EXPRO National Manual for Projects Management

Volume 11 , Chapter 3

Project Excavation and Trenching Procedure

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1.0 PURPOSE

The purpose of this procedure is to identify the minimum controls required to ensure the safety of operations associated with clearing and grubbing, excavation and backfill and soil testing activities.

The aim of this Procedure is to:

- Ensure that all excavation, trenching activities and work within excavations/trenches are adequately planned and performed safely, in accordance with all applicable regulatory standards.
- Define the standard work process for all excavation, trenching activities.
- Provide personnel with the knowledge and skills to be able to do the right thing, the right way, every time.

2.0 SCOPE

The scope of this procedure applies to all works performed under all Government Construction Contracts executed throughout the Kingdom of Saudi Arabia.

3.0 DEFINITIONS

Definitions	Description
Backfill	Soil, rocks or similar material used to replace previously excavated material
Benching	Terracing or stepping the sides of an excavation to prevent a cave-in or forming one or more horizontal levels or steps
Borrow Pit	An area where material has been excavated for use at another location as backfill or as a source of raw material.
Clearing and Grubbing	Involves removal of tree stumps, shrubs, top soil and any organic material and debris from the construction area
Competent Person	One who can identify 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.
Excavation	Any man-made cut, cavity, trench, depression or hole in the earth, or a face of earth, formed after rock, sand, soil or other material is removed (such as a trench, ditch, shaft, well, tunnel, pier hole, cutting or caisson or a hole drilled in the earth)
Excavation Work	Work to make, fill, or partly fill an excavation (includes digging, grating, scraping, penetrating and pushing)
Pot Holing	The process of safely exposing the underground utility to precisely locate and identify it. Pot Holing is done with hand tools, vacuum excavation or other means that is unlikely to damage the utility.
PTW	Permit-to-Work
Responsible Person	A member of the organization who is directly responsible for directing the work activity (e.g., craft supervisor or leading hand) at the workface. The person who is accountable to resolve or minimize the effect of the critical item
Shoring	Hydraulic, mechanical, or timber reinforcement used to support the sides of an excavation to prevent cave-in
Sloping (Battering)	Removing soil from the sides of an excavation so they are inclined away from the excavation sufficiently to prevent cave-ins; the angle of the incline required varies with differences in such factors as the soil type, environmental conditions of exposure, and application of surcharge loads
Spoils	Dirt or rock excavated but not used for a specific purpose and therefore removed from the worksite.
Stockpile	An area where excavated soil or rocks that have a specific purpose may be deposited until required.
Trench	A narrow excavation made below the surface of the ground in which the depth is greater than the width

Definitions	Description
Utilities	Any piping, wiring, conduit or other equipment that serves as a conduit for electricity, fuel, water, compressed air, sewer, and telecommunication, etc., to or from a facility. Utilities may be located above or below ground.
OSHA	Occupational Safety and Health Administration
HSSE	Health, Safety, Security and Environment
JHA	Job Hazard Analysis
STARRT	Safe Task Analysis and Risk Reduction Talk
PPE	Personal Protective Equipment
SWMS	Safe Work Method Statement

4.0 REFERENCES

OSHA 29 CFR 1926 Subpart G Signs, Signals and Barricades
OSHA 29 CFR 1926 Subpart P Excavations
EPM-KSS-PR-000001 Project General Safe Working Requirements Procedure
EPM-KSS-PR-000006 Project Barricades and Signs Procedure
EPM-KSS-PR-000007 Project Confined Space Entry Procedure
EPM-KSS-PR-000016 Project Hazardous Work Permit Procedure
EPM-KSS-PR-000026 Project Utility Clearance Procedure

5.0 RESPONSIBILITIES

Leadership is the single largest factor for success in the establishment of an injury-free workplace. By their actions, leaders cascade, manage, and drive execution, instill operational discipline, and work to ensure that the entire workforce complies with Safety and Health requirements.

5.1 Project Manager

The Project Manager is responsible for ensuring the resources and arrangements are available for the implementation and Management of this procedure.

5.2 Contractor Site Manager

The Contractor Site Manager is responsible for monitoring the allocation of resources, people, equipment, and training to facilitate the requirements of this Procedure, and for confirming that the requirements of this Procedure are properly implemented. The Contractor Site Manager demonstrates operational discipline by requiring that the Procedure requirements are put in place and properly functioning.

5.3 Site HSSE Manager

The Contractor HSSE (Health, Safety, Security and Environment) Manager is responsible for the development of this Procedure and for the assessment of the Project's compliance with its requirements.

5.4 Project Engineer

The Project Engineer is responsible for supervision and assignment of field engineering personnel required to provide technical support consistent with the requirements of this Procedure. The Project Engineer is also responsible for the implementation of the Permit process, and resourcing requirements to support the process.

5.5 Superintendent

The Superintendent is responsible for coordinating and monitoring the Subcontractor's scope of work.

Permit responsibilities of the Superintendent are as follows:

- Verifying that the proposed work is necessary and risks associated with simultaneous construction activities, inclusive of specific work site and adjacent work activities, are identified and mitigated prior to reviewing the Permit
- Supporting Subcontractor coordination of applicable area construction activities
- Undertake workplace inspections to ensure permit requirements are being followed.
- Undertake a review of work-site conditions and Permit requirements after Permit issuance, this will include:

    - Verifying that all Authorized Employees have signed onto the Permit and adhere to the requirements
    - Stopping work due to any Permit non-compliance
    - Coordinating area construction activities to avoid conflicts or interferences by evaluating the number of work Permits occurring in the same area.

5.6 Supervisor (Responsible Person)

The Supervisor is responsible for planning and directing the excavation work. The responsibilities of the Supervisor are:

- Initiating the Permit request and verifying that the Permit request has been completed correctly and contains all the required information which includes a review of as-builts
- The Permit shall have the updated “as-builts” These drawings are to be specific to the area being excavated under this permit. As built drawings are to be red-lined with proposed excavations and form part of the permit request including expanded view of drawing for crossing pipes and conduits, multiple conduits and piping near in same trench
- Verifying that the personnel assigned to execute the work have the necessary qualifications, experience and have attended training to safely perform their tasks for the permitted task
- Ensure activities that require a Permit do not commence without a Permit
- Ensuring all persons working on the permit are signed onto the daily Permit workers sign on sheet
- Ensure Trench inspection forms are with the permit and filled correctly for each shift of permitted work
- Ensuring that rescue equipment for the task is available and staged for emergency scenarios.
- Conducting daily assessments of the Excavation work activities to assess compliance with the workplace conditions.

5.7 Competent Person

A Competent Person, in relation to the doing of anything, means a person who has acquired through training, qualification, or experience, or a combination of those things, the knowledge and skills required to do that thing competently.

With respect to excavation/trenching and ground floor penetration works, the knowledge and skills required of a Competent Person will increase as the complexity of the excavation work increases. Size is not the only determinant of knowledge and skills needed. Many small size excavation works will be complex because of soil conditions and stability considerations. Many simple and straightforward excavations will only require experience while more complex work may require training and qualifications as well.

Because of the technical issues involved in many situations covered below, a competent person will either need to be an appropriately experienced engineer, or to act on advice from an engineer on a specific aspect of the excavation.

6.0 RISK ASSESSMENT

An integral aspect of the work planning process is the performance of a proper risk assessment. Risk Assessments must be conducted at the Planning Stage to identify the hazard risks and determine control measures.

The Risk Assessments that shall be conducted at the Planning Stage are as follows:

- Project Risk Assessment.
- Work Method Statements (WMS)
- Job Hazard Analysis (JHA).
- Safe Task Analysis and Risk Reduction Talk (STARRT).

It is imperative that prior to beginning any work activity, a STARRT briefing occurs to discuss the contents of the WMS/JHA which includes mitigations for any other hazards noted by the crew at the jobsite. The discussion shall also include job steps, expected hazards associated with the activity, and the mitigation and protection methods that shall be implemented to prevent incidents.

If circumstances change by way of the environment, other work crews are in the area, additional hazards are now present, change of methodology of the task etc..… another STARRT briefing shall occur.

The Hierarchy of control shall be used to reduce the likelihood of an incident occurring.

- ***Elimination*** (Remove the Hazard)
- ***Substitution/Isolation*** (Replacing material, process or hazard with a lower risk one/ separate people from the hazard (such as suitable guarding, distance, etc.)
- ***Engineering Controls*** (Redesign or replacement of plant and equipment)
- ***Administration Controls*** (Procedures, training, signage)
- **PPE -** PERSONAL PROTECTIVE EQUIPMENT

No work is to commence until the above has been implemented and signed by the relevant Supervisor in charge.

6.1 Safe Work Method Statements and JHA

Below are guidelines and considerations to be implemented when developing Risk Assessments for excavations:

The Subcontractor(s) shall collate all gathered site data and required work controls and conduct a thorough Safe Work Method Statement (SWMS) and Job Hazard Analysis (JHA) for the Excavation/Trenching or Penetration scope of work and all Utility Avoidance operations.

Subcontractor's SWMS and JHA shall also consider the following primary hazards:

- Injury or death to personnel from collapse (engulfment), or unwanted contact with moving equipment (e.g., bucket swing from backhoe)
- Striking underground and overhead utilities, triggering serious consequences such as leaks, explosions, electrical shock, etc.
- Encountering a hazardous atmosphere.

7.0 GENERAL

7.1 General Requirements

- Excavations and adjacent areas must be inspected at least once a day for possible cave in, failure of protective systems and equipment, hazardous atmosphere or other potentially hazardous conditions.
- Trenches 1.2mts or more in depth must be properly shored, or the walls cut back to the appropriate slope, to protect employees from collapse.
- Spoil material removed from an excavation (and any other material storage) must be kept at least 0.6mts away from the excavation edge.
- Barricades must be kept at least 1.83mts from open edges of trenches and excavations.
- No employee is permitted underneath loads handled by lifting or digging equipment.
- Employees must remain clear/stand away from any vehicle that is being loaded or unloaded to avoid being struck by Spillage or falling materials.
- Prior to starting an excavation, the Responsible Supervisor and Competent Person must ensure that all required safety measures are in place.

- A Competent Person must identify hazards, conduct daily inspections, and conduct inspections during and/or following rainstorms.
- Sloping or benching for excavations greater than 6.08mts deep is designed by a competent engineer.
- Signage must be written in multi-language where workers/others can understand.

7.2 Planning

The executing party must appoint a competent person to supervise excavations, trenching, and backfilling, the qualification and resume of the proposed person is to be approved by the Project/entity management, the selected person by the very nature of works should be a competent civil engineer.

A geotechnical report must be produced to determine the characteristics and properties of the soil materials that will be encountered during excavations and provide geotechnical conclusions and recommendations for the design of control measures for the Project. The report should provide information to cover the following elements:

- Dewatering requirements
- Slope stability
- Soil classification
- Ground support requirements
- Shoring requirements
- Ground hardness
- Suitability of materials for excavation
- Guidelines for equipment selection
- Ground pressure guidelines by depth
- Estimated swelling adjusting factor
- Location of aquifers
- Soil contaminants
- Other related issues to support site earthwork activities.

In some instances, it may be necessary to perform additional borings or subsurface investigations to identify subsurface utilities, obstructions and soil conditions. (Refer to EPM-KSS-PR-000026 Project Utility Clearance Procedure).

- Executing party must pre-qualify any third party associated with the work such as construction water providers, borrow pit sources, material testing laboratories, etc.
- A risk assessment must be developed for the work being executed covering the different stages of work.
- If the excavation is expected to encounter water through groundwater, leaking pipes, storm water, or other sources, a dewatering system must be provided. The Construction Phase Environmental plan shall include some dewatering instructions detailing the pumps to be used, well-point system, availability of power, water discharge locations and discharge permits if applicable, including a drawing showing locations of pumps, generators and discharge locations. Dewatering operations should normally be started 24 hours before excavation work commences.

7.3 Underground Utilities and Installations

Before excavations activities commence, engineering shall confirm the locations of any known or suspected underground pipes, cables, vessels, structures, etc…that are in the area. The following should apply:

- Contact the appropriate authorities such as Utilities, Communications, POD, Pipelines etc… and request them to accurately mark the locations of their utilities.
- Contractor to ensure that all services are marked on ground prior the work commencing.
- All utilities are also marked on drawings to verify locations.
- Mechanical excavators shall not be used until all underground utilities have been exposed by hand digging.

- Mechanical excavators with pneumatic breakers shall not be used within 3 meters of any services/utilities. Shall only be used, when no other methods available to break concrete or other hard materials.
- Never undermine any existing services, manholes sidewalks etc…. until excavation is braced or shored.
- Always consider the closed, capped, loosed or sealed underground utilities as live otherwise its proven.
- Cables must never used as anchorage point or climbing point.
- All damage underground utilities must be reported immediately to the concern engineer

7.4 Excavation Permits

Each Project must develop an excavation permit system to control the work flow and associated hazards.

The Permit Requester initiates the permit by completing the necessary information on the work to be performed, then the appointed excavation competent person/s must verify work site conditions, including but not limited to:

- Location.
- Review any applicable as built drawings and detection of all utilities and services.
- Protection method to be used if applicable (i.e. slopping, shoring, benching)
- Availability of equipment to be used as detailed in the risk assessment
- The construction plant equipment certification, and operator qualifications.
- Safe sequence of work.

7.5 Excavation Work Operation

Following issuance of the permit, the executing supervisor and the competent person shall check the job location to ensure that the required safety measures are in place those requirements included but not limited to:

- Spoil, material removed from the excavation or any other material and equipment storage should be kept away a minimum of 0.6mts from the edge of the excavation.
- Excavations and trenches are appropriately identified with signs, warnings, and barricades.
- Barricades are properly positioned and interlocked. Proper warning signs must be placed.
- Pedestrian traffic and/or walking around or behind excavation equipment is avoided and ground personnel establish positive eye contact with equipment operators before moving into the path of equipment.
- Review daily and / or weekly weather forecasts to properly plan and stage trenching and deep excavation activities. Adverse weather condition that could affect trench and excavation stability and therefore cause changes in ground pressures is monitored.
- Competent person inspects the excavation and adjacent areas for possible cave in. failure of protective systems and equipment, hazardous atmosphere or other hazardous conditions.
- Projects shall develop a reporting protocol If hazardous, suspect or potential archaeological items are suspected/encountered; the responsible person must suspend the excavation work operations, and trigger the reporting protocol immediately.
- Consideration on overhead power line/utilities must be considered.

7.6 Entry and Exit

- Ladders and/or other means of egress such as ramps are provided in every excavation; no more than 8mts of lateral travel should be required to reach a ladder or other means of egress.
- All ladders shall conform with the requirements in the EPM-KSS-PR-000011 Project Portable Ladders Inspection and Control Procedure.
- Ladders shall rest on the bottom of the excavation and secured against fall. Shall extend at least 1 meter above the top landing point.
- Personnel shall not be in or near the excavation where they could be struck by heavy equipment. Personnel shall not be within the operating radius of the equipment.

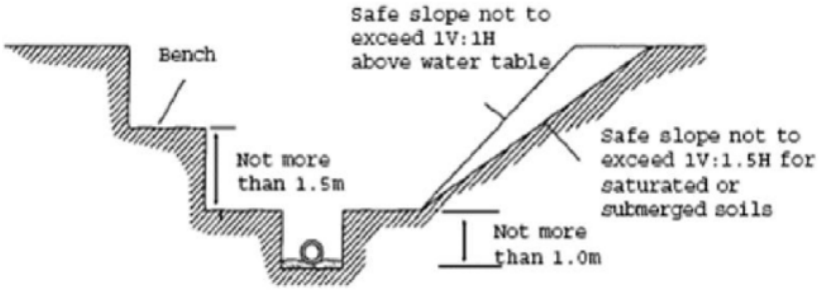
- Personnel shall not be in an excavation where they could be exposed to a possible cave-in, such as could be caused by equipment operating or passing nearby.

7.7 Excavations to be Battered, Benched or Shored

Examination of Site conditions by the Competent Person is necessary to determine safe slopes for excavations. The competent person to determine this is by a civil engineer. Safe slopes depend on the height of the face, soil type and geological conditions, the moisture content of the soil and any surcharge loads. Soil moisture content and geological conditions may change as excavation progresses, causing safe slopes to become hazardous.

Unless the stability of the excavated face is determined by a civil engineer or other qualified professional, the safe slope should not exceed:

- 1 vertical to 1 horizontal or the angle of repose, whichever is flatter, for soils above the water table.
- 1 vertical to 1.5 horizontal or the angle of repose, whichever is flatter, for saturated or submerged soils, or for excavations greater than 3 m (9.8 ft.) in depth.
- Where the slope of an excavation is benched, the height between benches should not exceed 1.5 m. The bench adjacent to the work area shall not exceed 1 m (see Figure below) Overall, the total width of the benched excavation should not be less than required.
- A slope steeper than 1 vertical to 1.5 horizontal may be used, up to maximum slope of 1.5 vertical to 1 horizontal, where a civil engineer or other qualified professional has assessed the soil conditions, and deemed this slope to be suitable.



7.8 Protections against Sidewall Cave-in

Protective systems shall be in place prior to any person entering into the excavations. Below is guidance in ensuring safe entry:

- Suitable shoring to be installed, or side benched as show above as a minimum.
- The determination of the slope angle, benches, or choice of design of shoring, shall be based on the evaluation of the engineer. Factors to determine this are as follows:
    - Type of soil.
    - Depth of excavation.
    - Possible variation in water content of the soil while the excavation is open.
    - Anticipated changes in soil from exposure to air, sun or water.
    - Loading imposed by structures, equipment, overlaying material or stored material.
    - Vibrations from equipment, blasting, traffic or other sources.

- Shoring material shall be in good condition.
- Workers shall be trained to look for signs of shoring or sidewall bulge, surface cracking, sand penetration from behind shoring or cracked shoring, which can be a warning sign of a collapse about to happen.

7.8.1 Types of Shoring

There are numerous types of shoring that are available. The type to use generally depends on the soil type which is determined by the engineer. The engineer shall then prescribe the type to use. Below are the different types that can be used:

- Excavation Boxes and Trench Shields.
- Hydraulic Shoring for excavations.
- Scaffold Tube Cross Braces for excavations.
- Timber shoring.
- Shoring using screw jacks.

All shoring must be installed as per the manufacturer recommendation and installed by a competent person with a supervision by an excavation competent person or competent civil engineer.

7.9 Hazardous Atmospheres and Materials

If there is any suspicion that there could be any oxygen deficiency or the present of a flammable/toxic atmosphere testing atmospheric testing is required.

The causes of such conditions may come from the following:

- Exhaust gases.
- Hazardous Materials.

7.10 Edge Protection

All excavations shall have some type of hard type barricade erected around the excavation to prevent any accidental fall. These shall be placed no closer than 1.8 meters from the edge.

Signage shall be erected outlining the hazard and well as lighting.

7.11 Backfill Operation

- Prior to the start of backfilling, the assigned competent engineer must verify that structures and utilities affected by the backfill activity have been inspected.
- The Responsible Person ensures the excavation is cleaned of all trash, organic material, standing water, and other unacceptable materials.
- The assigned competent engineer verifies the correct grade of backfill is used, and arrange for compaction testing as required.

8.0 MONITORING AND EVALUATION

Daily monitoring of excavation operations shall be performed by the Superintendent, and Responsible Person to verify that all excavation activities and work within excavations are performed in a safe and controlled manner. Contractor shall verify, as far as practicable, that:

- Excavation work is carried out in accordance with the JHA.
- If the work is not carried out in accordance with the JHA – the excavation work may need to be stopped.

The Contractor is responsible for the assessment of the Project's compliance with the requirements of this Procedure. The Contractors delegates shall conduct quarterly formal assessments of the Excavation and Trenching Operations by completing an Excavation Assessment Checklist. (Example in Attachment 1).

9.0 RECORDS

Excavation Permit Logs and the original copies of Excavation/Trenching Permits will be archived in Project archive containers. Hard copies of Excavation/Trenching Permits and associated drawings/documentation shall be made available upon request and held as per legislative requirements.

10.0 TRAINING

All employees performing excavation work or working in an excavation shall be trained in excavation operations. It shall be the responsibility of the Subcontractor conducting excavation and trenching operations to verify that all personnel engaged in excavation and trenching operations are competent to perform this activity before starting work

11.0 ATTACHMENTS

1. EPM-KSS-TP-000010 - HSSE Excavation Assessment Checklist
2. EPM-KSS-TP-000011 - Excavation and Penetration Permit Template

Attachment 1 - EPM-KSS-TP-000010 - HSSE Excavation Assessment Checklist

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HSSE Excavation Assessment Checklist

EXCAVATION ASSESSMENT CHECKLIST DIRECTIONS: Check either "YES," "NO," or "NA." If corrective action is required, answer "NO." For every "NO" answer, provide a brief description of the issue in the "COMMENTS" column. Add the finding/issue to the ES&H Tracking Register.					
No.	EXCAVATION & TRENCHING	ANSWER			COMMENTS
		YES	NO	N/A	
	Subcategory 1: Earthwork Operations				
1	Have the Responsible Supervisor and Field Engineer prepared a thorough Work Plan for each construction area that outlines all earthwork operations? (***Note*** *that the plan need not be formally written, just comprehensive and thorough*).				
2	Does the Project inspect excavations and adjacent areas at least once a day for possible cave-in, failure of protective systems and equipment, hazardous atmosphere or other hazardous conditions?				
3	Are trenches 1.2 m (4 ft) or more in depth properly shored, or the walls cut back to the appropriate slope to protect employees from collapse?				
4	Are ladders or other means of egress provided in each excavation?				
5	Does the Project ensure that there is no more than 7.6 m (25 ft) of lateral travel to reach a ladder or other approved safe egress?				
6	Is spoil material removed from an excavation (and any other material storage) kept at least 1 m (3 ft) away from the excavation edge?				
7	Where a 1 m (3 ft) separation from excavation edge is not possible, are proper retaining devices used to prevent materials or equipment from falling or rolling into excavations?				
8	Are excavation and trenches appropriately identified with signs, warnings and barricades?				
9	Are barricades kept at least 1.8 m (6 ft) from open edges of trenches and excavations?				
10	Does the Project ensure that no employee is permitted underneath loads handled by lifting or digging equipment?				
11	Do employees remain clear / stand away from any vehicle that is being loaded or unloaded to avoid being struck by any spillage or falling materials?				

Attachment 2 - EPM-KSS-TP-000011 - Excavation and Penetration Permit Template

Part A – Application (Completed by Permit Requestor)

Date from:	Time:	Permit Requestor:	Application Date:	
Date to:	Time:	Company:	Contact Details:	
As indicated on the attached drawing / as-built / GIS, permission is requested to excavate / penetrate to the following approximate dimensions:		Depth (m):	Width (m):	Length (m):
Work description / reason for excavation:				
Work area location:				

The following objects / services are known to be buried / contained in this area:

Objects / services	Location	Approximate depth

Equipment Used:

Part B – Assessment (Completed by Permit Approver and Responsible Person)

Are the following required?		Permit Number:	Will the following conditions occur?		Apply Controls:
Hot work	☐ Yes ☐ No		UG services / services within 1m	☐ Yes ☐ No	
Confined space entry	☐ Yes ☐ No		Paralleling or crossing services	☐ Yes ☐ No	
Mechanical isolation	☐ Yes ☐ No		Unstable ground conditions	☐ Yes ☐ No	
LOTO isolation	☐ Yes ☐ No		Limited / broken areas for material stockpiling	☐ Yes ☐ No	
Grid mesh removal	☐ Yes ☐ No		Limited access / egress into work area	☐ Yes ☐ No	
Crane hoisted workbox	☐ Yes ☐ No		Open holes / trip hazards	☐ Yes ☐ No	
Environmental Work Authority	☐ Yes ☐ No		Traffic interactions	☐ Yes ☐ No	
			Hazardous material (asbestos / fibres)	☐ Yes ☐ No	

Part C – Work Controls (Completed by Permit Approver and Responsible Person)

Requirements:		Tick applicable controls:					
SWMS / JHA / STARRT Card	☐ Yes	Gas testing / monitoring	☐	Excavation stability (shoring / benching)	☐	Lighting	☐
Daily Trenching and Excavation Inspection Report	☐ Yes ☐ No	Warning signs / barricades	☐	Pot holing	☐	PPE	☐
Emergency Response Plan	☐ Yes ☐ No	Hard barricading (1.8m from edge)	☐	Hand digging (or sonic) – excavating services	☐	Access / egress 7.5m	☐
Lock Out / Tag Out	☐ Yes ☐ No	Scaffolding (if required)	☐	Hydro vac excavation	☐	Spotter	☐

Additional work controls (above & underground):

Part D – Permit Issue and Acceptance

Permit Approver:	Signature:	Date:	'Authorization is given to commence work under the conditions prescribed on this Permit (attached Risk Assessment, SWMS, JHA)'
Responsible Person:	Signature:	Date:	'I understand and accept the conditions and precautions detailed above. I shall ensure that all personnel involved in the work described are informed of them.' 'I confirm that all interim safety measures and protection as described in Part C, are in place'