

Excavation and Trenching

Short description

The purpose of this section is to protect personnel against cave-ins and other unexpected hazards associated with excavation and/or trenching operations.

Contact person

Andrew Richardson

Name

770-613-2999

Phone number

HSEQ

Functional Department

arichardson@cce-inc.com

Email address

Responsible

Brent LeVander

Name

HSEQ

Functional Department

Approval

Geoff Preisman

Name

President and CEO

Title

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1 Objective and area of application

This section establishes the minimum requirements for work practices to assure the safety of Centennial employees, subcontractors and other affected personnel who work in or around excavations and/or trenches as part of their job duties.

This section sets forth the practices and guidelines required for excavations and/or trenches with a depth of four feet or greater along any portion of its length that will be entered by Centennial employees, subcontractors, or other affected personnel on Centennial project sites. All excavations or trenches 5 feet or greater in depth shall be appropriately sloped, benched, shored, or shielded according to this section. Excavations or trenches 20 feet deep or greater shall have a protective system designed by an RPE.

The most frequent causes of incidents related to excavation operations are due to:

- Collapse of soils and materials (cave in) due to lack of, inadequate or weak protective systems
- The striking or damaging of underground utility services
- Persons falling into excavations due to lack of barriers or inadequate fencing
- Asphyxiation from toxic gases which have collected in the excavation/trench
- Spoil (soil from excavation/trench) or materials/equipment being placed too close to the sides of the excavation/trench which then become overloaded and collapse
- Failure to check and maintain shoring, particularly after inclement weather
- Water accumulation or seepage
- Moisture in soil
- Falls from unsafe means of access/egress into or out of the excavation/ trench
- Employees being struck by excavation machinery
- Vehicles being driven into the excavation due to driving errors, inadequate barriers, or the absence of stop blocks or adequate control procedures
- Changing weather conditions
- Lack of training or technical knowledge

An Excavation and Trenching Plan (Appendix 1) shall be submitted and approved by the PSO or HSEQ Manager and SSR anytime that employees or subcontractors are working in or around a trench or excavation.

2 Superior and additional applicable documents

1000_GP_11_01_en_7.0 Group Policy on Health, Safety, Environment and Quality (HSEQ)

This section of the HSEQ Manual applies to all Centennial employees and subcontractors who are performing work in Centennial facilities and project sites. There may be more stringent requirements than this section as defined by specific State, local or contract specific excavation or trenching requirements. If there is a conflict between this section and other applicable regulations, the more stringent will apply.

3 Definitions

The following definitions of terms are important for an understanding of this section.

Term	Definition
Centennial	All Centennial employees, joint venture employees, subcontractors, and business partners
Benching	Method of protecting personnel from cave-ins by excavating the sides of an excavation to form one or a series of horizontal levels or steps, usually with vertical or near-vertical surfaces between levels
Cave in	The undesired separation of a mass of soil or rock material from the side of an excavation, or the loss of soil from under a trench shield or support system, and its sudden movement into the excavation, either by falling or sliding, in sufficient quantity so that it could entrap, bury, or otherwise injure and immobilize a person
Cohesive soil	Soil with a high clay content, which has cohesive strength. Cohesive soil does not crumble, can be excavated with vertical side slopes, and is plastic when moist. Cohesive soil is hard to break up when dry, and exhibits significant cohesion when submerged
Competent person	Person who is capable of identifying existing and predictable hazards in the surroundings or working conditions that are unsanitary, hazardous, or dangerous to employees and has authority to take prompt corrective measures to eliminate or protect against those hazards
Excavation	Any man-made cut, cavity, trench, or depression in an earth surface, formed by earth removal, regardless of size or depth

