



PROCESS
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PRACTICES

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Civil

**PIP CVS02100
Site Preparation, Excavation,
and Backfill Specification**

PURPOSE AND USE OF PROCESS INDUSTRY PRACTICES

In an effort to minimize the cost of process industry facilities, this Practice has been prepared from the technical requirements in the existing standards of major industrial users, contractors, or standards organizations. By harmonizing these technical requirements into a single set of Practices, administrative, application, and engineering costs to both the purchaser and the manufacturer should be reduced. While this Practice is expected to incorporate the majority of requirements of most users, individual applications may involve requirements that will be appended to and take precedence over this Practice. Determinations concerning fitness for purpose and particular matters or application of the Practice to particular project or engineering situations should not be made solely on information contained in these materials. The use of trade names from time to time should not be viewed as an expression of preference but rather recognized as normal usage in the trade. Other brands having the same specifications are equally correct and may be substituted for those named. All Practices or guidelines are intended to be consistent with applicable laws and regulations including OSHA requirements. To the extent these Practices or guidelines should conflict with OSHA or other applicable laws or regulations, such laws or regulations must be followed. Consult an appropriate professional before applying or acting on any material contained in or suggested by the Practice.

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PIP CVS02100 Site Preparation, Excavation, and Backfill Specification

Table of Contents

1. Scope	2
2. References	2
2.1 Process Industry Practices	2
2.2 Industry Codes and Standards	2
2.3 Government Regulations	3
3. Definitions	3
4. Requirements	4
4.1 General	4
4.2 Materials – Fill and Backfill	10
4.3. Construction	11

1. Scope

This Practice describes the requirements for excavation, placement, inspection, and management of materials during the site preparation, excavation, and backfill phase of a construction project.

2. References

Applicable parts of the following Practices, industry codes and standards, and references shall be considered an integral part of this Practice. The edition in effect on the date of contract award shall be used, except as otherwise noted. Short titles are used herein where appropriate.

2.1 Process Industry Practices (PIP)

- PIP CVS02350 - *Roadway and Area Paving Construction Specification*

2.2 Industry Codes and Standards

- ASTM International (ASTM)
 - ASTM C136/C136M - *Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates*
 - ASTM D698 - *Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³))*
 - ASTM D1140 - *Standard Test Methods for Determining the Amount of Material Finer Than the 75- μ m (No.200) Sieve in Soils by Washing*
 - ASTM D1556/D1556M - *Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method*
 - ASTM D1557 - *Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2700 kN-m/m³))*
 - ASTM D2167 - *Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method*
 - ASTM D2937 - *Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method*
 - ASTM D3740 - *Standard Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction*
 - ASTM D4253 - *Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table*
 - ASTM D4254 - *Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density*
 - ASTM D4318 - *Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils*
 - ASTM D5084 - *Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter*
 - ASTM D5268 - *Standard Specification for Topsoil Used for Landscaping Purposes*
 - ASTM D6938 - *Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)*

2.3 Government Regulations

- U.S. Department of Labor, Occupational Safety and Health Administration (OSHA)
 - 29 CFR 1926 - *Safety and Health Regulations for Construction*
- U.S. Environmental Protection Agency (EPA)
 - 40 CFR 122 *National Pollutant Discharge Elimination System (NPDES) General Permit for Point Source Discharge to Public Waterways (Permit)*

3. Definitions

Best Management Practices (BMP): The techniques (e.g., buffers, silt fences, detention ponds, swales, etc.), schedules of activities, prohibitions of practices, and maintenance procedures used to prevent or reduce the discharge of pollutants

constructor: Party responsible for supplying the materials, equipment, tools, supervision, and labor for performing site preparation, excavation, fill, and backfill in accordance with contract documents. The term constructor applies also to constructor's subcontractor(s) and vendor(s).

contract documents: Any and all documents, including codes, studies, design drawings, specifications, sketches, practices, and data sheets that purchaser or engineer of record has transmitted or otherwise communicated, either by incorporation or reference, and made part of the legal contract agreement or purchase order between purchaser and constructor

engineer of record: Purchaser's authorized representative with overall authority and responsibility for engineering design, quality, and performance of civil works, structure, foundations, materials, and appurtenances described in contract documents. Engineer of record is licensed as defined by laws of the locality in which the work is to be constructed, and is qualified to practice in the specialty discipline required for the work described in contract documents.

