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Section 10.1

PILES

10.1.1 Purpose

To establish a procedure for obtaining production pile lengths and driving criteria to be used in structures. This chapter also provides the procedure for documentation of pile installation. This procedure applies to conventional projects; for Design Build projects refer to **Section 10.12**.

10.1.2 Authority

Sections 20.23(3)(a), and 334.048(3), Florida Statutes (F.S.)

10.1.3 References

Section 455, Standard Specifications for Road and Bridge Construction and any supplements thereto.

10.1.4 Scope

The principal users of this document include the State Construction Office District Materials and Research Offices (DMRO), District Construction Offices (DCO), District Operations Centers, the State Materials Office (SMO), and Construction Engineering and Inspection (CEI) firms working for the Department.

10.1.410.1.5

Definitions

District Construction Engineer (DCE): The authority on the entire construction activity in the District.

Construction Engineering and Inspection (CEI): In this procedure, it refers to the Consultant personnel performing CEI services or the Florida Department of Transportation (Department) personnel group performing CEI services.

Geotechnical Engineer: In this procedure, the Geotechnical Engineer may be the District Geotechnical Engineer (DGE), any Department Engineer assigned for the

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project by the DGE, the Consultant Geotechnical Engineer working directly for the DGE, or the Geotechnical Engineer employed by the Department's Consultant CEI and performing under the direction of the DCE and DGE.

Project Administrator (PA): The Administrator who shall be responsible for the everyday construction activity at the project under the direction of the Resident Engineer/Senior Project Engineer.

Resident Engineer (RE): The Engineer supervising the CEI personnel and is responsible for the construction activities in the residency. In this procedure, this could be the Senior Project Engineer responsible for the construction activities of the project.

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The steps to establish pile lengths and driving criteria consist of reviewing the Contractor's hammer system as detailed in the pile installation plan, recording test pile data, and setting of production pile lengths and driving criteria in accordance with **Section 455, Structures Foundations, Standard Specifications (Section 455)**. All documents referred in this section must be signed in accordance with section 4-1 of the Standard Specifications.

10.1.610.1.7

P

ile Installation Plan

(A) Resident Level Responsibilities

The RE (or PA) shall receive from the Contractor at the preconstruction conference or at least thirty (30) days prior to the driving of the initial test pile a completed **Pile Driving Installation Plan Form, No. 700-020-01**. Within two (2) working days, the RE (or PA) shall forward the Pile Installation Plan (PIP), including the **Pile Driving Installation Plan Form** to the Geotechnical Engineer for review and recommendations.

The RE (or PA), within two (2) working days of receipt of the Geotechnical Engineer's comments shall forward them to the Contractor. The RE (or PA) shall perform a concurrent separate review of the PIP, incorporate their own comments to the ones received from the Geotechnical Engineer, and forward them to the Contractor.

The RE (or PA) shall contact as soon as possible the Geotechnical Engineer if the pile driving system does not appear to drive the piles satisfactorily. A satisfactory driving system means a system being able to drive the piles in compliance with all the requirements of **Section 455**.

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If, after field observations and evaluation of dynamic test data and driving records, the Geotechnical Engineer recommends rejecting the PIP, the RE (or PA) shall notify the Contractor of this rejection within one (1) working day of receiving the recommendation for rejection. The notification shall contain the reason(s) for rejection of the PIP plan.

The RE (or PA) shall upload PIP submittals and Geotechnical Engineer's recommendations and comments into the Department's electronic document management system, including revisions and addenda.

(B) District Materials and Research Office (DMRO) Level Responsibilities

The DGE shall make comments to the RE (or PA) on the driving system within five (5) working days of receiving the PIP.

If, after field observations, the pile driving system does not perform satisfactorily, the Geotechnical Engineer shall evaluate dynamic testing data, driving records, and other pertinent data. Additional dynamic testing may be required. If it is established that the driving system does not produce results within the specifications, the Geotechnical Engineer shall issue a notification to the RE (or PA) recommending the rejection of the PIP. The notification shall include the reasons for the rejection of the PIP. This notification shall be made immediately after evaluating the field and dynamic test data.

