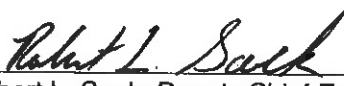


SUPERSEDED BY EB 15-031 EFFECTIVE 9/28/15		New York State Department of Transportation ENGINEERING INSTRUCTION	EI 07-016
Title: REVISED SECTION 650 - TRENCHLESS INSTALLATION OF CASING			
Distribution: ☐ Manufacturers (18) ☐ Local Govt. (31) ☒ Agencies (32) ☐ Surveyors (33) ☒ Consultants (34) ☒ Contractors (39) ☐ _____ ()		Approved:  Robert L. Sack, Deputy Chief Engineer, Technical Services Division 4-MAY-07 Date	

ADMINISTRATIVE INFORMATION:

- This Engineering Instruction (EI) is effective beginning with projects submitted for the letting of January 10, 2008.
- Superseded issuance(s): This EI supersedes EI 04-014.
- Disposition of issued materials: The information transmitted by this issuance will be included in a future update of the Standard Specifications.

PURPOSE: The purpose of this EI is to revise and update the Standard Specifications.

TECHNICAL INFORMATION:

- Section 650 in the Standard Specifications is deleted and replaced with the revised Section 650 transmitted by this issuance.
- Design guidance for trenchless installation of casing is being issued concurrently via EI 07-017.
- The following is a list of the revisions to Section 650:
 1. Section 650 provided requirements for jacking reinforced concrete pipes. EI 04-014 issued a special specification for the installation of a casing via trenchless methods. This generic special specification permitted various types of trenchless installation methods (which may include Auger Boring, Slurry Boring, Microtunneling, or Horizontal Directional Drilling Method) to allow the Contractor to utilize their experience and expertise to decide on the appropriate method to progress through the anticipated subsurface conditions. Based on comments received from the implementation of that special specification, the Standard Specification Section 650 was revised incorporating those concepts.
 2. In addition to the trenchless installation methods outlined above, Pipe Jacking was included. Pipe Jacking is defined as a technique for installing a prefabricated pipe through the ground from a drive shaft to a reception shaft. The pipe is propelled by jacks located in the drive shaft. The jacking force is transmitted through the pipe to the face of the PJ excavation. The excavation is accomplished, and the spoil is transported out of the jacking pipe and shaft manually or mechanically. Both the excavation and spoil removal processes require workers to be inside the pipe during the jacking operation. The previously defined Auger Boring is a form of Pipe Jacking. However, the upper range of common diameter installations utilizing the Auger Boring method is 900 mm. To allow for larger pipe installations, the Pipe Jacking method was introduced. The upper range of common diameter installations utilizing the Pipe Jacking method is 1830 mm.
 3. In addition to the trenchless installation methods outlined above, Utility Tunneling was included. Utility Tunneling is defined as a 2-stage process in which a temporary ground

support system is constructed to permit the installation of a utility. The temporary tunnel liner is installed as the tunnel is constructed. Workers are required inside the tunnel to perform the excavation and/or spoil removal. The excavation can be accomplished manually or mechanically. To allow for larger pipe installations, the Utility Tunneling method was introduced. Since Utility Tunneling requires person-entry, a minimum diameter of 1060 mm should be specified. There is no theoretical limit to the upper range.

IMPLEMENTATION:

- The following special specifications are disapproved:

Item 650.010152411	Furnish and Jack Steel Casing.
Item 650.0114--02	Install 14" Steel Casing Pipe and 8" Steel Carrier Pipe under Railroad.
Item 650.05----03	Furnish and Jack Casing XX NPS.
Item 650.05----07	Furnish and Install Specified Size Steel Casing by Bore and Jack Method under Railroad.
Item 650.05xx--08	Furnish and Jack Steel Casing (Personnel Entry Required).
Item 650.05----11	Furnish and Jack Steel Casing.
Item 650.0512--10	Furnish and Jack Steel Casing 12-NPS (Jacking Operation Only).
Item 650.0524--11	Furnish and Jack Steel Casings.
Item 650.05xx--25	Furnish and Jack Steel Casing __ mm dia. (O.S.).
Item 650.0600xx07	Furnish and Install 24 NPS Steel Casing Pipe by Bore and Jack Method.
Item 650.0801--10	Jack Steel Pipe under Highway.
Item 650.08xx--10	Furnish and Jack Steel Casing __NPS Diameter.
Item 650.50xxnn17	Trenchless Installation of Casing Under Highway.
Item 650.51xxnn17	Trenchless Installation of Casing Under Railroad.
Item 650.6701--25	Jacking Steel Pipe Casing under Toll Area.
Item 650.75----02	Furnish and Install by Vertically Jacking- Steel Casing.
Item 680.5299--11	Directional Drilling.

