LAFAYETTE COLLEGE

Excavation and Trenching Safety Plan

Department of Public Safety - Environmental, Health and Safety
Standard Operating Procedure (SOP) #41

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1.0 INTRODUCTION

Excavation and trenching are among the most hazardous construction operations. The Occupational Safety and Health Administration's (OSHA) Excavation and Trenching standard, 29 CFR 1926.650 Subpart P, contains requirements for excavation and trenching operations. This plan highlights key elements of the standard and describes safe work practices to protect workers from cave-ins and other hazards. This plan applies to all College employees and contractors working for the College.

2.0 POLICY

It is the policy of Lafayette College to take every reasonable precaution to provide a work environment free from recognized hazards for its employees in accordance with the General Duty Clause of the OSHA act and in accordance with specific OSHA standards.

Appropriate safety equipment (e.g. shoring, shielding, equipment, etc.) shall be provided by the College when such equipment is necessary to protect the health and safety of the employee(s). The supervising department is responsible for the purchase of such equipment.

A competent person (see definitions) shall be placed in charge of all excavations by the supervising department. The competent person will be evaluated and designated by the supervising department by form ET-1, Appendix C. The supervising department is responsible for maintaining a copy of the ET-1 form and this form should be available for review by Environmental, Health and Safety personnel. Status as a competent person shall be reviewed every 3 years by the department supervisor.

3.0 DEFINITIONS

Accepted Engineering Practices - requirements which are compatible with standards of practice required by a registered professional engineer.

Aluminum Hydraulic Shoring - pre-engineered shoring system comprised of aluminum hydraulic cylinders (cross braces) used in conjunction with vertical rails (uprights) or horizontal rails (wales). Such system is designed specifically to support the sidewalls of an excavation and prevent cave-ins.

Benching (Benching System) - 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, or otherwise injure and immobilize a person.

Competent Person - one who is capable of identifying existing and predictable hazards in the surroundings, or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.
Cross Braces - the horizontal members of a shoring system installed perpendicular to the sides of the excavation, the ends of which bear against either uprights or wales.

Excavation - any man-made cut, cavity, trench, or depression in an earth surface, formed by earth removal.

Faces 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.

Hazardous Atmosphere - an atmosphere which by reason of being explosive, flammable, poisonous, corrosive, oxidizing, irritating, oxygen deficient, toxic, or otherwise harmful, may cause death, illness, or injury.

Kick Out - the accidental release or failure of a cross brace.

Protective System - a method of protecting employees from cave-ins, 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.

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 to be a "registered professional engineer" within the meaning of this standard when approving designs for "manufactured protective systems" or "tabulated data" to be used in interstate commerce.

Sheeting - the members of a shoring system that retain the earth in position and in turn are supported by other members of the shoring system.

Shield (Shield System) - a structure that is able to withstand the forces imposed on it by a cave-in and thereby protect employees within the structure. Shields can be permanent structures or can be designed to be portable and moved along as work progresses. Additionally, shields can be either pre-manufactured or job-built in accordance with 1926.652(c)(3) or (c)(4). Shields used in trenches are usually referred to as "trench boxes" or "trench shields."

Shoring (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.

Sides – See "Faces"

Sloping (Sloping System) - 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 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 material that can be excavated with vertical sides and will remain intact while exposed. Unstable rock is considered to be stable when the rock material on the side or sides of the excavation is secured against caving-in or movement by rock bolts or by another protective system that has been designed by a registered professional engineer.

Structural Ramp - a ramp built of steel or wood, usually used for vehicle access. Ramps made of soil or rock are not considered structural ramps.

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 (Trench Excavation) - 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 (4.6 m). If forms or other structures are installed or constructed in an excavation so as to reduce the dimension measured from the forms or structure to the side of the excavation to 15 feet (4.6 m) or less (measured at the bottom of the excavation), the excavation is also considered to be a trench.

Trench Box – See Shield

Trench Shield – See Shield

Uprights - the vertical members of a trench shoring system placed in contact with the earth and usually positioned so that individual members do not contact each other. Uprights placed so that individual members are closely spaced, in contact with or interconnected to each other, are often called "sheeting."

Wales - horizontal members of a shoring system placed parallel to the excavation face whose sides bear against the vertical members of the shoring system or earth.

4.0 SPECIFIC EXCAVATION REQUIREMENTS

4.1 Competent Person and Training Requirements

A competent person, as defined above, shall be at the excavation site while excavation activities are being performed. To be classified as a competent person, an individual must have attended an EHS approved excavation safety course; received a certificate and/or card indicating successful completion of the course; and have been evaluated and designated by form ET-1, Appendix C. For employees who will be performing work in and around an excavation, under the supervision of the competent person, it will be required that they attend an EHS approved excavation safety awareness course.

A competent person must demonstrate training, experience and understanding of the excavation standard, 29 CFR 1926 Subpart P, soil analysis and the use of protective systems.

The competent person must have the authority to stop work and take corrective action to eliminate hazards that exist or might exist.

4.2 Responsible Party

It is anticipated that control and responsibility for each excavation will need to be established on a per project basis. Ideally, if Department A was responsible for removing soil for an excavation, and Department B was responsible for performing work within the excavation, Department A would maintain control and responsibility for the excavation during the soil removal period, while Department B would maintain control and responsibility for the excavation after Department B takes control of the excavation site.

4.3 Staging and Surface Encumbrances

When leaving an excavation open and unattended measures shall be taken to prevent unauthorized access. When an excavation is unattended and in excess of one (1) foot in depth a six (6) foot chain link fence is required surrounding the excavation. When an excavation is less than a foot in depth, 42 inch temporary fencing is acceptable. Fencing is required for depressions left by the removal of trees unless the depression is backfilled at once. On farms, where field tiling projects or research activities may make fencing impractical, an equally effective means of notification or warning of an excavation shall be employed.

Any surface encumbrances, or impediments, that are located in a position that could create a hazard to employees in or around the excavation shall be removed or supported to safeguard employees. All soil and rock removed during the excavation shall be placed at least two (2) feet from the edge of the excavation.

4.4 Utility Locating

It is expected that all utilities in the vicinity of the excavation will be marked or located prior to the disturbance of soil or ground cover. The location of the utilities should be performed jointly by designated College personnel (utility locators) and by the *Pennsylvania* Underground *Utility* Line Protection System (PA One Call System).