10.1.87 Test Pile Installation

(A) Resident Level Responsibilities

Test pile installation, whether it is for a permanent or temporary structure, shall be documented in the pile driving record. As soon as the Contractor's schedule for driving test piles is known, the RE (or PA) shall notify the Geotechnical Engineer of the schedule so the Geotechnical Engineer may observe the installation of the test piles to aid in setting production pile lengths.

Every test pile driven on the project shall be recorded electronically in the field in the ***Pile Driving Log, Form No. 700-010-60***. It shall contain all the data and observations pertaining to the driving of the test pile. The test pile lengths and any special requirements for piles can be found in the plans or specifications.

Two to four pages of the ***Pile Driving Log, Form No. 700-010-60*** are dedicated for recording information relating to each pile driven. Page 1 contains the general information about the project, driving criteria, and procedures. Page 2 (there could be up to Page 4 depending on the pile length) contains the ***driving log record*** and

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comments. Additional guidance is provided in the Pile Driving log instructions. The test pile information must be completed as soon as practical. Note that for projects let after June 30, 2020, a pile inspection device must be used for the inspection of test piles and production piles that displays and stores electronically the stroke in open-ended Diesel hammers, blows per foot and blows per minute for all hammers, and exports the electronic data into a file that produces or replicate the Department's Pile Driving Record form.

Most of the items on Page 1 are self-explanatory. The subcontractor's name should be noted only if someone other than the prime Contractor drives the piling.

The notes section shall describe any occurrences during the driving of the pile or any information that the recorder feels may be beneficial to the Geotechnical Engineer or the PA.

Page 2 (there could be up to Page 4 depending on the pile length) describes the actual pile driving. All of the field information shall be completed for each foot of driving. The specifications require the Contractor to furnish high and low ground elevations at each pile group and bent. This elevation shall be of the ground line, not of the water line.

The measured hammer energy is the hammer energy determined during driving by observed stroke lengths, pressure gauges or hammer instrumentation (other methods may be used when proposed and approved). Stroke/pressure details must be documented.

The pile rebound shall be monitored and recorded accurately with the amount of rebound shown in inches and the elevation limits of rebound shown.

The notes column must describe, accurately and completely, the manner in which the pile driving proceeded noting any irregularities, unexpected occurrences, deviations from driving criteria or procedures, actual elevations where the jets were turned on and off, relationship between the pile tip and jet tip, depth to which the pile penetrated under its own weight, spalling, cracks, where and when cushions were changed, etc.

Upon completion of test pile driving documentation, the inspector must sign the form in the appropriate place. The original is retained in the project files. A completed form is to be sent to the Geotechnical Engineer within 24 hours of completion for review and use in setting the production pile lengths.

Additional information will need to be sent to the Geotechnical Engineer to aid in setting pile lengths. This information would include field data notes, including notes obtained for the monitoring of equipment, any dynamic load test information obtained,

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static/Static load test results, and any other information that explains or records the events occurring during the driving of the piles.

This information shall be attached to the test pile record. Construction Training Qualification Program (**CTQP**) qualified inspectors shall be employed to document the pile driving logs for both permanent and temporary piles.

10.1.98 Production Pile Lengths and Driving Criteria

Production pile lengths for permanent structures are established utilizing the results of the test pile program and contract documents.

(A) DMRO Level Responsibilities

Within four (4) working days of the performance of the test pile dynamic and/or static load test data, the Geotechnical Engineer shall review and examine the test pile data and set up the production pile length. A Production Pile Lengths letter shall be sent to the RE recommending production pile lengths to be used on the project. Refer to **Guidance Documents 10-1-A** and **10-1-B** for **sample letters**. This letter is to be signed by the Geotechnical Engineer. When the Geotechnical Consultant generates the letter, the DGE shall review the letter and recommend acceptance or rejection to the RE (or PA). The final produced letter submitted to the Contractor will include the signature of the DGE recommending acceptance of the Consultant's recommendations. A letter of recommendation (Driving Criteria Letter) containing pile driving criteria shall be sent to the RE (or PA) recommending the blow count criteria vs. stroke (or chamber pressure) for acceptance, practical refusal criteria, minimum tip elevation or penetration requirements, the maximum allowable strokes to control installation stresses, special instructions to increase or reduce the stroke, the pile driving equipment for which the criteria is applicable, and any other special considerations that the inspector should follow during the installation of the piles. If using a diesel hammer, a table of blow count versus stroke (open-end diesel hammers) or blow count versus chamber pressure (closed-end diesel hammers) shall also be furnished and attached to the Driving Criteria letter. For air hammers, the blow count shall be given for a fixed stroke determined as appropriate to mobilize capacity within the specifications. For hydraulic hammers, the blow count shall be given for one or more equivalent strokes, or one or more energy levels (measured automatically by a sensor) determined as appropriate to mobilize capacity within the specifications. This Driving Criteria letter must be prepared and submitted within three (3) working days of furnishing the Production Pile Lengths letter

to the RE (or PA). Refer to **Guidance Documents 10-1-C** and **10-1-D** for **sample letters**.

Production Pile Lengths and Driving Criteria letters shall include the dynamic load test data and wave equation analyses performed to establish authorized lengths and driving criteria.

(B) Resident Level Responsibilities

Upon receipt of the Production Pile Lengths letter from the Geotechnical Engineer, the RE shall approve the recommendation and send it to the Contractor within one (1) working day. Upon receipt of the Driving Criteria letter from the Geotechnical Engineer, the RE shall forward it to the Contractor within one (1) working day.

The RE (or PA) shall upload all test pile logs, the Production Pile Lengths letter and the Driving Criteria letter into the Department's electronic document management system, including the dynamic load test data and analyses data.

10.1.109 Production Pile Installation

Pile driving of every production pile (permanent or temporary) shall be inspected and documented on the **Pile Driving Log** in accordance with Section 10.1.87 of this procedure. The RE (or PA) shall review the logs for accuracy.

Instrumented piles and instrumented set-checks shall be certified by the Geotechnical Engineer performing the instrumentation in accordance with section 10.1.124.

(A) DMRO Level Responsibilities

Review instrumented Dynamic Load Test (DLT) information and make comments as required. Perform periodic review of all driving logs to verify compliance with specifications and driving criteria information.

(B) Resident Level Responsibilities

The RE (or PA) shall upload all production pile driving logs, DLT data for all instrumented DLT (full length monitoring and/or set-checks), analysis outputs, certification letter produced in accordance with 10.1.124, and the DGE concurrence, into the Department's electronic document management system.

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10.1.1~~10~~ Pile Lengths and Driving Criteria for Temporary Piles

(A) Resident Level Responsibilities

Upon receipt of the pile lengths and driving criteria packages from the Contractor, the RE (or PA) shall forward them to the DGE and the Geotechnical Engineer for review. Upon receipt of comments from the Geotechnical Engineer, the RE (or PA), shall forward them to the Contractor.

The RE (or PA) shall coordinate the activities to make sure the review process of this submittal is performed within the deadlines set forth by the specifications.

The RE (or PA) shall upload all test pile logs, and Production Pile Lengths and Driving Criteria letters and comments of Geotechnical Engineer for temporary piles into the Department's electronic document management system, including the dynamic load test data and analyses data.

(B) DMRO Level Responsibilities

Within three (3) working days of receiving the Production Pile Lengths letter, the Geotechnical Engineer shall perform a review of the proposed lengths and submit comments in a notification to the RE (or PA).

Within three (3) working days of receiving the Driving Criteria letter, the Geotechnical Engineer shall perform a review of the analysis, proposed blow count, and driving directions, and shall submit a notification to the RE (or PA) recommending approval or rejection of the driving criteria. If the Contractor submits lengths and driving criteria in one package, pile lengths comments and driving criteria recommendation for approval or rejection shall be performed within three (3) working days. If the Driving Criteria letter is not approved, the notification must include the reasons for rejection. Review comments, approvals, or rejection performed by a consultant geotechnical engineer shall be discussed with and concurred by the DGE before submitting them to the RE (or PA).

10.1.1~~21~~ Documentation for Instrumented Production Piles.

Any instrumented test and production pile (including temporary and permanent piles) shall be certified by the Dynamic Testing Engineer (DTE) performing the instrumentation regardless whether the DTE works for the CEI or for the DMRO. The DTE shall submit a signed and sealed letter per bent/pier with instrumented piles, certifying the capacity obtained in the instrumented piles to the RE (or PA) and the DGE,

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within two working days of finishing the pile installation in the bent/pier that is being certified. The letter shall include a table indicating the final capacity measured of every instrumented pile. When the capacity was measured during an instrumented set-check, the capacity shall be determined in accordance with the Soils and Foundation Handbook, Appendix F. The letter shall include the dynamic load test results along with any additional analysis performed to estimate capacity (CAPWAP for PDA or FDOT-EDC method for EDC). In 100% instrumented piles, the certification letter shall include both production and test pile results.

(A) Resident Level Responsibilities

When the DTE works for the CEI, the RE (or PA) shall coordinate the activities to make sure the certification letter is submitted within the deadline specified above and the comments issued by the DGE office are addressed.

(B) DMRO Level Responsibilities.

The DGE office shall review the certification letter. When the DTE works for the DMRO the DTE shall address all DGE's comments and the DGE shall submit a concurrence e-mail along with the revised certification letter to the RE (or PA) within four working days of finishing the pile installation of the particular bent/pier being certified. When the DTE works for the CEI the DGE shall submit comments or concurrence to the RE (or PA) within two working days of receiving the certified letter.

10.1.13 Training

All FDOT and CEI personnel performing inspections of pile installation must hold the Construction Training Qualification Program (CTQP) as Pile Driving Inspector.

10.1.14 Forms

The following forms are available from the Policy & Process Management Forms Library at <https://fms.fdot.gov>:

700-010-60, Pile Driving Log

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700-020-01, Pile Driving Installation Plan Form

Guidance Document 10-1-A

**SAMPLE LETTER No. 1
PRODUCTION PILE LENGTHS**

(Date)

(ADDRESSEE)

Re: PRODUCTION PILE LENGTHS
Financial Project ID:
FAP No.:
Contract No.:
County:
Structure #

Dear (_____):

The District (put in which District, 1-7, or Turnpike Enterprise) Geotechnical Office has completed its review of the dynamic test/test load/core boring data for the subject bridge. The recommended production pile lengths are as follows:

LOCATION	PILE SIZE	RECOMMENDED PILE LENGTH
<hr/>		

Recommended by:

District Geotechnical Engineer

Authorized for contract administration purpose by:

Resident Engineer

(Initials/Initials)

cc: State Construction Geotechnical Engineer
State Structures Engineer's Office (State Geotechnical Engineer)
FHWA (only if Federal Aid oversight project)

Guidance Document 10-1-B

SAMPLE LETTER No. 2 PRODUCTION PILE LENGTHS

(Date)

(ADDRESSEE)

Re: PRODUCTION PILE LENGTHS
Financial Project ID:
FAP No.:
Contract No.:
County:
Structure #

Dear (_____):

The (Geotechnical Consultant Firm name) has completed its review of the dynamic test/test load/core boring data for the subject bridge. The recommended production pile lengths are as follows:

LOCATION	PILE SIZE	RECOMMENDED PILE LENGTH
<hr/>		

Recommended by: _____
Consultant Geotechnical Engineer

Recommended for acceptance by: _____
District Geotechnical Engineer

Authorized for contract administration purpose by: _____
Resident Engineer

(INITIALS/INITIALS)

cc: State Construction Geotechnical Engineer
State Structures Engineer's Office (State Geotechnical Engineer)
FHWA (only if Federal Aid oversight project)

Guidance Document 10-1-C

SAMPLE LETTER No. 3 DRIVING CRITERIA LETTER (OPEN-END DIESEL HAMMER)

(Date)

(ADDRESSEE)

Re: DRIVING CRITERIA
Financial Project ID:
FAP No.:
Contract No.:
County:
Structure #

Dear (_____):

The District (put in which District, 1-8) Geotechnical Office (or Geotechnical Consultant Firm name) has completed its review of the dynamic load test data, pile driving records, and other information for the subject bridge. The recommended driving criteria are as follows:

BENT (OR PIER) #

Pile Driving for the _____ foot long, _____ tons (____ Kips) Nominal Bearing Capacity production piles may be ~~stopped~~ accepted if one of the following conditions is achieved:

1. Practical refusal (20 blows per 1 inch or less with a hammer stroke of at least _____ ft and pile rebound less than 0.25 inch) is achieved during the driving -and the minimum tip elevation presented in the plans is achieved. A minimum of _____ blows shall be required on a new cushion before practical refusal can be applied.
- ~~1.~~
2. The required blow count at the respective stroke height presented in the following table is achieved for 2 consecutive feet with less than 0.25 inch rebound and the minimum tip elevation is achieved. The blow count over the last two feet must be increasing. A minimum of _____ blows shall be required on a new cushion before the criterion below can be applied.

Stroke Height (ft) **Blows Per Foot**
 (several rows of stroke vs. Blows per foot)

XX.X	XX
XX.X	XX
XX.X	XX

Firm Material Definition: (Note: Include this paragraph if no minimum tip elevation is specified) For purposes of penetration, firm material is defined as the material that offers a driving resistance of at least ___ per foot, at a minimum stroke of ___ ft.

Driving Requirements: (Indicate here at what maximum stroke and/or setting to start the driving, and the instructions to gradually increase the stroke, or reduce the stroke if the blow count reduces significantly and may create tension stresses) (Indicate also the maximum stroke allowed at any time of driving to prevent excessive stresses)

(Indicate special instructions for predrilling and performing if applicable)

(Indicate instructions regarding pile cushions) (Indicate that a new pile cushion shall be used for every pile) (Indicate the thickness required for the cushion) (Include the expected number of blows a cushion will need to be replaced) (~~Indicate the number of blows required, after a cushion change, before the driving criteria can be applied~~)

(Indicate the equipment to which the criteria applies) The above Driving Criteria are based on the (Hammer Type) , serial number _____, using a hammer cushion consisting of _____ inch thick of (Material) and _____ inch of (Material) as utilized during the test piles. If there is a change in the driving system please notify us immediately so that a new driving criteria can be determined.

Recommended by: _____
 Geotechnical Engineer (If a Consultant generates the letter)

Recommended for acceptance by: _____
 District Geotechnical Engineer

(Initials/Initials)

cc: State Construction Geotechnical Engineer
State Structures Engineer's Office (State Geotechnical Engineer)
FHWA (only if Federal Aid oversight project)

Guidance Document 10-1-D

SAMPLE LETTER No. 4 DRIVING CRITERIA LETTER (HYDRAULIC HAMMER)

(Date)

(ADDRESSEE)

Re: DRIVING CRITERIA
Financial Project ID:
FAP No.:
Contract No.:
County:
Structure #

Dear (_____):

The District (put in which District, 1-8) Geotechnical Office (or Geotechnical Consultant Firm name) has completed its review of the dynamic load test data, pile driving records, and other information for the subject bridge. The recommended driving criteria are as follows:

BENT (OR PIER) #

Pile Driving for the _____ foot long, _____ tons (____ Kips) Nominal Bearing Capacity production piles may be ~~stopped~~ accepted if one of the following conditions is achieved:

1. Practical refusal (20 blows per 1 inch or less with a hammer equivalent stroke of at least ____ ft (or an energy of ____ K-ft) and pile rebound less than 0.25 inch) is achieved during the driving and the minimum tip elevation presented in the plans is achieved. A minimum of _____ blows shall be required on a new cushion before practical refusal can be applied.
~~4.~~
2. The required blow count at the respective equivalent stroke height presented in the following table is achieved for 2 consecutive feet with less than 0.25 inch rebound and the minimum tip elevation is achieved. The blow count over the last two feet must be increasing. A minimum of _____ blows shall be required on a new cushion before the criterion below can be applied.

<u>Minimum Equivalent Stroke Height (ft) (or Minimum Energy (K-ft))</u>	<u>Blows</u>
<u>Per Foot – Blows/minute</u>	<u>Per Foot Range (BPM)</u>
<u>(or Min. Energy (K-ft))</u>	<u>Per Foot Range (BPM)</u>
_____	_____ (one to three rows of stroke or Energy- vs. Blows per foot and BPM)
XX.X	XX XX to XX
XX.X	XX XX to XX
XX.X	XX XX to XX

Note: Energy to be measured by a (name of the remote device measuring energy)

Firm Material Definition: (Note: Include this paragraph if no minimum tip elevation is specified. This step may be omitted if dynamic load test data and other field observations indicate that all production piles will not reach the required blow count criterion until a minimum penetration of 20 feet is exceeded.) For purposes of penetration, firm material is defined as the material that offers a driving resistance of at least ___ per foot, at a minimum equivalent stroke (or minimum energy) of ____ ft (or K-ft).

Driving Requirements: (Indicate here at what maximum equivalent stroke and/or energy to start the driving, and the instructions to gradually increase the equivalent stroke, or reduce the equivalent stroke if the blow count reduces significantly and may create tension stresses) (Indicate also the maximum equivalent stroke (or energy) allowed at any time of driving to prevent excessive stresses)

(Indicate special instructions for predrilling and performing if applicable)

(Indicate instructions regarding pile cushions) (Indicate that a new pile cushion shall be used for every pile) (Indicate the thickness required for the cushion) (Include the expected number of blows a cushion will need to be replaced) (~~Indicate the number of blows required, after a cushion change, before the driving criteria can be applied~~)

(Indicate the equipment to which the criteria applies) The above Driving Criteria are based on the (Hammer Type) , serial number _____, using a hammer cushion consisting of _____ inch thick of (Material) and _____ inch of (Material) as utilized during the test piles. If there is a change in the driving system please notify us immediately so that a new driving criteria can be determined.

Recommended by: _____
Geotechnical Engineer (If a Consultant generates the letter)

Recommended for acceptance by: _____

District Geotechnical Engineer

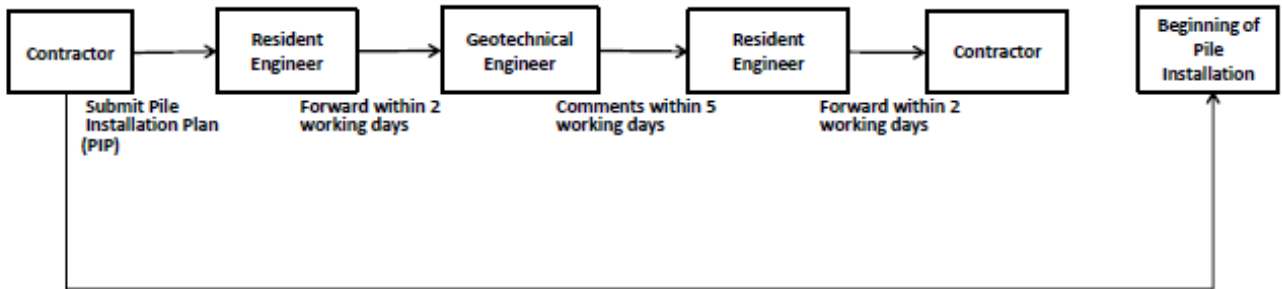
District Geotechnical Engineer

(Initials/Initials)

cc: State Construction Geotechnical Engineer
State Structures Engineer's Office (State Geotechnical Engineer)
FHWA (only if Federal Aid oversight project)

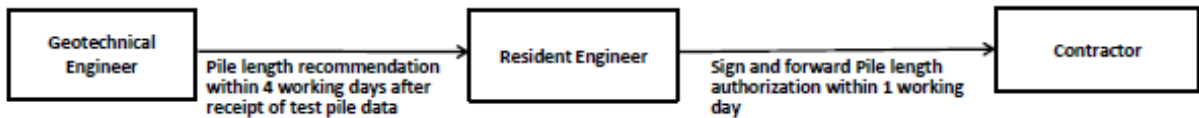
**Attachment 10-1
Flow Charts**

REVIEW OF PILE INSTALLATION PLAN

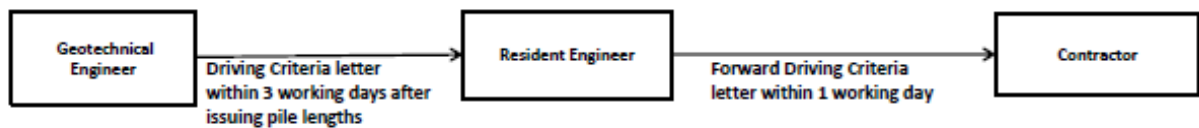


Contractor shall submit PIP at the preconstruction conference or 30 days prior to beginning of pile driving

PRODUCTION PILE LENGTHS-PERMANENT PILES



DRIVING CRITERIA-PERMANENT PILES



PILE LENGTHS AND DRIVING CRITERIA-TEMPORARY PILES

