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TRENCH AND EXCAVATION	
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1. PURPOSE AND SCOPE

- 1.1. This Health, Safety, and Environment Procedure provides minimum procedures to be followed when employees are engaged in activities requiring entry into or work around excavations. It applies to all employees and subcontractors engaged in operations on a MAPP controlled site.

2. RESPONSIBILITIES

- 2.1. General responsibilities for HSE Program implementation are stated in HSEP 1.5. Additional management, staff, employee, and subcontractor responsibilities that address duties specific to this topic are stated in this procedure.

2.2. Site Management

- 2.2.1. Site Management is responsible for assuring the overall implementation and compliance with the Company's excavation HSEP. They must be familiar with the excavation HSEP and utilize expertise at their disposal to ensure employees are protected from excavation hazards.
- 2.2.2. Site Management shall designate Competent Persons for trenching and excavation activities on-site, only after they have completed an appropriate course taught by the Corporate HSE Department, or some other recognized third party

2.3. Site Supervision

- 2.3.1. Supervisors responsible for employees performing work covered by the excavation HSEP must:
 - 2.3.1.1. Ensure that Competent Persons have been assigned to inspect the safety of excavations and monitor the work for any hazardous situations. Confirm each excavation job is properly evaluated and prepared with hazards being addressed ensuring employees are protected.
 - 2.3.1.2. Ensure employees are aware of any hazards associated with their work, and they are properly trained on this HSEP and any site-specific excavation procedures.
 - 2.3.1.3. Ensure that employees adhere to all excavation HSEP requirements and any established task requirements.
 - 2.3.1.4. Continuously monitor the work to assure compliance with this HSEP.

2.4. Competent Persons

- 2.4.1. Competent Persons assigned to excavation sites have the responsibility to:
- 2.4.2. Train employees on the content of this procedure and ensure it is clearly understood.
- 2.4.3. Evaluate whether the excavation is also a confined space.

- 2.4.4. Perform documented daily inspections of excavations, the adjacent areas, and protective systems before the start of work each day and as necessary throughout the shift.
- 2.4.5. Inspections shall additionally be made after every rainstorm or other hazard-increasing occurrence.
- 2.4.6. Where evidence indicates a possible cave-in, failure of the protective system, or other hazardous condition, employees shall be removed until the proper precautions have been taken.

3. DEFINITIONS

Aluminum Hydraulic Shoring	A pre-engineered excavation shoring system comprised of aluminum hydraulic cylinders (cross braces) used in conjunction with vertical rails (uprights) or horizontal rails (wales).
Bell Bottom Pier Hole	A type of shaft or footing excavation, the bottom of which is made larger than the cross section above to form a belled shape.
Benching	A method of protecting employees 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 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, injure, or immobilize a person.
Competent Person	One who is capable of identifying existing and predictable hazards in the work environment and who has the authority to correct them. For purposes of a Competent Person for excavation activities, this person must receive training and designation through the Corporate Health, Safety, and Environment Department.
Excavation	Any man made cut, cavity, trench, or depression in an earth surface, formed by earth removal.
Oxygen Deficient	Having an oxygen concentration of less than 19.5%.
Protective System	A method of protecting employees from cave-ins; from material that could fall or roll from an excavation face or into an excavation. Protective systems include: sloping systems, benching systems shoring systems and shield systems.
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.

Registered Professional Engineer	A person who is registered as a professional engineer in the state where the work is to be performed. However, a professional engineer, registered in any state is deemed appropriate when approving designs for pre-engineered or manufactured protective systems.
Shield	A structure that is able to withstand the forces imposed on it by a cave-in and thereby protect employees within the structures, or can be designed to be portable and moved along as work progresses.
Shoring	A structure such as a timber shoring system, or an aluminum hydraulic shoring system that supports the sides of an excavation and which is designed to prevent cave-ins.
Sloping	A method of protecting employees 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 the slope varies with differences in soil type, environmental conditions and application of imposed loads.
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.
Trench	A narrow excavation, the depth of which normally exceeds the width (not more than 15 feet wide).

