SECTION 31 09 17

DYNAMIC PILE TESTING

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   1. ASTM International (ASTM): D4945, Standard Test Method for High-Strain Dynamic Testing of Piles.

1.2 DEFINITIONS

A. High Strain Dynamic Testing (HSDT): Testing performed with Case-Goble Pile Driving Analyzer (PDA) to determine the drivability, pile toe and shaft friction capacity of specified piles, pile integrity and hammer performance. Gauges are attached to pile approximately 1 m below pile head and connected with cable to monitoring station on ground away from pile. Gauges consist of two accelerometers, two strain transducers, and junction box.

B. Impact Stress: Peak stress at pile head on impact from driving train as determined from measurements using pile driving analyzer.

C. Production Piles: Piles incorporated into the Work, utilizing a uniform selection of materials and workmanship, and which are determined acceptable by Contract Administrator based on observation and pile test results.

D. Test Piles: Piles constructed of same materials and workmanship, and installed as specified for production piles at locations other than for production pile locations or production pile locations.

1.3 SUBMITTALS

A. Informational Submittals:
   1. Qualifications: Testing agency and testing instrumentation installer.
   2. Test equipment description and layout.
   3. Test procedures.
   4. Test record documents.

1.4 QUALIFICATIONS

A. Testing Agency: Independent, certified, and at least 5 years' experience in similar testing including installing instrumentation, performing testing, monitoring specified testing, analyzing data.

B. Testing Instrumentation Installer: At least 5 years' experience in installation of the test pile instrumentation.

1.5 INSTRUMENTATION PREINSTALLATION MEETING

A. Discussion to include details and scheduling of test equipment installation, testing, and test monitoring.

B. Attended by Contractor, testing agency, pile installation personnel, and Contract Administrator, and City before starting Work specified under this section.

1.6 DELIVERY, STORAGE, AND HANDLING

A. As specified for production piles.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 TEST PROCEDURES

A. Minimum (i) test descriptions, (ii) forms, and (iii) checklists to be used to control and document each required test.

B. Describe specific test to be performed.

C. Provide space(s) after each test description for Contractor, Contract Administrator, and testing agency to certify that successful testing, in accordance referenced standards, has been completed.

D. Contract Administrator’s acceptance required prior to commencement of respective testing.

3.2 RECORD DATA

A. Record for each test pile driven and tested, include minimum:
1. Dynamic Testing Report: In accordance with referenced standard for test performed.
2. Driving record.
3. Pile length.
4. Number of hammer blows-per-300 mm of penetration.
5. Resistance in blows-per-25 mm of last 300 mm of final driving.
6. Hammer stroke, and rate of operation during driving.
7. Unusual occurrence(s) during driving.

3.3 TEST RECORD DOCUMENTS

A. Make available to Contract Administrator at Site.

B. List of specific piles to be tested.

C. Updated versions of documentation required for testing.

D. Certifications of calibration.

E. Testing record data.

3.4 HIGH STRAIN DYNAMIC TESTING

A. Testing Equipment:
1. Contractor: Provide dynamic monitoring equipment, including Pile Driving Analyzer (PDA), and all ancillary equipment and movable monitoring station as necessary to conduct the high strain dynamic testing and conforming to ASTM D4945.

B. Pile Driving Equipment:
1. Use same hammer, driving system, and ancillary equipment to drive test piles and production piling. Maintain and operate driving equipment in accordance with manufacturer's instructions.
2. If determined necessary based on results of PDA monitoring, modify pile cushion material and thickness to increase or decrease pile driving stresses. Confer with Contract Administrator on appropriate material and thickness.

C. Test Piles: Approximately 5 percent of piles will be tested. If any pile tested indicates nonconformance with specified criteria, percentage of tests stated above may be increased by Contract Administrator.

D. Test Pile Preparation: Mark entire length of each test pile at 300 mm intervals and number marks consecutively starting at pile toe for the purpose of recording penetration resistance and depth of pile penetration. Make marks and numbering clearly visible for monitoring personnel. Upon request, perform additional marks at 25 mm intervals for selected length.

