TECHNOLOGY Locations: Worldwide, onshore and offshore

Advanced Approaches to Site Restoration

SUMMARY

At the end of an oil or gas well's economic life, typically spanning 15 to 30 years, the well must be plugged and abandoned, all production equipment removed, and the surrounding area restored as closely as possible to its original state to prevent potential environmental or public health risks. To ensure the future ecological and economic viability of closed site lands, the industry is continually developing and applying innovative site restoration practices and technologies, including Risk-Based Corrective Action, soil bioremediation, and wetlands restoration. In addition, operators are actively supporting industry-led clean-up efforts such as those being carried out by the Oklahoma Energy Resources Board, a privatized state agency funded solely by industry's voluntary contributions.

BLUEPRINT ON TECHNOLOGY

Advanced technology and practices underscore a widespread commitment to environmental excellence

Closing sites

Of approximately 3.4 million oil and gas wells drilled in the United States since 1859, more than 2.5 million have been plugged and abandoned—a complex effort involving significant planning and expense. Onshore, wellbores are permanently plugged with cement to prevent any flow of subterranean fluids into the wellbore, thereby protecting groundwater. Waste-handling pits are closed, and storage tanks, wellheads, processing equipment, and pumpjacks removed. Offshore, wellbores are sealed below the sea floor and platforms are fully or partially removed, or toppled in place as part of artificial reef programs. About 17,000 onshore wells are plugged and abandoned annually, and 100 offshore platforms decommissioned each year.

Unplugged or orphaned wells with no existing owner or operator are largely a legacy of historic operations, when site restoration was not considered necessary. Today, a new approach to restoration integrates advanced technology, increased research and development, and a spirit of voluntarism and responsibility.

An exemplary model

A highly effective industry-led site restoration program is run by the Oklahoma Energy Resources Board (OERB), with near-unanimous support from Oklahoma producers and royalty owners, whose annual voluntary contributions solely fund this unique initiative. Since 1995, this privatized state agency has restored more than 1,000 orphaned and abandoned well sites across Oklahoma—with 500 more sites under way—mitigating potential health and environmental risks and restoring blighted lands to the benefit of landowners, the community, and the environment, at no cost to the landowner. OERB's success demonstrates industry's commitment to preserving the lands on which it operates.

Diverse approaches

Rather than employing a "one-size-fits-all" approach to site restoration, industry is turning to flexible Risk-Based Corrective Action (RBCA) processes to ensure swift, efficient clean-ups. A joint American Petroleum Institute-Gas Research Institute (GRI) project has resulted in development of an E&P-specific set of RBCA tools to help operators undertake risk-based remedial planning. In this approach,

ECONOMIC BENEFITS

- Reduced long-term environmental clean-up costs and lowered risk of future liability
- Increased economic value of land returned to productive agricultural, residential, or commercial uses

ENVIRONMENTAL BENEFITS

- Mitigation of potential public health and environmental risks
- Restoration of sensitive habitats and ecosystems
- Organic cleaning of petroleum-stained soil through bioremediation, maintaining and sometimes even improving soil health

human-health and ecological-risk analyses and decisions are integrated with the corrective action process, ensuring that remedial measures are appropriate given a specific site's characteristics and risk levels, and that resources are focused first on sites presenting the greatest potential risk.

Emerging bioremediation technology is a cost-effective tool with powerful environmental advantages. During E&P operations, soil layers can become stained with hydrocarbon molecules ranging from heavy crudes to volatile organic compounds. Bioremediation involves stimulating existing or placing carbon-eating microorganisms in stained soils to digest excess hydrocarbons or break them down into simpler, non-toxic compounds such as carbon dioxide and water. Bioremediation maintains the microbial populations needed to keep soil healthy, and can also enhance soil health.

Within the natural gas industry, R&D efforts focus on remediating mercury-contaminated sites, which can entail potentially significant environmental and public health risks. In conjunction with DOE, GRI is examining the extent of the contamination, developing risk-based prioritization models, and testing advanced remediation technologies, including physical separation, chemical, and thermal techniques.

