Reprinted from Proceedings of the 2000 Ground Water Protection Council Annual Forum, September 24-27, 2000, Ft. Walton Beach, FL

History, Regulation, and Closure of Abandoned Centralized and Commercial Drilling-Fluid Disposal Sites in Louisiana, New Mexico, Oklahoma, and Texas

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ABSTRACT

State regulatory agencies have responsibility for closure of drilling-fluid disposal sites that have been abandoned. There may be as many as 80 abandoned drilling-fluid disposal sites in Louisiana, New Mexico, Oklahoma, and Texas. Other disposal sites in operation in the early to mid-1980s were either upgraded to meet present regulations, or closed by operators or by State-funded oilfield remediation programs. Information on the number, acreage and volume of waste pits, and levels of constituents in the drilling waste and adjacent soil and groundwater are being compiled and summarized, mainly from files at the State regulatory agencies. Because data on abandoned sites can be sparse, we are also looking at sites that have been closed under State regulation as well as active or recently permitted sites to better understand potential composition of waste in the remaining abandoned sites.

INTRODUCTION

Drilling fluids used in oil and gas exploration and production (E&P) operations may be mixed with drilling additives, cuttings, formation water and crude oil. During the past few decades, the amount of spent drilling fluids sent offsite for disposal has decreased from about 28 to 2 percent on a nationwide basis (American Petroleum Institute, 2000). Although current regulations address the operation and closure of present-day drilling-fluid disposal sites, many older sites were operated under less stringent regulation. They may have received wastes other than spent drilling fluids and may have been abandoned without proper closure. Without investigation of individual disposal sites, prediction of the quantity and character of constituents at these abandoned facilities is difficult because few compilations and summaries are available.

Closure of abandoned drilling-fluid disposal sites in Louisiana, New Mexico, Oklahoma, and Texas is the jurisdiction of State regulatory agencies: Louisiana Department of Natural Resources Office of Conservation, New Mexico Energy, Mineral, and Natural Resources Department Oil Conservation Division, Oklahoma Corporation Commission, and Railroad Commission of Texas, respectively.

This study is a census, compilation, and summary of information on abandoned centralized or commercial drilling-fluid disposal sites in these four states. Centralized facilities receive spent drilling fluid from several leases held by an operator or from several sites on the same lease. Centralized facilities are noncommercial sites with no commingling of waste from other operators. Commercial facilities accept drilling fluid and other waste allowed by their disposal permit from any operator on a fee basis. Information on closure of small onsite reserve pits at individual wells and disposal their spent drilling fluid is not part of this study. Reserve pit sites, unlike centralized or commercial pits, are used only during drilling.

Information being gathered includes number and acreage of pits, waste volume, and levels of selected constituents in the waste and adjacent soil and groundwater. Sources of data on abandoned centralized and commercial disposal sites mainly are permit files at State regulatory agencies. Because data on abandoned sites can be sparse, we are also compiling data for sites that have been closed by operators and by State-funded programs as well as for active permitted sites to better understand the remaining abandoned sites.

This paper gives a summary of the origins of spent drilling fluid, State regulations, and recent changes in technology of drilling fluid and disposal practices.

GENERATION OF SPENT DRILLING FLUID

The 1980 Solid Waste Disposal Amendments to the Resource Conservation and Recovery Act (RCRA) exempted drilling fluids, produced water, and associated E&P drilling wastes from regulation as Subtitle C hazardous wastes. In 1988, the Environmental Protection Agency (EPA) confirmed the appropriateness of this exemption because the volumes are large, toxicities are low, and economic impact of its regulation could be high. EPA found that State regulation of E&P waste was appropriate. In 1993, EPA clarified the regulatory determination of wastes as exempt or non-exempt.

Changes in the E&P industry over the past few decades include changes in the amount and characteristics of spent drilling fluid being generated and drilling-fluid disposal practices (American Petroleum Institute, 2000). Constituents of drilling-fluid waste found in abandoned drilling-fluid disposal sites, most of which date from the 1970s and 1980s, therefore, should be expected to differ from those of more up-to-date drilling-fluid disposal sites.

Drilling fluid pumped into a well bore has a number of functions, not least of which is removal of cuttings from subsurface formations. Much but not all of the cuttings are removed at the surface for recycling of the drilling fluid and control of its properties. When drilling efficiency or mud properties become adversely affected, the whole batch may be disposed of and replaced by new fluid. In addition to drilling mud and formation cuttings, the discarded drilling wastes may include additives, formation water and produced hydrocarbons, rig washwater including soaps and oils, and wastes from cementing operations. Most (70 to 90 percent) of drilling waste is liquid, but drilling-fluid waste constitutes the majority of the solid waste generated in oil and gas E&P operations (American Petroleum Institute, 2000).

