

Protocol #18

Excavation and Trenching

DGS Accident and Illness Prevention Program (AIPP)

A. Policy Statement

The following protocol for excavation and trenching is official policy for the PA Department of General Services (DGS) and its employees. Authority and responsibility for its execution are pursuant to DGS Secretary “[Safety Program Policy Statement](#),” [PA Management Directive 530.31, Workplace Safety and Health Program](#) and “[Element C](#)” of the DGS Accident and Illness Prevention Program (AIPP).

This policy includes material that applies directly to DGS operations. It is based on material from the Occupational Safety and Health Administration, the National Safety Council, and other credible resources in excavation safety. This protocol applies to situations in which a man-made cut, cavity, trench, or depression in the earth’s surface is formed by earth removal.

This policy must be considered together with DGS Protocol P-11 – Preoperational Process Review due to the hazardous nature of excavation operations. A preoperational process review must be conducted prior to commencement of any excavation operations.

B. Definitions

Bell-bottom pier hole – a type of shaft or footing excavation, the bottom of which is made larger than the cross section above to form a belled shape.

Cave-in – the separation of a mass of soil or rock material from the side of an excavation, or the loss of soil from under a trench shield or support system, and its sudden movement into the excavation, either by falling or sliding, in sufficient quantity so that it could entrap, bury, or otherwise injure and immobilize a person.

Competent person – a person designated by management as capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees and who has authorization to take prompt corrective measures to eliminate them, including stopping work until corrective measures are completed.

Excavation – any man-made cut, cavity, trench, or depression in the earth’s surface formed by earth removal.

Faces – the vertical or inclined earth surfaces formed because of excavation work, also referred to as “sides.”

Failure – the breakage, displacement, or permanent deformation of a structural member or connection, reducing its structural integrity and supportive capabilities.

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

Personal protective equipment (PPE) – specialized clothing or equipment worn by an employee for protection against a hazard, such as gloves, eye protection, hearing protection, high-visibility apparel, and hardhats.

Protective system – a method (either sloping or trench box) to protect 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.

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

Safety zone – an area established on a case-by-case basis surrounding a work area to prevent accidental entry by persons or machinery not involved in the work.

Sides – the vertical or inclined earth surfaces formed because of excavation work, also referred to as “faces.”

Site inspections – examinations of the site and surrounding area by a competent person to ensure ongoing compliance with this and other AIPP protocols.

Sloping – a protective system involving sloping the sides of an excavation at 34 degrees from horizontal (1 ½ feet horizontal for every 1 foot vertical) to prevent cave-ins.

Soil classification – all soils shall be classified as “Type C” for any DGS excavation, which limits protective measures to sloping and trench boxes.

Structural ramp – a ramp built of steel, wood, or other suitable material used for employee or vehicle access to an excavation.

Support system – a structure such as underpinning, bracing, or shoring, which provides support to an adjacent structure, underground installation, or the sides of an excavation.

Trench – an excavation that is longer than it is wide, and less than 15 feet wide.

Trench box – a professionally manufactured, portable structure that can be lowered into a trench that is able to withstand the forces imposed on it by a cave-in and thereby protect employees within it.

Type C soil – the least stable type of soil. Type C includes granular soils in which particles don't stick together

Work area – an area encompassing the entire site being excavated, and the areas where employees and machinery will need to maneuver to complete the work.

C. Requirements

1. Pre-operational planning must be conducted prior to excavation operations. [DGS AIPP protocol P-11](#) should be adhered to before any excavation or trenching operations begin. The competent person(s) who will be present during the excavation or trenching operations shall participate in the pre-operational planning, along with employees involved in the operation. Pre-operational planning for any excavation should include completion of Appendix A, Excavation Inspection Form. Excavation Inspection Forms should be completed by the competent person and remain on file for the length of the project.
2. The work area shall be free of recognized hazards.
3. All materials which DGS excavates shall be deemed to be Type C soil.
4. Underground installations:
 - a. PA One Call (811) shall be contacted not less than 3 nor more than 10 business days prior to any excavation start date if excavating will involve the use of powered equipment or explosives to identify the approximate location of underground installations that could be encountered. All PA One Call requirements must be adhered to. For detailed information, visit PaOneCall.org.
 - c. Managers in charge of excavations shall be familiar with PA One Call and follow its provisions, such as employing prudent techniques to determine the precise location of underground installations.
 - d. While the excavation is open, underground installations shall be protected, supported or removed as necessary to safeguard employees.
5. Overhead utilities

- a. When working near overhead utilities, a spotter shall be utilized and adequate clearance will be kept based on the line's voltage; however, a minimum of 10 feet will be maintained.