- The following three special specifications will remain active:

Item 660.78XX--01	HDPE Pipe by Directional Drilling (NPS).
Item 660.78XX--10	HDPE Pipe by Directional Drilling (NPS).
Item 663.50----17	Installing Water Supply Utilities by Directional Drilling.

These special specifications are for direct utility installations and include specific requirements relating to the utility type.

TRANSMITTED MATERIALS:

Attached is the revised Section 650- Trenchless Installation of Casing.

BACKGROUND: The specification was created to provide flexibility to a Contractor given a situation where the traditional open-cut-trench method is not permitted, or where the trenchless installation of casing is more efficient, less disruptive, etc. The generic specification requires the Contractor to submit the method of trenchless installation, which may include the Auger Boring, Slurry Boring, Pipe Jacking, Microtunneling, Horizontal Directional Drilling or Utility Tunneling method.

REFERENCE: The definitions for the trenchless installation methods were taken from, and described further in, the following:

National Cooperative Highway Research Program, NCHRP Synthesis 242.

Trenchless Installation of Conduits Beneath Roadways, A Synthesis of Highway Practice.

Transportation Research Board, National Research Council.

National Academy Press, Washington DC, 1997.

CONTACT: Questions or comments regarding this issuance should be directed to Randy Romer of the Geotechnical Engineering Bureau at (518) 457-4714, romer@dot.state.ny.us.

Make the following changes to the Standard Specifications of May 4, 2006.

Pages 644 through 645, under Section 650- Jacking Reinforced Concrete Pipe, remove the entire section and replace it with the following:

SECTION 650 – TRENCHLESS INSTALLATION OF CASING

650-1 DESCRIPTION. Under this work the Contractor shall furnish and install a casing by trenchless installation methods in accordance with the contract documents and as directed by the Engineer. The casing length, type, and size shall be as indicated in the contract documents. Acceptable methods of trenchless installation include Auger Boring, Slurry Boring, Pipe Jacking, Microtunneling, or Horizontal Directional Drilling. Pipe Ramming or Soil Compaction methods will not be allowed. For an installation under a railroad, methods which leave an uncased bore hole through the embankment will not be allowed.

650-1.01 Definitions. The following definitions were obtained from the NCHRP Synthesis 242 Trenchless Installation of Conduits Beneath Roadways.

A. Auger Boring (AB). A technique that forms a bore hole from a drive shaft to a reception shaft by means of a rotating cutting head. Spoil is transported back to the drive shaft by helical-wound auger flights rotating inside a steel casing that is being jacked in place simultaneously. AB may provide limited tracking and steering capability. It does not provide continuous support to the excavation face. AB is typically a 2-stage process (i.e., casing installation and product pipe installation).

B. Slurry Boring (SB). A technique that forms a bore hole from a drive shaft to a reception shaft by means of a drill bit and drill tubing (stem). A drilling fluid (i.e., bentonite slurry, water, or air pressure) is used to facilitate the drilling process by keeping the drill bit clean and aiding with spoil removal. It is a 2-stage process. Typically, an unsupported horizontal hole is produced in the first stage. The pipe is installed in the second stage.

C. Pipe Jacking (PJ). A technique for installing a prefabricated pipe through the ground from a drive shaft to a reception shaft. The pipe is propelled by jacks located in the drive shaft. The jacking force is transmitted through the pipe to the face of the PJ excavation. The excavation is accomplished, and the spoil is transported out of the jacking pipe and shaft manually or mechanically. Both the excavation and spoil removal processes require workers to be inside the pipe during the jacking operation.

D. Microtunneling (MT). A remotely controlled, guided pipe-jacking process that provides continuous support to the excavation face. The guidance system usually consists of a laser mounted in the drive shaft communicating a reference line to a target mounted inside the MT machine's articulated steering head. The MT process provides ability to control excavation face stability by applying mechanical or fluid pressure to counterbalance the earth and hydrostatic pressures.

