Environmentally friendly drilling targets responsible operations in sensitive locations

By John D Rogers and Tom Williams,
Noble Technology Services; Richard Haut,
Houston Area Research Center;
David Burnet; Texas A&M University

THE PETROLEUM INDUSTRY is well equipped to demonstrate the economic contributions and benefits it brings to society through energy, chemicals and other products and through wealth generation and employment creation. A key challenge for the industry is how to satisfy energy demand while safeguarding the environment. Misconceptions about the oil and gas industry's ability to responsibly produce hydrocarbons have resulted in many sensitive areas in the continental US and worldwide being set aside or severely restricted from oil and gas production. Efforts within the industry to correct inaccurate attitudes of the public are proceeding (for example, see the IADC-led International Forum of Energy Centres & Museums' efforts on Page 63 of the May/June 2006 DRILLING CONTRACTOR).

Unfortunately, oil and gas is often found in fragile ecosystems, such as arid/semi-arid deserts and coastal inland wetlands that can be very sensitive to disruptive activity. Social responsibility in these types of environments is a key emerging issue that needs to be addressed proactively and systematically and will require long-term solutions.

Environmental issues are a part of every energy industry endeavor, whether exploiting new natural gas resources in the Western US or extending field development in coastal areas. Development of a compendium of best available technology to address this issue from a technical view is the overarching purpose of a project funded by the US Department of Energy.

Anadarko Petroleum Corporation photo

Noble Technology Services is participating in an integrated petroleum environmental development program. One partner in the project is Anadarko Petroleum Corporation, which built an elevated, modular and mobile platform for drilling wells in the arctic shallow water or environmentally sensitive locations. The system was tested while drilling one of the first hydrate exploration wells in Alaska during 2003-2004.

ENVIRONMENTALLY RESPONSIBLE PROJECT

Texas A&M University, Noble Technology Services (a subsidiary of **Noble Corporation**) and the Houston Advanced Research Center have formed an integrated petroleum environmental development program that is supported by a growing team of partners from industry:

- **Anadarko Petroleum Corporation**
- **BP**
- **Chevron**
- **ConocoPhillips**
- **Derrick Equipment**
- **Halliburton**
- **M-I Swaco**
- **Shell**
- **National Oilwell Varco**
- **Statoil**
- **Huisman-US**

Designated as the Environmentally Friendly Drilling Systems Program (EFD), its purpose is to incorporate engineering and environmental knowledge specifically to reduce environmental impact on ecologically sensitive areas from oil and gas extraction activities.

The first phase of the project is identifying low-impact technologies for two extreme environmental conditions: desert-like ecology environments and a coastal margin ecosystem. Balancing the value of energy production with social, environmental and economic considerations will provide a different perspective on the true cost of resource development.

The goal of the project is to integrate current and new technology into a field-demonstrable drilling system for compatibility with ecologically sensitive, restricted access, off-limits areas of the lower 48 states of the US (e.g., Otero Basins of New Mexico, wetlands of Louisiana, East Texas and Mississippi Coasts, and Rocky Mountain areas). The concept is to integrate currently known but unproven or novel technology into a drilling process or system to enable moderate (10,000–15,000 ft vertical depth) to deep (15,000–20,000 ft vertical depth) drilling and production operations for hydrocarbons with very limited environmental impact through the entire life cycle of a well and field.

Four primary areas are being addressed:

1. Transportation equipment and methods. Various approaches were developed for other sensitive areas and do not require building roads but allow carrying heavy loads with little or no damage to soils, vegetation, or animals.

2. Drilling equipment and methods. These encompass pad drilling using horizontal, multilateral drilling and/or extended-reach drilling, not only for multiple completions in gas reservoirs but also for production and gathering lines and disposal systems. The "zero pad" concept uses an innovative onshore platform to effect a low-impact ecological footprint. Improve drilling equipment efficiency and methodology to reduce greenhouse gas emissions, i.e., zero-discharge concepts. Bring lessons learned offshore to onshore.

3. Production completion systems. Disposal systems are included for mitigation of fluids such as produced water. U-tube concept of trenchless production gathering systems. Waste management during drilling and production operations life cycle. Low ecological footprint.

