

Section 22

Excavation Operations

22.1 Scope

This section establishes requirements for all excavation operations at Bureau of Reclamation (Reclamation) facilities and Reclamation activities at other facilities. This section does not cover tunnel and shaft constructions (see Reclamation Safety and Health Standards (RSHS) Section 23, *Tunnel and Shaft Construction*). Reclamation considers trenching operations 20 feet deep, or more, drilling operations and does not cover those operations in this section (see RSHS Section 27, *Reclamation Drilling Standards*).

22.2 General Requirements

Reclamation's excavation work plans (EWPs) shall ensure the safety of employees and members of the public while protecting public and Reclamation property. Excavations exceeding 36 inches deep, and 10 feet long, will require an EWP. All excavation work must comply with standards and regulations in Occupational Safety and Health Administration (OSHA) 29 CFR 1926, *Safety and Health Regulations for Construction*, Subpart P, *Excavations*, and the Department of the Interior (Department) Department Manual Series 27, Part 485, *Safety and Occupational Health Program*.

22.3 Responsibilities

22.3.1 Area Office Safety Professional

22.3.1.1 Shall review and provide the excavation planner with feedback on the EWP (see paragraph 22.6.2, *Routine Work Site Inspection* of this section).

22.3.2 First-Line Supervisors

22.3.2.1 Shall review and sign EWPs.

22.3.2.2 Shall review and sign Job Hazard Analysis (JHAs) for the excavation work.

22.3.2.3 Shall ensure all employees acquire training or certification for their assigned excavation duties.

22.3.2.4 Shall designate the qualified competent person in writing.

22.3.2.5 Shall designate the excavation planner.

22.3.3 Competent Person

- 22.3.3.1** Shall stop work and take prompt corrective measures in dangerous, hazardous, or unsafe situations.
- 22.3.3.2** Shall complete required training or have experience equivalent to the requirements in paragraph 22.4, *Training Requirements* of this section.

22.3.4 Excavation Planner

- 22.3.4.1** Shall prepare and update the EWP (see paragraph 22.6.2), after any change in conditions.
- 22.3.4.2** Shall oversee initial and periodic inspections of the worksite to include inspection for changes in conditions and reported changes.

22.3.5 Pipefitters, Welders, and Site Personnel

- 22.3.5.1** Shall immediately report any condition change or hazard increase to the first-line supervisor or on-site competent person.
- 22.3.5.2** Shall incorporate ergonomic considerations into the work planning with the competent person and excavation planner (e.g., prolonged exposure to kneeling, bending over, awkward body positions).

22.4 Training Requirements

22.4.1 Initial Training

The competent person must take OSHA 3015, *Excavation, Trenching, and Soil Mechanics* and OSHA 7410, *Managing Excavation Hazards* trainings, have training in, or be able to demonstrate expertise in, the following elements:

- types of excavations,
- methods to analyze soil and other site conditions,
- determining need for protective systems,
- determining type of protective systems needed,
- analyzing protective systems for adequacy in strength and suitability, proper installation, moving of protective systems, and final removal,
- anticipating hazards that may develop at the excavation site,
- recognizing signs of developing hazards,
- issuing immediate stop work authority as needed and taking immediate corrective measures,
- identifying and monitoring potential hazardous atmospheres,
- anticipating unexpected events that may cause hazardous conditions,
- types of shoring systems and the conditions that require shoring system use,
- types and configurations of shielding systems,
- determining proper location and management of spoil piles,

- ability to create a traffic control plan and plan the proper use of barricades and stop logs for vehicular hazard control,
- planning public protection,
- protecting workers and the public from hazards of excavation work and use of heavy equipment,
- conducting preliminary site investigations, and
- other knowledge deemed necessary to be qualified as a competent person.

22.4.2 Refresher Training

Refresher training is necessary when OSHA makes a change to 29 CFR 1926, Subpart P.

22.4.3 Proficiency Qualification

The first-line supervisor will consider a competent person proficient when the person demonstrates expertise in the elements of 22.4.1, *Initial Training*.

