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SNS CCS Screening

Bacton – Neptune Energy

September 2022

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Oilfield Production Consultants (OPC)

- Established in 1988
- Founder led and managed
- In-house technical team and software
- Technical expertise
- Expert, Independent, and Efficient

34 Years	45 Countries
761 Clients	6,289 Projects

Screening Criteria

Criteria

- Existing pipeline infrastructure
- Driven by public data
  - COP reports, CO2Store, Strategic UK CCS Storage Appraisal Project, Lyell Collection
- Accelerated development opportunity
  - Depleted field
- Limited leak paths (wells)
- Timing is compatible with Bacton (up & running 2030)
- Sufficient storage capacity until 2050

Existing pipeline infrastructure

- Pipeline data provided by Xodus (Supply SIG)
- Traffic light criteria:
  - Likelihood of availability in 2030
    - Currently producing or COP near-term
  - Good pipeline condition
  - Sufficient size
  - Maximum allowable operating pressure for Liquid/Supercritical CO2

Pipeline Data – Bacton

Pipeline	Operator	Key fields	Traffic Light	Likelihood of availability in 2030	Connection to Store	Pipeline Condition	Pipeline size (")	Pipeline Age in 2030	MAOP (barg)
SEAN P TO BACTON TERMINAL TRUNKLINE	ONE-DYAS	**Sean**	A	CoP ~ 2025	Yes / Maybe	A	NA	NA	NA
Leman BT to Bacton A2	Perenco Oil and Gas	**Leman**	A	Currently producing	Yes / Maybe	A	30	60	99.3
Leman 49/27 AP to Bacton A1	Perenco Oil and Gas	**Leman**	A	Currently producing	Yes / Maybe	A	30	62	93.1
Lancelot to Bacton	Perenco Oil and Gas		A	Currently producing	Yes / Maybe	A	20	38	103.5
Indefatigable 49/23 AT to 49/27 BT	Perenco Oil and Gas	**Indefatigable**	A	Currently producing	Yes / Maybe	A	30	59	110
Clipper PT to Bacton	Shell	**Clipper South, Galleon**	A	Currently producing	Yes / Maybe	A	24	40	112
Leman AP to Bacton	Shell	**Leman**	A	Currently producing	Yes / Maybe	A	30	63	99.3
Bacton to Clipper PT	Shell	Clipper South, Galleon	A	Currently producing	Yes / Maybe	A	3	36	150
Bacton to Leman AP	Shell	Leman	A	Currently producing	Yes / Maybe	A	4	63	45
LEMAN 49/26-BT TO BACTON	Shell	Leman	A	Currently producing	Yes / Maybe	Poor	30	57	Mothballed
Trent tie-in to Bacton	Perenco Oil and Gas	Cygnus	A	Unlikely CoP to mid 2030s	No	A	24	46	131
BACTON TO THAMES	IOG PLC	Elgood	A	Unlikely CoP to mid 2030s	No	A	24	44	129
HEWETT SOUTHERN EXPORT A-LINE TO BACTON	ENI UK LIMITED	Hewett	A	CoP now	Yes / Maybe	Poor	30" external	62	N/A following pipeline failure*
HEWETT NORTHERN EXPORT B-LINE TO BACTON	ENI UK LIMITED	Hewett	A	CoP now	Yes / Maybe	Poor	30" external	57	26.89**
SHEARWATER TO BACTON (SEAL)	Shell	Elgin Franklin	A	Unlikely CoP to 2040s	No	A	34	31	153

Public Databases

- CO2 Stored
- Strategic UK CCS Storage Appraisal Project
- A Summary of Results from the Strategic UK CO Storage Appraisal Project
- NSTA Offshore Oil and Gas Activity Map
- Lyell Collection field reports

Required Storage Capacity

- Required running period 2030-2050

- 2030 CO2 supply scenarios:
  - Core 1-3 Mt/yr
  - Build out 3-5 Mt/yr

- 2050 CO2 supply:
  - 20-25 Mt/yr

Required Storage Capacity (2030-50)

