

**TES-CT-SLOPE-GL Slope Work Specification
(CAN-US-MEX)**


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	WARNING
	Equipment on hard surfaces (e.g., mats, bridge decks, roads, and rock) can have reduced traction. The risk of equipment losing traction become unstable, sliding and rolling over is greatly increased when the surface is slightly sloped and/or when the surface is wet (i.e., rain, dew, snow, ice) and/or when the surface is covered with loose material (i.e., mud, gravel).

PURPOSE

This Specification defines requirements for the construction and maintenance work on slopes and other earthworks where there is a risk of:

- ground instability (any type)
- slope or soil failure
- equipment instability (including instability on slippery, icy and wet hard surfaces)
- personnel falling
- debris falling on personnel, equipment and/or infrastructure

SCOPE

This Specification applies to pipelines and facilities operated by the Company in Canada, United States (U.S.) and Mexico.

This Specification applies to construction and maintenance work on pipelines, facilities and the Right-of-Way (ROW), including related areas such as temporary workspaces, and site access roads.

This Specification is intended for internal and external use.

Within an Engineering Standards Collection document, the following terms and definitions apply for requirements:

- 'Company' means the TC Energy entity for whom work, services and/or materials are being provided.
- 'Must' or a similar term (e.g., 'shall') is used to express a mandatory requirement. All statements in this document must be interpreted as mandatory requirements unless clearly stated as optional. A formally approved Variance Request is required to deviate from a mandatory requirement.
- 'Should' or 'may' is used to express an optional recommendation or that which is advised or permissible but not required.

Wherein governmental or regulatory requirements conflict with this Specification, the more stringent requirement shall govern except in cases where use of an alternate requirement is mandated by regulation.

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1 GLOSSARY**ATV (All-Terrain Vehicle)**

A motorized recreational type off-highway vehicle designed to travel on off-highway terrain. This Specification considers all recreational type Utility Task or Terrain Vehicle (UTV) and Recreational Off-highway Vehicle (ROV) as a recreational All-Terrain Vehicle (ATV).

ASME

American Society of Mechanical Engineers

Authorities

Any duly constituted federal, state, provincial, territorial, municipal or local agency, board, or other public authority having jurisdiction.

Base-mounted hoisting equipment

Base-mounted drum or winch.

Company or Company Representative

The person assigned on behalf of the Company to act in the Company's best interests and ensure the Contractor complies with this specification. This person will be the Project Manager or a designee.

Competent person

Person capable of identifying existing and predictable hazards in the surroundings or working conditions that are hazardous or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate the hazards.

Contractor

Any person, firm or corporation contracting with the Company to perform the work as set out in the Agreement.

Duration of exposure

The length of time an operator will be working on a specific hazardous slope area. This interacts with the operator's competencies, experience and state of mind. Along with dynamic conditions such as weather, the duration of exposure is a risk factor that must be assessed.

Earthworks

Work that consists of altering and/or making modification to an area of land.

Engineering professional

A professional able to evaluate scientific analytic principles and processes to reveal the properties and state of the system, device or mechanism under study, and validate equipment usage, construction methods, site-specific details, and environmental and geographical threats, (e.g., slope and soil stability).

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Equipment

All types of machinery (e.g., ATV, trucks, side-booms, bulldozers, excavators) and connecting equipment and/or links (e.g., pins, wire rope, cables, shackles, slings, anchor pieces).

Fall Protection Plan

Procedure developed that outlines the methods for fall protection or climbing aids when any personnel working on a slope requires fall protection or climbing aids.

Geotechnical professional

A professional able to evaluate the stability of natural slopes and man-made soil deposits; assess risks posed by site conditions; design earthworks and structure foundations; and monitor site conditions, earthwork and foundation construction.

Hazardous slope

Slope where there is a risk of: ground instability, slope failure, equipment instability, personnel falling or debris falling on personnel. A geotechnically stable slope under *optimal dry conditions* with a length greater than or equal to 10 m (32.8 ft), and a surveyed slope angle equal to or greater than 30% gradient (16.7°). The relationship between gradient and slope angle is shown in Figure 1-1.

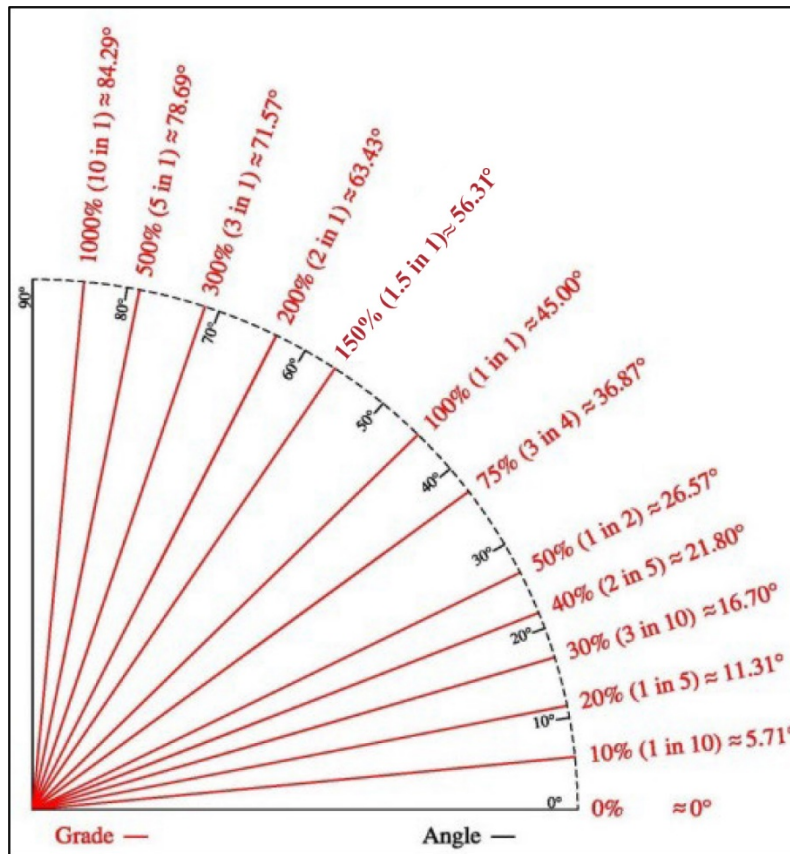


Figure 1-1: Illustration of Grades (Percentages) and Angles (Degrees)

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Hazardous Slope Work Plan

Plan that outlines the method and construction process to be utilized for each hazardous slope identified. This plan is to contain more site-specific details as to how the Hazardous Slope Risk Assessment and Management Plan will be implemented to complete the work.