Three main types of drilling fluid are water based, oil based, and synthetic muds (table 1). Use of various drilling muds differs by region as well as with drilling targets. Technology of drilling mud has changed over the past few decades to meet safety and cost requirements and environmental concerns. Various materials such as

saltwater and lignosulfonate may be added to control interaction between the drilling fluid and formations. Saltwater is used where it is more economical or available than freshwater, or where needed to prevent excessive borehole enlargement when drilling through salt formations. Lignosulfonate mud was the most common water-based drilling mud during the 1970s and 1980s, both for onshore and offshore drilling. Lignosulfonate is a synthetic material derived from the wood-processing industry and lignosulfonate mud was particularly effective in deep drilling under high pressures and temperatures. Lignosulfonate mud often contained several volume percent of diesel oil for lubricity and 2 to 4 weight-percent chromium for thermal stability.

Oil-based (usually 6 to 10 percent diesel by volume) muds may outperform water-based muds in a number of situations: oil muds can be more stable at high temperatures, have better lubricating properties, and better protect the drill string from becoming stuck in the borehole. A more refined, less toxic petroleum oil began to replace diesel oil as an additive circa 1980. Changes in oil-mud emulsifiers, wetting agents, and viscosifiers further improved the drilling performance of the mineral-oil muds. Mineral-oil-based drilling waste was regulated the same way as diesel-oil-based drilling waste. Other constituents identified in spent drilling fluid that could pose human health and environmental risks at abandoned sites include organics, such as benzene and other volatile organic hydrocarbons; metals, such as barium, chromium, lead, and zinc; saltwater; and naturally occurring radioactive materials (NORM) from pipe scale and tank sludge.

Between 1985 and 1995 the use of saltwater-based and oil-based drilling fluid decreased nationwide (table 1). The decrease reflects improved performance of water-based and new synthetic-based drilling muds and substitution of environmentally moderate materials where feasible (American Petroleum Institute, 2000).

ABANDONED CENTRALIZED AND COMMERCIAL DRILLING FLUID DISPOSAL SITES

Total onshore footage drilled in the U. S. decreased by more than 60 percent between 1985 and 1995 (American Petroleum Institute, 2000). Volume of drilling-fluid waste probably decreased by an even greater factor, given improvements in efficiency. In 1995, about 108 million barrels of drilling waste was generated in Louisiana, New Mexico, Oklahoma, and Texas (table 2). Less than three percent of onshore drilling waste nationwide was sent offsite for disposal in 1995, for example, to commercial disposal facilities (table 2). In comparison, in 1985, more than 25 percent of drilling waste was hauled offsite for disposal (American Petroleum Institute, 2000).

In Louisiana, disposal of E&P waste by multiple operators in a centralized company-owned facility is not allowed by Statewide Order No. 29-B. The rule also says that E&P waste must be taken to a commercial facility if taken offsite for disposal. Prior to 1981 Louisiana had no Statewide regulations for disposal of drilling fluids; a succession of regulations were issued between 1982 and 1990 pertaining to drilling waste disposal facilities. Louisiana now requires pits at commercial facilities to be registered and tested before closure. Some pits must be lined to prevent seepage and contamination of ground water. If closure or land farming is not permissible because toxic or otherwise hazardous materials are present, then hauling to a certified landfill is often necessary. This is expensive, and the liability for site closure and possible ground-water contamination from that landfill could return to the disposer.

In New Mexico, most disposal of spent drilling fluid is on site; special permission is needed to move spent drilling fluid offsite. Offsite disposal is allowed where onsite disposal may affect sensitive areas or where landowner restrictions apply.

Oklahoma rules do not allow the use of centralized disposal facilities; all offsite disposal is at commercial facilities.

Texas allows centralized and commercial facilities to be used for disposal of spent drilling fluid in accordance with State regulations (Railroad Commission of Texas Rule 8). Pits in operation before 1984 were grandfathered into Rule 8 and are referred to as Previous Authority drilling mud pits (PA pits).

Enforcement of new or additional State regulations during the mid-1980s coincided with both a decrease in drilling activity and more efficient use of drilling fluid, resulting in a decreased need for offsite disposal of spent drilling fluid. As regulatory agencies issued more stringent regulations during the 1980s, some operators of disposal facilities chose to revamp their operations to come into compliance with the new rules. Earthen pits were commonly used for disposal of oil-field wastes up through the mid-1980s. Some permitted sites converted their pit operations to more sophisticated land treatment or land farming facilities. Other operators chose to close their

sites following conventional methods such as landspreading, dilution burial, or solidification burial, or wastes were excavated and hauled to other waste disposal facilities. In some cases, however, sites were abandoned rather than closed under State regulation, for example, following bankruptcy. State agencies did not have special funding appropriated for State-sponsored cleanup of abandoned sites until the early to mid-1990s.

Preliminary estimates of the number of abandoned drilling-fluid disposal sites in the four states as identified in State agency files are at least 8 in New Mexico, more than 15 in Louisiana, none in Oklahoma, and as many as 60 or 70 in Texas. These numbers remain subject to revision, however, as the count may include sites that actually have been closed or have a permit, and thus should not be defined as abandoned. The count also may include facilities that were not mainly drilling-fluid disposal sites, for example, saltwater-disposal sites that have only a small amount of spent drilling fluid. Oklahoma has perhaps the most aggressive State-sponsored cleanup program, and most if not all abandoned sites in Oklahoma have been closed within the past few years.

Information can be limited in State regulatory agency files on abandoned sites that have not yet been closed. State inspectors may have surveyed the sites and documented the location, number, and extent of disposal pits, but analytical results of soil or water samples are generally scant. Files for sites that have been closed under State-sponsored cleanup programs document the size of sites and volume of waste, complaints and other reasons for action to close the site, and constituents found in wastes during site investigation. Information on sites that operators have closed may also include the size and number of pits that had been present and a summary of actions taken to satisfy closure requirements. Information on active permitted E&P disposal sites is the most complete, for example, containing historical correspondence, permit applications, records of waste receipts, quarterly reports of monitoring data, as well as information on enforcement and cleanup actions related to permit violations. Changes in technology and regulation mean that a typical drilling waste now being sent to permitted disposal sites is different from the waste sent to such sites during the 1970s to mid-1980s. Changes include a decreased use of oil-based and high-chromate lignosulfonate muds, as well as adherence to regulations regarding mixing NORM, hydrocarbon-rich tank-bottom sediments, and other E&P waste with spent drilling mud. Some constituents of spent drilling mud remain the same, however, although concentrations have changed. In addition, some permitted sites also contain older spent drilling fluid. Data for active or recently permitted sites, therefore, should have some transferability to predicting constituents and soil impacts at abandoned sites.

CONCLUSION

Compiled and evaluated data on abandoned as well as closed and permitted offsite drilling-fluid disposal sites in Louisiana, New Mexico, Oklahoma, and Texas should provide a basis for improving the cost effectiveness of assessment and remediation of abandoned sites in these and other states. Although current regulations address the operation and closure of drilling-fluid disposal sites, the legacy of abandoned sites includes uncertainty as to the quantity and character of possible contaminants in spent drilling mud. As State regulations were developed for E&P waste disposal sites in the early to mid-1980s, many facilities were upgraded to be in compliance or closed by their operators, yet other sites were abandoned without proper closure. There may be at least 80 abandoned drilling-fluid disposal sites in Louisiana, New Mexico, Oklahoma, and Texas. Cleanup of abandoned sites is the jurisdiction of State-funded programs administered by regulatory agencies. There are no standards for the assessment and remediation of abandoned drilling-fluid disposal sites.

ACKNOWLEDGMENTS

This study is being sponsored by the U.S. Department of Energy under award No. DE-AC26-99BC15225 and co-sponsored by a grant from the American Petroleum Institute. The views and opinions of authors expressed in this report reflects information available to the authors and should not be interpreted as representing the official policies, regulations, or records of any federal, State, or other agency.

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Table 1. Percentage of drilling waste by mud type.
Derived from American Petroleum Institute (2000).

	Year	Freshwater based mud	Saltwater based mud	Oil based mud	Other
Louisiana	1995	93		7	
New Mexico	1995	82	16		2
Oklahoma	1995	63		37	
Texas	1995	93	7		
U.S. average	1995	92.5	5.5	<1.5	0.5
U.S. average	1985	64	23	7	6

Table 2. Estimated volume (thousand barrels) of disposal of solid drilling waste. Derived from American Petroleum Institute (2000).

	Year	Total	Burial onsite	Land spread onsite	Land spread offsite	Commercial disposal facility	Reuse or recycle	Other
Louisiana	1995	22,477	4,495	899		2,922		
New Mexico	1995	7,421	965	223				
Oklahoma	1995	13,162	6,581					
Texas	1995	65,367	8,533	197	65		394	65
U.S. total	1995	139,602	29,732	3,104	389	2,926	394	870