4. PROCEDURE

4.1. General Requirements

- 4.1.1. A proper permit must be issued before excavation work begins. This permit is typically issued by the facility owner or the client and is reviewed by a Jacobs HSE Department representative.
- 4.1.2. All employees shall be protected with personal protective equipment for the protection of head, eyes, respiratory organs, hands, feet, and other parts of the body as required.
- 4.1.3. In many instances, excavations are considered confined spaces. If this is the case, all parts of both the excavation and the confined space entry procedures must be followed.
- 4.1.4. Physical barricades must be placed around all excavations.
- 4.1.5. Employees outside of excavations and exposed to vehicular traffic shall wear reflectorized or highly visible warning vests.
- 4.1.6. No person shall be permitted under loads handled by lifting or digging equipment.
- 4.1.7. No employees shall stand or work near a vehicle being loaded. Operators may remain in the enclosed cab of the vehicle.
- 4.1.8. All excavating work must have the prior approval of the area supervisor.
- 4.1.9. The possibility of flammable or toxic gases settling in low places of excavations must be assessed before entering excavations or doing hot work.
- 4.1.10. Employees entering excavations less than five feet in depth must be protected by an adequate protective system, as described below, when a Competent Person determines the possibility of hazardous ground movement.
- 4.1.11. All surface objects that may present a hazard to employees by rolling or falling into an excavation shall be removed, or all excavations four feet or more in depth require a safe means of access and egress.

4.2. Underground Utility Clearance

- 4.2.1. Prior to opening an excavation, the location of utility installations that may be encountered shall **be determined**.
- 4.2.2. The location of underground installations shall be determined before excavation. When utility companies or owners cannot respond to a request to locate underground utility installations within 24 hours, or cannot establish exact location of these installations, the employer may proceed, provided the employer does so with caution and provided detection equipment or other acceptable means to locate utility installations are used.

- 4.2.3. While the excavation is open, underground installations shall be protected, supported, or removed to safeguard employees.

4.3. Access and Egress

- 4.3.1. A stairway, ladder, ramp, or other safe means of access and egress shall be located in excavations that are four feet or more in depth so as to require no more than 25 feet of lateral travel for employees.
- 4.3.2. Ladders must extend 36 inches above the point of support at the top of the excavation.
- 4.3.3. Structural ramps used solely by employees shall be designed by a Competent Person.
- 4.3.4. Structural ramps used by equipment shall be designed by a Competent Person qualified in structural design and shall be constructed accordingly.

4.4. Prohibited Task Health Hazard Conditions

- 4.4.1. No worker shall enter a work area where:
 - 4.4.1.1. Oxygen concentrations are less than 19.5% or greater than 23.5%, or
 - 4.4.1.2. Atmospheres are greater than 1% of the Lower Explosive Limit, or
 - 4.4.1.3. Atmospheres are potentially Immediately Dangerous to Life or Health (IDLH), or
 - 4.4.1.4. There is unprotected exposure to known human carcinogens, mutagens, or teratogens, or
 - 4.4.1.5. There is unprotected exposure to known chemical sensitizers.

When work in these environments seems to be absolutely necessary, the project manager shall appeal to the appropriate senior operations manager and senior HSE manager for written approval to proceed and for specific safe work procedures.

4.5. Work In Potentially Hazardous Atmospheres

- 4.5.1. Where oxygen deficiency or flammable or toxic atmospheres could exist, the air shall be tested before employees enter excavations.
- 4.5.2. Adequate precautions shall be taken to prevent employee exposure to oxygen deficiency or hazardous atmospheres. These precautions may include providing task modifications, ventilation, or, as a last resort, respiratory protection.
- 4.5.3. Periodic testing shall be conducted to ensure that potentially hazardous atmospheres remain safe.
- 4.5.4. Emergency rescue equipment, such as a self-contained breathing apparatus and a safety harness and lifeline shall be readily available where hazardous atmospheres exist or could develop. This equipment shall be maintained by a qualified attendant.