When excavation operations approach the estimated location of underground installations, clearance must be maintained between the underground utility, as marked, and the cutting edge or point of mechanized equipment. Per *Pennsylvania* Underground *Utility* Line Protection Law, the clearance must not be less than two (2) feet on either side of the outer limits of the utility. However, if the clearance is less than two (2) feet, exposure of the utility may be accomplished only by the use of hand excavation, air cutting, or vacuum excavation. Any utilities exposed during excavation activities shall be properly supported to prevent movement of the utility line.

4.5 Access and Egress

A stairway, ladder, ramp, or other safe means of egress shall be located in trench excavations that are four (4) feet in depth or greater. Safe means of egress should be provided so that no more than 25 feet of lateral travel is necessary for employees to reach the egress. If a ladder is used for access or egress it must be secure and extend at least 36 inches above the landing. Structural ramps that are used solely by employees shall be designed by a competent person, while ramps that are used for access or egress of equipment shall be designed by a competent person qualified in structural design.

4.6 Exposure to Vehicular Traffic and Falling Loads

Employees exposed to public vehicular traffic shall wear ANSI Class II safety vests. Additionally, employees shall don hard hats when working in an excavation and should not be under loads handled by lifting or digging equipment.

4.7 Hazardous Atmospheres

When potential or existing oxygen deficient or hazardous atmospheres exist, atmospheric monitoring should be performed using existing College confined space monitors. At a minimum, monitoring shall be performed for percent oxygen content, lower explosive limit (LEL), carbon monoxide, and hydrogen sulfide. Atmospheric monitoring should be performed prior to employee entry and continuously during employee entry into an excavation with a potential for an oxygen deficient or hazardous atmosphere. Safe entry conditions are defined as an oxygen content between 19.5-23.5%, a lower explosive limit < 10%, carbon monoxide < 25 parts per million (ppm), and hydrogen sulfide < 1 ppm. If an additional specific atmospheric contaminant exists or has the potential to exist, monitoring for that contaminant shall be performed.

If an oxygen deficient or hazardous atmosphere exists, measures shall be taken to prevent employee exposure. Measures that can possibly be taken include providing forced ventilation and, if necessary, the use of appropriate respiratory protection equipment. Prior to a member of the excavation crew donning respiratory protection equipment, the competent person for the excavation should contact the administrator of the College's Respiratory Protection Program in EHS for consultation.

Where hazardous atmospheric conditions exist or may reasonably be expected to develop during work in an excavation the Public Safety shall be notified.

4.8 Hazards from Water Accumulation

College employees shall not work in excavations in which there is accumulated or accumulating water unless appropriate precautions have been taken to protect employees from hazards presented by water. The necessary precautions may vary based on the project, but it is anticipated that precautions should include support or shield systems to protect from cave-ins, water removal to control the level of accumulating water, or the use of a safety harness and lifeline.

If water removal equipment is utilized to control accumulating water it should be monitored by a competent person.

If excavation work interrupts the natural drainage of surface water, diversion ditches, dikes, or other suitable means shall be used to prevent surface water from entering the excavation and to provide adequate drainage of the area adjacent to the excavation.

4.9 Stability of Adjacent Structures

Where the stability of adjoining buildings, walls, or other structures is endangered by excavation operations, support systems such as shoring, bracing, or underpinning shall be provided to ensure the stability of such structures for the protection of employees.

Excavation below the level of the base or footing of any foundation or retaining wall that could reasonably be expected to pose a hazard to employees shall not be permitted except when:

- A support system, such as underpinning is provided to ensure the safety of employees and the stability of the structure; or
- The excavation is in stable rock; or
- A registered professional engineer has approved the determination that the structure is sufficiently removed from the excavation so as to be unaffected by the excavation activity; or
- A registered professional engineer has approved the determination that such excavation work will not pose a hazard to employees.

Sidewalks, pavement, and ancillary structures shall also not be undermined unless a support system or other method of protection is provided to protect employees from the collapse of such structures.

4.10 Protection of Employees in Excavations

All earthen materials and equipment shall be kept at least two (2) feet from the edge of an excavation to prevent materials or equipment from falling or rolling into excavations. Protection shall also be afforded to prevent loose rock or soil from falling and rolling from an excavation face onto an employee.

Measures that can be taken to prevent such events are scaling to remove loose material, installation of protective barricades on the face to stop and contain material, or other means that provide equivalent protection.

Employees are not permitted to work on the faces of sloped or benched excavations at levels above other employees except when employees at lower levels are protected from the hazard or falling, rolling, or sliding material and equipment.

Each employee shall be protected from cave-ins by adequate protective systems, which will be discussed below.

4.11 Inspections

A competent person shall perform daily inspections before work begins and as needed throughout the shift. Form ET-2 Excavation Site Checklist and Daily Field Report (See Appendix C), shall be used. The inspections shall include the excavations, the adjacent areas, and the protective systems. They also shall include the identification of problems with the excavation that could result in a cave-in or to identify indications of failure with the protective systems. The inspection shall also include an evaluation of the potential for a hazardous atmosphere to develop. The ET-2 forms shall be maintained by the supervising department for a period of one (1) year and be made available for EHS to review, if requested.

No employee shall enter an excavation prior to inspection by the competent person.

Additionally, no employee shall enter an excavation if a hazard is identified until that hazard has been mitigated.

4.12 Fall Protection

Walkways shall be provided when employees or equipment are required or permitted to cross over an excavation. Guardrails which comply with 1926.502(b) shall be provided where walkways are six (6) feet or more above lower levels.

5.0 REQUIREMENTS FOR PROTECTIVE SYSTEMS

OSHA excavation and trenching standards do not require a protective system when an excavation is made entirely in stable rock or when an excavation is less than 5 feet deep and a competent person has examined the ground and found no indication of a potential cave-in.

5.1 Soil Classification

All soils on campus shall be designated as Type C soils unless a determination is made by the competent person that a Type A or B soil is present. When soils are configured in layers, they will be classified by the weakest layer. Appendix A to 1926 Subpart P provides further guidance on the definitions of the types of soil and the acceptable visual and manual tests that can be performed to determine soil type. This Appendix is also provided as Appendix A to this document. Soil shall be classified by the competent person before selecting a protective system.

5.2 Design of Sloping and Benching

As described above it is assumed that all soil is type C unless determined otherwise by a competent person. The maximum allowable slopes per soil type are provided in the table below.

