Protecting Natural Gas Pipelines from Geo-Hazards Exacerbated by a Change in Climate*

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Abstract

NW Natural operates over 600 miles (1000 km) of high pressure natural gas transmission pipelines in western Oregon. 235 miles (392 km) of these pipelines traverse the Oregon Coast Range Mountains. The combination of high winter rainfall, deep weathering, ancient landslides, and disturbed drainage systems can produce geo-hazards, such as erosion and landsliding which may affect the safe operation of a pipeline. In the Pacific Northwest rainfall appears to occur in “wet” or “dry” cycles of 20 to 25 years duration. The majority of NW Natural’s Coast Range transmission pipelines were constructed in the late 1960’s near the end of a “wet” cycle. During the subsequent “dry” cycle of 20 plus years, pipeline Rights of Way (ROW) were stable. In the mid-1990’s, the climate switched to a “wet” cycle. As a consequence, ROW’s, particularly when impacted by intense Pacific storms, became much more susceptible to geo-hazards. NW Natural’s response to this “climate change” was to create a risk-based “Geo-Hazard Program” for their transmission pipeline system. The program entails identification, assessment, remediation and ongoing monitoring of geo-hazards. Key to this program was the formation of a team, which consisted of pipeline engineers, geotechnical professionals, and pipeline field personnel that had the responsibility of addressing geo-hazard issues. Another important element involved training ROW maintenance personnel to recognize geo-hazards, report/repair them, and collect monitoring data. Rainfall “triggers” were established to initiate immediate inspection of pipeline ROW’s. The Geo-Hazard Program exceeds the minimum requirements of Federal pipeline safety regulations, 49 CFR, Part 192. The program was voluntarily initiated by NW Natural in a partnership with the Oregon Public Utility Commission.
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Pipelines
Geo-Hazards + Climate Change

A Discussion Of The Evolution Of NW Natural’s Geo-Hazard Program

OR

How A Climate Change Drove A Change In Pipeline Operations
NW Natural

- Investor Owned LDC
- Incorporated 1859
- Serves NW Oregon/SW Washington
- 650,000 Customers
- 13,000 mi. of Distribution Mains
- 609 mi. of Transmission Pipelines
- 235 mi. In Areas Prone to Geo-Hazards
Location, Location, Location

Portland
Seattle
Newport
Astoria
OREGON
WASHINGTON
Salem
San Antonio
Definition Of Geo-Hazard

Any Threat To Pipeline/ROW Integrity

Triggered By:

- Rain: Common - Daily, Hourly, Seasonal
- Volcanoes: Rare - Centuries to Millennia
- Earthquakes: Rare - Unpredictable
- Human: Common – Unpredictably Predictable
Transmission Pipeline Inspection Requirements Required By PHMSA (49 CFR Parts 191, 192)

**Class 1 & 2:** Patrol Once Each Calendar Year NTE 15 Months

**Class 1 & 2:** Leakage Surveys - Once Each Calendar Year NTE 15 Months

**Unusual Conditions:** Continuing Surveillance Procedure

**Reporting Requirement:** If a Threat to the Serviceability of a Pipeline is Detected
NW Natural’s Pre-1999 Transmission Pipeline ROW Inspection Routine

• Patrolled Each Pipeline Four Times A Year
• One Patrol Was A Leakage Survey
• Normal ROW Maintenance
  – Vegetation Control/Brush Clearing
  – Culvert Repair, Marker Poles
  – Police Human ROW Encroachment
  – Geo-Hazards: Local Flooding – Bridge Crossings
Water Is The Major Geo-Hazard Driver In The Pacific Northwest

NW Oregon Average Annual Precipitation 1971 -2000

Map copyright (c) 2006 by the PRISM Group and Oregon Climate Service, Oregon State University.
Long Term Wet-Dry Cycles in Oregon

George H. Taylor, Oregon Climate Service

http://www.ocs.oregonstate.edu/index.html
Threats To The Pipelines Directly As A Result Of Late 90’s Increased Rainfall

- Slope Movement
- Deflection of 20” Pipeline
- Exposed Pipe in Stream/River Crossings
- Slope Movement
Rainy Season Of 1998/99

Third Consecutive Very Wet Rainy Season

Portions of Two Large Dormant Landslides Reactivated

Two Transmission Pipelines Threatened
Rainy Season Of 1998/99 (cont.)

NW Natural’s Response:

- Formed Ad Hoc Geo-Hazard Team
  - Chief Engineer
  - Geologist/Geotechnical Engineer
  - Field Construction Personnel

- Developed and Instituted **Investigation**, **Mitigation** and **Monitoring** Procedures for Affected Areas
March 1999 George Taylor, Oregon State Climatologist, Published His Paper on Wet Dry Cycles in Oregon

Realization by NW Natural That Going Forward ROW Maintenance Needed to be Enhanced

It Would be Prudent to be Proactive in Identifying and Mitigating Geo-Hazard Risks to Pipeline Safety
Spring - 1999

First Steps:

Acquired New Aerial Photography Over ROW’s
Interpreted Specifically for Geo-hazards

Contracted With Geo-technical Firm to Conduct
Site Specific Studies on 19 Locations Considered
“Priority”
Then The 1999 Thanksgiving Weekend Rain Event Hit

Pipeline Location

Water Year Precipitation, Oregon Coast Division, 1986-1998
As A Result NW Natural Quickly Formalized It’s Geo-Hazard Program

Developed “Priority List” of Areas at Risk of Becoming Chronic Mitigation Sites

Began to Implement Site Specific Mitigation

Trained Field Personnel to Recognize Geo-Hazards
Instituted Risk Based Field Monitoring Schedule
Schedule Defined by Geo-Technical Risk

- Low > 50 ft. Low Potential for Movement
- Moderate < 50 ft. Rapid Movement Unlikely
- High < 50 ft. Active Landslide

Instituted Rainfall Triggered ROW Inspection

Instituted Immediate Geo-technical Investigation of New Events
Patrol Triggers Unique to NW Natural
Pacific NW Rainstorms “Bulls Eye”

Rainfall Triggered ROW Inspection Criteria

Immediately after 4 or more inches in 48 hrs.

Immediately after 6 or more inches within a 7-day period

Immediately after a rain on snow event

Rainfall is Recorded Daily From Key Locations
NW Natural’s Geo-Hazard Program

Triggered by a Long Term Weather Cycle

Driven by Inherent Corporate Safety Philosophy

Self Designed – “Prudent Operator”

Self Imposed – Exceeds 49 CFR 192

Absolutely Not Possible Without the Support of:
NW Natural Senior Management and the
Oregon Public Utility Commission
NW Natural’s Formal Geo-Hazard Program
And The Oregon Public Utility Commission

Enhanced Pipeline Safety Program 2001 - 2006

Annual Rate Treatment for Investigation, Mitigation
and Monitoring of Geo-Hazard Threats to Pipeline Safety

Provided the Bridge to Present Day Program Funding
In Summary - NW Natural’s Experience With A “Normal” Climate Change

Taught Us To:
Assess The Geo-Hazard Drive Mechanisms
Form A Responsible Team
Be Proactive – Analyze And Anticipate

Which Led To A:
Fundamental Company Culture Change
Thank You