- 4.5.5. Employees entering bell-bottom pier holes or similar deep and confined footing excavations shall wear a harness with a lifeline securely attached. The lifeline shall be individually attended at all times.

4.6. Water Accumulation

- 4.6.1. Employees shall not work in excavations in which water has accumulated, unless proper precautions have been taken.
- 4.6.2. Precautions include support or shield systems, water removal to control the level, and use of a safety harness and lifeline. When used, a Competent Person must monitor water removal equipment.

4.7. Stability of Adjacent Structures

- 4.7.1. Except in stable rock, excavation below the level or base of footing of any foundation or retaining wall shall not be permitted unless the wall is underpinned and other precautions have been taken to ensure the stability of the adjacent walls and the safety of employees involved in the work.
- 4.7.2. Shoring, bracing, or underpinning shall be inspected daily, or more often, as conditions warrant by a Competent Person. The protection shall be effectively maintained.

4.8. Protection of Employees from Loose Rock or Soil

- 4.8.1. Excavated or other material and equipment shall be maintained at a distance of at least two feet from the edge of excavations or behind retaining devices sufficient to prevent material or equipment from falling or rolling into the excavation.
- 4.8.2. If the operator of mobile equipment adjacent to or near the edge of an excavation does not have a clear view of the edge of the excavation, a warning system such as barricades, stop logs, or hand signals shall be used. If possible, the grade should be away from the excavation.

4.9. Fall Protection

- 4.9.1. Where employees or equipment are required or permitted to cross over excavations, walkways or bridges with standard guardrails shall be provided.
- 4.9.2. Adequate barricades providing physical protection shall be provided at all excavations. All wells, pits, shafts, etc., shall be barricaded or covered.
- 4.9.3. Upon completion of operations, temporary wells, pits, shafts, etc., shall be promptly and adequately back filled.

4.10. Soil Classification

- 4.10.1. Each soil and rock deposit shall be classified by a Competent Person as stable rock, type A, type B, or type C in accordance with the definitions set forth in 29 CFR 1926.652 (Appendix A) and documented on the Daily Trench and Excavation Inspection form (HSE42-002).

- 4.10.2. The classification shall be based on at least one visual and at least one manual analysis. Such analysis shall be conducted by a Competent Person using tests described in 29 CFR 1926.652 (Appendix A).

4.11. Protective Systems

4.11.1. Sloping and Benching

A Registered Professional Engineer shall design sloping and benching systems for excavations greater than **20 feet deep**.

For excavations 20 feet deep or less, one of the following options may be used:

- 4.11.1.1. Option 1 - Excavations shall be sloped one-and-one-half horizontal to one vertical (34 degrees measured from the horizontal) unless you use Option 2, 3, or 4. Slopes shall be excavated to form configurations in accordance with slopes shown for Type C Soil in Appendix B, Maximum Allowable Slopes, of 29 CFR 1926.652.
- 4.11.1.2. Option 2 - Slopes and configurations for sloping and benching systems shall be determined in accordance with the provisions of Soil Classification, as set forth in this HSEP, and with Appendix B, Maximum Allowable Slopes, of 29 CFR 1926.652.
- 4.11.1.3. Option 3 - Designs of sloping and benching systems shall be in accordance with tabulated data and charts identifying parameters, limits of use, and explanatory information as necessary. This data must be in written form on the jobsite and bearing the seal of the approving Registered Professional Engineer.

When excessive loads from stored material or equipment, operating equipment, or traffic are present, the Competent Person shall determine to what degree the slope must be reduced below the maximum allowable slope.

4.11.2. Support and Shield Systems (Shoring)

For excavations greater than 20 feet deep, a Registered Professional Engineer must design or approve any support/shield systems used.

