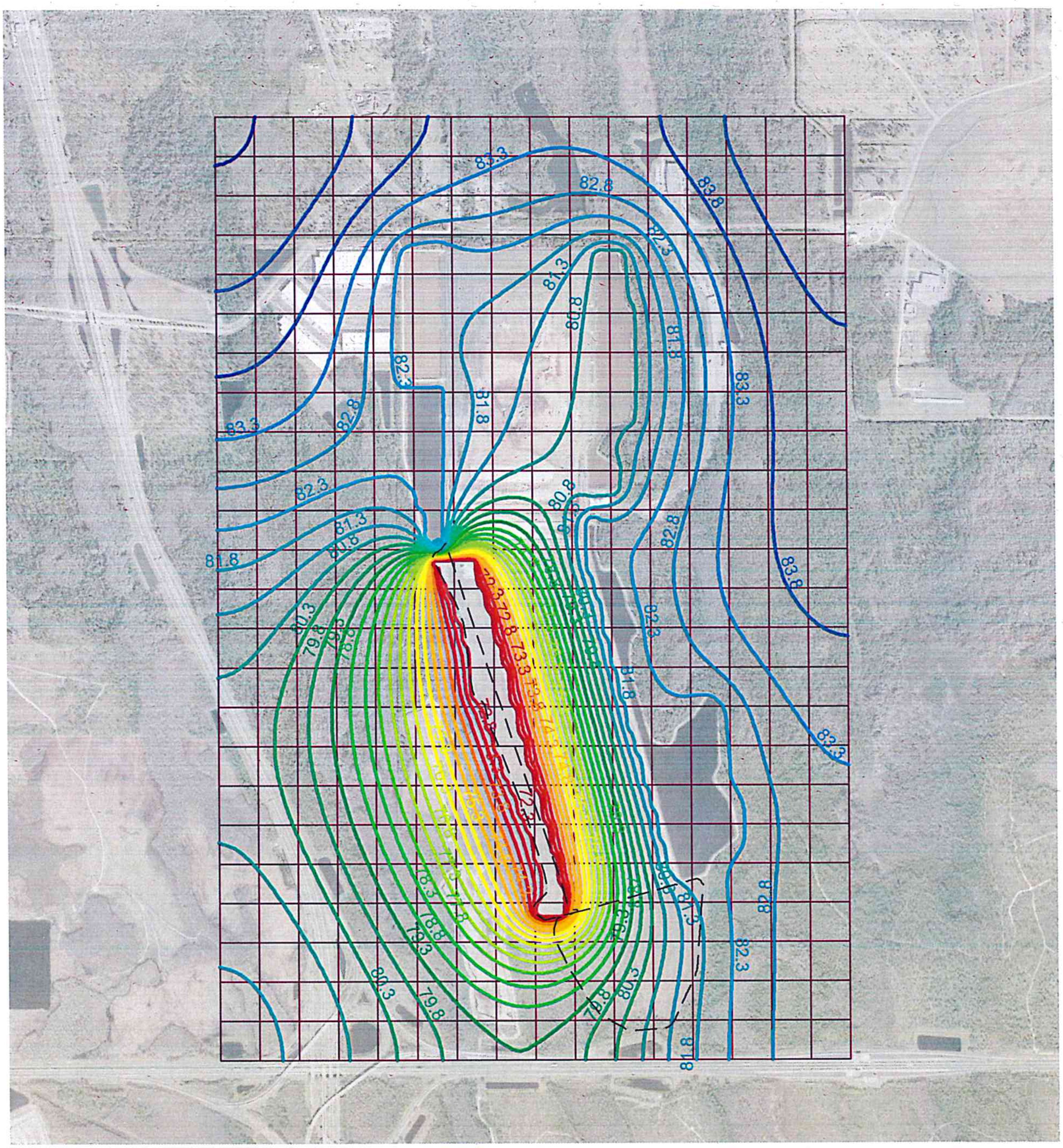

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SCALE: —1"=1,500'

AERIAL PHOTOGRAPH PROVIDED BY ORANGE COUNTY PROPERTY APPRAISER

DATE OF AERIAL SURVEY: 2017

SEASONAL HIGH GROUNDWATER ELEVATION IN A NORMAL RAINFALL YEAR DURING POND 9A CONSTRUCTION

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

ENGINEERING EVALUATION OF GROUNDWATER LEVELS CELLS 11 AND 12 ORANGE COUNTY LANDFILL SOUTHERN EXPANSION SITE

DRAWN BY: RDH	CHECKED BY: JM	DATE: 03/29/18
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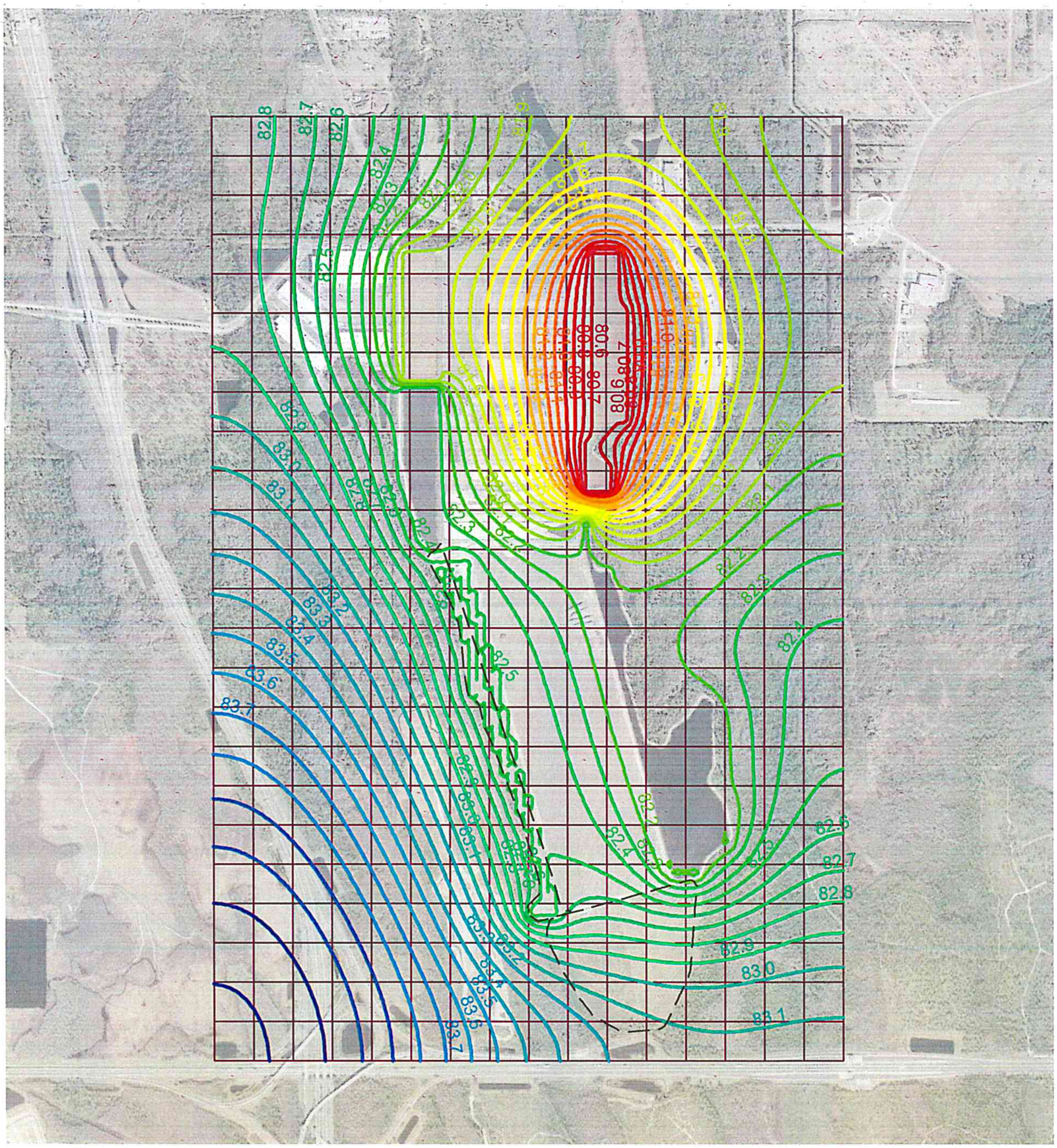

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0 750 1500

SCALE: 1"=1,500'

