

Report LT-1

Static Load Testing at Highway 400-89

**Highway 400-89 Interchange Reconstruction
Site 30-256
MTO 2018-4019**

Prepared for

**Fermar Paving Limited
1921 Albion Road
Etobicoke, ON M9W 5S8**

Our File No. 1905CS1373

October 15, 2019

Prepared by:



Shawn Ferguson, P.Eng.

Distribution: 1 electronic copy to Fermar Paving Limited
1 electronic copy to Urkkada

Report LT-1

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Highway 400-89 Interchange Reconstruction

Site 30-256

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1. Terms of Reference

Urkkada has been retained by Fermar Paving Inc. (Fermar) to observe and document the static load tests performed at the Highway 400-89 Interchange. Mr. Charles Ezomo, Fermar, was the contact person and coordinated the activities during the load test.

The purpose of the static load testing was to investigate the axial resistances of a driven steel 310 x 110 H-pile. This report presents the results of the static load tests performed from October 7 – 8th, 2019 and October 9 – 10th, 2019. The static load tests were performed in general conformance with the contract documents and ASTM D1143, and as amended by Golder Associates (Golder) acting as the Foundation Engineering Specialist for the owner.

2. Test Pile

One 310x110 H-pile with a cross sectional area of 141.0 cm² was subjected to static load testing. Per Item 103, vibrating wire piezometers were installed around the test pile location.

The test pile was installed at a non-production location, as indicated on Contract Drawing 184 and Urkkada sheet L07-01 (copies enclosed in Appendix 1).

3. Pile Installation and Static Load Test Set-up

The test pile installation and set-up of the static load test frame was in general compliance with the piling subcontractor's submittal, included in Appendix 2.

Four reaction piles were installed as detailed in the piling subcontractor's submittal. The reaction piles consisted of a steel 310 x 110 H-pile, three driven to a tip depth of 36 m and the fourth to a tip depth of 43.25 m below grade.

Two linear displacement dial gauges for vertical movement and two linear displacement dial gauges for lateral movement (details provided in the piling subcontractor's submittal) were the primary instruments used to measure pile movements. A test pile wireline was also installed to provide backup measurements for the vertical movement. A sketch showing the location and numbering of the monitoring points and reaction piles is provided in Appendix 3.

The installation log for the test pile, prepared by Bare Eng. Ltd. is included in Appendix 4. Based on the installation log, the test pile was driven to a penetration resistance of 6 blows for 250 mm of movement at end of drive.

The results of the PDA testing, performed by Urkkada are included in Appendix 4.

4. Soils Information

Based on the boring logs provided in the contract documents, the soil profile at the test location is as follows:

1. Elev. 227.4 m to 226.7 m: Fill
2. Elev. 226.7 m to 209.6 m: Silty – Sandy Silt
3. Elev. 209.6 m to 208.9 m: Silty Clay
4. Elev. 208.9 m to 206.5 m: Silt and Sand
5. Elev. 206.5 m to 195.5 m: Clayey Silt – Silty Clay
6. Elev. 195.5 m to 189.0 m: Silt and Sandy Silt
7. Elev. 189.0 m to 182.9 m: Clayey Silt
8. Elev. 182.9 m: Clayey Silt Till

Copies of the logs from the two closest borings, 89UP-03 and 89UP-05, as taken from "*Foundation Investigation Report, Hill Embankment, Highway 400-89 Interchange Reconstruction, Town of Innisfil, Simcoe County*" prepared by Golder dated September 2018, are included in Appendix 5.

5. Calibration Records

The load cell used during the static loading test was calibrated on September 11, 2019 by Geokon. A copy of the calibration record is included in Appendix 6.

Powell's test pile submission package (enclosed in Appendix 2) contained a calibration record for the hydraulic jack / digital pressure gauge performed by Canadian BBR Inc. dated August 28, 2019. A copy of

this calibration record is included in Appendix 6.

A comparison of the load cell reading and hydraulic jack pressure produced a noticeable difference in stated applied load. Due to the uncertainty between the instruments, the load cell was used to determine the load applied to the pile during testing.

6. Static Load Test Results

The complete field readings for the static load tests are provided in Appendix 7. The enclosed tables provide the following information:

- ☐ Date and time of each reading
- ☐ Load cell reading
- ☐ Pressure gauge reading
- ☐ Readings from two vertical dial gauges mounted to the test pile
- ☐ Average vertical movement of the pile head based on the two dial gauges
- ☐ Readings from two lateral dial gauges mounted to the test pile
- ☐ Test pile wire line reading
- ☐ Test pile movement based on wire line
- ☐ Survey readings from the four reaction piles

Initially Load Test #1 proceeded to the 300 kN interval, however it was noted that the load cell readout was not operating as intended. The load was removed, the issue corrected then the test was restarted with a 250 kN load as shown in the logs.

At the 1050 kN load interval of Test #1, it became apparent that the pile would exceed the movement limit of 30 mm prior to reaching hold phase of the test. Per Golder's instruction, the test was modified to obtain a maximum loading without exceeding the movement limit, followed immediately by lowering the load to the first decrement interval.

At the 1300 kN load interval of Test #2, the pile was not capable of maintaining the load, and when it was apparent that the pile would exceed the movement limit of 60 mm, the test was amended to proceed directly to the first decrement interval.

The load movement data for Test #1 is presented in Figure 1 and the load movement data for Test #2 is presented in Figure 2, both placed in Appendix 8. The results are plotted as the applied load based on the load cell and the vertical movement based on the displacement dial gauges. The Davisson Offset based on the as-built pile dimensions (310x110 H-pile) are also plotted on Figures 1 and 2. A summary of Load – Movement data used to produce Figures 1 and 2 are provided in Tables 1 and 2 respectively, also placed in Appendix 8.

The combined load movement curves for both Test #1 and Test #2 are shown on Figure 3 in Appendix 8.

7. Static Load Test Photos

A selection of photos detailing the setup of the load test is provided in Appendix 9.

8. Conclusion

Based on the results of the static load test, the following comments can be made:

1. Using the Davisson Offset Load Limit criterion, the ultimate capacity of the pile is typically defined as the point where the load-movement curve crosses the Offset Load Limit Line (unless a specific movement criterion is specified, which has not been provided for this project). Based on the load-movement curves provided in Appendix 8, the ultimate capacity of the test pile using the Davisson Offset Load Limit Method was found to be 780 kN during Load Test #1 and 860 kN during Load Test #2.
2. A plunging failure was observed during Load Test #2. The pile was not capable of maintaining the 1,300 kN loading.

Appendix 1

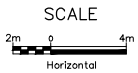
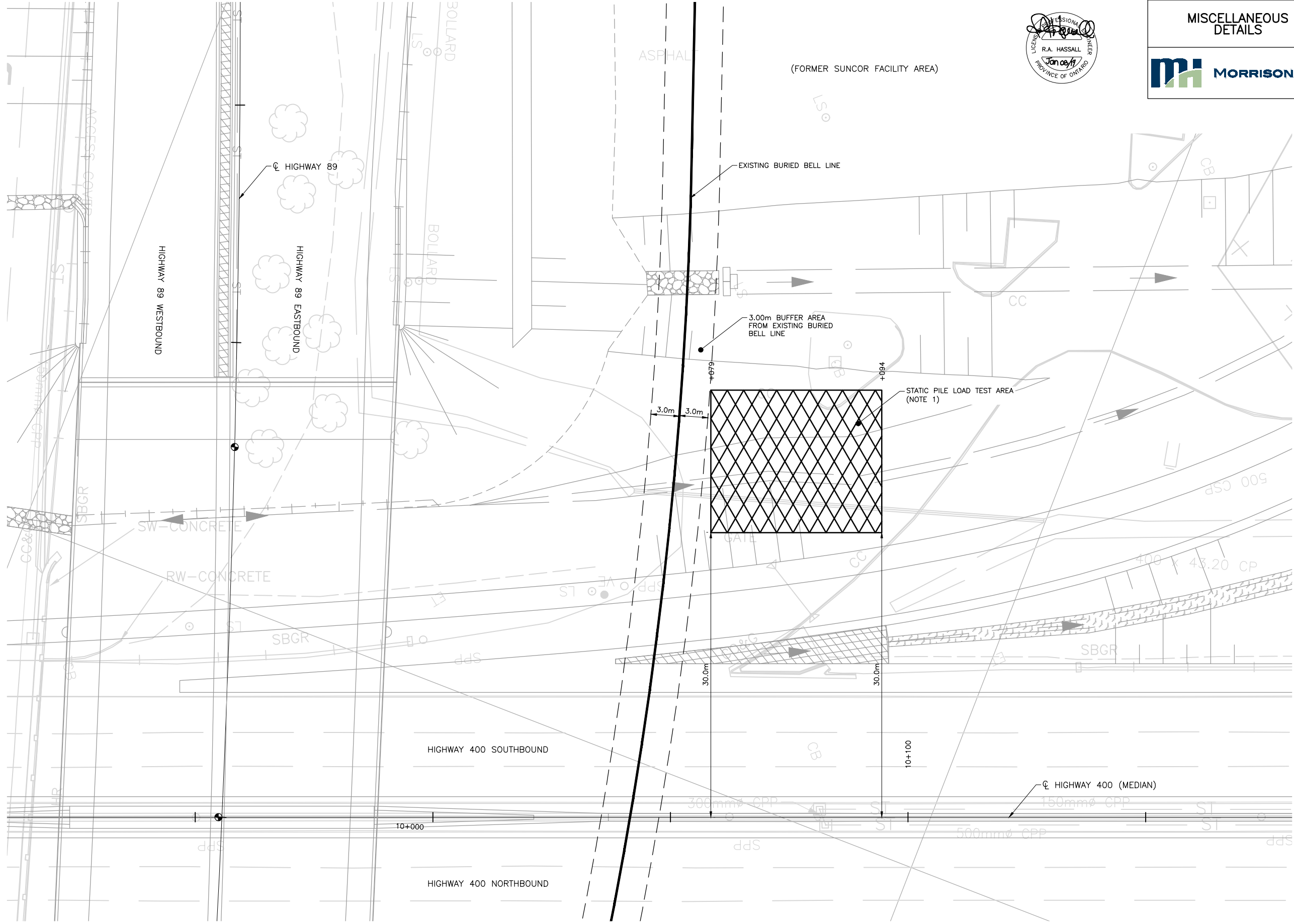
Contract Drawings 183 and Urkkada L07-015

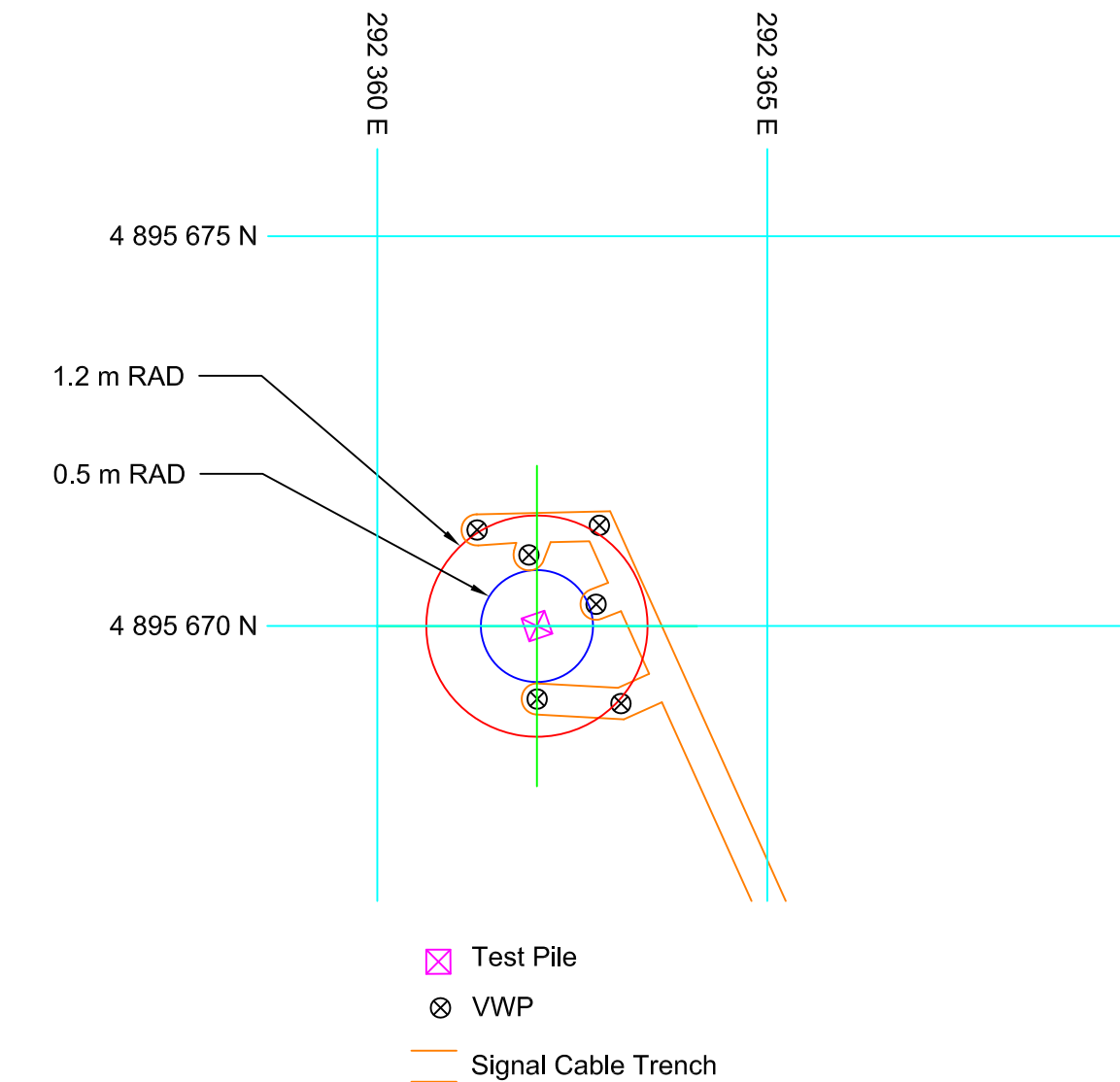
- NOTES:
1. STATIC PILE LOAD TEST TO BE COMPLETED AS DOCUMENTED ELSEWHERE IN THE CONTRACT DOCUMENTS.
 2. CONSTRUCTION INGRESS & EGRESS SHALL BE FROM HIGHWAY 89 AS SHOWN ELSEWHERE IN THE CONTRACT DRAWINGS.

METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN



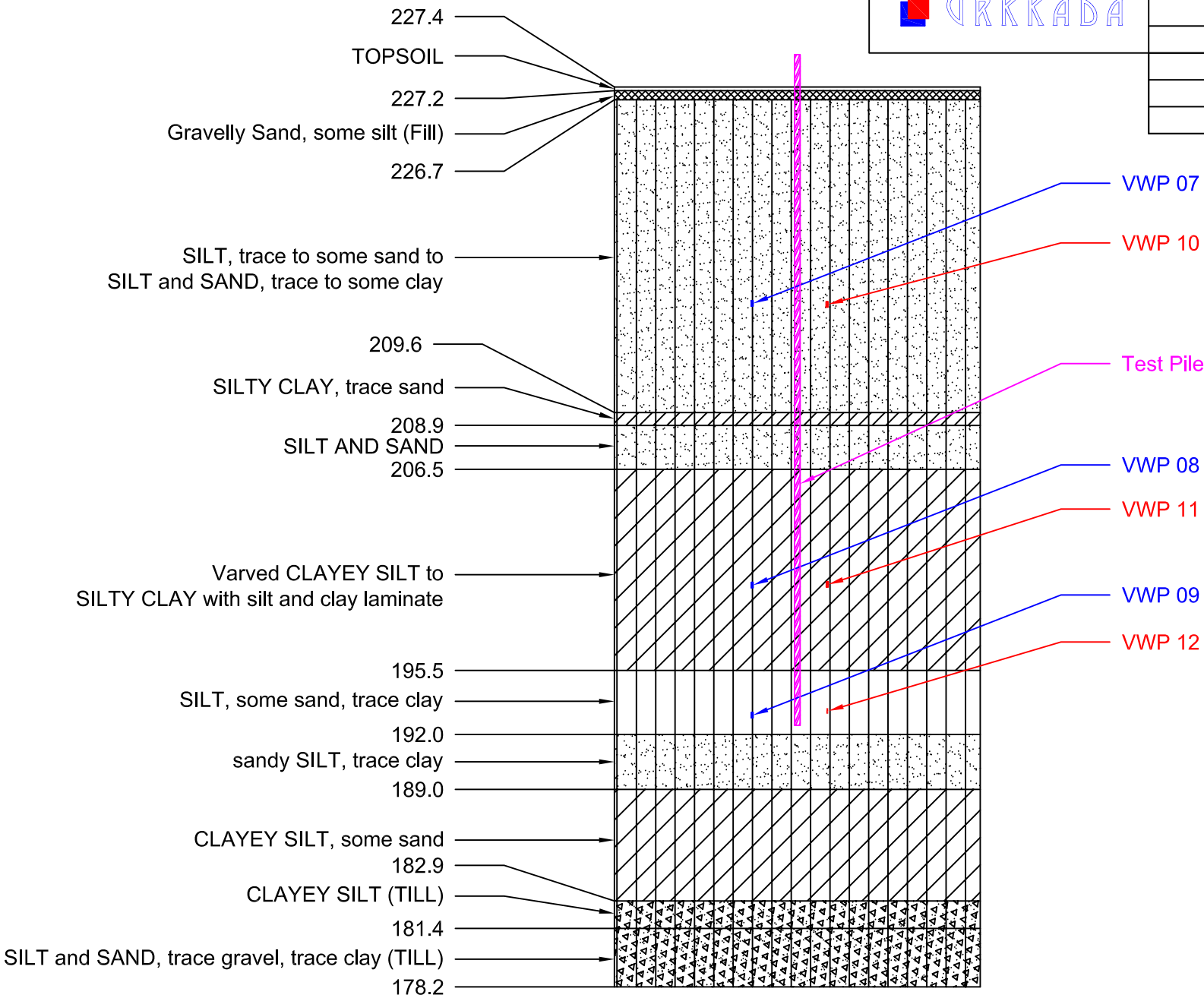
PLATE No		
CONT WP	2018-2024 2438-13-00	
MISCELLANEOUS DETAILS		SHEET 184-4





Test Pile Instrument Locations			
Item	Northing	Easting	Elevation
VWP 07	4 895 670.913	292 361.946	215.42
VWP 08	4 895 670.280	292 362.806	200.02
VWP 09	4 895 669.065	292 362.051	192.91
VWP 10	4 895 669.007	292 363.126	215.37
VWP 11	4 895 671.292	292 362.849	200.06
VWP 12	4 895 671.233	292 361.281	193.14

PLAN VIEW



NOTES:

1.) All soil profile details were obtained from borehole 89UP-03 performed by Golder Associates, included in the contract tender package

2.) VWP and test pile horizontal positions are shown for clarity only. Refer to Plan View for locations

PROFILE VIEW

Appendix 2

Fermar / Powell Submission

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CONTRACT SUBMISSION



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1.0 INTRODUCTION

This document describes the requirements to implement an axial pile load test program at the Highway 400 / 89 underpass site to investigate the axial resistances of driven steel piles proposed for the replacement bridge and to measure the gain in axial geotechnical resistance with time.

2.0 SCOPE

The proposed static pile load test program includes subjecting one test pile (HP310x110) to axial static compression in accordance with ASTM D1143M Procedure B and as amended in the testing procedure specified in this special provision. The static pile load tests shall be carried out on one test pile installed north of Highway 89 and west of Highway 400 as shown in the Contract Drawings.

Dynamic analysis using a Pile Driving Analyzer (PDA) is required on the test pile (HP310x110) on completion of initial driving and restrrike. The PDA testing procedure shall be as specified in Section 7.5.

The Contractor shall provide a qualified site superintendent throughout the access preparation, test pile installation and PDA tests, static pile load tests, and site decommissioning phase.

The Contractor shall retain a Contractor's Engineer to conduct the PDA testing and witness the execution of the static pile load testing.

Vibrating Wire Piezometers shall be installed at a distance of 0.5 m and 1.2 m from the test pile to monitor pore pressures. Details of the installation, monitoring and decommissioning are provided in Special Provision (Supply and Installation of Embankment Monitoring Equipment).

3.0 DEFINITIONS:

Contractor's Engineer (CE): An engineering firm that is registered with MTO RAQS in the Geotechnical (Structures and Embankments) specialty with a minimum of medium complexity. It is expected that the selected firm will have conducted at least three (3) static pile load tests within the last ten (10) years and that the firm has at least five (5) years of experience in conducting high strain dynamic (pile driving analyzer (PDA)) tests. The CE shall be retained by the Contractor to undertake the PDA tests and static pile load tests, and associated reporting as outlined herein.

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Foundation Engineering Specialist (FES): An engineering firm, retained by the Contract Administrator, that is registered with MTO RAQs in the Geotechnical – Structures and Embankments specialty with a minimum of high complexity. It is expected that the selected firm will have conducted at least three (3) static pile load tests within the last ten (10) years and that the firm has experience in conducting and analyzing high strain dynamic (PDA) tests. The FES shall ensure general conformance with the Contract Documents.

4.0 DESIGN AND SUBMISSION REQUIREMENTS

4.1 QUALIFICATIONS

The Piling contractor will be Powell Foundations and Urkkada Technology Limited will be the Contractor's CE/FES.

Powell Foundations

Powell Foundations helps general contractors, property owners and developers by designing and installing shoring, foundation and noise wall systems. With over 60 years of experience in delivering results on MTO, Metrolinx and private projects Powell Foundations offers total expertise for every type of shoring, foundation and noise wall project (***See company profile, experience & qualifications in Appendix 1).***

Urkkada Technology Limited

Urkkada is a geotechnical engineering firm, providing a wide range of services in the design, testing, and monitoring of structures and soils (***See company profile, experience & qualifications in Appendix 2).***

Some of the services offered include:

- Deep foundation design and review
- PDA, CAPWAP, WEAP and other pile testing
- Design, supply, installation, and monitoring of geotechnical instrumentation
- Value added engineering of foundation elements
- Design and quality verification engineering (QVE) of SoE, wick drains, and lightweight fills
- Ground improvement design and analysis
- Noise and vibration modeling
- Finite element analysis
- Failure investigations and stability analysis
- Expert witness testimony

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As per Pre-structural meeting of August 7th, 2019, the combined experience and qualifications of Powell Foundations and Urkkada Technology Limited meets the requirement of section 4.1 in addendum no.2 of the contract.

4.2 STATIC PILE LOAD TEST

a) **Access and Site Preparation Plan;** The proposed test pile location will be as shown in Drawing sheet 45-B and 184-4¹ within the existing paved section of MacDonald/Suncor Gas Station parking lot. Access to the static test pile area is via the existing E/W-S ramp which has a ramp gate to prevent unauthorised access from the public and personnel from tampering with the test pile installation and equipment.

b) H-Pile Installation Procedures; ***See appendix 4 Procedure for Installation of Driven H-Piles, Section 1 and 2.***

c) Reaction frame setup details for static pile load test; ***See attached Appendix 5.*** Including FES review letter and SRE design calculations.

d) Calibration certificates for all instruments; ***See attached Appendix 6*** for hydraulic jack calibration certificates. All hydraulic jack(s), pressure gauge(s), and pressure transducers have been calibrated to at least 120 per cent of the maximum testing load within six months of the tests.

e) Urkkada Technology Limited shall submit a test report to the CA as per ASTM D4945 within forty-eight (48) hours of the completion of the PDA tests. The report shall be signed and stamped by a qualified licensed professional engineer in the Province of Ontario.

f) Urkkada Technology Limited shall submit a test report to the CA as per the ASTM D1143M within forty-eight (48) hours of the completion of the static pile load tests. The report shall be signed and stamped by a qualified licensed professional engineer in the Province of Ontario.

5.0 MATERIALS – NOT USED

6.0 EQUIPMENT (SEE ATTACHED APPENDIX 7)

6.1 Piling Rig

Soilmec SC-90 HD – Heavy Duty Crawler Crane.

Soilmec SC-90 HD Pile Driving Lead System.

¹ Drawing 45-B and 184-4 – Appendix 3

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6.2 Piling Hammer

Hammers shall be capable of installing the piles, casings, and liners to the depth or resistance specified in the Contract Documents, without damage to the portions that are not cut off.

Powell Foundations will be using B32 #24 Hammer;

B32 SINGLE ACTING DIESEL HAMMER SPECIFICATIONS

Total Weight 7 448kg/16 420 lb

Ram Weight 3 198kg/7 050 lb

Rated Stroke 3.5m/11.5 ft

Frequency 35–56 BPM

Fuel Capacity 72L/19 gal(US)

Oil Capacity 25L/6.5 gal(US)

Max. Kinetic Energy 109.9kJ/50 040ft-lb

Max. Rated Energy 67.8kJ/81 080ft-lb

7.0 CONSTRUCTION

7.3 SITE PREPARATION

The area is free of any vegetation and grading is not required as the area is flat, level and stable for the installation of the test pile, reaction piles and loading frames, testing equipment and instrumentation required for testing.

As stated in section 4.2(a), additional fencing using snow fence will be installed around the static test pile area to protect the public and construction personnel from hazards attributed to static pile test operations, until the piles are abandoned or removed.

In addition, the test pile location has existing drainage in the form of ditches. It is a dry working area and outside the existing roadway.

All utility locates and any necessary permits has been obtained by both Fermar Paving Limited and {Powell Foundations prior to commencement of any site work for the test pile installation and static pile load tests.

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7.3.1 Vibrating wire Piezometers (VWP)

Nine (9) vibrating wire piezometers (VWP) were installed; three (3) at the west abutment location, and six (6) at the test pile area. VWPs were installed in accordance with the installation details in Item No. 103 of the Contract Specification - Addendum 3, Sheets 215-1 thru 215-4 of the Contract Drawings, and per the manufacturer's recommendations. VWP signal cables were extended to datalogging equipment, placed in a Monitoring Enclosure. Installation logs and calibrating records for the VWPs are provided in **Appendix 8**.

The following equipment was used for the installation:

Manufacturer	Product Name	Product Type	Description
Slope Indicator	Standard VW Piezometer	Model 52611020, 3.5 bar Piezometer	Piezometer with 4-wire signal cable

Completion of Installation of VWPs

Per Item 103, Section 7.3.4 of the contract specifications, stabilization of the VWPs is deemed to have occurred:

- a) When no change in the measured value has occurred over a period of five (5) consecutive days and the measured value is within 10 percent of the anticipated hydrostatic value; and,
- b) When the daily rate of change is less than four (4) kPa per day for three (3) consecutive days and the measured value is within 5 percent of the anticipated hydrostatic value.

Urkkada recorded the VWP readings until July 12, 2019.

7.4 PILE INSTALLATION

The piles shall be reinforced at the tip with standard bearing points to reduce the potential for damage to the pile during driving.

A test pile (HP310x110 driven to an approximate tip elevation of 192.5 m) and all required reaction piles/anchors shall be installed within the prepared area west of Highway 400 and north of Highway 89. The Contractor shall ensure that the pile driving hammer is adequately warmed up before striking or re-striking the test pile to conduct the PDA testing. The piles shall be cut to an appropriate level for testing.

The CE and FES will be on site during installation of the test pile and reaction system. The CE shall provide installation records for the test pile, including blow counts and final installation depths, within 24 hours of installation.

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7.5 PILE DRIVING ANALYZER (PDA) TESTING

7.5.1 General

Pile Driving Analyzer (PDA) tests will be carried out on the test pile as per ASTM D4945 by Urkkada Technology Limited, the CE.

There will be two PDA tests required on the test pile:

- During the final 2 m depth of initial driving of the test pile; and
- During restrike, a minimum of 48 hours after completion of initial driving.

Powell Foundations shall prepare the pile top as necessary to mount the pile driving hammer on the pile and hitting the pile with the hammer. The CE shall install PDA gauges (strain transducers and accelerometers) connected to monitoring stations by means of cables. Where required, the Contractor shall assist the CE personnel in the installation of the transducers and accelerometers.

Adequate clearance and pile stickup shall be provided to allow the PDA gauges to be installed at a distance of 2.5 times the pile diameter below the top of the pile, and to allow sufficient clearance between the gauges and the ground.

Before commencement of pile driving, the CE shall verify that all transducers and accelerometers are functioning. The Contractor shall ensure necessary protection to avoid damage to the gauges, transducers, cables and PDA testing equipment.

The CE shall submit a test report to the CA as per ASTM D4945 within forty-eight (48) hours of the completion of the PDA tests. The report shall be signed and stamped by a qualified licensed professional engineer in the Province of Ontario.

7.5.2 Notice

The FES will be on site to witness the PDA testing.

The Contractor shall coordinate with the FES and provide access to the FES during the PDA testing. The Contractor shall notify the CA and FES a minimum of seven (7) days before each PDA test.

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7.6 STATIC PILE TEST

Urkkada Technology Limited will be the FES performing the static pile test.

Static pile load tests will be performed as per ASTM D1143M Procedure B. Two static pile load tests shall be performed on the test pile:

- one at a minimum of two (2) weeks after installation of the test pile and reaction system to 120% of the factored design load for the centre pier ($120\% \times 1,150 \text{ kN} = 1,380 \text{ kN}$); and
- the second at seven (7) weeks after test pile installation to 120% of the ultimate (unfactored) load ($120\% \times 3,125 \text{ kN} = 3,750 \text{ kN}$), or to failure, whichever occurs first.

The FES will be on site to witness the static pile load tests. The Contractor shall coordinate with the FES and provide access to the FES for the static pile load tests.

The CE shall submit a test report to the CA as per the ASTM D1143M within forty-eight (48) hours of the completion of the static pile load tests. An interim report as per the ASTM D1143M is required following the first pile load test, and a full report as per the ASTM D1143M is required following completion of the second pile load test.

The reports shall be signed and sealed by a qualified licensed professional engineer in the Province of Ontario.

All hydraulic jack(s), pressure gauge(s), and pressure transducers must have been calibrated to at least 120 per cent of the maximum testing load within six months of the tests. The calibration documentation shall be included as a part of the final report and shall be provided to the CA and FES prior to testing.

In addition, the following shall be provided by Fermar Paving Limited;

- A suitable enclosure over the test platform to ensure weather protection
- power source for conducting the tests.
- Access to the test platform.
- Adequate lighting.
- Qualified personnel during the full duration leading up to, during and to the completion of the 24-hour static pile load test.

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7.6.2 Load Test Frame

An anchored reaction frame shall be assembled as per Figure 1 of ASTM D1143M.

An alternative reaction frame setup may be proposed by the Contractor for consideration by the CA and FES. The number and locations of reaction piles/anchors and reaction frame assembly shall be as per Contractor's design approved by the CA, FES and MTO Design Team and shall require the seal and approval of the CE and a qualified structural engineer registered in Ontario.

The reaction frame shall be designed to withstand 120 per cent of the maximum load at seven (7) weeks (i.e. $120\% \times 3,750 = 4,500$ kN).

The displacement measurement apparatus shall have an accuracy as per ASTM D1143M.

7.6.3 Notice

Notification shall be given to the CA and FES a minimum of seven (7) days before testing.

7.6.4 Test Procedure

Test procedure for static pile load tests shall be in accordance with ASTM D1143M Procedure B and the following;

- a) The Contractor shall allow a minimum three (3) 24-hr shifts to complete the tests.

The maximum axial compressive load to be applied to the test pile is anticipated to be 1,380 kN for the first pile load test at two (2) weeks following test pile installation, and 3,750 kN or until total axial movement reaches 10 per cent of pile width (specified movement) for the second pile load test at seven (7) weeks after pile installation.

- b) The sensitivity of Contractor's loading system and load cell shall consider these load application requirements.
- c) The tests shall be conducted by incrementally loading or unloading until the pile reaches the specified load or movement/failure. Load shall be applied in maximum increments of 150 kN and 325 kN at two (2) weeks and at seven (7) weeks during loading and in decrements of 25 per cent of maximum applied load during unloading, respectively.
- d) Contractor shall record test readings before and after the application of each load increment or decrement.

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- e) During each load increment, readings shall be taken 5, 10 and 20 minutes after the application of the load increment, and every 20 minutes thereafter as needed. If the pile fails, readings shall be recorded immediately before removing the first load decrement.
- f) Maintain each load increment until the rate of axial movement does not exceed 0.25 mm per hour, with a maximum duration of 2 hours (specified movement). If the pile reaches the specified movement or fails, readings shall be taken immediately before removing the first load decrement.
- g) After applying the maximum load, provided that the test pile has not reached the specified movement or failed, readings shall be taken at 5, 10, and 20 minutes, then every 20 minutes up to 2 hours, then every hour. If the test pile reaches the specified movement or fails, readings shall be taken immediately before removing the first load decrement.
- h) Unloading shall begin after applying the maximum load and reaching an overall test duration of 24 hours. If the pile fails during loading, maintain the failure load until the specified movement is reached.
- i) After completing the final load increment, remove the loading in decrements of 25 per cent of the maximum test load with 1 hour between decrements. Record readings taken at time intervals of 20 minutes (i.e. three readings per decrement). Record a final reading 12 hours after removing all load.

7.7 SITE ABANDONMENT

Upon completion of the static pile load test program, the test pile and reaction piles/anchors shall be cut off at a minimum depth of 1.5 m below ground surface, and their presence documented on as-built records for the replacement bridge. Contractor shall remove the reaction frame and associated testing materials, and leave the site in a clean, safe and orderly fashion.

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APPENDIX

- 1. POWELL FOUNDATIONS COMPANY PROFILE, EXPERIENCE & QUALIFICATIONS**
- 2. URKKADA TECHNOLOGY LIMITED COMPANY PROFILE, EXPERIENCE & QUALIFICATIONS**
- 3. STATIC PILE LOAD TEST LOCATION AS PER DRAWING NO 45-B AND 184-4**
- 4. PROCEDURE FOR THE INSTALLATION OF DRIVEN H-PILES AND SPICING**
- 5. REACTION FRAME SETUP DETAILS FOR STATIC PILE LOAD TEST AND DESIGN CALCULATIONS**
- 6. CALIBRATION CERTIFICATE FOR HYDRAULIC JACK**
- 7. PILING EQUIPMENT DATA SHEET/TECHNICAL SPECIFICATIONS**
- 8. VIBRATION WIRE PIEZOMETERS AS BUILT RECORDS**



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SOLUTIONS

For Developers

Powell Foundations provides solutions to strengthen soils, control water, retain material, control noise/sound, provide privacy and designs and builds support structures. We operate as a single point of contact and handle every aspect of the shoring and foundation project.

For General Contractors

Powell Foundations helps general contractors, property owners and developers by designing and installing shoring, foundation and noisewall systems. With over 60 years of experience in delivering results on MTO, Metrolinx and private projects Powell Foundations offers total expertise for every type of shoring, foundation and noisewall project – when you choose Powell, your project gets done on schedule as planned.

BENEFITS

**Powell Foundations is an
asset to you beyond shoring
and foundation services**

Clear Communication:

We give you absolute transparency throughout the project including progress, scheduling and challenges that arise. We are here to make your life easier... and clear, consistent communication is key.

Prioritize Safety:

Our top priority is making sure our team (and yours) arrives home safe every night. We go beyond government requirements to make sure our people use safety best-practices on the job site at all times.

Quality & Flexibility:

Our policy is to constantly improve processes, build in quality and offer flexibility in our approach. Our people have been hired for reasons beyond core skills – we identify free thinkers and problem-solvers. Powell Foundations is here to make your project a success, whatever it takes.

Operational Excellence:

Our people show up ready to work, with the right resources in the right condition to execute our plan. You can count on Powell Foundations to respect your time and treat your project with the respect it deserves.

SERVICES

Caissons

Sign Footings

Sheet Piling

Shoring

Micropiling/Piling

**Noisewalls/
Sound Barriers**

CONTACT

MTO 2018-2024

Hwy400/89 Interchange
COOKSTOWNE, ON
JULY 2019



Piling Superintendent: Ross Fernie

Powell Foundations, Piling superintendent: 3 years
Kiewit Energy Canada, Piling Superintendent: 6 years
James Donn Piling, Piling Superintendent: 9 years

Piling Foreman: Drew Paterson

Birmingham, Piling Foreman / Crane Operator 2 years
Kiewit Energy Canada, Piling Foeman / Crane Foreman 2.5 years
Pacer Foundations, Piling Foreman 1.5 years
Deep Foundations, Piling Crane Operator / Front End Man 6 years

Piling Crane Operator: Steve Miller

Powell Foundations, Piling Crane Operator 2 years
Kiewit Energy Canada, Piling Crane Operator 2 years
Ranking Construction, Piling Operator 35 years

Piling Crane Operator: Kory Brown

Powell Foundations, Piling Crane Operator 2 years
Deep Foundations, Piling Crane Operator 2 years

Piling Crane Operator: Tom Fernie

Powell Foundations, Piling Crane Operator 3 months
Birmingham, Piling Crane Operator 4 years
Kiewit Energy Canada, Piling C

Powell Foundations Inc.
180 Ram Forest Rd. Stouffville ON L4A 2G8
Phone: 226-706-8380
Email: info@powellfoundations.ca

MTO 2018-2024

Hwy400/89 Interchange
COOKSTOWNE, ON
JULY 2019



Static Load Pile Testing Specific Experience

Piling Superintendent: Ross Fernie

Project: Barrie Water Treatment Plant
Company: James Donn Piling
Role: Piling Superintendent
Scope: 7 Static Load Pile Tests

Piling Foreman: Drew Paterson

Project: Schomberg Wastewater Treatment Center
Company: Deep Foundations
Role: Piling Crane Operator / Frontend Man
Scope: 1 Static Load Pile Test

Project: Ajax City Bus Garage Expansion
Company: Deep Foundations
Role: Piling Crane Operator / Frontend Man
Scope: 1 Static Pile Load Test

Powell Foundations Inc.
180 Ram Forest Rd. Stouffville ON L4A 2G8
Phone: 226-706-8380
Email: [info@powellf](mailto:info@powellf.com)

June 25, 2019
1373-CEzomo-L03.pdf

Fermar Paving Limited
1921 Albion Road
Rexdale ON M9W 5S8

Attention: Mr. Charles Ezomo, Senior Project Manager

Subject: MTO 2018-2024, Cookstown, ON
Our File 1905CS1373

Dear Charles,

Further to your request, this letter is to confirm that Urkkada Technology Ltd. meets requirements to perform the Contractor's Engineer's duties as specified in the Contract documents.

Urkada is registered with MTO RAQS in the Geotechnical (Structures and Embankments) specialty with a Medium Complexity rating. We have supervised static loading tests at multiple projects over the last 25 years, including the Hunt Club Road Extension, City of Ottawa Contract ISB09-5133 (4 static load tests), and the Replacement of the Bronx Approach of the Bronx-Whitestone Bridge in New York (4 static load tests). In addition, Urkkada has performed high strain dynamic testing for over 500 projects worldwide. A copy of our partial project list is included in Appendix I.

Samples of our Pile Driving Logs, and Static Load Test logs are provided in Appendix II.

We hope that this information is sufficient to address your needs and please contact us should you have any questions or need any additional information.

Best regards,



Shawn Ferguson, P.Eng.
Urkada Technology Ltd.

Appendix I

Urkkada Project List

List of Projects

- PR-53 Bridge, Ceiba-Naguabo, PR
- Container Wharf, Port of Los Angeles, CA
- St. Esprit Embankment, Québec
- Cambalache Power Plant - Initial Phase, Arecibo, PR
- Wellington Marine Terminal, Hamilton, ON
- CFB Halifax Dockyard, Halifax, NS
- Ironde Quoit Creek Bridge, Monroe County, NY
- Trois- Rivières Port, Trois-Rivières, QC
- South Keys Station, Ottawa, ON
- Olmsted Lock, Olmsted, IL
- Nelson Street Bridge, Wallaceburg, ON
- Blue Water Bridge, Sarnia, ON
- Western Plaza, Mayaguez, PR
- Cambalache Power Plant - Phase 1, 2 and 3, Arecibo, PR.
- Golf Piers, Chelsea Piers, NY
- McClean Lake Mine, McClean Lake, SK
- Lac St. Pierre, Yamachiche Area, QC
- Lynwood Village, Nepean, ON
- VA Medical Centre, San Juan, PR
- PTH#83 Bridge over Assiniboine River, MB
- San Juan Landfill, San Juan, PR
- Land Reclamation - Hong Kong
- Puerto Nuevo Bridge, San Juan, PR
- Leon's Facility, Ottawa, ON
- White River Bridge, YT
- MCIA Retention Pond, Gloucester, ON
- Wheat and Corn Mill, Guayanabos, PR
- QIT Plant, Tracy, QC
- Alfaro's Peak, Manila, Philippines
- 1561 Booth Ave., Coquitlam, BC
- Park Nicolet Medical Complex, St. Louis Park, MN
- San Francisco Airport, San Francisco, CA
- Oba Lake Hoodoo Bridge, Oba Lake, ON
- Deltaport Extension, Delta, BC
- Grain Elevator, Gilbert Plains, MB
- OPP Tower, North Bay, ON
- Centerm Improvement - Ballantyne Pier, Vancouver, BC
- MTO 96-59 - HWY 416 and County Road 19 Overpass, ON
- Wisconsin Central Railroad, Lublin, WI
- Pacific Coast Terminal, Vancouver, BC
- JFK International Air Terminal - Part 1, Jamaica, NY
- Glenview Veterans Rehousing, Westminster, B. C.
- Route 19 & Hwy 416, Drillco
- Montreal River Bridge, Elk Lake, ON
- Wilkes Avenue Reservoir, Winnipeg, MB
- Letellier Grain Elevator, Letellier, MB
- Ste-Anne Bridge, Hawkesbury, ON
- KNOE-TV Tower, Monroe, LA
- Lac St. Pierre Islands, Yamachiche Area, QC
- Quisibis River Bridge, St. Leonard, NB
- Mosquito Creek Bridge, North Vancouver, BC
- Primrose Steam Environment, Cold Lake, AB
- Calgary International Airport, Calgary, AB
- My Thuan Bridge , Vietnam
- Maple Ridge Ice Arena, Maple Ridge Fairgrounds, BC
- SPT Measurements for 16th Avenue, Markham, ON
- Corner Brook Pulp and Paper Mill Ltd., Cornerbrook, NF
- JFK Airport Terminal 4 Redevelopment, Jamaica, NY
- Bridge 0.52 - Moose Jaw Yard, Moose Jaw, SK
- SR-26 Riverdale Road Bridge Replacement, Weber County, UT
- Quayside Neighbourhood Development, Vancouver, BC
- Goose Creek Bridge, Long Island, NY
- Famous Players Multiplex, Coquitlam, BC
- Soilex Expander Analysis at Sea Island, Richmond, BC
- Canwest Ltd. Property, Surrey, BC
- AGT Station N.E. Terminal Building Expansion, Orlando, FL
- Trans Canada HWY 1 over South Brook Bridge, NF
- Richview Golf Course, Richmond, BC
- Pacific Place Area 4DE, Vancouver, BC
- Amoco Canada Petroleum Empress Plant Phase 5 Expansion, AB
- PanCanadian Empress Plant (Delta Hudson), AB
- PanCanadian Petroleum Empress Ethane Recovery, AB
- Ford Dearborn Stamping Plant, Dearborn, MI
- 388 Bloor Street Building, Toronto, ON
- Torah Substation Mile 282.56 Bridge Replacement, Lacrosse, WI
- St. John River Bridge, Coytown, NB
- QLT Inc., Vancouver, BC
- Basic Technologies, Welland, ON
- Bayshore Shoreline Development, Vancouver, BC
- CFB Petawawa Community Center, Petawawa, ON
- L.B. Building Power Station, Ottawa, ON
- Canadian Pacific Rail Bridge 109.51, Swift Current, SK
- Port of Melbourne, Australia
- JFK Airport Terminal 4, Jamaica, NY
- Pacific Place Area 4DE, Vancouver, BC
- Bank Street / Hunt Club Development, Ottawa, ON
- Hugh Keenleyside Dam, Castlegar, BC
- Air Liquide Plant, Fort Saskatchewan, AB

- Pacific Place Area 4FG, Vancouver, BC
- Lafarge Cement, Richmond, BC
- Westminster Quay, New Westminster, BC
- Michigan State University, East Lansing, MI
- Amoco Primrose, Cold Lake, AB
- Trans Canada HWY 1 over Southwest Brook Bridge, NF
- Island Cogeneration Facility, Campbell River, BC
- Skeena River Bridge, Terrace, BC
- Forhan Street Bridge over Running Creek, Wallaceburg, ON
- Neptune Terminal Berth 3, North Vancouver, BC
- Orlando Airport, Orlando, FL
- Century Tel Midwestern Headquarters, Lacross, WI
- Corner Brook Pulp and Paper Mill Ltd. St. John's, NF
- John Hart Bridge, Prince George, BC
- Pacific Coast Terminal, Port Moody, BC
- Walgreens Distribution Center, Carolina, PR
- Airport Connector, Richmond, BC
- Connaught Rifle Range, Ottawa, ON
- Strathcona Transit Station, Sherwood Park, AB
- MTO 2000-0008 Mississippi River Bridge on HWY417, Arnprior, ON
- US95 Sandpoint, Sandpoint, ID
- St. John's Wharf, St. John's, NF
- Sechelt Deep Sea Berth and Shiploader, Sechelt, BC
- Southside Marine Base Training Facility, Memorial University, St. John's, NF
- Hazeldean Pumping Station, Kanata, ON
- Canada Place, Vancouver, BC
- JFK Light Rail, Jamaica, NY
- Victoria Memorial Museum, Ottawa, ON
- IBM Canada Ltd. Plant, Markham, ON
- New Jersey PDA Review, Newark, NJ
- Load Cell for Garden River Contractors, Sault Ste. Maitre, ON
- Bonita Bay, FL, Dennis O'Meara
- IKEA Store, Coquitlam, BC
- Ford Dearborn Stamping Plant, Dearborn, MI
- Volvo Dealership, North Vancouver, BC
- NAIT ICT Centre, Edmonton, AB
- Great Canadian Casino, Coquitlam, BC
- Ochre River Bridge, Mackenzie Valley Winter Road, NT
- Russ Baker Overpass Airport Connector, Richmond, BC
- NY Power Authority, Brooklyn, NY
- American Airlines Terminal, JFK Airport, NY
- Domtar Mill, Chapleau, ON
- Miami International Airport, Miami, FL
- HWY 50 Bridge over CN Rail Line, Buckingham, QC
- Ottawa International Airport, Ottawa, ON
- Vanterm Berth Extension, Vancouver, BC
- Bell Island Ferry Terminal, Bell Island, NF
- Po River Bridge, Piacenza, Italy
- Law Enforcement Building, South Jamaica, NY
- Muskeg River Oil Sands, Fort McMurray, AB
- Queen Elizabeth II Bridge, Gander, NF
- Salt Lake City, UT, Kleinfelder
- Campbell Creek Bridge, Inuvik, NT
- Canyon Creek Bridge, Golden, BC
- Wyandotte Power Plant, Wyandotte, MI
- Canadian Tire Store, Whitecourt, AB
- Goldbar Creek, Edmonton, AB
- Humber Arm Bridge, Deer Lake, NF
- McDonald Creek Bridge, West Vancouver, BC
- Fremont Power Center, Fremont, OH
- Temporary Detour Bridge - HWY 1 over Gander River, Gander, NF
- Freedom Hill Metropolitan Parkway Amphitheatre, Sterling Heights, MI
- Queensborough Middle School, New Westminster, BC
- Muskwa River Bridge, Fort Nelson, BC
- Saline River Bridge, Mackenzie Valley Winter Road, NT
- Vermillion Creek Bridge, Mackenzie Valley Winter Road, NT
- Steep Creek Bridge, Mackenzie Valley Winter Road, NT
- Whitesand Creek Bridge, Mackenzie Valley Winter Road, NT
- Cornerbrook Pulp and Paper Mill Cogeneration Plant, Cornerbrook, NF
- 196th Avenue and Deerfoot Trail Interchange, Calgary, AB
- Humber Arm Bridge, Deer Lake, NF
- NSER Warehouse, Hay River, NT
- Carter Industries Ltd. Construction Yard, Hay River, NT
- MTO 2001-0002 RR22 and RR 29 Overpass HWY417, Arnprior, ON
- A.J. Forsyth Plant, Delta, BC
- Campbell Collegiate, Regina, SK
- Inland Cement Plant, Edmonton, AB
- East Coast Interceptor - Gyro Park, Victoria, BC
- Syncrude Existing C4 Area, Fort McMurray, AB
- Bridgeview Elementary School, Surrey, BC
- Paul Bunyan Drive Bridge Replacement, Remidji, MN
- Queen Elizabeth II Bridge, Gander, NF
- AEC Foster Creek Cogeneration Plant, AB
- St. Lawrence Wharf, St. Lawrence, NF
- Boundary Dam Power Station, Estevan, SK
- MDOT I94 Bridge S20 over Little Mach Ave. Replacement, Port Huron, MI
- Shaw Tower, Vancouver, BC

- Southbridge Ave. Overpass, Prince George, BC
- Merton Creek Rail Bridge, Prince George, BC
- MTO 2002-4001 RR 20 Overpass HWY 417, Antrim, ON
- GRVC Phase 1, Rikers Island, NY
- Newtown Creek WPCP, North Battery, Brooklyn, NY
- Downtown Center, Ann Arbor, MI
- Fundy Gypsum Company Pier, Hantsport, NS
- GVRD Beach Yard, North Vancouver, BC
- Christina Lake Enterprises, Conklin, AB
- Arch Street Maintenance Facility, Queens, NY
- Cirebon Bypass, Indonesia
- GRVC Phase 2, Rikers Island, NY
- Macleod Trail and Shawnessy Blvd Interchange, Calgary, AB
- Omega-Salmon Fish Hatchery, Ocean Falls, BC
- American Airlines Signage, JFK Airport, NY
- MTA Revenue Facility, Queens, NY
- Mineola Blvd over Long Island Railroad Bridge Replacement, Nassau, NY
- Bradhurst Court Development, New York, NY
- St. Lawrence Wharf, St. Lawrence, NF
- Brighton Development, Vancouver, BC
- 200th Street Overpass, Langley, BC
- Branch Wharf, Branch, NF
- MTO 2002-4028 - CN Rail Bridge Replacement, Cornwall, ON
- Waste Water Treatment Plant, St. Clair, MI
- Visteon Village Headquarters, Van Buren Township, MI
- Concord Pacific Building 1GHJ, Vancouver, BC
- Richmond Steel, Vancouver, BC
- Poletti Power Plant, Queens, NY
- Inifinit Dealership, Halifax, NS
- Waste Water Treatment Plant, Port Huron, MI
- Marathon Ashland Petroleum Office Building, Detroit, MI
- CNRL Horizon, Fort McKay, AB
- Springwells Seawall, Detroit, MI
- Wha-Ti Community Center, Wha-Ti, NT
- Jamaica Bay Peaking Facility, Jamaica, NY
- NAIT ICT Center, Edmonton, AB
- Argentine Connection Bridge, Kansas City, MO
- MTA Corona Maintenance Shop, Flushing, NY
- Whitestone Expressway at Van Wick Expressway Replacement Bridge, Queens, NY
- Red Garage, JFK Airport, NY
- Great Canadian Casino Bridgeport Resort, Richmond, BC
- 3rd Avenue Bridge over Harlem River, Manhattan, NY
- NJ Turnpike over East Viaduct, NJ
- Lenawee County Jail, Lenawee County, MI
- Harlem River Bridge Shop, Manhattan, NY
- SUNY Maritime College, Bronx, NY
- MTA Central Maintenance Facility, Queens, NY
- Park Royal Shopping Center, West Vancouver, BC
- Gilbert River Bridge, Labrador
- Lesser Slave River Bridge - HWY 88, Slave Lake, AB
- Keephills Power Station, AB
- Lafarge - Detroit Terminal, Detroit, MI
- Heavy Lift Terminal, Bay Robert, NF
- Belt Parkway over Ocean Parkway Interchange, Brooklyn, NY
- Fort Tryon, Manhattan, NY
- Pedestrian Bridge over HWY 417, Kanata, ON
- Terwillegar Drive and Anthony Henday Drive Interchange, Edmonton, AB
- Wharf Reconstruction, English Harbor East, NF
- MTO 2003-5114 Frederick House River Bridge, Timmins, ON
- DTE-Fermi2 Blackstart Generator, Newport, MI
- CPR Culvert, Thunder Bay, ON
- South Surrey Interceptor, Surrey, BC
- Schaefer Development, Brooklyn, NY
- Stephenville Wharf, Stephenville, NF
- Cody Creek Gillan Bridge, Ottawa, ON
- Anthony Henday Drive over North Saskatchewan River Bridge, Edmonton, AB
- Battery Park City Site 19B, New York, NY
- Cole Avenue Bridge over Hoosic River, Williamstown, MA
- Riverside South Building and Delivery Platform, New York, NY
- OPTI- Long Lake SAGD, Anzac, AB
- AGRA Yard Test Site, Edmonton, AB
- Petro-Canada Refinery Tank 282, Edmonton, AB
- Cesso Plant, Edmonton, AB
- 18th and 20th Avenue Bridges over Sea Beach Rail Line, Brooklyn, NY
- Kahkewistahaw Community School, Broadview, SK
- CFB Esquimalt Barracks, Esquimalt, BC
- 350 King Edward, Ottawa, ON (PWGSC)_
- Wal-Mart, Ithaca, NY
- Bears Stadium, Newark, NJ
- Nita Lake Lodge, Whistler, BC
- HWY 6 underpass Glancaster Road, Hamilton, ON
- Iqaluit Hospital Expansion, Iqaluit, NU
- Rensseler Polytechnic Institute, Troy, NY

