



# Trenching and Excavation Training - Handbook

## **Trench and Excavation Safety for Wastewater Workers and Plumbing Contractors**

### **Safety and Health Investment Project (SHIP)**

Written by The Washington On-Site  
Sewage Association, Funding and Support  
Provided by the Washington State  
Department of Labor and Industries





## Excavation and Trenching Onsite Wastewater Systems

Developed by the Washington Onsite Sewage Association Under an LNI SHIP Grant # 2016 ZA 00329



*Funding and support for this project has been provided by the State of Washington, Department of Labor & Industries, Safety & Health Investment Projects*

## Excavation and Trenching Operations For Contractors in On-Site.

### Course objective:

To raise awareness of the excavation, trenching and shoring regulations and requirements in Part N, Chapter 296-155 of the Washington Administrative Code.



## Insert Video From Keith Pelzel OSS Designer in this slide position.

<https://www.bing.com/videos/search?q=wossa+safety&view=detail&mid=291817032441F3556B03291817032441F3556B03&FORM=VRDGAR>

### Topics covered

- Introduction to Trench Safety & Review of the WAC Part N Rules
- Definitions
- Competent Person Responsibilities
- Soil classification
- Trench protective systems:
  - Shoring & sloping
  - Shielding Guidelines
  - Protective Systems Options
- Common OSS Scenario's



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### What are the rules?

#### Chapter 296-155 WAC SAFETY STANDARDS FOR CONSTRUCTION WORK

- 22 Sections:
  - Parts A - V Cover a wide scope of activities from working on Roofs to Crane and more.
- Part N and appendixes are Excavation and Trenching rules.

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### Chapter 296-155 WAC Safety Standards for Construction Work

Part N consists of 3 Primary Sections

#### PART N EXCAVATION, TRENCHING, AND SHORING

- |                                    |  |
|------------------------------------|--|
| <a href="#"><u>296-155-650</u></a> | Scope, application, and definitions applicable to this part. |
| <a href="#"><u>296-155-655</u></a> | General protection requirements.                             |
| <a href="#"><u>296-155-657</u></a> | Requirements for protective systems.                         |

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## Chapter 296-155 WAC Safety Standards for Construction Work

Part N also has 6 additional appendices for Guidance

[296-155-66401](#)  
[296-155-66403](#)  
[296-155-66405](#)

Appendix A—Soil classification.  
Appendix B—Sloping and benching.  
Appendix C—Timber shoring for trenches.

[296-155-66407](#)

Appendix D—Aluminum hydraulic shoring for trenches.

[296-155-66409](#)

Appendix E—Alternatives to timber shoring.

[296-155-66411](#)

Appendix F—Selection of protective systems

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## Part N Excavation, Trenching and Shoring: 296-155-650

### Scope, Application and Definitions

- "This part applies to all open excavations made in the earth's surface. Excavations are defined to include trenches."

Most common field exposures that the on-site industry are involved with include:

- Tank Excavations
- Side Sewer
- Soil Test Pits
- Other – Utility work, Sewer Mains

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## 296-155-650 - Definitions

### Excavation

Any person-made cut, cavity, trench, or depression in the earth's surface, formed by earth removal.

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## 296-155-650 - Definitions

### 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 (4.6m).

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.

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## 296-155-650 - Definitions

### Cave-in

The separation of a mass of soil or rock material from the side of an excavation, or loss of soil from under a trench shield or support system, and its sudden movement into the excavation in quantity that it could entrap, bury, injure, or immobilize a person.

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## 296-155-650 - Definitions

### 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, 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.

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## 296-155-650 - Definitions

### Ramp

An inclined walking or working surface that is used to gain access to one point to another, and is constructed from earth or from structural materials such as steel or wood

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## 296-155-650 - Definitions

### 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.

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## 296-155-650 - Definitions

### 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.

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## 296-155-650 - Definitions

### 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.

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## 296-155-650 - Definitions

### Aluminum Hydraulic Shoring

A pre-engineered shoring system comprised of aluminum hydraulic cylinders (cross-braces) used in conjunction with vertical rails (uprights) or horizontal rails (walers).

Such system is designed, specifically to support the sidewalls of an excavation and prevent cave-ins.

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## 296-155-650 - Definitions

### 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.

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## 296-155-650 - Definitions

### 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 WAC 296-155-657 (3)(c) or (d). Shields used in trenches are usually referred to as "trench boxes" or "trench shields."

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## 296-155-650 - Definitions

### Tabulated data

Tables and charts approved by a registered professional engineer and used to design and construct a protective system.

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## 296-155-650 - Definitions

### Benching (benching system)

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.

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## 296-155-650 - Definitions

### Competent person

One who can identify existing or predictable hazards in the surroundings that are unsanitary, hazardous, or dangerous to employees.

Has authorization or authority by the nature of their position to take prompt corrective measures to eliminate them.

The person must be knowledgeable in the requirements of this position.

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## 296-155-650 - Definitions

A Complete list of definitions can be found at:

<http://apps.leg.wa.gov/WAC/default.aspx?cite=296-155-650>

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## 296-155-655 – General Protection Requirements

This Section has Twelve (12) Parts

Part N – Page 3-6

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## 296-155-655 – General Protection Requirements

### (1) Surface encumbrances

You must remove or support surface encumbrances that are located so as to create a hazard to employees, as necessary, to safeguard employees.

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## 296-155-655 – General Protection Requirements

### (2) Underground installations

- (a) You must locate utility installations, such as sewer, telephone, fuel, electric, water lines, or any other underground installations that reasonably may be expected to be encountered during excavation work, prior to opening an excavation.
- (b) You must contact utility companies or owners within established or customary local response times, advised of the proposed work, and asked to locate the underground utility installation prior to the start of actual excavation.