Light Detection and Ranging (LiDAR)

Remote sensing method used to examine the surface of the earth.

Machine-mounted hoisting equipment

Drum hoist or winch mounted on a machine such as a side-boom or bulldozer.

Mats

Portable platforms used to distribute the weight of equipment. Various types of mats used in construction (e.g., swamp mats, rig mats, access mats) will be defined as mats.

Multiple Hazardous Slope Identification Procedure

Procedure developed that outlines how multiple hazardous slopes and slopes that might impact equipment stabilities and the other factors identified within this Specification are to be identified. The procedure is only required when there are multiple slopes (i.e., three or more) on a project or a work pack with varying degrees, complexities, stabilities and the other factors identified within this Specification.

Optimal dry conditions

Ground surface condition that provides the most favourable situation for machine stability and the highest coefficient of friction (traction).

Plans / Processes

Written explanations describing issues, risks and explaining how work is going to be conducted. This specification required up to four (4) plans and processes: Multiple Hazardous Slope Identification Procedure (three or more slopes), Hazardous Slope Risk Assessment and Management Plan, Hazardous Slope Work Plan, Fall Protection Plan.

Roughness features

Physical features that affect machine stability; includes boulders, rocky outcrops, gullies, hummocks and depressions.

Slope

Section of ground that is at an inclined angle with reference to a horizontal plane.

Slope Risk Assessment and Management Plan

Plan developed by the Contractor and submitted to the Company outlining the risks and hazards associated with working on hazardous slopes and appropriate measures to eliminate or minimize them.

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Soils

Mineral soils underlying surface organic matter, evaluated to determine its ability to provide machine traction.

Soil depth

Average distance measured from the top of the mineral soil to bedrock or the hardpan layer that could restrict machine stability and traction.

Special Anchoring Devices

An anchoring device that uses the natural substrate for restraint, including anchors that are grouted into a drilled hole.

Tracked machine

Machine propelled by a band of track plates; includes excavators, bulldozers, feller-bunchers, pay-welders, and side-booms (pipelayers).

Wheeled machine

Machine propelled by wheels. Includes dump trucks, wheeled backhoes, hydro-axes, front-end loaders, graders, utility vehicles, tractor-trailers (e.g., high-boy, low-boy and pipe haulers), farm tractors, skidders and four- and two-wheeled drive vehicles.

Work

Activities being performed on a hazardous slope or ground condition where there exists a risk of slope failure, ground instability, equipment instability, personnel falling or debris falling on personnel.

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2 SLOPE IDENTIFICATION REQUIREMENTS

2.1 Slope Identification

2.1.1 A slope must be defined as a section of ground that is at an inclined angle in the direction of work with reference to a horizontal plane.

2.1.2 A slope or sloped section must be identified as a hazardous slope if there is the risk of slope failure, ground instability, equipment instability, personnel falling or debris falling on personnel, equipment and/or infrastructure.

2.1.3 A slope or sloped section must be identified as a hazardous slope if the slope is geotechnically stable under optimal dry conditions and both of the following criteria applies:

- The slope has a measured gradient greater than or equal to 30% (16.7°).
- The length of the slope is equal to or greater than 10 m (32.8 ft).

Note: The slope angle can be converted from degrees to per cent and from per cent to degrees using the follow correlations:

$$\text{Slope_Angle_Percent} = 100 \times \tan(\text{Slope_Angle_Degrees})$$

$$\text{Slope_Angle_Degrees} = \arctan(\text{Slope_Angle_Per cent}) / 100$$

2.1.4 In cases within a right-of-way (ROW) where cut and fill is used to level the surface, the cross-slope work may be exempted from hazardous slope requirements in section 4 if the following two conditions are met:

1. site-specific evaluation of the risks is submitted to the Company
2. exemption is approved by the Company

2.1.5 If a slope consists of several hazardous sections, the overall elevation difference and slope length must not be averaged to determine the overall gradient.

Note: For slopes containing both hazardous slope sections and sections that do not fit the definition of a hazardous slope, the overall elevation difference and slope length cannot be used to determine the gradient.

2.1.6 The sections of the overall slope that fit the hazardous slope definition must be treated separately from the sections of the overall slope that do not meet the hazardous slope definition.

2.1.7 A slope with a gradient of less than 30% (16.7°) or a measured length shorter than 10 m (32.8 ft) must be classified as a hazardous slope if there is the possibility of the slope or equipment becoming unstable during adverse environmental or weather conditions (e.g., rain, dew, snow, ice, mud, or loose fill or other material on the slope).

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- 2.1.8 A slope with a gradient of less than 30% (16.7°) must be classified as a hazardous slope if specialized equipment (equipment that typically is not used on flat and level ground) is required for excavation or backfill and anchoring and/or special anchoring devices for anchor points of equipment, pipe, materials and/or personnel are required.
- 2.1.9 A slope must be classified as a hazardous slope if there is the possibility of stockpiled fill material or equipment around the stockpiled fill material becoming unstable.
- 2.1.10 Any slope or condition defined as hazardous within this Specification along the travel path for ingress or egress to a sight must be considered a hazardous slope and is required to meeting the requirements of this specification.

2.2 Multiple Hazardous Slope Identification Procedure for Pipeline Construction Projects

- 2.2.1 The Contractor must develop a procedure for the identification of hazardous slopes for pipeline construction projects that contain three or more hazardous slopes.
- 2.2.2 The use of topographic information (e.g., maps, air photos, LiDAR and ground truthing) may be used for initial hazardous slope identification followed by field measurements (e.g., a layout crew using a clinometer or similar device).
- 2.2.3 The Multiple Hazardous Slope Identification Procedure must identify where conventional pipeline construction techniques will be used and where cable crane technology will be used.
- 2.2.4 The Multiple Hazardous Slope Identification Procedure must include the details of how the gradient and the slope length will be analyzed, identified, measured, assessed and calculated.
- 2.2.5 The Contractor must submit the Multiple Hazardous Slope Identification Procedure to the Company for review a minimum of thirty (30) business days prior to construction, or unless otherwise specified in the Agreement or as approved by the Company.
- 2.2.6 The Company must reserve the right of a longer period to review the Multiple Hazardous Slope Identification Procedure if required.
- 2.2.7 The Company must review all slopes listed in the Multiple Hazardous Slope Identification Procedure and the proposed construction procedures.

3 HAZARDOUS SLOPE RISK ASSESSMENT AND MANAGEMENT PLAN**3.1 General**

- 3.1.1 If a hazardous slope or hazardous earthworks situation has been identified, the Contractor must develop a Hazardous Slope Risk Assessment and Management Plan based on the risks of, personnel falling, equipment and geotechnical stability and debris falling on personnel, equipment and/or infrastructure.
- 3.1.2 The Hazardous Slope Risk Assessment and Management Plan must include safety procedures and a plan for emergency preparedness.
- 3.1.3 The Hazardous Slope Risk Assessment and Management Plan must address (i.e., assess, manage, and mitigate) fall protection for workers rappelling to the ground and/or the certification of workers using climbing aids (if required).