- Vancouver Convention Center Expansion, Vancouver, BC
- Oakland Airport, Oakland, CA
- Clarence Street Overpass CN Rail Line, Saskatoon, SK
- Rogers Food Ltd Storage Silos, Chilliwack, BC
- Polygon Khanie Development, Port Moody, BC
- MTA Grand Avenue Bus Depot, Queens, NY
- Building A, The Riverwalk at Port Imperial, West New York, NJ
- LNG Storage Facility, Freeport, TX
- LNG Storage Facility, Hackberry, LA
- Gateway Casino, Langley, BC
- M165 Pedestrian Bridge over Silver Creek, Morenci, MI
- Concord Pacific Building 1P, Vancouver, BC
- Anthony Henday Drive and Calgary Trail Interchange, Edmonton, AB
- Meadowlands Xanadu Development, East Rutherford, NJ
- Jamaica Bay Peaking Facility, Jamaica, NY
- Anthem Properties Ltd. Tandem, Burnaby, BC
- Marathon Ashland Petroleum Gas Oil Hydrotreater, Detroit, MI
- Marathon Ashland Petroleum ESP, Detroit, MI
- Ocean City Causeway, NJ
- Canada Winter Games Multi-Plex, Whitehorse, YT
- American Airlines Sign Structure, JFK Airport, NY
- BC Rail Bridge over Rutherford Creek, Whistler, BC
- Lou Romano Water Treatment Plant, Windsor, ON
- Irving Oil Mooring Bollards, St. John's, NF
- Schaumburg Convention Center, Schaumburg, IL
- W 31st Street, New York, NY
- Alky & Goth Civil Works, Detroit, MI
- Whitehorse Creek Bridge, Cadomin, AB
- Hot House Growers Greenhouse, Delta, BC
- 300713 Sterling Glen, Roslyn, NY
- East Greenwich Water Treatment Facility, East Greenwich, RI
- Routes 1 and 9 Interchange, Elizabeth, NJ
- Ipsco Steel Plant, Regina, SK
- Great Canadian Casino Expansion, Coquitlam, BC
- Terwillegar Drive and Anthony Henday Drive Interchange, Edmonton, AB
- Assisted Living Facility, Edmonton, AB
- Tapertube Piles near Sterling Glen, Roslyn, NY
- Winona Clinic Addition, Winona, MN
- Bearspaw Water Treatment Plant, Calgary, AB
- Reactivation of the Staten Island Railway, Bridges 386, 389 and 392, Staten Island, NY
- Battery Park City Site 26, New York, NY
- Queens West Parcel 6, Queens, NY
- Windsor Park Development, Englewood, NJ
- Renaissance Center, Council Bluffs, Iowa
- Red Garage, JFK Airport, NY
- 87th Ave Bridge over Anthony Henday Drive, Edmonton, AB
- David Ave Connector Bridges over Coquitlam River and Hyde Creek, Port Coquitlam, BC
- Kinder Morgan Terminal, Perth Amboy, NJ
- College Point, Queens, NY
- East Greenwich Water Treatment Facility, East Greenwich, RI
- Wastewater Treatment Plant, Swift Current, SK
- Bowater Deinking Plant, Thunder Bay, ON
- Petro Canada Refinery Tank 281, Edmonton, AB
- Lindenhurst Navy Air Base, NJ
- TPT Piles at Sterling Glen, Roslyn, NY
- MTO 2004-5120, Sault-Ste Marie, ON
- Home Hardware Expansion, Whitehorse, YT
- Teslin River Bridge Rehabilitation, YT
- Marathon Ashland Petroleum West Cracking Plant, Detroit, MI
- New Future Shop Store, Sudbury, ON
- Falling Creek Rail Bridge, Willow Creek Coal, Falls Mountain Coal, BC
- River Rock Lodge, Fernie, BC
- Marathon Ashland Petroleum Preflashing Unit, Detroit, MI
- Polygon Khanie Development - Salal Site, Port Moody, BC
- 20 Bayard St, Brooklyn, NY
- Pembina River Bridge, HWY 43, AB
- GCC Site - Warehouse, College Point, Queens, NY
- United Nations Credit Union, Queens, NY
- Millennium Point Tower 2, Battery Park City - Site 2A, New York, NY
- Half Moon Harbour, Phase II, North Bergen, NJ
- CN Rail Overpass, Willow Creek Coal, Falls Mountain Coal, BC
- West Regional Road Bridge Over Sturgeon River, St. Albert, AB
- 255 Hudson Street, New York, NY
- Reactivation of the Staten Island Railway, Howland Hook Bridge, Staten Island, NY
- 39-08 Janet Place, Queens, NY
- UNFCU, Long Island City, NY
- Proposed Restaurant Depot, Dearborn, MI
- Reactivation of the Staten Island Railway, Culvert at Depart of Sanitation Station, Staten Island, NY
- Centerm Redevelopment, Vancouver, BC

- Queensborough Casino, New Westminster, BC
- Nexen - Long Lake Cogeneration Unit, Anzac, AB
- Riker's Island, NY
- Diamond Beach, Long Branch, NJ
- Roger Pierlet Bridge, Cloverdale, BC
- 50 Bayard St, Brooklyn, NY
- Park and Ride Development, Wayne, NJ
- Reactivation of the Staten Island Railway, Three Bridges, Staten Island, NY
- Silverdale Creek Bridge, Mission, BC
- MTO 2004-5004, Estaire, ON
- Providence Center, Providence, RI
- Suncor Voyageur, Fort McMurray, AB
- Liberty North, Jersey City, NJ
- JFK Terminal 5, NY
- Freedom Hill Amphitheatre, Sterling Heights, MI
- One Executive Place, Calgary, AB
- Corner Stone, Site 6, New York, NY
- Coke Plant, Toledo, OH
- Castle Road over Squaw Creek, MI
- South Bay Center, Boston, MA
- Newtown Creek WPCP, North Battery, Brooklyn, NY
- Gansevoort Market, New York, NY
- MTA Corona Maintenance Shop, Flushing, NY
- The Waterfront Condominium Development, North Bergen, NJ
- Conklin Pipe Piles, Conklin, AB
- Cypress Regional Hospital, Swift Current, SK
- Paerdegat Basin Facility, NY
- Anthony Henday over Calgary Trail Interchange, Edmonton, AB
- Penstock Re-Alignment, Deer Lake power, Deer Lake, NF
- Bulk Material Import Terminal, Brooklyn, NY
- SLGA Liquor Board Store, Swift Current, SK
- Beaver Creek Bridge, YK
- 100 Jay Street, Brooklyn, NY
- TransCanada HWY Twinning, Banff, AB
- Anthony Henday over Calgary Trail Interchange, Edmonton, AB
- MTO 2005-5147, Sault Ste. Marie, ON
- BMW Dealership, Westbury, NY
- Marine Promenade Properties Inc., Vancouver, BC
- Astoria Energy Receiving Platform, Queens, NY
- Lincoln Road Bridge, Brooklyn, NY
- Ave Z & E, 16th Street, Brooklyn, NY
- Kalahari, New York, NY
- CNR Overpass on HWY 43, Sangudo, AB
- High Bridge Combined Cycle, St. Paul, MN
- Bank of America Building, Boston, MA
- Forest City Ratner Companies - Beekman Site, New York, NY
- Riverside Avenue South, New York, NY
- Salmon River Bridge, Shannonville, ON
- Sun Rise School, Hay River, NT
- The Waterfront Condominium Development, North Bergen, NJ
- Polygon Klahanie Tides Site, Port Moody, BC
- Devon Jackfish SAGD, Conklin, AB
- Guardian Fiberglass, Albion, MI
- Bates Outfall, Detroit, MI
- Newtown Creek WPCP, Timber Piles, Brooklyn, NY
- Blue Water Bridge, Sarnia, ON
- Riker's Island ARDC, NY
- One River Terrace, Battery Park, New York, NY
- Westin Hotel Addition, Providence RI
- Queensborough Casino, New Westminster, BC
- 270 Greenwich St., New York, NY
- West 1st Street, Brooklyn, NY
- The Obelisk Highrise Development, Coquitlam, BC
- 184th St. Bridge over Nicomekl River, Surrey, BC
- Olive Garden at South Beach Center, Boston, MA
- Furry Creek Bridge, Furry Creek, BC
- Lincoln Road Bridge, Brooklyn, NY
- TF Green Airport, Providence, RI
- Churchill River Bridge, Goose Bay, NF
- 206th St Viaduct, Langley, BC
- Officer / Senior NCO Quarters, CBF Wainwright, Wainwright, AB
- United Rentals, Ridgefield Park, NJ
- Rockaway Metroplex, Rockaway, NY
- Jacobson Floral Supply, Boston, MA
- WMS Steam Line, Wyandotte, MI
- Maine Medical Center, Portland, ME
- Golden Ears Bridge, Maple Ridge, BC
- Borgata North Tower and Employee Garage, Atlantic City, NJ
- Morrisville Yard Phase 2 Expansion, Bucks County, PA
- Santini Brothers Iron Works, Medford, MA
- North Glengarry WWTP, North Glengarry, ON
- 34 Ave Over Anthony Henday Drive, Edmonton, AB
- Deer Lake Airport Expansion, Deer Lake, NF
- Whole Food Market, Cambridge, MA
- Chabad House, Port of Washington, NY
- University of Massachusetts Lowell Parking Garage, Lowell, MA
- Deck Replacement on the Randall's and Ward's Island Viaducts at the Triborough Bridge, NY
- Mets Stadium, New York, NY
- BA Energy Upgrader, Fort Saskatchewan, AB
- Suncor Voyageur, Fort McMurray, AB

- MTO 2005-2041, St. Catherine's, ON
- Queen Street Wharf, Kingston, ON
- 164 Kent Ave., New York, NY
- Maxwell House Block B, Hoboken, NJ
- CNRL Horizon Sulphur Recovery Test Program, Fort McKay, AB
- Devon Canada SDC Exploration Ship, Beaufort Sea
- Kennedy Bridge Replacement, South Stormont, ON
- Beakman Tower, New York, NY
- Avalon on the Sound, New Rochelle, NY
- Cold Storage Facility, Edmonton, AB
- Humber River Bridge, Vaughan, ON
- Bow River Bridge, Banff, AB
- Center for Science and Exploration, Hartford, CT
- East River Plaza, Brooklyn, NY
- Banana Building Apartments, Weehawken, NJ
- CN Sprague Detour Bridge, Winnipeg, MB
- Villa Hotel, Burnaby, BC
- College Point Warehouse, Queens, NY
- MTO 2005-5009, Parry Sound, ON
- Red Hook Homes, Brooklyn, NY
- RIDOT Bridge 250, Portsmouth, RI
- U.S. Tennis Center, Queens, NY
- Newtown Creek Phase 2, Brooklyn, NY
- RAV Segmental Casting Yard, Vancouver, BC
- Detroit Riverwalk Phase II, Detroit, MI
- University of Alberta, CCIS Phase II, Edmonton, AB
- Pier 64, Manhattan., NY
- Yankee Stadium, Bronx, NY
- DTE Monroe FGD Upgrade, Monroe, MI
- Port Imperial, West New York, NJ
- American Airlines Elevated Roadway, JFK Airport, Jamaica, NY
- Joint Intelligence Center, MacDill AFB, Tampa, Florida
- CNRL Horizon Sulphur Recovery, Fort McKay, AB
- Detroit Diesel, Red Ford, MI
- Plaza on the Hub, NY
- Detroit Metro Airport, Detroit, MI
- Glenmore Causeway Bridge, Calgary, AB
- Shell AOSP Upstream Expansion, Jackpine Mine, AB
- MOA Nickel S.A., Cuba
- Suncor Firebag Stage 3+, AB
- CPR Malakwa Bridge, Sicamous, BC
- CNRL Horizon Cogeneration Unit, Fort McKay, AB
- Harlow Burrows, BC
- Serpentine River Bridge, BC
- Penstock Re-Alignment #2, Deer Lake power, Deer Lake, NF
- Tommy Douglas Collegiate, Saskatoon, SK
- Three Nation Lake Mine Expansion, Timmins, ON
- Suncor MP Condensate Area, Fort McMurray, AB
- CNRL Horizon, Mineral Extraction, Fort McKay, AB
- Canada Line North Arm Bridge, Richmond, BC
- West 19th Street and 11th Ave, New York, NY
- Superior Court & Center for Juvenile Matters, Bridgeport, CT
- Greenpoint Power Center, Brooklyn, NY
- Mamquam River Bridge, Squamish, BC
- Port Royal Bridge, New Westminster, BC
- Polygon Homes, Sahalee Site, Port Moody
- Regina Corrections Center, Regina, SK
- Lafarge Asphalt Plant, Surrey, BC
- Duck Pond Mine, Millertown, NF
- Rego Park Mall, Queens, NY
- East River Science Park, Manhattan, NY
- OPTI/NEXEN - Long Lake (NEXEN), Anzac, AB
- East River Plaza, Manhattan, NY
- William R. Bennett Bridge, Kelowna, BC
- Olympic Speed Skating Rink, Richmond, BC
- 1281 Metropolitan Ave, New York, NY
- JetBlue Yellow Garage at JFK International Arrivals, Jamaica, NY
- MTO 2005-4017, Casselman, ON
- Bluewater YMCA, Port Huron, MI
- Big Bend Crossing, Burnaby, BC
- Flat Rock Square Development, Englewood, NJ
- 100 11th Street, Manhattan, NY
- Hudson Park North, New York, NY
- Longboat Landing Development, Fort McMurray, AB
- Snap Lake Mine, NWT
- Regina Correctional Center, Regina, SK
- MTO 2006-5157, Estaire, ON
- Regina Wingate Hotel, Regina, SK
- 1330 Intervale Ave, Bronx, NY
- Serpentine River Bridge, Surrey, BC
- Harmon Wheel Truing Facility Pahse III, Whitestone, NY
- MTA Corona Maintenance Yard, Flushing, NY
- BX Creek Bridge, Vernon, BC
- Lafarge Asphalt Plant, Surrey, BC
- MTO 2004-5151, North Bay, ON
- Progress Energy Bartow Power Plant Expansion, St. Petersburg, FL
- Rite Aid, Oakland County, MI
- Golden Ears Bridge, Maple Ridge, BC
- FDS Coke Plant, Toledo, OH

- OPTI/NEXEN - Long Lake Phase II, Anzac, AB
- Bridge over Hollybridge Way Canal, Richmond, BC
- Connacher Great Divide SAGD, Mariana Lake, AB
- Bow Valley College, Calgary, AB
- AOSP Jackpine Upstream Expansion Extraction/Tailings, Fort McKay, AB
- AEPC Kyger Creek FGD, Cheshire, OH
- Keephills Power Station, AB
- Harmon Wheel Truing Facility, Croton on Hudson, NY
- Suncor Firebag Expansion, Fort McKay, AB
- AOSP Shell Scotford Downstream Expansion (NA), Fort McKay, AB
- Pump Station, West Palm Beach, FL
- AOSP Shell Scotford Downstream Expansion (AGRA), Fort McKay, AB
- North Cowichan Aquatic Center, Duncan, BC
- Ethanol Production Facility, Marysville, MI
- CNRL Horizon Power Transmission Towers, Fort McKay, AB
- Bay Ave, NJ
- East Harlem School, Manhattan, NY
- CNRL Wolf Lake, Cold Lake, AB
- Flushing Town Center - Driven Piles, Flushing, NY
- Dow Chemical Parentis Plant, Lacombe, AB
- Giants Stadium, Stadium Club Road, Meadowland, NJ
- Meadowland Railroad, Meadowland, NJ
- Kanata West Development, Ottawa, ON
- Bronx Terminal Station, Bronx, NY
- HANAC Seniors Housing, Queens, NY
- Flushing Town Center - Drilled Shaft Piles, Flushing, NY
- 2183 Third Ave, New York, NY
- CN Bridge 243.4 Redditt Sub. Temporary Detour Bridge, Winnipeg, Manitoba
- Suncor Voyageur, Fort McMurray, AB
- Clarence Ave Overpass, Saskatoon, SK
- PS366, Brooklyn, NY
- Hackensack Homeless Shelter, NJ
- Meadowlands Facility, NJ
- The Edge Apartments, Brooklyn, NY
- Snookie Bay Wharf, NF
- Apartment Building - 22 Renwick, Manhattan, NY
- Glenco Club Curling Rink, Calgary, AB
- Ontario Power Coffe Dam, Lac Seul, ON
- MOTT Haven Campus, Bronx, NY
- 8th St Tim Horton's, Saskatoon, SK
- Caleb Office Complex, Saskatoon, SK
- Yankee Stadium Garage, Bronx, NY
- Fordham Place, 400 East Fordham Road, Bronx, NY 10458
- Suncor Firebag Stage 3+ Administration Complex, Fort McMurray, AB
- EPCOR Clover Bar Energy Center, 1515 130th Ave., Edmonton, AB
- Newton Creek WTP Main Building Addition, Brooklyn, NY
- North Bay Regional Health Center, 50 College Drive, North Bay, ON
- Revbel, Atlantic City, NJ
- MTO 2006-4080, Ottawa, ON
- Newtown Creek WTP, Brooklyn, NY
- Moraine Creek Bridge, Lake Louise, AB
- Timmins WTP, Timmins, ON
- 544 Union Ave, Brooklyn, NY
- Twins Stadium, Minneapolis, MN
- West 72nd Street & Riverside Drive, Manhattan, NY
- Alexan at Bayonne Bay, Bayonne, NJ
- GNWT Education Center, Fort Simpson, NWT
- North Bergen Transfer Station, North Bergen, NJ
- Suncor Firebag Steam Generation Plant, Fort McMurray, AB
- 303 East 33rd Street, New York, NY
- NY Giants Training Facility, NJ
- Marquette Soccer Stadium, Marquette, WI
- Powell Cove Estates, College Point, NY
- Shea Stadium, Flushing, NY
- IPISCO Plant, Regina, SK
- Enbridge Plant, Edmonton, AB
- MTO 2005-4017 - HWY 417 Culvert at Limoges Rd
- The Beach Club Phase 2 Tower, Parksville, BC
- Bowery Bay WPCP Upgrade, Queens, NY
- Whole Foods Facility, Brooklyn, NY
- Caritas Island Bridge, CT
- Nicholsville Bridge, NF
- 164 Kent Ave. Phase II, Brooklyn, NY
- EKPC Spurlock Unit 2 FGC System, Mason County, KY
- 511 West 23rd St., New York, NY
- Suncor Firebag Cogeneration Facility, Fort McMurray, AB
- 4469 Broadway, Manhattan, NY
- Suncor Firebag PWBFW & Clarifier Sludge Zone, Fort McMurray, AB
- Yankee Stadium, Bronx, NY
- Tapertube Piles in Brooklyn, NY
- USS Steel Mill, Detroit, MI
- 236 Livingston Street, New York, NY
- CN Bridge 243.4 Redditt Bridge, Winnipeg, Manitoba
- 703 Chemin de la Source, Authier, QC
- Cull's Harbour Pier, Tarrytown, NY
- Ludlow Hotel, NY, 180-184 Ludlow Street
- 316 11th Ave, New York, NY
- MTO 2007-3043, Windsor, ON
- MTO 2007-5200, Huntsville, ON
- Suncor Village, Suncor Firebag, Fort McMurray, AB
- 235 and 277 Gold Street, Brooklyn, NY

- Suncor Firebag Stage 3+, Fort McMurray, AB
- West 61st St - West 64th St., Miller Highway Tunnel, Manhattan, NY
- The Beach Hotel, Long Beach, NY
- Route 25 Over LIRR, Suffolk, NJ
- 544 Union Ave, Brooklyn, NY
- Ann and Nassau Streets, NY
- MOA Nickel S.A. - Sulphuric Acid Plant, Cuba
- JFK Redevelopment Program, Terminal 4, Emirate Gate 6 Access, NY
- CPR Bridge RR213, Strathcona County, AB
- Shea Stadium Light Towers, New York, NY
- Bank Street Development, White Plains, NY
- Hudson Tea Buildings, Hoboken, NJ
- Skanska Building Addition, College Point, NY
- 303 West 10th St, Manhattan, NY
- Ares Printing, College Point, NY
- MTO 2005-4017 - CNR Overhead Structure, ON
- Manhattan College, New York, NY
- EPCOR Clover Bar Energy Center, 1515 130th Ave., Edmonton, AB
- 303 10th Ave, Manhattan, NY
- 39-08 Janet Place, Queens, NY
- American Airlines, LaGuardia Airport, Queens, NY
- East 4th St. and Bowery, New York, NY
- PS/IS 102 Q, Elmhurst, NY
- Powerhouse Facility, Queens, NY
- FedEx Facility, Woodbridge, NJ
- The Edge, 164 Kent Ave Vault Installation
- Canola Crushing Facility, Clavet, SK
- NAO SC Leismer, Conklin, AB
- Mercedes Dealership, Saskatoon, SK
- E125th St. Salt Shed, Manhattan, NY
- 332 E22nd St., New York, NY
- Bloomfield Development, Bloomfield Township, MI
- Hudson Generating Station, NJ
- 181 3rd Ave, Brooklyn, NY
- Marathon Petroleum Detroit Coker Feasibility, Detroit, MI
- Port Imperial, West New York, NJ
- MGM Grand, Atlantic City, NJ
- Fort Hills Oil Sand, Alberta
- Gotham Center, Queens, NY
- 610 Lexington Ave, Manhattan, NY
- NACG Hydraulic Hammer Testing
- CN Assiniboine M21.0 Bridge, Strugis, SK
- No. 7 Railway Line, Manhattan, NY
- 158 Madison Ave, Manhattan, NY
- 75 Schmerhorn St, Brooklyn, NY
- Oliver House, 131 Second Place, Brooklyn, NY
- 99 Church St., New York, NY
- 501 51st St., New York
- 29-43 41 St Street, Queens, NY
- UN Building, NY
- 17566 Mississauga Road, Caledon, ON
- Owls Head Water Pollution Control Plant, Owls Head, NY
- N10th Street, Brooklyn, NY
- Marginal Wharf, Jersey side, NJ
- ConEd Newtown Substation, Brooklyn, NY
- Lower Sturgeon Coffe Dam, Timmins, ON
- Newton Creek WPCP, Brooklyn, NY
- Fordham University Residence, Bronx, NY
- 164 Kent Ave - Phase 3, Brooklyn, NY
- 10th Line Widening, Ottawa, ON
- 181 3rd Ave Shoring System, Brooklyn, NY
- ConEd Newtown Substation, Brooklyn, NY
- Ferris Wheel, Meadowlands, NJ
- Suncor PEW Supply, Fort McMurray, AB
- Borgata Garage 2, Atlantic City, NJ
- BC Ferries Terminal, Vancouver, BC
- Multi-Use Facility, Melfort, SK
- Suncor Voyageur SRU, Fort McMurray, AB
- Suncor Voyageur Administration Complex, Fort McMurray, AB
- 610 Lexington, Manhattan, NY
- PS276, Battery Park, NY
- Air Terminal Building, Whitehorse Airport, Whitehorse, YT
- Chief T'Selehye School, Fort Good Hope, NWT
- Indian River Bridge, Delaware
- Montana's Restaurant, Edmonton, AB
- Kearl Oil Sand, Fort McKay, AB
- MTO2008-5111, North Bay, ON
- Ross Creek Bridge, Fort Saskatchewan, AB
- Air Terminal Building, James Richardson Airport, Winnipeg, MB
- PS48Q, Queens, NY
- MTO2007-5200, Sunridge, ON
- Harley Davidson Dealership, Edmonton, AB
- Suncor Village, Suncor Voyageur, Fort McMurray, AB
- Harlem River Tunnel, Manhattan, NY
- Jersey City Medical Center, Jersey City, NJ
- 8th Street Bridge, PA
- Dundurn Army Base, Dundurn, SK
- MTO2008-5114, Burkes Falls, ON
- MTO2008-3004, Woodstock, ON
- 115th Ave and Bridgeview Drive, Surrey, BC
- Total Upgrader, Fort Saskatchewan, AB
- Suncor Voyageur Transmission Towers, AB
- CanETIC Facility, Thompson, MB
- Flat Bay Bridge, Stephenville, NF
- Bronx-Whitestone Bridge, Bronx Approach, Bronx, NY
- Kip's Bay, Manhattan, NY

- Cobble Hill, Brooklyn, NY
- 29 Flatbush, Manhattan, NY
- Sheepshead Bay, Brooklyn, NY
- Baker Road WWTP, Grimsby, ON
- Gowanus Expressway, Brooklyn, NY
- Bayonne Power Plant, Bayonne, NJ
- Newtown Creek WPCP - Area 47F, Brooklyn, NY
- 33 Beekman Street, Manhattan, NY
- Holiday Inn Express, Ottawa, ON
- Serpentine River Bridge, Surrey, BC
- Statoil Leismer CPF, Conklin, AB
- Suncor Firebag Stage 4 Cogen Facility, Fort McMurray, AB
- NJCU West Campus, Jersey City, NJ
- SaskPower Queen Elizabeth Power Station, Saskatoon, SK
- Solar Farm, Arnprior, ON
- Two Elk Generating Station, Campbell County, Wyoming
- MTO2008-5113, Huntsville, ON
- Bindi Distribution Center, Hackensack, NJ
- Campbell Collegiate, Regina, SK
- Jackson County Bridge, MI
- US12 over Rouge River, Wayne County, MI
- Marine Transfer Station, Queens, NY
- CitiField Light Stands, Flushing, NY
- Shore Parkway Bridge over Fresh Creek Basin, Brooklyn, NY
- Hamilton Ave. Marine Transfer Station, Brooklyn, NY
- Marbarak Center, Pakistan
- Gilmerton Bridge, Chesapeake, VA
- New Orleans Dykes, New Orleans, LA
- Fitterman Hall, New York
- Greenside Type II Hanger, Quantico, VA
- Gowanus Power Plant, Brooklyn, NY
- Waste Water Treatment Plant, Baltimore, MD
- Proposed Dearborn Town Center, Dearborn, MI
- Long Island Railroad Rehabilitation, Long Island, NY
- Sugar House Interim Casino, Philadelphia, PA
- DOW Chemical CV-916 FRAC Cavern, Forty Saskatchewan, AB
- Spring Creek School, Brooklyn, NY
- Cross Bronx Expressway, Bronx, NY
- Blackwater Bridge, MacKenzie Valley Winter Road, NT
- Christopher Columbus Mixed Use Center, Atlantic City, NJ
- MN Trunk Highway 52, Minnesota
- New Haven Rail Yard, New Haven, Connecticut
- Phipps House, New York, NY
- Como Creek Bridge Replacement, Coquitlam, BC
- Western Regional Water Reclamation Facility, Boone County, KY
- Proposed 15 Story Hotel and Parking Garage, Norfolk, Virginia
- CAT-DEL 200 UV Disinfection, Westchester County, NY
- William Taft High School, Brooklyn, NY
- Grand Jersey Parking Garage, Jersey City, NJ
- 155 West St., Brooklyn, NY
- MTO 2007-5200, Huntsville, ON
- Jefferson Memorial, Washington DC
- Areva Newport News, Newport News, VA
- Columbia University, New York, NY
- MTO 2009-5131 - Estaire, ON
- AMP - Base Load Generating Station, Meigs County, OH
- Elizabeth Parking Garage, Elizabeth NJ
- Lagoon Pond Bridge, Tisbury, MA
- Ocean Breeze Park Site Work and Foundation, Staten Island, NY
- Rockaway Parkway Bridge, Brooklyn, NY
- MTO 2009-4012 Barnes Creek Culvert, Kemptville, ON
- New Haven Rail Yard, New Haven, CT
- Municipal Recreation Center, Fort McMurray, AB
- Alaskan Way Viaduct and Seawall Replacement, Seattle, WA
- Works Yard Relocation, Bermuda
- MTO2008-3023, Kitchener, ON
- Chevron Refinery, Burnaby, BC
- Belt Parkway Bridges, Brooklyn, NY
- NYPD Police Academy, College Point, NY
- Northwood Pulp and Paper Mill, Prince George, BC
- Brattleboro WWTF, Brattleboro, VT
- New Brunswick Gateway, NB
- Lower Mattagami, Moose River Basin, ON
- The Green Way, Brook Ave and 156th Street, Bronx, NY
- Hunt Club Rd Extension, Ottawa, ON
- Hartford Water Pollution Control Facilities, Hartford, CT
- Windsor Essex Parkway, Windsor, ON
- Various TTC Investigation Sites - SPT Energy Testing, Toronto, ON
- Mosaic K-1 Mine, Esterhazy, SK
- Algonquin Tunnel, ON
- 60 W 139th Street, NY
- Paerdegat Basin Trestle, Brooklyn, NY
- East Athabasca HWY, Jackpine Creek Bridge, Ft McMurray, AB
- Hamilton Ave. Marine Transfer Station, Brooklyn, NY
- Letellier Bridge Over the Red River, Letellier, MB
- New Jersey Turnpike, Interchange 6 to 9 Widening Program, NJ
- Kew Gardens Interchange, Queens, NY
- MTO 2006-5158, Estaire, ON
- Canaan Road Culvert Replacement, Ottawa, ON
- Treated Water Reservoir, Slave Lake, AB

- NYSDOT - Gowanus Expressway I-278 Bridge Rehabilitation, Brooklyn, NY
- Public Safety Answering System, Bronx, NY
- Citrus Lakefront Levee, New Orleans, LA
- Matabitchuan GS Spillway, Cobalt, ON
- Spring Street Garage, Manhattan, NY
- Keswick WPCP, Keswick, ON
- Whitestone Bridge, Bronx, NY
- MTO 2008-4009, Kingston, ON
- Gowanus Expressway Emergency Repair and Shore Parkway Interchange, Brooklyn, NY
- Tilden Lake dam, North Bay, ON
- Great Neck WCPC, Long Island, NY
- Cape Horn Bridge, Vancouver, BC
- Hartford WPCP, Hartford, Connecticut
- MTO 2010-5101, Cochrane, ON
- Keyera Energy Rimbey Edmonton Terminal, Edmonton
- 120 Bayway Ave Development, Elizabeth, NJ
- MTA Bus Garage, NY
- Indian River AQCS Retrofit, Indian River, DE
- New Westminster Waterfront Park, New Westminster, BC
- Kearl Oil Sands, Fort McKay, AB
- Young Davidson Tailings Dam, Matechewan, ON
- MTO 2010-5108, Frederickhouse River Bridge, Cochrane, ON
- PS281M, Manhattan, NY
- Proposed Bindi Distribution Center, Kearny, NY
- Northfold Southern Railroad Overpass, Lawrence County, PA
- Ramseyville Rd Terramesh, Ottawa, ON
- Transfer Station, Venice, LA
- Heritage Field Redevelopment, Bronx, NY
- Potash Mine, Esterhazy, SK
- TopCo Plant, Edmonton, AB
- Cattaraugus County Replacement Bridge, Cattaraugus County, NY
- North Surrey Interceptor Relocation, Surrey, BC
- Nicomekl Bridge at 208th Street, Langley, BC
- Salt Shed at Berth 16, Brooklyn, NY
- Nordenskiold River Crossing, Carmacks, Yukon
- Homer Watson Pumping Station, Kitchener, ON
- HWY 1 Bridge, Chaplin, SK
- Camp LeJeune Northeast Bridge, North Carolina
- Pumping Station, Dryden, ON
- Kinder-Morgan Structural Support, Surrey, BC
- Waste Water Treatment Plant, Kitchener, ON
- 78th Street Pedestrian Bridge, Manhattan, NY
- Middle Barachois Bridge, Stephenville, NF
- MTO 2010-4003, Cornwall, ON
- West End Community Center, Sault Ste. Marie, ON
- PDA Testing of Screw Piles, Ponoko, AB
- State University of New York, Hospital Dormitory, Albany, NY
- Delta Airlines JFK Terminal 4 Concourse Extension, Jamaica, NY
- Paerdegat Basin Timber Piles, Brooklyn, NY
- MTO 2010-5121, Sault Ste. Marie, ON
- I.S. 404, Queens, NY
- Navy Green Building, Queens, NY
- Autoroute 30, Bridge 2.11, Beauharnois, QC
- King Edward South Embankment, Vancouver, BC
- NYC Sanitation Garage, Manhattan, NY
- Whitestone Bridge Queens Approach, Queens, NY
- Schuyler Hein Bridge, Los Angeles, CA
- Eglinton Crosstown LRT SPT Energy Testing, Toronto, ON
- Expressrail Corbin Street Intermodal Facility Phase 2A - Flyover, Port Newark, Newark, NJ
- MTO 2010-4003, Cornwall, ON - Aecon Change Proposal
- Wally Park Garage, Newark, NJ
- Grand River Bridge Replacement, Cayuga, ON
- BC Hydro Substation, Chilliwack, BC
- Brooklyn Atlantic / Long Island Railroad Yards Car Shop, Brooklyn, NY
- Newark Liberty International Airport - Port Street and Brewster Road Improvements, Newark, NJ
- Fischell's River Bridge, Stephenville, NF
- Expressrail Corbin Street Intermodal Facility Phase 2A - Flyover, Port Newark, Newark, NJ
- Crabbs River Bridge, Stephenville, NF
- Studio City, New York, NY
- Montauk LIRR Bridges, Long Island, NY
- WPCP, Penetanguishene, ON
- Whitney Museum, Manhattan, NY
- 105 Enterprise Ave South, Secaucus, NJ
- Bronx Mental Health Redevelopment, Bronx, NY
- Mother Clara Hale Bus Depot, New York, NY
- PSEG Peaking, New Haven, CT
- Queens West Building No. 2, Queens, NY
- Borden Avenue, Long Island City, New York
- 537 West 20th St, NY
- Eglinton LRT West Launch Area, Toronto, ON
- PS 71, Staten Island, NY
- Humber River Bridge, Toronto, ON
- JerseySide Wharf, JerseySide, NF
- Hess Newark Energy Center, Newark, NJ
- 1951 Park Avenue, New York, NY

- Enon Road Bridge, Lawrence County, PA
- Gansevoort & Washington St., NYC
- New Wal-Mart, Edmonton, AB
- Light Rail, Ottawa, ON
- MTO 2011-5110, Kirkland Lake, ON
- Liquid Asphalt Tanks, Hamilton, ON
- GM Dealership, Timmins, ON
- Hudson Converter Station, Ridgefield, NJ
- 1951 Park Ave, New York, NY
- Birchgroove Rd Culvert, Ottawa, ON
- 113 Nassau St, New York, NY
- New Retail Development, Edmonton, AB
- Hunt Club Rd Extension, Ottawa, ON
- PNCT Expansion, Elizabeth, NJ
- Goethals Bridge Modernization, NY
- CIL Tank Farm, Porcupine, ON
- 2nd Ave and East 104th St, NY
- Hilton Development, Calgary, AB
- Abitibi Facility, Iroquois Falls, ON
- Hunt Club Rd Extension (Change Proposal), Ottawa, ON
- W30th Street and 10th Ave, Manhattan, NY
- Eglinton Crosstown LRT Phase 2, Toronto, ON
- MTO 2011-5130, Cochrane, ON
- World Trade Center Tower 2, Manhattan, NY
- Trevor Day School, 312-318 East 95th St., Manhattan, NY
- India Pile
- Avalon - West Chelsea
- Soil Mix Wall
- Kenneth Burns Bridge, Worcester, MA
- Tappan Zee Bridge Pile Demonstration, NY
- Liberty Mines Cofferdam, Timmins, ON
- Vopak Terminal Berth, Perth Amboy, NJ
- WATERFRONToronto - Heavy Civil Constructability Advisory Services
- 433 Main St., Port Washington, NY
- Boundary Dam Power Station, Estevan, SK
- Three Nations Bridge, Cornwall, ON
- Harbortown, Perth Amboy, NJ
- Overpeck Landfill, Ridgefield Park, NJ
- Highway 335 over Leather River, Arborfield, SK
- JFK Terminal 1 Upgrade, Jamaica, NY
- Silicon Valley Rapid Transit, CA
- Black Creek Drive, Toronto, ON
- 164 Kent Ave - Phase 3, Brooklyn, NY
- Parcel D1 and D2, Washington, DC
- Searson Gut Bridge, NF
- Robinson River Bridge, NF
- Boundary Dam Power Station, Estevan, SK
- W30th Street and 10th Ave, Manhattan, NY
- Fore River Bridge, Quincy-Weymouth, MA
- W116th St., New York, NY
- MTO 2012-5001 - Highway 69, Sudbury, ON
- MTO 2012-5101 - Highway 69, Sudbury, ON
- Newtown Creek WPCP Upgrade 50G, Brooklyn, NY
- 508 West 24th St, New York, NY
- Mattagami WPCP, Timmins, ON
- Airport Rail Link, Toronto, ON
- Abibow Mill Site 115kV Tower, Iroquois Falls, ON
- Route I-65 Crossing the Ohio River, KY
- MTO 2012-4001, 417 Overpass Carling and Kirkwood, Ottawa, ON
- Belt Parkway Bridges, Brooklyn, NY
- LaGuardia Airport, New York, NY
- Marine Transfer Station, Brooklyn, NY
- Bridge J-8 at JFK, Jamaica, NY
- Jockvale Road Bridge, Ottawa, ON
- Terra Nova Bridge, Newfoundland
- Sunoco Ethane Storage, Marcus Hook, PA
- Cowessess Wind Farm, Cowessess, SK
- Northern Blvd and Honeywell Street, Long Island City, NY
- 1752 Shore Parkway, Brooklyn, NY
- Gertrude Colpus / T.R. McEwen Public School, Oshawa, ON
- Georgetown South - West Corridor Expansion, Martin Grove Road Bridge, Toronto, ON
- Georgetown South - West Corridor Expansion, Kipling Avenue Overpass, Toronto, ON
- NJDOT Direct Connection, NJ
- 1045 Sixth Avenue, New York, NY
- Prudential Skyline, Manhattan, NY
- 110 First Street, New York, NY
- 281 West St., Manhattan, NY
- Proposed B.L. England Unit 2 Repowering, Beesley's Point, NJ
- Harrah's Convention Center, Atlantic City, NJ
- Eglinton Scarborough Crosstown LRT, Toronto, ON
- Marine Transfer Station, Brooklyn, NY
- Paramus, NJ
- Weston Tunnel, Toronto, ON
- Northland Power Solar Farms, Smith Falls, ON
- NYU Science Buidling, Manhattan, NY
- 505 West 19th Street, New York, NY
- Burk's Falls Solar Farm, Burk's Falls, ON
- Glendale Cornwall Solar Farm, Cornwall, ON
- North Burgess Solar Farm, North Burgess, ON
- EACOM Sawmill Reconstruction, Timmins, ON
- PSEG Generating Station, Burlington, NJ
- NYU Kimmel Pavilion, Manhattan, NY
- Graham Vehicle Center, Edmonton, AB
- Rehabilitation/Replacement of the Kosciuszko Bridge of Newtown Creek, Brooklyn, NY

- Walker Ave Reconstruction, Peterborough, ON
- Sewer Reconstruction, Cornwall, ON
- Rockaway Baffle Wall, NY
- Devon Pike Lodge, Conklin, AB
- Valley Energy Center, Wawayanda, NY
- University of Winnipeg Fieldhouse, Winnipeg, MB
- Harrison Station, Harrison, NJ
- West Memorial Place, Houston, TX
- CNRL Horizon, Fort McMurray, AB
- Kirk Avenue Bus Maintenance Facility, Baltimore, MD
- 15 Renwick, Manhattan, NY
- 616 First Avenue, Manhattan, NY
- Cliffside Park, NJ
- Little Barachois River Bridge, Cornerbrook, NL
- Placentia Lift Bridge, Placentia, NL
- LGA Garage, Queens, NY
- Bell Cell Tower, Thunder Bay, ON
- MTO 2007-5200, Huntsville, ON (Bot Construction)
- UHDE
- MTO 2012-4007 HWY 417 Widening
- Nexen Long Lake, Fort McMurray, AB
- MTO 2012-4054 - Cornwall Rapid Lift
- The Landmark Development, Greenbrough, NY
- Delta Airlines JFK Terminal 4 Concourse Extension, Jamaica, NY
- HWY 407 Structure M9, Toronto, ON
- Siemens Crossings Converter Station, Rocky View County, AB
- High Prairie Hospital
- MTO 2013-2019
- 616 First Avenue, Manhattan, NY
- Deer Lake Pentacostal Church, Deer Lake, NF
- 365 Bond Street, NY
- Route 3 - Passaic River Bridge
- MTO 2013-2002 - Cobble Dick Road and East Townline Road
- MTO 2012-4056 - HWY 401, Kingston, ON
- Winbrook Redevelopment, White Plain NY
- Proposed Grain Silos, Quebec City, QC
- USTA Ashe Roof, New York
- ILCS, Bronx, NY
- Navy Green Building, Queens, NY
- Ocean Breeze Park, Staten Island, NY
- 24 Leonard Street, New York, NY
- vivaNext, Toronto, ON
- Keephills, AB
- Caruso ECC, NJ
- Goethals Bridge Modernization, NY
- Yucca Loma Bridge, Apple Valley, CA
- BAM Tower, Brooklyn, NY
- Jockvale Road Bridge, Ottawa, ON
- River Road Culvert, Ottawa, ON
- Gateway on the Greens, Regina, SK
- PS 170K, Brooklyn, NY
- 261 Hudson St., NY
- Slope Failure, St. Vincent
- Manahawkin Bridge, Stafford, NJ
- Snow Dump Road, Cornwall, ON
- Proton Therapy Center, New York, NY
- FedEx Building, NY
- Kelson Ridge Power Plant, St. Charles, Maryland
- Bayonne Bridge, Bayonne, NJ
- Hawkstone Development, Regina, SK
- E.F. Barrett Station Repowering, Island Park, NY
- Ecofuels Pellet Storage Terminal, Portsmouth, VA
- LGA Terminal Redevelopment, Queens, NY
- 227 Cherry Street, New York, NY
- The Edge Phase 2, 164 Kent Ave, Brooklyn, NY
- Riverside Building 5, Manhattan, NY
- Voisey's Bay, Newfoundland
- Rockefeller Flushing Commons Development, NY
- 149 Kent Ave., Brooklyn, NY
- 365 Bond Street, Brooklyn, NY
- 1 John Street, Brooklyn, NY
- Post Grouted Piles, Texas
- Sandy Lake Narrows Bridge, Howley, NL
- JFK Runway 4R ALSF-2 Structures, Jamaica, NY
- 222 E40th Street, Manhattan, NY
- OPG Whitesands Shoreline Rehabilitation
- 1st Street Tunnel, Washington DC
- American Dream Amusement Park, East Rutherford, NJ
- The Edge Phase 2, 164 Kent Ave, Brooklyn, NY
- Holiday Inn, Ottawa, ON
- PS-298, Queens, NY (Underpinning)
- Goethals Bridge Modernization, NY (Intercoastal)
- Sugar House Casino, Philadelphia, PA
- Brooklyn Marine Transfer Station, Brooklyn, NY
- Enbridge GTA - Hydro Corridor, Markham, ON
- PS-298, Queens, NY (Soil Solutions)
- Norman Wells Health Center, Norman Well, NT
- FedEx Warehouse, Jersey City, NJ
- Birchgroove Rd Culvert, Ottawa, ON
- Harmon Yards, NJ
- Artsbridge Senior Housing, Bronx, NY
- PennDOT764-20B Bridge over Sandy Run, Blair County, PA
- VivaNext H2 and H3.4, Toronto, ON
- Seward Park, Site 2, New York, NY
- 363 Bond Street Development, New York, NY
- LutherCare Village, Saskatoon, SK
- Northland Power Solar Farms, ON
- SP Belle Plaine Spur, Belle Plaine, SK
- MTO 2007-5200, Huntsville, ON (Bot Construction)

- 170 Main Street, Hackensack, NJ
- Domino Sugar - Site E, Brooklyn, NY
- James St GO Station Monitoring
- NY Wheel Development, NY
- North Carolina Department of Transportation Project No. U-2519CB
- Mets Sign Structure, Queens, NY
- Essex Crossing, NY
- 155 West Street, NY
- Edam West Central Processing Facility, Edam, SK
- MTO 2014-4038 - Kent St. Rapid Lift, Ottawa, ON
- 55 Bank St, New York, NY
- Kitchener WWTP, Kitchener, ON
- 30-17 40th Avenue, Long Island City, NY
- Maple Leaf Foods Facility, Hannon, ON
- 160 West Street, Brooklyn, NY
- MTO 2014-6026
- 174 N 11th Street, Brooklyn, NY
- Main Street Reconstruction, Ottawa, ON
- Mill Basin Bridge, Brooklyn, NY
- Carlsbad Lane Bidge, Ottawa, ON
- Prince of Wales Culvert, Ottawa, ON
- I-4 Bridges, Florida
- Avalon Sheepshead Bay, Brooklyn, NY
- Sir Robert Bond Bridge, Gander, NL
- 416 Kent Avenue, Brooklyn, NY
- Brooklyn Navy Yard, Brooklyn, NY
- CPV Valley Energy, Wawayanda, NY
- Shell Chemical, Monica, PA
- Battle River Bridge, Hoadley, AB
- Brichgrove Road Culvert Replacement, Ottawa, ON
- Proton Therapy Center, New York, NY
- MTO 2015-5121 - Virginiatown, ON
- Modera on the Hudson, Yonkers, NY
- USTA Authur Ashe Stadium, Brooklyn, NY
- Hudson Park III, Yonkers, NY
- 99 Hudson Street, Jersey City, NJ
- Meadow Glenn Mall, Medford, Mass
- Brockton Clean Energy Project, Main Power Plant, Brockton, MA
- Retirement Housing, Sorel-Tracy, QC
- AGLC Project, St. Albert, AB
- I84 Bridge over Rattlesnake Creek, Pike County, PA
- Highway 400 Manhole Rehabilitation, Toronto, ON
- FedEx Distribution Center, Maspeth, NY
- Senior Care Center, Edmonton, AB
- Rideau Valley Drive Grit Seperator, Ottawa, ON
- Water Reclamation Center, East Gwillimbury, ON
- Greens Creek Tributary, Ottawa, ON
- PSEG Sewaren 7 Plant, Woodbridge Township, NJ
- South Beach Residential Building, Staten Island, NY
- Tett Center Redevelopment, Kingston, ON
- MTO 2015-5119, Highway 69, Sudbury, ON
- Artists for Humanity – Epicenter Expansion, Boston, MA
- Port Access Road, Charleston, SC
- HWY 407 Phase 2, Toronto, ON
- 6 Tide Street Development; South Boston Massachusetts
- Woodrow Wilson Building, 75 Park Lane south, Jersey City, New Jersey
- Windsor LRT, Windsor, ON
- Clifton Shops – Staten Island, NY
- Iroquois Fall Sanitary Sewer, Iroquois Falls, ON
- Manhattanville Development, Columbia University, NY
- Sayerville Pump Station, Sayerville, NJ
- 1900 St. Joseph., Ottawa, ON
- ES1 Logging Equipment - Crosslinx, Toronto, ON
- Tin Building, Manhattan, NY
- USTA Armstrong, NY
- I-405, California
- Moody Drive Falsework, Ottawa, Ontario
- Suncor Tailings Pond, Fort McMurray, AB
- 280 Richard St. , Brooklyn, NY
- Brule Creek Culvert, Thunder Bay, ON
- I-70 East Corridor Project, Denver, Colorado
- GE Headquarters, Boston, MA
- Harlem River Drive, Manhattan, NY
- 295 Canal Street, Malden, MA
- Davol Square Graduate Student Housing Project, Providence, Rhode Island
- Newark Liberty International Airport, Newark, NJ
- APM Terminals, Elizabeth, NJ
- Holiday Inn, Jersey City, NJ
- MTO 2016-6004 Moose Creek Bridge, ON
- Halton Region Ninth Line Watermain
- Parcel Q1, Drydock Avenue, South Boston, MA
- Phase 2 - Rehabilitation/Replacement of the Kosciuszko Bridge of Newtown Creek, Brooklyn, NY
- East Mall Marketplace, Wantagh, New York
- FedEx Ground Distribution Facility, Maspeth, NY
- 3514 Surf Avenue, Brooklyn, NY
- MTO 2017-5106 Mindemoya Bridge Replacement
- PS143Q Expansion, Queenn, NY
- Combined Sewage Storage Tunnel Site 10, Ottawa, Ontario
- RKO Plaza, Queens, NY
- Garafraxa Bridge, Wellington, ON
- Glen Isle Waterfront Redevelopment, Glen Cove, NY
- The Current on River Apartments, Hackensack, NJ

- Hurricane & Storm Drainage Reduction, Raritan Bay & Sandy Hook Bay
- Newark Liberty International Airport, Terminal A
- Dayton Ave Education Campus, Passiac, NJ
- MTO 2017-4031 Hwy 417 Island Park, Ottawa, ON
- Archer Green Development, 92-23 168th Street, Queens, New York
- Highland Creek WWTP, Toronto, ON
- MTO 2017-2019 Hwy 401 Lloydtown-Aroua Rd, King, ON
- LAX Automated People Mover, Los Angeles, CA
- 339 Sands Street, Brooklyn, NY
- Brookfield Commons Phase 2, White Plains, NY
- Manhattan College Stem Project, 3825 Corlear Ave., Bronx, NY
- North Washington Street Bridge over the Charles River, Boston, MA
- Puyallup River Overcrossing Bridge, Seattle
- Alliance Residential, White Plains, NY
- MTO 2017-4048 - 2nd and 3rd Line Bridges, HWY401, Lancaster, ON
- Rideau River Drive South CDS Unit, Ottawa, ON
- Redhook Houses, Brooklyn, NY
- RIDOT Reconstruction of the Route 6 / Route 10 Interchange, Providence, Rhode Island
- 72 Canton Place Development, Brooklyn, NY
- Proposed Mixed Use Building, 40-17 28th Avenue, Queens, NY
- Forest Hills Co-Op, Queens, NY
- MTO 2018-4007 Hwy 401 Cornwall Trenchless
- NOVA Chemicals Corunna Site, Hydro One Tower 6 Foundation Depth Analysis
- 2401 Third Ave., Bronx, NY
- 101 Linclon Avenue, Bronx, NY
- MTO 2018-4005, Vankleek, ON
- Leslie Nymark Development
- The Stiles Development Site, 18 India Street, Brooklyn, NY
- 2505 Bruckner Blvd, Bronx, NY
- Pier 55 Waterfront Structures, Hudson River Park, Manhattan, NY
- Former Citizens Gas Works MGP Site, Brooklyn, NY
- Jet Fuel Storage Tank, JFK Airport, Brooklyn, NY
- Errol Shores Subdivision Slope Stability, Errol, ON
- East Parcel Redevelopment, Sleepy Hollow, NY
- Brooklyn District 3 Garage, Brooklyn, NY
- Delta Airlines LGA Airfield Reconfiguration Program, Queens NY
- Kew Gardens Interchange, Queens, NY
- 601 W29th Street, Manhattan, NY
- JFK Logistics Center, Nassau County, NY
- John Counter Blvd., Kingston, ON
- LIRR 3rd Track Urban Avenue Undergrade Crossing
- Conley Terminal New Berth 10 Project, Phase II, Boston, MA
- Greenpoint Landing – Parcel D, Brooklyn, NY
- MTO 2018-4019 Ramsayville Rd, Ottawa, ON
- Rideau Canal Rehabilitation, Ottawa, ON
- MTO 2018-4023, Cornwall, ON
- Carey Gardens Community Services Center, Brooklyn, NY
- 155 King Street, Brooklyn, NY
- OLRT2 - Confederation Line
- Gordie Howe International Bridge, Detroit, MI
- MTO 2018-6020, Sturgeon River Bridge, Emo, ON
- MTO 2018-2024, Hwy 89 Underpass, Cookstown, ON
- Birchgrove Rd. Culvert, Limoges, ON
- TDKB Site D Lower Lock 40, Lagoon City, ON
- 1 Huron Street, Brooklyn, NY
- MTO 2018-4008, Hwy 401 and County Rd 2/34, Lancaster, ON

Appendix II

Sample Records

PILE NO: _____

Project: _____

Location: _____

Owner: _____

Contractor: _____

Inspector: _____

Urkkada Job No. _____

Date: _____

Time: _____

Pile Size: _____

Pile Type: _____

Embedment (m): _____

Jack Serial # _____

[illegible]

Job No: _____



URKKADA

Pile Driving Record

Project: _____ Pile No: _____ Driving Shoe: None

Client: _____ Type of Pile: _____ Inclination: _____

Pile Size: _____ Straightness: _____

Structure: _____ Length: _____

Hammer:	Site Conditions	Date	AM	PM
Crane:				
Ground Elev:				
Cut Off Elev:				

Penetration (m)	Blows	Penetration (m)	Blows	Penetration (m)	Blows	Penetration (m)	Blows	Comments
0.25		10.25		20.25		30.25		Pile Head Inclination at End of Drive: N/S: E/W:
0.50		10.50		20.50		30.50		
0.75		10.75		20.75		30.75		
1.00		11.00		21.00		31.00		
1.25		11.25		21.25		31.25		
1.50		11.50		21.50		31.50		
1.75		11.75		21.75		31.75		
2.00		12.00		22.00		32.00		
2.25		12.25		22.25		32.25		
2.50		12.50		22.50		32.50		
2.75		12.75		22.75		32.75		
3.00		13.00		23.00		33.00		
3.25		13.25		23.25		33.25		
3.50		13.50		23.50		33.50		
3.75		13.75		23.75		33.75		
4.00		14.00		24.00		34.00		
4.25		14.25		24.25		34.25		
4.50		14.50		24.50		34.50		
4.75		14.75		24.75		34.75		
5.00		15.00		25.00		35.00		
5.25		15.25		25.25		35.25		
5.50		15.50		25.50		35.50		<div>Date / Time</div> <div>Work Performed</div>
5.75		15.75		25.75		35.75		
6.00		16.00		26.00		36.00		
6.25		16.25		26.25		36.25		
6.50		16.50		26.50		36.50		
6.75		16.75		26.75		36.75		
7.00		17.00		27.00		37.00		
7.25		17.25		27.25		37.25		
7.50		17.50		27.50		37.50		
7.75		17.75		27.75		37.75		
8.00		18.00		28.00		38.00		<i>Splice Information</i> Location of Splice: Date welded: Date welded: Number of Welder (s):
8.25		18.25		28.25		38.25		
8.50		18.50		28.50		38.50		
8.75		18.75		28.75		38.75		
9.00		19.00		29.00		39.00		
9.25		19.25		29.25		39.25		<i>Heat Number</i> Bottom: Top:
9.50		19.50		29.50		39.50		
9.75		19.75		29.75		39.75		
10.00		20.00		30.00		40.00		

Inspector: _____



MORRISON HERSHFIELD



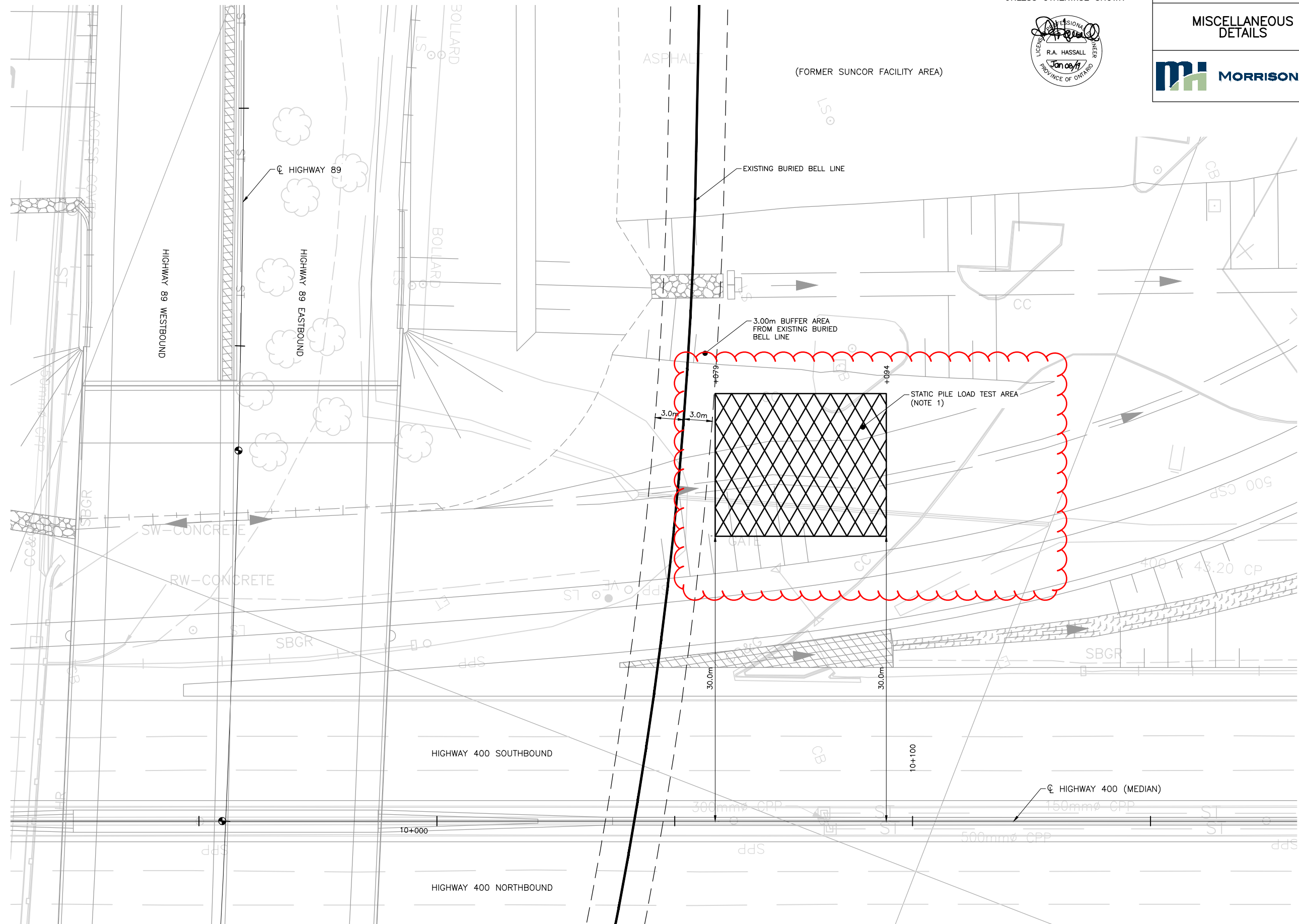
1. STATIC PILE LOAD TEST TO BE COMPLETED AS DOCUMENTED ELSEWHERE IN THE CONTRACT DOCUMENTS.
2. CONSTRUCTION INGRESS & EGRESS SHALL BE FROM HIGHWAY 89 AS SHOWN ELSEWHERE IN THE CONTRACT DRAWINGS.

