Frequently Asked Questions

1. ***What are Induced Seismicity and Triggered Seismicity?***

   Induced seismicity is defined as earthquake activity triggered by environmental changes caused by man; usually associated with either the injection or extraction of large amounts of fluid in the ground or the impoundment of a reservoir (USGS, http://pugs.usgs.gov/bul/1951/report.pdf)

   Triggered seismicity is also caused by human activity, but occurs in areas where faults are already close to failure and prone to movement due to existing subsurface pressure and stresses. Triggered seismicity alters the frequency of occurrence and magnitude of seismic events from natural levels. It also typically occurs in areas where natural earthquakes would likely occur eventually.

   The two terms are often used interchangeably.

2. ***How big are induced seismic events? Have they caused any damage?***

   Induced seismic events tend to be relatively small, seldom greater than a magnitude 4.0, which is considered by the U.S. Geological Survey (USGS) as light, small or minor. In many cases these events are either unrecognizable as an earthquake or not felt at all. According to the USGS, with very few exceptions, induced earthquakes have been too small to cause structural damage.

3. ***If certain activities (i.e. wastewater injection) can cause earthquakes, why aren't those processes prohibited?***

   The vast majority of wastewater injection operations do not cause earthquakes. The purpose of this Primer is to identify a range of approaches that states have used to manage and mitigate the risks associated with seismicity that may be induced by wastewater injection.

   Injection wells have been used in the United States since at least the 1930s. Alternatives to injection include recycling, reuse, and other surface-related activities, but each of those comes with its own set of regulatory, geologic, economic and environmental considerations.

4. ***Are injection wells only used in an oil and gas context?***

   No. A range of industries, including manufacturing and agriculture, use injection wells for disposing of waste. Injection wells associated with oil and gas production are classified as Class II by the EPA. Most injection wells in the United States are Class V wells, which are typically on-site disposal systems.

5. ***Do induced earthquakes threaten groundwater resources?***

   At this time, there is no evidence to suggest that induced seismicity creates a risk to groundwater, as in many cases these events are either unrecognizable as an earthquake or not felt at all, and according to the USGS, with very few exceptions, induced earthquakes have been too small to cause structural damage. States enforce regulations on disposal well construction that are designed to protect against such contamination.

6. ***There does not appear to be a model regulation or rule in this report. What does it accomplish?***

   Although regulatory decisions are the responsibility of the appropriate agencies, the primer makes clear that a one-size-fits-all approach would not be an effective tool for state regulators. The primer provides regulatory agencies with a guide, detailing data needs, various tools and other considerations to conduct an evaluation of induced seismicity risk. It is also designed to help those agencies develop strategies for managing and mitigating associated risks and for providing information in a transparent and effective manner; and considerations for evaluating whether a specific activity may have induced an earthquake.

7. ***What is the "traffic light system"?***

   The traffic light system (TLS) was recommended by the National Research Council as one possible option for mitigating and responding to potentially induced seismicity. TLS is a combination of seismic monitoring and a decision-making process, where regulators assess the status of a given area where wastewater injection is occurring.

   The Primer emphasizes that a TLS needs to be flexible and adaptive to unique site and regional characteristics, but it generally works as follows: If injection is occurring without seismicity, the region is in "green light" status – that is, operations can proceed as permitted. If seismic events begin occurring in that area, regulators may deem that area in "yellow light" status, requiring additional information before permitting new wells or requesting changes to existing operations. If seismicity stops, the area may go back to a green light status. If seismicity continues with the occurrence of more frequent or larger earthquakes, regulators may move the area into "red light" status, indicating a halt in permitting and/or operations.

8. ***There are oil operations in my town. Is induced seismicity a risk to my community?***

   Overall, the risk of induced seismicity from any given oil and gas operation is still very low. For example, there are more than 30,000 Class II disposal wells used for oil and gas wastewater in the United States, and only a small number of those wells have been associated with felt seismic events.

Some areas of the country with oil and gas operations have experienced a significantly higher frequency of seismic events, but many other areas have seen no comparative increase. While we continue to learn more about the causes and effects of induced seismic events, it is clear that many parts of the country with oil and gas operations have far lower risk of induced seismicity than others. It is also clear that not all types of oil and gas operations contribute to induced seismicity.

9. ***Why does the Primer put so much emphasis on site-specific analysis? Aren't induced earthquakes occurring in many different areas with injection activity?***

An overwhelming majority of injection wells do not pose a hazard for induced seismicity according to the USGS[1]. Wells that may be associated with induced seismicity, by contrast, exist in proximity to unique geologic and reservoir conditions. For injection to induce an earthquake, three conditions must be met: the presence of a fault that is favorable to slipping, stresses acting on that fault, and a pathway for the pressure increase from injection to interact with the fault. These three conditions are rarely present among the tens of thousands of wastewater injection wells in the United States.

The Primer is designed to provide state regulators with a guide to addressing and mitigating potentially induced seismicity. Approaches to assess and manage induced seismicity should account for local conditions, operational scope, geological setting, and historical seismicity levels. They should also reflect reasonable and prudent consideration of risks for each area (i.e. remote versus urbanized), as local conditions can vary even within designated "Areas of Interest" for state regulators.