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Engulfment	The surrounding and effective capture of a person by liquid or a finely divided solid substance that can be aspirated to cause death by filling or plugging the respiratory system or that can exert enough force on the body to cause death by strangulation, constriction, or crushing
Entry	The action by which a person passes through an opening into a permit-required confined space. Entry includes ensuing work activities in that space and is considered to have occurred as soon as any part of the entrant's body breaks the plane of an opening into the space
Entry supervisor	The individual responsible for determining if acceptable entry conditions are present at a permit space where entry is planned, for authorizing entry and overseeing entry operations, and for terminating entry as required by this section
Face or sides	The vertical or inclined earth surfaces formed as a result of excavation work
Failure	The breakage, displacement, or permanent deformation of a structural member or connection so as to reduce its structural integrity and its supportive capabilities
Fissure	Soil material that tends to break along definite planes of fracture with little resistance, or a material that exhibits open cracks, such as tension cracks, in an exposed surface
Hazardous atmosphere	An atmosphere that may expose employees to the risk of death, incapacitation and/or impairment of ability to self-rescue (that is, escape unaided from a confined space), injury, or acute illness from one or more of the following causes: atmospheric oxygen concentration below 19.5 percent or above 23.5 percent; flammable gas, vapor, or mist in excess of zero percent of its lower flammable limit (LFL); atmospheric concentration of any substance, which could result in employee exposure in excess of its occupational exposure limit
HSEQ	Health, Safety, Environment and Quality
OSHA	Occupational Health and Safety Administration
Potholing	Potholing is the practice of digging test holes by hand digging or by using non-invasive methods to expose and verify underground utilities
Protective system	A method of protecting personnel from cave-ins, from material that could fall or roll from an excavation face or into an excavation, or from the collapse of adjacent structures. Protective systems include support systems, sloping and benching systems, shield systems, and other systems that provide the necessary protection
PSO	Project Safety Officer

Ramp	An inclined walking or working surface that is used to gain access to one point from another, and is constructed from earth or from structural materials such as steel or wood
RPE	Registered Professional Engineer
Sheeting	A component of a shoring system that retains the earth in position and in turn is supported by other members of the shoring system
Shield system	A structure that is able to withstand the forces imposed on it by a cave-in and thereby protects personnel within the structure. Shields can be permanent structures or can be designed to be portable and moved along as work progresses. Shields used in trenches are usually referred to as "trench boxes" or "trench shields"
Shoring system	A structure such as a metal hydraulic, mechanical, or timber shoring system that supports the sides of an excavation and which is designed to prevent cave-ins
Sloping	A method of protecting personnel from cave-ins by excavating to form sides of an excavation that are inclined away from the excavation so as to prevent cave-ins. The angle of incline required to prevent a cave-in varies with differences in such factors as the soil type, environmental conditions of exposure, and application of surcharge loads
Stable rock	Natural solid mineral that can be excavated with vertical sides and will remain intact while exposed
Support system	A structure such as underpinning, bracing, or shoring, which provides support to an adjacent structure, underground installation, or the sides of an excavation
Tabulated data	Tables and charts approved by a registered professional engineer and used to design and construct a protective system
Trench	A narrow excavation (in relation to its length) made below the surface of the ground. In general, the depth is greater than the width, but the width of a trench (measured at the bottom) is not greater than 15 feet
TSF	Tons per square foot
HSEQ Director	Leads the HSEQ Team

4 Pre-excavation activities

4.1 Utility locates

The location of sewer, telephone, fuel, electric, water, or any other underground installations or wires that may be encountered during excavation work shall be determined and marked prior to

opening an excavation. Federal or state sponsored 811 “Call Before you Dig” will provide the location of underground utilities at no cost and may prevent unintentionally striking underground utilities that could cause property damage or personal injury. If the location of underground utilities is not accurate, is unclear or conflicting with other information then the use of a third-party utility locate service shall be required. When concrete demolition/slab removal is required (including concrete coring) additional procedures shall be required for locating and identifying known and unknown utilities, i.e., interior concrete demolition/removal shall require surface penetrating X-ray scanning or radar imaging. Exterior concrete slabs within six (6) feet of any structure/building shall require surface penetrating X-ray scanning. Arrangements shall be made by the project superintendent and competent person with the appropriate utility entity for the protection, removal, shutdown, or relocation of underground installations.

Excavation shall be done in a manner that does not endanger the underground installations or the employees and subcontractors engaged in the excavation work. When underground utilities have been identified, potholing is required to expose and verify the physical location of the utility. Utilities left in place shall be protected by barricades, shoring, suspension, or other means necessary to protect affected personnel.

4.2 Protection of the personnel near excavations

Excavations shall be isolated from public access by a substantial physical barrier. Appropriate barricades, lighting and posting shall be installed prior to the start of excavation operations. All temporary excavations of this type shall be backfilled as soon as possible. Barricades, walkways, lighting, and posting shall be provided for the protection of the public prior to the start of excavation operations.

