



The Business Case for Decarbonization of Oil & Gas Waste Management—A Case Study on Slurry Injection

November 2024

ACKNOWLEDGEMENTS

This case study was written by Assistant Research Scholar Beverly Teng and Senior Research Lead Chisara Ehiemere, of the NYU Stern Center for Sustainable Business. This case study was developed as the basis for a practical guide to institutions and is not intended to serve as an endorsement, source of primary data, or illustration of either effective or ineffective management.

NYU Stern CSB acknowledges Milestone Environmental Services and Jenny Brusgul, Sustainability Advisory Practice Leader at CohnReznick, for their valuable contributions to this project.

NYU STERN CENTER FOR SUSTAINABLE BUSINESS

The NYU Stern Center for Sustainable Business (CSB) was founded on the principle that sustainable business is good business. We provide education, conduct research, and influence industry practice by proving the financial value of sustainability for business management and performance. At CSB, we aim to equip future and current corporate leaders with updated business frameworks that embrace proactive and innovative mainstreaming of sustainability, resulting in competitive advantage and resiliency for their companies as well as a positive impact for society. For more information, visit www.stern.nyu.edu/sustainability.

INTRODUCTION

The oil and gas industry must play a significant role in advancing and achieving global climate change targets.¹ Under all of the Intergovernmental Panel on Climate Change's (IPCC) global warming scenarios, including the 1.5°C scenario, oil and gas will still be necessary to meet global energy demand in the interim even as we aspire to transition to a net zero energy system by 2050.

The oil and gas industry, in addition to its direct emissions, also produces indirect emissions and detrimental environmental health impacts through the waste generated. Researchers have found a variety of negative impacts resulting from exposure to upstream oil extraction activities, including soil, air, and water quality contamination as well as increased risk of cancer and liver damage for local residents.² A key upstream extraction activity which damages the environment is the disposal of drilling waste. Reducing the environmental impact of waste management operations is a critical opportunity for oil and gas companies to reduce environmental impact and start meaningfully contributing to this transition.

NYU Stern Center for Sustainable Business partnered with Milestone Environmental Services, an energy waste sequestration provider based in Texas, and CohnReznick, an accounting and financial advisory firm, to understand the financial benefits to all stakeholders of an alternative form of drilling waste disposal.

THE CHALLENGE

When oil wells are drilled, various fluids are injected throughout the process to help clear the area, cool the drill bit, and maintain the necessary pressure level for extraction.¹ Two common types of on-site disposal methods in Texas include “landfarming” and “reserve pits.” In landfarming, waste is deliberately spread onto surface land to be incorporated into soil, diluting the concentration of any contaminants and allowing the waste to be volatilized and/or biodegraded.³ More recent academic literature has found that high concentrations of petroleum hydrocarbons, such as what may be found in oil and gas waste, reduce microbial diversity in soil⁴ and negatively impact soil multifunctionality, which encompasses various ecosystem services essential for nutrient cycling and maintaining soil fertility.^{5,6}

¹ [“The Oil and Gas Industry in Net Zero Transitions: Executive summary”](#) (IEA, Accessed 12 Aug 2024)

² [“Impact of upstream oil extraction and environmental public health: A review of the evidence”](#) (Johnston, Lim & Roh, 2019)

³ [“Landfarming: A contested space for the management of waste from oil and gas extraction”](#) (Bloomfield & Doolin, 2017)

⁴ [“Petroleum pollution changes microbial diversity and network complexity of soil profile in an oil refinery”](#) (Zhuang et al., 2023)

⁵ [“Response of the soil microbial community to petroleum hydrocarbon stress shows a threshold effect: Research on aged realistic contaminated fields”](#) (Jia et al., 2023)

⁶ [“Ecosystem multifunctionality and soil microbial communities in response to ecological restoration in an alpine degraded grassland”](#) (Shu et al., 2023)

Reserve pits are a “temporary earthen pit used to store only those materials used or generated in drilling and workover operations”.⁷ The requirements for setting up and maintaining a reserve pit may vary depending on local regulation. For example, in Texas, reserve pits must be lined, emptied, and inspected annually or be equipped with a double liner and monthly monitored leak detection system.⁸ However, even with the use of liners in reserve pits, it is still possible for waste fluids to leach into soil or groundwater, which may expose local populations to elevated levels of heavy metals such as cadmium, chromium, and nickel.¹ The US Fish & Wildlife Service found that reserve pits also pose a significant risk to migratory birds and other types of wildlife, such as bats and amphibians, that mistake them as bodies of water.⁹

Given the detrimental environmental health impacts associated with reserve pits and other common on-site waste management approaches, the oil and gas industry should use alternative strategies to reduce negative outcomes. Milestone uses slurry injection to sequester certain types of fluid waste deep under the earth’s surface with the goal of minimizing CO₂ emissions and reducing the risk of negative environmental health impacts.¹⁰ In order to understand the financial tangible and intangible benefits associated with using their slurry injection technology to dispose of waste, Milestone collaborated with CohnReznick and NYU Stern Center for Sustainable Business (CSB) to apply the Return on Sustainability Investment (ROSI™) methodology to their slurry operations.

THE BUSINESS CASE FOR WASTE DISPOSAL VIA SLURRY INJECTION

As society moves towards holding oil companies accountable for the low carbon transition, investors are also becoming more aware of how environmental issues impact the market, resulting in a bigger push for companies “to disclose consistent, comparable, and reliable data” and driving greater sustainable investing.¹¹ These market trends are further supported by new government regulations on climate data disclosure. For example, the European Union’s (EU) Corporate Sustainability Reporting Directive (CSRD) recently came into effect in January of 2023.¹² The CSRD recognizes the growing impact of climate change on business activities and requires that many large companies and SMEs report on sustainability so that their investors and other stakeholders are able to access all the information essential to accurately assess climate-related, financial risks and opportunities.

There have been recent proposals to update oil and gas waste management regulations in Texas to improve the state’s stewardship of its natural resources.¹³ The Railroad Commission of Texas (RRC) considered implementing significant changes to Statewide Rule 8 placing more

⁷ [“Onsite Exploration & Production \(E&P\) Waste Storage and Disposal”](#) (The Louisiana Department of Energy and Natural Resources, Accessed 12 Aug 2024)

⁸ [“Summary of Statewide Rule 8”](#) (Railroad Commission of Texas, Accessed 12 Aug 2024)

⁹ [“Reserve Pit Management: Risks of Migratory Birds”](#) (Ramiers JR., 2009)

¹⁰ [“Clean Up EnergySM: Delivering Sustainable Value”](#) (Milestone, 2022)

¹¹ [“The future is now: How oil and gas companies can decarbonize”](#) (McKinsey, 2020)

¹² [“Corporate sustainability reporting”](#) (European Commission, Accessed 12 Aug 2024)

¹³ [“RRC Proposes Major Overhaul for Water Protection and Oil & Gas Waste Management Rules”](#) (Railroad Commission of Texas, 2023)

responsibility on oil and natural gas exploration & production companies (E&Ps) to properly manage non-commercial waste pits in order to minimize potential contamination of surrounding groundwater supplies.¹⁴ These regulatory changes have not yet passed. Regardless of what Statewide Rule 8 will look like in the future, there is already evidence that the current regulation does not provide adequate protections for both Texas landowners and groundwater supplies. For example, the 2022 Joint Groundwater Monitoring and Contamination Report from the Texas Groundwater Protection Committee recorded six active cases of groundwater contamination due to waste pits.^{14,15} Given the evolving regulatory environment in Texas and throughout the US, third-party waste management companies, such as Milestone, may find themselves at an advantage in the future by being able to provide more cost-effective solutions and by helping companies better manage their waste.

ROSI™ FINANCIAL BENEFITS

CohnReznick and NYU Stern CSB used the Return on Sustainability Investment (ROSI™) methodology to identify the following potential financial benefits for Milestone, their customers, and the landowners from whom they lease land. Those shown in bold are the financial benefits that were monetized as part of this project:

Financial Benefits for Milestone

1. Reduced interest rate on loans
2. Market share growth
3. Increased customer loyalty

Financial Benefits for Landowners

1. Increased income relative to type of land use, in comparison to cotton farming
2. Retention of land value, in comparison to reserve pits and landfarming

Financial Benefits for Milestone's Customers

1. Avoided cost of carbon
2. Reduced waste management/disposal costs
3. Reduced exposure to oil and gas fines and penalties in Texas
4. Reduced cost of insurance

METHODOLOGY: APPLYING ROSI™

The ROSI™ process combined comprehensive research on the oil and gas waste management industry, internal stakeholder interviews to understand Milestone's slurry injection technology and climate mitigation efforts, and scoping and prioritization of benefits that would have the most significant impact based on data availability. Additional details on the ROSI™ process and the financial benefits assessed are highlighted below.

