



# NORTH CAROLINA

Department of Transportation



# Excavation & Trenching Safety

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# Why Excavation Safety?

- Hazard related to your job;
- Necessary for your protection and the protection of others from injury or death while on the job;
- Working safely is a condition of employment;
- Protect from criminal charges, a civil lawsuit, or an OSHA citation;
- In 1990 the DOT had a cave-in fatality in Iredell County.
- In 2015 the DOT had a cave-in that injured 2 workers.

# Course Objectives

- Terminal objective: The student will be able to recognize and avoid hazards associated with excavations.
- Enabling objectives:
  - Identify hazards associated with excavations.
  - Describe the methods for protecting employees.
  - Describe the role of a competent person at an excavation site.
  - Apply excavation hazard protection methods.

# Why Excavation Safety?

- Federal law mandates that all workers have a safe place to work.
- OSHA Regulation – 29 CFR 1926.650
- NCDOT - Safety Policy and Procedure 1926.650
  - This safety policy and procedure is established in accordance with Occupational Safety and Health Standards for Construction Industry 29 CFR 1926.650.
- NCDOT – Workplace Safety Manual SOP 11E-3

# What are the Dangers?

- On average two workers are killed every month in trench collapses.
  - What is the single most dangerous hazard associated with excavations?

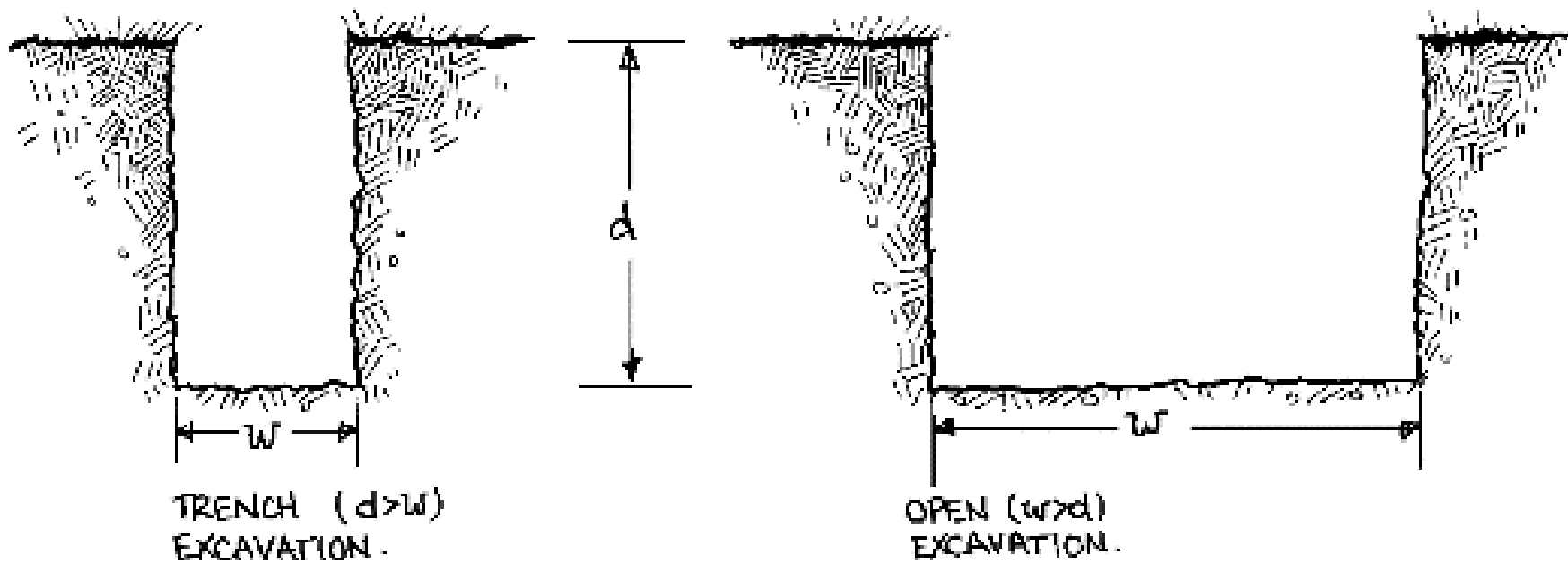
## **CAVE-INS**

- What are other potential hazards associated with excavations?
  - **Falls**
  - **Falling Loads**
  - **Hazardous Atmospheres**
  - **Incidents involving mobile equipment (backhoes, excavators)**
  - **Struck By**

Oregon OSHA  
Excavation  
Inspection

Tim Marcum,  
Compliance Officer

# Trench vs. Excavation



**Trench** - Depth is greater than the width.

**Excavation** - Any man made cut formed by earth removal.

# Excavation Definitions

- Spoil Pile – excavated materials, topsoil, rocks, etc., temporarily stored beside excavation.
- Surcharge Load – the weight of spoils or equipment exerting pressure on the surface of the soil near an excavation.
- Registered Professional Engineer (RPE) – a person who is registered in the state where work is to be performed.



# Excavation Definitions

- **Competent Person:**
  - Can identify existing or predictable hazards in an excavation,
  - Has the authority to take corrective actions as necessary,
  - Is familiar with the excavation standards,
  - Is knowledgeable in soil analysis and classification as well as the erection, use, and precautions for the protective system on site.

# Competent Person

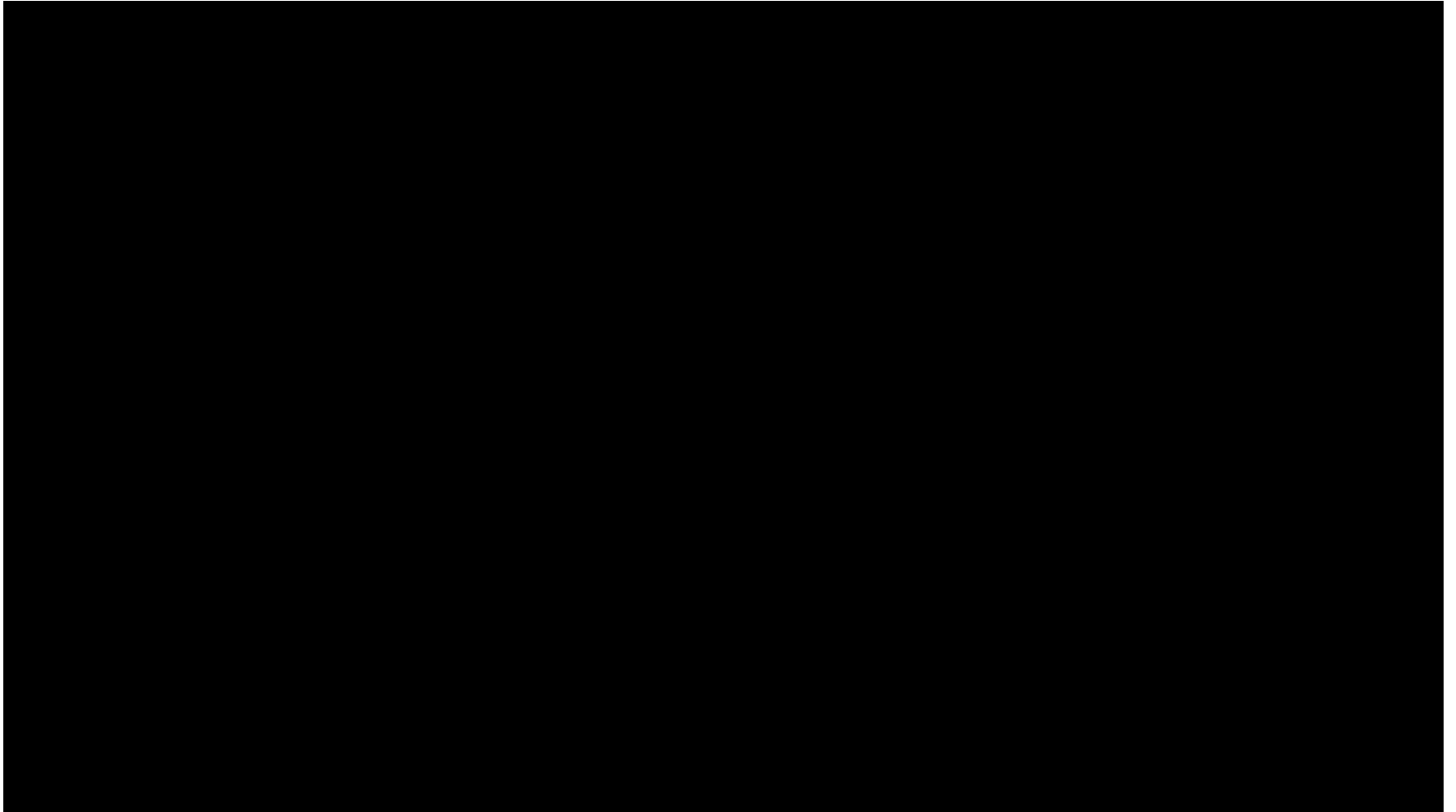
- OSHA says that, “... for the purposes of this standard, one must have had specific training in and be knowledgeable about:
  - soils analysis,
  - the use of protective systems, &
  - the requirements of the standard.