impermeable fill: Compacted clay fill which has a hydraulic conductivity of less than one foot per year (1×10^{-6} cm/second) using the fluids to be retained

inspector: Party responsible for verifying quality of all materials, installations, and workmanship furnished by constructor. Inspector is qualified by training and experience and holds certifications or documentation of their qualifications. Unless otherwise specified in contract documents, inspector is an independent party retained by purchaser

owner: Party who has authority through ownership, lease, or other legal agreement over project site

professional engineer: An engineer, other than engineer of record licensed as defined by laws of the locality in which the work is to be performed, and qualified to practice in the specialty discipline required for the work described in contract documents

purchaser: The party who awards contract to constructor. Purchaser may be owner or the owner's authorized agent.

Storm Water Pollution Prevention Plan (SWPPP): Written plan that defines erosion and sediment control practices in accordance with the independent requirements of the federal construction general permits

4. Requirements

4.1 General

4.1.1 Quality Control and Submittals

- 4.1.1.1 A written Quality Control Program document that provides details of how compliance with the requirements of this Practice and contract documents shall be achieved shall be submitted by constructor to purchaser for approval a minimum of 15 days before start of construction.
- 4.1.1.2 Certified laboratory test data for materials and products to be used in work shall be submitted to purchaser for approval a minimum of 15 days before shipping of materials and products.
- 4.1.1.3 Results of quality control tests required during performance of work shall be submitted to purchaser within 48 hours of completion.
- 4.1.1.4 Inspector will provide submittals listed in Section 4.1.2.2 to purchaser and constructor.
- 4.1.1.5 The following submittals shall be provided to purchaser. Data shall include horizontal dimensions, elevations, size, and slope gradients, as appropriate for the utility and as required by purchaser:
 - a. Accurately recorded as-built locations of project-installed underground utilities
 - b. Tie-in points/interferences encountered during project construction
- 4.1.1.6 Notify purchaser not less than five days in advance of any blasting operation. Blasting shall commence only after owner approval provided by purchaser.
- 4.1.1.7 If excavation bracing (i.e., shoring and sheeting, manufactured systems) is required, the following submittals shall be provided to purchaser:
 - a. Plans, sketches, and/or details of the materials and shoring system to be used, including sequence and method of installation
 - b. Supporting calculations prepared by a professional engineer
 - c. Identification of any bracing components that shall remain after filling or backfilling
- 4.1.1.8 If dewatering of an excavation is required, proposed methods and details shall be submitted to purchaser for review before beginning excavation.
- 4.1.1.9 If required by an authority having jurisdiction, a soil erosion control plan and/or a storm water runoff pollution prevention plan shall be provided to purchaser and the appropriate authority.
- 4.1.1.10 If completed work is not in accordance with this Practice, constructor shall be responsible for repairing or reconstructing deficiencies to meet this Practice and other contract documents at constructor's expense.

4.1.2 Quality Assurance and Submittals

- 4.1.2.1 Inspector shall perform field and laboratory testing and/or evaluations in accordance with criteria of *ASTM D3740* to verify compliance of work with requirements of this Practice and to ensure achievement of intents and purposes of the work.
- 4.1.2.2 Inspector shall provide the following submittals to purchaser and constructor:
 - a. A statement attesting that constructor's work is in accordance with requirements of this Practice and contract documents
 - b. Informal daily "pass" or "fail" reports
 - c. Formal weekly reports including all test logs and comments. These formal reports shall include density and moisture content test logs, indicating location of tests by coordinates and elevation and all appropriate comments.
 - d. Upon earthwork completion, all density and moisture content test logs and comments compiled and submitted for permanent project records.
 - e. Sources and test results of all borrow materials used for fill.
- 4.1.2.3 During construction, purchaser shall have access to all constructor's facilities and records for purpose of conducting performance inspection/audits.
- 4.1.2.4 During an audit by purchaser, all inspection and test reports, and/or engineering analyses and calculations associated with scope of work shall be provided to purchaser upon request.

4.1.3 Surveying

All lines and grades shall be determined by constructor for constructor's operations from horizontal and vertical control points furnished by purchaser.