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT	2018-2024
WP	2438-13-00



SHEET
184-4



SCALE

2m 0 4m

Horizontal

DRAWING NAME: \\TORO1FP\Dat1\share\Proj\1170121\08 Design and Development\Highways-Roads\Working Drawings\11 TYP& DETAIL\184-4-1170121_M0.dwg (Layout1)
PLOT DATE: 2019/01/08 10:54:12 AM

MTO 2018-2024

HWY 400 / 89
COOKSTOWN, ON
AUGUST 2019

Appendix

4

Pile driving



PILE DRIVING PROCEDURE

Powell Foundations Inc.
180 Ram Forest Rd. Stouffville ON L4A 2G8
Phone: 226-706-8380
Email: info@powellfoundations.ca



Powell Foundations Inc.

180 Ram Forest Road, Stouffville, ON L4A 2G8

TEL (226) 706-8380 FAX (905) 727-1229

Procedure for Installation of Driven H-Piles **MTO#2018-2024 Hwy. 400 & Hwy. 89 Interchange**

1. General Notes

- 1.1. An adequate, level, compacted platform is to be provided by others to allow for safe movement of the drill rig/crane within the work area.
- 1.2. Ensure that all locates are valid and up to date prior to commencing any of the piling work. A copy of the locates will be in the cab of the piling rig during all piling operations.
- 1.3. All of the equipment and materials are to stay within the safe working area as provided by the General Contractor.
- 1.4. When delivering steel to site, unload using proper hoisting and rigging techniques and appropriate machinery.
- 1.5. The crane and other heavy machinery shall stay within the designated path of travel as provided by the General Contractor.
- 1.6. Layouts for the center of piles are to be provided by others prior to commencement of pre-drilling and pile driving. Offsets will continually be used to ensure alignment of the driven piles.
- 1.7. Before the start of any piling, an inspection of the work area shall be conducted by the General Contractor to identify any potential hazards. All hazards are to be removed where practicable, confirmation and exposing of existing underground services are to be provided and overhead line clearances are also to be confirmed by others prior to commencement of piling. Overhead lines are to be protected and de-energized by others if applicable. A written report shall be prepared and distributed to the involved parties, indicating all of the remedial work conducted and identify any unremoved hazards.
- 1.8. During the installation of piles, the workers shall wear all required PPE, including double hearing protection within a fifty (50) foot radius of the hammer and any appropriate working at heights protection when required.

2. H-Pile Installation Procedure (as Per OPSS 903.07.02)

- 2.1. Prior to the start of piling a Field Level Hazard Assessment (FLHA) shall be conducted by a competent person, and all equipment to be inspected and recorded in the logbook by the operator.

*NOTE: These procedures are general guidelines for pile installation; actual onsite procedures may vary.



Powell Foundations Inc.

180 Ram Forest Road, Stouffville, ON L4A 2G8

TEL (226) 706-8380 FAX (905) 727-1229

- 2.2. Crane and piling equipment will then be setup on the platform inside of the work area.
- 2.3. A stable area as close to the piling works as possible is to be supplied for pile and material storage.
- 2.4. Weld driving shoe on to the H-piles as per the manufactures instructions provides with the point (Titus Point). Using a CWB certified welder.
- 2.5. H-pile with a welded pile point on the toe will be hoisted with appropriate slings at the correct lifting points that have been checked by a competent person. Adequate clearance of overhead lines will be verified prior to hoisting the H-pile.
- 2.6. The H-pile will then be driving into the center of the layout location and set to a founding elevation on the top of bedrock or as per set criteria in the contract documents.
- 2.7. Once first piece of H-pile is driving to approximately at meter above grade the second piece will be spliced in place using a certified CWB welder ass per W47.1. All splicing shall be completed as per Powell Foundations splicing (welding) procedure and OPSD 3000.150. No splice shall be within the top 6m of the H-pile, and any damaged material shall be cut-off prior to splicing.

Step 2.8 Added only for Test Pile(as per ASTM D1143/D1143m-07)

- 2.8. Two PDA tests are required during the final 2 m depth of the initial driving of the test, and during restrike, a minimum of 48 hours after completion of initial driving.
- 2.9. The hammer will be warmed up prior to restrike of the test pile by firing the hammer 20 times on an external piece of steel (ie. a sheet pile anvil or the steel greasing stand) only if using a diesel hammer.
- 2.10. Static load frame will be set as per the Engineer stamped working drawings.
- 2.11. Static load testing at 2 weeks and 7 weeks after test pile installation will be conducted by Thurber Engineering.

Step 2.12 – 2.16 For Production Piles at Abutments and Pier Only

- 2.12. Restrike of H-piles no sooner than 24 hrs after installation. PDA testing of 10% of piles (or no less than 2) as per OPSS 903 shall be completed. The hammer shall be adequately warmed up prior to restrike of piles only if using a diesel hammer.
- 2.13. The elevation of the top of H-pile is to be verified that it is at the correct elevation.

*NOTE: These procedures are general guidelines for pile installation; actual onsite procedures may vary.



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- 2.14. Cut pile tops at cut-off elevations. Cut-off elevations to be provided by others.
- 2.15. Installation of CSP and placement loose uniformly graded sand backfill inside the CSP, by others.
- 2.16. All testing, monitoring, QVE and inspection by others.

Prepared by Powell Foundations

Reviewed by Saferoads Engineering
Mohammad Vakili, P.Eng.



*NOTE: These procedures are general guidelines for pile installation; actual onsite procedures may vary.

MTO 2018-2024

HWY 400 / 89
COOKSTOWN, ON
AUGUST 2019



PILE SPLICING PROCEDURE & WEDLDING LETTER OF VALIDATION

Powell Foundations Inc.
180 Ram Forest Rd. Stouffville ON L4A 2G8
Phone: 226-706-8380
Email: info@powellfoundations.ca



Powell Foundations Inc. ■ 180 Ram Forest Road, Stouffville, ON L4A 2G8 ■ Ph: 905-727-2518 ■ www.powellfoundations.com

POWELL FOUNDATIONS INC. PILE SPLICING PROCEDURE



1.0. PILE SPLICING

1.1. PREPARE PREVIOUSLY DRIVEN PILE

An assessment will be made of the existing pile heads to determine what needs to be cut-off, the welders will mark the cut-off they will perform on the existing HP pile. They will mark the existing pile with soap stone using a square to ensure the cut-off is level. With the use of an oxygen/acetylene torch, the existing pile will be rough cut to the required elevation. A grinder will be used to clean and level the head of the existing piles. A hand level will be used to ensure levelness of the pile head.

1.2. PREPARE SPLICE EXTENSIONS

The end of the extension that will be welded to the previously driven pile will be cleaned and beveled to a 45 degree angle with a grinder. Extensions will be left long for hoisting and rough cut off. Each extension piece and previously pile will be marked with a number to ensure the correct extension is mated up with the correct existing pile as every extension length will be different.

1.3. SET EXTENSION

Prepped extension lengths will be hoisted into place by a service crane and quick release shackle. Extensions to have a pin hole placed at top of extension to connect quick release shackle for hoisting, pin hole to be placed with oxygen/acetylene torch. Extensions will be fitted and squared with a sufficient gap (6mm) left between the previously driven pile head and the bottom bevel of new pile extension to allow full penetration weld to be performed. The extensions will be tacked in place at this time. All extension will be set in place and tack welded before the full penetration joint weld is carried out.

1.4. ROOT OPENINGS

Root openings wider than those permitted but not greater than twice the thickness of the thinner part or 20mm (3/4in), whichever is less, may be corrected by welding to acceptable dimensions prior to joining the parts by welding. Root openings larger than the above may be corrected by welding only with the approval of the Contractor's Engineer.

1.5. RE-ENTRANT CORNERS

Re-entrant corners, except for the corners of weld access cope holes adjacent to a flange, shall be contoured to a radius of not less than 14mm (9/16in). The transition from the curved to the straight surface shall be smooth and without offsets.

1.6 WELD ACCESS HOLE DIMENSIONS

All weld access holes required to facilitate welding operations shall have a length from the toe of the weld preparation not less than 1.5 times the thickness of the material in which the hole is made. The height of the access



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hole shall be adequate for deposition of sound weld in the material in which the hole is made, but not less than the thickness of the material. In hot-rolled shapes and built-up shapes, all beam copes and weld access holes shall be shaped free of notches or sharp re-entrant corners, except that when fillet weld-to-flange welds are used in built-up shapes, access holes may terminate perpendicular to the flange. Fillet welds shall not be returned through weld access holes.

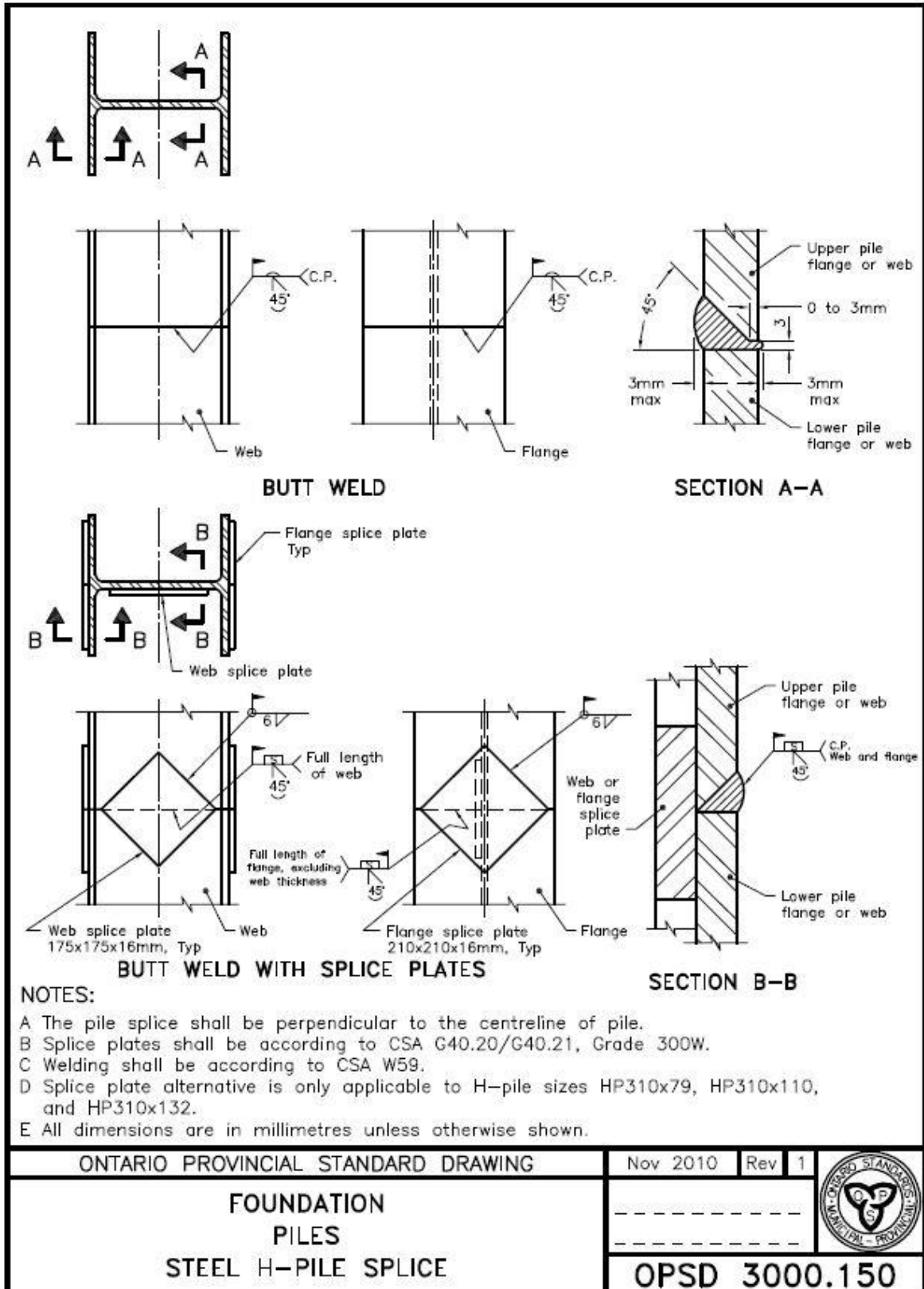
Note: When weld access holes must be closed for cosmetic or corrosion protection reasons, sealing by use of mastic materials is preferable to welding.

1.7. PERFORMING FULL PENETRATION WELD

After every extension is fit and leveled, welding of the full penetration joints will commence. The method of welding Powell Foundations will employ for the full penetration joint is SMAW (stick welding). Only competent welders to perform this weld.

All welding rods will be kept in an oven.

C.W.B. welding supervisor will make field visits to aid in any welding procedures and provide on going training and mentoring or revisions of practices to ensure a quality finished product.



POWELL FOUNDATIONS

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WELDING PROCEDURE DATA SHEET/ WELDING PROCEDURE SPECIFICATION				WPDS #:	SM-BTC-4-2G PG1					
Company Name:				Date:	September 17, 2015					
Address:				Ref. Standards:	CSA W47.1 & W59					
MILTON ONTARIO L9T 3L5				Ref. WPS:	SM-WPS-01					
Ref. PQR:										
Process:	SMAW	Pulsed?	No	Position:	Horizontal					
Base Mat'l:	Steel Group 1,2,3 Table 11.1/12.1 CSA W59, ASTM A252 Gr 2/3, ASTM A106 Gr B/C, API 5L X42 / X46 / X52 / X56 / X60 / X65 (max CE = 0.5) (see notes)			Flux Type:	N/A					
Filler Metal:	E4918-1-H4 / E4918-1-H4R / E4918-H4			Tungsten Type:	N/A					
Clearing:	REMOVE SLAG AND WIRE BRUSH			Tungsten Dia.:	N/A in					
				Min. PHT Temp:	Table 5.3 CSA W59*					
				PWHT Temp:	N/A °F					
				Interpass:	Min:	PHT				
					Max:	550 °F				
Typical Joint Preparation:				Typical Pass and Layer Sequence:						
Joint Dimensions:				G = 0-1/8 Q T = 45 R _{min} = 1/16 ETT (E) = T						
Joint Tolerances:				±						
WELD TYPE:				Unless noted dimensions are in inches.						
Groove Weld				Butt	X	Electrical Stickout:				
TYPE OF PENETRATION:				Tee	X	N/A in				
Complete Joint Penetration				Corner	X	Nozzle Dia:				
TYPE OF BACKING:				Lap		N/A in				
Backgouged to Sound Metal				Edge		Avg. Deposition Rate:				
Material:				lbs/h						
Thickness:										
(in)										
Technique:				* Preheat - For ASTM A252 Gr 2/3 use Column 3 Table 5.3 preheat requirements based on material thickness						
Material Thickness (in)	Weld Size (in)	No. of Layers	No. of passes	Electrode Size (in)	Current Polarity	Current (A)	Wire Feed Speed (in/min)	Voltage (Volts)	Travel Speed (in/min) Min Max	Heat Input (kJ/in) Min Max
3/8	3/8	1 - 2	1 - 3	1/8	DCRP	110 - 160		20 - 28	2 8	
		3	4	5/32	DCRP	160 - 220		20 - 28	3 12	
		4	5 - 6	5/32	DCRP	160 - 220		20 - 28	3 10	
1/2	1/2	1 - 2	1 - 3	1/8	DCRP	110 - 160		20 - 28	2 8	
		3	4	5/32	DCRP	160 - 220		20 - 28	3 12	
		4 - 5	5 - 9	5/32	DCRP	160 - 220		20 - 28	3 10	
5/8	5/8	1 - 2	1 - 3	1/8	DCRP	110 - 160		20 - 28	2 8	
		3	4	5/32	DCRP	160 - 220		20 - 28	3 12	
		4 - 6	5 - 12	5/32	DCRP	160 - 220		20 - 28	3 10	
3/4	3/4	1 - 2	1 - 3	1/8	DCRP	110 - 160		20 - 28	2 8	
		3	4	5/32	DCRP	160 - 250		20 - 28	3 12	
		4 - 6	5 - 12	3/16	DCRP	220 - 250		20 - 28	3 10	
		7	13 - 15	5/32	DCRP	160 - 220		20 - 28	3 10	
Notes:				ASTM A252 Grade 2/3: CE Max=0.5%, S max=0.65%, P max=0.04% Prior to initiating welding the contractor must confirm base material chemistry: $CE = C + (Mn+Si)/6 + (Cr+Mo+V)/5 + (Ni+Cu)/15$						
Revision Date:		Explanation:		CWB Approval:		Company's Authorization:				
				 October 02, 2015 Welding & welding communications are certified by the CWB		 9/17/2015				
Prepared by: Oneworld Integrated Solutions										

POWELL FOUNDATIONS

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WELDING PROCEDURE DATA SHEET/ WELDING PROCEDURE SPECIFICATION		WPDS #:	SM-BTC-4- 2G PG2																																																																																																																																															
Company Name: BLACKROCK FOUNDATION SOLUTIONS INC.		Date:	September 17, 2015																																																																																																																																															
Address: 1-581 MCGREACHIE DRIVE MILTON ONTARIO L9T 3L5		Ref. Standards:	CSA W47.1 & W59																																																																																																																																															
		Ref. WPS:	SM-WPS-01																																																																																																																																															
		Ref. PQR:																																																																																																																																																
Process:	SMAW Pulsed? No	Position:	Horizontal																																																																																																																																															
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Filler Metal:	E4918-1-H4 / E4918-1-H4R / E4918-H4	Tungsten Type:	N/A																																																																																																																																															
Cleaning:	REMOVE SLAG AND WIRE BRUSH	Tungsten Dia.:	N/A in																																																																																																																																															
		Min. PHT Temp:	Table 5.3 CSA W59																																																																																																																																															
		PWHT Temp:	N/A																																																																																																																																															
		Interpass:	Min: PHT Max: 550																																																																																																																																															
Typical Joint Preparation:		Typical Pass and Layer Sequence:																																																																																																																																																
Joint Dimensions:		G = 0-1/8 Q (") = 45 R _{min} ≥ 1/16 ETT (E) = T																																																																																																																																																
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Notes: ASTM A252 Grade 2/3: CE Max=0.5%, S max=0.05%, P max=0.04% Prior to initiating welding the contractor must confirm base material chemistry CE = C + (Mn+Si)/6 + (Cr+Mo+V)/5 + (Ni+Cu)/15																																																																																																																																																		
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Prepared by: Omniweld Integrated Solutions		9/17/2015																																																																																																																																																



LETTER OF VALIDATION

The CWB acknowledges that

Powell Foundations Inc.

21 Fortecon Drive
Stouffville, ON, L4A 2G8, Canada

is certified to CSA Standard **W47.1**

“Certification of Companies for Fusion Welding of Steel”

In the DIVISION 2

for the period **09/15/2018 to 10/14/2019**

Company Code: BLACF1

Scope: Installation of structural steel in shoring and foundation systems as per code.

Reason for Issue: Renewal

Issue Date: 09/15/2018

*For the latest CWB certification
Documents & Forms and
Certification Terms & Conditions,
please visit: www.cwbgroup.org*



Registrar



Accredited
CB-PS
(Certification Body - Product/Services)

8260 Parkhill Drive, Milton, Ontario L9T 5V7
1-800-844-6790 | Int: 905-542-1312 | Fax: 905-542-1318
Email: info@cwbgroup.org | Web: www.cwbgroup.org



Welder Qualification

This card is valid only while employed by a CWB certified company

Transferable Welder

Name: **AARON HICKS**

Exp. Date: **Apr 24, 2021**

Employer: **AV Hicks Mobile Welding, Oshawa, ON**

Thickness Range: **3mm & above**

Material: **Carbon Steel**

Mode: **MANUAL**

Process: **SMAW**

Standard: **CSA W47.1**

Classification: **S**

Electrode: **F4**

Class: **FLAT/HORIZONTAL/VERTICAL UP/OVERHEAD**

See Reverse for Conditions



Welder Qualification

This card is valid only while employed by a CWB certified company

Transferable Welder

Name: ANTHONY BOODRAM

Exp. Date: Jan 07, 2020

Employer: Labourers Int. Union of North America - Local 183, Woodbridge, ON

Thickness Range: 3mm & above

Material: Carbon Steel

Process: SMAW

Mode: MANUAL

Standard: CSA W47.1

Classification: S

Electrode: F4

Class: FLAT/HORIZONTAL/VERTICAL UP/OVERHEAD

See Reverse for Conditions



Welder Qualification

This card is valid only while employed by a CWB certified company

Transferable Welder

Name: **DEVIN MADILL**

Exp. Date: **Mar 15, 2020**

Employer: **Labourers Int. Union of North America - Local 183, Woodbridge, ON**

Thickness Range: **3mm & above**

Material: **Carbon Steel**

Process: **SMAW**

Mode: **MANUAL**

Standard: **CSA W47.1**

Classification: **S**

Electrode: **F4**

Class: **FLAT/HORIZONTAL/VERTICAL UP/OVERHEAD**

See Reverse for Conditions



Welder Qualification

This card is valid only while employed by a CWB certified company

Transferable Welder

Name: JEFF POTIPCO

Exp. Date: Sep 27, 2020

Employer: Labourers Int. Union of North America - Local 183, Woodbridge, ON

Thickness Range: 3mm & above

Material: Carbon Steel

Mode: MANUAL

Process: SMAW

Standard: CSA W47.1

Classification: S

Electrode: F4

Class: FLAT/HORIZONTAL

See Reverse for Conditions



Welder Qualification

This card is valid only while employed by a CWB certified company

Transferable Welder

Name: **JEREMY W. KEELER**

Employer: **Labourers Int. Union of North America - Local 183, Woodbridge, ON**

Thickness Range: **3mm & above**

Mode: **MANUAL**

Exp. Date: **Feb 06, 2021**

Material: **Carbon Steel**

Process: **SMAW**

Standard: **CSA W47.1**

Classification: **S**

Electrode: **F4**

Class: **FLAT/HORIZONTAL/VERTICAL UP/OVERHEAD**

See Reverse for Conditions



Welder Qualification

This card is valid only while employed by a CWB certified company

Transferable Welder

Name: **JAMES D. MCLEAN**

Exp. Date: **Sep 27, 2019**

Employer: **Labourers Int. Union of North America - Local 183, Woodbridge, ON**

Thickness Range: **3mm & above**

Material: **Carbon Steel**

Mode: **MANUAL**

Process: **SMAW**

Standard: **CSA W47.1**

Classification: **S**

Electrode: **F4**

Class: **FLAT/HORIZONTAL/VERTICAL UP/OVERHEAD**

See Reverse for Conditions



Welder Qualification

This card is valid only while employed by a CWB certified company

Test Centre Welder Test Record

Transferable Welder

Name: **RONALD B. KEELER**

Exp. Date: **Feb 10, 2021**

Test Facility: **General Welding School Ltd.**

Thickness Range: **3mm & above**

Material: **Carbon Steel**

Process: **SMAW**

Mode: **MANUAL**

Standard: **CSA W47.1**

Classification: **S**

Electrode: **F4**

Class: **FLAT/HORIZONTAL/VERTICAL UP/OVERHEAD**

See Reverse for Conditions

APPENDIX 'E' -4.2 c) – Static Load Test Frame Design and Associated Documentation

1. General Note

The design of the reaction frame was performed by Saferoads Engineering Inc. as per ASTM D1143M Figure 1. The sealed design is provided in Appendix 'E' along with a sealed letter of review by the Contractor's Engineer, Urkkada

2. Contents

- 2.1. Saferoads Engineering Inc: Static Load Testing Frame Calculations and Design Drawings.
- 2.2. Urkkada: Sealed Letter of Review
- 2.3. Canadian BBR Inc: Static Load Test Jack Calibration, Gauge Calibration
 - 2.3.1. Dial Gauges to be installed as per ASTM 1143 Section 7.2.2: Displacement Indicators— Mount a minimum of two displacement indicators on the reference beams to bear on the pile top at axisymmetric points equidistant from the center of the test pile, or pile cap, with stems parallel to the longitudinal axis of the pile, inclined pile, or pile group. Orient two parallel reference beams, one on each side of the test pile or pile cap, in a direction that permits placing their supports as far as feasible from anchor piles or cribbing. Alternatively, mount the two indicators on axisymmetric points equidistant from the center of the test pile, or pile cap, with the stems parallel to the longitudinal axis of the pile or pile group to bear on the reference beams.
- 2.4. Hoskins Scientific: Load Cell Description
 - 2.4.1. Note: Calibration will be provided prior to testing.

Appendix B – Pile Testing Frame SRE Drawing

August 12, 2019
1373-CEzomo-L06

Fermar Paving Limited
1921 Albion Road
Rexdale, ON M9W 5S8

Attention: Mr. Charles Ezomo, Senior Project Manager

Subject: Item 258 – Steel Axial Compressive Load Testing
MTO 2018-2024, Cookstown, ON
Our File 1905CS1373


Dear Charles,

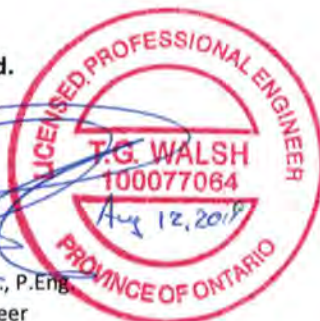
Per the requirements of Section 4.2 of Item 258 – Steel Axial Compressive Load Testing, we have reviewed the static load test submittal (as provided in "Hwy400 & Hwy89 Pile Testing Drawing-stamped.pdf", copy enclosed) prepared by Powell Foundations and Safe Roads Engineering dated July 19, 2019.

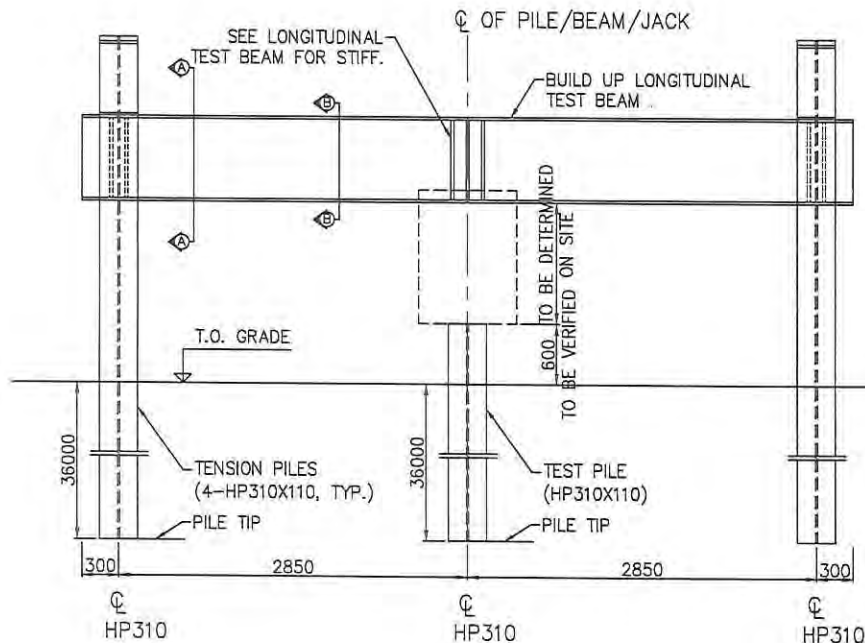
The load test configuration presented in the above indicated document is in general conformance with the contract requirements and ASTM D1143. Based on the geotechnical information provided in the "Foundation Investigation Report, High Fill Embankment, Highway 400-89 Interchange Reconstruction" prepared by Golder dated September 25, 2018, the reaction piles, as designed by Powell Foundations and Safe Roads Engineering, are sufficient to provide the required tensile resistance for both static load tests provided that the piles are not disturbed between driving and performance of the load tests. Please note that we have not reviewed the structural design of the load frame as this is outside of our scope of work.

Per Item 158, Section 4.2.d "Calibration certificates for all instruments, hydraulic jack(s), pressure gauges(s) and pressure transducers. All hydraulic jack(s), pressure gauge(s), and pressure transducers must have been calibrated to at least 120 per cent of the maximum testing load within six months of the tests." The calibration certificates have not been provided in the submittal and are required prior to performing the static load test.

Best regards,
Urkada Technology Ltd.


Thomas Walsh, M.A.Sc., P.Eng.
Senior Geotechnical Engineer





ELEVATION
N.T.S.

GENERAL NOTES:

- DRAWING HAVE BEEN PROVIDED FOR THE JACKING BEAM, HEADWORKS, TEMPORARY TENSION PILES AND TEST PILE LAYOUT FOR MTO 2018-2024. REFER TO LOAD TEST PROCEDURE PREPARED BY URKKADA, THE CONTRACT SPECIFICATIONS AND ASSOCIATED GEOTECHNICAL REPORTS. DESIGN IS BASED ON A MAXIMUM AXIAL TEST LOAD OF 3750 KN(4500 KN FACTORED).
- PILES(TEST PILE AND TENSION PILES) SHALL BE INSTALLED TO WITHIN A 10MM TOLERANCE OF THEIR THEORETICAL LOCATIONS. PILE TEMPLATES SHALL BE UTILIZED TO ENSURE PROPER ALIGNMENT WITH THE TEST FRAME AND ENSURING TOLERANCES ARE MET. CA/FES RECOMMEND INSTALLATION OF THE TEST PILE, TEMPORARILY ATTACHMENT OF THE TEST PILE TO THE LONGITUDINAL TEST BEAM, AND UTILIZATION OF THE LONGITUDINAL TEST BEAM AS A DRIVING TEMPLATE FOR THE REMAINING TEMPORARY TENSION PILES. ADDITIONAL TEMPLATE KEEPERS AND ASSEMBLIES ARE THE RESPONSIBILITY OF THE CONTRACTOR.
- DESIGN, FABRICATION AND CONSTRUCTION SHALL BE PER THE REQUIREMENTS OF CAN/CSA-S6(LATEST EDITION).
- ALL WORK TO BE CARRIED OUT IN ACCORDANCE WITH ONTARIO OCCUPATIONAL HEALTH AND SAFETY REGULATIONS.
- ALL STRUCTURAL STEEL SHALL BE NEW STOCKS OR EXISTING STOCK IN GOOD CONDITION WITH LESS THAN 5% SECTION LOSS AND CONFORM TO THE FOLLOWING GRADES:
 - ALL PLATE, ANGLES, CHANNELS AND WIDE FLANGE SECTIONS: CAN/CSA-G40.21-13 TYPE 350W.
- NDT TESTING REQUIREMENTS FOR FABRICATION:
 - WELD INSPECTORS QUALIFIED AS PER THE REQUIREMENTS OF CWB AND CSA W178.2;
 - ACCEPTANCE CRITERIA FOR ALL INSPECTIONS AS PER THE REQUIREMENTS OF CSA W59-03, SECTION 11, CL 11.5.4;
 - WELD TESTING REQUIREMENTS IN ACCORDANCE WITH CAN/CSA-S6(LATEST EDITION).
- GROUND PREPARATION AND TEST LOCATION DETERMINATION IS THE RESPONSIBILITY OF THE CONTRACTOR. FINAL TEST LOCATION SHALL BE SUBMIT TO THE CA/FES FOR REVIEW AND APPROVAL PRIOR TO PROCEEDING WITH TEST PILE INSTALLATION TO ENSURE ASSUMED GEOTECHNICAL PARAMETERS ARE APPLICAITON FOR THE TEST LOCATION AND GROUND ELEVATION.

METRIC
DIMENSIONS ARE IN
MILLIMETERS
UNLESS OTHERWISE SHOWN



180 RAM FOREST ROAD
STOUFFVILLE, ON
L4A 2G8



180 RAM FOREST ROAD
STOUFFVILLE, ON
L4A 2G8



Guigui Zu P.Eng.

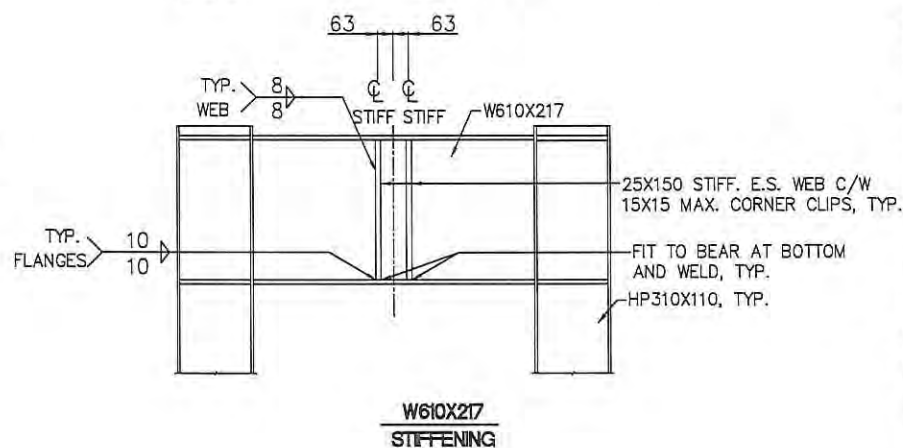
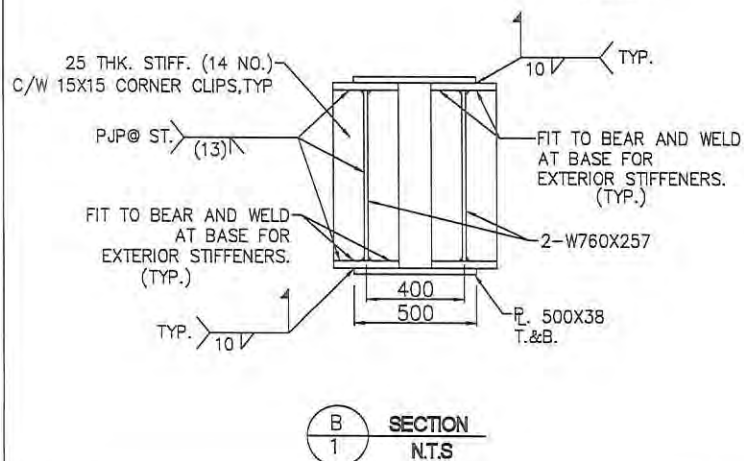
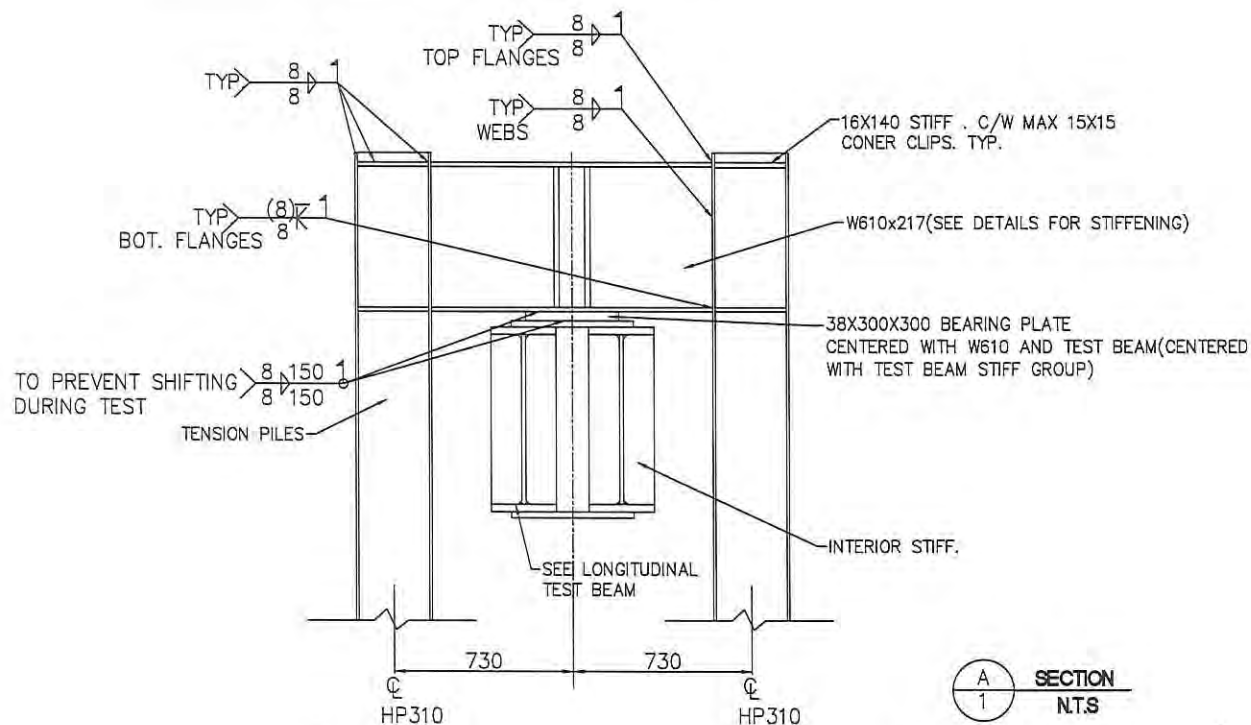


Mohammad Vakil P.Eng.

Rev	Date	By	Description
2	05/09/2015	G.Z.	Double Stamp
1	04/09/2015	G.Z.	Minor Change
0	19/07/2015	S.H.	Issued for Approval

Client:	Powell Foundations		
Project:	MTO # 2018-2024 Hwy 400& Hwy 89 Interchange		
Location:	Barrie, ON		
Drawing Name:	PILE TEST FRAME ELEVATION		
Designed By:	S.H.	Drawn By:	S.H.
Reviewed By:	M.V.	Start Date:	
Drawing No.:		SRE Code:	

Sheet No.
1 of 3



METRIC
DIMENSIONS ARE IN
MILLIMETERS
UNLESS OTHERWISE SHOWN



180 RAM FOREST ROAD
STOUFFVILLE, ON
L4A 2G8



180 RAM FOREST ROAD
STOUFFVILLE, ON
L4A 2G8



Guigui Zu P.Eng.



Mohammad Vakili P.Eng.

Rev.	Date	By	Description
2	05/09/2019	G.Z.	Double Stamp
1	04/03/2019	G.Z.	Minor Change
0	19/07/2019	M.C.B.	Issued for Approval

Client: Powell Foundations

Project: MTO # 2018-2024 Hwy 400& Hwy 89 Interchange

Location: Barrie, ON

Drawing Name: Sections and Details

Designed By: S.H. Drawn By: S.H.

Reviewed By: M.V. Start Date:

Drawing No.: SRE Code:

Sheet No.

2 of 3



Ph. 905.727.4198

Fax. 905.727.1229

21 FORTECON DR, GORMLEY, ON, L0H1G0

MTO #2018-2024 Hwy400&Hwy89 Interchange Pile Testing Frame Calculation

Prepared for Powell Foundations

August 30, 2019

Table of Contents

1. Background
2. Reference Documents
3. Design Summary

Appendices

Appendix A - Detail Design Calculation of Pie Testing Frame

Appendix B – Pile Testing Frame SRE Drawing

MTO #2018-2024 Hwy400&Hwy89 Interchange Pile Testing Frame Calculation

1 Background

Powell Foundations had retained Safe roads engineering to perform calculation for MTO #2018-2024 Hwy400&Hwy89 Interchange pile testing frame.

2 Reference documents

- Canadian Highway Bridge Design Code (CHBDC, CAN/CSA-S6-14);
- Contract Drawings: Hwy89/Hwy400 Underpass Drawings. Morrison Hershfield. Contract No. 2018-2024. WP No. 2438-13-00. Sheet 287 A, 290A, 292A (SK1 to SK2 Dwg);
- Hwy400& Hwy89 Pile Testing Frame Drawings (Sheet # 1 to 3) by SRE.

3 Design Summary

Pile should be 2 - W760x257 with top and bottom 38x500mm cover plates. Testing beam resting on transversal beam (W610x217), which are supported on 2 No. tension piles (HP310x110) on each side.

Design is based on a maximum axial test load of 3750 KN (4500 KN factored)

Detail design calculation of pile testing frame can be found in Appendix A. Pile testing frame SRE drawing is in Appendix B.



Report Prepared by:
Guigui Zu, M.E.Sc, P.Eng
Structural Engineer

Report Checked by:
Mohammad Vakili, MSc, P.Eng
Senior Structural/Bridge Engineer

Appendix A- Detail Design Calculation of Pile Testing Frame

MTO #2018-2024 Hwy400&Hwy89 Interchange Pile Testing Frame Calculation

1) Test Beam

Section :W760x257

$f_y := 343 \text{ Mpa}$:Yield stress $\phi_s := 0.95$

$E := 2 \cdot 10^5 \text{ Mpa}$:Young's Modulus $G_s := 77000 \text{ Mpa}$:Shear Modulus

$S_x := 8875 \cdot 10^3 \text{ mm}^3$ $Z_x := 9970 \cdot 10^3 \text{ mm}^3$ $I_x := 3430 \cdot 10^6 \text{ mm}^4$ $I_y := 250 \cdot 10^6 \text{ mm}^4$

$A := 32900 \text{ mm}^2$ $r_x := 322.9 \text{ mm}$ $r_y := 87.2 \text{ mm}$

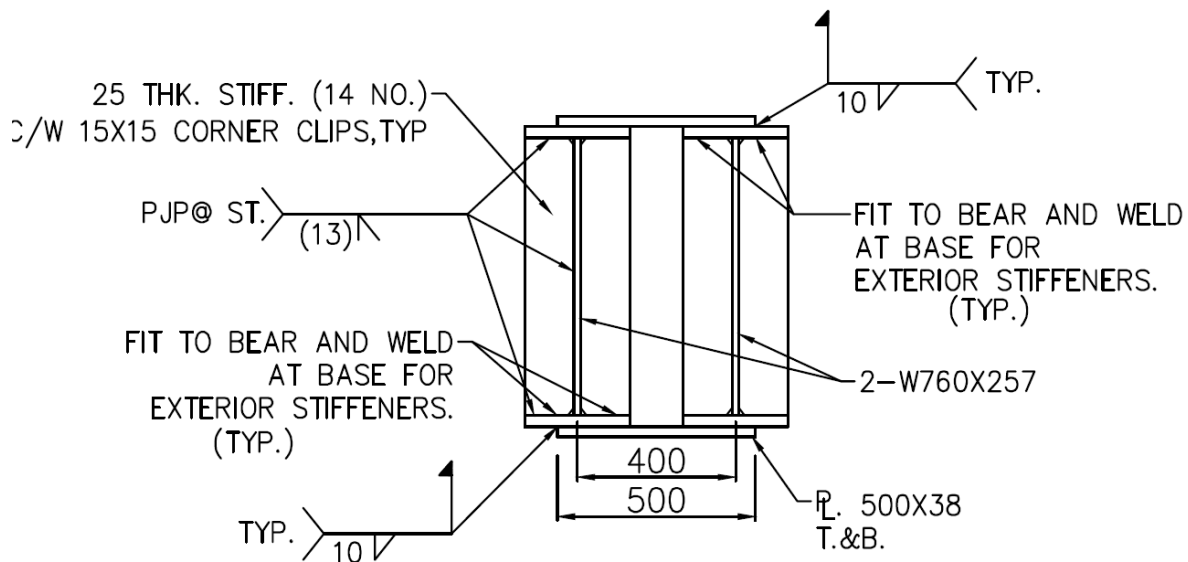
$L_{girder} := 2.85 \cdot 2 = 5.7 \text{ m}$

Test load = 3750 KN at middle of Test beam (considered simple span)

$$M_f := 3750 \cdot 1.2 \cdot \frac{L_{girder}}{4} = 6.413 \cdot 10^3 \text{ KN} \cdot \text{m}$$

$$S_{req} := \frac{M_f \cdot 10^6}{\phi_s \cdot f_y} = 1.968 \cdot 10^7 > 2 \cdot S_x = 1.775 \cdot 10^7 \text{ mm}^3 \text{ NG}$$

So, try top and bottom cover plates: Plate 38x500



$$A_{pl} := 38 \cdot 500 = 1.9 \cdot 10^4 \text{ mm}^2$$

$$I_{pl} := A_{pl} \cdot 2 \cdot \left(\frac{773 + 38}{2} \right)^2 = 6.248 \cdot 10^9 \text{ mm}^4 \quad S_{pl} := \frac{I_{pl}}{\left(\frac{760}{2} + 38 \right)} = 1.495 \cdot 10^7 \text{ mm}^3$$

MTO #2018-2024 Hwy400&Hwy89 Interchange Pile Testing Frame Calculation

$$S_{total} := 2 \cdot S_x + S_{pl} = 3.27 \cdot 10^7 \text{ mm}^3 > S_{req} = 1.968 \cdot 10^7 \text{ mm}^3 \quad (\text{OK})$$

∴ Use 2W760x257+Plate 500x38 (T&B)

Longitudinal weld of cover plate to W section:

Consider 10mm fillet weld,

$$V_f := \frac{3750 \cdot 1.2}{2} = 2.25 \cdot 10^3 \text{ KN} \quad : \text{ Max shear force on beam}$$

$$Q := A_{pl} \cdot \left(\frac{773}{2} \right) = 7.344 \cdot 10^6 \text{ mm}^3$$

$$I_t := 2 \cdot I_x + I_{pl} = 1.311 \cdot 10^{10} \text{ mm}^4$$

$n := 2$: 2 No. welds

$$f_v := \frac{V_f \cdot Q}{I_t \cdot n} = 0.63 \frac{\text{KN}}{\text{mm}} \quad f_r := 1.56 \frac{\text{KN}}{\text{mm}}$$

$$\frac{D}{C} = \frac{f_v}{f_r} = 0.404 < 1 \quad (\text{OK})$$

∴ Use 10mm weld

2) Transversal beam W610x217

$$L_t := 1.46 \text{ m} \quad S_x := 6083 \cdot 10^3 \text{ mm}^3$$

$$M_f := \frac{V_f \cdot L_t}{4} = 821.25 \text{ KN} \cdot \text{m}$$

$$S_{req} := \frac{M_f \cdot 10^6}{\phi_s \cdot f_y} = 2.52 \cdot 10^6 < S_x = 6.083 \cdot 10^6 \quad (\text{OK})$$

3) Tension Pile HP310x110

$$T_f := \frac{V_f}{2} = 1.125 \cdot 10^3 \text{ KN} \quad A_s := 14100 \text{ mm}^2$$

$$f_t := \frac{T_f \cdot 10^3}{A_s} = 79.787 \text{ MPa} < \phi_s \cdot f_y = 325.85 \text{ MPa} \quad (\text{OK})$$



Canadian BBR Inc.
3450 Midland Avenue
Agincourt Ontario

Calibration of Hydraulic Components

28-Aug-19

RJ 1000-18-5306

Ram Area (sq. in.) 243.7
Friction Calibration 1.017

Calibrated with Digital pressure gauge
Enerpac Model DGB / 10000 psi
Load cell BBR no.2



Gauge psi	Voltage run 1	Voltage run 2	Voltage run 3	Voltage (avg)	Load kips
1000	1.691	1.703	1.711	1.702	238.23
2000	3.409	3.423	3.422	3.418	478.52
3000	5.136	5.14	5.146	5.141	719.69
4000	6.834	6.855	6.855	6.848	958.72
5000	8.55	8.567	8.566	8.561	1198.54
5800	9.9	9.918	9.91	9.909	1387.31



P.O. Box 37, Agincourt, ON M1S 3B4
3450 Midland Ave., Scarborough, ON M1V 4V4

Tel: (416) 291-1618
Fax: (416) 291-9960

CERTIFIED TEST REPORTS

Reference No. : **256** Date : **09-Aug-19**

Gauge Type : **WIKA 0 - 10,000 PSI**

Machine : **Deadweight Tester Mansfield & Green**

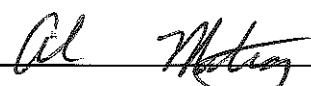
Traceability To : **National Bureau Standards**

Dead Weight Pressure

1000 psi
2000 psi
3000 psi
4000 psi
5000 psi
6000 psi
7000 psi
8000 psi
9000 psi

Gauge Indicated Pressure

1025 psi
2025 psi
3025 psi
4000 psi
5000 psi
6000 psi
7000 psi
8000 psi
9000 psi

Signature : 



P.O. Box 37, Agincourt, ON M1S 3B4
3450 Midland Ave., Scarborough, ON M1V 4V4

Tel: (416) 291-1618
Fax: (416) 291-9960

CERTIFIED TEST REPORTS


Reference No. : **257** Date : **28-Aug-19**
Gauge Type : **WIKA 0 - 10,000 PSI**
Machine : **Deadweight Tester Mansfield & Green**
Traceability To : **National Bureau Standards**

Dead Weight Pressure

1000 psi
2000 psi
3000 psi
4000 psi
5000 psi
6000 psi
7000 psi
8000 psi
9000 psi

Gauge Indicated Pressure

975 psi
2000 psi
3000 psi
4000 psi
5000 psi
5975 psi
6975 psi
7950 psi
8950 psi

Signature : 

Strain Gauge Solid Load Cell SGLC-7050 Series

Typically used to measure and monitor compressive load or force in structural members, struts and piles



Strain Gauge Solid Load Cell SGLC-7050 Series

Overview



The Geosense® SGLC 7050 series load cell consists of a solid cylinder of high strength stainless steel with a series of electrical resistance strain gauges connected around the periphery as a Wheatstone Bridge that compensates for unevenly distributed loads and provides a single mV/V signal output.

When the load cell is subjected to load the resistance of the strain gauges will change and the output signal is directly proportional to the applied load. Mounting surfaces should be flat and parallel for optimum performance and the use of loading cap for strut monitoring is recommended.

Connection to the load cell is via a heavy duty multi-core sheathed cable which can be connected to a direct portable readout, data logging or Wi-SOS 400 system.

APPLICATIONS

Measurement of load acting on:

Piles

Struts

Arch Supports

Props

FEATURES

High strength steel construction

Load distribution plates available

Proven long term accuracy

Accommodates eccentric loading

Multiple gauge system

Data logger compatible

Available with plug connector or cable



Strain Gauge Load Solid Cell SGLC-7050 Series

Specifications

LOAD CELL

Range (kN)	1000, 2000, 3000, 5000, 10000
Non linearity	± 1% FS
Over range	150%
Excitation	10V DC
Output	1.5mV/V
Bridge resistance	1400 Ohms
Number of sensors	16
Material	Stainless steel
Temperature range	-20 to + 70°C
Temperature effect on output	0.01% applied load/°C

DIMENSIONS

Capacity (kN)	Diameter (mm)	Height (mm)
1000	100	150
2000	125	180
3000	138	185
5000	165	250
10000	276	400

Strain Gauge Solid Load Cell SGLC-7050 Series

Specifications



LOAD DISTRIBUTION PLATES

Capacity(kN)	OD(mm)	Height(mm)
1000	100	100
2000	125	100
3000	138	100
5000	165	100
1000	276	100

ANCILLARY EQUIPMENT

MP12 readout

Data loggers

Load distribution plates

Cable - Type 910 - Multi-core with Foil Screen & Drain Wire

Centraliser bushings if required

Fly Connector

Cable End Protector

Jump Cables

ORDERING INFORMATION

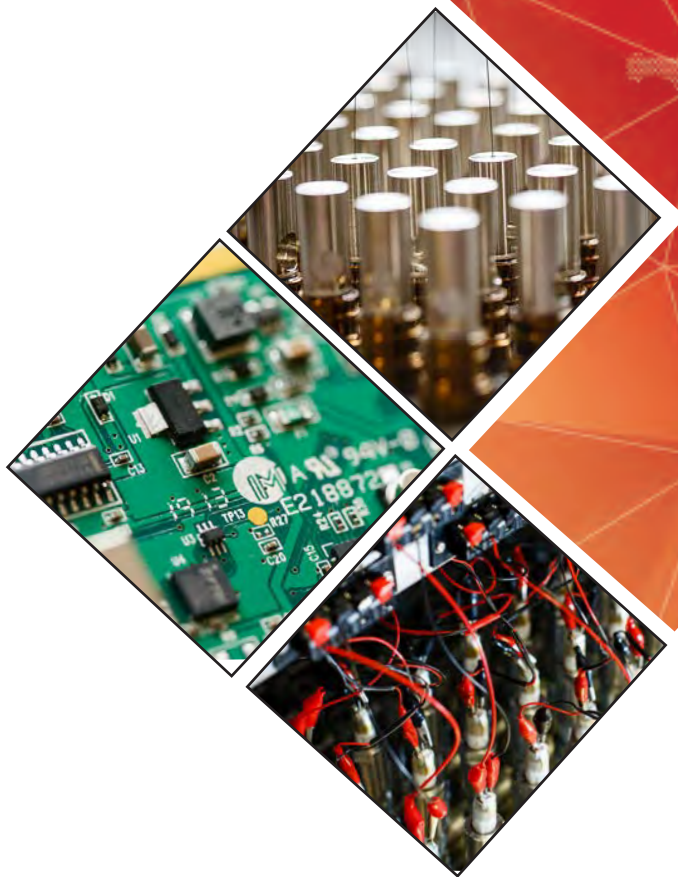
Capacity

Cable length

Readout

Load distribution plate

Connectors



Geosense Ltd, Nova House, Rougham Industrial Estate, Rougham, Bury St Edmunds, Suffolk IP30 9ND, England

www.geosense.co.uk e sales@geosense.co.uk t +44(0)1359 270457

Multipurpose Readout MP12

A multipurpose manual readout unit which can be used with all types of electrical outputs including vibrating wire



Multipurpose Readout MP12

Overview



The Geosense® MP12 is a multipurpose manual readout unit which can be used with all types of electrical outputs including vibrating wire.

Colour coded connections for the different sensor types makes the MP12 easy to use with any type of sensor cable.

The simple display means that you do not have complicated multiple screen menus and can be operated with just six simple buttons.

The MP12 comes with a rugged lightweight carry case complete with battery charger and colour coded "jumper cables" complete with crocodile clip.

APPLICATIONS

Manual readout for:

Piezometers

Load cells

Tilt Meters & Tilt Beams

Strain gauges

Rod extensometers

Settlement systems

Joint Meters & Crack Meters

Pressure cells & NATM cells

Thermistors & Thermocouples

FEATURES

Multiple sensor inputs

Small & lightweight

Easy to use

Simple keyboard buttons

Easy to see

Re-chargeable battery

Displays battery status

Fully CE compliant



Multipurpose Readout MP12

Specifications

GENERAL

Signal inputs	4-20mA 2C, 4-20mA 3C, V, mV, mV/V 3C, mV/V 4C, °C, Hz, PT100, NTC
Sensor supply voltage	+20V, +/-12V, +5V
Power supply	Internal 12 volt battery (re-chargeable)
Measurement resolution	16 bit
Display	LCD 16 x 2 back-light characters
Operating temperature	-20 to +70 °C
Temperature drift	+15ppm/°C maximum
Enclosure	IP65
Dimensions L x B x H	130 x 100 x 35mm
Weight	600g



Geosense Ltd, Nova House, Rougham Industrial Estate, Rougham, Bury St Edmunds, Suffolk IP30 9ND, England

www.geosense.co.uk e sales@geosense.co.uk t +44(0)1359 270457



PILE DRIVING RIG EQUIPMENT

Heavy Duty Crawler:



SC-90HD

Pile Driving Lead System:



SC-90HD Pile Driving VLT

Pile Driving Hammer:



B32 Diesel Hammer

Heavy Duty Crawler Crane

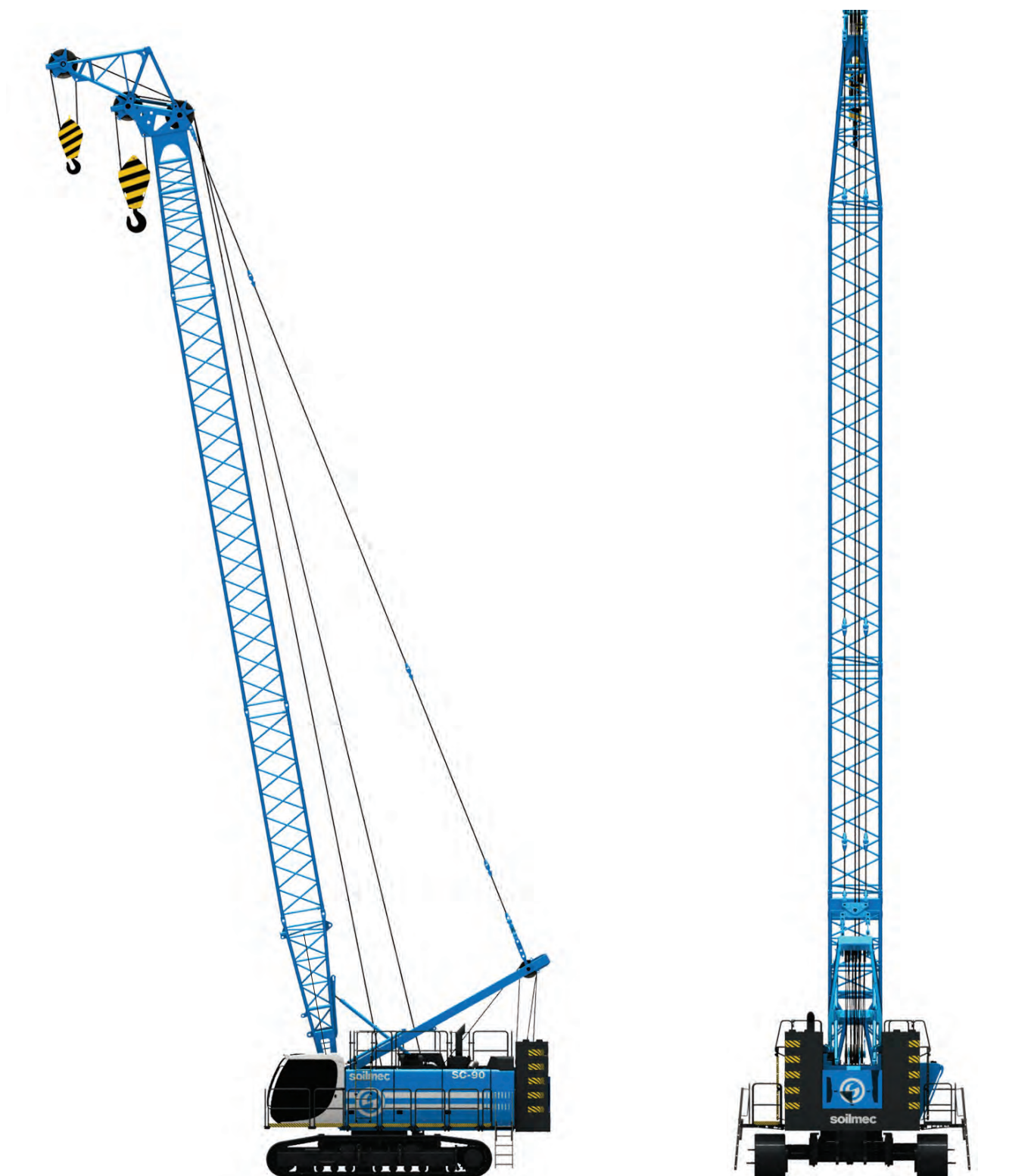
SC-90 HD



soilmec 
Drilling and Foundation Equipment

SC-90 HD Heavy Duty Crawler Crane

LIFTING APPLICATION



Operating weight (approx.)

93000 kg

205029.7 lb

SC-90 HD Heavy Duty Crawler Crane

TECHNICAL DATA SHEET

Diesel engine	CAT C18 ACERT™	CAT C18 ACERT™
- Max Rated Power	470 kW @ 1800 rpm	630 HP @ 1800 rpm
- Engine conforms to exhaust emissions standard	EU Stage IV - US EPA Tier 4f or EU Stage IIIA - US EPA Tier 3	EU Stage IV - US EPA Tier 4f or EU Stage IIIA - US EPA Tier 3
- Displacement	18,1 liters	4.78 US gal
- Aspiration	Turbocharged, air to air aftercooled	Turbocharged, air to air aftercooled
Hydraulic system		
- Main pums max oil flow	3 x 360 l/min; 2 x 325 l/min	3x95 gal/min; 2x86 gal/min
Service refill capacity		
- Fuel Tank	800 l	211.3 gal
- Hydraulic Tank	800 l	211.3 gal
Main winches	Free Fall	Free Fall
- 1st layer line pull (effective)	250 kN	56202 lbf
- Rope diameter	34 mm	1.3 in
- Rope speed	77 m/min	253 ft/min
- Rope capacity (1st layer)	36 m	118 ft
Swing System		
- Nr° of swing drivers	1 or 2	1 or 2
- Max swing speed	3 rpm	3 rpm
- Tail swing radius	4900 mm	193 in
Boom		
- Length min-max	11 - 56 m	36 - 184 ft
- Boom extension length	3 - 6 - 12 m	9.8 - 19.7 - 42.6 in
Undercarriage	variable gauge - removable sides	variable gauge - removable sides
- Overall width (extended side frames)	5000 mm	196.8 in
- Overall width (retracted side frames)	3500 mm	138 in
- Overall length of crawlers	6370 mm	250.8 in
- Track shoe width - Triple grouser	800 mm	31.5 in
- Travel speed	1,2 - 2,4 km/h	0.75 - 1.5 mph

STANDARD EQUIPMENT

BASE MACHINE

- Two front working lights
- PLC system for electric-hydraulic controls
- Rear view mirror
- Steps for crawlers
- Counterweight self-removal
- Tracks with chain tensioning device
- Swivel for main rope
- Grease lubricated tracks
- Hydro-clean micro filtration with water separation
- Automatic swing parking brake and automatic travel parking brake
- Electric refuelling pumps for diesel and hydraulic oil with automatic stop system.

CAB/CONTROL

- Air conditioner, heater and defroster with automatic climate control
- Beverage/Cup holder
- Stationary skylight
- Radio and CD player
- Sunshade for windshield
- High brightness led internal to the cab
- Travel control pedals with removable hand levers
- Courtesy lights in the cab
- Parallelogram wiper including a washer nozzle mounted below the cab windshield
- Signal/warning horn
- Hydraulic oil contamination warning inside the cab
- H-Cab with sliding doors

- Retracted seat belt
- 12" DMS touch or 10" non touch
- Tempered safety glass panel
- Armrests

SAFETY DEVICE

- Load Moment Limiter (with boom lowering slow stop function)
- Fire extinguisher
- State-of-the-art safety load indicator with graphic display and 3 color percentage indicator traffic light
- Cab top guard
- Catwalk (on side and in front of operator's cab)
- Hoist limit switch on both winches
- Safety 3 rope turns unwinding limited switch on winches

OPTIONAL EQUIPMENT

- Flat truck shoes: 900 mm
- Electric hand throttle
- Flat track shoes
- Tagline winch
- Reversible cooling fan including protective screen
- Automatic lubrication system
- Bio lubrication engine oil
- Boom walk ways with personal fall arrest system

- Winch synchronisation (both winches work at the same speed) for 2 rope grab operations
- "CAT BIO HYD ADVANCED" hydraulic bio-oil (compliant with European directive 2005/360/EC).
- GSM modem
- Hydraulic arrangement for Casing oscillator attachment
- Swing and travel alarm
- Positive or negative free fall controls

- Lights for overall dimensions
- Satellite system for remote transmission of operating data
- LCD cameras monitor multi-display
- Removable tracks
- Swing limitation system
- Depthmeter on both winches

SC-90 HD Heavy Duty Crawler Crane

LOAD CHART FOR LIFTING APPLICATION

SC-90HD Load chart (t) for lifting operation

	Boom Length (m)															
Radius (m)	11 m	14 m	17 m	20 m	23 m	26 m	29 m	32 m	35 m	38 m	41 m	44 m	47 m	50 m	53 m	56 m
3,6	90,0	90,0	90,0													
4,0	90,0	89,5	86,0	79,8												
5,0	73,6	70,4	66,0	62,1	58,5	55,3	49,1	41,6								
6,0	59,4	56,2	53,2	50,6	48,1	45,7	43,7	41,6	36,7	31,9	28,0	24,8				
7,0	49,1	46,7	44,6	42,6	40,8	39,0	37,4	35,8	34,4	31,9	28,0	24,8	22,9	20,6	16,8	14,1
8,0	40,6	39,8	38,2	36,7	35,2	33,9	32,5	31,3	30,0	29,0	27,9	24,8	22,9	20,6	16,8	14,1
9,0	34,8	34,7	33,4	32,0	30,9	29,7	28,7	27,6	26,6	25,7	24,7	23,8	22,9	20,6	16,8	14,1
10,0	30,1	30,6	29,6	28,4	27,6	26,5	25,6	24,7	23,8	23,0	22,2	21,5	20,6	19,9	16,8	14,1
11,0	26,0	27,4	26,5	25,4	24,7	23,8	23,0	22,2	21,6	20,8	20,1	19,3	18,7	18,0	16,8	14,1
12,0		24,4	23,8	23,0	22,3	21,6	20,9	20,2	19,5	18,9	18,3	17,6	17,0	16,5	15,8	14,1
13,0		21,9	21,8	21,0	20,4	19,7	19,1	18,5	17,9	17,3	16,7	16,1	15,6	15,0	14,5	13,9
14,0		19,7	19,8	19,2	18,7	18,1	17,6	17,0	16,5	15,9	15,3	14,8	14,3	13,8	13,3	12,8
16,0			16,4	16,4	16,0	15,4	15,0	14,4	14,0	13,5	13,1	12,6	12,2	11,8	11,3	10,9
18,0				13,8	13,8	13,4	12,9	12,5	12,1	11,7	11,3	10,9	10,5	10,1	9,7	9,3
20,0				11,8	11,8	11,8	11,4	10,9	10,6	10,2	9,8	9,4	9,1	8,7	8,4	8,0
22,0					10,2	10,1	10,0	9,6	9,3	9,0	8,6	8,3	8,0	7,6	7,3	6,9
24,0						8,8	8,7	8,5	8,3	7,9	7,6	7,3	7,0	6,7	6,3	6,0
26,0						7,7	7,6	7,5	7,4	7,1	6,7	6,4	6,2	5,8	5,5	5,2
28,0							6,7	6,6	6,5	6,3	6,0	5,7	5,4	5,1	4,8	4,5
30,0								5,8	5,7	5,6	5,4	5,0	4,8	4,5	4,2	3,9
32,0								5,1	5,0	4,9	4,7	4,5	4,3	4,0	3,7	3,4
34,0									4,4	4,3	4,1	4,0	3,8	3,5	3,2	2,9
36,0										3,8	3,6	3,4	3,3	3,0	2,8	2,5
38,0										3,3	3,1	3,0	2,9	2,7	2,4	2,1
40,0											2,7	2,6	2,4	2,3	2,1	1,8
42,0												2,2	2,1	1,9	1,7	1,5
44,0												1,8	1,7	1,6	1,4	1,2
46,0													1,4	1,2	1,1	

SC-90HD Load chart (t) for duty cycle operation

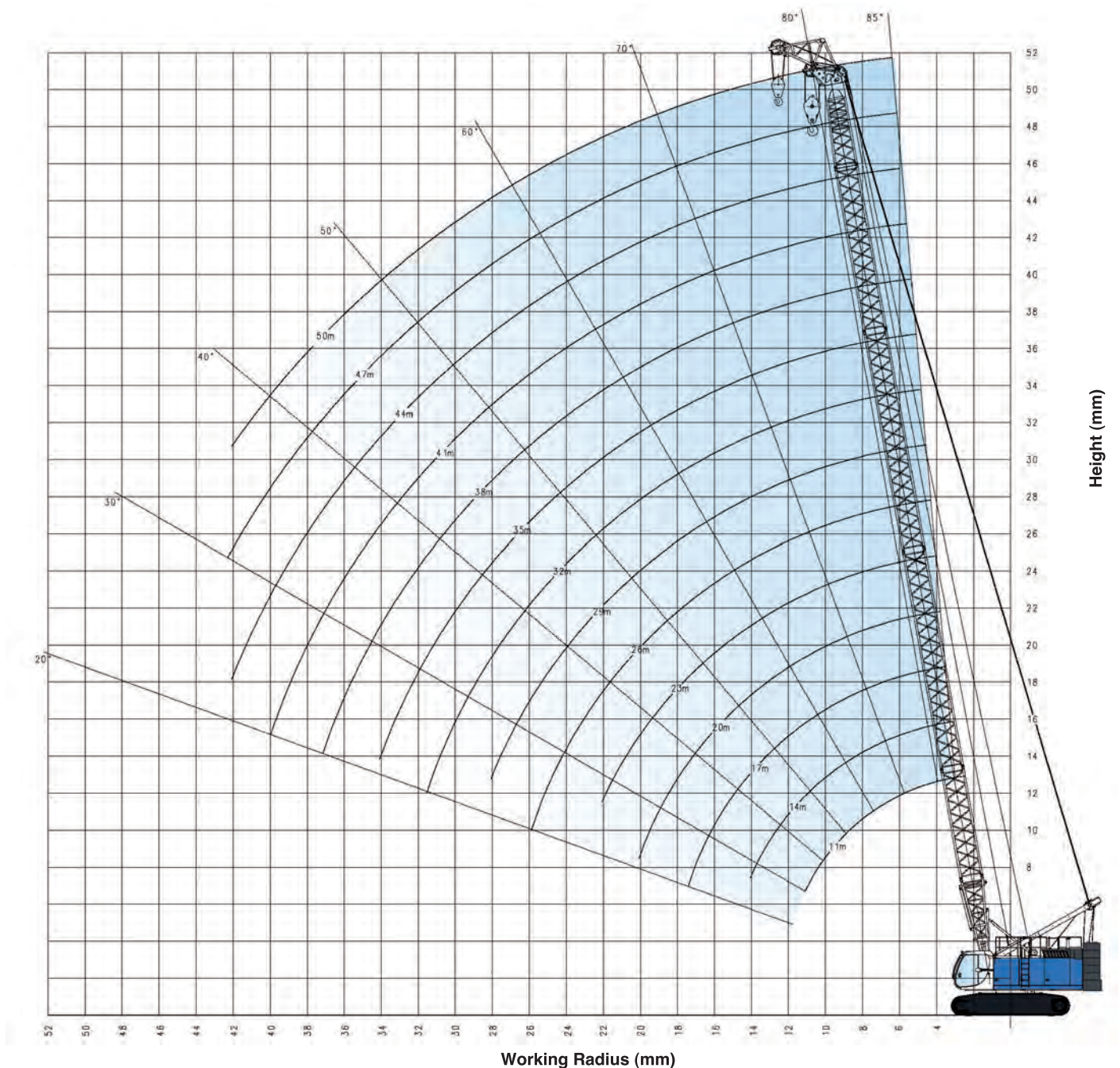
	Boom Length (m)							
Radius (m)	17 m	20 m	23 m	26 m	29 m	32 m	35 m	38 m
6,0	38,7	35,2	32,4	29,7	27,5	25,4	23,4	1,8
7,0	33,6	30,9	28,6	26,5	24,5	22,6	21,2	19,5
8,0	29,6	27,3	25,5	3,6	21,8	20,6	19,2	17,8
9,0	26,4	24,3	22,7	21,4	20,1	18,7	17,5	16,4
10,0	24,0	22,2	20,9	19,5	18,3	17,1	16,0	15,0
12,0	18,9	18,4	17,6	16,5	15,5	14,5	13,5	12,6
14,0	15,3	15,2	15,0	14,2	13,1	12,3	11,8	11,1

Boom Configuration

Boom Length		Boom foot	Boom insert	Boom insert	Boom head
m		5,5 m	3 m	6 m	5,5 m
11	n. boom extension	1	-	-	1
14		1	1	-	1
17		1	-	1	1
20		1	1	1	1
23		1	-	2	1
56		1	1	2	1
29		1	-	3	1
32		1	1	3	1
35		1	-	4	1
38		1	1	4	1
41		1	-	5	1
44		1	1	5	1
47		1	-	6	1
50		1	1	6	1
53		1	-	7	1
56		1	1	7	1

SC-90 HD Heavy Duty Crawler Crane

LIFTING APPLICATION WORKING RANGE



Auxiliary Jib

standard

Max capacity

25 t 55115 lb

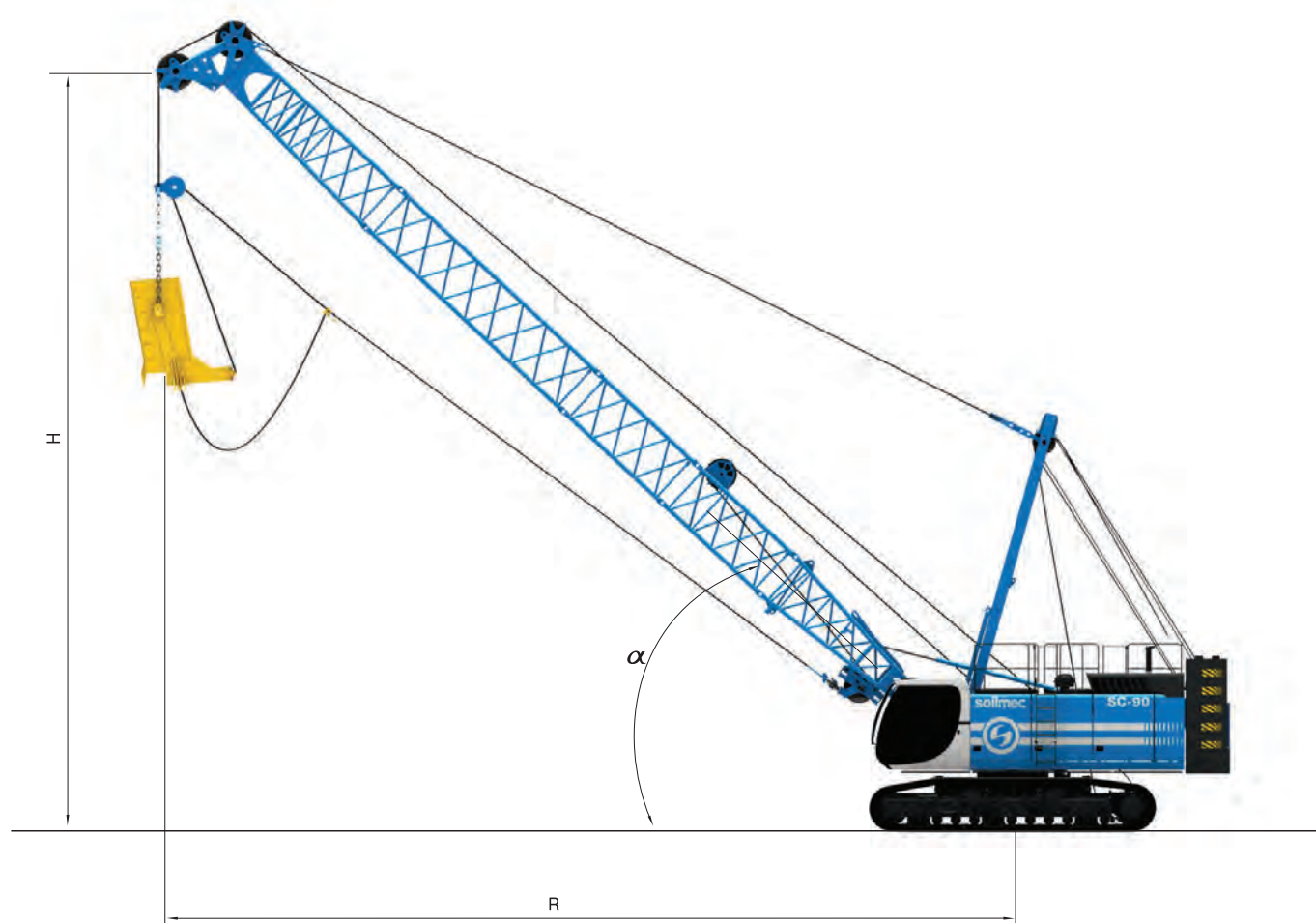
Load chart programmed in Load moment indicator

Boom configuration

- Rated loads are in metric tons valid for 360 degrees working area.
- Lifting capacities are in compliance with ISO 4305 (Table 1+2) + tipping angle 4° for dynamic effect
- Working radius are measured from the swing center of the machine and under load.
- Rated loads are calculated with the machine on firm and level ground, without travelling
- Weights of lifting attachments (e.g.: hook, ropes, bucket, etc.) are included in the rated load: therefore their weights must be subtracted from rated load to obtain net lifting value.
- Load charts are valid with maximum undercarriage track.
- Optional equipment on boom (e.f. boom catwalks; jib; etc.) must be deducted from rated load to get net lifting value.
- Lifting capacities are based on freely suspended loads. Rated loads and operating speeds must be reduced in case of adverse conditions (e.g.: wind, soft ground, out-of-level, pendulum action, sudden load stopping, operating speeds, etc.)
- Load chart above are only for reference. For actual lifting capacities please refer to load chart in operator's manual.
- Instruction in the "Operator's Manual" must be strictly observed during machine operations.

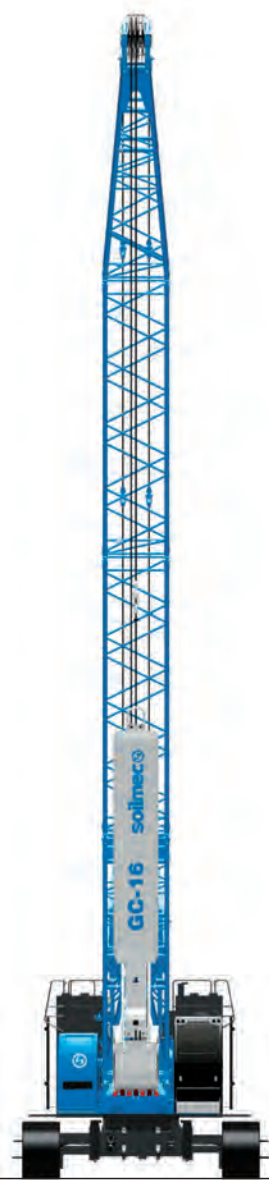
SC-90 HD Heavy Duty Crawler Crane

DRAGLINE APPLICATION



Angle	Boom length (m)																	
α (deg)	14			17			20			23			26			29		
	R (m)	H (m)	Capacity (t)	R (m)	H (m)	Capacity (t)	R (m)	H (m)	Capacity (t)	R (m)	H (m)	Capacity (t)	R (m)	H (m)	Capacity (t)	R (m)	H (m)	Capacity (t)
50	10,8	12,2	19,9	12,7	14,5	19,9	14,6	16,8	17,1	16,6	19,1	14,3	18,5	21,4	12,0	20,4	23,7	10,2
45	11,6	11,3	19,9	13,7	13,4	18,8	15,9	15,5	15,2	18,0	17,6	12,6	20,1	19,8	10,6	22,2	21,9	8,9
40	12,4	10,3	19,9	14,7	12,3	17,1	17,0	14,2	13,7	19,3	16,1	11,4	21,6	18,0	9,5	23,9	20,0	7,9
35	13,0	9,3	19,9	15,5	11,0	15,7	18,0	12,8	12,6	20,4	14,5	10,4	22,9	16,2	8,6	25,3	17,9	7,1
30	13,6	8,2	18,8	16,2	9,7	14,7	18,8	11,2	11,7	21,4	12,7	9,6	24,0	14,2	7,9	26,6	15,7	6,5
25	-	-	-	16,8	8,4	13,9	19,6	9,7	11,0	22,3	10,9	9,0	25,0	12,2	7,4	27,7	13,5	6,1

SC-90 HD Heavy Duty Crawler Crane
MECHANICAL GRAB APPLICATION



Mechanical grab		
Max grab weight	16 t	35274 lb
Winches	2 x 250 kN	2 x 56202 lbf
Max rope speed at first layer	82 m/min	269 ft/min

Please refer to load chart for duty cycle operation

SC-90 HD Heavy Duty Crawler Crane

HYDRAULIC GRAB APPLICATION



Diaphragm wall grab	Hydraulically controlled suspended by rope	
Max grab weight	16 t	35274 lb
Grab revolving system	Rotograb 360°	Rotograb 360°
Max depth	75 m	246 ft
Excavation dimension range (width x lenght)	600/1500 x 2800/4200 mm	24/60 x 112/165 in

Please refer to load chart for duty cycle operation

SC-90 HD Heavy Duty Crawler Crane
CLAMSHELL APPLICATIONS

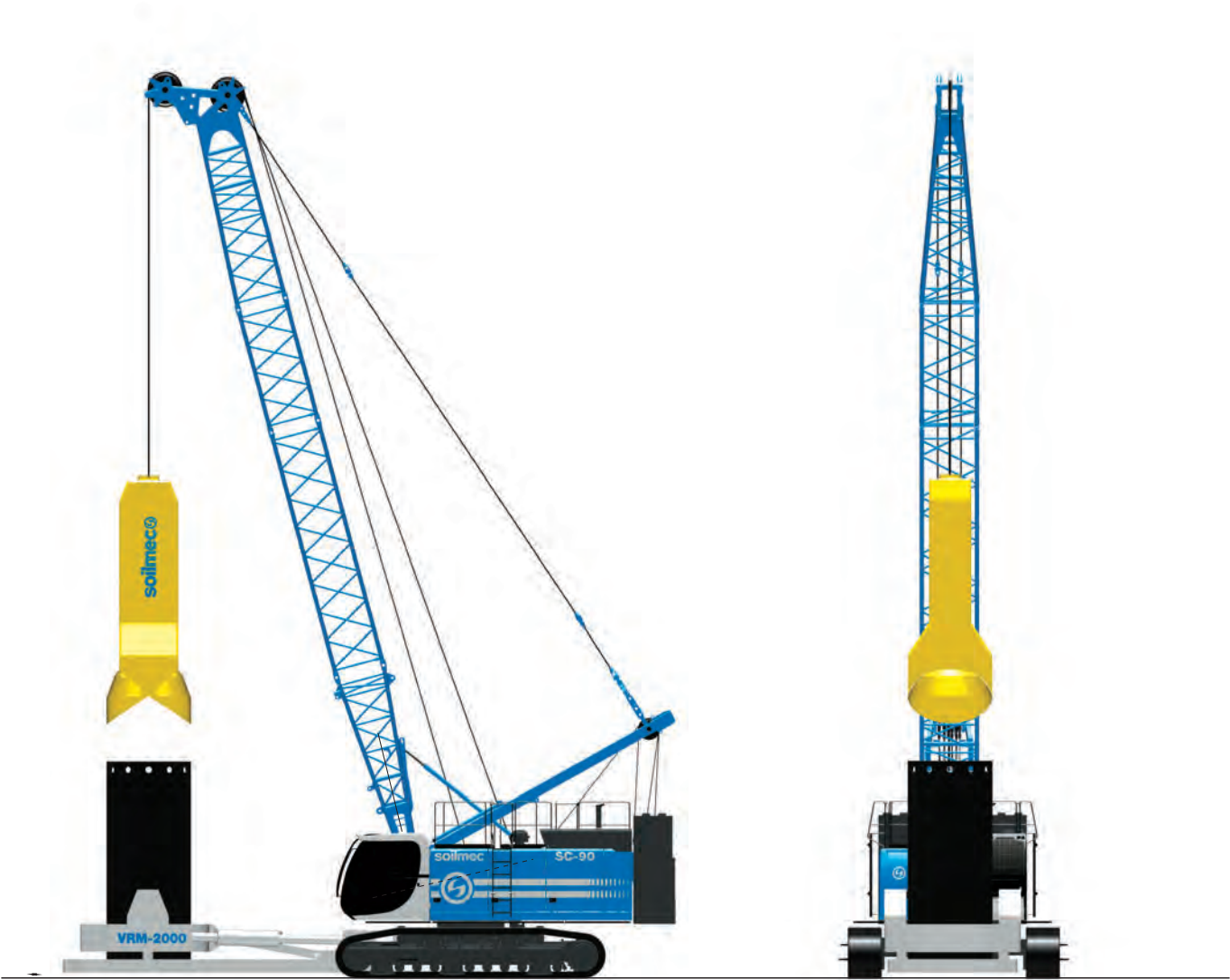


Clamshell

1 - rope clamshell	21 t	46297 lb
2 - rope clamshell	28 t	61729 lb

SC-90 HD Heavy Duty Crawler Crane

HAMMER GRAB AND CASING OSCILLATOR APPLICATION



Hammer grab and casing oscillator		
Max weight	18 t	39683 lb
Max drilling diameter	2000 mm	78.7 in

SC-90 HD Heavy Duty Crawler Crane
PILE DRIVING

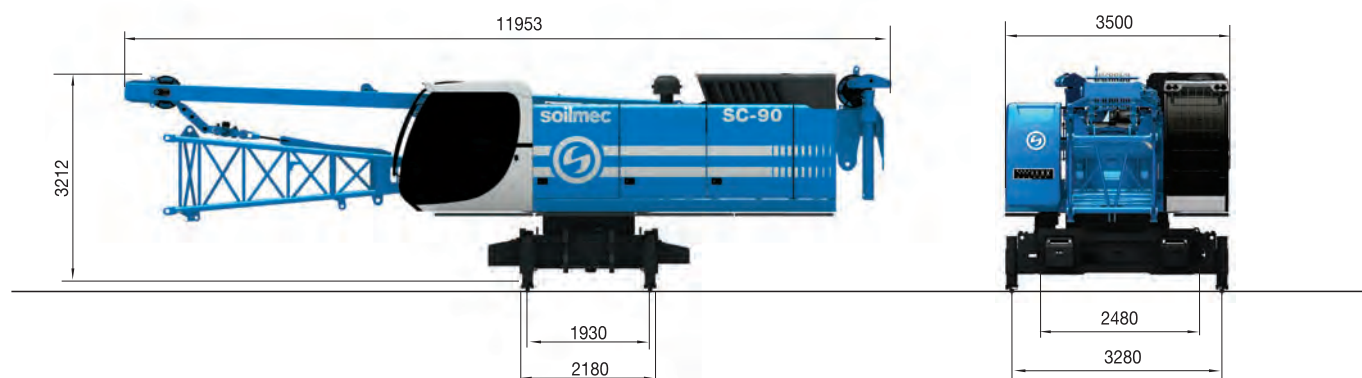


Pile driving		
Pile length	30 m	98.4 ft
Crane boom length	23 m	75.5 ft
Leader length	36 m	118.1 ft
Possible leader inclinations - Front/rear/side batter	16°/18°/15°	16°/18°/15°

SC-90 HD Heavy Duty Crawler Crane

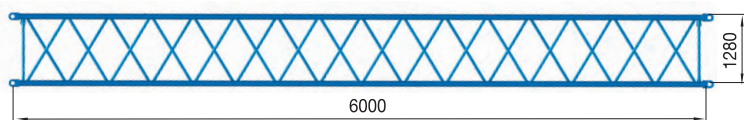
TRANSPORT DIMENSIONS AND WEIGHTS

Main machine

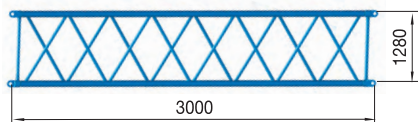


Width	3500 mm	138 in
Weight	44000 kg	97000 lb
Weight c/w tracks	64000 kg	141100 lb

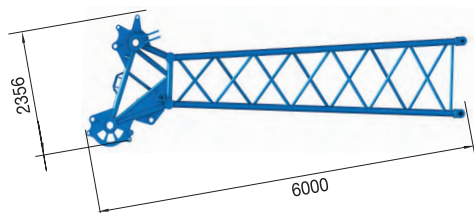
Boom



Width	1360 mm	53.5 in
Weight	1000 kg	2204.6 lb

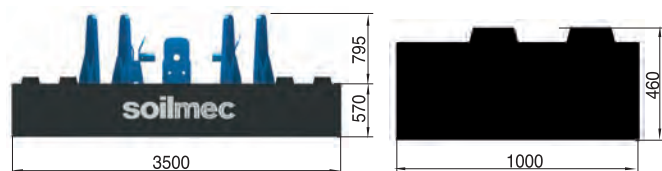


Width	1360 mm	53.5 in
Weight	650 kg	1433 lb



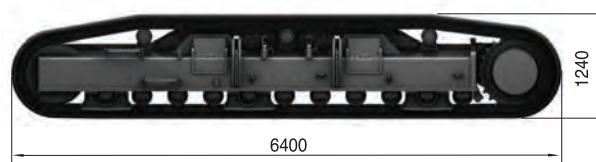
Width	1360 mm	53.5 in
Weight	2800 kg	6172.9 lb

Counterweight (26.5 t)



Base width	1010 mm	40 in
Base weight	12060 kg	26588 lb
Block width	942 mm	37 in
Block weight	1350 kg	2970 lb

Sideframes



Width	800 mm	315 in
Weight	20000 kg	44092 lb

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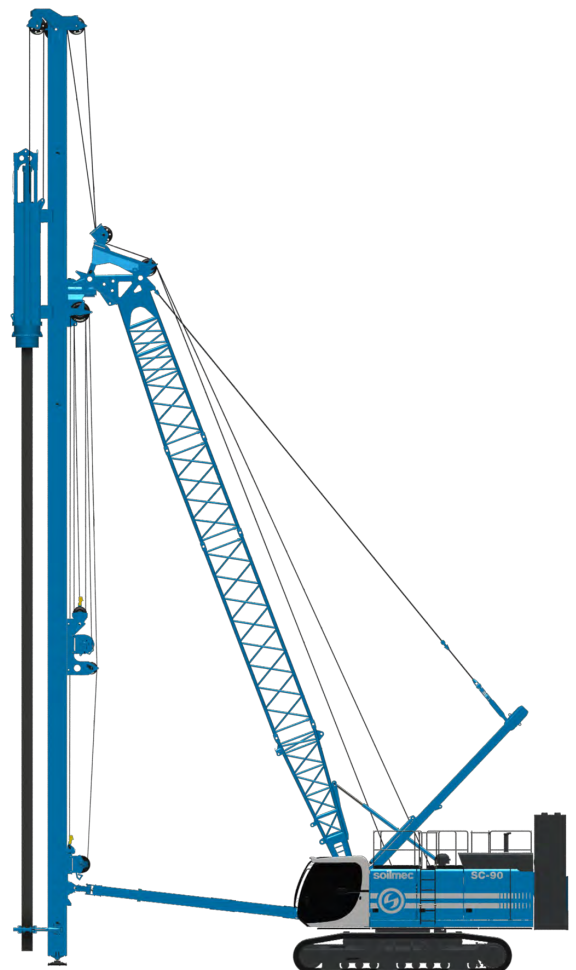
Model: SC-90HD Pile Driving VTL

New pile driving application:

- Soilmecc has developed a multi-configurations system for pile driving execution by means of Hydraulic or Diesel hammers.
- Three different type of leader mast available for 18-22-30 m (59-72.1-98.4 ft) piles length, designed to drive heavy duty hammers.
- VTL (Vertical Travel Lead) system developed to allow vertical movement between main boom and mast leader.
- Spotter telescopic system, single cylinder operated, to allows various inclined configurations.

Soilmecc solution advantages:

- Greater working radius and angles than dedicated pile driving rigs.
- Possibility to use the mast leader for CFA/TJ/ DP and TCT applications.
- Real time control, high safety level and production data thanks to DMS.

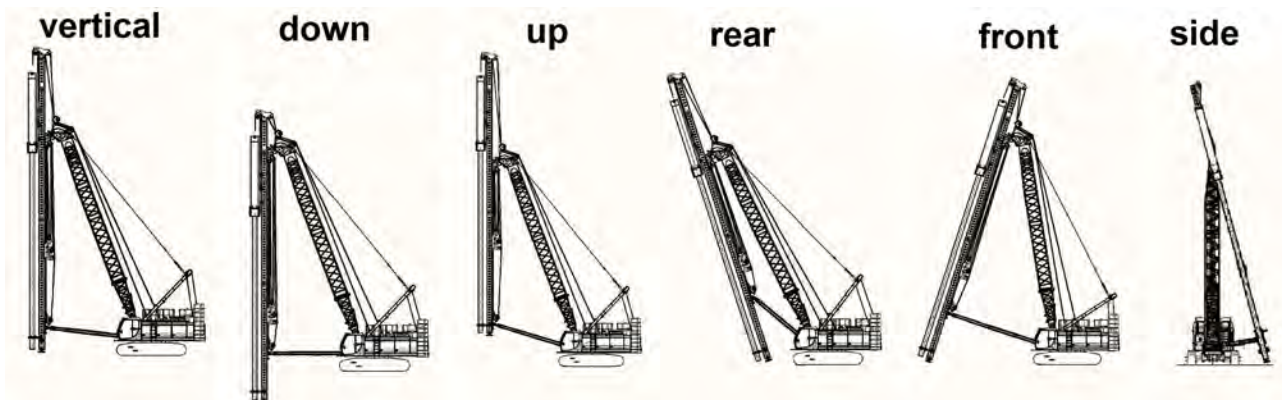
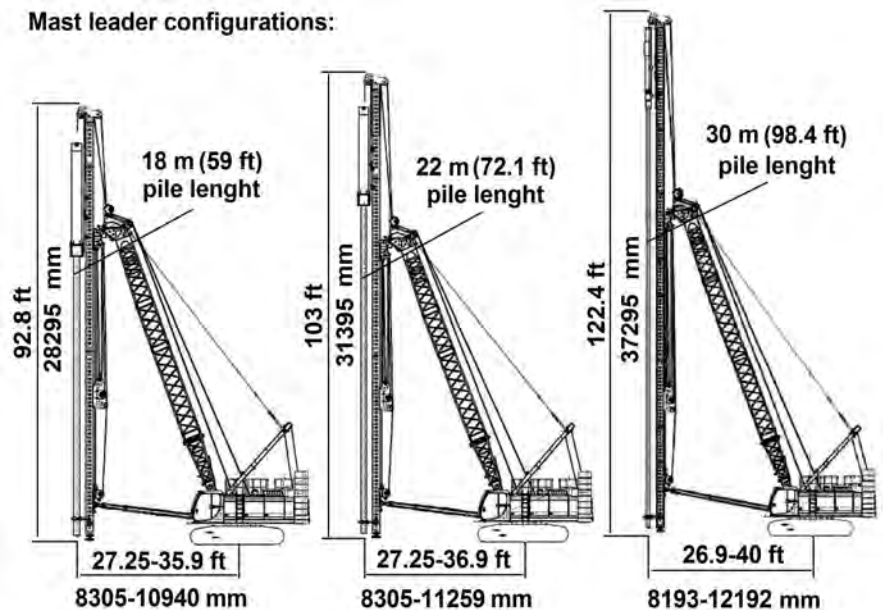


Model: **SC-90HD Pile Driving VTL**

Tech data:

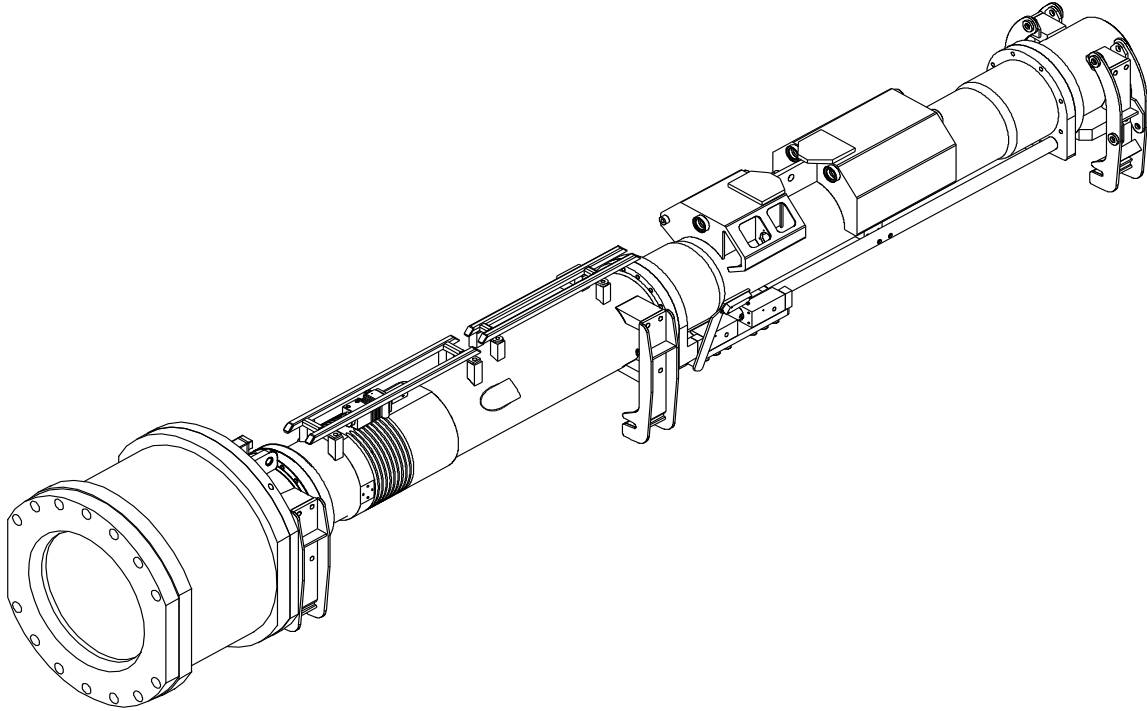
- Additional counterweight: 5200 kg (11.46 lb) - 4 pieces
- Spotter main cylinder stroke: 3300 mm (10.83 ft)
- Spotter winch 1° line pull: 130 kN (2 part line pull system)
- VTL system winch 1° line pull: 600 kN (6 part line pull system)
- Hammer rope diameter: 26 mm (1.02 in)
- Pile rope diameter: 26 mm (1.02 in)
- Leader mast torque admissible: 100 kNm (73756 lbfft)

Mast leader configurations:



Pile length configuration	Max pile weight	Max hammer weight with cap	Forward/backward/ side batter max inclination	Upper/lower mast translation @ max working radius
18 m (59 ft)	3000 kg (6614 lb)	11 t (24251 lb)	± 18°/18°/15°	4,3 / 3 m (14.1 / 9.8 ft)
22 m (72.1 ft)	3550 kg (7826 lb)	9,15 t (20172 lb)	± 18°/18°/15°	4,3 / 3 m (14.1 / 9.8 ft)
30 m (98.4 ft)	4800 kg (10582 lb)	4 t (8819 lb)	± 16°/18°/15°	4,3 / 3 m (14.1 / 9.8 ft)

BERMINGHAMmer
FOUNDATION EQUIPMENT



B32 #24 Hammer Manual

Serial Number: 18-024-B32



BeRMINGHAMmer

FOUNDATION EQUIPMENT



SERIAL No.

18-024-B32

MADE IN CANADA

Parts Drawings and Parts Lists

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Fuel Filter Assemblies	Pg 24-25
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B32

SINGLE ACTING DIESEL HAMMER
MADE IN CANADA

SERIAL # 18-024-B32

B32 SPECIFICATIONS

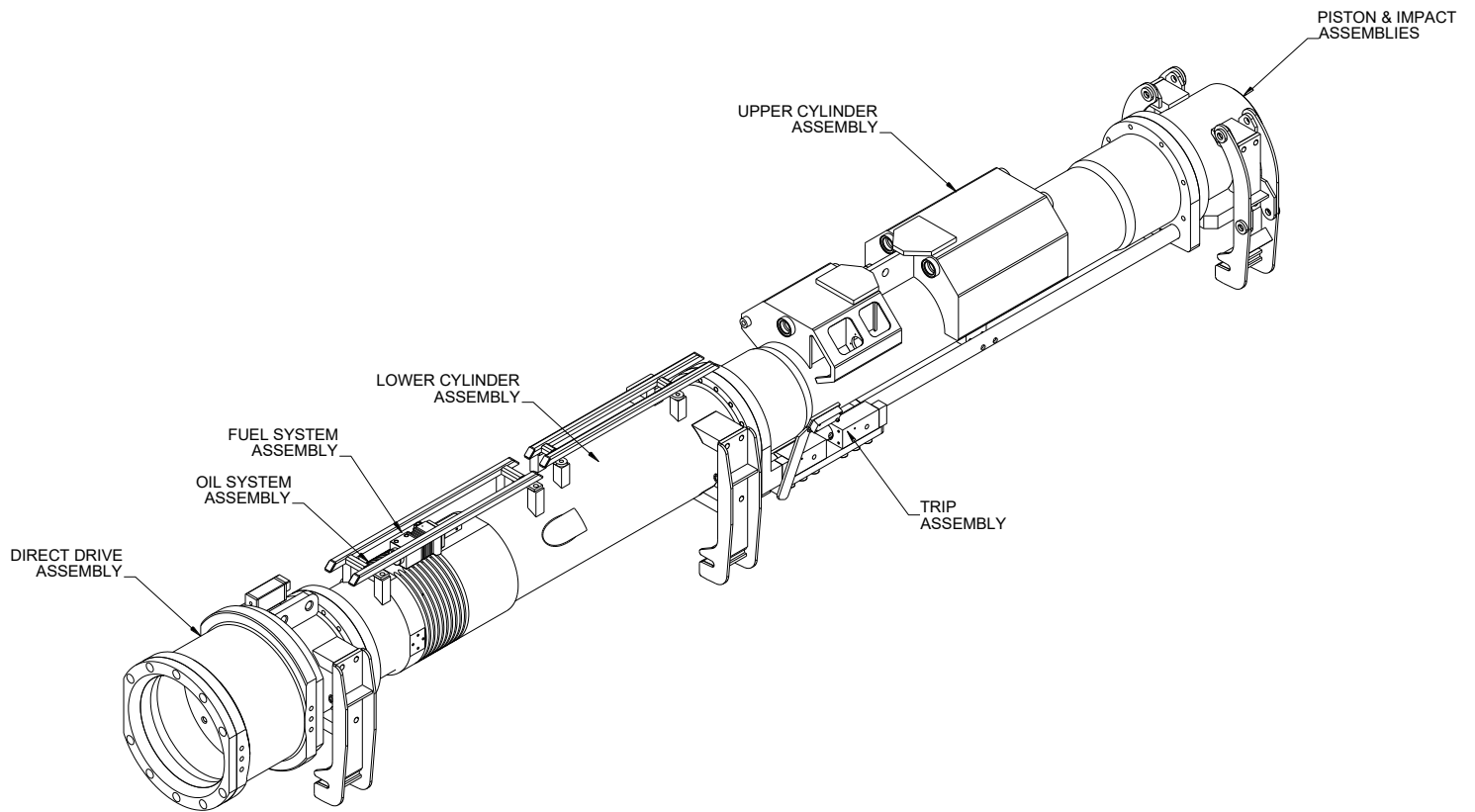
Total Weight	7 448kg/16 420 lb
Ram Weight	3 198kg/7 050 lb
Rated Stroke	3.5m/11.5 ft
Frequency	35–56 BPM
Fuel Capacity	72L/19 gal _(US)
Oil Capacity	25L/6.5 gal _(US)
Max. Kinetic Energy	109.9kJ/50 040ft-lb
Max. Rated Energy	67.8kJ/81 080ft-lb

For More Information, Contact:

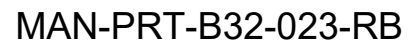
BERMINGHAMMER
FOUNDATION EQUIPMENT



HAMILTON, ONTARIO, CANADA 1-800-668-9432

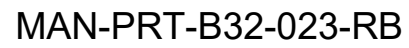


Hammer Complete Assembly



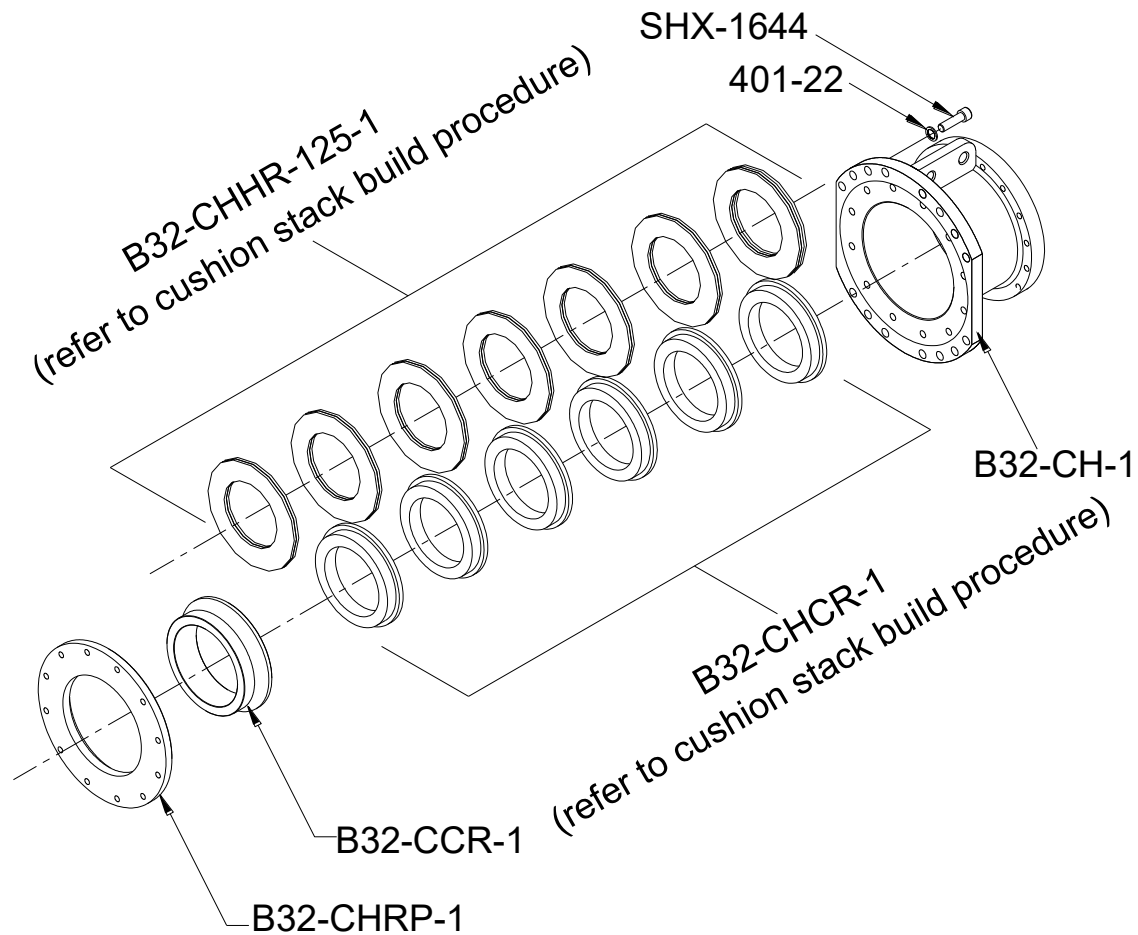
**Upper Cylinder Assembly****B32**

PART No.	DESCRIPTION	QUANTITY
Upper Cylinder		
B32-UC-1	Upper Cylinder	1
B32-CRC-1	Catch Ring Cap	1
B32-CRCSR-1	Catch Cap Stop Ring	1
SHX-1672	Catch Ring Cap Bolt (1" x 4-1/2" NC SHCS)	8
401-22	1" Nord Lock Washer	8
SHX-1672	Upper Cylinder to Lower Cylinder (1" x 4-1/2" NC SHCS)	14
401-22	1" Nord Lock Washer	14
Fuel Caps		
BCF-TF-0	Fuel Tank Plug c/w Vent Assembly	1
BCF-TP-0	Fuel Tank Plug	1
Fuel Feeds		
455-18	In-Tank Fuel Suction Strainer Assembly	2
BCF-FF-1-0	Fuel Filter Assembly	-
BCF-FF-2	Fuel Filter Grommet	-
Trip Track Rail		
B32-TRR-1	Trip Track Rail	2
B20-TRR-2	Spacer (Trip Track Rail)	4
SHX-1032	Trip Track Rail & Spacer Bolt (5/8" x 2" NC SHCS)	8
251-21	5/8" Nord Lock Washer	8
452-8-3	Trip Rail End Cap	2
Other Parts		
352-15	Sensor Cover Plate	1
SHX-0612	Sensor Cover Plate Bolt (3/8" x 3/4" NC SHCS)	4
251-20	3/8" Nord Lock Washer	4
B32-WC-1	Weather Cap	-
252-5	Weather Cap Securing Straps (Not Shown)	2
458-3	Piston Transportation Pin	-
310-1-0	Velocity Sensor Assembly (Optional)	-
SHX-0628	Velocity Sensor Bolts (3/8" x 1-3/4" NC SHCS)	4
251-20	3/8" Nord Lock Washers (for velocity sensor bolts)	4
B32-TRS-0	Trip Safety Assembly (Not Shown)	1

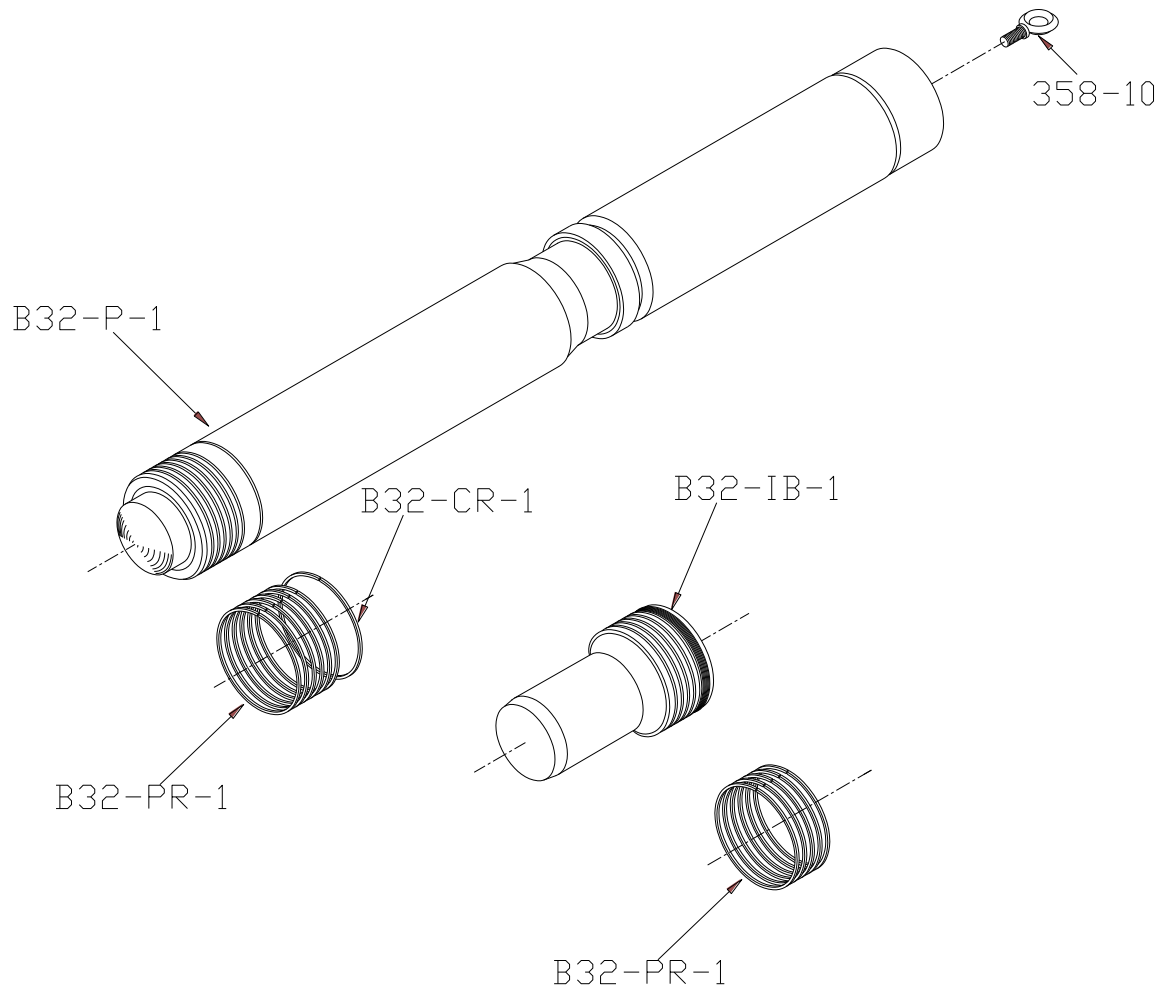


**Lower Cylinder Assembly****B32**

PART No.	DESCRIPTION	QUANTITY
Lower Cylinder		
B32-LC-1B-23	Lower Cylinder	1
BCLF-B125P-1	Grease Fitting (Button Style Not Shown)	4
BCOR-465-B70	'O' Ring #2-465 (Lower Cylinder to Upper Cylinder)	1
B32-EPE-5	Exhaust Port Extension	2
SHX-1672	Lower Cylinder to Cushion Housing Bolt (1" x 4-1/2" NC SHCS)	16
401-22	1" Nord Lock Washer	16
B32-CH-2A	Cushion Housing Guide Ring	1
B32-CH-3	Cushion Ring Support	1
Fuel System Protection		
B32-FG-1D-23	Fuel Guard Assembly	1
SHX-1280	Fuel Guard Bolt (3/4" x 5" NC SHCS)	8
BHM-440	3/4" Nord Lock Washer	8
RP-M2845-1A	M28 Roll Pin	8
Transportation & Storage Tooling		
B32-EPP-1	Exhaust Port Cap	2
451-18-1-1	Exhaust Port Cap Thumb Screw	2
Throttle Hose Mounting (Not Shown)		
BCSC-2127	Throttle Line Clamp (1/2 Welded to B32-FG-1C) (RH)	2
Other Parts Shown		
	Fuel System (see Fuel System)	–
B32-FP-0	Fuel Pump Assembly (see Fuel Pump Assembly)	–
BC-TS-0C	Throttle Valve Assembly (see Throttle Valve Assembly)	–
BCOP-1-0A	Oil Pump Assembly (see Oil Pump Assembly)	–

**Cushion Housing Assembly****B32**

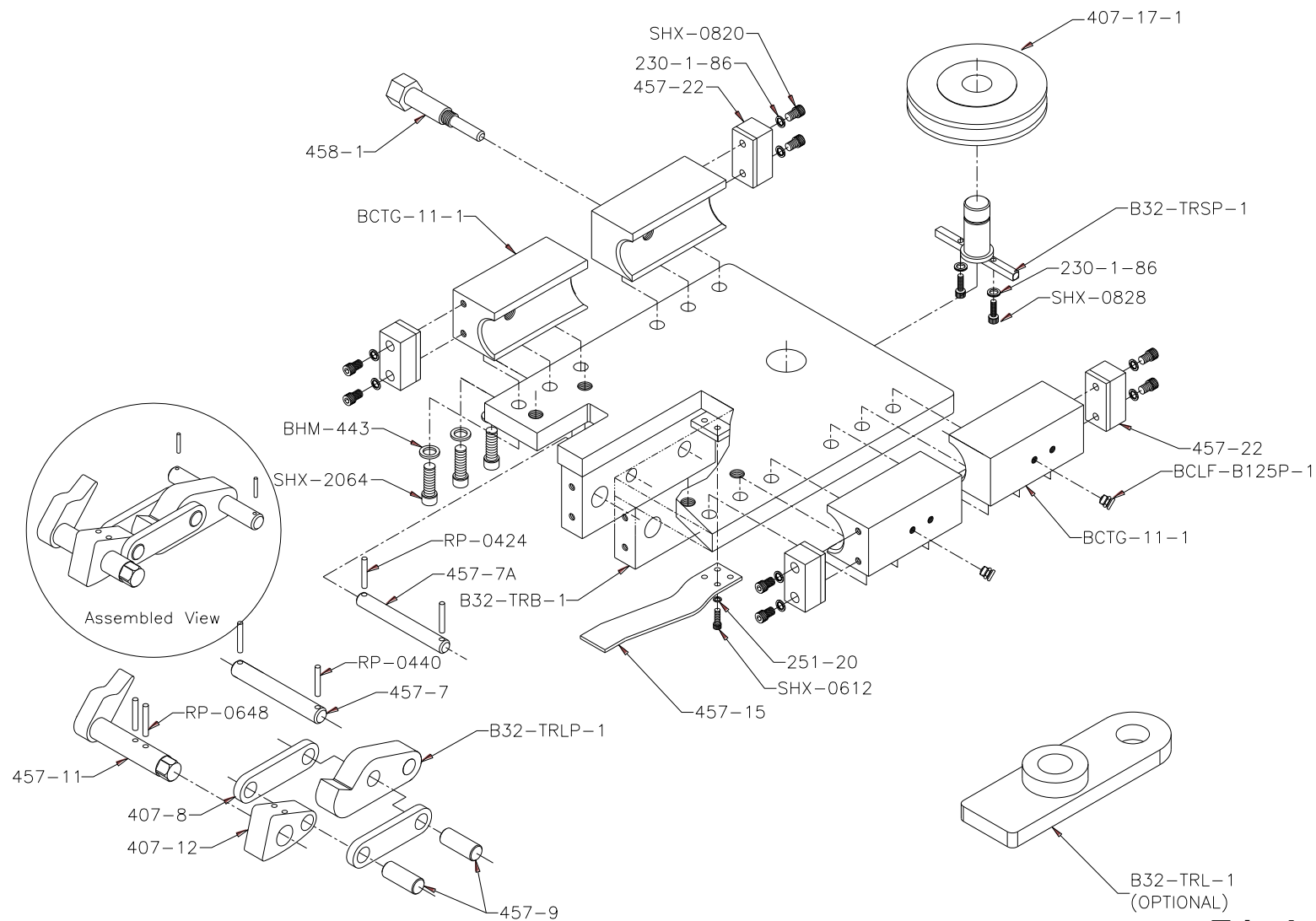
PART No.	DESCRIPTION	QUANTITY
B32-CH-0	Cushion Housing Assembly	-
B32-CH-1	Cushion Housing	1
B32-CHCR-1	Cushion Ring (refer to cushion stack build procedure)	6
B32-CHHR-125-1	Shim Plate (refer to cushion stack build procedure)	15
B32-CCR-1	Cushion Compression Ring	1
B32-CHRP-1	Cushion Housing Retainer Plate	1
SHX-1644	Retainer Ring Retainer Bolt (1" × 2-3/4" NC SHCS)	12
401-22	1" Nord Lock Washer	12



Piston & Impact Block Assemblies

B32

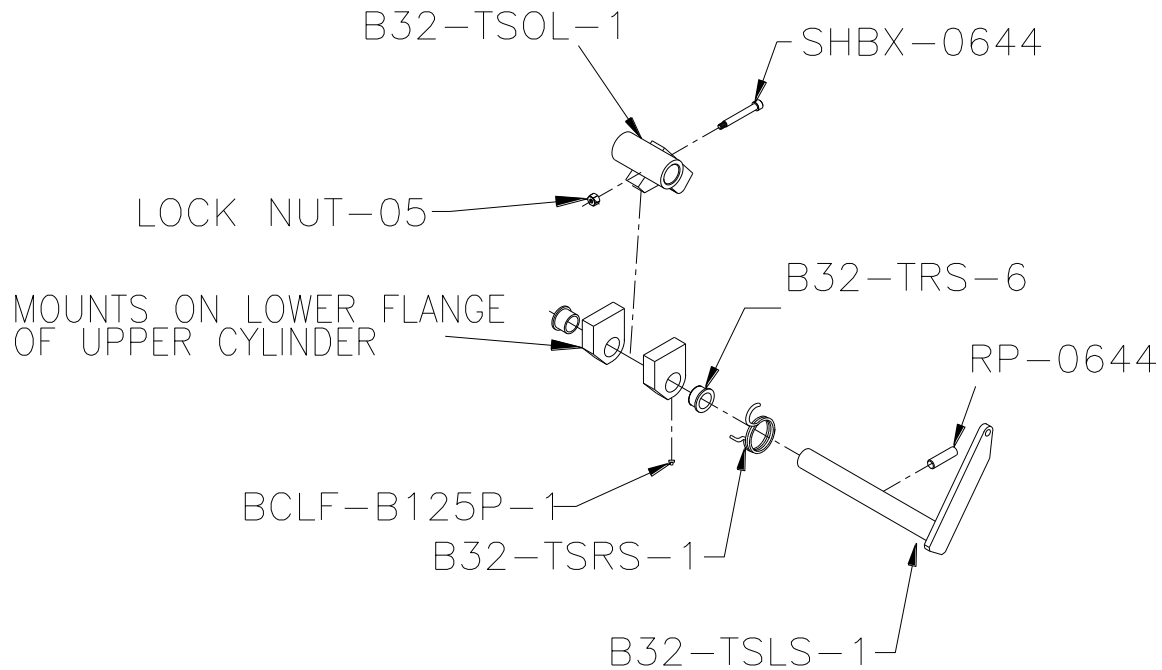
PART No.	DESCRIPTION	QUANTITY
	Piston Assembly	
B32-P-1	B32 Piston	1
B32-PR-1	Compression Ring	6
B32-CR-1	Catch Ring	1
	Impact Block Assembly	
B32-IB-1	Impact Block	1
B32-PR-1	Compression Ring	5
	Other Parts Shown	
358-10	Piston Lifting Eyebolt	1



Trip Assembly

**Trip Assembly****B32**

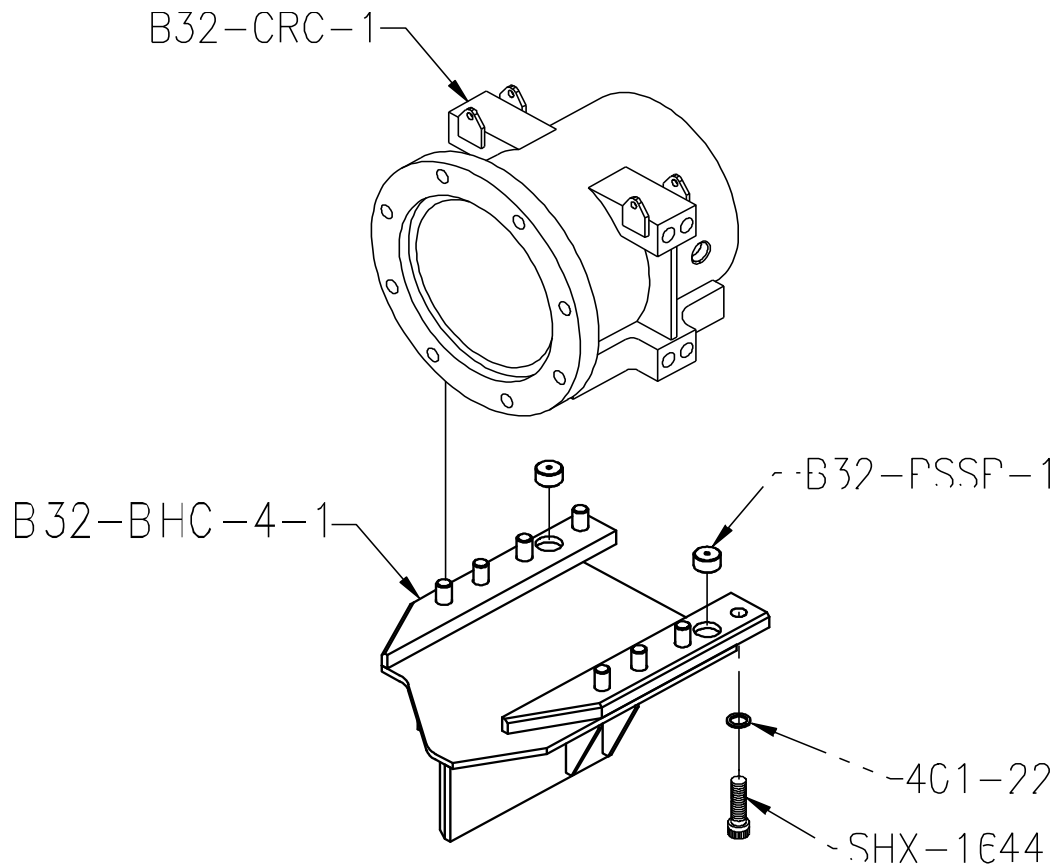
PART No.	DESCRIPTION	QUANTITY
B32-TRA-0	Trip Assembly	-
B32-TRB-1	Trip Body	1
457-11	Lever & Shaft	1
407-12	Trip Cam	1
RP-0648	Roll Pin	2
407-8	Connecting Link	2
457-9	Connecting Link Pin	2
B32-TRLP-1	Lifting Pawl	1
457-7	Lifting Pawl Pin	1
RP-0440	Roll Pin	2
457-7A	Lifting Pawl Stop Pin	1
RP-0424	Roll Pin	2
457-15	Leaf Spring	1
SHX-0612	Leaf Spring Bolt (3/8 x 3/4" NC SHCS)	4
251-20	3/8" Nord Lock Washer	4
457-22	Rubber Bumper	4
SHX-0820	Rubber Bumper Bolt (1/2 x 1-1/4" NC SHCS)	8
230-1-86	1/2" Nord Lock Washer	8
BCTG-11-1	Gib	4
SHX-2064	Gib Mounting Bolt (1 1/4" x 4" NC SHCS)	12
BHM-443	1-1/4" Nord Lock Washer	12
407-17-1	Trip Sheave	1
B32-TRSP-1	Sheave Pin	1
SHX-0828	Rubber Bumper Bolt (1/2 x 1-3/4" NC SHCS)	2
230-1-86	1/2" Nord Lock Washer	2
BCLF-B125P-1	Gib Grease Fitting (1/8" Button Head)	4
458-1	Trip Lock Bolt	1
B32-TRL-1	Trip Connecting Link for Single Part Line Operation (Optional)	-



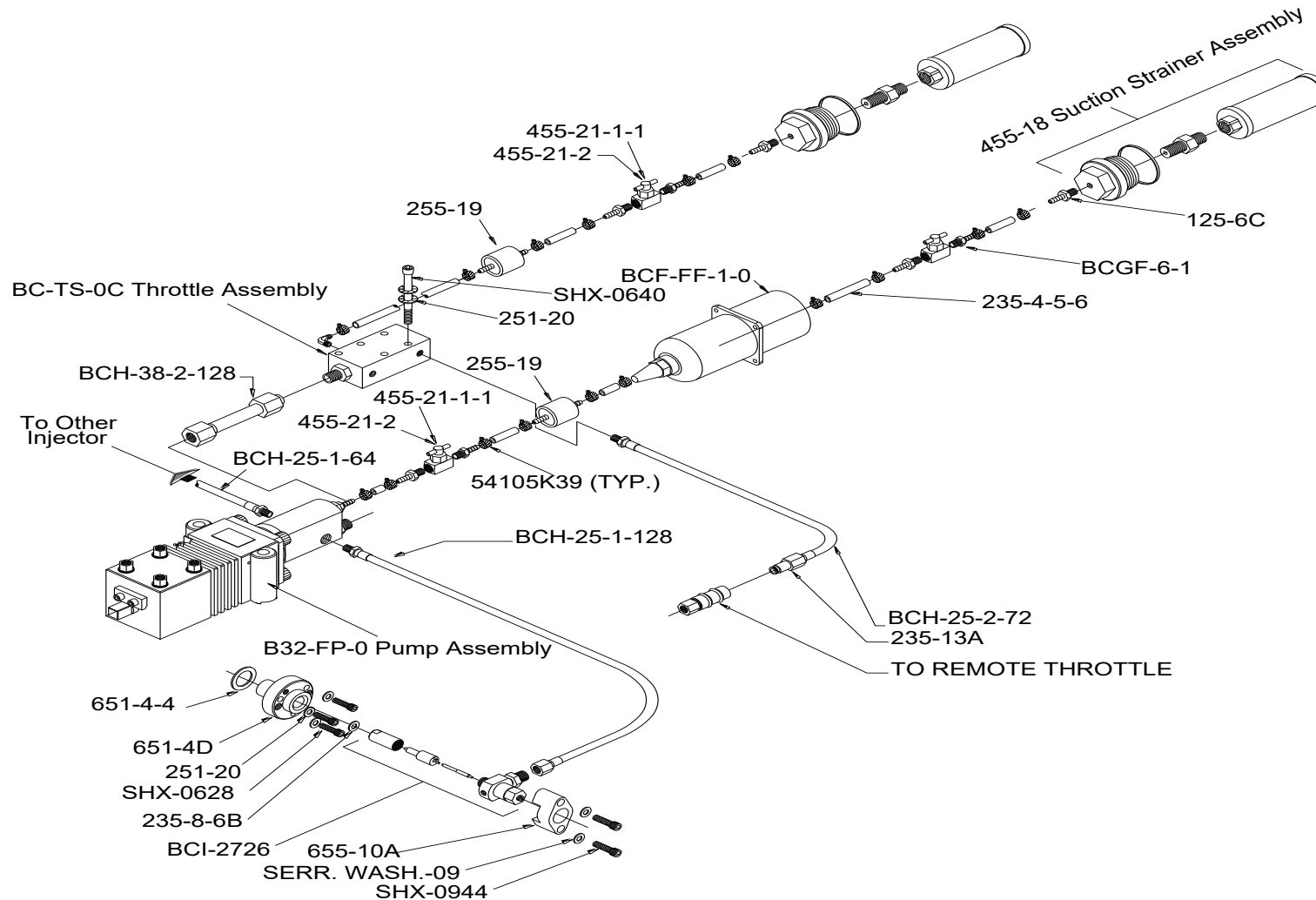
Trip Safety Assembly

B32

B32-TRS-0	Integral Trip Safety Assembly	
B32-TSOL-1	Operating Lug	1
B32-TSLS-1	Lever and Shaft	1
B32-TSRS-1	Return Spring	1
B32-TRS-6	Bushing	2
SHBX-0644	Retaining Bolts (3/8" x 2-3/4" Socket Shoulder Bolt)	2
LOCK NUT-05	5/16" NC Nylon Insert Lock Nut	2
RP-0644	Roll Pin	1
BCLF-B125P-1	Grease Fitting (Button style)	2

**Hammer Support Assembly****B-32**

PART No.	DESCRIPTION	QUANTITY
B32-BHC-4-0	Hammer Support Assembly	-
B32-BHC-4-1	Hammer Support Frame	1
B32-PSSP-1	Shear Pin	2
401-22	1" Nord Lock Washer	8
SHX-1644	Support Frame Mounting Bolts (1" x 2-3/4" NC SHCS)	8
Hammer Cat Assembly is included in the Lead System Parts Manual.		



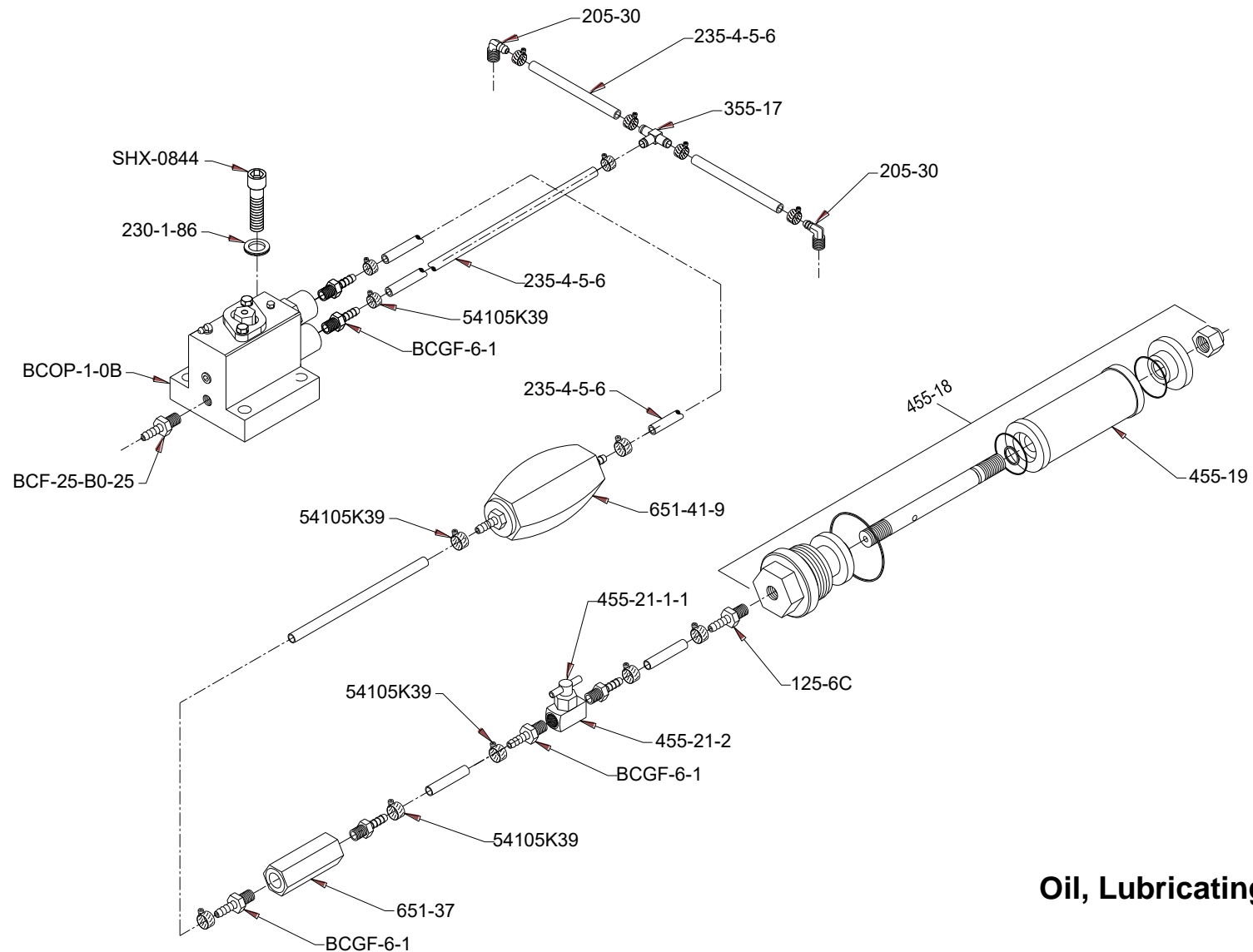
Fuel System

**Fuel System****B32**

PART No.	DESCRIPTION	QUANTITY
B32-FP-0	Fuel Pump Assembly	1
Injection		
651-4-4	Injector Carrier Seal	2
651-4D	Injector Carrier	2
SHX-0628	Injector Carrier Bolt	12
251-20	3/8" Nord Lock Washer	12
235-8-6B	Injector Seal	2
BCI-2726	Fuel Injector	2
655-10A	Injector Clamp	2
SHX-0944	Injector Mounting Bolt	4
SERRATED WASHER-09	9/16" Nord Lock Washer	4
BCH-25-1-128	32" Injector Line	1
BCH-25-1-64	16" Injector Line	1
Throttle		
BC-TS-0C	Throttle Valve Assembly	—
SHX-0640	Throttle Valve Bolt	5
251-20	3/8" Nord Lock Washer	5
BCH-38-2-128	32" Braided Return Line	1
Throttle Line Connection		
BCH-25-2-72	Throttle Block Whip Line	1
235-13A	Nipple (Male) (Hook Up To Remote Throttle)	1


Fuel System
B32

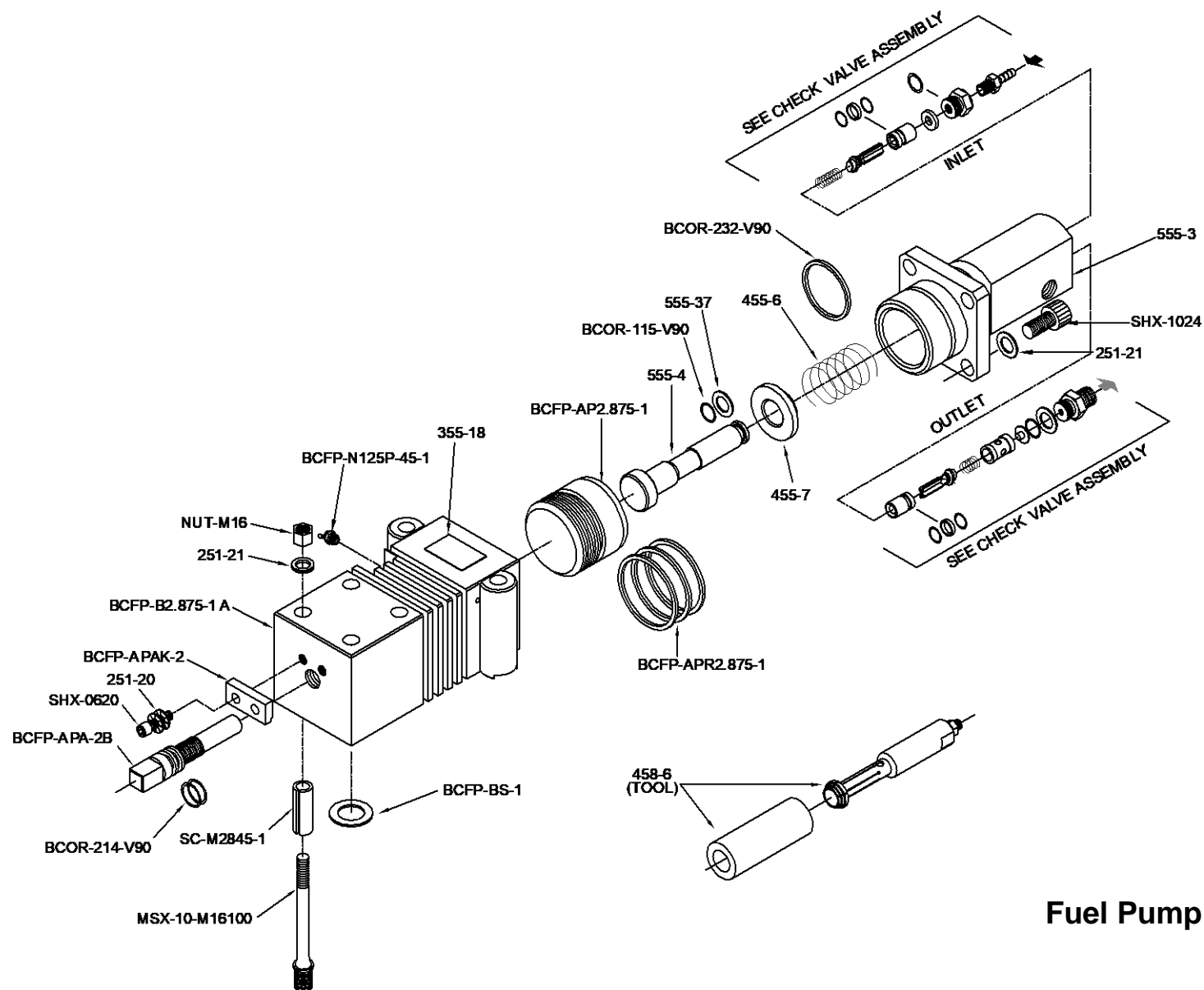
PART No.	DESCRIPTION	QUANTITY
Fuel Lines-Feed-Tank to Pump		
455-18	Suction Strainer Assembly	1
125-6C	3/8" NPT to 3/8" Barb Fitting	1
235-4-5-6	3/8" Fuel Line	As Req.
54105K39	Hose Clamp	8
455-21-2	Fuel Feed Valve (Shut-Off)	2
455-21-1-1	Fuel Feed Valve Handle	2
BCFG-6-1	1/4"-NPT Straight Fitting 3/8 Barbed Male	4
255-19	In line Fuel Filter	1
BCF-FF-1-0	In-Line Fuel Filter	1
Fuel Lines-Fuel Tank Return from Throttle Block		
455-18	Suction Strainer Assembly	1
125-6C	3/8" NPT to 3/8" Barb Fitting	1
235-4-5-6	3/8" Fuel Line	As Req.
54105K39	Hose Clamp	6
455-21-2	Fuel Feed Valve (Shut-Off)	1
455-21-1-1	Fuel Feed Valve Handle	1
BCGF-6-1	1/4"-NPT Straight Fitting 3/8 Barbed Male	2
255-19	In line Fuel Filter	1
Fuel Lines—Ground Fuel Tank Filling System (Not Shown)		
352-32-2	3/4" Hose Barb Fitting	3
CV-12	3/4" Inline Check Valve	1
352-32-1	3/4" Rubber Hose	As Req.
B32-GFM-1-0	Ground Fueling Manifold Assembly (consisting of)	1
B32-GFM-1	Manifold Plate	1
BH-136-46-1B	3/4" Male Quick Disconnect Nipple	1
BH-139-26B	1/2" Male Quick Disconnect Nipple	1
352-32-2	3/4" NPT to 3/4" Barb	1
655-21-9-1	1/2" NPT to 1/2" Barb	1



Oil, Lubricating System

**Oil, Lubricating System****B32**

PART No.	DESCRIPTION	QUANTITY
Oil Feed –Tank to Pump		
455-18	Suction Strainer Assembly	1
125-6C	3/8" NPT(M) to 3/8" Barb Fitting	1
235-4-5-6	3/8" Oil Line	As Req.
54105K39	Hose Clamp	6
455-21-2	Oil Feed Valve #B-4P4T5-M2 (Shut-Off)	1
455-21-1-1	Oil Feed Valve Handle	1
BCGF-6-1	1/4" NPT(M) to 3/8 Barb Fitting	3
651-37	Inline Oil Strainer	1
651-41-9	In-Line Priming Pump	1
Oil Feed –Tank to Lower Cylinder		
125-6C	3/8" NPT(M) to 3/8 Barb Fitting	1
235-4-5-6	3/8" Oil Line	As Req.
54105K39	Hose Clamp	6
355-17	3/8 Barbed Tee	1
205-30	1/4" NPT(M) to 3/8" Barb 90 Degree Fitting	2
Ground Oil Tank Filling System (Not Shown)		
655-21-9	1/2" Hose Barb Fitting	3
655-21-5	1/2" Rubber Hose	As Req.
Open Stock	3/4" x 1/2" Reducer Bushing	1
CV-08	1/2" Inline Check Valve	1
B32-GFM-1-0	Ground Fueling Manifold Assembly (see fuel system)	-
Oil Pump Drip Line		
BCF-25-B0-25-1	1/4" NPT to 1/4" Barbed Fitting	1
Mounting Hardware		
SHX-0844	Oil Pump Mounting Bolt (1/2" x 2-3/4" SHCS)	4
230-1-86	1/2" Nord-Lock Washer	4



Fuel Pump Assembly

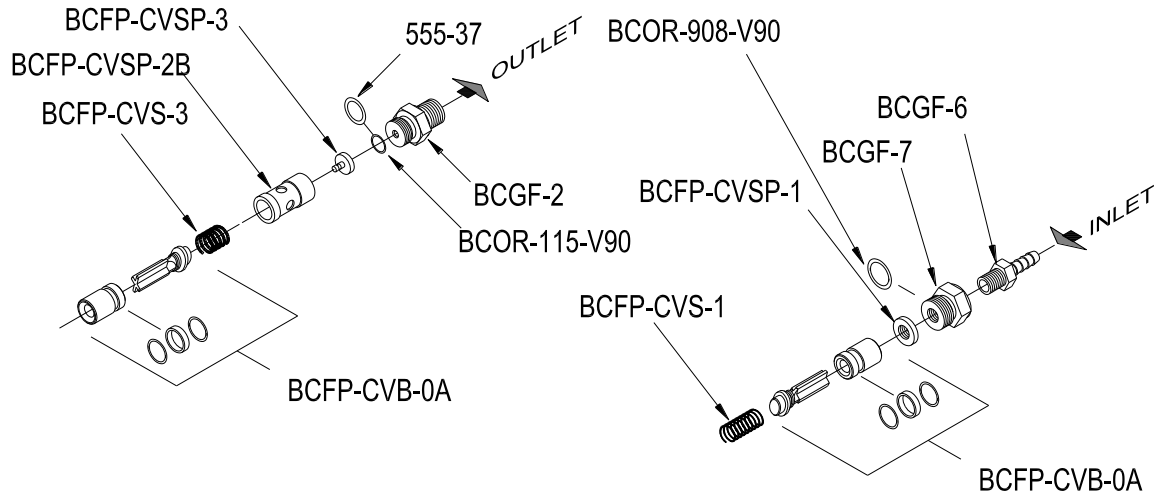


Fuel System

B32

Fuel Pump Assembly

PART No.	DESCRIPTION	QUANTITY
B32-FP-0	Fuel Pump Assembly	-
BCFP-B2.875-1A	Fuel Pump Lower Body	1
BCFP-APA-2B	Adjusting Screw	1
BCLF-N125P-45-1	Lubrication Fitting (Oiler For Pump)	1
BCFP-AP2.875-1	Air Piston	1
BCFP-APR2.875-1	Piston Ring	3
BCFP-APAK-2	Adjusting Screw Keeper	1
BCOR-214-V90	'O'-Ring #214 (90 Durometer Viton)	2
251-20	3/8" Nord Lock Washer	2
SHX-0620	Keeper Bolt	2
555-3	Fuel Pump Head	1
BCOR-232-V90	'O'-Ring #232 (90 Durometer 90)	1
455-6	Spring	1
455-7	Spring Seat	1
555-4	Plunger	1
555-37	Seal	1
BCOR-115-V90	'O' Ring #115 (90 Durometer Viton)	1
SHX-1024	Pump Head Bolt	4
251-21	5/8" Nord Lock Washer	4
	See check valve arrangement below	
	Other Parts Shown	
BCFP-BS-1	Copper Seal	1
MSX-10-M16100	Pump Mounting Stud	6
SC-M2845-1	M28 Shear Collar	4
251-21	Disc Lock Washer	6
NUT-M16	M16 Nut	6
	Tools	
238-14-1	Check Valve Extractor Tool	-
458-6	Ring Compressor Tool	-
B32-FPSK-1	Fuel Pump Seal Kit	-



Fuel System

B32

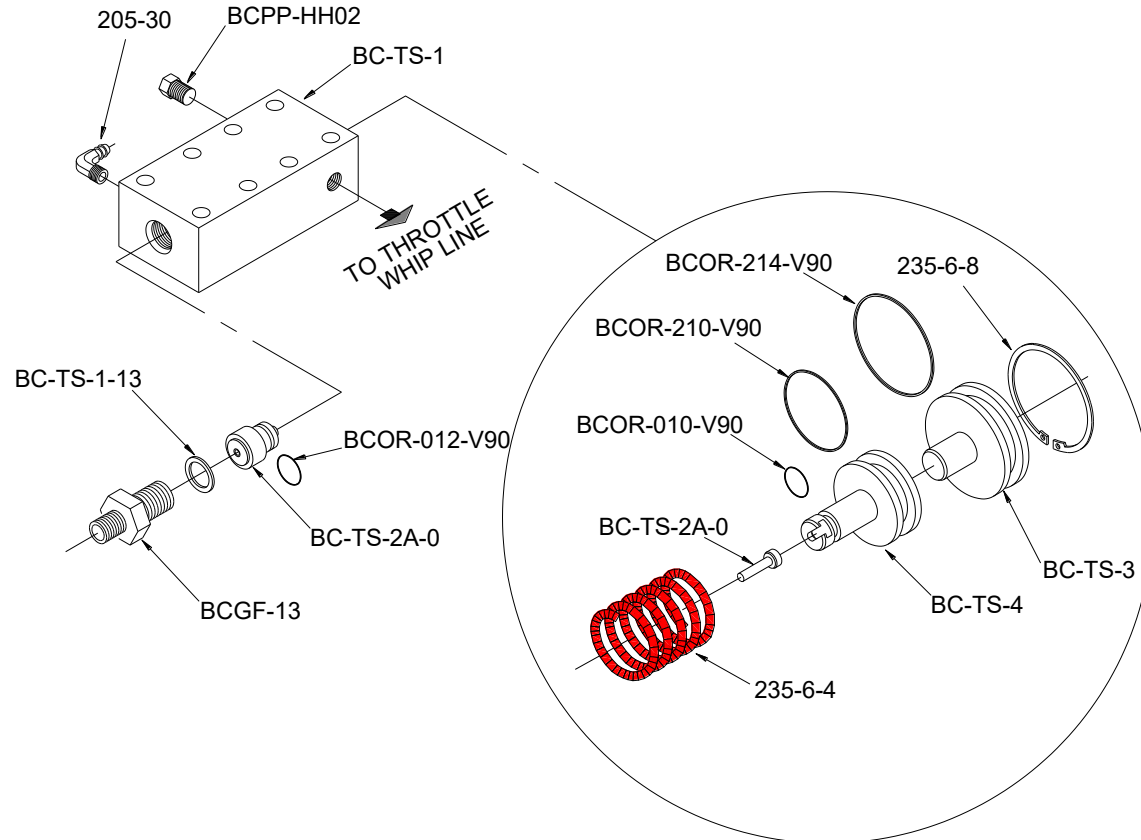
PART No.	DESCRIPTION	QUANTITY
	Outlet—Check Valve	
BCFP-CVB-0A	Check Valve Assembly (see below)	1
BCFP-CVS-3	Spring	1
BCFP-CVSP-2B	Outlet Spacer	1
BCFP-CVSP-3	Outlet Spring Stop	1
555-37	Seal	1
BCOR-115-V90	'O' Ring #115 (90 Durometer Viton)	1
BCGF-2	Adapter	1
	Inlet—Check Valve	
BCFP-CVS-1	Spring	1
BCFP-CVB-0A	Check Valve Assembly (see below)	1
BCFP-CVSP-1	Inlet Spacer	1
BCOR-908-V90	'O' Ring #3-908 (90 Durometer Viton)	1
BCGF-7	Adapter (Female)	1
BCGF-6	Straight Fitting Barbed Male	-
BCFP-CVB-0A	Check Valve Assembly	-
BCFP-CVB-1	Valve Body	1
BCFP-CVB-2	Valve Stem	1
BCOR-014-V90	'O' Ring #014 90 Durometer Viton	1
BCOR-014-BKR	Back-Up Ring #014	2



Fuel System

B32

Throttle Valve Assembly

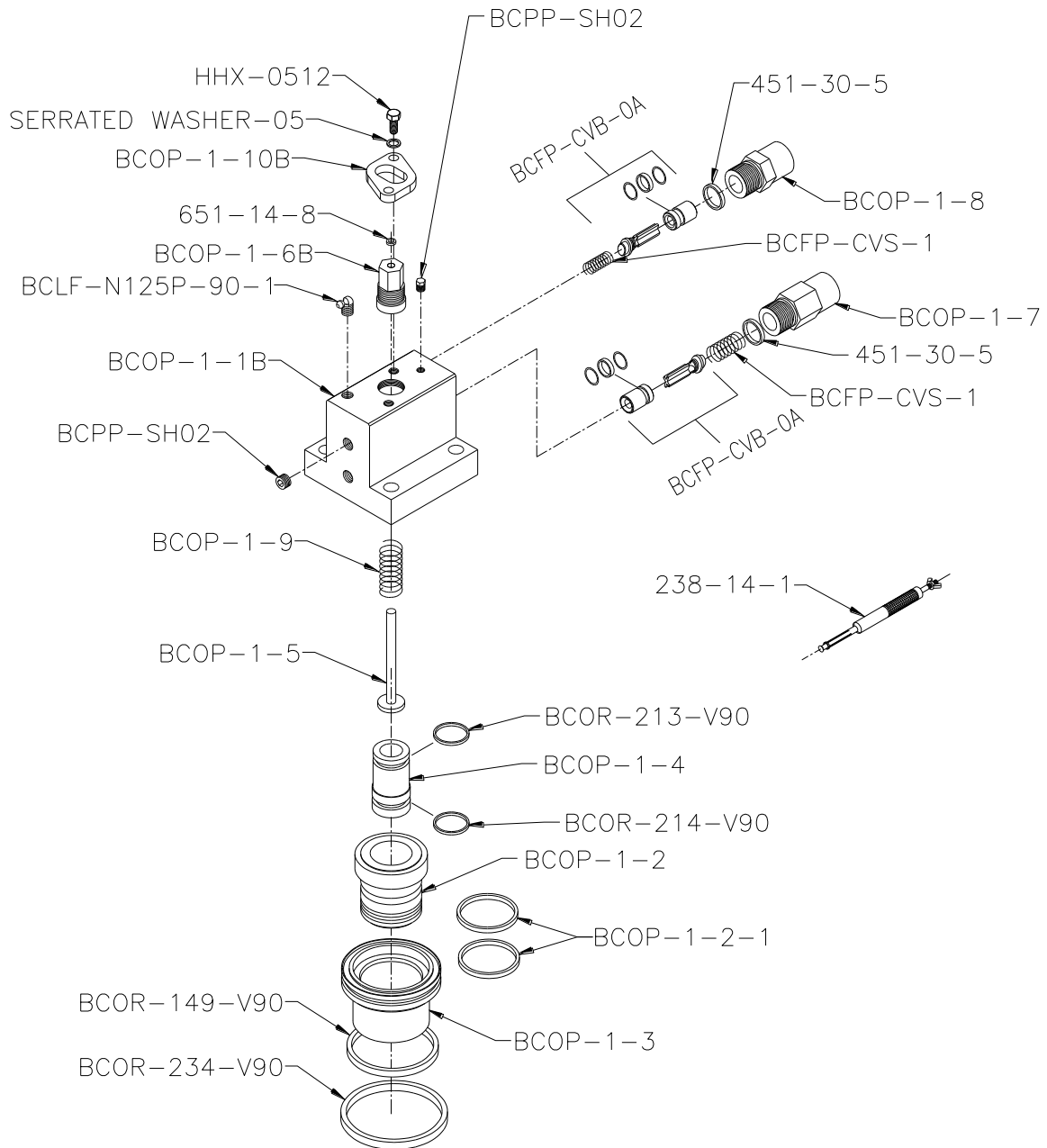


PART No.	DESCRIPTION	QUANTITY
BC-TS-0C	Throttle Valve Assembly	-
BC-TS-1	Throttle Housing	1
235-6-4	Return Spring	1
BC-TS-4	Throttle Piston	1
BC-TS-2A-0	Needle & Seat	1
BCOR-012-V90	Needle Seat O-Ring	1
BC-TS-1-13	Needle Seat Copper Seal	1
BCOR-210-V90	Piston Hydraulic 'O' Ring	1
BCOR-010-V90	Piston Fuel 'O' Ring	1
BC-TS-3	Needle Retainer	1
BCOR-214-V90	Retainer 'O' Ring	1
235-6-8	Snap Ring	1
205-30	1/4" NPT to 3/8" Barb 90° Elbow Fitting	1
BCPP-HH02	Pipe Plug (Hex Head) (Bleed Screw)	1
BCGF-13	Adapter	1
BC-TBSK-1B	Throttle Block Seal Kit	-



Sub-Assembly Oil Pump Assembly

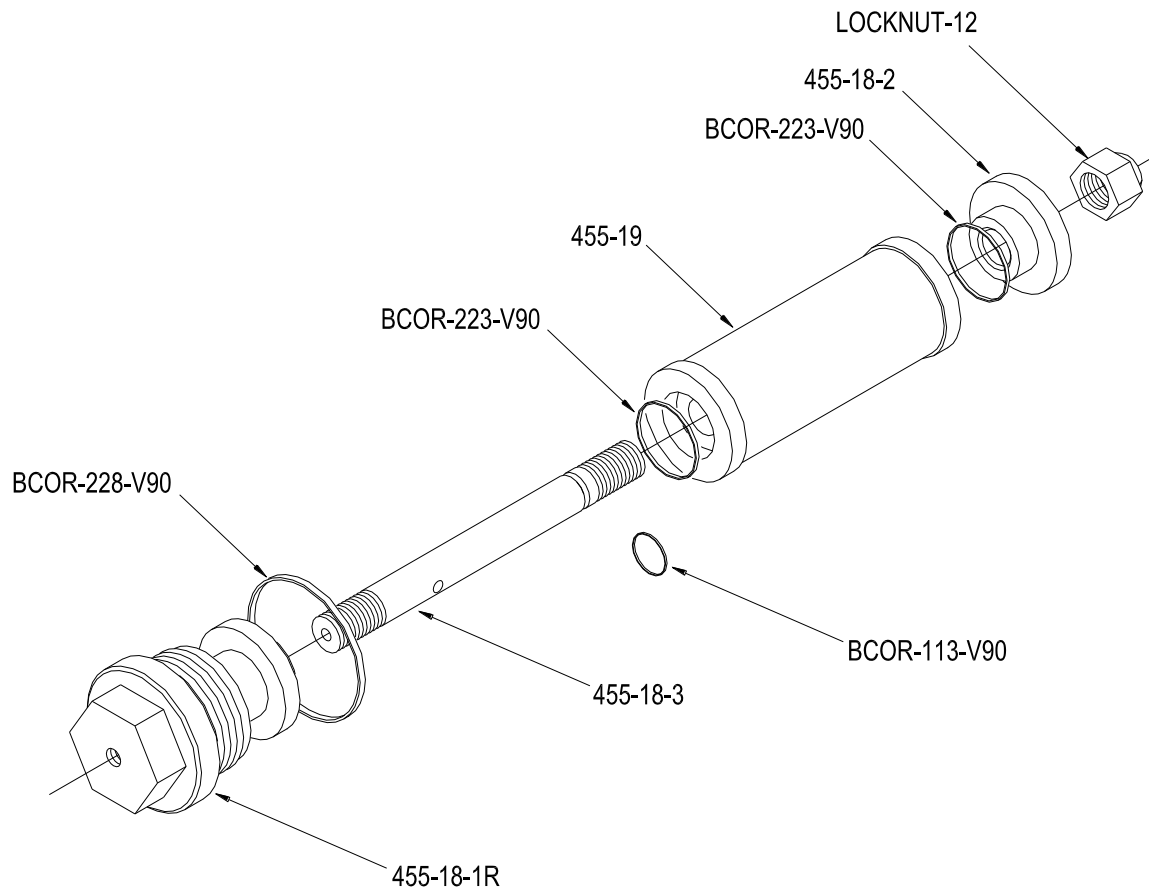
B32



Oil Pump Assembly

**Sub-Assembly Oil Pump****B32**

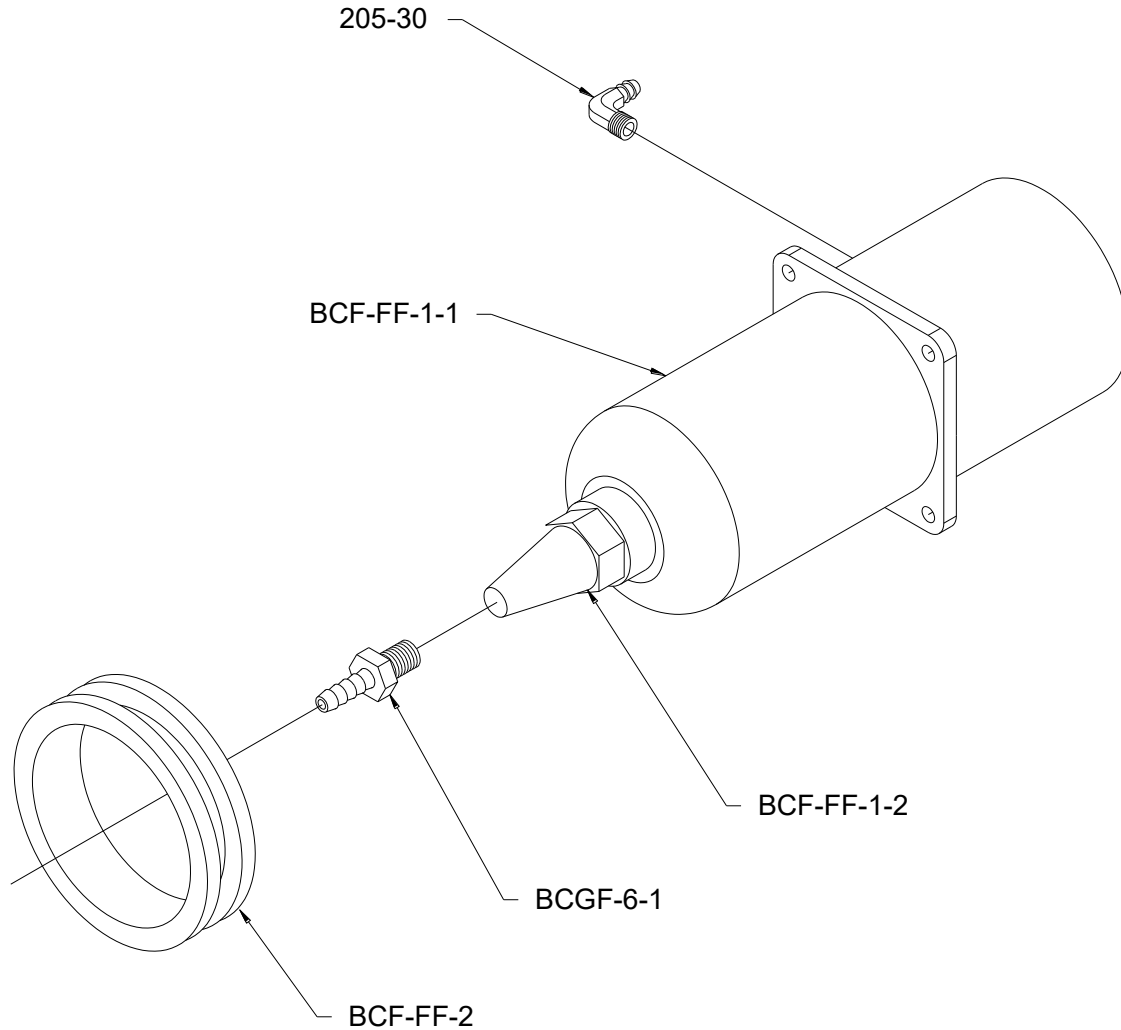
PART No.	DESCRIPTION	QUANTITY
BCOP-1-0B	Oil Pump Assembly	-
BCOP-1-1B	Oil Pump Body	1
BCOP-1-2	Air Piston	1
BCOP-1-2-1	Air Piston Rings	2
BCOP-1-3	Air Piston Cylinder	1
BCOP-1-4	Plunger	1
BCOP-1-5	Indicator	1
BCOP-1-6B	Adjustable End Cap	1
BCOP-1-7	Outlet Retainer	1
BCOP-1-8	Inlet Retainer	1
BCOP-1-9	Spring	1
BCOP-1-10B	End Cap Retainer	1
BCFP-CVB-0A	Check Valve Assembly	2
BCFP-CVS-1	Check Valve Spring	2
651-14-8	Wiper Seal for Indicator	1
BCOR-213-V90	Plunger 'O' Ring (Small)	1
BCOR-214-V90	Plunger 'O' Ring (Large)	1
451-30-5	Retainer Seal (CV Ret. Outlet)	2
BCLF-N125P-90-1	Lubrication Fitting	1
HHX-0512	End Cap Retaining Plate Bolts (5/16" x 3/4" HHCS)	2
SERRATED WASHER-05	5/16" Nord Lock Washer	2
BCOR-234-V90	Air Piston Cylinder 'O' Ring (Large)	1
BCOR-149-V90	Air Piston Cylinder 'O' Ring (Small)	1
BCPP-SH02	Pipe Plug (Socket Head)	2
SHX-0844	Oil Pump Mounting Bolt (1/2" x 2 3/4" SHCS)	4
230-1-86	1/2" Nord-Lock Washer	4
BCOP-SK-1	Oil Pump Seal Kit	-
238-14-1	Check Valve Extractor Tool	-



Sub-Assembly Tank Mounted Fuel Filter

B32

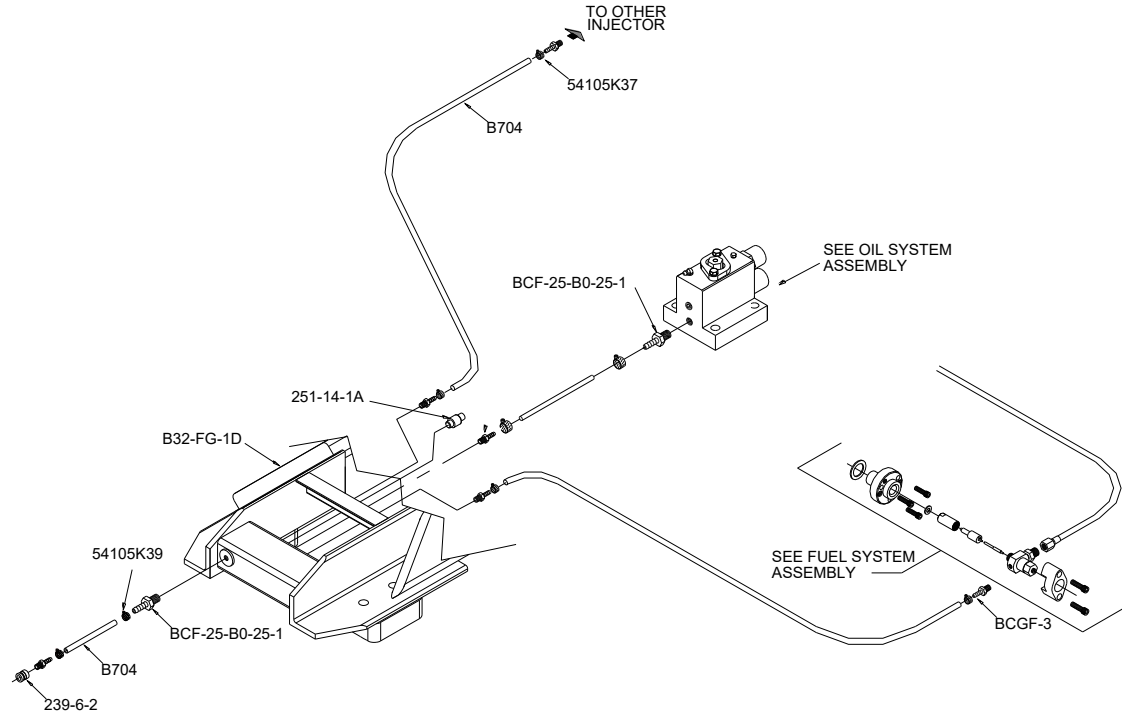
PART No.	DESCRIPTION	QTY
455-18	In-Tank Fuel Filter Mounting Assembly	
455-18-1R	Fuel Filter Mounting Base	1
BCOR-228-V90	Mounting Base 'O' Ring #228	1
455-18-3	Mounting Bolt	1
BCOR-113-V90	Mounting Bolt 'O' Ring #113	1
BCOR-223-V90	Fuel Filter Element "O" Ring #223	2
455-18-2	Retaining Cap	1
LOCK NUT-12	Nylon Insert Lock Nut 3/4" NC	1
455-19	Fuel Filter (Element) (#PF-387)	1



