Practices for Mitigating Surface Impacts Associated with Hydraulic Fracturing

API GUIDANCE DOCUMENT HF3
FIRST EDITION, JANUARY 2011

AMERICAN PETROLEUM INSTITUTE

Practices for Mitigating Surface Impacts Associated with Hydraulic Fracturing

Upstream Segment

API GUIDANCE DOCUMENT HF3
FIRST EDITION, JANUARY 2011

AMERICAN PETROLEUM INSTITUTE

Special Notes

API publications necessarily address problems of a general nature. With respect to particular circumstances, local, state, and federal laws and regulations should be reviewed.

Neither API nor any of API's employees, subcontractors, consultants, committees, or other assignees make any warranty or representation, either express or implied, with respect to the accuracy, completeness, or usefulness of the information contained herein, or assume any liability or responsibility for any use, or the results of such use, of any information or process disclosed in this publication. Neither API nor any of API's employees, subcontractors, consultants, or other assignees represent that use of this publication would not infringe upon privately owned rights.

Users of this guidance document should not rely exclusively on the information contained in this document. Sound business, scientific, engineering, and safety judgment should be used in employing the information contained herein.

API is not undertaking to meet the duties of employers, manufacturers, or suppliers to warn and properly train and equip their employees, and others exposed, concerning health and safety risks and precautions, nor undertaking their obligations to comply with authorities having jurisdiction.

Information concerning safety and health risks and proper precautions with respect to particular materials and conditions should be obtained from the employer, the manufacturer or supplier of that material, or the material safety datasheet.

Where applicable, authorities having jurisdiction should be consulted.

Work sites and equipment operations may differ. Users are solely responsible for assessing their specific equipment and premises in determining the appropriateness of applying the publication. At all times users should employ sound business, scientific, engineering, and judgment safety when using this publication.

API publications may be used by anyone desiring to do so. Every effort has been made by the Institute to assure the accuracy and reliability of the data contained in them; however, the Institute makes no representation, warranty, or guarantee in connection with this publication and hereby expressly disclaims any liability or responsibility for loss or damage resulting from its use or for the violation of any authorities having jurisdiction with which this publication may conflict.

API publications are published to facilitate the broad availability of proven, sound engineering and operating practices. These publications are not intended to obviate the need for applying sound engineering judgment regarding when and where these publications should be utilized. The formulation and publication of API publications is not intended in any way to inhibit anyone from using any other practices.

Foreword

Nothing contained in any API publication is to be construed as granting any right, by implication or otherwise, for the manufacture, sale, or use of any method, apparatus, or product covered by letters patent. Neither should anything contained in the publication be construed as insuring anyone against liability for infringement of letters patent.

Shall: As used in a publication, “shall” denotes a minimum requirement in order to conform to the publication.

Should: As used in a publication, “should” denotes a recommendation or that which is advised but not required in order to conform to the specification.

Suggested revisions are invited and should be submitted to the Standards Department, API, 1220 L Street, NW, Washington, DC 20005, standards@api.org.

Contents

Executive Summary

Hydraulic fracturing has played an important role in the development of America's oil and gas resources for nearly 60 years. In the U.S., an estimated 35,000 wells are hydraulically fractured annually and it is estimated that well over one million wells have been hydraulically fractured since the first well in the late 1940s. As production from conventional oil and gas fields continues to mature, the need for hydraulic fracturing becomes even more important to the economic recovery of non-conventional resources.

This guidance document identifies and describes best practices currently used in the oil and natural gas industry to minimize potential surface environmental impacts associated with hydraulic fracturing operations. It complements two other API documents: API Guidance Document HF1, *Hydraulic Fracturing Operations—Well Construction and Integrity Guidelines*, First Edition, October 2009, which focuses on groundwater protection related to drilling and hydraulic fracturing operations [1] while specifically highlighting recommended practices for well construction and the integrity of hydraulically fractured wells, and API Guidance Document HF2, *Water Management Associated with Hydraulic Fracturing,* First Edition, June 2010 [2].

A fourth related guidance document, API 51R*, Environmental Protection for Onshore Oil and Gas Production Operations and Leases,* First Edition, July 2009 [3], addresses the design and construction of access roads and well locations prior to drilling, as well as site abandonment, reclamation and restoration operations, including produced water handling.

While hydraulic fracturing does not introduce new or unique environmental risks to exploration and production (E&P) operations, concerns have been raised due to the potential scale of operations where this technology is applied, especially with regard to emerging developments in shale gas in the United States. Many of the best practices for E&P operations are the same as those applicable to hydraulic fracturing operations.

Moreover, where shale gas development intersects with urban settings, regulators and the industry have developed special practices to alleviate potential nuisances and sensitive environmental resources impacts, along with interference with existing commercial activity. Operators need to be vigilant and proactive in mitigating potential environmental impacts from E&P operations, including hydraulic fracturing operations. The following provides highlights from this guidance document:

1) Operators must comply with all federal, state and local requirements. Approvals may be necessary for many activities including:

   — surface water use;

   — wastewater management;

   — injection activities;

   — site construction;

   — stormwater discharges;

   — air emissions; and

   — protection of sensitive areas.

2) Two principal reasons for recent concerns regarding hydraulic fracturing, especially as applied in the development of shale gas, are: the increase in well permitting in a number of regions in the U.S. and the new development activity in areas that have not experienced concentrated oil and gas development in the past. Consequently, operators should be cognizant of the increase in public scrutiny of fracturing operations, be

proactive in communicating to, and working with, communities and local regulatory authorities, and minimize, whenever possible, the impacts of their operations. For example, the use of multi-well pads when feasible, which can consolidate water storage, minimize overall footprint, reduce truck traffic and allow for centralized management of fluids.

3) Like all oil and gas E&P operations, before hydraulic fracturing operations are initiated, approvals from one or more government agencies are required. Operators must obtain all necessary permits before commencing operations, and ensure that operations comply with the requirements of local, state and federal regulatory authorities. Proactive engagement with surface owners and/or surface users to inform the owners about the operations prior to project initiation is also recommended. Upon initial development, planning and resource extraction of a new basin, operators should review the available information and, if necessary, assess the baseline characteristics.

4) To alleviate concerns associated with fracture fluid management, hydraulic fracturing operations should be planned and designed in a manner that manages materials and protects the environment. All components of fracture fluids, including water, additives and proppants, should be managed properly on site before, during and after the fracturing process. Both the operator and on-site contractors should require that all responsible personnel involved in the fracturing job and in pre- and post-fracture activities be trained in the transportation and handling of fluids, chemicals and other materials associated with the process. Personnel should be trained on the equipment to be used and the procedures to be implemented to prevent leaks and spills during fracturing operations.

5) State authorities must retain the ability to assess potential incident response needs and plan accordingly, with appropriate confidentiality protections. To balance the protection of trade secrets with the public's need to know, proprietary formulations should be disclosed upon request by designated state agency representatives and health professionals in the event of an emergency, or when designated state agency representatives and health professionals demonstrate a need to know such information.

6) Using hydraulic fracturing fluids in an environmentally safe way means that the base fluid and any additives are sourced, transported, prepared, pumped into the formation, returned from the formation, reused/recycled, and/or finally disposed of in a way that is fully compliant with all federal, state, and local regulations.

7) Surface impoundments, including those used for storing fracture fluids, must be constructed in accordance with existing regulations. Depending on the fluids being placed in the impoundment, the duration of the storage and the soil conditions, impoundment design and construction should be impervious to prevent infiltration of fluids into the subsurface. All surface impoundments must be properly closed in accordance with all local, state and/or federal regulations. Materials removed from impoundments should be reclaimed, recycled or disposed.

8) Fracture fluids should be managed according to federal and state regulations. Fracturing operations should be conducted in a manner that minimizes the potential for any unplanned release and movement beyond the site boundaries. Spill prevention, response and cleanup procedures should be in place prior to initiating activities that have a potential for a spill. The best way to avoid adverse effects of spills is to prevent their occurrence.

9) Hydraulic fracturing is a highly technical process performed by trained personnel. Equipment should be maintained, inspected and tested to assure proper operating integrity and reliability. Facilities and equipment should be kept clean, maintained and operated in a safe and environmentally sound manner. All leaks should be immediately contained and repairs initiated upon discovery—as safety permits. Any spill or leak should be addressed promptly and reported to the site manager for proper identification, management, cleanup and appropriate regulatory actions. It may be necessary to fence operations to prevent access to the facility by the general public, livestock or wildlife.

10) Public concerns relating to fracturing operations may be heightened by the location chosen for the well and the techniques used in constructing the access road and the overall site. To the extent practicable,

consideration for siting a well location might include visual impact of the operational layout; preservation of salient natural features such as natural terrain, trees, groves, waterways and other similar resources; and minimizing cut and fill operations.

11) Truck traffic creates additional concern in populated areas of development. Opportunities to reduce truck traffic might include use of flowlines to transport fluids. Where feasible, producers are increasingly turning to temporary surface flowlines to transport fresh water to impoundments and to wellsites. However, in many situations, the transport of fluids associated with hydraulic fracturing by surface pipeline may not be practical, cost effective or even feasible. Multi-well pads allow centralized water storage and management of flowback water, reducing truck transport. In some cases, it can also enhance the option of pipeline transport of water. Often, operators are able to construct storage ponds and drill source wells in cooperation with private property owners to provide close access to a water source and add improvements to the property that benefit the landowner.

Practices for Mitigating Surface Impacts Associated with Hydraulic Fracturing

1 Scope

The purpose of this guidance document is to identify and describe practices currently used in the oil and natural gas industry to minimize surface environmental impacts—potential impacts on surface water, soils, wildlife, other surface ecosystems and nearby communities—associated with hydraulic fracturing operations. While this document focuses primarily on issues associated with operations in deep shale gas developments, it also describes the important distinctions related to hydraulic fracturing in other applications.

2 Terms and Definitions

For the purposes of this document, the following definitions apply.

2.1
aquifer
A subsurface formation that is sufficiently permeable to conduct groundwater and to yield economically significant quantities of water to wells and springs.

2.2
basin
A closed geologic structure in which the beds dip toward a central location; the youngest rocks are at the center of a basin and are partly or completely ringed by progressively older rocks.

2.3
casing
Steel piping positioned in a wellbore and cemented in place to prevent the soil or rock from caving in. It also serves to isolate formations and water zones from production fluids, such as water, gas and oil, from the surrounding geologic formations.

2.4
completion
Following drilling, the activities and methods to prepare a well for production, including the installation of equipment to produce a well.

2.5
downhole
Located in a wellbore.

2.6
flowback
The fracture and produced fluids that return to surface after a hydraulic fracture is completed.

2.7
formation (geologic)
A rock body distinguishable from other rock bodies and useful for mapping or description. Formations may be combined into groups or subdivided into members.

2.8
fracturing fluids
A mixture of water, proppant (often sand) and additives used to hydraulically induce cracks in the target formation.

2.9
gelling agent
Chemical compounds used to enhance the viscosity and increase the amount of proppant a fracturing fluid can carry.

2.10
groundwater
Subsurface water (fresh or saline) that is in the zone of saturation; source of water for wells, seepage and springs. The top surface of the groundwater is the water table.

2.11
horizontal drilling
A drilling procedure in which the wellbore is drilled vertically to a kickoff depth above the target formation and then angled through a wide 90° arc such that the producing portion of the well extends horizontally through the target formation.

2.12
hydraulic fracturing
Injecting fracturing fluids into the target formation at a force exceeding the parting pressure of the rock, thus inducing fractures through which oil or natural gas can flow to the wellbore.

2.13
hydrocarbons
Any of numerous organic compounds, such as methane (the primarily component of natural gas), that contain only carbon and hydrogen.

2.14
original gas in place
The entire volume of gas contained in the reservoir, regardless of the ability to produce it.

2.15
perforations
The holes created from the wellbore into the reservoir (subsurface hydrocarbon-bearing formation). These holes create the mechanism by which fluid can flow from the reservoir to the inside of the casing, through which oil or gas is produced.

2.16
permeability
A rock's capacity to transmit a fluid; dependent upon the size and shape of pores and interconnecting pore throats. A rock may have significant porosity (many microscopic pores) but have low permeability if the pores are not interconnected. Permeability may also exist or be enhanced through fractures that connect the pores.

2.17
porosity
The voids or openings in a rock, generally defined as the ratio of the volume of all the pores in a geologic formation to the volume of the entire formation.

2.18
produced water
Any of the many types of water produced from oil and gas wells.

2.19
propping agents/proppant
Specifically sized silica sand or other manmade or naturally occurring particles pumped into a formation during a hydraulic fracturing operation to keep fractures open and maintain permeability.

2.20
reclamation
Restoration of a disturbed area to make it acceptable for designated uses. This normally involves regrading, replacement of topsoil and vegetation, and other work necessary to restore it.

2.21
reservoir
Subsurface hydrocarbon-bearing formation.

2.22
shale gas
Natural gas produced from low-permeability shale formations.

2.23
slickwater
A water-based fluid mixed with friction reducing agents, to reduce friction pressure during hydraulic fracturing operations.

2.24
solid waste
Any solid, semi-solid, liquid or contained gaseous material that is intended for disposal.

2.25
stimulation
Any of several processes used to enhance near-wellbore permeability and reservoir permeability, including hydraulic fracturing.

2.26
tight gas
Natural gas trapped in a hard rock, sandstone or limestone formation that is relatively impermeable.

2.27
total dissolved solids
TDS
The dry weight of dissolved elements, organic and inorganic, contained in water and usually expressed in parts per million.

2.28
underground source of drinking water
USDW
Defined in 40 *CFR* Section 144.3, as follows:

"An aquifer or its portion:

(a) (1) Which supplies any public water system; or

(2) Which contains a sufficient quantity of groundwater to supply a public water system;

and

(i) Currently supplies drinking water for human consumption; or

(ii) Contains fewer than 10,000 mg/l total dissolved solids; and

(iii) Which is not an exempted aquifer."

2.29
water quality
The chemical, physical and biological characteristics of water with respect to its suitability for a particular use.

2.30
watershed
All lands which are enclosed by a continuous hydrologic drainage divide and lay upslope from a specified point on a stream.

2.31
well completion
See **completion**.

3 Introduction and Overview

Hydraulic fracturing is the injection of fluids into a subsurface geologic formation containing oil and/or gas at a pressure sufficient to induce fractures through which oil or natural gas can flow to a producing wellbore.

Hydraulic fracturing has played an important role in the development of America's oil and gas resources for nearly 60 years. In the U.S., an estimated 35,000 wells are hydraulically fractured annually and it is estimated that more than one million wells have been hydraulically fractured since the first well in the late 1940s [4]. As production from conventional oil and gas fields continues to mature and the shift to non-conventional resources increases, the importance of hydraulic fracturing will continue to escalate as new oil and gas supplies are developed from these precious resources. The escalating importance of these resources is a testament to America's increased reliance on natural gas supplies from unconventional resources such as gas shale, tight gas sands and coal beds—all resources that generally require hydraulic fracturing to facilitate economically viable natural gas production [5]. In addition, advances in hydraulic fracturing have played a key role in the development of domestic oil reserves, such as those found in the Bakken formation in Montana and North Dakota [6].

In fact, very few unconventional gas formations in the U.S. and throughout the world would be economically viable without the application of horizontal drilling and hydraulic fracturing. These extremely low permeability formations tend to have fine grains with few interconnected pores. Permeability is the measurement of a rock or formation's ability to transmit fluids. In order for natural gas to be produced from low permeability reservoirs, individual gas molecules must find their way through a tortuous path to the well. Hydraulic fracture stimulation can increase the pathways for gas flow in a formation by several orders of magnitude [7].

Recently, natural gas production from gas-bearing shales in the U.S. has increased significantly, with hydraulic fracturing playing a key role. Some of this expansion has occurred in geographic regions with little to no history of oil and gas development. While the use of hydraulic fracturing itself has not introduced any new or unique environmental concerns associated with oil and gas development, as shale gas development has occurred in new areas, new challenges have been encountered, and increased focus has been given to address community concerns.

For example, communities may be especially sensitive to the surface footprint left by expanded oil and natural gas development. In response, operators should consider the advantages of multi-well pad development and horizontal well fracturing. Compared to drilling vertical wells with single hydraulic fractures, multi-well pad drilling and fracturing horizontal wells from one location can significantly reduce surface disturbance and the potential for surface-related impacts. Horizontal drilling has the advantages of requiring substantially fewer well pads and reducing surface disturbances, while providing for a comparable volume of production.

Where shale gas development has intersected with urban settings, regulators and industry have developed special practices to alleviate nuisance impacts, impacts to sensitive environmental resources and interference with existing commercial activity. Examples of such practices in the Dallas/Fort Worth area include establishing set-backs of buildings and construction at specific distances from the natural gas wellbore; establishment of buffer zones around drill sites next to protected use areas; limiting gas well drilling to only certain identified property; and requiring approval of both a local Specific Use Permit and a Gas Well Permit.

Nonetheless, this increase in attention and focus on hydraulic fracturing requires operators to pursue such practices with renewed focus and diligence, as set forth in this guidance document.

4 Stakeholder Engagement

One way to address many of the concerns associated with hydraulic fracturing operations is through proactive engagement by operators with regulators and surface owners. Collaboration between the industry, regulators, and the public have resulted in positive solutions for the environment.

Similar to all oil and gas E&P operations, before hydraulic fracturing operations are initiated, approvals from one or more (primarily state) government agencies may be required for a series of activities, including surface water use, wastewater management, injection activities, site construction, stormwater discharges, air emissions and protection of sensitive areas. Operators must obtain all necessary permits before commencing operations, and verify that operations are conducted in accordance with the requirements of all local, state and federal regulatory authorities. Proactive consultation with the appropriate regulatory authorities can help greatly in ensuring local considerations are addressed and the appropriate permits are provided as expeditiously as possible.

Proactive engagement with surface owners and/or surface users before fracturing operations are initiated may foster understanding and alleviate concerns. It is recommended that the operator communicate with land owners or surface users concerning activities planned for the site and measures to be taken for safety, protection of the environment and minimizing impacts to surface uses. Additional recommendations may be found in API 51R [3], Annex A—*Good Neighbor Guidelines*. Operators of federal oil and gas leases under private surface ownership are encouraged to consult the BLM publication, *Surface Operating Standards and Guidelines for Oil and Gas Exploration and Development* ("Gold Book"), for BLM guidance with respect to communication and recommended practices to address concerns of surface owners [8].

The footprint of hydraulic fracturing operations can vary depending on the operator's equipment and operational needs, and the mutual objectives established by the operator, appropriate regulatory agencies and the owner of the surface rights.

Upon initial development, planning and resource extraction of a new basin, operators should review the available information describing water quality characteristics (surface and groundwater) in the area and, if necessary, proactively work with state and local regulators to assess the baseline characteristics of local groundwater and surface water bodies, Depending on the level of industry involvement in an area, this type of activity may be best handled by a regional industry association, joint industry project, or compact. On a site specific basis, pre-drilling surface and groundwater sampling/analysis should be considered as a means to provide a better understanding of on-site water quality before drilling and hydraulic fracturing operations are initiated.

5 Wide-scale Development

One of the principal reasons for the rise in concerns regarding hydraulic fracturing operations, especially as applied to gas shale development, is the increase in the number of wells being permitted throughout several regions in the U.S. In addition, many communities are experiencing new development activity where there has been no concentrated oil and natural gas development in the past. This has caused regulatory authorities in several states to re-evaluate their regulatory schemes to verify that their rules are appropriate for the heightened level and broader geographic extent of development activity. Furthermore, as the level and extent of drilling activity has increased, so has the public concern for the health, safety and welfare of neighboring communities.

Consequently, operators should be cognizant of the increase in public scrutiny and be proactive in communicating to, and working with, communities and regulatory authorities to minimize impacts from hydraulic fracturing operations.

Several examples of the ways the oil and natural gas industry is currently working collaboratively to inform its members on best practices, working cooperatively with regulatory agencies and other stakeholders to promote best practices, and reaching out to local communities about these practices include:

— Barnett Shale Energy Education Council (BSEEC). The BSEEC is a community resource that provides information to the public about natural gas drilling and production in the Barnett shale region. The goal of BSEEC is to provide information and answers to questions regarding the opportunities and issues related to urban drilling in the Barnett shale. The BSEEC also works on promoting best practices in operations, community relations and other issues important to the communities they serve [9].

— Barnett Shale Water Conservation and Management Committee. Similarly, a consortium of energy companies formed the Barnett Shale Water Conservation and Management Committee to study the industry's water use in the Barnett shale and to discuss conservation and water management techniques to help conserve freshwater resources.

— Marcellus Shale Coalition (MSC). The MSC was founded in 2008 as an organization committed to the responsible development of natural gas from the Marcellus shale in Pennsylvania and the enhancement of the Commonwealth's economy that can be realized by this clean-burning energy source. The members of the coalition work together to address concerns with regulators, government officials and the people of the Commonwealth about all aspects of drilling and extracting natural gas from the Marcellus shale formation.

— State Review of Oil and Natural Gas Environmental Regulations (STRONGER). This organization was formed in 1999 to reinvigorate and carry forward the state review process begun cooperatively in 1988 by the U.S. Environmental Protection Agency (EPA) and the Interstate Oil and Gas Compact Commission (IOGCC). STRONGER is a non-profit, multi-stakeholder organization whose purpose is to assist states in documenting the environmental regulations associated with the exploration, development and production of crude oil and natural gas. STONGER shares innovative techniques and environmental protection strategies and identifies opportunities for program improvement. The state review process is a non-regulatory program and relies on states to volunteer for reviews.

— Environmentally Friendly Drilling (EFD). Industry has made great strides in protecting the environment while increasing oil and natural gas production in the U.S. The objective of EFD is to identify, develop and test innovative technologies that reduce the environmental impact of oil and gas activities in environmentally sensitive areas, should these areas be opened up for development. The program continues to add participants from environmental organizations, academia, state and federal agencies, government laboratories and industry. Currently, more than 100 organizations support this effort in a variety of ways, including providing grants and other financial assistance. The partnership identifies new technologies and transfers them to areas that must incorporate new practices to address environmental concerns. Regional partners optimize technologies to fit the needs of their locale. Partners routinely come together to discuss progress with the sponsors/advisors.

— The National Petroleum Council (NPC). The sole purpose of the NPC is to represent the views of the oil and natural gas industry in advising, informing and making recommendations to the Secretary of Energy with respect to any matter relating to oil and natural gas. The NPC is chartered by the Secretary of Energy under the provisions of the Federal Advisory Committee Act of 1972. In selecting the membership, special attention is given by the Secretary to assure a well-balanced representation from all segments of the oil and gas industry, from all sections of the country, and from large and small companies. The Council also has members with interests outside of oil or gas operations, including representatives from academic, financial, research, Native American and public interest organizations and institutions.

Operators are encouraged to participate in regional and national organizations and partnerships to keep abreast of best practices, to learn about local environmental issues and concerns, and to communicate with stakeholders. In areas of the country where such organizations are not readily accessible, operators are encouraged to establish such groups.

6 Selection of Hydraulic Fracturing Fluids

The design of a hydraulic fracture job and fracture fluid composition takes into consideration the type of geologic formation, anticipated well spacing and proppant requirements. Other considerations include the formation temperature and pressure, compatibility with the formation lithology and fluid (oil, gas, water, etc.), the productive interval to be fractured, reservoir depth, formation and underlying/overlying rock properties, fluids within the formation and other site-specific considerations.

Water is the primary component of hydraulic fracture treatments, representing the vast majority of the total volume of fluid injected during fracturing operations. The proppant (normally sand) is the next largest constituent in the injected fracturing slurry. In addition to water and proppant, other additives may be essential to a successful fracture stimulation operation.

The fracturing fluid is a carefully formulated product. Service providers vary the design of this fluid based on the characteristics of the reservoir formation, make-up water quality and operator objectives. The appropriate composition of the fluid for successful fracturing will vary by basin, contractor and well. Situation-specific challenges that must be addressed include scale formation, bacterial contamination, proppant transport, iron content, fluid stability and viscosity breakdown requirements. Addressing each of these criteria may require specific additives to achieve the desired performance; however, not all fracture jobs will require all categories of additives.

When developing hydraulic fracturing plans, in addition to considerations associated with successfully fracturing the target formations, operators should carefully consider the fluid management and disposal implications of their choices for fracture fluid formulations. Operators should regularly evaluate new products that provide environmental protection opportunities while meeting operational goals.

7 Management of Chemicals and Materials

Like other exploration and production activities, both service companies and operators have key roles in managing the chemicals and materials stored and utilized on site for fracturing operations. It is the responsibility of the service companies to educate operators about the various fluids and additives that may be used as a part of a fracture fluid. An essential first step is providing operators with the Material Safety and Data Sheets (MSDS) for products used in their wells.

Operating companies have the responsibility to understand the base fluids and additives that may be used as a part of a fracture fluid and to utilize proper handling procedures of the fluid during fracture treatment and flowback. Service companies work with operators for optimal fracturing designs, which should include a full complement of suggested fluid alternatives, along with the potential environmental impacts and costs associated with each alternative. Training and procedures for operating and handling for each chemical utilized in the fracturing process improve responsiveness to potential surface incidents. As part of the overall operation plan, service companies should provide operating and handling procedures for each chemical utilized, including those for emergencies and disposal.

API recommends that operators be prepared to disclose information on chemical additives and their ingredients. Our own policy position on chemical disclosure follows below.

POLICY POSITION OF API ON CHEMICAL DISCLOSURE FOR

HYDRAULIC FRACTURING OPERATIONS

Hydraulic fracturing is, and has been, a routine industry practice since 1947. Hydraulic fracturing operations have safely enabled increased production of domestic oil and natural gas in more than 1 million wells over the last 60-plus years [1]. While America has abundant natural gas resources, most cannot be produced without this technology. Experts estimate that 90 percent of gas wells drilled in the United States utilize hydraulic fracturing in operations [2] and studies have shown this to be an environmentally safe practice [3].

States have played, and continue to play, the critical role in the oversight and management of hydraulic fracturing operations and are best positioned to tailor requirements to local conditions and to closely monitor environmental performance. API supports transparency regarding the disclosure of the chemical ingredients used in hydraulic fracturing operations to ensure that state regulators have the ability to assess potential incident response needs and plan accordingly, with appropriate confidentiality protections.

Additionally, we endorse state programs that balance the need to protect oilfield service company confidential business information with the public's need to know. Subject to an agreement of confidentiality, we support disclosure of proprietary formulations upon request by designated state agency representatives and health professionals in the event of an emergency, when the designated state agency representatives and health professionals have demonstrated a need to know such information in order to treat or diagnose patients. States must require the designated individuals to keep the supplied information confidential.

Hydraulic fracturing should not be regulated under the Safe Drinking Water Act (SDWA) or any other federal statue. Since hydraulic fracturing has been successfully managed at the state level, it would be problematic, unnecessary and duplicative to have any additional requirements at the federal level.

1 "States Experience with Hydraulic Fracturing, A Survey of the Interstate Oil and Gas Commission," July 2002.

2 Testimony Submitted To The House Committee On Energy and Commerce By Victor Carrillo, Chairman, Texas Railroad Commission, Representing The Interstate Oil and Gas Compact Commission. February 10, 2005. http://www.rrc.state.tx.us/commissioners/carrillo/press/energytestimony.html

3 Environmental Protection Agency, "Study of Potential Impacts of Hydraulic Fracturing of Coalbed Methane Wells on Underground Sources of Drinking Water," Office of Ground Water and Drinking Water report, June 2004, accessed December 6, 2006; Ground Water Protection Council, "State Oil and Gas Regulations Designed to Protect Water Resources," May 2009; Ground Water Protection Council, "Inventory and Extent of Hydraulic Fracturing in Coalbed Methane Wells in the Producing States," 1998.

8 Transport of Chemicals and Other Materials

Materials should be transported to and from the site of hydraulic fracturing operations in accordance with federal, state and local regulations, and in a manner designed to prevent spillage and minimize air and noise impacts. All transport vehicles should display proper markings as required.

Trucks and temporary piping are the more common method for transporting the equipment, proppant, additives and fluids to the site. Trucking costs can be the biggest part of the water management expense. One option to consider as an alternative to trucking is the use of temporary or permanent surface pipelines. Producers are increasingly turning to temporary surface pipelines to transport fresh water to impoundments and to well sites. However, in many situations, the transport of fluids associated with hydraulic fracturing by surface pipeline may not be practical, cost effective, or even feasible. The use of multi-well pads make the use of central water storage easier, reduces truck traffic, and allows for easier and centralized management of flow back water. In some cases it can enhance the option of pipeline transport of water. In order to make truck transportation more efficient, cost effective and less impactful operators may want to consider constructing storage ponds and drilling source wells in cooperation with private property owners. The opportunity to help a private landowner by constructing or improving an existing pond, drilling a water well, and/or improving the roads on their property can be a win-win situation for the operator and the landowner. It provides close access for the operator to a water source, and adds improvements to the property that benefit the landowner.

Operators should also consider utilizing agricultural techniques to transport the water used near the water sources. Large diameter, aluminum agricultural pipe is sometimes used to move the fresh water from the source to locations within a few miles where drilling and hydraulic fracturing activities are occurring. Water use by the shale gas industry has spurred agricultural and field service companies to supply the temporary pipe, pumps, installation, and removal as a business pursuit in some areas.

Fracturing equipment transported over the highway and equipment used to transport fracturing fluids should be checked for leaks and any open-ended lines should be properly capped prior to leaving the storage yard or warehouse. Proppant containers should be checked to ensure materials cannot leak out or be impacted by the wind while on public or private thoroughfares. Chemical additive containers should be checked to make sure there are no leaks. Tankers carrying fracturing fluids should be checked to ensure all discharge valves are closed and leak free.

9 Pre-job Planning

Prior to fracturing operations, operators and/or service companies should consider conducting a job site safety meeting with all site personnel to ensure that personnel performing and supporting the fracture job understand their responsibilities and recognize potential environmental and safety impacts associated with fracturing operations. Suggestions for this meeting include the following.

— Spill prevention measures for any equipment or material they bring on site or manage for the fracture treatment.

— Awareness that spilled materials constitute a waste that should be cleaned up, managed, and disposed of or reused in an approved manner.

— Communication about and location of the Material Safety Data Sheet (MSDS) information for each hazardous chemical used. Awareness that the MSDS must be readily accessible for each chemical on site. Hazard communication to personnel should include emergency and first aid procedures.

— Procedures to report all leaks or spills caused by the service companies to the service companies' on-site manager, appropriate operator manager and personnel, and regulatory agencies (the information should include the material spilled, the MSDS for the material, the location of the spill, the estimated amount of the material that was spilled, and the response action taken and planned).

— And, operator and/or contractor procedures and response plans to properly manage, reuse or dispose of all waste generated.

10 Water Management

10.1 General

Using hydraulic fracturing fluids in an environmentally safe way means that the water and chemicals are sourced, transported, prepared, pumped into the formation, returned from the formation and disposed of in a way in that is in full compliance with all federal, state, and local regulations, and that minimizes impacts. Briefly:

— water must be obtained according to local regulations and use agreements;

— water should be transported to the wellsite in enclosed tanks aboard tanker trucks in Department of Transportation (DOT) compliant vehicles, or via authorized flowline;

— water is stored in tanks or impoundments on the wellsite while waiting to be pumped;

— hydraulic fracturing equipment (blenders and pumpers) must be monitored for leaks and loss of integrity;

— prior to pumping the fracture job, piping must be pressure tested and job monitored so as not to exceed the pressure rating of the piping or equipment;

— after the fracture treatment is finished, fracture fluid must be flowed back into storage tanks, lined impoundments, production equipment or other suitable containers; and

— water must be transported to the approved disposal facility, treatment facility, approved discharge location, or to a subsequent hydraulic fracturing operation in enclosed tanks aboard DOT compliant tanker trucks or a dedicated pipeline system.

Water use and management is discussed in more detail in the companion API Guidance Document HF2, *Water Management Associated with Hydraulic Fracturing*, First Edition, April 2010 [2], focused on issues associated with the acquisition, use, management, treatment, and disposal of water and other fluids associated with hydraulic fracturing.

10.2 On-site Fluid Handling

All components of fracture fluids, including water, additives and proppants, should be managed properly on site before, during and after the fracturing process. Typically, fracture fluid components should be blended into the fluids used for fracturing only when needed. Any unused products should be removed from the location by the contractor or operator as appropriate. The job planning process should consider the possibility of unforeseen circumstances that may delay the fracture operations and provide a plan for proper material management. This includes management of fluids that remain in lines, tanks and other containment devices after the fracturing has been completed.

Operators should maintain information about their fluid management and storage at the site. Such information may include:

— site design and capacity of storage impoundments and/or storage tanks;

— information about the number, as well as the individual and total capacity of, receiving impoundments and/or tanks on the well pad;

— description of planned public access restrictions, including physical barriers and distance to edge of the well pad; and

— description of how liners are to be installed to prevent possible leakage from impoundments, in locations where liners are required by state or local regulations.

Both the operator and any on-site contractors should verify that all personnel involved in the fracturing job and pre- and post-fracture activities are fully trained in the proper precautions for transporting and handling fluids, chemicals and materials, and have operational knowledge of the equipment to be used and of the procedures implemented to prevent leaks and spills during a fracturing operation. The training should include:

— preventative measures for transporting and handling fluids, chemicals and materials; and operational knowledge of the equipment to be used and the procedures implemented to prevent leaks and spills during a fracturing operation;

— proper management, cleanup and disposal practices that should be utilized if any products are accidentally spilled or leaked;

— the management and disposal practices that should be followed for flowback operations including both the liquid and solid components, and managing well gas during the operation;

— procedures for testing and inspecting equipment, hoses and connections prior to, and during, pressure operations;

— procedures for collecting fluids remaining in lines including the use of collection buckets, catch basins or vacuum trucks; and

— remedial actions in the event of an incident to avoid and minimize impacts to soil, groundwater and surface waters.

The MSDS for each covered additive should be obtained from the supplier or manufacturer, be reviewed prior to using the chemical, and be readily available at the job site. The MSDS should contain information about physical hazards of the chemical, spill cleanup procedures and other information to minimize environmental and health impacts.

10.3 Surface Impoundments and Storage Tanks

Fluids used for hydraulic fracturing operations will generally be stored on-site in tanks or lined surface impoundments. Returned fluids, or flowback fluids, may also be directed to tanks or impoundments.

All surface impoundments, including those used for temporarily storing fracture fluids, must be constructed in accordance with existing state and federal regulations. In some states, an impoundment requires prior authorization from one or more regulatory agencies; and in some, a separate permit is required specifically for the impoundment's functional use [10]. In addition, documentation should be kept on all materials placed in surface impoundments.

Larger centralized impoundments must be designed and constructed to provide structural integrity for the life of their operation, taking into consideration their size and extended use. Proper design, installation and operation are imperative to preventing a failure or unintended discharge off the site.

Depending on the fluids being placed in the completion impoundment, the duration of the storage and the soil conditions, liners may be necessary to prevent infiltration of fluids into the subsurface. In most states, impoundments must have a natural or artificial liner designed to prevent the downward movement of fluids into the subsurface. Typically, liners are constructed of compacted clay or synthetic materials like polyethylene or treated fabric that can be joined using special equipment. Impoundments used for long-term storage of fluids should be sited in accordance with state stream setback distances from surface water to prevent unauthorized discharge to surface waters.

Additional information may be required by regulatory authorities for centralized surface impoundments for fracture fluids. For such facilities, requirements may include an initial review of site topography, geology and hydrogeology, in addition to inspection and maintenance procedures—especially if such impoundments are within defined distances of a water reservoir, perennial or intermittent stream, wetland, storm drain, lake or pond, or a public or private water well or domestic supply spring.

In some cases, impoundments used to hold freshwater for supply purposes may be retained by the landowner for their future use. Otherwise, all surface impoundments should be properly closed in accordance with local, state and/or federal regulations. Materials removed from surface impoundments should be reclaimed, recycled or properly disposed. Refer to API Environmental Guidance Document E5, *Waste Management in Exploration and Production Operations*, Second Edition, February 1997 [11] for additional guidance on fluid impoundments and practices on minimizing waste generation in the upstream sector.

In addition to surface impoundments, some operators store fluids used in, and produced from, fracturing operations in tanks. These tanks must meet applicable state and federal standards.

10.4 Spill Prevention and Control

Fracture fluids should be managed according to state and federal regulations. Some fluids found at E&P sites are actively or passively managed to eliminate spills using various containment methods, including those found in the federal Spill Prevention Control and Countermeasures (SPCC) requirements. Flowback fluids are a federally E&P exempt waste (i.e. exempt from hazardous waste requirements under the Resource Conservation and Recovery Act or RCRA); however, they still need to be addressed under any applicable state regulations. Products used to fracture a well, which have the potential to be released or spilled, may not meet the E&P exemption. Any spill to the ground creates a waste and should be managed properly.

Spills can create difficult operational, legal and public relations problems. Operations should be conducted to minimize the potential for any releases. Spill prevention, response and cleanup procedures, as part of the overall standard operating procedures (SOP) manual for the operation, are a recommended best practice for storing oil, chemicals or other fluids.

The best way to avoid adverse effects of spills is to prevent their occurrence. Key factors in spill incident prevention are planning and training. The facility design should be reviewed to determine where the potential for spills exists. Information on prior spill incidents should be included in the review to assess areas where changes in equipment or practices may be needed. Contingency elements might include the following.

— Modification of site layout or installation of new equipment or instrumentation, as needed, to reduce the possibility of spills, commensurate with the risk involved. Consideration should be given to the use of alarms, automatic shutdown equipment, or fail-safe equipment to prevent, control or minimize potential spills resulting from equipment failure or human error.

— Maintenance and/or corrosion abatement programs to provide for continued sound operation of all equipment.

— Tests and inspections of lines, vessels, dump valves, hoses and other pollution prevention equipment where failure(s) and/or malfunction(s) could result in a potential spill incident. These tests and inspections should be commensurate with the complexity, conditions and circumstances of the facility.

— Operating procedures that minimize potential spills. These operating procedures should be clearly written and available to all operating personnel.

— Examination of field drainage patterns and installation of containment, BMPs, barriers or response equipment as deemed appropriate.

When bringing fracturing materials on site, they should be stored in such a way to prevent any accidental release to the environment. These fluids may include both solid and liquid components. Primary containment methods commonly used include tanks, hoppers, blenders, sand separators, lines and impoundments. It is recommended these primary containers be visually inspected before and during the fracturing operation to ensure integrity.

The use of techniques such as sloping the well location away from surface water locations, positioning absorbent pads between sites and surface waters, and perimeter trenching systems and catchments may be used to contain and collect any spilled fluids.

Operators should evaluate the potential for spills and damages and use this information to determine the type and size of primary and secondary containment necessary. The contingency elements of the manual might include the location of emergency equipment, the type(s) of materials and products that can be used effectively for clean-up, and list sources and procedures for using these chemicals. Spill response drills/simulations should include participation of relevant contractor personnel.

In the event a spill occurs, the source of the spill should be controlled, or reduced to the extent possible, in a safe manner. The release should be confined or contained to minimize potentially adverse effects. Some methods to control and contain spilled substances, particularly oil, include:

— retaining walls or dikes around tanks;

— sluice gates;

— secondary catchment basins designed to prevent the spread of fluids that escape the primary wall or dike;

— absorbent pads;

— booms in water basins adjoining the facility;

— temporary booms deployed in the water after the spill occurs; and

— use of special chemicals to jell or bio-degrade the spilled fluids. Note that special chemicals may require approval prior to use.

10.5 Storm Water Management and Control

Construction designs may include installation of erosion and sedimentation control systems to control stormwater runoff (escaping off location) as well as run-on (storm water coming onto the location). Minimizing the storm water or precipitation that flows across the site will minimize the potential to transport contaminants into jurisdictional water.

Natural drainage patterns of the area should be considered in the location of equipment, pads and impoundments so stormwater runoff does not erode base material, which could lead to equipment instability, or adversely impact impoundments, potentially causing a discharge of fluids into local surface waters.

Site construction should be inspected on a routine basis and following each significant storm event. Repairs to the control systems should be completed promptly. During the drilling and completion phases, the site should be stabilized and all raw materials should be stored in a manner to prevent the contamination of natural runoff. Temporary containment and liners should be used to minimize the impact of spills and to prevent impacted precipitation from affecting surface or groundwater.

Operators are encouraged to consult the Guidance Document, *Reasonable and Prudent Practices for Stabilization (RAPPS) at Oil and Natural Gas Exploration and Production Sites* [12], that describes various operating practices and control measures used by oil and natural gas operators to effectively control erosion and sedimentation in stormwater runoff from clearing, grading and excavation operations at exploration and production sites under various conditions of location, climate and slope.

A wide variety of documents describing best management practices for stormwater management exist, and operators are encouraged to consult such documents. [13]

11 Maintaining Equipment and Facilities

11.1 General

Hydraulic fracturing is a complex operation performed by trained personnel who understand the operation of the fracture treatment, as well as their role and the role of the equipment they operate or the material they manage. Key personnel operating all equipment involved in the hydraulic fracturing operation, and others on site during the fracture stimulation operation should work together following a procedure that can be modified quickly in response to changing conditions.

Communication and training are critical to a successful operation. A SOP for fracturing operations might contain information about the equipment used, safe-operating practices for the equipment, start-up and shutdown procedures and emergency procedures.

11.2 Equipment Maintenance

All equipment, including wellhead valves and assemblies, should be evaluated to determine if they are designed for well fluid conditions, as well as pressures and abrasion created by the fracturing fluids and proppants during the fracture stimulation (see API 6A, *Specification for Wellhead and Christmas Tree Equipment* [14]). Fracturing valves or other devices may be used during fracturing to protect the original wellhead. The presence of contaminants such as H_2S or CO_2 may require additional design and safety considerations. Specially designed valves and equipment may be required to protect the wellhead to prevent failures and accidental releases to the environment during the hydraulic fracturing operation.

Proppant handlers are used to move large quantities of solid proppant to the blenders and mixers. Augers or conveyer belts are used to transport the proppant from a large storage container. Care should be taken to minimize any spillage of solids off the auger or conveyor belt systems.

Blenders and mixers are used to mix the fracturing fluids, proppant and chemicals. Equipment should be configured to minimize the potential for spillage of proppant or leaks of fracture fluids or chemicals. Pumping equipment may experience leaks from the drive train (engine and transmission), pumps, tanks or piping connections. The pumping unit should be tested for leaks after it is connected. All hoses and connections should be checked prior to pressuring up.

Hammer unions, in addition to threaded and flanged connections, are used to connect the fracture lines to the wellhead. The piping system should be inspected and tested before the fracturing operation is initiated. Piping used to transport fracturing fluids from the pumping units to the wellhead, and associated unions and connections, should be pressure tested to verify integrity and confirm they have been properly inspected and free of defects prior to use. Blowdown lines should be tied down securely and inspected prior to use to prevent unintended movement.

Upon discovery, a spill or leak should be promptly reported to the site manager for proper identification, management and clean-up, and, when required, reported to proper officials.

11.3 Inspections

Appropriate equipment should be used for all operations, and inspections/maintenance performed according to design and manufacturer's requirements. Monitoring, corrosion abatement or resistant equipment should be considered if produced fluids are suspected of being corrosive.

Operating procedures should provide for early identification of potential corrosion problems in failure-prone equipment. Consideration should be given to the analysis of failures or malfunctions so that corrective action can be taken to minimize future environmental incidents.

Equipment, including pump packing and hydraulic lines, should be inspected prior to, and during, operation for leaks that could result in pumped fluids being spilled on the ground. Engines should be checked for leaking lube oil, coolant and other fluids.

11.4 Facility Maintenance

Facilities and equipment should be kept clean, maintained and operated in a safe and environmentally sound manner. Signs should be posted in conspicuous locations to notify employees and the public of any dangerous situations such as flammable conditions, high voltage, etc. State or local regulations may specify certain posting requirements.

If the site is located near a populated area, emergency phone numbers should be posted at the entrance to the facility. Weeds should be controlled to a degree compatible with the local environment by cutting, mowing or spraying to improve appearance and reduce fire hazards. When herbicides are used to control weeds, they should be properly applied by trained personnel being cognizant of nearby landowners.

All equipment should be painted and/or kept clean to present an acceptable appearance and to provide protection from external corrosion. Waste receptacles should be provided at appropriate locations for segregating and collecting discarded paper, rags, etc. and emptied on a regular basis.

11.5 Pipeline Maintenance

Pipelines may be used to transport water from wells, ponds or municipal water connections. Pipelines may also be used for the transmittal of flowback and produced water associated with hydraulic fracturing operations. Pipelines should be tested for integrity after installation and inspected as appropriate to ensure they are not leaking. Any identified leaks in the pipelines should be repaired before continuing operation. Temporary lines should be flushed with fresh water before being dismantled, with the flush water disposed of according to appropriate state and federal requirements. Operators should not allow any unauthorized fluid to be discharged during the removal of the pipelines.

Additional steps that should be considered to reduce the potential of a release from a pipeline include the following.

— “Dead” piping and temporary connections should be removed when they are no longer required.

— Piping subject to vibration should be braced to reduce movement and avoid fatigue failures.

— Tanks should be checked for uneven settlement of the foundation, corrosion and leaks.

— Installation of pressure relief valves should be considered for liquid lines, which could potentially rupture from liquid expansion.

— Sleeve-type line couplings should not be used when there is a chance of line movement.

12 Minimizing Surface Disturbance

12.1 General

The well location should accommodate all the equipment used to perform the fracturing job. Any off-location equipment staged during the job should be parked so it does not restrict or block local or emergency traffic. If it is necessary to block portions of the road, affected residents and emergency agencies should receive advance notification.

Wellsites should always be planned with safety—both worker safety and community safety—as a first priority. In addition, site determinations are also based on operational issues and regulatory requirements. Public nuisance issues associated with certain locations, including: vehicle traffic, emissions, noise, lighting, erosion control, material use and management of produced hydrocarbons and fracturing wastes, including flowback fluids, are also important factors in a final site determination.

Larger drilling locations (pads) required for multiple wells and horizontal fracture stimulation, ultimately reduce the overall surface disturbance when compared to single well pads. Pads should be sized to accommodate the drilling and fracturing equipment, multiple well pads, and larger production facilities necessary for higher volumes of produced fluids. These larger locations may result in additional localized impacts during construction, drilling, fracturing, well completion and production operations that must be considered and mitigated as appropriate. As soon as practicable, temporary equipment can be removed and excess areas may be reclaimed, restored or returned to other uses, reducing the location size and overall footprint. See API 51R for further information on appropriate reclamation practices [3].

12.2 Mitigating Impacts Associated with Site Selection

Site selection for all E&P activities warrants careful evaluation and planning. To minimize surface impact, additional attention is prudent for hydraulic fracturing operations. For example, the layout of the site for hydraulic fracturing operations should consider the potential for soil and surface water impacts in the event of a spill. As possible, equipment and materials should be positioned and stored to minimize disturbance to the environment. An environmental site assessment can be valuable in site selection. This assessment might include evaluating topographic, population, environmental hazard, zoning and other maps to locate sensitive or high-exposure areas [such as churches, schools, hospitals, residential areas, surface waters, freshwater wells, flood zones, active fault areas, threatened and endangered plants and animals (including habitat), protected bird habitat, wetlands, archeological, recreational, biological or scenic areas]. Where feasible, the site should be located away from these sensitive areas. Potential impact from upset conditions, such as oil or produced water spills and leaks, should also be considered.

Existing roads and rights-of-way should be utilized to the maximum extent possible. The land owner and/or surface tenant should be consulted to consider present and future uses of affected and adjacent land. A site should be selected that minimizes the amount of surface terrain alteration to reduce environmental and aesthetic damages. Locations requiring construction practices such as cut and fill, which pose possible landslide or slump problems, should be avoided when possible. Consideration should be given to stock piling topsoil, if feasible. Subsurface soil conditions should be considered for adequate foundation support of buildings, pumps, engines, tanks and equipment used during hydraulic fracturing operations.

Detailed guidance for site selection considerations is provided in API 51R [3].

13 Protecting Air Quality

The sources of potential air emissions associated with hydraulic fracturing are temporary in nature. Hydraulic fracturing operations utilize large amounts of horsepower (hp), normally provided almost exclusively by diesel engines. There are federal, state, local and tribal requirements regarding air emissions that apply to oil and gas E&P operations.

Federal regulations that have a direct impact on controlling emissions from fracturing operations include the Standards of Performance for Stationary Compression Ignition and Spark Ignition Internal Combustion Engines (NSPS) and Reciprocating Internal Combustion Engine (RICE) NESHAP rules, which regulate new, reconstructed and existing stationary engines. In general, these rules apply to most internal combustion engines regardless of horsepower rating, location or fuel.

The EPA typically delegates implementation of air regulations to state and tribal agencies. This delegation of authority can include rule implementation, permitting, reporting and compliance. Any state with delegation of authority can pass more restrictive rules, but they are prohibited from passing a rule that is less stringent than the federal rule.

14 Preserving Visual Resources

The visual impacts from hydraulic fracturing operations at any particular site are generally minor and short-term, and vary with topography, vegetation and distance to the viewer. Site-specific impacts will be more pronounced with multi-well pads, but the overall impact of a large-scale operation is reduced. Horizontal drilling can provide flexibility to locate well pads in optimal locations and use of multi-well pads will reduce the number of visual impacts in an area. Operators should work with municipalities to identify and/or map potential areas of high visual sensitivity.

15 Mitigating Noise Impacts

Noise is best mitigated by distance—the further from receptors, the lower the impact. The second level of noise mitigation is direction. Directing noise-generating equipment away from receptors greatly reduces associated impacts. Timing also plays a key role in mitigating noise impacts. Scheduling the more significant noise-generating operations during daylight hours provides for tolerance that may not be achievable during the evening hours.

Hydraulic fracturing operations should be planned with these noise-related considerations in the forefront. When possible, attention to the location of the access road may mitigate noise impact associated with trucking and the hydraulic fracturing operations. When feasible, the wellsite and access road should be located as far as practical from occupied structures and places of assembly. The goal is to protect non-lease holders from noise impacts that conflict with their property use.

Other examples of noise mitigation techniques that can be considered with regard to hydraulic fracturing operations include:

— the placement of tanks, trailers, topsoil stockpiles or hay bales between the noise sources and receptors;

— the use of noise reduction equipment such as hospital mufflers, exhaust manifolds or other high-grade baffling; and

— the orientation of high-pressure discharge pipes away from noise receptors and the addition of noise wall or noise barriers.

16 Mitigating Road Use Impacts

One of the largest local concerns with large-scale deployment of hydraulic fracturing operations is often associated with lease roads. Lease roads are constructed and used to support various exploration and production activities, including fracturing operations. The environmental impact of the construction of a road can have longer lasting effects, beyond the limits of the right-of-way. Existing roads that meet transportation needs should be utilized, where feasible, to limit additional disturbance and new road construction. When it is necessary to build new roadways, they should be developed with potential impacts and purpose in mind. Mitigation options should be considered prior to construction and landowner recommendations should be part of the planning process. In addition, proper road maintenance is critical for the performance of roads, to manage erosion and to protect environmentally sensitive areas.

One of the potential impacts of the proposed activity on community character is the issue of trucking to support high-volume hydraulic fracturing. Local authorities retain control over local roads and, where appropriate, operators should obtain road use agreements.

Whether agreements are in place or not, in areas with traffic concerns, operators should develop a trucking plan that includes an estimated amount of trucking, hours of operations, appropriate off-road parking/staging areas and routes for informational purposes.

Examples of possible measures in a road use agreement or trucking plan include:

— route selection to maximize efficient driving and public safety;

— avoidance of peak traffic hours, school bus hours, community events and overnight quiet periods;

— coordination with local emergency management agencies and highway departments;

— upgrades and improvements to roads that will be traveled frequently;

— advance public notice of any necessary detours or road/lane closures; and

— adequate off-road parking and delivery areas at the site to avoid lane/road blockage.

Detailed guidance for lease road planning, design and construction, maintenance and reclamation, and abandonment are also provided in API 51R [3].

Bibliography

[1] American Petroleum Institute, API Guidance Document HF1, *Hydraulic Fracturing Operations—Well Construction and Integrity Guidelines,* First Edition, October 2009

[2] American Petroleum Institute, API Guidance Document HF2, *Water Management Associated with Hydraulic Fracturing*, First Edition, June 2010

[3] American Petroleum Institute, API Recommended Practice 51R, *Environmental Protection for Onshore Oil and Gas Production Operations and Leases*, First Edition, July 2009

[4] Bolin, David E., Deputy Director of the State Oil and Gas Board of Alabama, Testimony before the House Committee on Oversight and Government Reform, October 31, 2007

[5] See, for example, Stowers, Don, "Unconventional gas outlook to 2020," Oil and Gas Financial Journal, Published: Aug 1, 2009 (http://www.ogfj.com/index/article-display/7451348106/articles/oil-gas-financial-journal/volume-6/Issue_8/Features/Unconventional_gas_outlook_to_2020.html) and the Energy Information Administrations, Annual Energy Outlook 2009, (http://www.eia.doe.gov/oiaf/aeo/gas.html)

[6] Powell, Al, Oscar Bustos, Bill Morris, and Walt Kordziel, "Fiber-Based Frac Fluid A Hit In Bakken," *American Oil and Gas Reporter*, December 2006

[7] Chariag, Belgacem, Schlumberger, Inc., "Maximize reservoir contact", Hart Energy Publishing, LP, *Global Exploration & Production News*, January, 2007

[8] http://www.blm.gov/wo/st/en/prog/energy/oil_and_gas/best_management_practices/gold_book.html

[9] http://www.bseec.org

[10] Ground Water Protection Council, State Oil and Natural Gas Regulations Designed to Protect Water Resources, reported prepared for the Department of Energy (DOE), Office of Fossil Energy, Oil and Natural Gas Program and the National Energy Technology Laboratory (NETL), DOE Award No. DE-FC26-04NT15455), May 2009 (http://www.energyindepth.org/wp-content/uploads/2009/03/oil-and-gas-regulation-report-final-with-cover-5-27-20091.pdf)

[11] American Petroleum Institute, API E5, *Environmental Guidance Document: Waste Management in Exploration and Production Operations*, Second Edition, February 1997

[12] Terracon Consultants, Inc. *Guidance Document: Reasonable and Prudent Practices for Stabilization* (RAPPS) of Oil and Gas Construction Sites, (http://www.ipaa.org/news/docs/RAPPS_Guidance_Document_10-6-9.pdf)

[13] See, for example, http://www.oilandgasbmps.org/browse.php?cat=12, http://cfpub.epa.gov/npdes/stormwater/menuofbmps/ and http://yosemite.epa.gov/R10/WATER.NSF/0/17090627a929f2a488 256bdc007d8dee?OpenDocument

[14] American Petroleum Institute, Specification 6A, *Specification for Wellhead and Christmas Tree Equipment*, 19th Edition, July 2004

energy API®

AMERICAN PETROLEUM INSTITUTE

2010 PUBLICATIONS ORDER FORM

Effective January 1, 2010. API Members receive a 30% discount where applicable. The member discount does not apply to purchases made for the purpose of resale or for incorporation into commercial products, training courses, workshops, or other commercial enterprises.

Ordering Information Online: **www.api.org/pubs**
Phone: **1-800-854-7179** (Toll-free in the U.S. and Canada) | **(+1) 303-397-7956** (Local and International)
Fax: **(+1) 303-397-2740**

Date: ____________________

❑ **API Member** (Check if Yes)

Invoice To (❑ Check here if same as "Ship To")
Name:
Title:
Company:
Department:
Address:

City: State/Province:
Zip/Postal Code: Country:
Telephone:
Fax:
Email:

Ship To (UPS will not deliver to a P.O. Box)
Name:
Title:
Company:
Department:
Address:

City: State/Province:
Zip/Postal Code: Country:
Telephone:
Fax:
Email:

Quantity	Title	SO★	Unit Price	Total
	API HF1, Hydraulic Fracturing Operations--Well Construction and Integrity Guidelines		$40.00	
	API HF2, Water Management Associated with Hydraulic Fracturing		$40.00	
	RP 51R, Environmental Protection for Onshore Oil and Gas Production Operations and Leases		$50.00	

❑ Payment Enclosed ❑ P.O. No. (Enclose Copy) ____________

❑ Charge My IHS Account No. ____________

❑ VISA ❑ MasterCard ❑ American Express
❑ Diners Club ❑ Discover

Credit Card No.:

Print Name (As It Appears on Card):

Expiration Date:

Signature:

Subtotal	
Applicable Sales Tax (see below)	
Rush Shipping Fee (see below)	
Shipping and Handling (see below)	
Total (in U.S. Dollars)	

★ To be placed on Standing Order for future editions of this publication, place a check mark in the SO column and sign here:

Pricing and availability subject to change without notice.

Mail Orders – Payment by check or money order in U.S. dollars is required except for established accounts. State and local taxes, $10 processing fee, and 5% shipping must be added. Send mail orders to: **API Publications, IHS, 15 Inverness Way East, c/o Retail Sales, Englewood, CO 80112-5776, USA.**

Purchase Orders – Purchase orders are accepted from established accounts. Invoice will include actual freight cost, a $10 processing fee, plus state and local taxes.

Telephone Orders – If ordering by telephone, a $10 processing fee and actual freight costs will be added to the order.

Sales Tax – All U.S. purchases must include applicable state and local sales tax. Customers claiming tax-exempt status must provide IHS with a copy of their exemption certificate.

Shipping (U.S. Orders) – Orders shipped within the U.S. are sent via traceable means. Most orders are shipped the same day. Subscription updates are sent by First-Class Mail. Other options, including next-day service, air service, and fax transmission are available at additional cost. Call 1-800-854-7179 for more information.

Shipping (International Orders) – Standard international shipping is by air express courier service. Subscription updates are sent by World Mail. Normal delivery is 3-4 days from shipping date.

Rush Shipping Fee – Next Day Delivery orders charge is $20 in addition to the carrier charges. Next Day Delivery orders must be placed by 2:00 p.m. MST to ensure overnight delivery.

Returns – All returns must be pre-approved by calling the IHS Customer Service Department at 1-800-624-3974 for information and assistance. There may be a 15% restocking fee. Special order items, electronic documents, and age-dated materials are non-returnable.

AMERICAN PETROLEUM INSTITUTE

1220 L Street, NW
Washington, DC 20005-4070
USA

202-682-8000

Additional copies are available online at www.api.org/pubs

Phone Orders: 1-800-854-7179 (Toll-free in the U.S. and Canada)
303-397-7956 (Local and International)
Fax Orders: 303-397-2740

Information about API publications, programs and services is available on the web at www.api.org.

Product No. GHF301