4.1.4 Inspection and Testing

- 4.1.4.1 Unless otherwise specified in contract documents, inspector shall be responsible for quality assurance inspection and testing to ensure that work is in accordance with requirements of this Practice and contract documents.
- 4.1.4.2 Inspector shall perform tests as outlined in Section 4.1.5 or as otherwise specified in contract documents.
- 4.1.4.3 Performance or lack of performance of inspections and testing by inspector shall not be construed as granting relief for constructor from meeting requirements of this Practice or other contract documents.

4.1.5 Tests to be Performed

- 4.1.5.1 Tests of gradation, plasticity, density, and moisture content shall be performed for each type of fill material. These tests shall include the following:

- a. One standard sieve analysis in accordance with *ASTM C136/136M* or *ASTM D1140*
 - b. One liquid and plastic limit determination in accordance with *ASTM D4318*
 - c. One Modified Proctor Test in accordance with *ASTM D1557* or one Standard Proctor Test in accordance with *ASTM D698*
- 4.1.5.2 For granular soils that do not exhibit a well-defined moisture-density relationship, index density, unit weight, and relative density shall be determined in accordance with *ASTM D4253* and *ASTM D4254*.
- 4.1.5.3 If type or source of fill material changes, control tests shall be performed again with the new material.
- 4.1.5.4 Unless otherwise specified in contract documents, the following in-place dry density and moisture content testing (i.e., field density testing) on compacted fill shall be performed using one of the following methods:
- a. Sand-cone method in accordance with *ASTM D1556/D1556M*
 - b. Nuclear methods in accordance with *ASTM D6938*
 - c. Rubber balloon method in accordance with *ASTM D2167*
 - d. Drive-cylinder method in accordance with *ASTM D2937*
- 4.1.5.5 Unless otherwise specified in contract documents, field density testing shall be performed at the following frequencies:
- a. Structural fill under foundations and building slabs – one test every 1000 square feet (90 square meters) of each lift
 - b. Structural fill under roadways, railroads, area pavement and parking areas – one test every 2000 square feet (180 square meters) of each lift
 - c. Road base and sub-base – one test every 2000 square feet (180 square meters) of each lift
 - d. Backfill of trenches – one test for every 150 linear feet (45 linear meters) of each lift and one test within each segment between changes in direction.
 - e. Backfill over foundations – one test for every 1000 square feet (90 square meters) of each lift.
 - f. General fill – one test every 5000 square feet (460 square meters) of each lift
- 4.1.5.6 As a minimum, one in-place moisture content and one density test shall be performed on every lift of fill.
- 4.1.5.7 Until the required dry density has been achieved, further placement of fill or backfill shall not be permitted.
- 4.1.5.8 Number of field density tests shall be increased by 50% if more than 4% of tests fail to meet specified dry density. When failed tests become less

than 2%, number of tests shall revert to original specified frequency in Section 4.1.5.5.

- 4.1.5.9 For impermeable soil a sample shall be taken from each surface (i.e., base, side walls of ponds/ditches). At least one sample shall be taken at 22,500 square feet (2,090 square meters) or less.

4.1.6 Protection

- 4.1.6.1 Temporary fences, guardrails, barricades, lights, and other protective measures required for safety of personnel and premises shall be installed and maintained in good condition.
- 4.1.6.2 All reference points (e.g., property markers, benchmarks, etc.) shall be carefully maintained during excavation, backfilling, compaction, and earthwork.
- 4.1.6.3 If a reference point is damaged during performance of the work, reference point shall be repaired or replaced in accordance with requirements of owner.
- 4.1.6.4 Unless otherwise specified in contract documents, before earthwork begins, purchaser shall locate and mark all known utilities within project limits or note them in contract documents.
- 4.1.6.5 If other utility locations become evident as earthwork progresses, work stoppages may be required by owner until utilities are identified and until owner provides specific direction.
- 4.1.6.6 Utilities scheduled to remain shall be protected and preserved.
- 4.1.6.7 Bracing and shoring shall be used to protect excavations adjacent to existing underground installations (e.g., foundations, piping manholes, electrical, and duct banks) and personnel performing excavation activities during construction.
- 4.1.6.8 Unless otherwise specified in contract documents, excavation under foundations shall not be permitted.
- 4.1.6.9 Damage to structures, utility lines, or graded areas caused by erosion shall be repaired to original condition at constructor's expense. This includes areas that are seeded until such time that vegetation prevents erosion.
- 4.1.6.10 During performance of the work, constructor shall prevent dust from harming individuals and damaging adjacent properties and equipment.

