Stage 2 Earth and Environmental Science

Program 2: Assessment Type 1: Investigations Folio - Science as a Human Endeavour Investigation

Earth’s Resources

In this task you have the opportunity to investigate a contemporary example of how science interacts with society.

Select and explore a recent discovery or innovation linked to *Earth’s Resources*.

For example;

Use the article by [Stephen Long](http://www.abc.net.au/news/stephen-long/167162), 28 Feb 2017, *Methane emissions from coal seam gas development raise climate change concerns,* at <http://www.abc.net.au/news/2017-02-28/methane-emissions-from-coal-seam-gas-climate-change/8310932> as the basis for your discussion of the key concept:

* New technologies improve the efficiency of scientific procedures and data collection and analysis. This can reveal new evidence that may modify or replace models, theories, and processes

Use the development of hydroelectricity in Brazil as a basis for discussion of the key concept:

* The use of scientific knowledge may have beneficial or unexpected consequences; this requires monitoring, assessment, and evaluation of risk, and provides opportunities for innovation.

Use a variety of sources of information that enable an in depth discussion of your topic.

Prepare a scientific report, which must include the use of scientific terminology and:

* an introduction to identify the focus of the investigation and the key concept of science as a human endeavour that links to the investigation.
* relevant earth and environmental science concepts or background
* an explanation of how the focus of the investigation illustrates the interaction between science and society
* a discussion of the potential impact or significance of the focus of the investigation, e.g. potential of new development, effect on quality of life, environmental implications, economic impact, intrinsic interest
* a conclusion
* citations and referencing.

You can choose the format for your report. For example;

an article for a scientific publication, a letter to the editor, a multimedia presentation to an energy company.

The report should be a maximum of 1500 words if written or a maximum of 10 minutes for an oral presentation, or the equivalent in multimodal form.

**Performance Standards for Stage 2 Earth and Environmental Science**

| - | **Investigation, Analysis, and Evaluation** | **Knowledge and Application** |
| --- | --- | --- |
| **A** | Designs a logical, coherent, and detailed earth and environmental science investigation.Obtains, records, and represents data, using appropriate conventions and formats accurately and highly effectively.Systematically analyses and interprets data and evidence to formulate logical conclusions with detailed justification.Critically and logically evaluates procedures and their effect on data. | Demonstrates deep and broad knowledge and understanding of a range of earth and environmental science concepts.Develops and applies earth and environmental science concepts highly effectively in new and familiar contexts.Critically explores and understands in depth the interaction between science and society. Communicates knowledge and understanding of earth and environmental science coherently, with highly effective use of appropriate terms, conventions, and representations. |
| **B** | Designs a well-considered and clear earth and environmental science investigation.Obtains, records, and represents data, using appropriate conventions and formats mostly accurately and effectively.Logically analyses and interprets data and evidence to formulate suitable conclusions with reasonable justification.Logically evaluates procedures and their effect on data. | Demonstrates some depth and breadth of knowledge and understanding of a range of earth and environmental science concepts. Develops and applies earth and environmental science concepts mostly effectively in new and familiar contexts.Logically explores and understands in some depth the interaction between science and society. Communicates knowledge and understanding of earth and environmental science mostly coherently, with effective use of appropriate terms, conventions, and representations. |
| **C** | Designs a considered and generally clear earth and environmental science investigation.Obtains, records, and represents data, using generally appropriate conventions and formats with some errors, but generally accurately and effectively.Undertakes some analysis and interpretation of data and evidence to formulate generally appropriate conclusions with some justification.Evaluates procedures and some of their effect on data. | Demonstrates knowledge and understanding of a general range of earth and environmental science concepts.Develops and applies earth and environmental science concepts generally effectively in new or familiar contexts.Explores and understands aspects of the interaction between science and society. Communicates knowledge and understanding of earth and environmental science generally effectively, using some appropriate terms, conventions, and representations. |
| **D** | Prepares the outline of an earth and environmental science investigation.Obtains, records, and represents data, using conventions and formats inconsistently, with occasional accuracy and effectiveness.Describes data and undertakes some basic interpretation to formulate a basic conclusion.Attempts to evaluate procedures or suggest an effect on data. | Demonstrates some basic knowledge and partial understanding of earth and environmental science concepts.Develops and applies some earth and environmental science concepts in familiar contexts.Partially explores and recognises aspects of the interaction between science and society.Communicates basic earth and environmental science information, using some appropriate terms, conventions, and/or representations. |
| **E** | Identifies a simple procedure for an earth and environmental science investigation.Attempts to record and represent some data, with limited accuracy or effectiveness.Attempts to describe results and/or interpret data to formulate a basic conclusion.Acknowledges that procedures affect data. | Demonstrates limited recognition and awareness of earth and environmental science concepts.Attempts to develop and apply earth and environmental science concepts in familiar contexts.Attempts to explore and identify an aspect of the interaction between science and society.Attempts to communicate information about earth and environmental science. |

\*\* The reproduced work below has been extracted from [www.abc.net.au/news](http://www.abc.net.au/news) (September 2017)

**This exemplar identifies some key SHE concepts in an article**

**Methane emissions from coal seam gas development raise climate change concerns**

By [Stephen Long](http://www.abc.net.au/news/stephen-long/167162) <http://www.abc.net.au/news/2017-02-28/methane-emissions-from-coal-seam-gas-climate-change/8310932> 28 Feb 2017

**Click on the GIF:** The FLIR video recorder can detect invisible gases like methane. [**Map:** Chinchilla 4413](http://www.google.com/maps/place/Chinchilla%204413/%40-26.7394%2C150.6286%2C5z)

**Influence**

Advances in scientific understanding from research can influence developments in other areas of STEM

Tim Forcey is searching for a concealed threat. "We could be looking at a potential climate disaster here. We just don't know. It's hidden, invisible, unmeasured," he said.

**Influence**

Advances in scientific understanding from research can influence developments in other areas of STEM

The chemical engineer is a 35-year veteran of the oil and gas industry. What he is looking for cannot be seen by the naked eye, or by an ordinary camera. But his is no ordinary camera. "This is a sophisticated camera, military grade, that can detect invisible gases like methane," he said, showing me the $140,000 Forward Looking Infra-Red (FLIR) video recorder.

**Development**New technologies improve data collection and analysis. This can reveal new evidence that may modify or replace models, theories, and processes.

**Influence**

Advances in scientific understanding from research can influence developments in other areas of STEM

"The way that it does that is it has got a special device inside that can cool down the inside of the camera to minus 200 degrees Celsius." At these cryogenic freezing temperatures, the special sensors in the camera can detect methane being emitted into the atmosphere.

He shows me a gas vent on a ridge in the coal fields outside Chinchilla in Queensland. "You flop it over to the infrared and there you see the invisible gas now made visible," he said. What the camera reveals is amazing: an invisible greenhouse smokestack venting methane into the atmosphere.

**Methane gas 'can be dirtier than coal', researcher says**

Methane emissions gain less attention than emissions of carbon dioxide in the climate change debate, yet, when it comes to global warming, methane matters. It is a powerful greenhouse gas; up to 80 times more powerful than carbon dioxide emissions that are causing most concerns about climate change.

**Limitation**The use of scientific knowledge may have unexpected consequences; this requires monitoring, assessment, and evaluation of risk and provides opportunities for innovation.

Until recently, it has been viewed as less of a worry because it was presumed only tiny quantities of the gas leaked from onshore gas fields. But evidence emerging across the globe of "fugitive" emissions from coal seam gas development is raising questions about the industry's image as relatively clean and green — the obvious transition fuel from coal-fired power to renewable energy.

"It depends," said Mr Forcey, now a specialist researcher with the Melbourne Energy Institute at the University of Melbourne. "If you release enough of the gas — the methane in that gas into the atmosphere, then gas can be dirtier than coal; more than about 3 per cent emissions, it is actually worse than coal if you are making electricity." Alarming studies in the United States have detected methane emissions in some coal seam gas fields of between 2 per cent and 17 per cent.

How much methane is leaking from the coal seam gas fields here? Nobody really knows. The CSIRO completed a study four years ago but it only focused on the coal seam gas well-heads, not the vast infrastructure of seams and pipelines that now spread throughout the Surat Basin.

Researchers from Southern Cross University used sophisticated equipment to measure methane emissions and their results were concerning. "What we found by studying concentrations both inside the gas fields and outside the gas fields was elevated concentrations of methane within the gas fields," said Dr Douglas Tait, one of three scientists who conducted the study. "Concentrations outside the gas fields were about 1.7 parts per billion; when we were looking inside the gas fields we found spikes up to 6.5 parts per billion."

The gas industry is funding further research through a body known as GISERA, the Gas Industry Social and Environmental Research Alliance, which includes the CSIRO. Although they have equal voting rights, gas industry executives and spin doctors outnumber scientists on GISERA's national research management committee.

Its chairman, Professor Damian Barrett, denies that gas industry funding and involvement compromises the independence of CSIRO's research, arguing that there are robust governance controls in place.

**Questions raised over commitment to reduce greenhouse gases**

GISERA's latest research is focussing on "naturally occurring emissions" of methane; that has raised eyebrows, but Professor Barrett defends the focus. "In order to extract the signal for coal seam gas emissions in such a complex environment, we need to be able to take away all the other sources of emissions into the atmosphere," he said.

He said CSIRO has sophisticated ways of determining the source of emissions, though other scientists are sceptical and think that, because little measurement work was done before extensive coal seam gas development, the horse may have bolted. "What you need to do is get into those areas before you start development and before you start to alter the hydrology and geology of an area," Dr Tait said.

**Limitation
S**cience informs public debate; at times, there may be complex, unanticipated variables or insufficient data that may limit possible conclusions.

Diffuse or "migratory" emissions from coal seam gas development can spread through the geology far and wide. Mr Forcey and colleagues from the Melbourne Energy Institute are about to publish new research on migratory methane emissions of methane, commissioned by the Australia Institute. Migratory emissions are likely to expand with further coal seam gas mining.

It may be that leaks and deliberate emissions of methane from "unconventional gas" development are indeed negligible, as the industry maintains. But Mr Forcey argues that, in the light of findings in the United States, this is implausible. "They should get some planes up there with FLIR cameras and get equipment out there and comprehensively measure it," he said.

If it is the case that there are a whole lot of atmospheric methane emissions from onshore gas development not currently being measured, it raises big questions about Australia's ability to meet the commitments it made to reduce greenhouse gas emissions under the Paris Accord — let alone far more ambitious goals likely to come.