Guardrails, temporary fencing, and/or barricades shall be provided on excavations adjacent to walkways, driveways, and other pedestrian or vehicle thoroughfares. Warning lights or other illumination shall be maintained as necessary for the safety of the public, subcontractors, and employees during all times.

Wells, holes, pits, shafts, and all similar hazardous excavations shall be effectively barricaded or covered and posted as necessary to prevent unauthorized access.

Walkways or bridges protected by standard guardrails shall be provided where employees, subcontractors and the general public are permitted to cross over excavations. Where workers in the excavation may pass under these walkways or bridges, a standard guardrail and toe board shall be used to prevent the hazard of falling objects.

4.3 Competent person

Before the initial excavation/trenching work starts, all existing hazards shall be identified, and assessed by the competent person. All hazards and hazard controls in excavations shall be identified in an Excavation and Trenching Plan (Appendix 1).

The competent person shall inspect the excavation prior to the start of each work shift and as conditions change using the Excavation and Trench Inspection Checklist (Appendix 2) or other acceptable inspection checklist.

The competent person shall be evaluated and verified to be competent by the Centennial project superintendent or PSO prior to any excavation activity using the Excavation/Trenching Competent Person Evaluation Checklist (Appendix 3) or other approved checklist or document.

The competent person for excavation shall have the following responsibilities:

- Understand the requirements of this section, Federal, State, local and contract specific requirements regarding excavation/ trenching and be able to recognize potential hazards associated with excavation and trenching work
- Verify that underground utilities have been adequately located
- Determine the soil type and anticipate what worker protection will be required. At least two soil tests shall be conducted to properly determine the soil type. One test shall be visual and the other a manual analysis(see section 4.4 of this section for specific guidance on soil analysis)
- Inspect excavations, at a minimum, once a day for the purpose of identifying and abating potential hazards associated with the excavation/trench
- Have the authority to stop all work being performed in an excavation due to a hazardous condition or hazardous practices
- Approve adequate measures to ensure underground utilities do not pose a safety or health hazard to personnel while the excavation is open
- Determine, in all excavations greater than four (4) feet deep, if the possibility of a hazardous atmosphere exists
- Identifying potential overhead hazards (including overhead electrical power)

4.4 Soil analysis

Soil conditions shall be evaluated by a competent person who shall conduct both a visual and manual soil analysis to determine the stability of soils and surrounding excavation conditions. The competent person shall document this soil analysis on the AHA or Excavation and Trenching Plan (Appendix 1). The soil analysis shall take into consideration the work activities that may destabilize the soils in and near the excavation or trench.

4.4.1 Visual test(s)

Visual analysis is conducted to determine qualitative information regarding the excavation site in general, the soil adjacent to the excavation, the soil forming the sides of the open excavation, and the soil taken as samples from excavated material. Visual analysis includes the evaluation of the soil and surrounding area of the excavation by a competent person.

Visual tests include visual observation of:

- Soil samples that are excavated and observation of the soil in the on the sides of the excavation. The competent person performing the visual observation shall estimate the range of particle sizes and the relative amounts of the particle sizes
 - Soil that is primarily composed of fine-grained material is cohesive material.
 - Soil composed primarily of coarse-grained sand or gravel is granular material
- Soil as it is excavated
 - Soil that remains in clumps when excavated is cohesive

- Soil that breaks up easily and does not stay in clumps is granular
- The side of the opened excavation and the surface area adjacent to the excavation.
 - Crack-like openings such as tension cracks could indicate fissured material. If chunks of soil spall off a vertical side, the soil could be fissured.
 - Small spalls are evidence of moving ground and are indications of potentially hazardous situations that could result in a cave in
- The area adjacent to the excavation and the excavation itself for evidence of existing utility and other underground structures and to identify previously disturbed soil
- The opened side of the excavation to identify layered systems
- The area adjacent to the excavation and the sides of the opened excavation for evidence of surface water, water seeping from the sides of the excavation or the level of the water table
- The area adjacent to the excavation and the area within the excavation for sources of potential vibration

4.4.2 Manual test(s)

Manual analysis of soil samples is conducted to determine quantitative as well as qualitative properties of soil and to provide more information in order to classify soil properly.