22.4.4 Lack of Proficiency

The first-line supervisor shall remove a competent person demonstrating a lack of proficiency from a work site. The competent person must attend refresher training and the first-line supervisor must determine when reintegration at a work site may commence.

22.4.5 Recordkeeping

Reclamation training records shall be kept in the Department's official repository.

22.5 Hazard Identification, Assessment, and Safety Measures

22.5.1 Soil Classification

Prior to the creation of the EWP, a competent person must conduct a soil classification and, throughout the work, evaluate the soil conditions to determine if there is a change from previous classification(s). Type A soil classifications provide the highest safety protections and do not require soil reclassification but the competent person should still annotate this in the EWP.

Table 22-1. Soil Classification and Properties

Soil Type	Criteria	Other Considerations
Stable Rock	Natural solid mineral that can be excavated with vertical sides and remain intact while exposed.	-
Type A	Cohesive soil with an unconfined compressive strength of 1.5 tons per square foot (tsf) (144 kPa) or greater.	Cannot be Type A if soil is: <ul style="list-style-type: none"> • fissured, • subject to vibration from heavy traffic, pile driving, etc., • previously disturbed, • part of sloped, layered system where layers dip into excavation on a slope of greater than 4:1, or • subject to other factors requiring classification as a less stable material.
Type B	Cohesive soil with an unconfined compressive strength greater than 0.5 tsf (48 kPa) but less than 1.5 tsf (144 kPa).	Type B soil can also be: <ul style="list-style-type: none"> • granular cohesionless soils such as angular gravel, silt, silt loam, sandy loam, and in some cases, silty clay loam and sandy clay loam, • previously disturbed soils except those otherwise classified as Type C soil, • soil that meets the requirements of Type A, but is fissured or subject to vibration, • dry rock that is not stable, or • part of sloped, layered system where layers dip into excavation on a slope of 4:1, but only if the soil would otherwise be classified as Type A.
Type C	Cohesive soil with an unconfined compressive strength of 0.5 tsf (48kPa) or less.	Type C soil can also be: <ul style="list-style-type: none"> • granular soils including gravel, sand, and loamy sand, • submerged soil or soil from which water is freely seeping, • submerged rock that is not stable, or • part of sloped, layered system where layers dip into excavation on a slope of 4:1 or steeper.

TYPE C SOIL CANNOT BE BENCHED

22.5.2 Locating Underground Utilities

To request approval to dig, the excavation planner shall contact underground utilities or state central utility locator services at least 2 weeks prior to the start of work. Adjust the EWP based on the results of underground utility locations.

22.5.3 Hazardous Atmosphere

Excavations may have potential for hazardous atmospheres (i.e., oxygen deficiency). First-line supervisors must keep a log of any on-site air monitoring and make it available for workers and other personnel (OSHA 29 CFR 1926.651(g), *Hazardous Atmospheres*). The on-site competent person shall take precautions to prevent exposure to hazardous atmospheres. Precautions shall include respiratory protection or ventilation (OSHA 29 CFR 1926, Subpart E, *Personal Protective and Life Saving Equipment*, and Subpart C, *General Safety and Health Provisions*).

22.5.4 Vehicular Traffic

Employees shall wear high-visibility safety apparel as outlined in RSHS Section 8, *Personal Protective Equipment* (see 8.10.6 of RSHS Section 8). First-line supervisors shall provide protection to workers from vehicle hazards on and adjacent to the work site. Stop logs must be capable of preventing the work site's largest vehicle mass and momentum from entering or falling into the excavation. Barricades shall keep standard vehicles from encroaching on the excavation. Reclamation requires traffic control if the work impacts public roads or the safety of workers or visitors on private roads. The area office safety professional and/or first-line supervisor will make themselves aware of any state requirements for approved traffic control plans and/or qualified flaggers (RSHS section 9, *Signs, Signals, and Barricades*).