AERIAL PHOTOGRAPH PROVIDED BY
ORANGE COUNTY PROPERTY APPRAISER

DATE OF AERIAL SURVEY:
2017

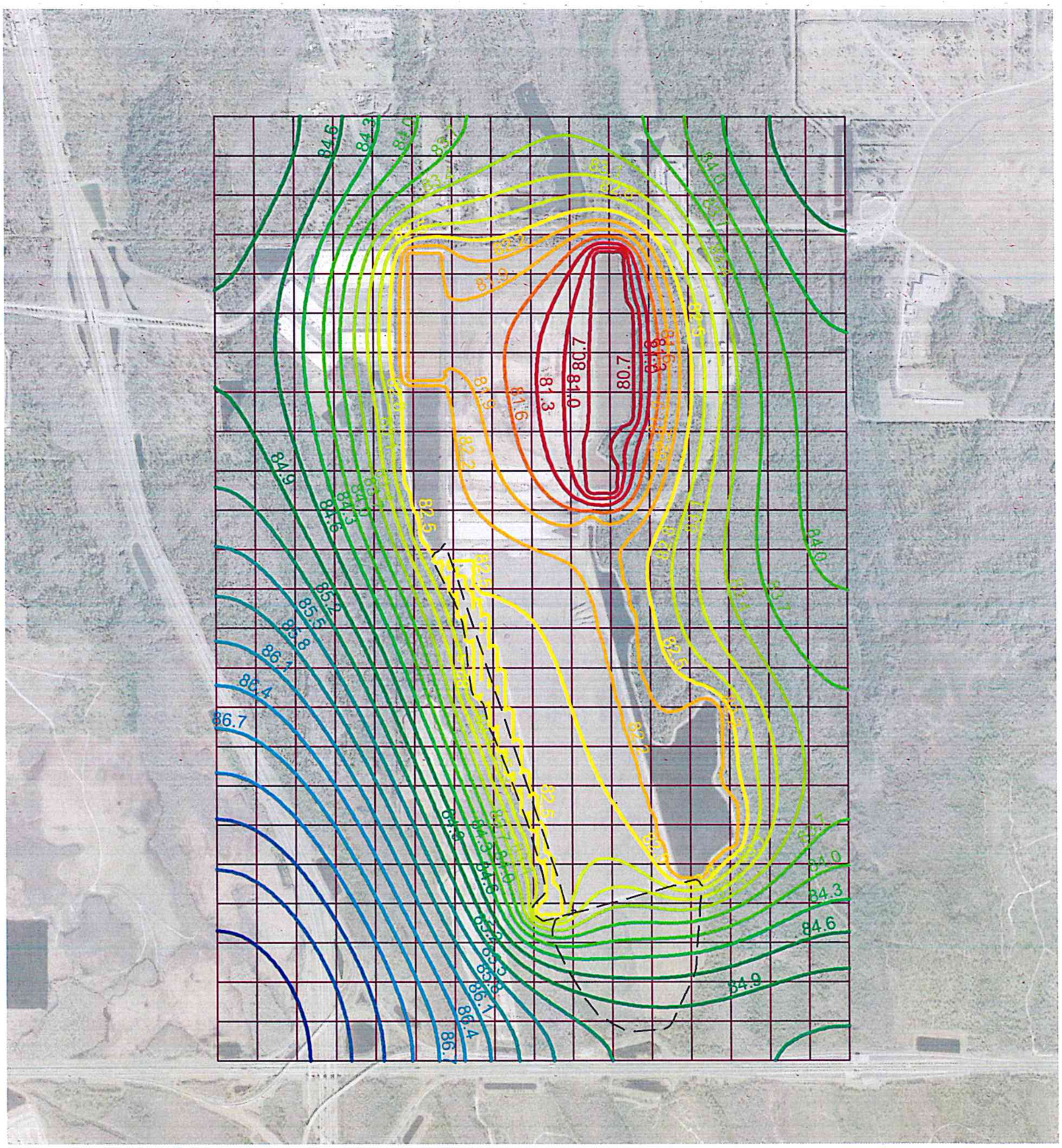
AVERAGE GROUNDWATER ELEVATION IN A NORMAL RAINFALL YEAR AFTER POND 9A CONSTRUCTION

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

ENGINEERING EVALUATION OF GROUNDWATER LEVELS
CELLS 11 AND 12
ORANGE COUNTY LANDFILL
SOUTHERN EXPANSION SITE

DRAWN BY: RDH	CHECKED BY: JM	DATE: 03/29/18
FILE NO. 17-13-0115	APPROVED BY: FKC	FIGURE: 8

R:\Corporate\17\17-13-0115\ENGINEERING EVALUATION OF GROUNDWATER LEVELS_Report\8 GROUNDWATER RECHARGE.dwg 2018/06/11 10:13 AM, Soto, Paula



LEGEND

Head

- 87.9
- 87.0
- 86.1
- 85.2
- 84.3
- 83.4
- 82.5
- 81.6
- 80.7

N

0 750 1500

SCALE: 1"=1,500'

AERIAL PHOTOGRAPH PROVIDED BY ORANGE COUNTY PROPERTY APPRAISER

DATE OF AERIAL SURVEY: 2017

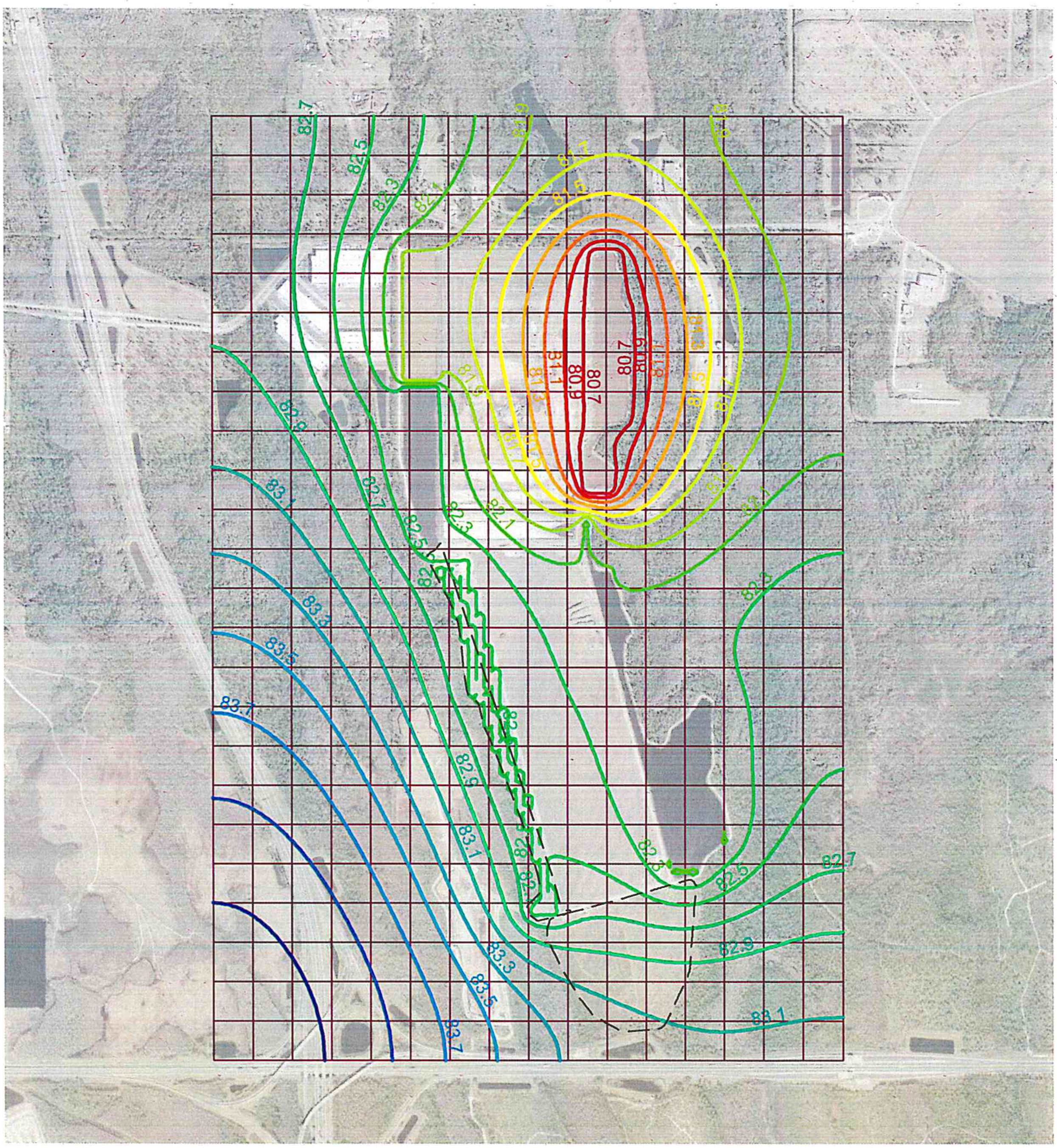
SEASONAL HIGH GROUNDWATER ELEVATION IN A NORMAL RAINFALL YEAR AFTER POND 9A CONSTRUCTION

