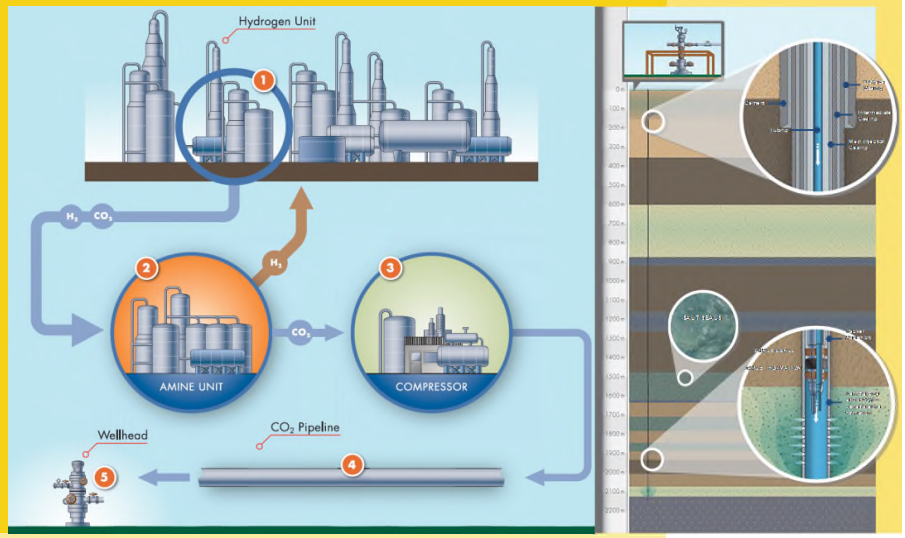
QUEST CCS PROJECT

CPANS Luncheon

Edmonton- Dec 5th, 2014



Chevron

Marathon Oil

Sean McFadden– Quest Sequestration Manager

LOCATION

- Capture plant located in Fort Saskatchewan, approx 50 km N.E. of Edmonton

THE ATHABASCA OIL SAND PROJECT (AOSP)

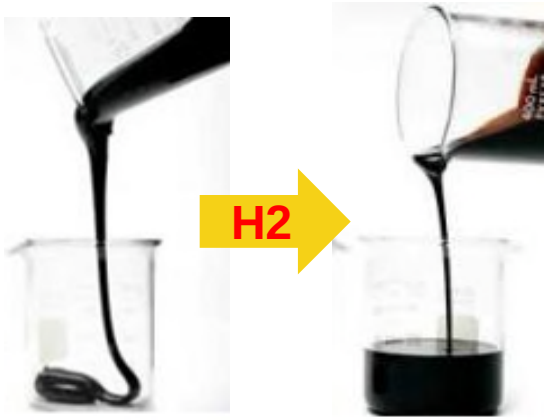
Muskeg River Mine

Corridor Pipeline

Scotford Upgrader

Scotford Refinery (Shell only)

Bitumen

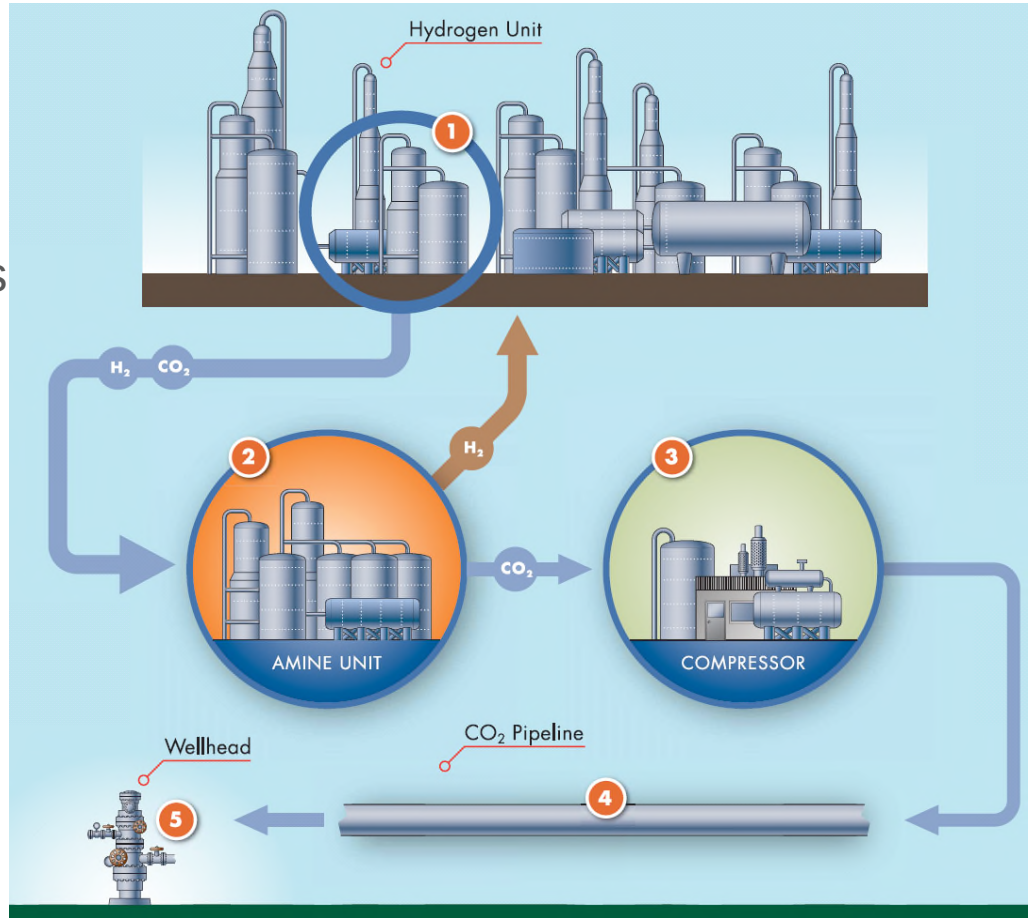


Bitumen to Synthetic crude (255,000 bpd)

Capture at the Scotford Upgrader from 3 Hydrogen Manufacturing Units

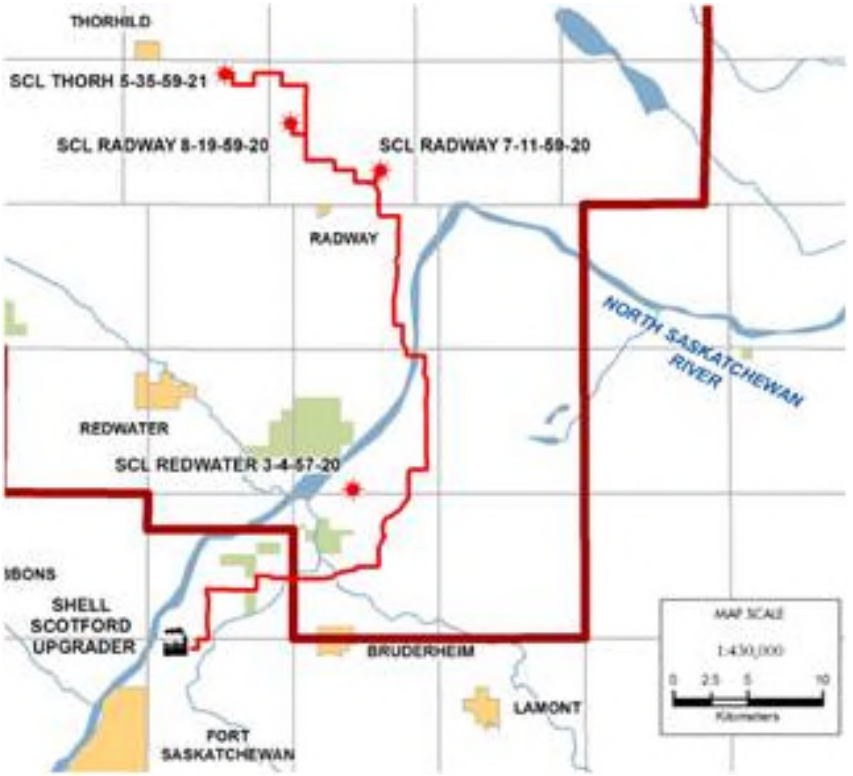
GENERAL FEATURES

- Quest CCS Project - fully integrated CCS (capture, transport & storage)
- One million tonnes CO_2 per year capacity for 25 years
- Equiv to emissions from175,000 cars
- JV among Shell (60%); Chevron (20%); and Marathon (20%)
- 35% reduction of Upgrader CO_2 emissions
- Project Approval – Sept 2012
- Start Injection Qtr1-2-2015

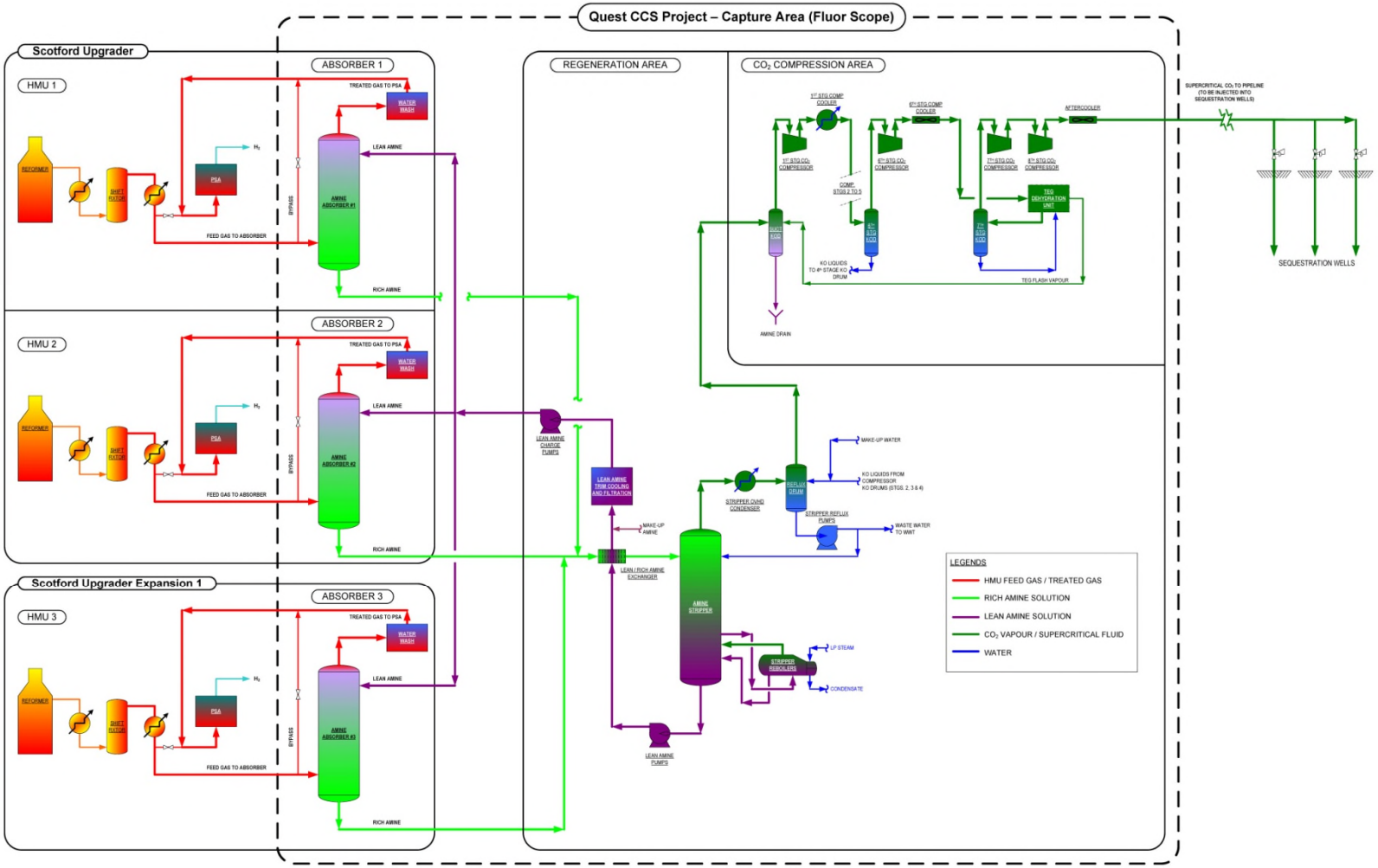


PIPELINE & WELLS

- CO_2 transported by 12 inch pipeline to storage, with 6 inch laterals
- Pipeline to 65 km north of the Upgrader
- Route selected to meet stakeholder requirements:
  - 28 km follows existing ROW
  - Drilled under North Saskatchewan River
  - 30+ re-routes to accommodate landowner wishes
- 3 injection wells, 3 deep monitoring, 9 ground water monitoring wells and associated monitoring.

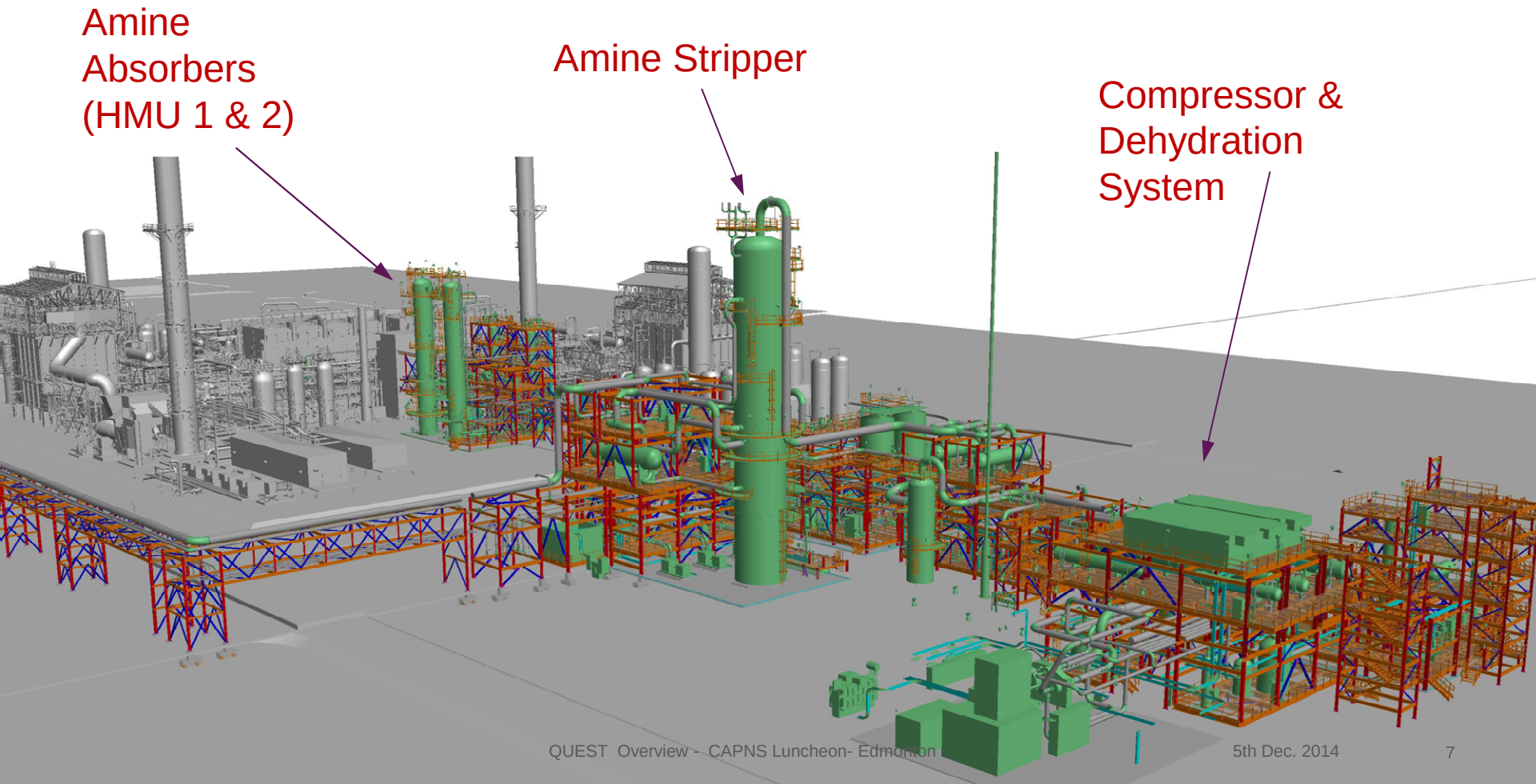


CAPTURE - DESIGN

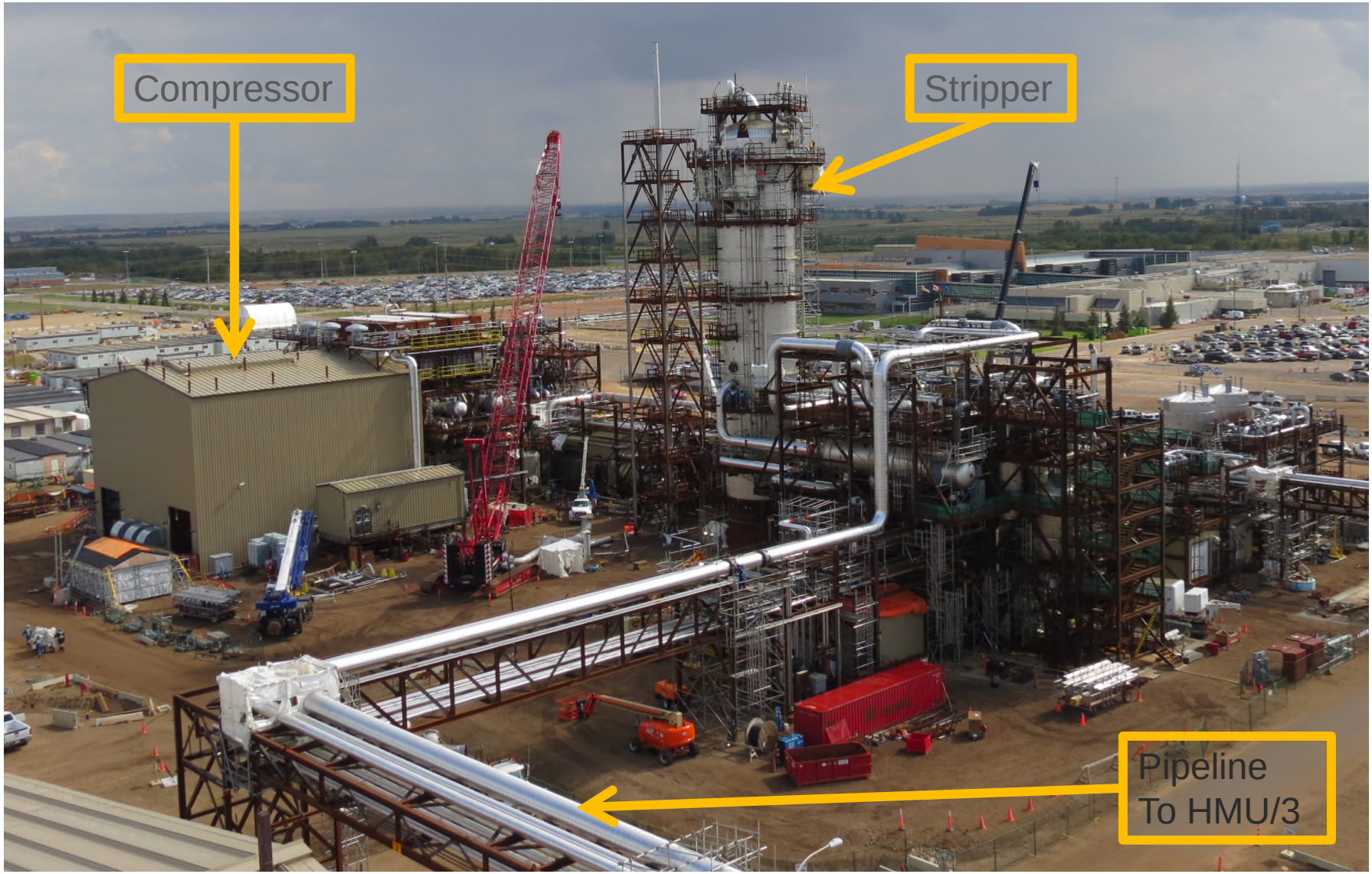


- Shell ADIP-X Amine process (99%+ pure CO_2),1.2 Mtpa capacity
- Multistage centrifugal compressor to 8.5 – 14 MPa (supercritical state)
- TEG dehydration unit, CO_2 with 4-6 lbs/MMscf

CAPTURE AND COMPRESSION UNIT



Capture modules set – Sept 2014

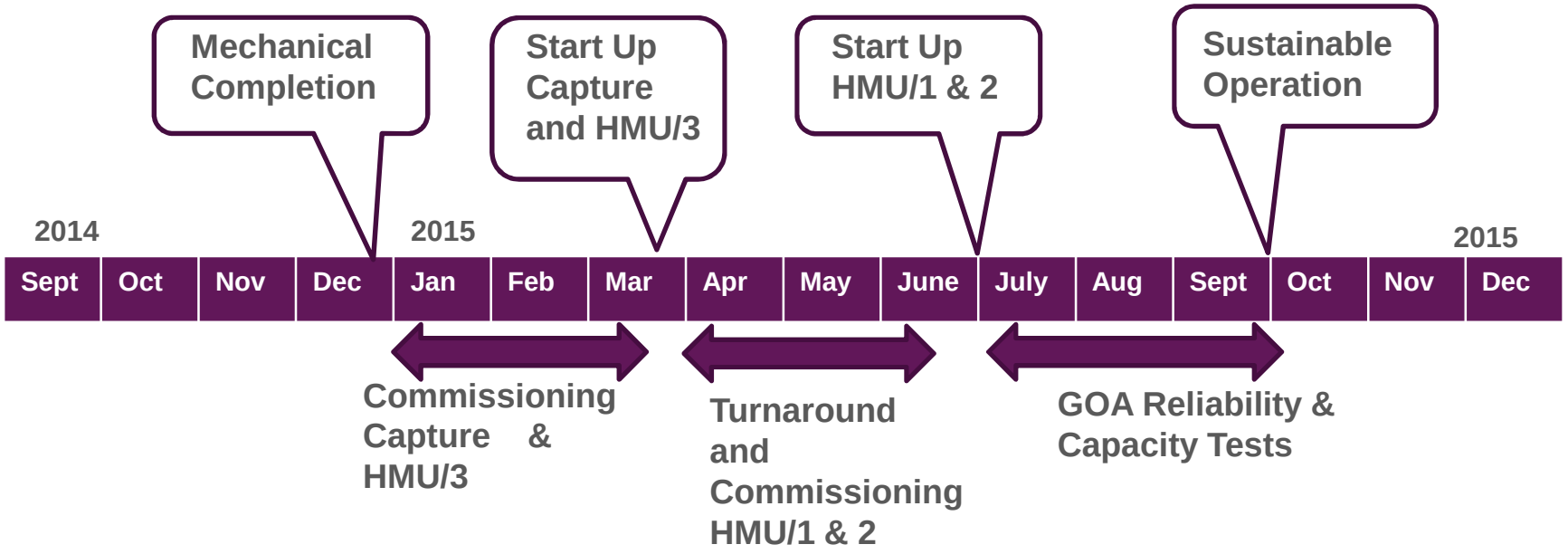


HMU 1& 2 module tie in work – Sept 2014

LBV 2 and solar panels - August 2014

Wellsite 5-35

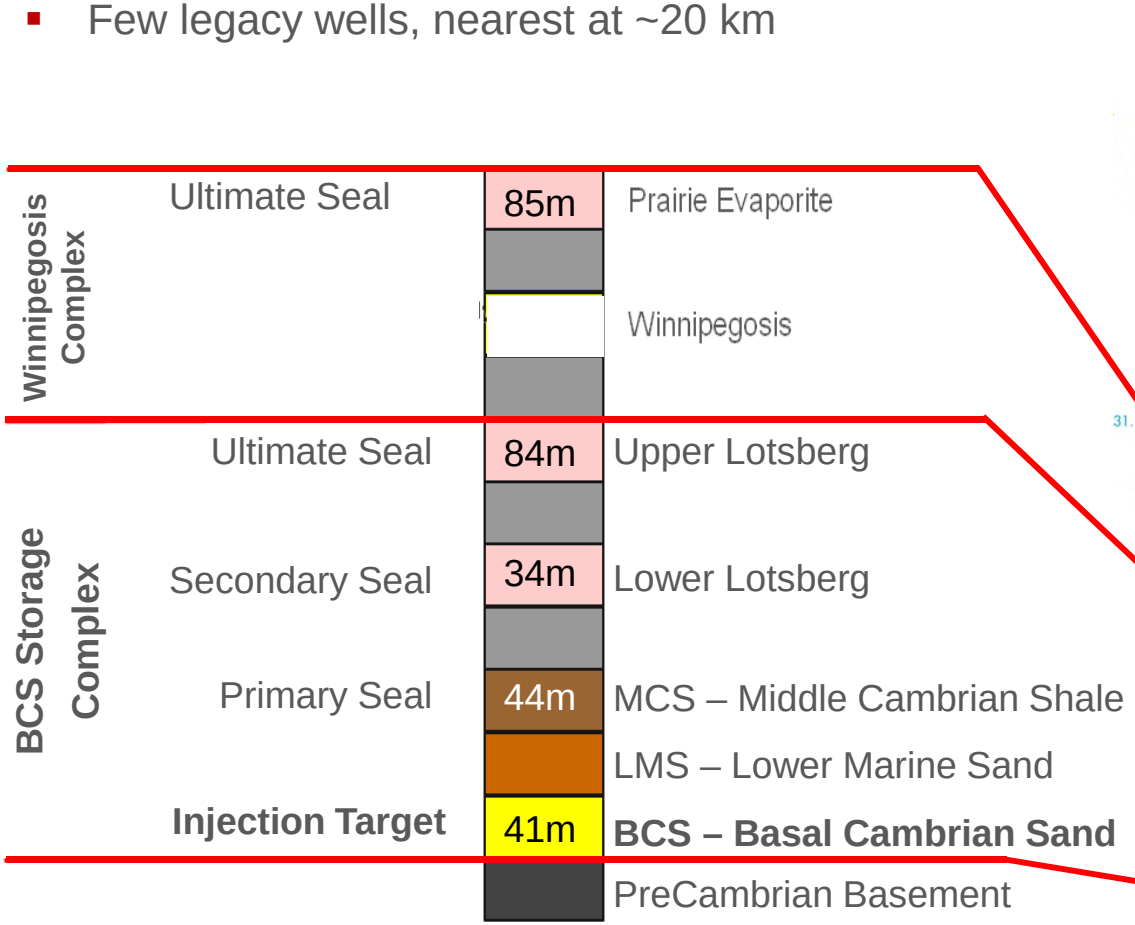
Timeline To Sustained Operations

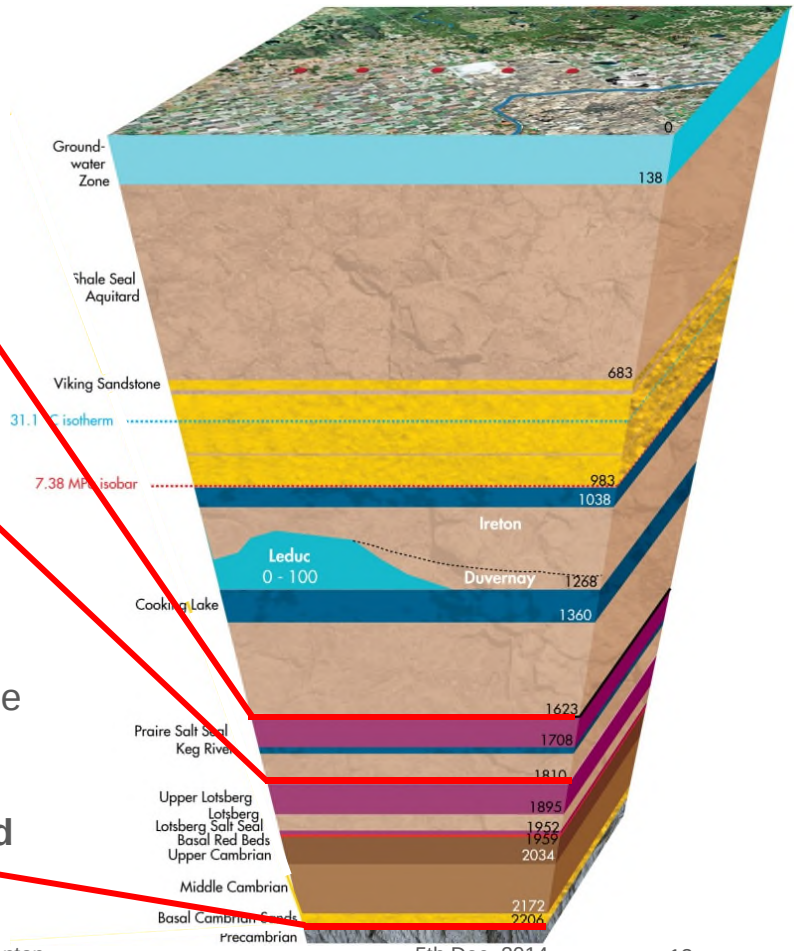


STORAGE - SUBSURFACE

BCS Storage Complex

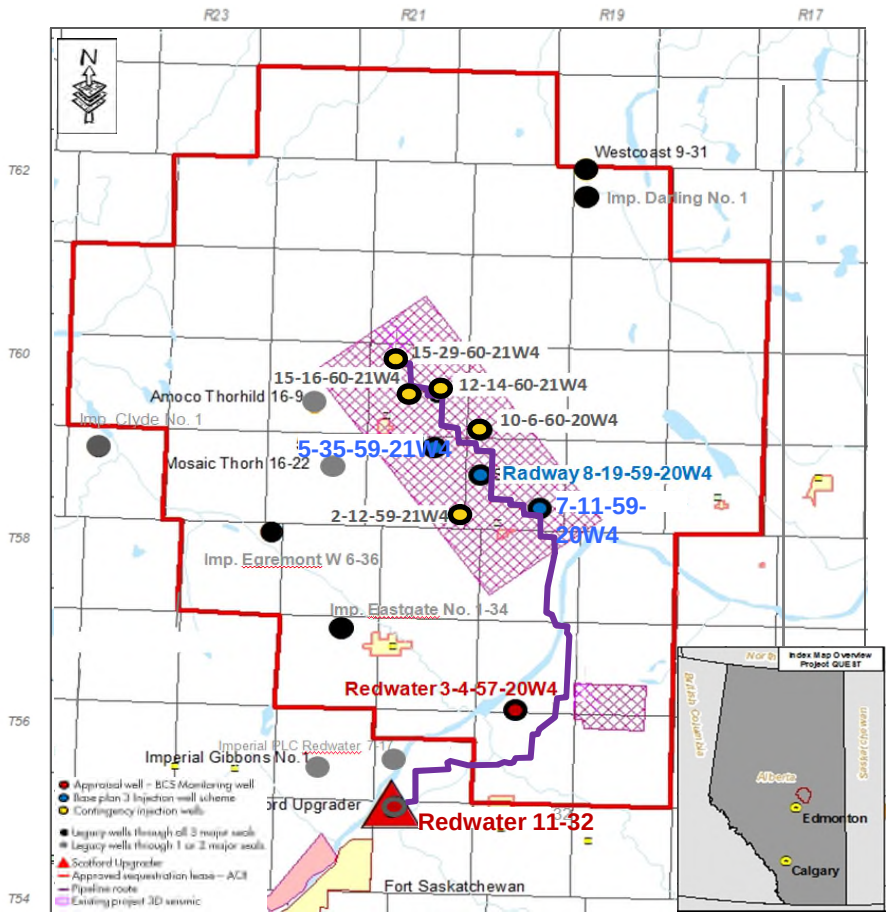
- Deep saline aquifer (~2km), porous sandstone (Por~16%, K~0.5-1.0 D)
- Multiple continuous seals to minimize containment risk
- No significant faulting visible from wells or seismic
- Well below hydrocarbon bearing formations(<1200m) and potable water zones (<200m)
- Few legacy wells, nearest at ~20 km



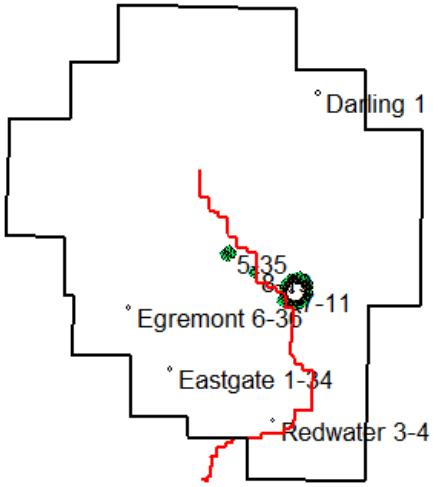


STORAGE – SEQUESTRATION LEASE AREA

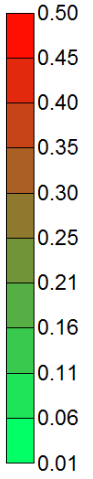
Sequestration Lease area=3670km^2



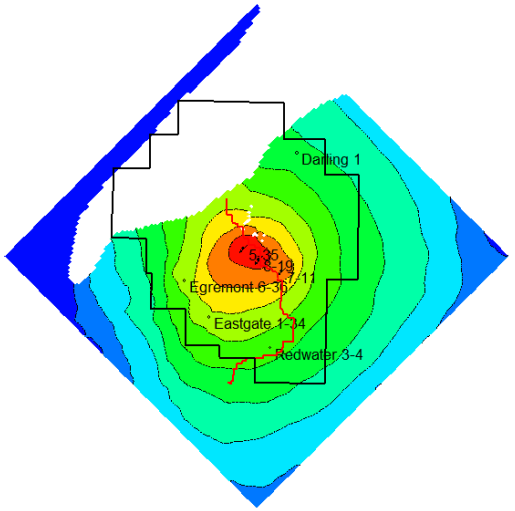
2040 – End of Injection

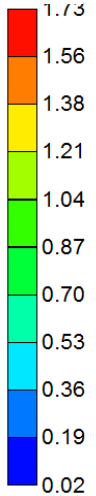


CO2 Saturation



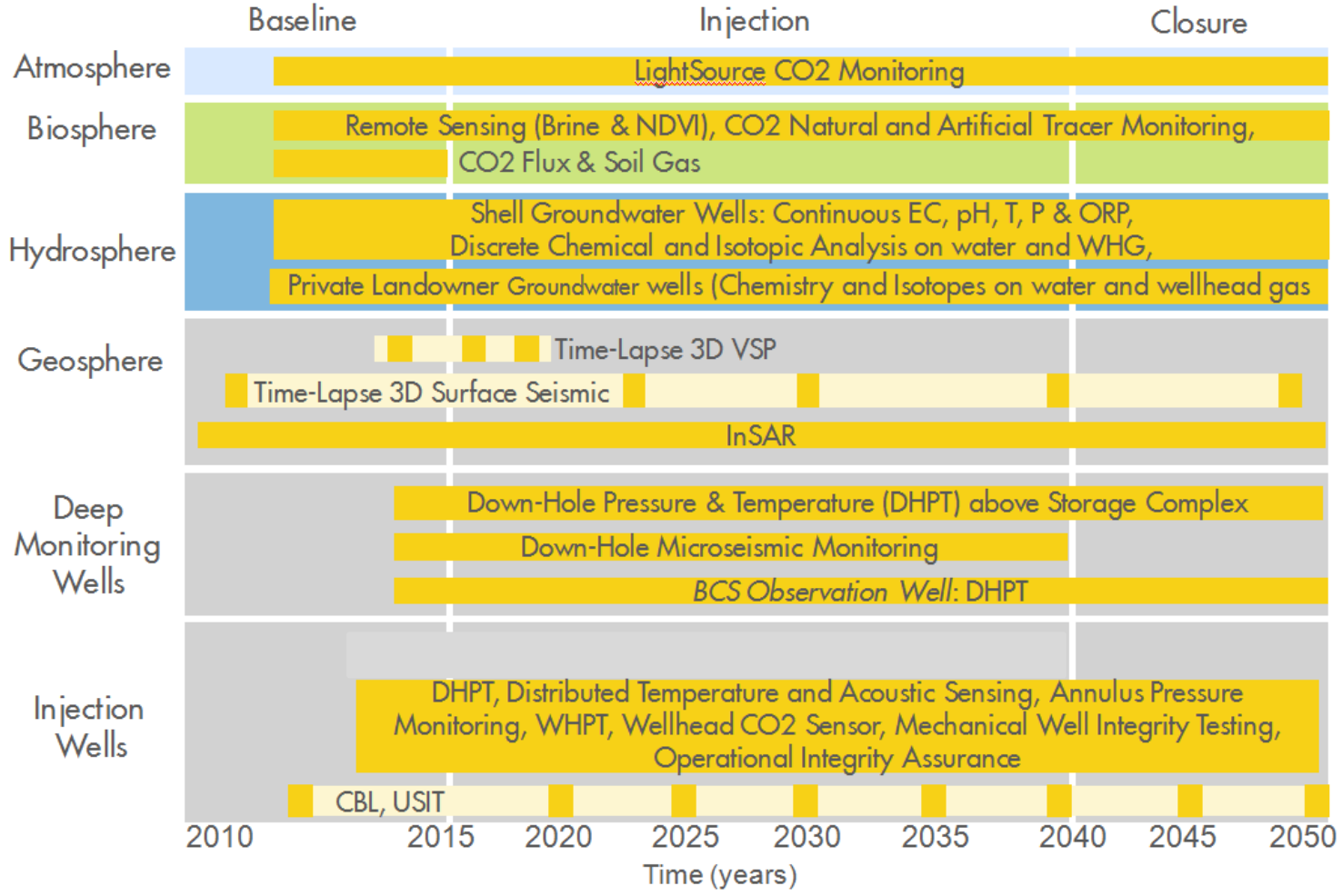
Pressure





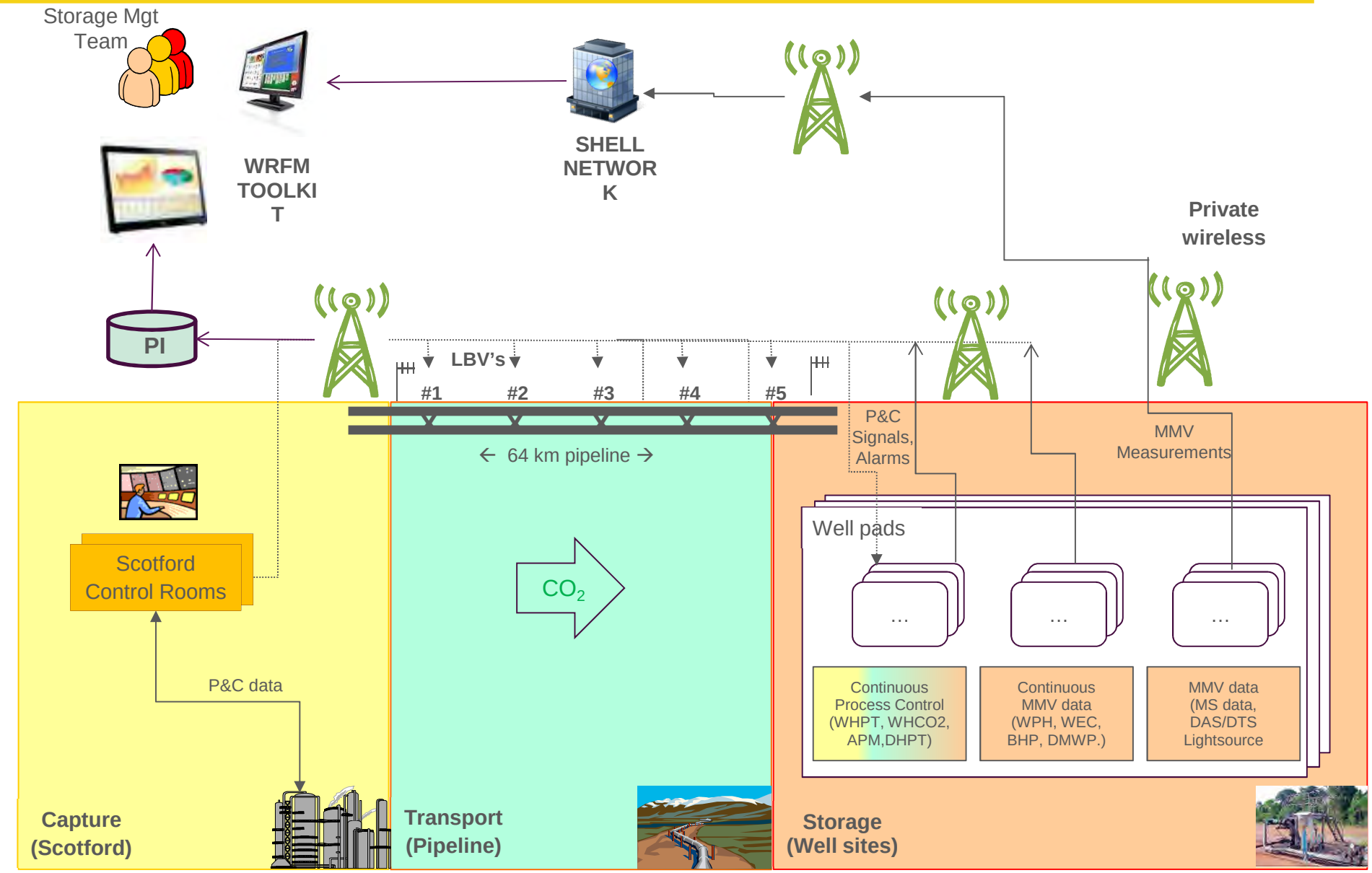
- Pore space area required to ensure no pressure interference

MMV - MEASUREMENT , MONITORING and VERIFICATION PLAN

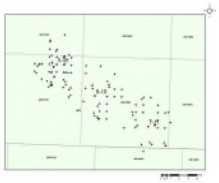


- Comprehensive plan developed – All domains from Geosphere to Athmosphere and entire lifecycle
- Independently (DNV) certified MMV and storage plan

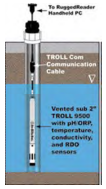
MMV Infrastructure



MMV Baselining - Hydrosphere



Up to 200 Local Landowner Wells within the Lease area



9 Project Ground Water Monitoring Wells on wellpads

Discrete GW well sampling (Landowner & Project Wells)

Sampling event	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Q4-2012											■	
Q1-2013			■	■								
Q2-2013						■						
Q3-2013								■				
Q4-2013										■		
Q1-2014		■										
Q2-2014					■							
Q3-2014								■				
Q4-2014											■	

Continuous GW well sampling (Project Wells only)

Sampling event	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2013			■	■	■	■	■	■	■	■	■	■
2014	■	■	■	■	■	■	■	■	■	■	■	■

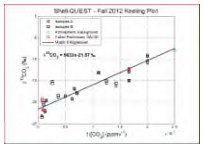
Studies

AITF study	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2013				start	■	■	■	■	■	■	■	interim report
2014	■	■	■	■	■	■	■	■	■	■	■	final report

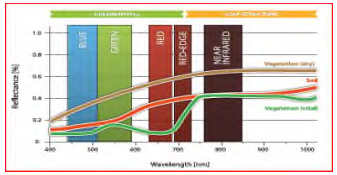
■ completed
■ planned

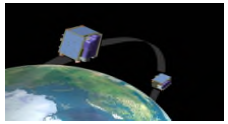
MMV Baselining - Biosphere

Soil Gas Conc./Flux

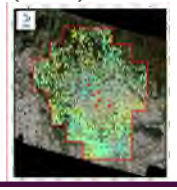


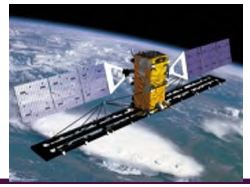
MIA-OPTICAL REMOTE SENSING for Plant Health





RADAR REMOTE SENSING for Salinity (SAR) & Surface Deformation (INSAR)





Soil Gas/Flux Sampling & Remote Sensing Calibration Data Acquisition

Sampling event	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Q4-2012												
Q1-2013			no soil gas									
Q2-2013												
Q3-2013												
Q4-2013												
Q1-2014		soil gas										
Q2-2014												
Q3-2014												
Q4-2014												

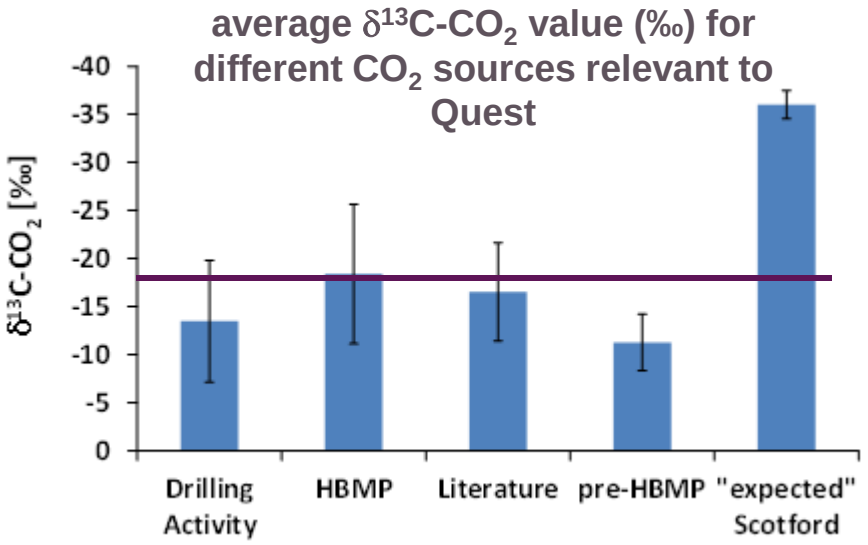
Studies

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
University of Calgary												
2013			start	phases 1, 2 & 3								
2014	final report				start	phase 4		final report				
Scotford Gas												
2013								start				
2014												
PFC Tracer												
2012			start									
2013		Review Report										
2014					final report							

completed
planned

‘Natural’ inherent tracer assessment: $\delta^{13}C$ – isotopic analysis

- Determined $\delta^{13}C$ for various CO_2 sources within Quest SLA
- Samples taken from sampling point at Scotford Upgrader closest to Quest capture infra-structure
- Expected injection gas (“expected” Scotford) distinct relative to background CO_2 sources in Quest SLA
- Laboratory Work and Modelling studies at the University of Calgary support $\delta^{13}C$ for MMV purposes



Recent Field activity : In-situ $\delta^{13}C$ – CO_2 measurements in collaboration with Shell Technology and Innovation group

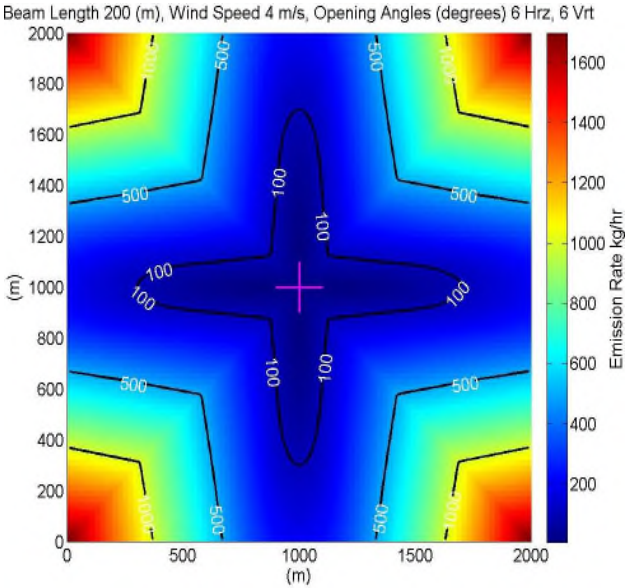
MMV Baselining - Atmosphere

LIGHTSOURCE / Eddy Covariance

- Carried out a controlled release test in Sept 2013
  (results indicate a lower sensitivity due to background effects)
- New contract with University of Vic. for processing EC data
- Second larger controlled release test planned for Sept 2014

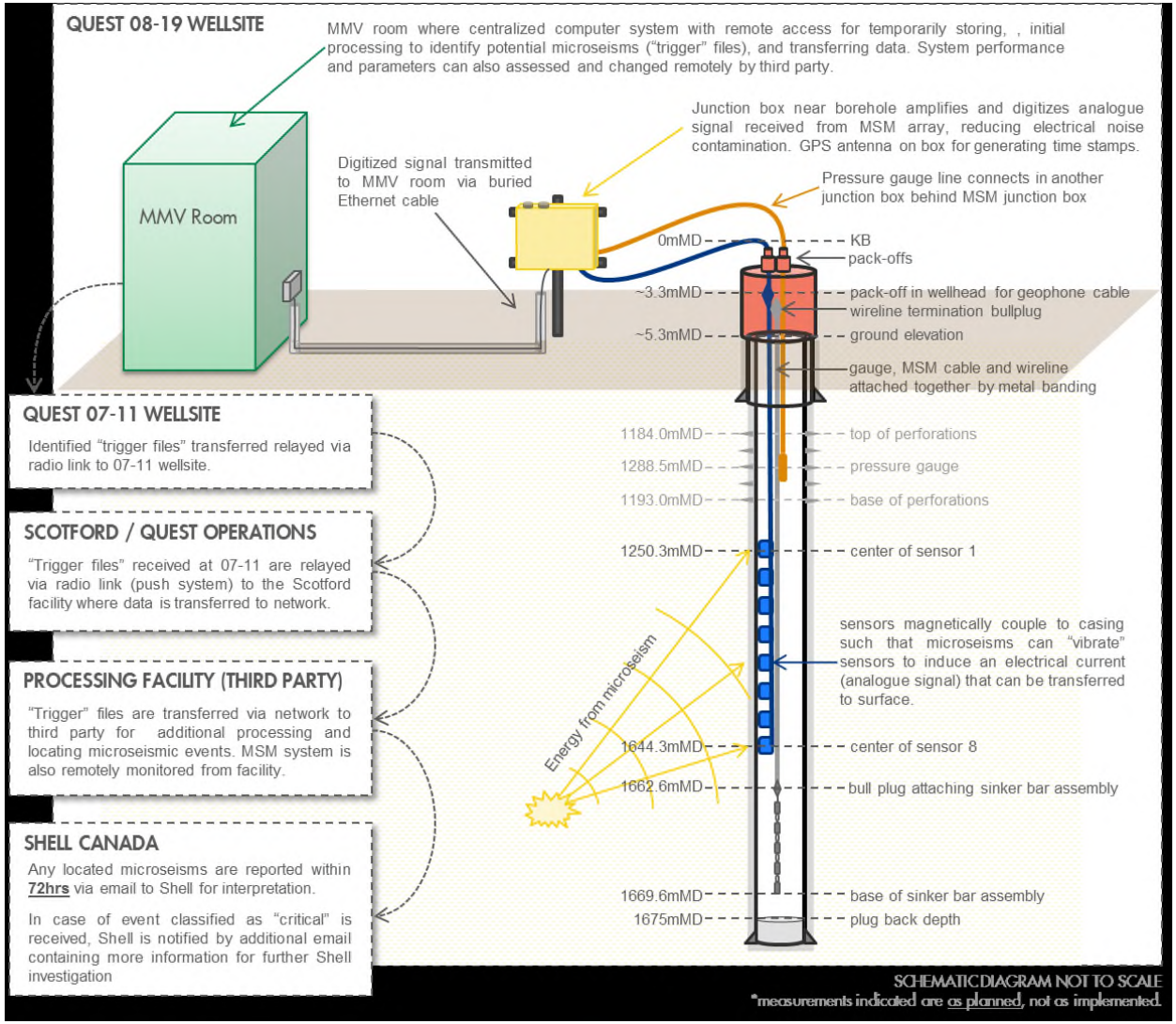
New Detection Limits based on Sept 2013 Release test