Manual tests include the following:

- **Plasticity test:** A moist or wet sample of soil is molded into a ball and the tester shall attempt to roll it into threads as thin as 1/8-inch in diameter. Cohesive material can be successfully rolled into threads without crumbling
- **Dry strength test**
 - If the soil is dry and crumbles on its own or with moderate pressure into individual grains or fine powder, it is granular (type B or C)
 - If the soil is dry and falls into clumps which break up into smaller clumps, but the smaller clumps can only be broken up with difficulty, it may be clay in any combination with gravel, sand, or silt (type A or B)
- **Thumb penetration test:** The thumb penetration test can be used to estimate the unconfined compressive strength of cohesive soils
 - Type A soils with an unconfined compressive strength of 1.5 (tons per square foot) TSF can be readily indented by the thumb; however, they can be penetrated by the thumb only with very great effort.
 - Type C soils with an unconfined compressive strength of 0.5 TSF can be easily penetrated several inches by the thumb, and can be molded by light finger pressure
- **Pocket penetrometer test:** Penetrometers are direct-reading, spring-operated instruments used to determine the unconfined compressive strength of saturated cohesive soils. Once pushed into the soil, an indicator sleeve displays the reading.
- **Shearvane (Torvane) test:** To determine the unconfined compressive strength of the soil with a shearvane, the blades of the vane are pressed into a level section of undisturbed soil, and the torsional knob is slowly turned until soil failure occurs. The direct instrument reading shall be multiplied by 2 to provide results in TSF

4.5 Soil types

4.5.1 Stable rock

Stable rock is natural solid mineral matter that can be excavated with vertical sides and remain intact while exposed. It is usually identified by a rock name such as granite or sandstone. Determining whether a deposit is of this type is stable rock may be difficult unless it is known whether cracks exist and whether or not the cracks run into or away from the excavation.

4.5.2 Type A soil

Type A soils are cohesive soils with an unconfined, compressive strength of 1.5 TSF or greater. Examples of cohesive soils are clay, silty clay, sandy clay, clay loam and, in some cases, silty clay loam and sandy clay loam. Cemented soils such as caliche and hardpan are also considered type A.

The soil shall not be classified as type A if:

- The soil is fissured
- The soil is subject to vibration from heavy traffic, pile driving, or similar effects
- The soil has been previously disturbed
- The soil is part of a sloped, layered system where the layers dip into the excavation on a slope of four horizontal to one vertical (4H:1V) or greater
- The material is subject to other factors that would require it to be classified as a less stable material

4.5.3 Type B soil

Medium stability: silt, sandy loam, medium clay, and unstable dry rock; previously disturbed soils unless otherwise classified as Type C soil.

The characteristics of Type B soil include:

- Cohesive soil with an unconfined compressive strength greater than 0.5 TSF but less than 1.5 TSF
- Granular cohesionless soils including angular gravel (similar to crushed rock), silt, silt loam, sandy loam and, in some cases, silty clay loam and sandy clay loam
- Previously disturbed soils except those which would otherwise be classified as Type C soil
- Soil that meets the unconfined compressive strength or cementation requirements for Type A, but is fissured or subject to vibration
- Dry rock that is not stable
- Material that is part of a sloped, layered system where the layers dip into the excavation on a slope less steep than four horizontals to one vertical (4H:1V), but only if the material would otherwise be classified as Type B

4.5.4 Type C soil

Type C soils are cohesive soils with an unconfined compressive strength of 0.5 TSF or less. Other Type C soils include granular soils such as gravel, sand and loamy sand, submerged soil, soil

from which water is freely seeping, and submerged rock that is not stable. Also included in this classification is material in a sloped, layered system where the layers dip into the excavation or have a slope of four horizontal to one vertical (4H:1V) or greater.

The characteristics of Type C soil include, but are not limited to:

- Submerged soil or soil from which water is freely seeping
- Submerged rock that is not stable
- Sloped, layered system which slopes into an excavation at an angle of 4H:1V or steeper

Any one of the following will cause soil to be classified as Type C:

- Water seepage into excavation
- Vibration from road traffic or equipment
- Signs of bulging, boiling, or sloughing
- Cracks or fissures
- Previously excavated or disturbed soil

4.5.5 Layered soils

Where soils are configured in layers, the soil shall be classified on the basis of the soil classification of the weakest soil layer. Each layer may be classified individually if a more stable layer lies below a less stable layer.