# NC Utility Location Service

- Dial 811 more than **72 hours** prior to excavation
- Document 811 ticket number
- NC law requires a three full working days notice to utility owners
- That begins the first day “after” dialing 811
- Weekend and holidays are not counted



# Video - NC 811








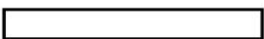


# NC Utility Location Service

- Document list of utility companies notified by NC 811
- Every utility company is not a member of NC 811
- Contact utility providers that are not members of NC 811



# NC 811 Utility Location Markings

- Verify NC 811 has responded and marked as requested
- Verify that NC 811 non-member utility owners have marked utilities
- Underground facilities will be marked by color coded paint, stakes or flags APWA

	<b>RED</b> – Electric Power Lines, Cables, Conduit, and Lighting Cables
	<b>YELLOW</b> – Gas, Oil, Steam, Petroleum, or Gaseous Material
	<b>ORANGE</b> – Communication, Alarm or Signal Lines, Cables, or Conduit
	<b>BLUE</b> – Potable Water
	<b>GREEN</b> – Sewers and Drain Lines
	<b>WHITE</b> – Proposed Excavation Limits or Route
	<b>PINK</b> – Temporary Survey Markings, Unknown / Unidentified Facilities
	<b>PURPLE</b> – Reclaimed Water, Irrigation, and Slurry Lines

# Utility Tolerance Zone

- When digging in Tolerance Zone:
- Hand dig only with shovels or post hole diggers
- Avoid use of picks or mattocks
- Keep face of shovel toward side of facility fig.1
- Post hold diggers, keep blade opening going same direction as facility fig. 2

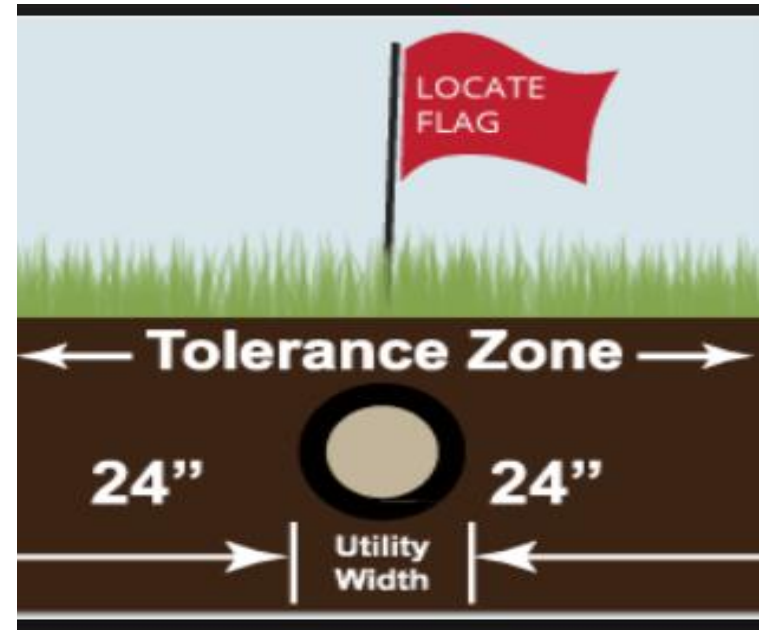


Figure 1 Shovel

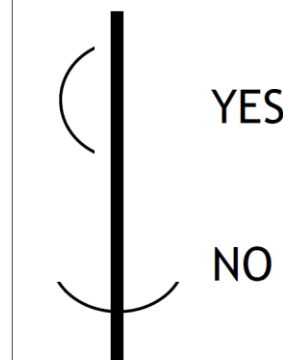
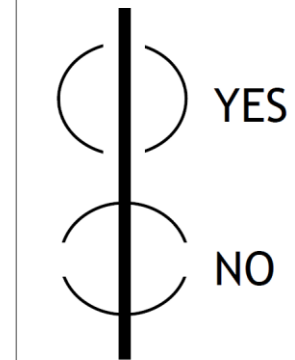
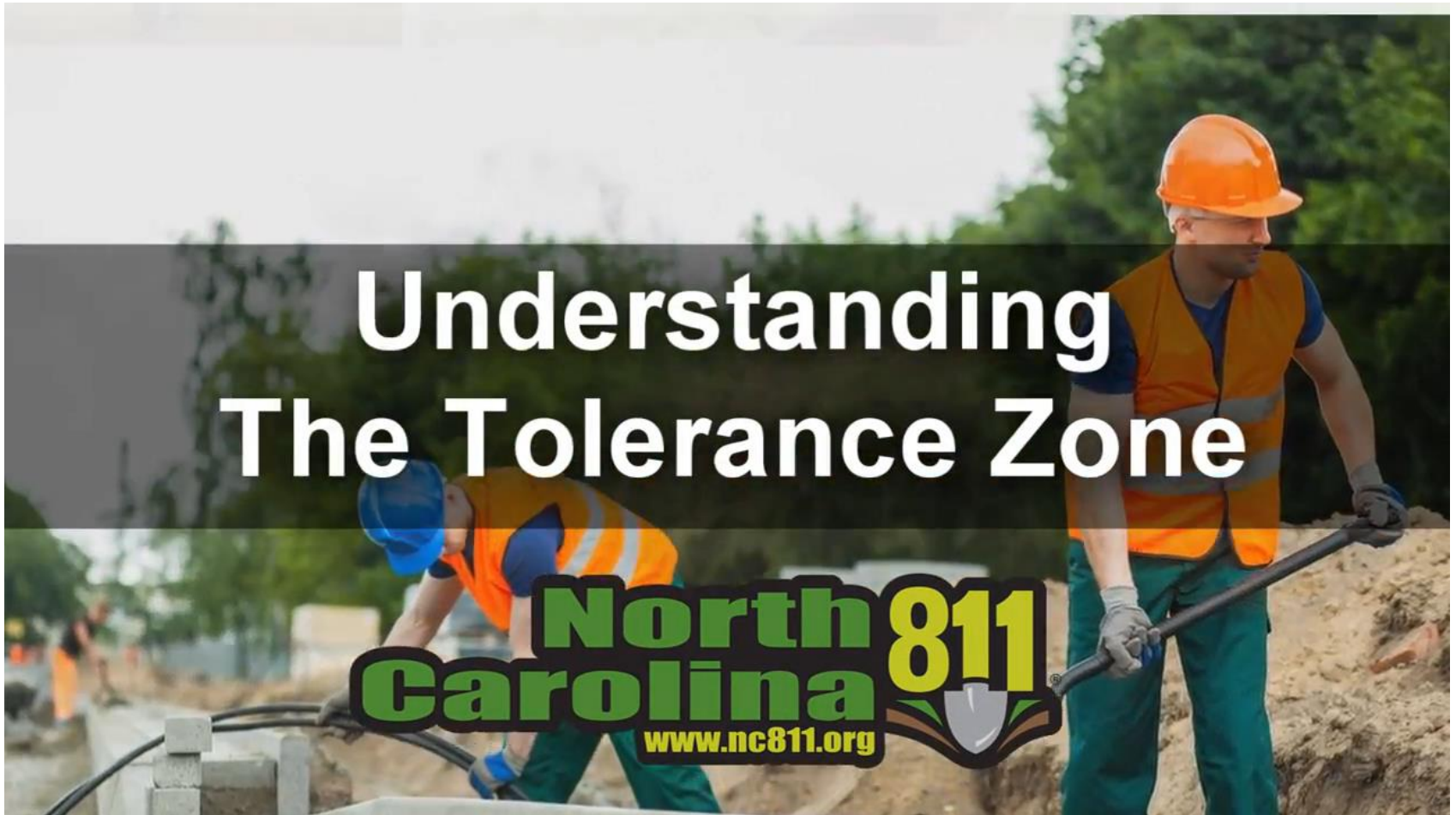