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## 296-155-655 – General Protection Requirements

### (2) Underground installations

- (c) When excavation operations approach the location of underground installations, you must determine the exact location of the installations by safe and acceptable means.
- (d) While the excavation is open, you must protect underground installations, supported, or removed as necessary to safeguard employees.

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## 296-155-655 – General Protection Requirements

### (3) Access and egress (a) Structural ramps.

- (i) Structural ramps that are used solely by employees as a means of access or egress from excavations must be designed by a competent person. Structural ramps used for access or egress of equipment must be designed by a competent person qualified in structural design, and must be constructed in accordance with the design.
- (ii) Ramps and runways constructed of two or more structural members must have the structural members connected together to prevent displacement.

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## 296-155-655 – General Protection Requirements

### (3) Access and egress (a) Structural ramps.

- (iii) Structural members used for ramps and runways must be of uniform thickness.
- (iv) Cleats or other appropriate means used to connect runway structural members must be attached to the bottom of the runway or must be attached in a manner to prevent tripping.
- (v) Structural ramps used in lieu of steps must be provided with cleats or other surface treatments on the top surface to prevent slipping.

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## 296-155-655 – General Protection Requirements

### (3) Access and egress

#### (b) Means of egress from trench excavations.

A stairway, ladder, ramp or other safe means of egress must be located in trench excavations that are 4 feet (1.22 m) or more in depth so as to require no more than 25 feet (7.62 m) of lateral travel for employees.

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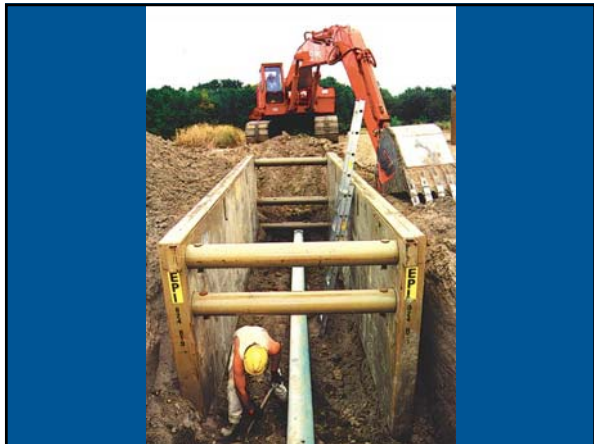
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## 296-155-655 – General Protection Requirements

### (4) Exposure to vehicular traffic

You must provide employees exposed to vehicular traffic with, and they must wear, high-visibility garments meeting the requirements of WAC 296-155-200, General requirements for personal protective equipment (PPE).

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## 296-155-655 – General Protection Requirements

### (5) Exposure to falling loads

You must not permit any employee underneath loads handled by lifting or digging equipment. You must require employees to stand away from any vehicle being loaded or unloaded to avoid being struck by any spillage or falling materials.

Operators may remain in the cabs of vehicles being loaded or unloaded when the vehicles are equipped, in accordance with WAC [296-155-610 \(2\)\(g\)](#), to provide adequate protection for the operator during loading and unloading operations.

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## 296-155-655 – General Protection Requirements

### (6) Warning system for mobile equipment

When mobile equipment is operated adjacent to an excavation, or when such equipment is required to approach the edge of an excavation, and the operator does not have a clear and direct view of the edge of the excavation, you must utilize a warning system such as barricades, hand or mechanical signals, or stop logs.

If possible, the grade should be away from the excavation.

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## 296-155-655 – General Protection Requirements

### (7) Hazardous atmospheres

(a) Testing and controls. In addition to the requirements set forth in parts B-1, C, and C-1 of this chapter ( 296-155 WAC) to prevent exposure to harmful levels of atmospheric contaminants and to assure acceptable atmospheric conditions, the following requirements apply:

#### 296-155 WAC

B-1 – Occupational Health and Environmental Control

C - Personal Protective & Life Saving Equipment

C-1 - Fall Protection Requirements for Construction

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## 296-155-655 – General Protection Requirements

### (7) Hazardous atmospheres (cont'd)

(a) Testing and controls. In addition to the requirements set forth in parts B-1, C, and C-1 of this chapter ( [296-155 WAC](#)) to prevent exposure to harmful levels of atmospheric contaminants and to assure acceptable atmospheric conditions, the following requirements apply:

(i) Where oxygen deficiency (atmospheres containing less than 19.5 percent oxygen) or a hazardous atmosphere exists or could reasonably be expected to exist, such as in excavations in landfill areas or excavations in areas where hazardous substances are stored nearby, you must test the atmospheres in the excavation before employees enter excavations greater than 4 feet (1.22 m) in depth.

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## 296-155-655 – General Protection Requirements

### (7) Hazardous atmospheres (cont'd)

(a) Testing and controls. In addition to the requirements set forth in parts B-1, C, and C-1 of this chapter ( [296-155 WAC](#)) to prevent exposure to harmful levels of atmospheric contaminants and to assure acceptable atmospheric conditions, the following requirements apply:

(ii) You must take adequate precautions to prevent employee exposure to atmospheres containing less than 19.5 percent oxygen and other hazardous atmospheres. These precautions include providing proper respiratory protection or ventilation in accordance with chapter [296-842 WAC](#).

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## 296-155-655 – General Protection Requirements

### (7) Hazardous atmospheres (cont'd)

(b) Emergency rescue equipment.

(i) Emergency rescue equipment, such as breathing apparatus, a safety harness and line, or a basket stretcher, must be readily available where hazardous atmospheric conditions exist or may reasonably be expected to develop during work in an excavation. This equipment must be attended when in use.