Maximum Allowable Slopes Soil or Rock Type	Maximum Allowable Slopes (Horizontal : Vertical) For Excavations Less Than 20 Feet Deep
Stable Rock	Vertical (90 Deg.)
Type A2	0.75 : 1 (53 Deg.)
Type B	1 : 1 (45 Deg.)
Type C	1.5 : 1 (34 Deg.)

- Numbers shown in parentheses next to maximum allowable slopes are angles expressed in degrees from the horizontal. Angles have been rounded off.
- A short term (< 24 hours) maximum allowable slope of ½ Horizontal : 1 Vertical (63 degrees) is allowed in excavations in Type A soil that are 12 feet or less in depth. Short term maximum allowable slopes for excavations greater than 12 feet in depth shall be ¾ Horizontal : 1 Vertical (53 degrees).
- Sloping or benching for excavations greater than 20 feet deep shall be designed by a registered professional engineer.
- Appendix B to 1926 Subpart P provides guidance on sloping and benching. This appendix is also provided as Appendix B to this document.

5.3 Materials and Equipment

Materials and equipment used for protective systems shall be free from damage or defects that may impair their proper function. A competent person shall examine materials or equipment that is used for protective systems. If the materials or equipment are found to be damaged or defective they shall be removed from service and not put back into service until it is evaluated and approved by a registered professional engineer.

Materials and equipment used for protective systems shall be used and maintained in a manner that is consistent with the recommendations of the manufacturer, and in a manner so as to prevent employee exposure to hazards.

5.4 Installation and Removal of Support

Excavation of material shall be limited to a level no greater than 2 feet below the bottom of the members of the support system, given that the system is designed to resist the forces calculated for the full depth of the trench and when given that there are no indications of the loss of soil from behind or below the support system.

Support systems shall be installed and removed in a manner that protects employees from cave-ins, structural collapses, or from being struck by members of the support system.

Members of the support system shall also be securely connected together to prevent sliding, falling, kick-outs, or other failures. Members of support systems shall not be subject to loads exceeding their capacity. Prior to removal of support members, precautions should be taken to ensure the safety of employees. Removal of support members shall begin at the bottom of the excavation and shall progress together with backfilling.

5.5 Shield Systems

A shield system shall be installed in a manner that will restrict lateral or other hazardous movement and shall not be subject to loads exceeding its capability. Employees shall be protected from the hazard of cave-ins when entering or exiting the areas protected by shields. Employees shall not be allowed in shields when they are being installed, removed, or moved vertically.

Excavations of materials shall be limited to a level no greater than 2 feet below the bottom of a shield only if the shield is designed to resist the forces calculated for the full depth of the trench and when there is no evidence of soil loss from behind or below the bottom of the shield.

APPENDIX A

Soil Classification

- **Part Number:** 1926
- **Part Number Title:** Safety and Health Regulations for Construction
- **Subpart:** 1926 Subpart P
- **Subpart Title:** Excavations
- **Standard Number:** 1926 Subpart P App A
- **Title:** Soil Classification

(a) Scope and application

(1) Scope. This appendix describes a method of classifying soil and rock deposits based on site and environmental conditions, and on the structure and composition of the earth deposits. The appendix contains definitions, sets forth requirements, and describes acceptable visual and manual tests for use in classifying soils.

(2) Application. This appendix applies when a sloping or benching system is designed in accordance with the requirements set forth in 1926.652(b)(2) as a method of protection for employees from cave-ins. This appendix also applies when timber shoring for excavations is designed as a method of protection from cave-ins in accordance with appendix C to subpart P of part 1926, and when aluminum hydraulic shoring is designed in accordance with appendix D. This Appendix also applies if other protective systems are designed and selected for use from data prepared in accordance with the requirements set forth in 1926.652(c), and the use of the data is predicated on the use of the soil classification system set forth in this appendix.

(b) Definitions. The definitions and examples given below are based on, in whole or in part, the following; American Society for Testing Materials (ASTM) Standards D653-85 and D2488; The Unified Soils Classification System; The U.S. Department of Agriculture (USDA) Textural Classification Scheme; and The National Bureau of Standards Report BSS-121.

"Cemented soil" means a soil in which the particles are held together by a chemical agent, such as calcium carbonate, such that a hand-size sample cannot be crushed into powder or individual soil particles by finger pressure.

"Cohesive soil" means clay (fine grained soil), or 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. Cohesive soils include clayey silt, sandy clay, silty clay, clay and organic clay.

"Dry soil" means soil that does not exhibit visible signs of moisture content.

"Fissured" means a soil material that has a tendency 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.

"Granular soil" means gravel, sand, or silt (coarse grained soil) with little or no clay content. Granular soil has no cohesive strength. Some moist granular soils exhibit apparent cohesion. Granular soil cannot be molded when moist and crumbles easily when dry.

"Layered system" means two or more distinctly different soil or rock types arranged in layers. Micaceous seams or weakened planes in rock or shale are considered layered.

"Moist soil" means a condition in which a soil looks and feels damp. Moist cohesive soil can easily be shaped into a ball and rolled into small diameter threads before crumbling. Moist granular soil that contains some cohesive material will exhibit signs of cohesion between particles.

"Plastic" means a property of a soil which allows the soil to be deformed or molded without cracking, or appreciable volume change.

"Saturated soil" means a soil in which the voids are filled with water. Saturation does not require flow. Saturation, or near saturation, is necessary for the proper use of instruments such as a pocket penetrometer or sheer vane.

"Soil classification system" means, for the purpose of this subpart, a method of categorizing soil and rock deposits in a hierarchy of Stable Rock, Type A, Type B, and Type C, in decreasing order of stability. The categories are determined based on an analysis of the properties and performance characteristics of the deposits and the characteristics of the deposits and the environmental conditions of exposure.

"Stable rock" means natural solid mineral matter that can be excavated with vertical sides and remain intact while exposed.

"Submerged soil" means soil which is underwater or is free seeping.

"Type A" means cohesive soils with an unconfined, compressive strength of 1.5 ton per square foot (tsf) (144 kPa) 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. However, no soil is Type A if:

(i) The soil is fissured; or

(ii) The soil is subject to vibration from heavy traffic, pile driving, or similar effects; or

(iii) The soil has been previously disturbed; or

(iv) 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; or

(v) The material is subject to other factors that would require it to be classified as a less stable material.