Figure 2 Post hole



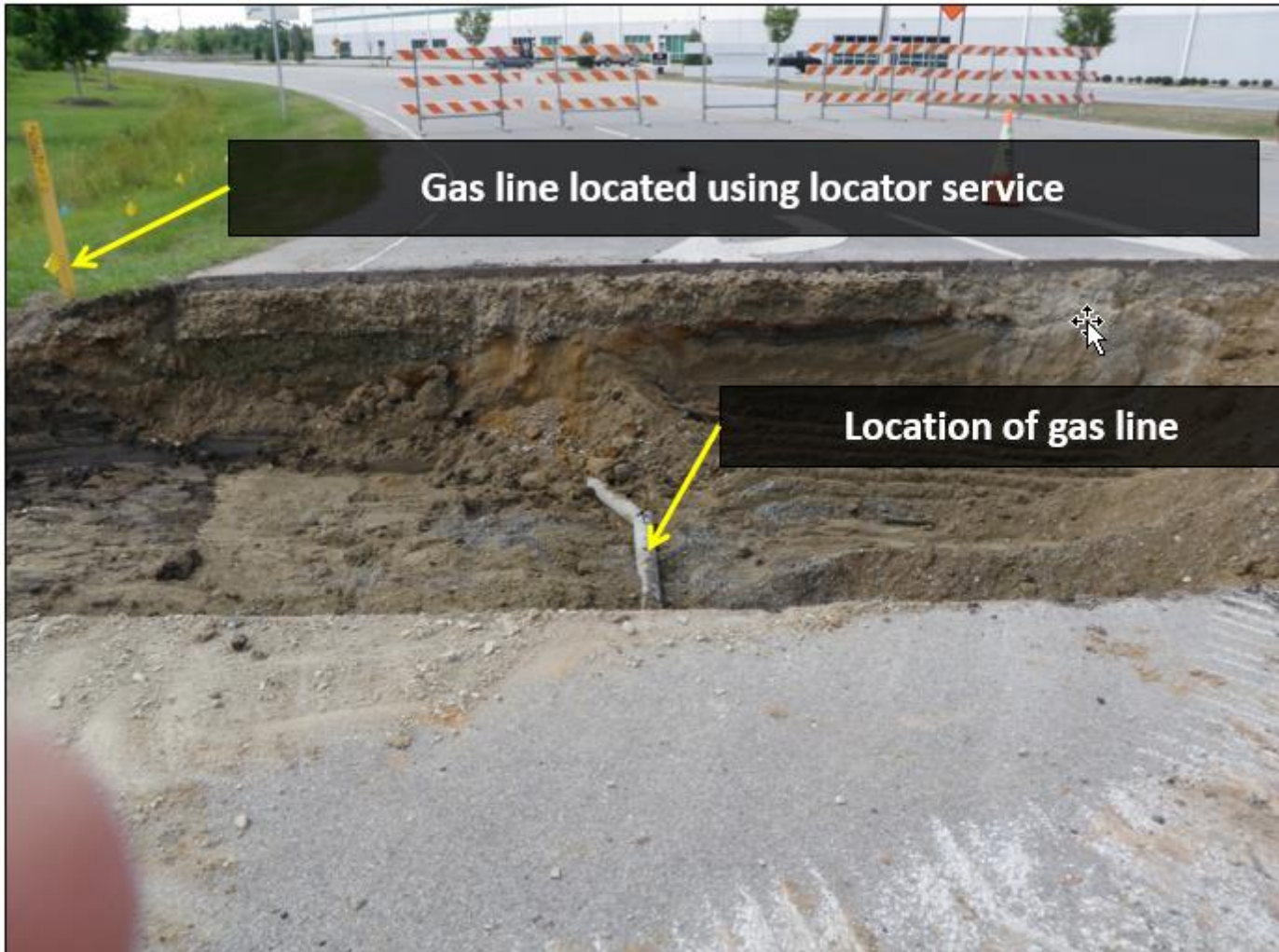


# Tolerance Zone Video





# Dig With Caution



# Surface Encumbrances

- All surface encumbrances that are located so as to create a hazard to employees shall be removed or supported, as necessary, to safeguard employees.
  - Gas Lines
  - Water/Sewer Lines
  - Phone Lines
  - Power Poles
  - Fiber Optic Cables
  - Sidewalks & Curbs
  - Adjacent structures





# What to do with Underground Utilities

- While the excavation is open, underground installations shall be:
  - Protected
  - Supported
  - Removed





# Utility Lines in an Excavation





# Utility Strike





# Means of Entry and Egress

- A stairway, ladder, ramp or other safe means of egress shall be located in trench excavations that are **4 feet** or more in depth so as to require no more than **25 feet** of lateral travel for employees.



# Exposure to Vehicular Traffic

- Employees exposed to public vehicular traffic shall be provided with, and shall wear, warning vests or other suitable garments marked with or made of reflectorized or high-visibility material.
  - Vest – ANSI Class II
  - Flaggers – orange hat





# Exposure to Falling Loads

- No employee shall be permitted underneath loads handled by lifting or digging equipment.





# Falling Loads – Loading & Unloading Vehicles

- Employees shall be required 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 to provide adequate protection”** for the operator during loading and unloading operations.

# 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, a warning system shall be utilized such as:
  - barricades;
  - hand or mechanical signals;
  - stop logs;
  - If possible, the grade should be away from the excavation.

# No Warning System



# No Warning System



# Hazardous Atmospheres

- Hazardous Atmospheres in excavations could be caused by:
  - Volatile Organic Compounds
  - Methane
  - Gas Powered Hand Tools (Carbon Monoxide)
  - Vehicle and Equipment Exhaust (Carbon Monoxide)
  - Natural Gas Lines
  - Sewer Lines (Hydrogen Sulfide)
  - Chemicals
  - Flammables and Combustibles



# Hazardous Atmosphere

- Where oxygen deficiency or a hazardous atmosphere exists or could reasonably be expected, the atmosphere in the excavation **shall be tested before employees enter excavations.**
- Safeguards shall be taken 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.

# Hazardous Atmospheres

- Safeguards shall be taken such as providing ventilation, to prevent employee exposure to an atmosphere containing a concentration of a flammable gas in excess of **20 percent** of the **lower flammable limit** of the gas.
- When controls are used that are intended to reduce the level of atmospheric contaminants to acceptable levels, testing shall be conducted as often as necessary to ensure that the atmosphere remains safe.

# Hazardous Atmospheres

- What do you use to determine oxygen level in an excavation?
- Where is your meter located?
- What does it test for?
- When was it last calibrated?
- Does the person operating it know the proper operation procedures and how to manipulate the meter?



# Emergency Rescue Equipment

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



# Water Hazard

Employees shall not work in excavations in which there is accumulated or accumulating water unless adequate precautions have been taken.

# Water in Excavations





# Water in Excavations



# Water Hazard

- A competent person will oversee the control or prevention of water accumulation, water removal equipment and operations.



Water/Mud Pump

Aqua-Dam and Well Points



# Stability of Adjacent Structures

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



Is that pole stable?