4.1.7 Environmental

4.1.7.1 Contaminated Soils and Water

1. Known contaminated soils within construction limits shall be managed in accordance with soil management plan and contract documents.
2. If unexpected soil contamination is encountered during the work, work shall be stopped and owner shall be notified immediately.
3. Water to be discharged that is potentially contaminated shall be managed in accordance with contract documents.

4.1.7.2 Erosion/Sediment Control

1. All procedures and work shall be in accordance with local, state, and federal regulations including NPDES General Permit for Point Source Discharge to Public Waterways or project specific permit.
2. Construction affected areas shall be maintained using temporary erosion and sediment control measures, in accordance with Storm Water Pollution Prevention Plan (SWPPP) requirements until permanent measures are completed and functioning.
3. Inspections and reporting shall be performed as specified by SWPPP.
4. If a project specific SWPPP is not required in contract documents, the following minimum prevention measures shall be provided unless otherwise specified by owner:
 - a. Silt Fence

Silt fence shall be installed in accordance with contract documents and on downslope sides of the following areas:

 - (1) All disturbed areas
 - (2) All stockpile areas
 - b. Inspections
 - (1) Daily inspections shall be performed in areas of active construction or equipment operation.
 - (2) Weekly inspections shall be performed in areas with no construction or equipment operation.
 - (3) Area inspections shall be performed within 24 hours of each 0.5-inch (13-mm) or greater rainfall event.
 - (4) Inspection reports shall be prepared after each inspection and submitted to purchaser within 2 working days.
 - c. Maintenance
 - (1) Sediment shall be removed from behind silt fence if it exceeds 6 inches (150 mm) in height. Removed sediment shall be placed in topsoil stockpile areas.
 - (2) Any silt fence damaged so it cannot perform its intended function shall be replaced.
 - (3) Silt fence shall be removed after area has been surfaced or seeded and has been approved by purchaser.
 - (4) Soil that is spilled or washed onto paved areas or streets shall be removed from the surface daily.
 - (5) Soil that breaches constructor's erosion and sediment control measures and spills or washes into drains, pipes, gutters, or ditches or onto adjacent property shall be removed at least daily. Measures shall be provided to prevent recurrence.

- (6) Erosion/sediment controls shall be revised as conditions change during construction or if the minimum sediment control measures are not effective in controlling erosion and sediment.
- (7) Construction site shall be kept free of trash, and storage bins shall be kept covered.

4.1.8 Safety

4.1.8.1 General

1. Work shall be in accordance with *OSHA 29 CFR 1926* and other applicable federal, state, and local codes and with safety requirements of owner.
2. Unless otherwise specified in the contract documents, a work permit shall be obtained from owner before performing earthwork.

4.1.8.2 Excavation Safety

1. Constructor is solely responsible for designing and constructing stable excavations as mandated by *OSHA 29 CFR 1926, Subpart P*.
2. Excavation and trench safety systems include, but are not limited to, sloping, sheeting, trench boxes or trench shields, sheet piling, cribbing, bracing, shoring, dewatering or diversion of water to provide adequate drainage.
3. Constructor's "competent" representative, as defined in *OSHA 29 CFR Part 1926.650 to 652* shall evaluate soil exposed in excavations and verify that excavation and trench safety systems, are certified for actual installation conditions as part of constructor's safety procedures.
4. Excavation slope height, slope inclination, and depth, including utility trench excavation depth, shall not be greater than specified in local, state, and federal safety regulations.
5. If evidence of possible cave-ins or slides is apparent, constructor shall immediately stop work in the excavation or trench and move personnel to safe locations until necessary precautions have been taken by Constructor to safeguard personnel entering trench.
6. Confined space entry permits shall be required for trenches and excavations qualifying as OSHA "permit required confined spaces."

4.1.8.3 Blasting

1. If blasting is required, a written blasting safety plan shall be submitted for owner's approval.
2. Permits for blasting shall be obtained by constructor from authorities having jurisdiction.
3. Copies of blasting permits shall be submitted to purchaser.
4. Written permission shall be obtained from owner before explosives are brought to the site and before drilling is started.

5. Explosives shall be stored, handled, and used in accordance with local regulations and owner's safety practices. These criteria shall be addressed in the blasting safety plan.
6. Constructor shall be responsible for all blasting operations.