E. Minimum Estimated Activity Times:
1. Preliminary Gauge Installation: 30 minutes.
2. Final Gauge Attachment: 30 minutes.
3. Dynamic Monitoring per Pile Driven: 60 minutes.
4. Removal of Gauges: 15 minutes.

F. Testing:
1. Perform in accordance with ASTM D4945.

3.5 DAMAGED, MISPLACED, OR OTHERWISE REJECTED PILES

A. Test piles found damaged, necked, or otherwise unfit for use that are located at production pile locations shall be replaced.

B. Remove from Site and replace with conforming piles.

END OF SECTION

SECTION 31 23 19.01

DEWATERING

PART 1 GENERAL

1.1 SUMMARY

A. Comply with Division 1, General Requirements.

B. Section Includes
1. Control of groundwater and surface run-off.
2. Monitoring of groundwater levels at project site using existing monitoring wells
3. Monitoring movements of existing structures.
4. Discharge of drainage water from construction site.

1.2 SYSTEM DESCRIPTION

A. Design and Performance Requirements
1. Prevent surface run-off from entering excavations.
2. Maintain dewatering activities until Total Performance is achieved.
3. Obtain the Contract Administrator’s written consent prior to transferring dewatering activities to others.

B. Dewatering Discharge Requirements
1. Provide appropriate filter screens so that no soil or foundation material is removed, and solids concentration of less than 500 parts per million in the discharge water is achieved.
2. Discharge drainage water to existing storm drainage system.

1.3 SUBMITTALS

A. Shop Drawings
1. Submit Water Control Plan that includes:
   a. Proposed dewatering equipment, method and standby equipment and power supply.
   b.
2. Dewatering Discharge Approval
   a. Apply and obtain dewatering discharge approval from Manitoba Conservation.
3. Monitoring Observation Wells
   a. Submit water elevation records weekly
4. Monitoring Movement bench marks
   a. Submit weekly records.

1.4 SITE CONDITIONS

A. Soils Report
1. Refer to Appendix for geotechnical information.

PART 2 PRODUCTS

2.1 EQUIPMENT

A. Dewatering Equipment
1. Pipes, hose, pumps, electrical generators, and other equipment.
2. Pumps and generators with effective muffling devices to keep noise levels at or below background noise levels.

PART 3 EXECUTION

3.1 DEWATERING SYSTEMS

A. Supply and Install dewatering equipment and continuously dewater excavations to maintain dry working conditions.

B. Standby power and equipment
1. Provide sufficient redundancy in each system to keep excavation free of water in event of component failure.

3.2 MONITORING GROUND WATER WELLS

A. Measure water levels observed in each existing observation well at least weekly whenever any event, including but not limited to flood, storms, changes in water surface elevation of nearby water bodies, may have caused a change in the groundwater elevation and provide to the Contract Administrator.

3.3 MOVEMENT MONITORING BENCH MARKERS

A. Install and maintain markers to monitor horizontal and vertical movements of existing structures as directed by the Contract Administrator.

B. Movement monitoring benchmarks installed for monitoring movement during pile installation may be used for this purpose.

3.4 DISPOSAL OF WATER

A. Obtain discharge permit for water disposal from authorities having jurisdiction.

B. Treat water collected by dewatering operations, as required by regulatory agencies, prior to discharge.

C. Discharge water as required by discharge permit and in manner that will not cause erosion or flooding, or otherwise damage existing facilities, completed Work, or adjacent property.

3.5 PROTECTION OF PROPERTY

A. Securely support existing facilities, completed Work, and adjacent property vulnerable to settlement due to dewatering operations. Support shall include, but not be limited to, bracing, underpinning, or compaction grouting.

