

Case Analysis

Ground Improvement for Data Center Site Development

Market Sector

INDUSTRIAL/COMMERCIAL
DEVELOPMENT



Application

IN-SITU COMPACTION



Project Phase

CONSTRUCTION PHASE



Site Description

This 74-acre site included two (2) warehouse style buildings, Ancillary buildings, a transformer yard, stormwater detention basin, parking areas, and driveways. The site was an undeveloped area that required clearing and grubbing, and cut and fills up to 6 feet prior to HEIC. The general soil conditions consisted of undocumented fill, fat clay underlain by lean clay, and sand deposits.

Project and Geological Review

The main geotechnical concern that potentially could impact the proposed construction included soft to medium soils near the surface that could result in excessive settlement and high collapse potential. This collapse could cause inherent damage to the soil structure, requiring ground improvement before construction of the foundation slab-on-grade and pavements. Considerations for different ground improvement methods, including over-excavation and replacement or HEIC, were evaluated and recommended prior to the construction of conventional foundations, slab-on-grade structures, and pavements.

4x faster completion

with a **60% cost reduction.**



Project Details

During the preconstruction phase, an alternative ground improvement option: over-excavating native soils to a depth of at least 4 feet and replacing them with moisture-conditioned on-site soils, was reviewed and compared to HEIC practices.

During this time, it was determined that the HEIC method was 60% more cost effective than an over-excavation and replacement, and with HEIC's up to 16-foot depth of influence, the improvement would be far more superior at reducing the risk of differential settlements at depth.

The schedule was critical to the client and HEIC was used on 450,000 square feet and completed with 40 surface passes in 8 days. The alternative over-excavation and replacement would have taken four weeks longer than HEIC ground improvement.

After the ground improvement process using HEIC, the proposed structure was supported on conventional spread footings.



“ Following completion of the HEIC work, we reviewed the traditional post-construction settlement testing and saw a clear reduction in risk. The HEIC method significantly improved ground conditions and minimized the potential for future settlement issues.

- Engineer of Record

Technical Memorandum

Between March 25 and April 4, Dynamic Compaction Solutions (DCS) carried out up to approximately 40 surface passes of HEIC on the site. In addition, four cone penetration tests (CPT's) were performed: tests—CPT01, CPT04, CPT07, and CPT08—both before and after the HEIC at the same locations. Following the HEIC works, two additional CPT tests (CPT09 and CPT10) were conducted to evaluate its impact on the site soils.

CPT's were advanced to depths of 4-10 feet below grade (Table 1) and terminated once refusal conditions were encountered, providing critical data for ground characterization.

Using established correlations, Langan calculated the average percent change in relative density, N-value, and unit weight at each depth from pre- and post-HEIC CPT data (CPT01, CPT04, CPT07, CPT08).

Results showed soils from the surface to ~5 feet were 20-45% more compact, had up to 180% higher N-values, and up to 14% higher unit weights. Below 5 feet, changes were minimal (0-9% more compact).

Table 1 - CPT Test Depths

CPT Test Depth (feet)											
CPT01		CPT04		CPT07		CPT08		CPT09		CPT10	
Pre HEIC	Post HEIC	Pre HEIC	Post HEIC	Pre HEIC	Post HEIC	Pre HEIC	Post HEIC	Pre HEIC	Post HEIC	Pre HEIC	Post HEIC
3.8	10	9.7	10	9.4	10.3	8.9	9.8	-	8.5	-	10

Technical Memorandum cont.