22.5.5 Safe Work Positioning

Employees must stand clear of vehicles during loading or unloading. The on-site competent person must ensure vehicle drivers and equipment operators know where personnel are in proximity to vehicles and equipment. Personnel shall ensure they are working or standing where drivers and equipment operators can see them. Employees must stand away from the operational swing of heavy machinery and out of the operational zone of lifted or suspended loads.

22.5.6 Removal of Surface Encumbrances

Before excavation, competent persons must remove trees, brush, boulders, and/or other surface encumbrances which may pose a hazard.

22.6 Pre-job Briefing and Planning Requirements

22.6.1 Preliminary Site Inspection

In preparation for the EWP, an excavation planner must inspect the work site and adjacent areas to determine conditions and potential hazards that would require special safety measures or mitigation.

22.6.2 Routine Work Site Inspection

Based upon the EWP, the excavation planner will oversee the work of routine site inspection. The excavation planner may delegate the routine work site inspection to another competent person.

22.6.3 Excavation Work Plan

The excavation planner, with input from the competent person and other competent persons, will complete the EWP. Reclamation does not require EWPs for site grading unless there is the presence of underground utilities. The EWP must include preliminary site inspection results, soil classification, work planning, safe work release from underground utilities, site layout, public protection, traffic control, hazard identification, environmental hazards management plans, JHAs, and all other applicable details to safely conduct the excavation work. This plan will detail all phases of excavation operations including:

- details of excavation work (e.g., width, depth, type of work),
- notation of all possible safety hazards (e.g., overhead and adjacent hazards),
- mitigation plan for identified and probable safety hazards,
- designation and creation of specifications for the protective system(s),
- JHA(s),
- emergency response actions and contacts,
- locations and means of ingress and egress (see paragraph 22.9.7, *Ingress and Egress* of this section),
- a detailed site plan diagram of all activity and adjacent areas,
- requirements for hazardous atmosphere testing,
- underground utility approval dig permit,
- initial soil classification,
- spoil material pile location and pile management,
- traffic control plan,
- excavation equipment management,
- locations of excavation equipment during operations, overnighting, or during long work stops,
- swing radius and full extension radius,
- stoplogs and barricades, and
- spotter or signalman.

22.6.4 Public Protections

The excavation planner must ensure excavation operations address safety measures for public protection. The excavation planner must provide advance warning through community outreach, direct communications, and appropriate signage.

22.7 Hazardous Environmental Conditions (Weather/Other)

22.7.1 Rain and Stormwater Runoff

Drainage must direct rainwater away from the excavation, prevent accumulation, and must not leave the work site unless allowed by a separate stormwater management plan. Melting snow or ice can become a water hazard. The excavation planner will direct competent persons to use diversion ditches, dikes, or other means to prevent rainwater or other precipitation from entering the work site. The excavation planner must also determine how to prevent stormwater runoff from entering the work site or interfering with material spoils piles.

22.7.2 Groundwater

Employees must stop work immediately if groundwater seeps or flows into the excavation site. Work cannot resume until all the groundwater is removed and no longer flows into the excavation.

22.7.3 Wind

Employees must manage loose materials and spoil piles so that wind cannot blow materials in or off the work site. Blowing particles or materials must not interfere with the ability of workers to safely perform their duties.

22.8 Other Safety Equipment

22.8.1 Emergency Rescue Equipment

The JHA must identify equipment (e.g., breathing apparatus, safety harness, basket stretcher) and first-line supervisors must make equipment readily available where hazardous atmospheres exist or may reasonably be expected to develop. A competent person must attend all equipment when in use. Workers do not need to wear a harness with a secured lifeline for excavation operations, unless defined as a confined footing or other similar dig. Consistent with OSHA 29 CFR 1926, Subpart P, Reclamation defines excavations deeper than 20 feet as drilling or shaft work (see RSHS Section 23, *Tunnel and Shaft Construction*).

22.9 Safe Practices

22.9.1 Simple Sloping

Excavations 5 feet deep, or more (trenches), must have sloping or shoring. Reclamation does not require sloping or shoring when the excavation is less than 5 feet deep and an examination of the soil by a competent person provides no indication of potential for unstable slopes. Excavations less than 20 feet deep must not exceed slopes of 53 degrees for Type A soils, 45 degrees for Type B soils, and 34 degrees for Type C soils. Competent

persons must measure slope from the horizontal plane and excavate to form sloping configurations for Type C soils per Figure 22.1.

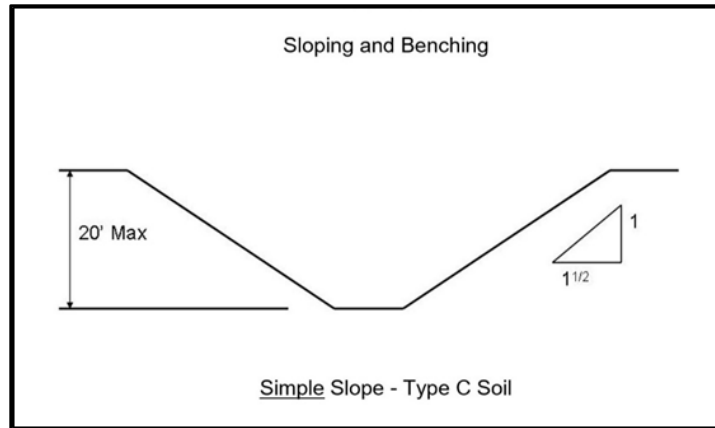


Figure 22-1. Simple Slope, Sloping, and Benching of a Type C Soil

22.9.2 Sloping with Shielding

Competent persons may use sloping in conjunction with shielding. Combination shielding and sloping systems (known as sloping with shielding) must match the Type C soil configuration found in Figure 22.2, below, or a registered professional engineer (PE) who specializes in sloping and shoring systems must design the sloping with shielding combination. The excavation work site will make a copy of the design readily available while constructing sloping with shielding and the design must remain available until the shielding is removed.

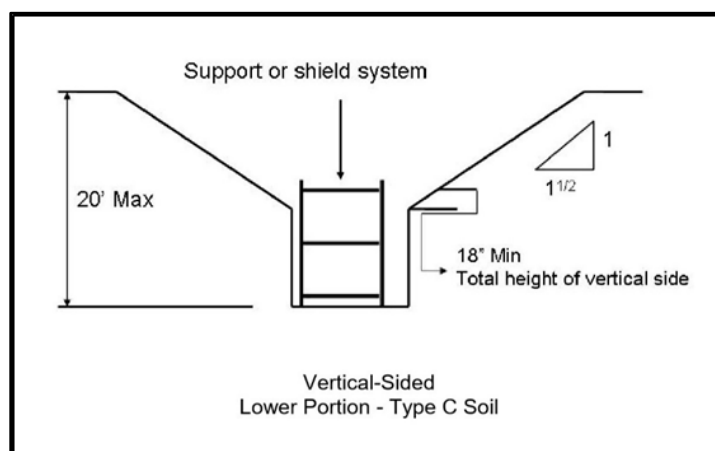


Figure 22-2. Combination Sloping with Shielding of a Type C Soil

22.9.3 Simple Benching

Reclamation only allows benching for Type A or Type B soils and when excavations are less than 20 feet deep. Maximum allowable slope is $\frac{3}{4}$:1. Simple benching has a single bench cut made adjacent to the bottom of the excavation. See Figure 22.3, below.