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- 3.1.4 The Hazardous Slope Risk Assessment and Management Plan must address situations where there is a risk of debris becoming dislodged from the location of work.
- 3.1.5 The Hazardous Slope Risk Assessment and Management Plan must include, but not be limited to:
- spoil management
 - equipment rollovers
 - wire rope and cable breaks
 - rock (boulders) or debris rolling downslope
 - area(s) of restricted access to personnel due to cable breakage or falling debris
 - loss of verbal communication
 - weather and weather emergency (e.g., lightning, rain, dew, snow, ice)
 - monitoring of variable conditions and threats
 - equipment breakdowns
 - equipment on mats, where the mats are not on flat and level ground
 - loss of equipment control
 - medical response times and medical response requirements
- 3.1.6 The Hazardous Slope Risk Assessment and Management Plan must be provided to the Company a minimum of twenty (20) business days prior to performing work on a hazardous slope, or unless otherwise specified in the Agreement or as approved by the Company.
- 3.2 Ground and Equipment Stability Risk Assessment Requirements**
- 3.2.1 The Hazardous Slope Risk Assessment and Management Plan must address ground stability factors and equipment stability while working on a slope including the equipment sliding on a slip surface.
- 3.2.2 The Hazardous Slope Risk Assessment and Management Plan must be based on both optimal and actual conditions of each slope.
- 3.2.3 The Hazardous Slope Risk Assessment and Management Plan must take into account winching requirements.
- 3.2.4 The Hazardous Slope Risk Assessment and Management Plan must identify conditional requirements for when mobile or stationary anchoring is required (e.g., slope gradient, slope type, the slope for optimal conditions as well as adverse weather conditions).
- 3.2.5 Where there is an increased risk of ground and equipment instability, the Contactor must provide an appropriate level of mitigation and management to reduce the risk of ground and equipment instability before, during, and after hazardous slope work.

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- 3.2.6 The Hazardous Slope Risk Assessment and Management Plan must take into account the recommendations listed in Table 3-1 for surface (ground) and equipment stability factors while working on a slope to determine appropriate construction techniques.

Table 3-1: Equipment Stability Factors Risk Matrix

Surface Stability Factor	Low Risk	Medium Risk	High Risk
Terrain stability/ classification	No instability indicators and slope grade less than 50% (26.5°)	Other instability indicators and slope grade less than 50% (26.5°)	Slope grade: greater than 50% (26.5°)
Ground roughness	Slope grade less than 30% (16.7°) ROW area covered by roughness features	Slope grade: 30% to 50% (16.7° to 26.5°) ROW area covered by roughness features	Slope grade: greater than 50% (26.5°) ROW area covered by roughness features
Soil type	Well-drained (e.g., gravel, coarse sand)	Moderately well drained (e.g., fine sand, silt); indications of sub-surface flows	Poorly drained or saturated (e.g., silt, clay), high water table
Soil depth to bedrock	Greater than 30 cm (11.8 in.)	15 cm to 30 cm (5.9 in. to 11.8 in.)	Thin soils less than 15 cm (5.9 in.), or exposed bedrock

- 3.2.7 The Hazardous Slope Risk Assessment and Management Plan must take into account the requirements for equipment stability listed in Table 3-2 based on the slope thresholds for a geotechnically stable slope under optimal dry conditions.

Table 3-2: Wheeled and Tracked Machine Stability Risk Matrix

Machine Type	Slope Features	Stability Risk		
		Low Risk	Medium Risk	High Risk
Wheeled Machine	Slope grade	30% to 45% (16.7° to 24.2°)	30% to 45% (16.7° to 24.2°)	>45% (24.2°)
	Slope length	<50 m (164 ft)	>50 m (164 ft)	>10 m (32.8 ft)
Tracked Machine	Slope grade	40% to 50% (21.8° to 26.5°)	40% to 50% (21.8° to 26.5°)	>50% (26.5°)
	Slope length	<50 m (164 ft)	>50 m (164 ft)	>10 m (32.8 ft)

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- 3.2.8 The Hazardous Slope Risk Assessment and Management Plan must also account for the probability of the slope or equipment becoming unstable during adverse environmental or weather conditions (e.g., rain, dew, snow, ice, mud, loose fill or other material on the slope).
- 3.2.9 The Hazardous Slope Risk Assessment and Management Plan must also account for equipment becoming unstable on hard surfaces when the surfaces become slippery, icy and wet (e.g., bridge decks, mats, roads, and rock), See Figure 3-2.

Note: Equipment on hard surfaces (e.g., mats, bridge decks, roads, and rock) can have reduced traction. The risk of equipment losing traction become unstable, sliding and rolling over is greatly increased when the surface is slightly sloped and/or when the surface is wet (i.e., rain, dew, snow, ice) and/or when the surface is covered with loose material (i.e., mud, gravel).

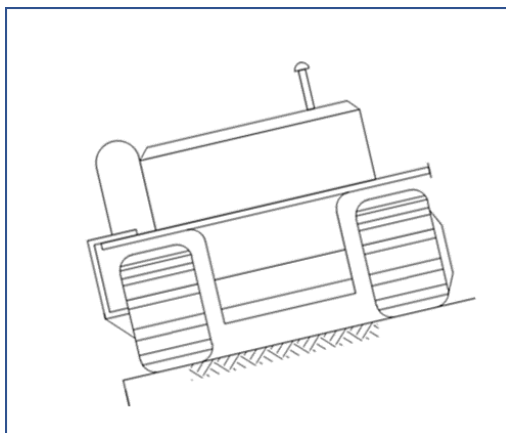


Figure 3-1: Illustration of Equipment Stability Concern on a Mat

- 3.2.10 The Hazardous Slope Risk Assessment and Management Plan must also take into consideration equipment stability in proximity to open excavations, sharp drop-offs, steep grades, loose fill, spoil piles, cross slope travel and uneven surfaces. See Figure 3-2 for working on or near slope and earthwork sites.