END OF SECTION

SECTION 31 62 13.23

PRESTRESSED CONCRETE PILES

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   1. Canadian Standards Association (CSA):
      a. A23.1, Concrete Materials and Methods of Concrete Construction.
      b. A23.2, Test Methods and Standard Practices for Concrete.
      c. A23.4, Precast Concrete – Materials and Construction
      d. A3000, Cementitious Materials Compendium.
      e. G30.18-M, Carbon Steel Bars for Concrete Reinforcement.
      f. S269.3, Concrete Formwork.
   2. ASTM International (ASTM):
      a. A416, Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete.
      b. A1064, Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.

1.2 DEFINITIONS

A. Design Position: The location of the centroid of the pile at cut-off elevation (x, y, and z coordinates) as shown.

B. Dynamic Monitoring: Monitoring performed with Case-Goble Pile Driving Analyzer (PDA). Gauges are attached to pile approximately 1 metre below pile head and connected with cable to monitoring station on ground away from pile. Gauges consist of two accelerometers and two strain transducers.

C. Elevations: Referenced to Benchmark located at existing Administration Building for all piles. Benchmark: Northing 5517633.414, Easting 636968.196, Elevation 234.059.

D. Fixed Leads: Leads that are pinned to crane boom at top and equipped with hydraulic spotter at bottom capable of spotting pile to its correct position and maintaining alignment during driving. Degree of rigidity and strength acceptable will be subject to review of Contract Administrator.

E. Impact Stress: Stress transferred to pile head at impact from driving train, as determined from measurements using Pile Driving Analyzer.

F. Obstruction: Sudden and significant increase of penetration resistance and deviation of pile out of tolerance resulting from encountering subsurface or physical condition.

G. Termination Criterion: Penetration resistance of a predetermined number of blows per 25 mm and to continue driving pile would be impractical.

H. Rated Hammer Energy:
   1. Diesel Hammers: Product of rated stroke times ram weight.
   2. Air Hammers: Rated energy from manufacturer's literature.

I. Representative Test Cylinder: A test cylinder made from same concrete pour, and cured under same conditions at same location as piles.

J. Set: Pile penetration in mm per blow.

K. Sweep: Deviation from straightness measured along two perpendicular faces of pile while not subject to bending forces.

L. Termination Penetration Resistance: Penetration resistance (blow count) at which driving may be terminated, as established by Contract Administrator.

M. Transferred Hammer Energy: Energy transferred to pile head from driving train impact, as determined from measurements using Pile Driving Analyzer.

1.3 DESIGN REQUIREMENTS

A. Design 300, 350, and 400 mm diameter hexagonal prestressed, precast concrete piling, with individual piles capable of sustaining:
   1. Axial Compression (SLS):
      a. For 300 mm diameter piles, 555 kN plus dead weight of pile.
      b. For 350 mm diameter piles, 780 kN plus dead weight of pile.
      c. For 400 mm diameter piles, 1050 kN plus dead weight of pile.
   2. Handling and driving stresses.

B. Coordinate the manufacturing of the piles and installation for the hammer used. Pile driving hammer selection shall consider result of wave equation analysis.

1.4 SUBMITTALS

A. Action Submittals:
   1. Details on Methods, Sequence, and Procedures:
      a. Pile forming system.
      b. Pile casting and curing.
      c. Pile extension, if required, formwork, casting and curing.
      d. Prestressing and tension release.
      e. Handling and transport.
   2. Design calculations and Shop Drawings for items listed below:
      a. Piles, including reinforcement.
      b. Pile extension, if required, including reinforcement.
      c. Anchorage devices.
      d. Anchoring stresses.
      e. Handling and transport stresses.
      f. Storage support point locations.
      g. Pile pickup points.
   3. Show that steel layout and details conform to those shown on Drawings.

4. Drawing giving an identification number and fabrication length for each pile, prior to pile manufacture.

B. Informational Submittals:
1. Schedule of planned sequence of driving no less than two (2) weeks prior to start of pile driving.
2. Installer qualifications.
3. Manufacturer's Certification of Compliance: Manufactured products.
4. Certified Test Results: Concrete mix design, including certified minimum 28-day compressive strength.
5. Mill Certificates: Prestressing steel, spirals, non-prestressed reinforced steel, pile anchorage steel, and all other embedded items.
6. Hammer selection analysis using wave equation theory.
7. Certification of Calibration:
   a. Pressure gauge for measuring air pressure (for air hammers) or chamber pressure (for closed and diesel hammers). Include:
      1) Correction data for hose losses if air pressure gauge is located away from hammer.
      2) Chart for closed end diesel hammers that equates bounce chamber pressure to other equivalent stroke of energy.
   b. Jacking System: Calibration curves used in prestressing.
8. Methods and materials for casting and curing concrete during cold weather.
9. Method(s) to align and maintain pile alignment, including type of leads to be used with details on methods and equipment to be used to measure alignment.
10. Manufacturer's product specifications and maintenance manuals for pile hammer and auxiliary equipment.
11. Complete Pile Hammer Data Sheet, attached to this Specification section.
12. Daily Log and Record: At end of each working day, for every pile installed that day.

1.5 QUALIFICATIONS

A. Shop Drawings: Prepared, stamped and signed by an engineer registered in the Province of Manitoba.

B. Piling Installer: Minimum of 5 years of past successful experience on ten projects of precast concrete pile installation.

1.6 SITE CONDITIONS

A. Soils Report
1. Refer to Information Available to Bidders.
2. Notify the Contract Administrator in writing if subsurface conditions differ from those indicated.

B. Existing Utilities and Services
1. Known underground services and utilities are indicated on Drawings. No guarantee is given of completeness or accuracy.
2. Notify the Contract Administrator in writing of any significant discrepancies.

3. Record locations of underground utilities encountered.
4. Repair damage to existing services and utilities resulting from work under this Section at no cost to the City.

C. For pile extensions, if required, comply with requirements of CSA A23.1, Cold-Weather Protection. Verify that concrete has attained specified compressive strength before backfilling.

1.7 STORAGE AND HANDLING

A. Do not subject piles to fracture by impact, bending stresses, abrasion, or other injury during delivery, storage, and handling.

B. Replace damaged piles to satisfaction of Contract Administrator.

C. Lift piles only at approved pickup points, by means of a bridle or slings attached to pile at marked pickup points.

D. Store piling on substantial and unyielding foundations.
1. Blocking: Sufficient to ensure that stored or stacked members will be supported at designated pickup points, plus one intermediate row of supports between each pickup point.
2. Bearing Points of Tiered Members: Locate one above other.
3. Tiering of piles more than four high, or storage of materials or equipment on piles, is not permitted.

1.8 SEQUENCING AND SCHEDULING

A. Complete foundation excavation for each new facility, including construction of earth support systems prior to beginning Work under this section.

1.9 QUALITY ASSURANCE

A. For pile extensions, if required, testing of concrete will be done by agencies paid for by the City.

PART 2 PRODUCTS

2.1 PILE ORDER LENGTHS

A. Order Lengths: Establish from cut-off elevations shown on Drawings.

B. Supply full length piles and provide suitable equipment for installation of full length piles without cutting or splicing. Provide sufficient pile length above cut-off elevations so that reinforcement or prestressing strands exposed after cut-off are of sufficient length for anchorage into supported structure.

C. Do not splice piles without written permission from Contract Administrator. Where approved, submit design details of splice stamped and signed by an engineer registered in the Province of Manitoba to Contract Administrator for review.

2.2 MATERIALS

A. Concrete: Class of Exposure S-3 in accordance with CSA A23.1.
   1. Minimum Compressive Strength:
      a. 35 MPa at 28 days.
      b. 30 MPa at transfer of prestress.

B. Aggregates:
   1. Coarse aggregate: CSA A23.1; rough and angular gravel or crushed stone.
   2. Fine aggregate: CSA A23.1; natural sand.

C. Prestressing Strands: Bright, seven-wire, stress-relieved, nominal diameter shown, ASTM A416, Grade 270.

D. Reinforcing Steel:
   1. Dowels and Reinforcing Steel: CSA G30.18.
   2. Spiral Steel Reinforcing: ASTM A1064.

E. Grout: non-metallic, non-gas-liberating, non-shrink hydraulic cement grout, with minimum strength of 35 MPa at 7 days.

2.3 FABRICATION

A. Forms:
   1. Steel or Wood: Arrange for ample working room and easy access for proper placing, compacting, and finishing of concrete for piles.
   2. Of rigid design and construction for removal without damage to completed piles.
   3. Free of dents, creases, and other irregularities.
   4. Design and align forms so that they will not restrict longitudinal movement of casting when prestress force is transferred.
   5. Thoroughly clean and oil prior to each use.
   6. Form top end of piles to details shown.
   7. Chamfer pile corners.

B. Placement of Reinforcement: Install prestressing strands and all mild steel reinforcing before concrete is placed. Keep strands and reinforcing clean from form oil, dirt, rust, grease, and other substances harmful to bond.

C. Prestressing:
   1. Tension prestressing reinforcement to approved jacking load.
   2. When two or more strands are tensioned simultaneously, provide means to obtain equal tension in all strands.
   3. Determine pretensioning force by elongation based on load-elongation curve of strand.

4. Initial Prestress:
   a. Not exceed 70 percent of ultimate strength of strands.
   b. Consider loss of prestress due to initial stress transfer and creep in achieving minimum effective prestress.
5. Jacks:
   a. Equip with accurately calibrated hydraulic pressure gauges and observable reading dial of at least 150 mm or clear digital display.
   b. Certify calibration curve of each jack.
   c. Measure elongation at completion of stressing and at time of placing concrete.
   d. Conform to strand manufacturer's elongation tables.

D. Casting:
1. Methods and materials for casting and curing concrete during cold weather below 5 degrees C will be subject to prior approval by Contract Administrator.
2. Perform in a continuous nonstop operation from start to finish.
3. In a horizontal position on level, tight platforms constructed to prevent settlement during casting and curing operations.
4. Casting in tiers will not be permitted.
5. Compact concrete by internally vibrating, supplement by spading and rodding, during placing.
6. Thoroughly work concrete around reinforcement and into corners of forms uniformly over length of pile.
7. Vibration: Sufficient to cause concrete to flow and settle into place.
8. Avoid displacement of reinforcement, enclosures, and prestressing steel.
9. Point piles with a 1:2 grout, filling all cavities or irregularities, immediately upon form removal.
10. Surfaces:
    a. Free from pockets, porosity, or excessive honeycomb:
       1) Surface honeycomb of greater than 12 mm shall be repaired.
       2) Honeycomb extending to plane of reinforcing will be cause for rejection.
    b. Finish piling exposed to view above ground line.
11. Marking: Casting date and location of pickup points on each pile.

E. Curing:
1. Water Curing: Continuously wet piles after casting for 10 days if portland cement is used, and not less than 3 days if high-early-strength cement is used.
2. Steam Curing:
   a. Recording Thermometers: Supply, arrange and calibrate to record a continuous 24-hour record of temperature of enclosure, and to be available for inspection during curing process.
      1) Accuracy: To within plus or minus 3 degrees C.
      2) Locate thermometers at intervals not to exceed 15 m.
   b. Start as soon as practical after casting of piles.
      1) First 2 Hours: Do not raise temperature of concrete above 38 degrees C.

2) After First 2 Hours: Concrete temperature may be raised to a maximum of 65 degrees C in increments not to exceed 14 degrees C per hour.
3) At Maximum Temperature: Maintain continuously until concrete has attained a minimum compressive strength of 30 MPa as determined from representative test cylinder breaks.

c. After concrete has attained required strength, cool concrete to air temperature by reducing heat applied in increments of not more than 10 degrees C per hour.
d. After removal from casting bed, protect pile as necessary to avoid cooling at a rate greater than 11 degrees C per hour.

3. Remove side forms any time 24 hours after concrete is placed, provided air temperature surrounding piles is maintained at or above 10 degrees C for remaining required curing time.

F. Transfer of Prestress:
1. Do not commence release of prestressed reinforcement until representative test cylinder breaks indicate that concrete has attained compressive strength of 30 MPa.
2. Before removing jacks from pretensioning reinforcement, relieve stress at jack by gradual release before cutting reinforcement.
3. Burn off exposed pretension steel flush with concrete surface.
4. Protect exposed ends with an epoxy coating intended for such purpose.

G. Do not subject piles to any handling stress until breaks from representative test cylinders show a strength of at least 30 MPa.

H. Tolerances:
1. Ends: Plane surfaces perpendicular to axis of pile with a maximum tolerance of 10 mm per m transversely.
2. Maximum Sweep:
a. 3 mm in any 3 m of its length.
b. 8 mm in any 10 m of its length.
3. Cross-Section: Within minus 5 mm to plus 10 mm.
4. Pile Head: Plus or minus 1/2 degree from a true right-angle plane.
5. Location of Reinforcing Steel:
a. Main reinforcement cover minus 3 mm, plus 5 mm.
b. Spacing of spiral plus or minus 10 mm.
6. Failure to maintain pile dimension tolerances and reinforcing location tolerance will be cause for rejection of pile.

2.4 SOURCE QUALITY CONTROL

A. Prepare minimum three standard concrete test cylinders for each 50 m^3 or fraction thereof of concrete placed in the precast work in accordance with CSA A23.1 and CSA A23.2.

B. Test and record concrete strengths.

PART 3 EXECUTION

3.1 GENERAL

A. Ensure that ground conditions and any buried utilities to remain in place at pile locations are adequate to support pile driving operation.

B. Ensure access and egress to pile locations is adequate for equipment.

C. Do not commence pile installation until excavation in the area is complete.

D. Survey and locate each pile.

E. Record the condition of existing structures adjacent to pile locations prior to commencing pile installation.

F. Protect adjacent structures, services, from damage due to pile driving operations. If damage occurs, make good damaged items at no cost to City.

G. Provide access to all portions of Work for review by Contract Administrator and any inspection and testing personnel hired by the City.

H. Provide and install temporary ramps, bridges, mats, platforms, and railing as required.

3.2 PRE-BORING

A. Pre-bore slightly oversized holes for piles 3 to 4 m below grade at all pile locations to allow for setting up of piles, and to reduce ground vibration and potential ground heave in large pile groups.

B. Remove pre-bore tailings and dispose of off-site.

3.3 PILE DRIVING EQUIPMENT

A. Pile Driving Hammer and Driving System:
   1. Select hammer based on wave equation analysis, including but not limited to, consideration for pile cushion, hammer cap block, soil parameters, damping factors, blow count, pile stresses.
   2. Capable of continuous operation at all fuel and/or trip valve settings.
   3. Size and type to consistently deliver an effective dynamic energy sufficient to drive pile to required ultimate pile capacity and minimum toe elevation.
   4. Air hammer shall have compressor/boiler capacity at least 10 percent greater than manufacturer’s minimum requirement.
   5. Air Hammer Calibrated Pressure Gauge: Furnish and position on hammer side of all valves, no more than 30 m of hose away from hammer inlet and located for easy observation.
   6. Closed End Diesel Hammer Calibrated Pressure Gauge: Furnish and position near ground level for easy observation.

7. Indicate location of tripping valves determining air/steam intake and cut-off, with reference to top of cap block, on Pile Hammer Data Sheet attached at end of this section.
8. Hammer shall not overstress or otherwise cause damage to the pile during installation.
9. Hammer: Adjustable and capable of low energy driving or tapping (short strokes) through soft soil strata to prevent tensile stress from exceeding net prestress in concrete pile.
10. Measuring System: Suitable for determining hammer stroke; a saximeter will be acceptable.

B. Hammer Cap block: Manufactured from stable and predictable material.

C. Helmet: Seat onto pile and bear evenly and concentrically with minimum play upon pile.

D. Pile Head: Free to rotate.

E. Pile Cushion:
1. A pad consisting of laminated wood (plywood) placed in pile driving helmet.
2. Minimum Thickness: 150 mm.
3. Place a new cushion in helmet at start of driving.
4. Replace cushion in helmet as soon as it has reached 50 percent of its original thickness, or it has begun to smoke, burn, or deteriorate.
5. Increase cushion thickness to reduce tension or compressive stresses.

F. Pile Driving Leads:
1. Fixed, with hydraulic spotter and other equipment necessary to drive piles within tolerances specified.
2. Of sufficient length so use of a follower is not necessary.
3. Straight and parallel, not deviating from a straight line by more than 10 mm over any 4 m length.
4. Easily adjustable to permit axial driving without interruption if piles deviate from required alignment.

G. Means or device suitable to indicate penetration of piles visible at a reasonable and safe distance from pile driver.

3.4 PILE DRIVING

A. Notify Contract Administrator or appointed representative 7 days in advance of and perform driving in presence of Contract Administrator or appointed representative.

B. Do not drive piles until breaks from representative test cylinders indicate minimum compressive strength specified.

C. Pile Toe Protection: In accordance with manufacturer’s instructions.

D. Do not drive piles within 10 m of structural concrete less than 7 days old and of concrete masonry units installed within prior 3 days.

E. Pile Marking: At 300 mm intervals for purpose of recording driving resistance and depth of penetration of pile.

F. Maintain hammer concentric with driving train in axial alignment on pile. Do not use hammer to limit deviation of pile during driving by exerting lateral forces or striking at angle. Where pile orientation is essential, take special care to maintain orientation during driving.

G. Impact driving may be terminated when the required ultimate capacity has been obtained.

H. Penetration resistances required to obtain ultimate capacity, as follows:

Estimated Penetration Resistance Criteria Table	
Pile Size	Penetration Resistance (Blow Count)
300 mm diameter	5 blows/25 mm
350 mm diameter	8 blows/25 mm
400 mm diameter	12 blows/25 mm

I. Drive piles continuously, and without voluntary interruption, to termination penetration resistance as determined by Contract Administrator, or to termination criterion driving resistance.

J. Termination penetration resistance shall only apply after minimum toe elevation has been achieved.

K. Diesel Hammer: Throttle back hammer to operate at a reduced energy level at initial stage of impact driving to avoid potential for high tension stress in pile.

L. Remove any material forced up between piles above bottom elevation shown for foundation pit.

M. Monitor elevation of top of piles within a 5 pile diameter radius of piles being driven.

N. Redrive piles that heave during driving, heaved, or that become disturbed by driving of piles within a 5 pile diameter radius. Redrive piles within this radius that have raised more than 10 mm. Pulling piles into alignment or position will not be permitted. No additional payment will be given for redriving of piles.

O. Driving Tolerances:
1. Not more than 1 percent from vertical or 2 percent from inclination shown.
2. Centroid of pile at cut-off elevation shall not vary from design position shown by more than 50 mm after driving.
3. Piles not meeting these tolerances will be rejected.

3.5 SHORT PILES

A. Where the top of the piles is below the cutoff elevation plus the minimum length required for exposed tendons, a pile extension is required. Refer to Contract Drawings.

B. Notify the Contract Administrator prior to installing a pile extension. If proposed pile extension exceeds maximum allowable extension length, pile may be rejected.

C. No additional payment will be given for measures to remedy short piles.

D. Materials: same as prestressed concrete piles.

E. Formwork and falsework: Comply with requirements of CSA S269.3.

F. Curing: Wet cure for 10 consecutive days at a minimum temperature of 5 degrees C.

3.6 PILE CUT-OFF

A. Cut at required elevation with tools that will not fracture or damage area below cut surface.

B. Cut off piles neatly and squarely at elevations indicated. Do not damage reinforcing steel and prestressing strand during chipping and cut-off operations.