- Core scenario mid case: **42** MT CO_2
  - 2 MT/yr
  - 1 well required

- Build Out scenario mid case: **84** MT CO_2
  - 4 MT/yr
  - 2 wells required

See appendix 1 for breakdown

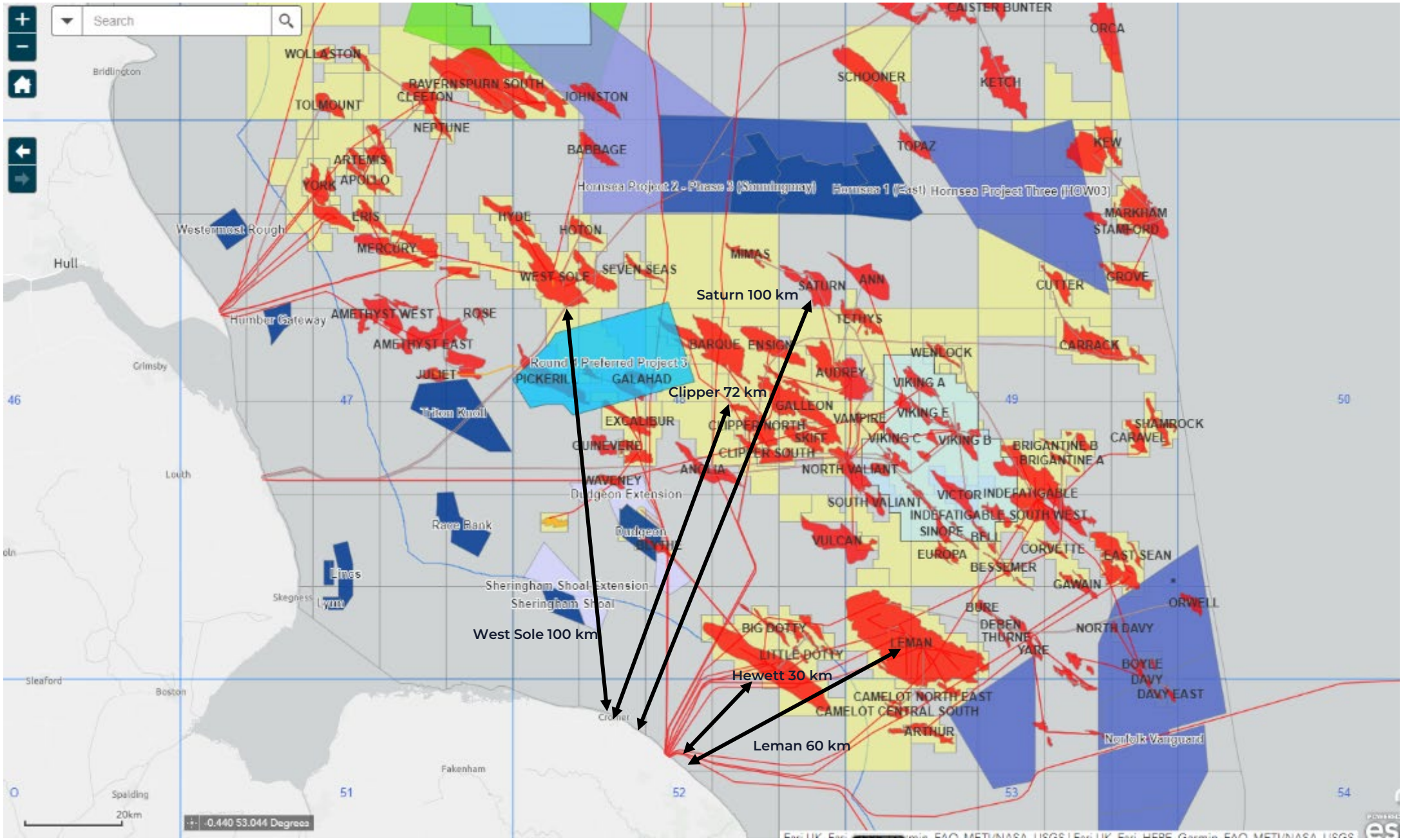
Required Storage Capacity (2050-70)

- Assuming mid case ‘Build Out’ scenario
- Build out scenario mid case: **513** Mt CO2
  - 22.5 Mt/yr
  - 8 wells required

See appendix 2 for breakdown

Summary of Requirments

- 42 – 84 MT CO_2 storage (up to 2050)
- Existing pipeline to limit cost
- Not too many wells (limit containment risk)
- COP soon to align with Bacton timeline
- Gas field to limit apprasial cost and time