Cartridge Fuel Filter

B32

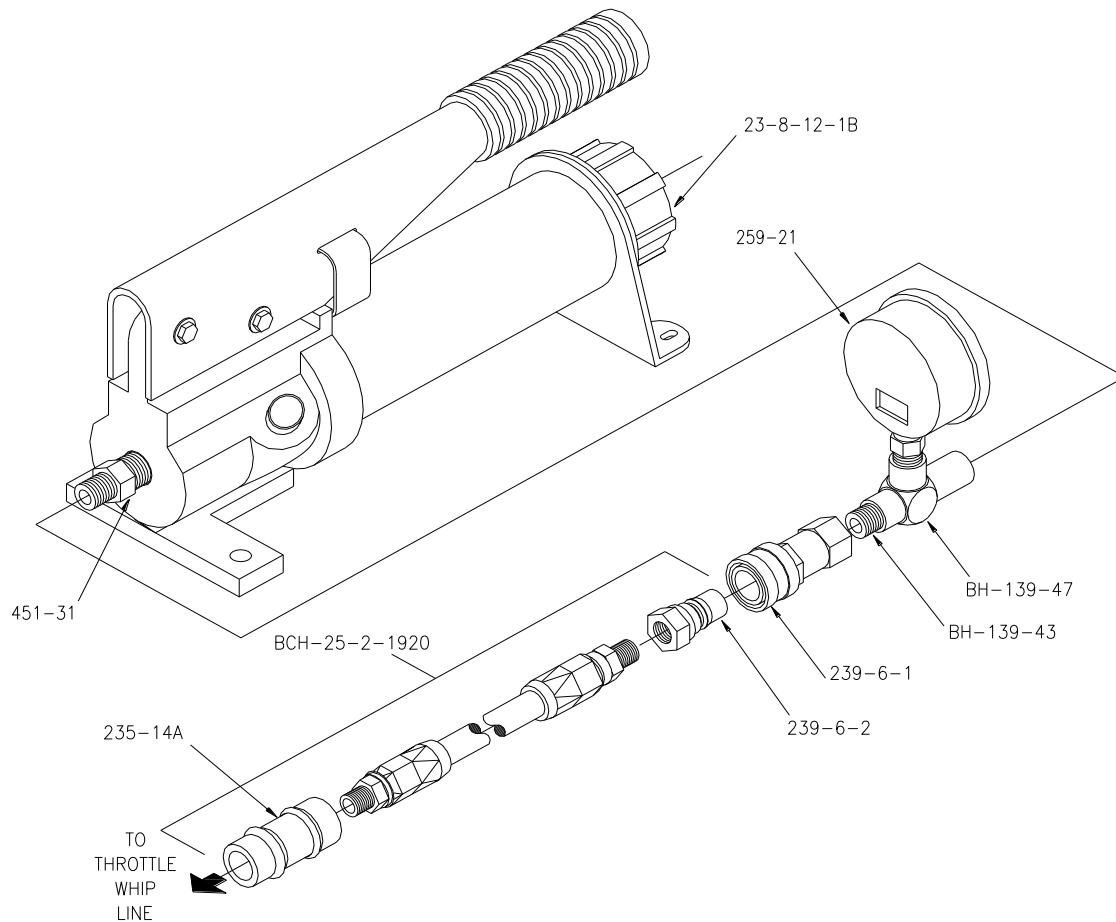
PART No.	DESCRIPTION	QUANTITY
BCF-FF-1-0	Cartridge Fuel Filter Assembly	1
BCF-FF-1-1	Filter Unit	1
BCF-FF-1-1A	Replacement Filter Element	-
BCF-FF-1-2	SAE O-ring to 1/4" NPT adapter	2
BCGF-6	1/4" NPT to 3/8" Barb Fitting	1
205-30	1/4" NPT to 3/8" Barb Fitting 90°	1
BCF-FF-2	Rubber Gasket	1



Waste Tank System

B32

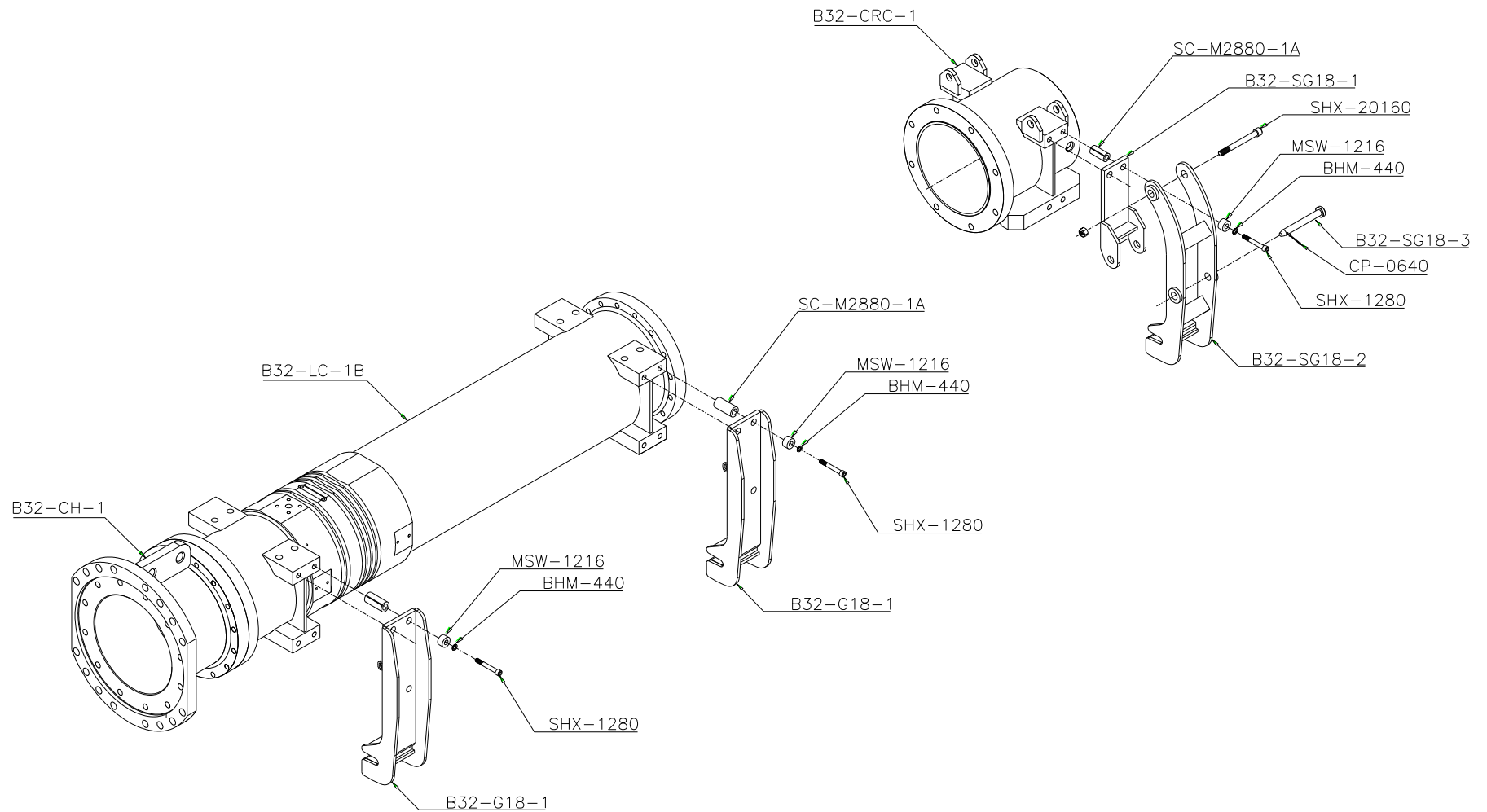
PART No.	DESCRIPTION	QUANTITY
B32-FG-1D-0	Fuel Guard w/ Integrated Waste Tank Assembly	
B32-FG-1D	Fuel Guard w/ Waste Tank	1
251-14-1A	Vent Valve Assembly	1
BCF-25-B0-25-1	1/4"NPT to 1/4" Barb (Brass)	5
B704	1/4" Rubber Hose	As Req.
54105K37	1/4" (Hose) Clamp	2
239-6-2	Quick Disconnect Fitting	1
239-6-5	Dust Cap (Not Shown)	1
Injector Waste System Lines		
BCGF-3	1/8" NPT To 1/4" Hose Barb	2
B704	1/4" Rubber Hose	As Req.
54105K37	1/4" Hose Clamp	4
Oil Pump Waste System Lines		
BCF-25-B0-25-1	1/4"NPT to 1/4" Barb (Brass)	1
B704	1/4" Rubber Hose	As Req.
54105K37	1/4" Hose Clamp	2



Sub-Assembly Remote Throttle Assembly

B32

PART No.	DESCRIPTION	QTY
238-12-1B	Hydraulic Hand Pump Assembly	
23-8-12-1B	Hydraulic Hand Pump (Complete) #Power Team P23	1
451-31	Fitting (Nipple) (3/8x1/4 FF-S)	1
BH-139-43	Fitting (Nipple) (1/4x1/4 FF-S)	1
BH-139-47	Run Tee (1/4 MROS)	1
259-21	Pressure Gauge #CFIP-070A/1000	1
239-6-1	Q.D. Fitting (Female) #FD 45-1003-04-04 (Q.D. Female)	1
BCH-25-2-1920	Hose Set Assembly :	
235-14A	SNAP-TITE 1/4" COUPLER C/W SLEEVE LOCK	1
239-6FW	Hose 1/4" x 120' w/ 1/4" NPT(m) ends and 239-6-2 QD Fitting	1
239-6-2	Q.D. Fitting (Male) #FD 45-1002-04-04 (Q.D. Male)	1
Note	Fluid for Remote Throttle Control Reservoir (Hand Pump) – Esso Automatic Transmission Fluid Dextron II or equivalent	



Spud Lead System Assembly

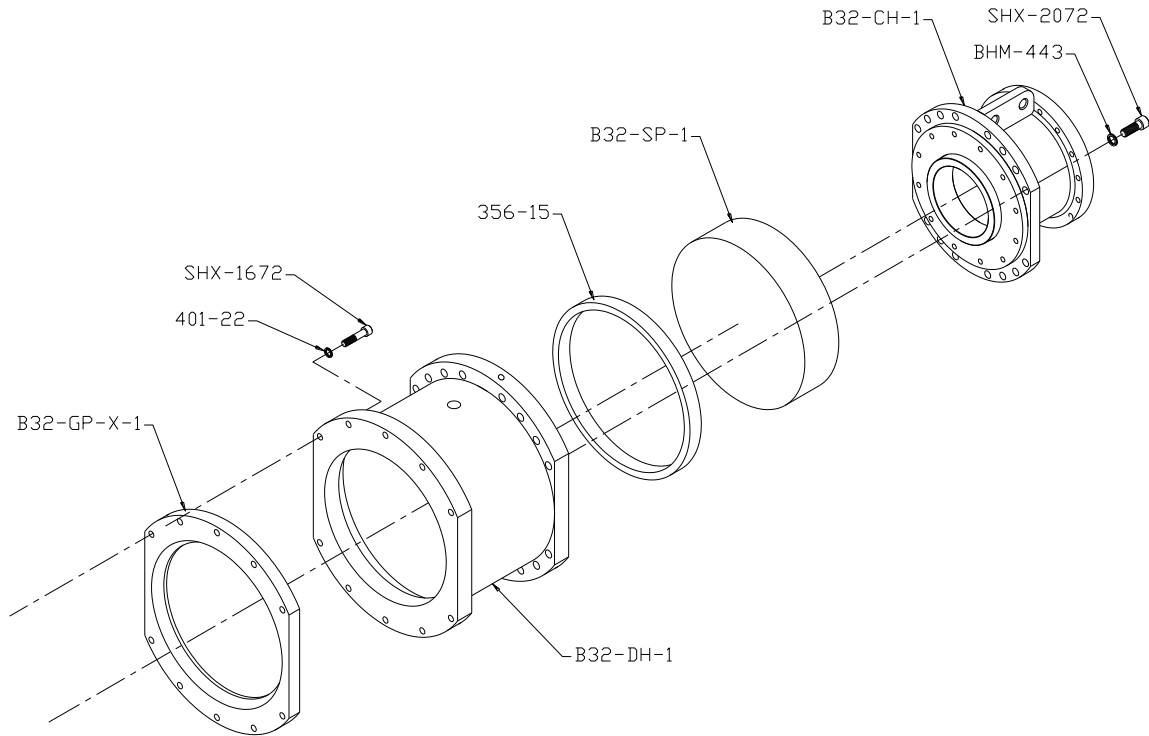


Lead Mounting Systems

B32

Spud Lead Mounting Method

PART No.	DESCRIPTION	QUANTITY
18" Drive Center for L18/L23 Leads		
B32-G18-0	L18/23 Fixed Gib Assembly (Hydraulic Trip)	
B32-G18-1	Fixed Gib	2
SHX-1280	Fixed Gib Bolt ($\frac{3}{4}$ " x 5" NC SHCS)	16
BHM-440	$\frac{3}{4}$ " Nord Lock Washer	16
MSW-1216	Spacer Washer	16
SC-M2880-1	Shear Collar 28mm x 80mm	16
B32-SG18-0	Swing Gib Assembly	
B32-SG18-1	Swing Gib Support Bracket	2
B32-SG18-2	Swing Gib	2
SHX-1280	Swing Gib Bracket Bolts ($\frac{3}{4}$ " x 5" NC SHCS)	8
BHM-440	$\frac{3}{4}$ " Nord Lock Washer	8
MSW-1216	Spacer Washer	8
SHX-20160	Gib Pivot Bolt (1- $\frac{1}{4}$ " x 10" NC SHCS)	2
LOCK NUT-20	1- $\frac{1}{4}$ " Nylon Insert Lock Nut	2
B32-SG18-3	Retainer Pin	2
CP-0640	Cotter Pin (3/8" x 2- $\frac{1}{2}$ ")	2
Other Spud Type Lead Mounting Systems		
18" Drive Center for L20 Leads		
B32-G20-1-0	Fixed Gib Assembly	1
B32-SG20-1-0	Swing Gib Assembly	1
26" Drive Centre for C15/C18/L18/L23 Leads		
B32-G18-0A	Fixed Gib Assembly	1
B32-SG18-0A	Swing Gib Assembly	1
18" Drive Center for H12 Leads		
B32-GH12-1-0	Fixed Gib Assembly	1
B32-SGH12-0	Swing Gib Assembly	1
**Other Lead Mounting Systems and Drive Centers Available on Request		



Direct Drive Assembly

B-32

PART No.	DESCRIPTION	QUANTITY
B32-DH-0A	Drive Housing Assembly	
B32-DH-1	Adapter Plate	1
SHX-2072	Cushion Housing to Drive Housing Bolt (1-1/4" X 4-1/2" NC SHCS)	16
BHM-443	1-1/4" Nord Lock Washer	16
356-15	Cushion Ring	1
B32-SP-1	Striker Plate	1
B32-GP-X-1	Drive Housing Guide Plate (x=Opening Size)	1
SHX-1672	Guide Plate Bolts (1-1/4" x 3-1/2" NC SHCS)	10
401-22	1" Nord Lock Washer	10
**Other Drive Housing Assemblies Available on Request		

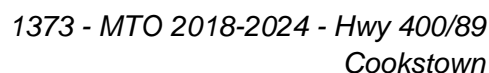
**Tools****B32**

PART No.	DESCRIPTION
B32-8	Complete B32 Spare Parts/Tool Box
259-1-2	Tool Box (Box Only)
Allen Wrenches	
358-5	5/16 Hex Key
258-5	3/8 Hex Key
358-7	1/2 Hex Key
258-4	5/8 Hex Key
408-4	3/4 Hex Key
458-4	7/8 Hex Key
Greasing	
BCLT-1-0	Grease Gun Assembly w/ Button Adapter
BCLT-1-4A	Berminghammer Grease
Oiling	
BCLT-2-1	Oil Gun
CYL ESSO TK 680 OIL 1L	Cyl esstic TK-680 (1 liter)
Ground Refueling	
BCHT-GFP-0	Ground Fueling Pump Assembly
BCHT-GFH-1-0	Ground Fueling Hose Assembly
238-22-1	Oil Filling Pump Assembly
Fuel & Oil Systems Tools	
238-14-1	Check Valve Extractor
458-6	Teflon Ring Expander & Compressor
Piston	
453-2	Piston Lifting Eye (1 1/2")
258-3A	Ring Pliers
Fuel and Oil Pump Tooling	
358-4	Ring Compressor Tool
238-14-1	Check Valve Extractor Tool
Upper Cylinder	
255-27	Trip Safety Lever Cord (3/8 × 100 ft)



NOTES;

Vibrating Wire Piezometer (VWP)



Instrument Type: VWP Array Type: West Abt Install Date: July 2, 2019

Instrument ID No.: VWP 1

Sensor S/N: 1901818

Installed By: MF

Drilling Contractor: Walker Drilling
Drill Rig: D-120
Operator(s): Farmer/Vishal

Times:	Coring	Drilling	Install	Notes: 75m Cable
Start		8:00 (June 28)	10:45	
Finish		10:00	13:16	

Location:	Northing	<u>4 895 629.96</u>	Station	<u> </u>
	Easting	<u>292 376.20</u>	Offset	<u> </u>

	Depth (m)	Elevation (m)		Depth (m)	Description
Ground Surface	0.00	227.41	Stratigraphy	0.00	Soil/Organic
Bottom of Hole	25.35	202.06		1.50	Sand/Organic
Tip of Piezometer	24.41	203.00		3.00	Sandy Clay
Top of Filter Sand	23.44	203.97		4.50	Clay with Silt
Top of Bentonite	21.87	205.54			
Top of Grout				24.00	Soft Clay
				In Hole Water Depth	N/A

	Readings		
Date/Time	Freq. (Hz)	Temp. (°C)	Description
02-Jul	2988.0	22.4	Pre-installation
02-Jul	2624.0	13.2	Post-installation
03-Jul	2625.7	9.8	
04-Jul	2623.5	9.6	
05-Jul	2623.5	9.5	

Notes:

First 3.5m of the hole was drilled with 4" hollow stem augers. Augers were then removed and 3.5m of P casing was placed in the borehole. The annulus between the borehole and casing was sealed with 3/8" hole plug. A tri-cone w/ recirculation tank was used for the duration of the borehole drilling.

VW Piezometer Calibration Certificate

Serial #: 1901818
 Range : 350 kPa
 Cable Length: 75 m
 Date of Calibration: 6/7/2019

Part #: 52611020
 Cable Part #: 50613324
 Calibrated by: JLW
 Note:

ABC Calibration Factors

	A	B	C
kPa	-1.018819E-4	-4.819660E-2	1.052280E+3
psi	-1.477672E-5	-6.990326E-3	1.526203E+2

Pressure in kPa/psi = $(A \times \text{Hz}^2) + (B \times \text{Hz}) + C$, where Hz is frequency in Hertz.

TI Calibration Factors

	C0	C1	C2	C3	C4	C5
kPa	1.049852E+3	-4.817603E-2	1.479742E-1	-1.020322E-4	4.653066E-5	-3.198693E-3
psi	1.522628E+2	-6.987096E-3	2.146109E-2	-1.479800E-5	6.748464E-6	-4.639149E-4

Pressure in kPa/psi = $C0 + (C1 \times \text{Hz}) + (C2 \times T) + (C3 \times \text{Hz}^2) + (C4 \times \text{Hz} \times T) + (C5 \times T^2)$

Where Hz is the frequency reading in Hertz and T is the Thermistor reading in degrees C.

TI factors are calculated from temperatures at 5.0, 15.0 and 25.0 degrees C.

Applied pressure and temperature are NIST traceable.

Summary of Test Results at 15°C

Thermistor reading is 15.5 °C.

Applied Pressure is referenced to 1 atm. Calculated Pressure uses ABC Calibration factors.

Applied (kPa)	Equivalent (psi)	Frequency (Hz)	Calculated (kPa)	Calculated (psi)	Error (%FS)
0.0	0.00	2985.8	0.1	0.01	-0.03
35.0	5.08	2932.2	35.0	5.08	0.00
70.0	10.15	2877.8	69.8	10.13	0.05
105.0	15.23	2822.0	104.9	15.22	0.02
140.0	20.31	2765.0	140.1	20.32	-0.03
175.0	25.38	2707.2	175.1	25.40	-0.03
210.0	30.46	2648.4	210.0	30.46	-0.01
245.0	35.53	2588.3	245.0	35.53	0.00
280.0	40.61	2526.9	279.9	40.60	0.01
315.0	45.69	2464.0	315.0	45.68	0.01
350.0	50.76	2399.5	350.0	50.77	-0.01

Instrument Installation Record

Instrument Type: VWP

Array Type: West Abt

Install Date: June 27, 2019

Instrument ID No.: VWP 2

Sensor S/N: 1901812

Installed By: MF

Drilling Contractor: Walker Drilling

Drill Rig: D-120

Operator(s): Farmer/Vishal

Times:

	Coring	Drilling	Install
Start		8:30	12:10
Finish		12:00	14:50

Notes: 100m Cable

Location:

Northing 4 895 628.19

Easting 292 376.89

Station

Offset

	Depth (m)	Elevation (m)
Ground Surface	0.00	227.41
Bottom of Hole	29.44	197.97
Tip of Piezometer	28.30	199.11
Top of Filter Sand	27.25	200.16
Top of Bentonite	26.24	201.17
Top of Grout		

	Depth (m)	Description
Stratigraphy	0.00	Soil/Organic
	1.50	Sand
	3.00	Sand with Clay
	28.00	Clay with trace silt

In Hole Water Depth N/A

	Readings		
Date/Time	Freq. (Hz)	Temp. (°C)	Description
27-Jun	3054.2	24.1	Pre-installation
27-Jun	2658.3	12.3	Post-installation
28-Jun	2660.2	9.7	
30-Jun	2661.9	9.3	
02-Jul	2662.8	9.2	

Notes:

First 3.5m of the hole was drilled with 4" hollow stem augers. Augers were then removed and 3.5m of P casing was placed in the borehole. The annulus between the borehole and casing was sealed with 3/8" hole plug.

A tri-cone w/ recirculation tank was used for the duration of the borehole drilling.

VW Piezometer Calibration Certificate

Serial #: 1901812
 Range : 350 kPa
 Cable Length: 100 m
 Date of Calibration: 6/7/2019

Part #: 52611020
 Cable Part # : 50613324
 Calibrated by: JLW
 Note:

ABC Calibration Factors

	A	B	C
kPa	-1.212348E-4	1.837248E-2	1.072677E+3
psi	-1.758362E-5	2.664703E-3	1.555787E+2

Pressure in kPa/psi = (A x Hz²) + (B x Hz) + C, where Hz is frequency in Hertz.

TI Calibration Factors

	C0	C1	C2	C3	C4	C5
kPa	1.072475E+3	1.677892E-2	1.157339E-1	-1.211882E-4	7.195989E-5	-2.412195E-3
psi	1.555439E+2	2.433491E-3	1.678519E-2	-1.757624E-5	1.043653E-5	-3.498470E-4

Pressure in kPa/psi = C0 + (C1 x Hz) + (C2 x T) + (C3 x Hz²) + (C4 x Hz x T) + (C5 x T²)

Where Hz is the frequency reading in Hertz and T is the Thermistor reading in degrees C.

TI factors are calculated from temperatures at 5.0, 15.0 and 25.0 degrees C.

Applied pressure and temperature are NIST traceable.

Summary of Test Results at 15°C

Thermistor reading is 15.3 °C.

Applied Pressure is referenced to 1 atm. Calculated Pressure uses ABC Calibration factors.

Applied (kPa)	Equivalent (psi)	Frequency (Hz)	Calculated (kPa)	Calculated (psi)	Error (%FS)
0.0	0.00	3051.3	-0.0	-0.00	0.00
35.0	5.08	3002.3	35.0	5.08	-0.01
70.0	10.15	2952.6	70.0	10.16	0.00
105.0	15.23	2902.0	105.0	15.23	0.00
140.0	20.31	2850.6	139.9	20.29	0.03
175.0	25.38	2798.1	174.9	25.37	0.03
210.0	30.46	2744.5	209.9	30.45	0.02
245.0	35.53	2689.6	245.1	35.55	-0.02
280.0	40.61	2633.7	280.1	40.63	-0.04
315.0	45.69	2576.8	315.0	45.69	-0.01
350.0	50.76	2518.7	349.9	50.74	0.04

VW Piezometer Calibration Certificate

Serial #: 1901811
 Range : 350 kPa
 Cable Length: 100 m
 Date of Calibration: 6/7/2019

Part #: 52611020
 Cable Part #: 50613324
 Calibrated by: JLW
 Note:

ABC Calibration Factors

	A	B	C
kPa	-1.045458E-4	-1.160902E-1	1.330215E+3
psi	-1.516309E-5	-1.683746E-2	1.929314E+2

Pressure in kPa/psi = $(A \times \text{Hz}^2) + (B \times \text{Hz}) + C$, where Hz is frequency in Hertz.

TI Calibration Factors

	C0	C1	C2	C3	C4	C5
kPa	1.333699E+3	-1.196381E-1	-3.117145E-3	-1.041414E-4	8.407788E-5	-1.294700E-3
psi	1.934299E+2	-1.735143E-2	-4.520877E-4	-1.510390E-5	1.219404E-5	-1.877737E-4

Pressure in kPa/psi = $C0 + (C1 \times \text{Hz}) + (C2 \times T) + (C3 \times \text{Hz}^2) + (C4 \times \text{Hz} \times T) + (C5 \times T^2)$

Where Hz is the frequency reading in Hertz and T is the Thermistor reading in degrees C.

TI factors are calculated from temperatures at 5.0, 15.0 and 25.0 degrees C.

Applied pressure and temperature are NIST traceable.

Summary of Test Results at 15°C

Thermistor reading is 15.4 °C.

Applied Pressure is referenced to 1 atm. Calculated Pressure uses ABC Calibration factors.

Applied (kPa)	Equivalent (psi)	Frequency (Hz)	Calculated (kPa)	Calculated (psi)	Error (%FS)
0.0	0.00	3054.6	0.1	0.02	-0.04
35.0	5.08	3008.0	35.1	5.09	-0.02
70.0	10.15	2960.9	69.9	10.14	0.02
105.0	15.23	2913.1	104.8	15.21	0.05
140.0	20.31	2864.7	139.7	20.26	0.09
175.0	25.38	2815.0	175.0	25.38	0.01
210.0	30.46	2764.6	210.2	30.49	-0.06
245.0	35.53	2713.8	245.2	35.57	-0.06
280.0	40.61	2662.3	280.1	40.63	-0.04
315.0	45.69	2610.1	315.0	45.68	0.01
350.0	50.76	2557.0	349.8	50.74	0.05

Instrument Installation Record

Instrument Type: VWP

Array Type: Pile testInstall Date: June 25, 2019Instrument ID No.: VWP 7Sensor S/N: 1901820Installed By: MFDrilling Contractor: Walker DrillingDrill Rig: D-120Operator(s): Farmer/Vishal

Times:

	Coring	Drilling	Install
Start		8:00	10:00
Finish		10:00	13:40

Notes: 75m Cable

Location:

Northing 4 895 670.91Easting 292 361.95Station Offset

	Depth (m)	Elevation (m)
Ground Surface	0.00	228.37
Bottom of Hole	14.05	214.32
Tip of Piezometer	12.95	215.42
Top of Filter Sand	12.09	216.28
Top of Bentonite	11.00	217.37
Top of Grout		

	Depth (m)	Description
Stratigraphy	0.00	Asphalt
	1.50	Sand
	3.00	Sand trace clay
	4.50	Sand Clay
	9.00	Loose Clay
	10.50	Loose Clay
	13.10	Sandy Silt
In Hole Water Depth		<u>N/A</u>

Readings			
Date/Time	Freq. (Hz)	Temp. (°C)	Description
25-Jun	2913.9	19.3	Pre-installation
25-Jun	2727.1	12.4	Post-installation
26-Jun	2726.0	11.4	
27-Jun	2725.8	11.3	
28-Jun	2726.6	11.3	

Notes:

First 3.5m of the hole was drilled with 4" hollow stem augers. Augers were then removed and 3.5m of P casing was placed in the borehole. The annulus between the borehole and casing was sealed with 3/8" hole plug. A tri-cone w/ recirculation tank was used for the duration of the borehole drilling.

VW Piezometer Calibration Certificate

Serial #: 1901820
 Range : 350 kPa
 Cable Length: 75 m
 Date of Calibration: 6/7/2019

Part #: 52611020
 Cable Part #: 50613324
 Calibrated by: JLW
 Note:

ABC Calibration Factors

	A	B	C
kPa	-8.198331E-5	-1.256881E-1	1.059697E+3
psi	-1.189067E-5	-1.822952E-2	1.536961E+2

Pressure in kPa/psi = $(A \times \text{Hz}^2) + (B \times \text{Hz}) + C$, where Hz is frequency in Hertz.

TI Calibration Factors

	C0	C1	C2	C3	C4	C5
kPa	1.057391E+3	-1.255994E-1	1.095691E-1	-8.221910E-5	6.106713E-5	-1.751466E-3
psi	1.533562E+2	-1.821601E-2	1.589109E-2	-1.192445E-5	8.856727E-6	-2.540197E-4

Pressure in kPa/psi = $C0 + (C1 \times \text{Hz}) + (C2 \times T) + (C3 \times \text{Hz}^2) + (C4 \times \text{Hz} \times T) + (C5 \times T^2)$

Where Hz is the frequency reading in Hertz and T is the Thermistor reading in degrees C.

TI factors are calculated from temperatures at 5.0, 15.0 and 25.0 degrees C.

Applied pressure and temperature are NIST traceable.

Summary of Test Results at 15°C

Thermistor reading is 15.2 °C.

Applied Pressure is referenced to 1 atm. Calculated Pressure uses ABC Calibration factors.

Applied (kPa)	Equivalent (psi)	Frequency (Hz)	Calculated (kPa)	Calculated (psi)	Error (%FS)
0.0	0.00	2909.6	-0.1	-0.01	0.02
35.0	5.08	2850.7	35.2	5.10	-0.05
70.0	10.15	2791.4	70.0	10.16	-0.01
105.0	15.23	2731.2	104.9	15.21	0.04
140.0	20.31	2669.4	140.0	20.31	0.00
175.0	25.38	2606.8	174.9	25.37	0.02
210.0	30.46	2542.7	210.1	30.47	-0.02
245.0	35.53	2477.6	245.0	35.54	-0.01
280.0	40.61	2411.1	280.1	40.62	-0.01
315.0	45.69	2343.3	315.0	45.69	0.00
350.0	50.76	2273.9	350.0	50.76	0.00

Instrument Installation Record

Instrument Type: VWP

Array Type: Pile testInstall Date: June 24, 2019Instrument ID No.: VWP 8Sensor S/N: 1901817Installed By: MFDrilling Contractor: Walker DrillingDrill Rig: D-120Operator(s): Farmer/Vishal

Times:

	Coring	Drilling	Install
Start		8:00	12:00
Finish		11:30	14:30

Notes: 75m Cable

Location:

Northing 4 895 670.28Easting 292 362.81Station Offset

	Depth (m)	Elevation (m)
Ground Surface	0.00	228.34
Bottom of Hole	29.82	198.52
Tip of Piezometer	28.32	200.02
Top of Filter Sand	27.05	201.29
Top of Bentonite	11.00	25.45
Top of Grout		

	Depth (m)	Description
Stratigraphy	0.00	Asphalt
	1.50	Sand
	3.00	Sandy Clay
	20.00	Clay
	28.00	Firm Clay
In Hole Water Depth		<u>N/A</u>

Readings			
Date/Time	Freq. (Hz)	Temp. (°C)	Description
24-Jun	3039.2	20.5	Pre-installation
24-Jun	2628.3	12.5	Post-installation
25-Jun	2639.3	10.2	
26-Jun	2639.4	10.1	
27-Jun	2639.0	10.0	

Notes:

First 3.5m of the hole was drilled with 4" hollow stem augers. Augers were then removed and 3.5m of P casing was placed in the borehole. The annulus between the borehole and casing was sealed with 3/8" hole plug. A tri-cone w/ recirculation tank was used for the duration of the borehole drilling.

VW Piezometer Calibration Certificate

Serial #: 1901817
 Range : 350 kPa
 Cable Length: 75 m
 Date of Calibration: 6/7/2019

Part #: 52611020
 Cable Part #: 50613324
 Calibrated by: JLW
 Note:

ABC Calibration Factors

	A	B	C
kPa	-1.164722E-4	1.824886E-2	1.018149E+3
psi	-1.689287E-5	2.646773E-3	1.476700E+2

Pressure in kPa/psi = $(A \times \text{Hz}^2) + (B \times \text{Hz}) + C$, where Hz is frequency in Hertz.

TI Calibration Factors

	C0	C1	C2	C3	C4	C5
kPa	1.017660E+3	1.693682E-2	1.187599E-1	-1.164660E-4	7.270414E-5	-3.646871E-3
psi	1.475939E+2	2.456392E-3	1.722406E-2	-1.689137E-5	1.054447E-5	-5.289153E-4

Pressure in kPa/psi = $C0 + (C1 \times \text{Hz}) + (C2 \times T) + (C3 \times \text{Hz}^2) + (C4 \times \text{Hz} \times T) + (C5 \times T^2)$

Where Hz is the frequency reading in Hertz and T is the Thermistor reading in degrees C.

TI factors are calculated from temperatures at 5.0, 15.0 and 25.0 degrees C.

Applied pressure and temperature are NIST traceable.

Summary of Test Results at 15°C

Thermistor reading is 15.4 °C.

Applied Pressure is referenced to 1 atm. Calculated Pressure uses ABC Calibration factors.

Applied (kPa)	Equivalent (psi)	Frequency (Hz)	Calculated (kPa)	Calculated (psi)	Error (%FS)
0.0	0.00	3035.8	0.1	0.02	-0.04
35.0	5.08	2984.7	35.0	5.08	-0.01
70.0	10.15	2932.7	69.9	10.14	0.02
105.0	15.23	2879.7	104.8	15.21	0.05
140.0	20.31	2825.4	139.9	20.30	0.02
175.0	25.38	2770.0	175.0	25.38	-0.01
210.0	30.46	2713.4	210.1	30.48	-0.04
245.0	35.53	2655.8	245.1	35.55	-0.03
280.0	40.61	2596.9	280.1	40.62	-0.02
315.0	45.69	2536.6	315.0	45.69	-0.01
350.0	50.76	2474.9	349.9	50.75	0.03

Instrument Installation Record

Instrument Type: VWP

Array Type: Pile testInstall Date: June 20, 2019Instrument ID No.: VWP 9Sensor S/N: 1901816Installed By: MFDrilling Contractor: Walker DrillingDrill Rig: D-120Operator(s): Varon/Vishal

Times:

	Coring	Drilling	Install
Start		7:10	11:45
Finish		11:30	14:00

Notes: 100m Cable

Location:

Northing 4 895 669.07

Station

Easting 292 362.05

Offset

	Depth (m)	Elevation (m)
Ground Surface	0.00	228.37
Bottom of Hole	36.65	191.72
Tip of Piezometer	35.46	192.91
Top of Filter Sand	34.39	193.98
Top of Bentonite	33.02	195.35
Top of Grout		

	Depth (m)	Description
Stratigraphy	1.00	Sand
	3.00	Silty Sand
	4.50	Clay with Sand
	35.00	Firm Silt
In Hole Water Depth		<u>N/A</u>

Readings			
Date/Time	Freq. (Hz)	Temp. (°C)	Description
20-Jun	3062.4	17.7	Pre-installation
20-Jun	2528.7	10.8	Post-installation
21-Jun	2529.8	9.6	
24-Jun	2529.7	9.3	
25-Jun	2529.5	9.3	

Notes:

First 3.5m of the hole was drilled with 4" hollow stem augers. Augers were then removed and 3.5m of P casing was placed in the borehole. The annulus between the borehole and casing was sealed with 3/8" hole plug.
A tri-cone w/ recirculation tank was used for the duration of the borehole drilling.

VW Piezometer Calibration Certificate

Serial #: 1901816
 Range : 350 kPa
 Cable Length: 100 m
 Date of Calibration: 6/7/2019

Part #: 52611020
 Cable Part #: 50613324
 Calibrated by: JLW
 Note:

ABC Calibration Factors

	A	B	C
kPa	-9.703598E-5	-6.341570E-2	1.103384E+3
psi	-1.407388E-5	-9.197670E-3	1.600323E+2

Pressure in kPa/psi = $(A \times Hz^2) + (B \times Hz) + C$, where Hz is frequency in Hertz.

TI Calibration Factors

	C0	C1	C2	C3	C4	C5
kPa	1.104627E+3	-6.548736E-2	4.722216E-2	-9.683832E-5	6.076577E-5	-1.389384E-3
psi	1.602070E+2	-9.497804E-3	6.848754E-3	-1.404472E-5	8.813020E-6	-2.015060E-4

Pressure in kPa/psi = $C0 + (C1 \times Hz) + (C2 \times T) + (C3 \times Hz^2) + (C4 \times Hz \times T) + (C5 \times T^2)$

Where Hz is the frequency reading in Hertz and T is the Thermistor reading in degrees C.

TI factors are calculated from temperatures at 5.0, 15.0 and 25.0 degrees C.

Applied pressure and temperature are NIST traceable.

Summary of Test Results at 15°C

Thermistor reading is 15.3 °C.

Applied Pressure is referenced to 1 atm. Calculated Pressure uses ABC Calibration factors.

Applied (kPa)	Equivalent (psi)	Frequency (Hz)	Calculated (kPa)	Calculated (psi)	Error (%FS)
0.0	0.00	3061.0	0.1	0.01	-0.02
35.0	5.08	3007.4	35.0	5.08	-0.01
70.0	10.15	2953.0	69.9	10.14	0.02
105.0	15.23	2897.5	105.0	15.22	0.01
140.0	20.31	2841.1	139.9	20.30	0.01
175.0	25.38	2783.7	174.9	25.37	0.02
210.0	30.46	2725.1	210.0	30.45	0.01
245.0	35.53	2665.2	245.1	35.55	-0.03
280.0	40.61	2604.2	280.1	40.63	-0.04
315.0	45.69	2542.2	315.1	45.69	-0.01
350.0	50.76	2479.0	349.9	50.74	0.04

Instrument Installation Record

Instrument Type: VWP

Array Type: Pile testInstall Date: June 26, 2019Instrument ID No.: VWP 10Sensor S/N: 1901819Installed By: MFDrilling Contractor: Walker DrillingDrill Rig: D-120Operator(s): Farmer/Vishal

Times:

	Coring	Drilling	Install
Start		7:30	9:40
Finish		9:30	11:45

Notes: 75m Cable

Location:

Northing 4 895 669.01Station Easting 292 363.13Offset

	Depth (m)	Elevation (m)
Ground Surface	0.00	228.37
Bottom of Hole	14.10	214.27
Tip of Piezometer	13.00	215.37
Top of Filter Sand	11.91	216.46
Top of Bentonite	10.97	217.40
Top of Grout		

	Depth (m)	Description
Stratigraphy	0.00	Asphalt
	1.50	Sand
	3.00	Sandy Clay
	4.50	Loose clay
	13.00	Silt with some clay

In Hole Water Depth N/A

Readings			
Date/Time	Freq. (Hz)	Temp. (°C)	Description
26-Jun	2950.1	19.3	Pre-installation
26-Jun	2762.4	11.9	Post-installation
27-Jun	2762.2	11.2	
28-Jun	2763.0	11.2	
30-Jun	2765.0	11.2	

Notes:

First 3.5m of the hole was drilled with 4" hollow stem augers. Augers were then removed and 3.5m of P casing was placed in the borehole. The annulus between the borehole and casing was sealed with 3/8" hole plug. A tri-cone w/ recirculation tank was used for the duration of the borehole drilling.

VW Piezometer Calibration Certificate

Serial #: 1901819
 Range : 350 kPa
 Cable Length: 75 m
 Date of Calibration: 6/7/2019

Part #: 52611020
 Cable Part # : 50613324
 Calibrated by: JLW
 Note:

ABC Calibration Factors

	A	B	C
kPa	-8.284498E-5	-1.263912E-1	1.092146E+3
psi	-1.201565E-5	-1.833149E-2	1.584024E+2

Pressure in kPa/psi = $(A \times \text{Hz}^2) + (B \times \text{Hz}) + C$, where Hz is frequency in Hertz.

TI Calibration Factors

	C0	C1	C2	C3	C4	C5
kPa	1.090158E+3	-1.260347E-1	3.395456E-2	-8.309054E-5	6.168102E-5	-1.082946E-3
psi	1.581085E+2	-1.827914E-2	4.924519E-3	-1.205084E-5	8.945761E-6	-1.570625E-4

Pressure in kPa/psi = $C0 + (C1 \times \text{Hz}) + (C2 \times T) + (C3 \times \text{Hz}^2) + (C4 \times \text{Hz} \times T) + (C5 \times T^2)$

Where Hz is the frequency reading in Hertz and T is the Thermistor reading in degrees C.

TI factors are calculated from temperatures at 5.0, 15.0 and 25.0 degrees C.

Applied pressure and temperature are NIST traceable.

Summary of Test Results at 15°C

Thermistor reading is 15.4 °C.

Applied Pressure is referenced to 1 atm. Calculated Pressure uses ABC Calibration factors.

Applied (kPa)	Equivalent (psi)	Frequency (Hz)	Calculated (kPa)	Calculated (psi)	Error (%FS)
0.0	0.00	2947.2	0.1	0.01	-0.02
35.0	5.08	2889.9	35.0	5.08	0.00
70.0	10.15	2831.7	70.0	10.15	0.01
105.0	15.23	2772.5	104.9	15.22	0.02
140.0	20.31	2712.2	139.9	20.30	0.02
175.0	25.38	2650.8	175.0	25.38	0.01
210.0	30.46	2588.2	210.1	30.47	-0.02
245.0	35.53	2524.6	245.0	35.54	-0.01
280.0	40.61	2459.6	280.1	40.62	-0.03
315.0	45.69	2393.5	315.0	45.69	-0.01
350.0	50.76	2326.0	349.9	50.76	0.02

Instrument Installation Record

Instrument Type: VWP

Array Type: Test Pile

Install Date: June 21, 2019

Instrument ID No.: VWP 11

Sensor S/N: 1901821

Installed By: MF

Drilling Contractor: Walker Drilling

Drill Rig: D-120

Operator(s): Mackenzie/ Vishal

Times:

	Coring	Drilling	Install
Start		7:30	13:00
Finish		12:45	14:55

Notes: 75m Cable

Location: Northing 4 895 671.29

Easting 292 362.85

Station

Offset

	Depth (m)	Elevation (m)
Ground Surface	0.00	228.37
Bottom of Hole	29.28	199.09
Tip of Piezometer	28.31	200.06
Top of Filter Sand	26.78	201.59
Top of Bentonite	25.24	203.13
Top of Grout	1.11	227.26

	Depth (m)	Description
Stratigraphy	0.00	Asphalt
	0.10	Sand
	2.00	Silty Sand
	3.50	Clay with Sand
	28.34	Firm Clay
	In Hole Water Depth <u>N/A</u>	

Readings			
Date/Time	Freq. (Hz)	Temp. (°C)	Description
21-Jun	2953.9	16.5	Pre-installation
21-Jun	2506.3	12.2	Post-installation
24-Jun	2553.2	10.0	
25-Jun	2553.9	10.0	
26-Jun	2553.9	10.0	

Notes:

First 3.5m of the hole was drilled with 4" hollow stem augers. Augers were then removed and 3.5m of P casing was placed in the borehole. The annulus between the borehole and casing was sealed with 3/8" hole plug. A tri-cone w/ recirculation tank was used for the duration of the borehole drilling.

VW Piezometer Calibration Certificate

Serial #: 1901821
 Range : 350 kPa
 Cable Length: 75 m
 Date of Calibration: 6/7/2019

Part #: 52611020
 Cable Part #: 50613324
 Calibrated by: JLW
 Note:

ABC Calibration Factors

	A	B	C
kPa	-9.194057E-5	-1.317277E-1	1.189812E+3
psi	-1.333485E-5	-1.910549E-2	1.725676E+2

Pressure in kPa/psi = (A x Hz²) + (B x Hz) + C, where Hz is frequency in Hertz.

TI Calibration Factors

	C0	C1	C2	C3	C4	C5
kPa	1.192530E+3	-1.347710E-1	3.744338E-2	-9.161495E-5	7.810265E-5	-3.057976E-3
psi	1.729558E+2	-1.954619E-2	5.430512E-3	-1.328716E-5	1.132743E-5	-4.435063E-4

Pressure in kPa/psi = C0 + (C1 x Hz) + (C2 x T) + (C3 x Hz²) + (C4 x Hz x T) + (C5 x T²)

Where Hz is the frequency reading in Hertz and T is the Thermistor reading in degrees C.

TI factors are calculated from temperatures at 5.0, 15.0 and 25.0 degrees C.

Applied pressure and temperature are NIST traceable.

Summary of Test Results at 15°C

Thermistor reading is 15.5 °C.

Applied Pressure is referenced to 1 atm. Calculated Pressure uses ABC Calibration factors.

Applied (kPa)	Equivalent (psi)	Frequency (Hz)	Calculated (kPa)	Calculated (psi)	Error (%FS)
0.0	0.00	2951.6	0.0	0.00	-0.01
35.0	5.08	2899.4	35.0	5.07	0.01
70.0	10.15	2846.3	70.0	10.16	-0.01
105.0	15.23	2792.5	105.0	15.23	0.00
140.0	20.31	2737.9	140.0	20.30	0.01
175.0	25.38	2682.4	174.9	25.37	0.02
210.0	30.46	2626.0	209.9	30.44	0.03
245.0	35.53	2568.3	245.0	35.54	-0.01
280.0	40.61	2509.6	280.2	40.64	-0.05
315.0	45.69	2450.2	315.1	45.70	-0.03
350.0	50.76	2389.9	349.9	50.74	0.04

Instrument Installation Record

Instrument Type: VWP Array Type Test PileInstall Date: June 19, 2019Instrument ID No.: VWP 12Drilling Contractor: Walker DrillingSensor S/N: 1901815Drill Rig: D-120Installed By: MFOperator(s): Farmer/ Vishal

Times:

	Coring	Drilling	Install
Start		16:25 (June 18)	12:01
Finish		11:52	13:52

Notes: 100m Cable

Location: Northing 4 895 671.23 Station
Easting 292 361.28 Offset

	Depth (m)	Elevation (m)
Ground Surface	0.00	228.37
Bottom of Hole	36.49	191.88
Tip of Piezometer	35.23	193.14
Top of Filter Sand	34.29	194.08
Top of Bentonite	33.25	195.12
Top of Grout	1.52	226.85

Stratigraphy	Depth (m)	Description
	0.00	Asphalt
	0.10	Sand
	2.00	Silty Sand
	3.50	Clay with Sand
	35.35	Dense Silt

In Hole Water Depth N/A

Readings			
Date/Time	Freq. (Hz)	Temp. (°C)	Description
19-Jun	2918.4	22.2	Pre-installation
19-Jun	2376.2	11.0	Post-installation
20-Jun	2377.3	9.6	
21-Jun	2376.6	9.4	
24-Jun	2378.0	9.4	

Notes:

First 3.5m of the hole was drilled with 4" hollow stem augers. Augers were then removed and 3.5m of P casing was placed in the borehole. The annulus between the borehole and casing was sealed with 3/8" hole plug.

A tri-cone w/ recirculation tank was used for the duration of the borehole drilling.

VW Piezometer Calibration Certificate

Serial #: 1901815
 Range : 350 kPa
 Cable Length: 100 m
 Date of Calibration: 6/7/2019

Part #: 52611020
 Cable Part #: 50613324
 Calibrated by: JLW
 Note:

ABC Calibration Factors

	A	B	C
kPa	-1.161818E-4	1.979662E-2	9.289222E+2
psi	-1.685075E-5	2.871257E-3	1.347288E+2

Pressure in kPa/psi = $(A \times \text{Hz}^2) + (B \times \text{Hz}) + C$, where Hz is frequency in Hertz.

TI Calibration Factors

	C0	C1	C2	C3	C4	C5
kPa	9.253038E+2	2.020046E-2	1.603636E-1	-1.164142E-4	5.292852E-5	-1.764159E-3
psi	1.341992E+2	2.929726E-3	2.325796E-2	-1.688386E-5	7.676363E-6	-2.558606E-4

Pressure in kPa/psi = $C0 + (C1 \times \text{Hz}) + (C2 \times T) + (C3 \times \text{Hz}^2) + (C4 \times \text{Hz} \times T) + (C5 \times T^2)$

Where Hz is the frequency reading in Hertz and T is the Thermistor reading in degrees C.

TI factors are calculated from temperatures at 5.0, 15.0 and 25.0 degrees C.

Applied pressure and temperature are NIST traceable.

Summary of Test Results at 15°C

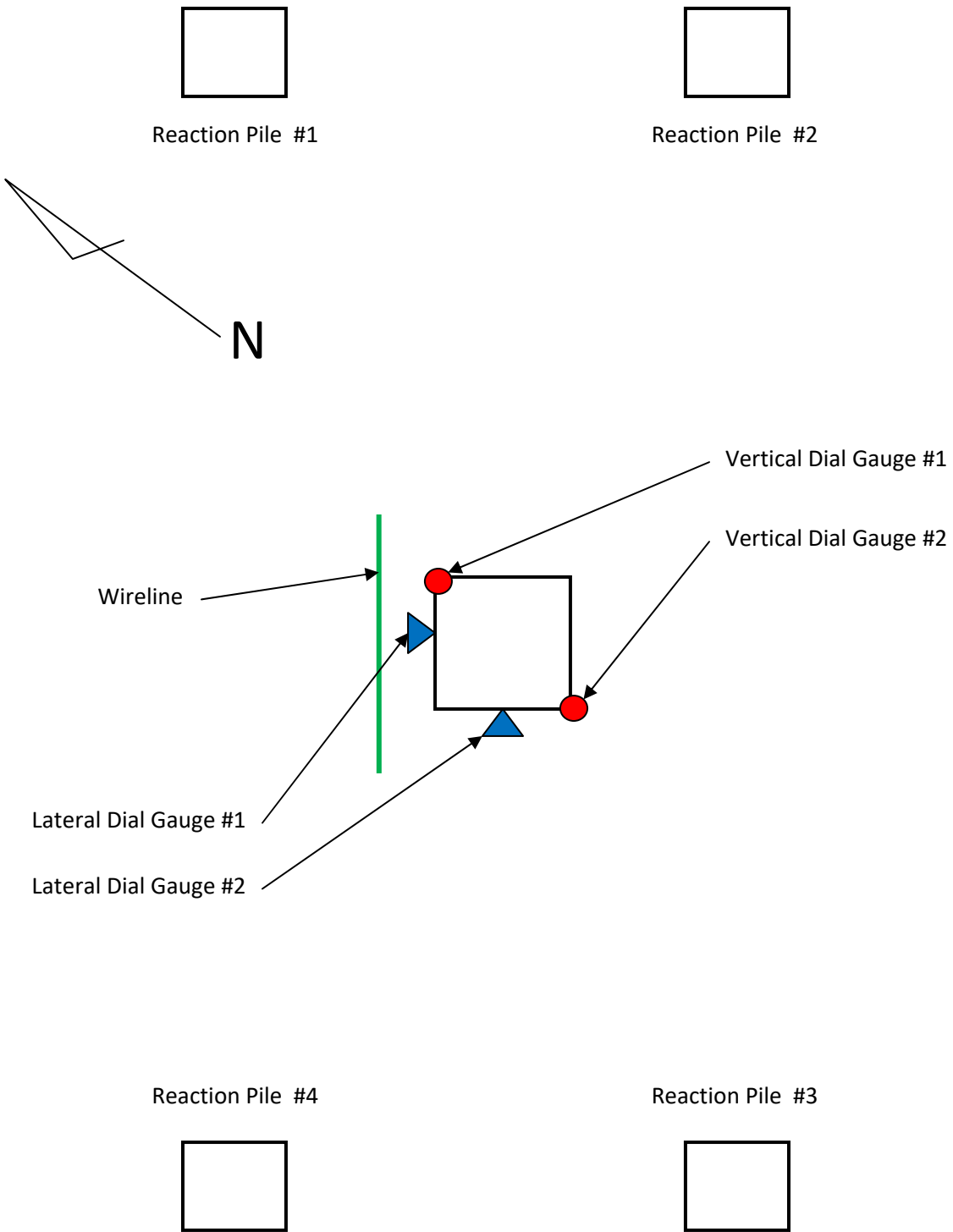
Thermistor reading is 15.3 °C.

Applied Pressure is referenced to 1 atm. Calculated Pressure uses ABC Calibration factors.

Applied (kPa)	Equivalent (psi)	Frequency (Hz)	Calculated (kPa)	Calculated (psi)	Error (%FS)
0.0	0.00	2913.8	0.2	0.03	-0.06
35.0	5.08	2860.4	35.0	5.07	0.01
70.0	10.15	2805.7	69.9	10.14	0.03
105.0	15.23	2749.9	104.8	15.20	0.06
140.0	20.31	2692.7	139.8	20.28	0.05
175.0	25.38	2633.9	175.1	25.39	-0.02
210.0	30.46	2573.9	210.2	30.48	-0.05
245.0	35.53	2512.6	245.2	35.56	-0.05
280.0	40.61	2450.0	280.0	40.62	-0.01
315.0	45.69	2385.7	314.9	45.67	0.03
350.0	50.76	2319.2	349.9	50.75	0.02

Appendix 3

Monitoring Point Layout Sketch



General Test Pile Layout
Not to Scale

Appendix 4

Pile Installation Log and PDA Test Report

Pile Driving Record

Contract: 2018-2024
 General Contractor: (FERMME) POWELL F.
 Hammer Details: SC-90 SOLMEC B32 DIESEL
 Pile Details: HP 310 X 110 STEEL
 Pile #s: TS
 Length: 15.28 Elevation: 228.470

Structure: MCDONALD PARKING LOT
 Design Load Capacity: 2300 KN
 Pile Type: VIBRT
 Date Driven: SEPT. 16, 2019
 Time: 2:52 PM

SEPT. 19, 2019
 3:43 43

Length to Ground (m)	B	BPM	BFCM	Length to Ground (m)	B	BPM	BFCM	Length to Ground (m)	B	BPM	BFCM	Length to Ground (m)	B	BPM	BFCM	Length to Ground (m)	B	BPM	BFCM
0.25	9			10.75	3			20.25	6			30.75	8			40.25			
0.50	2			10.50	3			20.50	6			30.50	8			40.50			
0.75	2			10.75	2			20.75	6			30.75	8			40.75			
1.00	2			11.00	3			21.00	5			31.00	4			41.00			
1.25	2			11.25	2			21.25	6			31.25	8			41.25			
1.50	1			11.50	2			21.50	6			31.50	8			41.50			
1.75	1			11.75	2			21.75	6			31.75	8			41.75			
2.00	1			12.00	3			22.00	5			32.00	8			42.00			
2.25	1			12.25	4			22.25	7			32.25	7			42.25			
2.50	2			12.50	4			22.50	5			32.50	7			42.50			
2.75	2			12.75	3			22.75	5			32.75	8			42.75			
3.00	3			13.00	3			23.00	5			33.00	10			43.00			
3.25	2			13.25	3			23.25	5			33.25	12			43.25			
3.50	4			13.50	3			23.50	4			33.50	10			43.50			
3.75	3			13.75	3			23.75	5			33.75	10			43.75			
4.00	2			14.00	3			24.00	5			34.00	9			44.00			
4.25	3			14.25	4			24.25	4			34.25	11			44.25			
4.50	3			14.50	4			24.50	4			34.50	12			44.50			
4.75	3			14.75	4			24.75	5			34.75	11			44.75			
5.00	3			15.00	4			25.00	5			35.00	10			45.00			
5.25	3			15.25	5			25.25	5			35.25	6			45.25			
5.50	3			15.50	5			25.50	5			35.50	6			45.50			
5.75	2			15.75	5			25.75	4			35.75	11			45.75			
6.00	3			16.00	5			26.00	5			36.00	11			46.00			
6.25	3			16.25	6			26.25	5			36.25				46.25			
6.50	3			16.50	5			26.50	5			36.50				46.50			
6.75	2			16.75	6			26.75	5			36.75				46.75			
7.00	2			17.00	6			27.00	5			37.00				47.00			
7.25	2			17.25	6			27.25	5			37.25				47.25			
7.50	2			17.50	6			27.50	5			37.50				47.50			
7.75	2			17.75	6			27.75	5			37.75				47.75			
8.00	2			18.00	7			28.00	4			38.00				48.00			
8.25	2			18.25	6			28.25	5			38.25				48.25			
8.50	2			18.50	6			28.50	5			38.50				48.50			
8.75	3			18.75	5			28.75	3			38.75				48.75			
9.00	3			19.00	5			29.00	10			39.00				49.00			
9.25	2			19.25	6			29.25	8			39.25				49.25			
9.50	2			19.50	6			29.50	9			39.50				49.50			
9.75	2			19.75	6			29.75	9			39.75				49.75			
10.00	3			20.00	5			30.00	8			40.00				50.00			

SEPT. 19, 2019
 15 47 44

VIBRT / U/T PERFORMED
 ON 09/08/19 OK TOTAL PILE
 LENGTH =

Report on
Dynamic Testing and Analysis of Piles

**Highway 400 and 89 Interchange
MTO 2018-2024**

Prepared for

**Fermar Paving Limited
1921 Albion Road
Rexdale, ON M9W 5S8**



Our File No. 1905CS1373

September 24, 2019

Prepared by:




Shawn M. Ferguson, P. Eng.
Project Engineer

Thomas Walsh, M.A.Sc., P. Eng.
Sr. Geotechnical Engineer

Distribution: 1 electronic copy to Fermar
1 electronic copy to Urkkada

Report on
Dynamic Testing and Analysis of Piles
Highway 400 and 89 Interchange
MTO 2018-2024

1. Terms of Reference

Urkada has been retained by Fermar Paving Limited (Fermar) to perform Pile Driving Analyzer (PDA) testing and analysis on the Highway 400 and 89 Interchange project.

The purpose of the dynamic testing was to assess the capacity of the test pile. This report presents the results of dynamic pile testing on one (1) pile during testing on September 20 and 23, 2019. The dynamic testing was performed in accordance with ASTM D4945 and the contract specifications.

2. Piles

The pile subjected to PDA testing is a 310x110 H-Pile.

3. Hammer Used

The pile was driven and tested using a Bermingham B-32 single acting diesel hammer. During driving, the fuel pressure for the hammer was approximately 450 psi. Powell Foundations Inc. was the piling subcontractor.

4. Subsurface Conditions

The test pile is located at the northwest corner of the project. A copy of the closest available boring logs, 89UP-3, is attached in Appendix I.

5. Results

5.1 General

Details of the test pile, hammer information, dates of testing, depths, etc. are summarized in Table 1 placed after the text portion of the report.

Dynamic test data, such as Case Method Estimates of mobilized static resistance, transferred energy, maximum compressive stresses, computed compressive stress at pile toe, corresponding penetration resistance values, CAPWAP results, and other information, are presented in Table 2.

The dynamic records from the pile are compiled in Pile Driving Analyzer (PDA) Diagrams presented in Appendix II. The PDA diagrams presented in Figures II-1 and II-2 show the following values versus blows in sequence (Figure II-1) and versus pile penetration (Figure II-2):

- Maximum Transferred Energy (EMX, kJ)
- Maximum Compressive Force (FMX, kN)
- CMES Capacity (RMX, kN)
- Maximum Average Compressive Stress (CSX, MPa)
- Computed Compressive Stress at the Pile Toe (CSB, MPa)
- Penetration Resistance (PRES, blows/0.25)

Figure II-2 is based on the pile blow counts provided by Powell. The depth for each blow is calculated based on the PRES values.

Two CAPWAP analyses are performed as indicated in Table 1. Detailed CAPWAP results are enclosed in Appendix III. The CAPWAP results include two pages of graphs. The first shows the measured wave traces, and the results of the analysis shown as force match, simulated static loading tests for pile head and pile toe, and the distribution of shaft resistance and pile forces. The second shows diagrams of the distribution of “extrema” along the pile, that is, the following values:

- Maximum Force and Maximum Transferred Energy
- Maximum Compressive Stress and Maximum Tension Stress
- Maximum Velocity and Maximum Displacement

5.2 Pile Capacity

As indicated in Table 2, the CAPWAP computed mobilized resistances of the tested pile are as follows:

Pile ID	Testing Condition	CAPWAP Mobilized Resistance (kN)	Shaft Resistance (kN)	Toe Resistance (kN)
Test Pile	End of Initial Drive	850	650	200
	Restrike	1,150	875	275

5.3 Hammer Transferred Energy

The maximum transferred energy for the blows subjected to CAPWAP analysis ranged between 35.8 kJ and 36.6 kJ.

5.4 Maximum Compressive Stress During Testing

The maximum compressive stress for the blows subjected to CAPWAP analysis ranged between 203 MPa and 211 MPa.

5.5 Pile Structural Integrity

No structural damage was observed during testing.

Dynamic Testing and Analysis of Piles
MTO 2010-2024 - Highway 400 and 89 Interchange

TABLE 1 PILE DATA SUMMARY

Pile No.	Date of of Testing	Testing Condition	Hammer Model and Type	Pile Type	Pile Size	Pile Cross Section Area at Sensors (cm ²)	Total Length (m)	Length below Gages (m)	Embed. Depth during Dynamic Testing (m)	CAPWAP Analysis Performed
Test Pile	September 19, 2019 September 23, 2019	ID RSTR	Junttan HHk-7S	H-Pile	310x110	26.1	115.0	37.0	34.00 - 36.00 36.00 - 36.34	Yes Yes

ID: Initial Drive
RSTR: Restrike

Dynamic Testing and Analysis of Piles
MTO 2010-2024 - Highway 400 and 89 Interchange

TABLE 2 : PDA DATA TABLE and CAPWAP RESULTS

Pile (No.)	Record (No.)	Testing Condition	Equivalent PRES (bl/0.25m)	Pile Driving Analyzer Data							CAPWAP RESULTS						
				EMX	Max. Force	CSX	CSB	RMX J = 0.8	RMX J = 1.0	RMX J = 1.2	Mobilized Static Resistance			Smith Damping Factor		Quake	
				(kJ)	(kN)	(MPa)	(MPa)	(kN)	(kN)	(kN)	Total (kN)	Shaft (kN)	Toe (kN)	Shaft (s/m)	Toe (s/m)	Shaft (mm)	Toe (mm)
Test Pile	93 23	EOID BOR	11 17	36.6	2,887	203	49	986	940	894	850	650	200	0.2	0.8	2.5	15.0
				35.8	2,904	211	34	1,286	1,160	1,057	1,150	875	275	0.3	0.2	2.5	10.7

PRES: Penetration Resistance
 EOID: End of Initial Drive
 BOR: Beginning of Restrike
 EMX: Maximum Transferred Energy at Sensors
 CSX: Maximum Average Compressive Stress
 CSB: Computed Compressive Stress at Pile Toe
 RMX: Maximum Case-Golbe Capacity
 RA2 : Auto Capacity Friction Piles

APPENDIX I

Boring 89UP-03

PROJECT <u>1668512</u>		RECORD OF BOREHOLE No 89UP-03		SHEET 1 OF 4		METRIC	
G.W.P. <u>2438-13-00</u>		LOCATION <u>N 4895628.3; E 292375.2 MTM NAD 83 ZONE 10 (LAT. 44.200549; LONG. -79.655451)</u>		ORIGINATED BY <u>DF</u>			
DIST <u>Central</u> HWY <u>400</u>		BOREHOLE TYPE <u>D50 Track Mount, NW Casing and Wash Boring with Drilling Mud</u>		COMPILED BY <u>DH</u>			
DATUM <u>Geodetic</u>		DATE <u>July 17 to 21, 2017</u>		CHECKED BY <u>SMM/TZ</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						WATER CONTENT (%)			GR	SA	SI	CL
								20	40	60	80	100		W _p	W	W _L				
227.4	GROUND SURFACE																			
0.0	TOPSOIL																			
0.2	Gravelly sand, some silt (FILL)		1	SS	6															
226.7	Loose Brown Moist																			
0.7	SILT, trace to some sand to SILT and SAND, trace to some clay Loose to very dense Grey Wet		2	SS	6															
			3	SS	16															
			4	SS	22															
			5	SS	17															
			6	SS	22															
			7	SS	13															
			8A	SS	23															
			8B																	
			9	SS	17															
			10	SS	10															
			11A	SS	33															
			11B																	
			12	SS	16															
			13	SS	17															

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+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

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PROJECT <u>1668512</u>		RECORD OF BOREHOLE No 89UP-03		SHEET 2 OF 4		METRIC	
G.W.P. <u>2438-13-00</u>		LOCATION <u>N 4895628.3; E 292375.2 MTM NAD 83 ZONE 10 (LAT. 44.200549; LONG. -79.655451)</u>		ORIGINATED BY <u>DF</u>			
DIST <u>Central</u> HWY <u>400</u>		BOREHOLE TYPE <u>D50 Track Mount, NW Casing and Wash Boring with Drilling Mud</u>		COMPILED BY <u>DH</u>			
DATUM <u>Geodetic</u>		DATE <u>July 17 to 21, 2017</u>		CHECKED BY <u>SMM/TZ</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						WATER CONTENT (%)			GR	SA	SI	CL
	--- CONTINUED FROM PREVIOUS PAGE ---																			
	SILT, trace to some sand to SILT and SAND, trace to some clay Loose to very dense Grey Wet		14	SS	37															
			15	SS	80															
209.6																				
17.8	SILTY CLAY, trace sand Grey Moist																			
208.9			16A																	
18.5	SILT and SAND Dense to very dense Grey Wet		16B	SS	44															
			17	SS	59															
206.5																				
20.9	Varved CLAYEY SILT to SILTY CLAY with silt and clay laminae Stiff to very stiff Grey Moist - Sand inclusions from 20.9 m to 22.4 m		18	SS	11															
			19	SS	8															
			20	TO	PH															
			21	SS	3															
			22	TO	PH															
			23	SS	4															

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+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

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PROJECT <u>1668512</u>		RECORD OF BOREHOLE No 89UP-03		SHEET 3 OF 4		METRIC	
G.W.P. <u>2438-13-00</u>		LOCATION <u>N 4895628.3; E 292375.2 MTM NAD 83 ZONE 10 (LAT. 44.200549; LONG. -79.655451)</u>		ORIGINATED BY <u>DF</u>			
DIST <u>Central</u> HWY <u>400</u>		BOREHOLE TYPE <u>D50 Track Mount, NW Casing and Wash Boring with Drilling Mud</u>		COMPILED BY <u>DH</u>			
DATUM <u>Geodetic</u>		DATE <u>July 17 to 21, 2017</u>		CHECKED BY <u>SMM/TZ</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE							w _p w w _L		
								● QUICK TRIAXIAL × REMOULDED									
						20	40	60	80	100	10	20	30				
	--- CONTINUED FROM PREVIOUS PAGE ---																
195.5	Varved CLAYEY SILT to SILTY CLAY with silt and clay laminae Stiff to very stiff Grey Moist		24	SS	9												
31.9	SILT, some sand, trace clay Compact to very dense Grey Wet - Clayey silt inclusions encountered between depths of about 32.0 m and 32.6 m		25	SS	27												
			26	SS	86												
192.0																	
35.4	Sandy SILT, trace clay Very dense Grey Wet																
			27A	SS	100												
			27B														
189.0																	
38.4	CLAYEY SILT, some sand Very stiff Grey Moist																
			28	SS	17												

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+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

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PROJECT		1668512		RECORD OF BOREHOLE No 89UP-03				SHEET 4 OF 4		METRIC								
G.W.P.		2438-13-00		LOCATION		N 4895628.3; E 292375.2 MTM NAD 83 ZONE 10 (LAT. 44.200549; LONG. -79.655451)				ORIGINATED BY		DF						
DIST		Central		HWY		400		BOREHOLE TYPE		D50 Track Mount, NW Casing and Wash Boring with Drilling Mud				COMPILED BY		DH		
DATUM		Geodetic		DATE		July 17 to 21, 2017				CHECKED BY		SMM/TZ						
SOIL PROFILE				SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	SHEAR STRENGTH kPa					W _p	W	W _L					
	--- CONTINUED FROM PREVIOUS PAGE ---																	
181.4	CLAYEY SILT (TILL) Grey Moist		30A	SS	101													
46.0	SILT and SAND, trace gravel, trace clay (TILL) Very dense Grey Wet		30B															
178.2			31	SS	100/0.10													
49.2	END OF BOREHOLE																	
NOTES: 1. Water level measurements in the casing at the beginning of each work shift: Date Depth (m) Elev. (m) 18/07/17 0.7 226.7 19/07/17 1.6 225.8 20/07/17 0.0 227.4 21/07/17 3.3 224.1 2. A borehole was advanced to a depth of about 4.0 m immediately next to borehole 89UP-03 in order to install a standpipe piezometer. 3. Water level measurements in standpipe piezometer: Date Depth (m) Elev. (m) 03/08/17 1.0 226.4 10/08/17 1.0 226.4 15/08/17 1.2 226.2 19/09/17 1.3 226.1 05/03/18 0.7 226.7 16/05/18 0.5 226.9																		

APPENDIX II

PDA Plots

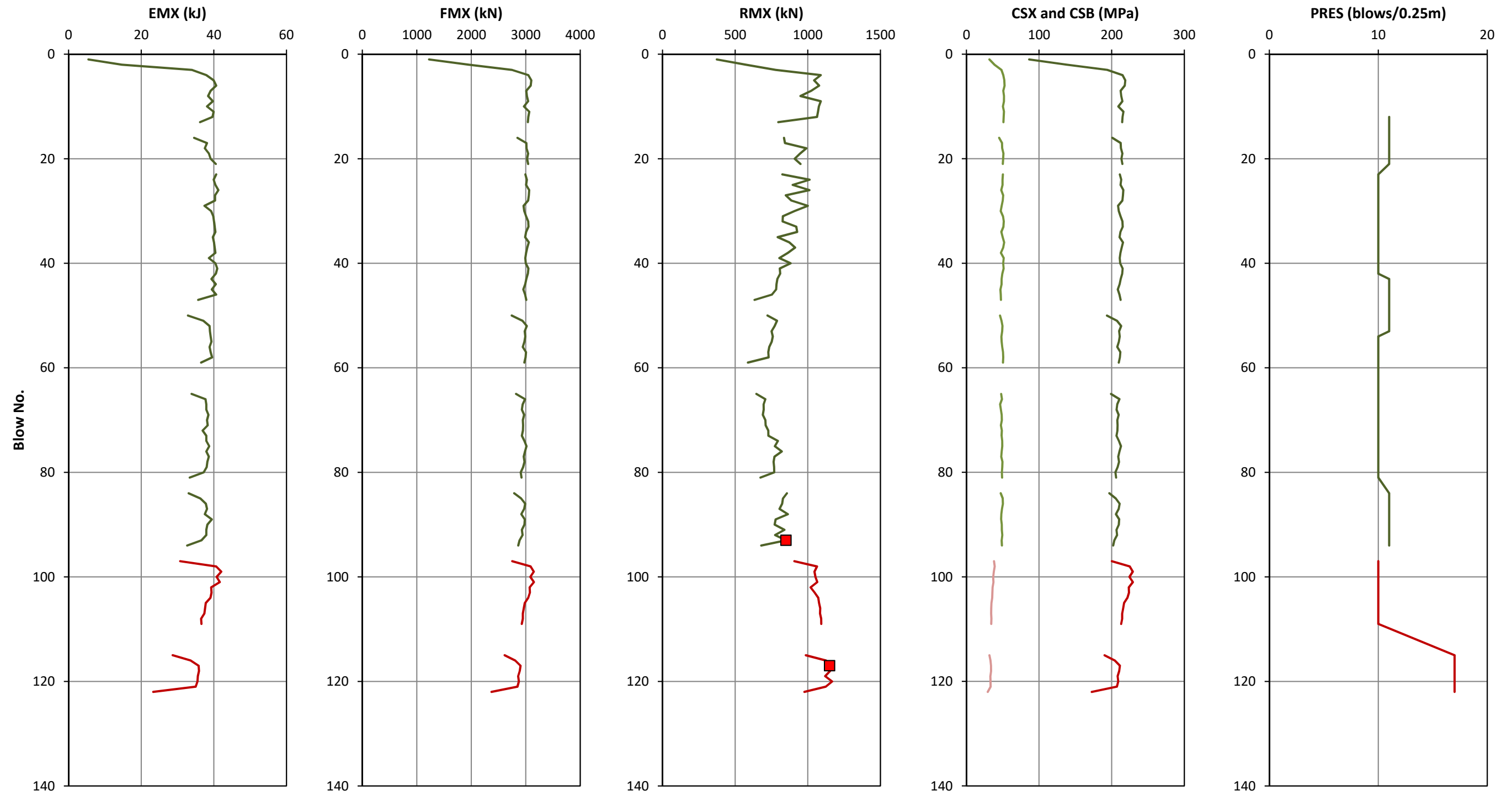


Figure II-1: PDA Diagram of Test Pile at Initial Drive and Restrike
(Quantities vs Blows in Sequence)

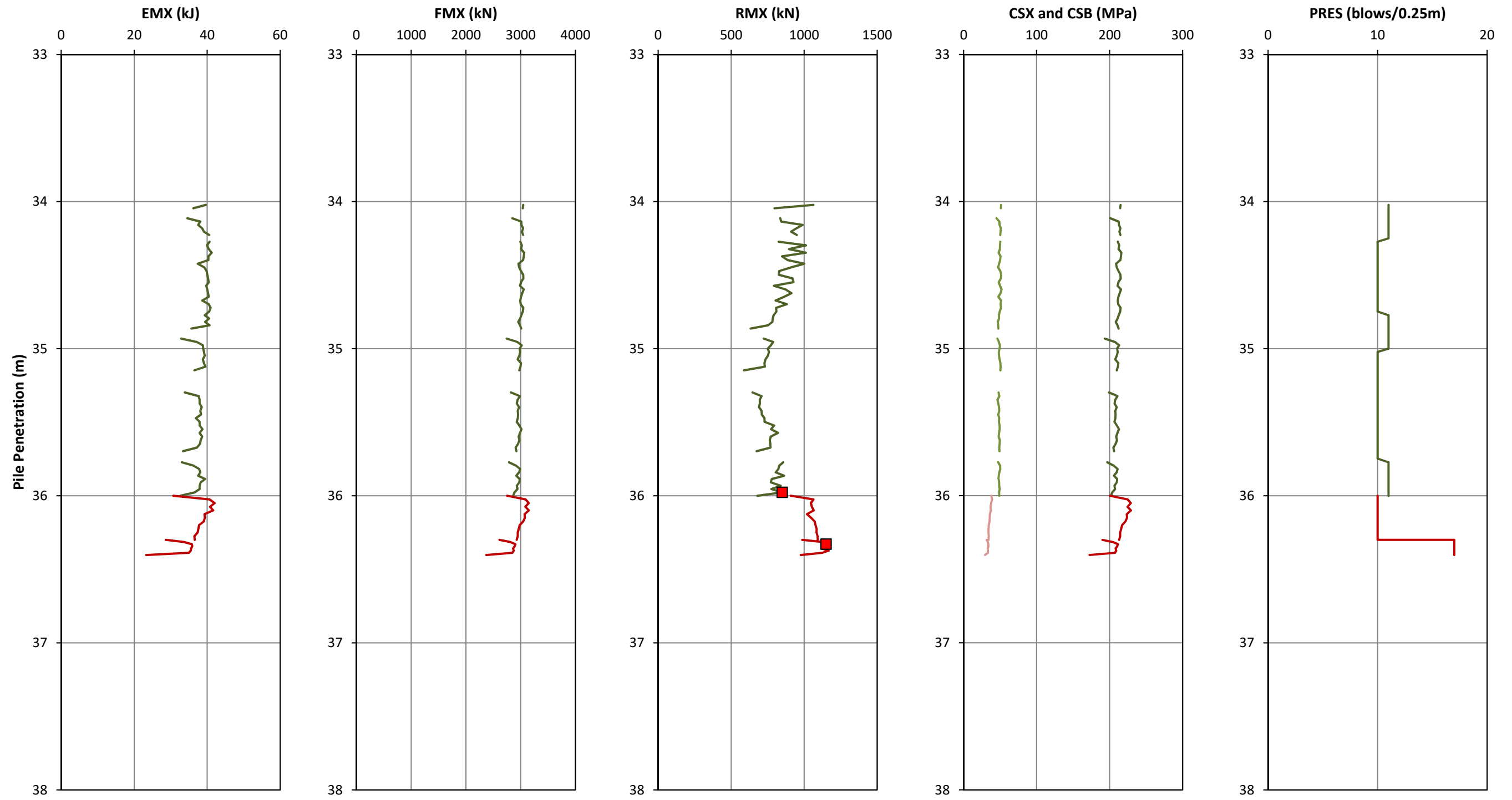
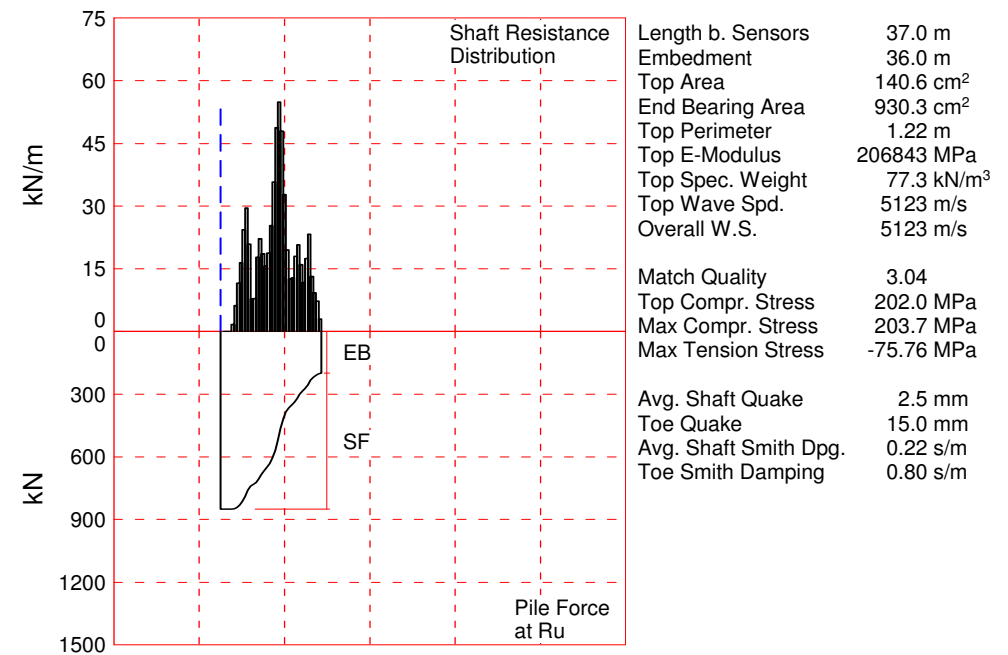
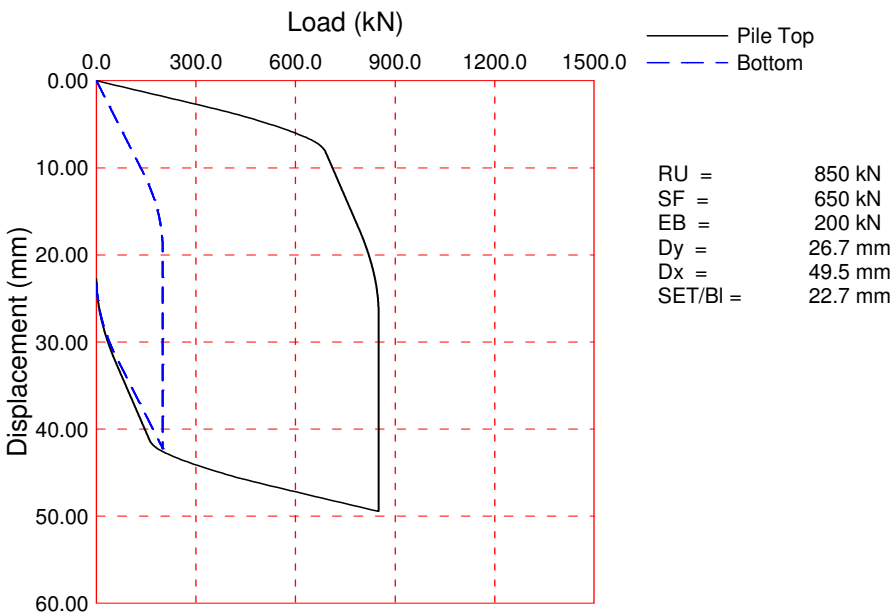
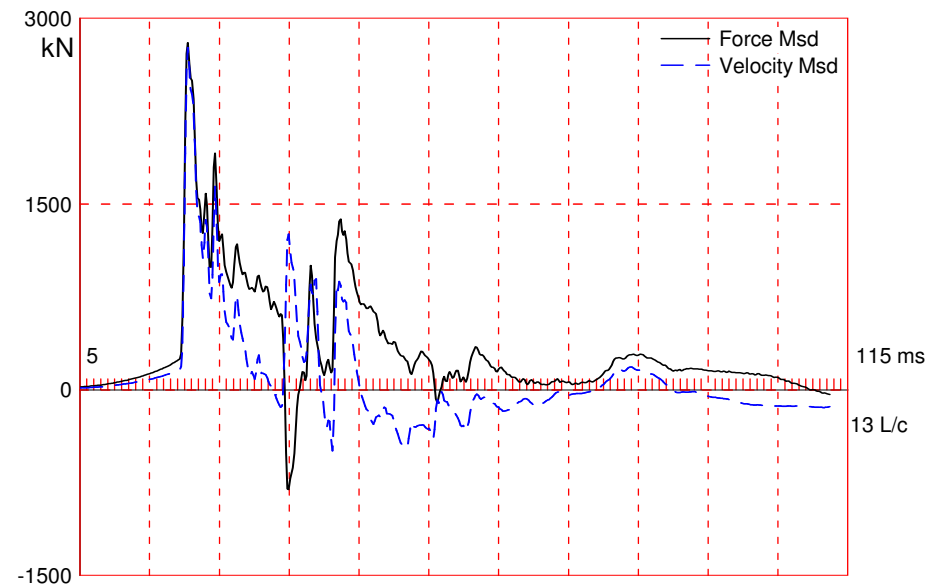
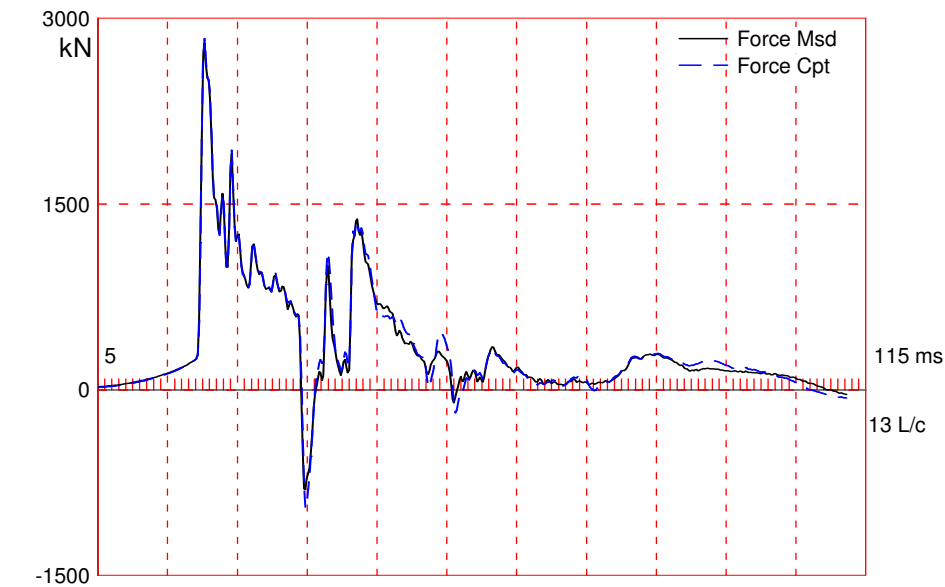


Figure II-2: PDA Diagram of Test Pile at Initial Drive and Restrike
(Quantities vs Pile Penetration)

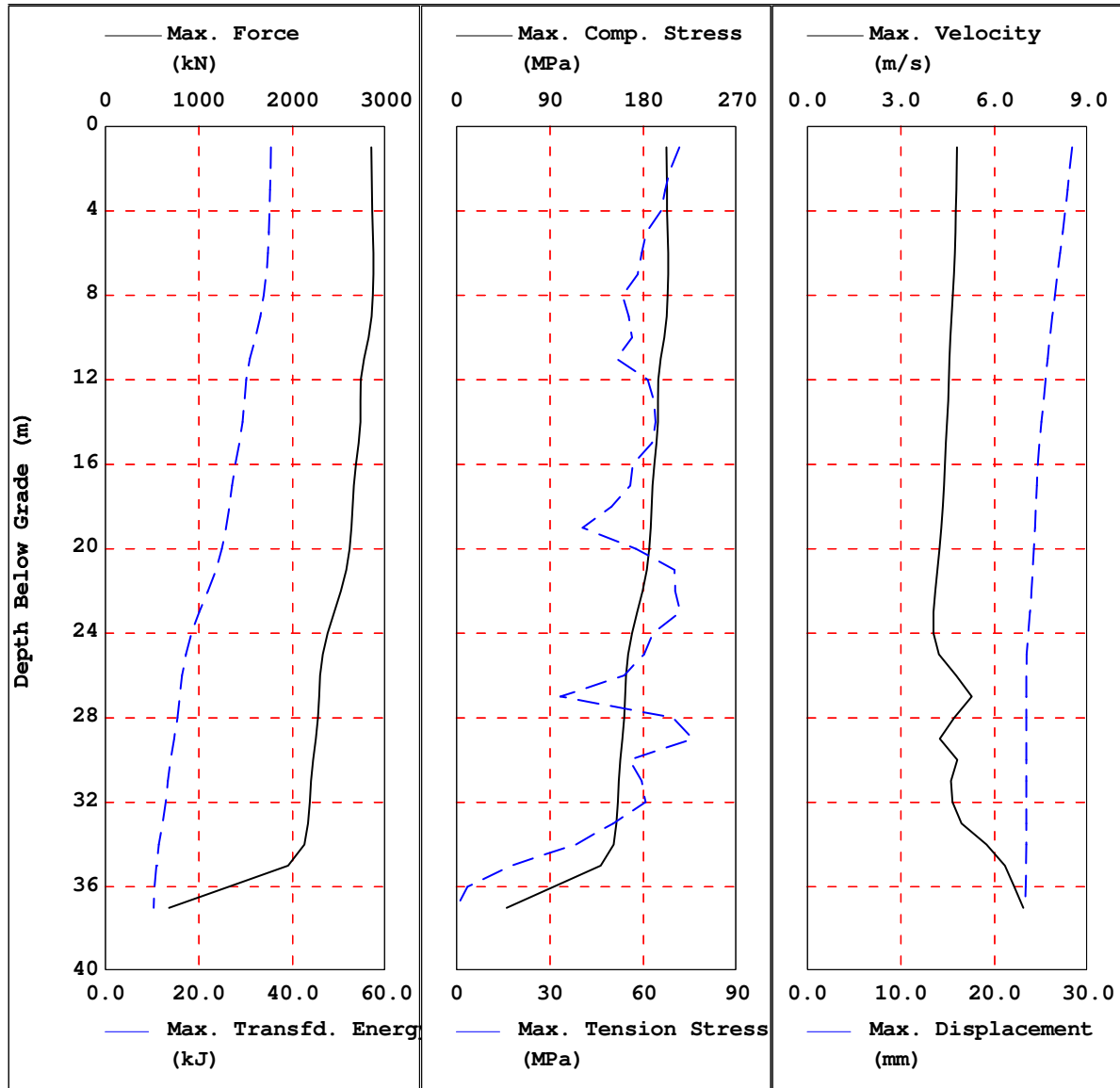
APPENDIX III

CAPWAP Analysis Results



File: Test Pile (E01D)
Blow: 93
Urkkada Technology Ltd.

Test: 19-Sep-2019 16:10
CAPWAP (R) 2014-3
OP: MF



File: Test Pile (EOID)
 Blow: 93
 Urkkada Technology Ltd.

Test: 19-Sep-2019 16:10
 CAPWAP (R) 2014-3
 OP: MF

CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 850.3; along Shaft 650.3; at Toe 200.0 kN

Soil Sgmt No.	Dist. Below Gages m	Depth Below Grade m	Ru kN	Force in Pile kN	Sum of Ru kN	Unit Resist. (Depth) kN/m	Unit Resist. (Area) kPa	Smith Damping Factor s/m
4	5.0	4.0	1.7	848.6	1.7	1.70	1.39	0.22
5	6.0	5.0	6.2	842.4	7.9	6.20	5.08	0.22
6	7.0	6.0	11.6	830.8	19.5	11.60	9.51	0.22
7	8.0	7.0	16.5	814.3	36.0	16.50	13.52	0.22
8	9.0	8.0	24.4	789.9	60.4	24.40	20.00	0.22
9	10.0	9.0	29.6	760.3	90.0	29.60	24.26	0.22
10	11.0	10.0	20.9	739.4	110.9	20.90	17.13	0.22
11	12.0	11.0	7.8	731.6	118.7	7.80	6.39	0.22
12	13.0	12.0	7.9	723.7	126.6	7.90	6.48	0.22
13	14.0	13.0	17.8	705.9	144.4	17.80	14.59	0.22
14	15.0	14.0	22.2	683.7	166.6	22.20	18.20	0.22
15	16.0	15.0	18.6	665.1	185.2	18.60	15.25	0.22
16	17.0	16.0	15.6	649.5	200.8	15.60	12.79	0.22
17	18.0	17.0	18.8	630.7	219.6	18.80	15.41	0.22
18	19.0	18.0	25.4	605.3	245.0	25.40	20.82	0.22
19	20.0	19.0	35.8	569.5	280.8	35.80	29.34	0.22
20	21.0	20.0	48.8	520.7	329.6	48.80	40.00	0.22
21	22.0	21.0	54.9	465.8	384.5	54.90	45.00	0.22
22	23.0	22.0	47.9	417.9	432.4	47.90	39.26	0.22
23	24.0	23.0	32.8	385.1	465.2	32.80	26.89	0.22
24	25.0	24.0	19.5	365.6	484.7	19.50	15.98	0.22
25	26.0	25.0	12.6	353.0	497.3	12.60	10.33	0.22
26	27.0	26.0	12.9	340.1	510.2	12.90	10.57	0.22
27	28.0	27.0	18.0	322.1	528.2	18.00	14.75	0.22
28	29.0	28.0	20.8	301.3	549.0	20.80	17.05	0.22
29	30.0	29.0	16.0	285.3	565.0	16.00	13.11	0.22
30	31.0	30.0	11.7	273.6	576.7	11.70	9.59	0.22
31	32.0	31.0	17.5	256.1	594.2	17.50	14.34	0.22
32	33.0	32.0	23.3	232.8	617.5	23.30	19.10	0.22
33	34.0	33.0	13.2	219.6	630.7	13.20	10.82	0.22
34	35.0	34.0	9.3	210.3	640.0	9.30	7.62	0.22
35	36.0	35.0	7.3	203.0	647.3	7.30	5.98	0.22
36	37.0	36.0	3.0	200.0	650.3	3.00	2.46	0.22
Avg. Shaft			18.1			18.06	14.81	0.22
Toe			200.0				2149.96	0.80

Soil Model Parameters/Extensions

	Shaft	Toe
Quake (mm)	2.5	15.0
Case Damping Factor	0.25	0.28
Damping Type	Viscous	Sm+Visc

File: Test Pile (E01D)
 Blow: 93
 Urkkada Technology Ltd.

Test: 19-Sep-2019 16:10
 CAPWAP (R) 2014-3
 OP: MF

Soil Model Parameters/Extensions		Shaft	Toe
Unloading Quake	(% of loading quake)	80	100
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	10	

max. Top Comp. Stress = 202.0 MPa (T= 20.7 ms, max= 1.008 x Top)
 max. Comp. Stress = 203.7 MPa (Z= 7.0 m, T= 21.9 ms)
 max. Tens. Stress = -75.76 MPa (Z= 29.0 m, T= 29.3 ms)
 max. Energy (EMX) = 35.4 kJ; max. Measured Top Displ. (DMX)= 29.3 mm

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages m	max. Force kN	min. Force kN	max. Comp. Stress MPa	max. Tens. Stress MPa	max. Trnsfd. Energy kJ	max. Veloc. m/s	max. Displ. mm
1	1.0	2840.3	-1005.3	202.0	-71.50	35.4	4.80	28.3
2	2.0	2842.7	-965.6	202.2	-68.68	35.3	4.79	28.0
4	4.0	2850.9	-923.0	202.8	-65.65	35.1	4.77	27.6
6	6.0	2862.9	-835.3	203.6	-59.41	34.8	4.73	27.0
8	8.0	2856.4	-749.8	203.2	-53.33	33.8	4.66	26.5
10	10.0	2811.7	-791.1	200.0	-56.27	32.1	4.59	25.9
12	12.0	2729.3	-863.1	194.1	-61.38	30.1	4.54	25.4
14	14.0	2724.9	-898.1	193.8	-63.87	29.3	4.48	25.0
16	16.0	2676.1	-794.7	190.3	-56.52	27.8	4.41	24.6
18	18.0	2640.0	-699.8	187.8	-49.77	26.5	4.35	24.4
20	20.0	2608.5	-809.7	185.5	-57.59	24.9	4.24	24.2
22	22.0	2518.0	-986.0	179.1	-70.13	22.0	4.10	24.0
24	24.0	2373.5	-886.9	168.8	-63.08	18.4	4.05	23.6
26	26.0	2295.7	-756.4	163.3	-53.80	16.4	4.77	23.4
28	28.0	2270.2	-975.8	161.5	-69.40	15.4	4.71	23.4
30	30.0	2219.1	-781.2	157.8	-55.56	14.0	4.81	23.4
32	32.0	2185.6	-852.5	155.5	-60.63	12.9	4.65	23.4
33	33.0	2163.4	-707.1	153.9	-50.29	12.3	4.94	23.4
34	34.0	2126.0	-539.6	151.2	-38.38	11.4	5.75	23.4
35	35.0	1951.3	-247.6	138.8	-17.61	10.9	6.33	23.4
36	36.0	1318.8	-51.1	93.8	-3.64	10.6	6.63	23.3
37	37.0	681.5	0.0	48.5	0.00	10.3	6.93	23.3
Absolute	7.0			203.7			(T =	21.9 ms)
	29.0				-75.76		(T =	29.3 ms)

File: Test Pile (EOID)
 Blow: 93
 Urkkada Technology Ltd.

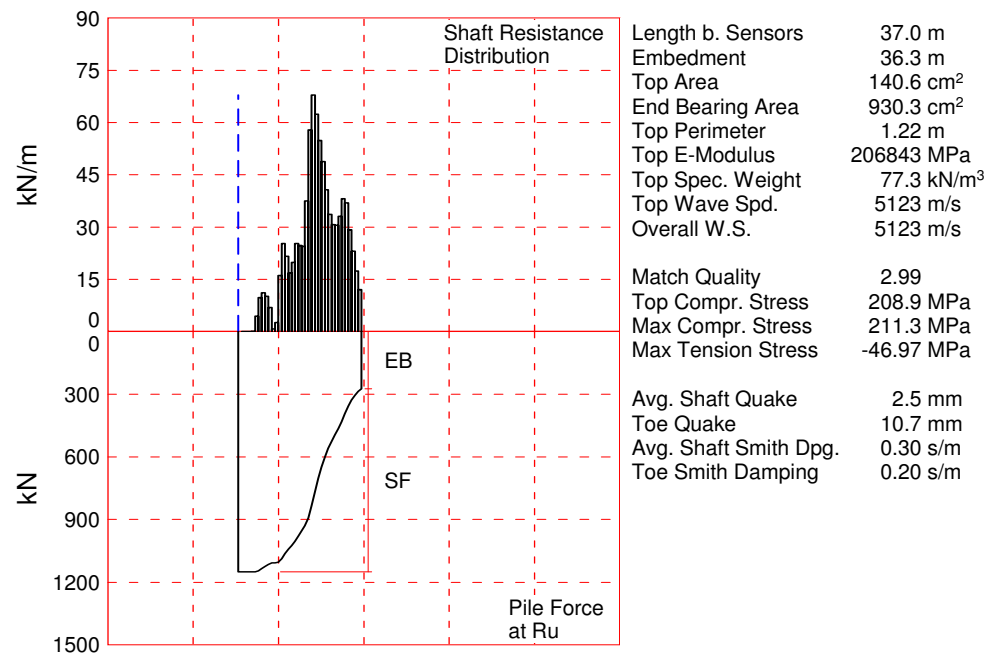
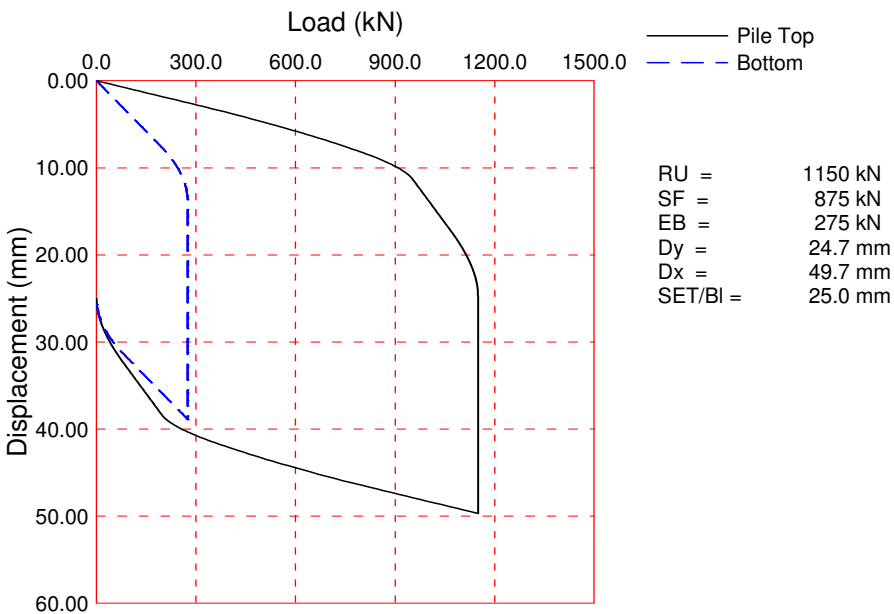
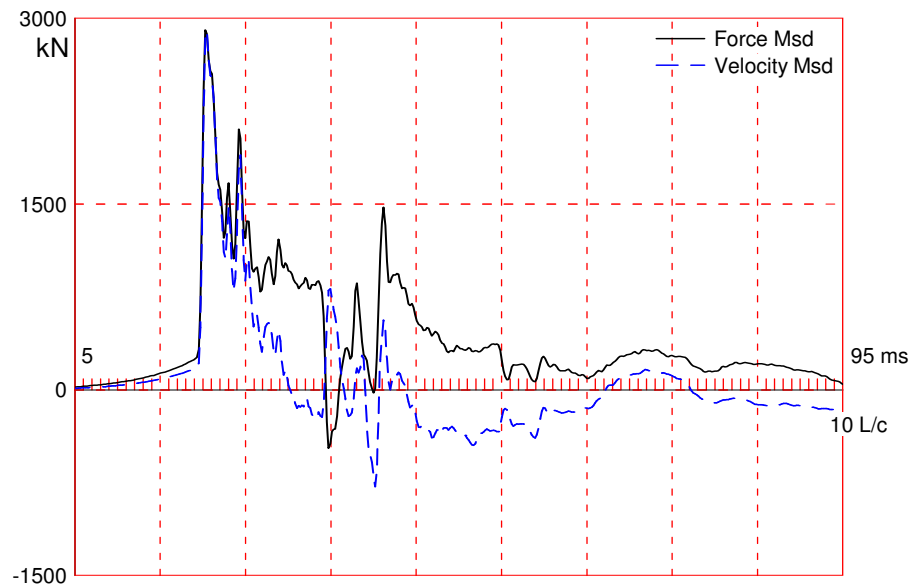
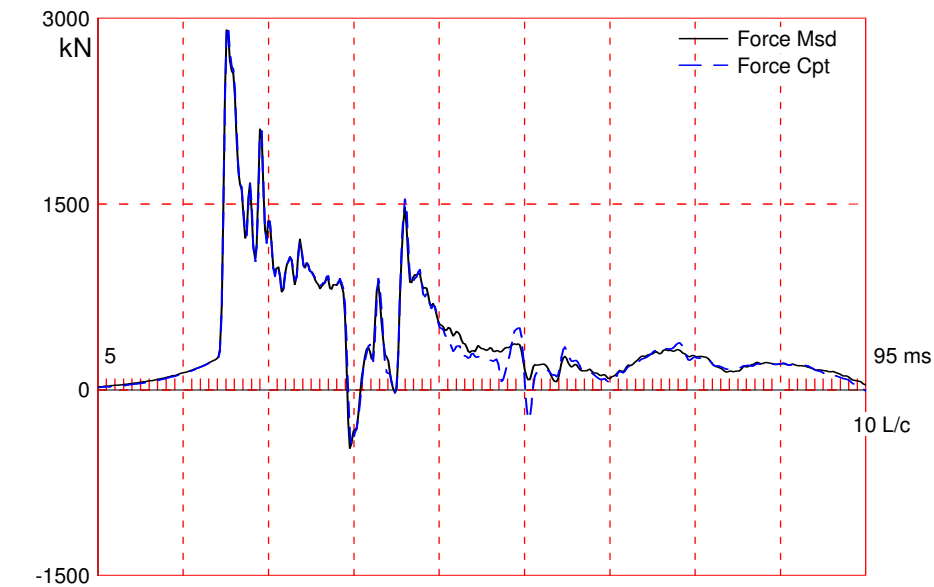
Test: 19-Sep-2019 16:10
 CAPWAP (R) 2014-3
 OP: MF

	CASE METHOD									
J =	0.0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8
RP	1760	968	176	0	0					
RX	1760	1181	1078	1032	986	940	894	870	870	870
RU	1787	1001	214	0	0					

RAU = 870 (kN); RA2 = 931 (kN)

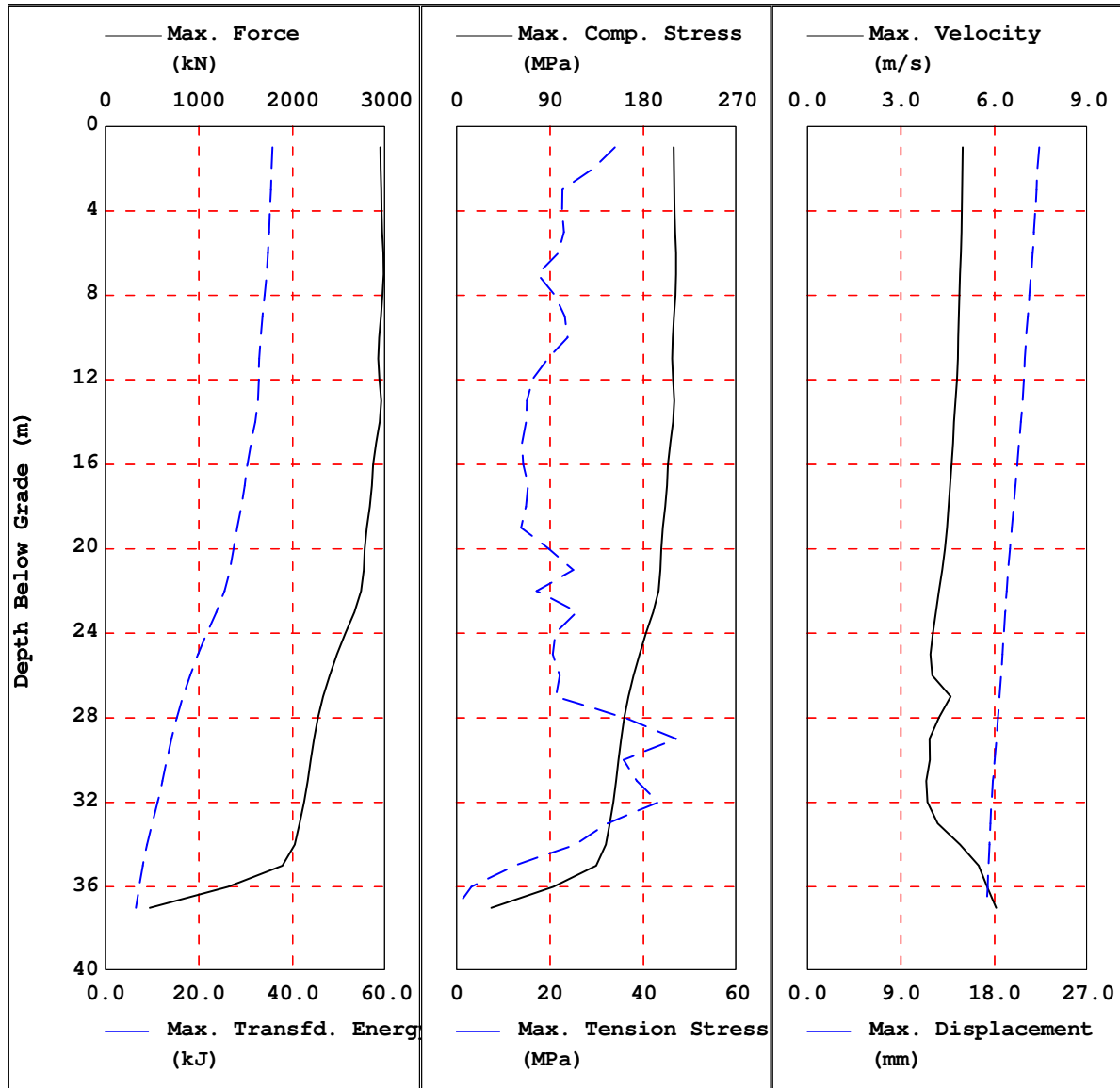
Current CAPWAP Ru = 850 (kN); Corresponding J(RP)= 0.23; matches RX20 within 5%

VMX	TVP	VT1*Z	FT1	FMX	DMX	DFN	SET	EMX	QUS	KEB
m/s	ms	kN	kN	kN	mm	mm	mm	kJ	kN	kN/mm
4.99	20.50	2833	2887	2887	29.3	22.7	22.7	36.6	1407	13



File: Test Pile (BOR)
Blow: 23
Urkkada Technology Ltd.

Test: 23-Sep-2019 08:57
CAPWAP (R) 2014-3
OP: MF



File: Test Pile (BOR)
 Blow: 23
 Urkkada Technology Ltd.

Test: 23-Sep-2019 08:57
 CAPWAP (R) 2014-3
 OP: MF

CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 1150.0; along Shaft 875.0; at Toe 275.0 kN

Soil Sgmt No.	Dist. Below Gages m	Depth Below Grade m	Ru kN	Force in Pile kN	Sum of Ru kN	Unit Resist. (Depth) kN/m	Unit Resist. (Area) kPa	Smith Damping Factor s/m
4	5.0	4.3	0.1	1149.9	0.1	0.10	0.08	0.30
5	6.0	5.3	4.4	1145.5	4.5	4.40	3.61	0.30
6	7.0	6.3	9.8	1135.7	14.3	9.80	8.03	0.30
7	8.0	7.3	11.1	1124.6	25.4	11.10	9.10	0.30
8	9.0	8.3	10.1	1114.5	35.5	10.10	8.28	0.30
9	10.0	9.3	6.9	1107.6	42.4	6.90	5.66	0.30
10	11.0	10.3	0.8	1106.8	43.2	0.80	0.66	0.30
11	12.0	11.3	2.6	1104.2	45.8	2.60	2.13	0.30
12	13.0	12.3	16.1	1088.1	61.9	16.10	13.20	0.30
13	14.0	13.3	25.3	1062.8	87.2	25.30	20.74	0.30
14	15.0	14.3	21.6	1041.2	108.8	21.60	17.70	0.30
15	16.0	15.3	16.8	1024.4	125.6	16.80	13.77	0.30
16	17.0	16.3	19.9	1004.5	145.5	19.90	16.31	0.30
17	18.0	17.3	25.3	979.2	170.8	25.30	20.74	0.30
18	19.0	18.3	24.7	954.5	195.5	24.70	20.25	0.30
19	20.0	19.3	24.5	930.0	220.0	24.50	20.08	0.30
20	21.0	20.3	37.5	892.5	257.5	37.50	30.74	0.30
21	22.0	21.2	57.9	834.6	315.4	57.90	47.46	0.30
22	23.0	22.2	67.9	766.7	383.3	67.90	55.66	0.30
23	24.0	23.2	62.4	704.3	445.7	62.40	51.15	0.30
24	25.0	24.2	54.9	649.4	500.6	54.90	45.00	0.30
25	26.0	25.2	48.8	600.6	549.4	48.80	40.00	0.30
26	27.0	26.2	40.7	559.9	590.1	40.70	33.36	0.30
27	28.0	27.2	33.7	526.2	623.8	33.70	27.62	0.30
28	29.0	28.2	30.7	495.5	654.5	30.70	25.16	0.30
29	30.0	29.2	30.5	465.0	685.0	30.50	25.00	0.30
30	31.0	30.2	33.1	431.9	718.1	33.10	27.13	0.30
31	32.0	31.2	38.1	393.8	756.2	38.10	31.23	0.30
32	33.0	32.2	37.0	356.8	793.2	37.00	30.33	0.30
33	34.0	33.2	29.2	327.6	822.4	29.20	23.93	0.30
34	35.0	34.2	23.1	304.5	845.5	23.10	18.93	0.30
35	36.0	35.2	17.4	287.1	862.9	17.40	14.26	0.30
36	37.0	36.2	12.1	275.0	875.0	12.10	9.92	0.30
Avg. Shaft			24.3			24.14	19.79	0.30
Toe			275.0				2956.19	0.20

Soil Model Parameters/Extensions

	Shaft	Toe
Quake (mm)	2.5	10.7
Case Damping Factor	0.46	0.10
Damping Type	Viscous	Viscous

File: Test Pile (BOR)
 Blow: 23
 Urkkada Technology Ltd.