"Type B" means:

(i) Cohesive soil with an unconfined compressive strength greater than 0.5 tsf (48 kPa) but less than 1.5 tsf (144 kPa); or

(ii) 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.

(iii) Previously disturbed soils except those which would otherwise be classed as Type C soil.

(iv) Soil that meets the unconfined compressive strength or cementation requirements for Type A, but is fissured or subject to vibration; or

(v) Dry rock that is not stable; or

(vi) Material that is part of a sloped, layered system where the layers dip into the excavation on a slope less steep than four horizontal to one vertical (4H:1V), but only if the material would otherwise be classified as Type B.

"Type C" means:
(i) Cohesive soil with an unconfined compressive strength of 0.5 tsf (48 kPa) or less; or
(ii) Granular soils including gravel, sand, and loamy sand; or
(iii) Submerged soil or soil from which water is freely seeping; or
(iv) Submerged rock that is not stable, or
(v) Material in a sloped, layered system where the layers dip into the excavation or a slope of four horizontal to one vertical (4H:1V) or steeper.

"Unconfined compressive strength" means the load per unit area at which a soil will fail in compression. It can be determined by laboratory testing, or estimated in the field using a pocket penetrometer, by thumb penetration tests, and other methods.

"Wet soil" means soil that contains significantly more moisture than moist soil, but in such a range of values that cohesive material will slump or begin to flow when vibrated. Granular material that would exhibit cohesive properties when moist will lose those cohesive properties when wet.

(c) Requirements

(1) Classification of soil and rock deposits. 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 paragraph (b) of this appendix.

(2) Basis of classification. The classification of the deposits shall be made based on the results of at least one visual and at least one manual analysis. Such analyses shall be conducted by a competent person using tests described in paragraph (d) below, or in other recognized methods of soil classification and testing such as those adopted by the American Society for Testing Materials, or the U.S. Department of Agriculture textural classification system.

(3) Visual and manual analyses. The visual and manual analyses, such as those noted as being acceptable in paragraph (d) of this appendix, shall be designed and conducted to provide sufficient quantitative and qualitative information as may be necessary to identify properly the properties, factors, and conditions affecting the classification of the deposits.

(4) Layered systems. In a layered system, the system shall be classified in accordance with its weakest layer. However, each layer may be classified individually where a more stable layer lies under a less stable layer.

(5) Reclassification. If, after classifying a deposit, the properties, factors, or conditions affecting its classification change in any way, the changes shall be evaluated by a competent person. The deposit shall be reclassified as necessary to reflect the changed circumstances.

(d) Acceptable visual and manual tests. - (1) Visual tests. 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.

(i) Observe samples of soil that are excavated and soil in the sides of the excavation. 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.

(ii) Observe 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.

(iii) Observe 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.

(iv) Observe 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.

(v) Observed the opened side of the excavation to identify layered systems. Examine layered systems to identify if the layers slope toward the excavation. Estimate the degree of slope of the layers.

(vi) Observe 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 location of the level of the water table.

(vii) Observe the area adjacent to the excavation and the area within the excavation for sources of vibration that may affect the stability of the excavation face.

(2) Manual tests. 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.

(i) Plasticity. Mold a moist or wet sample of soil into a ball and attempt to roll it into threads as thin as 1/8-inch in diameter. Cohesive material can be successfully rolled into threads without crumbling. For example, if at least a two inch (50 mm) length of 1/8-inch thread can be held on one end without tearing, the soil is cohesive.

(ii) Dry strength. If the soil is dry and crumbles on its own or with moderate pressure into individual grains or fine powder, it is granular (any combination of gravel, sand, or silt). 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. If the dry soil breaks into clumps which do not break up into small clumps and which can only be broken with difficulty, and there is no visual indication the soil is fissured, the soil may be considered unfissured.

(iii) Thumb penetration. The thumb penetration test can be used to estimate the unconfined compressive strength of cohesive soils. (This test is based on the thumb penetration test described in American Society for Testing and Materials (ASTM) Standard designation D2488 - "Standard Recommended Practice for Description of Soils (Visual - Manual Procedure).") Type A soils with an unconfined compressive strength of 1.5 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. This test should be conducted on an undisturbed soil sample, such as a large clump of spoil, as soon as practicable after excavation to keep to a minimum the effects of exposure to drying influences. If the excavation is later exposed to wetting influences (rain, flooding), the classification of the soil must be changed accordingly.

(iv) Other strength tests. Estimates of unconfined compressive strength of soils can also be obtained by use of a pocket penetrometer or by using a hand-operated shearvane.

(v) Drying test. The basic purpose of the drying test is to differentiate between cohesive material with fissures, unfissured cohesive material, and granular material. The procedure for the drying test involves drying a sample of soil that is approximately one inch thick (2.54 cm) and six inches (15.24 cm) in diameter until it is thoroughly dry:

(A) If the sample develops cracks as it dries, significant fissures are indicated.

(B) Samples that dry without cracking are to be broken by hand. If considerable force is necessary to break a sample, the soil has significant cohesive material content. The soil can be classified as an unfissured cohesive material and the unconfined compressive strength should be determined.

(C) If a sample breaks easily by hand, it is either a fissured cohesive material or a granular material. To distinguish between the two, pulverize the dried clumps of the sample by hand or by stepping on them. If the clumps do not pulverize easily, the material is cohesive with fissures. If they pulverize easily into very small fragments, the material is granular.

APPENDIX B

Slopping and Benching

- **Part Number:** 1926
- **Part Number Title:** Safety and Health Regulations for Construction
- **Subpart:** 1926 Subpart P
- **Subpart Title:** Excavations
- **Standard Number:** 1926 Subpart P App B

- **Title:** Sloping and Benching

(a) ***Scope and application***. This appendix contains specifications for sloping and benching when used as methods of protecting employees working in excavations from cave-ins. The requirements of this appendix apply when the design of sloping and benching protective systems is to be performed in accordance with the requirements set forth in § 1926.652(b)(2).

(b) ***Definitions***.

Actual slope means the slope to which an excavation face is excavated.