4. Studies related to environmental management in E&P operations and research on public perception of impacts from oil and gas explorations in ecologically sensitive or protected area. Review regulations and potential impact of technology demonstration on regulations and access to targeted sensitive areas.

Individually, several of these concepts have been developed to varying degrees. The key objective is synergistic incorporation of current and emerging technologies into an integrated, clean drilling/production system with no or very limited impact. The bottom line is to:

1. Define the best available technology (system) for sustainable drilling in specific areas.

2. Demonstrate that technology is sufficiently available to economically develop oil and gas resources while protecting the environment.

3. Encourage sustainable access to environmentally sensitive areas that are currently off-limits or restricted for hydrocarbon development.

4. Transfer lessons learned offshore to sensitive onshore environments.

RIG TECHNOLOGY

Equipment for onshore operations has evolved from large cumbersome rigs needing large ginpole trucks and cranes for rig-up and rig-down to designs that are self-erecting and require smaller and fewer roadable loads. Most innovative rig designs in the last decade have evolved from the necessity to reduce drilling costs, increase ROP and the speed of drilling wells, and reduce the cost and time of rig moves. These highly mobile, automatic and semi-automatic (robotic) rigs emphasize the safety of rig workers and the environment. Innovative designs have emerged worldwide from US, European and Asian manufacturers.

Acceptance of self-elevating substructures, automation and environmental considerations has grown (often slowly) for 40 years after one of the first self-elevating rigs was disclosed by Moore in 1966. **Helmerich & Payne International Drilling Company** introduced its FlexRigs in 1996. Most land-based newbuilds have reduced the number of people required on a drilling rig and substantially automated the drilling process with pipe-handling equipment, iron roughnecks and digital controls from the driller's doghouse.

These advances have substantially reduced the physical footprint, increased efficiency, improved predictability of drilling operations, and made drilling rigs a considerably safer working environment compared with the vintage 1950 system.

ONSHORE RIG PLATFORM

In 2004, Anadarko was issued a patent (Kadaster, US patent 6,745,852) for an elevated, modular and mobile platform for drilling oil and gas wells in the arctic, shallow water or environmentally sensitive geographical locations. The purpose of the platform was to drill in sensitive areas without significantly disturbing the ground surface. A key secondary goal was to extend the drilling cycle time (season) in the arctic and other sensitive soil and wildlife habitat areas. The system was tested while drilling one of the first hydrate exploration wells in Alaska during 2003–2004.

The system consists of aluminum modules approximately 12.5 ft wide and 50 ft long. Modules need not be in those dimensions but should be light enough to be transported to a drilling location by aircraft, land vehicles, sleds, boats, barges, etc. Additionally, the modules may be configured to float and to be towed on water to the drilling site in shallow coastal marshlands.

Use of a raised onshore platform in environmentally sensitive areas requires piles for support. BP is currently using piles to support a large rig to infill-drill a deep gas resource in the Tuscaloosa reservoir in southern Louisiana. Piles are used to mitigate settling under the rig substructure. This type of effort currently cannot be justified on less complicated wells with shorter duration drilling times of 10–30 days (drilling time for this BP well is approximately 90–120 days).

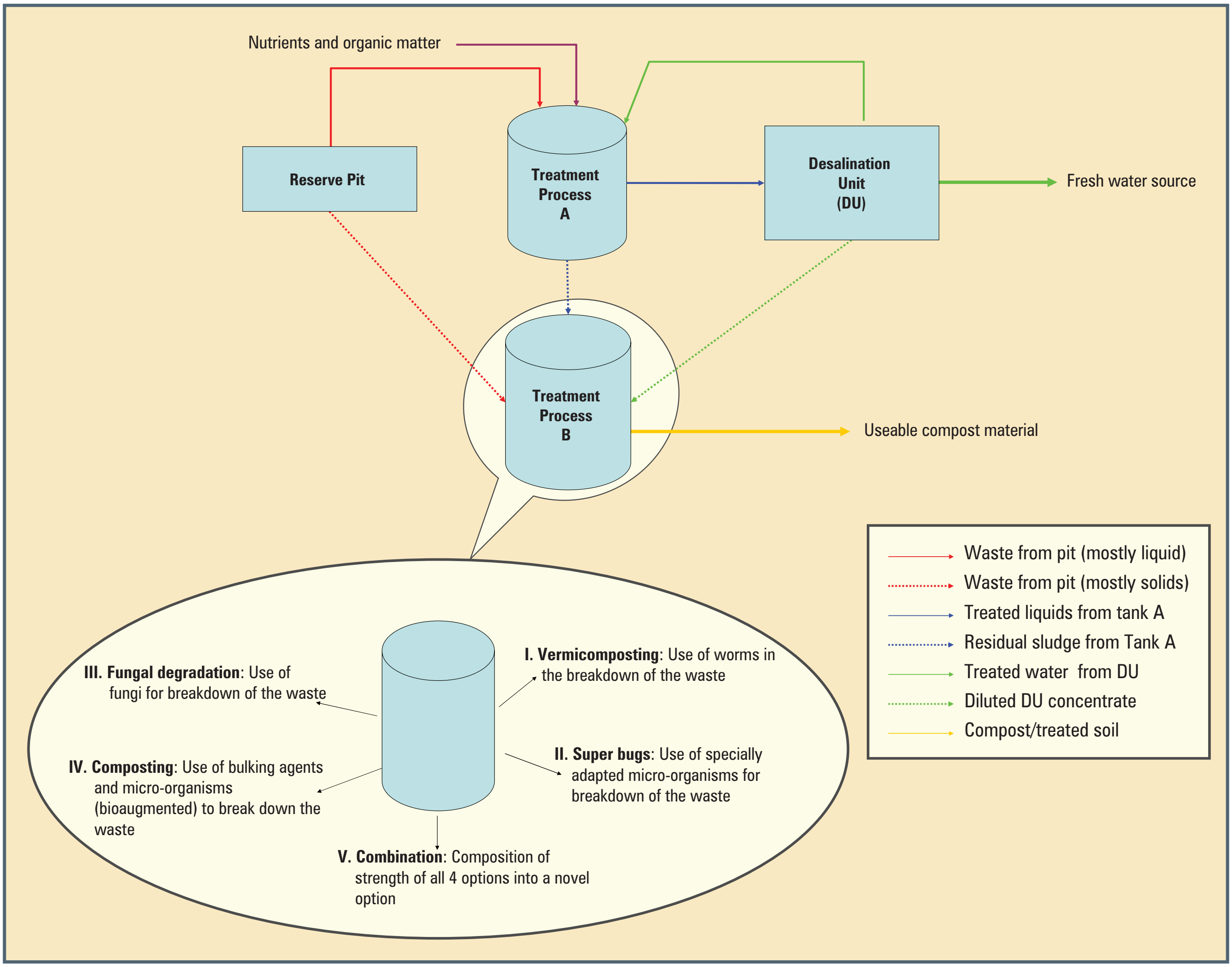
Lessons learned from this type of site construction should be captured and may represent some of the best available technology for EFD. Equipment on site could be cut into small sections, trucked to different drilling sites and reassembled. The reduction on environmental impacts could be significant. The onshore drilling platform should be considered for not only those areas where contact with the ground requires a raised platform (i.e., minimal soil contact) but also for areas where setting the platform on the ground is possible, because other benefits of engineering and environmental impact can be obtained.

WASTE MANAGEMENT

Eliminating or minimizing waste generation is crucial to protect the environment and manage operational costs. The waste management portion of this EFD project is directed at reducing, reusing, recycling and recovering, and disposing (in that order). Drilling smaller holes where applicable reduces cuttings volume.

Operators have employed a variety of methods for managing drilling wastes depending on state and federal regulations. Historically, waste pits (reserve pits) were used at land rig sites. Wet cuttings were left to dry naturally and bulldozed or covered with soil. Both on land and offshore, extensive fluids-recovery and cuttings-disposal methods are currently employed.

Onshore operations have a wider range of options than offshore. These include landspreading and landfarming, dewatering and burial onsite, underground injection, incinerating and other thermal treatment, bioremediation and composting and reuse and recycling. Bio-treatment using vermicomposting (worms) to remediate cuttings, converts the cuttings



Bioremediation to minimize waste generation can be used to protect the environment and manage operational costs.

into a compost material that is useful as a soil enhancer.