E. Horizontal Directional Drilling (HDD). A 2-stage process that consists of drilling a small diameter pilot directional hole along a predetermined path and then developing the pilot hole into a suitable bore hole that will accommodate the desired utility and then pulling the utility into place. The HDD process provides the ability to track the location of the drill bit and steer it during the drilling process. The vertical profile of the bore hole is typically in the shape of an arc entrapping

drilling fluid to form a slurry pathway rather than an open hole. This entrapped slurry provides continuous support to the bore hole.

F. Utility Tunneling (UT). A 2-stage process in which a temporary ground support system is constructed to permit the installation of a utility. The temporary tunnel liner is installed as the tunnel is constructed. Workers are required inside the tunnel to perform the excavation and/or spoil removal. The excavation can be accomplished manually or mechanically.

650-2 MATERIALS.

650-2.01 Casing.

A. General. Casing shall be of sufficient length and type and size as indicated on the contract documents.

B. Pipe Jacking or Utility Tunneling Cutting Shield. For a Pipe Jacking or Utility Tunneling operation, provide a steel cutting shield or poling plates designed to support the anticipated loading. The design shall allow for the attachment of temporary louvers in case collapsible soil conditions are encountered.

1. Full Tunnel Shield. The advancing face shall be provided with a hood extending not more than 500 mm beyond the face and extending around no less than the upper two-thirds of the circumference. It shall be of sufficient length to permit the installation of at least one complete ring of liner plates within the shield before it is advanced for the installation of the next ring of liner plates. It shall conform to and not exceed the outside dimensions of the pipe being installed by more than 25 mm at any point on the periphery, unless otherwise approved. It shall be adequately braced and provided with necessary appurtenances for completely bulkheading the face.

2. Partial Tunnel Shield. The advancing face shall be provided with a hood extending not more than 500 mm beyond the face and extending around no less than the upper one-third of the circumference. It shall conform to and not exceed the outside dimensions of the pipe being installed by more than 25 mm at any point on the periphery, unless otherwise approved.

3. Poling Plates. Poling plates shall be designed to support the ground outside the bounds of the tunnel through beam action. The beam action shall be capable of extending not more than 500 mm beyond the face and extending around no less than the upper one-third of the circumference. The poling plates shall conform to the configuration of the pipe being installed.

C. Utility Tunneling Liner Plates. For a Utility Tunneling operation, provide tunnel liner plates designed to support the anticipated loading. When a shield is used, the tunnel lining shall be designed to withstand the thrust from jacking the shield.

1. Steel Tunnel Liner Plates. Provide tunnel liner plates manufactured from steel meeting the metallurgic requirements of ASTM A569 with the following mechanical properties before cold forming:

- Minimum tensile strength: 290 Mpa.
- Minimum yield strength: 190 Mpa.
- Elongation, 50 mm: 30%.

Tunnel liner plates shall be 2-flange with a minimum 5 mm thickness or 4-flange with a minimum 6 mm thickness. The nominal diameter shall be as indicated in the contract documents. Actual liner plate thickness shall be determined by the Contractor.

All tunnel liner plates shall be formed to provide circumferential flanged joints. Longitudinal

joints may be flanged or offset lap seam type. All plates shall be punched for bolting on both longitudinal and circumferential seams or joints. Bolt spacing in circumferential flanges shall be in accordance with the manufacturer's standard spacing and shall be a multiple of the plate length so the plates having the same curvatures will be interchangeable and will permit staggering of the longitudinal seams. Bolt spacing at flanged longitudinal seams shall be in accordance with the manufacturer's standard spacing. For lapped longitudinal seams, bolt size and spacing shall be in accordance with the manufacturer's standard but not less than the required to meet the longitudinal seam strength requirements of AASHTO Standard Specifications for Highway Bridges, Section 15 Steel Tunnel Liner Plates.

All liner plates in the tunnel shall be the same type, and shall be interchangeable.

Liner plates shall be hot-dip galvanized in accordance with ASTM A123.

Bolts and nuts shall be not less than 16 mm in diameter. The bolts and nuts shall conform to ASTM A307 Grade A with rolled threads on bolts. Circumferential seam bolts shall conform to ASTM A307 or better.

