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BRICKYARD COMMONS

HELICAL PILE DESIGN

Property Address: 1420 Brickyard Road, Palm Harbor, Florida

Prepared for: Foundation Contractors

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Design parameters: 37.5 kips compression / 14.5 kips tension allowable / lateral load not supplied - FS = 2 - 3-1/2" x 0.300" shaft - Kt = 7/ft

Acceptance torque 10,714 ft-lb (derived) - shaft torsional rating 14,460 ft-lb - 2 borings, 2 design zones

RECOMMENDATION

Both zones: 10"-12" double helix on 3-1/2" x 0.300" shaft, installed to 10,714 ft-lb final tip torque.
Estimated depth 22.50 ft (North / East zone, B-1) and 31.50 ft (South / West zone, B-3).

Boring	Zone	Config	Depth Z (ft)	Top Helix (ft)	Lead	Extensions	Total	Compression Allowable (kips)	Tension Allowable (kips)	Lateral Allowable (kips)	Torque (ft-lbs)
B-1	North / East zone	10-12 dbl	22.50	20.00	7 ft	3 x 7 ft	28 ft	44.1	39.7	2.46 free	10,714
B-3	South / West zone	10-12 dbl	31.50	29.00	7 ft	4 x 7 ft	35 ft	44.5	40.0	2.37 free	10,714

Scope. Design of helical piles for 2 design zones at the Brickyard Commons, each referenced to its own soil boring per the marked-up foundation plan supplied by the client. All borings are the geotechnical laboratory report GTR-25-0418, drilled 04/18/2025. This report presents the soil model, capacity-versus-depth for each boring, the recommended configuration and installation depth, the derived field acceptance criterion, order quantities, and the boring logs.

IMPORTANT - LIMITATIONS AND DISCLAIMER

THIS REPORT IS A PRODUCT RECOMMENDATION, NOT AN ENGINEERING DESIGN. It is prepared by TMG Manufacturing solely from the soil boring data supplied to TMG and identified in this report. TMG has not visited the site, has performed no subsurface investigation of its own, and has not independently verified any of the supplied data.

NOT FOR PERMITTING. NOT FOR CONSTRUCTION. This document is not a sealed engineering opinion and must not be submitted for permit, used as the sole basis of design, or relied upon for construction. Final design - including verification of loads and load combinations, connections, anchor layout, and all site conditions - is the responsibility of a licensed professional engineer of record.

THE DATA CONTAINED HEREIN IS FOR REFERENCE ONLY and is based on industry-accepted formulas. It is not intended to be the final and actual load determination. TMG MANUFACTURING IS NOT OFFERING ANY OPINIONS OR DESIGN CONCLUSIONS.

Subsurface conditions between and below the borings may differ materially from those interpreted here, and conditions may change over time. The recommendations in this report are contingent on the accuracy and completeness of the data supplied to TMG. TMG Manufacturing assumes no liability for the use of this report, for any design or construction decision made in reliance on it, or for any consequence arising from conditions differing from the supplied data. Use of this report constitutes acceptance of these limitations.

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2. EXECUTIVE SUMMARY

2 the geotechnical laboratory borings define 2 design zones. **B-1 (North / East zone)**: Concrete and limerock base to 1 ft; SAND, medium dense to dense to 14 ft; CLAY, stiff to 19 ft; CLAY, CEMENTED, very hard to 29 ft; LIMESTONE, weathered, very hard to 30 ft. **B-3 (South / West zone)**: Concrete and limerock base to 1 ft; SAND, medium dense to 20 ft; CLAY, CEMENTED, hard to 25.5 ft; CLAYEY SAND, medium dense to 29 ft; LIMESTONE, weathered, very hard to 35 ft. Groundwater at 8.1 ft in all borings. Capacity is by individual plate bearing, Qu = SUM Ah x (9 su + q') in cohesive strata and Ah x q' Nq in granular, net of the shaft. Strength inferred from refusal blow counts is bounded at su = 8.0 ksf. The cylindrical shear mode (soil-cylinder shear between the top and bottom helix, plus bearing at the lead plate) is CALCULATED for every configuration rather than assumed - 98.2 k (B-1), 98.5 k (B-3) versus 88.3 k / 89.0 k by individual plates - the plate method governs and is published directly. Shaft friction along the shank above the lead section is also computed - 9.0 k (B-1) and 15.8 k (B-3) - and is disclosed as RESERVE capacity only; it is not credited toward the published design values absent a site-specific load test.

The 8"-10" double nominated for the North / East zone zone reaches only 28.3 kips on B-1, 75% of requirement, and was rejected. **A 10"-12" double is specified for every zone.** Field acceptance is 10,714 ft-lb final tip torque, DERIVED as Qreq x FS / Kt = 37.5 x 2 / 7. That is 74% of the 14,460 ft-lb shaft torsional rating - a thin margin, and the installation controls in Section 7 exist because of it.

Boring	Zone	Config	Depth Z (ft)	Top Helix (ft)	Lead	Extensions	Total	Compression Allowable (kips)	Tension Allowable (kips)	Lateral Allowable (kips)	Torque (ft-lbs)
B-1	North / East zone	10-12 dbl	22.50	20.00 ft	7 ft	3 x 7 ft	28 ft	44.1 k	39.7 k	2.46 k free	10,714
B-3	South / West zone	10-12 dbl	31.50	29.00 ft	7 ft	4 x 7 ft	35 ft	44.5 k	40.0 k	2.37 k free	10,714

• **TORSIONAL MARGIN.** The acceptance torque of 10,714 ft-lb is 74% of the 14,460 ft-lb shaft rating, so the maximum design capacity certifiable on this shaft is 50.6 kips against 37.5 required. Drive heads must be calibrated, torque read continuously rather than only at termination, and installation stopped AT acceptance torque - not driven past it. An anchor reaching the rating without reaching acceptance must be stopped and referred to the engineer of record.

• **SOUTH / WEST ZONE - TORQUE WILL FALL BEFORE IT RISES.** At B-3 the torque-to-develop profile peaks near 22.8 ft, falls to 48% of that peak by 25.2 ft, then climbs again. **Do not terminate on the first peak.** The 31.50 ft depth is below the weak layer deliberately. An anchor meeting acceptance torque above 25.2 ft has not found the bearing stratum this design relies on.

• **STRENGTH AT REFUSAL IS BOUNDED, NOT MEASURED.** Both bearing strata are logged at 50 blows for a few inches. Design strength is capped at su = 8.0 ksf (4 tsf, upper end of the standard consistency scale). No laboratory strength testing exists for this site. The depths published here are model ESTIMATES; the acceptance torque is the control, and if the material is weaker the anchor simply goes deeper before torque is reached.

• **LOGGED ANOMALY.** B-3 records 50% loss of drilling fluid circulation at 28.0 ft. It is not modelled. Abrupt torque loss below 28 ft on the South / West zone zone must stop work pending the engineer of record.

• **ANCHOR QUANTITIES NOT ISSUED.** Trench lengths and anchor spacing have not been supplied. Section 8 gives per-anchor material only; multiply by the anchor schedule when the engineer of record issues it.

• **LATERAL CAPACITY IS PUBLISHED, DEMAND IS NOT CONFIRMED.** Section 6 gives allowable lateral load per anchor: 2.37 to 2.46 kips free head and 3.76 to 3.91 kips fixed head, governed by the shaft hinge. **Head fixity must be declared by the engineer of record** - it changes capacity by about 60%. No lateral demand has been supplied; the EOR must compare their demand against these values.

• **CORROSION LOSS, 50-YEAR DESIGN LIFE.** No resistivity, pH, chloride or sulfate data has been supplied for this coastal site. The shaft is GALVANIZED (part no. -G), modelled as galvanized: zinc coat (86 um/face) is consumed sacrificially over the first ~16 years (AASHTO model: 15 um/yr x 2 yr, then 4 um/yr), after which bare steel corrodes at 12 um/yr for the remaining 34 years - net base-steel loss 0.016 in per face, taken on both the OD and ID surfaces (shaft ends are not sealed). End-of-life net section retains 89% of the as-installed plastic hinge moment. Axial steel stress on the corroded section at 37.5 k is 13.9 ksi, 21% of Fy - PASSES, but confirm with a corrosion study once available; this default is not a substitute for one.

• **AXIAL BUCKLING - SCREENED, NOT GOVERNING.** Both borings show N >= 4 throughout the embedded shaft (the standard threshold below which soil no longer reliably restrains the shaft against column buckling), so buckling is not expected to govern. Quantified lower-bound: allowable buckling load 154 kips versus 37.5 kips required - large margin.

• **SITE-WIDE GEOTECHNICAL SCREENING.** This revision adds a full round of site-condition checks: shallow-foundation bearing (comparative baseline, Section 5), lateral earth pressure by stratum, slope stability (screened out - at-grade site), seepage/piping (screened - excavation stays above the water table), liquefaction triggering (Seed-Idriss/Youd, FS >= 5.2 everywhere against a 1.2 threshold), seismic design parameters (USGS ASCE 7-22, SDC A), downdrag (screened out, negligible), and group effects (Converse-Labarre efficiency tabulated pending the anchor schedule). None of these govern the design; all are computed, not asserted - see the dedicated sections following Section 6.

2. EXECUTIVE SUMMARY (CONTINUED)

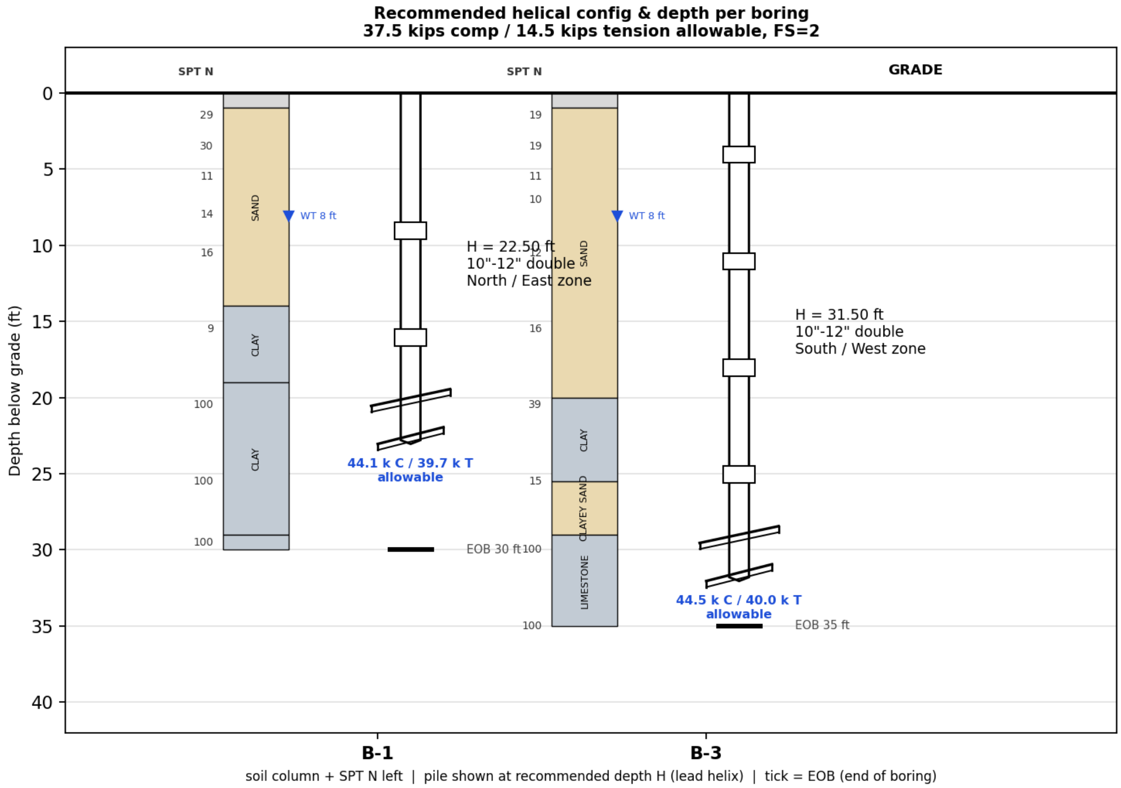
• **KARST - THE ONE OPEN ITEM THAT MATTERS.** B-3 logs 50% loss of drilling fluid circulation at 28.0 ft, the classic signature of a solution feature in this setting, and the recommended B-3 anchor bears BELOW it (uppermost helix 29.0 ft). Every kip that anchor delivers passes through the suspect horizon. 2 SPT borings cannot resolve this; Section 16 issues 4 field hold points with named owners, and a probe program is an engineer-of-record decision TMG has not been engaged for. **This is the item most likely to change the design.**

• **SETTLEMENT - CHECKED, NOT GOVERNING.** Total axial settlement is 0.21 in against a 1.0 in serviceability limit, and it is dominated by elastic shortening of the steel shaft rather than by the ground - so it is predictable and largely independent of the soil modulus assumption. Differential between strips is 0.056 in. Combined axial-plus-flexure interaction (AISC H1.1) reaches 0.89 in the fixed-head case, which is the tightest structural margin in the report and another reason head fixity needs declaring.

• **COUPLING - DEMAND PUBLISHED, CAPACITY NOT.** TMG coupling ratings were not supplied, so this report publishes the demand any rating must meet (12,713 ft-lb torsion, 44.5 k compression, 40.0 k tension) rather than inventing a capacity. No conventional bolt configuration carries that torsion on bolt shear alone, so the coupling's tested rating must be confirmed.

• **NOT EVALUATED.** Cap and termination connection capacity, which requires an engineer-of-record detail that has not been provided.

3. SITE SUMMARY - Recommended Config & Depth per Boring



	B-1 North / East zone	B-3 South / West zone
Design boring source	geotechnical laboratory report GTR-25-0418, Log of Borehole B-1, drilled 04/18/2025	geotechnical laboratory report GTR-25-0418, Log of Borehole B-3, drilled 04/18/2025
Boring termination	30 ft	35 ft
Bearing stratum	CLAY, CEMENTED, very hard	LIMESTONE, weathered, very hard
Configuration	10"-12" double	10"-12" double
Recommended depth H	22.50 ft	31.50 ft
Uppermost helix	20.00 ft (12D req. 12.0 ft)	29.00 ft (12D req. 12.0 ft)
Compression - Allowable	44.1 kips	44.5 kips
Tension - Allowable	39.7 kips	40.0 kips
Lateral - Allowable, free head	2.46 kips	2.37 kips
Lateral - Allowable, fixed head	3.91 kips (fixity NOT declared)	3.76 kips (fixity NOT declared)
Acceptance torque	10,714 ft-lb	10,714 ft-lb
Shaft footage per anchor	28 ft	35 ft

4. DESIGN PARAMETERS & METHODS

Parameter	Value	Basis / where used
Code basis	IBC / ICC-ES AC358	acceptance criteria; AISC 360 for steel checks
Load basis	ALLOWABLE	working loads checked against Qult / FS
FS, bearing (geotechnical)	2.0	AC358 / IBC
FS, shaft (structural)	AISC allowable	torsional rating at 0.6 Fy (shear yield)
Depth investigated	B-1: 30 ft | B-3: 35 ft	the geotechnical laboratory GTR-25-0418 SPT borings
Clays su	0.13 N (ksf), capped 8.0 ksf	estimated from SPT; refusal N bounded - see Sensitivity table, Formulas section
Sands phi	28 + 0.28 N, capped 36 deg	estimated from SPT
Soil elasticity Es	800 su / 10.44 (N+15) ksf	estimated from SPT; used in Axial Settlement section
Unit weights	carried in the project spec	values supplied/transcribed with the project data; TMG default table applies only where a stratum has none
Cylinder method	Mitsch-Clemence	computed both borings; plate mode governs - Detailed Calculations appendix
Shaft friction	computed, HELD IN RESERVE	not credited without a site load test - Detailed Calculations appendix A4
Pile tip resistance	not credited	plate bearing net of shaft area
Manufacturer	TMG Manufacturing Corp	Tampa, FL
ICC-ES evaluation report	ESR-4621	AC358 evaluation of the TMG helical pile system. NOTE: ESR-4621 covers the 2-7/8" shaft
Helical pile	600-35-S80-7-1012-G	600 = helical starter; 35 = 3-1/2" OD shaft; S80 = Schedule 80 pipe (0.300" wall); 7 = 7 ft pipe length; 1012 = 10" and 12" helical blades; G = galvanized (B would be bare steel)
Helical plates	10"-12" double, 0.375" (ASSUMED)	plate thickness not supplied
Pile diameter O.D.	3.5 in	
Wall thickness	0.300 in	Schedule 80
Pile steel area As	3.02 in2	net section
Shaft Fy	65 ksi	SPECIFIED MINIMUM of the 65-72 ksi range, AISC 360 A3.1
Yield strength, shaft	196.0 k	Fy x As
Torque capacity	14,460 ft-lb	0.6 Fy J/c (shear yield) - DERIVED, Calculation Methodology section
Torque factor Kt	7 /ft	AC358, 3-1/2" round shaft
Design life	50 years	zinc ~16 yr, then steel 12 um/yr (AASHTO model, ASSUMED) - Corrosion sections
Coating	Galvanized, ASTM A123 (part no. -G)	ASTM A123 hot-dip; zinc ~16 yr, then base steel - Corrosion sections
Lateral analysis	Broms + Reese-Matlock	ALWAYS published, demand supplied or not - Lateral Loads section
Pile head (rotation)	free AND fixed published	fixity NOT declared by EOR - Lateral Loads / Interaction sections
Lateral load (demand)	not supplied	EOR to compare demand vs published capacity
Cyclic loading	screened out	hard cemented bearing stratum - Consolidation/Cyclic section
Settlement method	elastic + helix bearing	Axial Settlement section; p-y style curves in the Lateral Loads charts
Seismic	SDC A	USGS ASCE 7-22, site class D assumed - Liquefaction/Seismic section
Geotechnical firm	Geotechnical Laboratory (identity withheld - sample report)	licensed engineering and geology business, State of Florida
Geotech file number	Report No. GTR-25-0418	the geotechnical laboratory; parcel withheld (sample report)
Date drilled	04/18/2025	all borings
Drill machine	not stated on the logs	
Hammer	Safety hammer - MANUAL (rope and cathead)	stated on the logs; typical energy ratio ~60%, consistent with CE = 1.0 used in the liquefaction screen
Ground elevation	"Existing" - no datum or value given	all depths in this report are below existing grade
Drilled by	field technician	project geologist
Drill method	Rotary	stated on the logs; borehole sealed/grouted on completion
Sampling method	Split spoon, ASTM D-1586	stated on the logs

4. DESIGN PARAMETERS (CONTINUED)

Where TMG's basis differs from common design-software defaults, the difference is deliberate: shaft Fy is taken at the 65 ksi specified minimum rather than 72 ksi, and the torque capacity is derived at 0.6 Fy J/c (AISC shear yield) rather than Fy J/c - a full-Fy torsional value overstates shear yield by about 73% and must not be used for acceptance. Assumed values are marked and carried in the Coverage Manifest.