Saturn 100 km
Clipper 72 km
West Sole 100 km
Hewett 30 km
Leman 60 km
Hornsea Project 2 - Phase 3 (Sonningmay)
Hornsea 1 (East)
Hornsea Project Three (HOW03)
Round 4 Preferred Project 5
Dudgeon Extension
Sheringham Shoal Extension
Sheringham Shoal
Race Bank
Triton Knoll
Norfolk Vanguard
Humber Gateway
Westermost Rough
WOLLASTON
RAVENSPURN SOUTH
CLEETON
JOHNSTON
TOLMOUNT
NEPTUNE
BABBAGE
TOPAZ
KEW
ARTEMIS
APOLLO
YORK
ERIS
HYDE
HOTON
MERCURY
WEST SOLE
SEVEN SEAS
MIMAS
SATURN
ANN
TETHYS
CUTTER
GROVE
MARKHAM
STAMFORD
AMETHYST WEST
ROSE
AMETHYST EAST
JULIET
PICKERIL
GALAHAD
BARQUE
ENSIGN
AUDREY
WENLOCK
VIKING A
CARRACK
EXCALIBUR
GALLEON
VAMPIRE
VIKING E
CLIPPER NORTH
SKIFF
VIKING C
VIKING B
GUINEVERE
CLIPPER SOUTH
BRIGANTINE B
BRIGANTINE A
SHAMROCK
CARAVEL
WAVENEY
NORTH VALIANT
SOUTH VALIANT
VICTOR
INDEFATIGABLE
INDEFATIGABLE SOUTH WEST
SINOPE
BELI
VULCAN
EUROPA
CORVETTE
EAST SEAN
BESSEMER
GAWAIN
ORWELL
BURE
DEBEN
THORNE
YARE
NORTH DAVY
BIG DOTTY
LITTLE DOTTY
LEMAN
BOYLE
DAVY
DAVY EAST
CAMELOT NORTH EAST
CAMELOT CENTRAL SOUTH
ARTHUR
CAISTER BUNTER
ORCA
SCHOONER
KETCH
Search
Hull
Bridlington
Grimsby
Louth
Lincs
Skegness
Lynn
Sleaford
Boston
Spalding
Fakenham
Cromer
20km
-0.440 53.044 Degrees

Results

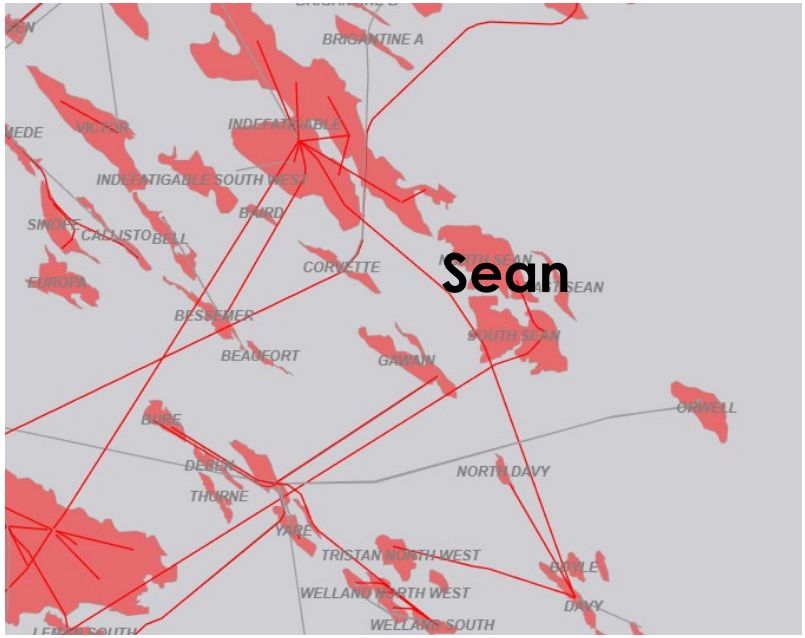
Storage Site Results

- 25 gas fields screened
- Majority of prospects target the Rotliegend Group

Field Name	Capacity (MT)	COP	Pipeline	Wells	Gas Produced (BCF)	Distance (km)
Sean (N/S)	82	2025	SEAN P TO BACTON TERMINAL TRUNKLINE	16	722	100