Grout holes shall be 50 mm minimum diameter tapped couplings welded into place over holes cut in the liner plate. Provide a minimum of three grout holes, one every ring alternating 10, 12 and 2 o'clock position. Grout holes shall be provided with steel or iron threaded plugs.

2. Precast Concrete Tunnel Liner Plates. Precast concrete tunnel liner plates shall conform to the details shown in the contract documents and requirements of AASHTO Standard Specifications for Highway Bridges, Section 8 Concrete Structures. If such details are not provided, the Contractor may elect to propose the use of precast concrete liner plates.

650-2.02 Filler Material.

A. Controlled Low Strength Material (CLSM). Fill any abandoned borings with controlled low strength material (CLSM) (no fly ash) meeting the requirements of Section 204.

B. Grout. Fill any voids/ annular space between the casing and excavated boring with grout meeting the following requirements:

Material	Subsection
Portland Cement, Type 1 or 2	§701-01
Grout Sand	§703-04
Water	§712-01
Bentonite (Optional) Bentonite Additives	There are no material requirements for bentonite, except that it shall be supplied in powdered form.

650-2.03 Equipment. Furnish equipment of adequate capacity and power to install the casing by trenchless installation methods. Supplement each rig with the necessary auxiliaries, appurtenances, tools, and other equipment required for proper operation. Tunnels may be excavated manually or by the use of tunnel boring machines (TBM's or "moles").

A. Safety Equipment for Tunnel Entry.

For safe personnel entry to the confined space,

- Provide a four gas meter atmospheric testing device, including oxygen, explosive gases, hydrogen sulfide and carbon monoxide. Testing equipment shall be calibrated as required by manufacturer and be in proper working condition.
- Provide mechanical ventilation (portable blower with flexible duct work) to purge the confined space and provide continuous ventilation.

- Provide body harness, life line, and mechanical retrieval equipment. If the confined space working environment has obstructions or turns such that mechanical retrieval equipment is not practical or creates more of a hazard, on-site rescue shall be immediately available prior to entry.

650-3 CONSTRUCTION DETAILS

650-3.01 Approval. Construction drawings, showing the proposed method and procedure of trenchless installation, construction of entrance and exit pits, and schedule of activities required to perform all trenchless installations indicated in the contract documents shall be submitted to the Engineer for approval before work on the trenchless installation operation is started. Approval of construction drawings shall not relieve the Contractor's responsibility to perform the work without damage to existing facilities. Field conditions may require changes in the approved drawings and such changes shall be subject to the approval of the Engineer. Approval will remain in force only as long as all conditions set forth in the approval are met and satisfactory results are obtained. In the event that unsatisfactory results and/or damage occurs, the Contractor shall stabilize the area and stop work, modify the methods of installation, and submit them for review and approval.

Clear all drill hole(s) and path locations in accordance with 16 NYCRR 753 *Protection of Underground Facilities*. For an installation under a railroad, additionally contact the railroad company to identify the location of railroad underground facilities and the company's additional requirements pertaining to the method of installation.

Install casing of the length(s), size(s), and type(s) specified in the contract documents to the alignment(s) and profile(s) shown on the plans. For an installation under a railroad, work shall be carried out under the joint supervision of the Department and the railroad company, in accordance with §105-09 Work Affecting Railroads.

A. Trenchless Installation Under Railroad. Construction drawings, methods, work and necessary precautions related to trenchless installation under a railroad shall be submitted to, meet the requirements of, and have the approval of the Chief Engineer of the railroad company. No work shall commence until such approval has been received from the railroad company.

B. Submittal. Do not start work prior to receiving the Engineer's written approval. Approval will be based on the decision of the Deputy Chief Engineer for Technical Services (DCETS) as to the acceptability of the proposed work plan and any variations to provide satisfactory installation of the casing and avoid damage to the surrounding area and/or structure(s)/utilities. Installation of casing under railroads shall be jointly approved by the Department and the railroad company.

Information in this work plan shall include, but not be limited to, the following:

1. General.

- a. Qualifications of the Contractor showing that all trenchless installation operations will be performed by a competent driller who has successfully installed casing on two projects in the past five (5) years, of similar size and type shown on the plans, via the proposed trenchless method. Completed projects with details of the types of installations, owner contact names, and telephone numbers shall be included.
- b. Designed drill path indicating compliance with the contract documents. Unless otherwise indicated in the contract documents or directed by the Engineer, the minimum separation below the existing road surface and the top of casing shall be 1.5 m. The minimum separation between the final ground surface and the top of pipe outside the pavement area shall be 1 m.
- c. Equipment list including make and model number and specifications (catalog cuts) of all major equipment proposed for use. The Contractor is responsible for the final

determination of the drill rig size based on the length and depth of the actual runs, the subsurface conditions expected, etc.

- d.** Monitoring plan for the proposed path of the casing installation, including location of monitoring points and surveying intervals.
- e.** Method for CLSM placement, including CLSM mix design, used for abandoning a boring.
- f.** Method for grouting (e.g. grout hole locations, attachment of grout tube to outer circumference of casing, grid pattern for ground surface approach, etc.), including grout mix design, used for filling voids/ annular space between the casing and excavated boring.
- g.** For instances where a utility is to be installed in the casing, method of installation and identification of the material to be placed between the casing and the utility carrier pipe. The material shall be nonconductive and retain its insulating properties during long-term submergence in water.

2. Auger Boring.

- a.** Plan showing the work zone equipment configuration at the ends of the bore(s), staging areas, storage areas, cuttings and pit spoil-handling areas, and final placement areas.
- b.** Boring procedure, thrust block design, tooling for drilling. Include details on the mechanical device that will prevent the cutting head from protruding ahead of casing and the need for a cutting shield at the head of casing.
- c.** Design of entrance and exit pits including shoring elements, type, depth, bracing size, etc. All flexible wall-system designs that are part of the construction submittal shall be stamped by a licensed and currently registered New York State Professional Engineer and shall be done in accordance with the procedures contained in the appropriate Departmental publication, Geotechnical Design Procedure for Flexible Wall Systems (GDP-11). This publication is available upon request to the Regional Director or the Director, Geotechnical Engineering Bureau (DGEB).
- d.** Steering (e.g. articulated steering head) and tracking equipment (e.g. sonde transmitter & receiver, water level line, etc.), procedures, and proposed locations requiring surface or subsurface access.

3. Slurry Boring.

- a.** Plan showing the work zone equipment configuration at the ends of the bore(s), staging areas, storage areas, location of slurry, cuttings and pit spoil-handling areas, and final placement areas.
- b.** Boring procedure, tooling for drilling, water source for drilling operations, method to control slurry.
- c.** If pit launched, design of entrance and exit pits including shoring elements, type, depth, bracing size, etc. All flexible wall-system designs that are part of the construction submittal shall be stamped by a licensed and currently registered New York State Professional Engineer and shall be done in accordance with the procedures contained in the appropriate Departmental publication, Geotechnical Design Procedure for Flexible Wall Systems (GDP-11). This publication is available upon request to the Regional Director or the DGEB.
- d.** Materials list including bentonite and bentonite additives proposed for use on the project, along with material safety data sheets for all other materials used in the trenchless installation method.
- e.** Steering (e.g. articulated steering head) and tracking equipment (e.g. sonde transmitter & receiver, water level line, electromagnetic down-hole navigational system, etc.),

procedures and proposed locations requiring surface or subsurface access.

4. Pipe Jacking.

- a.** Plan showing the work zone equipment configuration at the ends of the bore(s), staging areas, storage areas, location of slurry for pipe lubrication, cuttings and pit spoil-handling areas, and final placement areas.
- b.** Boring procedure, thrust block design, tooling for drilling, verification that size and type of casing can withstand installation stresses and method to verify that installed casing is acceptable. Include details on the cutting shield at the head of casing and type of soil conveyance system to be utilized (e.g. wheeled carts, belt conveyor, slurry system, auger system, vacuum extraction system).
- c.** Design of entrance and exit pits including shoring elements, type, depth, bracing size, etc. All flexible wall-system designs that are part of the construction submittal shall be stamped by a licensed and currently registered New York State Professional Engineer and shall be done in accordance with the procedures contained in the appropriate Departmental publication, Geotechnical Design Procedure for Flexible Wall Systems (GDP-11). This publication is available upon request to the Regional Director or the DGE.
- d.** Materials list including bentonite and bentonite additives proposed for pipe lubrication, along with material safety data sheets for all other materials used in the trenchless installation method.
- e.** Steering and tracking equipment (e.g. laser & survey tools), procedures and proposed locations requiring surface or subsurface access.
- f.** Outline of work in accordance with §107.05 Safety and Health Requirements, R. Confined Spaces and a written confined space plan (addresses prevention of unauthorized entry, type of hazard, work practices, monitoring, provision for attendant, duties of employees, rescue and emergency medical services, multi-employer operations, and provisions for review procedures).