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

ENGINEERING EVALUATION OF GROUNDWATER LEVELS CELLS 11 AND 12 ORANGE COUNTY LANDFILL SOUTHERN EXPANSION SITE

DRAWN BY: RDH	CHECKED BY: JM	DATE: 03/29/18
FILE NO. 17-13-0115	APPROVED BY: FKC	FIGURE: 9

R:\Corporate\17\17-13-0115\ENGINEERING EVALUATION OF GROUNDWATER LEVELS_Report\9 GROUNDWATER RECHARGE.dwg 2018/06/11 10:14 AM, Soto, Paula



LEGEND

Head

- 83.9
- 83.5
- 83.1
- 82.7
- 82.3
- 81.9
- 81.5
- 81.1
- 80.7

N

0 750 1500

SCALE:—1"=1,500'

AERIAL PHOTOGRAPH PROVIDED BY ORANGE COUNTY PROPERTY APPRAISER

DATE OF AERIAL SURVEY: 2017

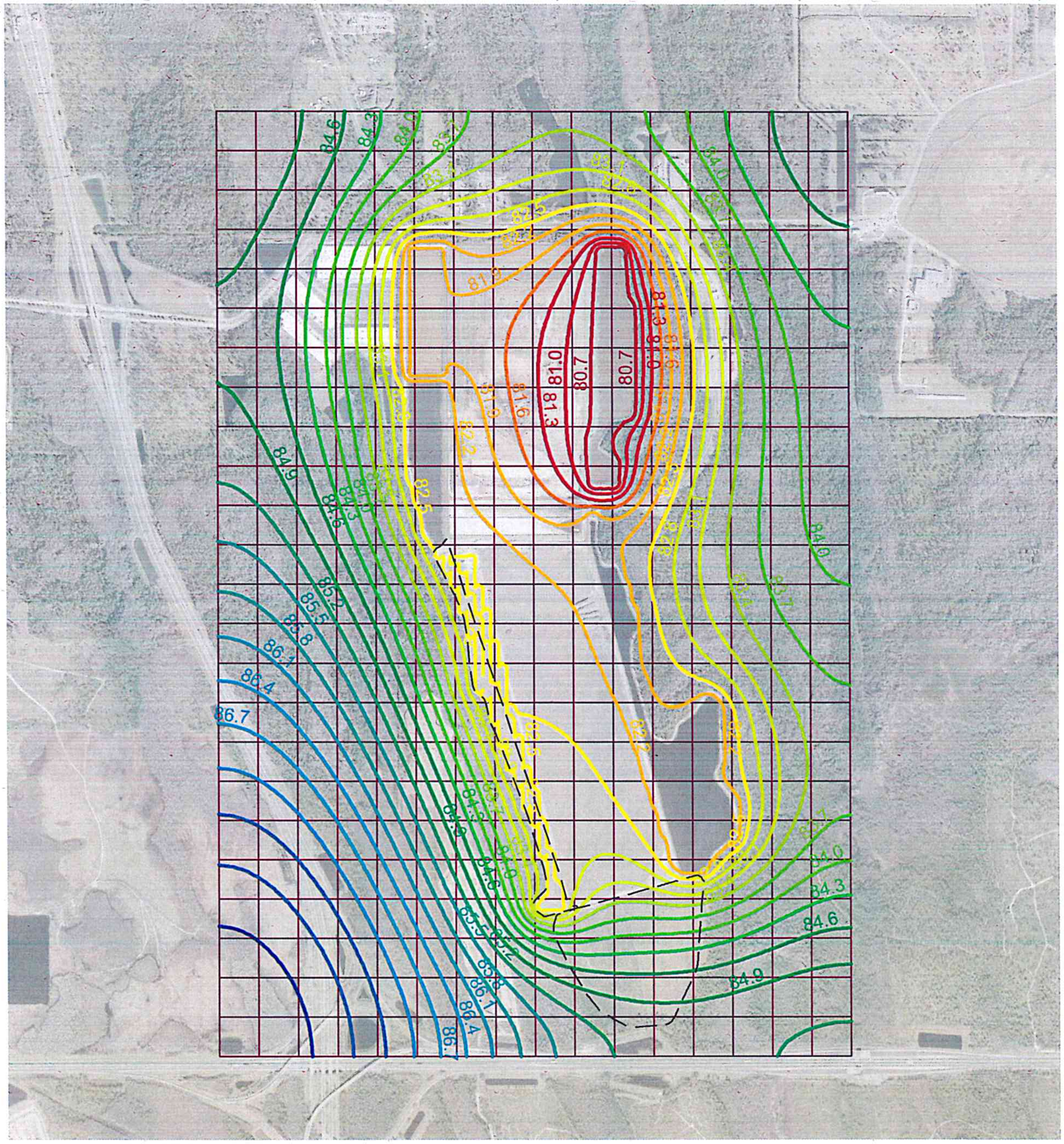
AVERAGE GROUNDWATER ELEVATION IN A NORMAL RAINFALL YEAR AFTER LINED CELL 11 CONSTRUCTION

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

ENGINEERING EVALUATION OF GROUNDWATER LEVELS CELLS 11 AND 12 ORANGE COUNTY LANDFILL SOUTHERN EXPANSION SITE

DRAWN BY: RDH	CHECKED BY: JM	DATE: 03/29/18
FILE NO. 17-13-0115	APPROVED BY: FKC	FIGURE: 10

R:\Corporate\17\17-13-0115\ENGINEERING EVALUATION OF GROUNDWATER LEVELS_Report\10 GROUNDWATER RECHARGE.dwg 2018/06/11 10:15 AM, Soto, Paula



LEGEND

Head
- 87.9
- 87.0
- 86.1
- 85.2
- 84.3
- 83.4
- 82.5
- 81.6
- 80.7

N

0 750 1500

SCALE: 1"=1,500'

AERIAL PHOTOGRAPH PROVIDED BY ORANGE COUNTY PROPERTY APPRAISER

DATE OF AERIAL SURVEY: 2017

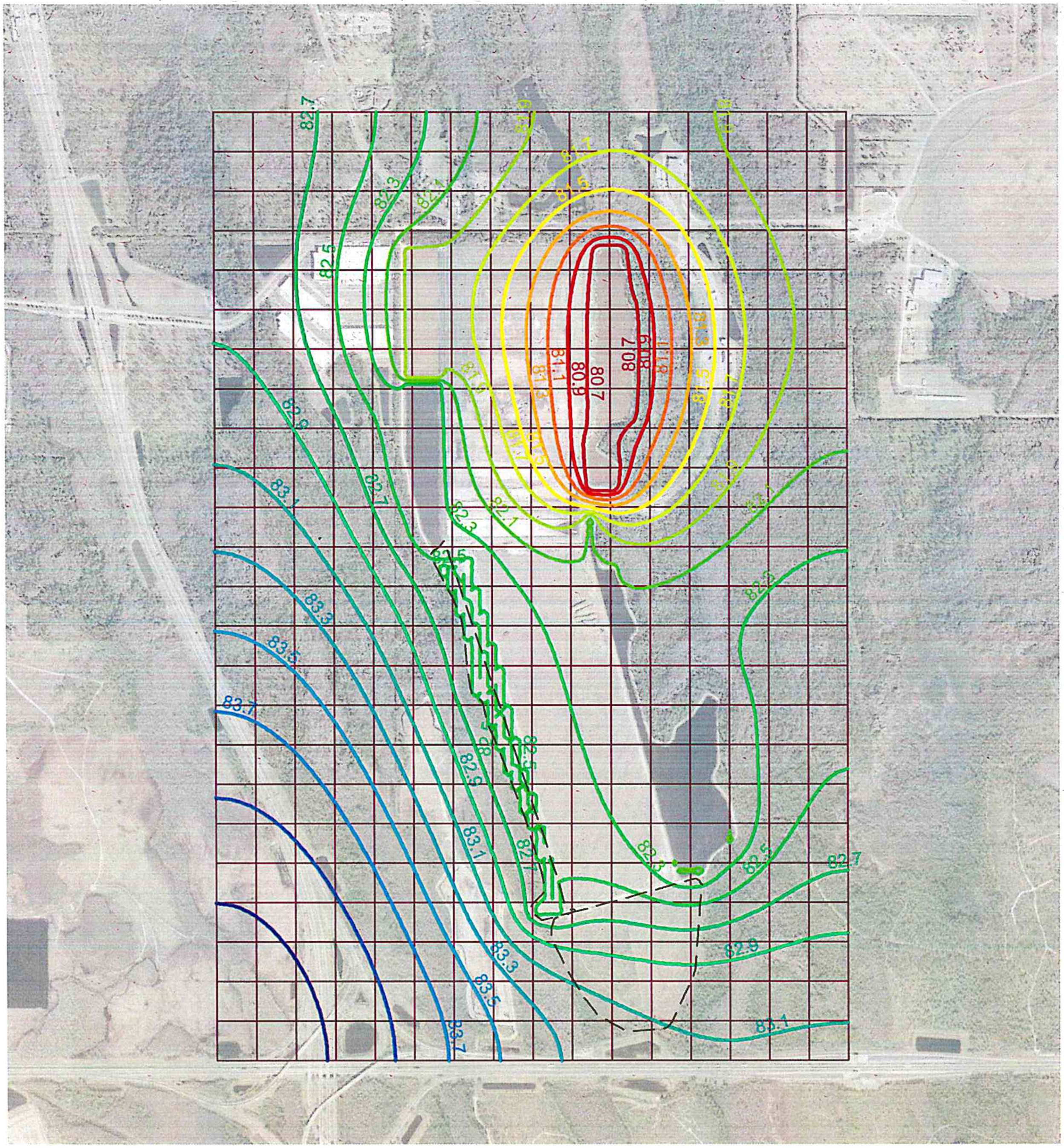
SEASONAL HIGH GROUNDWATER ELEVATION IN A NORMAL RAINFALL YEAR AFTER LINED CELL 11 CONSTRUCTION