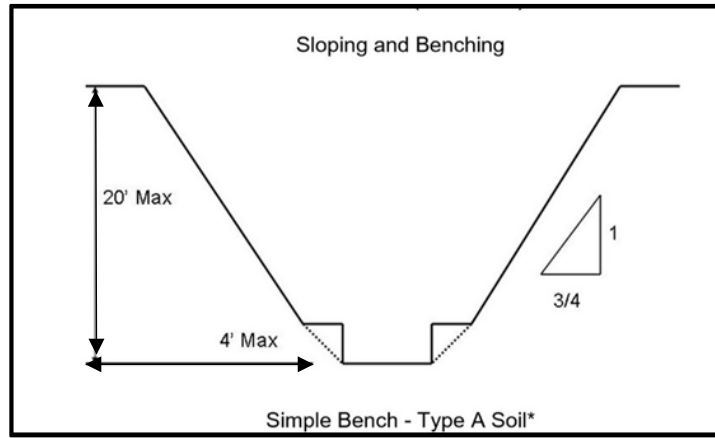


Figure 22-3. Simple Benching, Sloping and Benching, Type A or Type B Soils

22.9.4 Tiered (Multiple) Benching

Tiered, or multiple, benching has more than one cut into the slope of the excavation. Tiered benching shall only be used in Type A soils. See Figure 22-4, below.

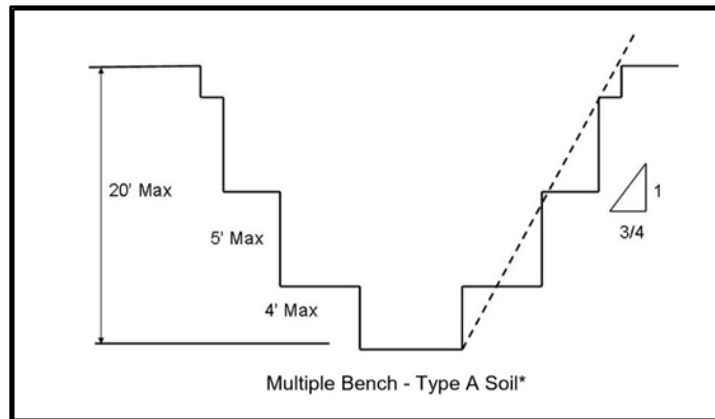


Figure 22-4. Tiered (Multiple) Benching, Type A Soil

22.9.5 Alternative Benching

A registered professional engineer (PE) with expertise in excavation operations must design the benching system or the system must follow Figures 22-3 or 22-4.

22.9.6 Shielding/Protective Systems

A registered PE with expertise in shielding/protective systems must design the systems or Reclamation must purchase a manufactured shielding/protective system. The system must

be in good working order and condition, free from damage and defect, and used per the system design specifications. Competent persons within the excavation site must also install the shielding/protective system properly to restrict lateral or other hazardous movement of the shield under sudden lateral loads. The shielding/protective system must protect against hazards of cave-in or collapse during ingress, egress, and while workers are inside the system. Workers shall not be inside the shields when competent persons install, remove, or move the shielding/protective systems.

22.9.7 Ingress and Egress

For excavations 4 feet deep or more, the excavation site must provide stairs, ramps, or ladders as a safe means of egress. Each worker must be within 25 linear feet in the direction of lateral travel to a ramp, stair, or ladder and must have at least two means of egress. If a barrier or other hazard prevents the worker from reaching the other side of the excavation easily, the excavation site must provide egress options on the same side as the worker. Ladders must extend from the bottom of the excavation to no less than 3 feet above the surface. Ramps shall be a minimum of 4 feet wide and only used for personnel. Personnel shall not use, store, or move any equipment on ingress/egress ramps (RSHS Section 13, *Walking and Working Surfaces*).

22.9.8 Spoil Piles

Spoil piles must be a minimum of 2 horizontal, linear feet away from the open excavation area. The excavation site must place the spoil pile so that spalling, raveling, or sloughing will not encroach upon the open excavation area clear space. In addition, the excavation site must maintain the spoil pile to keep spoil pile materials from becoming a hazard to workers, others on the site, and the general public.