# Adjacent Structures

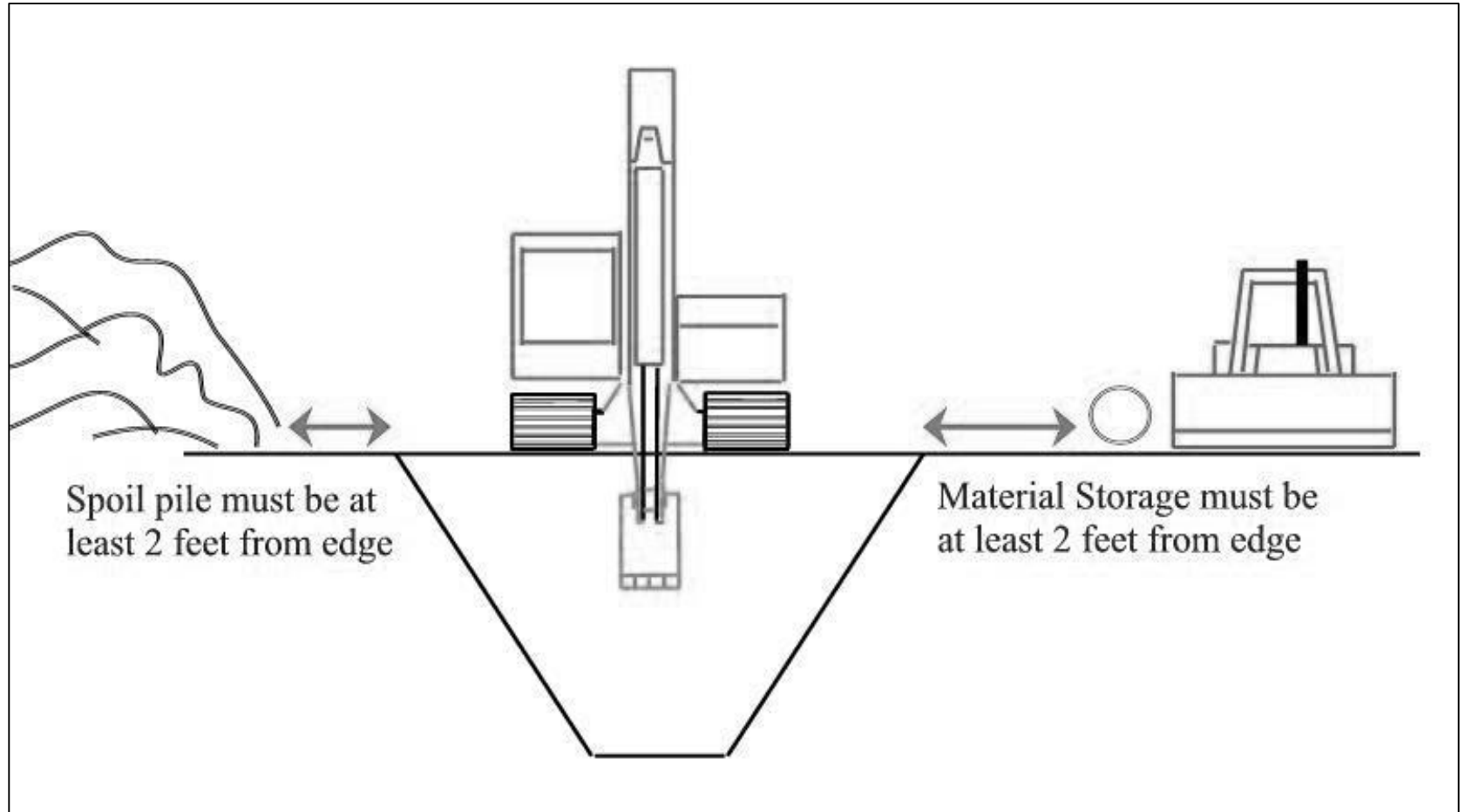


# Protection From Loose Rock or Soil

- Protect employees from loose rock or soil that could pose a hazard by falling or rolling from an excavation face.
  - 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
  - hard hats
- Employees shall be protected from excavated or other materials or equipment that could pose a hazard by falling or rolling into excavations.
  - protection shall be provided by placing and keeping such materials or equipment **at least 2 feet** from the edge of excavation
  - 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.



# Spoil Piles & Material Storage



# Fall Protection & Excavations

- 1926.501(b)(7) (i) Each employee at the edge of an excavation 6 feet or more in depth shall be protected from falling by guardrail systems, fences, or barricades when the excavations are not readily seen because of plant growth or other visual barrier;



# Fall Protection & Excavations

- 1926.501(b)(7)(ii) Each employee at the edge of a **well, pit, shaft, and similar excavation** 6 feet or more in depth shall be protected from falling by guardrail systems, fences, barricades, or covers.



# Fall Protection

- Walkways shall be provided where employees or equipment are required or permitted to cross over excavations.
- Guardrails which comply with fall protection regulations shall be provided where walkways are 6 feet (1.8 m) or more above lower levels.





# Excavation Protective Systems

- Each employee in an excavation shall be protected from cave-ins by an adequate protective system except when:
  - Excavations are made entirely in stable rock; or
  - Excavations are less than 5 feet in depth **and examination of the ground by a “competent person” provides no indication of a potential cave-in.**  
1926.652(a)(1)(ii)
- If the excavation is less than 5 feet, a competent person must examine it before workers enter it.

# Protective Systems

Protective systems for excavations:

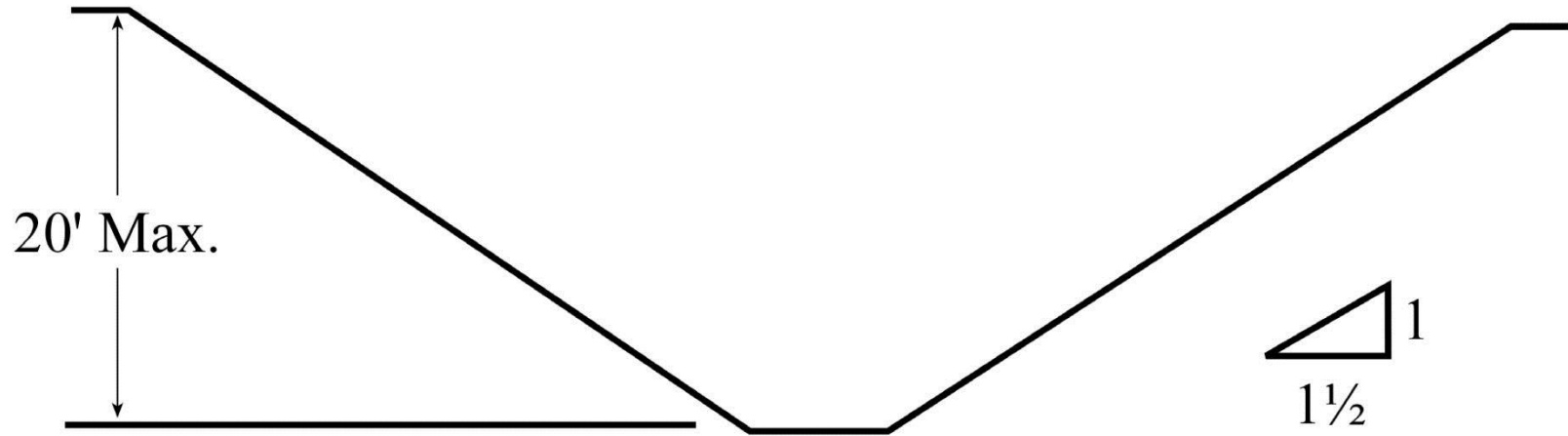
- Sloping the sides of the excavation
- Shoring the sides of the excavation
- Shielding the work area.



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

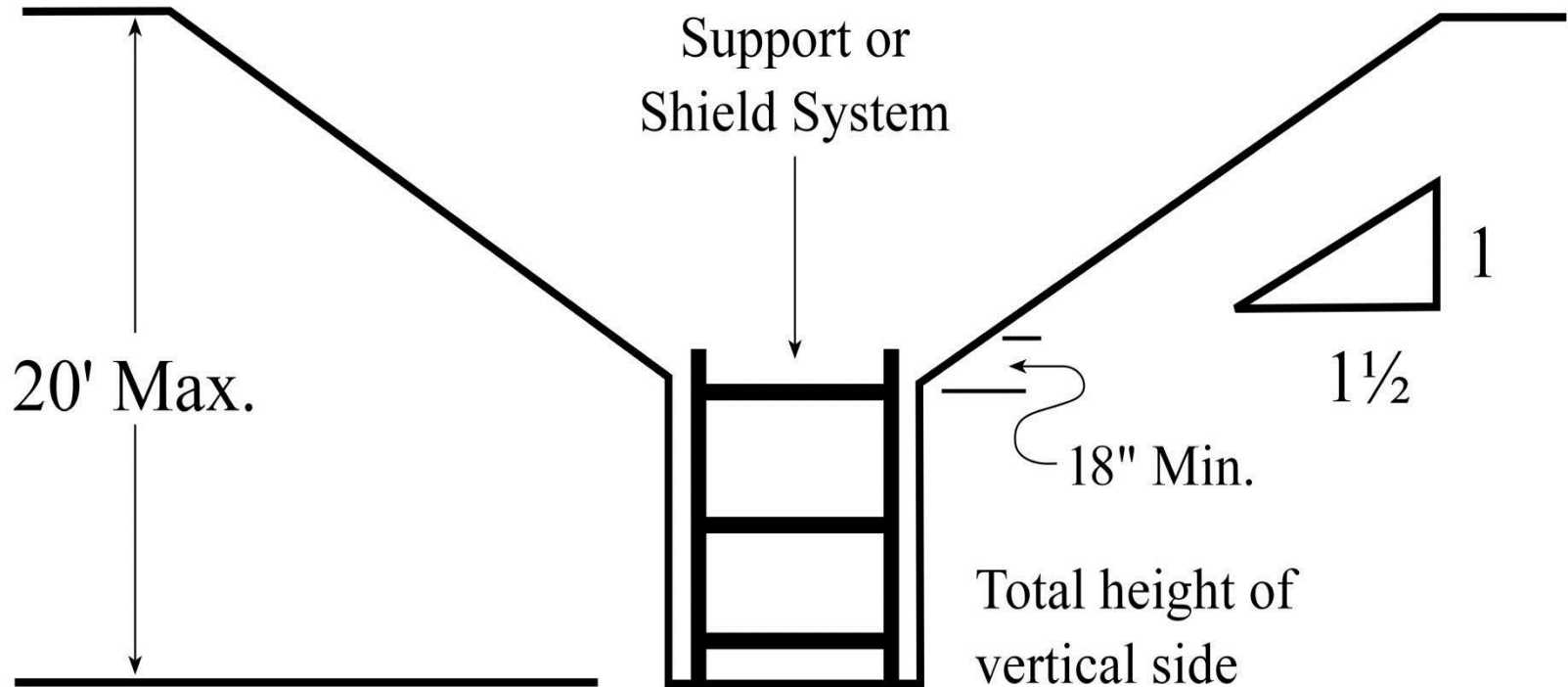


# Excavations in Type "C" Soil

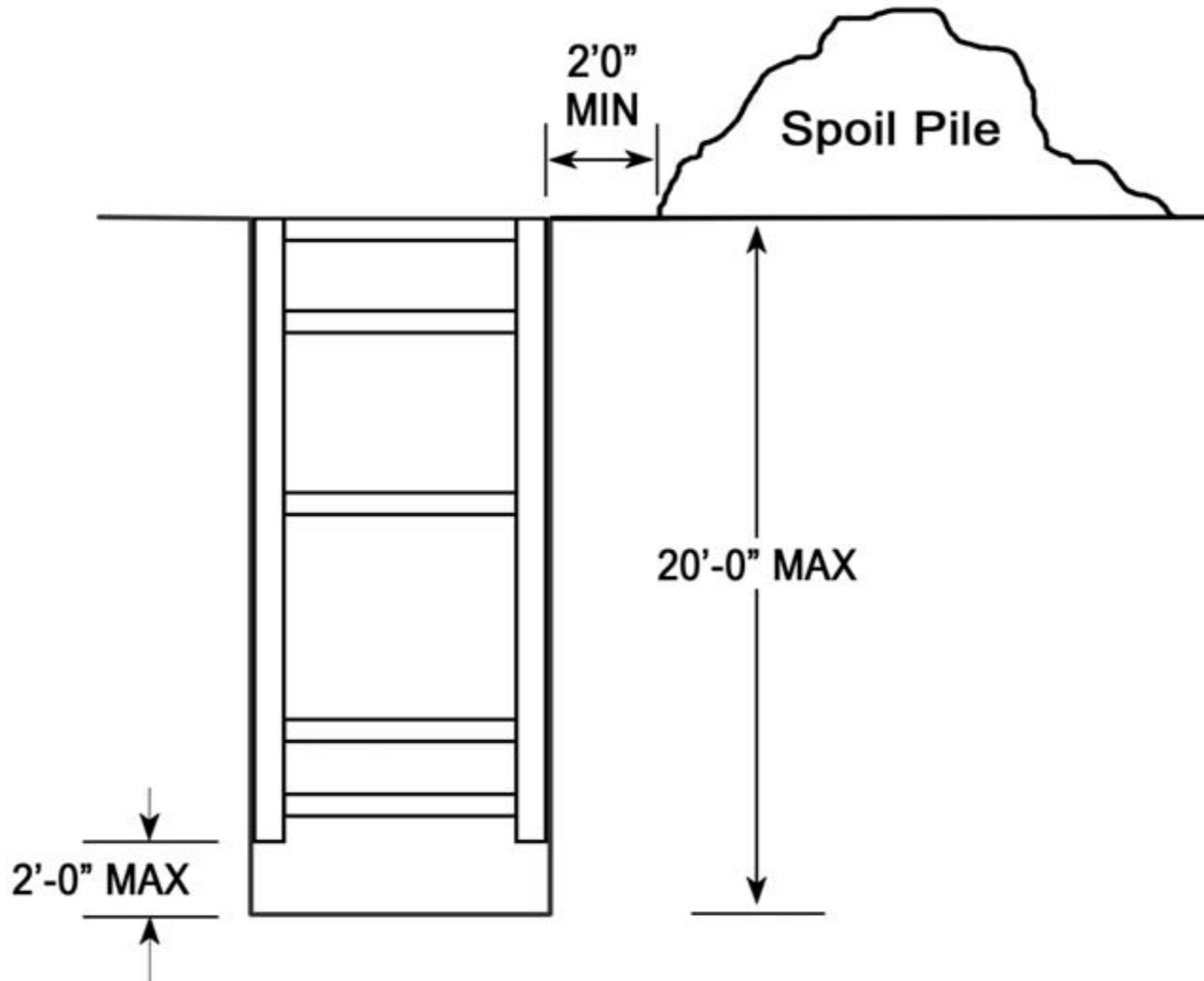


**Simple Slope**

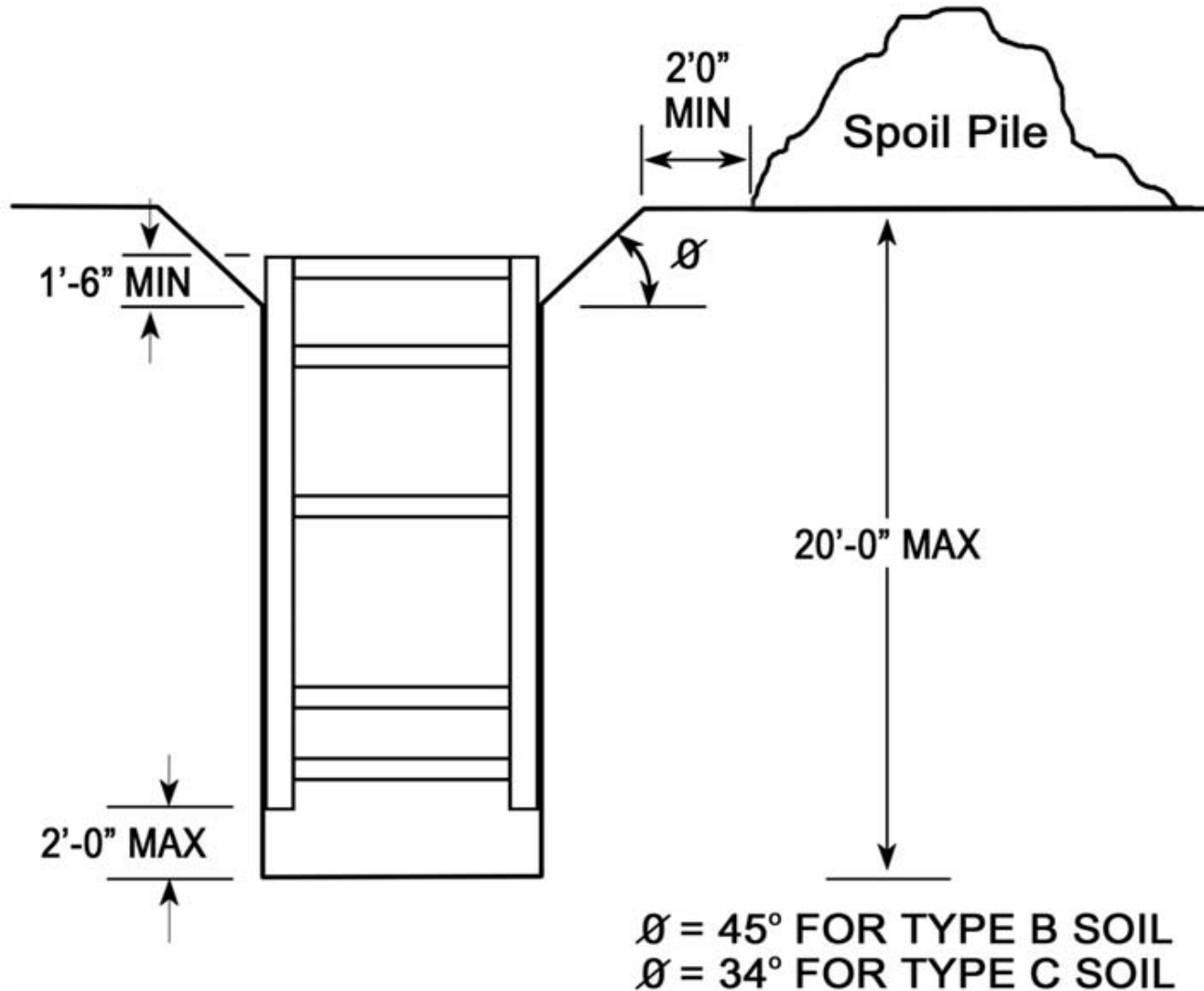
# Excavations Made in Type "C" Soil



# Shield Installed At Grade



# Shield Installed Below Grade



# Trench Shield/Box

- Employees shall not be allowed in shields when shields are being installed, removed, or moved vertically.





# Trench 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.
- The shield must be designed by a Registered Professional Engineer, be in good condition, and be used per manufacturers recommendation.
  - “You need to have the Manual.”



# Trench Shield Inspection

- Conducted by the Competent Person.
- Conducted daily, prior to each shift and as needed throughout the shift.
- Conducted after every rainstorm or other hazardous event.
- Two categories of the inspection:
  - Condition of the protective system (Trench Shield/box)
  - Proper installation of the protective system



# Sheet-Piles as a Protective System

- The use of sheet-piles in NCDOT must be designed and stamped by a registered professional engineer.
- Please consult with the Area Geotechnical Operations Engineers before using sheet-piles as a protective system.

**NCDOT Standard Drawing "Not Stamped"**

SURCHARGE CASE OR TRAFFIC IMPACT	SURCHARGE CASE WITH TRAFFIC IMPACT				SURCHARGE CASE WITH TRAFFIC IMPACT			
	SHEET PILES		SHEET PILES WITH TRAFFIC IMPACT		SHEET PILES		SHEET PILES WITH TRAFFIC IMPACT	
MINIMUM REQUIRED EMBEDMENT (SEE NOTE 1)	MINIMUM REQUIRED EMBEDMENT (SEE NOTE 2)	MINIMUM REQUIRED EMBEDMENT (SEE NOTE 3)	MINIMUM REQUIRED EMBEDMENT (SEE NOTE 4)	MINIMUM REQUIRED EMBEDMENT (SEE NOTE 1)	MINIMUM REQUIRED EMBEDMENT (SEE NOTE 2)	MINIMUM REQUIRED EMBEDMENT (SEE NOTE 3)	MINIMUM REQUIRED EMBEDMENT (SEE NOTE 4)	
1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	
2	2	2	2	2	2	2	2	
3	3	3	3	3	3	3	3	
4	4	4	4	4	4	4	4	
5	5	5	5	5	5	5	5	
6	6	6	6	6	6	6	6	
7	7	7	7	7	7	7	7	
8	8	8	8	8	8	8	8	
9	9	9	9	9	9	9	9	
10	10	10	10	10	10	10	10	

**NOTES:**

- AS SHOWN, STANDARD TEMPORARY SHORING IS TO BE USED AT THE SAME.
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**CONCRETE BARRIER**  
 TOP OF SHORING = EDGE OF PAVEMENT

**TEMPORARY GUARDRAIL**  
 TOUGHRAIL FACE = EDGE OF PAVEMENT

**STANDARD TEMPORARY SHORING**  
 SURCHARGE CASE  
 SEE TABLE ABOVE.

**STANDARD TEMPORARY SHORING**  
 SURCHARGE CASE  
 SEE TABLE ABOVE.

GEOTECHNICAL ENGINEERING UNIT  
 STATE OF NORTH CAROLINA  
 DEPARTMENT OF TRANSPORTATION  
 RALEIGH

STANDARD DRAWING NO. 100210  
 STANDARD TEMPORARY SHORING  
 (10/10/10)



# Inspections

- All excavations & protective equipment must be inspected on a daily basis by a competent person:
  - Daily and before the start of each shift;
  - As dictated by the work being done in the trench;
  - After every rainstorm;
  - After other events that could increase hazards, e.g. snowstorm, windstorm, thaw, earthquake, etc.;
  - When fissures, tension cracks, sloughing, undercutting, water seepage, bulging at the bottom, or other similar conditions occur;
  - When there is a change in the size, location, or placement of the spoil pile; and
  - When there is any indication of change or movement in adjacent structures.

# Supervisor Excavation Checklist

- Employees prohibited from working on faces of sloped or benched excavations above other employees.
- Warning system established and used when mobile equipment is operating near edge of excavation.
- Utility companies contacted and/or utilities located.
- Exact location of utilities marked when near excavation.
- Underground installations protected, supported, or removed when excavation is open.
- Precautions taken to protect employees from accumulation of water.

# Supervisor Excavation Checklist

- Water removal equipment monitored by Competent Person.
- Surface water controlled or diverted.
- Inspection made after each rainstorm.
- Atmosphere tested when there is a possibility of oxygen deficiency or build-up of hazardous gases.
- Oxygen content is between 19.5% and 21%.
- Ventilation provided to prevent flammable gas build-up to 20% of lower explosive limit of the gas.

# Supervisor Excavation Checklist

- Testing conducted to ensure that atmosphere remains safe.
- Emergency Response Equipment readily available where a hazardous atmosphere could or does exist.
- Employees trained in the use of Personal Protective and Emergency Response Equipment.

