

## Pipeline Depth of Cover

<b>Purpose</b>	The purpose of this document is to share learnings from operators relating to loss of cover after original installation or relocating/ changing the profile of the existing pipeline system or segment.
<b>Reference</b>	<p>49 CFR 195.210      “Pipeline location”</p> <p>49 CFR 195.246      “Installation of pipe in a ditch”</p> <p>49 CFR 195.248      “Cover over buried pipeline”</p> <p>49 CFR 195.401(b)    “General requirements”</p> <p>ASME B31.4 Pipeline Transportation Systems for Liquids and Slurries</p>
<b>Appendices</b>	<ul style="list-style-type: none"> <li>• Appendix A: Forms and Reports</li> <li>• Appendix B: Other Documents</li> </ul>
<b>Related Toolbox Topics</b>	<ul style="list-style-type: none"> <li>• ROW Patrol and Response (Air/Ground)</li> <li>• Excavation Monitoring and Observation</li> <li>• Crossing and Encroachment Agreements and Correspondence</li> <li>• One Call Notifications Response and Communications</li> </ul>

**Introduction:**

Pipelines are installed to meet or exceed applicable minimum regulatory requirements at the time of construction. In some instances, cover may be altered due to excavation activities, erosion, cultivation, construction, flooding, ground subsidence or other environment factors or human intervention. In the event an operator identifies an area where a large amount of cover has been removed, the operator may perform an evaluation to determine whether mitigation actions are warranted under the circumstances.

**Identification Methods**

There are a variety of methods operators can use to determine if cover is sufficient over an existing pipeline system, should they deem it necessary. Below is a list of methods operators may consider when attempting to identify shallow or exposed pipe.

**CONSIDERATIONS: To Identify Shallow or Exposed Pipe Along ROW**

- Close Interval Survey
- Depth of Cover Survey
- Line Locating Activities
- Maintenance Activities
- In Line Inspection or other Integrity Management Activities
- ROW Patrol

**Evaluating Depth of Existing Pipelines:**

Listed in the tables below are minimum depth-of-cover requirements for constructing new lines and relocating, replacing or otherwise changing existing systems. Existing pipelines are not required to meet these depths of cover requirements unless replaced, relocated or otherwise changed. These charts may be useful as a starting point in evaluating whether or not the current depth of existing pipelines warrants further analysis.

**Hazardous Liquid Pipelines:**

Pipe must be buried so that it is below the level of cultivation and so the cover between top of pipe and ground level, road bed, river bottom or underwater natural bottom complies with the following minimum requirements:

Cover Requirements Over Newly Installed Pipe		
Location	Normal Excavation	Rock Excavation
Cultivated, agricultural areas where plowing or subsurface ripping is common	Below the level of cultivation (48*) in 1219 mm	N/A
Industrial, Commercial, Residential Areas	36 (48*) in 914 (1219) mm	30 in 762 mm
Inland water body crossings > 100 ft wide from high water mark to high water mark	48 in 1219 mm	18 in 457 mm
Drainage Ditches at Public Roads and Railroads	36 (48*) 914 (1219) mm	36 in 914 mm
Deepwater Port Safety Zones	48 in 1219 mm	24 in 610 mm
Any Other Onshore Area	30 (36*) in 762 (914) mm	18 in 457 mm
Gulf of Mexico and its Inlets in Water < 15 ft Deep (as measured from mean low water)	36 in 914 mm	18 in 457 mm
Other Offshore Areas Under Water < 12 ft Deep (as measured from mean low water)	36 in 914 mm	18 in 457 mm

\*Denote minimum cover requirements given in ASME B31.4 are more stringent than DOT and are shown in parentheses. The minimum depths of cover requirements given above, including the associated notes below, are in accordance with DOT regulations.

Note 1: Rock excavation is any excavation that requires blasting or removal by equivalent means.

Note 2: At least 12 inches additional cover is required if the line is located within 50 ft. of any private dwelling, or any industrial building or place of public assembly in which persons work, congregate, or assemble.

Note 3: Except for the Gulf of Mexico and its inlets in waters < 15 ft, pipe may be installed with less cover where it is impractical to meet these requirements and additional protection is provided that is equivalent to the minimum required cover.