Distress means that the soil is in a condition where a cave-in is imminent or is likely to occur. Distress is evidenced by such phenomena as the development of fissures in the face of or adjacent to an open excavation; the subsidence of the edge of an excavation; the slumping of material from the face or the bulging or heaving of material from the bottom of an excavation; the spalling of material from the face of an excavation; and raveling, i.e., small amounts of material such as pebbles or little clumps of material suddenly separating from the face of an excavation and trickling or rolling down into the excavation.

Maximum allowable slope means the steepest incline of an excavation face that is acceptable for the most favorable site conditions as protection against cave-ins, and is expressed as the ratio of horizontal distance to vertical rise (H:V).

Short term exposure means a period of time less than or equal to 24 hours that an excavation is open.

(c) ***Requirements*** -- (1) ***Soil classification***. Soil and rock deposits shall be classified in accordance with appendix A to subpart P of part 1926.

(2) ***Maximum allowable slope***. The maximum allowable slope for a soil or rock deposit shall be determined from Table B-1 of this appendix.

(3) ***Actual slope***. (i) The actual slope shall not be steeper than the maximum allowable slope.

(ii) The actual slope shall be less steep than the maximum allowable slope, when there are signs of distress. If that situation occurs, the slope shall be cut back to an actual slope which is at least ½ horizontal to one vertical (½H:1V) less steep than the maximum allowable slope.

(iii) When surcharge loads from stored material or equipment, operating equipment, or traffic are present, a competent person shall determine the degree to which the actual slope must be reduced below the maximum allowable slope, and shall assure that such reduction is achieved. Surcharge loads from adjacent structures shall be evaluated in accordance with § 1926.651(i).

(4) ***Configurations***. Configurations of sloping and benching systems shall be in accordance with Figure B-1.

TABLE B-1

MAXIMUM ALLOWABLE SLOPES

SOIL OR ROCK TYPE	MAXIMUM ALLOWABLE SLOPES (H:V)(1) FOR EXCAVATIONS LESS THAN 20 FEET DEEP(3)
STABLE ROCK	VERTICAL (90º)
TYPE A (2)	3/4:1 (53º)
TYPE B	1:1 (45º)
TYPE C	1 ½:1 (34º)

Footnote(1) Numbers shown in parentheses next to maximum allowable slopes are angles expressed in degrees from the horizontal. Angles have been rounded off.

Footnote(2) A short-term maximum allowable slope of 1/2H:1V (63º) is allowed in excavations in Type A soil that are 12 feet (3.67 m) or less in depth. Short-term maximum allowable slopes for excavations greater than 12 feet (3.67 m) in depth shall be 3/4H:1V (53º).

Footnote(3) Sloping or benching for excavations greater than 20 feet deep shall be designed by a registered professional engineer.

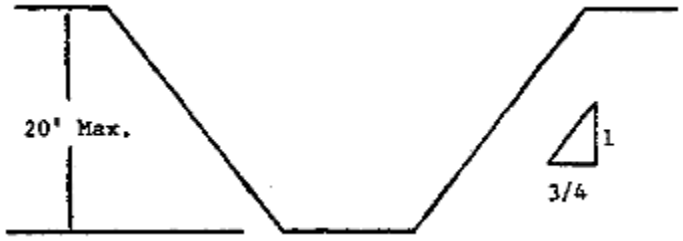
Figure B-1

Slope Configurations

(All slopes stated below are in the horizontal to vertical ratio)

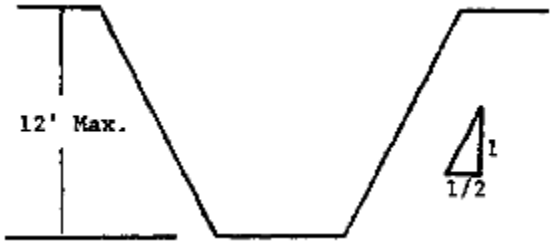
B-1.1 Excavations made in Type A soil.

1. All simple slope excavation 20 feet or less in depth shall have a maximum allowable slope of ¾:1.



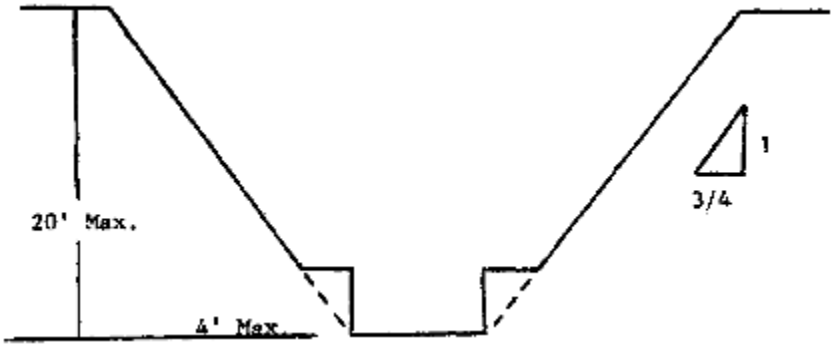
SIMPLE SLOPE -- GENERAL

Exception: Simple slope excavations which are open 24 hours or less (short term) and which are 12 feet or less in depth shall have a maximum allowable slope of ½:1.

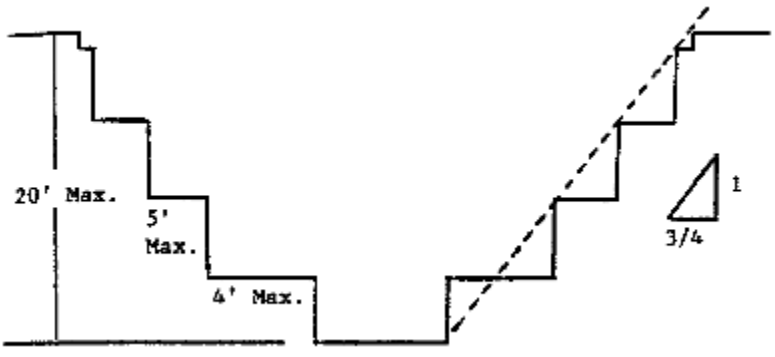


SIMPLE SLOPE -- SHORT TERM

2. All benched excavations 20 feet or less in depth shall have a maximum allowable slope of 3/4 to 1 and maximum bench dimensions as follows:

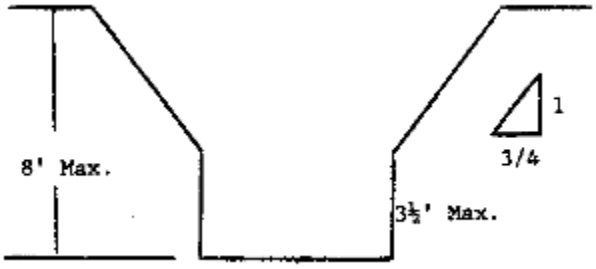


SIMPLE BENCH



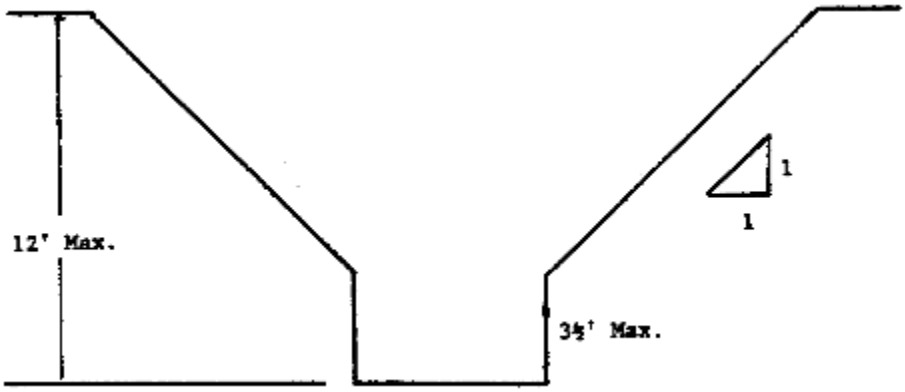
MULTIPLE BENCH

3. All excavations 8 feet or less in depth which have unsupported vertically sided lower portions shall have a maximum vertical side of 3½ feet.



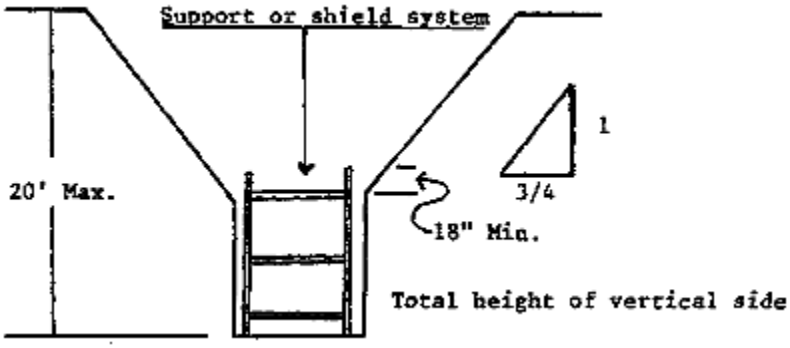
UNSUPPORTED VERTICALLY SIDED LOWER PORTION -- MAXIMUM 8 FEET IN DEPTH)

All excavations more than 8 feet but not more than 12 feet in depth with unsupported vertically sided lower portions shall have a maximum allowable slope of 1:1 and a maximum vertical side of 3½ feet.



UNSUPPORTED VERTICALLY SIDED LOWER PORTION -- MAXIMUM 12 FEET IN DEPTH)

All excavations 20 feet or less in depth which have vertically sided lower portions that are supported or shielded shall have a maximum allowable slope of ¾:1. The support or shield system must extend at least 18 inches above the top of the vertical side.

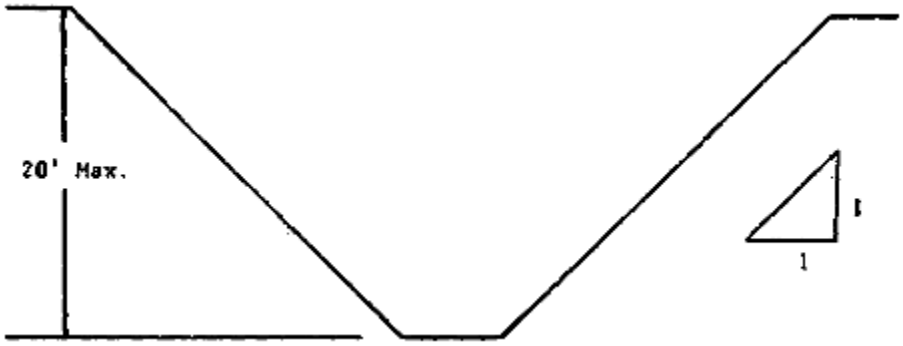


SUPPORTED OR SHIELDED VERTICALLY SIDED LOWER PORTION

4. All other simple slope, compound slope, and vertically sided lower portion excavations shall be in accordance with the other options permitted under § 1926.652(b).

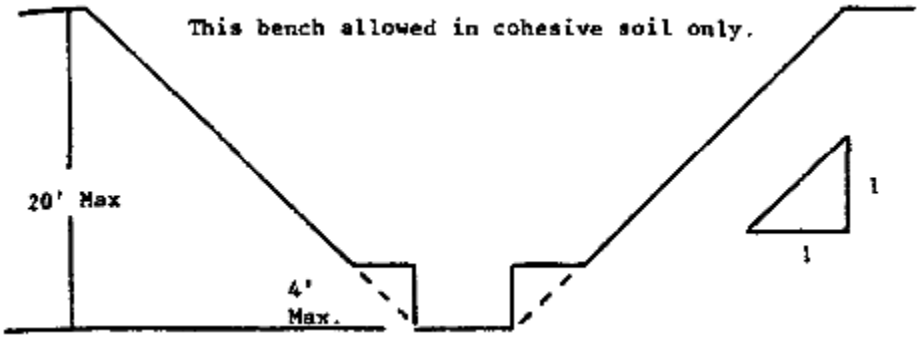
B-1.2 Excavations Made in Type B Soil

1. All simple slope excavations 20 feet or less in depth shall have a maximum allowable slope of 1:1.

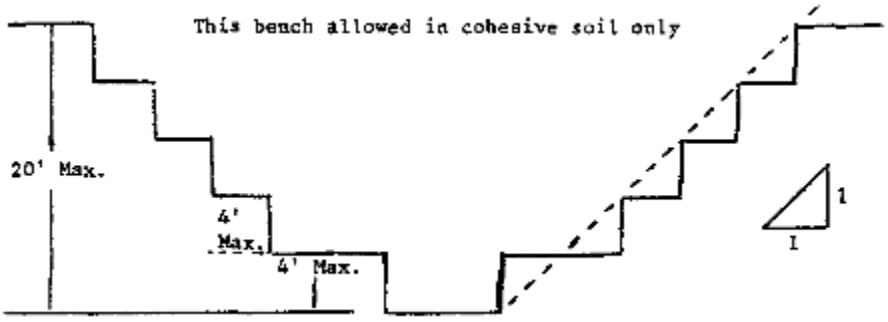


SIMPLE SLOPE

2. All benched excavations 20 feet or less in depth shall have a maximum allowable slope of 1:1 and maximum bench dimensions as follows:

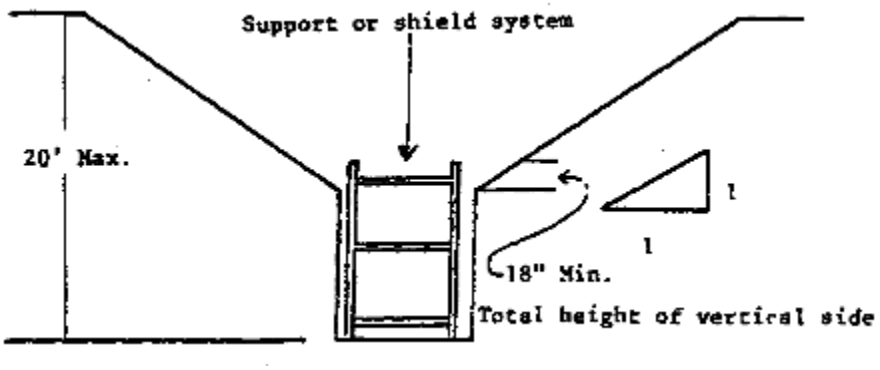


SINGLE BENCH



MULTIPLE BENCH

3. All excavations 20 feet or less in depth which have vertically sided lower portions shall be shielded or supported to a height at least 18 inches above the top of the vertical side. All such excavations shall have a maximum allowable slope of 1:1.

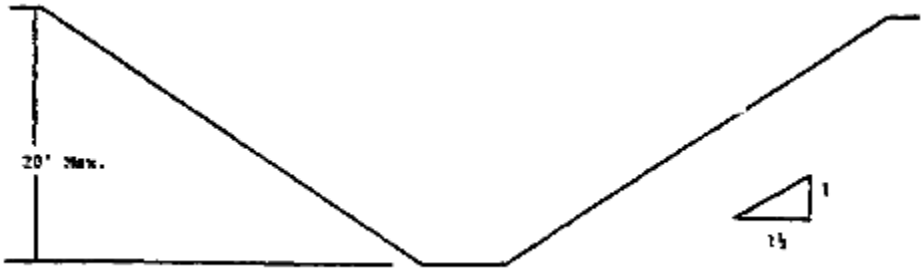


VERTICALLY SIDED LOWER PORTION

4. All other sloped excavations shall be in accordance with the other options permitted in § 1926.652(b).

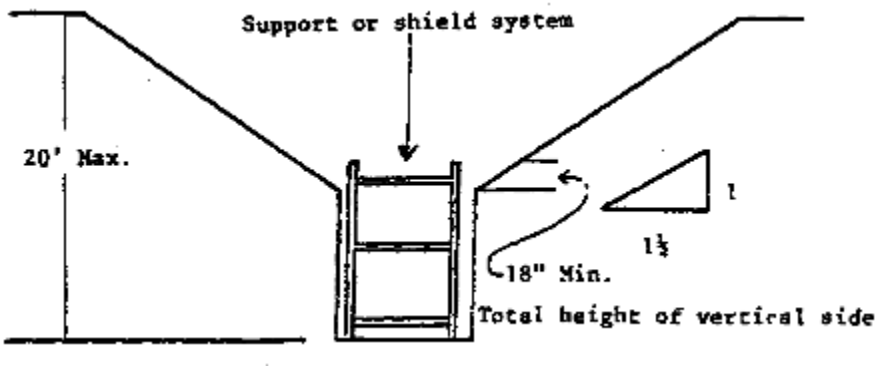
B-1.3 Excavations Made in Type C Soil

1. All simple slope excavations 20 feet or less in depth shall have a maximum allowable slope of 1½:1.



SIMPLE SLOPE

2. All excavations 20 feet or less in depth which have vertically sided lower portions shall be shielded or supported to a height at least 18 inches above the top of the vertical side. All such excavations shall have a maximum allowable slope of 1½:1.

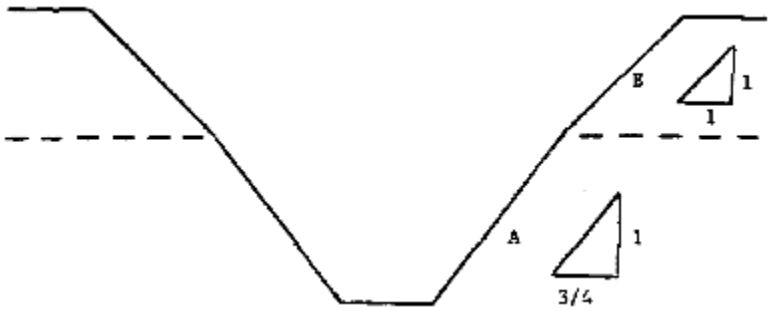


VERTICAL SIDED LOWER PORTION

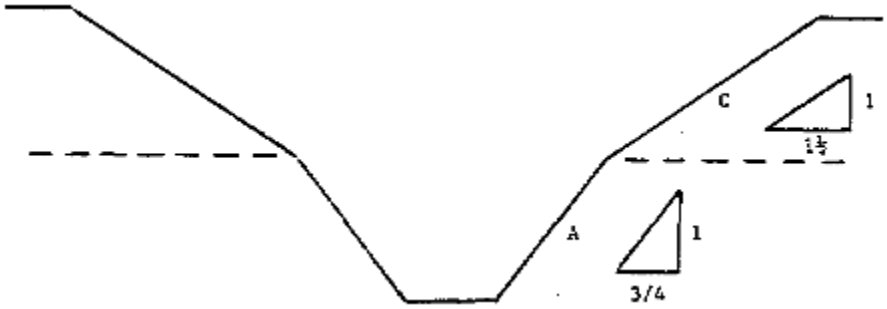
3. All other sloped excavations shall be in accordance with the other options permitted in § 1926.652(b).