On well Pad - **45 kg/hr (435 tons /annum or 0.04 %)**
1km from wells - **800 kg/hr**



Minimum detectable CO_2 source emission on 2km x 2km grid

MMV Baseling – Geosphere - MicroSeismic



Objectives

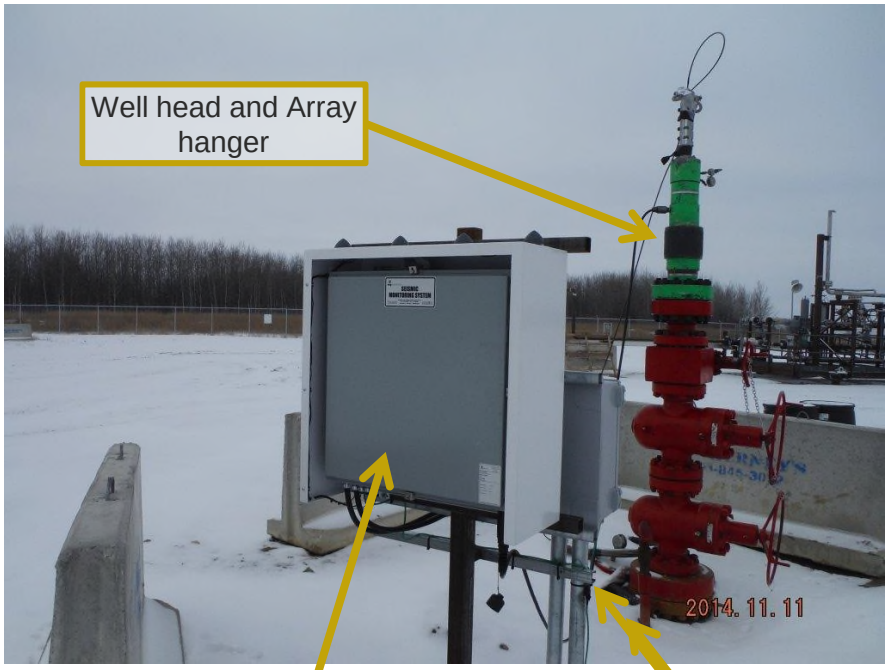
- Seal Integrity (fracturing)
- Induced Seismicity (fault reactivation)

Status

- Installed at the deep monitoring well at 8-19 and operational since 7th Nov.

MMV Baseling – Geosphere - MicroSeismic

Micro- Seismic Array - Surface Equipment



Well head and Array hanger

Junction box with near borehole amplifies and digitizes analogue signal received from MS array

Conduit with Ethernet and power to MMV room

Modem for real time data transmission

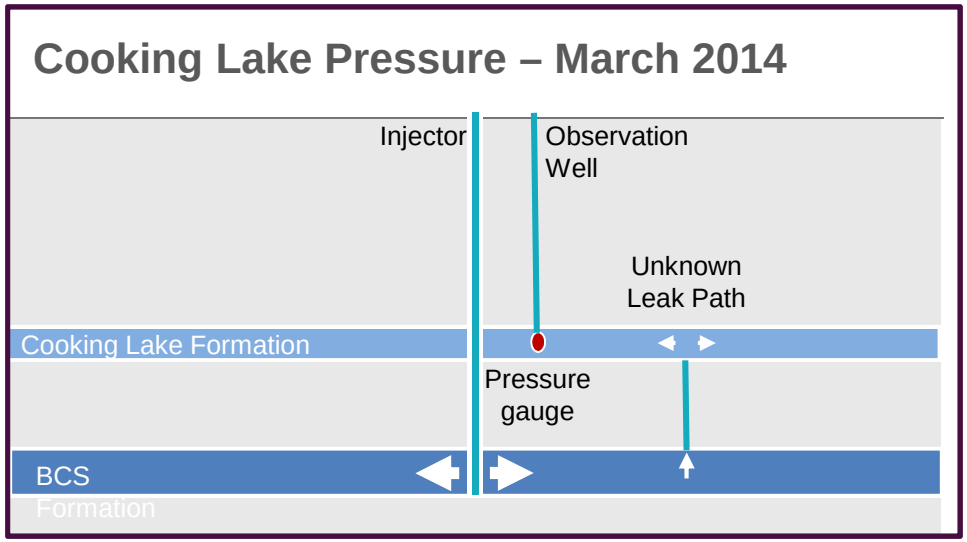
Smart UPS

MS computer with watchdog

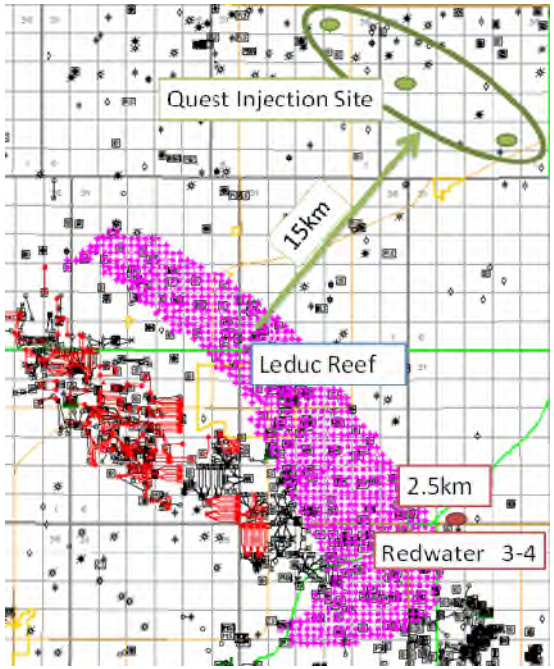
MMV Baseling – Geosphere - MicroSeismic

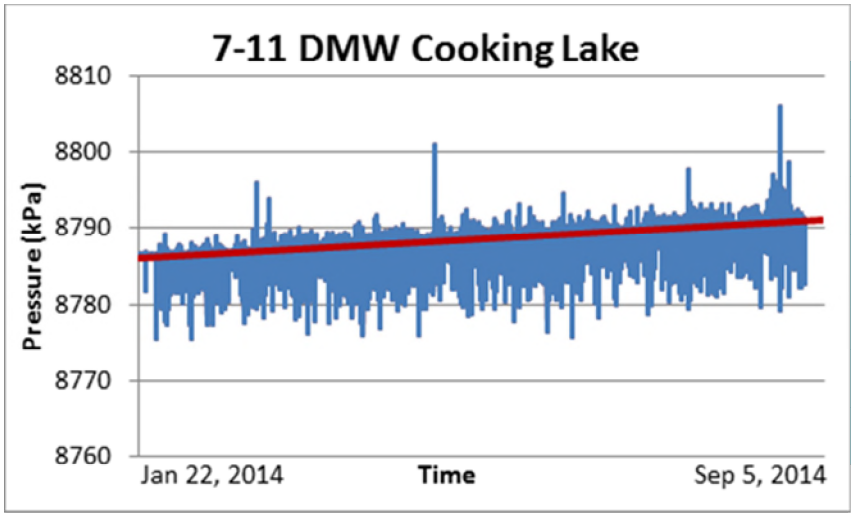
Date	# of Triggers	# *Auto Triggers*	# Locatable Events	# Single Phase Events	# Acoustic	# Noise	# Surface	# Electrical Spikes	Hammer _Tap Test
06-Nov-14	142	7	0	0	0	135	0	0	
07-Nov-14	161	22	0	0	14	123	0	0	2
08-Nov-14	32	24	0	0	8	0	0	0	
09-Nov-14	89	24	0	0	5	60	0	0	
10-Nov-14	26	24	0	0	2	0	0	0	
11-Nov-14	31	24	0	0	3	4	0	0	
12-Nov-14	29	24	0	0	3	2	0	0	
13-Nov-14	623	23	0	0	0	600	0	0	
14-Nov-14	45	24	0	0	3	18	0	0	
15-Nov-14	311	24	0	0	9	278	0	0	
16-Nov-14	701	24	0	0	1	676	0	0	
17-Nov-14	488	22	0	0	56	406	0	0	4
18-Nov-14	40	24	0	0	1	15	0	0	
19-Nov-14	37	24	0	0	8	5	0	0	
20-Nov-14	283	24	0	0	225	34	0	0	
21-Nov-14	34	24	0	0	0	10	0	0	
22-Nov-14	28	24	0	0	1	3	0	0	
23-Nov-14	29	24	0	0	0	5	0	0	
24-Nov-14	31	24	0	0	0	7	0	0	
25-Nov-14	25	24	0	0	0	1	0	0	