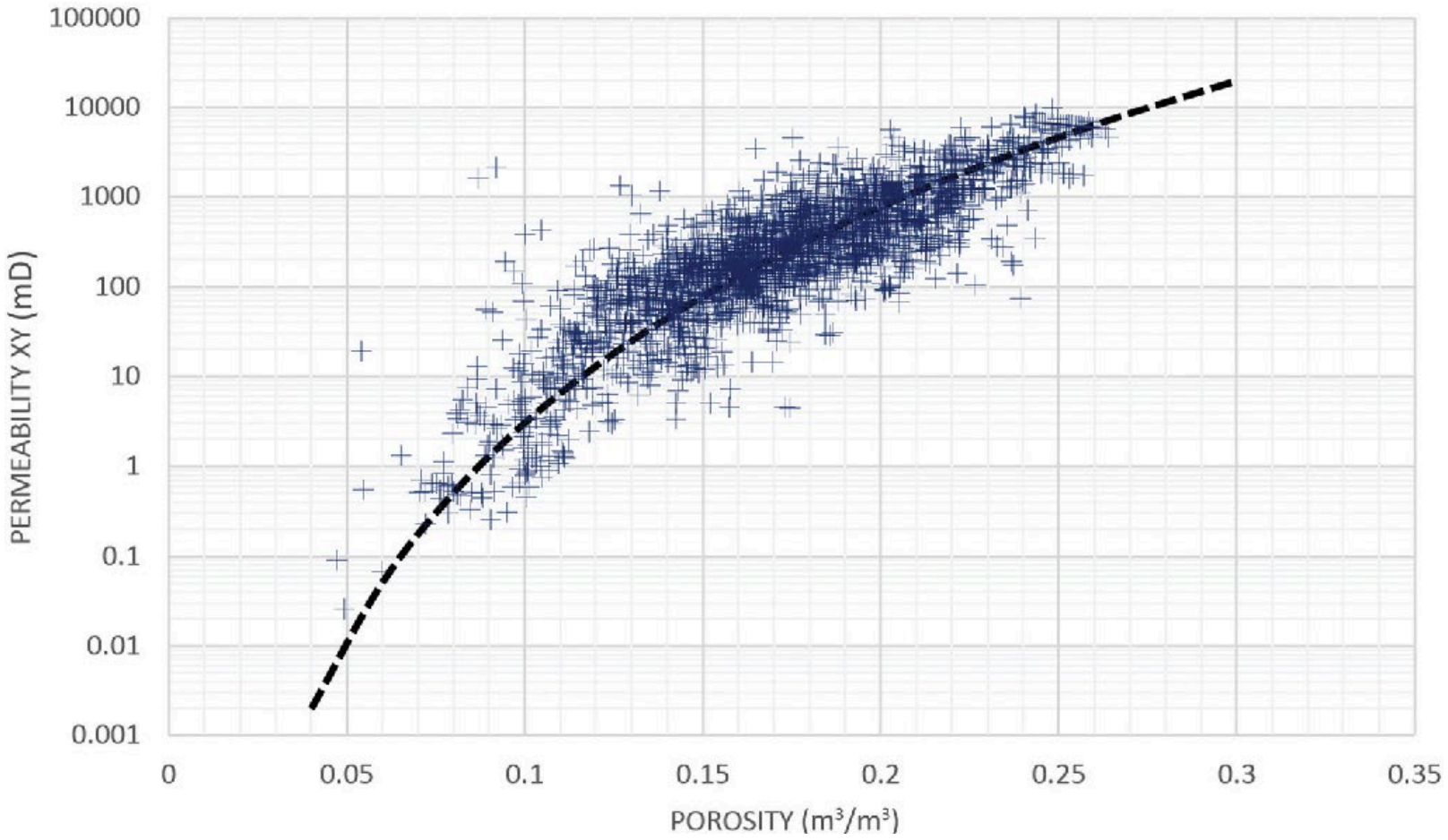
Results – Sean (N/S/E)