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

ENGINEERING EVALUATION OF GROUNDWATER LEVELS CELLS 11 AND 12 ORANGE COUNTY LANDFILL SOUTHERN EXPANSION SITE

DRAWN BY: RDH	CHECKED BY: JM	DATE: 03/29/18
FILE NO. 17-13-0115	APPROVED BY: FKC	FIGURE: 11

R:\Corporate\17\17-13-0115\ENGINEERING EVALUATION OF GROUNDWATER LEVELS_Report\11 GROUNDWATER RECHARGE.dwg 2018/06/11 10:16 AM, Soto, Paula



LEGEND

Head

- 83.9
- 83.5
- 83.1
- 82.7
- 82.3
- 81.9
- 81.5
- 81.1
- 80.7

0 750 1500

SCALE:—1"=1,500'

AERIAL PHOTOGRAPH PROVIDED BY ORANGE COUNTY PROPERTY APPRAISER

DATE OF AERIAL SURVEY: 2017

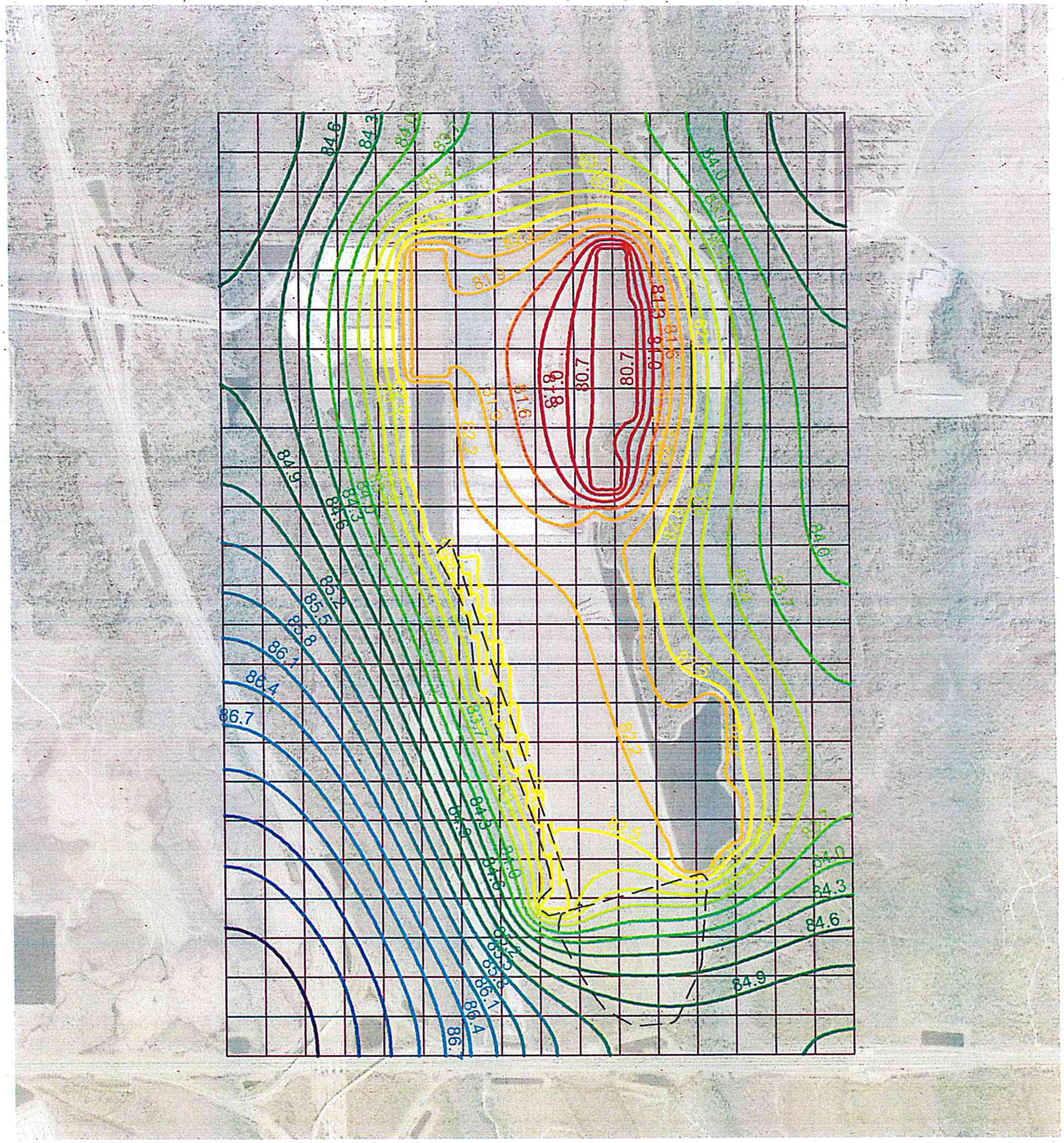
AVERAGE GROUNDWATER ELEVATION IN A NORMAL RAINFALL YEAR AFTER LINED CELL 12 CONSTRUCTION

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

ENGINEERING EVALUATION OF GROUNDWATER LEVELS CELLS 11 AND 12 ORANGE COUNTY LANDFILL SOUTHERN EXPANSION SITE

DRAWN BY: RDH	CHECKED BY: JM	DATE: 03/29/18
FILE NO. 17-13-0115	APPROVED BY: FKC	FIGURE: 12

R:\Corporate\17\17-13-0115\ENGINEERING EVALUATION OF GROUNDWATER LEVELS_Report\12 GROUNDWATER RECHARGE.dwg 2018/06/11 10:17 AM, Soto, Paula



LEGEND

Head
- 87.9
- 87.0
- 86.1
- 85.2
- 84.3
- 83.4
- 82.5
- 81.6
- 80.7

N

0 750 1500

SCALE:—1"=1,500'