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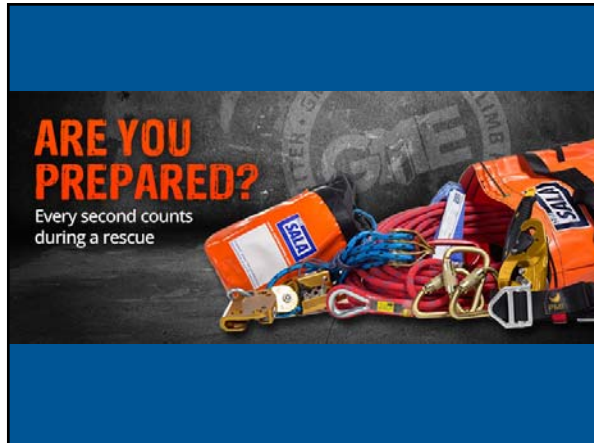
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## 296-155-655 – General Protection Requirements

### (7) Hazardous atmospheres (cont'd)

(a) Testing and controls. In addition to the requirements set forth in parts B-1, C, and C-1 of this chapter ( 296-155 WAC) to prevent exposure to harmful levels of atmospheric contaminants and to assure acceptable atmospheric conditions, the following requirements apply:

(iii) You must take adequate precaution such as providing ventilation, to prevent employee exposure to an atmosphere containing a concentration of a flammable gas in excess of 10 percent of the lower flammable limit of the gas.

(iv) When controls are used that are intended to reduce the level of atmospheric contaminants to acceptable levels, you must conduct testing as often as necessary to ensure that the atmosphere remains safe.

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## 296-155-655 – General Protection Requirements

### (8) Protection from hazards associated with water accumulation.

(a) Employees must not work in excavations in which there is accumulated water, or in excavations in which water is accumulating, unless adequate precautions have been taken to protect employees against the hazards posed by water accumulation.

The precautions necessary to protect employees adequately vary with each situation, but could include special support or shield systems to protect from cave-ins, water removal to control the level of accumulating water, or use of a safety harness and lifeline.

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## 296-155-655 – General Protection Requirements

### (8) Protection from hazards associated with water accumulation – cont'd

(b) If water is controlled or prevented from accumulating by the use of water removal equipment, the water removal equipment and operations must be monitored by a competent person to ensure proper operation.

(c) If excavation work interrupts the natural drainage of surface water (such as streams), you must use diversion ditches, dikes, or other suitable means to prevent surface water from entering the excavation and to provide adequate drainage of the area adjacent to the excavation. Excavations subject to runoff from heavy rains will require an inspection by a competent person and compliance with subdivisions (a) and (b) of this subsection.



## 296-155-655 – General Protection Requirements

### (9) Stability of adjacent structures

(a) Where the stability of adjoining buildings, walls, or other structures is endangered by excavation operations, you must provide support systems such as shoring, bracing, or underpinning to ensure the stability of such structures for the protection of employees.





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## 296-155-655 – General Protection Requirements

### (9) Stability of adjacent structures – cont'd

(b) You must not permit excavation below the level of the base or footing of any foundation or retaining wall that could be reasonably expected to pose a hazard to employees except when:

- (i) A support system, such as underpinning, is provided to ensure the safety of employees and the stability of the structure; or
- (ii) The excavation is in stable rock; or
- (iii) 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
- (iv) A registered professional engineer has approved the determination that such excavation work will not pose a hazard to employees.

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## 296-155-655 – General Protection Requirements

### (9) Stability of adjacent structures – cont'd

(c) Sidewalks, pavements, and appurtenant structure must not be undermined unless a support system or another method of protection is provided to protect employees from the possible collapse of such structures.

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## 296-155-655 – General Protection Requirements

### (10) Protection of employees from loose rock or soil.

- (a) You must provide adequate protection to protect employees from loose rock or soil that could pose a hazard by falling or rolling from an excavation face.

Such protection must consist of scaling to remove loose material; installation of protective barricades at intervals as necessary on the face to stop and contain falling material; or other means that provide equivalent protection.

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## 296-155-655 – General Protection Requirements

### (10) Protection of employees from loose rock or soil.

- (b) You must protect employees from excavated or other materials or equipment that could pose a hazard by falling or rolling into excavations.

Protection must be provided by placing and keeping such materials or equipment at least two feet (.61 m) from the edge of excavations, or by the use of retaining devices that are sufficient to prevent materials or equipment from falling or rolling into excavations, or by a combination of both if necessary.

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## 296-155-655 – General Protection Requirements

### (11) Inspections

(a) Daily inspections of excavations, the adjacent areas, and protective systems must be made by a competent person for evidence of a situation that could result in possible cave-ins, indications of failure of protective systems, hazardous atmospheres, or other hazardous conditions.

An inspection must be conducted by the competent person prior to the start of work and as needed throughout the shift.

Inspections must also be made after every rainstorm or other hazard increasing occurrence. These inspections are only required when employee exposure can be reasonably anticipated.

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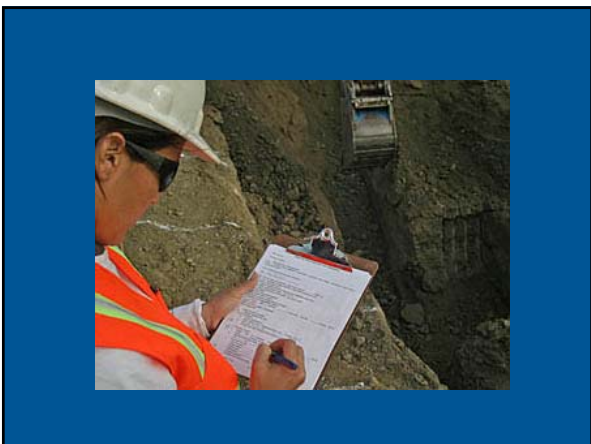
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## 296-155-655 – General Protection Requirements

### (11) Inspections - cont'd

(b) Where the competent person finds evidence of a situation that could result in a possible cave-in, indications of failure of protective systems, hazardous atmospheres, or other hazardous conditions, you must remove exposed employees from the hazardous area until the necessary precautions have been taken to ensure their safety.