Although the Primer is not intended to provide specific policy recommendations, it does emphasize that a "one-size fits all" regulatory approach would be inappropriate for effectively managing potentially induced seismicity.

10. ***What is the Induced Seismicity Working Group?***

The Induced Seismicity Working Group is a collaborative effort between state oil and natural gas agency members and other advisory experts, including industry and academic representatives to share science, research and practical experience. The goal is to equip the states with the best decision making tools to evaluate the potential relationship between seismic events and wastewater injection, minimize risk, and enhance readiness when seismic events occur.

11. ***What role has industry played in drafting these recommendations?***

These recommendations were drafted based on collaboration between volunteer subject matter experts from academia, NGOs, and industry, all of whom volunteered their knowledge of specific technical disciplines as advisors to the Induced Seismicity Working Group. Members of the Working Group include representatives from state regulatory agencies and representatives of state

[1] http://earthquake.usgs.gov/research/induced/myths.php

geological surveys. A listing of all of the Working Group members and Advisors can be found at www.statesfirstinitiative.org.

12. What role should U.S. EPA have in managing induced seismicity risk?

Injection wells are currently regulated under the federal Safe Drinking Water Act, specifically the Underground Injection Control program (UIC). The EPA, which administers the SDWA, grants what is known as "primacy" to states if their regulatory programs for injection meet certain baseline criteria. Under primacy delegation, regulators for most of the oil and gas producing states are in charge of overseeing injection activities and administering the law.

The recently issued EPA report (February 2015) *"Minimizing and Managing Potential Impacts of Injection Induced Seismicity from Class II Disposal Wells: Practical Approaches*" is one such example of how the EPA actively works with the states in managing induced seismicity risk with recognition that (state-delegated) UIC directors and regulators are best equipped with in-depth knowledge of local conditions that should be considered in managing the risks of induced seismicity.

13. What do I do if I am in an area where there is oil and gas development and I experience a seismic event?[2]

The USGS and several other state and federal agencies provide guidance on earthquake preparedness. Please visit:

http://earthquake.usgs.gov/learn/preparedness.php

http://www.fema.gov/earthquake-publications

or your state agency for tips on earthquake readiness.

14. Is hydraulic fracturing causing the induced earthquakes?[2]

Induced seismicity associated with hydraulic fracturing is rare. However, in limited cases, hydraulic fracturing has been associated with felt levels of induced seismicity. Most induced earthquakes in the United States are a result of the deep disposal of fluids (wastewater) related to oil and gas production.

15. Is the wastewater injected in disposal wells spent hydraulic fracture fluid?[2]

The amount of spent hydraulic fracturing fluid injected into wastewater disposal wells is highly variable. The fluids disposed of near earthquake sequences in Youngstown, Ohio, and Guy,

[2] Rubenstein, J. L. and Mahani, A.B. (2015) *"Myths and Facts on Wastewater Injection, Hydraulic Fracturing, Enhanced Oil Recovery, and Induced Seismicity"*, Seismologicial Research Letters, 86 (4), doi:10.1785:0220150067, p. 1060-1067

Arkansas, are believed to consist largely of spent hydraulic fracturing fluid. However, in contrast, in Oklahoma spent hydraulic fracturing fluid represents 10% or less of the fluids disposed of in salt-water disposal wells; the vast majority of the fluid that is disposed of in disposal wells in Oklahoma is produced water from conventional oil and gas development and is not associated with the disposal of hydraulic fracturing flowback water.

16. **What is produced water?** [2]

Produced water is the salty water from ancient oceans that was entrapped in the rocks when the sediments were deposited. This water is trapped in the same pore space as oil and gas, and as oil and gas is extracted, the produced water is extracted with it. Produced water often must be disposed in injection wells because it is frequently laden with dissolved salts, minerals, treatment constituents, and other materials that make it unsuitable for other uses. Produced water is common with production of conventional oil and gas reservoirs.

17. **Would there be no need for wastewater disposal if hydraulic fracturing was not used?** [2]

Even without the use of hydraulic fracturing, underground disposal of wastewater would be needed because of the large volumes of produced water generated from oil and gas production.

18. **Does induced seismicity only occur close to the injection well and at a similar depth as injection?** [2]

There have been instances where seismicity has been induced at distances of 10 km or more away from the injection point and at significantly greater depths than injection. In the classic case of injection-induced seismicity at the Rocky Mountain Arsenal, seismicity was induced at distances of at least 10 km laterally from the well and at depths of at least 4 km greater than the depth of injection.

19. **Do all injection wells (hydraulic fracturing, wastewater disposal, and enhanced oil recovery) induce Earthquakes?** [2]

The vast majority of injection wells do not cause felt earthquakes. There are approximately 34,000 active wastewater disposal wells, over 134,000 active enhanced oil-recovery wells, and tens of thousands of wells are hydraulically fractured every year in the United States. Only a few dozen of these wells are believed to have induced felt earthquakes.