New techniques for restoring wetlands lost to saltwater encroachment are under development. For example, with assistance from DOE-funded research at Southeastern Louisiana University (SLU) is demonstrating that drill cuttings can be safely used to restore and create wetlands. Using SLU's unique temperature-controlled mesocosm greenhouse facilities to simulate wetlands' full range of tidal fluctuations, researchers have found that certain processed drill cuttings appear capable of supporting healthy wetlands vegetation.

CASE STUDIES

Success in the Field

Proactive, global, site restoration

Together with other companies and the State of California, Phillips Petroleum is leading the restoration of the abandoned 880-acre Bolsa Chica oil field near Huntington Beach, California. The project includes cleaning up old well sites and building a tidal inlet where waterfowl can rest and feed before migrating 3,000 miles across the Pacific Flyway.

In Phu Khieo, Thailand, Texaco restored a nonproductive exploratory drill site, although not legally obligated under Thai law, by treating drilling wastes, capping the site with clean topsoil, and building dikes to support rice paddies and sugar cane fields. The Thai government has since proposed Texaco's approach as a regulatory environmental management model.

Working with Kansas State agencies, Mobil E&P U.S., Inc. bioremediated hydrocarbon-stained soils at its Hugoton Gas Field. Using cow manure as a soil nutrient and microbial base catalyst, total petroleum hydrocarbon levels were reduced by more than 99 percent. At the project's conclusion, native grasses were planted to re-vegetate the area.

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TECHNOLOGY Locations: Gulf of Mexico

Rigs to Reefs

SUMMARY

Industry, regulators, and environmentalists now recognize the advantages of toppling decommissioned offshore platforms and anchoring them on the sea floor as permanent artificial reefs. Under existing State programs, oil and gas companies can donate platforms to States for use as artificial reefs, along with a percentage of their cost savings to be used for reef maintenance and development. Designed for marine environments and impervious to displacement or breakup, these steel platforms make ideal reefs. Thriving habitats are typically well established on working rigs, and dismantling and moving them threatens these habitats. To date, more than 100 donated offshore platforms have been placed off the coasts of Texas, Louisiana, and other Gulf States, where they host complex ecosystems that attract fish and enhance commercial fishing and recreational activities.

BLUEPRINT ON TECHNOLOGY

Converting obsolete platforms into artificial reefs benefits marine habitats, commercial fishers, divers, vacationers, and the oil and gas industry

Removing rigs

THE U.S. MINERALS Management Service (MMS) requires removal of all platforms in Outer Continental Shelf (OCS) waters within one year from production shutdown. Currently, platform removals from the Gulf of Mexico OCS are averaging 100 platforms per year. MMS estimates that over half of about 3,900 remaining structures will require removal by 2000. For smaller structures in shallow waters, companies typically dismantle the platform using explosives, or sometimes torches or cutters, and then tow the deck and jacket to shore for refurbishment or scrapping. This option is often elected when the platform is not located near a "rigs to reefs" zone.

Creating artificial reefs

When decommissioning in deeper waters (generally beyond 100 feet) at more remote locations, operators can reduce removal costs significantly by toppling structures (fully or partially) in place as artificial reefs, or towing them to a designated site for toppling. To date, about 10 percent of the Gulf's platform removals have been converted to artificial reefs; this percentage is expected to increase as more decommissioned deepwater platforms require removal.

The typical 20-story steel jackets that support offshore platforms provide acres of habitat for various underwater flora and fish species—within six months to one year of initial placement, platforms are covered with marine life. The submerged hard surfaces invite invertebrates such as barnacles, corals, sponges, clams, bryo-zoans and hybroids, which in turn attract resident reef fish such as snapper and grouper and transients like mackerel and billfish. Fish are also drawn by

ECONOMIC BENEFITS

- Potential for significant reductions in platform removal and disposal costs, particularly in locations where partial removal is viable
- Industry cost savings fund State reef maintenance and development programs
- Enhancement of commercial fishing opportunities
- Promotion of local tourism through enhanced recreational fishing and diving opportunities

ENVIRONMENTAL BENEFITS

- Enhanced protection and nurture of complex marine ecosystems and habitats
- Creation of new marine habitats
- Reduced impacts of platform demolition and relocation
- Increased recreational use of water resources

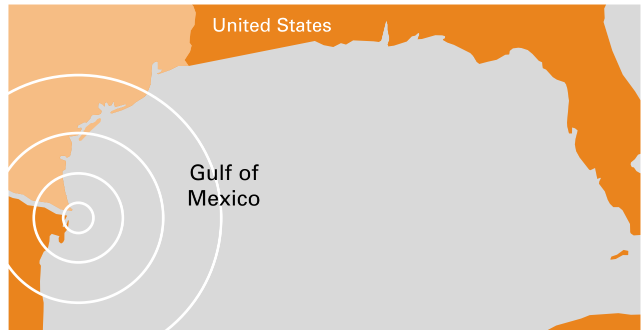
the shape, size, and openness of these structures, which attract an estimated 20 to 50 times more fish than the Gulf's naturally flat, soft bottom.

Removing platforms after shutdown threatens these complex fish populations as well as the commercial and recreational industries that rely on them. Through "rigs to reefs," industry and State governments are collaborating to ensure the greatest possible number of platform conversions, thereby protecting rich marine ecosystems and enriching the Gulf's commercial fishing and recreational opportunities.

The first planned rigs-to-reefs conversion took place in 1979, when an Exxon-owned subsea template located offshore Louisiana was moved to offshore Florida. The National Fishing Enhancement Act, passed in 1984, led to the development of the National Artificial Reef Program and formal support from MMS. State programs followed in Louisiana (1986) and Texas (1990); Mississippi, Alabama, and Florida have since formed their own programs. Today, artificial reefs exist around the world, with the Gulf of Mexico boasting the most extensive and successful conversions.

CASE STUDIES

Success in the Field



Rig reefs boost tourism in South Texas

Mobil Exploration and Production U.S., Inc., performed an environmentally outstanding conversion in 1994. Over a 75-day period, Mobil dismantled six platforms located in several South Padre Island blocks, moving four jackets 10 miles to Port Mansfield Liberty Ship Reef and two jackets 27 miles to Port Isabel. Mobil elected to cut away the platform legs rather than blast them, despite explosives being cheaper, faster, and more reliable. Mechanical cutting avoided undue harm and disruption to the rich marine life inhabiting the rigs offshore environmentally sensitive South Padre Island.

The added time and expense of cutting and transport negated any cost savings, but Mobil still earned tremendous payback. Jeffrey Passmore of Mobil noted: "We were able. . .to give. . .structures with 15 to 20 years of [marine habitat] buildup on them." Jan Culbertson, Texas Parks and Wildlife Department, commented, "We almost begged Mobil to take the structures to Port Isabel. That's where our tourism dollars are. Mobil bent over backward to give us their structures in a natural state with no animals hurt or removed. We even had turtles living on the structures that we had to move out of the way. All the animals, the little blennies [fish] that were inside the barnacles, all made it to their new reef-site home."

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TECHNOLOGY Locations: United States

Road Mix and Roadspreading

SUMMARY

Tank cleaning and other common exploration and production operations routinely generate large amounts of non-hazardous crude oil wastes sometimes suitable for use as road paving (road mix) materials. These hydrocarbon residuals act as binders, and can be mixed on-site with native soils or imported aggregate, then safely paved into roads. Similarly, another routine oil-field waste, produced water—the brine or brackish water extracted with oil or gas during the production process—can be used for road de-icing or dust control. Road mixing and spreading technology provides useful products, significant disposal cost-savings for producers, and conservation of limited landfill capacity. Minimizing landfill use also significantly reduces the potential for reactive hydrocarbon emissions and soil and water contamination. While this practice promises environmental benefits under certain conditions, application is limited and discrimination necessary.

BLUEPRINT ON TECHNOLOGY

Crude oil residuals and produced water can be safely and creatively recycled for road building, stabilization, de-icing, and dust suppression

Creative use of oilfield waste

As landfill and other traditional disposal methods become more limited and costly, in some areas the petroleum industry is increasingly recycling various oilfield wastes as road mix material.

Paralleling the commercial road mixing process, the petroleum industry mixes crude oil residuals from tank cleaning, sump abandonments, and production flowline leaks with imported aggregate (coarse binding materials) or native soils for light duty road paving or dust suppression.

Tank residuals are the largest source of recycled binding agents. These residuals, made up of fine sediments or sands and heavy, low-volatility hydrocarbons that settle during storage, are periodically cleaned out of tanks by high-pressure water jets, creating a slurry that is dewatered to make sludge. The sludge—with cohesive and adhesive properties similar to commercial road mix materials—is mixed with aggregate, graded, and cured.

The resulting road mix can either be stockpiled or applied immediately with standard paver/spreader equipment, and compacted if necessary. Depending on final use, the hydrocarbon content of the raw materials, and the type of road mix needed, petroleum facilities may add commercial asphalt cements to their road mix.

Other oilfield wastes, such as completion and workover fluids and produced brine, are also suitable for roadspreading to suppress dust or de-ice unpaved roads. In northern

ECONOMIC BENEFITS

- Significant reduction in costs and potential liability associated with management and disposal of nonhazardous oilfield wastes
- More expensive alternatives such as paving would be necessary without recycled road mix
- Landfill space conserved
- Conservation of natural resources through product substitution

ENVIRONMENTAL BENEFITS

- Reduced waste volumes to landfill or reinject into the earth's subsurface, thus reducing potential environmental risks and future liability
- Reduced dust and particulate matter emissions from unpaved roads
- Greatly reduced reactive organic hydrocarbon compound emissions, compared with landfill disposal
- Demonstrated low hydrocarbon and metal leachability
- Demonstrated nonhazardous by acute aquatic testing

States, using these wastes to de-ice roads instead of salt can conserve this limited natural resource.

Today, the petroleum industry uses most of its recycled road mix to develop access roads to remote exploration and production sites and to control dust in production areas. California operators have been using crude oil-impacted waste materials as road mix for nearly a century with no adverse environmental impacts. Similarly, brine spreading to stabilize roadways and control dust has been used effectively in certain areas for years. The primary alternatives to road mixing and roadspreading are landfilling the solid wastes at an average cost of $75 per ton, and subsurface reinjection of produced water for disposal or enhanced oil recovery, also very costly.

CASE STUDIES

Success in the Field

Roadspreading in Pennsylvania

A portion of the 1.7 million barrels of brine produced annually by Pennsylvania's oil and gas wells is spread on its unpaved secondary roads for dust suppression and road stabilization. To minimize environmental impacts from this practice, including the risk of contaminants leaching into surface or ground waters, the Pennsylvania Department of Environmental Protection (DEP) has developed mandatory roadspreading guidelines for brine generators, transporters, applicators, and roadway administrators.

Funded by a Federal Clean Water Act grant, the DEP tested water quality impacts along seven unpaved roadways in western Pennsylvania on which brine had been spread. Between 1992 and 1995, surface water samples were taken from culverts, roadside ditches, streams, and ponds at the selected road sites, while groundwater was sampled from monitoring wells installed to measure the impact of brine-spreading on water quality. Over the sampling period, lysimeters were used to determine whether brine had migrated from the roadbed. Soil and roadbed samples were also taken to identify any leaching or accumulation of heavy metals or other harmful pollutants. Through monitoring and subsequent analyses, the DEP concluded that although potential exists for harm to surface water and groundwater from brine migration or run-off, risks could be significantly minimized by controlling the frequency and application rate of brine and by following the roadspreading guidelines. Roadspreading offers a cost-effective means to recycle and dispose of a portion of Pennsylvania's produced water waste stream, with minimal environmental impact.

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