22.10 Definitions

Benching	Method of protecting workers 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. Benching cannot be done in Type C soil.
Cohesive Soil	Clay-type soil (fine grained soil), or soil with a high clay content, which has the property of sticking together tightly and does not crumble. Cohesive soil is hard to break up when dry and exhibits significant cohering unity when submerged.
Competent Person	An individual, designated by the first-line supervisor, who can identify existing and predictable working conditions or surroundings which are unsanitary,

	hazardous, or dangerous to workers. The competent person is authorized to take prompt corrective measures to eliminate these hazards.
Dry Soil	Soil that does not exhibit any visible signs of moisture content.
Excavation	Any man-made cut, cavity, trench, or depression in the earth's surface formed by earth removal. Simple excavations are typically less than 5 feet deep, and trenches are deeper excavations that go to 20 feet deep.
Excavation Planner	A person who is either an engineer or equivalent competent person with sufficient experience and knowledge of excavation work and planning. The excavation planner creates the EWP and oversees inspections at the excavation site.
Excavation Work Plan	The work details to be conducted at an excavation site.
Fissured	Soil material that tends to break along definitive planes of fracture with little resistance, or a material that has open cracks in an exposed surface.
Granular Soil	Soil material comprised of mainly gravel, sand, or silt (coarse grained soil) with little to no clay content. Granular soil has no cohesive strength. Some moist granular soils exhibit false cohesion but cannot be molded and will crumble when dry.
Hazardous Atmosphere	An atmosphere that may expose workers to the risk of death, incapacitation, injury, acute illness, or impairment of ability to self-rescue.
Layered System	Two or more distinctly different soil or rock types arranged in layers. Micaceous seams or weakened planes in rock or shale are considered layered systems.
Maximum Allowable Slope	The steepest incline of an excavation face that is acceptable for the most favorable site conditions. The maximum allowable slope is expressed as a ratio of horizontal distance to vertical rise (H:V).
Raveling	Movement of individual particles of soil in shallow troughs on the veneer of the soil.
Registered Professional Engineer (PE)	A person registered as a professional engineer in the state where the work is performed. Reclamation allows a PE from any state to approve designs of manufactured protective systems or tabulated data when used in interstate commerce.
Respiratory Protection	Controls used to reduce or eliminate the hazards associated with air contaminated by harmful dusts, fogs, fumes, mists, gasses, smokes, sprays, vapors, or other hazardous particulates in the air.

Shielding	A trench box or other complex, walled, protective system used to protect workers in trenching excavations.
Shoring	Aluminum hydraulic or other types of engineered support systems to prevent soil movement and cave-ins.
Short Term Exposure	A period of time, 24 hours or less, that an excavation is open.
Site Grading	Grading or scraping of soil at depths of six inches or less.
Sloping	Cutting back the excavation or trench wall at an angle inclined away from the excavation.
Sloughing	Clumps or slabs of soil breaking away from the main soil body and falling off slopes, banks, or vertical cuts.
Soil Classification System	Method of categorizing soil and rock deposits in a set hierarchy. See Table 22-1.
Spalling	The breaking off of flakes or small clusters of soil from the larger soil mass.
Stable Rock	Natural, solid mineral matter that can be excavated with vertical sides and remain intact while exposed.
Submerged Soil	Soil located underwater or free seeping.
Tabulated Data	Tables and charts approved by a PE used to design and construct a protective system.
Trench	A narrow excavation, in relation to its length, made below the surface of the ground. Generally, the depth of a trench is greater than its width, but not where the width is greater than 15 feet (measured at the bottom of the trench). A trench shall be no greater than 20 feet deep.

22.11 References

Occupational Safety and Health Administration. 29 C.F.R. 1926, Subpart P, Excavations.

<https://www.osha.gov/laws-regs/regulations/standardnumber/1926>

Department of the Interior. Department Manual Series 27, Safety Management (Part 485 *Safety and Occupational Health Program*).

Occupational Safety and Health Administration. 29 C.F.R. 1926 Subpart D, Occupational Health and Environmental Controls. <https://www.osha.gov/laws-regs/regulations/standardnumber/1926>

Occupational Safety and Health Administration. 29 C.F.R. 1926, Subpart E, Personal Protective and Life Saving Equipment. <https://www.osha.gov/laws-regs/regulations/standardnumber/1926>

U.S. Bureau of Reclamation. Reclamation Manual SAF 01, Appendix A, *Stop Work Authority Procedures*. <https://www.usbr.gov/recman/policies.html#SAF>