¹⁴ ["Texas proposes first new rules for oilfield waste in 40 years"](#) (Pskowski, 2024)

¹⁵ [Joint Groundwater Monitoring and Contamination Report](#) (Texas Groundwater Protection Committee, 2023)

Financial Benefit(s) for Milestone

Financial Benefit 1: Reduced interest rate on loans

According to Sustainalytics, a “sustainability linked loan (SLL)” is a type of loan where the borrowed funds are “tied solely to the borrower’s ESG-related performance and not the use of proceeds or the projects financed”.¹⁶ Sustainability linked loans can serve as a tool to incentivize borrowers “to improve their sustainability performance” while also helping lenders meet their sustainable finance commitments. Previously, Milestone’s sustainability linked loan allowed them to expand their slurry injection business at a lower interest rate, in comparison to a traditional loan. Milestone’s loan statement was the primary data source used to quantify the benefit from using the sustainability linked loan through the following process:

1. Calculate the cumulative interest accrued in two scenarios: (1) with the sustainability-linked loan’s decreased interest rate and (2) with a standard interest rate (without the decrease from the sustainability-linked loan).
2. Compare the difference between both scenarios in Step 1.

The specific sustainability linked loan that Milestone received included the additional financial benefit of a decreased interest rate. In order to qualify for their sustainability linked loan, Milestone continuously met specific annual sustainability targets.

Financial Benefit 2: Market share growth

For Milestone, value can be created through further penetration of the on-site disposal market for slurry injection within the geographic reach of their operational sites. Growth of Milestone’s market share can be an important indication of shifting trends in oil and gas waste disposal practices in Texas, where reserve pits and landfarming continue to dominate despite their detrimental environmental impacts. The following data was used to analyze Milestone’s potential for market share growth:

- Milestone’s fixed and variable costs
- Milestone’s projected growth rate
- relevant oil basin sizes in Texas
- volume of on-site waste at each basin in Texas + estimated compound annual growth rate (CAGR)

The following analysis illustrates the varying impacts on Milestone’s potential market share and net cash flows under different market conditions:

1. Using the estimated total volume of on-site waste throughout Texas, calculate the Total Addressable Market (TAM) within a reasonable radius of Milestone’s operations.
2. Calculate the net present value (NPV) of Business as Usual (BAU) assuming Milestone’s expected growth rate.

¹⁶ [“Sustainability Linked Loans: Helping build Sustainability Linked Loan Programs”](#) (Sustainalytics, Accessed 12 Aug 2024)

- Determine three different cases based on different estimated portions of the TAM that Milestone would be able to capture.

Financial Benefit(s) for Landowners

Milestone has found that their slurry injection facilities typically utilize significantly less land to dispose of the equivalent amount of waste compared to reserve pits and landfarming. Consequently, for the analysis of the following landowner benefits, it is assumed that landowners would retain more usable surface land when leasing land to Milestone for slurry injection versus leasing land for on-site reserve pits and landfarming. Therefore, in comparison to the alternative methods of waste disposal, Milestone's slurry injection may also result in higher useful value of the surface land long-term.

Financial Benefit 1: Increased income for landowners on a portion of their land relative to the type of land use, in comparison to cotton farming

According to the US Department of Agriculture (USDA), Texas is the largest cotton producing state—accounting for approximately 40% of the country's annual cotton production (2022). To demonstrate the difference in financial returns for landowners, the returns generated by Milestone's contract royalties were compared to returns from cotton farming on the equivalent amount of land. Data collected for this comparison includes:

- average cotton yield per acre of land (lb/acre)
- average price of cotton per pound (\$/lb) in Texas
- amount of surface land used by Milestone (acre)
- Milestone's royalties (\$)

To calculate the estimated value of cotton produced:



This comparison found that Milestone's lease offered substantially higher returns for the landowner, relative to cotton farming on the same area of surface land. Milestone is able to, then, use this comparison to better communicate additional benefits to the landowners that they work with. Note that this is a form of income diversification for farmers on a percentage of their land, not an abandonment of farming altogether.

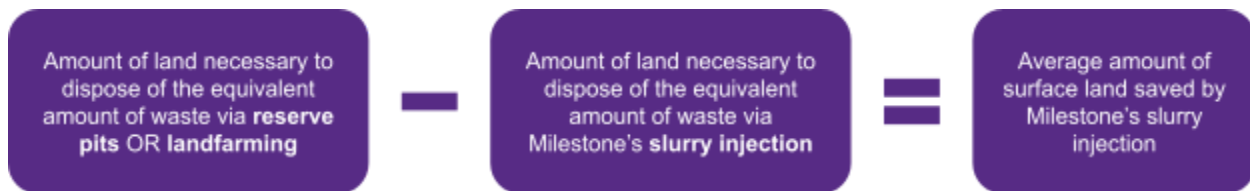
Financial Benefit 2: Retention of land value, in comparison to reserve pits and landfarming

Milestone only occupies a limited portion of the usable land at each of their slurry injection sites. To assess the land value saved by using slurry injection versus reserve pits or landfarming, the following data were collected:

- amount of surface land used by Milestone (acre)
- amount of surface land used via land spreading and reserve pits for the equivalent amount of waste (acre)
- average nominal land value per acre (\$/acre) at each of Milestone's sites

To measure the approximate magnitude of the land value savings from using slurry injection instead of reserve pits and landfarming:

1. Calculate the average amount of surface land saved by Milestone's slurry injection by subtracting the amount of land necessary to dispose of the equivalent amount of waste via reserve pits. Repeat this for landfarming as well.



