QUEST – Risk Management & Monitoring

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Quest - Overview

- One million tonnes CO2 capture per year for 25 years - roughly 1/3 reduction of Scotford Upgrader direct CO2 emissions
- JV among Shell (60%); Chevron (20%); and Marathon (20%)
- Project Approval – Sept 2012, Construction completed Spring 2015, Commissioning & start-up underway

- CO2 transported by 12 inch pipeline to storage, 65 km north of the Upgrader
- 3 injection wells, 3 deep monitoring, 9 ground water monitoring wells and associated monitoring.
Subsurface Risk & Uncertainty Management Process

Uncertainty Management
- Data Gathering
- Analysis
- Modeling

TESLA

Risk Management process

EASYRISK

Bowties

ALARP risks

Risk Based MMV Plan

Independent External Review
MMV Iterative Design Process

- Risk-Based
  - Verifies geological & engineered safeguards
  - Reduces containment risk to ALARP (As Low As Reasonably Practicable)

- Site-Specific
  - Tailor made monitoring
  - Informed by appraisal data

- Diversified
  - Multiple independent monitoring systems
  - Multiple independent safeguards

- Adaptive
  - Responds to observed performance
  - Contingency plans in place

Source: Adapted from CO2Qualstore Report (DNV, 2009)
Quest Monitoring Plan Outline

Atmosphere
- LightSource Laser CO2 Monitoring
- Eddy Covariance Flux Monitoring

Biosphere
- CO2 Natural Tracer Monitoring
- CO2 Flux and Soil Gas
- Remote Sensing (Brine & NDVI)

Hydrosphere
- Shell Groundwater Wells: Continuous EC, pH
  Discrete Chemical and Isotopic Analysis on water and gas
- Private Landowner Groundwater Wells (discrete chemistry and Isotopes on water and gas)

Geosphere
- Time-Lapse Walkaway VSP Surveys
- Time-Lapse 3D Surface Seismic
- InSAR

Deep Monitoring Wells
- Downhole Pressure & Temperature (DHPT) above Storage Complex (CKLK Fm)
- Downhole Microseismic Monitoring

Injection Wells
- Injection Rate Metering, RST Logging, Temperature logging
- DHPT, Well Head PT, Distributed Temperature and Acoustic Sensing, Annulus Pressure Monitoring, Wellhead CO2 Sensor, Mechanical Well Integrity Testing, Operational Integrity Assurance

CBL, USIT

Time (years)
- 2010
- 2015
- 2020
- 2025
- 2030
- 2035
- 2040
- 2045
- 2050
Shell has a mature risk management process which has been applied to Quest that provides an assessment/management of risk which is a key input to project decisions.

This has resulted in the development of a risk based, site specific MMV plan.

To date, the data modelling and acquisition has significantly reduced subsurface uncertainty, while site selection and injection plan has already significantly reduced containment risks.