4.2 Materials – Fill and Backfill

4.2.1 Basic Requirements

- 4.2.1.1 Fill and backfill materials shall be from either on-site excavation, designated borrow areas, or off-site sources in accordance with requirements of Sections 4.2.1.3, 4.2.3, and 4.2.4.
- 4.2.1.2 All borrow material and all supply sources shall be submitted to purchaser and approved by engineer of record.
- 4.2.1.3 Fill and backfill shall contain no rocks or stones larger than 3 inches (75 mm) and shall be free of frozen lumps, organic matter, trash, chunks of highly plastic clay, snow, ice, contamination, or other deleterious material.
- 4.2.1.4 Liquid limit and plastic limit of materials shall be determined in accordance with *ASTM D4318*.

4.2.2 Topsoil

Topsoil shall conform to *ASTM D5268* or contract documents.

4.2.3 General Fill Material

Fill and backfill to be used as general fill shall be material capable of being compacted to the requirements of Section 4.3.7.8 (b).

4.2.4 Structural Fill Material

- 4.2.4.1 Fill and backfill to be used as structural fill shall be gravel, sand, clay, or silt, or a mixture of these constituents capable of being compacted to requirements of Section 4.3.7.8 (a).
- 4.2.4.2 Except for sands or gravels that exhibit no plasticity characteristics, structural fill material shall be in accordance with the following requirements:
 - a. Liquid limit – 40 maximum
 - b. Plasticity index – 6 through 20

4.2.5 Controlled Low-Strength Material (CLSM)

- 4.2.5.1 CLSM may be substituted for either structural fill material or general fill material, if approved by purchaser.
- 4.2.5.2 Mix design shall be proportioned to produce a 28-day compressive strength between 50 and 100 psi (0.3 and 0.7 MPa) for general fill and 100 and 200 psi (0.7 and 1.4 MPa) for structural fill, pre-tested using actual raw materials and approved by engineer of record before use on project.

4.2.6 Impermeable Fill

- 4.2.6.1 Earthen dikes, dams, or levees shall use fill material with hydraulic conductivity, liquid limit and plasticity index as specified in contract documents. Channel or pond linings shall have a minimum of 12 inches (300 mm) thick layer of compacted clay unless noted otherwise in contract documents.
- 4.2.6.2 Unless noted otherwise in design documents, hydraulic conductivity shall be measured in accordance with *ASTM D5084*.

4.3. Construction

4.3.1 Site Preparation

4.3.1.1 Clearing and Grubbing

1. Clearing and grubbing shall consist of removal and disposal of trees, stumps, roots, vegetation, logs, rubbish, and other unsuitable material.
2. Except for trees and shrubs in areas designated in contract documents for preservation, areas designated for clearing and grubbing shall be cleared.
3. During construction operations, trees, shrubs, and other landscape features specifically designated in the contract documents for preservation shall be carefully protected from abuse, marring, or damage.
4. Trees and other vegetation outside the construction area shall not be damaged in any manner.
5. Trees, stumps, and other vegetation in the areas designated for clearing and grubbing shall be removed to the bottom of their root zone.
6. Depressions made by clearing and grubbing operations shall be filled in accordance with Section 4.3.7 and compacted to conform to the adjacent surface of the original ground.

4.3.1.2 Stripping

1. Before any soil is removed, the area shall be cleared of all debris.
2. Stripping shall consist of excavation, removal, and satisfactory disposal of all topsoil and soil containing organic material. Such stripped materials shall not be used as structural fill material under any circumstances.
3. Topsoil shall be removed to full-depth or as specified in contract documents.
4. Reusable materials shall be stockpiled as necessary for constructor's operations in areas approved by purchaser.

4.3.1.3 Rough Grading

1. General area grading shall be completed to within a tolerance of plus or minus 0.20 feet (60 mm) of elevations shown in contract documents but shall not be uniformly high or low.

2. Roads, parking areas, and building areas shall be excavated or filled to subgrade elevations shown in contract documents.
3. Rock encountered through cut sections shall be excavated to 1 foot (300 mm) below subgrade elevation and shall be backfilled to specified elevation.
4. If unsatisfactory field conditions caused by rain, inclement weather, or other circumstances prevent satisfactory performance of work, earthwork operations shall be suspended, and purchaser notified.
5. After completing grading operations and before grassing operations, graded areas that are not to be further improved shall be overlaid with topsoil of a compacted thickness of 4 inches (100 mm) minimum.