5. CAPACITY vs DEPTH - BORING B-1

BORING B-1 | 10"-12" Double | Recommended H = 22.50 ft | WT 8.1 ft | Termination 30 ft | North / East zone

Depth Z (ft)	Top Helix (ft)	Comp Ult (kips)	Comp Allow (kips)	Tension Ult (kips)	Tension Allow (kips)	Lateral Allow free/fixed (k)	Torque (ft-lbs)	12D	37.5 k check
5.00	2.50	8.3 c	4.2	7.5	3.7	2.46 / 3.91	1,188	-	-
6.00	3.50	9.9 c	4.9	8.9	4.4	2.46 / 3.91	1,410	-	-
7.00	4.50	12.2 c	6.1	11.0	5.5	2.46 / 3.91	1,746	-	-
8.00	5.50	14.1 c	7.0	12.7	6.3	2.46 / 3.91	2,013	-	-
9.00	6.50	15.4 c	7.7	13.9	6.9	2.46 / 3.91	2,200	-	-
10.00	7.50	17.4 c	8.7	15.6	7.8	2.46 / 3.91	2,479	-	-
11.00	8.50	18.5 c	9.2	16.6	8.3	2.46 / 3.91	2,637	-	-
12.00	9.50	19.5 c	9.8	17.6	8.8	2.46 / 3.91	2,791	-	-
13.00	10.50	20.6 c	10.3	18.5	9.3	2.46 / 3.91	2,941	-	-
14.00	11.50	11.9 c	5.9	10.7	5.3	2.46 / 3.91	1,694	-	-
15.00	12.50	13.2 c	6.6	11.9	5.9	2.46 / 3.91	1,883	ok	-
16.00	13.50	14.4 c	7.2	12.9	6.5	2.46 / 3.91	2,053	ok	-
17.00	14.50	14.3	7.1	12.9	6.4	2.46 / 3.91	2,040	ok	-
18.00	15.50	14.3	7.2	12.9	6.5	2.46 / 3.91	2,050	ok	-
19.00	16.50	43.8	21.9	39.5	19.7	2.46 / 3.91	6,262	ok	-
20.00	17.50	43.9	22.0	39.5	19.8	2.46 / 3.91	6,273	ok	-
21.00	18.50	44.0	22.0	39.6	19.8	2.46 / 3.91	6,283	ok	-
22.00	19.50	88.2	44.1	79.4	39.7	2.46 / 3.91	12,605	ok	PASS
22.50	**20.00**	**88.3**	**44.1**	**79.4**	**39.7**	**2.46 / 3.91**	**12,611**	**ok**	**PASS**
23.00	20.50	88.3	44.2	79.5	39.7	2.46 / 3.91	12,617	ok	PASS
24.00	21.50	88.4	44.2	79.6	39.8	2.46 / 3.91	12,629	ok	PASS
25.00	22.50	88.5	44.2	79.6	39.8	2.46 / 3.91	12,641	ok	PASS
26.00	23.50	88.6	44.3	79.7	39.9	2.46 / 3.91	12,653	ok	PASS
27.00	24.50	88.7	44.3	79.8	39.9	2.46 / 3.91	12,665	ok	PASS
28.00	25.50	88.7	44.4	79.9	39.9	2.46 / 3.91	12,677	ok	PASS
29.00	26.50	88.8	44.4	79.9	40.0	2.46 / 3.91	12,689	ok	PASS
30.00	27.50	88.9	44.5	80.0	40.0	2.46 / 3.91	12,702	ok	PASS

'c' after Comp Ult *= the cylindrical shear mode governs at that depth and the tabulated ultimate IS the cylinder value, MIN(plate, cylinder) per AC358 / gate G24.*

Lateral Allow column: *allowable lateral capacity at the pile head, free / fixed head (Broms, FS 2). Lateral capacity is mobilised in the top 3.4 ft of soil and does not grow with tip depth - it is constant once the shaft is embedded past the depth to fixity ('n/a' above that).*

Highlighted row *= recommended install depth H = 22.50 ft. Tension = 0.90 x compression. Torque = Qu / Kt, Kt = 7. Full live formulas in the accompanying workbook.*

12D column: *ICC-ES AC358 requires the UPPERMOST helix to be embedded at least 12 helix diameters below grade before tension (uplift) capacity may be counted - for the 12" top helix here, 12 x 12" = 12.0 ft. Shallower than that, an uplift load can fail the soil upward to the surface as a cone instead of loading the helix in deep bearing, so the 0.90 x compression tension rule is not valid. 'ok' = the top helix at that depth satisfies the rule and the tension value in that row may be used; '-' = too shallow, tension NOT certifiable at that depth regardless of the number shown, and the 37.5 k check is failed. The 12D condition is one of the three requirements (compression, tension, embedment) a row must pass to read PASS in the last column.*

6. CAPACITY vs DEPTH - BORING B-3

BORING B-3 | 10"-12" Double | Recommended H = 31.50 ft | WT 8.1 ft | Termination 35 ft | South / West zone

Depth Z (ft)	Top Helix (ft)	Comp Ult (kips)	Comp Allow (kips)	Tension Ult (kips)	Tension Allow (kips)	Lateral Allow free/fixed (k)	Torque (ft-lbs)	12D	37.5 k check
5.00	2.50	8.1 c	4.1	7.3	3.7	2.37 / 3.76	1,162	-	-
6.00	3.50	9.8 c	4.9	8.8	4.4	2.37 / 3.76	1,395	-	-
7.00	4.50	11.1 c	5.6	10.0	5.0	2.37 / 3.76	1,586	-	-
8.00	5.50	12.7 c	6.4	11.5	5.7	2.37 / 3.76	1,820	-	-
9.00	6.50	14.5 c	7.3	13.1	6.5	2.37 / 3.76	2,077	-	-
10.00	7.50	15.6 c	7.8	14.1	7.0	2.37 / 3.76	2,232	-	-
11.00	8.50	16.6 c	8.3	15.0	7.5	2.37 / 3.76	2,375	-	-
12.00	9.50	17.6 c	8.8	15.8	7.9	2.37 / 3.76	2,512	-	-
13.00	10.50	18.5 c	9.3	16.7	8.3	2.37 / 3.76	2,646	-	-
14.00	11.50	21.5 c	10.7	19.3	9.7	2.37 / 3.76	3,068	-	-
15.00	12.50	22.6 c	11.3	20.4	10.2	2.37 / 3.76	3,233	ok	-
16.00	13.50	23.7 c	11.9	21.4	10.7	2.37 / 3.76	3,390	ok	-
17.00	14.50	24.8 c	12.4	22.3	11.1	2.37 / 3.76	3,540	ok	-
18.00	15.50	25.8 c	12.9	23.2	11.6	2.37 / 3.76	3,689	ok	-
19.00	16.50	26.9 c	13.4	24.2	12.1	2.37 / 3.76	3,839	ok	-
20.00	17.50	30.7 c	15.4	27.6	13.8	2.37 / 3.76	4,388	ok	-
21.00	18.50	43.5 c	21.8	39.2	19.6	2.37 / 3.76	6,220	ok	-
22.00	19.50	52.0	26.0	46.8	23.4	2.37 / 3.76	7,424	ok	-
23.00	20.50	43.3	21.7	39.0	19.5	2.37 / 3.76	6,190	ok	-
24.00	21.50	39.4 c	19.7	35.4	17.7	2.37 / 3.76	5,622	ok	-
25.00	22.50	29.6 c	14.8	26.6	13.3	2.37 / 3.76	4,226	ok	-
26.00	23.50	37.6	18.8	33.9	16.9	2.37 / 3.76	5,375	ok	-
27.00	24.50	36.6 c	18.3	33.0	16.5	2.37 / 3.76	5,233	ok	-
28.00	25.50	35.4 c	17.7	31.9	16.0	2.37 / 3.76	5,064	ok	-
29.00	26.50	46.3 c	23.2	41.7	20.8	2.37 / 3.76	6,618	ok	-
30.00	27.50	67.3 c	33.6	60.5	30.3	2.37 / 3.76	9,610	ok	-
31.00	28.50	73.6	36.8	66.2	33.1	2.37 / 3.76	10,508	ok	-
31.50	**29.00**	**89.0**	**44.5**	**80.1**	**40.0**	**2.37 / 3.76**	**12,713**	**ok**	**PASS**

'c' after Comp Ult *= the cylindrical shear mode governs at that depth and the tabulated ultimate IS the cylinder value, MIN(plate, cylinder) per AC358 / gate G24.*

Lateral Allow column: *allowable lateral capacity at the pile head, free / fixed head (Broms, FS 2). Lateral capacity is mobilised in the top 3.4 ft of soil and does not grow with tip depth - it is constant once the shaft is embedded past the depth to fixity ('n/a' above that).*

6. CAPACITY vs DEPTH - BORING B-3 (continued, 2 of 2)

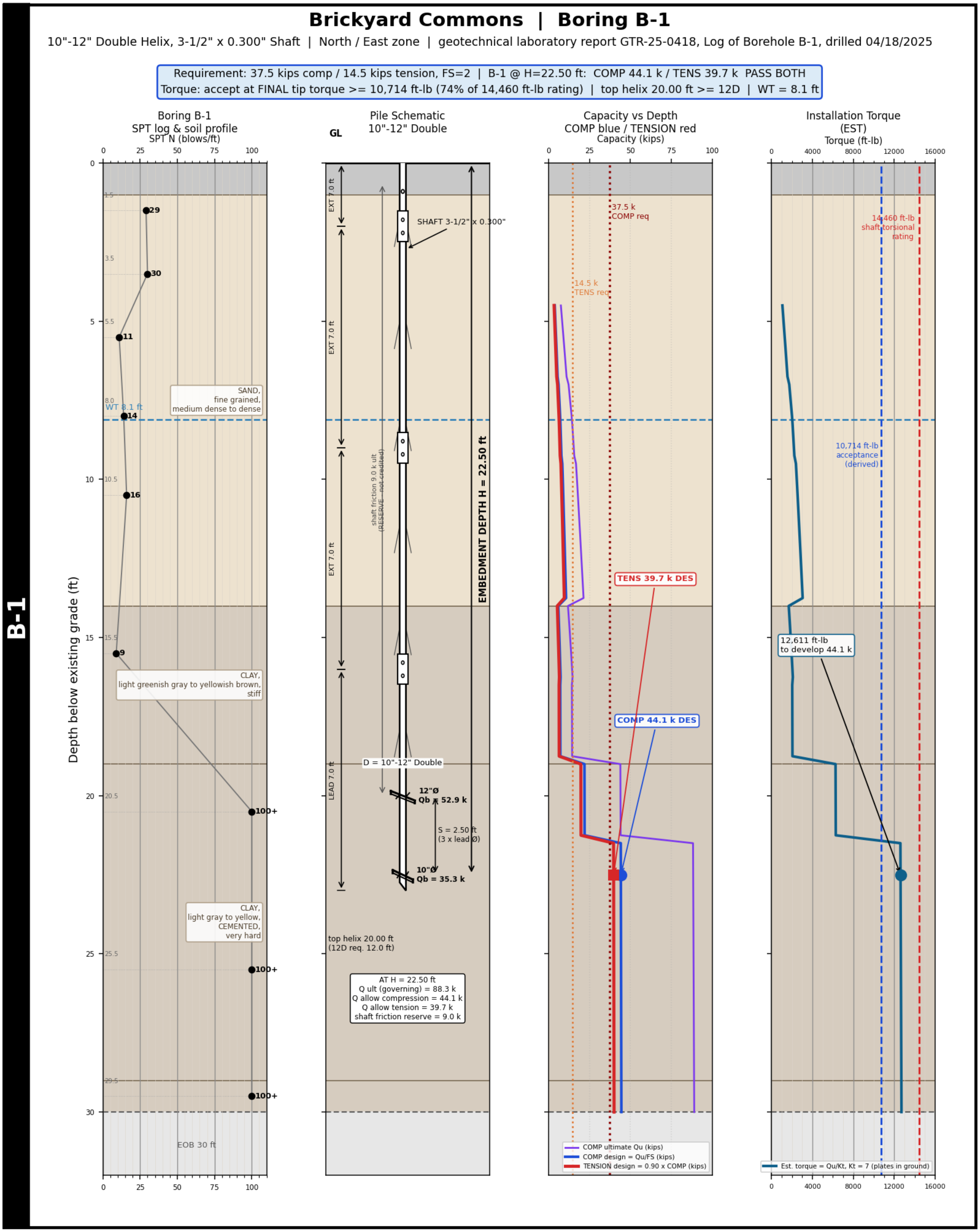
BORING B-3 | 10"-12" Double | Recommended H = 31.50 ft | WT 8.1 ft | Termination 35 ft | South / West zone

Depth Z (ft)	Top Helix (ft)	Comp Ult (kips)	Comp Allow (kips)	Tension Ult (kips)	Tension Allow (kips)	Lateral Allow free/fixed (k)	Torque (ft-lbs)	12D	37.5 k check
32.00	29.50	89.0	44.5	80.1	40.1	2.37 / 3.76	12,720	ok	PASS
33.00	30.50	89.1	44.6	80.2	40.1	2.37 / 3.76	12,734	ok	PASS
34.00	31.50	89.2	44.6	80.3	40.2	2.37 / 3.76	12,748	ok	PASS
35.00	32.50	89.3	44.7	80.4	40.2	2.37 / 3.76	12,761	ok	PASS

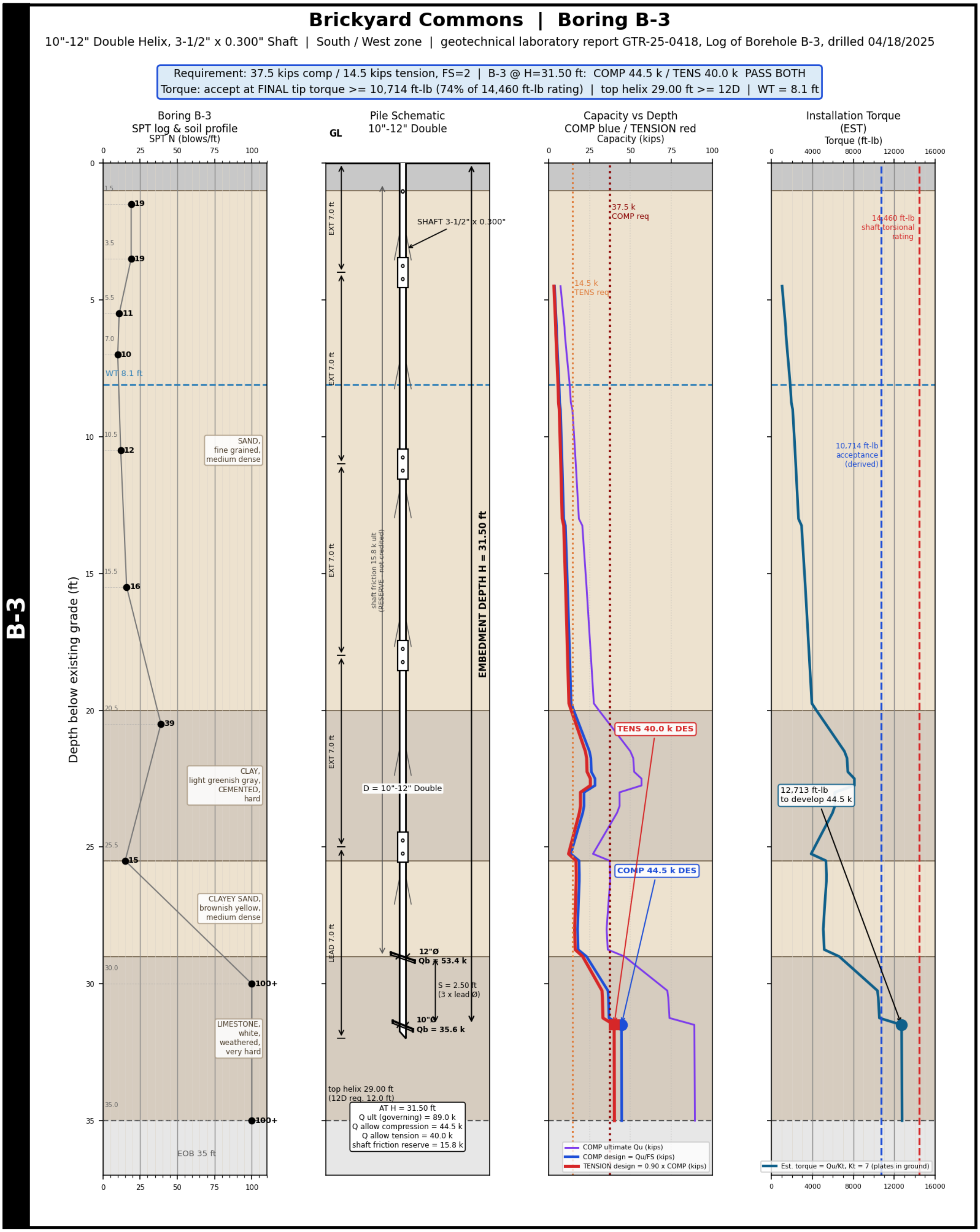
Lateral Allow column: *allowable lateral capacity at the pile head, free / fixed head (Broms, FS 2). Lateral capacity is mobilised in the top 3.4 ft of soil and does not grow with tip depth - it is constant once the shaft is embedded past the depth to fixity ('n/a' above that).*

Highlighted row *= recommended install depth H = 31.50 ft. Tension = 0.90 x compression. Torque = Qu / Kt, Kt = 7. Full live formulas in the accompanying workbook.*

12D column: *ICC-ES AC358 requires the UPPERMOST helix to be embedded at least 12 helix diameters below grade before tension (uplift) capacity may be counted - for the 12" top helix here, 12 x 12" = 12.0 ft. Shallower than that, an uplift load can fail the soil upward to the surface as a cone instead of loading the helix in deep bearing, so the 0.90 x compression tension rule is not valid. 'ok' = the top helix at that depth satisfies the rule and the tension value in that row may be used; '-' = too shallow, tension NOT certifiable at that depth regardless of the number shown, and the 37.5 k check is failed. The 12D condition is one of the three requirements (compression, tension, embedment) a row must pass to read PASS in the last column.*



B-1
Brickyard Commons | Boring B-1
10"-12" Double Helix, 3-1/2" x 0.300" Shaft | North / East zone | geotechnical laboratory report GTR-25-0418, Log of Borehole B-1, drilled 04/18/2025
Requirement: 37.5 kips comp / 14.5 kips tension, FS=2 | B-1 @ H=22.50 ft: COMP 44.1 k / TENS 39.7 k PASS BOTH
Torque: accept at FINAL tip torque >= 10,714 ft-lb (74% of 14,460 ft-lb rating) | top helix 20.00 ft >= 12D | WT = 8.1 ft
Boring B-1
SPT log & soil profile
SPT N (blows/ft)
Depth below existing grade (ft)
WT 8.1 ft
SAND, fine grained, medium dense to dense
CLAY, light greenish gray to yellowish brown, stiff
CLAY, light gray to yellow, CEMENTED, very hard
EOB 30 ft
Pile Schematic
10"-12" Double
GL
SHAFT 3-1/2" x 0.300"
EXT 7.0 ft
LEAD 7.0 ft
shaft friction 9.0 k ult (RESERVE - not credited)
EMBEDMENT DEPTH H = 22.50 ft
D = 10"-12" Double
12"Ø Qb = 52.9 k
S = 2.50 ft (3 x lead Ø)
10"Ø Qb = 35.3 k
top helix 20.00 ft (12D req. 12.0 ft)
AT H = 22.50 ft
Q ult (governing) = 88.3 k
Q allow compression = 44.1 k
Q allow tension = 39.7 k
shaft friction reserve = 9.0 k
Capacity vs Depth
COMP blue / TENSION red
Capacity (kips)
37.5 k COMP req
14.5 k TENS req
TENS 39.7 k DES
COMP 44.1 k DES
COMP ultimate Qu (kips)
COMP design = Qu/FS (kips)
TENSION design = 0.90 x COMP (kips)
Installation Torque (EST)
Torque (ft-lb)
14,460 ft-lb shaft torsional rating
10,714 ft-lb acceptance (derived)
12,611 ft-lb to develop 44.1 k
Est. torque = Qu/Kt, Kt = 7 (plates in ground)