6. Access and egress:

- a. For excavations that are 4 feet or more in depth, a stairway, ladder, ramp, or other safe means of access and egress shall be located so as to require no more than 25 feet of lateral travel for employees. The top of a ladder used for access and egress must be secured and extend at least 3 feet above the upper landing surface.
- b. Structural ramps that are used solely by employees as a means of access or egress from excavations shall be designed by a competent person. Structural ramps used for access or egress of equipment shall be designed by a competent person qualified in structural design and shall be constructed in accordance with the design.
- c. Ramps and runways constructed of 2 or more structural members shall have structural members that are of uniform thickness, and that are connected together to prevent displacement.
- d. Cleats or other appropriate means used to connect runway structural members shall be attached to the bottom of the runway or shall be attached in a manner to prevent tripping.
- e. Structural ramps used in lieu of steps shall be provided with cleats or other surface treatments on the top surface to prevent slipping.
- f. Employees entering bell-bottom pier holes, or other similar deep and confined footing excavations, shall wear a harness with a lifeline securely attached to it. The lifeline shall be separate from any line used to handle materials, shall be individually and always attended while the employee wearing the lifeline is in the excavation.

7. Vehicular traffic:

- a. Employees exposed to vehicular traffic shall be provided with and shall wear high-visibility vests and/or other suitable high-visibility garments.
- b. If interference with vehicular traffic is required to establish an appropriate safety zone, Capital Police or the police department with jurisdiction over the

area shall be notified in advance and consulted for advice, instructions, and support if needed.

8. Falling loads:

- a. No employee shall be permitted underneath any loads handled by lifting or digging equipment, or that are suspended in any manner.
- b. Employees shall be required to stand away from any vehicle being loaded or unloaded to avoid being struck by any spillage or falling materials.
- c. Operators may remain in the cabs of vehicles being loaded or unloaded only if the vehicles are equipped with a cab shield and/or canopy adequate to protect the operator from shifting or falling materials.

9. Warning system for mobile equipment:

- a. 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, or stop logs.
- b. If possible, the grade should be away from the excavation.

10. Hazardous atmospheres:

- a. 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, the atmosphere in the excavation shall be tested before employees enter.
- b. Adequate precautions shall be taken to prevent employee exposure to atmospheres containing less than 19.5 percent oxygen and other hazardous atmospheres, including ventilation or proper respiratory protection as needed.
- c. Adequate precautions shall be taken to prevent employee exposure to an atmosphere containing a concentration of a flammable gas exceeding 10% of that gas' lower flammable limit.
- d. When controls are used that are intended to reduce the level of atmospheric contaminants to acceptable levels or assure a minimum 19.5% oxygen content

in the atmosphere, testing shall be conducted as often as necessary to ensure that the atmosphere remains safe.

11. Protection from hazards associated with water accumulation:

- a. Employees shall 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.
- b. If water is controlled or prevented from accumulating by using water removal equipment, the water removal equipment and operations shall be monitored by a competent person to ensure proper operation.

12. Stability of adjacent structures:

- a. Where the stability of adjoining buildings, wall, or other structures is endangered by excavation operations, support systems such as shoring, bracing, or underpinning shall be provided to ensure the stability of such structures for the protection of employees.
- b. 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 shall not be permitted except when:
 - (1) A support system such as underpinning is provided to ensure the safety of employees and the stability of the structure; or
 - (2) The excavation is in stable rock; or
 - (3) A registered professional engineer has approved the determination that the structure is sufficiently removed from the excavation so as to be unaffected by excavation activity; or
 - (4) A registered professional engineer has approved the determination that such excavation work will not pose a hazard to employees.

- c. Sidewalks, pavements, trees, and adjacent structures 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.

13. Protection of employees from loose rock or soil:

- a. Adequate protection shall be provided to protect employees from loose rock or soil that could pose a hazard by falling or rolling from an excavation face. Such protection shall 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.
- b. 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 excavations, or by using retaining devices that are sufficient to prevent materials or equipment from falling or rolling into excavations, or by a combination of both if necessary.

14. Inspections:

- a. Daily inspections of excavations, the adjacent areas, and protective systems shall 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 shall be conducted by the competent person prior to the start of work and as needed throughout the shift. Inspections shall also be made after every rainstorm or other hazard increasing occurrence.
- 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, exposed employees shall be removed from the hazardous area until the necessary precautions have been taken to ensure their safety.