4.3.2 Excavation

4.3.2.1 Structural Excavation

1. Structural excavation shall include excavations for area paving, roadways, railways, foundations, grade beams, sumps, basements, retaining walls, manholes, catch basins, trenches, and all other in-ground and below-ground facilities, and areas to be used in the future to support structural loads as specified in contract documents.
2. Structural excavation shall be performed in accordance with contract documents to dimensions, grades, and elevations as noted and as required for formwork.
3. Overexcavation shall not be permitted unless otherwise specified in contract documents or approved by engineer of record.
4. Soils encountered at bottom of excavation elevation specified in contract documents which do not meet compaction requirements of Section 4.3.6.3 or 4.3.6.4 shall be removed and replaced with compacted structural fill or CLSM.

4.3.2.2 Earthen Structures

1. Earthen structures include, but are not limited to, ponds, canals, ditches, retention basins, levees, and dikes.
2. Excavation for earthen structures shall be made to the lines, grades, and cross sections as specified in contract documents.
3. Side slopes of excavations shall be cut and graded to specified cross section.
4. Unstable soil in the slopes shall be removed, and slopes repaired using material and methods in accordance with Sections 4.2 and 4.3.7.
5. Bottoms of excavations shall be graded to elevations and configurations as specified in contract documents.
6. Overexcavation shall be backfilled and compacted in accordance with Sections 4.2 and 4.3.7.

4.3.2.3 Trenching

1. Trenches are excavations made for placement of, but not limited to, underground piping, electrical cables, duct banks, geotextile anchoring, and drainage ditches.
2. Bottom of trenches shall be graded to the elevations as specified in the contract documents.
3. When applicable install shoring in advance of or simultaneously with trench excavation so that soils within full height of trench excavation walls will remain laterally supported at all times.
4. Unstable soil in bottom of trenches shall be removed and replaced using material and methods in accordance with Sections 4.2 and 4.3.7.
5. Overexcavation of trenches shall not be permitted unless otherwise specified in contract documents or approved by engineer of record.

4.3.2.4 Rock Excavation

1. Rock excavation shall consist of excavation of boulders or pieces of detached rock measuring 1 cubic yard (0.76 cubic meter) in volume or greater, or rock in ledges, bedded deposits, and conglomerate deposits so firmly cemented that they present all characteristics of solid rock, which cannot be excavated with earth moving, heavy equipment. All other excavation shall be earth excavation.
2. If blasting is not permitted, rock shall be excavated with mechanical rippers, mechanical breakers, or mechanical drills with non-explosive demolition agents.
3. If blasting is permitted and required, blasting operations shall be managed in accordance with the rock-blasting plan (see Section 4.1.8.3).
4. If unexpected hard rock is encountered during the work, work shall be stopped until a blasting plan is developed or until owner provides specific direction.

4.3.3 Stockpiling

- 4.3.3.1 Material shall be stockpiled in a location specified by owner.
- 4.3.3.2 Stockpiles shall be placed, graded, and shaped for drainage.
- 4.3.3.3 Storage or stockpiling of material shall not be permitted on a completed subgrade.
- 4.3.3.4 Stockpiling of contaminated soils shall be in accordance with an owner approved contaminated soils management plan or as specified by owner.

4.3.4 Drainage

- 4.3.4.1 Drainage of cuts, excavations, fills, stockpiles, spoil areas, surcharge embankments, and borrow areas shall be maintained at all times to prevent ponding of surface water because of ground water or rainfall by providing temporary ditches, swales, culverts, and/or pumping systems as required in each respective site area.

- 4.3.4.2 Temporary drainage facilities shall be removed at completion of project or as specified by owner.
- 4.3.4.3 A temporary surface seal (e.g., sealing with a smooth drum roller) shall be constructed as required to prevent saturation during wet weather or temporary shutdown of operations.
- 4.3.4.4 Soil that becomes saturated shall be removed completely or reconditioned in accordance with Section 4.3.7.