AERIAL PHOTOGRAPH PROVIDED BY ORANGE COUNTY PROPERTY APPRAISER

DATE OF AERIAL SURVEY: 2017

SEASONAL HIGH GROUNDWATER ELEVATION IN A NORMAL RAINFALL YEAR AFTER LINED CELL 12 CONSTRUCTION

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

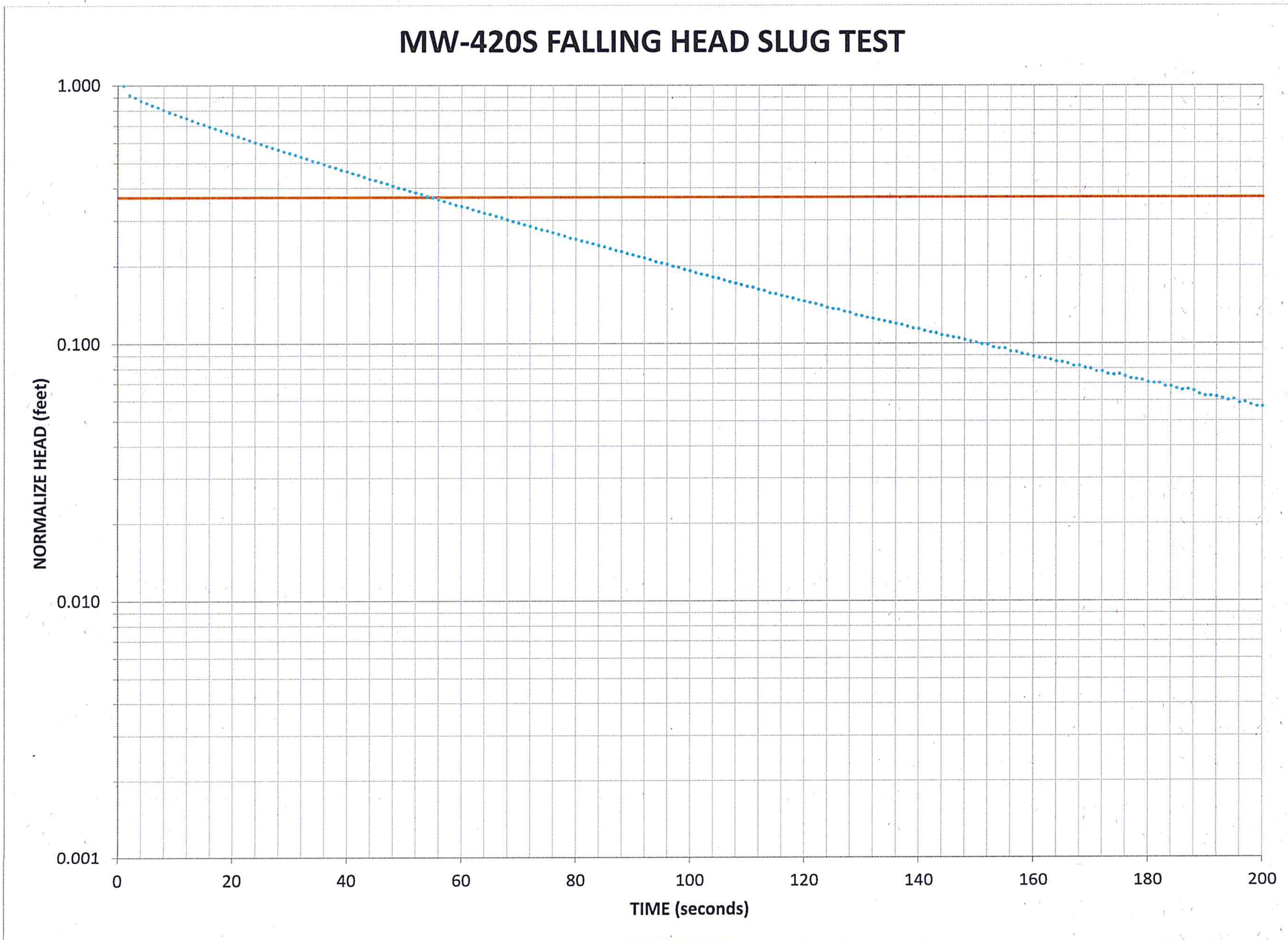
ENGINEERING EVALUATION OF GROUNDWATER LEVELS
CELLS 11 AND 12
ORANGE COUNTY LANDFILL
SOUTHERN EXPANSION SITE

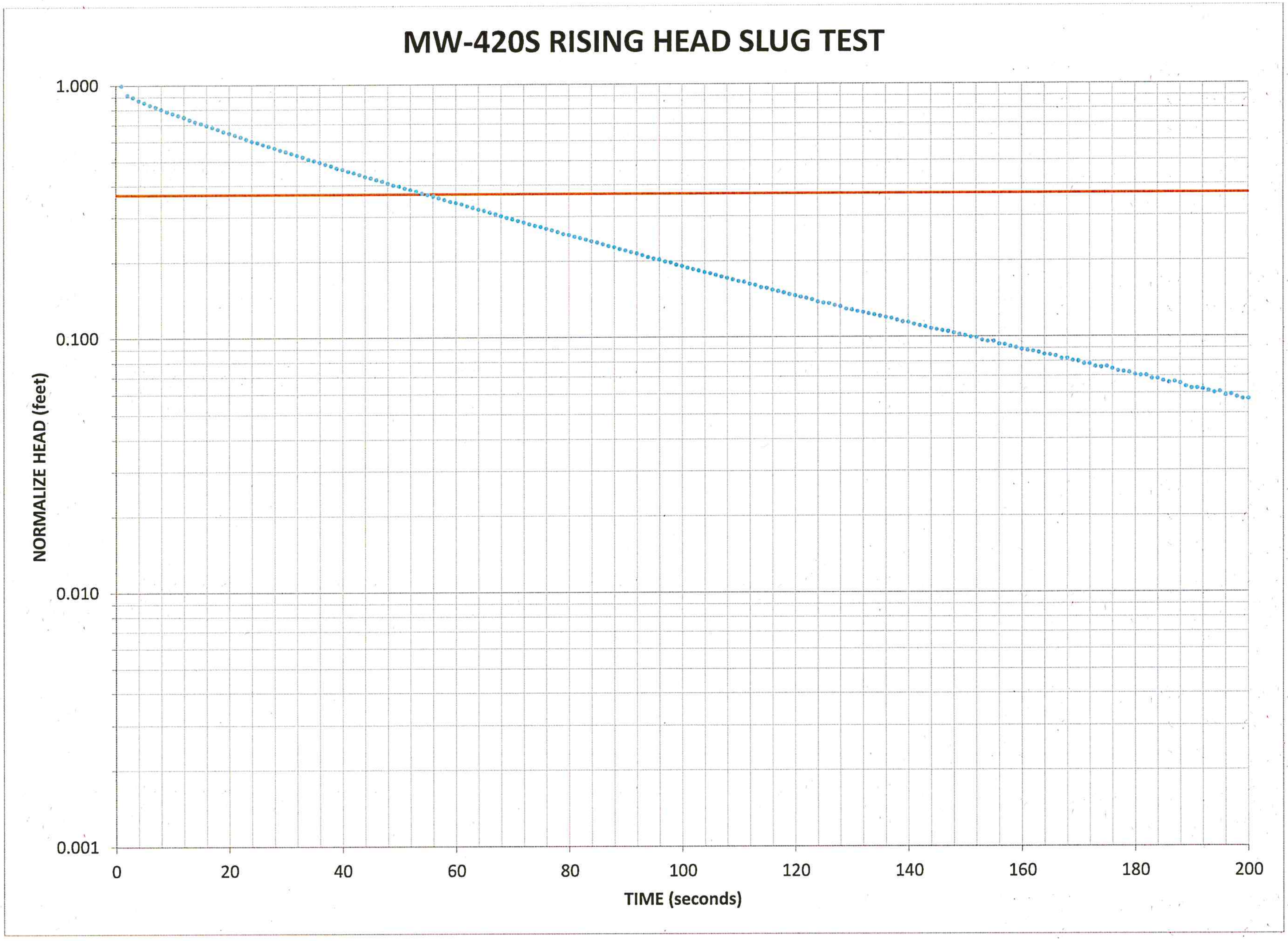
DRAWN BY: RDH	CHECKED BY: JM	DATE: 03/29/18
FILE NO. 17-13-0115	APPROVED BY: FKC	FIGURE: 13

R:\Corporate\17\17-13-0115\ENGINEERING EVALUATION OF GROUNDWATER LEVELS_Report\13 GROUNDWATER RECHARGE.dwg 2018/06/11 10:18 AM, Soto, Paula

Appendix 1

Results of Field Permeability Testing


MW-420S FALLING HEAD SLUG TEST
1.000
0.100
0.010
0.001
NORMALIZE HEAD (feet)
0
20
40
60
80
100
120
140
160
180
200
TIME (seconds)



MW-420S RISING HEAD SLUG TEST
1.000
0.100
0.010
0.001
NORMALIZE HEAD (feet)
0
20
40
60
80
100
120
140
160
180
200
TIME (seconds)

Calculation of K Value (K)

Project No.:	**113-17-13-0115**
Client:	**ORANGE COUNTY**
Location/Facility:	**ORANGE COUNTY LANDFILL**
Date:	**2/9/2018**