- Estimated ~82 MT CO2 capacity
  - Storage estimate may be ambitious due to water influx
- Partial communication between fields
- COP ~2025
- Dedicated Sean – Bacton Trunkline
- 16 wells drilled
- ~100km offshore
- Initial pressure 3800-900 psi

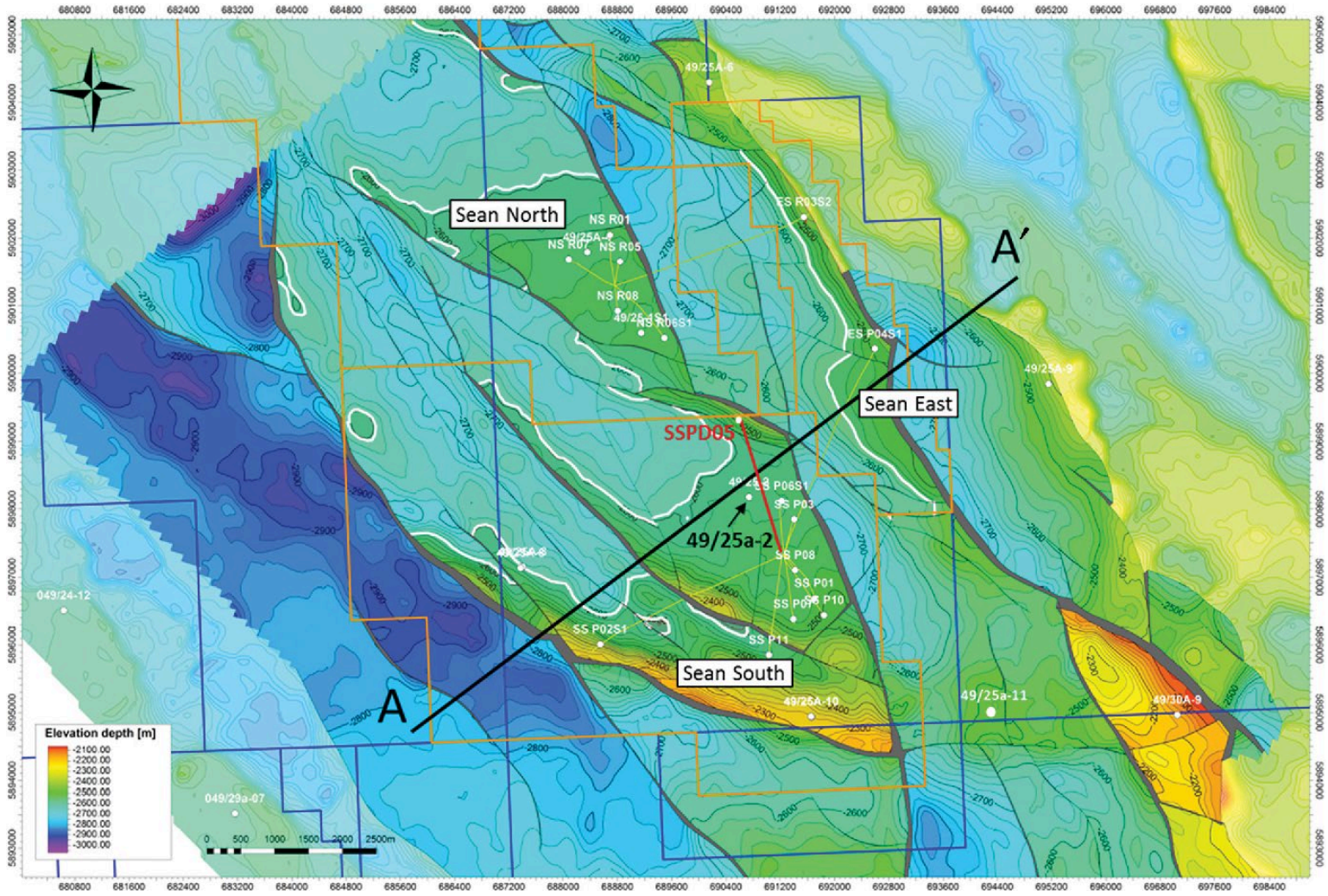


OneDyas Operated

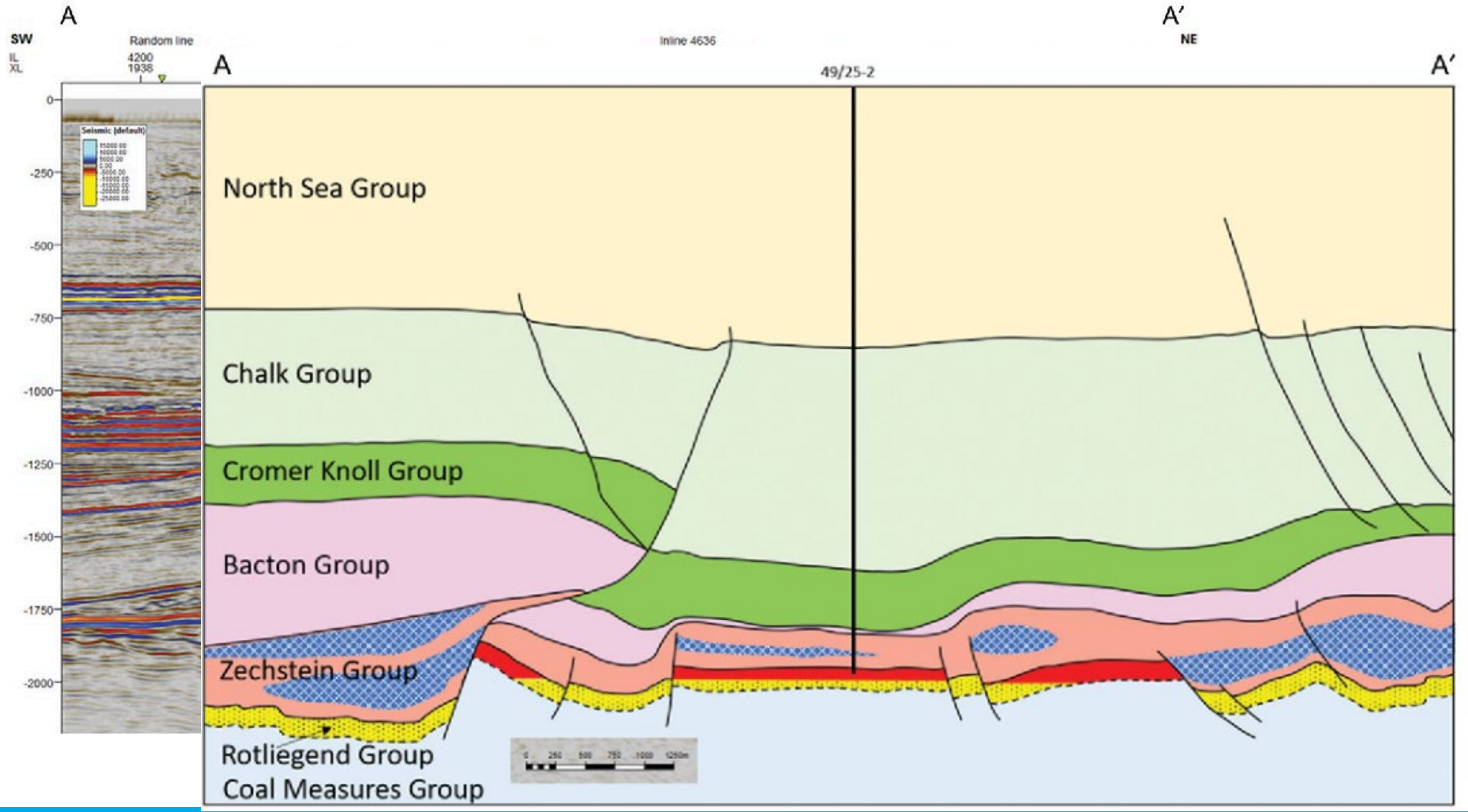
Sean – Perm/Porosity



Sean - Containment

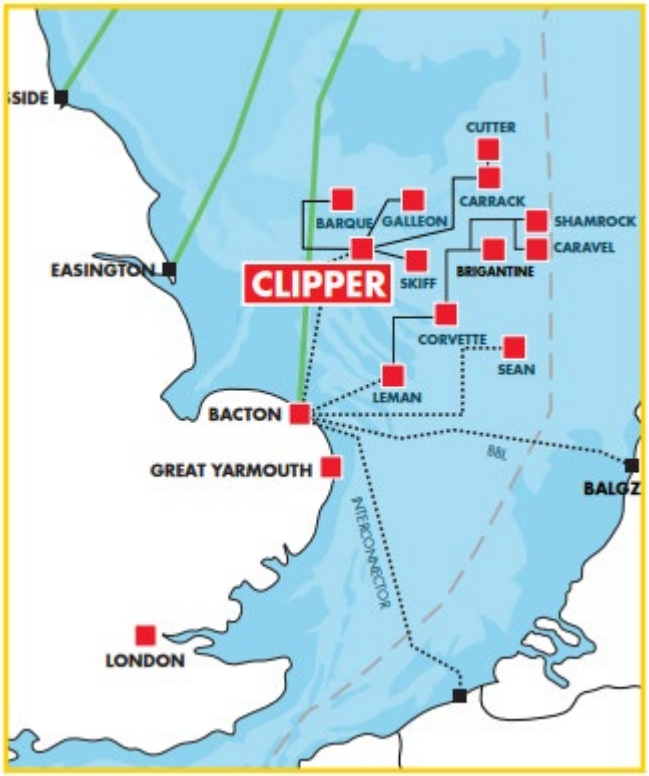


Sean - Containment



Results – Without Pipeline Criteria

Field Name	Capacity (MT)	COP	Pipeline	Wells
Barque	108	2040?	BARQUE PB - CLIPPER PT - Bacton	26
Clipper (Inc. S)	144	2040	Cipper PT to Bacton	4
Sean (N/S)	82	2025	SEAN P TO BACTON TERMINAL TRUNKLINE	16
Galleon	137	NA	GALLEON PG - CLIPPER - PMGAS CLIPPER PT - BACTON	17
West Sole	143	NA	Easington	25
Indefatigable & SW	357	2021	Indefatigable 49/23 AT to 49/27 BT	56



- Costs drastically increase with new pipeline
- Barque & Galleon route via Clipper which will operate until ~2040
- Indefatigable has potential
- West Sole closer to Easington

Indefatigable

- Porosity: 15%; permeability 10-1000mD
- Rotliegend Leman Sandstone Formation
- Stacked aeolian dunes
- 90km new pipeline required or an extension of Sean-Bacton pipeline
- Reservoir is subdivided into 15 compartments
- Only a very small number of wells exhibit water production
- Initial pressure: 4122 psi; RF 84%
- 56 wells

Other Sites of Interest…

Popular stores:

- Hewett – 36 wells drilled
- Leman – 96 wells drilled
- Clipper – COP ~2040
- Saturn – abandoned

Bunter:

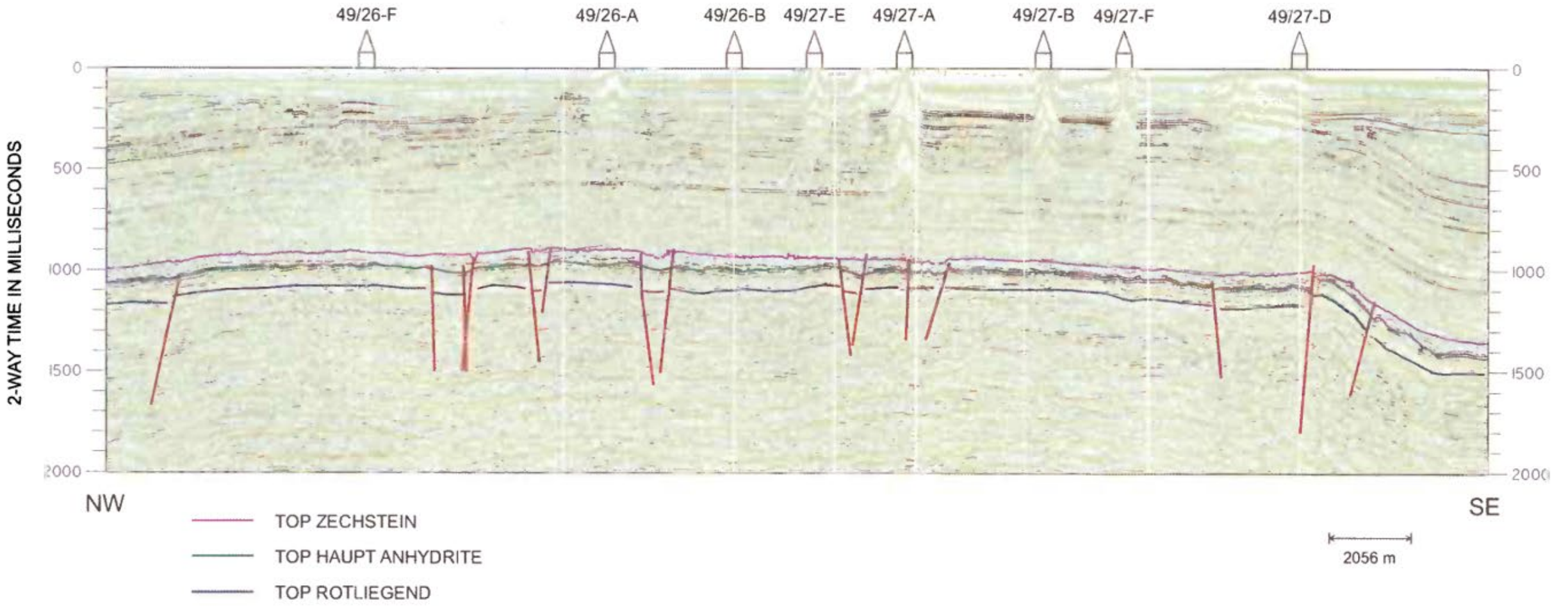
- 3 – 230Mt capacity – Above Viking A
- 9 – 2000Mt capacity – Above Leman

Leman & Hewett

- Main concern is quantity of wells intersecting any sealing units which act as migration pathways for buoyant CO_2
- Hewett & Leman are highly compartmentalised
- Future injection could target specific blocks with boundary sealing faults

Some thoughts on Leman

NW – SE (below); 300 psi depletion pressure



Hewett

- Bunter above Hewett 205 MT of CO2 Storage
- 42 Wells intersect unit meaning legacy wells are high risk

Criterion	Endurance	Hewett	Viking A	BC36	Scale			Comments
					Ready to submit	Studies needed	Samples required	
CO_2 appraisal maturity	●	●	●	●				Appraisal well needed for BC36?
Capacity	●	●	●	●	>150 Mt	50-150 Mt	<50 Mt	Viking A small & faulted
*SPE SRMS**	*CDOH*	*CUC*	*CUC*	*CUC or Prospect*				
Injectivity	●	●	●	●	>100mD; no risk	Halite risk	Low K_H (<100 mD)	Saline aquifer injectivity better with 100+ m interval & thermal frac
Containment	●	●	●	●	All wells assured	CCS P&A needed	Multiple P&A'd wells	All good geological seal; risk is legacy wells
Hydrodynamics	●	●	●	●	Physics Clear	More Clarity Needed	Physics Unclear	Saline aquifer: CO_2 ↑ crest
Monitorability	●	●	●	●	Required options viable	Limited MMV options viable	Insufficient MMV options viable	All good
Accessibility	●	●	●	●	Option secured	Talks needed	Inaccessible	Discussions with operators

Taken from East Coast cluster assessment

Recommendations

- New pipeline likely needed
- Further research on Saline Aquifer Stores
- Further data / clarity on SNS gas fields
- Hewett & Leman further examination required
- There is ample storage, but can it be developed cost effectively with speed remains uncertain

Appendix 1

2030 - 2050 Core Capacity Requirements (MT CO_2)

Case	Low	Mid	High
Storage Capacity (Cum. 2050)	21	**42**	63
Injection Rate (MT/yr)	1	2	3
Wells Required	1	1	1

2030 - 2050 Build Out Capacity Requirements (MT CO_2)

Case	Low	Mid	High
Storage Capacity (Cum. 2050)	63	**84**	105
Injection Rate (MT/yr)	3	4	5
Wells Required	1	2	2

Appendix 2

2050 - 2070 Build Out **Capacity Requirements**

Scenario	Low	Mid	High
Storage Capacity (2050)	463	513	563
Injection Rate (MT/yr)	20	22.5	25
Wells Required	7	8	8

Thank you

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