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## 296-155-655 – General Protection Requirements

### (12) Fall protection

(a) You must provide walkways where employees or equipment are required or permitted to cross over excavations. You must provide guardrails which comply with chapter WAC 296-155, Part C-1 where walkways are 4 feet or more above lower levels.

You must provide adequate barrier physical protection at all remotely located excavations. You must barricade or cover all wells, pits, shafts, etc. Upon completion of exploration and similar operations, you must backfill temporary wells, pits, shafts, etc.

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## 296-155-657 – Requirements for Protective Systems

This Section has Seven (7) Parts

Part N - Pages 6-9

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## 296-155-657 – Requirements for Protective Systems

### **(1) Protection of employees in excavations.**

(a) You must protect each employee in an excavation from cave-ins by an adequate protective system designed in accordance with subsections (2) or (3) of this section except when:

(i) Excavations are made entirely in stable rock; or

(ii) Excavations are less than 4 feet (1.22m) in depth and examination of the ground by a competent person provides no indication of a potential cave-in.

(b) Protective systems must have the capacity to resist without failure all loads that are intended or could reasonably be expected to be applied or transmitted to the system.

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## 296-155-657 – Requirements for Protective Systems

### **(2) Design of sloping and benching systems.**

The slopes and configurations of sloping and benching systems must be selected and constructed by the employer or employer's designee and must be in accordance with the requirements of subdivision (a); or, in the alternative, subdivision (b); or, in the alternative, subdivision (c); or, in the alternative, subdivision (d), as follows:

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## 296-155-657 – Requirements for Protective Systems

### (2) Design of sloping and benching systems.

#### 3 options:

- (a) Option 1—Allowable configurations and slopes.
- (i) Excavations must be sloped at an angle not steeper than 1 1/2 horizontal to one vertical (34 degrees measured from the horizontal), unless the employer uses one of the other options listed below.
- (ii) Slopes specified in item (i) of this subdivision, must be excavated to form configurations that are in accordance with the slopes shown for Type C soil in Appendix B to this part.

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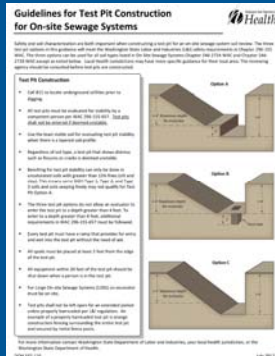
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## Washington Soil Test Pit Configurations

All test pits must be evaluated for stability by a competent person per WAC 296-155-657. Test pits shall not be entered if deemed unstable.

Use the least stable soil for evaluating test pit stability when there is a layered soil profile.

Regardless of soil type, a test pit that shows distress such as fissures or cracks is deemed unstable.



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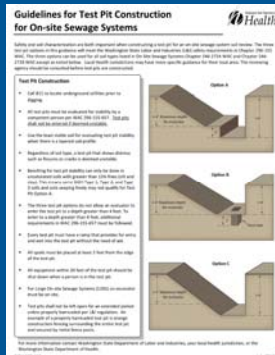
## Washington Soil Test Pit Configurations

Every test pit must have a ramp that:

Provides for entry and exit into the test pit without the need of aid.

All spoils must be placed at least 2 feet from the edge of the test pit.

All equipment within 20 feet of the test pit should be shut down when a person is in the test pit.



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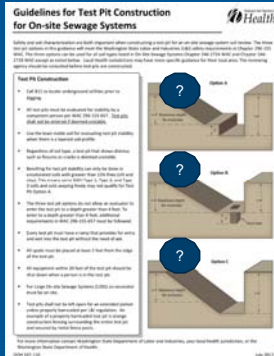
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## Washington Soil Test Pit Configurations

Benching for test pit stability can only be done in unsaturated soils with greater than 15% fines (silt and clay)

This means some DOH Type 1, Type 2, and Type 3 soils and soils seeping freely may not qualify for Test Pit Option A.

Test pit options do not allow an evaluator to enter the test pit to a depth greater than 4 feet. To enter to a depth greater than 4 feet, additional requirements in WAC 296-155-657 must be followed

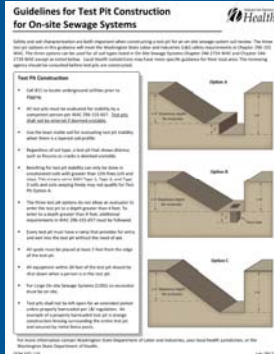


## Washington Soil Test Pit Configurations

CAUTION!

Test pits shall not be left open for an extended period unless properly barricaded per L&I regulation.

An example of a properly barricaded test pit is: Orange construction fencing surrounding the entire test pit and secured by metal fence posts.

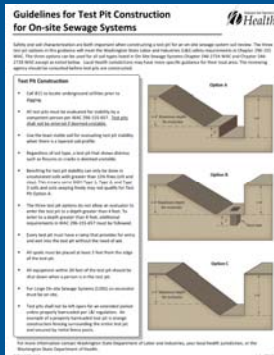


## Washington Soil Test Pit Configurations

Discussion?

What is local practice?

Does it comply?



## 296-155-657 – Requirements for Protective Systems

### (2) Design of sloping and benching systems.

(b) Option 2—Determination of slopes and configurations using Appendices A and B.

Maximum allowable slopes, and allowable configurations for sloping and benching systems, must be determined in accordance with the conditions and requirements set forth in appendices A and B to this part.