**CONSIDERATIONS To Evaluate Whether or Not The Current Depth of Existing Pipelines Warrants Further Analysis**

- Is there evidence of significant loss of cover?
- Is there ongoing erosion occurring in the area or has past erosion occurred?
- Is the area around the pipeline prone to compaction/settlement?
- Is wetland erosion is occurring?
- Is the existing pipeline located in a High Consequence Area (HCA)?
- Is there evidence of previous third party damage?
- Is the existing pipeline located in a ditch or waterway?
- Is the existing pipeline located in an area where there is evidence of frequent cultivation activities?
- Is there active excavation for residential, commercial or industrial development occurring?

**Mitigation of Shallow or Exposed Pipe:**

Mitigation actions may or may not be warranted, depending on the results of an evaluation. Evaluation results may indicate action is necessary to address a loss of cover. The following are methods operators may consider.

**CONSIDERATIONS: Mitigation Actions That May Be Used to Address Depth of Cover Issues Include:**

- Adding cover over pipeline
- Placing protective barrier over/near pipeline
- Installing warning mesh over pipeline
- Providing additional pipeline signage/markings
- Installing pipe in casing
- Lowering/relocating the pipeline
- Other engineered options
- Ongoing depth monitoring
- Increased patrol frequency
- Increase public awareness in affected area
- Modify land use agreements and/or easements to preclude excavation in area

**Training/Personnel Responsibility:**

Training may be necessary to ensure that designated personnel can assess, evaluate, and mitigate loss of cover methods chosen. Operators may designate personnel to manage depth of cover issues as necessary.

**Records Information:**

In the event measurements are taken to determine cover over an existing pipeline, the Operator may record a range of pertinent information.

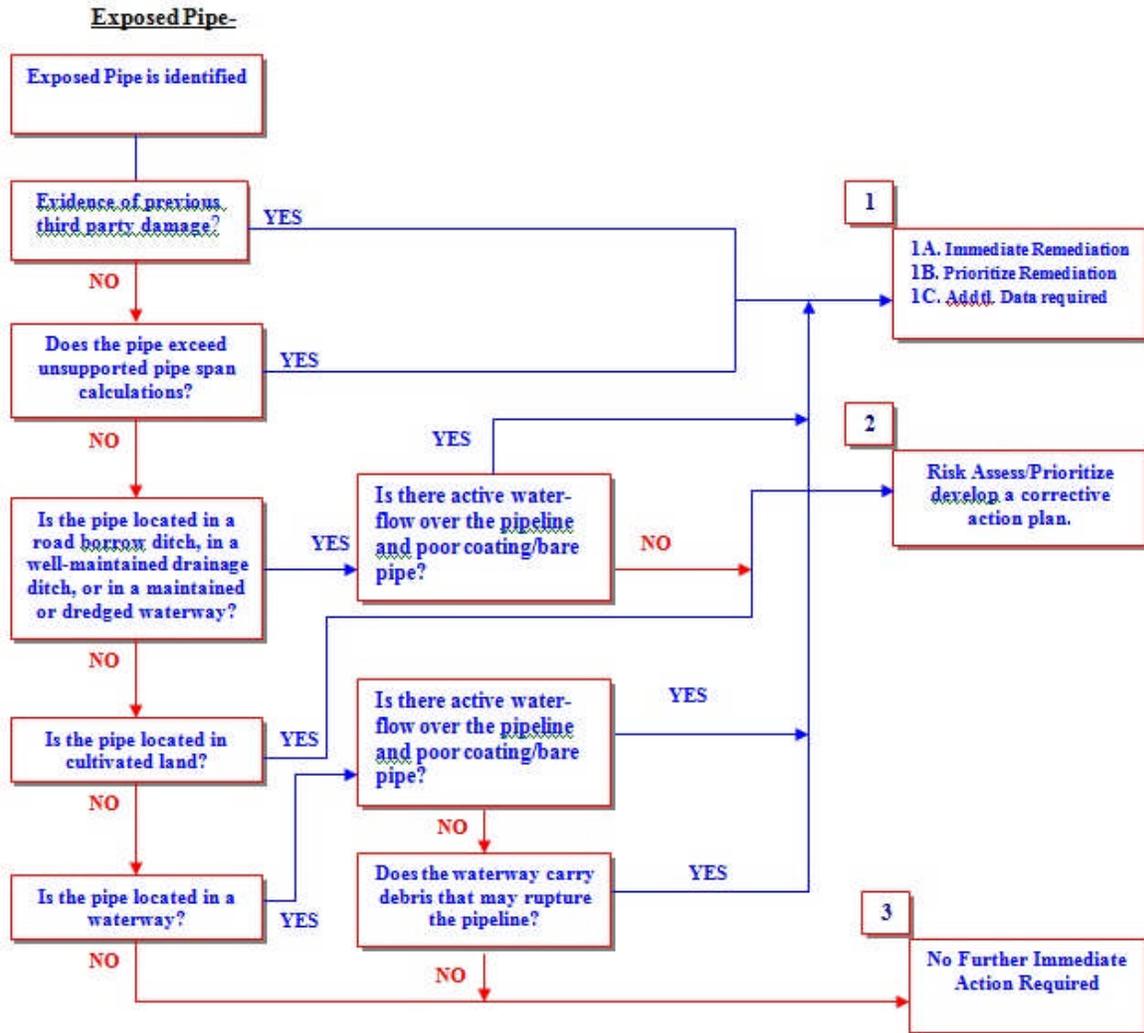
**CONSIDERATIONS: Information Related to Measurement of Cover Over Existing Pipeline  
May Include:**

- Date measurement was taken
- Location of measurement
- Ground elevation data
- Depth of cover measurement in feet and tenths of feet
- Documentation regarding surroundings (road crossing, railroad crossing, ditch, exposed pipe, photographs)

# 1 Appendix B: Other Documents

*This appendix contains industry examples of forms and reports related to the topic.*

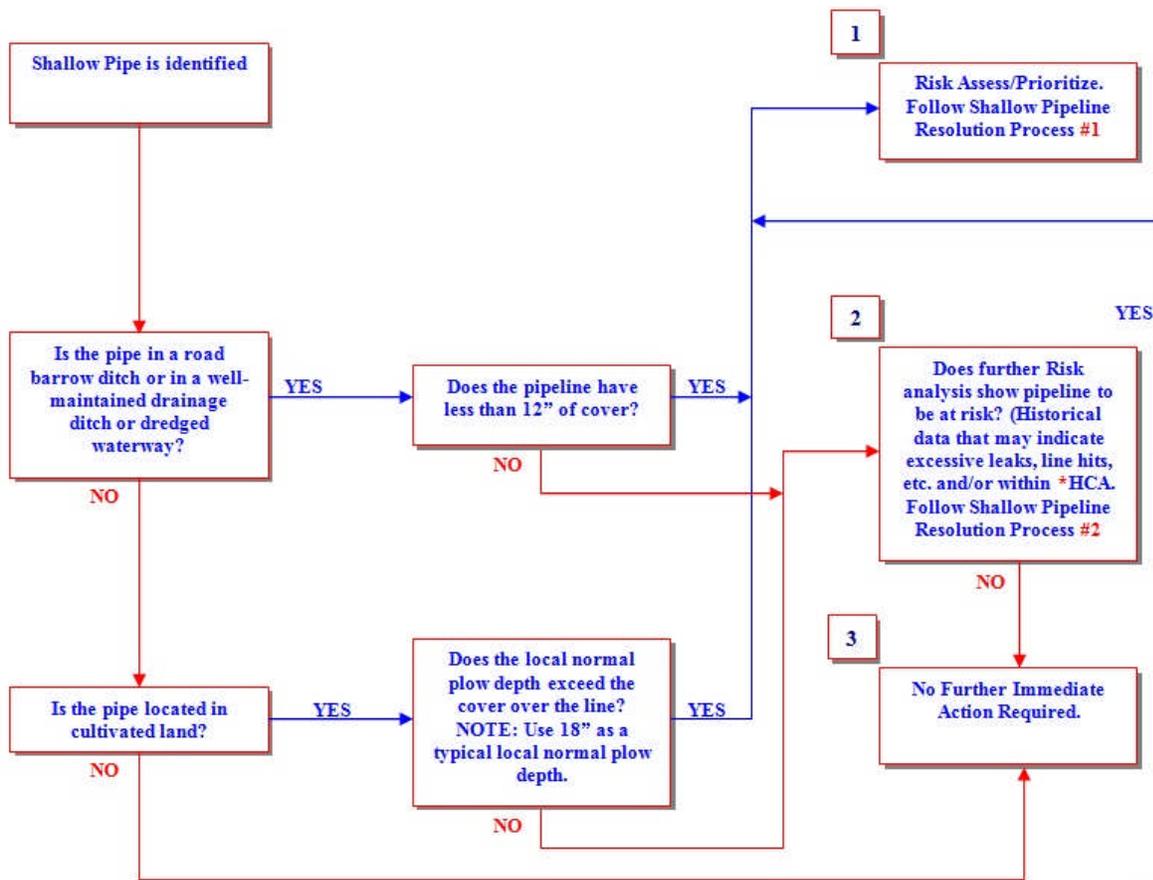
## 1.1 Example Flow chart for Exposed Pipe and Shallow Pipe Locations



\* HCA (High Consequence Area) High populated and/or High environmental impact area.

Definition:  
 1A. – Reported Mechanical damage, Engineering Failures: (eg. Overspan, Non-spec material, soil degradation “slide”, etc., DOT required repair.  
 1B. Other areas with debris flow that are not at immediate risk.  
 1C. More data required to fully assess. (eg. P/S potentials, coating analysis.)

**Shallow Pipe-**



- HCA (High Consequence Area) High populated and/or High environmental impact area.

## 1.2 Example Pipeline Depth Monitoring Program

### PIPELINE DEPTH MONITORING PROGRAM FOR LIQUIDS PIPELINES

#### I. Purpose of Document

The purpose of this document is to outline the proposed objectives, methodology, and mitigation for the Pipeline Depth Monitoring Program (PDMP). The intent is to provide a consistent process for the regular monitoring of the depth of cover for the company's pipelines. Scheduling and an estimation of costs are projected.

#### II. Monitoring Program Guidelines

##### 1.0 Purpose

The PDMP is an operational governance process designed to routinely test, evaluate, and where required, take appropriate action to ensure a consistent standardized depth of cover over company pipelines. Such a program is intended to protect public safety and the environment by reducing the potential for incidents involving company pipelines and related facilities and landowner/tenant equipment.

##### 2.0 Program frequency

The PDMP will be based on 10 calendar year increments. For the purposes of cost effectiveness and staff resourcing, the program will be carried out in identified geographical segments on a yearly basis with the whole system completed after 10 calendar years. The program would be conducted over a 10 calendar year period of time with a portion of the system being covered annually.

For facilities that are not in operation (deactivated, inactive, out of service), depth of cover information shall be collected every 10 calendar years unless officially abandoned and the interest in the land "easement" is discharged from title.

Special consideration must be given to the inspection and maintenance of pipeline crossings of waterways

*The owner of a pipeline that crosses water or unstable ground shall at least once annually inspect the pipeline right-of-way to assess*

- The surface conditions on and adjacent to the right-of-way,
- Indications of any leak in the pipeline,
- Any construction activity performed by others,
- Any encroachment or development near the pipeline right-of-way, or
- Any other condition affecting the operation of the pipeline.

Depth of cover inspections for navigable waterways must be inspected every 5 years based on the requirements found in the Code of Federal Regulations, Section 195.412.

3.0 Minimum depth requirements for existing pipelines

In assessing whether mitigative action is required, the cover requirements for existing pipelines (active, deactivated, inactive, out of service) shall be as provided in Table 1, except where land use, underground structures, or adverse conditions prevent the maintenance of such cover. It shall also be permissible to allow less cover in these cases, provided no mitigation is required or the pipelines are protected against anticipated external loads or

**Table 1: Minimum Depth of Cover Guidelines**

Location		Type of Pipeline	Class Location	Minimum cover for buried operating pipelines		
						
General (other than as indicated below)		Any	Any	30"	0.60m	0.80m
Below travelled surface	Highway	Any	Any	48"	1.20m	1.40m
	Highway ditch	Any	Any	36"	0.75m	1.40m
Below travelled surface	Road	Any	Any	48"	1.20m	1.20m
	Road ditch	Any	Any	36"	0.75m	1.10m
Below base of rail	Cased	Any	Any	62"	1.60m	1.60m
	Uncased	Any	Any	10'	3.05m	3.05m
Rail ditch	Cased	Any	Any	36"	1.00m	1.00m
	Uncased	Any	Any	36"	2.00m	2.00m
Water crossing		Any	Any	48"	1.20m	1.20m
Water crossing (in rock)		Any	Any	*18"	0.60m	0.60m
Drainage or irrigation ditch invert		Any	Any	30"	0.75m	0.80m

#### 4.0 Schedule and Cost

Costs relative to conducting a depth of cover survey may vary from year to year. In 2010, \$1000/km (\$1600/mi) was used as an estimated cost for traditional survey but should be confirmed by a preferred vendor.

### III. Data Collection Methodology

The following section describes the traditional methodology of collecting depth of cover information.

The company will use pipe locating and depth detection equipment to accurately locate and record depths for each pipeline in the right-of-way. The data to be collected at each location is as follows:

**Table 2: Data Collection**

Field	Units	Description
ID	N/A	Unique number assigned sequentially to each data point
Northing	Metres	UTM northing coordinate
Easting	Metres	UTM easting coordinate
Zone	N/A	UTM zone
Latitude	Decimal degrees	NAD83
Longitude	Decimal degrees	NAD83
Elevation	Metres	From Mean Sea Level
Depth	Metres	Distance from top of pipe to ground
Probe depth	Metres	Where measured
Pipeline number	N/A	Number assigned to identify each pipeline
Pipe feature	N/A	Such as: pig trap, valve, rectifier, etc.
Topo feature	N/A	Such as: ditch, road, creek, river, etc.
Detailed feature	N/A	Specific location of the shot recorded, such as: centerline of road, road shoulder, road ditch
Land use	N/A	Park, farming, grazing, urban, etc.
Notes	N/A	Additional descriptions or comments where applicable, such as: too deep
Date	N/A	When each shot was recorded

### 1.0 Location and Frequency of Data Collection

Under typical right-of-way conditions, the depth and position of the pipe will be identified and recorded every 50m. In the event that a depth of cover is less than that identified in Table 1, the company will conduct additional monitoring at intervals of 15m. This additional monitoring will take place over the 50m distance on either side of the location where the depth is deficient, as per Table 1. If the frequency of data collection is greater than every 50m, the risk of missing a deficient location is heightened. This is of particular concern in highly populated areas or areas of high activity.

Data will also be collected for the following features unless they are within 2m of the 50m interval:

**Table 3: Data Collection for Feature Types**

Field	Feature Type	Location of Data Collection
Topo feature	Paved road	Shoulders and ditches on either side of the road
Topo feature	Unpaved road	Centerline of road and ditches on either side
Topo feature	Railway	Ditches on both sides
Topo feature	Significant elevation change	At 2m intervals and at the highest and lowest elevation points. Significant ground elevation changes are defined as a change in elevation of more than 1m over 4m of pipeline right-of-way.
Topo feature	Ditch	Bottom of ditch
Topo feature	Creek	Center of creek
Topo feature	River	Within 2m of each shore line
Topo feature	Wetland	Within 2m of edge of wetland
Pipe feature	Fenced facilities	At the fence line on each side of facilities, such as valve sites, compressor stations, test stations. Only to be done if the facility is on top of the pipe.
Pipe feature	Pipe Appurtenances	On top of valves, pig traps, rectifiers.

In order to comply with Energy Resource Conservation Board (ERCB) regulation, watercourse crossings for ERCB regulated pipelines must be monitored annually. This could be achieved by analyzing inline inspection tool coordinate data in conjunction with a sonar profile of the bottom of the water crossing. As-built crossing drawings, if available, would also help with data quality verification.

## 2.0 Depth verification

The pipelines shall be manually probed to ascertain the exact depth at the following locations:

- At the beginning of each section of work, to validate the accuracy of and calibrate the field equipment. This must be undertaken at least twice per day.
- Where the depth of cover readings approach the minimum allowable limits, as shown in Table 1.
- Where there are multiple pipelines and/or utilities in the same or adjacent ROW, verification should be done at 50m intervals. This will permit post-processing techniques to compensate for the additional interference.

For small diameter pipelines or in areas of excessive depth of cover where probing is not feasible, further evaluation shall be performed to determine whether exposure by hand or hydrovac is needed to verify depth reading accuracy.

## 3.0 Survey methodology

Adequate survey control (monuments) will be used and/or established in order to define a consistent frame of reference. A national, provincial, or the company control network shall be used. Subsequently, raw survey data should be post-processed to correct for errors and to ensure collected coordinates are as accurate as possible. The process of collecting the data must be efficient, repeatable and documented.

## 4.0 Accuracy and quality assurance

The survey was initiated to accurately determine the depth of cover over the company's pipeline. For this reason, accuracy is of prime importance and the data will be accepted based on the following criteria:

- GPS locations: Horizontal coordinates must be accurate to a minimum of 1m; elevations must have a minimum accuracy of 2m.
- Depth measurements: 90% of the electronic readings must fall within 2% for probed depths less than 2m, excluding locations where pipe was not found by probing or where probing depths exceeded 2m. Excluded locations will not be considered as part of the statistical data.

In the first week of data collection, data must be checked by a spatial data specialist to ensure quality and proper methodology.

The company performing the survey must have a defined quality assurance process in place that is documented and followed to ensure data integrity.

## 5.0 Equipment

The equipment used to perform the survey shall have the following features:

- The pipe locator shall be accurate to within 5% for depths less than 2m.
- The GPS equipment shall be an electronic data collector RTK (Real Time Kinematic) unit.
- In utility corridors where it is difficult to receive accurate depth readings due to interference, alternate equipment or methodology must be used to obtain the data points by other means.

## 6.0 Survey timeframe

Surveys will be weather dependent and undertaken during time periods of the year when it does not impede landowners/tenants' ability to conduct their agricultural activities. Consideration should be given to not conducting surveys during the winter months when the ground is frozen or during summer months when farmer fields are fully occupied with crops.

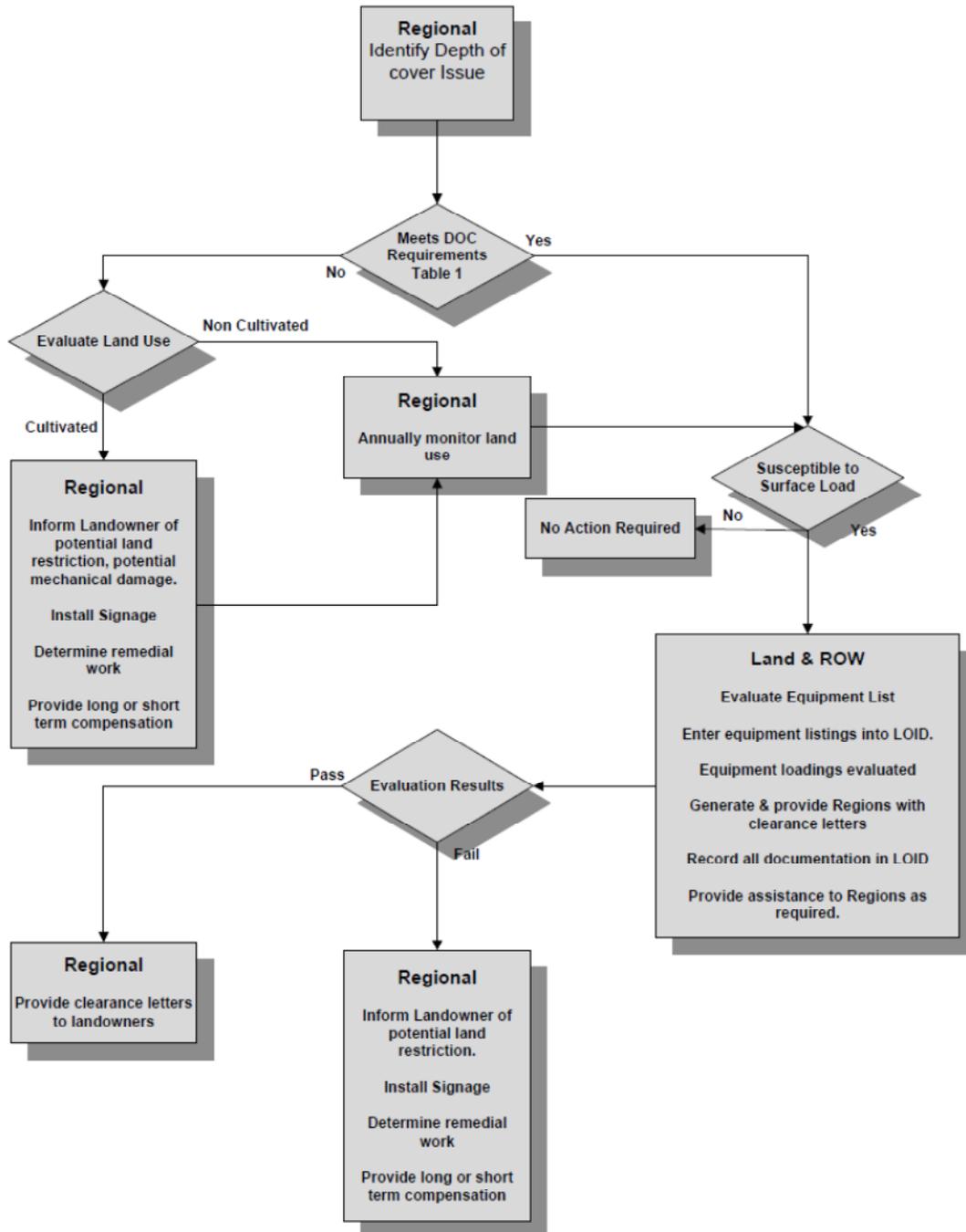
## 7.0 Land Access

The Region or Project Team is to determine the route to work site. Registered easement documents provide the rights for ingress/egress along the ROW for maintenance purposes; access may or may not be allowed on adjacent lands. Seven days' (Canada) three days' (US) notice should be given prior to access unless it falls outside of the terms of the easement agreement and formal access approval is needed. In both cases, landowner/tenant consent is desirable (see Section V). Regulatory and Environmental approval may also be necessary depending on the scope of work. Care must be taken to not impact areas with wildlife or vegetation sensitivities, such as areas that may be habitat for or used by Species at Risk (Canada) or Threatened Endangered Species (US). Prior to entry, landowners/tenants should be asked if herbicides and/or pesticides have been applied to the land. (For practices regarding weed management, please see Appendix.)

**IV. Evaluation Process**

The following flow chart outlines the process for evaluating depth of cover issues.

**Procedural Flow Chart RE: Depth of Cover Governance**



## V. Mitigation Measures

If locations are found where the depth of cover of the pipeline is less than indicated in Table 1 (or other particular depth of cover requirements, i.e. road allowances etc.) and the reduced depth interferes with the cultivation of a landowner or tenant's land or poses a safety concern, Regions will develop and prioritize an appropriate mitigation plan based on risk. If the reduced depth of cover prevents the landowner/tenant from crossing the pipeline with agricultural equipment (and the equipment is not being used in a manner that exceeds the manufacturer's specified load limits) and/or hinders the ordinary cultivation of the lands, Regions will implement mitigative measures to ensure the safe crossing of the landowner or tenant's farming equipment and practices over the pipeline.

With respect to cultivated lands and in accordance with our current landowner association agreements, company will pay compensation for any resulting crop loss or other direct damages related to its PDMP activities on the lands. For compensation values, please see the Appendix.