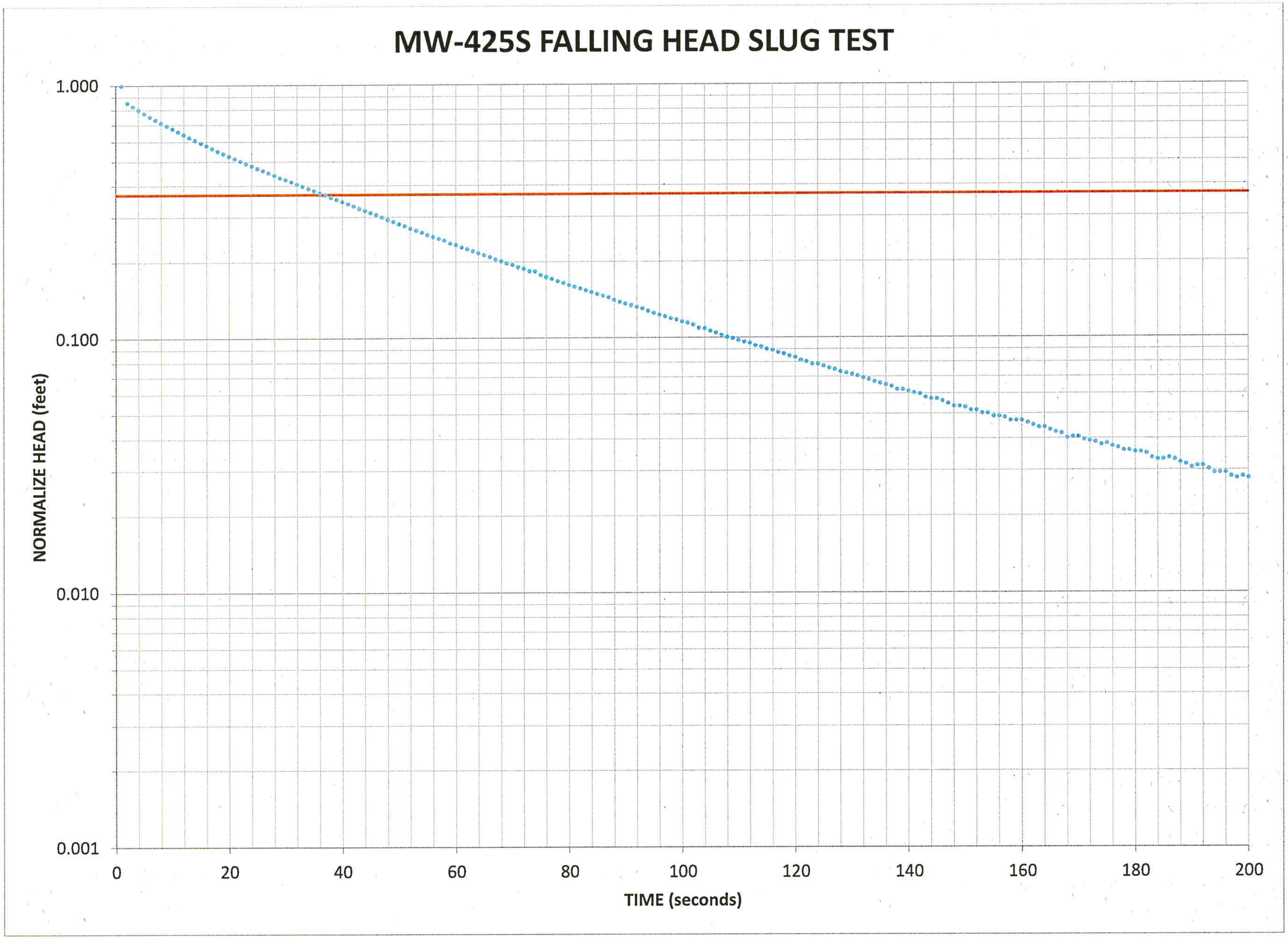
$$K = \frac{r^2 \ln (L/R)}{2\ L\ T_0}$$

"MW-420S" (Falling Head)

r = Casing Radius (ft)	0.086
L = Length of Screen	5
R = Filter Pack Radius (ft)	0.34375
T_0 = Basic Time Lag (sec) [recovery = 36.8%]	50
K = Hydraulic Conductivity **(ft/sec)**	3.97175E-05
K = Hydraulic Conductivity **(ft/day)**	3.43

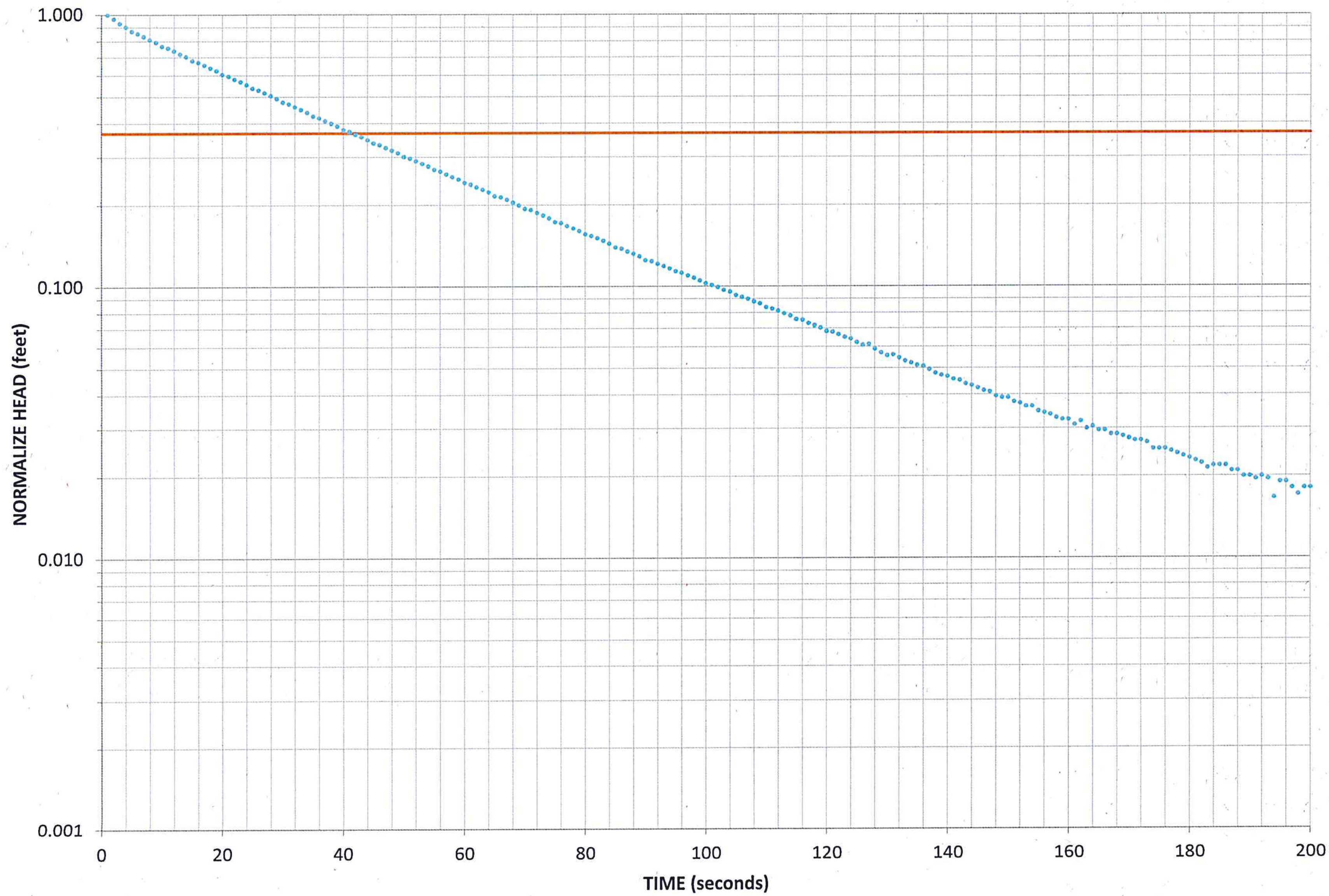
"MW-420S" (Rising Head)

r = Casing Radius (ft)	0.086
L = Length of Screen	5
R = Filter Pack Radius (ft)	0.34375
T_0 = Basic Time Lag (sec) [recovery = 36.8%]	54.5
K = Hydraulic Conductivity **(ft/sec)**	3.64381E-05
K = Hydraulic Conductivity **(ft/day)**	3.15



MW-425S FALLING HEAD SLUG TEST
1.000
0.100
0.010
0.001
NORMALIZE HEAD (feet)
0
20
40
60
80
100
120
140
160
180
200
TIME (seconds)

MW-425S RISING HEAD SLUG TEST



Calculation of K Value (K)

Project No.: 113-17-13-0115
Client: ORANGE COUNTY
Location/Facility: ORANGE COUNTY LANDFILL
Date: 2/9/2018