4.3.5 Disposal of Excess and Waste Materials

- 4.3.5.1 If practicable, all suitable materials removed by excavation shall be used as fill.
- 4.3.5.2 Excavated material, in excess of that required for normal embankment construction, shall be stockpiled within construction limits or shall be placed in a designated spoil area beyond construction limits as specified by owner.
- 4.3.5.3 Material unsuitable for fill and debris, removed by clearing, grubbing, stripping, and excavation, shall be removed to a disposal area approved by owner.
- 4.3.5.4 Burning of combustible materials shall be performed only with approval of owner and only if permitted by local authorities.

4.3.6 Preparation of Areas for Structural Fill or Loading

- 4.3.6.1 Areas of structural excavation to receive structural fill or loading shall be free of frozen subgrade, roots, trash, snow, ice, or other deleterious material.
- 4.3.6.2 Areas shall be prepared for structural fill or loading as follows:
 - a. Drained of standing water
 - b. Proof-rolled by crossing the area repeatedly and methodically with a 10-ton (9-tonne) minimum weight pneumatic tire compactor or a fully loaded dump truck. See *PIP CVS02350* for proof-rolling requirements for roadways and area paving.
 - c. If proof-rolling demonstrates ruts between 1 and 2 inches (25 and 50 mm) deep after localized soft spots have been repaired, the top 6 inches (150 mm) of the overall area shall be scarified and re-compacted. For areas where ruts exceed 2 inches deep, the top 12 inches (300 mm) shall be scarified and re-compacted.
 - d. For enclosed areas or tightly spaced areas, if access by proof rolling equipment is limited, hand operated rollers or plate compactors may be used if approved by owner.
 - e. In accordance with any other requirements specified in contract documents including but not limited to overexcavation, moisture conditioning and re-compacting of the upper soils, and chemical stabilization or other methods of improving soil conditions.

- 4.3.6.3 Density of the top 6 inches (150 mm) in areas for structural fill or loading shall not be less than 90% of the maximum Modified Proctor density in accordance with *ASTM D1557*, or 95% of maximum Standard Proctor density in accordance with *ASTM D698*.
- 4.3.6.4 Density of the top 6 inches (150 mm) in areas of structural fill or loading, where granular soils exist that do not exhibit well-defined moisture-density relationship, shall be compacted to at least 80% relative density in accordance with *ASTM D4253* and *ASTM D4254*.

4.3.7 Filling and Backfilling

- 4.3.7.1 Unless otherwise specified in contract documents, the following areas shall be filled or backfilled using structural fill:
 - a. For foundations that require fill for subgrade improvement or to raise elevation, directly beneath and 3 feet (1meter) beyond perimeter of foundations.
 - b. Beneath slabs, roadways, railroads, area pavement, and parking areas directly beneath and 3 feet (1meter) beyond the perimeter of improved area.
- 4.3.7.2 All other areas not designated above may be filled or backfilled using general fill, unless otherwise specified in contract documents.
- 4.3.7.3 Before placement of structural fill or backfill, the area to receive fill shall be prepared in accordance with Section 4.3.6.
- 4.3.7.4 Compacting shall begin only after fill or backfill has been properly placed and material is at the specified moisture content.
- 4.3.7.5 When air temperature is below freezing, earth fill shall not be placed on frozen soil. Earth fill shall be free draining and be placed at temperatures above 35° F (2° C).
- 4.3.7.6 Unless otherwise specified in contract documents, material shall be placed in loose lifts not exceeding the following criteria, provided that the specified compaction is achieved for the full depth:
 - a. Structural fill shall be placed in lifts of 8 inches (200 mm) maximum in loose depth.
 - b. General fill shall be placed in lifts of 12 inches (300 mm) maximum in loose depth.
 - c. General and structural fill materials placed as backfill and compacted with hand-operated equipment shall be placed in lifts of 4 inches (100 mm) maximum in loose depth unless otherwise approved by purchaser.
- 4.3.7.7 Compaction shall be performed with equipment compatible with soil type.
- 4.3.7.8 Unless otherwise specified in contract documents, fill and backfill layers shall be uniformly compacted in accordance with the following density and moisture content requirements:
 - a. Structural Fill Compaction Densities