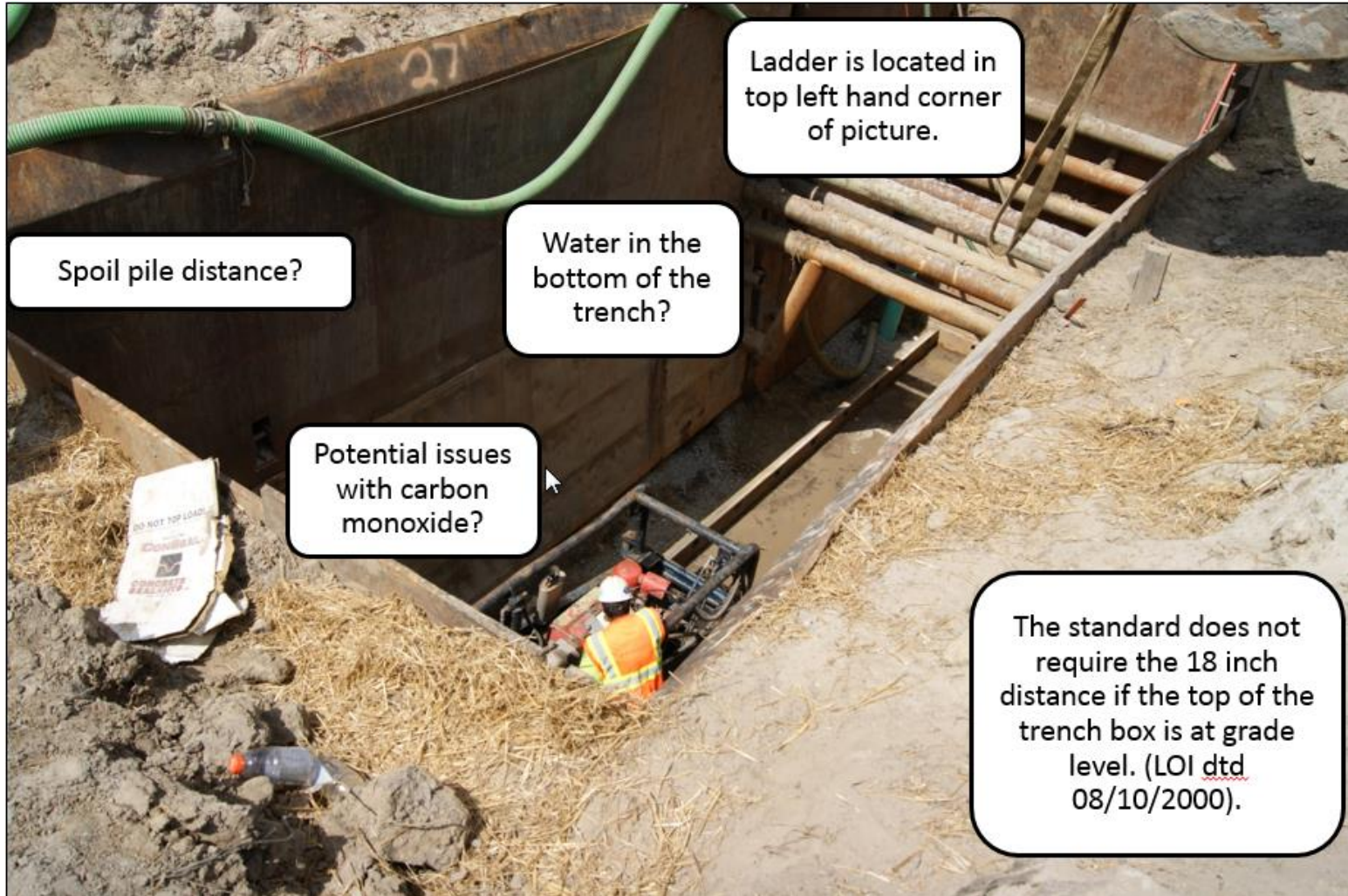


# What are the Hazards?





# Supervisor Observations



Ladder is located in top left hand corner of picture.

Spoil pile distance?

Water in the bottom of the trench?

Potential issues with carbon monoxide?

The standard does not require the 18 inch distance if the top of the trench box is at grade level. (LOI dtd 08/10/2000).



# What are the Hazards?

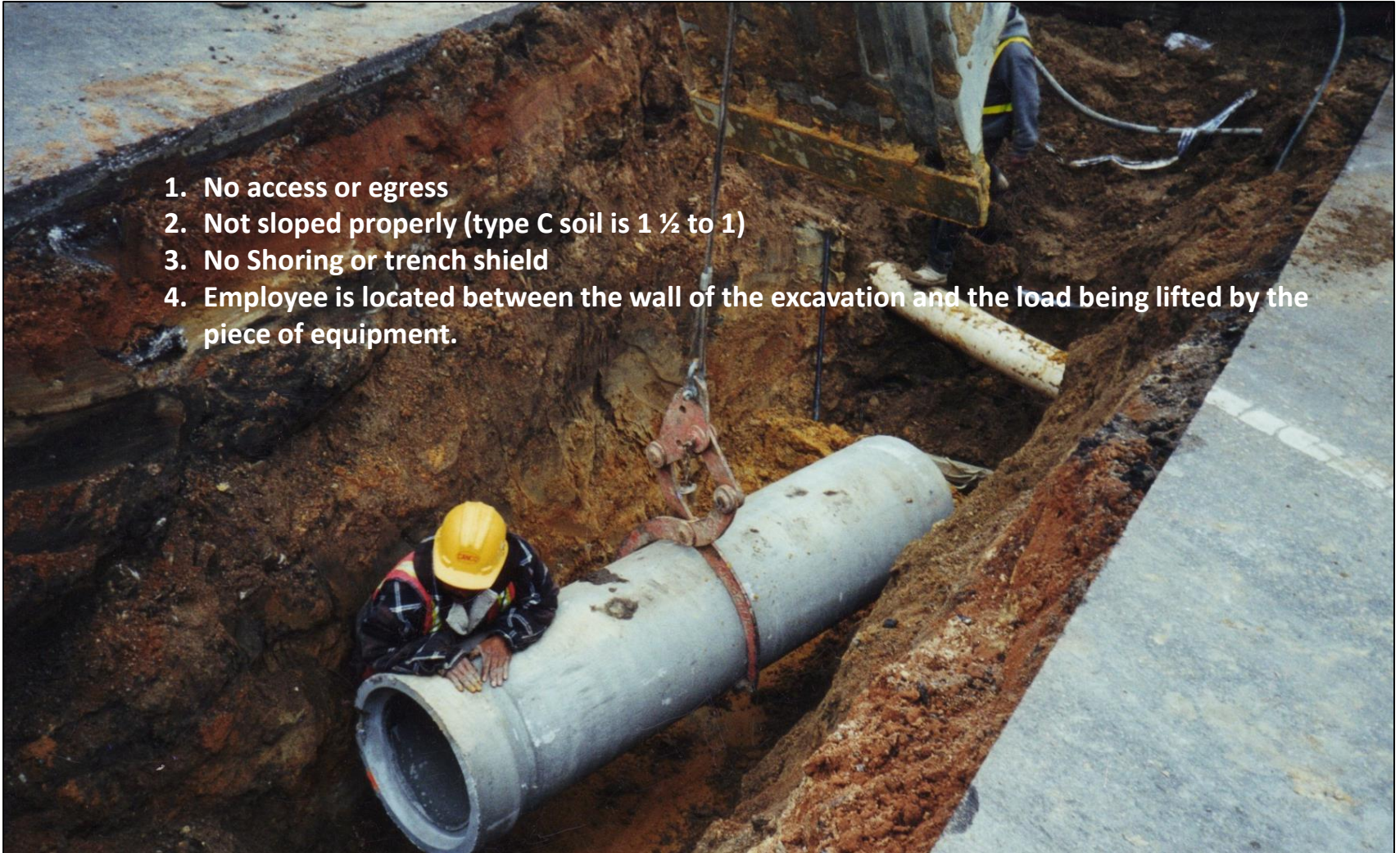


1. Ladder does not extend 3 feet above the edge of the excavation.
2. Not properly sloped
3. Traffic Control?
4. Carbon Monoxide
5. Can not bench class C soil



# What are the Hazards?

1. No access or egress
2. Not sloped properly (type C soil is 1 ½ to 1)
3. No Shoring or trench shield
4. Employee is located between the wall of the excavation and the load being lifted by the piece of equipment.





# Are They At Risk?



# Access & Egress?



- Good thing he's holding the ladder securely in place!