5. Microtunneling.

- a.** Plan showing the work zone equipment configuration at the ends of the bore(s), staging areas, storage areas, location of slurry for pipe lubrication, cuttings and pit spoil-handling areas, and final placement areas.
- b.** Boring procedure, thrust block design, tooling for drilling, verification that size and type of casing can withstand installation stresses and method to verify that installed casing is acceptable. Include details on spoil removal system and controlling ground conditions via earth pressure balance at the face of the microtunneling boring machine (MTBM) (i.e. slurry or auger).
- c.** Design of entrance and exit pits including shoring elements, type, depth, bracing size, etc. All flexible wall-system designs that are part of the construction submittal shall be stamped by a licensed and currently registered New York State Professional Engineer and shall be done in accordance with the procedures contained in the appropriate Departmental publication, Geotechnical Design Procedure for Flexible Wall Systems (GDP-11). This publication is available upon request to the Regional Director or the DGE.
- d.** Materials list including bentonite and bentonite additives proposed for use on the project, along with material safety data sheets for all other materials used in the trenchless installation method.
- e.** Steering and tracking equipment (e.g. laser & survey tools), procedures and proposed locations requiring surface or subsurface access.

6. Horizontal Directional Drilling.

- a.** Plan showing the work zone equipment configuration at the ends of the bore(s), staging areas, storage areas, location of slurry, cuttings and pit spoil-handling areas, and final placement areas.
- b.** Boring procedure, tooling for drilling, water source for drilling operations, method to control slurry.
- c.** If pit launched, design of entrance and exit pits including shoring elements, type, depth, bracing size, etc. All flexible wall-system designs that are part of the construction submittal shall be stamped by a licensed and currently registered New York State Professional Engineer and shall be done in accordance with the procedures contained in the appropriate Departmental publication, Geotechnical Design Procedure for Flexible Wall Systems (GDP-11). This publication is available upon request to the Regional Director or the DGEB.
- d.** Materials list including bentonite and bentonite additives proposed for use on the project, along with material safety data sheets for all other materials used in the trenchless installation method.
- e.** Steering (e.g. offset jets incorporated into a direction sensing and steering head) and tracking equipment (e.g. sonde transmitter & receiver, electromagnetic down-hole navigational system, etc.), procedures and proposed locations requiring surface or subsurface access.

7. Utility Tunneling.

- a.** Plan showing the work zone equipment configuration at the ends of the bore(s), staging areas, storage areas, cuttings and pit spoil-handling areas, and final placement areas.
- b.** Boring procedure and tooling for tunneling. Include details on how to control the tunnel face (i.e. design calculations for a full tunnel shield or poling plates) and type of soil conveyance system to be utilized (e.g. wheeled carts, belt conveyor, auger system, vacuum extraction system).
- c.** Design of entrance and exit pits including shoring elements, type, depth, bracing size, etc. All flexible wall-system designs that are part of the construction submittal shall be stamped by a licensed and currently registered New York State Professional Engineer and shall be done in accordance with the procedures contained in the appropriate Departmental publication, Geotechnical Design Procedure for Flexible Wall Systems (GDP-11). This publication is available upon request to the Regional Director or the DGEB.
- d.** Steering and tracking equipment (e.g. laser & survey tools), procedures and proposed locations requiring surface or subsurface access.
- e.** Outline of work in accordance with §107.05 Safety and Health Requirements, R. Confined Spaces and a written confined space plan (addresses prevention of unauthorized entry, type of hazard, work practices, monitoring, provision for attendant, duties of employees, rescue and emergency medical services, multi-employer operations, and provisions for review procedures).
- f.** Engage the services of a professional engineer currently registered in the State of New York to provide the design of the Utility Tunnel.
 - i.** Steel tunnel liner plate(s) shall be designed in accordance with AASHTO Standard Specifications for Highway Bridges, Section 15 Steel Tunnel Liner Plates. The design of the tunnel shall incorporate the combined effects of live and dead loads, hydrostatic loads, and loads, both temporary and permanent caused by the Contractor's methods of construction. The design shall meet the following minimum criteria: