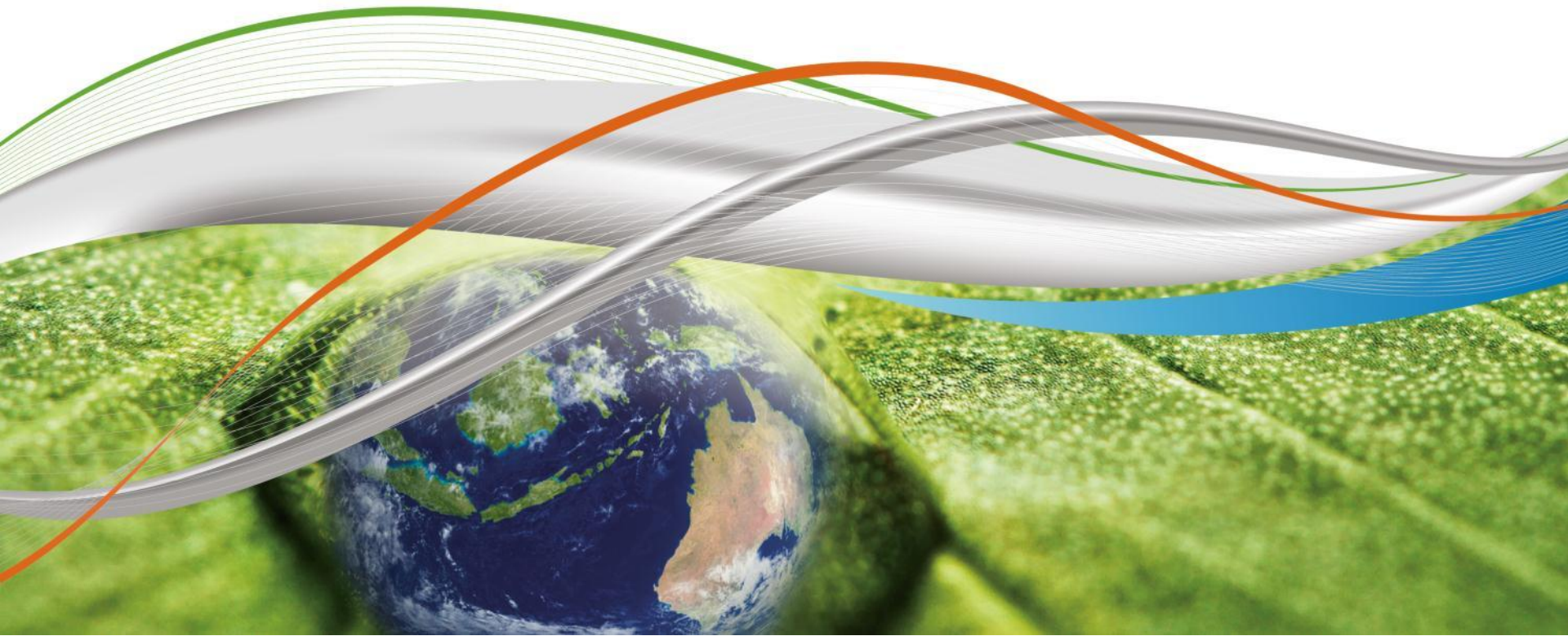


AGL Fugitive Methane Emissions Monitoring Program

JUSTINE FIRTH
7 MAY 2014



Overview

- Why are we monitoring for fugitive emissions?
- Monitoring program for the Camden Gas Project (CGP)
- Equipment
- Results
- Conclusion

Purpose of study

- Address community concerns:
 - What are the methane levels in Macarthur region?
 - Are the levels a health issue?
 - Is AGL a significant source of fugitive methane emissions?
- AGL's social responsibility
- Baseline methane levels in background locations

Characteristics of Methane

- Constitutes ~90-95% CSG from CGP (~3-5% carbon dioxide, 3-5% nitrogen, ~1% oxygen)
- Greenhouse Gas (latest figures report a 28 times greater contribution over 100 years compared to CO₂ (IPCC AR5, 2013))

Methane Overview

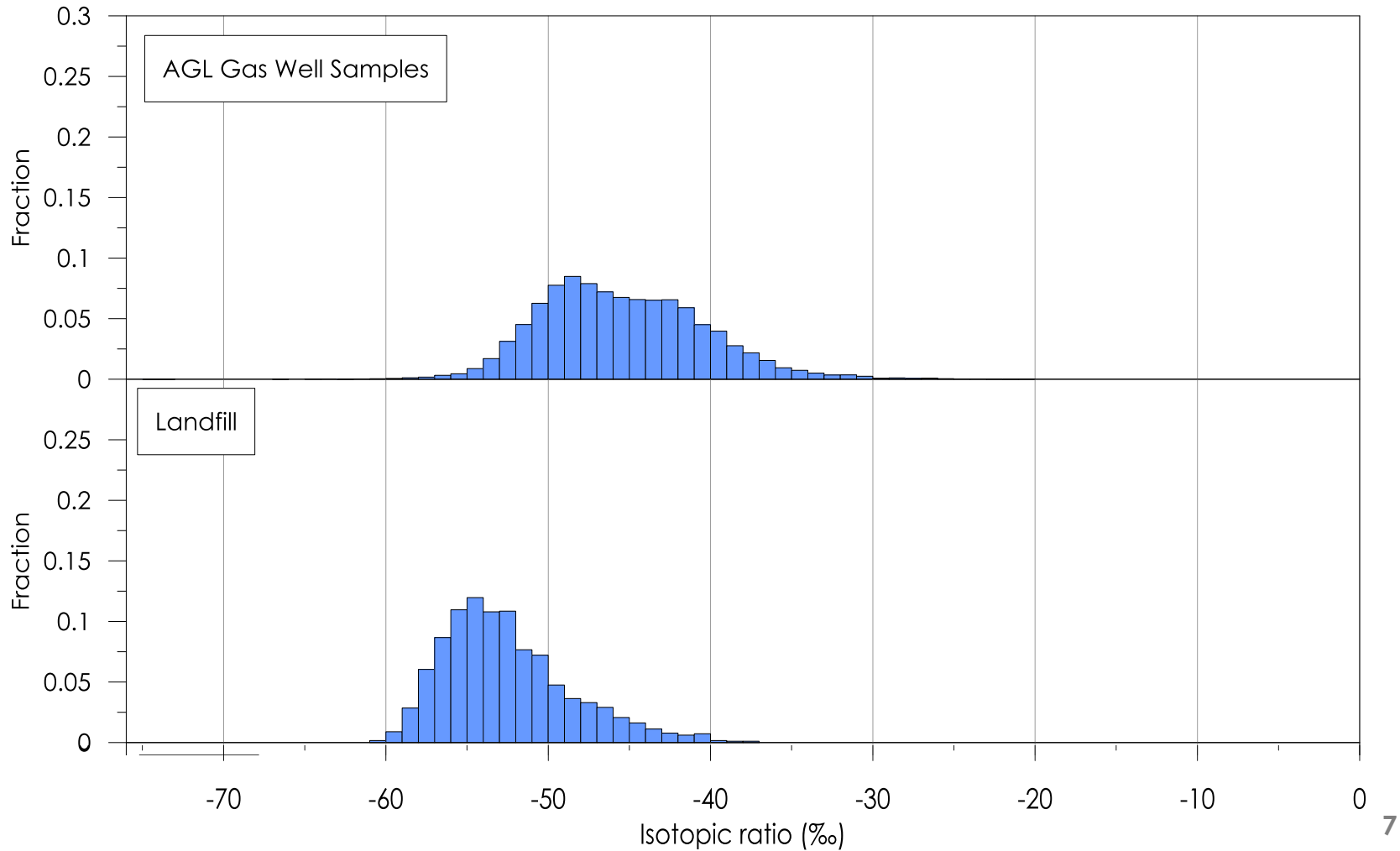
- No significant health criteria in NSW or Internationally:
 - 500,000ppm based on asphyxiation
 - 50,000ppm based on explosivity (LEL)
 - 1,000ppm occupational exposure criterion, based on 8-hour working day
- Naturally occurring e.g. coal seams, wetlands, permafrost, termite activity
- Man-made e.g. rice paddies, livestock, landfill, biomass burning, waste water treatment, natural gas distribution, coal mining
- Any of these may be expected to yield ambient methane concentrations of >10ppm
- Global background ~1.8ppm (WMO, 2013)
- Concentrations found to be greater in urban areas (e.g. London 1.8–3.0ppm)

Picarro Instrument

- PRP Condition U4.2 : *Investigation of Best Management Practices and Monitoring Techniques*
- A number of techniques and equipment types were investigated
- Picarro analyser was considered the most suitable for the field monitoring as it:
 - Laboratory Grade Instrumentation
 - Can be used for mobile applications
 - Methane concentration
 - 1 parts per billion (ppb) precision (1.8 parts per million (ppm) global background)
 - Determine ^{13}C isotopic signature of methane



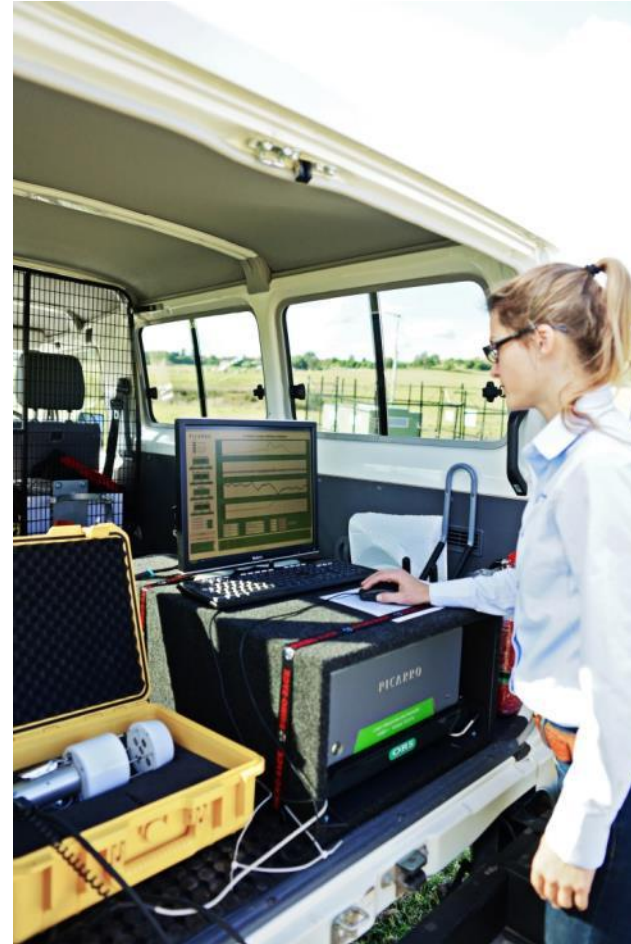
^{13}C Isotopic Signature



Equipment

- Mobile configuration
 - Toyota Landcruiser
 - Picarro analyser
 - GPS
 - Weather station

- 1-second measurements
 - methane concentration
 - ^{13}C Isotopic ratio
 - Wind speed
 - Wind direction
 - Latitude/longitude



Equipment



- Power supplied through Toyota Landcruiser Troop Carrier
- Sample line fixed to bull bar
- Review of data near real-time
- Instrumentation calibrated



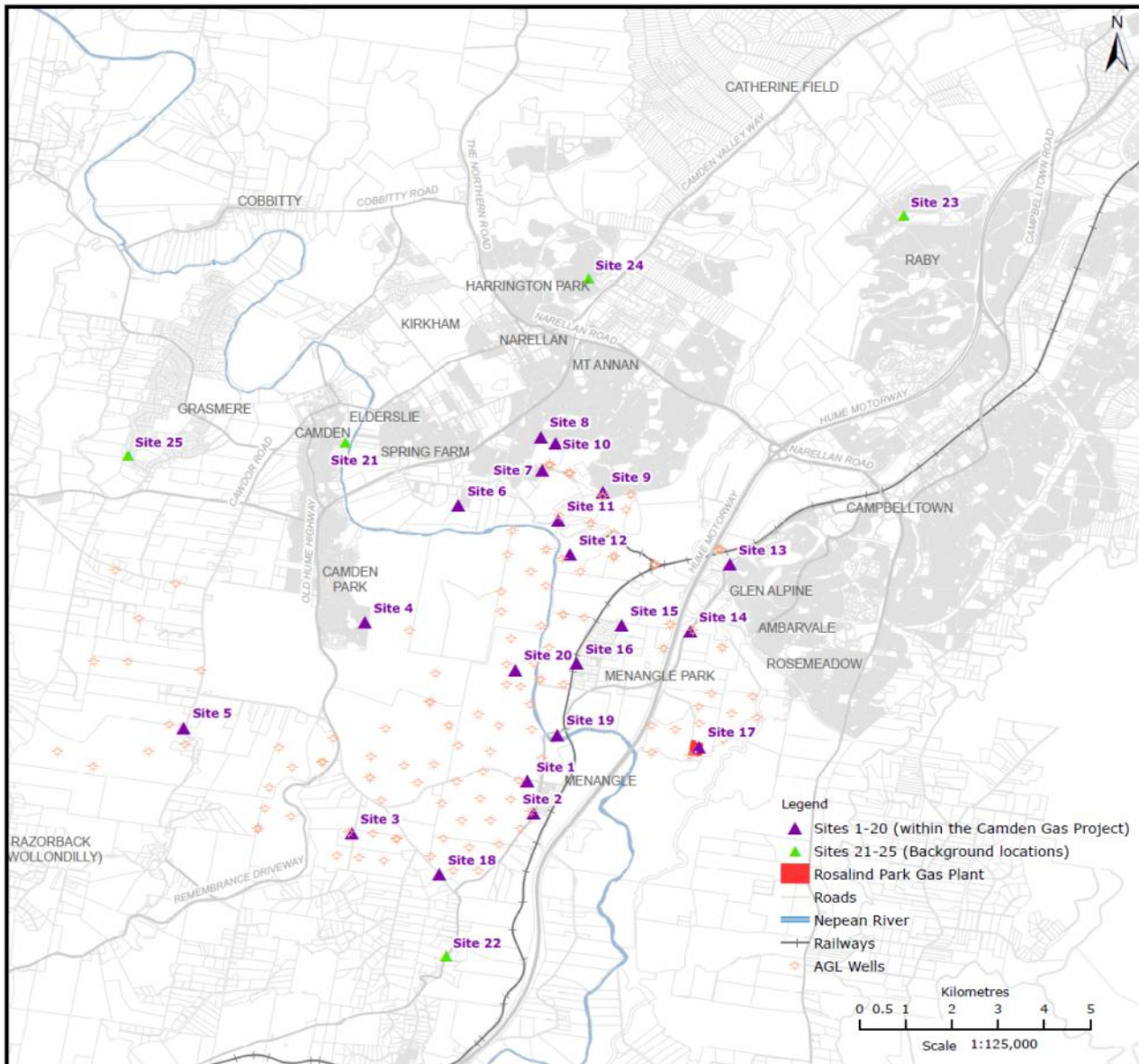
Monitoring Program

- 12 week monitoring program
 - Commenced 29 April 2013
 - Sites selected in consultation with the community
 - 25 sites visited over two days each week
 - 15-minutes at each monitoring site
 - Changing days and times of week
 - Night monitoring

- 25 monitoring locations
 - 20 selected sites in proximity to AGL wells
 - 5 background sites >2km from a well

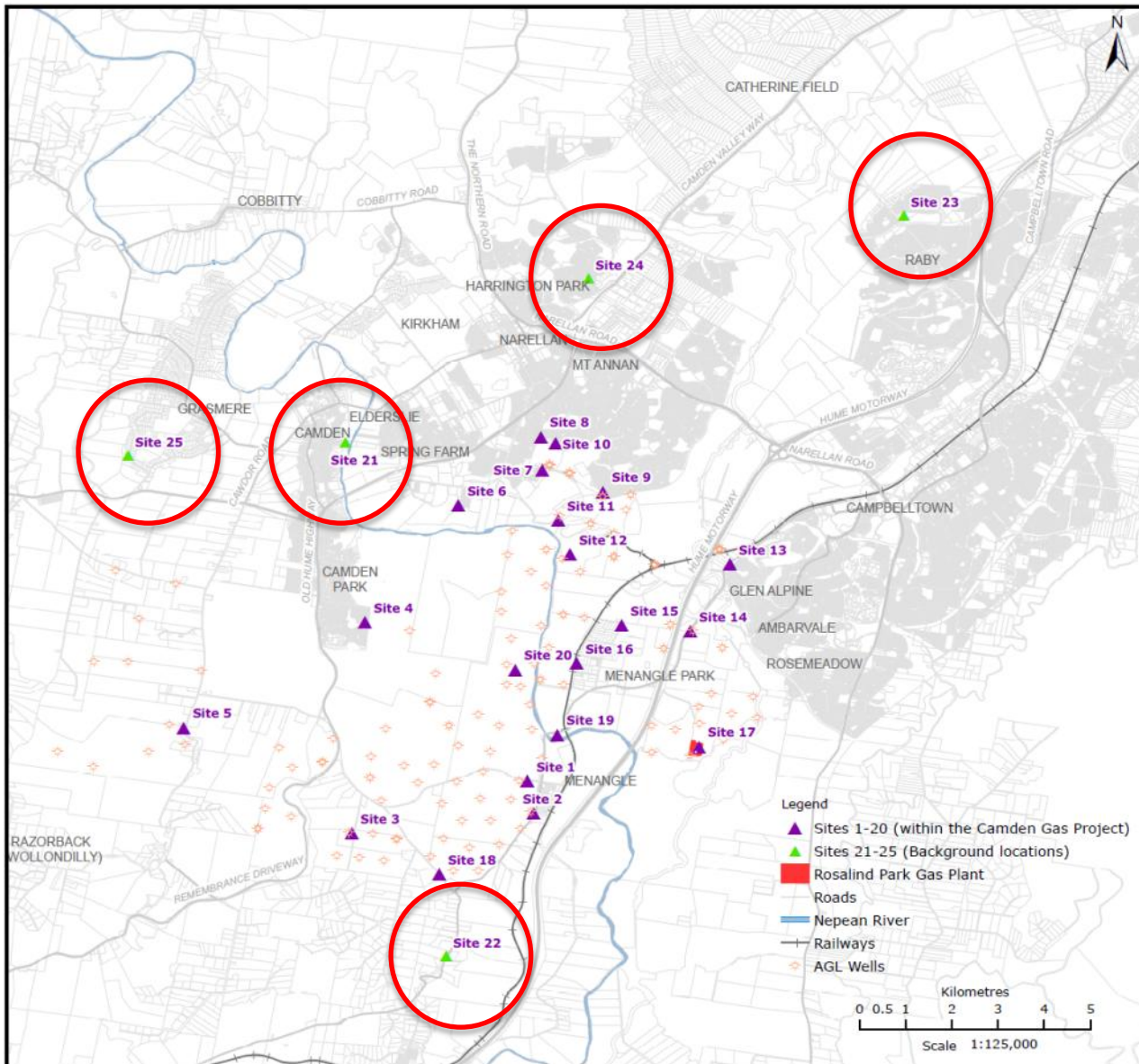
- Located near other methane sources
 - Land fill
 - Soil mix
 - Sewage treatment plant
 - Agriculture
 - Coal washery





Methane Monitoring Locations

Ref: 3189



Methane Monitoring Locations

Ref: 3189

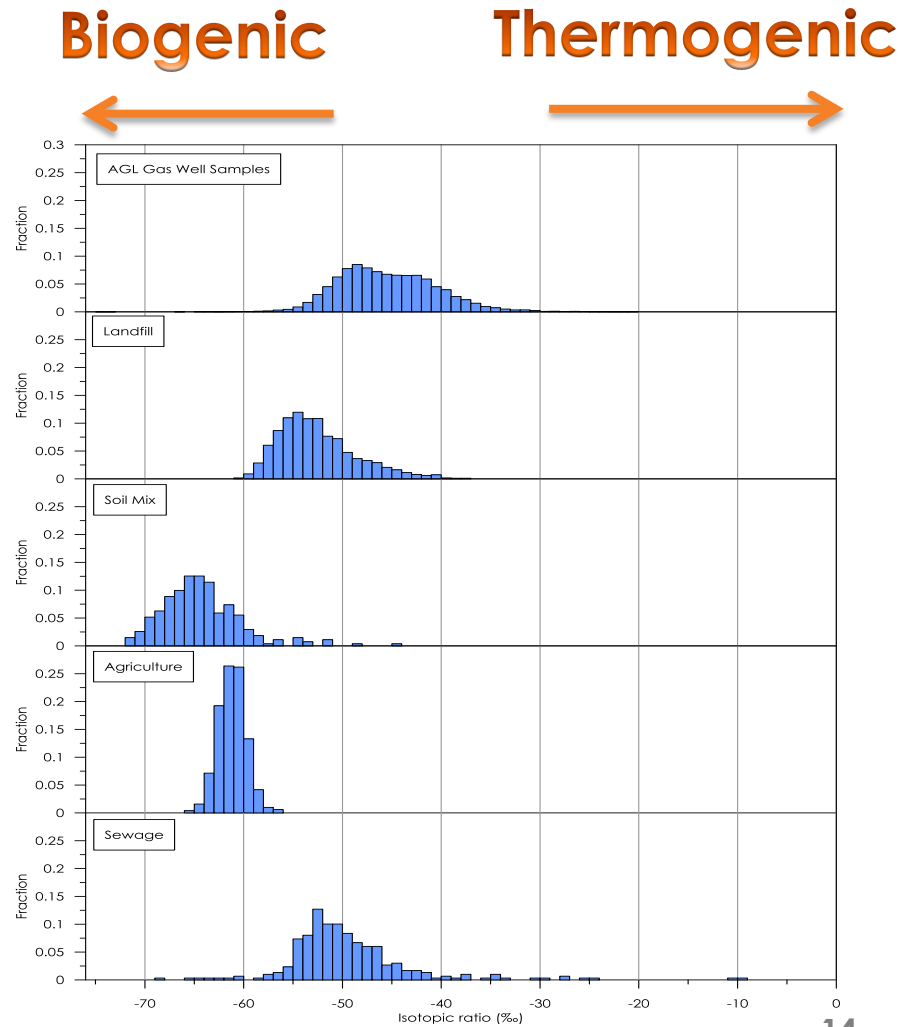
Reference Samples

- Need to characterise isotopic signature of other methane sources in Macarthur area
- Reference samples for methane isotopic signature
 - AGL CSG
 - Landfill
 - Fresh
 - Placed
 - Capped
 - Soil Mix
 - Livestock
 - Sewage



Reference Samples

- Samples showed a range in isotopic ratio values
- Isotopic readings overlap between source groups
- At lower methane concentrations (as measured in the field) there is more variability (or noise) in the readings
- This is because at ambient concentration (global average 1.8ppm) the methane measured will be a mixture of sources
- For this reason, ^{13}C isotopic signature considered indicative



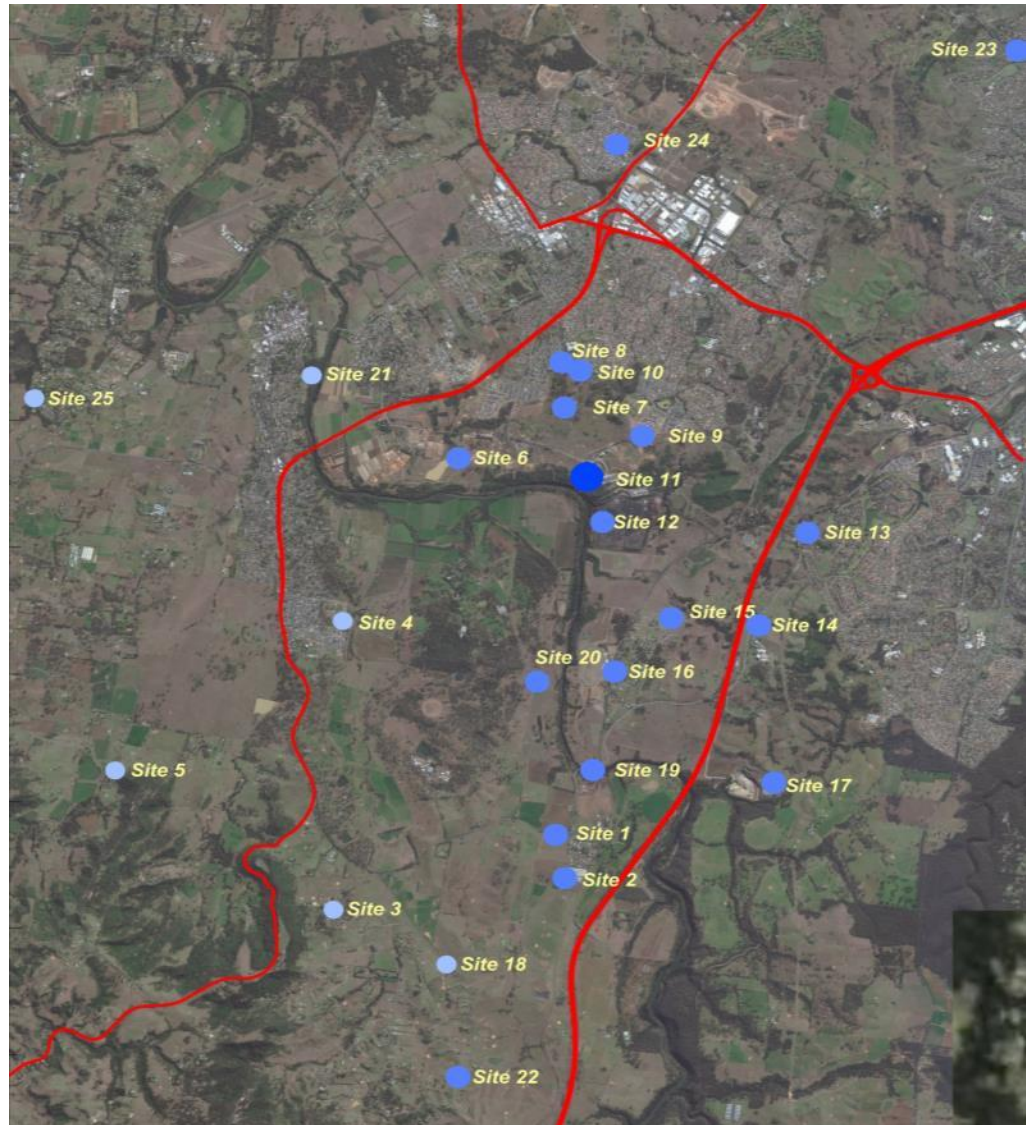
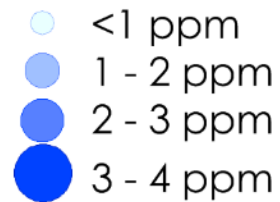
Results - Overview

- 75 hours of 1-second interval methane data was measured over the 12 weeks
- Over the 12 week monitoring program the average methane concentration was 2.1ppm. This is just above the global background average of ~1.8ppm and in line with urban values ranging between 1.8–3.0ppm
- The average methane concentration:
 - Sites 1 – 20: 2.1ppm
 - Sites 21-25: 2.0ppm
- 15-minute average methane concentration of methane ranged between 1.7ppm to 16.6ppm with a maximum one second methane concentration of 23.2ppm.
- 15-minute average ^{13}C isotopic ratio ranged between -36‰ and -52‰
- Night monitoring during Week 11 showed diurnal variations in methane concentrations

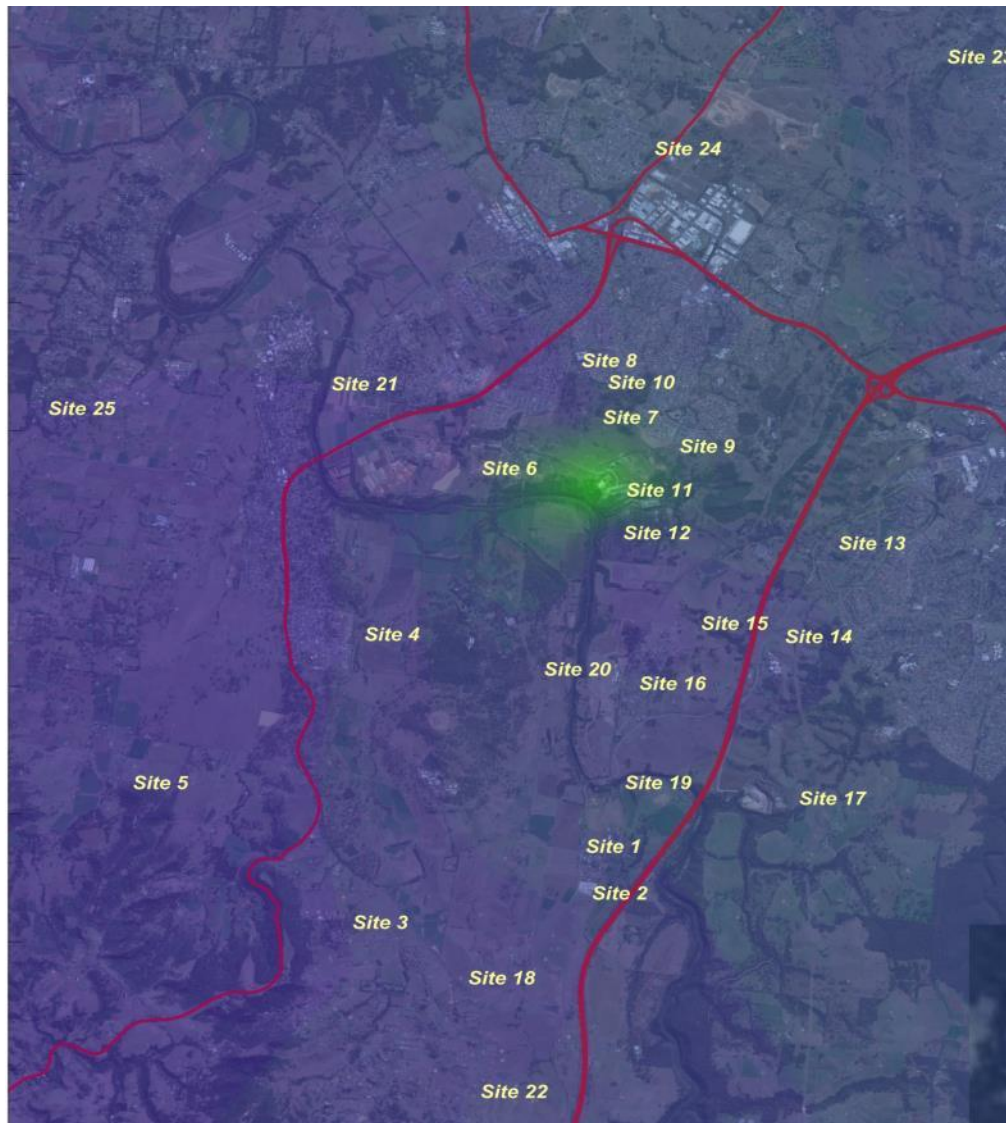
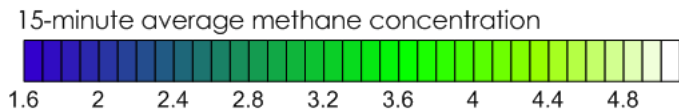
Summary of 15-minute data by site

Monitoring site	Average	Minimum	Maximum
Site 1	2.1	1.8	3.3
Site 2	2.0	1.8	2.9
Site 3	1.9	1.7	2.6
Site 4	1.9	1.7	2.8
Site 5	1.8	1.7	2.2
Site 6	2.0	1.7	2.5
Site 7	2.0	1.8	2.7
Site 8	2.0	1.7	2.9
Site 9	2.4	1.7	4.2
Site 10	2.1	1.8	3.5
Site 11	3.8	1.8	16.6
Site 12	2.0	1.7	2.7
Site 13	2.2	1.7	3.2
Site 14	2.0	1.7	2.5
Site 15	2.0	1.7	2.8
Site 16	2.0	1.7	2.4
Site 17	2.2	1.7	3.5
Site 18	1.9	1.7	2.8
Site 19	2.1	1.7	3.1
Site 20	2.1	1.7	3.0
Site 21	1.9	1.7	2.5
Site 22	2.0	1.7	2.6
Site 23	2.1	1.7	2.9
Site 24	2.3	1.8	4.7
Site 25	1.9	1.7	2.5

15-minute average
methane
concentration across
12 week monitoring
program

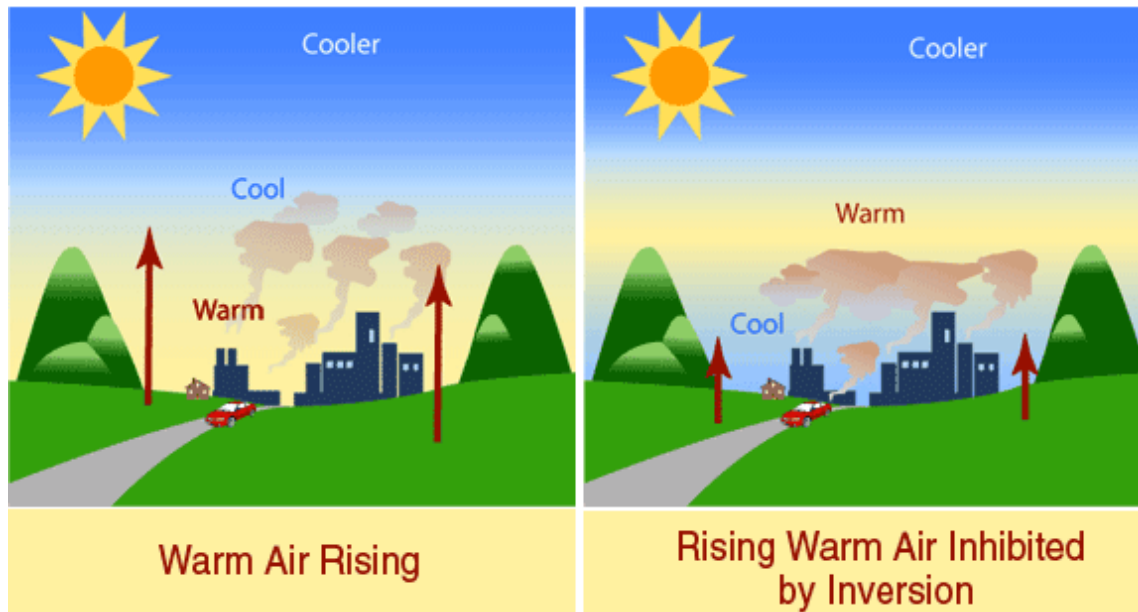


15-minute average
methane
concentration across
12 week monitoring
program



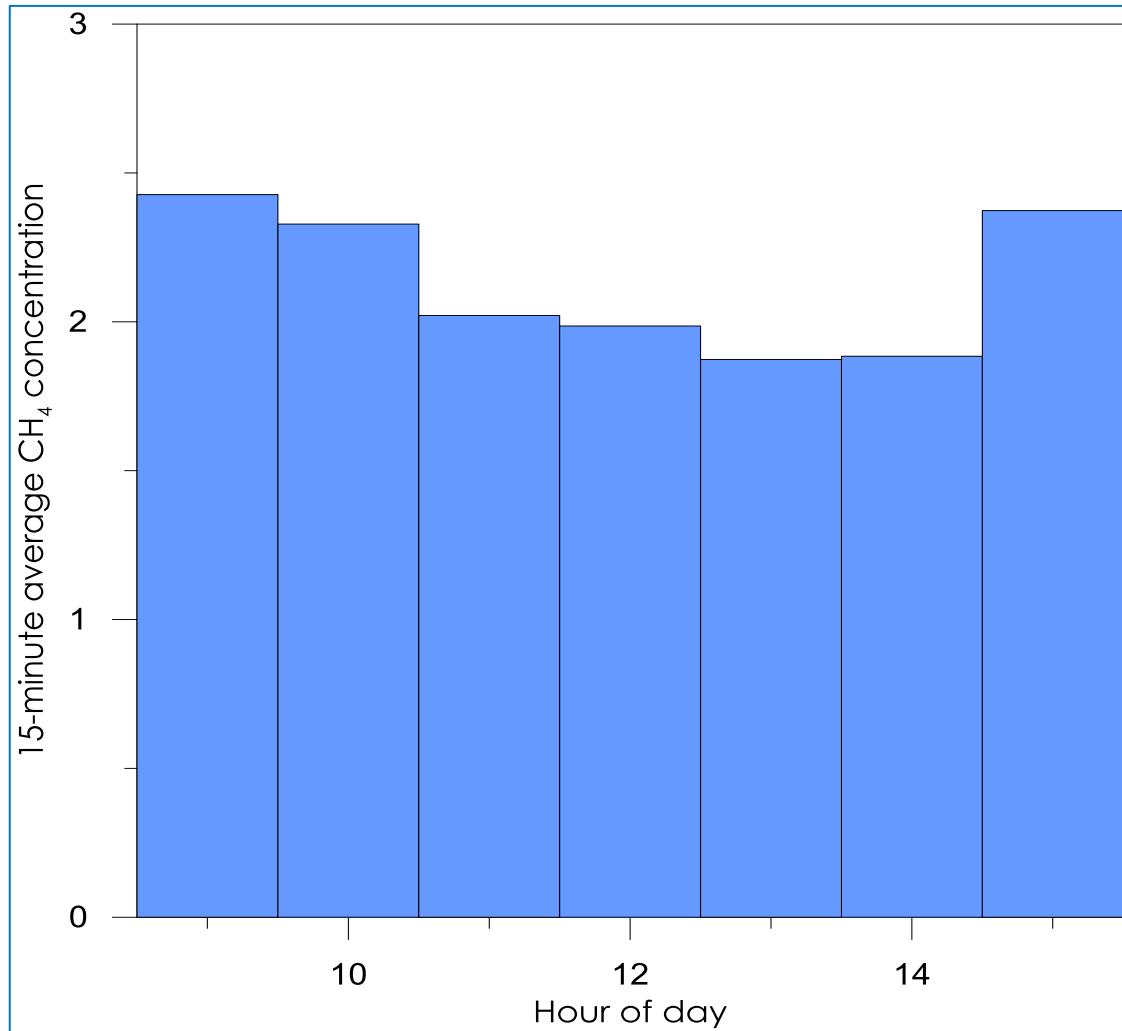
Results - Meteorology

- Meteorology has an influence on methane concentrations
- Temperature inversions can lead to elevated measurements
- Lower levels measured in afternoon or on windy days
- Diurnal variations in methane concentrations

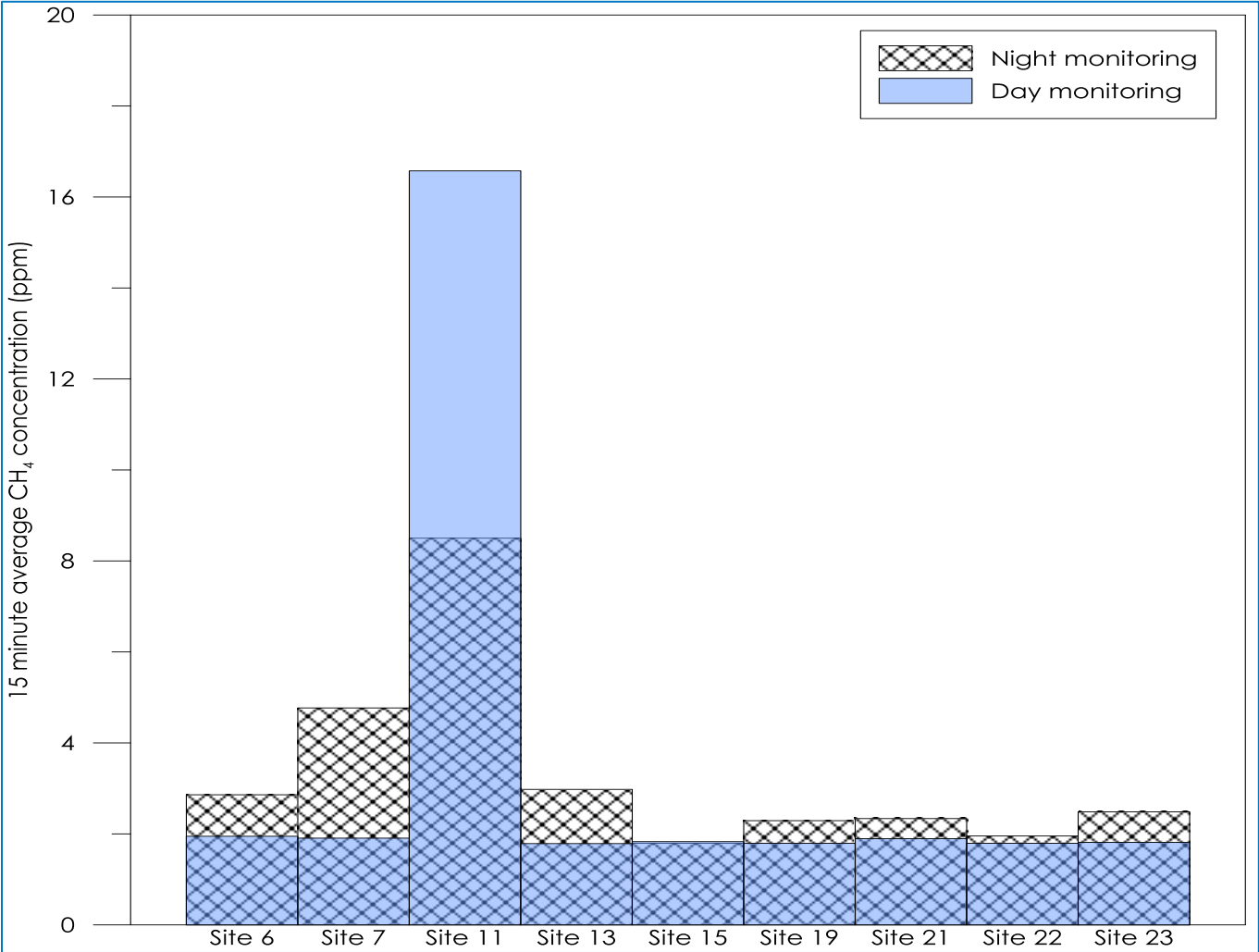


Source: <http://pollutionfree.files.wordpress.com>

Results – Diurnal variation



Results Week 11 – Night Monitoring

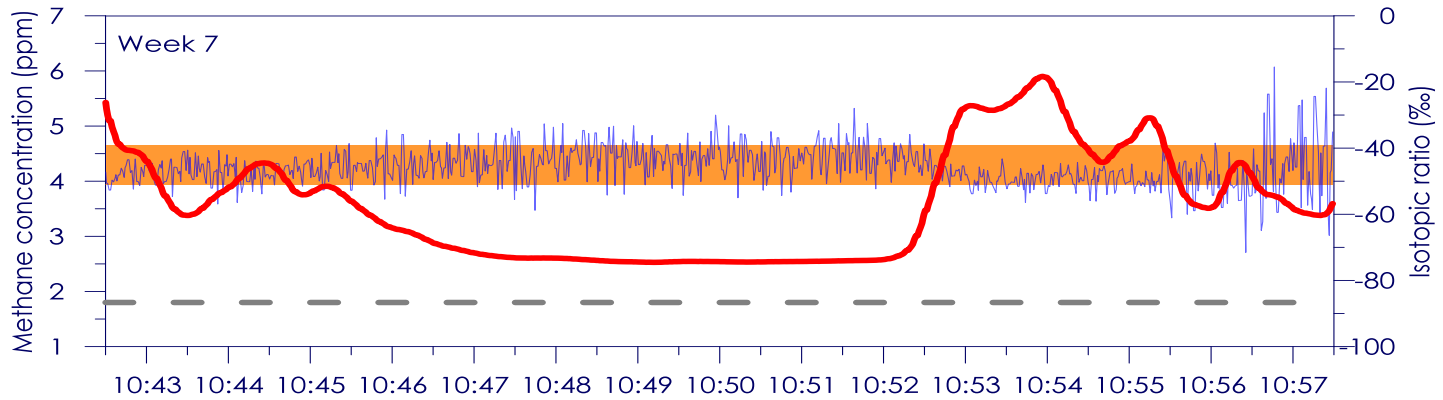


Results ^{13}C isotopic ratio

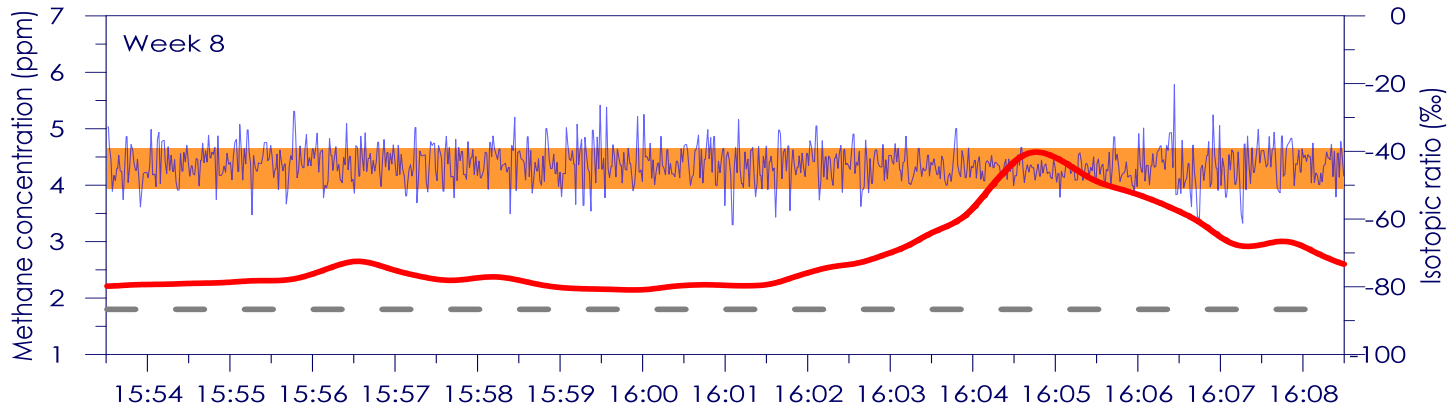
- Given the low concentrations measured, difficult to make strong conclusions around much of the ^{13}C isotopic ratio data
- No significant difference in ^{13}C isotopic ratio between background and CGP sites
- ^{13}C isotopic ratio measured as part of this study were found to be 'lighter' than values established for residential in other studies
- Suggests that there are greater contributions from 'lighter' methane sources (i.e. biogenic sources)
- On occasion where spikes in methane concentration was observed it was easier to differentiate the ^{13}C isotopic ratio



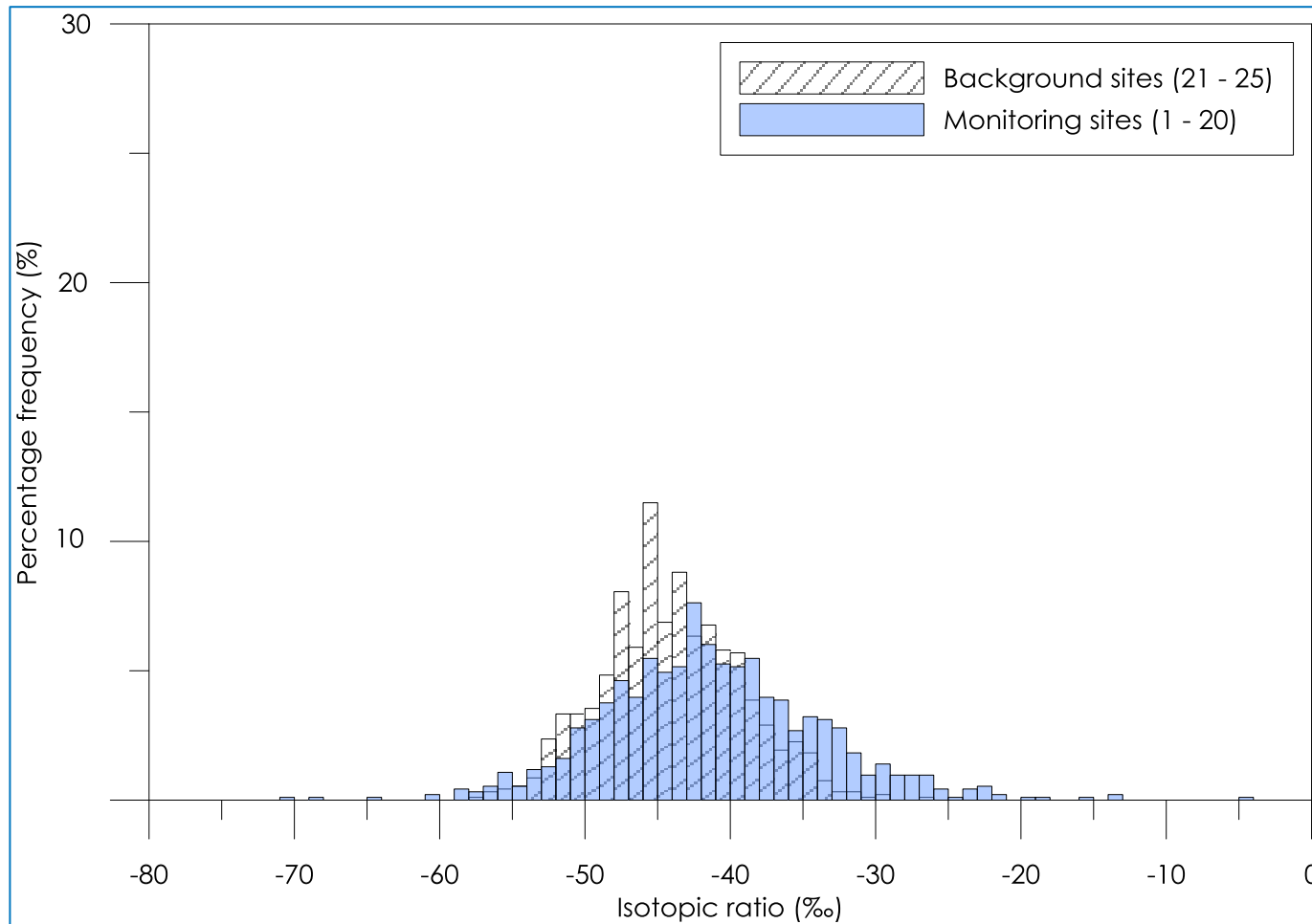
Site 11



Site 17



Results - ^{13}C isotopic ratio



Conclusion

- 12 week monitoring campaign for Camden Gas Project.
- This study is considered to represent an indicative screening analysis of the current conditions in the vicinity of the Camden Gas Project.
- Methodology and Technical Report reviewed by CSIRO.
- Over the 12 week monitoring program the average methane concentration was 2.1ppm. This is just above the global background average of ~1.8ppm and in line with urban values ranging between 1.8–3.0ppm.
- These levels are not a health issue as asphyxiation levels are 250,000 times, and occupational criteria 500 times higher, than the observed methane concentrations in the Macarthur region.
- Results identify several influences of methane concentrations in the study area
- No significant difference was determined for methane concentrations measured within the CGP and the background sites when the influence of the landfill was removed from the dataset
- No significant difference in ^{13}C isotopic ratio values measured within the CGP and the background sites

Thank You

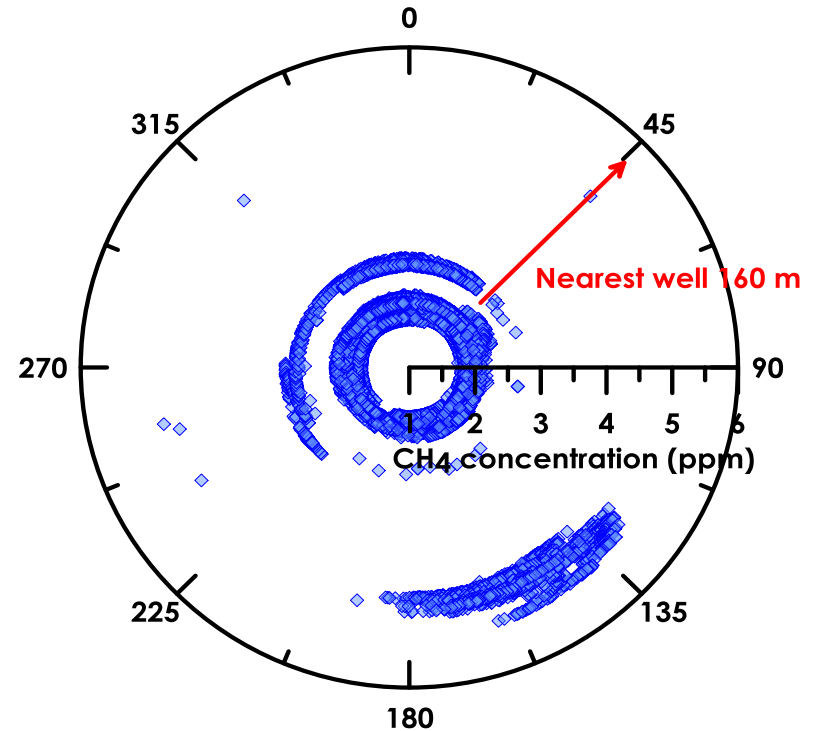


Acknowledgements: CSIRO

Q & A

Results - Sites

- 11 sites in close proximity (<300m) from AGL well
- Further analysis on upwind sources completed
- At most site the origin of fugitive emission was not discernable due to variability of the wind direction
- Site 7 Week 11 showed directional component, review of ^{13}C isotopic ratio indicated source likely to be biogenic

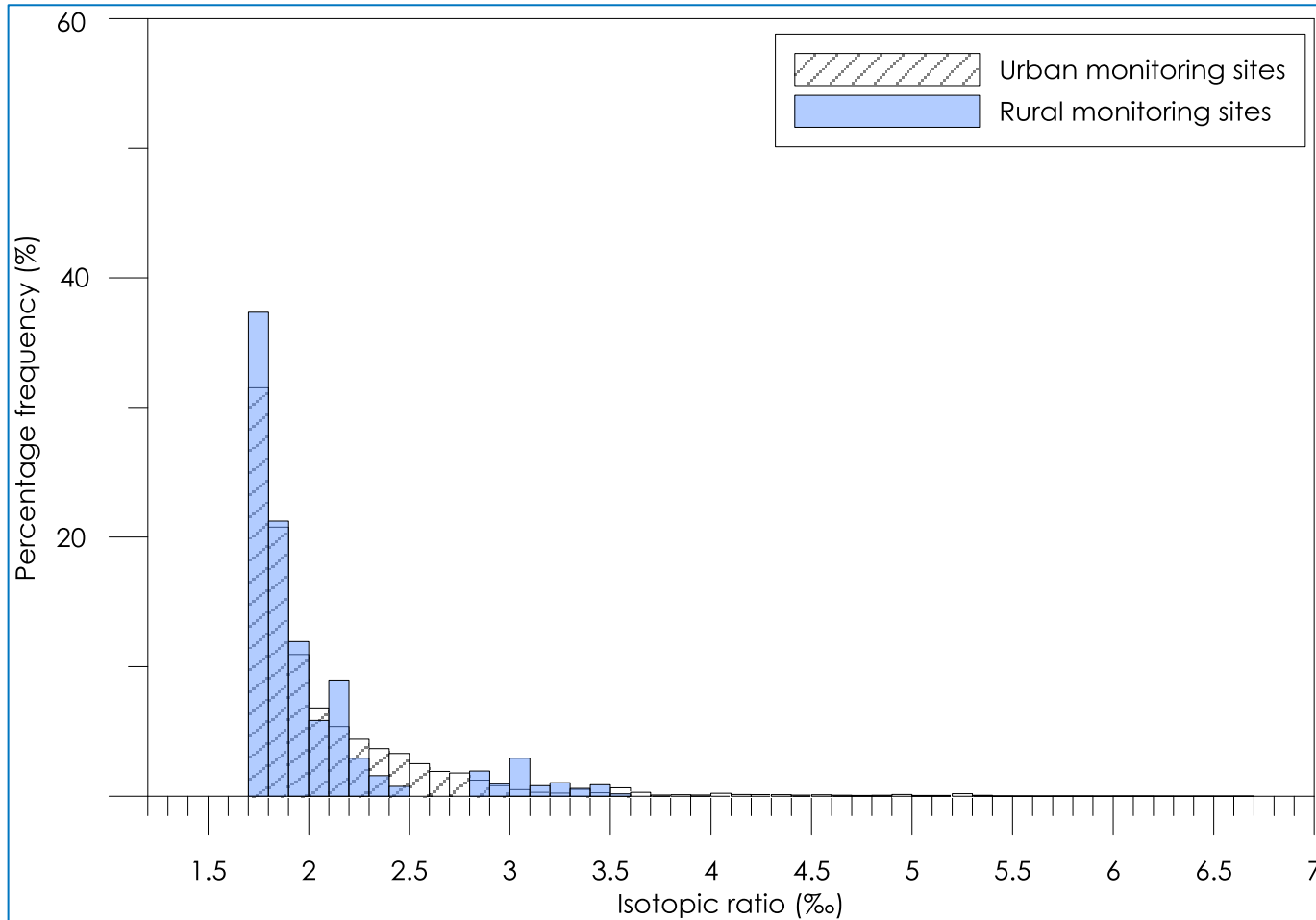


Results - Landuse

- Contributions from agriculture relatively small during study period
- Methane concentrations varied according to landuse:
 - Urban – mean of 2.2ppm
 - Rural – mean of 2.0ppm
- Statistical difference established



Results – Methane Concentration

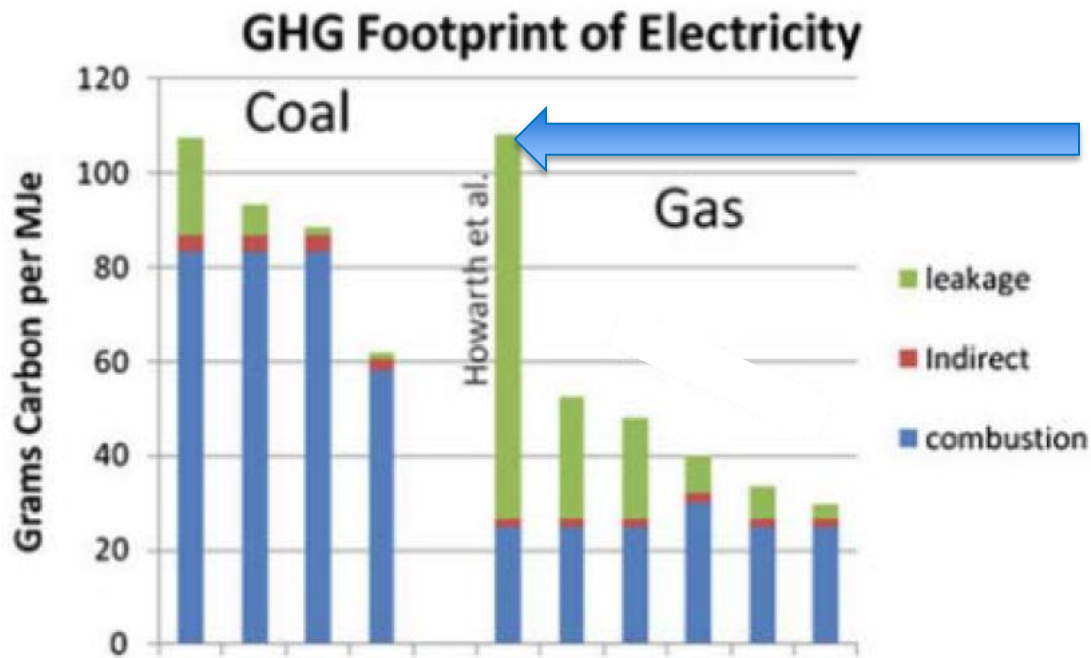


Results – Background vs CGP Sites

- The combined site average methane concentration over 12 weeks:
 - Sites 1 – 20: 2.1ppm
 - Sites 21 - 25: 2.0ppm
- Statistical analysis used on data to determine if there is a significant difference in CGP (Sites 1 – 20) and Background sites (Sites 21 – 25)
- Methane concentration:
 - Significant difference established
 - When sites close to landfill removed, no significant difference
 - Both areas show similar distributions in methane concentrations, consistent with natural variability of ambient methane.

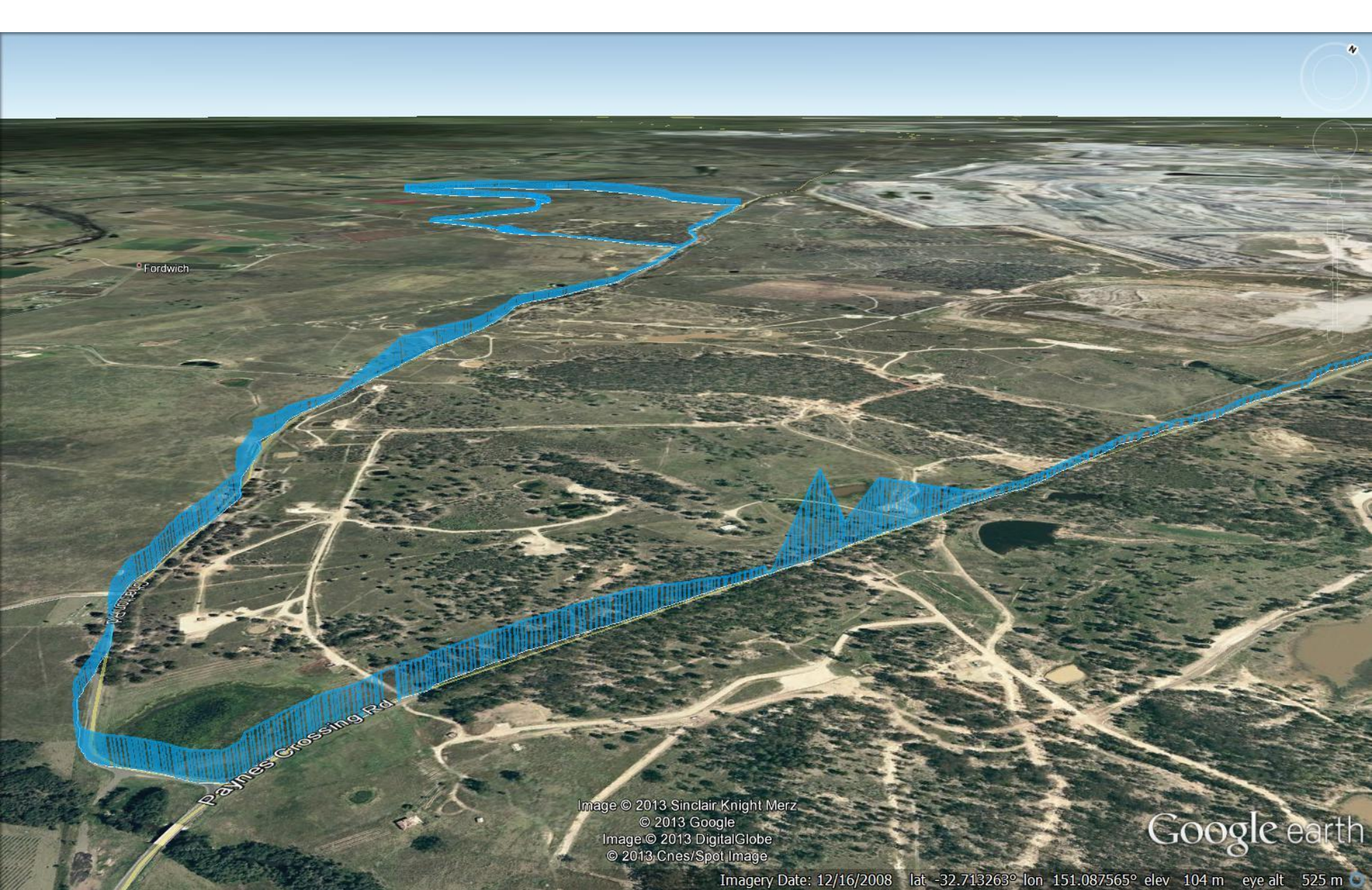
Why the Concern?

- Health (Community)
- Leak detection (Industry)
- Baseline Evaluation
- Greenhouse Gas Quantification



Howarth et al, 2011
(Cornell University)

Carbon emissions for coal and gas under various scenarios (CSIRO, after Cathies et al, 2012) 32



Fordwich

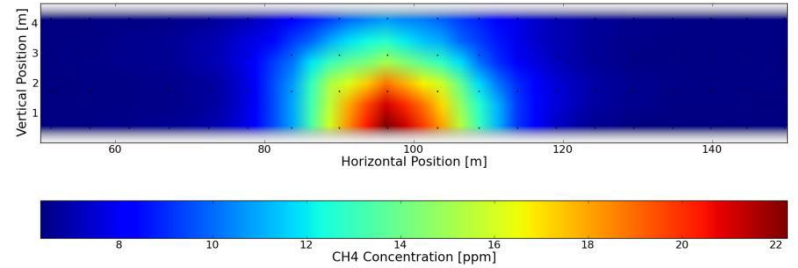
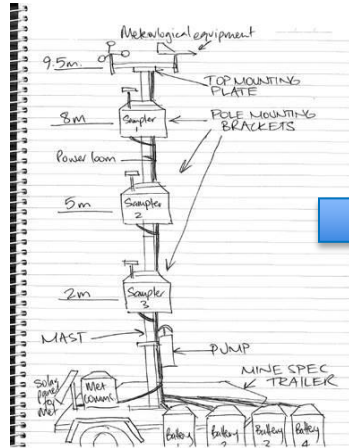
Paynes Crossing Rd

Paynes Crossing Rd

Image © 2013 Sinclair Knight Merz
© 2013 Google
Image © 2013 DigitalGlobe
© 2013 Cnes/Spot Image

Google earth

Imagery Date: 12/16/2008 lat -32.713263° lon 151.087565° elev 104 m eye alt 525 m

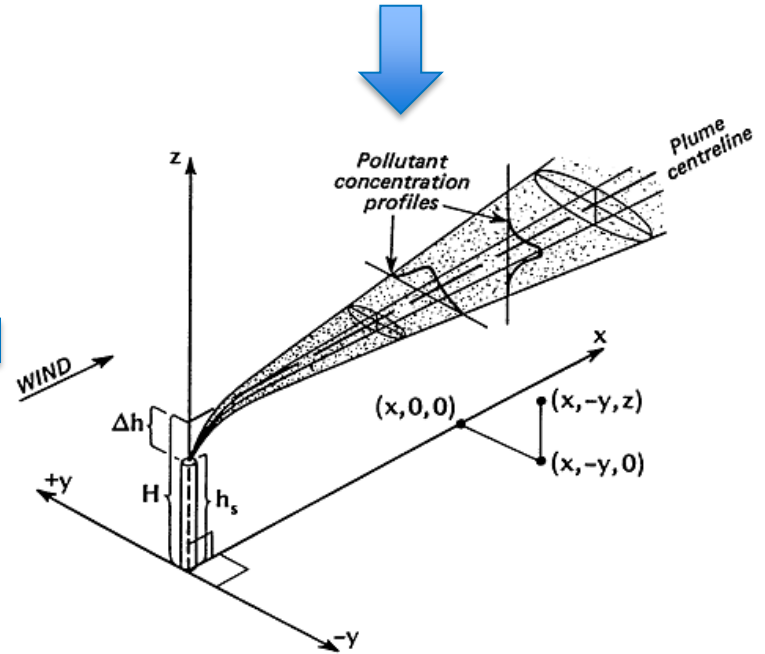
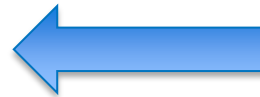


Vertical Measurement of Concentration and Met

Spatial Distribution of Concentration



**Methane Flux
(mass per unit time)**

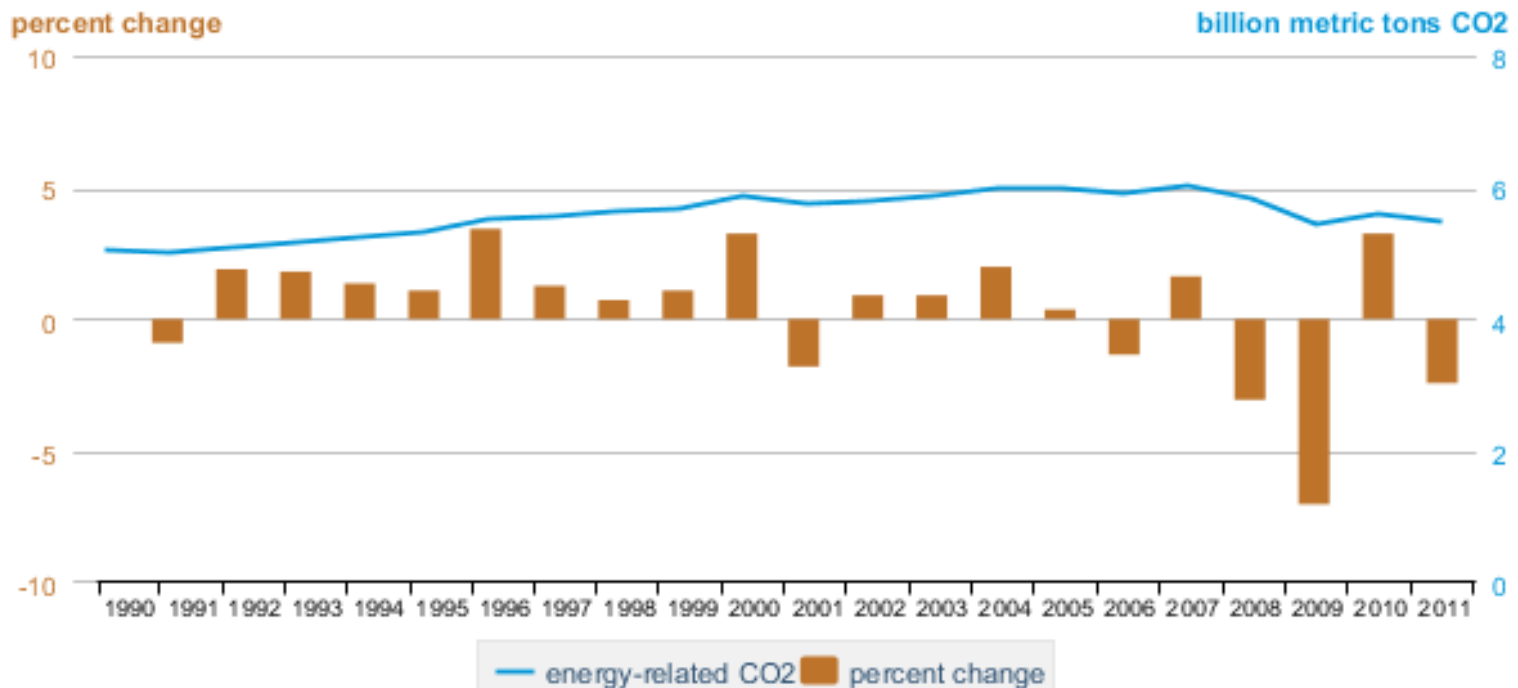


**Gaussian Plume
Formula**

Something Provocative..

- If you care about the environment, shouldn't you care about CSG?

Energy-related carbon dioxide emissions, 1990-2011



Source: U.S. Energy Information Administration, *Monthly Energy Review* (July 2012), Table 12.1.