For support and shield systems in excavations 20 feet or less in depth, one of the following options may be used.

- 4.11.2.1. Option 1 - Designs for timber shoring shall be determined using tables C1.3 or C2.3 (29 CFR 1926.652 Appendix C) for soil type C. Designs for aluminum hydraulic shoring shall be in accordance with manufacturers data or 29 CFR 1926.652 (Appendix D).
- 4.11.2.2. Option 2 - Designs for timber shoring shall be determined in accordance with the provisions, as set forth in this HSEP, of Soil Classification and in accordance with the provisions of Timber Shoring.

- 4.11.2.3. Option 3 - Use of pre-fabricated support systems, such as aluminum hydraulic shoring or other protective systems drawn from manufacturers data, must be used in accordance with all specifications and limitations issued by the manufacturer.
- 4.11.2.4. Option 4 - Designs of support, shield, or other protective systems must be in accordance with tabulated data and bear the seal of the approving Registered Professional Engineer.

4.11.3. Materials and Equipment

- 4.11.3.1. Materials and equipment used for protective systems shall be free from damage or defects that might impair their proper function. Manufactured materials and equipment shall be used in a manner that is consistent with the recommendations from the manufacturer. Damaged material or equipment shall be removed from use.

4.11.4. General Requirements for Shoring

- 4.11.4.1. Members of support systems shall be securely connected in order to prevent sliding, falling, kick outs, or other failure.
- 4.11.4.2. Support systems shall be installed and removed in a manner that protects employees from cave ins, collapses, or being struck by support members. Removal shall begin at and progress from the bottom of the excavation. Members shall be released slowly so that changes in the stability of the structure or excavation can be readily assessed.
- 4.11.4.3. Components of pre-fabricated systems must be supplied with the manufacturer's seal or identification markings. These markings must remain legible.
- 4.11.4.4. Excavation of material from no greater than two feet below the bottom of the support or shield systems is permitted if the system is designed to resist the forces of the full depth.
- 4.11.4.5. Employees shall not be allowed in excavations when shields are being installed, removed, or moved.

4.11.5. Timber Shoring

- 4.11.5.1. Timber shoring may be provided in excavations that do not exceed 20 feet as a means of protection from cave-ins.
- 4.11.5.2. A Registered Professional Engineer must design timber shoring for excavations greater than 20 feet deep.
- 4.11.5.3. In order to use timber shoring, the soil type must first be determined by a Competent Person using the steps set forth in Soil Classification, as found in this HSEP.

- 4.11.5.4. There are six tables in 29 CFR 1926.652; Appendix C, two for each soil type. Minimum sizes of shoring members are specified for each soil type. Using the appropriate table, a selection of size and spacing of members can be made. Selection is based on trench depth and width and on spacing of the cross braces.
- 4.11.5.5. The members specified in the table are not adequate when:
 - 4.11.5.5.1. Stored material adjacent to the excavation exceeds the load imposed by a two-foot soil surcharge.
 - 4.11.5.5.2. When surcharge loads are present from equipment weighing in excess of 20,000 pounds.
 - 4.11.5.5.3. When vertical loads imposed on cross braces exceeds a 240-pound gravity load distributed on a one foot section of the center of the cross brace.
 - 4.11.5.5.4. When any of these conditions exists, an alternate timber shoring or protective system shall be used.

5. INSPECTION AND STORAGE (Competent Person)

- 5.1. Designated Competent Persons shall make inspections of excavations, the adjacent areas, and protective systems before employees or equipment are allowed to enter an excavation, before the start of work each day, and as necessary throughout the shift, by using the Daily Trench/Excavation Inspection form.
- 5.2. The designated Competent Person must determine whether the excavation is also a confined space and what additional requirements shall apply.
- 5.3. Inspections by Competent Persons shall additionally be made after every rainstorm or other event that has the potential to create or increase hazard(s).
- 5.4. Where there is evidence, which indicates a possible cave-in, failure of the protective system, or other potentially hazardous condition, employees shall be **immediately** removed until the Competent Person can inspect the situation and proper precautions have been taken.