# What Are The Hazards?



1. Slope?
2. 25 ft. from means of access and egress?
3. Utilities supported?
4. Ladder height?



# Hazards?





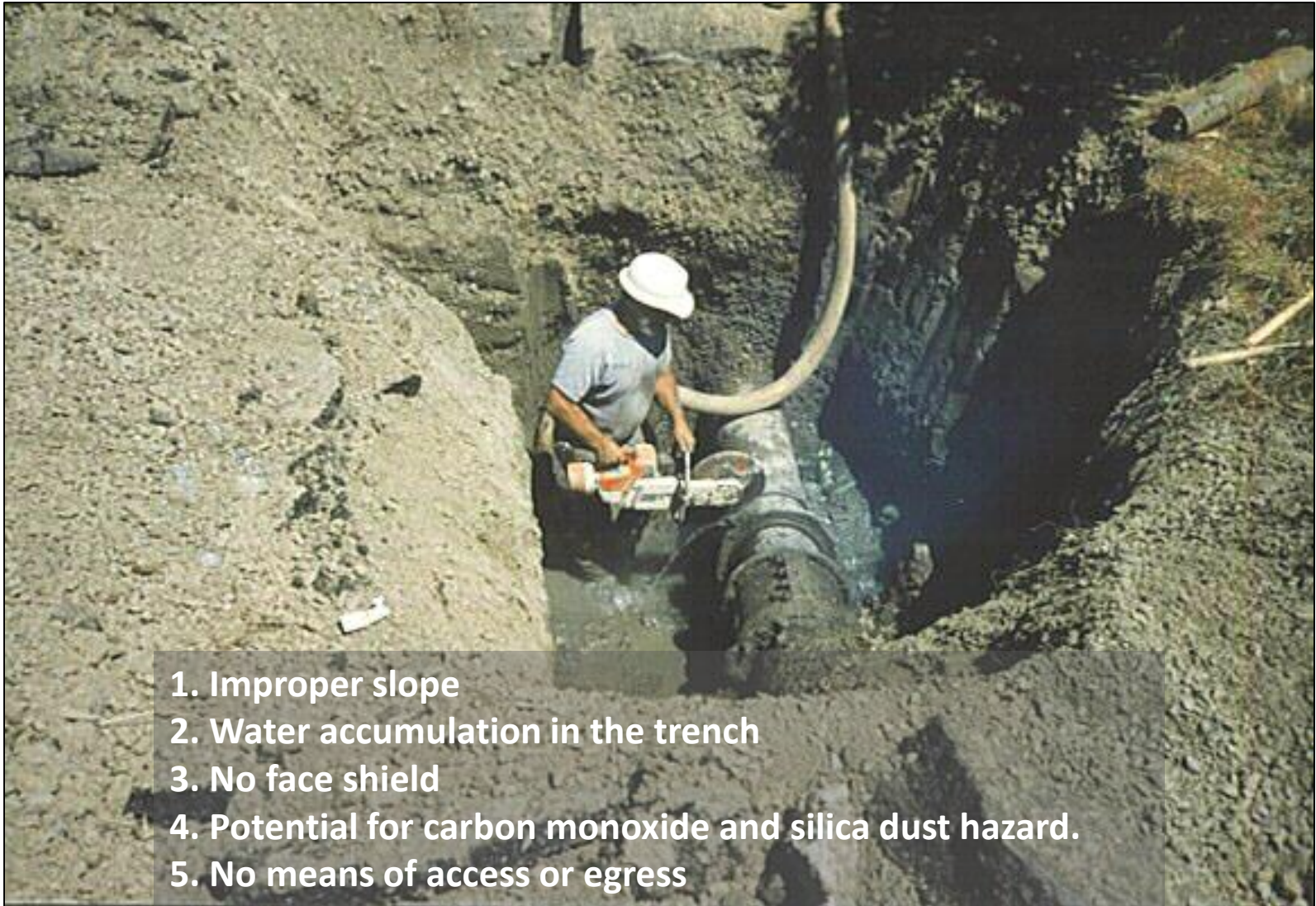
# What are the Hazards?

- Depth – slope
- Carbon Monoxide
- Ladder
- Gas can





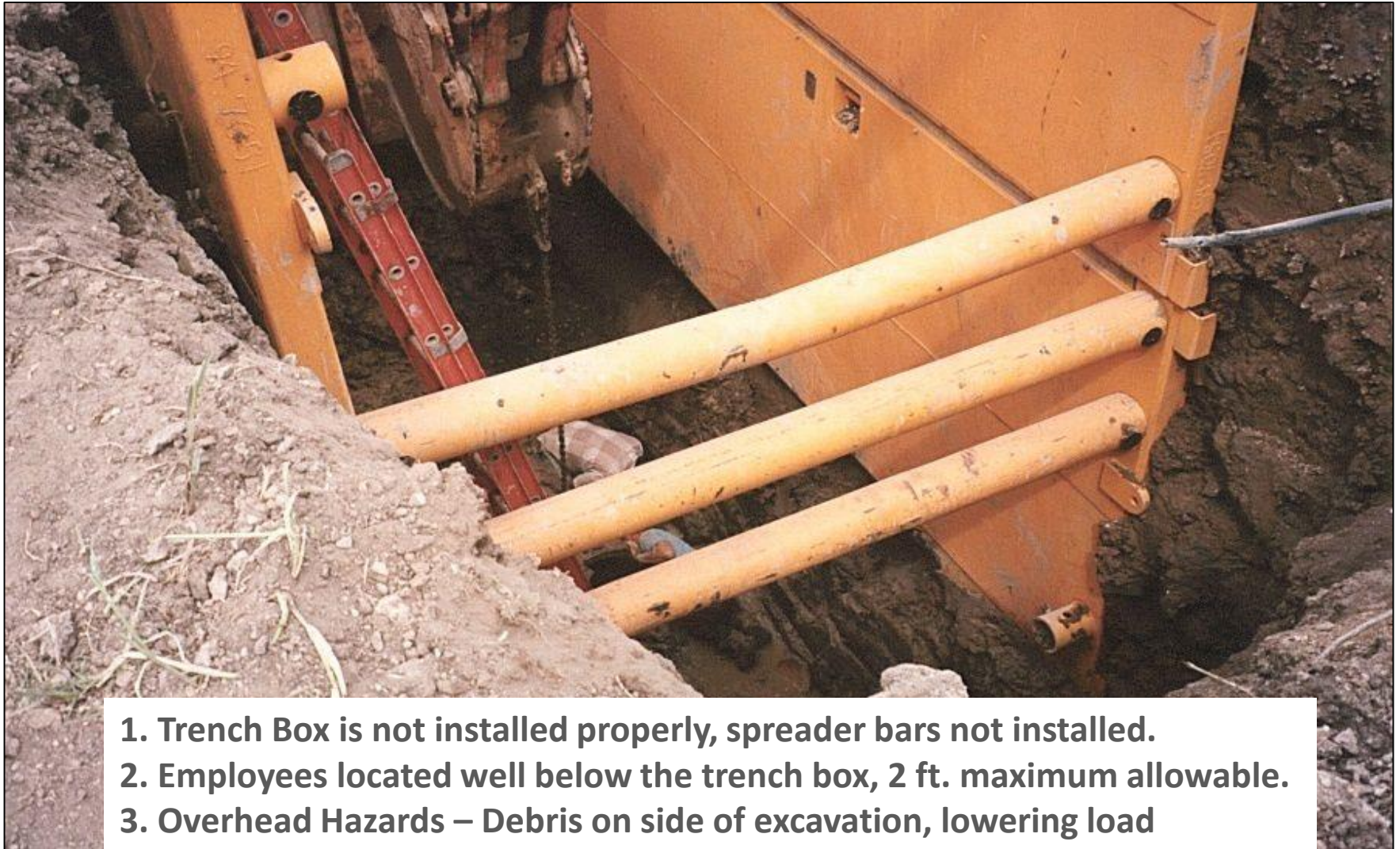
# What are the Hazards?



1. Improper slope
2. Water accumulation in the trench
3. No face shield
4. Potential for carbon monoxide and silica dust hazard.
5. No means of access or egress



# What Are the Hazards?



- 1. Trench Box is not installed properly, spreader bars not installed.**
- 2. Employees located well below the trench box, 2 ft. maximum allowable.**
- 3. Overhead Hazards – Debris on side of excavation, lowering load**



# What are the Hazards?



1. Slope – Is it cut back far enough? Trench Box?
2. Depth - Means of Access and Egress?
3. Vehicular Traffic – Are protections in place for the workers?
4. Competent Person onsite?



# What are the Hazards?

- Trench Box Installation
- Means of Access and Egress
- Spoil Pile back 2 feet?
- Depth of trench box in relation to side walls of excavation
- Trench box stability



Comments, Questions,  
Remarks, Statements, or  
Debates?

Thank you!