15. Walkways shall be provided where employees or equipment are required or permitted to cross over excavations. Approved guardrail systems according to AIPP P-19 Fall Protection shall be provided where walkways are 6 feet or more above lower levels.

16. Only the minimum number of employees required to perform the work, as determined by the competent person on site, shall be allowed inside an excavation.
17. Employees working in or near excavations shall wear DGS-provided PPE as required by management or the competent person on site based on their judgment in each situation. This can include gloves, eye protection, hearing protection, hard hats, and/or high visibility garments.
18. A safety zone for each excavation work area shall be determined by the competent person on site. It will be cordoned off in such a way as to prevent incidental entry by any persons not required for the work being performed. High visibility PPE shall be worn if any exposure to traffic hazards exists.
19. Rescue operations are performed by outside services and not DGS employees.

D. Protection of Employees in Excavations

1. Each employee in an excavation shall be protected from cave-ins by an adequate protective system. The only protective systems used by DGS are trench boxes or sloping, except when:
 - a. Excavations are made entirely in stable rock and examined and approved for entry by a registered professional engineer, or
 - b. 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.
2. Protective systems shall 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.
3. Benching systems will not be used since all soils are deemed to be Type C.
4. Excavations shall be sloped at an angle not steeper than 1 ½ feet (horizontal) : 1 foot (vertical); 34 degrees measured from the horizontal, unless a commercially manufactured trench shield is used in accordance with manufacturer's tabulated data.
5. Equipment usage shall be in accordance with manufacturers' specifications, recommendations, and limitations unless written approval for deviations is provided by a manufacturer or a registered professional engineer.
6. Equipment manufacturers' specifications, recommendations, and limitations, and/or their written approval to deviate from their specifications, recommendations, and

limitations will be in written form at the jobsite during construction of the protective system. After that time, this data may be stored off the jobsite, but a copy will be made available for review if requested.

7. Materials and equipment used for protective systems shall be free from damage or defects that might impair their proper function.
 - a. Manufactured materials and equipment used for protective systems shall be used and maintained in a manner that is consistent with the recommendations of the manufacturer, and in a manner that will prevent employee exposure to hazards.
 - b. When material or equipment that is used for trench boxes is damaged, a competent person shall 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 such material or equipment shall be removed from service and be evaluated and approved by a registered professional engineer before being returned to service.
8. Installation and removal of a trench box shall be performed in such a manner that employees are protected from cave-ins, structural collapses, or from being struck by members of the trench box.
9. Before employees may enter a trench box, it shall be backfilled on both sides the excavation faces.
10. A trench box can be used in combination with other protective systems, such as sloping and benching. Under that circumstance, the trench box must extend 18 inches above the vertical part of the excavation walls to keep dirt, rocks and other debris from rolling into the trench. If the top of the trench box is at ground level, however, the trench box does not have to extend 18 inches above grade.
11. Employees shall not be permitted to work on the faces of sloped or other 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.
12. Employees shall not be allowed inside trench boxes when they are being installed, removed, or moved.

13. Excavation of material to a level no greater than 2 feet below the bottom of the members of a support system shall be permitted, but only if the system 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 support system.

E. Communication of Hazards

1. Physical warning barriers, such as portable sawhorses with ropes, shall be set up around the safety zone of any excavation operations so that neither employees nor passersby will incidentally enter the safety zone.
2. Signs that managers in charge of excavating operations deem appropriate warning of hazards such as changes in level, moving machinery, falling objects, etc. shall be posted along with the physical barriers cordoning off the safety zone.

F. Training

1. Advance training sufficient to allow for the safe performance of excavating operations shall be arranged for all workers by the managers in charge.
2. Training needs should be determined by the manager in charge during pre-operational planning and delivered prior to the job's commencement.
3. The purposes of pre-job training are to make employees aware of their role(s) in the process and to familiarize them with proper procedures while involved in excavation work. These matters will have been finalized during pre-operational process review.
4. Training should also include reviewing this protocol with all participating employees.

G. Recordkeeping

1. Manufacturers' tabulated data, instruction manuals, record of purchase date, and other materials required by this protocol and training materials will be kept on file by the managers, supervisors, and foremen responsible for excavation operations.
2. Training records will be kept on file by managers in charge of excavation operations when new training or re-training is required, and a copy of the sign-in sheet will be provided to the DGS Safety Coordinator.