### 1.0 Depth of Cover Compensation (Land Use Restriction)

In these circumstances, the mitigative options may include, but are not limited to:

- Lowering the pipeline to achieve a satisfactory depth of cover
- Restoration of soil to a satisfactory depth of cover
- Restricted quasi-permanent land use (i.e. temporary workspace for two years)

In circumstances where the reduced depth of cover is not interfering with ordinary cultivation of lands, the mitigative options may include but are not limited to:

- Installation of protective mechanical barriers, i.e. concrete slab.
- Temporary, localized land use restrictions (with appropriate landowner/tenant compensation, if applicable). In areas where the depth of cover is an issue, fencing may be required. As an alternative to fencing, fiberglass composite warning signs (as shown below) may be used. Signs should be installed at intervals along the pipeline to clearly indicate where depth of cover is an issue and in a manner to accommodate the landowner or tenant's farming practices.
- Additional signage where public safety is not an issue and where warranted by land use. Fiberglass warning signs are flexible in only two directions (forwards and back) and should therefore be placed to accommodate the landowner or tenant's farming practices. Before installing signage, consult with the landowner or tenant.
- Self-impose temporary, voluntary pipeline pressure restrictions.
- No action, if depth of cover is not interfering with land use activities and does not pose a hazard to the public or the environment, based on risk.



These mitigation options represent the primary mitigation that should be explored to address the insufficient cover. Other options may be considered, and their justification from the evaluation (or engineering assessment) shall be documented. All mitigation activities shall be properly documented and recorded. The appropriate stakeholders shall be notified.

## VI. Communication with Landowners and Tenants

### 1.0 Prior to and during the survey

Prior to entering a landowner or tenant's property for the purposes of the PDMP survey or mitigation efforts, the company will make reasonable efforts to contact the affected landowner/tenant in regards to the work being commenced a minimum of seven days in (Canada) and three days in the US in advance via mail, telephone or other appropriate means. Upon contact, the company will review with each landowner/tenant the timeframe of the work and discuss site-specific issues and, as required, the implementation of appropriate mitigation measures.

Once field data has been verified, the company will notify the landowner or tenant within 5 working days to indicate whether an insufficient depth of cover issue poses an immediate or near-term safety concern to the pipeline or farm equipment. The notification will consist of a phone call and follow-up site visit of the specific areas in question. If necessary, such areas will be staked or fenced off to ensure the landowner/tenant is aware of the areas to avoid with their agricultural equipment.

Communication should also include the discussion of mitigation options in consultation with the landowner and where appropriate, the tenant. A report will be completed for the property in question indicating the specific areas of reduced depth of cover (i.e. map), strategy, and timing of implementing mitigation measures. Compensation paid to the landowner/tenant for crop loss and/or direct damages will be made in accordance with

current practices or negotiated agreements, as applicable. The company will ensure the mitigation of reduced depth of cover issues which either pose safety risks to the landowner/tenant or the pipeline, or which impact agricultural activity as detailed above. Other reduced depth of cover issues will be addressed on an as required, prioritization risk basis.

It is anticipated that the PDMP will not cause significant issues for landowners/tenants and will be comparable to our close interval surveys.

## VII. Communications with Internal Stakeholders

- 1.0 Pipeline Integrity: the Pipeline Integrity Mechanical Damage Management Plan (MDMP) includes a process for integrating depth of cover data collected through the PDMP program with In-line Inspection (ILI) data. The data integration facilitates identification of joints of interest that may require further assessment or excavation to confirm the presence of mechanical damage resulting from a third party contact with the pipeline.

Depth of cover data must be forwarded to Pipeline Integrity for all areas identified as not meeting the depth of cover requirements outlined in Table 1. The data should be forwarded to the Mechanical Damage Management Plan lead or Subject Matter Expert (SME).

- 2.0 Operational Risk Management: the Mainline Risk Assessment Model incorporates depth of cover as an input for threat analysis. The data assists in identification of locations more vulnerable to mechanical damage resulting from a third party contact with the pipeline.

All depth of cover data must be forwarded to Operational Risk Management for all areas identified as not meeting the depth of cover requirements outlined in Table 1. The data should be forwarded to the Data Collection team lead.

## VIII. Conclusion

The PDMP is an important program to further enhance the company's damage prevention efforts along its buried assets. Depth of cover monitoring is a core component to ensure our buried assets are protected from competing land use activities. From a safety perspective, adequate cover and monitoring play an important role in protecting the public, environment, pipeline assets, landowners and their respective equipment.