Although drill cuttings and excess drilling fluids comprise the majority of E&P wastes, other wastes include contaminated water, material and chemical packaging, air emissions such as carbon dioxide and oxides of nitrogen, scrap metals, fuel, lubricants and other oils as well as the usual human and industrial wastes associated with E&P operations.

The vermicomposting technique is a novel method for effective drilling waste management and may be applicable in environmentally sensitive areas. Combined with environmentally friendly design of the drilling fluid, it is preferred over thermal treatment of the cuttings.

A project has been established to investigate developing a bioremediation treatment processor that can be located at a drill site. The key deliverable for the project is a small-footprint, low-impact environmental treatment process adaptable to real drilling operations, based on engineering and biological principles capable of converting drilling wastes to a usable product. Goals include:

1. Determine optimized treatment process that can be adapted to build mobile, small-footprint treatment processes.

2. Determine waste(s) that can be effectively treated using this method.

3. Determine conditions such as climate, environmental areas, drilling sites where treatment process can be used and limitations.

4. Determine efficiency of the process, cost implications, environmental implications, product uses and environmental laws and regulations associated with process.

Cuttings injection is a waste-disposal technique where drill cuttings and other oilfield wastes are mixed into slurry by being milled and sheared in with water, usually seawater (offshore) and contact stormwater (onshore). The resulting slurry is pumped into a dedicated disposal well, a previous well, or into the annulus of the well being drilled, into a fracture created at the casing shoe set in a suitable formation.

Wastewater contains contaminants such as sediment, mud and drilling additives. Proper handling, containment and disposal of wastewater are important to mitigate potential harm to the environment. Stormwater should contain only clean rainwater, and only clean, non-contaminated stormwater should be allowed to flow directly into rivers, oceans and other waters.

Addressing potential stormwater pollution can:

- Improve awareness of the impact of drilling on the environment.

- Meet public expectations that drilling activities do not pollute.

- Reduce environmental impacts.

• Comply with legal and environmental responsibilities.

• Provide a cleaner work environment.

• Increase long-term cost savings through increased efficiency and reduced costs.

Wastewater should be contained on site and disposed of away from any watercourse or wetland area. Wastewater can usually be contained by using a temporary reserve pit and recycled, processed to reduce volume, or transported for proper disposal.

LOW-IMPACT ACCESS

Moving equipment, supplies and people to and from a drilling site at the right time is often logistically complex. Add the restriction that there must be no or limited impact to the environment, and complexity is magnified. Protecting cryptobiotic soils in the west and southwest and inland and coastal wetlands will be challenging. However, low-environmental-impact transport could be achieved by implementing combinations of current large transport and temporary road technology.

"Artificial" or temporary roads and drilling sites to minimize impact may be constructed by using a nonwoven geotextile and laying strong and light synthetic composite mats. This material supports heavy loads and can distribute the load more evenly. If used in conjunction with Rolligon trucks or hovercraft, sensitive soils can be protected from compaction and erosion. Temporary bridging techniques, as well as temporary road construction technology developed for the military, can be used with little effect on the ecology.

As part of this project, a national academic student contest is being initiated to develop innovative ideas and concepts to achieve the goal of moving heavy equipment with no dust, emissions, compaction of soils, or damage to ecosystems.

SUMMARY

The primary goal of sustainable development is to responsibly meet the demands of today without jeopardizing opportunities for the next generation. Sustainable development means to give back more than we take. It also influences the private sector and business. Environmental conservation is firmly on the public agenda. Operators are maintaining a strong focus on safety and environmental protection. Worker protection legislation in most industrial nations, in particular the European community, has set new standards based on other onshore industries.

The oil and gas industry strives to satisfy global energy demands while safeguarding the environment. To accomplish its goals, industry must:

• Control emissions.

• Manage local impacts from operations and from using products.

• Protect biodiversity.

• Internalize environmental costs.

• Be transparent and open in communication and decision-making.

This project provides an opportunity for government, industry and academia to cooperate to develop technologies and strategies to improve the industry's environmental stewardship.

This article is based on a presentation made at the 2007 IADC Environmental Conference & Exhibition, 3-4 April 2007, Amsterdam.