Part N – Pages 15 -25

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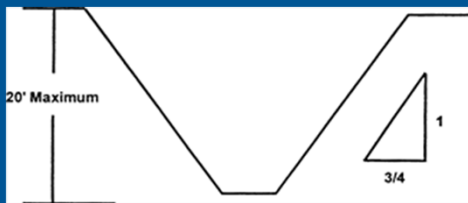
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**Figure N-1**  
**Slope Configurations**  
**for Type A Soil**



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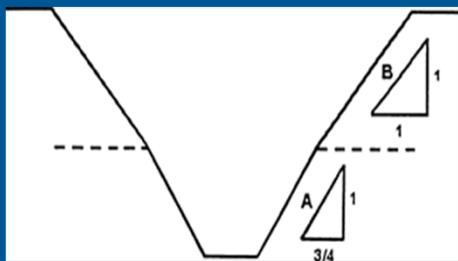
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**Figure N-14 Two distinct layers**



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## 296-155-657 – Requirements for Protective Systems

### (2) Design of sloping and benching systems.

(c) Option 3—Designs using other tabulated data.

(i) Designs of sloping or benching systems must be selected from and be in accordance with tabulated data, such as tables and charts.

(ii) The tabulated data must be in written form and must include all of the following:

(A) Identification of the parameters that affect the selection of a sloping or benching system drawn from such data;

(B) Identification of the limits of use of the data, to include the magnitude and configuration of slopes determined to be safe;

Part N – Pages 26- 45

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## 296-155-657 – Requirements for Protective Systems

### (2) Design of sloping and benching systems.

(C) Explanatory information as may be necessary to aid the user in making a correct selection of a protective system from the data.

(iii) You must maintain at least one copy of the tabulated data which identifies the registered professional engineer who approved the data at the job site during construction of the protective system.

After that time the data may be stored off the job site, but you must make a copy of the data available to the director upon request.

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## 296-155-657 – Requirements for Protective Systems

### (2) Design of sloping and benching systems.

(d) Option 4—Design by a registered professional engineer.

(i) Sloping and benching systems not utilizing Option 1 or Option 2 or Option 3 under subsection (2) of this section must be approved by a registered professional engineer.

(ii) Designs must be in written form and must include at least the following:

(A) The magnitude of the slopes that were determined to be safe for the particular project;

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## 296-155-657 – Requirements for Protective Systems

### (2) Design of sloping and benching systems.

(d) Option 4—Design by a registered professional engineer.

(ii) Designs must be in written form and must include at least the following:

(C) The identity of the registered professional engineer approving the design.

(iii) You must maintain at least one copy of the design at the job site while the slope is being constructed. After that time the design need not be at the job site, but you must maintain a copy available to the director upon request.

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## 296-155-657 – Requirements for Protective Systems

### (3) Design of support systems, shield systems, and other protective systems.

Designs of support systems, shield systems, and other protective systems must be selected and constructed by the employer or employer's designee and must be in accordance with the requirements of subdivision (a); or, in the alternative, subdivision (b); or, in the alternative, subdivision (c); or, in the alternative, subdivision (d) as follows:

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## 296-155-657 – Requirements for Protective Systems

### (3) Design of support systems, shield systems, and other protective systems.

(a) Option 1—Designs using appendices A, C, and D. Designs for timber shoring in trenches must be determined in accordance with the conditions and requirements set forth in appendices A and C to this part.

Designs for aluminum hydraulic shoring must be in accordance with subdivision (b) of this subsection, but if manufacturer's tabulated data cannot be utilized, designs must be in accordance with appendix D.

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## 296-155-657 – Requirements for Protective Systems

### (3) Design of support systems, shield systems, and other protective systems.

- (b) Option 2—Designs using manufacturer's tabulated data.
- (i) Design of support systems, shield systems, or other protective systems that are drawn from manufacturer's tabulated data must be in accordance with all specifications, recommendations, and limitations issued or made by the manufacturer.
  - (ii) Deviation from the specifications, recommendations, and limitations issued or made by the manufacturer must only be allowed after the manufacturer issues specific written approval.

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## 296-155-657 – Requirements for Protective Systems

### (3) Design of support systems, shield systems, and other protective systems.

- (b) Option 2—Designs using manufacturer's tabulated data.
- (iii) Manufacturer's specifications, recommendations, and limitations, and manufacturer's approval to deviate from the specifications, recommendations, and limitations must be in written form at the job site during construction of the protective system.
- After that time this data may be stored off the job site, but you must make a copy available to the director upon request.

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## 296-155-657 – Requirements for Protective Systems

### (3) Design of support systems, shield systems, and other protective systems.

- (c) Option 3—Designs using other tabulated data.
- (i) Designs of support systems, shield systems, or other protective systems must be selected from and be in accordance with tabulated data, such as tables and charts.
  - (ii) The tabulated data must be in written form and include all of the following:
    - (A) Identification of the parameters that affect the selection of a protective system drawn from such data;

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## 296-155-657 – Requirements for Protective Systems

### **(3) Design of support systems, shield systems, and other protective systems.**

(c) Option 3—Designs using other tabulated data.

(B) Identification of the limits of use of the data;

(C) Explanatory information as may be necessary to aid the user in making a correct selection of a protective system from the data.

(iii) You must maintain at least one copy of the tabulated data, which identifies the registered professional engineer who approved the data at the job site during construction of the protective system. After that time the data may be stored off the job site, but you must make a copy of the data available to the director upon request.

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## 296-155-657 – Requirements for Protective Systems

### **(3) Design of support systems, shield systems, and other protective systems.**

(d) Option 4—Design by a registered professional engineer.

(i) Support systems, shield systems, and other protective systems not utilizing Option 1, Option 2 or Option 3, above, must be approved by a registered professional engineer.

(ii) Designs must be in written form and must include the following:

(A) A plan indicating the sizes, types, and configurations of the materials to be used in the protective system; and

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## 296-155-657 – Requirements for Protective Systems

### **(3) Design of support systems, shield systems, and other protective systems.**

(d) Option 4—Design by a registered professional engineer.

(B) The identity of the registered professional engineer approving the design.

(iii) You must maintain at least one copy of the design at the job site during construction of the protective system.

After that time, the design may be stored off the job site, but you must maintain a copy of the design available to the director upon request.

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## 296-155-657 – Requirements for Protective Systems

### (4) Materials and equipment.

- (a) Materials and equipment used for protective systems must be free from damage or defects that might impair their proper function.
- (b) You must use and maintain manufactured materials and equipment used for protective systems in a manner that is consistent with the recommendations of the manufacturer, and in a manner that will prevent employee exposure to hazards.

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## 296-155-657 – Requirements for Protective Systems

### (4) Materials and equipment.

- (c) When material or equipment that is used for protective systems is damaged, a competent person must examine the material or equipment and evaluate its suitability for continued use.

If the competent person cannot assure the material or equipment is able to support the intended loads or is otherwise suitable for safe use, then you must remove such material or equipment from service, and it must be evaluated and approved by a registered professional engineer before being returned to service.

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## 296-155-657 – Requirements for Protective Systems

### (5) Installation and removal of support.

- (a) General.
  - (i) Members of support systems must be securely connected together to prevent sliding, falling, kickouts, or other predictable failure.
  - (ii) You must install and remove support systems in a manner that protects employees from cave-ins, structural collapses, or from being struck by members of the support system.

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## 296-155-657 – Requirements for Protective Systems

### (5) Installation and removal of support.

(a) General.

(iii) You must not subject individual members of support systems to loads exceeding those which those members were designed to withstand.

(iv) Before temporary removal of individual members begins, you must take additional precautions to ensure the safety of employees, such as installing other structural members to carry the loads imposed on the support system.

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## 296-155-657 – Requirements for Protective Systems

### (5) Installation and removal of support.

(a) General.

(v) Removal must begin at, and progress from, the bottom of the excavation. You must release members slowly so as to note any indication of possible failure of the remaining members of the structure or possible cave-in of the sides of the excavation.

(vi) Backfilling must progress together with the removal of support systems from excavations.

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## 296-155-657 – Requirements for Protective Systems

### (6) Sloping and benching systems.

You must not permit employees to work on the faces of sloped or benched excavations at levels above other employees except when employees at the lower levels are adequately protected from the hazard of falling, rolling, or sliding material or equipment

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## 296-155-657 – Requirements for Protective Systems

### (7) Shield systems.

#### (a) General.

- (i) You must not subject shield systems to loads exceeding those which the system was designed to withstand.
- (ii) You must install shields in a manner to restrict lateral or other hazardous movement of the shield in the event of the application of sudden lateral loads.
- (iii) You must protect employees from the hazard of cave-ins when entering or exiting the areas protected by shields.
- (iv) You must not allow employees in shields when shields are being installed, removed, or moved vertically.

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## 296-155-657 – Requirements for Protective Systems

### (7) Shield systems.

(b) Additional requirement for shield systems used in trench excavations. Excavations of earth material to a level not greater than two feet (.61 m) below the bottom of a shield is permitted, but only if the shield is designed to resist the forces calculated for the full depth of the trench, and there are no indications while the trench is open of a possible loss of soil from behind or below the bottom of the shield.

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## Competent Person Responsibilities

### Responsibilities include:

- Understand the standards and rule
- Conduct tests for Soil Classification
- Determine proper protective system
- Recognize and reclassify soil when conditions change
- Monitor and inspect protective systems for damage and take it out of use if it becomes inadequate for protection

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## Competent Person Responsibilities

Responsibilities include:

- Evaluate site conditions and conduct air tests for hazardous atmosphere if needed
- Design of structural ramps within the scope of rule
- Locate underground installations and utilities
- Monitor water removal equipment and operation if used and when in use
- Perform and document daily inspections

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## Competent Person

Employer Requirements: Every excavation must have a "Competent Person"

**Competent person.** *"One who can identify existing or predictable hazards in the surroundings that are unsanitary, hazardous, or dangerous to employees. Also has authorization or authority by the nature of their position to take prompt corrective measures to eliminate them. The person must be knowledgeable in the requirements of this part."*

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## Classifying Soils

It is important to correctly classify soil type before selecting and using a protective system.

In order to classify soil, at least one visual test and one manual test are required to determine if the soil is Type A, Type B, or Type C.

Most engineers agree that less than 5% of the soil in Washington can be classified as Type A, and as soon as the Type A soil is disturbed, it must be down graded to a Type B.

NOTE: If you designate the soil as Type C, no testing is required.

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## Soil characteristics

**Type A:** Good cohesive soil with a high compressive strength such as: clay, silty clay, sandy clay, clay loam and cemented soils such as caliche, duricrust and hardpan

**Type B:** Cohesive soil with a moderate compressive strength such as: silt, silty clay, sandy clay, clay loam, silt loam, sandy loam, angular gravel (similar to crushed rock), any previously disturbed fissured or soil or subject to vibration

**Type C:** Cohesive soil with a low compressive strength such as: granular soils including gravel, sand, and loamy sand or submerged soil or rock that is not stable or soil from which water is freely seeping

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## Soil classification

### ■ Type A

- Fine grained
- Doesn't crumble
- Hard to break up when dry
- Examples:
  - Clay
  - Hardpan
  - Silty or sandy clay, clay loam



Clay Loam



Clay

As more organic matter, silt and sand (together known as loam) gets mixed in and as the grains get larger, the classification will be degraded to type B. As the mix has less and less clay and organic matter in it becoming closer to pure sand or gravel it is further degraded to Type C.