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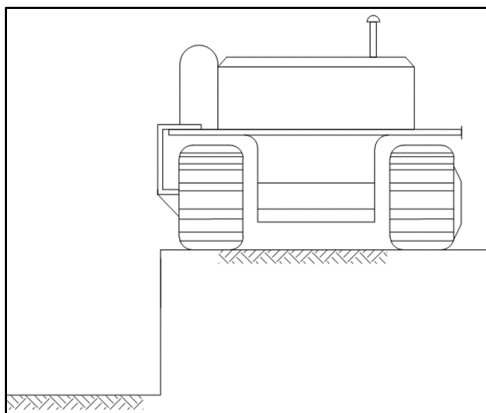


Figure 3-2: Illustration of Equipment Stability Concern in Proximity to an Open Excavation

3.3 Wheeled Vehicles and ATV Stability Risk

- 3.3.1 The Hazardous Slope Risk Assessment and Management Plan must include the use and/or restrictions of wheeled vehicles including All-Terrain Vehicle (ATV).
- 3.3.2 The use of wheeled vehicles on a hazardous slope must be managed, including when the wheeled vehicles is providing access and/or mobility on or to the work site and/or travelling along the right-of-way.
- 3.3.3 The use of wheeled vehicles must have an appropriate level of mitigation and rules to manage the mitigation.
- 3.3.4 The rules for managing the mitigation may include (1) driving requirements (e.g., low speed, gearing down when driving down hills, not riding the breaks), (2) winching and/or towing, (3) a risk-based assessment, and/or (4) strictly prohibiting wheeled vehicles on the hazardous slope.
- 3.3.5 The winching and/or towing of wheeled vehicles must be conducted with a sufficiently sized tow rigging and/or anchoring for the size of the wheeled vehicles.
- 3.3.6 The winching and/or towing rigging must be inspected prior to use for any defects
- 3.3.7 Where the hazardous slope has a measured gradient greater than 30 degrees or an unknown steep slope gradient, access using wheeled vehicles must be limited or restricted, unless an appropriate level of mitigation has been provided to manage the risk of instability including engineered calculations.
- 3.3.8 The owner's manuals for wheeled vehicles must be reviewed to ensure that any restrictions provide by the manufactures for the maximum slope gradient that the wheeled vehicles can operate on is strictly followed.
- 3.3.9 The owner's manuals must always be located on the recreational type ATV when the ATV is on a hazardous slope.

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- 3.3.10 The contractor must develop a maximum slope gradient that the wheeled vehicles can operate on, if the manufactures of wheeled vehicle has not provided a restriction.

3.4 Geotechnical Stability Risk Assessment Requirements

- 3.4.1 The Hazardous Slope Risk Assessment and Management Plan must include an evaluation by a geotechnical professional of the stability of natural slopes and man-made soil deposits on the slope as well as adjacent to, above or below the work site when:

- there is evidence of an active landslide or ground movement by ground observations:
 - ground instability (e.g., failure scars, active moving soil blocks, tension cracks, head scarps, side scarps, slumping, slump blocks, and/or transverse fissures)
 - signs of active rock falls, rockslides and/or rock block failures
 - signs of active debris flow(s) along the slope(s)
 - presence of debris that has the potential to roll or fall on personnel
- the surface of the slope is saturated with surface water or groundwater. Signs of saturation can include pre-existing seepage and drainage areas (i.e., standing water, seeps, springs, excessively wet, undrained depressions)
- managing an excessive amount of spoil material on, adjacent to, above or below a slope
- working across excessively steep side slope (i.e., 26.5° or greater)
- management of the excessive fill spoil material requires mixing to dry and/or stabilize soil material
- using flowable fill material or shotcrete on a slope
- anchor points are being installed in rock and/or earth for personnel fall protection, or for materials and equipment
- there is design and installation of cable cranes and cable crane systems
- mitigation requires the installation of slope retention or avalanche control systems such as:
 - wire mesh drapery, nets or netting anchored to the slope using a dense matrix of soil or rock anchors, specialized anchor plates and/or plate piles
 - catchment barrier for rockfalls or shallow landslides

- 3.4.2 The written direction from a geotechnical professional or geotechnical approved design or procedure must be used when:

- backfilling on a slope with a slope ratio 26.5° or greater.
- pipeline is being placed on, supported by or within fill material

Note: The pipeline being placed on, supported by or within fill material is not for general pipeline construction and does not pertain to or include weld tie-ins, locations

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of hanging pipe within a trench and/or when pipeline pillows are being used for the installation of the pipeline on a hard surface which are covered under the Company's or Project's compaction control procedures.

- areas where there is a high risk of soil settlement and/or subsidence sinkholes (e.g., pipeline is traveling across or through man-placed fills, locations of known mine activity where there is the potential for collapse, Karst sinkholes)
- mitigation of soil settlement, subsidence sinkholes, deep scour and/or channels
- sections of the ROW where there is a high risk of trench erosion that can cause pipeline buoyancy issues

- 3.4.3 The terms "excessive" and "excessively" (as indicated in clause 3.3.1) must be defined in the Hazardous Slope Risk Assessment and Management Plan and the Multiple Hazardous Slope Identification Procedure (if an Identification Procedure is developed) to provide guidance when the assistance of a geotechnical professional is required.
- 3.4.4 A geotechnical professional must be used for the design and installation of structure foundations and anchors for any type of cable crane technology used for slope work.
- 3.4.5 A geotechnical professional must be used for the design and installation of earthworks and structure foundations on a slope (e.g., gabions, retaining walls).
- 3.4.6 A geotechnical professional must be used when there are trench stability issues.
- 3.4.7 The geotechnical professional must review the work plan and site by ground observations to evaluate the risk of slope failure, ground instability, equipment instability, personnel falling debris falling on personnel, equipment and/or infrastructure or if and where required.
- 3.4.8 The Contactor must ensure that a geotechnical professional is involved in the work if and where required, or unless otherwise specified in the Agreement or as approved by the Company.
- 3.4.9 The geotechnical professional may be employed, contracted or subcontracted to the Contactor and/or the Company, or unless otherwise specified in the Agreement or as approved by the Company.
- 3.4.10 The geotechnical professional must review the risks with the Company and the Contactor before developing mitigation plans and/or proceeding with more investigative testing and/or studies.
- 3.4.11 All geotechnical investigative testing and/or studies must be approved by the Company or unless otherwise specified in the Agreement.
- 3.4.12 The geotechnical professional must inform the Company if the pipeline is or can be at risk due to an active geohazard, so an integrity evaluation can be conducted on the pipeline.
- 3.4.13 The Contractor must ensure that construction activities do not affect the stability of the hazardous slope or stability of the surrounding terrain.

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- 3.4.14 The Contractor must be vigilant throughout the day (visual observations) for any signs of ground movement to ensure that construction activities have not affected the stability of the hazardous slope or stability of the surrounding terrain.
- 3.4.15 The Contractor must document at least twice daily (i.e., prior to use and mid-day) visual observations that construction activities have not affected the stability of the hazardous slope or stability of the surrounding terrain.
- 3.4.16 The Contractor must immediately report any signs of instability of the hazardous slope or instability of the surrounding terrain that occur during the time of construction to the Company. (e.g., failure scars, tension cracks, soil slumping, rock falls, rockslides, or signs of unstable debris that can potentially roll or falling on personnel.
- 3.4.17 The Contractor must use a geotechnical professional to evaluate, address and/or mitigate the stability of the hazardous slope or instability of the surrounding terrain caused during construction.
- 3.5 Risk Mitigation**
- 3.5.1 The Hazardous Slope Risk Assessment and Management Plan must identify mitigation measures to reduce the risks involved in hazardous slope work.
- 3.5.2 The Hazardous Slope Risk Assessment and Management Plan must include procedures that define and explain how the mitigation measures will be applied before, during and after hazardous slope work.
- 3.6 Auditing**
- 3.6.1 The Contractor must ensure that the mitigation measures used to reduce the risks involved in hazardous slope work are auditable to the Hazardous Slope Risk Assessment and Management Plan.
- 3.6.2 The Contractor must ensure that mitigation measures used to reduce the risks involved in hazardous slope work are inspected and documented at least twice daily (i.e., prior to use and mid-day).
- 3.6.3 The Hazardous Slope Risk Assessment and Management Plan must contain a checklist for inspecting the mitigation measures involved in hazardous slope work.
- 3.6.4 The documented checklist must be used for inspecting the mitigation measures involved in hazardous slope work
- 3.6.5 The documented checklist for inspecting must be accepted by the Company.

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4 HAZARDOUS SLOPE WORK PLAN REQUIREMENTS

4.1 General

- 4.1.1 The Contractor must develop a Hazardous Slope Work Plan for all slopes identified as a hazardous slope.
- 4.1.2 The Contractor must develop a Hazardous Slope Work Plan for each slope or for multiple slopes if:
- slopes contain both hazardous slope sections and sections that do not fit the definition of a hazardous slope
 - changing weather conditions, moisture or obstacles on the slopes could cause the slope or equipment working on the slope to become unstable
- 4.1.3 The Contractor must develop a Hazardous Slope Work Plan for each method of construction, conventional pipeline construction and, if utilized, cable crane technology.
- 4.1.4 The Contractor must provide the Hazardous Slope Work Plan as follows:
- Pipeline construction projects: minimum of twenty (20) business days prior to performing hazardous slope work, after the Multiple Hazardous Slope Identification Procedure has been reviewed by the Company, or unless otherwise specified in the Agreement or as approved by the Company.
 - Planned pipeline integrity projects: minimum of five (5) business days prior to performing hazardous slope work, or unless otherwise specified in the Agreement or as approved by the Company.
- 4.1.5 In the U.S., personnel performing Covered Tasks must be qualified in accordance with the *Operator Qualifications Program* (Item ID [004504739](#)) and have all current certifications.

4.2 Hazardous Slope Work Plan for Conventional Pipeline Construction

- 4.2.1 For conventional pipeline construction on a hazardous slope, the Hazardous Slope Work Plan must include, but is not limited to, the following:
- Include phase of construction
 - equipment mobilization, access, set-up, clearing, right-of-way grading, excavation, blasting, pipe stringing, welding, coating, pipe laying, backfilling, compaction, cleanup, restoration, equipment demobilization, and all other pipeline construction activities
 - Equipment
 - equipment and machinery types intended to be used on the hazardous slope (consider configuration of equipment, single, double or triple grousers)
 - allowable operating conditions (weight, wind loading)
 - equipment stability risks (tracked vs. wheeled)
 - coefficient of friction (traction) factors and rolling resistance requirements
 - hoisting and rigging of equipment:

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- working loads and breaking strength of cable and wire rope,
 - third-party cable and wire rope certifications,
 - connection equipment (e.g., shackles, slings, D-rings)
- equipment connection points (points on equipment)
- winching and hoisting of pipe and equipment (base-mounted hoisting equipment vs machine-mounted hoisting equipment)
- Engineering Controls
 - calculations and engineering analysis for any proposed equipment anchoring authenticated (stamped) by a competent engineering professional.
 - anchoring includes winching, hoisting, rigging and the use of coefficient of friction (traction) factors and rolling resistance used for equipment stability.
- Geotechnical
 - surveyed slope angle and slope length
 - terrain stability and classification
 - soil classification (type, drainage, depth)
 - ground roughness
- Environment
 - slope stability during environmental or weather conditions (i.e., heavy rains)
 - environmental factors (climate)
 - monitoring of weather conditions
- Water Management
 - management of surface and ground water as per *TES-CT-PTB-GL Pipeline Trench Breaker Specification (CAN-US-MEX)* (Item ID [1017338859](#))
 - management of water way diversion or erosion and sediment control
- Safety
 - operator experience and qualifications
 - duration of time the operator has been working on the slope (i.e., affects operator fatigue)
 - all other safety measures identified

4.3 Hazardous Slope Work Plan for Pipeline Construction using Cable Crane Technology

4.3.1 If cable crane technology is used for slope work on a hazardous slope, the Hazardous Slope Work Plan must include, but not be limited to the following:

- Include phase of construction
 - equipment mobilization, access, set-up, clearing, right-of-way grading, excavation, blasting, pipe stringing, welding, coating, pipe laying, backfilling, compaction, cleanup, restoration, equipment demobilization, and all other pipeline construction activities
- Equipment
 - equipment and machinery types intended to be used on the hazardous slope
 - allowable operating conditions (weight, wind loading)

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- winching, hoisting, and rigging of equipment
 - winching and hoisting of pipe and equipment (base-mounted hoisting equipment or machine-mounted hoisting equipment)
 - hoisting and rigging of equipment:
 - working loads and breaking strength of cable and wire rope,
 - third-party cable and wire rope certifications,
 - connection equipment (e.g., shackles, slings, D-rings)
 - equipment connection points (points on equipment)
 - winching and hoisting of pipe and equipment (base-mounted hoisting equipment vs machine-mounted hoisting equipment)
- Engineering Controls
 - calculations and engineering analysis authenticated (stamped) by a competent engineering professional retained.
 - Anchoring and anchoring equipment
 - Winching, hoisting, rigging equipment.
 - Structure and other infrastructure required for the cable crane
- Geotechnical
 - surveyed slope angle and slope length
 - terrain stability and classification
 - soil classification (type, drainage, depth)
 - ground roughness
- Environment
 - slope stability during environmental or weather conditions (i.e., heavy rains)
 - environmental factors (climate)
 - monitoring of weather conditions
- Water Management
 - management of surface and ground water as per *TES-CT-PTB-GL Pipeline Trench Breaker Specification (CAN-US-MEX)* (Item ID [1017338859](#))
 - management of water way diversion or erosion and sediment control
- Safety
 - operator experience and qualifications
 - duration of time the operator has been working on the slope (i.e., affects operator fatigue)
 - all other safety measures identified
- all calculations and analysis validated and authenticated (stamped) by a competent engineering professional

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4.4 Geotechnical Work

4.4.1 The Contractor must include the following considerations related to geotechnical professional requirements in the Hazardous Slope Work:

- evaluation of the stability of the slope before, during and after the hazardous slope work
- presence of a geotechnical professional on-site during construction
- monitoring of geotechnical stability of the slope during the hazardous slope work
- geotechnical design prior to start of work on the hazardous slope
- consideration of materials existing in the area
- use of geotechnical structure typical drawings
- maintenance of geotechnical structures

4.5 Equipment Analysis and Engineering Oversight

4.5.1 The Hazardous Slope Work Plan must list all equipment that will be used during the hazardous slope work.

4.5.2 The Hazardous Slope Work Plan must identify the equipment and machine manufacturer's recommended safe working limitations.

4.5.3 Any fabrication of, or modifications to, the equipment for winching, securing and/or stabilizing (e.g., welding on or fabrication of hooks or rigging) must be conducted under the direction and design authority of an authenticating (stamped) competent engineering professional who is knowledgeable in the modifications that are being conducted.

4.5.4 The Hazardous Slope Work Plan must include the calculations and analysis used to determine the safe use of the equipment based on the forces and slope characteristics.

4.5.5 The calculations and analysis used to determine the safe use of the equipment based on the forces and slope characteristics must be authenticated (stamped) by a competent engineering professional.

4.5.6 All equipment weights identified in the winching load calculation or stability analysis must be based on actual operating weights including fuel, lubricants, operator and material load and potential swing movement.

4.5.7 The Hazardous Slope Work Plan must identify the need for specialized equipment, sizes, number of anchor pieces, special anchoring devices at the anchor points and on the equipment and certifications of the equipment that is needed to perform work on a slope.

4.5.8 Base-mounted winching equipment required to hold construction equipment while working on a hazardous slope must be placed on flat and level ground on the top of each slope.

4.5.9 Base-mounted winching equipment required to hold construction equipment while working on hazardous slope must be appropriately anchored using Special Anchoring Devices.

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- 4.5.10 The Contractor must ensure that each piece of winching and/or hoisting equipment in the load path (including shackles and cables) is certified and installed as per manufacturer's and/or authenticating (stamped) engineering professional recommendations and as per regulations.
- 4.5.11 The Contractor must ensure that each piece of winching and/or hoisting equipment in the load path (e.g., cables and wire rope, winch drums, hooks) involved in hazardous slope work is inspected and documented at least twice daily (i.e., prior to use and mid-day).
- 4.5.12 The Contractor must have a checklist for inspecting the winching and/or hoisting equipment in the load path and involved in hazardous slope work.
- 4.5.13 The Contractor must include in the Hazardous Slope Work Plan a documented process for the loading, unloading, storage and securement of any equipment or materials required on the hazardous slope.
- 4.5.14 Special anchoring devices attached to the ground or rock as anchor points must be designed and installed under the direction of an authenticating (stamped) competent engineering professional.
- 4.5.15 Winching equipment that secures construction equipment while working on hazardous slopes must be installed under the direction of an authenticating (stamped) competent engineering professional.
- 4.5.16 All assumptions identified and utilized in the analysis by the authenticating (stamped) competent engineering professional must be validated by the Contractor.
- 4.5.17 Assumed values utilized for engineering analysis such as coefficient of friction (traction) factors and rolling resistance must be validated by on-site field testing.
- Note:** If the coefficient of friction (traction) factors and rolling resistance is assumed to be zero on-site field testing is not required.
- 4.5.18 Any assumptions identified and utilized in the analysis by the authenticating (stamped) competent engineering professional that cannot be validated must be identified to the Company in writing.
- 4.5.19 Any assumptions identified and utilized in the analysis by the authenticating (stamped) competent engineering professional that cannot be validated must have an additional safety factor applied and identified in writing to the Company to ensure that the identified and utilized assumption meets the Company's risk tolerance.
- 4.5.20 The engineering professional(s) may be employed, contracted or subcontracted to the Contractor and/or the Company, or unless otherwise specified in the Agreement or as approved by the Company.

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4.6 Site Conditions

- 4.6.1 The Hazardous Slope Work Plan must identify the site conditions required for the plan to be valid (e.g., coefficient of friction [traction] factors, rolling resistance, weather conditions).
- 4.6.2 The Hazardous Slope Work Plan must identify the changes to the site conditions that would effect a change to the Hazardous Slope Work Plan (e.g., rain, ice, snow, lightning storm).
- 4.6.3 The site conditions must be assessed throughout the day as well as when site conditions change.

4.7 On-Site Personnel

- 4.7.1 The Contractor must list in the Hazardous Slope Work Plan the designation and assignment of dedicated resources, including but not limited to:
- supervisors
 - horn and flag personnel
 - spotters
 - safety resources
 - operators
- 4.7.2 The Contractor must identify the competent personnel responsible for assessing the site conditions and/or changing site conditions due to weather or other hazardous conditions.
- 4.7.3 The Contractor's competent personnel responsible for assessing the site conditions and/or changing site conditions must also consider that equipment can become unstable on slippery or icy surfaces (e.g., bridge decks, mats, roads, rock and other surfaces).
- 4.7.4 In situations where there is a risk of falling debris onto and/or from the locations of work, the Contractor must have in place appropriate safety measures for protection and warning of personnel (e.g., debris spotters).
- 4.7.5 In rocky terrain, a competent person must monitor rock spillage down the slope and use the horn as necessary for warning.