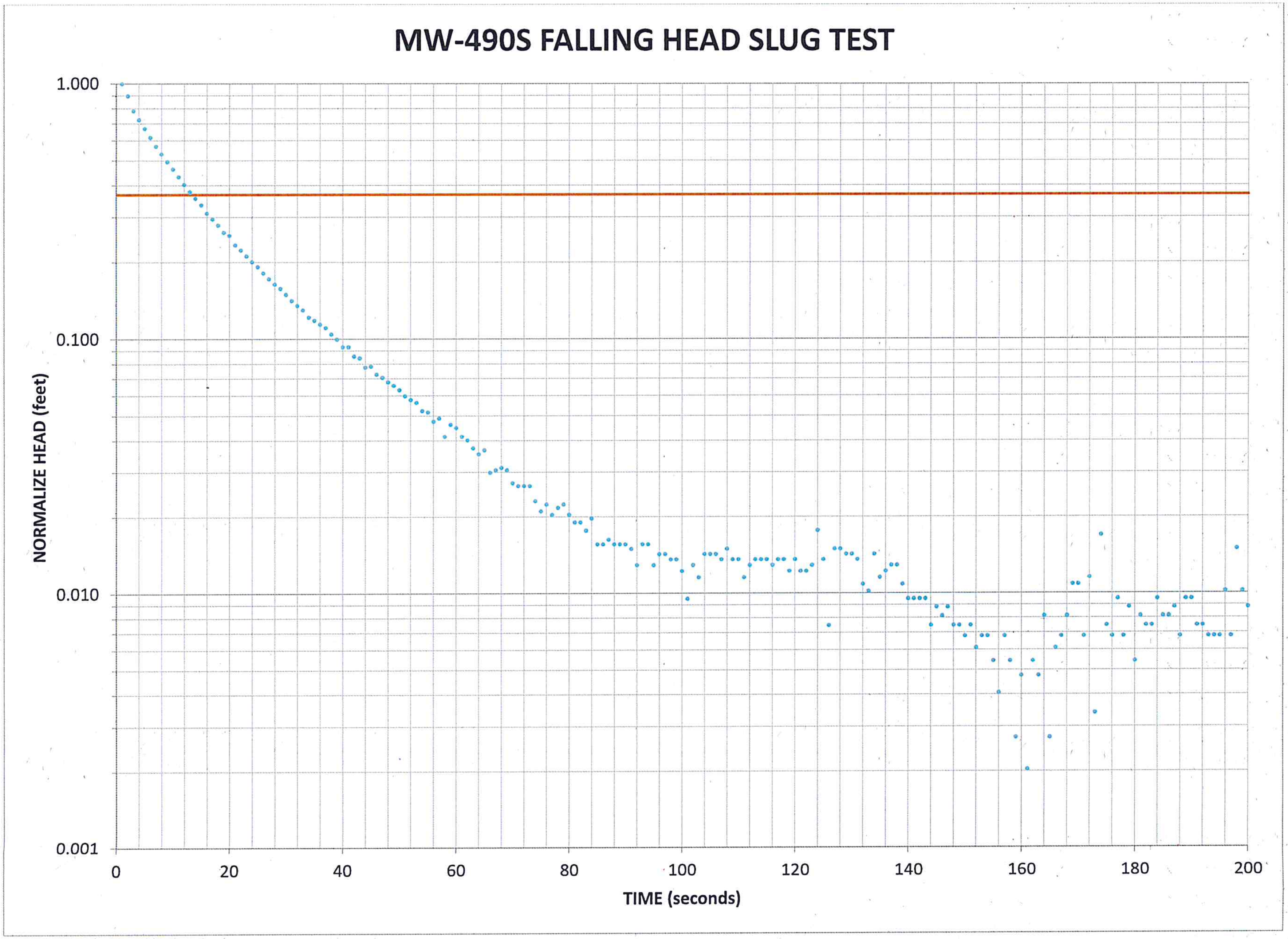
$$K = \frac{r^2 \ln(L/R)}{2 L T_0}$$

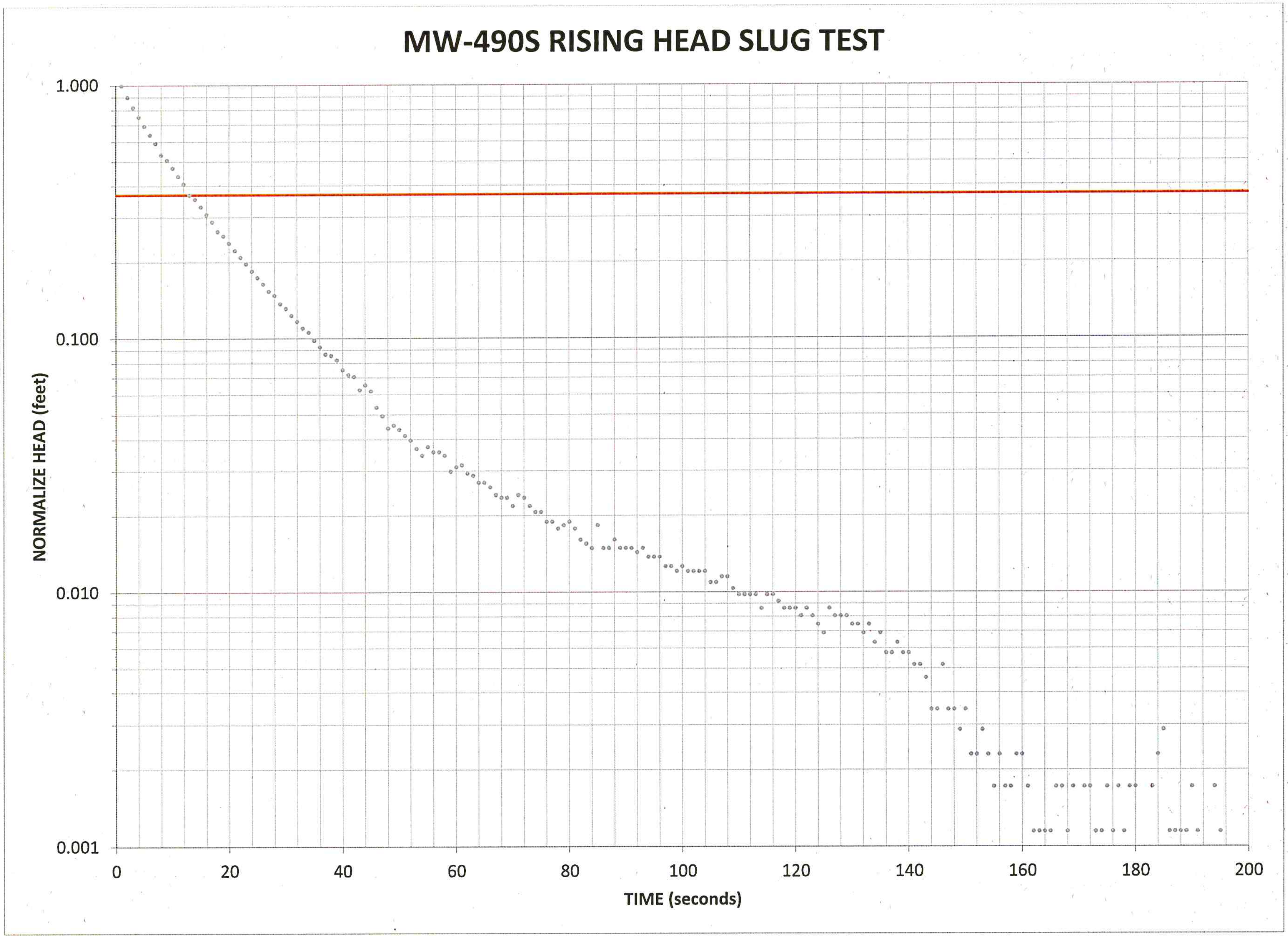
"MW-425S" (Falling Head)

r = Casing Radius (ft)	0.086
L = Length of Screen	5
R = Filter Pack Radius (ft)	0.34375
T_0 = Basic Time Lag (sec) [recovery = 36.8%]	36.5
K = Hydraulic Conductivity **(ft/sec)**	5.44075E-05
K = Hydraulic Conductivity **(ft/day)**	4.70

"MW-425S" (Rising Head)

r = Casing Radius (ft)	0.086
L = Length of Screen	5
R = Filter Pack Radius (ft)	0.34375
T_0 = Basic Time Lag (sec) [recovery = 36.8%]	41.5
K = Hydraulic Conductivity **(ft/sec)**	4.78524E-05
K = Hydraulic Conductivity **(ft/day)**	4.13


MW-490S FALLING HEAD SLUG TEST
1.000
0.100
0.010
0.001
NORMALIZE HEAD (feet)
0
20
40
60
80
100
120
140
160
180
200
TIME (seconds)


MW-490S RISING HEAD SLUG TEST
1.000
0.100
0.010
0.001
NORMALIZE HEAD (feet)
0
20
40
60
80
100
120
140
160
180
200
TIME (seconds)

Calculation of K Value (K)

Project No.:	**113-17-13-0115**
Client:	**ORANGE COUNTY**
Location/Facility:	**ORANGE COUNTY LANDFILL**
Date:	**2/9/2018**