MMV Baselining – Geosphere – Pressure



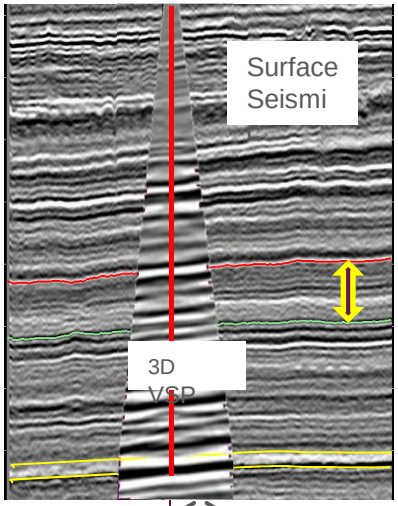
- Recording pressure data in two deep monitoring wells since March 2014
- Shows a gradually increasing trend – decreased production in the Leduc field
- Application for approval to perforate Redwater 3 -4 pending





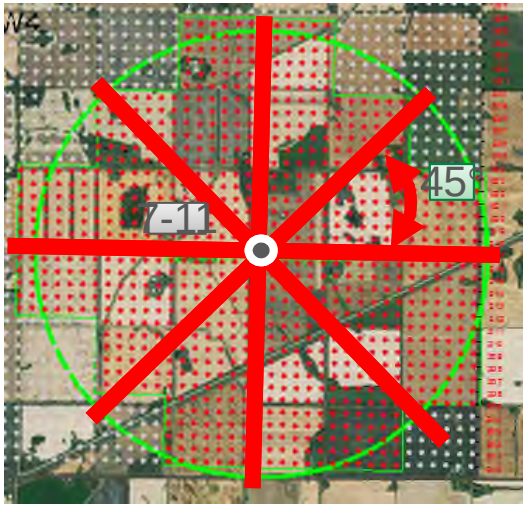
MMV Baseline - Geosphere - Vertical Seismic Profile (VSP)

3D Vertical Seismic Profile– Feb 2015



Objectives

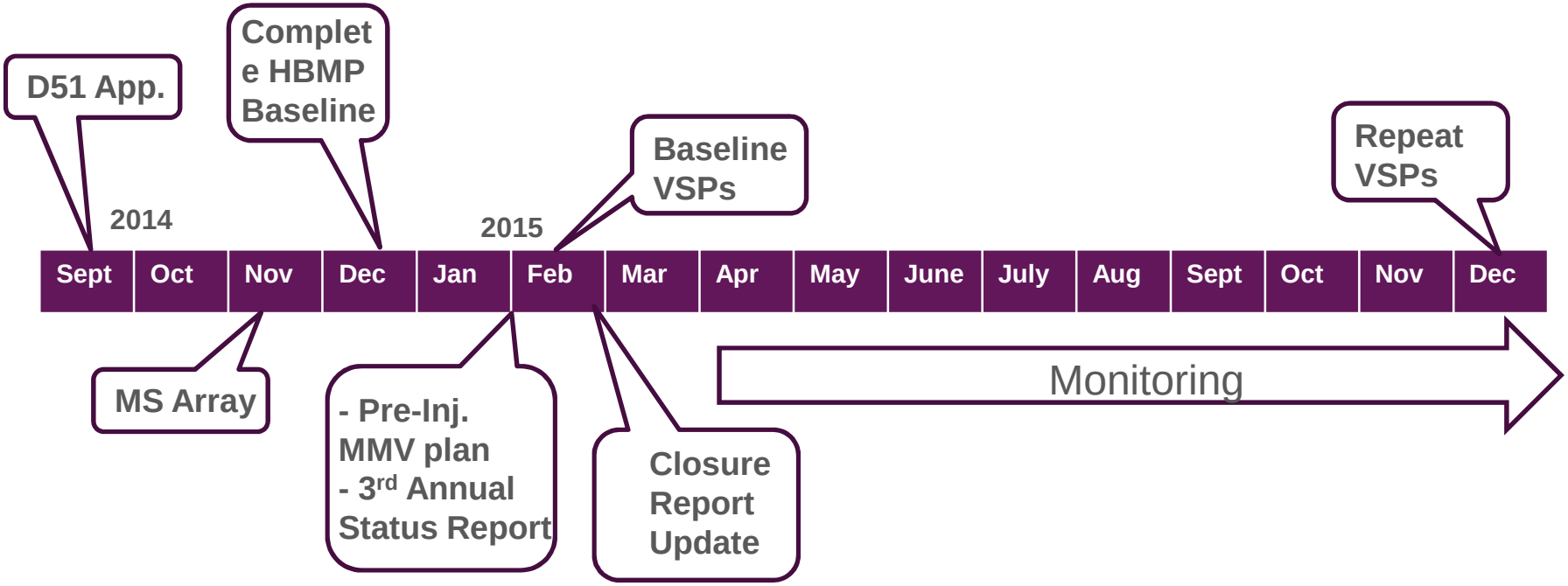
- Initial Plume Development
- Leak Detection



- Design Complete
- Contract in Place.
- Permitting Ongoing
- Start Water Well Testing campaign in January
- Survey in early Feb.

- Multi-azimuth 2D approach
- Four 4800m lines at 45 deg. intervals

MMV, Regulatory and Stakeholder Engagement Timeline



COSTS / REVENUES and FUNDING AGREEMENTS

- Total cost of Quest – Approx. Cdn$1.4 billion
  - Includes Pre FID, capital and 10 years opex
  - Capital Ratio: 80% Capture, 10% pipeline, 10% wells
- Revenues – GHG offsets (credits)
  - Net amount – stored CO2, less direct and indirect emissions
  - Credits to be used first by Shell's Alberta assets for regulatory compliance
  - Additional credits as early developer
- Government Funding Support – Cdn$865 million
  - Cdn$120 million Canadian Federal Government (Pre FID)
  - Cdn$745 million Alberta Province (Construction, Startup and 10 years operation)
  - Extensive knowledge sharing
  - Stringent monitoring (MMV) plan
  - NPV Zero commitment

Regulatory Development

- Provincial GHG Framework Established
  - November 2010 – CCS Act passed, establishing overall structure
  - May 2011 – Pore space regulations set
  - 2012 –Regulatory Framework Assessment (RFA) and GHG Quantification Protocols in Development
  - 2013 – Summary Report of the RFA
- Sequential Licensing Process
  - June 2011 – Quest acquires required pore space area
  - March 2012 – Provincial regulator (ERCB) public hearing
  - July 2012 – ERCB Hearing Decision Report Issued with conditional approval
  - August 2012 – Quest License (D65 Approval) granted with Ministers Approval
  - September 2012 – Well License approvals granted
  - August 2013 – Updated D65 approval – Clarification of CO2 containment zone

STAKEHOLDER ENGAGEMENT

- Extensive and continuous public engagement
  - 1st public project disclosure: Oct 2008 (booklet, news release and open house)
  - Stakeholder consultation program initiated Jan 2010
    - All landowners within 450 m of either side of pipeline right of way
    - All landowners in storage AOI
    - All Landowners within 5 km of Scotford
    - Municipal districts/local authorities
    - Industry stakeholders
    - Provincial / Federal regulators
    - Aboriginal communities
  - 25 Open Houses: March and November 2010, September 2011 and November 2012 Oct. 2013 and Nov 2014
  - Quest Café's: June, October 2011
  - Bi-annual County and Town Council updates
  - Community Advisory Panel Meetings (CAP) on MMV program started in Q4 2012
  - Local Coffee sessions started in 2013

Thank You