2. Using available land value data, calculate the value saved by multiplying the area of land saved from Step 1 by the value of the land.

In addition to loss of land value, after landfarming there can be significant uncertainties associated with soil health and safety and substantial costs incurred to rehabilitate surface land.

Financial Benefit(s) for Milestone's Customers

Financial Benefit 1: Avoided cost of carbon

Milestone's slurry injection helps customers avoid CO₂ emissions that would have otherwise been released into the atmosphere from the degradation of hydrocarbons during landfarming.⁹

Essential data to understand the avoided cost of carbon include:

- annual amount of CO₂ emissions avoided (MT)
- carbon emissions per barrel (MT/bbl)
- estimated cost of on-site waste disposal per barrel (\$/bbl)
- estimated cost of Milestone's disposal per barrel (\$/bbl)
- cost of carbon (\$/MT)

The specific cost of carbon utilized in this calculation depends on what would be most relevant for each company. For example, for Milestone's analysis, the cost of carbon was derived from the California Air Resources Board, but other potentially relevant proxies include cost of carbon offsets (\$/MT) and social cost of carbon (\$/MT).

Measuring the impact of Milestone's avoided carbon emissions equips them with an impactful strategy to quantify and communicate the financial benefits passed onto customers:

1. For this benefit analysis, Milestone's 2023 CO₂ emissions avoided (MT), estimated third-party cost of disposal per barrel (\$/bbl), and estimated cost of disposal per barrel on-site (\$/bbl) were used to establish a baseline.
2. Using the baseline data provided, changes in CO₂ emissions avoided and cost per barrel disposed can be modeled through FY2031 by applying known business growth rates or relevant proxies (e.g., growth rate for the cost of diesel).
3. To determine the carbon cost savings per barrel, the most relevant cost of carbon (e.g.e.g., carbon credits, social cost of carbon, carbon tax) was identified and the change in the cost of carbon was also forecasted through FY2031. The cost of carbon per barrel was then added to the cost of on-site disposal to reflect a more holistic cost of on-site disposal with the financial impact of carbon emissions factored in.
4. Avoided cost of carbon was calculated by subtracting cost of third-party disposal from the cost of on-site disposal with carbon cost from Step 3.

By helping customers avoid CO₂ emissions, Milestone's slurry injection services can potentially: (1) reduce customers' need to purchase carbon credits to offset emissions associated with waste management and support decarbonization goals and (2) avoid potential fees and financial penalties related to the amount of carbon emissions.

CONCLUSION

Through this collaboration with Milestone, CohnReznick and CSB have identified potential financial benefits for Milestone, Milestone's customers, and landowners, and demonstrated the business case for one method of reducing the oil and gas industry's environmental impact through improved waste management practices. The reduced environmental impact associated with Milestone's slurry injection allows the company to benefit through sustainability-linked loans and market share growth during the changing regulatory environment, create value for the landowners they lease from and the customers they service, and drive emissions reductions. The ROSI™ Methodology was applied in collaboration with CohnReznick to Milestone's slurry injection operations to explore the value creation opportunities from adopting a more sustainable waste management strategy. However, the methods and lessons learned from this project can also potentially be used by other organizations operating in the oil and gas and energy waste management industries.

Oil and gas companies have a vital role to play in addressing climate change, so it is imperative that companies thoroughly explore opportunities to reduce their environmental impact and mitigate risk as we work towards net zero by 2050. Energy waste management companies, such as Milestone, can play a critical role in collaboration with the oil and gas industry to reduce emissions during the transition to net zero. This project is one example of how ROSI™ can uncover opportunities and value in the energy space.

Disclaimer Note:

The primary purpose of this case study is to demonstrate a financial analysis of Milestone Environmental Services slurry injection methodology. For this case study, NYU Stern CSB and CohnReznick did not independently verify the efficacy of Milestone's specific practices. For further information on the environmental impact of slurry injection, please see Argonne National Laboratory's ["Evaluation of Slurry Injection Technology for Management of Drilling Wastes"](#).

For questions on this case study and NYU Stern CSB's other research, feel free to contact:

Chisara Ehiemere, Senior Research Lead, NYU Stern CSB @ ce2198@stern.nyu.edu

Beverly Teng, Assistant Research Scholar, NYU Stern CSB @ bkt244@stern.nyu.edu