C. Thoroughly clean projecting prestressing strands of concrete.

3.7 FIELD QUALITY CONTROL

A. Daily Log and Record: Document for each pile showing as a minimum:
1. Pile identification/location.
2. Weather/groundwater conditions.
3. Predrilling diameter and depth.
4. Hammer settings.
5. Date and time start and complete driving.
6. Respective depths of penetration.
7. Pile toe and cut-off elevations.
8. Driving resistance for each metre for pile tip above EL 214.000, each 100 mm for pile top below EL 214.000, 25 mm during PDA testing.
9. Equipment used.
10. Installation method.
11. Nature and location of obstructions encountered.
12. Final pile head position (x, y, z coordinates) after cut off indicating if pile is installed within the specified tolerances.
13. Any unusual occurrences during driving.
14. Re-driving records.
15. Other pertinent pile driving behavior.

B. Dynamic Monitoring: Plan, coordinate, and accomplish in accordance with Section 31 09 17, Dynamic Pile Testing.

C. Installation of each pile will be subject to review of Contract Administrator. Contract Administrator will be sole judge of acceptability of each pile with respect to final driving resistance, depth of penetration, or other criteria used to determine load capacity. Piles not meeting criteria will be rejected.

D. Damaged piles as determined by Contract Administrator will be rejected.

E. Pile extensions: Slump, air content, and standard strength tests will be made throughout progress of the Work and will be paid for by the City. Tests will be in accordance with CSA A23.1. Provide labour, concrete and other facilities for making the test specimens.

3.8 REJECTED PILES

A. The Contract Administrator may require one (1) or more of the following measures for each rejected pile:
1. Pull out rejected pile and replace with new pile.
2. Pull out rejected pile and replace with new, and if necessary, longer pile.
3. Pull out rejected pile and fill hole as directed by Contract Administrator.
4. Leave rejected pile in place and cut off as directed by Contract Administrator.
5. Leave rejected pile in place, and place new pile at new location as directed by Contract Administrator.

B. No extra compensation will be given for measures to remedy rejected piles.

3.9 PROTECTION

A. Protect exposed piles from damage until pile caps or foundations of supported structures are ready to be installed.

B. Ensure that no loads are imposed on the piles except those for which they are intended, unless written permission has been obtained from the Contract Administrator.

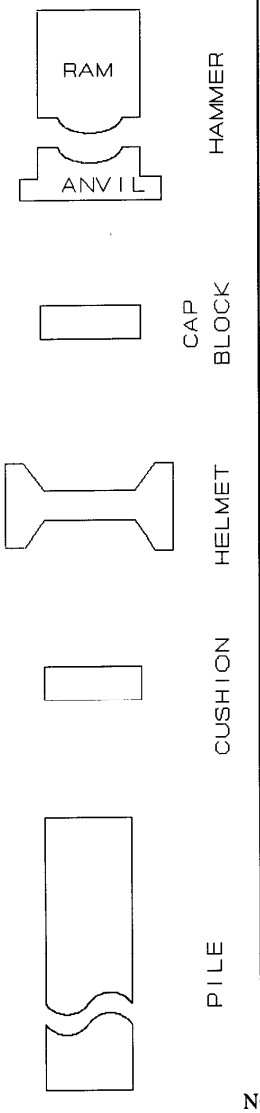
3.10 SUPPLEMENT

A. The supplement listed below, following “End of Section,” is a part of this Specification.
1. Hammer Data Sheet.

END OF SECTION

HAMMER DATA SHEET

Contract No.:	Structure Name and/or No.:
Project:	
Pile Driving CONTRACTOR or Subcontractor:	
County:	Piles Driven By:



Manufacturer:	Model:
Type:	Serial No.
Rated Energy: @	Length of Stroke
Modifications:	
Material:	
Thickness:	Area:
Modulus of Elasticity - E	(MPa)
Coefficient of Restitution - e	
ALL COMPONENTS	Weight:
Cushion Material:	
Thickness:	Area:
Modulus of Elasticity - E	(MPa)
Coefficient of Restitution - e	
Pile Type:	Weight/ m
Length in Leads:	
Pile Diameter:	Taper:
Design Pile Capacity:	kN
Description of Splice:	
Tip Treatment Description:	

NOTE: If mandrel is used to drive pile, attach separate manufacturer's detail sheet(s), including weight and dimensions.

Submitted By:_____ Date:_____