Test: 23-Sep-2019 08:57
 CAPWAP (R) 2014-3
 OP: MF

Soil Model Parameters/Extensions		Shaft	Toe
Unloading Quake	(% of loading quake)	110	90
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	1	
Resistance Gap (included in Toe Quake) (mm)			0.7

max. Top Comp. Stress = 208.9 MPa (T= 20.7 ms, max= 1.011 x Top)
 max. Comp. Stress = 211.3 MPa (Z= 7.0 m, T= 21.9 ms)
 max. Tens. Stress = -46.97 MPa (Z= 29.0 m, T= 29.3 ms)
 max. Energy (EMX) = 35.7 kJ; max. Measured Top Displ. (DMX)= 22.5 mm

EXTREMA TABLE

File Sgmnt No.	Dist. Below Gages m	max. Force kN	min. Force kN	max. Comp. Stress MPa	max. Tens. Stress MPa	max. Trnsfd. Energy kJ	max. Veloc. m/s	max. Displ. mm
1	1.0	2937.8	-475.9	208.9	-33.85	35.7	4.98	22.3
2	2.0	2941.8	-411.0	209.2	-29.23	35.5	4.98	22.1
4	4.0	2950.6	-318.2	209.9	-22.63	35.2	4.96	21.9
6	6.0	2969.4	-306.3	211.2	-21.79	34.8	4.92	21.7
8	8.0	2959.5	-295.8	210.5	-21.04	34.0	4.88	21.3
10	10.0	2925.0	-334.3	208.0	-23.78	33.2	4.84	21.0
12	12.0	2929.0	-228.8	208.3	-16.28	32.8	4.80	20.8
14	14.0	2931.6	-209.7	208.5	-14.91	32.0	4.71	20.5
16	16.0	2861.3	-201.1	203.5	-14.30	30.4	4.63	20.2
18	18.0	2825.3	-209.3	200.9	-14.89	29.1	4.53	19.8
20	20.0	2768.5	-278.3	196.9	-19.79	27.4	4.42	19.5
22	22.0	2733.3	-241.3	194.4	-17.16	25.5	4.22	19.2
24	24.0	2563.5	-297.1	182.3	-21.13	21.7	4.03	18.9
26	26.0	2397.2	-310.3	170.5	-22.07	18.1	4.00	18.6
28	28.0	2270.9	-505.1	161.5	-35.92	15.3	4.21	18.3
30	30.0	2193.4	-502.7	156.0	-35.75	13.2	3.93	18.0
32	32.0	2124.5	-605.9	151.1	-43.09	11.2	3.86	17.7
33	33.0	2076.0	-454.8	147.7	-32.35	10.0	4.18	17.6
34	34.0	2023.5	-359.1	143.9	-25.54	8.9	4.89	17.5
35	35.0	1891.6	-175.7	134.5	-12.49	8.0	5.50	17.4
36	36.0	1311.5	-45.7	93.3	-3.25	7.3	5.77	17.3
37	37.0	474.9	0.0	33.8	0.00	6.5	6.06	17.3
Absolute	7.0			211.3			(T =	21.9 ms)
	29.0				-46.97		(T =	29.3 ms)

File: Test Pile (BOR)
 Blow: 23
 Urkkada Technology Ltd.

Test: 23-Sep-2019 08:57
 CAPWAP (R) 2014-3
 OP: MF

CASE METHOD										
J =	0.0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8
RP	2258	1924	1590	1255	921	587	253	0	0	0
RX	2258	1924	1640	1460	1286	1160	1057	1026	994	963
RU	2410	1739	1068	396	0	0	0	0	0	0

RAU = 793 (kN); RA2 = 1188 (kN)

Current CAPWAP Ru = 1150 (kN); Corresponding J(RP) = 0.66; J(RX) = 1.02

VMX	TVP	VT1*Z	FT1	FMX	DMX	DFN	SET	EMX	QUS	KEB
m/s	ms	kN	kN	kN	mm	mm	mm	kJ	kN	kN/mm
5.10	20.50	2892	2874	2904	22.5	7.1	25.0	35.8	1509	28

Appendix 5

Borehole Logs




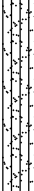
PROJECT <u>1668512</u>		RECORD OF BOREHOLE No 89UP-03		SHEET 1 OF 4		METRIC	
G.W.P. <u>2438-13-00</u>		LOCATION <u>N 4895628.3; E 292375.2 MTM NAD 83 ZONE 10 (LAT. 44.200549; LONG. -79.655451)</u>		ORIGINATED BY <u>DF</u>			
DIST <u>Central</u> HWY <u>400</u>		BOREHOLE TYPE <u>D50 Track Mount, NW Casing and Wash Boring with Drilling Mud</u>		COMPILED BY <u>DH</u>			
DATUM <u>Geodetic</u>		DATE <u>July 17 to 21, 2017</u>		CHECKED BY <u>SMM/TZ</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)		
227.4	GROUND SURFACE																
0.0	TOPSOIL																
0.2	Gravelly sand, some silt (FILL)		1	SS	6												
226.7	Loose Brown Moist																
0.7	SILT, trace to some sand to SILT and SAND, trace to some clay Loose to very dense Grey Wet		2	SS	6												
			3	SS	16												
			4	SS	22												
			5	SS	17												
			6	SS	22												
			7	SS	13												
			8A	SS	23												
			8B	SS	23												
			9	SS	17												
			10	SS	10												
			11A	SS	33												
			11B	SS	33												
			12	SS	16												
			13	SS	17												

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PROJECT 1668512		RECORD OF BOREHOLE No 89UP-03				SHEET 2 OF 4		METRIC							
G.W.P. 2438-13-00		LOCATION N 4895628.3; E 292375.2 MTM NAD 83 ZONE 10 (LAT. 44.200549; LONG. -79.655451)				ORIGINATED BY DF									
DIST Central HWY 400		BOREHOLE TYPE D50 Track Mount, NW Casing and Wash Boring with Drilling Mud				COMPILED BY DH									
DATUM Geodetic		DATE July 17 to 21, 2017				CHECKED BY SMM/TZ									
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
--- CONTINUED FROM PREVIOUS PAGE ---															
209.6	SILT, trace to some sand to SILT and SAND, trace to some clay Loose to very dense Grey Wet		14	SS	37		212							18.5 (C)	
								211							
								210							
17.8	SILTY CLAY, trace sand Grey Moist		15	SS	80										
208.9	SILT and SAND Dense to very dense Grey Wet		16A	SS	44		209								
18.5			16B												
									208						
			17	SS	59		207								
206.5	Varved CLAYEY SILT to SILTY CLAY with silt and clay laminae Stiff to very stiff Grey Moist - Sand inclusions from 20.9 m to 22.4 m		18	SS	11		206								
20.9								205							
			19	SS	8		204								
			20	TO	PH		203								
			21	SS	3		201								
			22	TO	PH		200								
			23	SS	4		198								

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PROJECT <u>1668512</u>		RECORD OF BOREHOLE No 89UP-03		SHEET 3 OF 4		METRIC	
G.W.P. <u>2438-13-00</u>		LOCATION <u>N 4895628.3; E 292375.2 MTM NAD 83 ZONE 10 (LAT. 44.200549; LONG. -79.655451)</u>		ORIGINATED BY <u>DF</u>			
DIST <u>Central</u> HWY <u>400</u>		BOREHOLE TYPE <u>D50 Track Mount, NW Casing and Wash Boring with Drilling Mud</u>		COMPILED BY <u>DH</u>			
DATUM <u>Geodetic</u>		DATE <u>July 17 to 21, 2017</u>		CHECKED BY <u>SMM/TZ</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa											WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE											w _p w w _L		
								● QUICK TRIAXIAL × REMOULDED													
		--- CONTINUED FROM PREVIOUS PAGE ---					20	40	60	80	100		10	20	30						
		Varved CLAYEY SILT to SILTY CLAY with silt and clay laminae Stiff to very stiff Grey Moist									+										
			24	SS	9						>96										
195.5																					
31.9		SILT, some sand, trace clay Compact to very dense Grey Wet - Clayey silt inclusions encountered between depths of about 32.0 m and 32.6 m	25	SS	27																
			26	SS	86																
192.0																					
35.4		Sandy SILT, trace clay Very dense Grey Wet																			
			27A	SS	100																
			27B																		
189.0																					
38.4		CLAYEY SILT, some sand Very stiff Grey Moist																			
			28	SS	17																

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PROJECT		1668512		RECORD OF BOREHOLE No 89UP-03				SHEET 4 OF 4		METRIC								
G.W.P.		2438-13-00		LOCATION		N 4895628.3; E 292375.2 MTM NAD 83 ZONE 10 (LAT. 44.200549; LONG. -79.655451)				ORIGINATED BY		DF						
DIST		Central HWY 400		BOREHOLE TYPE		D50 Track Mount, NW Casing and Wash Boring with Drilling Mud				COMPILED BY		DH						
DATUM		Geodetic		DATE		July 17 to 21, 2017				CHECKED BY		SMM/TZ						
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)
	--- CONTINUED FROM PREVIOUS PAGE ---																	
181.4	CLAYEY SILT (TILL) Grey Moist		30A	SS	101													
46.0	SILT and SAND, trace gravel, trace clay (TILL) Very dense Grey Wet		30B															
178.2			31	SS	100/0.10													
49.2	END OF BOREHOLE																	
NOTES: 1. Water level measurements in the casing at the beginning of each work shift: Date Depth (m) Elev. (m) 18/07/17 0.7 226.7 19/07/17 1.6 225.8 20/07/17 0.0 227.4 21/07/17 3.3 224.1 2. A borehole was advanced to a depth of about 4.0 m immediately next to borehole 89UP-03 in order to install a standpipe piezometer. 3. Water level measurements in standpipe piezometer: Date Depth (m) Elev. (m) 03/08/17 1.0 226.4 10/08/17 1.0 226.4 15/08/17 1.2 226.2 19/09/17 1.3 226.1 05/03/18 0.7 226.7 16/05/18 0.5 226.9																		

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PROJECT 1668512		RECORD OF BOREHOLE No 89UP-05		SHEET 1 OF 4		METRIC						
G.W.P. 2438-13-00		LOCATION N 4895649.6; E 292418.6 MTM NAD 83 ZONE 10 (LAT. 44.200750; LONG. -79.654912)		ORIGINATED BY DF								
DIST Central HWY 400		BOREHOLE TYPE D50 Track Mount, NW Casing and Wash Boring with Drilling Mud		COMPILED BY DM								
DATUM Geodetic		DATE June 26 to 29 and July 3, 2017		CHECKED BY SMM/TZ								
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC NATURAL LIQUID UNIT REMARKS			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	W _p W W _L	WATER CONTENT (%)	γ	GR SA SI CL
229.2	GROUND SURFACE											
0.0	ASPHALT (250 mm)						229					
	Sand and gravel (FILL) (250 mm)						228					
0.5	Silt and sand, trace to some clay with organic odour (FILL) Very loose to loose Brown mottled with grey Moist to wet		1	SS	6		227					
			2	SS	3		226			o		0 45 46 9
226.2	Silty SAND Compact Grey Wet		3	SS	17		225			o		
3.0			4	SS	20		224					
			5	SS	26		223					
223.6	SILT to Sandy SILT, trace clay with clayey silt pockets Compact to very dense Grey Wet		6	SS	14		222					
5.6			7	SS	16		221					
			8	SS	20		220			o		0 26 73 1
			9	SS	25		219					
			10	SS	15		218					
			11	SS	20		217			o		
							216					
							215			H o		0 11 77 12

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PROJECT <u>1668512</u>		RECORD OF BOREHOLE No 89UP-05		SHEET 2 OF 4		METRIC	
G.W.P. <u>2438-13-00</u>		LOCATION <u>N 4895649.6; E 292418.6 MTM NAD 83 ZONE 10 (LAT. 44.200750; LONG. -79.654912)</u>		ORIGINATED BY <u>DF</u>			
DIST <u>Central</u> HWY <u>400</u>		BOREHOLE TYPE <u>D50 Track Mount, NW Casing and Wash Boring with Drilling Mud</u>		COMPILED BY <u>DM</u>			
DATUM <u>Geodetic</u>		DATE <u>June 26 to 29 and July 3, 2017</u>		CHECKED BY <u>SMM/TZ</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					w _p	w	w _L		GR	SA	SI	CL	
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× REMOULDED	WATER CONTENT (%)									
	--- CONTINUED FROM PREVIOUS PAGE ---						20	40	60	80	100										
	SILT to Sandy SILT, trace clay with clayey silt pockets Compact to very dense Grey Wet		12	SS	27									○				0	10	87	3
			13	SS	30																
			14	SS	44																
			15	SS	39									○							
			16	SS	55									○							
206.8																					
22.4	Varved CLAYEY SILT, with silt and clay laminae Stiff to very stiff Grey Wet		17	SS	10										○			0	0	62	38
204.1																					
25.1	Varved SILTY CLAY, with silt and clay laminae Stiff to very stiff Grey Wet		18	SS	5																
											</										

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PROJECT <u>1668512</u>		RECORD OF BOREHOLE No 89UP-05		SHEET 3 OF 4		METRIC	
G.W.P. <u>2438-13-00</u>		LOCATION <u>N 4895649.6; E 292418.6 MTM NAD 83 ZONE 10 (LAT. 44.200750; LONG. -79.654912)</u>		ORIGINATED BY <u>DF</u>			
DIST <u>Central</u> HWY <u>400</u>		BOREHOLE TYPE <u>D50 Track Mount, NW Casing and Wash Boring with Drilling Mud</u>		COMPILED BY <u>DM</u>			
DATUM <u>Geodetic</u>		DATE <u>June 26 to 29 and July 3, 2017</u>		CHECKED BY <u>SMM/TZ</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					W _p	W	W _L		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED									
	--- CONTINUED FROM PREVIOUS PAGE ---							20	40	60	80	100					
195.0	Varved SILTY CLAY, with silt and clay laminae Stiff to very stiff Grey Wet		20	SS	5												
34.2	SILT, trace to some sand, trace clay Very dense Grey Wet		21	SS	54												
			22	SS	71												
189.3	CLAYEY SILT, trace to some sand Very stiff Grey Wet		23	SS	15												
186.2	Sandy CLAYEY SILT, some gravel (TILL) Hard Grey Wet		24	SS	35												

Continued Next Page

+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GTA-MTO 001 S:\CLIENTS\MTOWHY_400_AND_HWY_89_INTERCHANGE\02_DATA\GINT\HWY_400_AND_HWY_89_INTERCHANGE.GPJ GAL-GTA.GDT 09/12/18

PROJECT		1668512		RECORD OF BOREHOLE No 89UP-05				SHEET 4 OF 4		METRIC								
G.W.P.		2438-13-00		LOCATION		N 4895649.6; E 292418.6 MTM NAD 83 ZONE 10 (LAT. 44.200750; LONG. -79.654912)		ORIGINATED BY		DF								
DIST		Central HWY 400		BOREHOLE TYPE		D50 Track Mount, NW Casing and Wash Boring with Drilling Mud		COMPILED BY		DM								
DATUM		Geodetic		DATE		June 26 to 29 and July 3, 2017		CHECKED BY		SMM/TZ								
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)
	--- CONTINUED FROM PREVIOUS PAGE ---							20	40	60	80	100						
	Sandy CLAYEY SILT, some gravel (TILL) Hard Grey Wet					184												
	- Inferred cobbles/boulders encountered between depths of about 46.3 m and 46.9 m					183												
			25	SS	43	182												
						181												
						180												
178.8 50.4	END OF BOREHOLE		26	SS	100/70 10	179												
NOTE:																		
1. Water level measurements in the casing at the beginning of each work shift:																		
Date Depth (m) Elev. (m)																		
27/06/17 1.1 228.1																		
28/06/17 4.3 224.9																		
29/06/17 1.1 228.1																		
03/07/17 9.0 220.2																		
The water level measurements are not considered to be representative of the groundwater level due to introduction of water/drilling mud during wash boring operations.																		

GTA-MTO 001 S:\CLIENTS\TOHWY_400_AND_HWY_89_INTERCHANGE02_DATA\GINT\HWY_400_AND_HWY_89_INTERCHANGE.GPJ GAL-GTA.GDT 09/12/18

Appendix 6

Calibration Records

CERTIFICATE OF QUALITY, CONFORMITY & CALIBRATION

WE HEREBY CERTIFY that the manufactured materials listed below (SCHEDULE A)

Furnished to: GKM Consultants

Reference Geokon Job No.: 20039293R, 20041577R/20065549

order no.: 4682 (021-0279), contract no.: N/A in all aspects

In the amount specified in Schedule A, identified by our label "GEOKON"

Complies/Conforms to, or exceeds the requirements and specifications of your purchase order no: contract no: N/A in all aspects.

Country(s) of Origin: United States of America

WE FURTHER CERTIFY that the product supplied has been inspected, tested and calibrated as applicable, in conformance to the relevant specifications and drawings of the GEOKON registered ISO 9001:2015 Quality Management System, Revision 17. Calibration and testing standards are calibrated by ISO 17025 Accredited Laboratories, are maintained per ANSI/NCSL Z540-1 and are traceable to the N.I.S.T.

SCHEDULE A

MODEL NO.	QUANTITY	TYPE OF INSTRUMENT	SERIAL NO.
4900-400-3	1	Repair, 4900 Series VW Load Cell	1321488
GK-502	1	Repair, GK-502 RLC Readout	1426693
TRACKING	1		N/A

Signed by:



Adam Webster
Quality Assurance Manager

Date: September 13, 2019



Ref: 20065549

Vibrating Wire Load Cell Calibration Report

Model Number: 4900-400-3Calibration Date: September 11, 2019

This calibration has been verified/validated as of 09/12/2019

Serial Number: 1321488Calibration Instruction: CI-4900 TiniusMax. Range (lbs): 400000Cable Length: 65 meters

Initial Cycling Data

Load (lbs):	0	0	400000	0
Reading:	7306	7302	5974	7301

Technician: 

Applied Load in lbs	First Cycle				Second Cycle				Average (2 Cycles)	Linearity % Max Load	Polynomial Error (%FS)
	Gauge 1	Gauge 2	Gauge 3	Average	Gauge 1	Gauge 2	Gauge 3	Average			
0	7378	7212	7314	7301	7377	7212	7313	7301	7301	1.49	1.34
40000	7268	7083	7199	7183	7267	7083	7199	7183	7183	0.24	0.14
80000	7138	6953	7067	7053	7136	6953	7066	7052	7052	-0.03	-0.06
120000	7004	6820	6932	6919	7003	6820	6932	6918	6919	-0.11	-0.08
160000	6871	6687	6797	6785	6869	6687	6796	6784	6785	-0.15	-0.09
200000	6736	6552	6660	6649	6735	6554	6661	6650	6650	-0.14	-0.06
240000	6601	6418	6523	6514	6599	6418	6523	6513	6514	-0.04	0.05
280000	6469	6284	6388	6380	6466	6284	6388	6379	6380	-0.10	-0.03
320000	6331	6147	6248	6242	6329	6148	6248	6242	6242	0.15	0.19
360000	6198	6010	6111	6106	6197	6012	6112	6107	6107	0.19	0.17
400000	6068	5880	5979	5976	6067	5882	5981	5977	5976	-0.12	-0.22
0	7377	7211	7313	7300	7377	7211	7313	7300	7300		

GK-401 Pos. B Readout

Linear Gauge Factor (G): -297.1 lbs/digitRegression Zero (R_0):* 7321Polynomial Gauge Factors: A: -0.002071B: -269.8C: 2086000Calculate C by setting $L = 0$ and R_1 = initial field zero reading in the polynomial equation

Calculated Load:

Linear, $L = G (R_1 - R_0)$ Polynomial, $L = AR_1^2 + BR_1 + C$

Linearity = ((Calculated Load - Applied Load) / Max. Applied Load) x 100%

For additional accuracy the data could be analysed in segments, calculating gage factors for each segment

* Note: The above calibration uses a linear regression method. The Regression Zero Reading shown is ideal for straight line computation and does not usually agree with the actual no-load reading.

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

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Canadian BBR Inc.
3450 Midland Avenue
Agincourt Ontario

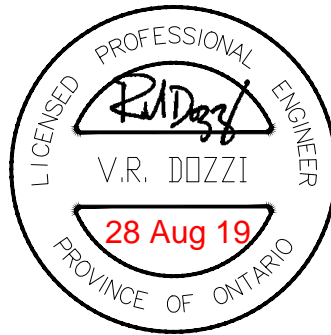
Calibration of Hydraulic Components

28-Aug-19

RJ 1000-18-5306

Ram Area (sq. in.) 243.7
Friction Calibration 1.017

Calibrated with Digital pressure gauge
Enerpac Model DGB / 10000 psi
Load cell BBR no.2



Gauge psi	Voltage run 1	Voltage run 2	Voltage run 3	Voltage (avg)	Load kips
1000	1.691	1.703	1.711	1.702	238.23
2000	3.409	3.423	3.422	3.418	478.52
3000	5.136	5.14	5.146	5.141	719.69
4000	6.834	6.855	6.855	6.848	958.72
5000	8.55	8.567	8.566	8.561	1198.54
5800	9.9	9.918	9.91	9.909	1387.31



P.O. Box 37, Agincourt, ON M1S 3B4
3450 Midland Ave., Scarborough, ON M1V 4V4

Tel: (416) 291-1618
Fax: (416) 291-9960

CERTIFIED TEST REPORTS

Reference No. : **256** Date : **09-Aug-19**

Gauge Type : **WIKA 0 - 10,000 PSI**

Machine : **Deadweight Tester Mansfield & Green**

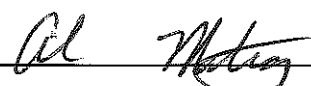
Traceability To : **National Bureau Standards**

Dead Weight Pressure

1000 psi
2000 psi
3000 psi
4000 psi
5000 psi
6000 psi
7000 psi
8000 psi
9000 psi

Gauge Indicated Pressure

1025 psi
2025 psi
3025 psi
4000 psi
5000 psi
6000 psi
7000 psi
8000 psi
9000 psi

Signature : 



P.O. Box 37, Agincourt, ON M1S 3B4
3450 Midland Ave., Scarborough, ON M1V 4V4

Tel: (416) 291-1618
Fax: (416) 291-9960

CERTIFIED TEST REPORTS

Reference No. : 257

Date : 28-Aug-19

Gauge Type : WIKA 0 - 10,000 PSI

Machine : Deadweight Tester Mansfield & Green


Traceability To : National Bureau Standards

Dead Weight Pressure

1000	psi
2000	psi
3000	psi
4000	psi
5000	psi
6000	psi
7000	psi
8000	psi
9000	psi

Gauge Indicated Pressure

975	psi
2000	psi
3000	psi
4000	psi
5000	psi
5975	psi
6975	psi
7950	psi
8950	psi

Signature : 

Appendix 7

Load Test Records



Load Increment 250 kN

PILE NO: Test Pile

Urkkada Job No. 1905CS1373

Project: MTO 2018-2024

Date: Oct 7, 2019

Location: HWY 400 & 89

Start Time: 12:42 PM

Owner: MTO

Pile Size: 310x110

Contractor: Fermar Paving Limited

Pile Type: H-Pile

Inspector: S. Ferguson/M. El Kotob

Embedment (m): 36.34

[illegible]



Load Increment 450 kN

PILE NO: Test Pile

Urkkada Job No. 1905CS1373

Project: MTO 2018-2024

Date: Oct 7, 2019

Location: HWY 400 & 89

Start Time: 01:08 PM

Owner: MTO

Pile Size: 310x110

Contractor: Fermar Paving Limited

Pile Type: H-Pile

Inspector: S. Ferguson/M. El Kotob

Embedment (m): 36.34

[illegible]



Load Increment 600 kN

PILE NO: Test Pile

Urkkada Job No. 1905CS1373

Project: MTO 2018-2024

Date: Oct 7, 2019

Location: HWY 400 & 89

Start Time: 01:35 PM

Owner: MTO

Pile Size: 310x110

Contractor: Fermar Paving Limited

Pile Type: H-Pile

Inspector: S. Ferguson/M. El Kotob

Embedment (m): 36.34

[illegible]



Load Increment 750 kN

PILE NO: _____ Test Pile

Urkkada Job No. 1905CS1373

Project: MTO 2018-2024

Date: Oct 7, 2019

Location: HWY 400 & 89

Start Time: 02:21 PM

Owner: MTO

Pile Size: 310x110

Contractor: Fermar Paving Limited

Pile Type: H-Pile

Inspector: S. Ferguson/M. El Kotob

Embedment (m): 36.34

Date	Time		Applied Load (kN)	Gauge Reading (psi)	Test Pile								Wire Line Reading (cm)	Movement from Wire Line (cm)	Reaction Pile 1 (cm)	Reaction Pile 2 (cm)	Reaction Pile 3 (cm)	Reaction Pile 4 (cm)
					Vertical Gauge #1 (in)	Vertical Gauge #2 (in)	Gauge #1 Δ (mm)	Gauge #2 Δ (mm)	Average Δ Gauge (mm)	Lateral #1 (in)	Lateral #2 (in)							
	ZERO		0	0	3.480	1.085		-	-	0.200	0.876	29.00			55.9	60.5	67.2	65.9
2019-10-07	0 min	02:21 PM	719	850	3.101	0.665	9.63	10.67	10.15	0.178	0.930	28.20	0.80					
	2 min	02:23 PM	701	825	3.097	0.664	9.73	10.69	10.21	0.178	0.929	28.20	0.80					
	5 min	02:26 PM	681	800	3.095	0.661	9.78	10.77	10.27	0.177	0.928	28.20	0.80					
	10 min	02:31 PM	680	800	3.094	0.659	9.80	10.82	10.31	0.178	0.928	28.20	0.80	55.9	60.3	67.2	65.9	
	20 min	02:41 PM	670	800	3.092	0.658	9.86	10.85	10.35	0.177	0.929	28.10	0.90					
	40 min	03:01 PM	664	800	3.088	0.655	9.96	10.92	10.44	0.177	0.929	28.10	0.90					
	60 min	03:21 PM	659	800	3.088	0.655	9.96	10.92	10.44	0.178	0.929	28.10	0.90					
	80 min	0.65	654	800	3.088	0.654	9.96	10.95	10.45	0.178	0.929	28.10	0.90					



Load Increment 900 kN

PILE NO: _____ Test Pile
 Project: _____ MTO 2018-2024
 Location: _____ HWY 400 & 89
 Owner: _____ MTO
 Contractor: _____ Fermar Paving Limited
 Inspector: _____ S. Ferguson/M. El Kotob

Urkkada Job No. _____ 1905CS1373
 Date: _____ Oct 7, 2019
 Start Time: _____ 03:49 PM
 Pile Size: _____ 310x110
 Pile Type: _____ H-Pile
 Embedment (m): _____ 36.34

Goulder requested pump up back to target load at 40 & 60 min intervals

Date	Time		Applied Load (kN)	Gauge Reading (psi)	Test Pile									Reaction Pile 1 (cm)	Reaction Pile 2 (cm)	Reaction Pile 3 (cm)	Reaction Pile 4 (cm)
					Vertical Gauge #1 (in)	Vertical Gauge #2 (in)	Gauge #1 Δ (mm)	Gauge #2 Δ (mm)	Average Δ Gauge (mm)	Lateral #1 (in)	Lateral #2 (in)	Wire Line Reading (cm)	Movement from Wire Line (cm)				
	ZERO		0	0	3.480	1.085		-	-	0.200	0.876	29.00		55.9	60.5	67.2	65.9
2019-10-07	0 min	03:49 PM	855	950	2.901	0.475	14.71	15.49	15.10	0.174	0.933	27.50	1.50				
	2 min	03:51 PM	797	925	2.907	0.472	14.55	15.57	15.06	0.174	0.933	27.60	1.40				
	5 min	03:54 PM	791	925	2.904	0.470	14.63	15.62	15.13	0.173	0.931	27.80	1.20				
	10 min	03:59 PM	780	925	2.901	0.467	14.71	15.70	15.20	0.173	0.931	27.70	1.30				
	20 min	04:09 PM	769	900	2.899	0.464	14.76	15.77	15.27	0.173	0.930	27.70	1.30				
	40 min	04:29 PM	760	900	2.895	0.460	14.86	15.88	15.37	0.172	0.930	27.70	1.30				
	41 min	04:30 PM	841	950	2.855	0.422	15.88	16.84	16.36	0.174	0.930	27.50	1.50	56.0	60.8	67.3	66.0
	60 min	04:49 PM	788	900	2.847	0.412	16.08	17.09	16.59	0.175	0.932	27.50	1.50				
	61 min	04:50 PM	855	975	2.819	0.384	16.79	17.81	17.30	0.178	0.935	27.40	1.60				
	80 min	05:09 PM	809	925	2.812	0.377	16.97	17.98	17.48	0.178	0.933	27.40	1.60				
	100 min	05:29 PM	802	925	2.809	0.374	17.04	18.06	17.55	0.177	0.932	27.40	1.60				
	120 min	05:49 PM	802	925	2.805	0.371	17.15	18.14	17.64	0.177	0.932	27.40	1.60				



Load Increment 1050 kN

Vertical Gauge #2 was adjusted at 10 min interval to allow more travel

Pre-Adjustment was 0.084" equal to Post-adjustment 1.709"

PILE NO: Test Pile

Urkkada Job No. 1905CS1373

Project: MTO 2018-2024

Date: Oct 7, 2019

Location: HWY 400 & 89

Start Time: 05:56 PM

Owner: MTO

Pile Size: 310x110

Contractor: Fermar Paving Limited

Pile Type: H-Pile

Inspector: S. Ferguson/M. El Kotob

Embedment (m): 36.34

[illegible]

**Unloading Cycle - 25% Decrements**

Vertical Gauge #2 was adjusted during 1050 kN loading. Subtract 1.625"
from all readings to obtain true relative reading

PILE NO: _____ Test Pile
Project: _____ MTO 2018-2024
Location: _____ HWY 400&89
Owner: _____ MTO
Contractor: _____ Ferman Paving Limited
Inspector: _____ S. Ferguson

Urkkada Job No. _____ 1905CS1373
Date: _____ Oct 7 & 8, 2019
Start Time: _____ 06:50 PM
Pile Size: _____ 310x110
Pile Type: _____ H-Pile
Embedment (m): _____ 36.34

Date	Time		Applied Load (kN)	Gauge Reading (psi)	Test Pile								Wire Line Reading (cm)	Movement from Wire Line (cm)	Reaction Pile 1 (cm)	Reaction Pile 2 (cm)	Reaction Pile 3 (cm)	Reaction Pile 4 (cm)
					Vertical Gauge #1 (in)	Vertical Gauge #2 (in)	Gauge #1 Δ (mm)	Gauge #2 Δ (mm)	Average Δ Gauge (mm)	Lateral #1 (in)	Lateral #2 (in)							
	ZERO		0	0	3.480	1.085		-	-	0.200	0.876	29.00			55.9	60.5	67.2	65.9
2019-10-07		750 kN																
	0 min	06:50 PM	878	900	2.357	1.545	28.52	29.59	29.06	0.178	0.935	26.20	2.80					
	20 min	07:10 PM	878	900	2.356	1.544	28.55	29.62	29.08	0.178	0.936	26.30	2.70	57.0	61.8	68.0	66.5	
	40 min	07:30 PM	876	900	2.355	1.543	28.58	29.64	29.11	0.179	0.936	26.30	2.70					
	60 min	07:50 PM	876	900	2.354	1.543	28.60	29.64	29.12	0.179	0.937	26.40	2.60					
		500 kN																
	0 min	07:58 PM	521	550	2.438	1.634	26.47	27.33	26.90	0.191	0.926	26.50	2.50					
	20 min	08:18 PM	533	550	2.438	1.635	26.47	27.31	26.89	0.191	0.925	26.50	2.50					
	40 min	08:38 PM	533	550	2.438	1.635	26.47	27.31	26.89	0.191	0.925	26.50	2.50					
	60 min	08:58 PM	533	550	2.438	1.635	26.47	27.31	26.89	0.191	0.925	26.50	2.50					

2019-10-07		250 kN															
	0 min	09:01 PM	227	300	2.446	1.757	26.26	24.21	25.23	0.204	0.913	26.80	2.20				
	20 min	09:21 PM	237	300	2.447	1.759	26.24	24.16	25.20	0.203	0.913	26.80	2.20				
	40 min	09:41 PM	239	300	2.448	1.759	26.21	24.16	25.18	0.203	0.912	26.80	2.20				
	60 min	10:01 PM	239	300	2.448	1.759	26.21	24.16	25.18	0.203	0.912	26.80	2.20				
		0 kN															
	0 min	10:14 PM	44	0	2.682	1.913	20.27	20.24	20.26	0.210	0.886	27.30	1.70				
	5 min	10:19 PM	0	0	2.698	1.924	19.86	19.96	19.91	0.210	0.886	27.40	1.60	57.3	62.0	68.2	66.8
10-08	12 hr	10:12 AM	0	0	2.705	1.931	19.69	19.79	19.74	0.210	0.886	27.30	1.70	57.3	62.1	68.2	66.8



Load Increment 500kN

PILE NO: _____ Test Pile

Urkkada Job No. 1905CS1373

Project: MTO 2018-2024

Date: Oct 9, 2019

Location: HWY 400&89

Start Time:	10:09 AM
-------------	----------

Owner:	MTO
--------	-----

Pile Size:	310x110
-------------------	---------

Contractor:	Fermar Paving
--------------------	---------------

Pile Type:	H-Pile
-------------------	--------

Inspector: S. Ferguson/M. Ferguson

Embedment (m):	36.34
----------------	-------

[illegible]



Load Increment 700kN

PILE NO: Test Pile

Urkkada Job No. 1905CS1373

Project: MTO 2018-2024

Date: Oct 9, 2019

Location:	HWY 400&89
-----------	------------

Start Time: 11:30 AM

Owner:	MTO
--------	-----

Pile Size:	310x110
-------------------	---------

Contractor:	Fermar Paving
--------------------	---------------

Pile Type:	H-Pile
-------------------	--------

Inspector: S. Ferguson/M. Ferguson

Embedment (m):	36.34
----------------	-------

[illegible]



Load Increment 900kN

PILE NO: Test Pile

Urkkada Job No. 1905CS1373

Project: MTO 2018-2024

Date: Oct 9, 2019

Location: HWY 400&89

Start Time: 12:07 PM

Owner: MTO

Pile Size: 310x110

Contractor: Fermar Paving

Pile Type: H-Pile

Inspector: S. Ferguson/M. Ferguson

bedment (m): 36.34

Inspection: _____

Embeccament (m): 5015

[illegible]

**Load Increment 1100kN**

Load increased to target value at 10, 40 & 80 minute intervals

Vertical Dial #1 Reset for additional travel at 100 minute interval

Pre-adjustment: 0.851" = Post-adjustment: 2.002"

PILE NO: _____ Test Pile _____

Urkkada Job No. 1905CS1373

Project: MTO 2018-2024

Date: Oct 9, 2019

Location: HWY 400&89

Start Time: 02:23 PM

Owner: MTO

Pile Size: 310x110

Contractor: Fermar Paving

Pile Type: H-Pile

Inspector: S. Ferguson/M. Ferguson

Embedment (m): 36.34

Date	Time		Applied Load (kN)	Gauge Reading (psi)	Test Pile												
					Vertical Gauge #1 (in)	Vertical Gauge #2 (in)	Gauge #1 Δ (mm)	Gauge #2 Δ (mm)	Average Δ Gauge (mm)	Lateral #1 (in)	Lateral #2 (in)	Wire Line Reading (cm)	Movement from Wire Line (cm)	Reaction Pile 1 (cm)	Reaction Pile 2 (cm)	Reaction Pile 3 (cm)	Reaction Pile 4 (cm)
	ZERO		0	0	1.991	3.819		-	-	0.400	0.736	27.20		42.6	47.2	54.2	52.8
2019-10-09	0 min	02:23 PM	1070	1100 (+)	1.049	2.819	23.93	25.40	24.66	0.378	0.821	24.80	2.40				
	2 min	02:25 PM	1011	1100	1.042	2.816	24.10	25.48	24.79	0.378	0.820	24.60	2.60				
	5 min	02:28 PM	996	1100 (-)	1.040	2.813	24.16	25.55	24.85	0.379	0.819	24.60	2.60				
	10 min	02:33 PM	985	1100 (-)	1.037	2.810	24.23	25.63	24.93	0.379	0.818	24.60	2.60				
	11 min	02:34 PM	1055	1100	0.994	2.765	25.32	26.77	26.05	0.384	0.819	24.40	2.80				
	20 min	02:43 PM	995	1100 (-)	0.986	2.760	25.53	26.90	26.21	0.386	0.819	24.40	2.80				
	40 min	03:03 PM	977	1050 (+)	0.981	2.757	25.65	26.97	26.31	0.386	0.816	24.40	2.80				
	41 min	03:23 PM	1085	1100 (+)	0.918	2.691	27.25	28.65	27.95	0.387	0.817	24.20	3.00	42.0	46.6	53.6	52.2
	60 min	03:43 PM	1002	1100 (-)	0.907	2.682	27.53	28.88	28.21	0.387	0.816	24.20	3.00				
	80 min	04:03 PM	994	1100 (-)	0.902	2.678	27.66	28.98	28.32	0.386	0.815	24.20	3.00				
	81 min	04:04 PM	1073	1100 (+)	0.863	2.635	28.65	30.07	29.36	0.388	0.819	24.20	3.00				
	100 min	04:23 PM	1019	1100 (-)	2.002	2.626	28.96	30.30	29.63	0.388	0.816	24.10	3.10				
	120 min	04:43 PM	1010	1100 (-)	2.002	2.622	28.96	30.40	29.68	0.388	0.815	24.10	3.10				

**Load Increment 1300kN**

Load increased to target value at 10, 20, 40 & 60 minute intervals

Pile displacement exceeded mirror/wireline at 60 minute interval

PILE NO: _____ Test Pile _____

Urkkada Job No. 1905CS1373

Project: _____ MTO 2018-2024 _____

Date: _____ Oct 9, 2019 _____

Location: _____ HWY 400&89 _____

Start Time: _____ 04:51 PM _____

Owner: _____ MTO _____

Pile Size: _____ 310x110 _____

Contractor: _____ Fermar Paving _____

Pile Type: _____ H-Pile _____

Inspector: _____ S. Ferguson/M. Ferguson _____

Embedment (m): _____ 36.34 _____

Date	Time		Applied Load (kN)	Gauge Reading (psi)	Test Pile												
					Vertical Gauge #1 (in)	Vertical Gauge #2 (in)	Gauge #1 Δ (mm)	Gauge #2 Δ (mm)	Average Δ Gauge (mm)	Lateral #1 (in)	Lateral #2 (in)	Wire Line Reading (cm)	Movement from Wire Line (cm)	Reaction Pile 1 (cm)	Reaction Pile 2 (cm)	Reaction Pile 3 (cm)	Reaction Pile 4 (cm)
	ZERO		0	0	1.991	3.819		-	-	0.400	0.736	27.20		42.6	47.2	54.2	52.8
2019-10-09	0 min	04:51 PM	1250	1350	1.555	2.167	40.31	41.96	41.14	0.383	0.871	22.90	4.30				
	2 min	04:53 PM	1178	1200 (+)	1.538	2.161	40.74	42.11	41.43	0.383	0.876	22.90	4.30				
	5 min	04:56 PM	1153	1200 (+)	1.533	2.157	40.87	42.21	41.54	0.384	0.878	22.90	4.30				
	10 min	05:01 PM	1131	1200 (-)	1.529	2.152	40.97	42.34	41.66	0.384	0.881	22.90	4.30				
	11 min	05:04 PM	1278	1300 (+)	1.272	1.892	47.50	48.95	48.22	0.389	0.889	22.20	5.00				
	20 min	05:11 PM	1164	1250	1.258	1.881	47.85	49.23	48.54	0.392	0.892	22.20	5.00				
	21 min	05:15 PM	1278	1300	1.155	1.777	50.47	51.87	51.17	0.385	0.889	22.00	5.20	41.8	46.5	53.7	52.2
	40 min	05:31 PM	1178	1250 (-)	1.140	1.763	50.85	52.22	51.54	0.384	0.890	21.90	5.30				
	41 min	05:34 PM	1282	1300	1.030	1.651	53.64	55.07	54.36	0.385	0.891	21.60	5.60				
	60 min	05:51 PM	1193	1250	1.015	1.639	54.03	55.37	54.70	0.384	0.892						
	61 min	05:53 PM	1301	1325	0.908	1.531	56.74	58.12	57.43	0.385	0.890						
	80 min	06:11 PM	1211	1250 (+)	0.894	1.519	57.10	58.42	57.76	0.388	0.816						
	100 min	06:21 PM	1194	1250	0.880	1.513	57.45	58.57	58.01	0.388	0.815						



Unloading Cycle - 25% Decrements

PILE NO: _____ Test Pile _____
 Project: _____ MTO 2018-2024 _____
 Location: _____ HWY 400&89 _____
 Owner: _____ MTO _____
 Contractor: _____ Fermar Paving Limited _____
 Inspector: _____ S. Ferguson/M. Ferguson _____

Urkkada Job No. _____ 1905CS1373 _____
 Date: _____ Oct 9, 2019 _____
 Start Time: _____ 06:38 PM _____
 Pile Size: _____ 310x110 _____
 Pile Type: _____ H-Pile _____
 Embedment (m): _____ 36.34 _____

Date	Time		Applied Load (kN)	Gauge Reading (psi)	Test Pile									Reaction Pile 1 (cm)	Reaction Pile 2 (cm)	Reaction Pile 3 (cm)	Reaction Pile 4 (cm)	
					Vertical Gauge #1 (in)	Vertical Gauge #2 (in)	Gauge #1 Δ (mm)	Gauge #2 Δ (mm)	Average Δ Gauge (mm)	Lateral #1 (in)	Lateral #2 (in)	Wire Line Reading (cm)	Movement from Wire Line (cm)					
	ZERO		0	0	1.991	3.819		-	-	0.400	0.736	27.20		42.6	47.2	54.2	52.8	
2019-10-09		975 kN																
	0 min	06:38 PM	976	950 (+)	0.924	1.550	56.34	57.63	56.98	0.388	0.689							
	20 min	06:58 PM	985	950 (+)	0.924	1.549	56.34	57.66	57.00	0.389	0.689							
	40 min	07:18 PM	990	975	0.923	1.549	56.36	57.66	57.01	0.389	0.689							
	60 min	07:38 PM	995	975	0.923	1.549	56.36	57.66	57.01	0.390	0.689							
		650 kN																
	0 min	07:40 PM	623	650	1.034	1.668	53.54	54.64	54.09	0.397	0.780							
	20 min	08:00 PM	634	650	1.034	1.668	53.54	54.64	54.09	0.397	0.780							
	40 min	08:20 PM	637	650 (+)	1.033	1.667	53.57	54.66	54.11	0.398	0.779							
	60 min	08:40 PM	639	650 (+)	1.033	1.667	53.57	54.66	54.11	0.398	0.779							



Unloading Cycle - 25% Decrements

PILE NO: Test Pile

Project: MTO 2018-2024

Location: HWY 400&89

Owner: MTO

Contractor: Fermax Paving Limited

Inspector: S. Ferguson/M. Ferguson

Urkkada Job No. 1905CS1373

Date: Oct 9, 2019

Start Time: 06:38 PM

Pile Size: 310x110

Pile Type: H-Pile

Embedment (m): 36.34

Date	Time		Applied Load (kN)	Gauge Reading (psi)	Test Pile												
					Vertical Gauge #1 (in)	Vertical Gauge #2 (in)	Gauge #1 Δ (mm)	Gauge #2 Δ (mm)	Average Δ Gauge (mm)	Lateral #1 (in)	Lateral #2 (in)	Wire Line Reading (cm)	Movement from Wire Line (cm)	Reaction Pile 1 (cm)	Reaction Pile 2 (cm)	Reaction Pile 3 (cm)	Reaction Pile 4 (cm)
2019-10-09		325 kN															
	0 min	08:42 PM	331	350	1.164	1.816	50.24	50.88	50.56	0.410	0.761						
	20 min	09:02 PM	344	350 (+)	1.165	1.816	50.22	50.88	50.55	0.410	0.759						
	40 min	09:22 PM	345	350 (+)	1.166	1.816	50.19	50.88	50.53	0.410	0.759						
	60 min	09:42 PM	345	350 (+)	1.166	1.817	50.19	50.85	50.52	0.410	0.759						
		0 kN															
	0 min	09:46 PM	13	0	1.365	2.038	45.14	45.24	45.19	0.405	0.719	22.8	4.4	42.1	46.8	53.7	52.3
	5 min	09:51 PM	15	0	1.369	2.041	45.03	45.16	45.10	0.408	0.719	22.8	4.4				
	12 hr	09:46 AM	2	0	1.477	2.148	42.29	42.44	42.37	0.402	0.715	23.0	4.2	40.4	44.8	51.8	51.0

Appendix 8

Load Movement Curves

Figure 1: Load Movement Curve for from Static Load Test #1

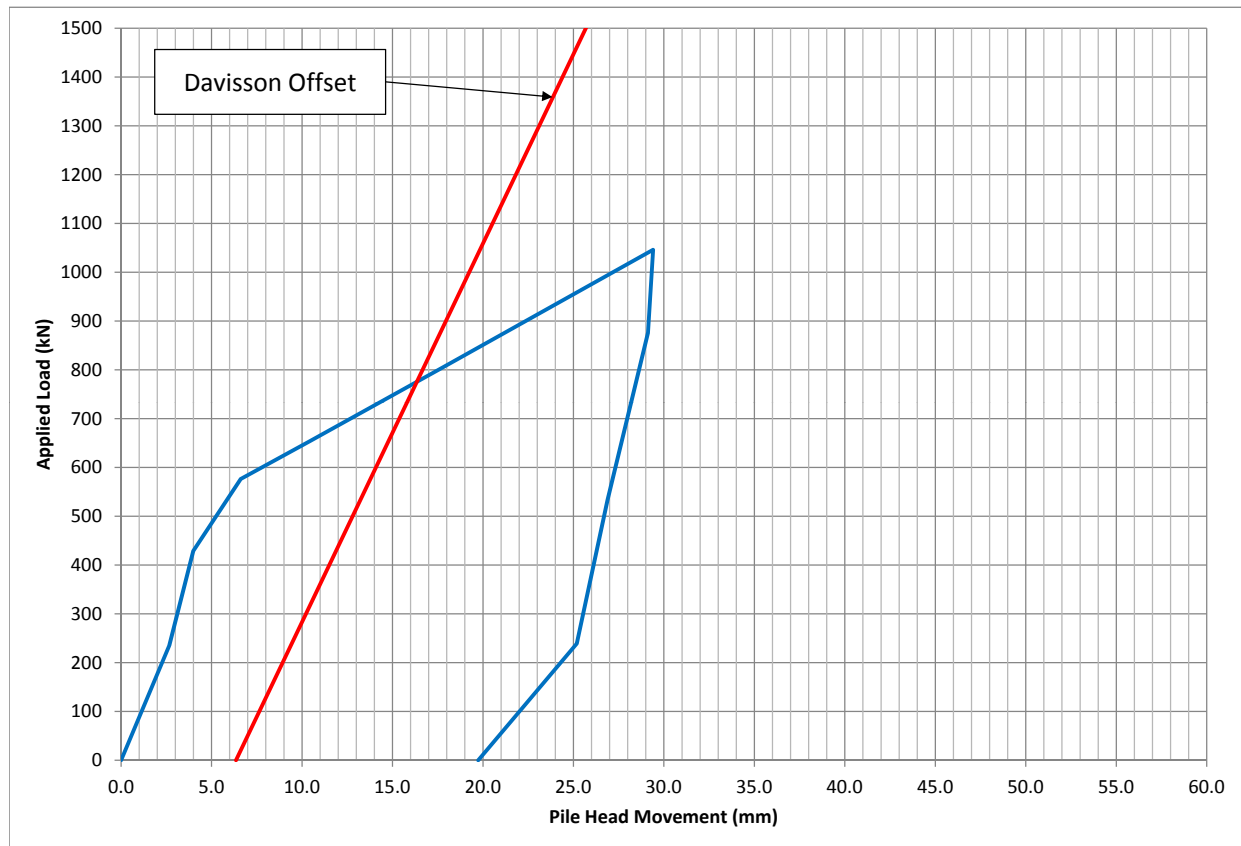


Table 1: Load Movement Summary

Load (kN)	Movement (mm)
0	0.0
235	2.7
429	4.0
576	6.6
654	10.5
802	17.6
1046	29.4
876	29.1
533	26.9
239	25.2

Figure 2: Load Movement Curve for from Static Load Test #2

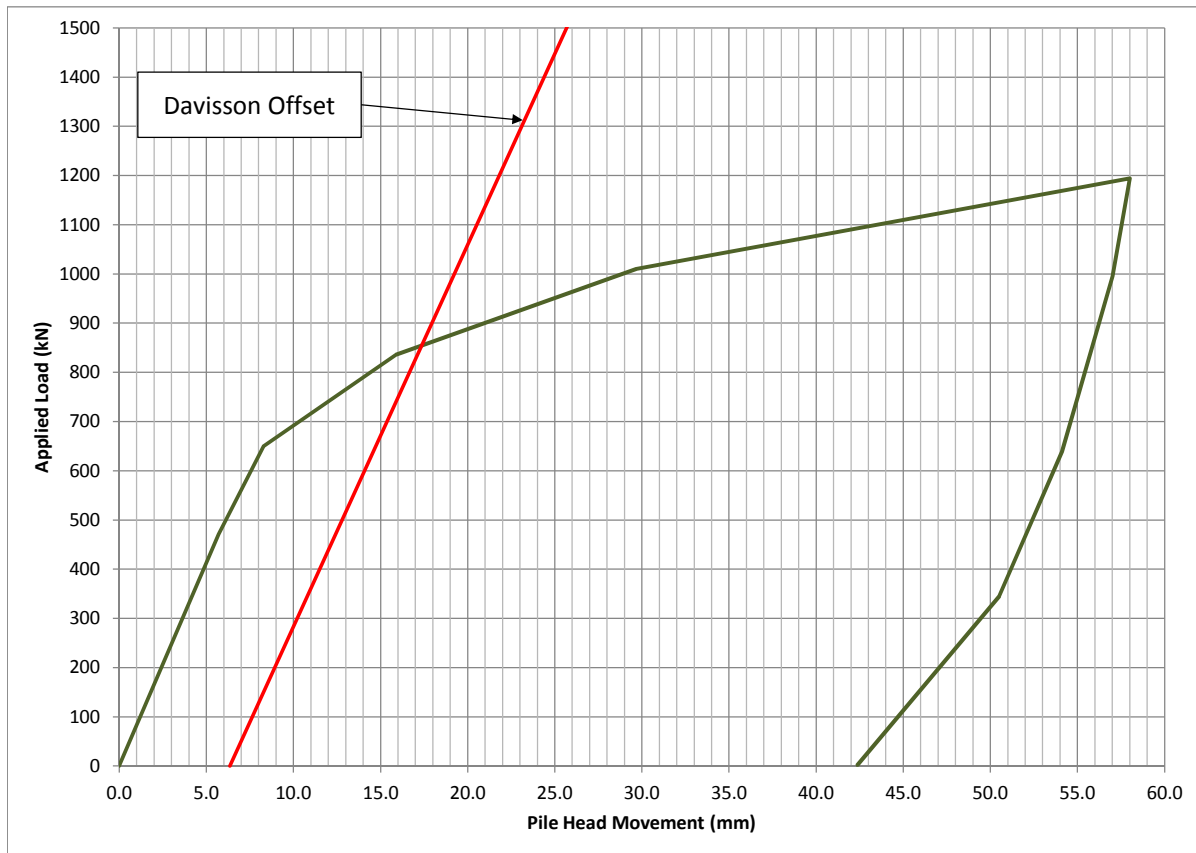
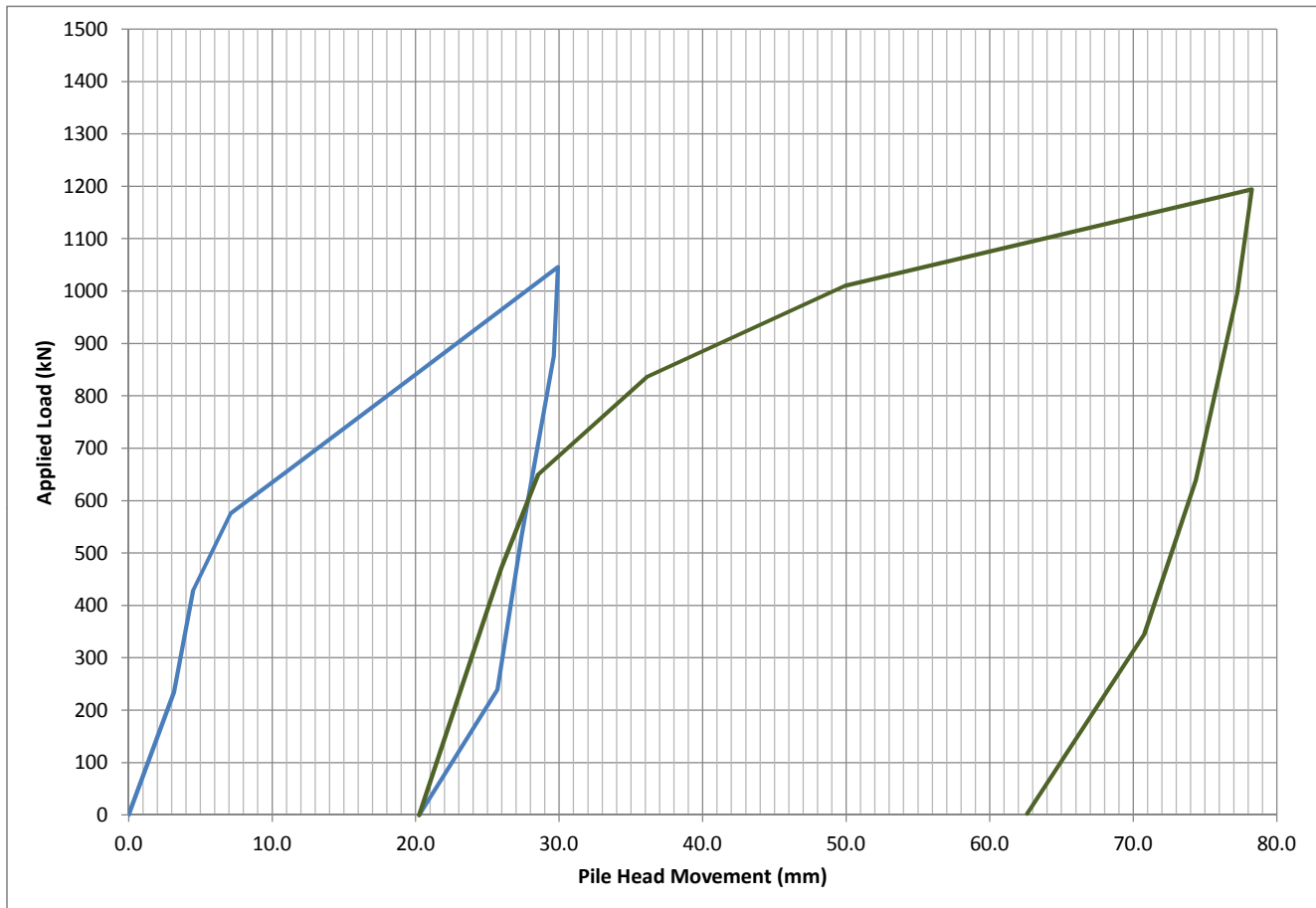


Table 2: Load Movement Summary

Load (kN)	Movement (mm)
0	0.0
471	5.7
650	8.3
836	15.9
1010	29.7
1194	58.0
995	57.0
639	54.1
345	50.5
2	42.4

Figure 3: Load Movement Curve for from Static Load Tests #1 and #2



Appendix 9

Site Photographs