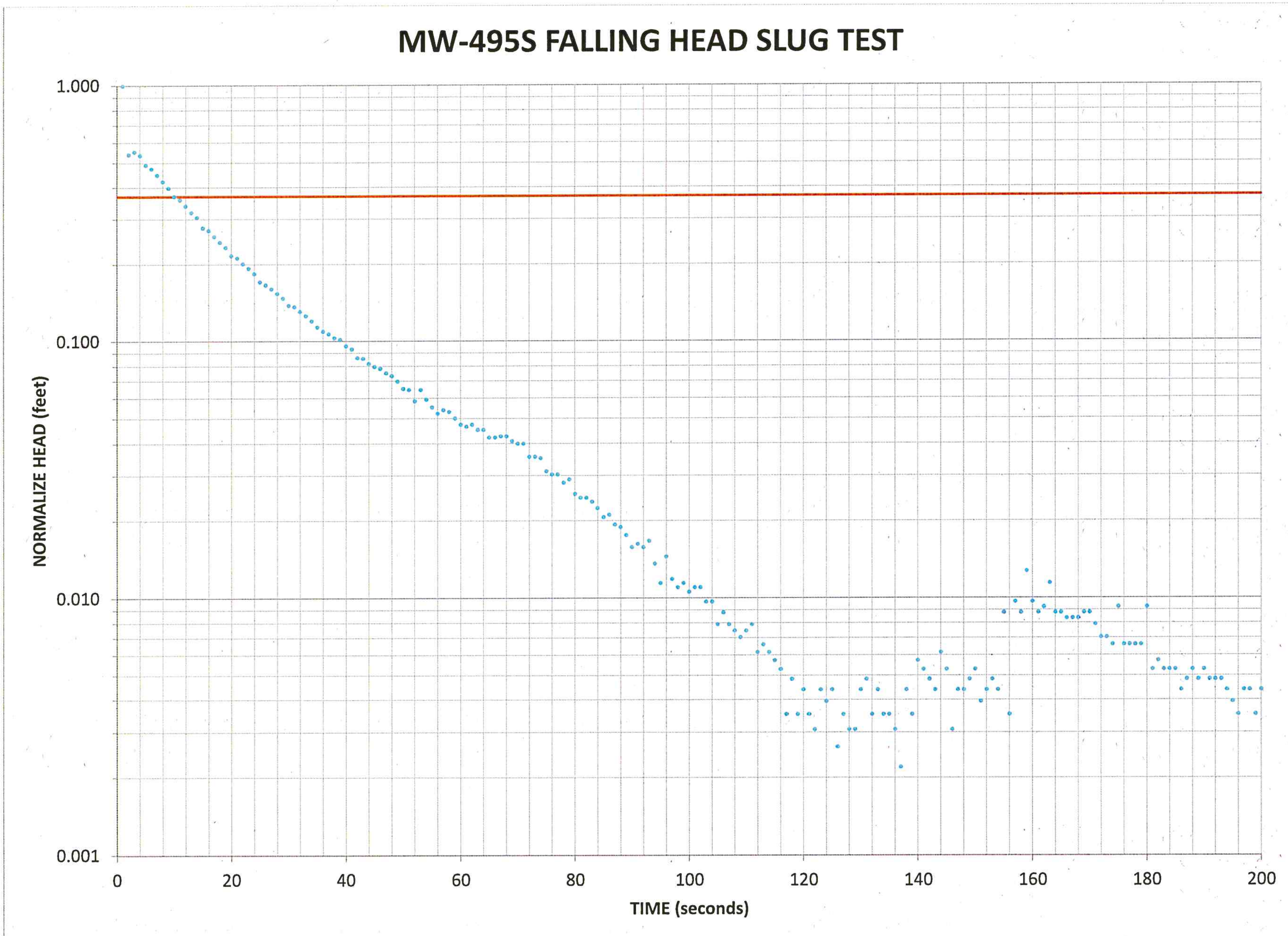
$$K = \frac{r^2 \ln (L/R)}{2 L T_0}$$

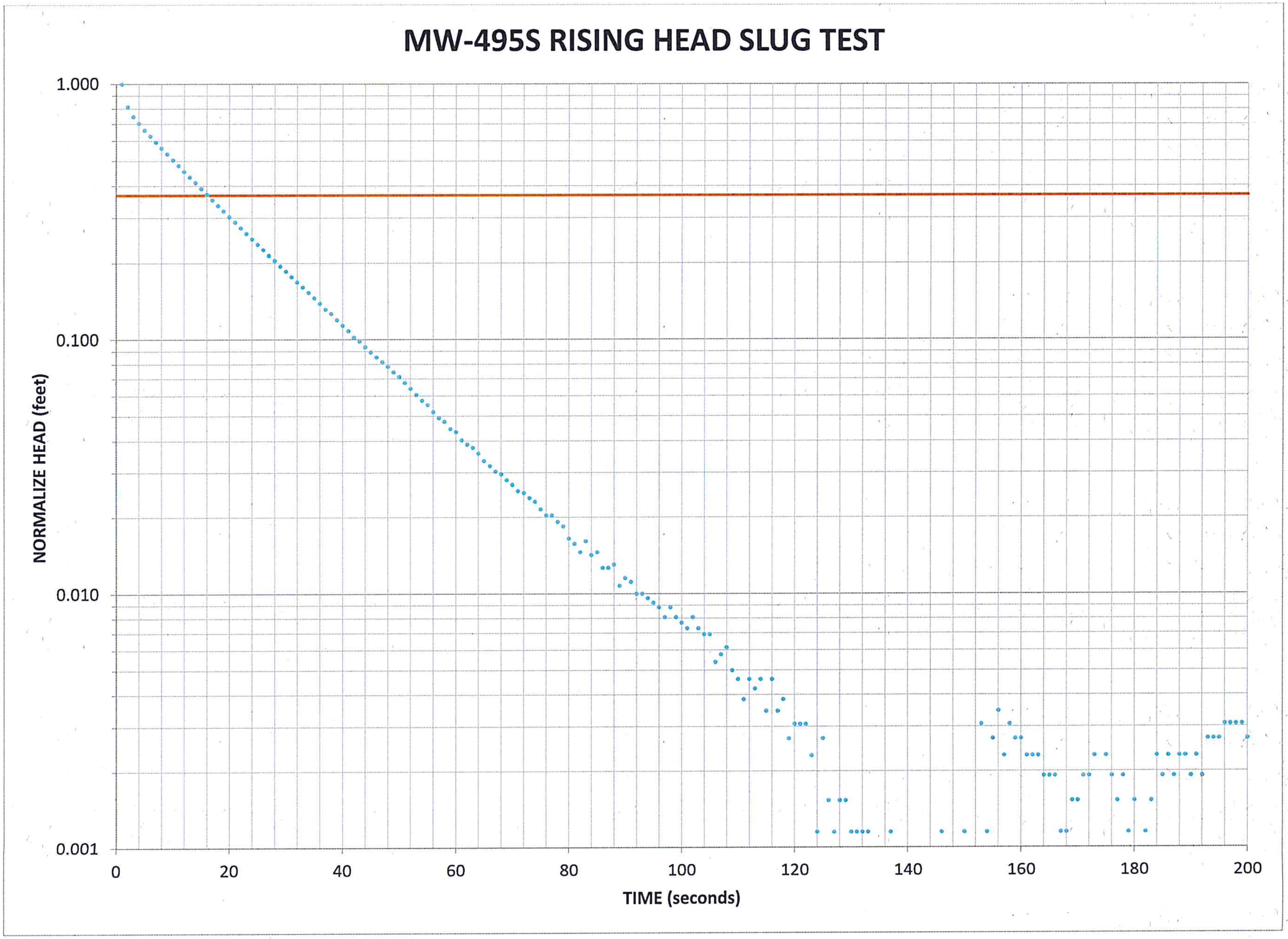
"MW-490S" (Falling Head)

r = Casing Radius (ft)	0.086
L = Length of Screen	5
R = Filter Pack Radius (ft)	0.34375
T_0 = Basic Time Lag (sec) [recovery = 36.8%]	14
K = Hydraulic Conductivity **(ft/sec)**	0.000141848
K = Hydraulic Conductivity **(ft/day)**	12.26

"MW-490S" (Rising Head)

r = Casing Radius (ft)	0.086
L = Length of Screen	5
R = Filter Pack Radius (ft)	0.34375
T_0 = Basic Time Lag (sec) [recovery = 36.8%]	13
K = Hydraulic Conductivity **(ft/sec)**	0.00015276
K = Hydraulic Conductivity **(ft/day)**	13.20


MW-495S FALLING HEAD SLUG TEST
1.000
0.100
0.010
0.001
NORMALIZE HEAD (feet)
0
20
40
60
80
100
120
140
160
180
200
TIME (seconds)


MW-495S RISING HEAD SLUG TEST
NORMALIZE HEAD (feet)
1.000
0.100
0.010
0.001
0
20
40
60
80
100
120
140
160
180
200
TIME (seconds)