6. TRAINING

- 6.1. Employees involved in trenching and excavations shall be properly trained in accordance with this HSEP.
- 6.2. Employee training shall be conducted and documented by Competent Persons.
- 6.3. Competent Persons shall be so designated by the Site Manager, only after completing an appropriate excavation and trenching course taught by Corporate HSE or other qualified subject matter specialist.

7. ENVIRONMENTAL

- 7.1. The excavation of soil in an area of known or suspected contamination may require a permit from the local air quality management district. This permit, at a minimum, will likely require routine testing of the air over the soil for volatile organic compounds and/or other contaminants. For a large excavation project in an area of known contamination, the filing of a site-specific mitigation plan may be required.
- 7.2. If the concentration of volatile organic compounds emitted by the soil exceeds the regulatory action level, mitigation measures must be taken to control emissions and the district or agency must be notified. Potential mitigation measures include covering the soil pile with a tarp or spraying with water or vapor suppressant.
- 7.3. Stockpiled soil that is contaminated must be kept covered to prevent emissions and the cover must be inspected daily. This soil must be moved to a regulated disposal site or treatment unit within 30 days of placement.
- 7.4. Excavation work may require a wet weather erosion control permit from regulators. The purpose of this permit is to prevent sediment runoff from impacting storm water quality. Best management practices include covering stockpiled soil, placement of sand bags in front of storm water inlets, and wash-down of trucks before they leave the site.
- 7.5. Deep excavations may encounter groundwater that must be removed from the pit. This water can be loaded with sediment and direct discharge to the street or storm drain may be prohibited. A filter sock on the end of the discharge hose may be used to filter out solids or the water may be pumped to a settling pit prior to discharge.
- 7.6. It is not always safe to assume that clear and odorless water is free from harmful contaminants. Testing of the water should be conducted if there is a concern. Removal of contaminants prior to discharge may be required. Common removal methods include air stripping, carbon treatment, and offsite disposal.

Daily Trench/Excavation Inspection

Date: _____ Time: _____ Project: _____

Excavation Location _____

Site Evaluation

- | | |
|-------------------------------------|---|
| _____ Surface encumbrances | _____ Warning system for mobile equipment |
| _____ Underground installations | _____ Protection from water accumulation |
| _____ Access and egress | _____ Stability of adjacent structures |
| _____ Exposure to vehicular traffic | _____ Employee protection - loose rock/soil |
| _____ Exposure to falling loads | _____ Inspections |
| _____ Hazardous atmospheres | _____ Fall protection |
| _____ % Oxygen (O ₂) | _____ % of Lower Explosive Limit |

Note: Atmospheres in excavations greater than four feet shall be tested for oxygen content and flammable gas concentrations prior to entry of personnel. Emergency rescue equipment shall be readily available.

Soil Classification

Soil classification shall be made based on the results of at least one visual, and one manual test.

_____ Stable rock _____ Type A _____ Type B _____ Type C

Visual Tests

Inspect worksite for:

- _____ Fissured ground
- _____ Layered soil
- _____ Previously disturbed earth
- _____ Seepage
- _____ Vibration
- _____ Poor drainage

Manual Tests

Analyze soil for:

- _____ Plasticity
- _____ Dry strength
- _____ Thumb penetration
- _____ Pocket penetrometer
- _____ Sherevane
- _____ Drying test

Protective Support Systems**Sloping & Benching**☐ Stable rock: 90 degrees☐ Type A: 53 degrees☐ Type B: 45 degrees☐ Type C: 34 degrees**Shoring & Shielding**☐ Timber or hydraulic☐ Trench boxes, trench shields☐ Design using tabulated data☐ RPE design**Additional Comments or Information:** _____

Inspection performed by:

Authorized Competent Person (Signature)

Work Authorized to Begin by:

MAPP Superintendent (Signature)