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## Soil Classification

### Type A

Even if soil has high clay content and is plastic when moist, it cannot be classified as "Type A" if it is:

- fissured,
- has been previously disturbed, or
- subject to vibration from heavy traffic, etc.



This soil is fissured changing the classification from A to B

Clues for previously disturbed soil: soil discoloration, lack of vegetation, you dig and discover pipes or something else. If the work orders are specific to replacing existing pipes---this is a heads up that you are dealing with previously disturbed soil.

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## Soil classification

### Type B

- Granular: coarse grains
- Little or no clay content
- Crumbles easily when dry
- Examples:
  - **Silt**-fine mineral particles in size between clay and sand
  - **Loam**-from fragments of rock deposits in water
  - **Angular gravel**-crushed rock-the angular nature of the individual rocks provides some resistance to movement



Silty loam



Loam



Angular gravel

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## Soil Classification

### Type C \*

- Granular soil: very coarse
- Minimal cohesion
- Examples:
  - Sand
  - Gravel
  - Loamy sand
  - Submerged soil or soil with freely seeping water
  - Submerged rock that is not stable.



Sand



Gravel



Loamy sand

\* Type C is the most common soil classification in Washington.

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## Types of Protection Systems

Your Choices are:

- Sloping and Benching
- Shoring System
  - Timber, Aluminum-Hydraulic
- Shield System
  - Steel Shield Box, Aluminum Box

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### What are the protective system requirements?

Use protective systems when there is potential for cave-in for Class A, B, and C soils:

- **Under 4'** deep if a potential for a cave-in exists
- **4' to 20'** deep
  - Sloping or Benching (benching is not an option in C soil)
  - Shield or Shoring
- **Over 20'** deep - protective system must be designed by Registered Professional Engineer or approved in manufacturer's tabulated data
- Protective system is not required for stable rock

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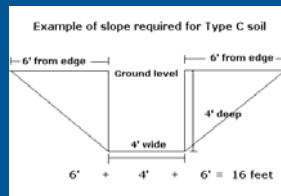
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### Sloping

Sloping is the process of removing soil to eliminate the chance of a cave in.

The required maximum allowable slope is determined by the class of soil.



The requirements are as follows:

- For each foot of trench depth, the ratio of slope measured from the trench edge at ground height must be:

Soil Type A –  $\frac{3}{4}$  to 1 ( $53^\circ$ )

Soil Type B – 1 to 1 ( $45^\circ$ )

Soil Type C –  $1\frac{1}{2}$  to 1 ( $34^\circ$ )

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### Shoring

Shoring is one of the most common used methods of worker protection. It is light-weight, portable and easy to install.

The manufacturer provides tabulated data with the shoring that provides the limitations, precautions, required spacing and proper use.



This photo shows an example of aluminum hydraulic shoring.

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## Shields

Shields are manufactured by a number of companies and are designed to protect workers working within the confines of the shield.

Check tabulated data for the maximum allowable depth it can be used. The tabulated data must accompany the shield when it is being used.

Additionally, the shield must be designed by a Registered Professional Engineer, be in good condition, and used properly.



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## RPE-Designed Protective System

A Registered Professional Engineer can design a protection system for use on a specific project.

The RPE will consider the soil type and conditions as well as other concerns that might exist at the excavation site.

The system must be used as designed by the RPE.

Even with an RPE, the Competent Person must still perform daily inspections checking site conditions and any change.

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## Other Shoring Method Examples

Must be designed by a registered professional engineer regardless of depth



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## What is an Excavation?

- An excavation is any person-made cut, cavity, trench, or depression in the earth's surface.
- A trench is an excavation
- Employees must be protected from cave-in when the excavation is 4 feet or more in depth.
- Cave-in protection is not required when:
  - Excavations are made entirely in stable rock; or
  - They are less than 4 feet in depth and examination of the ground by a competent person provides no indication of a potential cave-in.

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## 15 Fatalities Related to Excavation Activities in Washington State 1998 – 2008

### Types of Incidents

Soil collapse (cave-in) = 7

Struck by machinery = 4

Struck by motor vehicle = 1

Struck by falling object = 1

Electrocution = 1

Fall = 1

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## What makes trenches hazardous?

The factors shown in this illustration can create deadly conditions for workers.

The spoils pile and the equipment being too close to the vertical walls of the trench are called "surcharge loads" which increase the likelihood of collapse.

Additionally, equipment vibration, adverse weather conditions and ground water can change the condition and classification of the soil.



A "Competent Person" must take all of these factors into consideration and re-evaluate the jobsite periodically.

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### Example of a Hazardous Trench

This trench is well over 4' deep, cut into loose sand (class C soil), that is sloughing off the trench walls. The spoils pile is a surcharged load. The shear weight of the spoils not being set at least 2 feet back from the vertical face increases the likelihood of a cave-in and it adds to the depth of the trench. If the trench is 8' deep and the spoils pile is 8' high directly at the edge, the trench is now 16' deep! A trench that is 3' deep could easily become 5-6' deep if the spoils pile is on the edge.



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### Hazardous Trench Example (cont.)

- The weight & vibration of the track-hoe also increases the probability of a collapse.
- The employees working in the trench are exposed to:
  - overhead hazards (no hard hats), and
  - trench collapse without a protective system
- It does not appear that safe access or egress has been provided.\*



\*A stairway, ramp, ladder or other safe means of egress must be located so workers don't have to travel more than 25 feet laterally in the trench.

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### Another hazardous trench example



Nearby heavy equipment and the spoils pile directly on the right edge of the excavation both create a surcharge load. The protective system in this photo does not extend far enough up the trench to provide adequate protection for the two workers in the trench.