- (1) Structural fill shall be compacted to at least 90% of maximum Modified Proctor density in accordance with *ASTM D1557*, or 95% of maximum Standard Proctor density in accordance with *ASTM D698*.
 - (2) Granular soil used as structural fill that does not exhibit well-defined moisture-density relationship shall be compacted to at least 80% relative density in accordance with *ASTM D4253* and *ASTM D4254*.
- b. General Fill Compaction Densities
- (1) General fill shall be compacted to at least 85% of maximum Modified Proctor density in accordance with *ASTM D1557*, or 90% of the maximum Standard Proctor density in accordance with *ASTM D698*.
 - (2) Granular soil used as general fill that does not exhibit well-defined moisture-density relationship shall be compacted to 70% to 75% relative density in accordance with *ASTM D4253* and *ASTM D4254*.
- c. Moisture content of material being compacted shall be within plus or minus 3% of the optimum moisture content in accordance with applicable *ASTM D1557* or *ASTM D698*. Fill materials shall be conditioned as necessary to achieve required moisture content, without additional cost to purchaser.
- d. Chemical stabilization may be used provided the engineer of record approves modifications necessary to obtain satisfactory compaction.
- 4.3.7.9 Topsoil shall be placed, leveled to grade and lightly rolled to produce a firm surface suitable for landscape purposes.
- 4.3.7.10 Compaction by water jetting or flooding shall not be permitted.
- 4.3.7.11 Fill and backfill adjacent to structures (e.g., retaining walls, pits, and basements) shall not be compacted with heavy equipment, but with hand-operated equipment to a distance of 4 feet (1.2 meters) or greater beyond the sides of the structures.
- 4.3.7.12 To prevent unnecessary eccentric loading on a structure or foundation, every effort shall be made to place backfill materials symmetrically and in uniform layers.
- 4.3.7.13 Unless otherwise permitted by purchaser, backfill around or over cast-in-place concrete shall not be permitted until the concrete has attained 75% of its specified strength.
- 4.3.7.14 Compacted surfaces of fill and backfill shall be finish-graded to cross sections, lines, grades, elevations and tolerances specified in contract documents.
- 4.3.7.15 Where specified by the contract documents, utility warning/marketing tape shall be placed continuous during backfill over the utility.

4.3.8 Installation of Base Course

- 4.3.8.1 Base course for roads, parking areas, and other areas to be surfaced shall be prepared in accordance with this section and *PIP CVS02350*.
- 4.3.8.2 The existing ground to the toe of fill slopes shall be cleared, grubbed, and stripped in accordance with Sections 4.3.1.1 and 4.3.1.2.
- 4.3.8.3 Excavation of areas in cut shall be in accordance with Section 4.3.2.
- 4.3.8.4 Backfill of base course shall be in accordance with Sections 4.3.6 and 4.3.7, with the following exceptions:
 - a. Compaction shall be to at least 95% of the maximum Modified Proctor density in accordance with *ASTM D1557*, or 100% of maximum Standard Proctor density in accordance with *ASTM D698*.
 - b. If base course materials are clean granular material, compaction shall be to 85% of relative density in accordance with *ASTM D4253* and *ASTM D4254*.
- 4.3.8.5 Geosynthetic materials shall be installed in accordance with manufacturer's written instructions and/or as specified in the contract documents.
- 4.3.8.6 Compacted base course shall be shaped to a smooth and even surface, free of voids, and to the required elevation.
- 4.3.8.7 Deviation greater than 1/2 inch (12 mm) in cross section or 1/2 inch (12 mm) in length as measured with a 16-foot (5-meter) straightedge shall be corrected by loosening, adding, or removing material and then reshaping and re-compacting by sprinkling and rolling.
- 4.3.8.8 Base course shall be maintained in a smooth, true-to-grade, compacted condition until it is covered by other construction.

4.3.9 Dewatering

- 4.3.9.1 All dewatering methods and disposal of water shall be approved by owner.
- 4.3.9.2 If required for construction, before excavation, an approved dewatering system shall be installed and operated when necessary to lower the groundwater.
- 4.3.9.3 Design of dewatering system shall be the responsibility of constructor.
- 4.3.9.4 Constructor shall be responsible for any effects of dewatering on adjacent facilities.
- 4.3.9.5 Surface water shall be prevented from flowing into excavations by installing ditches, trenches, protective swales, pumps, or other purchaser approved measures.
- 4.3.9.6 All diverted and pumped non-contaminated water shall flow to existing drainage system in accordance with Section 4.1.7.1.
- 4.3.9.7 Excavations for foundations and other underground installations shall not be used as temporary drainage ditches.