4.8 Fall Protection Requirements

- 4.8.1 The Hazardous Slope Work Plan must include a documented Fall Protection Plan for any personnel working on a slope where fall protection or climbing aids are required.
- 4.8.2 The Fall Protection Plan must include, but not be limited to:
- harnesses
 - lanyards
 - ropes
 - specialized hard hats with chin straps
 - climbing anchors

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- 4.8.3 The Contractor must ensure that all dedicated personnel and resources are competent and trained for the required task.
- 4.8.4 The Contractor must ensure that all personnel utilizing fall protection have been certified as per the requirements of the Authorities in the local jurisdiction.
- 4.8.5 If climbing aids are being used for rope access and/or if any rope work is conducted on the hazardous slope, all dedicated personnel and resources must be competent and trained for the required task (e.g., Society of Professional Rope Access Technicians [SPRAT], Industrial Rope Access Trade Association [IRATA] or to the requirements of the Authorities in the local jurisdiction).
- 4.9 Communication Protocol and Signage**
- 4.9.1 The Contractor must have a documented communication protocol for verbal and/or visual communication between the supervisor, operators and signallers at all times.
- 4.9.2 The Contractor's documented communication protocol must include, but not be limited to, the following:
- communication devices
 - signage
 - signallers
- 4.9.3 Signallers must be identifiable by a distinctive coloured reflective vest, flag and distinctive hard hat to ensure the signallers stand out from other individuals.
- 4.9.4 Site-specific communication devices (e.g., radios, satellite phones, cell phones) must be used to facilitate on-site, off-site, and remote communication.
- 4.9.5 The signage must be placed at all access points to each hazardous slope (e.g., base and top of the slope).
- 4.9.6 The signage must state, as a minimum, the following information:
- A "CAUTION" warning title,
 - A "hazardous slope" or "hazardous condition" warning subtitle,
 - slope or hazard identification number (for projects with multiple hazardous conditions and/or hazardous slopes)
 - The hazardous risk category and/or slope angle classification.
 - Notice indicating not proceeding before reviewing and following the Hazard Slope Work Plan for the hazardous slope.
 - Notice outlining the appropriate level of mitigation and rules to manage the mitigation for the use of wheeled equipment on the hazardous slope or hazardous condition.
 - Notice of any special precautions.

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- Notice of provision to ascend or descend the hazardous slope,
- Equipment types allowed to travel on the hazardous slope or hazardous condition,
- Contact number(s) and
- Communication protocol (e.g., radio number)

4.9.7 The signage must be colour coded to indicate risk category and/or classification.

4.9.8 For projects with multiple hazardous conditions and/or hazardous slopes the signage must contain the slope or hazard identification number.

4.9.9 The Contractor must ensure that daily tailgate meetings and job safety hazard analysis are conducted at least once per day or whenever planned activities, scope of work and/or environmental conditions have changed.

4.10 Excavation, Backfill and Compaction

4.10.1 The Contractor must include in the Hazardous Slope Work Plan an excavation and backfill procedure for hazardous slopes in accordance with *TES-CT-EXC-GL Excavation Specification (CAN-US-MEX)* (Item ID [005890120](#)) and *TES-CT-COMPC-GL Compaction Control Measures for Pipeline Excavations Specification (CAN-US-MEX)* (Item ID [005974567](#)).

4.10.2 The excavation and backfill procedure must ensure that material from clearing, blasting, excavation, backfill, and/or compaction does not roll down the slopes.

4.10.3 In areas where there is a risk of material rolling down the slopes, the Contractor must have safety measures such as netting or barriers in place to prevent rocks or debris from rolling down the slopes and coming into contact with personnel, equipment, and/or infrastructure (i.e., roadway, vehicles on the roadway).

Note: Depending on the situation infrastructure can include buried piping, cables or fiber optic lines. As ground cover is not always sufficient at mitigating that damage from rolling or falling debris.

4.10.4 The excavation and backfill procedure must ensure that the backfill is properly and safely delivered to the intended location in a controlled manner and is not allowed to free-fall down the slope.

4.10.5 The Contractor must follow the project specific backfill requirements (e.g., trench breakers, gabion walls).

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5 HAZARDOUS SLOPE WORK DOCUMENTATION REQUIREMENTS**5.1 Documentation**

5.1.1 As part of the turnover package, the Contractor must supply the following written hazardous slope work documentation to the Company no later than sixty (60) days after completing the slope work:

- Hazardous Slope Risk Assessment and Management Plan (if changed or modified during hazardous slope work)
- Hazardous Slope Work Plan (if changed or modified during hazardous slope work)
- engineering assessments (if changed or modified during hazardous slope work)
- lessons learned (knowledge gained during the hazardous slope work)

Note:

A flowchart that illustrates the steps in planning hazardous slope work is shown in Figure 5-1.



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6 DOCUMENTATION AND RECORDKEEPING

1. Multiple Hazardous Slope Identification Procedure – for Pipeline Construction Projects (if pipeline construction project contains three or more hazardous slopes).
2. Hazardous Slope Risk Assessment and Management Plan – if a hazardous slope or hazardous condition has been identified where there is a risk of debris falling on personnel, personnel falling, equipment and geotechnical stability, including:
 - checklist for inspecting the mitigation measures involved in hazardous slope work at least twice daily (i.e., prior to use and mid-day)
 - checklist for inspecting each piece of winching and/or hoisting equipment (e.g., cables and wire rope, winch drums, hooks) involved in hazardous slope work at least twice daily (i.e., prior to use and mid-day)
3. Hazardous Slope Work Plan – for all slopes identified as a hazardous slope, including:
 - engineering analysis (authenticated (stamped) by a competent engineering professional) for any:
 - anchoring
 - hoisting and rigging of equipment, including:
 - sizing of cables
 - sizing of connecting equipment (e.g., shackles, slings, D-rings)
 - equipment connection points (points on equipment)
 - winching and hoisting of pipe and equipment (base-mounted hoisting equipment or machine-mounted hoisting equipment)
 - coefficient of friction (traction) factors and rolling resistance
 - fabrication of or modifications to the equipment for winching, securing and/or stabilizing (e.g., welding on or fabrication of hooks or rigging).
 - documented communication protocol
4. Fall Protection Plan – any personnel working on a slope where fall protection or climbing aids are required.
5. Hazardous Slope Work Documentation (turnover package).

7 VARIANCES

Any deviation from this Specification's requirements must follow the Company *Controlled Document Library Variance Procedure (CDN-US-MEX)* (Item ID [007728702](#)). To initiate a variance request, external parties (e.g., contractors and manufacturers) must contact the Company.

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8 ROLES AND RESPONSIBILITIES

Table 9-1 outlines the roles and responsibilities required for the use of this Specification.

Table 9-1: Roles and Responsibilities

Role	Responsibilities
Company	The Company is responsible for receiving, verifying and filing in project records the required documentation.