B-3
Brickyard Commons | Boring B-3
10"-12" Double Helix, 3-1/2" x 0.300" Shaft | South / West zone | geotechnical laboratory report GTR-25-0418, Log of Borehole B-3, drilled 04/18/2025
Requirement: 37.5 kips comp / 14.5 kips tension, FS=2 | B-3 @ H=31.50 ft: COMP 44.5 k / TENS 40.0 k PASS BOTH
Torque: accept at FINAL tip torque >= 10,714 ft-lb (74% of 14,460 ft-lb rating) | top helix 29.00 ft >= 12D | WT = 8.1 ft
Boring B-3
SPT log & soil profile
SPT N (blows/ft)
Depth below existing grade (ft)
WT 8.1 ft
SAND, fine grained, medium dense
CLAY, light greenish gray, CEMENTED, hard
CLAYEY SAND, brownish yellow, medium dense
LIMESTONE, white, weathered, very hard
EOB 35 ft
Pile Schematic
10"-12" Double
GL
SHAFT 3-1/2" x 0.300"
EXT 7.0 ft
LEAD 7.0 ft
shaft friction 15.8 k ult (RESERVE - not credited)
EMBEDMENT DEPTH H = 31.50 ft
D = 10"-12" Double
12"Ø Qb = 53.4 k
S = 2.50 ft (3 x lead Ø)
10"Ø Qb = 35.6 k
top helix 29.00 ft (12D req. 12.0 ft)
AT H = 31.50 ft
Q ult (governing) = 89.0 k
Q allow compression = 44.5 k
Q allow tension = 40.0 k
shaft friction reserve = 15.8 k
Capacity vs Depth
COMP blue / TENSION red
Capacity (kips)
37.5 k COMP req
14.5 k TENS req
TENS 40.0 k DES
COMP 44.5 k DES
COMP ultimate Qu (kips)
COMP design = Qu/FS (kips)
TENSION design = 0.90 x COMP (kips)
Installation Torque (EST)
Torque (ft-lb)
14,460 ft-lb shaft torsional rating
10,714 ft-lb acceptance (derived)
12,713 ft-lb to develop 44.5 k
Est. torque = Qu/Kt, Kt = 7 (plates in ground)

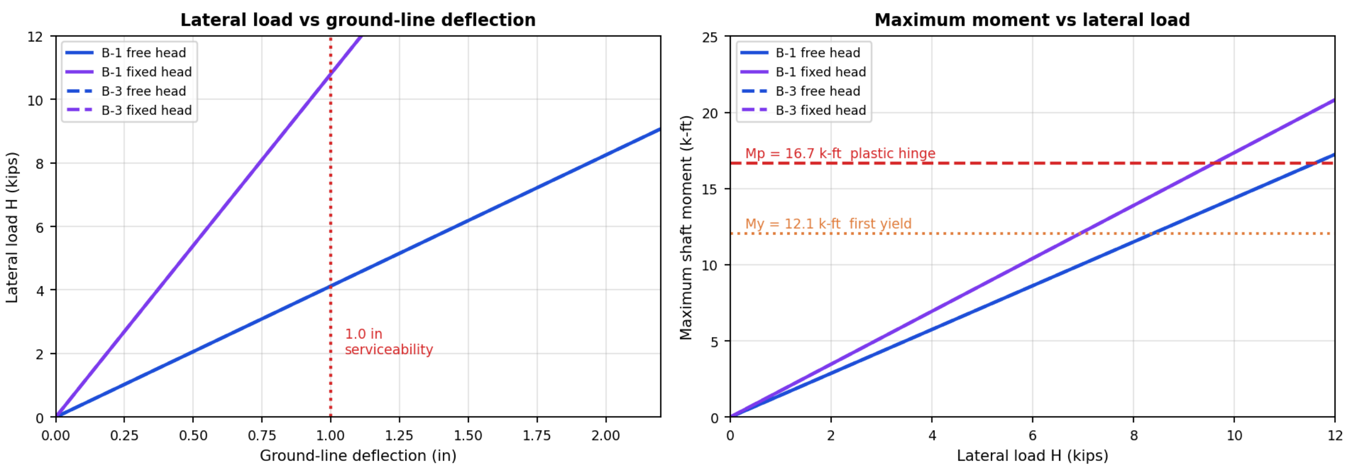
9. LATERAL LOADS - Capacity per Anchor

No lateral demand has been supplied for this project. Lateral CAPACITY does not depend on demand, so it is published here for the engineer of record to check against. Capacity is mobilised in the top 3.4 ft - the depth to fixity - which is SAND at both borings, so the granular Broms formulation governs and the deeper strata contribute nothing laterally.

Quantity	Value	Basis
Shaft	3-1/2" x 0.300"	round shaft, Fy = 65 ksi
Moment of inertia I	3.894 in4	pi/64 (D^4 - d^4)
Elastic section modulus Sx	2.225 in3	I / c
Plastic section modulus Zx	3.081 in3	(D^3 - d^3) / 6
First-yield moment My	12.05 k-ft	Fy Sx
Plastic hinge moment Mp	16.69 k-ft	Fy Zx - governs Broms long-pile capacity
Subgrade modulus nh	20 pci	medium dense sand, partly submerged - ASSUMED, see note
Characteristic length T	22.4 in (1.87 ft)	(EI / nh)^(1/5), Reese-Matlock
Depth to fixity	3.36 ft	approx. 1.8 T
Factor of safety, lateral	2.0	applied to Broms ultimate
Serviceability limit	1.0 in	ground-line deflection, ASSUMED - EOR to confirm

Boring	Top sand N	phi (deg)	Kp	Broms ult. FREE (k)	Broms ult. FIXED (k)	Allowable FREE (k)	Allowable FIXED (k)	H at 1.0 in FREE (k)	GOVERNING FREE (k)	GOVERNING FIXED (k)
B-1	29	36.0	3.85	4.92	7.81	2.46	3.91	4.12	2.46	3.91
B-3	19	33.3	3.44	4.74	7.52	2.37	3.76	4.12	2.37	3.76

RAMP-080526-00001 | Lateral response, 3-1/2" x 0.300" shaft | Reese-Matlock, nh = 20 pci, T = 22.4 in



The shaft hinge governs, not the soil. At both borings Broms ultimate (4.74 k free / 7.52 k fixed at B-3) is reached by a plastic hinge forming in the shaft before the sand fails in passive bearing. Deflection is not the binding check in the free-head case either - 1.0 in is reached at 4.12 kips, above the allowable. Capacity therefore scales with the shaft section, not with depth or helix configuration, and the borings differ by only about 4% because their top-of-hole soils are similar.

Head fixity must be declared. Fixed-head capacity is about 59% higher than free head. Whether the trench cap restrains rotation is a detailing decision that belongs to the engineer of record, and this report does not assume it. Where the connection is a simple bearing seat, use the FREE-head column.

9. LATERAL LOADS (CONTINUED) - End-of-Life Capacity & Axial Buckling

Assumptions requiring confirmation for the preceding section: nh = 20 pci is a published value for medium dense sand and has not been measured here; the 1.0 in serviceability limit is assumed; load is applied at the ground line with no eccentricity; group effects are not included and closely spaced anchors in a trench will reduce per-anchor lateral capacity.

END-OF-LIFE LATERAL CAPACITY (50 yr, corroded section) AND AXIAL BUCKLING

Boring	Mp as-installed (k-ft)	Mp end-of-life (k-ft)	GOVERNING free as-installed (k)	GOVERNING free end-of-life (k)	Buckling Pallow (k)	Buckling util. at required comp
B-1	16.69	14.89	2.46	2.28	154	24.4%
B-3	16.69	14.89	2.37	2.20	154	24.4%

Corrosion reduces the plastic hinge moment to 89% of the as-installed value over the 50-year design life (Section 8), so end-of-life lateral capacity is published alongside the as-installed case. Axial buckling is screened at N >= 4 throughout the embedment (both borings pass) and bounded with a Davisson-type closed-form estimate; allowable buckling load clears the 37.5 k compression requirement comfortably at both borings.

10. SHALLOW FOUNDATION BEARING CAPACITY - Comparative Baseline

Helical piles were requested for this project; this section asks the converse question - what could a CONVENTIONAL SHALLOW FOOTING carry at this site, and why is a deep/anchor solution indicated instead? Meyerhof's general bearing capacity equation is applied to the near-surface soil at each boring for a nominal continuous strip (grade-beam) footing, width B = 2.0 ft, embedment D = 2.0 ft - ASSUMED, since no shallow-footing detail has been issued by the EOR - at a bearing-capacity factor of safety of 3.0 (higher than the 2.0 used for the deep design, per conventional shallow-foundation practice).

Boring	Bearing stratum	N	phi (deg)	c (ksf)	Nc	Nq	Ng	q.ult (ksf)	q.allow (ksf)	Q.allow (k/ft)
B-1	gran	29	36.0	0.0	50.6	37.8	44.4	17.70	5.90	11.80
B-3	gran	19	33.3	0.0	39.7	27.1	27.7	12.01	4.00	8.01

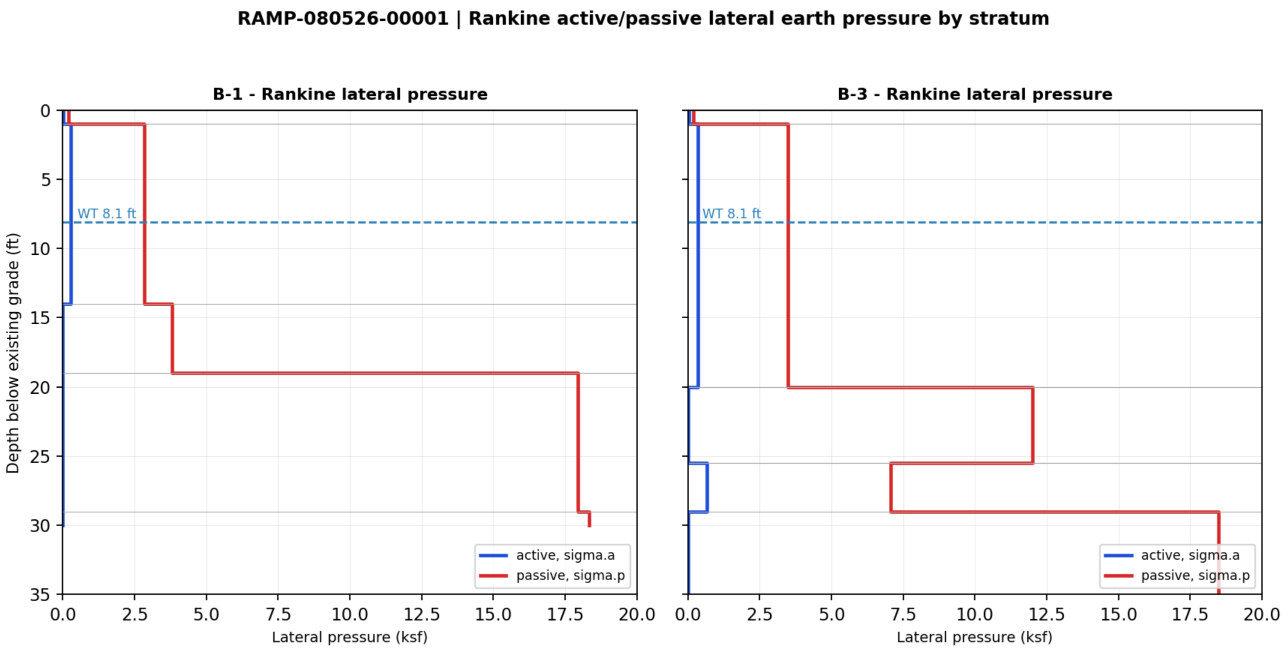
A 2 ft strip footing at 2 ft embedment could carry roughly 8.0-11.8 kips per linear foot in COMPRESSION at these borings - the near-surface sand is reasonably competent and compression alone is not, by itself, the reason a shallow footing is disfavored here.

The real driver is tension/uplift, not compression. A shallow footing resists uplift only through its own dead weight and the friction/adhesion mobilised on its sides and base - inefficient, and often unable to meet a 14.5 kip uplift requirement without an impractically large or deep footing, particularly where groundwater (at 8.1 ft) reduces the effective weight available to resist it. A helical anchor resists tension structurally, through helix bearing on the soil ABOVE each plate, independent of self-weight. This - together with the disturbed/variable existing pavement base and the practical difficulty of excavating a continuous new footing beneath an active parking structure - is why an anchor solution is indicated rather than underpinning with conventional footings.

This comparison uses ASSUMED footing geometry for illustration; it does not constitute a shallow-foundation design and must not be used for one. If a shallow-footing alternative is to be pursued, the EOR must issue footing dimensions, loads and a settlement criterion for a complete evaluation.

11. LATERAL EARTH PRESSURE - Rankine Coefficients by Stratum

Rankine active, at-rest and passive coefficients are computed for every logged stratum at both borings. Granular strata use Ka = tan2(45 - phi/2), K0 = 1 - sin(phi) (Jaky), Kp = tan2(45 + phi/2); cohesive strata use the undrained (phi = 0) forms sigma.a = sigma.v - 2 su and sigma.p = sigma.v + 2 su. The passive coefficient in the granular strata is the same Kp already used to derive the Broms lateral capacity in Section 6 - this section makes that basis explicit and extends it to active and at-rest conditions for excavation/shoring and any future retaining-element design at this site.



B-1 - stratum coefficients

Depth (ft)	Stratum	phi (deg)	su (ksf)	Ka	K0	Kp	sigma.a (ksf)	sigma.p (ksf)
0.0-1.0	Concrete and limerock base	30.0	-	0.33	0.50	3.00	0.02	0.19
1.0-14.0	SAND, fine grained, medium	31.9	-	0.31	0.47	3.24	0.27	2.85
14.0-19.0	CLAY, light greenish gray	-	1.2	1.00	1.00	1.00	0.00	3.79
19.0-29.0	CLAY, light gray to yellow	-	8.0	1.00	1.00	1.00	0.00	17.95
29.0-30.0	LIMESTONE, white, weathere	-	8.0	1.00	1.00	1.00	0.00	18.34

B-3 - stratum coefficients

Depth (ft)	Stratum	phi (deg)	su (ksf)	Ka	K0	Kp	sigma.a (ksf)	sigma.p (ksf)
0.0-1.0	Concrete and limerock base	30.0	-	0.33	0.50	3.00	0.02	0.19
1.0-20.0	SAND, fine grained, medium	31.4	-	0.32	0.48	3.17	0.35	3.48
20.0-25.5	CLAY, light greenish gray,	-	5.1	1.00	1.00	1.00	0.00	12.01
25.5-29.0	CLAYEY SAND, brownish yell	32.2	-	0.30	0.47	3.28	0.66	7.07
29.0-35.0	LIMESTONE, white, weathere	-	8.0	1.00	1.00	1.00	0.00	18.50

12. SLOPE STABILITY & SEEPAGE / PIPING SCREENING

SLOPE STABILITY

Screened out for this site. At-grade parking lot; no slope, embankment or retained cut geometry supplied in any boring, plan, or site document. Screened out, not computed against an assumed geometry. If a slope or excavation cut exists elsewhere on this site, it must be evaluated separately with its actual height and angle.

The calculation capability (infinite-slope method, Fellenius/Bishop-simplified extendable) is implemented in the TMG standard and will be applied automatically the moment a slope, embankment, or retained-cut geometry is supplied for this or any future project - it is not something a report author must remember to add by hand.

SEEPAGE / PIPING (open-cut trench excavation)

Groundwater is at 8.1 ft at both borings. Anchor CAP/LEAD work is a shallow open cut, ASSUMED at 2.5 ft (no excavation detail issued) - 5.6 ft above the water table, so seepage or a piping/quick condition into the open trench is not expected to govern. The anchor SHAFT itself is advanced by rotation below this, not excavated, so it is not exposed to open-cut seepage regardless of depth.

For reference, should a deeper excavation or dewatering scheme be contemplated at this site, the critical (quick-condition) hydraulic gradient for the near-surface sand is $i_{cr} = (G_s - 1)/(1 + e) = 1.15$, using an assumed $G_s = 2.65$ and a void ratio of 0.44 back-calculated from the boring unit weights. A dewatering/excavation-support design for any cut extending below 8.1 ft is outside the scope of this report.

13. LIQUEFACTION TRIGGERING & SEISMIC DESIGN PARAMETERS

SEISMIC SITE PARAMETERS (ASCE 7-22)

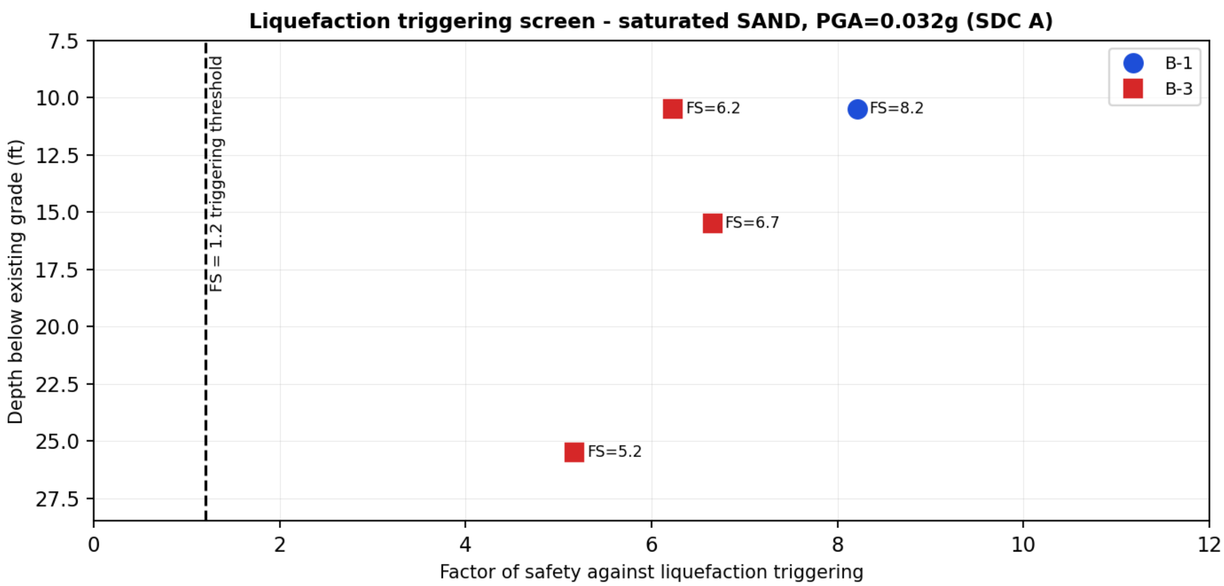
Sourced from the USGS ASCE 7-22 Design Maps web service for this site's coordinates (28.0197, -82.7718), Risk Category II. Site Class D (ASSUMED, no Vs30 measured) - no shear-wave velocity (Vs30) has been measured on this project; Site Class D is the standard ASCE 7 default absent one.

