Environmental Issues Related to Hydraulic Fracturing and Relevant Core Competencies within the Desert Research Institute

Hydraulic Fracturing is the process by which a mixture of water, proppants, and chemical additives are injected into geologic formations at sufficiently high pressures such that fractures are created that extend hundreds of feet away from the borehole. Its use, in combination with horizontal drilling, has become widespread in the oil and gas industry to increase production from tight hydrocarbon bearing formations.

Hydraulic fracturing is a complex process that requires large quantities of water to be acquired and transported to the drill pad, stored on site, mixed with proppants and chemical additives, injected into the subsurface, and either recycled or disposed of following recovery. A growing number of governmental agencies and environmental groups are expressing concerns over hydraulic fracturing and its potential impacts to the environment. These concerns have risen to a point where hydraulic fracturing has been banned in some areas (Longmont, Co.; State of New York). Concerns include diversion of limited water supplies, impacts to water quality due to surface spillage or leakage from boreholes, traffic hazards and air-particulates due to transportation and on-site power generation, storage of hazardous fluids and seismic impacts due to underground injection of waste water.

The Need for Peer-Reviewed Science
Unconventional oil and gas is viewed as a transitional fuel to low-carbon energy sources. As such it is here to stay. The oil and gas industry, governmental agencies, and the public would benefit from a decision making process that is informed by peer-reviewed science. Peer-review science can develop credible and comprehensive information that can be used to inform share-holders, prioritize risks, and improve operational practices. Unfortunately, the number of peer-reviewed studies of hydraulic fracturing is limited and consensus on a number of issues has yet to be reached.

Core Competencies
The Desert Research Institute (DRI) is the environmental research arm of the Nevada System of Higher Education. It has been conducting cutting-edge research into land, water, and air for over 53 years. It employs over 500 personnel and conducts approximately $50 million in environmental research every year. DRI maintains in-house expertise in a number of research areas that have specific application for understanding environmental issues associated with hydraulic fracturing. These include:

- Public Monitoring Systems – DRI operates and maintains multiple monitoring systems designed to monitor weather or the concentration of contaminants in water and air. One of the largest of these is the Community Environmental Monitoring Program designed to detect radionuclides
emitted by operations on the Nevada National Security Site. This network consists of 29 stations located in three states covering an area of approximately 40,000 sq. miles. Hydraulic fracturing may be more acceptable to communities directly engaged in monitoring potential impacts to their environment.

- Flow and Transport Modeling in Fractured Rock – DRI has developed state-of-the-art flow and transport models in fractured rock using stochastically generated discrete fracture network models in variably saturated rock. The models are capable of simulating transport of hydraulic fracture fluids within geologic formations.

- Ambient Stress Fields and Fracture Permeability - DRI is currently working on extending models of flow in fractured rock to incorporate the impact of ambient stress field on the permeability of fractures. This adds an additional degree of physical reality to the models by incorporating the effects of lithostatic stress to the simulations. Lithostatic stress is a critical component for understanding the propagation and performance of hydraulically generated fractures.

- Geothermal Reservoir Analysis - DRI is currently in the process of conducted geothermal reservoir analysis near Pyramid Lake, Nevada. The effort is funded by the Department of Energy and consists of field investigation comprised of drilling, geophysics, and reservoir testing coupled with reservoir modeling. Modeling efforts will be used to assess the long-term viability of the reservoir as a source for geothermal energy.

- Dissolved Gas Phase Changes - DRI is initiating a laboratory study of phase changes in response to seismic activity of carbon dioxide that has been geologically sequestered. Methane may be susceptible to similarly induced phase changes.

- Water Supply - DRI has extensive experience in assessing locally-available water supplies, both surface and groundwater. These experiences are comprised of field characterization and modeling of surface water and groundwater resources in response to natural and man-made stresses. DRI has also conducted well-head protection studies that assess the risk to existing wells of potential or actual sources of groundwater contamination.

- Groundwater Subsidence - DRI has experience in assessing groundwater subsidence due to fluid production. This has relevance to subsidence due to pumping of water-supply wells used as a source of water for hydraulic fracture fluids and for subsidence occurring as fluids are produced from oil and gas wells.

- Geochemical Analysis - DRI has extensive experience in the acquisition and analysis of water samples. DRI maintains a water chemistry lab and has experience in the analysis and interpretation of dissolved, organic, and isotopic parameters. Geochemical tracer studies are critical for understanding the fate and migration of groundwater and associated contaminants.

- Airborne Particulates - DRI has international recognition in the monitoring and analysis of airborne particulates, to include dust, black carbon, and air emissions from heavy-duty diesel vehicles. Specific studies include the monitoring of emissions from the Barnett Shale Natural Gas production facility.