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Role	Responsibilities
Contractor	<p>The Contractor is responsible for</p> <ul style="list-style-type: none"> providing the following to the Company prior to performing hazardous slope work for review and comments: <ul style="list-style-type: none"> Multiple Hazardous Slope Identification Procedure Hazardous Slope Risk Assessment and Management Plan Hazardous Slope Work Plan Engineering Assessments ensuring that the Multiple Hazardous Slope Identification Procedure, Hazardous Slope Risk Assessment and Management Plan, Hazardous Slope Work Plan, and Engineered Assessments meet regulatory compliance identifying and assigning all personnel involved in the identification, assessment and management of slope construction including, but not limited to, the following key roles: <ul style="list-style-type: none"> construction/excavation supervisors foreman professional engineer (e.g., mechanical, geotechnical, civil) surveyor blasters equipment operator signaller safety representative land agent environmental representative identifying qualification requirements for all personnel performing, monitoring and/or supervising construction activities associated with hazardous slope work ensuring that all personnel performing, monitoring and/or supervising construction activities associated with hazardous slope work have the qualification requirements and can perform the role assigned validating assumptions identified and utilized in the Engineering Assessment for specialized anchoring analysis by authentication (stamped) through an engineering professional (if required) coordinating work with all other contractors and subcontractors

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Role	Responsibilities
Engineer(s) involved with engineering assessment for specialized anchoring	<p>The engineer(s) involved with the engineering assessment for specialized anchoring must be responsible for:</p> <ul style="list-style-type: none"> being a competent engineering professional who is knowledgeable (by means of education, experience or a combination thereof, and possibly with guidance or input from qualified construction personnel), of the work, the hazards involved and the means to control the hazards being fully accountable and responsible to ensure that the engineered assessment on anchoring meets the regulatory compliance of the applicable provincial, state and federal regulatory jurisdictions and is defensible to a regulatory body with engineering justification identify all assumptions and ensure that the Contractor validates all the assumptions utilized in the analysis

9

REFERENCES

This document relies on a number of references to regulation, industry codes and standards, general industry guidance and internal references. These documents are listed in Table 9-1, Table 9-2 and Table 9-3.

Table 9-1: Regulatory References

Organization	Title
WorkSafeBC	OHS Regulation Part 26, Section 26.16 Slope Limitations.
Oregon Administrative Regulation	OAR 437-007-0935 Machine Operations on Slopes

Table 9-2: External Industry References

Organization	Title
BC Forest Safety	BC Forest Safety Council Steep Slope Resource Package April 2013
ASME	B30.7 Safety Requirements for Base Mounted Drum Hoists.
ASME	B30.9 Slings
ASME	B30.10 Hooks.
ASME	B30.14 Side Boom Tractor.
ASME	B30.26 Rigging Hardware.
Caterpillar® Machinery	Caterpillar® Machinery Handbook.

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Table 9-3: Internal References

Item ID	Title
007728702	<i>Controlled Document Library Variance Procedure (CDN-US-MEX)</i>
004504739	<i>Operator Qualification Program (US)</i>
1017338859	<i>TES-CT-PTB-GL Pipeline Trench Breaker Specification (CAN-US-MEX)</i>
005890120	<i>TES-CT-EXC-GL Excavation Specification (CAN-US-MEX)</i>
005974567	<i>TES-CT-COMP-GL Compaction Control Measures for Pipeline Excavations Specification (CAN-US-MEX)</i>

10**DOCUMENT HISTORY**

Rev.		
02	Description	Effective Date
	Clarification on Company requirements for geotechnical stability risk assessment.	2021-Dec-01
	Rationale Statement	Document Contact
	<p>This document was revised to address the following requirements:</p> <ul style="list-style-type: none"> ▪ Address the gap identified by the Nixon Ridge Root Cause Failure Analysis (RCFA) ▪ Address the gap identified by hazard alert for equipment instability on slippery, icy and wet hard surfaces (e.g., bridge decks, mats, roads, rock and other surfaces). ▪ Address the gap with wheeled vehicles on slopes include ATVs. 	Michael Martens, M.Sc., P. Eng.
	Impact Assessment Summary	Document Owner
	Construction Contractor are required to identify and address the potential risk to working on HAZARDOUS SLOPE. There is an expectation as to refer to a geotechnical specialist to evaluate the stability of the hazardous slope when assessing the risks.	Engineering Governance

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Rev.		
01	Description	Effective Date
	Improved clarification of Contractor responsibilities and the required documents to support hazardous slope work.	2018-Feb-01
	Rationale Statement	Document Contact
	This document was revised in order to address the following requirements: <ul style="list-style-type: none"> The knowledge obtained from several integrity projects has been included. The HAZARDOUS SLOPE RISK ASSESSMENT AND MANAGEMENT PLAN is now scalable to work and the project and based on the contractors experienced personnel. Renaming and revision of TES-PROJ-SSW Steep Slope Work Specification (CDN-US-MEX) 	Michael Martens, M.Sc., P. Eng.
	Impact Assessment Summary	Document Owner
	Construction Contractor are required to identify and address the potential risk to working on HAZARDOUS SLOPE.	Engineering Governance
00	Description	Effective Date
	New document.	2015-May-06
	Rationale Statement	Document Contact
	This document was developed to address the following requirements: <ul style="list-style-type: none"> safety and engineering requirements when working on steep slopes the Root Cause Failure Analysis (RCFA) of steep slope work issues discovered in Mexico. 	Michael Martens, M.Sc., P. Eng.
	Impact Assessment Summary	Document Owner
	Construction Contractor are required to identify and address the potential risk to working on steep slopes.	Engineering Governance

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DESCRIPTION OF CHANGE

Section	Description of Change
Regulatory	
N/A	N/A
Industry Standards	
N/A	N/A

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Section	Description of Change
General	
Revised Section 3.3	Geotechnical Stability Risk Assessment Requirements
Added Clause 3.2.9	Incident Alerts – a number of equipment roll overs sliding off of slippery, icy and wet surfaces (e.g., bridge decks, mats, roads, rock and other surfaces)
Added Clause 3.2.10	Incident Alert- rollover of a dozer to close to the edge excavation.

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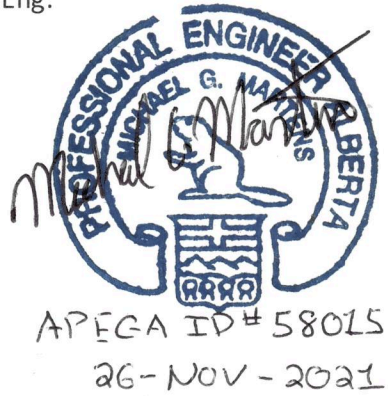

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APPROVALS

Document Contact	Michael Martens M.Sc., P. Eng. Engineering Governance
Document Owner Manager	Robert Phernambucq P. Eng. Engineering Governance
Discipline Checker	Ashton Friesen Threat Management
Discipline Checker	Janel Wageman Construction & Commissioning Excellence
Responsible Engineer	<p>Michael Martens M.Sc., P. Eng. Engineering Governance</p>  <p>Signature/Date</p>
Corporate Authorization	<p>Robert Phernambucq P. Eng. Engineering Governance</p> <p>TRANSCANADA PIPELINES LIMITED 7007100</p>  <p>MEMBER # 98155</p> <p>Nov. 26, 2021</p>