Layered systems may include the following:

- Two or more distinctly different soil or rock arranged in layers
- Micaceous seams or weakened planes in rock and shale
- The system is classified according to its weaker layer, except where a more stable layer lies under a less stable layer

5 General requirements for excavations

5.1 Access and egress

Access/egress-approved stairways, ladders or ramps shall be provided for access/egress in excavations that are 4 feet or more in depth and located so that personnel will not be required to travel laterally more than 25 feet, from any point within the excavation, for a safe means of egress. In extremely large excavations where it is not practical to provide a stairway, ladder, or ramp every 25 feet, they shall be placed in locations of easy access and shall provide a safe means of egress. All stairways and ramps shall be equipped with standard handrails and toe boards in accordance with HSEQ Manual section 16 (Stairways and Ladders).

5.1.1 Ramps

All structural ramps used for access/egress of personnel and/or equipment shall be designed by a qualified person and inspected by the competent person prior to use. Structural ramps that are used solely by employees as a means of access or egress from excavations shall be designed

by a competent person. The structural members of the ramp shall be of uniform thickness and connected to prevent displacement. Also, all ramps shall be free from tripping hazards and the surface treated to prevent slipping.

5.1.2 Ladders

Ladders - All ladders shall extend a minimum of three feet above the surface and shall be secured both top and bottom according to HSEQ Manual section 16 (Stairway and Ladders). Step ladders or a single section of an extension ladder shall not be used.

5.2 Spoils and falling object protection

5.2.1 Spoils

Temporary spoil piles shall not be placed closer than 2 feet from the surface edge of the excavation, measured from the nearest base of the spoil to the cut. This distance shall not be measured from the crown of the spoil deposit. This distance requirement ensures that loose rock or soil from the temporary spoil will not fall on employees in the trench and to reduce the lateral pressure on the side of the excavation (known as the “affected area” or “affected zone”).

Spoil piles shall be placed so that the design channels rainwater and other run-off water away from the excavation. Spoil piles shall be placed so that soil, rocks, or other debris cannot accidentally run, slide, or fall back into the excavation.

5.2.2 Falling object protection

Adequate protection shall be provided to protect Centennial employees and subcontractors from loose rock, soil or materials that could pose a hazard by falling or rolling from the excavation face.

Such protection shall consist of:

- Prohibiting personnel from working above one another where the danger of falling rock, soil or other materials exists
- Protecting personnel from excavated materials, equipment, or other materials that could pose a hazard by falling or rolling into excavations
 - Excavated materials and other materials shall be maintained at least two feet from the edge of excavations
 - The competent person may determine that excavated materials and other materials be stored further than two feet from the edge of the excavation if a hazardous loading condition may be created on the face of the excavation
- All materials piled, grouped, or stacked near the edge of the excavation shall be stable and self-supporting

5.3 Excavation warning systems and fall protection

Open excavations shall be protected by barricades, covers, or other means deemed appropriate by the Competent Person and the project superintendent to prevent personnel or equipment from falling into the excavation, particularly during non-work hours.

Centennial employees, subcontractors or other affected personnel shall not be permitted under loads being handled by weight handling equipment or digging equipment.

Employees, subcontractors, and other affected personnel who are exposed to vehicular traffic shall be provided with and shall wear ANSI/ISEA 107 retro-reflective warning vests or other suitable garments capable of warning approaching traffic.

5.4 Water accumulation

Centennial employees and subcontractors shall not be permitted to access or work in excavations where there is accumulated water, or where water is accumulating unless adequate precautions have been taken to protect employees against the hazards posed by the water.

5.5 Adjacent structures

The impact of excavation or trenching activities to adjacent structures or adjoining buildings shall be evaluated by the competent person.

Excavations shall not be conducted below the base or footing of any foundation or retaining wall that could reasonably be expected to pose a hazard to personnel unless:

- A support structure to ensure the stability of the structure and the safety of employees is installed
- The excavation is in stable rock
- An RPE has determined that the structure is at a sufficient distance from the excavation to not be affected

5.6 Hazardous atmospheres

Where the possibility exists of oxygen deficient or a hazardous atmosphere, as determined by the Competent Person, air monitoring shall be performed and conducted in accordance with HSEQ section 21 (Confined Space) before the start of work in all excavations deeper than 4 feet. Air monitoring shall be conducted by a person trained in the use of the atmospheric monitoring equipment.

Centennial employees or subcontractor shall not be exposed to harmful atmospheres in excavations or trenches. All contaminant levels shall be below the OSHA Permissible Exposure Limits and American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs) and their associated Short Term Exposure Limits (STELs) and Ceiling Values.