Appendix A - Excavation Inspection Form

This form should be completed by the Competent Person prior to excavation beginning and remain on file for the length of the project.

Location:		Date:
Time of Inspection(s):		
Weather Conditions:		Approx. Temp:
Competent Person Completing This Form:		
Soil Class: Class C		Soil Type:
Excavation Depth:	Excavation Width:	Excavation Length:
Type of Protective System Used:		

Indicate for each item: Yes - No - or N/A for not applicable

Yes	No	N/A	1. General Inspection of Jobsite
			Excavations, adjacent areas, and protective systems inspected by a Competent Person daily before the start of work.
			Competent Person has the authority to remove employees from the excavation immediately.
			Surface encumbrances removed or supported.
			Employees protected from loose rock or soil that could pose a hazard by falling or rolling into the excavation.
			Appropriate personal protective equipment (PPE) worn by all employees.
			Spoils, materials, and equipment set back at least 2 feet from the edge of the excavation.
			Barriers provided at all remotely located excavations, wells, pits, shafts, etc.
			Walkways and bridges over excavations 6 feet or more in depth are equipped with standard guardrails and toe boards.
			Warning vests or other highly visible clothing provided and worn by all employees exposed to public vehicular traffic.
			Employees required to stand away from vehicles being loaded or unloaded.
			Warning system established and utilized when mobile equipment is operating near the edge of the excavation.
			Employees prohibited from going under suspended loads.
			Employees prohibited from working on the faces of slopes or benched excavations above other employees.
Yes	No	N/A	2. Utilities
			Utility companies contacted and/or utilities located.
			Exact location of utilities marked.



			Underground installations protected, supported or removed when excavation is open.
Yes	No	N/A	3. Means of Access and Egress
			Lateral travel to means of egress no greater than 25 feet in excavations 4 feet or more in depth.
			Ladders used in excavations secured and extended 3 feet above the edge of the trench.
			Structural ramps used by employees designed by a Competent Person.
			Structural ramps used for equipment designed by a Registered Professional Engineer.
			Ramps constructed of materials of uniform thickness, cleated together on the bottom, and equipped with no-slip surface.
			Employees protected from cave-ins when entering or exiting the excavation.
Yes	No	N/A	4. Wet Conditions
			Precautions taken to protect employees from the accumulation of water.
			Water removal equipment monitored by a Competent Person.
			Surface water or runoff diverted or controlled to prevent accumulation in the excavation.
			Inspections made after every rainstorm or other hazard-increasing occurrence.
Yes	No	N/A	5. Hazardous Atmosphere
			Atmosphere within the excavation tested where there is a reasonable possibility of an oxygen deficiency, combustible, or other harmful contaminant exposing employees to a hazard.
			Adequate precautions taken to protect employees from exposure to an atmosphere containing less than 19.5% oxygen and/or to other hazardous atmospheres.
			Ventilation provided to prevent employee exposure to an atmosphere containing flammable gas in excess of 10% of the lower explosive limit of the gas.
			Testing conducted often, when applicable to ensure that the atmosphere remains safe.
			Emergency equipment such as breathing apparatus, safety harness, and lifeline and/or basket stretcher readily available where hazardous atmospheres could or do exist.
Yes	No	N/A	6. Protective Systems
			Materials and/or equipment for support systems selected based on Type C soil classification, trench depth, and expected loads.
			Excavation sloped to the appropriate angle for Type C soil (1 ½ : 1 aka 34 degrees.)
			Materials and equipment used for protective systems inspected and in good condition.

		Materials and equipment not in good condition have been removed from service.
		Damaged materials and equipment used for protective systems inspected by a Registered Professional Engineer after repairs and before being placed back into service.
		Protective systems installed without exposing employees to the hazards of cave-ins, collapses, or threat of being struck by materials or equipment.
		Members of support system securely fastened to prevent failure.
		Support systems provided to ensure stability of adjacent structures, buildings, roadways, sidewalks, walls, etc.
		Excavations below the level of the base or footing supported, approved by a Registered Professional Engineer.
		Removal of support systems progresses from the bottom and members are released slowly as to note any indication of possible failure.
		Backfilling progresses with removal of support system.
		Excavation of material to a level no greater than 2 feet below the bottom of the support system and only if the system is designed to support the loads calculated for the full depth.
		Shield system placed to prevent lateral movement.
		Employees are prohibited from remaining in shield system during vertical movement.
Comments, Concerns, and Corrective Actions		
Drawings, Sketches, and Pictures		