Ss (g)	S1 (g)	SDS (g)	SD1 (g)	PGA (g)	Seismic Design Category
0.066	0.030	0.059	0.043	0.032	A

Seismic Design Category A reflects the very low seismicity of the west-central Florida Gulf coast. Per ASCE 7, liquefaction evaluation is not typically REQUIRED at SDC A; it is performed anyway below for completeness, consistent with this report's practice of computing rather than assuming a check is unnecessary.

LIQUEFACTION TRIGGERING - Simplified Seed-Idriss / Youd et al. (2001) SPT Method

CSR = 0.65 (amax/g)(sigma.v/sigma'.v) rd is compared against CRR7.5 from the clean-sand SPT base curve (N1,60 corrected for overburden, hammer energy, rod length and borehole/sampler, per Youd et al. 2001), for every SATURATED cohesionless sample at both borings. No magnitude deaggregation is available for this site; MSF = 1.0 (equivalent to M 7.5) is used as the conservative default. No fines-content correction is applied - the clean-sand base curve is used directly, which is conservative for any silty/clayey sand present (fines generally increase CRR).



13. LIQUEFACTION TRIGGERING (CONTINUED) - Worked Values

B-1 - saturated sand samples

Depth (ft)	N	N1,60	sigma'v (ksf)	sigma.v (ksf)	rd	CSR	CRR7.5	FS	Susceptible?
10.5	16	17.8	1.10	1.25	0.98	0.023	0.189	8.2	no

B-3 - saturated sand samples

Depth (ft)	N	N1,60	sigma'v (ksf)	sigma.v (ksf)	rd	CSR	CRR7.5	FS	Susceptible?
10.5	12	13.3	1.10	1.25	0.98	0.023	0.144	6.2	no
15.5	16	16.7	1.41	1.87	0.96	0.027	0.177	6.7	no
25.5	15	14.5	2.05	3.14	0.94	0.030	0.155	5.2	no

Note: the B-3 sample at 25.5 ft is logged as CLAYEY SAND, not clean sand - it is screened here for completeness/conservatism (the clean-sand base curve understates its true CRR if it carries meaningful fines), but a plasticity/fines-content test would likely show it is less liquefaction-susceptible than tabulated.

Conclusion: no saturated stratum at either boring falls below the FS = 1.2 triggering threshold - all computed factors of safety range from 5.2 to well above 5, consistent with the very low PGA (0.032g, SDC A) at this site. Liquefaction-induced loss of shaft lateral or axial support is not expected to govern this design. This is a screening-level result using an ASSUMED Site Class and no magnitude deaggregation; it is not a substitute for a project-specific seismic hazard/liquefaction study should one be required by the authority having jurisdiction.

14. DOWNDRAG & GROUP EFFECTS

DOWNDRAG (NEGATIVE SKIN FRICTION)

Downdrag develops where soil settles relative to the shaft - typically new/recently placed fill, or a soft layer consolidating under new load - adding drag load above the neutral plane instead of resisting it. Neither boring logs anything but the EXISTING pavement base (1 ft) and medium-dense-to-dense sand / stiff-to-cemented clay; nothing in the profile is soft or indicates ongoing settlement.

Boring	Hypothetical settling zone	Qn (bounding case)	% of Q.ult	Applicable?
B-1	0 - 5.0 ft (bounding, well below the 1 ft actual base)	0.4 k	0.4%	NO - screened out
B-3	0 - 5.0 ft (bounding, well below the 1 ft actual base)	0.4 k	0.4%	NO - screened out

Even in a deliberately bounding case (the full alpha/K shaft-friction formula applied over a hypothetical 5 ft settling zone, five times the actual base thickness), the resulting drag load is under 0.4% of ultimate capacity - downdrag is SCREENED OUT for this design, not silently omitted. If new fill is placed at this site in the future, this screening should be revisited.

GROUP EFFECTS - Converse-Labarre Efficiency vs Spacing

Anchor spacing/schedule has not been issued for this project (see Coverage Manifest). Common helical-pile practice recommends a minimum center-to-center spacing of 3D (D = 1.00 ft, the largest helix) to limit group-interaction losses, mirroring the 3D helix-to-helix spacing already used within a single anchor. Efficiency below is tabulated by Converse-Labarre so any future anchor schedule can be checked directly.

Anchors per row	2D	3D	4D	5D	6D
2	0.85	0.90	0.92	0.94	0.95
3	0.80	0.86	0.90	0.92	0.93
4	0.78	0.85	0.88	0.91	0.92
6	0.75	0.83	0.87	0.90	0.91

At the recommended 3D minimum spacing, group efficiency runs 0.83-0.90 depending on how many anchors sit in a row - apply this factor to the per-anchor allowable capacities in Section 3 for any anchors closer than about 6D. This table will need to be re-run against the actual anchor schedule once the EOR issues it.

15. KARST / SOLUTION FEATURE SCREENING

This is the highest-consequence item in this report and it is not resolved by the data available. B-3 records 50% loss of drilling fluid circulation at 28.0 ft. In this setting that is the classic signature of a solution feature - a void, a raveled seam, or highly weathered pinnacled limestone. The site sits in Pinellas County, west-central Florida - covered-karst terrain of the Floridan aquifer system, where sand/clay overburden mantles an irregularly dissolved limestone surface.

Why it matters here specifically. The recommended B-3 anchor bears BELOW that horizon: tip at 31.5 ft and uppermost helix at 29.0 ft, against the anomaly logged at 28.0 ft. The bearing stratum is on the far side of the anomaly from the structure, so every kip delivered by that anchor is transmitted through the suspect horizon.

Boring	Carbonate / cemented top	Anomaly logged	Uppermost helix	Bears below anomaly?	Screening rating
B-1	19.0 ft	none logged	20.0 ft	no	MODERATE
B-3	20.0 ft	28.0 ft	29.0 ft	YES	ELEVATED

FIELD HOLD POINTS - stop-work triggers, not advisory notes

ID	Trigger	Required action	Owner
KH-1	Abrupt torque loss, free-fall advance, or sudden crowd loss at any depth below 25 ft on the South/West (B-3) strip	STOP that anchor. Do not continue advancing. Record depth and torque trace. Notify the engineer of record before resuming.	Installing contractor
KH-2	Any anchor on the South/West strip failing to reach the acceptance torque at or above the recommended tip depth	Do not deepen past the design depth to chase torque. Treat as a possible solution feature and refer to the engineer of record for disposition.	Installing contractor
KH-3	Before production installation on the South/West strip	Consider a probe boring or probe grouting program through the 28 ft horizon to confirm the loss zone is a weathered seam and not an open void. This is an engineer-of-record scope decision; TMG has not been engaged for it.	Engineer of record / owner
KH-4	Circulation loss, drop tools, or raveling observed in any future boring on this site	Extend this screening to that boring before anchors are installed in its zone.	Engineer of record

Limitation. This is a SCREENING of two SPT borings. It is not a sinkhole investigation and does not predict subsidence. Confirming or ruling out a solution feature requires a dedicated program - probe borings, ground-penetrating radar, or electrical resistivity imaging - which is outside this scope and has not been performed.

16. AXIAL SETTLEMENT & SERVICEABILITY

Every other axial check in this report proves the anchor will not FAIL. None of them prove it will not MOVE. Structures reach unacceptable movement long before they reach ultimate capacity, so settlement is computed here as two components in series: elastic shortening of the steel shaft, which is exact from section properties and admits no soil assumption, and helix bearing settlement, treating each plate as a deeply embedded rigid circular element in an elastic half-space. Shaft friction is not credited as settlement relief, consistent with the capacity model, which makes this estimate conservative.

Boring	Design load	Elastic shortening	Elastic (end-of-life)	Helix bearing	TOTAL	Limit	Utilisation
B-1	44.1 k	0.127 in	0.142 in	0.024 in	0.151 in	1.00 in	15%
B-3	44.5 k	0.183 in	0.205 in	0.024 in	0.207 in	1.00 in	21%

Elastic shortening of the shaft dominates - it is roughly 8x the helix bearing component at B-3 - because the anchors bear in very hard cemented material whose stiffness is high, while the shaft is a slender steel member carrying full load over 29+ ft. That is a useful result: settlement here is governed by the product, not the ground, so it is predictable and does not depend on the soil modulus correlation that carries most of the uncertainty in this section.

HELIX-BY-HELIX BEARING SETTLEMENT

Boring	Helix	Depth	Bearing pressure	Soil modulus Es	Es basis	Settlement
B-1	10"	22.5 ft	36.9 ksf	6,400 ksf	800 su, su = 8.00 ksf	0.020 in
B-1	12"	20.0 ft	36.9 ksf	6,400 ksf	800 su, su = 8.00 ksf	0.024 in
B-3	10"	31.5 ft	37.2 ksf	6,400 ksf	800 su, su = 8.00 ksf	0.020 in
B-3	12"	29.0 ft	37.2 ksf	6,400 ksf	800 su, su = 8.00 ksf	0.024 in

Differential settlement across boring locations is 0.056 in (B-1 0.151 in, B-3 0.207 in). Differential between boring locations B-3 and B-1. Angular distortion cannot be computed here because the pile-to-pile spans have not been issued; the engineer of record should divide this differential by the actual span to check it against the usual 1/500 distortion limit for the supported structure.

ASSUMED inputs in this section: Es correlated from SPT N - no modulus testing on this site; Poisson ratio nu = 0.35; deep-embedment factor 0.5; serviceability limit 1.0 in at the anchor head - EOR to confirm; shaft friction not credited as settlement relief (conservative). Soil modulus is the single largest uncertainty in any settlement estimate and none has been measured on this site.

17. COUPLING DEMAND & HELIX PLATE SCREENING

COUPLING - required capacity specification

TMG coupling ratings were not supplied for this project, so **no coupling capacity is published here** - What is published instead is the demand any rating must satisfy, computed from this project's own numbers, so the engineer of record can check a future rating against a hard value. Installation torque is the governing demand: it is applied to every coupling in the string, every revolution, for the full installation.

Demand	Value	Basis
Torsion (governing)	12,713 ft-lb	Q.ult / Kt at the B-3 recommended depth
Axial compression	44.5 k	certified design compression, not merely the requirement
Axial tension	40.0 k	certified design tension
(requirement only)	37.5 k / 14.5 k	supplied compression / tension requirement

Bolt-shear mechanism screening. A transverse through-bolt resists torque as a force couple with its two shear planes about one shaft diameter apart, requiring **43.6 kips per shear plane** at the governing torque. The table below accounts for bolt shear ONLY - it ignores bolt bearing on the tube wall, sleeve friction, and formed or hex drive features, all of which real couplings use and all of which add capacity.

Configuration	A325-N allowable	Utilisation	A325-X allowable	Utilisation
1 x 3/4" bolt	11.9 k	3.65	15.0 k	2.90
1 x 7/8" bolt	16.2 k	2.68	20.4 k	2.13
1 x 1" bolt	21.2 k	2.06	26.7 k	1.63
2 x 3/4" bolts	23.9 k	1.83	30.0 k	1.45
2 x 7/8" bolts	32.5 k	1.34	40.9 k	1.07
2 x 1" bolts	42.4 k	1.03	53.4 k	0.82

Read this correctly. No configuration screened clears the torsional demand on bolt shear alone. That does not mean these couplings are inadequate - it means a coupling for this duty cannot rely on bolt shear as its sole load path, and TMG's tested rating must be confirmed to cover the torsion above. This is a specification item for the engineer of record, not a defect finding.

HELIX PLATE - bearing-pressure screening (cantilever bound)

Boring	Helix	Bearing pressure	Radial projection	Thickness assumed
B-1	10"	36.9 ksf	3.25 in	0.375 in
B-1	12"	36.9 ksf	4.25 in	0.375 in
B-3	10"	37.2 ksf	3.25 in	0.375 in
B-3	12"	37.2 ksf	4.25 in	0.375 in

Read this as a DEMAND on the plate, not as a rating of it. The cantilever strip is an upper bound on stress by construction: a helicoidal plate is continuously supported along its spiral weld and develops ring and membrane action the model ignores, so the true stress is materially lower than this bound suggests. AC358 establishes helix plate capacity by full-scale load test, and that tested rating governs over this or any other closed-form estimate. The purpose of this screening is narrow and specific: the bearing pressures at both recommended depths are high because both anchors bear in very hard cemented material, so the engineer of record should confirm TMG's tested plate rating covers a bearing pressure of this order. Plate thickness 0.375 in and grade 50 ksi are ASSUMED for the comparison - TMG plate specification was not supplied.

18. COMBINED AXIAL + FLEXURE, LOAD BASIS & TEST PROGRAM

COMBINED AXIAL + FLEXURE INTERACTION (AISC 360 H1.1)

Sections 3 and 6 publish axial capacity and lateral capacity separately. Neither is valid in the presence of the other without an interaction check, and this is that check. Allowable moment Mc = Fy Zx / 1.67 = 9.99 k-ft; allowable axial Pc is the buckling-controlled value from Section 7. Nothing in this check is assumed - it runs on section properties and results already established.

Boring	Axial case	Head fixity	P / Pc	Moment M.r	Equation	Utilisation	Moment still available
B-1	requirement	free	0.244	3.54 k-ft	H1-1a	0.558	8.50 k-ft
B-1	requirement	fixed	0.244	6.78 k-ft	H1-1a	0.847	8.50 k-ft
B-1	certified design	free	0.287	3.54 k-ft	H1-1a	0.601	8.02 k-ft
B-1	certified design	fixed	0.287	6.78 k-ft	H1-1a	0.890	8.02 k-ft
B-3	requirement	free	0.244	3.41 k-ft	H1-1a	0.546	8.50 k-ft
B-3	requirement	fixed	0.244	6.53 k-ft	H1-1a	0.824	8.50 k-ft
B-3	certified design	free	0.289	3.41 k-ft	H1-1a	0.592	7.99 k-ft
B-3	certified design	fixed	0.289	6.53 k-ft	H1-1a	0.870	7.99 k-ft

All cases pass, with the governing utilisation 0.890 occurring in the **fixed-head** condition. That is the point worth carrying forward: fixed-head lateral capacity is roughly 59% higher than free-head, but it consumes most of the interaction margin to get there. Section 6 already flags that head fixity has not been declared by the engineer of record - this check shows that declaration has structural consequences, not just lateral ones.

LOAD BASIS - what the supplied numbers actually mean

This report designs against two bare numbers, 37.5 kips compression and 14.5 kips tension. A single number is not a load case: it carries no information about which combination produced it or whether it is a service or factored quantity. **Adopted interpretation: ASD (service / unfactored).** The supplied requirement is paired with a factor of safety of 2.0 applied to ultimate geotechnical capacity, which is the allowable-stress convention used throughout AC358 and standard helical practice. Treating the supplied values as already-factored LRFD loads and ALSO applying FS = 2.0 would double-count the safety margin.

Consequence if that interpretation is wrong. The certification ceiling set by the shaft torsional rating is 50.6 kips. The adopted requirement of 37.5 kips leaves 13.1 kips of headroom, so a modest upward revision of the requirement - for instance if an uplift or seismic combination not supplied turns out to govern - can be absorbed without changing the shaft. A revision above the ceiling cannot, and would require a larger shaft section rather than a deeper anchor.

LOAD TEST PROGRAM

The shaft friction reserve computed in Section 5 - 9.0 k at B-1 and 15.8 k at B-3 - is real capacity this report refuses to credit because nothing has calibrated it. A load test is what converts it into creditable capacity, without changing the product, the depth, or the installation.

ID	Test	Standard	Target	Quantity
LT-1	Axial compression	ASTM D1143	75.0 kips maximum test load (2.0 x the 37.5 kip requirement)	1 per anchor strip (2 total), sacrificial or proof
LT-2	Axial tension / uplift	ASTM D3689	29.0 kips maximum test load (2.0 x the 14.5 kip requirement)	1 per anchor strip (2 total)
LT-3	Lateral	ASTM D3966	To the lateral demand once the engineer of record supplies it	Optional - only if a lateral demand exists
LT-4	Torque correlation verification	AC358 Section 4.3	Record final tip torque on every test anchor and compare the measured capacity/torque ratio against the assumed Kt = 7	Concurrent with LT-1 and LT-2, no additional anchors

19. CONSOLIDATION, CORROSIVITY, CYCLIC LOADING & BLOCK FAILURE

CONSOLIDATION SETTLEMENT OF THE CLAY STRATA

Boring	Stratum	Depth	Disposition	Settlement
B-1	CLAY, light greenish gray to yellowish brown, stiff	14.0-19.0 ft	above bearing helix - bypassed, no stress increase from this anchor	0.000 in
B-1	CLAY, light gray to yellow, CEMENTED, very hard	19.0-29.0 ft	cemented / very hard (N = 100) - classical consolidation theory not applicable; elastic response covered in Section 12	0.000 in
B-1	LIMESTONE, white, weathered, very hard	29.0-30.0 ft	cemented / very hard (N = 100) - classical consolidation theory not applicable; elastic response covered in Section 12	0.000 in
B-3	CLAY, light greenish gray, CEMENTED, hard	20.0-25.5 ft	above bearing helix - bypassed, no stress increase from this anchor	0.000 in
B-3	LIMESTONE, white, weathered, very hard	29.0-35.0 ft	cemented / very hard (N = 100) - classical consolidation theory not applicable; elastic response covered in Section 12	0.000 in

Consolidation is evaluated stratum by stratum against two physical tests rather than applied blanket-fashion. First, load is delivered at the helix, so clay above the bearing elevation is bypassed by the shaft and receives no stress increase from this anchor - it cannot consolidate under this foundation regardless of its properties. Second, classical Cc/Cr theory describes a compressing soil skeleton and does not describe cemented material, where the cementation bond rather than the void ratio carries load; applying a virgin compression index to the very hard cemented clays logged here would generate a large and physically meaningless settlement. Those strata are screened on that basis and their real compressible response is captured by the elastic analysis in Section 12 instead. Where a stratum survives both tests the calculation is performed with a recompression index, appropriate to overconsolidated clay, and a 2:1 stress spread measured from the bearing helix. The liquid limit, initial void ratio and recompression ratio are ASSUMED - no Atterberg limits, consolidation tests or preconsolidation data exist for this site - so any stratum that did compute here would warrant real laboratory testing before being relied upon.

CYCLIC LOADING AND SUSTAINED-LOAD CREEP

Cyclic degradation - screened out. Both anchors bear in cemented clay or weathered limestone, materials that are not susceptible to the cyclic degradation mechanisms that govern loose saturated sands (pore-pressure buildup) or soft normally consolidated clays (remoulding). The liquefaction screening in Section 14 independently confirms the saturated sands above the bearing stratum are not susceptible, with a minimum factor of safety of 5.2. Parking live load is also a small fraction of the total on a foundation of this capacity. Cyclic degradation is therefore screened out rather than computed against an assumed cycle count and amplitude, neither of which was supplied.

Creep - screened out. Creep under sustained load is a concern for anchors bearing in soft to medium clay, and for tension anchors in particular. Both recommended bearing strata here are very hard (SPT refusal, strength bounded at the project cap), where creep strains are negligible at the working stresses computed in Section 12. If the engineer of record requires demonstrated creep performance - common for permanent tension anchors - the ASTM D3689 test in the load test program can be extended with a sustained-load hold, which is the direct measurement and costs little once the test frame is set.

GROUP BLOCK FAILURE

Anchors	Spacing	Group width	Q block	Sum of individual	Ratio	Governs
2	2D	3.0 ft	936 k	177 k	5.30	individual
2	3D	4.0 ft	1,188 k	177 k	6.73	individual
3	2D	5.0 ft	1,440 k	265 k	5.44	individual
3	3D	7.0 ft	1,944 k	265 k	7.34	individual
4	2D	7.0 ft	1,944 k	353 k	5.51	individual
4	3D	10.0 ft	2,700 k	353 k	7.65	individual
6	2D	11.0 ft	2,952 k	530 k	5.57	individual
6	3D	16.0 ft	4,212 k	530 k	7.95	individual

Block failure is only credible where a group is tight enough and the soil cohesive enough for the enclosed soil mass to move as a monolith. At the 3D minimum spacing this report recommends, the block capacity exceeds the sum of the individual anchor capacities at every group size tabulated, so the individual-anchor result continues to govern and no reduction applies. The table is published so the engineer of record can verify that conclusion against the actual anchor schedule once it is issued, since a schedule tighter than 3D would need rechecking. Depth and shear mobilisation are taken at the B-1 recommended geometry with the project su cap; both are stated so the arithmetic can be reproduced.

20. SOIL CORROSIVITY TESTING PROTOCOL

This report applies the galvanized model - zinc consumed over the first ~16 years, then base steel at 12 um/yr - over a 50 year design life, giving 0.016 in of base-steel sacrificial loss per face, and the end-of-life section still checks out with large margin (Section 9). That result is only as good as the assumed rate, and no soil corrosivity testing exists for this site. The five tests below are inexpensive relative to the anchor package and would convert the single largest assumption in the durability check into a measurement. A sacrificial anode system or a thicker wall are the available responses if the measured environment turns out aggressive (the anchors are already galvanized).

ID	Test	Standard	Threshold of concern	What it changes
CR-1	Soil resistivity	ASTM G187 (lab) or G57 (field Wenner)	Below 1,000 ohm-cm is severely corrosive; above 10,000 ohm-cm is mildly corrosive	The single strongest predictor of corrosion rate. Directly replaces the assumed 0.50 mils/yr/face.
CR-2	pH	ASTM G51	Below 5.5 accelerates loss; 5.5 to 10 is the normal range for buried steel	Governs whether the assumed rate is conservative or unconservative.
CR-3	Chloride content	ASTM D512	Above 100 ppm is aggressive; coastal sites frequently exceed this	The site is roughly 2 miles from open Gulf water, so chloride intrusion is plausible and unmeasured. This is the test most likely to move the answer here.
CR-4	Sulfate content	ASTM D516	Above 1,500 ppm is aggressive to both steel and any concrete cap	Governs cap/grout durability as well as shaft loss.
CR-5	Redox potential and sulfide screening	ASTM G200 / field	Low redox with sulfides indicates microbiologically influenced corrosion	MIC can produce rates several times the assumed uniform value and is not detectable from resistivity alone.

21. CALCULATION METHODOLOGY

1. Bearing capacity - individual plate method. Ultimate capacity is the sum over helical plates of the net plate area times the unit bearing at that plate's depth. Net area is pi/4 (D^2 - d^2) with d the shaft outside diameter, so the shaft is deducted from every plate. In cohesive strata unit bearing is 9 su + q'; in granular strata it is q' Nq with Meyerhof Nq.

2. Cylindrical shear check. For multi-helix piles the soil trapped between the top and bottom helix can fail as a single shear cylinder instead of at each plate individually. Qult.cyl = Q.bear(lead plate, full diameter) + pi Dmax x Lcyl x f, where f is the FULL undrained strength su or q' tan(phi) on the cylindrical surface (no interface reduction - it is a shear failure through intact soil, not at the steel). Governing capacity = MIN(individual plate, cylinder), per gate G4/G24. For the configurations here the cylinder value (98.2 k at B-1, 98.5 k at B-3) exceeds the plate value, so the plate method governs and is published; this is a CALCULATED result, not an assumption.

3. Shaft friction (reserve, not credited). Skin friction/adhesion along the round shaft from grade to the uppermost helix is computed - alpha su on the shaft perimeter in cohesive strata (alpha = 0.50, lower-bound smooth-steel adhesion) and K sigma'v tan(delta) in granular strata (K = 0.60, delta = 0.75 phi) - and is 9.0 k (B-1) / 15.8 k (B-3) at the recommended depths. TMG house practice does not credit this term toward the published design capacity without a site-specific load test (AC358 Sec. 4.3.6); it is disclosed here as an un-mobilised reserve, not added to Q.des or Q.tens.

4. Axial buckling. The soil-embedded shaft is screened against column buckling per Hubbell/Chance TB105-type guidance: buckling is not a governing concern where SPT N >= 4 throughout the embedment, because lateral soil support restrains column deformation at practical slenderness and service loads. Both borings satisfy the screen. It is also quantified with a Davisson-type closed-form lower bound, Pcr = 2 sqrt(EI k), k = nh x z evaluated at a shallow governing reference depth (10.5 in, 3 shaft diameters) - a conservative estimate, not a full variable-stiffness eigenvalue solution. Allowable buckling load clears the 37.5 k requirement by a wide margin at both borings.

5. Corrosion loss over the design life. No soil resistivity, pH, chloride or sulfate data has been supplied for this coastal site. Absent that, TMG applies the coating-aware model: galvanized: zinc coat (86 um/face) is consumed sacrificially over the first ~16 years (AASHTO model: 15 um/yr x 2 yr, then 4 um/yr), after which bare steel corrodes at 12 um/yr for the remaining 34 years; loss applies to both the OD and ID surfaces (shaft ends are not assumed sealed), over a 50-year design life - 0.016 in sacrificial thickness per face. The net section at end of life (t = 0.268 in, versus 0.300 in new) is carried through to a reduced plastic hinge moment for the end-of-life lateral case (Lateral Loads section) and to an axial steel-stress check at the required compression load. This is an ASSUMED default pending a resistivity/pH/chloride/sulfate study per AC358 Sec. 4.5, and is not a substitute for one.

6. Strength correlations and their bounds. Undrained shear strength su = 0.13 N ksf, bounded at 8.0 ksf wherever N derives from a refusal count (N >= 50). Friction angle phi = 28 + 0.28 N degrees, capped at 36 degrees. N is taken piecewise-constant from the nearest sample WITHIN the same stratum, so strength is never smeared across a layer boundary. Effective overburden accounts for the water table at 8.1 ft.

7. Tension. Design tension is 0.90 x design compression, after Perko (2009), whose test data show helical plates in uplift developing slightly less than their compression capacity once embedded below the critical depth carried by some evaluation reports. The AC358 condition that the uppermost helix sit at least 12 helix diameters below grade is applied as a hard gate - 12.0 ft for a 12 in helix - and is satisfied at both recommended depths.

8. Torque correlation and acceptance. Qult = Kt x T with Kt = 7 /ft for the 3-1/2 in ROUND shaft per ICC-ES AC358. The 10 /ft value is the SQUARE-shaft figure and is not used. Acceptance torque is DERIVED as Qreq x FS / Kt = 10,714 ft-lb and is never typed. Note that PREDICTED torque is Qu / Kt and is therefore algebraically the same statement as the capacity calculation - it is not an independent check. Only MEASURED field torque is independent.

9. Shaft torsional capacity. The governing torsional rating is 14,460 ft-lb. A geometric cross-check gives 0.6 Fy J/c = 14,465 ft-lb at Fy = 65 ksi (the specified minimum per AISC 360 A3.1) with J/c = 4.451 in3, consistent with it. The full tensile yield stress must NOT be used as a shear stress; doing so overstates torsional capacity by a factor of about 1.7.

10. Lateral capacity. Ultimate lateral capacity is by Broms for a long pile in cohesionless soil, the mechanism being a plastic hinge in the shaft at Mp = Fy Zx = 16.69 k-ft. Ground-line deflection and maximum moment use the Reese-Matlock non-dimensional solution with characteristic length T = (EI/nh)^(1/5) = 22.4 in. Because the depth to fixity is about 3.36 ft, only the near-surface sand participates; the cemented strata that carry the axial load contribute nothing laterally. Free-head and fixed-head cases are both published because head fixity has not been declared.

11. Shallow foundation bearing (comparative). Meyerhof's general bearing capacity equation (Nc, Nq, Ng with shape and depth factors) is applied to the near-surface soil at an ASSUMED nominal strip footing, purely as a comparative baseline to the helical anchor design - see the dedicated section. It is not a shallow-foundation design.

12. Lateral earth pressure. Rankine active/at-rest/passive coefficients (Ka, K0, Kp for granular strata; the undrained phi=0 form for cohesive strata) are computed for every logged stratum at both borings - see the dedicated section. Kp here is the same coefficient underlying the Broms lateral capacity in the Lateral Loads section.

13. Slope stability, seepage/piping. Slope stability is SCREENED OUT - no slope/embankment/cut geometry exists at this at-grade site - with the method implemented and ready for any project where one does. Seepage/piping is screened against the water table for the assumed open-cut trench depth, with a reference critical hydraulic gradient computed. See the dedicated section.

14. Liquefaction triggering and seismic parameters. Seismic design parameters (Ss, S1, SDS, SD1, PGA, Seismic Design Category) are sourced from the USGS ASCE 7-22 Design Maps web service for this site. Liquefaction triggering uses the simplified Seed-Idriss/Youd et al. (2001) SPT method (CSR vs CRR7.5) for every saturated cohesionless sample at both borings - see the dedicated section.

15. Downdrag and group effects. Downdrag (negative skin friction, neutral-plane concept) is quantified with the same alpha/K shaft-friction formula used for the friction reserve, applied to a deliberately bounding hypothetical settling zone, and screened out for lack of a settlement mechanism at this site. Group efficiency (Converse-Labarre) is tabulated versus spacing pending the anchor schedule. See the dedicated section.

16. Selection of the recommended depth. The shallowest tabulated depth satisfying compression, tension and 12D embedment is adopted, subject to a capacity-gradient check: a depth is rejected if terminating one foot shallower would lose more than 25% of capacity. That check moved the North/East recommendation off a stratum boundary where the loss would have been 50%.

17. Validation. Every figure in this report is generated from the analysis model and the workbook; none is transcribed. The deterministic pre-flight gate (tmg_gate.py, checks G1-G48) was run before issue and all checks passed. The gate blocks emission on a typed acceptance torque, a torsional rating read from a vendor field, a depth that fails any stated requirement, a depth on a capacity cliff, unbounded strength from refusal counts, a missing boring citation, an un-computed cylindrical shear comparison, a shaft-friction term silently folded into the governing capacity, an unscreened buckling check, an undisclosed corrosion basis, an uncomputed shallow-bearing/earth-pressure/seepage check, an un-flagged low-FS liquefaction result, undisclosed seismic parameters, or an un-quantified downdrag/group-effects screen. It further blocks a logged circulation loss without actionable field hold points, an uncomputed settlement or interaction check, a coupling row carrying no demand specification, a helix-plate bound published as a pass/fail rather than as a required thickness, an undisclosed load basis, a missing load-test program, a consolidation result without a per-stratum reason, and - after both were found in this project - any drawing written by two scripts, any module shadowing a Python standard-library name, and any coverage-manifest row that fails to render into the PDF.

22. FORMULAS & DETAILED CALCULATIONS

Every formula below is also implemented as a LIVE spreadsheet formula in the companion Excel workbook (RAMP_Sample_Report_Brickyard_Commons.xlsx): change an input on the '1 Inputs' tab - the requirement, FS, Kt, or the strength cap - and every dependent value in the workbook recalculates. Nothing in the workbook is a pasted number.

#	Quantity	Formula	Worked value
1	**Net helix area, 10 in**	pi/4 (D^2 - d^2), D = 10 in, d = 2.875 in	0.5003 ft2
2	**Net helix area, 12 in**	pi/4 (D^2 - d^2), D = 12 in	0.7403 ft2
3	**Helix spacing**	3 x lead helix diameter = 3 x 10 in	2.50 ft
4	**su from N**	su = 0.13 N, capped at su.cap	cap = 8.0 ksf
5	**phi from N**	phi = 28 + 0.28 N, capped	cap = 36 deg
6	**Unit bearing, cohesive**	q.ult = 9 su + q'	ksf
7	**Unit bearing, granular**	q.ult = q' Nq, Meyerhof	ksf
8	**Ultimate capacity**	Qu = SUM (Ah x q.ult) over plates	B-1: 88.3 kips
9	**Design capacity**	Q.des = Qu / FS	B-1: 44.1 kips
10	**Design tension**	Q.tens = 0.90 x Q.des	B-1: 39.7 kips
11	**12D embedment**	depth to uppermost helix >= 12 x D.max	12.0 ft for a 12 in helix
12	**Predicted torque**	T.pred = Qu / Kt (NOT an independent check)	B-1: 12,611 ft-lb
13	**Acceptance torque**	T.acc = Q.req x FS / Kt DERIVED	10,714 ft-lb
14	**Torsional modulus**	J/c = pi (D^4 - d^4) / (16 D)	4.451 in3
15	**Torsional yield cross-check**	T.el = 0.6 Fy (J/c), Fy = 65 ksi	14,465 ft-lb
16	**Torsional utilisation**	T.acc / rating	74%
17	**Max capacity certifiable**	rating x Kt / FS	50.6 kips
18	**Shaft friction, cohesive**	f = alpha x su, alpha = 0.50	ksf
19	**Shaft friction, granular**	f = K x q' x tan(delta), K = 0.60, delta = 0.75 phi	ksf
20	**Shaft friction reserve (not credited)**	Qf = SUM (f x pi x OD x dz), grade to top helix	B-1: 9.0 kips
21	**Cylindrical shear**	Q.cyl = Q.bear(lead) + pi x Dmax x Lcyl x f	B-1: 98.2 kips vs plate 88.3 kips
22	**Axial buckling (Davisson bound)**	Pcr = 2 sqrt(EI x k), k = nh x z at governing depth	B-1: 154 kips allowable (FS 2)
23	**Corrosion sacrificial thickness**	steel phase = (life - zinc life) x 12 um/yr = (50 - 16) yr x 12 um/yr	0.016 in per face
24	**Corroded net steel section**	A.steel = pi/4 (OD.corr^2 - ID.corr^2)	2.693 in2 (new 3.016 in2)
25	**Corroded axial stress check**	sigma = Q.req / A.steel.corr, vs Fy	13.9 ksi vs 65 ksi (21%)

SENSITIVITY TO THE BOUND ON REFUSAL STRENGTH

su cap (ksf)	B-1 max design compression	B-3 max design compression	Meets requirement?
4.0	22.9 kips at 30.00 ft	23.9 kips at 31.25 ft	neither
6.0	33.7 kips at 30.00 ft	33.9 kips at 35.00 ft	neither
8.0	**44.5 kips at 30.00 ft**	**44.7 kips at 35.00 ft**	**both strips**
10.0	55.2 kips at 30.00 ft	55.4 kips at 35.00 ft	both strips
12.0	66.0 kips at 30.00 ft	66.2 kips at 35.00 ft	both strips
14.0	71.4 kips at 30.00 ft	71.6 kips at 35.00 ft	both strips

How to read this table: bearing strata logged at refusal (N >= 50) have no measured strength - the design BOUNDS it at su = 8.0 ksf (bold row). Each row asks: if the real strength were only the value in column 1, would the anchors still certify 37.5 kips? RED rows = at that assumed strength no zone reaches the requirement; ORANGE = some do; BLUE = all do. The design holds at every bound of 8.0 ksf and above, and the field acceptance torque - not the assumed strength - is what proves the capacity of each installed anchor.

23. DETAILED CALCULATIONS - BORING B-1, WORKED IN FULL

Every check applied to Boring B-1 at the recommended depth H = 22.50 ft, worked step by step: symbol, substitution, result. Orange results are capped or limited values - the points where a design bound intervened. All values regenerate from the soil model; the same formulas run live in the workbook, and the full depth sweep is tabulated in the Capacity vs Depth section for B-1.

A1 SOIL INPUTS AT THE HELIX ELEVATIONS

10" helix, z = 22.50 ft	stratum: CLAY, light gray to yellow, CEMENTED, very hard | N = 100 (refusal) | $q' = \Sigma\gamma' \cdot \Delta z$ = 1.84 ksf	**N = 100**
Strength, 10" helix	$s_u = 0.13\ N \le 8.0$ ksf → 0.13 × 100 = 13.0 → **capped at 8.00**	**s_u = 8.00 ksf**
12" helix, z = 20.00 ft	stratum: CLAY, light gray to yellow, CEMENTED, very hard | N = 100 (refusal) | $q' = \Sigma\gamma' \cdot \Delta z$ = 1.66 ksf	**N = 100**
Strength, 12" helix	$s_u = 0.13\ N \le 8.0$ ksf → 0.13 × 100 = 13.0 → **capped at 8.00**	**s_u = 8.00 ksf**

Helices bearing in refusal material (N ≥ 50): a refusal blow count is a sampler index, not a strength measurement, so inferred strength is bounded at 8.0 ksf (4 tsf) and the sensitivity of the answer to that bound is tabulated in the Formulas section of the report.

A2 INDIVIDUAL PLATE BEARING - COMPRESSION

10" helix	$A_h = \pi/4\ (D^2 - d^2)$ = 0.479 ft² | $q_{ult} = 9\ s_u + q'$ = 9 × 8.00 + 1.84 = 73.8 ksf | Q = 0.479 × 73.8	**Q = 35.3 k**
12" helix	$A_h = \pi/4\ (D^2 - d^2)$ = 0.719 ft² | $q_{ult} = 9\ s_u + q'$ = 9 × 8.00 + 1.66 = 73.7 ksf | Q = 0.719 × 73.7	**Q = 52.9 k**
Ultimate (plate mode)	$Q_u = \Sigma\ A_h\ q_{ult}$ = 35.3 + 52.9	**Q_u = 88.3 k**

A3 CYLINDRICAL SHEAR MODE - THE COMPETING FAILURE SHAPE

Cylinder shear component	$Q_{shear} = \pi\ D_{avg}\ L_{cyl}\ s_u$ (soil cylinder between top and bottom helix, D_{avg} = 11", L = 2.5 ft)	**62.8 k**
Lead-plate bearing component	$Q_{bear} = A_{lead}\ (9\ s_u + q')$ at the lead helix	**35.3 k**
Cylinder-mode total	Q_{cyl} = 62.8 + 35.3	**98.2 k**
Governing mode	Q_u = MIN(plate, cylinder) = MIN(88.3, 98.2) = 88.3 → **plate mode governs**	**88.3 k**

A4 SHAFT FRICTION - COMPUTED, HELD IN RESERVE

Friction over the shaft	$Q_f = \Sigma\ \pi\ D_{shaft}\ \alpha\ s_u\ \Delta z$ (cohesive) + $\pi\ D\ K\ \sigma'_v\ \tan\delta\ \Delta z$ (granular), surface to top helix, α = 0.5, K = 0.6, δ = 0.75ϕ	**Q_f = 9.0 k**
Treatment	NOT credited to the published capacity - no site load test calibrates it. Held as disclosed reserve; the load test program converts it to creditable capacity.	**reserve only**

A5 DESIGN (ALLOWABLE) VALUES

Allowable compression	$Q_{des} = Q_u$ / FS = 88.3 / 2.0	**44.1 k ≥ 37.5 ✓**
12D embedment gate	top helix 20.0 ft ≥ 12 D_{max} = 12.0 ft ✓ → tension rule valid	**embedment OK**
Allowable tension	Q_{tens} = 0.90 × Q_{des} = 0.90 × 44.1	**39.7 k ≥ 14.5 ✓**

A6 INSTALLATION TORQUE - BOTH CHECKS

Torque to reach Q_u	$T = Q_u / K_t$ = 88,275 / 7 (K_t = 7 ft^{-1}, 3-1/2" round, AC358)	**12,611 ft-lb**
Acceptance torque (derived)	$T_{acc} = Q_{req}$ FS / K_t = 37,500 × 2.0 / 7	**10,714 ft-lb**
Shaft torsional rating	T_{el} = 0.6 F_y (J/c) = 0.6 × 65 × 4.451 / 12	**14,460 ft-lb**
Check 1 - criterion reachable	T_{acc} = 10,714 ≤ rating 14,460	✓
Check 2 - depth installable	T = 12,611 ≤ rating 14,460 (87% of rating)	✓
Certifiable ceiling	Q_{max} = rating × K_t / FS = 14.46 × 7 / 2.0 × 1000	**50.6 k**

A7 CORROSION - 50-YEAR SECTION LOSS (GALVANIZED, ASSUMED RATES, NO SITE DATA)

Zinc coat (sacrificial)	86 um/face hot-dip (ASTM A123); consumed at 15 um/yr × 2 yr, then 4 um/yr → zinc life = 2 + (86 – 30)/4	≈ **16 yr**
Base-steel loss per face	t_{loss} = (life – zinc life) × 12 um/yr = (50 – 16) × 12 um/yr	**0.016 in/face**
Corroded section	OD 3.50 → 3.47 in | wall 0.300 → 0.268 in | A 3.02 → 2.69 in²	**reduced section**
End-of-life axial stress	σ = Q_{req} / A_{corr} = 37.5 / 2.69	**13.9 ksi**
Utilisation vs yield	σ / F_y = 13.9 / 65	**21% ✓**

The corrosion rate is ASSUMED - no resistivity, pH, chloride or sulfate data exists for this site. The corrosivity testing protocol in the report specifies the five tests that would replace this assumption with measurement.

A8 AXIAL BUCKLING

Soil screen	N_{min} over the embedded shaft = 29 ≥ 4 → soil restrains the shaft; buckling not expected to govern	**screen OK**
Closed-form bound	P_{cr} = 2√(EI k), k = n_h z at z = 10.5 in (EI = 112,935 k-in², n_h = 20 pci)	**P_{cr} = 308 k**
Allowable	$P_{allow} = P_{cr}$ / 2.0 = 308 / 2.0	**154 k**
Utilisation	37.5 / 154	**24% ✓**

n_h = 20 pci is a published value for medium dense sand and has not been measured on this site; the screen result does not depend on it, the closed-form bound does.

A9 LATERAL CAPACITY (BROMS + REESE-MATLOCK)

Section strength	$M_y = F_y S_x$ = 65 × 2.225 / 12 = 12.05 k-ft | $M_p = F_y Z_x$ = 65 × 3.081 / 12	**M_p = 16.69 k-ft**
Characteristic length	T = $(EI / n_h)^{1/5}$ = $(112,935 / 20)^{1/5}$ = 22.4 in; depth to fixity ≈ 1.8 T = 3.4 ft	**T = 22.4 in**
Broms ultimate	plastic hinge governs: H_u free = 4.92 k, fixed = 7.81 k	**4.92 / 7.81 k**
Deflection-limited load	y = A H T³/EI ≤ 1.0 in → H free = 4.12 k, fixed = 10.80 k	**4.12 / 10.80 k**
Governing allowable	MIN(H_u/FS, H at deflection limit), free and fixed head	**2.46 / 3.91 k**

Head fixity has not been declared by the engineer of record; both values are published and the fixed-head figure must not be used unless the cap detail restrains rotation.

A10 COMBINED AXIAL + FLEXURE (AISC 360 H1.1)

Free head	P_r/P_c = 44.1/154 = 0.287 → H1-1a: 0.287 + 8/9 × (3.54/9.99)	**0.601 ≤ 1.0 ✓**
Fixed head	P_r/P_c = 44.1/154 = 0.287 → H1-1a: 0.287 + 8/9 × (6.78/9.99)	**0.890 ≤ 1.0 ✓**

A11 AXIAL SETTLEMENT AT DESIGN LOAD

Elastic shaft shortening	$\delta_e = \Sigma P_{seg} L_{seg}$ / (A E) with load shed at each helix: segments 44.1k×20.0ft + 17.6k×2.5ft, A = 3.02 in², E = 29,000 ksi	**0.127 in**
Helix bearing settlement	$\delta_h = q B (1–\nu^2) I_\rho F_{emb} / E_s$, governing helix ($E_s = 800 s_u$ = 6,400 ksf, correlated - no modulus testing on site)	**0.024 in**
Total vs limit	δ = 0.127 + 0.024 = 0.151 in vs 1.0 in (ASSUMED limit)	**15% of limit ✓**

End of Boring B-1 detailed calculations. Screening-level checks (karst, liquefaction, seismic, downdrag, group effects, consolidation) are worked in their own report sections and are not repeated here.

24. DETAILED CALCULATIONS - BORING B-3, WORKED IN FULL

Every check applied to Boring B-3 at the recommended depth H = 31.50 ft, worked step by step: symbol, substitution, result. Orange results are capped or limited values - the points where a design bound intervened. All values regenerate from the soil model; the same formulas run live in the workbook, and the full depth sweep is tabulated in the Capacity vs Depth section for B-3.

A1 SOIL INPUTS AT THE HELIX ELEVATIONS

10" helix, z = 31.50 ft	stratum: LIMESTONE, white, weathered, very hard | N = 100 (refusal) | $q' = \Sigma\gamma' \bullet \Delta z$ = 2.46 ksf	**N = 100**
Strength, 10" helix	$s_u = 0.13\,N \le 8.0$ ksf → 0.13 × 100 = 13.0 → **capped at 8.00**	**s_u = 8.00 ksf**
12" helix, z = 29.00 ft	stratum: LIMESTONE, white, weathered, very hard | N = 100 (refusal) | $q' = \Sigma\gamma' \bullet \Delta z$ = 2.25 ksf	**N = 100**
Strength, 12" helix	$s_u = 0.13\,N \le 8.0$ ksf → 0.13 × 100 = 13.0 → **capped at 8.00**	**s_u = 8.00 ksf**

Helices bearing in refusal material (N ≥ 50): a refusal blow count is a sampler index, not a strength measurement, so inferred strength is bounded at 8.0 ksf (4 tsf) and the sensitivity of the answer to that bound is tabulated in the Formulas section of the report.

A2 INDIVIDUAL PLATE BEARING - COMPRESSION

10" helix	$A_h = \pi/4\,(D^2–d^2)$ = 0.479 ft² | $q_{ult} = 9\,s_u + q'$ = 9 × 8.00 + 2.46 = 74.5 ksf | Q = 0.479 × 74.5	**Q = 35.6 k**
12" helix	$A_h = \pi/4\,(D^2–d^2)$ = 0.719 ft² | $q_{ult} = 9\,s_u + q'$ = 9 × 8.00 + 2.25 = 74.3 ksf | Q = 0.719 × 74.3	**Q = 53.4 k**
Ultimate (plate mode)	$Q_u = \Sigma\,A_h\,q_{ult}$ = 35.6 + 53.4	**Q_u = 89.0 k**

A3 CYLINDRICAL SHEAR MODE - THE COMPETING FAILURE SHAPE

Cylinder shear component	$Q_{shear} = \pi\,D_{avg}\,L_{cyl}\,s_u$ (soil cylinder between top and bottom helix, D_{avg} = 11", L = 2.5 ft)	**62.8 k**
Lead-plate bearing component	$Q_{bear} = A_{lead}\,(9\,s_u + q')$ at the lead helix	**35.6 k**
Cylinder-mode total	Q_{cyl} = 62.8 + 35.6	**98.5 k**
Governing mode	Q_u = MIN(plate, cylinder) = MIN(89.0, 98.5) = 89.0 → **plate mode governs**	**89.0 k**

A4 SHAFT FRICTION - COMPUTED, HELD IN RESERVE

Friction over the shaft	$Q_f = \Sigma\,\pi\,D_{shaft}\,\alpha\,s_u\,\Delta z$ (cohesive) + $\pi\,D\,K\,\sigma'_v\,\tan\delta\,\Delta z$ (granular), surface to top helix, α = 0.5, K = 0.6, δ = 0.75ϕ	**Q_f = 15.8 k**
Treatment	NOT credited to the published capacity - no site load test calibrates it. Held as disclosed reserve; the load test program converts it to creditable capacity.	**reserve only**

A5 DESIGN (ALLOWABLE) VALUES

Allowable compression	$Q_{des} = Q_u$ / FS = 89.0 / 2.0	**44.5 k ≥ 37.5 ✓**
12D embedment gate	top helix 29.0 ft ≥ 12 D_{max} = 12.0 ft ✓ → tension rule valid	**embedment OK**
Allowable tension	$Q_{tens} = 0.90 \times Q_{des}$ = 0.90 × 44.5	**40.0 k ≥ 14.5 ✓**

A6 INSTALLATION TORQUE - BOTH CHECKS

Torque to reach Q_u	$T = Q_u / K_t = 88{,}992 / 7$ ($K_t = 7\ ft^{-1}$, 3-1/2" round, AC358)	**12,713 ft-lb**
Acceptance torque (derived)	$T_{acc} = Q_{req}\ FS / K_t = 37{,}500 \times 2.0 / 7$	**10,714 ft-lb**
Shaft torsional rating	$T_{el} = 0.6\ F_y\ (J/c) = 0.6 \times 65 \times 4.451 / 12$	**14,460 ft-lb**
Check 1 - criterion reachable	$T_{acc} = 10{,}714 \leq$ rating 14,460	✓
Check 2 - depth installable	$T = 12{,}713 \leq$ rating 14,460 (88% of rating)	✓
Certifiable ceiling	Q_{max} = rating × K_t / FS = 14.46 × 7 / 2.0 × 1000	**50.6 k**

A7 CORROSION - 50-YEAR SECTION LOSS (GALVANIZED, ASSUMED RATES, NO SITE DATA)

Zinc coat (sacrificial)	86 um/face hot-dip (ASTM A123); consumed at 15 um/yr × 2 yr, then 4 um/yr → zinc life = 2 + (86 – 30)/4	≈ **16 yr**
Base-steel loss per face	t_{loss} = (life – zinc life) × 12 um/yr = (50 – 16) × 12 um/yr	**0.016 in/face**
Corroded section	OD 3.50 → 3.47 in | wall 0.300 → 0.268 in | A 3.02 → 2.69 in²	**reduced section**
End-of-life axial stress	$\sigma = Q_{req} / A_{corr} = 37.5 / 2.69$	**13.9 ksi**
Utilisation vs yield	$\sigma / F_y = 13.9 / 65$	**21%** ✓

The corrosion rate is ASSUMED - no resistivity, pH, chloride or sulfate data exists for this site. The corrosivity testing protocol in the report specifies the five tests that would replace this assumption with measurement.

A8 AXIAL BUCKLING

Soil screen	N_{min} over the embedded shaft = 19 ≥ 4 → soil restrains the shaft; buckling not expected to govern	**screen OK**
Closed-form bound	$P_{cr} = 2\sqrt{(EI\ k)}$, $k = n_h\ z$ at z = 10.5 in (EI = 112,935 k-in², n_h = 20 pci)	**P_{cr} = 308 k**
Allowable	$P_{allow} = P_{cr} / 2.0 = 308 / 2.0$	**154 k**
Utilisation	37.5 / 154	**24%** ✓

n_h = 20 pci is a published value for medium dense sand and has not been measured on this site; the screen result does not depend on it, the closed-form bound does.

A9 LATERAL CAPACITY (BROMS + REESE-MATLOCK)

Section strength	$M_y = F_y\ S_x = 65 \times 2.225 / 12 = 12.05$ k-ft | $M_p = F_y\ Z_x = 65 \times 3.081 / 12$	**M_p = 16.69 k-ft**
Characteristic length	$T = (EI / n_h)^{1/5} = (112{,}935 / 20)^{1/5} = 22.4$ in; depth to fixity ≈ 1.8 T = 3.4 ft	**T = 22.4 in**
Broms ultimate	plastic hinge governs: H_u free = 4.74 k, fixed = 7.52 k	**4.74 / 7.52 k**
Deflection-limited load	$y = A\ H\ T^3/EI \leq 1.0$ in → H free = 4.12 k, fixed = 10.80 k	**4.12 / 10.80 k**
Governing allowable	MIN(H_u/FS, H at deflection limit), free and fixed head	**2.37 / 3.76 k**

Head fixity has not been declared by the engineer of record; both values are published and the fixed-head figure must not be used unless the cap detail restrains rotation.

A10 COMBINED AXIAL + FLEXURE (AISC 360 H1.1)

Free head	P_r/P_c = 44.5/154 = 0.289 → H1-1a: 0.289 + 8/9 × (3.41/9.99)	**0.592 ≤ 1.0 ✓**
Fixed head	P_r/P_c = 44.5/154 = 0.289 → H1-1a: 0.289 + 8/9 × (6.53/9.99)	**0.870 ≤ 1.0 ✓**

A11 AXIAL SETTLEMENT AT DESIGN LOAD

Elastic shaft shortening	$\delta_e = \Sigma P_{seg} L_{seg}$ / (A E) with load shed at each helix: segments 44.5k×29.0ft + 17.8k×2.5ft, A = 3.02 in², E = 29,000 ksi	**0.183 in**
Helix bearing settlement	$\delta_h = q B (1–\nu^2) I_\rho F_{emb} / E_s$, governing helix ($E_s = 800 s_u$ = 6,400 ksf, correlated - no modulus testing on site)	**0.024 in**
Total vs limit	δ = 0.183 + 0.024 = 0.207 in vs 1.0 in (ASSUMED limit)	**21% of limit ✓**

End of Boring B-3 detailed calculations. Screening-level checks (karst, liquefaction, seismic, downdrag, group effects, consolidation) are worked in their own report sections and are not repeated here.

25. HELICAL PRODUCT COUNT / ORDER QUANTITIES

Quantities below are PER ANCHOR. Trench lengths and anchor spacing have not been issued, so no site total is published. Multiply by the anchor schedule when the engineer of record provides it.

Zone	Boring	Item	Description	Qty	Unit
North / East zone	B-1	Lead section	3-1/2" x 0.300" x 7 ft lead, 10"-12" double, 0.375" plates	1	ea
North / East zone	B-1	Extension	3-1/2" x 0.300" x 7 ft plain extension	3	ea
North / East zone	B-1	Coupling bolt set	per TMG coupling detail	3	set
North / East zone	B-1	Termination	anchor head / trench plate per EOR detail	1	ea
North / East zone	B-1	Shaft footage	supplied length (est. tip 22.50 ft)	28	ft
South / West zone	B-3	Lead section	3-1/2" x 0.300" x 7 ft lead, 10"-12" double, 0.375" plates	1	ea
South / West zone	B-3	Extension	3-1/2" x 0.300" x 7 ft plain extension	4	ea
South / West zone	B-3	Coupling bolt set	per TMG coupling detail	4	set
South / West zone	B-3	Termination	anchor head / trench plate per EOR detail	1	ea
South / West zone	B-3	Shaft footage	supplied length (est. tip 31.50 ft)	35	ft

INSTALLATION REQUIREMENTS

Advance rate. Advance at 10-20 RPM with steady crowd so the anchor advances approximately one helix pitch (3 in) per revolution - over-rotation churns the bearing stratum and reduces capacity. Slow to under 10 RPM over the final 3 ft so torque readings are stable at termination.

Torque logging. Record torque at 1 ft intervals of advance AND at the termination depth, for every anchor, including any terminating on refusal. The record is the capacity documentation - an anchor with no logged torque has no certified capacity. On adjacent underpinning work at this site, seventeen of thirty-two piers were annotated at refusal with no torque carried onto the capacity chart; re-reading the field sheet showed sixteen of the seventeen were below the acceptance criterion.

Stop AT acceptance torque. Installation stops when final tip torque reaches 10,714 ft-lb AND the minimum depth is met, whichever is deeper. Do not drive past acceptance - the margin to the 14,460 ft-lb shaft rating is only 26%. If an anchor reaches the rating without reaching acceptance torque, stop and refer to the engineer of record.

South / West zone - the torque dip is expected. Torque will peak near 22.8 ft and fall to about 48% of that peak by 25.2 ft as the upper helix passes out of the stronger overlying material, then climb again toward the bearing stratum. Do not terminate on the first peak; the 31.50 ft depth is below the weak layer deliberately.

Verification anchors. Install and log the first anchor in each strip as a verification anchor before production. Compare the measured torque profile against the profile drawings. An anchor reaching acceptance torque within about 3 ft of the estimated depth confirms the model; one that does not means the profile differs from the design boring and the strip must be reviewed.

26. COVERAGE MANIFEST - WHAT WAS AND WAS NOT CHECKED

Item	Status	Basis / note
Bearing capacity, compression	CHECKED	individual plate method (axial compression), both borings, full sweep
Bearing capacity, tension	CHECKED	0.90 x compression with AC358 12D embedment gate
Axial tension / uplift demand	SUPPLIED	14.5 k per structural pre-construction plan (sample report - document identifiers withheld)
Cylinder mode (cylindrical shear)	CHECKED	calculated, gate G24; plate method governs, MIN published
Shaft friction (reserve)	CHECKED, NOT CREDITED	alpha/K su-tan(phi) method; reserve only, no load test
Site-specific load test	NOT PERFORMED	no PDA/static load test this project; friction reserve uncalibrated
Axial buckling	CHECKED	N-screen + Davisson bound, gate G23; large margin both borings
Torque correlation Kt	CHECKED	AC358 round-shaft value, verified against shaft geometry
Acceptance torque	CHECKED	derived from requirement; gate G2a
Shaft structural capacity, torsional	CHECKED	rating cross-checked against 0.6 Fy J/c; gate G13
Depth vs exploration	CHECKED	both depths within explored ground; gate G10
Capacity gradient at depth	CHECKED	both depths clear of stratum boundaries; gate G18
Strength bounded at refusal	CHECKED	su capped at 8.0 ksf; gate G20
Water table	CHECKED	8.1 ft, applied to effective overburden
Unit weights	SUPPLIED	carried in the project spec with the boring data
Input data quality	DISCLOSED	SPT boring logs only, no lab testing on this site; gate G19
Coupling capacity, tension	DEMAND SPECIFIED	40.0 k required; TMG rating not supplied; gate G38
Coupling capacity, torsion	DEMAND SPECIFIED	12,713 ft-lb required; bolt-shear screened; gate G38
Cap / termination connections	NOT CHECKED	EOR detail not supplied
Lateral capacity, free head	CHECKED	Broms long-pile + Reese-Matlock; Section 6
Lateral capacity, fixed head	CHECKED	published alongside free head; fixity NOT declared by EOR
Lateral DEMAND	NOT SUPPLIED	EOR to compare demand against the published capacity
Subgrade modulus nh	ASSUMED	20 pci for medium dense sand; not measured on this site
Corrosion loss over design life	ASSUMED BASIS	50 yr, galvanized: zinc ~16 yr then steel ASSUMED, no site data; gate G25
Shallow foundation bearing	CHECKED, COMPARATIVE	Meyerhof, ASSUMED footing geometry; baseline only, gate G26
Lateral earth pressure	CHECKED	Rankine Ka/K0/Kp every stratum, both borings; gate G27
Slope stability	SCREENED OUT	at-grade site, no slope geometry supplied; gate G28
Seepage / piping	CHECKED	open-cut vs GWT, critical gradient reference; gate G29
Liquefaction triggering	CHECKED	Seed-Idriss/Youd SPT method, all saturated sand; gate G30
Seismic design parameters	CHECKED	USGS ASCE7-22 Design Maps web service, SDC A; gate G31
Downdrag (negative skin friction)	SCREENED OUT	bounding-case quantified, under 1% of Qult; gate G32
Group effects and spacing	TABULATED	Converse-Labarre vs spacing; anchor schedule not issued; gate G33
Axial settlement / serviceability	CHECKED	elastic + helix bearing, 0.21 in vs 1.0 in limit; gate G37
Differential settlement	CHECKED	0.056 in across boring locations; angular distortion needs pile spans

26. COVERAGE MANIFEST (CONTINUED 2 of 2)

Item	Status	Basis / note
Consolidation settlement	SCREENED OUT	stratum-by-stratum: bypassed or cemented; gate G43
Cyclic degradation	SCREENED OUT	hard cemented bearing stratum, liquefaction FS clears; gate G43
Sustained-load creep	SCREENED OUT	very hard bearing stratum; D3689 hold available if required
Helix plate structural	DEMAND SPECIFIED	bearing-pressure screening, cantilever bound; AC358 test governs; gate G39
Combined axial + flexure	CHECKED	AISC H1.1, max utilisation 0.89 (fixed head); gate G40
Load basis (ASD vs LRFD)	DISCLOSED	ASD adopted with reasoning; headroom bounded; gate G41
Load combinations	FORMS PUBLISHED	component loads not supplied; EOR to confirm envelope; gate G41
Load test program	SPECIFIED	ASTM D1143/D3689/D3966 + Kt verification; gate G42
Group block failure	TABULATED	individual governs at every spacing tabulated; gate G43
Soil corrosivity testing	PROTOCOL SPECIFIED	5 tests specified to replace the assumed rate; gate G43
Laboratory strength testing	NOT AVAILABLE	none exists for this site in supplied documents
Karst / solution feature	SCREENED, UNRESOLVED	B-3 bears below a logged anomaly; 4 field hold points issued; gate G36
Detailed worked calculations	INCLUDED	symbol-substitution-result appendix per boring, values live from the model; gate G48
References & design standards	INCLUDED	consolidated citation list; every document listed is actually invoked - no capability-list citations

Items marked NOT CHECKED are outside the data supplied to TMG and remain the responsibility of the engineer of record. This report must not be read as clearing them.

27. REFERENCES & DESIGN STANDARDS

Every code, standard, evaluation report, project document and published method relied on in this report is consolidated below with the edition applied and where it is used. A document appears on this list only if it is actually invoked in the body of the report.

A. CODES, STANDARDS AND EVALUATION REPORTS

Reference	Title / edition applied	Where used in this report
ICC-ES AC358	Acceptance Criteria for Helical Pile Systems and Devices (June 2020)	capacity methods; Kt values; 12D tension embedment gate; acceptance-torque basis; corrosivity study requirement (Sec. 4.5); friction crediting rule (Sec. 4.3.6) - Calculation Methodology, Design Parameters, Detailed Calculations
ICC-ES ESR-4621	TMG Manufacturing helical pile system evaluation report (2-7/8" shaft); renewal status to be confirmed with ICC-ES	product recognition. Covers the 2-7/8" shaft (Kt = 9.0); this project runs the 3-1/2" shaft at the AC358 round-shaft value Kt = 7 /ft - Design Parameters
ANSI/AISC 360-22	Specification for Structural Steel Buildings	shaft Fy at the specified minimum (Sec. A3.1); torsional rating at 0.6 Fy J/c (shear yield); combined axial + flexure interaction (Sec. H1.1) - Calculation Methodology, Structural Checks, Interaction
IBC	International Building Code, as adopted by the authority having jurisdiction (Florida Building Code amendments where applicable)	code basis for helical pile acceptance via AC358; FS = 2 on geotechnical capacity - Design Parameters
Perko (2009)	Helical Piles: A Practical Guide to Design and Installation, John Wiley & Sons	uplift-to-compression ratio applied to every published tension value - Design Parameters
ASCE/SEI 7-22	Minimum Design Loads and Associated Criteria for Buildings and Other Structures	seismic design parameters via the USGS Design Maps web service; site class and SDC; load-combination forms - Liquefaction/Seismic, Load Basis
ASTM D1586 / D1586M	Standard Penetration Test (SPT) and split-barrel sampling of soils	field method behind every N-value; all soil strengths derive from the the geotechnical laboratory SPT logs - Design Parameters, appendix logs
ASTM D1143 / D1143M	Deep foundation elements under static axial compressive load	specified site load-test program - Load Test Program
ASTM D3689 / D3689M	Deep foundation elements under static axial tensile load	load-test program; sustained-load creep hold option - Load Test Program, Consolidation/Cyclic
ASTM D3966 / D3966M	Deep foundation elements under lateral load	load-test program, lateral verification option - Load Test Program
ASTM A123 / A123M	Zinc (hot-dip galvanized) coatings on iron and steel products	coating specification for the -G part number; 86 um/face zinc basis of the corrosion model - Design Parameters, Corrosion sections
AASHTO / FHWA	Buried-steel corrosion model for galvanized elements: zinc 15 um/yr x 2 yr then 4 um/yr, base steel 12 um/yr thereafter	corrosion loss over the 50-yr design life (ASSUMED, pending site corrosivity data) - Corrosion sections, Detailed Calculations A7
NACE SP0169	Control of external corrosion on underground or submerged metallic piping systems	basis for the assumed bare-steel corrosion rate carried when the -B (bare) option is selected - Corrosion sections

B. PROJECT-SPECIFIC SOURCE DOCUMENTS

Document	Description	Where used in this report
the geotechnical laboratory Report No. GTR-25-0418	Geotechnical Laboratory geotechnical exploration, drilled 04/18/2025 (licensed engineering and geology business, State of Florida)	all subsurface data - SPT logs B-1 and B-3 reproduced in the appendix; drilling and sampling metadata in Design Parameters
structural pre-construction plan (sample report - document identifiers withheld)	Project structural requirement source	design requirement: 37.5 k compression / 14.5 k tension (allowable) - Cover, Executive Summary
TMG product data	Part 600-35-S80-7-1012-G definition; Schedule 80 pipe section properties	shaft geometry, section properties, torsional rating input - Design Parameters, Structural Checks

27. REFERENCES & DESIGN STANDARDS (CONTINUED)

C. PUBLISHED METHODS AND CORRELATIONS

Method	Published source	Where used in this report
Individual plate bearing	9 su + q-prime Nq, Meyerhof bearing factors (per AC358 methodology)	axial capacity, both borings - GOVERNS
Uplift-to-compression ratio	Perko (2009), Helical Piles: A Practical Guide to Design and Installation	design tension = 0.90 x design compression, all borings
Cylindrical shear	Mitsch & Clemence (1985)	multi-helix cylinder mode - computed both borings; plate mode governs
SPT strength correlations	su = 0.13 N ksf; phi = 28 + 0.28 N deg (Terzaghi-Peck lineage)	soil strength from N-values, bounded at refusal
Shaft adhesion factor	Tomlinson, lower-bound smooth-steel alpha	shaft friction reserve - computed, NOT credited
Lateral ultimate capacity	Broms (1964), long-pile plastic hinge mechanism	Lateral Loads - free and fixed head
Lateral deflection / moment	Reese & Matlock non-dimensional solution	ground-line deflection, max moment, depth to fixity
Axial buckling bound	Davisson-type closed form, Pcr = 2 sqrt(EI k)	buckling check alongside the N-screen
Shallow footing baseline	Meyerhof shallow bearing	comparative footing capacity - baseline only
Earth pressures	Rankine Ka / Kp; Jaky K0	lateral earth pressure tables, every stratum
Liquefaction triggering	Seed-Idriss simplified method per Youd et al. (2001)	liquefaction screen, all saturated sands
Group efficiency	Converse-Labarre	group effects vs spacing table
Consolidation index	Terzaghi & Peck, Cc = 0.009 (LL - 10)	consolidation screen (tier-2 secondary checks)

Standards this report does not use are deliberately not cited: no concrete is designed (no ACI 318), the site is in the United States (no Eurocodes, NTC, AS/NZS or other national codes), and superseded AISC editions are not carried alongside the current one. Where the authority having jurisdiction adopts different code editions, the engineer of record's governing code prevails. ESR-4621's current validity should be confirmed with ICC-ES before it is cited contractually.

GEOTECHNICAL LABORATORY

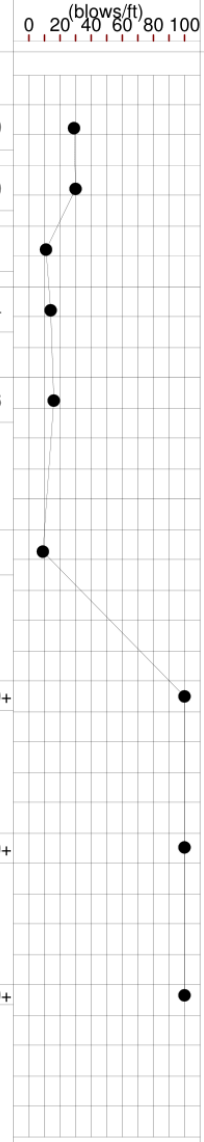
Client: Foundation Contractors
Project: Brickyard Commons
Location: Parcel: withheld (sample report)
City / State: Palm Harbor, Florida

Report No: GTR-25-0418
Log of Borehole: B-1
Date Drilled: 04/18/2025

SAMPLE REPORT - PROJECT AND LABORATORY IDENTIFIERS CHANGED

Depth	Subsurface Profile Description	Consistency	Blow Count	N value
0	Ground Surface			
	Concrete and Limerock Base			
	Sand Grayish brown, fine grained.	medium dense	17-16-13	29
	Sand Light brownish gray, fine grained, with shell fragments.	dense	6-15-15	30
5	***Sand*** Dark grayish brown to brown, fine grained.	medium dense	4-5-6	11
	Sand Light yelllowish brown to pale brown, fine grained.	medium dense	5-6-8	14
10		medium dense	5-7-9	16
15	***Clay*** Light greenish gray to yellowish brown.	stiff	3-4-5	9
20	***Clay*** Light gray to yellow, cemented.	very hard	39-50/5"	100+
25	***Clay*** Light greenish gray to yellowish brown, cemented.	very hard	50-50/4"	100+
30	***Limestone*** White, weathered.			
	End of Boring	very hard	50/0"	100+
35				

Standard Penetration Test (blows/ft)



Lab/ Notes

Notes: FEMA Flood Zone: X

No loss of drill fluid circulation
Borehole sealed/grouted

Water Table: 8.1' bls (Auger)
Ground Elevation: Existing
Drilled by: field technician
Compiled by: project geologist

Drill Method: Rotary
Sampling Method: Splitspoon ASTM D-1586 **(Safety Hammer)**

Sheet 1 of 1

GEOTECHNICAL LABORATORY

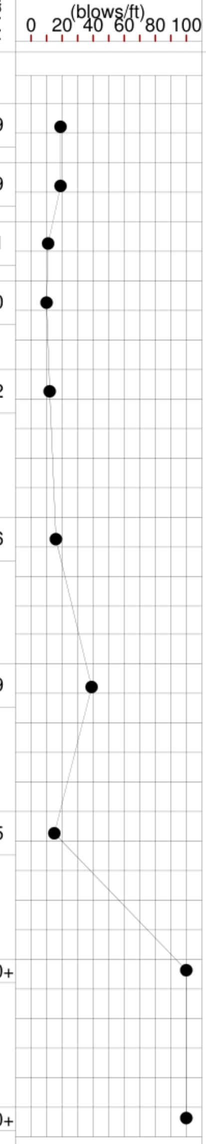
Client: Foundation Contractors
Project: Brickyard Commons
Location: Parcel: withheld (sample report)
City / State: Palm Harbor, Florida

Report No: GTR-25-0418
Log of Borehole: B-3
Date Drilled: 04/18/2025

SAMPLE REPORT - PROJECT AND LABORATORY IDENTIFIERS CHANGED

Depth	Subsurface Profile Description	Consistency	Blow Count	N value	Lab/ Notes
0	Ground Surface				
	Concrete and Limerock Base				
	Sand Gray, fine grained, minor shell fragments.	medium dense	6-9-10	19	
	Sand Grayish brown, fine grained.	medium dense	8-10-9	19	
5	***Sand*** Yellowish brown to light yellowish brown, fine grained.	medium dense	4-5-6	11	
		medium dense	4-5-5	10	
10	***Sand*** Light brownish gray to pale brown, fine grained.	medium dense	3-5-7	12	
15		medium dense	8-7-9	16	
20	***Clay*** Light greenish gray, cemented.	hard	15-18-21	39	
25	***Clayey Sand*** Brownish yellow, fine grained, minor yellowish red mottling.	medium dense	12-8-7	15	50% LOC
30	***Limestone*** White, weathered.	very hard	50/4"	100+	
35	End of Boring	very hard	50/1"	100+	

Standard Penetration Test (blows/ft)



Notes: FEMA Flood Zone: X

50% loss of circulation at 28.0'
Borehole sealed/grouted

Water Table: 8.1' bls (Auger)
Ground Elevation: Existing
Drilled by: field technician
Compiled by: project geologist

Drill Method: Rotary
Sampling Method: Splitspoon ASTM D-1586 **(Safety Hammer)**

Sheet 1 of 1

REPORT OF
GEOTECHNICAL INVESTIGATION

Proposed

BRICKYARD COMMONS

1420 Brickyard Road
Palm Harbor, Pinellas County, Florida

Prepared for

Foundation Contractors

Prepared by

GEOTECHNICAL LABORATORY

(laboratory identity withheld - sample document)

Report No. GTR-25-0418
April 18, 2025

SAMPLE DOCUMENT - FOR DEMONSTRATION ONLY

An illustrative example of the geotechnical report RAMP Geo Technologies analyzes. NOT a real investigation: no borings were drilled and no site was visited. Project, address, client and laboratory are fictional. Carries no professional engineer seal or signature. Not for design, permitting, construction, or any other use.

TABLE OF CONTENTS

1.0 SUMMARY OF FINDINGS

The Geotechnical Laboratory has completed a subsurface exploration and geotechnical evaluation for the proposed Brickyard Commons development at 1420 Brickyard Road in Palm Harbor, Pinellas County, Florida. The site is shown on the Site Location Map and Boring Location Plan included in the appendices of this report.

The proposed development consists of a single-story commercial structure with an adjacent paved parking area. Based on information provided by the client, maximum design loads are assumed to be less than the following:

- Column load – 40 kips
- Continuous wall load – 4 kips per linear foot

The subsurface exploration included drilling two soil borings, performing standard penetration tests, and evaluating the geotechnical conditions relevant to the proposed construction. A summary of our findings follows.

Generalized subsurface conditions. Beneath a surficial concrete and limerock base, natural coastal plain deposits were encountered consisting of fine grained SAND (USCS: SP) underlain by CLAY (USCS: CL) with variable cementation, over weathered LIMESTONE. Borings were terminated at 30.0 and 35.0 feet below existing grade. SPT N-values ranged from 9 blows per foot to refusal (100+ blows per foot) within the cemented and limestone materials.

Groundwater. Groundwater was encountered at approximately 8.1 feet below existing grade in both borings at the time of drilling. Levels are expected to fluctuate seasonally and following significant periods of precipitation.

Foundations. The on-site soils are anticipated to be suitable for support of the proposed structure on a deep foundation system. Based on the cemented clay and limestone bearing materials encountered at depth, a helical pile foundation system is considered appropriate. Final pile type, size, configuration and installation depth should be determined by the helical pile designer.

Site geology and karst. The site lies within the Peninsular Coastal Lowlands of west-central Florida, underlain by the Floridan aquifer system and characterized as covered-karst terrain. No sinkholes are reported within the immediate area. Where site-specific sinkhole risk evaluation is required, a supplemental investigation including deeper borings and geophysical methods is recommended.

2.0 INTRODUCTION AND SCOPE

The purpose of this subsurface exploration and analysis was to ascertain the subsurface profile at the test locations; estimate the engineering characteristics of the foundation bearing materials; provide geotechnical criteria for use by the design engineers; document groundwater levels at the time of the investigation; and recommend additional investigation if necessary.

2.1 Field Exploration

The field exploration was conducted by means of two soil borings, identified as B-1 and B-3. Borings were advanced using rotary drilling techniques and were sealed and grouted upon completion. Standard penetration tests were performed in general accordance with ASTM D1586 (*Standard Test Method for Standard Penetration Test and Split-Barrel Sampling of Soils*) using a safety hammer. Test locations were established in the field using conventional taping procedures and are presumed accurate within several feet of the locations plotted on the plan.

Boring	Location	Final Depth (ft)	Groundwater (ft)
B-1	North / east portion of proposed structure	30.0	8.1
B-3	South / west portion of proposed structure	35.0	8.1

The N-value obtained from the standard penetration test can be correlated with the engineering behaviour of earthworks and foundations. Where the sampler advanced under the weight of the hammer alone, or where 50 blows were recorded over a partial increment, the condition is noted directly on the boring log rather than converted to an N-value.

2.2 Laboratory Testing

Recovered samples were visually classified in general accordance with ASTM D2488 (manual procedure). Classifications are used in conjunction with the field data to estimate the properties of the soil types encountered and to assess soil response under construction and service loads. No advanced laboratory testing was performed as part of this scope.

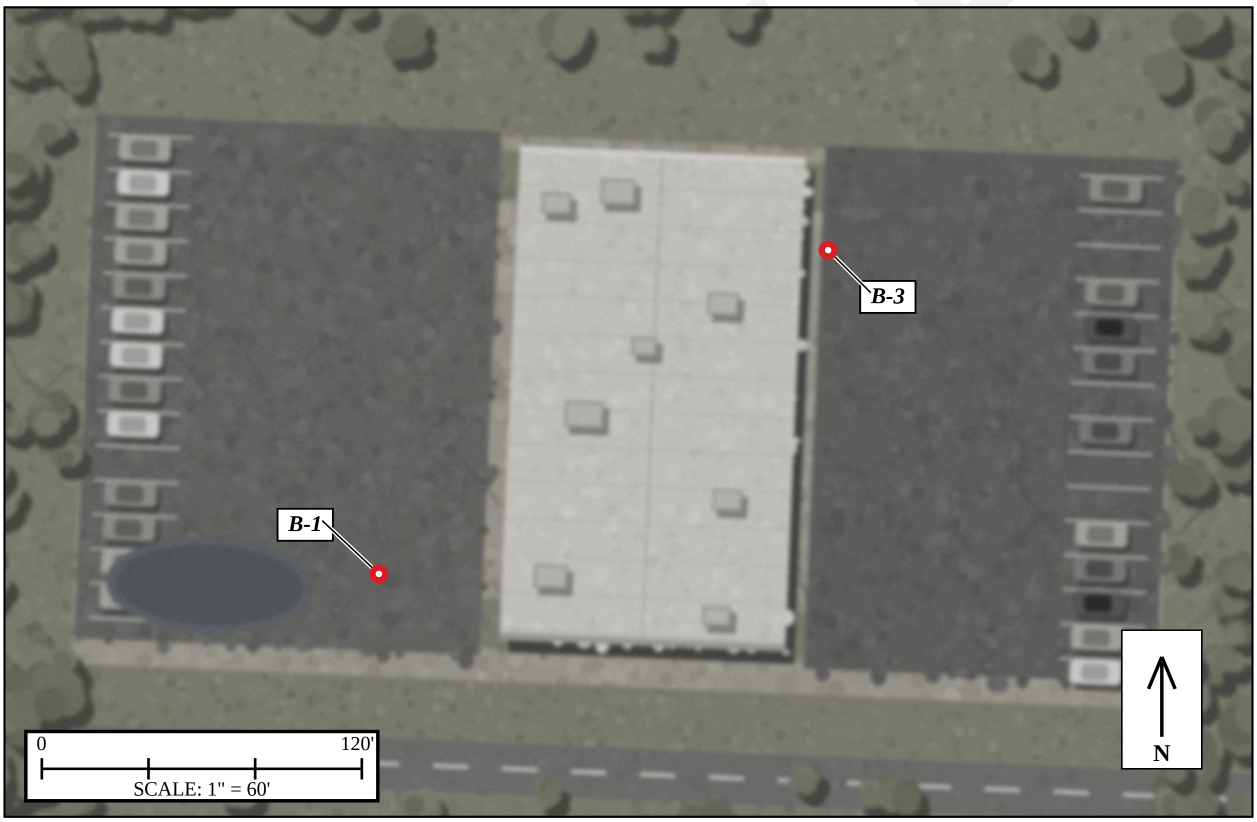
3.0 SITE DESCRIPTION

3.1 Location and Existing Conditions

The subject property is a level, previously developed parcel bounded by commercial development to the north and east, a public roadway to the south, and an existing access drive to the west. At the time of our investigation the site was covered by an existing concrete slab and limerock base course, remnants of prior development. Surface runoff generally follows existing topography toward a stormwater feature adjacent to the site.

3.2 Site Aerial and Boring Locations

The aerial below shows the site and the approximate locations of the test borings advanced for this study. Boring locations were established in the field by taping from existing site features and should be considered approximate.



Aerial base prepared for this sample document. Red symbols indicate approximate test boring locations. Not survey grade.

4.0 SUBSURFACE CONDITIONS

Details of the subsurface materials encountered are presented on the Records of Subsurface Exploration in the appendix. The subsurface conditions encountered in the soil borings consisted of the following generalized strata, in order of increasing depth. Stratum boundaries shown on the logs represent the approximate transition between soil types; in situ the transition may be gradual.

4.1 Generalized Soil Profile - Boring B-1

Depth (ft)	Material Description	Consistency / Density	N (bpf)
0.0 - 1.0	Concrete and limerock base	dense	-
1.0 - 14.0	SAND, fine grained, trace silt	medium dense to dense	11 - 30
14.0 - 19.0	CLAY, light greenish gray to yellowish brown	stiff	9
19.0 - 29.0	CLAY, light gray to yellow, CEMENTED	very hard	100+
29.0 - 30.0	LIMESTONE, white, weathered	very hard	100+

4.2 Generalized Soil Profile - Boring B-3

Depth (ft)	Material Description	Consistency / Density	N (bpf)
0.0 - 1.0	Concrete and limerock base	dense	-
1.0 - 20.0	SAND, fine grained, trace silt	medium dense	10 - 19
20.0 - 25.5	CLAY, light greenish gray, CEMENTED	hard	39
25.5 - 29.0	CLAYEY SAND, brownish yellow	medium dense	15
29.0 - 35.0	LIMESTONE, white, weathered	very hard	100+

4.3 Groundwater

Groundwater was encountered at approximately 8.1 feet below existing grade in both borings during drilling operations. Seasonal variation, tidal influence, precipitation and soil permeability will all influence actual groundwater levels. Groundwater elevations derived from sources other than seasonally observed monitoring wells may not be representative of true long-term levels. A loss of drilling fluid circulation was noted at approximately 28 feet in boring B-3; this observation is recorded on the log.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the subsurface conditions encountered, the proposed structure may be supported on a deep foundation system bearing within the cemented clay or weathered limestone materials encountered at depth. The recommendations presented herein are sufficient to support initial design and planning.

5.1 Deep Foundations - Helical Piles

Helical piles are considered a suitable deep foundation option for this site. The bearing materials below approximately 19 feet in boring B-1 and 20 feet in boring B-3 exhibit sufficient strength to develop meaningful helical bearing capacity. The following criteria should be observed:

- All helical bearing plates should be fully embedded within the cemented clay or limestone bearing stratum.
- Installation should be terminated on the basis of manufacturer-correlated installation torque for the selected pile type.
- Torque gauges on the installing equipment must be functional, recently calibrated and accurate.
- Piles should be installed plumb and in a smooth, continuous manner.
- Maximum installation torque should at no time exceed the manufacturer torsional rating of the pile shaft.
- Centre-to-centre spacing should be not less than three times the diameter of the largest helical plate to avoid group effects.

Termination torque. Termination torque depends on the manufacturer torque correlation factor (K_t) for the selected pile. The ultimate geotechnical resistance may be estimated as $Q_u = K_t \times T$, where T is installation torque. The final pile type, size, configuration, embedment depth and acceptance torque should be established by the helical pile designer using the subsurface data in this report.

Corrosion. Given the shallow groundwater and coastal setting, hot-dip galvanized coating is recommended for permanent helical elements. Site-specific soil corrosivity testing (resistivity, pH, chlorides, sulfates) was not performed as part of this scope and may be performed separately if requested.

Load testing. Where design capacities approach the limits of the empirical torque correlation, a site-specific load test program is recommended to verify capacity and to calibrate the torque correlation factor for these materials.

5.2 Supplemental Services

This investigation was completed during the initial design phase, and several assumptions regarding structural loads and finished elevations were necessary. The Geotechnical Laboratory should remain involved during final design to review final plans and loading conditions, and to confirm that the recommendations contained herein remain applicable.

6.0 GENERAL COMMENTS

Supplemental recommendations may be required upon finalization of construction plans or if significant changes are made in the characteristics or location of the proposed structure.

The recommendations presented herein should be utilized by a qualified engineer in preparing the project plans and specifications. These recommendations should be considered minimum physical standards that may be superseded by local and regional building codes and structural considerations.

The possibility exists that conditions between borings may differ from those encountered at the specific boring locations, and that conditions may not be as anticipated by the designers or contractors. The construction process may itself alter soil conditions. Deviations from the noted subsurface conditions encountered during construction should be brought to the attention of the geotechnical engineer.

The exploration and analysis of foundation conditions reported herein are presented to form a reasonable basis for foundation design. The recommendations submitted are based on the available soil information and the preliminary design details furnished or assumed.

ABOUT THIS SAMPLE DOCUMENT

This document was produced by RAMP Geo Technologies as an illustration of the type of geotechnical report our service analyzes. No site was visited, no borings were drilled, and no laboratory testing was performed. The project, address, client and laboratory are entirely fictional, and the document carries no professional engineer seal or signature.

It exists so prospective customers can see what a typical soil report looks like, and can follow how the data on these pages becomes the capacity tables and pile schedule in our sample helical report. It must not be used for design, permitting, construction, or any other purpose.

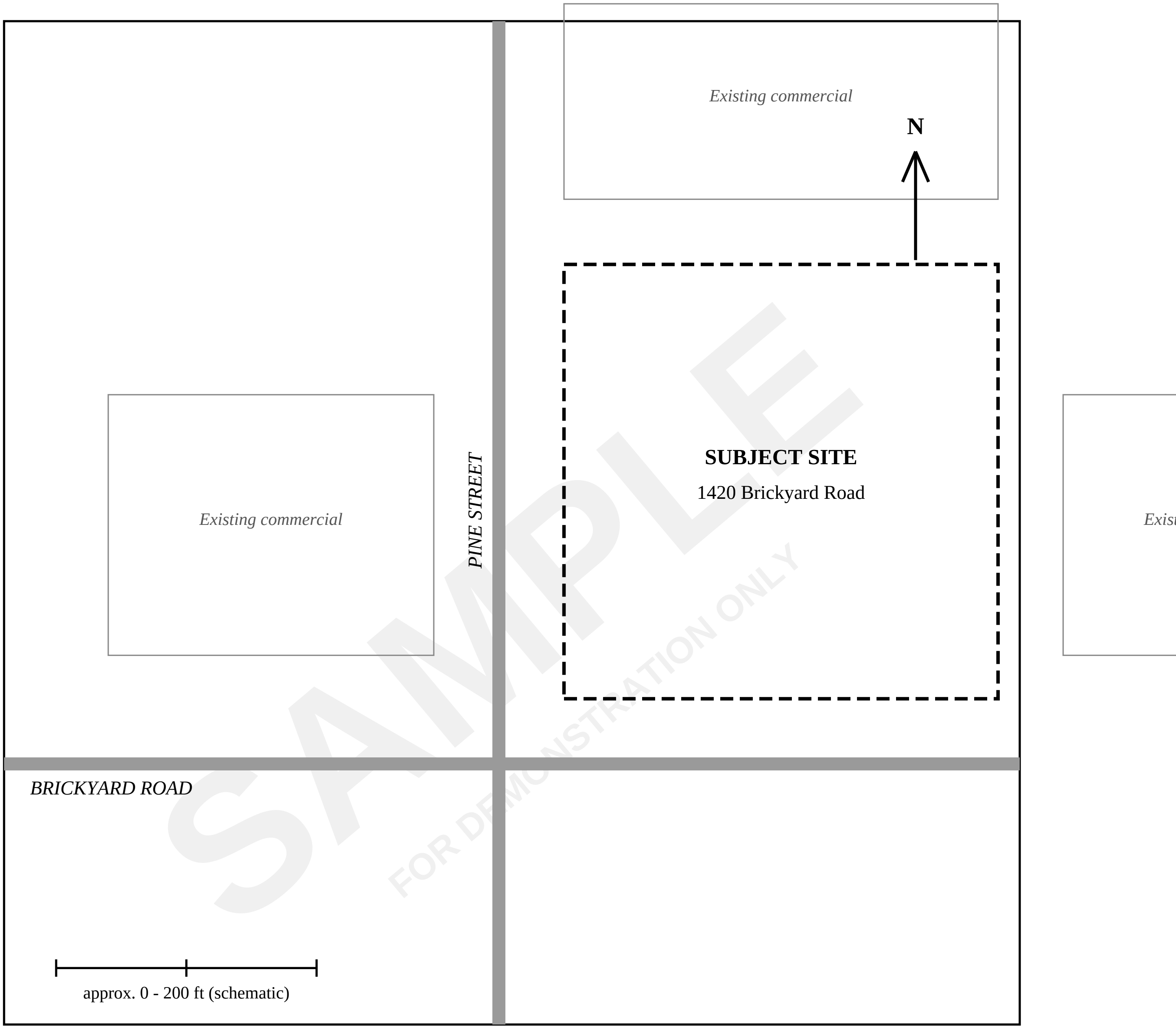
APPENDICES

Site Location Map

Boring Location Plan

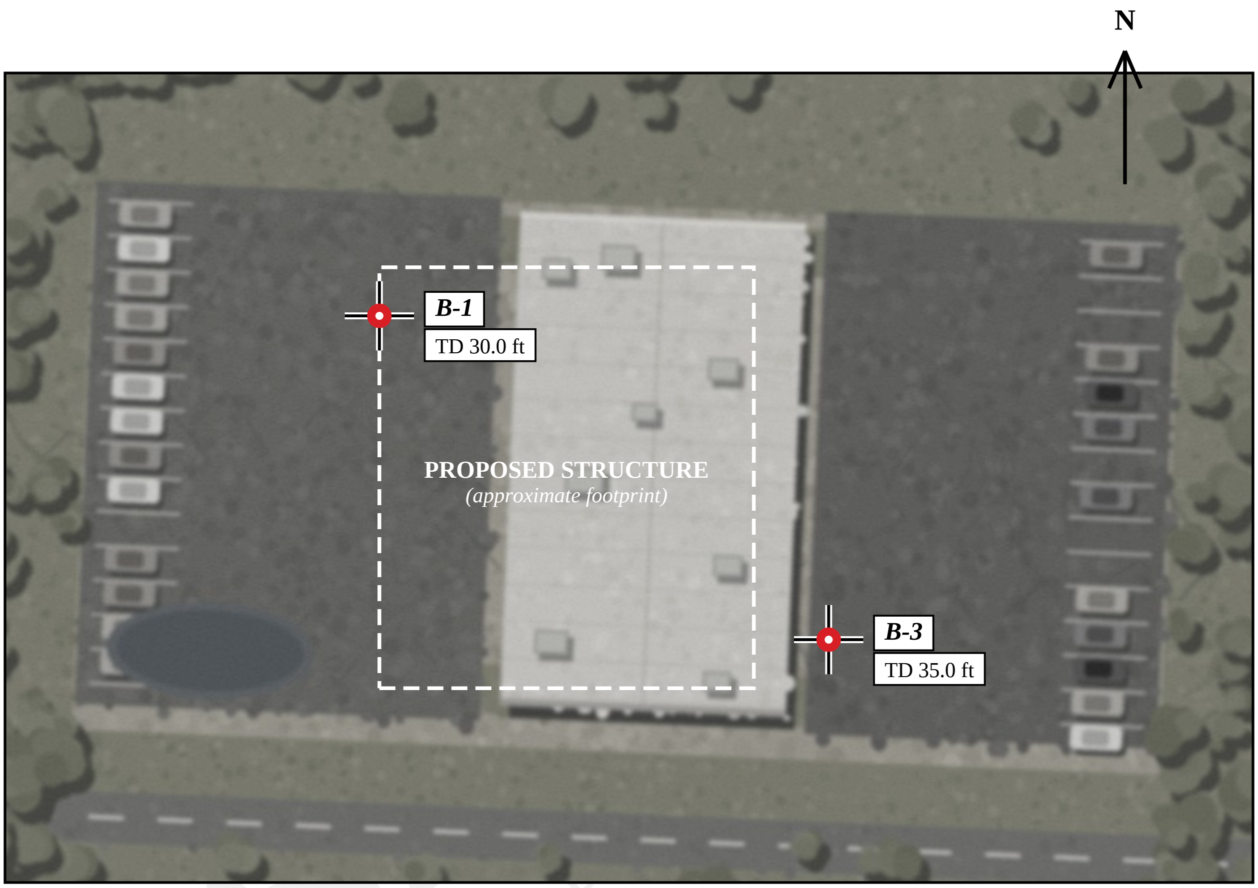
Records of Subsurface Exploration

SITE LOCATION MAP



Schematic vicinity map prepared for this sample document. Not to scale, not survey grade.

BORING LOCATION PLAN



LEGEND

Approximate boring location

TD = termination depth below existing grade

Aerial base prepared for this sample document. Boring locations are approximate, established by taping from existing features.

RECORD OF SUBSURFACE EXPLORATION - BORING B-1

GEOTECHNICAL LABORATORY

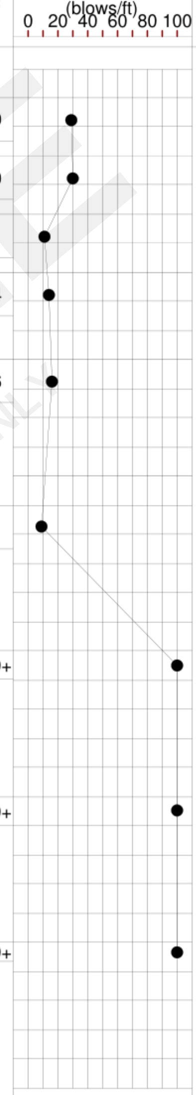
Client: Foundation Contractors
Project: Brickyard Commons
Location: Parcel: withheld (sample report)
City / State: Palm Harbor, Florida

Report No: GTR-25-0418
Log of Borehole: B-1
Date Drilled: 04/18/2025

SAMPLE REPORT - PROJECT AND LABORATORY IDENTIFIERS CHANGED

Depth	Subsurface Profile Description	Consistency	Blow Count	N value	Lab/ Notes
0	Ground Surface				
	Concrete and Limerock Base				
	Sand Grayish brown, fine grained.	medium dense	17-16-13	29	
	Sand Light brownish gray, fine grained, with shell fragments.	dense	6-15-15	30	
5	***Sand*** Dark grayish brown to brown, fine grained.	medium dense	4-5-6	11	
		medium dense	5-6-8	14	
10	***Sand*** Light yelllowish brown to pale brown, fine grained.	medium dense	5-7-9	16	
15	***Clay*** Light greenish gray to yellowish brown.	stiff	3-4-5	9	
20	***Clay*** Light gray to yellow, cemented.	very hard	39-50/5"	100+	
25	***Clay*** Light greenish gray to yellowish brown, cemented.	very hard	50-50/4"	100+	
	Limestone White, weathered.				
30	End of Boring	very hard	50/0"	100+	
35					

Standard Penetration Test (blows/ft)



Notes: FEMA Flood Zone: X

No loss of drill fluid circulation
Borehole sealed/grouted

Water Table: 8.1' bls (Auger)
Ground Elevation: Existing
Drilled by: field technician
Compiled by: project geologist

Drill Method: Rotary
Sampling Method: Splitspoon ASTM D-1586 **(Safety Hammer)**

Sheet 1 of 1

RECORD OF SUBSURFACE EXPLORATION - BORING B-3

GEOTECHNICAL LABORATORY

Client: Foundation Contractors
Project: Brickyard Commons
Location: Parcel: withheld (sample report)
City / State: Palm Harbor, Florida

Report No: GTR-25-0418
Log of Borehole: B-3
Date Drilled: 04/18/2025

SAMPLE REPORT - PROJECT AND LABORATORY IDENTIFIERS CHANGED

Depth	Subsurface Profile Description	Consistency	Blow Count	N value	Lab/ Notes
0	Ground Surface				
	Concrete and Limerock Base				
	Sand Gray, fine grained, minor shell fragments.	medium dense	6-9-10	19	
	Sand Grayish brown, fine grained.	medium dense	8-10-9	19	
5	***Sand*** Yellowish brown to light yellowish brown, fine grained.	medium dense	4-5-6	11	
		medium dense	4-5-5	10	
10	***Sand*** Light brownish gray to pale brown, fine grained.	medium dense	3-5-7	12	
15		medium dense	8-7-9	16	
20	***Clay*** Light greenish gray, cemented.	hard	15-18-21	39	
25	***Clayey Sand*** Brownish yellow, fine grained, minor yellowish red mottling.	medium dense	12-8-7	15	
					50% LOC
30	***Limestone*** White, weathered.	very hard	50/4"	100+	
35	End of Boring	very hard	50/1"	100+	

Standard Penetration Test (blows/ft): 0 20 40 60 80 100

Notes: FEMA Flood Zone: X
50% loss of circulation at 28.0'
Borehole sealed/grouted
Water Table: 8.1' bls (Auger)
Ground Elevation: Existing
Drilled by: field technician
Compiled by: project geologist

Drill Method: Rotary
Sampling Method: Splitspoon ASTM D-1586 **(Safety Hammer)**
Sheet 1 of 1