Continual atmospheric monitoring shall be conducted if the possibility exists of a hazardous or oxygen deficient atmosphere occurring in the excavation. A full body harness shall be worn by personnel where the possibility of a hazardous atmosphere or oxygen deficient atmosphere exists to facilitate rescue.

Adequate engineering controls shall be used to eliminate hazardous atmospheres if possible. If not, adequate personal protective equipment shall be used to reduce the hazard(s) in accordance with HSEQ Manual section 11 (Personal Protective Equipment).

5.7 Excavation and trench inspections

Frequent inspections of the excavation and surrounding work area by the competent person are critical to ensure the safety of those individuals who have accessed the excavation.

The competent person shall conduct inspections of the entire excavation site:

- Daily and before the start of each shift
- As dictated by the work being done in the trench
- After every rainstorm
- After protective systems have been installed
- When fissures, tension cracks, sloughing, undercutting, water seepage, bulging at the bottom, or other similar conditions occur
- When there is a change in the size, location, or placement of the spoil pile
- When there is any indication of change or movement in adjacent structures

Excavation inspections shall be accomplished using the Excavation and Trench Inspection Checklist (Appendix 2) or other acceptable inspection checklist.

6 Protective systems

Every employee and subcontractor accessing an excavation or trench shall be protected from potential cave in by an adequate protective system unless:

- The excavation is made in non-fissured stable rock
- Excavations are less than 5 feet in depth and the competent person performs an analysis of the soil in accordance with section 4.4 of this section and there is no indication of a potential cave in

Protective systems shall have the capacity to resist without failure all potential loads that are intended or could reasonably be expected to be applied or transmitted to the system.

All pre-manufactured protective systems shall be maintained and installed according to the manufacturer's recommendations and instructions for use. The manufacturer's tabulated data shall be maintained on the project site at all times when protective systems are used.

6.1 Sloping and benching

6.1.1 Sloping

Maximum allowable slopes for excavations less than 20 feet in depth based on soil type and angle to the horizontal are as follows:

Maximum Allowable Slopes		
Soil Type	Height/Depth Ratio	Slope Angle
Stable Rock	Vertical	90 degree
Type A Soil	$\frac{3}{4}$ to 1	53 degree
Type A (short term)	$\frac{1}{2}$ to 1	63 degree
Type B Soil	1 to 1	45 degree
Type C Soil	1 $\frac{1}{2}$ to 1	34 degree

Slope configurations for excavations greater than 20 feet shall be designed by an RPE.

6.1.2 Benching

There are two basic types of benching, simple and multiple. The type of soil determines the horizontal to vertical ratio of the benched side.

The bottom vertical height of the trench shall not exceed 4 feet for the first bench. Subsequent benches may be up to a maximum of 5 feet vertical in Type A soil and 4 feet in Type B soil to a total trench depth of 20 feet. All subsequent benches shall be below the maximum allowable slope for that soil type. For Type B soil the trench excavation is permitted in cohesive soils only (type A and B soils). Benching of type C soil on Centennial projects is prohibited.

6.2 Shoring systems

6.2.1 Hydraulic shoring

Hydraulic Shoring is a prefabricated strut and/or wale system manufactured of aluminum or steel. Hydraulic shoring provides a critical safety advantage over timber shoring because workers do not have to enter the trench to install or remove hydraulic shoring.

All shoring shall be installed from the top down and removed from the bottom up. Hydraulic shoring shall be inspected at least once per shift for leaking hoses and/or cylinders, broken connections, cracked nipples, bent bases, and any other damaged or defective parts.

6.2.2 Pneumatic shoring

Pneumatic Shoring works in a manner similar to hydraulic shoring. The primary difference is that pneumatic shoring uses air pressure in place of hydraulic pressure.