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## Process for Safe Trench Work

- Identify knowledgeable competent person
- Check and verify above and below ground utility locations, any adjacent structures or surface encumbrances, and water table
- Determine soil classification through testing
- Choose the correct protective system for soil type
- Verify protective system installation and set-up
- Provide safe access
- Comply with requirements specified in the Excavation, Trenching, and Shoring regulations.
- Conduct daily inspections prior to the start of work, after any weather event, and as needed.

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## First: you must locate utilities before digging!

Go to:

[www.callbeforeyoudig.org](http://www.callbeforeyoudig.org)

or

Call 1-800-425-5555

It's Free!



### Color Code for Utility Locations

Red	Electric
Yellow	Gas-Oil
Orange	Communications
Blue	Water
Green	Sewer
White	Proposed Excavation

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## Underground Installations (utilities)

You are required to call for utility locates and once the locates have been identified onsite, the employer *must do an exact locate as specified by:*

WAC 296-155-655(2)(c)

"When excavation operations approach the location of underground installations, the exact location of the installations shall be determined by safe and acceptable means."

Why do you need to do exact utility locates?

Because they are rarely spot-on, and older installations may not show up on current utility maps.

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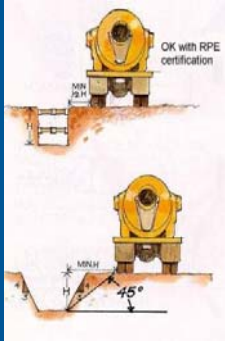
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## Controlling heavy vehicle surcharge loads



What does the 45-degree angle represent?

It represents the zone of influence or affected area. In other words, it represents the shear plane (weakest area), at which the excavation or trench wall will fail, and that is why it should always be kept clear of heavy equipment or machinery, and the spoils pile, *unless* the trench can be properly shored.

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## Controlling water accumulation

Water accumulation in a trench is hazardous because it erodes and changes soil; which means the stability of the soil is likely weakened.

Prevent water accumulation by using sump pumps, or create diversion ditches and dikes for natural drainage of streams interrupted by the excavation or in anticipation of heavy rainwater runoff, or consult with an RPE.



Special supports or shield systems may be needed if water accumulates on the trench floor.

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## Water Accumulation Control System

Water accumulation hazards should be prevented by either using a special support or shield systems designed for water drainage issues, or water removal to control the level of accumulating water, or use of a safety harness and lifeline by workers inside excavation.

Water controlled through the use of pumps and other equipment setups must be monitored by a competent person to ensure proper operation.

Diversion ditches, dikes, or other suitable means should be used to prevent surface water or rainwater from entering and accumulating in the excavation.



A water control system that got out of hand!

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## Provide safe entry and exit

A trench that is 4' or more in depth must have a safe means for workers to get in and out of the trench.

A means of egress is required to be within 25' of lateral travel.

The most common method for access is a straight ladder or an extension ladder. If a ladder is used, it must extend a minimum of 3' above the landing. The use of step ladders is **not** permitted.

Other means could be a stairway or ramps or other means as designed by a RPE.

Locating the method of access/egress outside of the protective system is prohibited.



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## Provide safe entry and exit

Buckets of excavators, backhoes, etc. are not to be used as a means of egress.



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Scenario One

Solutions



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Scenario Two



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Scenario Three



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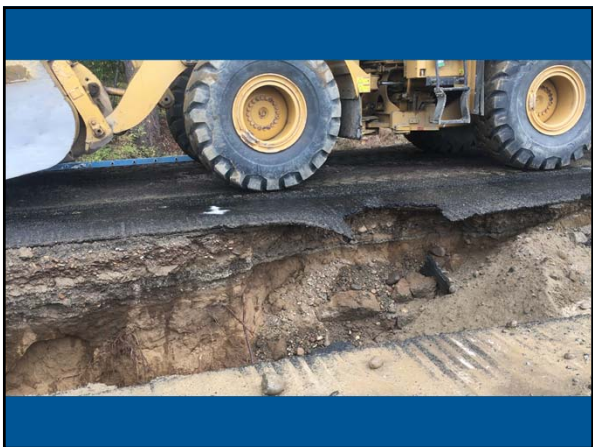
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Situational Awareness and Personal Safety

- Worker Close to Edge
- Working Equipment
- 8' Fall

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### Most Common Trenching Violations

- No cave-in protective system being used when required by soil classification, depth, and code
- Excessive surcharge load (spoils piles too close to excavation wall or equipment or traffic too close to excavation operations)
- No access/egress for excavations 4 feet or more in depth
- No competent person/and requirements

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**An Employer only working in an unprotected excavation/trench can be cited by DOSH.**

- If the employer is working in the trench alone (no employees in the trench) without using a protective system, the employer can be cited since, in the event of a cave-in, you are exposing every employee to cave-in hazards if they jump into the excavation to attempt rescue.
- See [WRD 1.18](#) which describes DOSH policy

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**More information and training**

Online Training course:  
[NIOSH -Trench Safety Awareness](#)

OSHA e-Tool: [OSHA Construction eTool: Trenching and Excavation](#)

Oregon OSHA : "Excavations Safe Practices" publication:  
<http://www.cbs.state.or.us/osha/pdf/pubs/2174.pdf>

DOSH excavation, Trenching and Shoring Rule:  
[http://www.lni.wa.gov/wisha/rules/construction/HTML/296-155N\\_1.htm](http://www.lni.wa.gov/wisha/rules/construction/HTML/296-155N_1.htm)

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**Questions?**

If you have more questions on trenching and excavation:

- Call your local Labor and Industries office and ask to speak to a safety consultant.
- Click here to get local office locations and numbers:

[lni.wa.gov/Main/ContactInfo/OfficeLocations](http://lni.wa.gov/Main/ContactInfo/OfficeLocations)

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