B-1.4 Excavations Made in Layered Soils

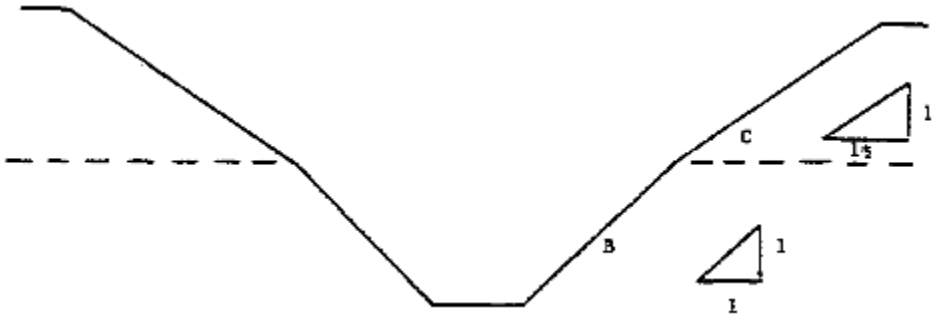
1. All excavations 20 feet or less in depth made in layered soils shall have a maximum allowable slope for each layer as set forth below.



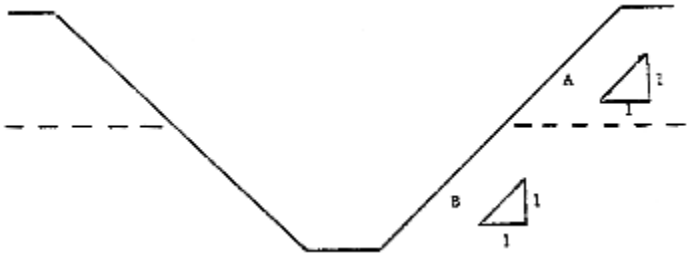
B OVER A



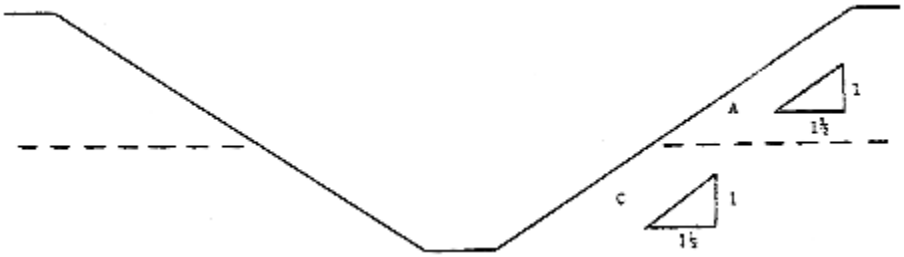
C OVER A



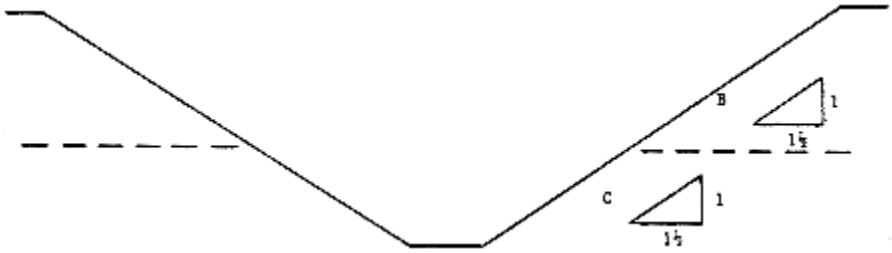
C OVER B



A OVER B



A OVER C



B OVER C

2. All other sloped excavations shall be in accordance with the other options permitted in § 1926.652(b).

APPENDIX C

Competent Person Evaluation Form – ET-1
Site Checklist and Daily Field Report – ET-2

Excavation Competent Person Evaluation – ET-1

Employee Name:	
Department:	Date:

Instructions: Evaluate the designated individual by completing the items in the evaluation list by indicating the appropriate response and noting descriptive conditions in the comments column.

Does the individual have training and knowledge of:	**Yes**	**No**	**Comments**

The requirements of 1926 Subpart P?			
The use of protective systems?			
Soils analysis and classification?			
The use of the soil classification worksheet?			
Hazardous environments?			
Does the individual have the authority to:	**Yes**	**No**	**Comments**
Take prompt corrective measures to eliminate existing and predictable hazards?			
To stop work?			
Does the individual have the knowledge and authority to conduct inspections:	**Yes**	**No**	**Comments**
Of the jobsite on a daily basis?			
Of adjacent areas?			
Of the protective systems?			
Prior to the start of work?			
As needed throughout the work shift?			
After a rainstorm or hazard-increasing occurrence?			
Of excavation safety equipment used in protective systems?			
Using the Excavation Site Checklist and Daily Field Report?			
Additional Comments:			

Supervisor: Date:

Excavation Site Checklist and Daily Field Report – ET-2

Competent Person:	Date:
Project Name:	Time:
Project Location:	
Weather Conditions:	Rainfall (inches):

Description of Inspection Item:	**Yes**	**No**	**Comments**

1. Have all utilities marked their locations?			
2. Have all affected parties been notified?			
3. Is proper traffic control in place?			
4. Has the soil been classified?	**X**		All soils are classified as Type C soils unless otherwise determined by the competent person.
5. Has a protective system been selected by the competent person?			
6. Has the competent person inspected the excavation/trench prior to start of each work period?			
7. Has the work plan been discussed with all employees?			
8. Are all employees protected from cave-ins when entering and exiting the excavation?			
9. Have hazardous objects around the excavation been removed or supported?			
10. Is all spoil maintained at least 2 feet back from the edge of the excavation?			
11. Are ladders used for access and egress? If so, are they installed correctly?			
12. Are employees protected from loose materials or tools which could fall into the trench?			
13. Are employees wearing the proper safety equipment?			
14. Is the excavation/trench free of standing or seeping water?			
15. Are there evidences of shrinkage cracks in the face of the trench wall?			
16. Were there evidences of sloughing of soil from the trench face since the last inspection?			
17. If a support system has been installed, was it installed in accordance with recommendations?			
18. Is heavy equipment kept away from the edge of the excavation?			
19. Are any changed conditions properly noted?			
20. Additional comments on safety.			

Competent Person: Date: