Integrity of Wells in the Nearshore Area Gippsland Basin*

Todd Goebel[1], Barry Nicholson[1], and Nick Hoffman[1]

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[1]The CarbonNet Project, Victoria State Department of Economic Development, Melbourne, VIC, Australia (nick.hoffman@ecodev.vic.gov.au)

Abstract

The CarbonNet Project is seeking CO_2 storage sites in the nearshore area of the Gippsland Basin that provide permanent and safe storage for 25 to 125 Mt of CO_2. The integrity of legacy or existing wells (which may include abandoned, production, injection, mineral/water bores, and Measurement, Monitoring, and Verification (MMV) wells) is recognised around the world as one of the most significant operational risks to CO_2 storage projects. The number of wells and quality of completions can vary significantly in different basins and jurisdictions. Furthermore, the drilling and completion requirements for onshore and offshore wells are subject to various regulatory, industry and operator standards and practices. The Gippsland Basin has been an active oil and gas production province since the 1960's and there is a reasonable database of well data and parameters to assess well integrity. In the nearshore area of the Gippsland Basin, the integrity of twelve (12) wells has been assessed and risks identified. The assessment was based on existing documentation lodged with the regulator under Australia's comprehensive offshore petroleum legislation. The assessment concludes that the risk of leakage from the twelve (12) legacy wells reviewed is low, even though the primary purpose of the completion was to secure the wells in a petroleum context. Ultimately for any CO_2 storage project, there is a requirement to demonstrate how to safely monitor legacy wells in an Australian context to show they are not potential leakage pathways and to outline plans for remediation of wells if they are shown to have problems. Options are explored for completion and monitoring of future petroleum wells and other boreholes to avoid any new risks.

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PESA Incorporating PESA's Eastern Australasian Basins Symposium

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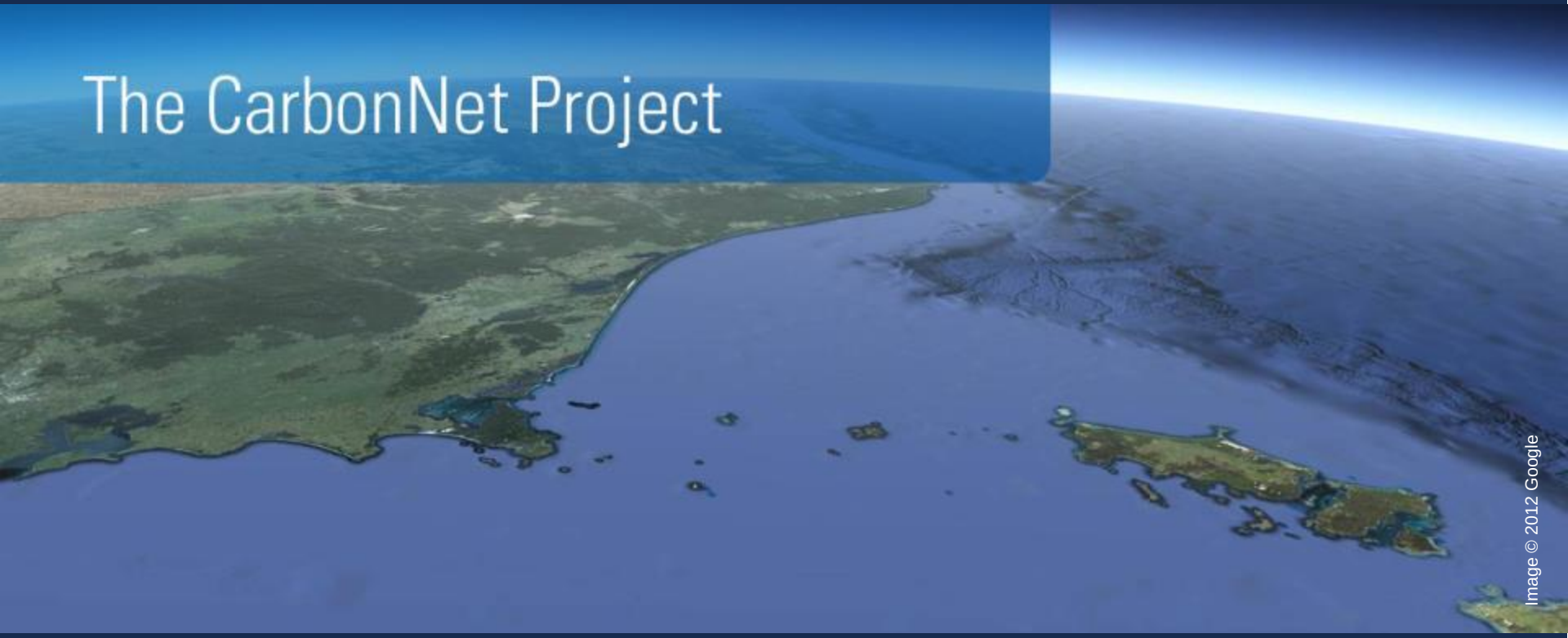
Todd Goebel, Lead Reservoir Engineer

September 2015



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State Government Victoria

Outline

- Introduction
- CarbonNet Project Background
- Area of Study
- Database of Wells
  - Wells of Interest
  - Well Assessments
- Risk Assessment
- Risk Register and Action Plan
- Summary of Conclusions

Introduction

- Wells present a risk for CO_2 storage (or any injection or production project) as potential leak paths
- The number of wells and quality of completions varies significantly and accordingly, the level of risk they pose
- It is important to understand the prior history of each basin proposed for CO_2 storage
- Conduct careful examination of the state of records, and make careful and objective risk assessments based on observable facts and documented evidence

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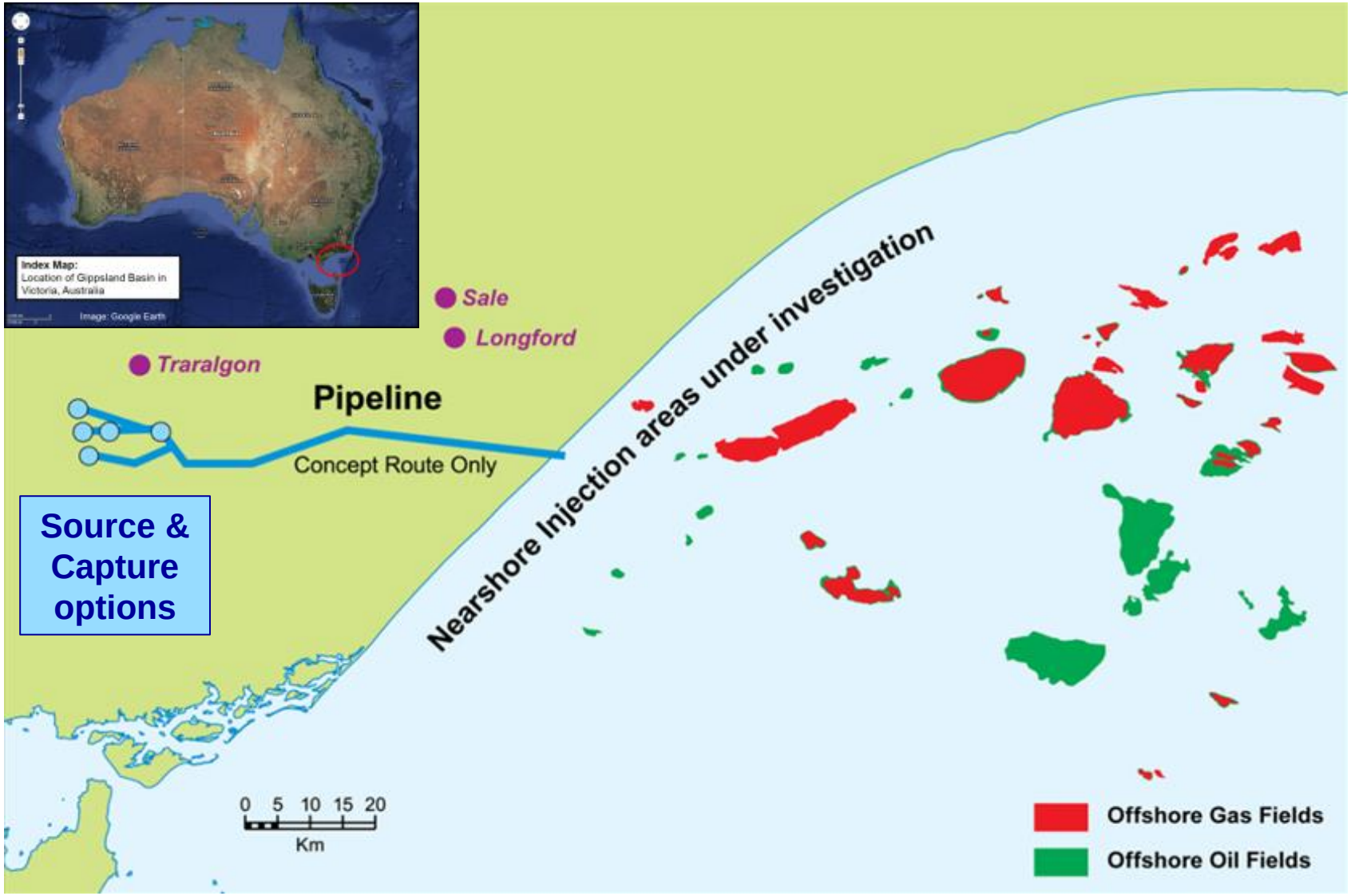
CarbonNet Project Background

- The CarbonNet project is an initiative of the Victorian State Department of Economic Development, Jobs, Transport and Resources (DEDJTR)

- The objective is to establish a large scale, multi user CCS network in the Gippsland Region of Victoria, Australia

- Investigating the feasibility of sequestering up to 5Mtpa of CO_2 in the nearshore area (3-15 nautical miles) of the Gippsland Basin

The CarbonNet Project



CarbonNet Project Background

- A portfolio of potential injection sites is being assessed, targeting the Cobia and Halibut subgroups of the Latrobe Group.

- Three sites have demonstrated the fundamental suitability requirements for the storage of 25 - 125Mt of CO_2.

- Injection is planned for a 25 year operational period.

CarbonNet Project Background

A comprehensive review of the legacy wells in this area was achievable for two key reasons:

1. Australia has a comprehensive open-file data system where petroleum data is released after a time period of 3-5 years

2. Gippsland Basin is an existing petroleum province with a large amount of information:
   - Available data (wells and seismic surveys)
   - Well completion reports, scientific papers about the oil and gas accumulations, their reservoirs and seals, basin stratigraphy, depositional setting and tectonic history

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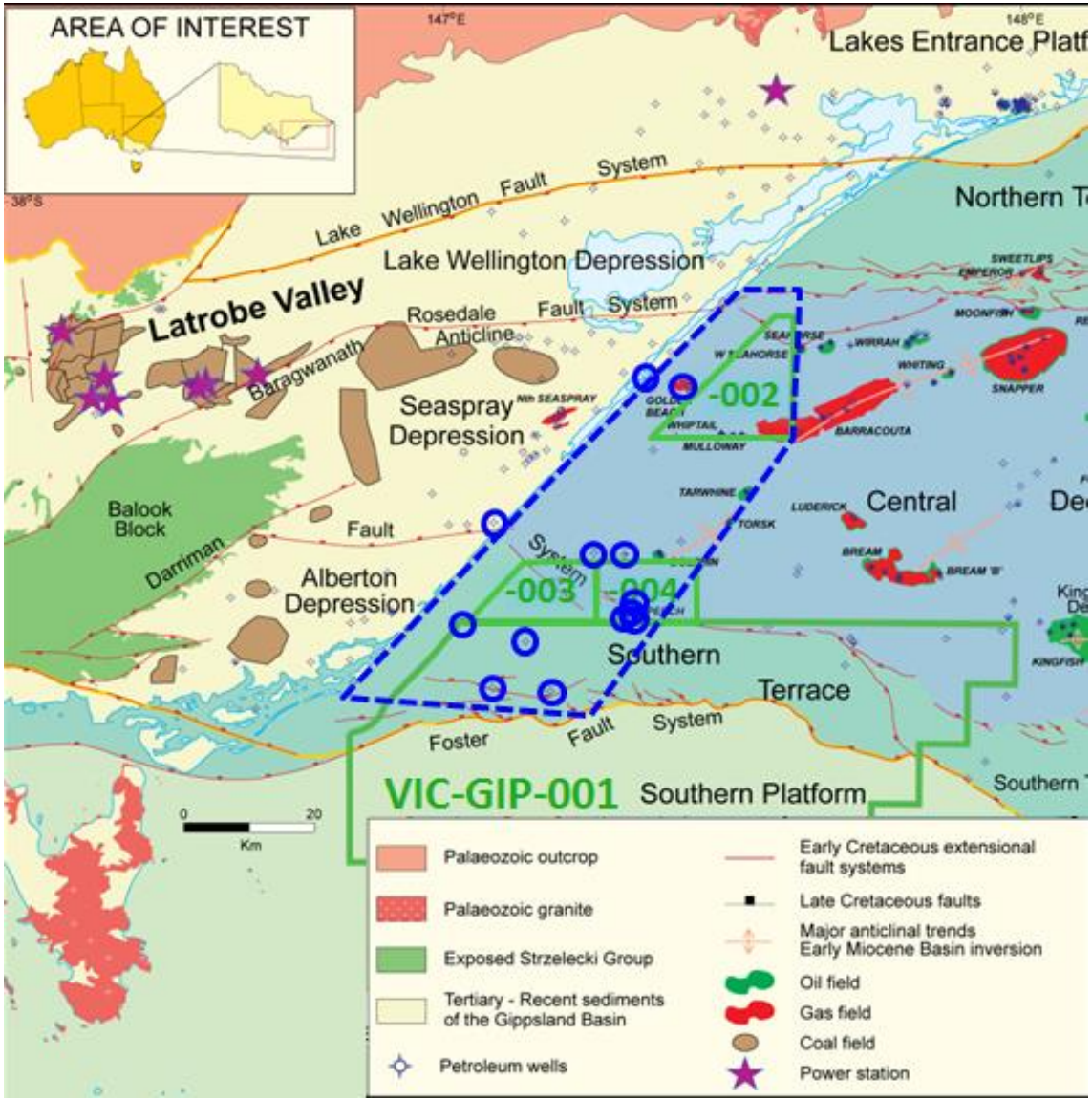
Area of Study



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Database of Wells

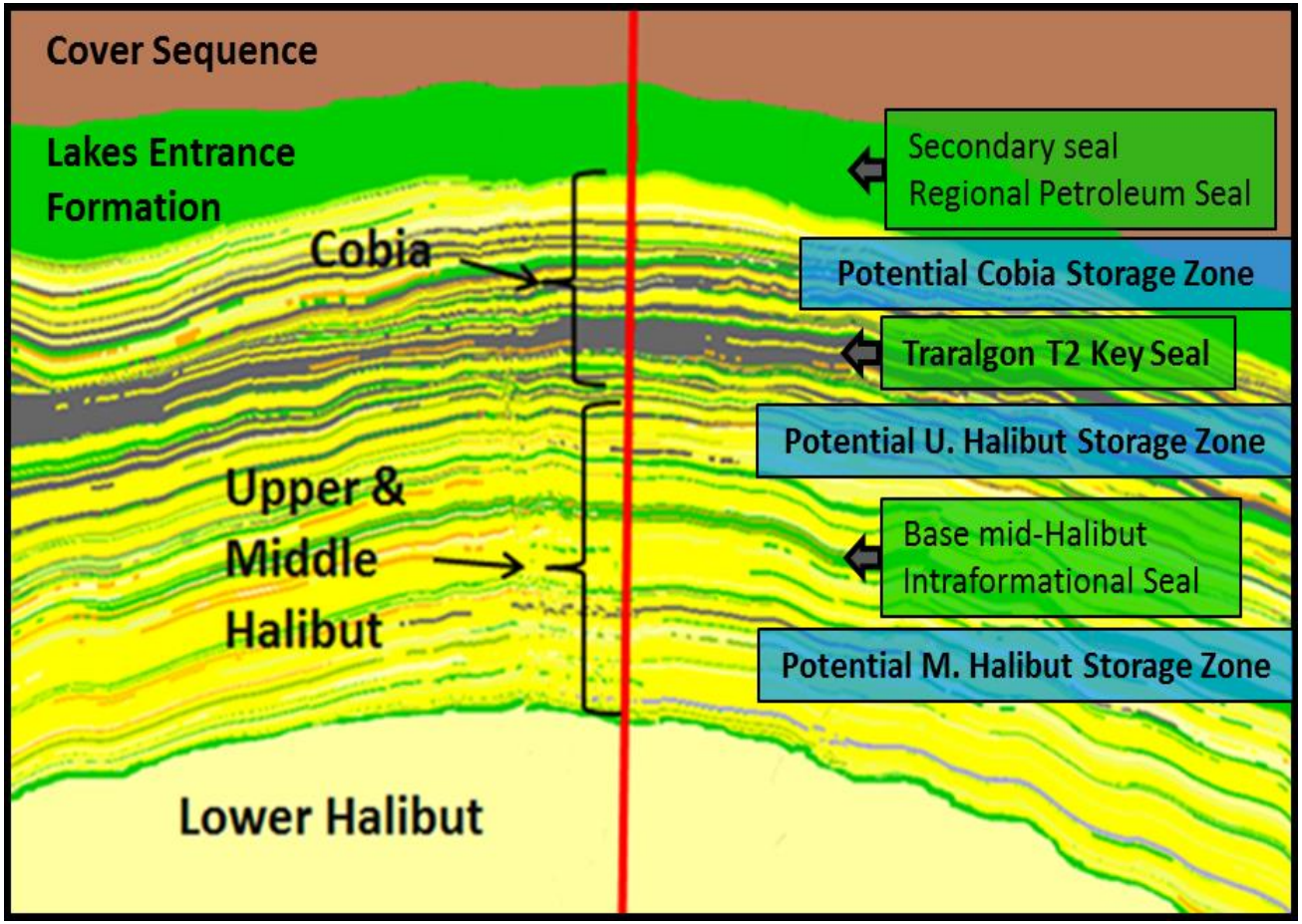
- 1562 wells in the basin
- 811 wells with basic geological data
- 546 wells with relevant log data
- 49 wells are located in the focus area considered by CarbonNet for CO_2 storage
- 14 wells are relatively close to sites that CarbonNet has assessed for offshore CO_2 storage

Wells of Interest

Well Name	Operator	Spud Date	Total Well Depth (mKB)	Well Depth Subsea (m)	Formation Potentially Exposed to CO2
Amberjack-1	BHP	4th May 1990	1750 m	-1729.0 m	Halibut
Broadbill-1	Lakes Oil	17th Jan 1998	1345 m	-1314.3 m	Halibut/T2/Cobia
Golden Beach-1A	Burmah	3rd May 1967	2905 m	-2892.8 m	Halibut
Golden Beach West-1	Woodside	11th Sep 1965	2290 m	-2278.1 m	Halibut/T2/Cobia
Kyarra-1A	Australian Aquitaine	16th Feb 1983	1280 m	-1249.5 m	Halibut
Palmer-1	Esso	12th Aug 1981	1723 m	-1702.0 m	Halibut/T2
Perch-1	Esso	13th Mar 1968	2867 m	-2857.5 m	Halibut/T2/Cobia
Perch-2	Esso	11th Feb 1985	1321 m	-1300.0 m	Halibut/T2
Perch-3	Esso	10th Oct 1989	1301 m	-1258.7 m	Halibut/T2/Cobia
Perch-4	Esso	1st Feb 1995	2052 m	-1247.0 m	T2/Cobia
Salt Lake-1	Woodside	12th Apr 1970	1670 m	-1620.7 m	Halibut/T2/Cobia
Tommyruff-1	BHP	20th May 1990	1550 m	-1529.0 m	Halibut/T2/Cobia
Wasabi-1	Apache	14th Feb 2008	2313 m	-2274.0 m	Halibut/T2/Cobia
Wyralla-1	Australian Aquitaine	16th Apr 1984	1160 m	-1139.0 m	Halibut/Cobia

Basic Stratigraphy for Wells of Interest

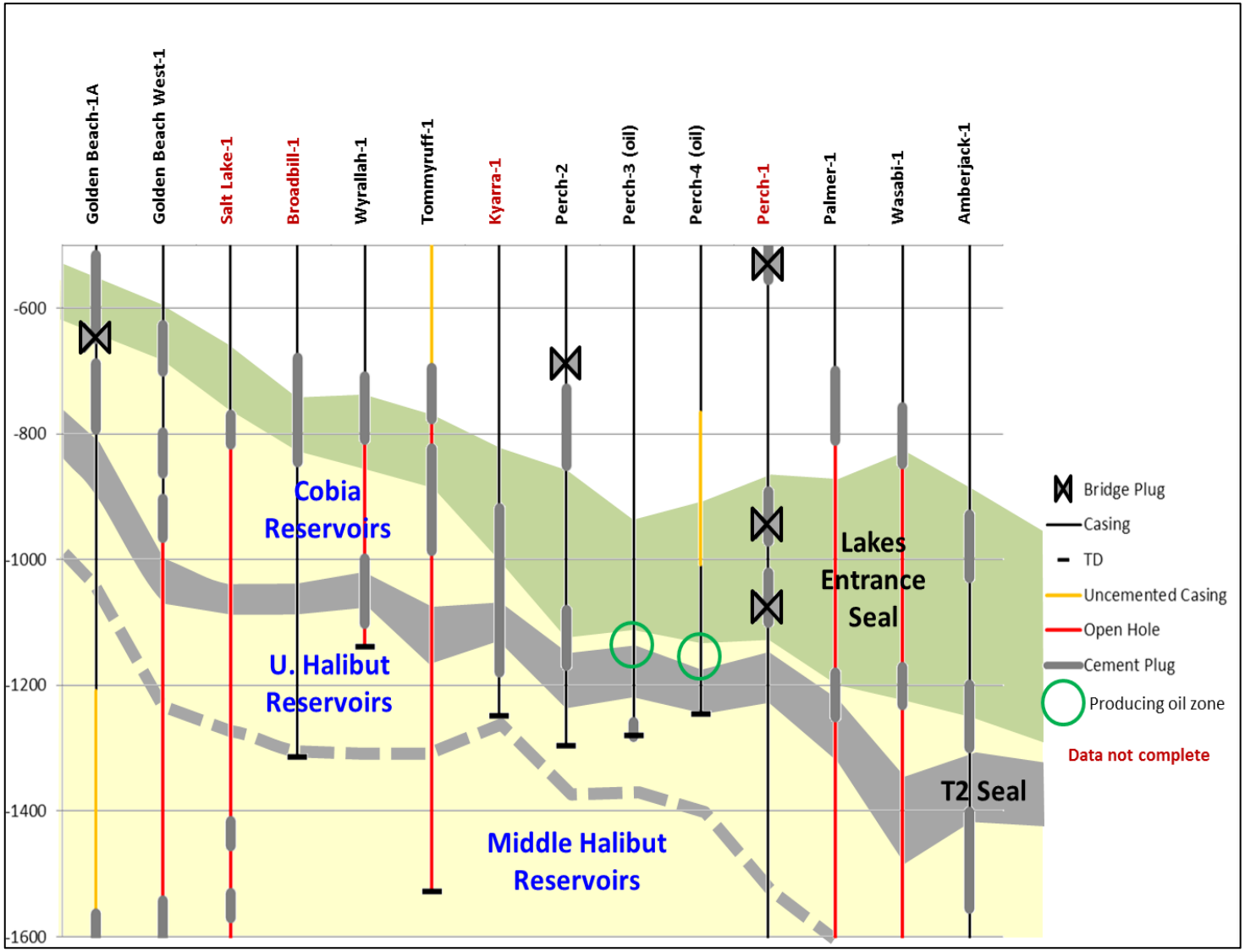
- For most of these wells, the likely target for CO_2 injection is the Cobia Subgroup or the underlying Halibut Subgroup



Well Assessments

- All wells in the Gippsland Basin have been completed to petroleum industry standards of the period
- Competent completions across the Lakes Entrance Formation topseal
- Deeper intervals have been completed in a less systematic manner and some of the intraformational seals that could be of value for storage may have been compromised
- In most cases, good data is available but for certain wells, the documentation is less complete
- The path the CO_2 plume takes depends on injection well location and the CO_2 may come into contact with existing petroleum exploration wells that have been plugged

Well Abandonment Details vs Formation Tops



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Risk Assessment Criteria Matrix

- Each well was assessed for the ***likelihood*** and ***consequence*** that **if a CO_2 plume encounters a well, CO_2 could migrate out of the primary storage reservoir into the upper reservoirs or to the surface, impacting the public or environment.**

			Consequence Criteria				
			1 – Insignificant	2 – Minor	3 – Moderate	4 – Major	5 – Catastrophic
Likelihood	A	The consequence is almost certain to occur in most circumstances	Medium (M)	High (H)	High (H)	Very High (VH)	Very High (VH)
	B	The consequence is likely to occur frequently	Medium (M)	Medium (M)	High (H)	High (H)	Very High (VH)
	C	Possible and likely for the consequence to occur at some time	Low (L)	Medium (M)	High (H)	High (H)	High (H)
	D	The consequence is unlikely to occur but could happen	Low (L)	Low (L)	Medium (M)	Medium (M)	High (H)
	E	The consequence may occur but only in exceptional circumstances	Low (L)	Low (L)	Medium (M)	Medium (M)	High (H)

Risk Assessment Findings

- The risk of a **CO_2 plume encountering a well and migrating out of the primary storage reservoir into the upper reservoirs or to the surface, impacting the public or environment** was judged to be **low to very low in all wells**

- High standards of protection applied to the Lakes Entrance Formation regional petroleum seal

- The alternative risk proposition that ***Intraformational* CO_2 storage at the well may be compromised by completion quality** was <u>not</u> evident for all wells

Risk Assessment Findings

- Concluding assessment of risk and risk management for intraformational storage at the fourteen wells of interest.

- Five of the fourteen wells provide a low risk for intraformational storage of CO_2.

- A further two currently-producing wells are expected to be abandoned in the future and to meet all relevant high quality P&A standards (hence, not pose a future risk).

- For the remaining seven wells, mitigation includes avoiding the stratigraphic levels at potential risk, or avoiding some wells entirely that have a likely chance of encountering the CO_2 plume.

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Risk Register and Action Plan

Identified Risks	Analysis & Evaluation			Further Actions			
Intraformational CO_2 storage at the well will be compromised by completion quality	Consequence (1, 2, 3, 4, or 5)	Likelihood (A, B, C, D or E)	Risk level (L, M, H or VH)	How to manage the risk.	Accept Risk (Y or N)	How to reduce this risk	Post-mitigation Risk level (L, M, H or VH)
Amberjack-1	2	E	L	No action required	Y	N/A	L
Broadbill-1	3	D	M	Avoid contact with Plume unless better documentation can be inspected	N	Seek additional paper records / Ensure not contacted by CO_2	L-M
Golden Beach West-1	3	C	H	Avoid contact with Plume at Halibut/T2 level. Top Cobia is OK.	Y	Plan storage to avoid CO_2 at this location	L
Golden Beach-1A	2	E	L	Monitor during injection	Y	N/A	L
Kyrra-1	3	D	M	Avoid contact with Plume unless better documentation can be inspected	N	Seek additional paper records / Plan storage to not require seal at this level – i.e. assume that plume ***will*** rise to top Cobia.	L-M
Palmer-1	2	D	M	Avoid storage at Halibut/T2 level. Top Cobia is OK.	Y	Plan storage to not require seal at this level – i.e. assume that plume ***will*** rise to top Cobia.	L
Perch-1	2	E	L	No action required	Y	Check for detailed full WCR	L
Perch-2	2	E	L	No action required	Y	N/A	L

Risk Register and Action Plan cont'd

Identified Risks	Analysis & Evaluation			Further Actions			
Intraformational CO_2 storage at the well will be compromised by completion quality	Consequence (1, 2, 3, 4, or 5)	Likelihood (A, B, C, D or E)	Risk level (L, M, H or VH)	How to manage the risk.	Accept Risk (Y or N)	How to reduce this risk	Post-mitigation Risk level (L, M, H or VH)
Perch-3	**2**	**C-D**	**L-M**	Avoid contact with producing oil zone. Halibut is OK.	Y	Influence final abandonment	L
Perch-4	**2**	**C-D**	**L-M**	Avoid contact with producing oil zone. Halibut is OK.	Y	Seek further information from well operator. Influence final abandonment	L
Salt Lake-1	**3**	**B**	**H**	Avoid storage at Halibut/T2 level. Top Cobia is OK.	Y	Plan storage to not require seal at this level – i.e. assume that plume ***will*** rise to top Cobia.	L
Tommyruff-1	**3**	**D-C**	**M-H**	Avoid storage at Halibut/T2 level. Top Cobia is OK.	Y	Plan storage to not require seal at this level – i.e. assume that plume ***will*** rise to top Cobia.	L
Wasabi-1	**3**	**C**	**H**	Avoid contact with Plume	N	Locate injector updip to avoid CO_2 contact	L
Wyrallah-1	**2**	**E**	**L**	No action required	Y	N/A	L

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Conclusions

- **None of the fourteen wells analysed present any significant risk of leakage through the Lakes Entrance Formation, demonstrating that the regulatory intention of aquifer and resource protection is being achieved.**

- Objectives for completion and abandonment of the wells have been met satisfactorily and to acceptable oilfield standard and practices of the period.

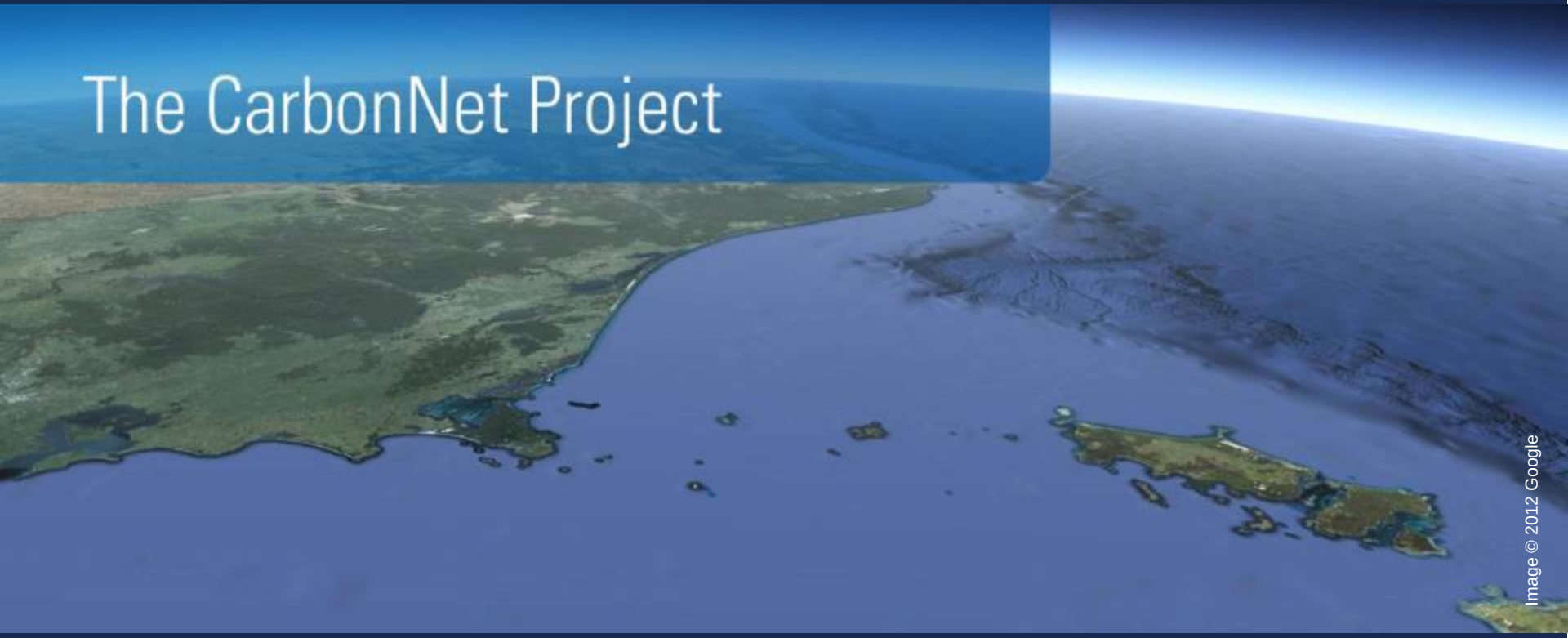
- Some of the completions undertaken for petroleum and aquifer purposes do not offer the level of desired protection for future CO_2 storage at an intraformational level at some specific sites.

  (Future petroleum well completion and abandonment requirements may require additional intervals to be fully cemented, additional wellbore plugs to be included, and for CO_2-resistant materials to be considered).

Conclusions cont'd

- CarbonNet has modified its plans to avoid the stratigraphic levels at risk or to avoid some sites entirely where any probable CO_2 plume might reach the well.

- **Overall, there is negligible risk of CO_2 rising to near-surface levels where it might present a risk to the environment or the general public.**



Thank You

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