Our vision is of healthy, empowered communities which have fair, democratic processes available to them to protect their land and water and deliver sustainable solutions to food and energy needs.

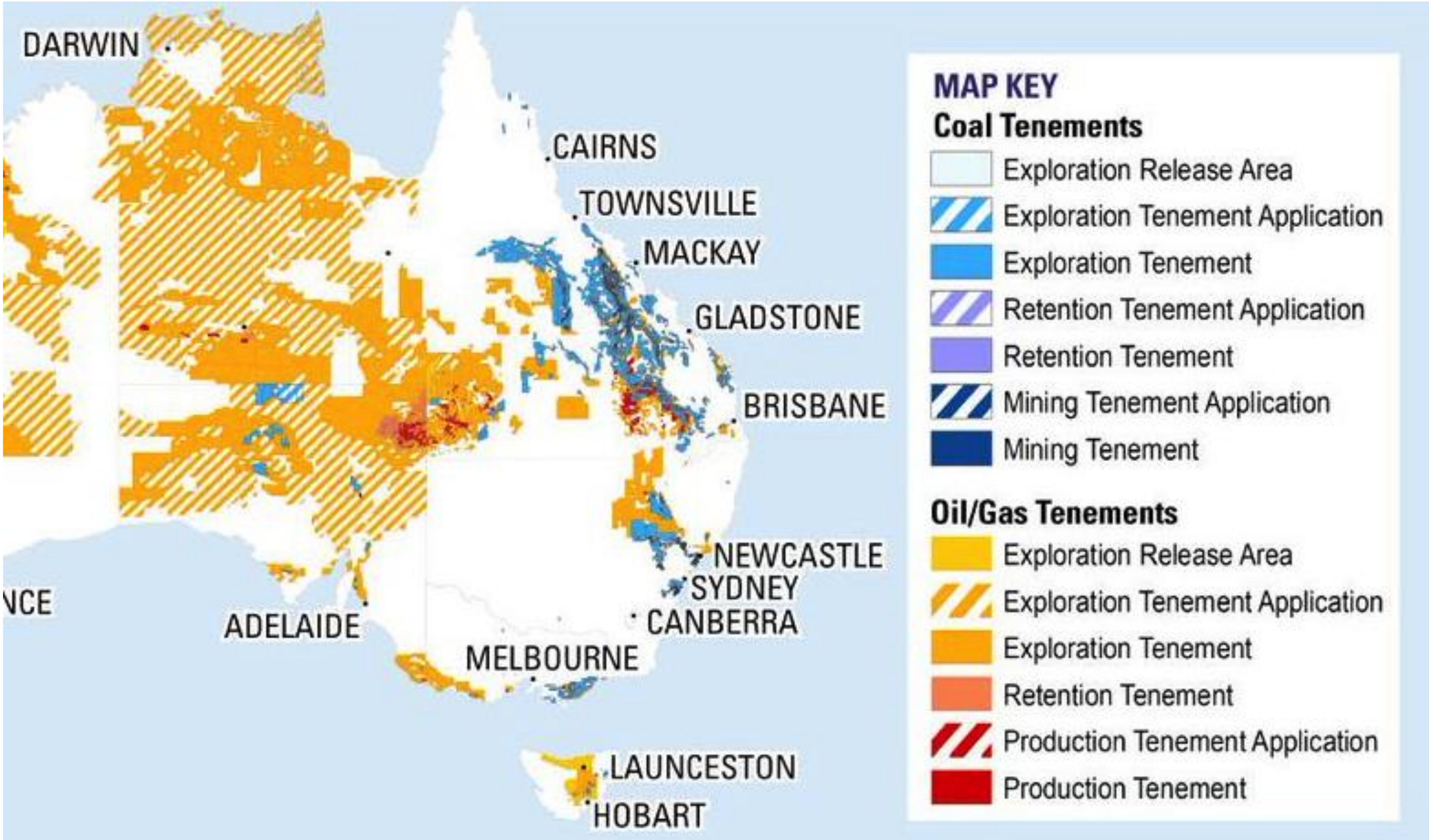
Key points

- Scale of the shale gas industry and the number of wells required is overlooked
- The risk factors are greater due to thousands of wells required and thousands of horizontal hydraulic fractures, pipelines and infrastructure
- High regulatory burden is not in shale gas industry’s interest due to shale gas extraction in the NT having a high cost of production
- Recent overwhelming scientific peer-reviewed evidence, shows harm and pollution increasing

Fracking Inquiry TOR

- 1. assess the scientific evidence to determine the **nature and extent of the environmental impacts and risks**, including the **cumulative impacts and risks**, associated with hydraulic fracturing of unconventional reservoirs and the Associated Activities in the Northern Territory;

NT Licenses and Applications



THE SCIENCE ON SHALE GAS DEVELOPMENT

A Survey of the Environmental Public Health Literature

The scientific community is **only beginning to understand** the impacts of shale and tight gas development on human health and the environment. Many data gaps remain, but **numerous hazards and risks have been identified.**

685+ Current total of peer-reviewed publications on the impacts of shale or tight gas development

80%+ More than 80% of all the peer-reviewed literature has been published since January 2013.

Number of peer-reviewed articles published per year

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- Air Quality
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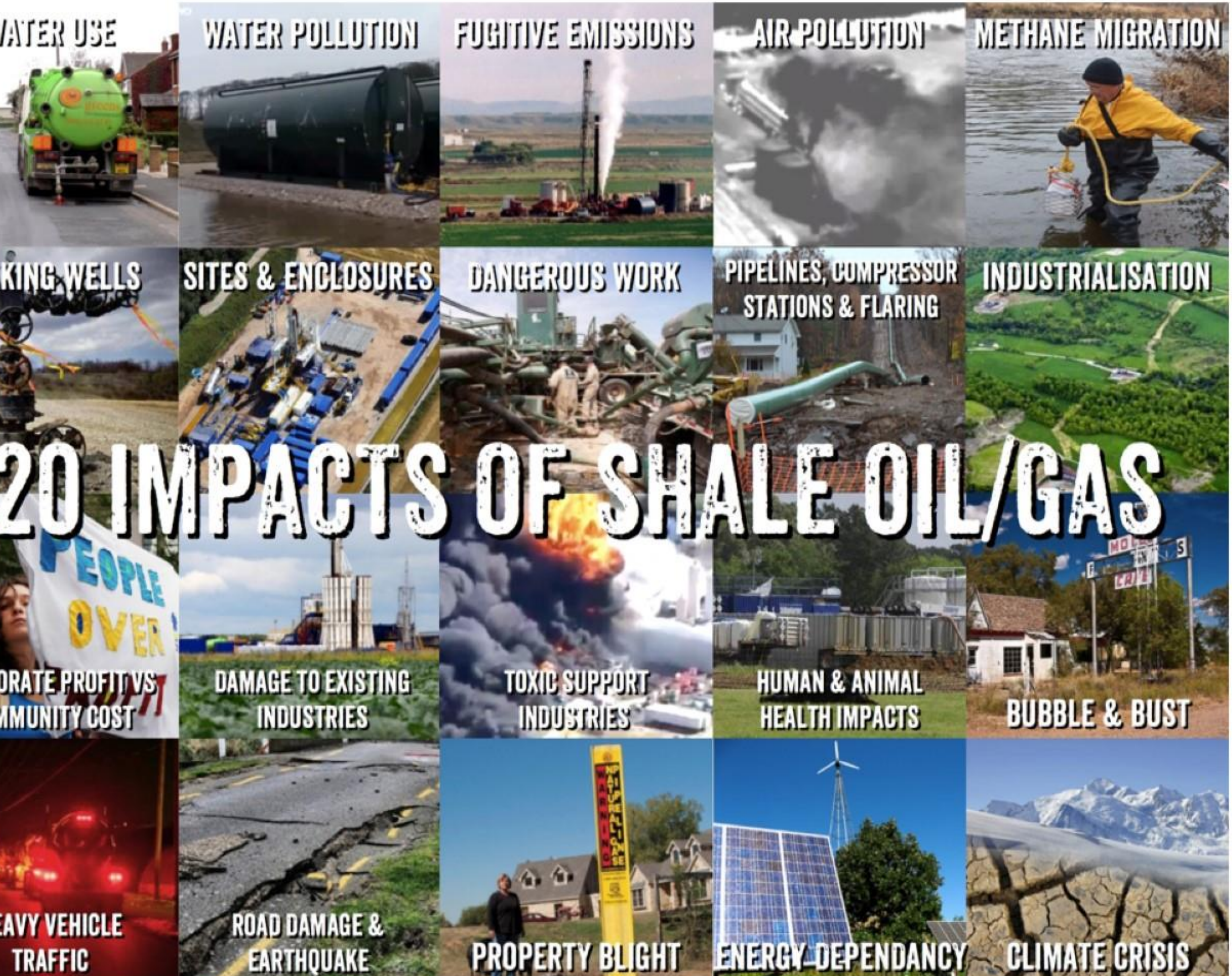
- Economics
- General
- Health
- Regulation
- Seismicity
- Waste/Fluids
- Water Quality
- Water Usage

Title	Creator	Date Modified
2017 One-Year Seismic-Hazard Forecast for the Central and Ea…	Petersen et al.	3/7/2017 3:35 AM
A bridge to nowhere: methane emissions and the greenhouse ga…	Howarth	8/25/2015 11:29 PM
A commentary on "The greenhouse-gas footprint of natural gas…	Cathles et al.	2/4/2017 11:12 AM
A Comprehensive Analysis of Groundwater Quality in The Barne…	Hildenbrand et al.	6/18/2015 12:11 AM
A conceptual model of the socioeconomic impacts of unconvent…	Measham et al.	3/28/2016 11:58 PM
A critical assessment of the efficacy of biocides used durin…	Struchtemeyer et al.	2/4/2017 11:11 AM
A critical evaluation of unconventional gas recovery from th…	Lee et al.	2/4/2017 9:11 AM
A Critical Review of the Risks to Water Resources from Uncon…	Vengosh et al.	4/29/2014 11:26 PM

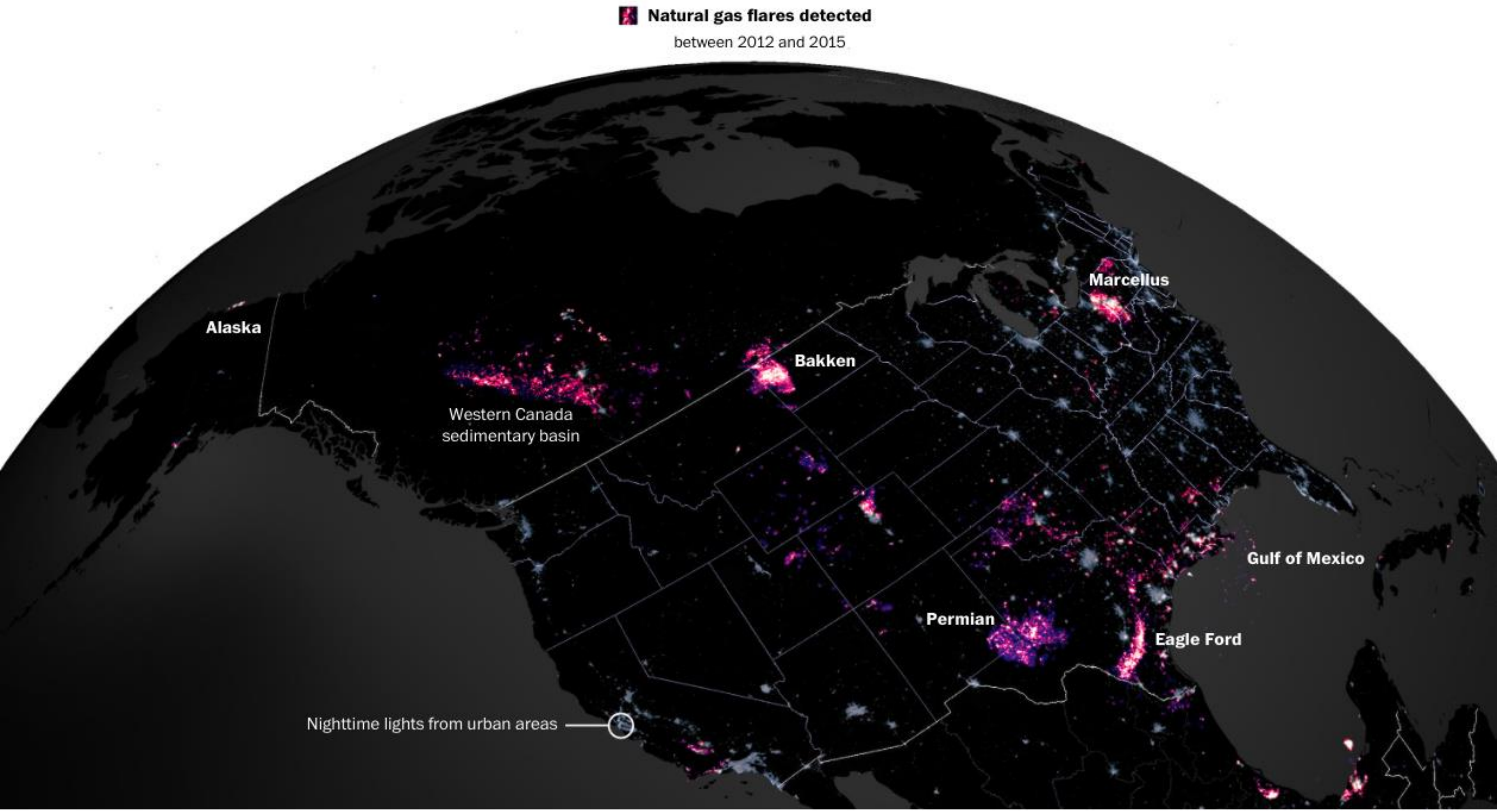


VATER USE
WATER POLLUTION
FUGITIVE EMISSIONS
AIR POLLUTION
METHANE MIGRATION
KING WELLS
SITES & ENCLOSURES
DANGEROUS WORK
PIPELINES, COMPRESSOR STATIONS & FLARING
INDUSTRIALISATION
20 IMPACTS OF SHALE OIL/GAS
PEOPLE OVER
ORATE PROFIT VS MMUNITY COST
DAMAGE TO EXISTING INDUSTRIES
TOXIC SUPPORT INDUSTRIES
HUMAN & ANIMAL HEALTH IMPACTS
BUBBLE & BUST
EAVY VEHICLE TRAFFIC
ROAD DAMAGE & EARTHQUAKE
PROPERTY BLIGHT
ENERGY DEPENDANCY
CLIMATE CRISIS

Shale gas fracking is invasive. It interferes with pre-existing industries, putting livelihoods at risk.

Hundreds, then thousands of shale wells are needed.

This is a Texas shale gasfield, Eagleford.



Natural gas flares detected
between 2012 and 2015
Alaska
Western Canada
sedimentary basin
Bakken
Marcellus
Gulf of Mexico
Permian
Eagle Ford
Nighttime lights from urban areas

Figure 5: These two satellite images from 1984 and 2011 show the high density of wells where over 1000 UG well pads (small, white dots) were cut into the Louisiana landscape (USA), most of them in recent years, as use of hydraulic fracturing technology became widespread.

The exploitation of UG has a significant footprint on the landscape (see Figure 5). As compared with CG, UG requires significantly more wells due to the limited area exploited per well (1 km^2) and shorter life span (five to 15 years), with most of the production occurring over the first six months (IEA, 2012). Each well requires approximately one to two hectares (ha) of land plus road networks (Belvalkar and Oyewole, 2010). Drilling also requires the clearing of land, which has a negative impact on landscapes and biodiversity, and can lead to significant soil erosion and sediment disposition (Adams et al., 2011). Horizontal drilling allows multiple wells


© 2013 Google
Google earth


Multiple Well Sites &
Compressor Station

Basin	Basin area (km2)	Number of shale gas wells	Water needed for fracking (GL)	Fracking water per year (GL)	Groundwater sustainable yield (GL/yr)	Groundwater abstraction (GL/yr)	Water footprint compared to gas footprint
Amadeus	162,294	12,679	190.2	7.6	142	14	26
Arckaringa	87,331	6,823	102.3	4.1	12	11	167
Bowen	161,559	12,622	189.3	7.6	224	101	17
Canning	534,046	41,722	625.8	25.0	834	22	15
Clarence-Morton	45,861	3,583	53.7	2.1	705	168	1.5
Cooper	121,382	9,483	142.2	5.7	20	29	139
Galilee	337,973	26,404	396.1	15.8	106	99	73
Georgina	362,638	28,331	425.0	17.0	241	64	34
McArthur	198,480	15,506	232.6	9.3	749	9	6
Officer	333,657	26,067	391.0	15.6	249	<1	31
Otway (onshore)	44,105	3,446	51.7	2.1	1,998	238	0.5
Perth	186,678	14,584	218.8	8.8	1,609	677	3
Sydney	60,630	4,737	71.1	2.8	896	79	2
Wiso	138,586	10,827	162.4	6.5	106	4	30

Table 2: Shale gas basins in Australia showing the potential number of wells (assuming well space of 800 metres and fairways making up 5% of the basin). The estimated volume of water needed to frack these wells assumes 15 ML/well. The volume of fracking water per year assumes a 25 year life span of the field.

Groundwater sustainable yield and groundwater abstraction values from NLWRA (2001) and AWR2005 (http://www.water.gov.au/). Shale gas basin boundaries were used to clip all groundwater management units (GMUs) within the shale gas basin and a *pro rata* estimate of sustainable yield made based on NLWRA 2001. Water footprint is the factor by which the area of land needed to sustainably withdraw 15 ML of water for fracking exceeds the area of land (640,000 m^2) covered by each gas well.

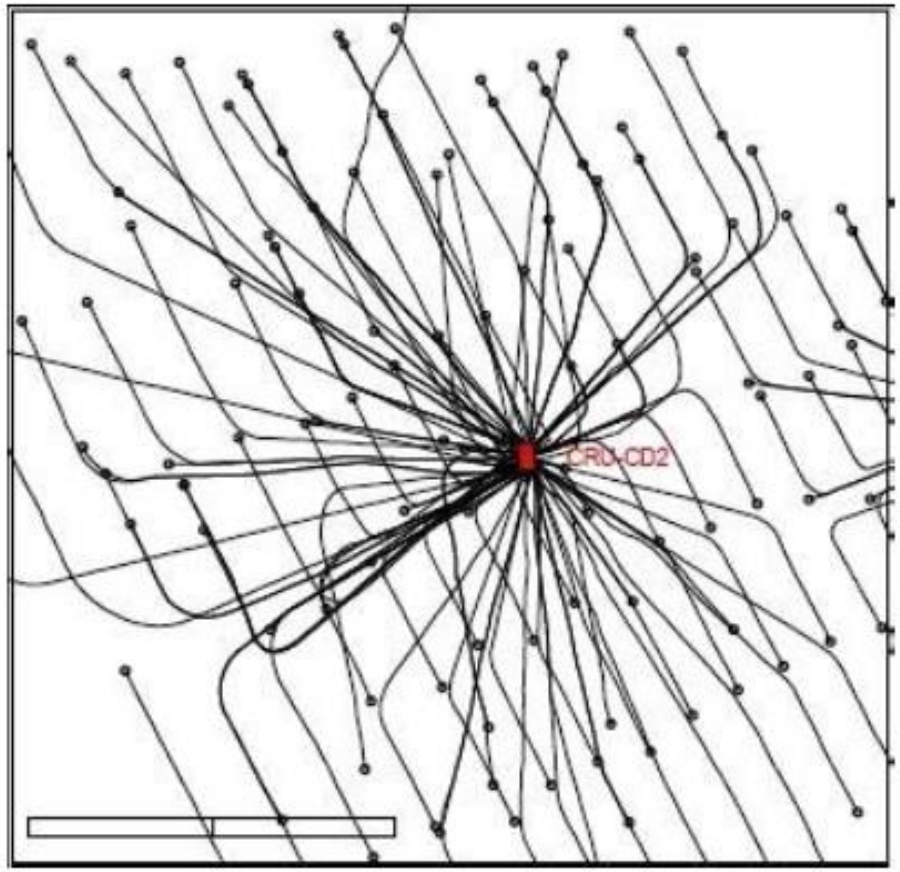


Figure 3. An octopused multi-well pad. The surface multi-well pad is shown in red with the wells (Black lines) radiating out underground. 2,000 acres of shale reservoirs can be fracked from one 7 acre pad. Source: Hicks 2012.

Well integrity

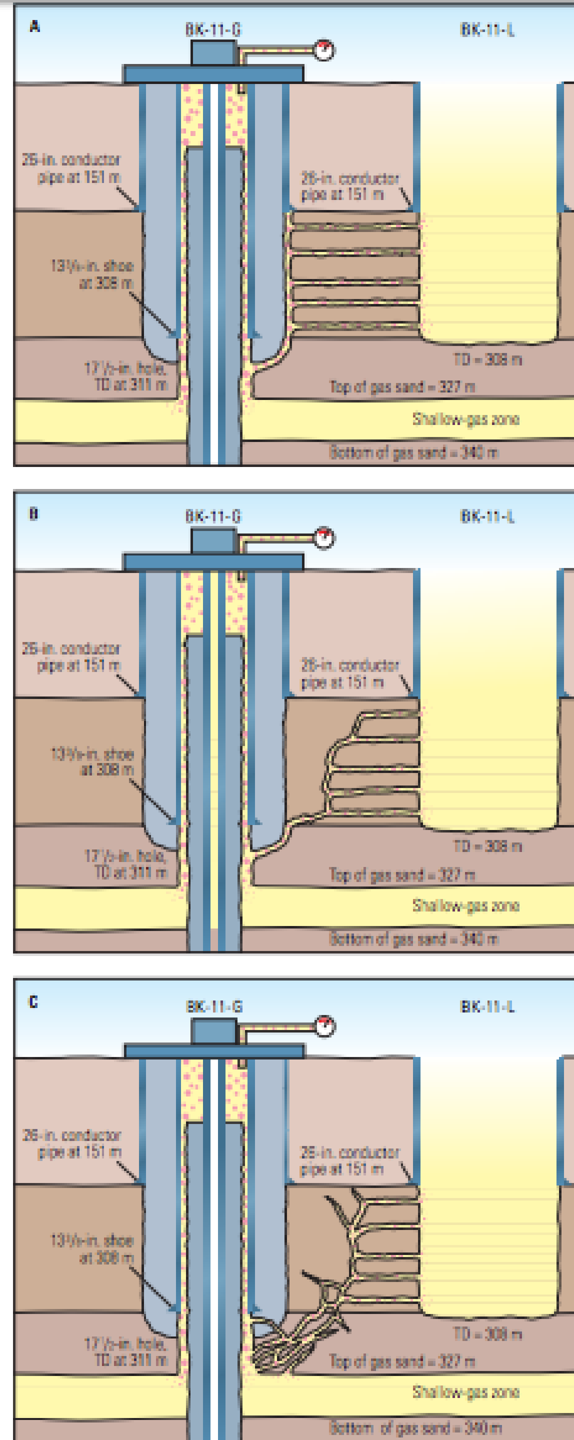
According to an OILFIELD REVIEW for Schlumberger, Autumn 2003, “Even after a flawless cement job, the cement can still be damaged by the routine operation of the well. Also the mechanical properties of casing and cement vary over time. Differential expansion and contraction due to temperature, pressure or vibration can cause the bond between casing and cement to fail.”

[1017 ft], then drill a 12¼-in. borehole through the shallow-gas sand and set 9⅝-in. casing at about 500 m [1640 ft]. Zonal isolation behind the 9⅝-in. casing was critical to the success of the project. Even though a gas-tight, or gas-influx-resistant, cement-slurry design was used, the first three 9⅝-in. casing primary cement jobs failed, resulting in both SCP at the surface and gas charging of upper-zone normally pressured sands (right).

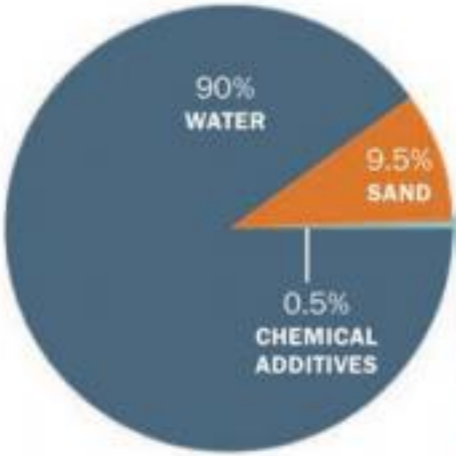
Although not under contract for the project, Schlumberger and M-I engineers working in conjunction with PTTEP and their partners, Total and BG, proposed a plan to integrate borehole stabilization with mud displacement and cement-system design.

The shallow formations in the 12¼-in. section consisted primarily of sand and shale, 30 to 40% of which was reactive clay. Historically, conventional water-base muds had been used to drill these formations, resulting in significantly washed-out sections, poor displacements, inadequate primary cement placement and loss of zonal isolation.

The M-I engineering team recommended controlling the borehole and cuttings integrity with SILDRIL mud, a sodium-silicate-base drilling fluid. The objective was to obtain a near-gauge borehole allowing optimized casing centralization, mud displacement and cement placement across the gas-bearing sand.



> Scenarios for upper-sand charging. In early drilling operations, previously nongas-bearing upper sands were charged with gas. Several scenarios were developed to explain gas crossflow between Wells BK-11-G and BK-11-L, and the development of SCP at surface. Gas is shown as red bubbles originating in the shallow-gas sand. In the three scenarios shown, gas migrates around poorly bonded cement (A). Gas moves around poorly bonded cement to vertical fractures (B). It migrates around poorly bonded cement and through a microfracture network (C). In all cases, primary cement failed to provide zonal isolation, resulting in gas migration to both upper sands and between casing strings, resulting in SCP.



Note: BTEX additives are banned in the NT

Compound	Purpose	Common application
Acids	Helps dissolve minerals and initiate fissure in rock (pre-fracture)	Swimming pool cleaner
Sodium Chloride	Allows a delayed breakdown of the gel polymer chains	Table salt
Polyacrylamide	Minimizes the friction between fluid and pipe	Water treatment, soil conditioner
Ethylene Glycol	Prevents scale deposits in the pipe	Automotive anti-freeze, deicing agent, household cleaners
Borate Salts	Maintains fluid viscosity as temperature increases	Laundry detergent, hand soap, cosmetics
Sodium/Potassium Carbonate	Maintains effectiveness of other components, such as crosslinkers	Washing soda, detergent, soap, water softener, glass, ceramics
Glutaraldehyde	Eliminates bacteria in the water	Disinfectant, sterilization of medical and dental equipment
Guar Gum	Thickens the water to suspend the sand	Thickener in cosmetics, baked goods, ice cream, toothpaste, sauces
Citric Acid	Prevents precipitation of metal oxides	Food additive; food and beverages; lemon juice
Isopropanol	Used to increase the viscosity of the fracture fluid	Glass cleaner, antiperspirant, hair coloring

Figure 6: Typical hydraulic fracturing fluid additives that may be used. Source: Modified from US Department of Energy, 2009, Modern Shale Gas Development in the United States: A Primer.

Hydraulic Fracturing Fluids: Chemical Toxicology and Exposure Pathways

Shale gas development uses fracturing fluids that contain organic and inorganic chemicals known to be health damaging (Aminto and Olson 2012; U.S. House of Representatives, Committee on Energy and Commerce 2011). Fracturing fluids can move through the environment and come into contact with humans in a number of ways, including surface leaks, spills, releases from holding tanks, poor well construction, leaks and accidents during transportation of fluids, flowback and produced water to and from the well pad, and run-off during blowouts, storms, and flooding events (Rozell and Reaven 2012). Further, the mixing of these compounds under conditions of high pressure—and often high heat—may synergistically create additional potentially toxic compounds (Kortenkamp et al. 2007; Teuschler and Hertzberg 1995; Wilkinson et al. 2000). Compounds found in these mixtures may pose risks to the environment and to public health through numerous environmental pathways, including water, air, and soil (Leenheer et al. 1982).

Chemicals are used in drilling and fracturing processes as corrosion inhibitors, biocides, surfactants, friction reducers, gels, and scale inhibitors, among others (Aminto and Olson 2012; New York State Department of Environmental Conservation 2011; Southwest Energy 2012). These chemicals include methanol, ethylene glycol, naphthalene, xylene, toluene, ethylbenzene, formaldehyde, and sulfuric acid, some of which are known to be toxic, carcinogenic, or associated with reproductive harm (Colborn et al. 2011; New York State Department of Environmental Conservation 2011). Many of these compounds are considered hazardous water pollutants and are regulated in other industries (Clean Water Act of 1972; Safe Drinking Water Act of 1974; U.S. House of Representatives 2011).

Many of the chemical compounds used in the fracturing process lack scientifically based maximum contaminant levels, making it more difficult to quantify their public health risks (Colborn et al. 2011). Moreover, uncertainty about the chemical makeup of fracturing fluids persists because of the limitations on required chemical disclosure, driven by the Energy Policy Act of 2005. For instance, in many states, companies are not mandated to disclose information about the quantities, concentrations, or identities of chemicals used in the process on the principle that trade secrets might be revealed (Centner 2013; Centner and O'Connell 2014; Maule et al. 2013).

2017 Shale and Tight Fracking Spills map
Four states studied. Water impacted spills map.

Make a Selection

State:

- (•) All
- ( ) Colorado
- ( ) New Mexico
- ( ) North Dakota
- ( ) Pennsylvania

Spill Volume (gallons):

All Volumes

Select Material:

All Materials

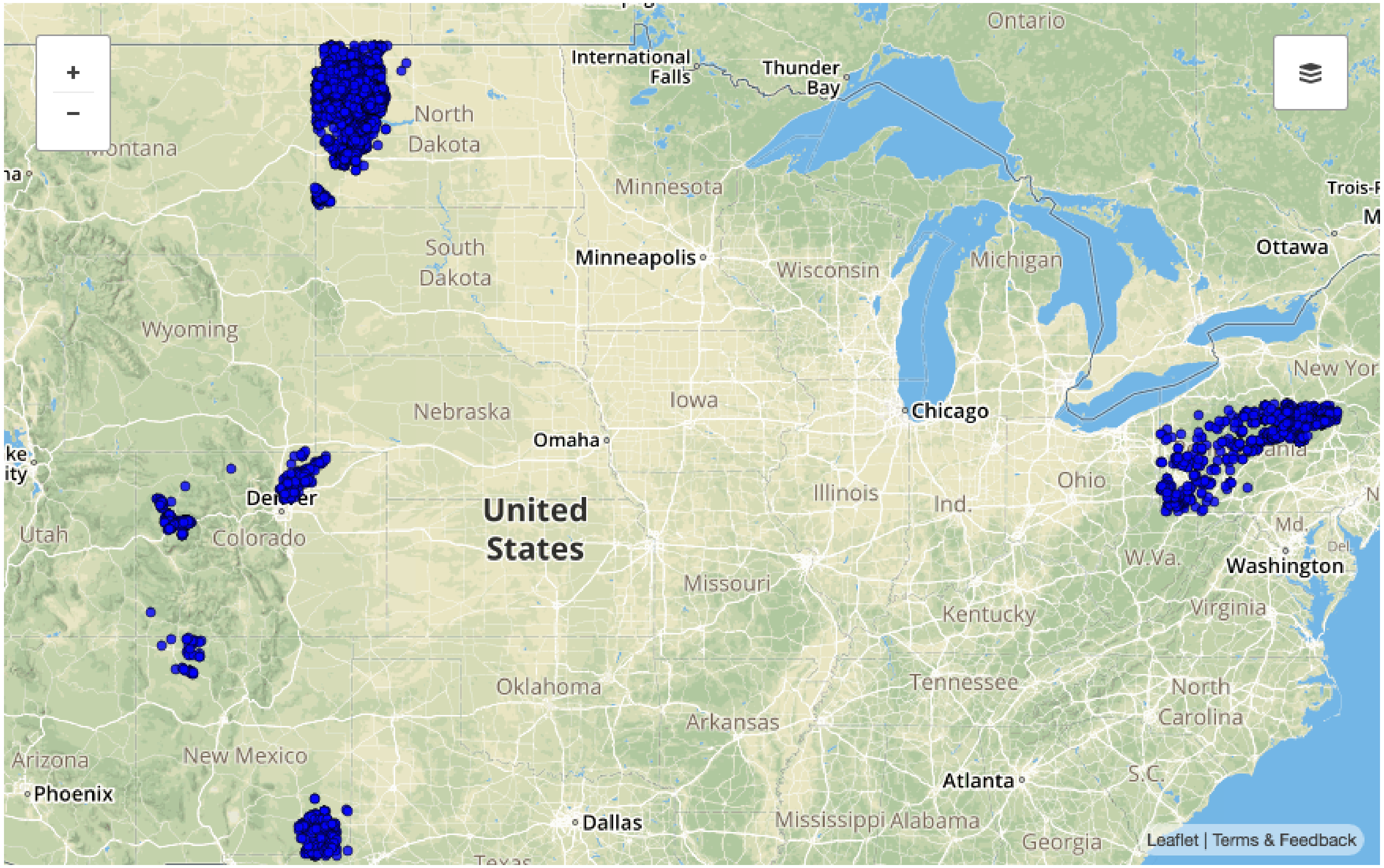
Containment of Spill:

All

Water Impact of Spill:

Water Impacted

Map of spills displays the location of unconventional oil and gas spills. Click on a spill for more information. Click on the map overlay icon in the upper right corner of the map to see all unconventional wells, shale plays and tight plays.



3. Water contamination is indeed widespread and systemic: Total complaints and water complaints are scattered throughout Pennsylvania's fracking fields and aren't concentrated in one area.

Source: PA Department of Environmental Protection	Fracking Complaints By EPA Regional Office				
	# Fracking Wells	# Water Complaints	% Water/Wells	# Total Complaints	% Total/ Wells
PA. E.P.A. Regional Offices:	2004-2016	2004-2016	2004-2016	2004-2016	2004-2016
Southwest Office	3,589	1,427	40%	3,653	102%
Northwest Office	1,027	1,159	113%	3,197	311%
Northcentral Office	5,413	1,522	28%	2,592	48%
Pennsylvania Totals:	10,029	4,108	41%	9,442	94%

A tally of the fracking wells drilled, total and water-related fracking complaints by EPA region in Pennsylvania.

Origin Energy EIS to the NT Government Beetaloo Basin

2.2.3 Proposed Stimulation Fluid Additives

HFS fluid mixtures typically comprise 99% water, sand and guar gum (if required) by volume with the remaining 1% made up of salts and fluid additives. Fluid additives used in HFS are commonly found in food and other household domestic products.

All chemicals used in Australia must be approved for use by the Federal Government, Department of Health and listed on the Australian Inventory of Chemical Substances (AICS) which is maintained under the National Industrial Chemicals Notification and Assessment Scheme (NICNAS). No HFS fluids or additives that are used in the process contain BTEX (benzene, toluene, ethylbenzene and xylene).

Origin is currently investigating two fluid systems that may be utilised during the 2016 program. The likely chemical compositions of the two fluid systems (Slickwater and Crosslinked Gel) are outlined in Table 5 and Table 6 respectively. Fluid and proppant volumes will vary dependent on stimulation fluid type. For a slickwater application the preliminary design is for 1000-1500 m^3 of fluid and 75-150 tonnes of sand (proppant) per stage. A crosslinked gelled system would comprise 500-1000 m^3 of fluid and 75-150 tonnes of sand per stage. Prior to commencing HFS activities, Origin will disclose the final composition of fluids and additives to the DME, including chemical abstracts service (CAS) number and material safety data sheet (MSDS) information.

Table 5 **Slickwater Stimulation Fluid**

Contains: Water, Surfactant, Hydrochloric Acid, Friction Reducer, Iron Control Agent, Scale Inhibitor, Clay Control Agent, Bactericide, Propping Agent Sand, Chelating Agent					
CAS #	**Chemical Name**	**Mass Fraction (%)**	**Mass (Kg)**	**Volume (L)**	**Volume Fraction (%)**
-	Water	~ 95	~ 14,500,000	~ 14,500,000	~ 97
57-13-6	Urea	< 0.001	< 1,000	< 1,000	< 0.01
64-02-8	Tetrasodium ethylenediaminetetraacetate	< 0.001	< 1,000	< 1,000	< 0.01
67-48-1	2-hydroxy-N,N,N-trimethylethanaminium	< 1	~ 160,000	~ 160,000	< 1
67-63-0	Propan-2-ol	< 0.001	< 1,000	< 1,000	< 0.01
79-06-1	2-Propenamid (impurity)	< 0.0001	< 100	< 100	< 0.001
107-21-1	Ethylene glycol	< 0.1	~ 16,000	~ 16,000	< 1
111-46-6	2,2"-oxydiethanol (impurity)	< 0.001	< 1,000	< 1,000	< 0.001
139-33-3	Disodium Ethylene Diamine Tetra Acetate (impurity)	< 0.0001	< 100	< 100	< 0.001
150-38-9	Trisodium Ethylenediaminetetraacetate (impurity)	< 0.0001	< 100	< 100	< 0.001
540-97-6	Dodecamethylcyclohexasiloxane	< 0.00001	< 10	< 10	< 0.00001
541-02-6	Decamethyl cyclopentasiloxane	< 0.00001	< 10	< 10	< 0.00001
556-67-2	Octamethylcyclotetrasiloxane	< 0.00001	< 10	< 10	< 0.00001
1310-73-2	Sodium hydroxide (impurity)	< 0.0001	< 100	< 100	< 0.0001
2682-20-4	2-methyl-2h-isothiazol-3-one	< 0.001	< 1,000	< 1,000	< 0.01
2836-32-0	Sodium Glycolate (impurity)	< 0.0001	< 100	< 100	< 0.001
5064-31-3	Trisodium nitrilotriacetate (impurity)	< 0.00001	< 10	< 10	< 0.0001
6381-77-7	Sodium erythorbate	< 0.0001	< 100	< 100	< 0.001
7447-40-7	Potassium chloride (impurity)	< 0.0001	< 100	< 100	< 0.0001
7631-86-9	Silicon Dioxide	< 0.0001	< 100	< 100	< 0.0001