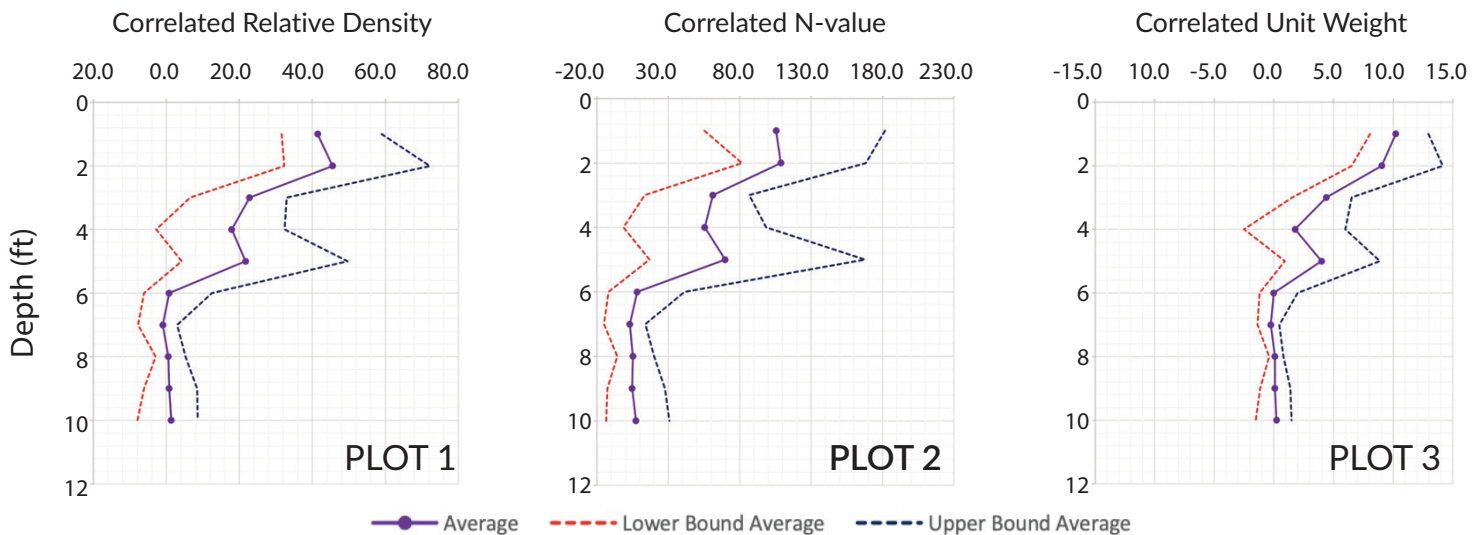
Table 2 - CPT Test Tip Resistances

Average Tip COR (tsf)												
Test Depth (feet)	CPT01		CPT04		CPT07		CPT08		CPT09		CPT10	
	Pre HEIC	Post HEIC	Pre HEIC	Post HEIC	Pre HEIC	Post HEIC	Pre HEIC	Post HEIC	Pre HEIC	Post HEIC	Pre HEIC	Post HEIC
0 - 1	42.46	74.17	74.34	78.22	60.26	170.21	79.82	153.29	-	108.09	-	166.94
1 - 2	168.22	236.89	168.20	227.45	104.36	233.83	141.91	269.74	-	227.33	-	225.40
2 - 3	188.60	243.20	182.18	246.70	229.75	233.38	195.38	298.27	-	191.24	-	226.53
3 - 4	258.22	201.61	195.71	270.62	325.61	301.78	175.33	279.99	-	233.93	-	252.83
4 - 5	-	174.71	183.24	287.00	269.66	269.43	266.44	288.24	-	264.79	-	273.80
5 - 6	-	104.35	195.16	281.98	241.04	228.54	281.72	261.10	-	303.00	-	221.47
6 - 7	-	184.09	267.90	296.75	325.34	266.30	307.91	246.98	-	287.16	-	278.29
7 - 8	-	216.34	270.77	276.98	320.36	281.40	311.70	364.98	-	278.38	-	284.87
8 - 9	-	236.76	290.77	260.54	301.15	296.70	317.51	381.49	-	272.54	-	294.50
9 - 10	-	239.35	298.78	257.31	304.83	315.84	326.48	380.49	-	262.75	-	303.00

Table 3 - CPT Test Friction Ratios

Average Friction Ratio (%)												
Test Depth (feet)	CPT01		CPT04		CPT07		CPT08		CPT09		CPT10	
	Pre HEIC	Post HEIC	Pre HEIC	Post HEIC	Pre HEIC	Post HEIC	Pre HEIC	Post HEIC	Pre HEIC	Post HEIC	Pre HEIC	Post HEIC
0 - 1	0.74	1.86	0.73	1.43	0.73	1.43	0.93	1.47	-	1.42	-	2.43
1 - 2	0.00	2.29	0.72	2.58	0.72	2.58	1.50	2.55	-	3.19	-	3.33
2 - 3	0.80	3.26	1.56	2.02	1.56	2.02	2.62	3.30	-	4.00	-	2.21
3 - 4	1.41	2.70	2.89	2.92	2.89	2.92	3.20	3.71	-	4.17	-	3.60
4 - 5	3.15	2.41	2.60	3.10	2.60	3.10	2.96	4.03	-	4.33	-	3.90
5 - 6	-	1.74	2.98	2.73	2.98	2.73	3.95	3.45	-	3.63	-	4.57
6 - 7	-	1.98	2.56	2.56	2.35	2.80	3.21	2.81	-	4.50	-	4.19
7 - 8	-	2.15	2.20	2.42	2.12	3.42	3.01	2.84	-	4.49	-	4.12
8 - 9	-	2.28	2.25	2.30	1.55	2.77	2.79	2.86	-	4.39	-	1.01
9 - 10	-	2.42	2.10	2.28	-	-	2.61	2.83	-	4.22	-	3.91

CPT 01, CPT 04, CPT 07 & CPT08 - Average Percentage Changes



Summary

Plots 1 through 3 show that the soils closest to the surface were the most impacted by the HEIC treatment, with the effect gradually decreasing below roughly five feet.

Plot 1 indicates that from the surface to about five feet, soils became significantly more compact—on average 20% to 45% denser. Below five feet, the change was minimal, averaging between -1% and 1.3%.

Plot 2 shows that correlated N-values increased by about 55% to 110% in the upper five feet. Deeper soils saw smaller gains, ranging from roughly 3.1% to 8.2%.

Plot 3 reveals that unit weights rose by about 1.8% to 10.2% in the upper five feet. Below this depth, changes were negligible, from -0.3% to 0.2%. Overall, post-HEIC CPT data confirms that the upper five feet of the soil profile was densified, as reflected by notable increases in relative density, N-values, and unit weights. Below this depth, improvements were limited due to the soils already being relatively dense prior to treatment.

Plot 4 and DCS's measurements indicate that the HEIC induced approximately six inches of average ground settlement across the site.

Based on pre- and post-HEIC results, the 40 passes completed appear to have sufficiently densified the upper soils, reducing the risk of potential soil collapse and aligning with geotechnical recommendations. Subgrade preparation and earthwork can proceed per project specifications. Additional post-HEIC testing, including Dynamic Cone Penetrometer and plate load testing, was reviewed by Langan for further evaluation.



- ✓ **4x faster completion time**
- ✓ **16 feet depth of influence**
- ✓ **60% more cost effective saving 4 weeks project time**

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