- **Screw Jacks:** Screw jack systems differ from hydraulic and pneumatic systems in that the struts of a screw jack system shall be adjusted manually. This creates a hazard because the worker is required to be in the trench in order to adjust the strut. In addition, uniform "preloading" cannot be achieved with screw jacks, and their weight creates handling difficulties
- **Single-Cylinder Hydraulic Shores:** Shores of this type are generally used in a water system, as an assist to timber shoring systems, and in shallow trenches where face stability is required
- **Underpinning:** This process involves stabilizing adjacent structures, foundations, and other intrusions that may have an impact on the excavation. As the term indicates, underpinning is a procedure in which the foundation is physically reinforced. Underpinning should be conducted only under the direction and with the approval of an RPE

6.3 Shield systems (also known as manhole or trench boxes)

Trench shield systems are designed to protect workers from the force experienced from a cave in or other similar incidents. The trench shield is lowered into the excavation and workers shall only access/egress the protected area within the shield system. Trench shields designed or certified by an RPE shall only be used on Centennial project sites. The use of a shield system shall be limited to those trenches for which the shield is designed (maximum depth and type of material). The shield manufacturer or RPE shall approve any modifications to the shields and the manufacturer's tabulated data shall be on site whenever a shield system is used, and the system shall be installed according to the manufacturer's tabulated data.

The excavated area between the outside of the trench box and the face of the trench should be as small as possible. The space between the trench box and the excavation side should be backfilled to prevent lateral or hazardous movement of the shield. Trench shields may be used in combination with sloping and benching. The box shall extend at least 18 inches above the surrounding area if there is sloping toward the excavation. This can be accomplished by providing a benched or sloped area adjacent to the box. Sloping used in conjunction with a shield system shall be accordance with the soil type shown in 6.1.1 of this section.

Shields may be placed two feet above the bottom of an excavation, provided they are calculated to support the full depth of the excavation and there is no caving under or behind the shield.

Workers shall enter and leave the shielded area in a protected manner, such as by a ladder or ramp. Workers may not remain in the shielded area while the shield is being moved.

The general requirements for shield systems are:

- Shields shall not be exposed to loads greater than their designed capacity
- Shields shall be installed in a manner to restrict lateral or other hazardous movement of the shield in the event of the application of sudden lateral loads
- Personnel shall be protected from the hazard of cave-ins when entering or exiting the areas protected by shields
- Personnel shall not be allowed in shields when shields are being installed, removed, or moved vertically or horizontally
- Excavation of soil or material to a level not greater than 2 feet below the bottom of a shield shall be permitted

7 Training

Employees and subcontractors shall be trained prior to entry in the specific duties and hazards associated with the work, responsibilities, and their assignments. Any employee or subcontractor required to dig or enter an excavation shall receive training on the potential hazards associated with the work or task.

Training shall be provided to all affected personnel and, at a minimum, include:

- Hazards related to excavation work or accessing an excavation
- Work practices and selection of appropriate protective systems
- Methods of evaluating soil and the site
- Inspection procedures
- Specific requirements of this section
- Emergency procedures

Retraining is required when:

- Changes in the workplace render previous training incomplete or obsolete
- Changes in the types of fall protection systems or equipment to be used render previous training incomplete or obsolete
- Inadequacies in an employee's knowledge or use of fall protection systems or equipment indicate that the employee has not retained the requisite understanding or skill

8 Amendment history

Date	Version	Revised content
04.22.2014	1.0	Initial Preparation
01.01.2015	1.1	Clarification on Excavation and Trenching Plan approval and signature authority
01.01.2018	2.0	Updates to Paragraph 2 Superior Documents to add the Group Policy and Global Standards, Paragraph 3 Definitions (Centennial and HSEQ Director) and Appendices 1 - 3 (logo)
01.01.2020	2.1	Updates to Paragraph 2 Superior Documents and Appendix 1 (Approvals)
11.01.2021	2.2	Updates to Paragraph 3 Definitions (Potholing) and Paragraph 4 Pre-excavation activities (potholing language)
04.01.2022	2.3	Update to Paragraph 1 Objective and Area of Application (clarified when plan is required), Paragraph 2 Superior Documents (Group Policy version), Paragraph 4.3 Competent Person (clarified when plan is required), Appendix 1 Excavation and Trenching Plan (inclusion of all excavation activities), and Appendix 2 Excavation and Trench Inspection Checklist (added signature)
11.07.2022	2.4	Update to Paragraph 4.1 Utility locates (adding use of third-party utility locate service)

9 Appendix

Appendix 1: Excavation and Trenching Plan (0206500_CP_11_22_en_A1.6)

Appendix 2: Excavation and Trench Inspection Checklist (0206500_CP_11_22_en_A2.2)

Appendix 3: Excavation/Trenching Competent Person Evaluation Checklist (0206500_CP_11_22_en_A3.1)