7647-14-5	Sodium chloride	< 0.01	< 10,000	< 10,000	< 0.01
7757-82-6	Sodium sulfate	< 0.0001	< 100	< 100	< 0.0001
7758-98-7	Copper(II) sulfate	< 0.00001	< 10	< 10	< 0.00001
7783-20-2	Ammonium sulfate	< 0.01	< 10,000	< 10,000	< 0.1
7786-30-3	Magnesium chloride	< 0.001	< 1,000	< 1,000	< 0.001
10043-52-4	Calcium Chloride	< 0.01	< 10,000	< 10,000	< 0.1
10377-60-3	Magnesium nitrate	< 0.001	< 1,000	< 1,000	< 0.01
14464-46-1	Cristobalite	< 0.0001	< 100	< 100	< 0.0001
14808-60-7	Quartz, Crystalline silica	< 5	~ 670,000	~ 260,000	< 2
26172-55-4	5-chloro-2-methyl-2h-isothiazolol-3-one	< 0.001	< 1,000	< 1,000	< 0.01
31726-34-8	Polyethylene glycol monohexyl ether	< 0.1	~ 16,000	~ 16,000	< 0.1
38193-60-1	Acrylamide, 2-acrylamido-2-methylpropanesulfonic acid, sodium salt polymer	< 0.01	< 10,000	< 10,000	< 0.1
61789-77-3	Dicoco dimethyl quaternary ammonium chloride	< 0.001	< 1,000	< 1,000	< 0.01
63148-62-9	Dimethyl siloxanes and silicones	< 0.00001	< 10	< 10	< 0.0001
67762-90-7	Siloxanes and silicones, dimethyl, reaction products with silica	< 0.00001	< 10	< 10	< 0.0001
91053-39-3	Diatomaceous earth, calcined	< 0.01	< 10,000	< 10,000	< 0.1

Contains: Water, Surfactant, Hydrochloric Acid, Friction Reducer, Iron Control Agent, Scale Inhibitor, Clay Control Agent, Bactericide, Propping Agent Sand, Chelating Agent

CAS #	Chemical Name	Mass Fraction (%)	Mass (Kg)	Volume (L)	Volume Fraction (%)
129898-01-7	2-Propenoic acid, polymer with sodium phosphinate	< 0.1	~ 16,000	~ 16,000	< 0.1
136793-29-8	Polymer of 2-acrylamido-2-ethylpropanesulfonic acid sodium salt and methyl acrylate	< 0.001	< 1,000	< 1,000	< 0.001

Table 6 Crosslinked Gel Stimulation Fluid

Contains: Water, Surfactant, Hydrochloric Acid, Breakers, Gelling Agent, Crosslinker, Iron Control Agent, Scale Inhibitor, Clay Control Agent, Bactericide, Propping Agent Sand, Activator, Chelating Agent

CAS #	Chemical Name	Mass Fraction (%)	Mass (Kg)	Volume (L)	Volume Fraction (%)
-	Water	~ 85	~ 4,450,000	~ 4,450,000	~ 89
64-02-8	Tetrasodium ethylenediaminetetraacetate	< 0.001	< 100	< 100	< 0.01
67-48-1	2-hydroxy-N,N,N-trimethylethanaminium chloride	< 1	~ 56,000	~ 51,000	< 1
67-63-0	Propan-2-ol	< 0.001	< 100	< 100	< 0.01
107-21-1	Ethylene Glycol	< 0.1	< 10,000	< 10,000	< 1
110-17-8	Fumaric acid	< 0.01	< 1,000	< 1,000	< 0.1
111-46-6	2,2''-oxydiethanol (impurity)	< 0.001	< 100	< 100	< 0.01
139-33-3	Disodium Ethylene Diamine Tetra Acetate (impurity)	< 0.0001	< 10	< 10	< 0.001
150-38-9	Trisodium Ethylenediaminetetraacetate (impurity)	< 0.0001	< 10	< 10	< 0.001

1310-73-2	Sodium hydroxide (impurity)	< 0.1	< 10,000	< 10,000	< 1
1319-33-1	Boronatrocalcite	< 0.1	< 10,000	< 10,000	< 1
1330-43-4	Sodium tetraborate	< 0.01	< 1,000	< 1,000	< 0.1
2682-20-4	2-methyl-2h-isothiazol-3-one	< 0.001	< 100	< 100	< 0.01
2836-32-0	Sodium Glycolate (impurity)	< 0.0001	< 10	< 10	< 0.001
5064-31-3	Trisodium nitrilotriacetate (impurity)	< 0.0001	< 10	< 10	< 0.001
6381-77-7	Sodium erythorbate	< 0.001	< 100	< 100	< 0.01
7447-40-7	Potassium chloride (impurity)	< 0.0001	< 10	< 10	< 0.001
7631-86-9	Non-crystalline silica (impurity)	< 0.01	< 1,000	< 1,000	< 0.1
7647-01-0	Hydrochloric acid	< 0.1	< 10,000	< 10,000	< 1
7647-14-5	Sodium chloride	< 0.01	< 1,000	< 1,000	< 0.1
7704-73-6	Monosodium fumarate	< 0.01	< 1,000	< 1,000	< 0.1
7727-54-0	Diammonium peroxidisulphate	< 0.1	< 10,000	< 10,000	< 1
7786-30-3	Magnesium chloride	< 0.001	< 100	< 100	< 0.01
7789-38-0	Sodium bromate	< 0.1	< 10,000	< 10,000	< 1
9000-30-0	Guar gum	< 3	~ 170,000	~ 240,000	< 5
10043-35-3	Boric acid	< 0.01	< 1,000	< 1,000	< 0.1
10043-52-4	Calcium Chloride	< 0.01	< 1,000	< 1,000	< 0.1
10377-60-3	Magnesium nitrate	< 0.001	< 100	< 100	< 0.01
14464-46-1	Cristobalite	< 0.0001	< 10	< 10	< 0.001
14807-96-6	Magnesium silicate hydrate (talc)	< 0.0001	< 10	< 10	< 0.001
14808-60-7	Quartz, Crystalline silica	< 12	~ 670,000	~ 260,000	< 5
25038-72-6	Vinylidene chloride/methylacrylate copolymer	< 0.01	< 1,000	< 1,000	< 0.1
26172-55-4	5-chloro-2-methyl-2h-isothiazolol-3-one	< 0.001	< 100	< 100	< 0.01
31726-34-8	Polyethylene glycol monohexyl ether	< 0.1	< 10,000	< 10,000	< 1

Contains: Water, Surfactant, Hydrochloric Acid, Breakers, Gelling Agent, Crosslinker, Iron Control Agent, Scale Inhibitor, Clay Control Agent, Bactericide, Propping Agent Sand, Activator, Chelating Agent					
CAS #	**Chemical Name**	**Mass Fraction (%)**	**Mass (Kg)**	**Volume (L)**	**Volume Fraction (%)**
61789-77-3	Dicoco dimethyl quaternary ammonium chloride	< 0.001	< 100	< 100	< 0.01
91053-39-3	Diatomaceous earth, calcined	< 0.01	< 1,000	< 10,000	< 1
125005-87-0	Diutan gum	< 0.001	< 100	< 100	< 0.01
129898-01-7	2-Propenoic acid, polymer with sodium phosphinate	< 0.01	< 1,000	< 1,000	< 0.1

2.2.4 Water and Flowback Management

All HFS flowback will be stored on location in lined, above ground flexipond(s) (refer Figure 2-1, Figure 2-2 and Figure 2-3) to allow Origin to assess the quality and chemistry of the flowback fluid to accurately determine the appropriate management of that fluid. Above ground contained storage also prevents access to the fluid by livestock and other ground dwelling fauna.

For this campaign, water will be sourced from aquifers within the Gum Ridge Formation utilising nearby water bores that were drilled under Origin's 2015 and 2016 Exploration Drilling EP with the exception of the Amungee NW-1H site where an additional water bore will be drilled – the location of this additional water bore will be located at the Amungee camp site (Easting: 380863, Northing: 8192820, zone 53K). It is anticipated that up to 10,000-15,000m^3 of water may be utilised per well for stimulation activity.

Fumaric acid; "Potential Acute Health Effects: Hazardous in case of eye contact (irritant), of ingestion. Slightly hazardous in case of skin contact (irritant, permeator), of inhalation.

The substance is toxic to lungs, mucous membranes. Repeated or prolonged exposure to the substance can produce target organs damage."

Siloxanes, including D4 and D5 which have already been highlighted as possible persistent organic pollutants, meaning they are persistent, bioaccumulative and possibly capable of long-range transport.

The large majority have no human toxicology data, environmental toxicology information. Together these make up an unqualified mixture that is released to the environment with no assessment for either for impacts on human health or the environment.

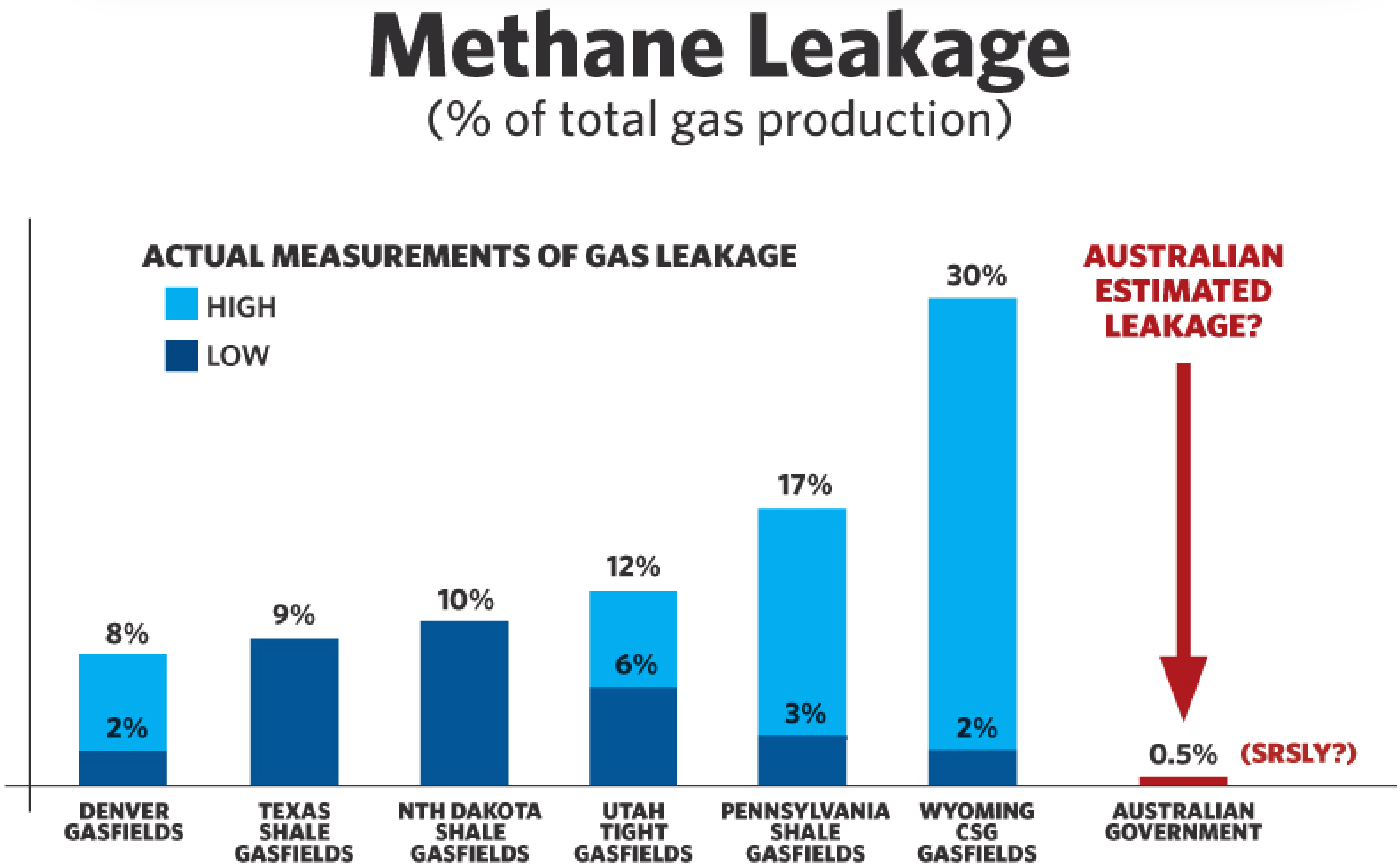
2. advise on the nature of any knowledge gaps and additional work or research that is required to make the determination in Item 1, including a program for how such work or research should be prioritised and implemented, that includes (but is not limited to);

a. baseline surface water and groundwater studies,
b. baseline fugitive emissions data,
c. geological and fault line mapping, and
d. focus areas for baseline health impact assessment,

1. Baseline surface water and groundwater studies

- Groundwater dependent ecosystems
- Water allocations and natural flows – how much water is available?
- What is the impact on base flows to river systems?
- What is the water quality like now, pre fracking?

2. Baseline fugitive emissions data



3. Geological and fault line mapping

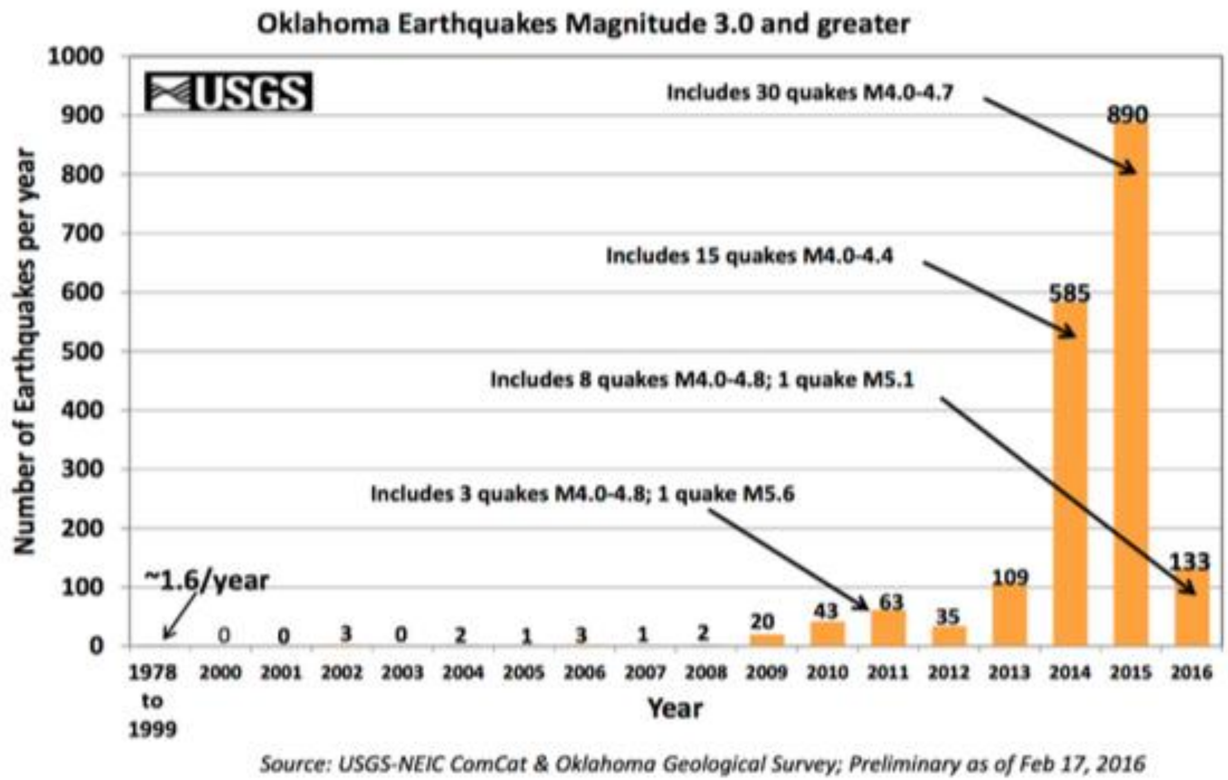


Figure 13. Oklahoma's earthquake incidence has increased dramatically since 2009. 2016 only includes January and early February figures. Source: USGS 2016.

4. Baseline health impact assessment

- Known target formation – nearby communities
- Low socioeconomic groups

3. for every environmental risk and impact that is identified in Item 1, advise the level of environmental impact and risk that would be considered acceptable in the Northern Territory context;

- 4. for every environmental risk and impact that is identified in Item 1,
- a. describe methods, standards or strategies that can be used to reduce the impact or risk; and
- b. advise whether such methods, standards or strategies can effectively and efficiently reduce the impact or risk to the levels described in Item 3;

The local impacts of coal in gas mining in the Darling Downs. CSRM

Stakeholders groups	Financial capital	Human capital	Built capital	Social capital	Natural capital
Gas	Better	Better	Worse	Better	Better
Mining	Better	Better	Worse	Better	Better
Agriculture	Worse	Worse	Worse	Worse	Worse
Local business	Worse	Worse	Worse	Worse	Worse
Local government	Worse	Better	Worse	Same	Same
Community	Worse	Better	Worse	Worse	Worse
Advocacy	Worse	Worse	Worse	Worse	Worse

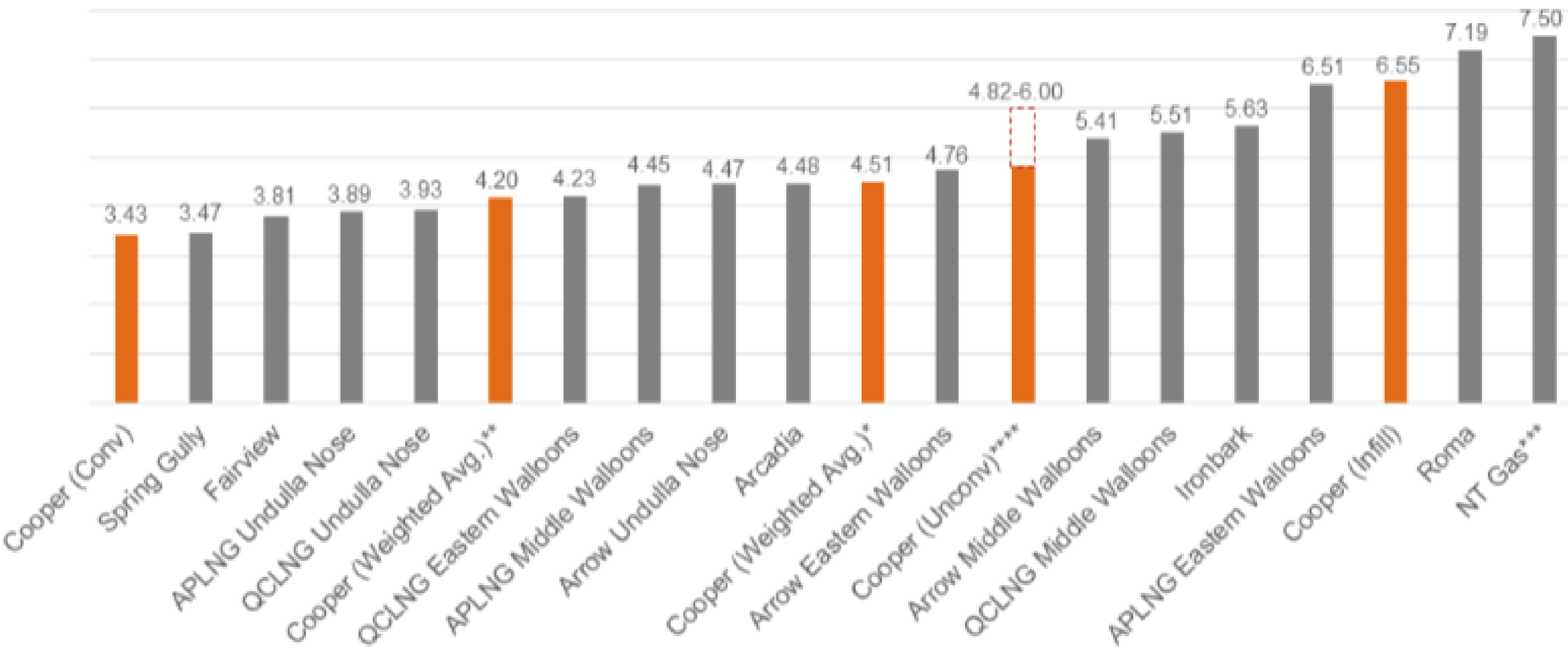
Table 3. Coal seam gas (CSG) employment spillovers over different sectors

	Elasticity	Additional job for each new CSG job
Local goods sector		
Construction	0.832 (0.426) *	1.414
Professional services	0.704 (0.259) **	0.422
Retail trade	0.011 (0.140)	0.024
Accommodation and food services	0.375 (0.263)	0.471
Other services	−0.385 (0.247)	−0.890
Tradable goods sector		
Manufacturing	0.068 (0.199)	0.160
Agriculture	−0.314 (0.182) *	−1.790

Notes

* $P < 0.10$; ** $P < 0.05$. Elasticity values are two-stage least square estimations for coefficient β in equation (2). The number of CSG wells in an statistical local area is used as instrument for the log change of mining employment. Values are estimated using sample 3 ($n = 48$). F-stat first-stage = 10.74. Robust clustered standard errors at Local Government Area levels are in parentheses. Other services sector includes employment in the Australian Bureau of Statistics categories of rental agencies, transport and 'other services'.

Figure 1.9 Comparison of Cooper Basin and Competitor Marginal Cost of Supply (ex-field) | AUD/GJ



* Represents the weighted average of the CBJV Conventional gas and the CBJV infill program, under the assumption that infill gas would meet the existing horizon contract shortfall.

** Represents the weighted average of the CBJV Conventional gas and unconventional plays, under the assumption that gas from unconventional reservoirs would meet the existing horizon contract shortfall and the contestable market.

*** NT Gas is estimated to have a range of AUD6/GJ (Blacktip ex-field) to AUD7.50/GJ for the higher cost unconventional plays.

**** Unconventional Cooper supply is estimated to have a cost of AUD4.82/GJ based on global best practice. In reality, this cost could be closer to AUD 6/GJ.

Also note that the type well used for the unconventional plays in the Cooper Basin is the median of five potential well profiles considered. If the most productive well is used the marginal cost could fall to around $4 per GJ.

- 6. identify priority areas for no go zones.

Survey results show landholders across the NT do not want to host shale gas fracking on their properties.

What is the Social Licence to Operate (SLO)?

The social licence to operate (SLO) refers to the level of acceptance or approval by local communities and stakeholders of mining companies and their operations.

Mining companies need not only government permission [or permits] but also “social permission” to conduct their business.

Without sufficient popular support it is unlikely that agencies from elected governments will willingly grant operational permits or licences [21].

- See more at: http://www.miningfacts.org/Communities/What-is-the-social-licence-to-operate/#sthash.17cci602.dpuf

There is no social licence to operate for NT Shale Gas Fracking in many parts of the Territory.

Precautionary Principle

The **precautionary principle** (or **precautionary approach**) to risk management states that if an action or policy has a suspected risk of causing harm to the public, or to the environment, in the absence of scientific consensus (that the action or policy is not harmful), the burden of proof that it is *not* harmful falls on those taking that action.

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