

AGL Gloucester – Evidence Matrix

POTENTIAL SOURCE	EVIDENCE	CONCLUSION
<p>1. BTEX introduced during fracture stimulation process by AGL or other relevant contractors</p>	<ul style="list-style-type: none"> • Flowback water samples analysed from Waukivory wells 11, 13 & 14 between 28/01/14 & 06/02/15 by AGL, EPA & DRE indicated elevated readings of BTEX. ⁱ • BTEX chemicals were not present in the chemicals constituting the fracture stimulation fluid used in the fracture stimulation process at the time of independent sampling by DRE and EPA and testing at NATA accredited labs (EPA and ALS) • AGL stated they have always complied with condition L9.1 of EPL 20358 which prohibits the use of chemicals ⁱⁱcontaining BTEX compounds ⁱⁱⁱ (denials) • When questioned AGL denied introducing BTEX chemicals into the fracture stimulation fluid and produced test results of samples taken from the fracture stimulation fluid and tested at SGS, a NATA Accredited lab. • Source water and fracturing stimulation fluid formations were 	<p>If the BTEX was introduced during the fracture stimulation process it would be reasonable to find consistent patterns of BTEX levels across all wells. To the contrary, the evidence from the various samples taken is not showing a similar pattern across all 4 wells. In particular Waukivory 12 has tested with low levels of BTEX (well below baseline results) throughout the extraction of the flowback water.</p> <p>An elevated level of BTEX is not as a result of being introduced during the fracture stimulation process.</p>

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	<p>tested prior to the fracture stimulation process to determine if the fluids used were BTEX free – SGS Labs analysed the samples and found them to be BTEX free^{iv}</p> <ul style="list-style-type: none"> • An analysis of the water samples taken from each well shows inconsistent patterns in the levels of BTEX. 	
<p>Sampling errors - contamination</p>	<ul style="list-style-type: none"> • The sampling that was conducted by AGL, EPA and DRE are returning consistent BTEX results. 	<p>Given the number of results taken from AGL, DRE and EPA, it is not considered the elevated levels of BTEX in the flowback water were as a result of sampling errors.</p> <p>The samples were all forwarded to NATA accredited laboratories – ALS, EPA and SGS.</p>
<p>Naturally occurring BTEX – in the coal seams and strata</p>	<ul style="list-style-type: none"> • Peter McGowan (BAppSc, MSc) concluded after reviewing AGL’s operations pertaining to the drilling and fracture stimulation of the well – <i>BTEX compounds have been reported to be present in coal formations.</i>^v • A report by Burns (1982) identified oil bearing coal in the Gloucester Basin (Wards River conglomerate) when Esso were drilling^{vi} • A report by Thornton (1982) concluded “<i>the geochemical results</i> 	<p>It is well recognised that BTEX is found within coal seams and naturally occurring oil. Specifically, relatively high concentrations of benzene and toluene were detected from the late Permian Avon and Stratford Coal Measures in the Gloucester basin. See Attachment 1 Map for the bore hole locations from which samples were collected for analysis in the reports Burns 1982, Thornton 1982, CSIRO 1983 and CSIRO 2010.</p> <p>Based on the evidence, on the balance of probabilities, the conclusion is the elevated BTEX levels identified in the flowback from WK 11, 13 and 14 is naturally occurring for the following reasons</p> <ol style="list-style-type: none"> 1. BTEX compounds occur naturally in crude oil 2. Independent reports have identified elevated levels of BTEX (particularly Benzene and Toluene) in the Bowens Road and Glenview coal seams 3. WK11 and 13 were fracture stimulated in the Glenview and

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	<p><i>show that the shales and coals through the Permian Section were both suitably rich and mature for the generation of hydrocarbons.^{vii}</i></p> <ul style="list-style-type: none"> • Analysis by CSIRO (1983) of coals from the late Permian Avon and Stratford Coal Measures from the Gloucester Basin identified the presence of a relatively high concentration of benzene and toluene. These elevated levels were observed in chromatograms for the Bowens Road and Glenview seams (Figures 10 and 11 in the CSIRO report)^{viii} • Analysis by CSIRO (2010) of seven (7) coals samples from the Wards River 03 Corehole. The samples were taken from the Bowens Road and Avon seams in the Gloucester Basin. Analysis identified traces of oil droplets in the samples taken from the Bowens Road seam at 337.31m, 363.5m and 391.2m^{ix} • Flowback water sample analysis of Waukivory 12 did not identify elevated levels of BTEX (this well was not perforated at the lower 	<p>Bowens Road coal seam</p> <ol style="list-style-type: none"> 4. WK 11 and 13 have elevated levels of BTEX particularly Benzene and Toluene 5. WK 12 was not fracture stimulated in the Glenview or Bowens Road coal seams, and did not perforate or fracture stimulate below the Fairbairns Road seam 6. WK 12 has consistently recorded low readings (below baseline) of BTEX across all sampling 7. As the flowback water was removed from the wells an upward trend in recorded levels of BTEX occurred in WK 11 and 13. This is consistent with the interpretation that the naturally occurring BTEX is progressively dissolving into the flow back water and the concentration increases with time.
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	<p>depths into the Glenview or Bowens Road seams.^x</p> <ul style="list-style-type: none">• More than 50% of the total volume of flowback water has been removed from Waukivory 12• Waukivory wells 13 & 11 were both perforated in the Glenview and Bowens Road seams with the levels of BTEX detected increasing as the flowback water was removed from the wells – currently 40% of the volume of flowback water has been removed from Waukivory 13 and 25% from Waukivory 11.^{xi}• Waukivory 14 well has been perforated in the Avon seam and not the Bowens Road or Glenview seams with 29% of the volume of flowback water removed. This would provide an explanation as to why the levels of BTEX analysed in the samples is decreasing as the water originally used to fracture stimulate the Avon seam has been removed with no intermingling of hydrocarbons from the Bowens Road seam as is the case with Waukivory wells 11 & 13.	
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	<ul style="list-style-type: none"> • WK14 did not fracture stimulate either the Bowens Road or Glenview seams but did fracture stimulate the Avon seam. The Avon seam was not fractured in WK12 but was fractured in both WK11 & WK13. • Independent advice received from A/Prof Manny Haghighi (Australian School of Petroleum-University of Adelaide) states BTEX compounds are naturally occurring in coal seams and the results of the flowback water sample analysis indicate the BTEX levels detected were not as a result of introduction in the fracture stimulation process • Dr Frederic Leusch and Dr Michael Bartkow of Griffith University state BTEX are naturally-occurring compounds in crude oil. Benzene for example is found at levels up to 4 g/l in crude petroleum...^{xii} 	
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ⁱ AGL sample analysis (Work Order ES1502205 – ALS Environmental), EPA Report 201500033 (Envirolab Services Pty Ltd) dated 25 February 2015, NSW Trade and Investment (Work Orders, ES1501813, 1502575, 1502602 & 1502687)

ⁱⁱ Jenny McMahon Head of Environment – Upstream Gas AGL *Potential causes of BTEX* – Coal Rev4.doc_06.02.2015AGL, pg 5

ⁱⁱⁱ AGL letter to EPA dated 06/02/2015 pg 5

^{iv} SGS Lab report SGS M14055AR2 (*Potential causes of BTEX* – Coal Rev4.doc_06.02.2015AGL pg 4)

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^v Peter McGowan – Advice on the sampling and analysis of flowback water samples. 6 February 2015 pg 7

^{vi} B.J Burns *Geochemical report on oils and rock extracts from two coal bores, in the Gloucester Basin, N.S.W 1982*

^{vii} R.C.N Thornton *Oil occurrence in ESSO stratigraphic corehole C 7029 Gloucester Basin 1982*

^{viii} J.W Hunt, R.P Philip and A. Telfer *Petrography and Geochemistry of coals from the late Permian Avon and Stratford Coal Measures in the Gloucester Basin N.S.W* CSIRO 1983

^{ix} Laura McParland, Kaydy Pinetown & Neil Sherwood *Coal Petrology Report Wards River 03 (WR03) Gloucester Basin* CSIRO October 2010

^x AGL sample analysis (Work Order ES1502205 – ALS Environmental), EPA Report 201500033 (Envirolab Services Pty Ltd) dated 25 February 2015, NSW Trade and Investment (Work Orders, ES1501813, 1502575, 1502602 & 1502687), AGL schematic diagram Waukivory 12

^{xi} AGL schematic diagrams and flowback volume reports

^{xii} Dr Frederic Leusch & Dr Michael Bartkow *A short primer on benzene, toluene, ethylbenzene and xylenes (BTEX) in the environment and in hydraulic fracturing fluids* Griffith University 17 Nov 2010 pg 2