Waste Management and the Deepwater Horizon Oil Spill

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1. Looking Back

The Deepwater Horizon Oil Spill resulted in an influx of 4.9 million barrels of crude oil into the Gulf of Mexico, an unprecedented amount of oil emerging from the sea floor. Currently, 26% of the oil remains in the ocean. The rest of the oil was remediated using skimmers, sorbent booms, in-situ burning and chemical dispersants, as well as a portion that was natural dispersed, evaporated or dissolved. The spill and its subsequent clean-up methods generated 89,202.9 tons of solid waste and 1,193,084 BBLs of liquid waste (as of November 28, 2010) that needed to be disposed of effectively.[1] Detailed waste management plans were created to outline how and to ensure that the disaster waste was properly handled. These waste plans were approved by the EPA, the Coast Guard, Unified Area Command and the states.

Waste Management

BP employed private contractors to proceed over the management of the debris and waste generated by the cleanup activities. Waste Management was contracted to work out of the Mobile Command Site, in charge of the waste for Alabama, Mississippi and Florida. Heritage, Inc. was contracted to work out of the Houma Command Site overseeing the Louisiana clean-up effort – the state of Louisiana has special regulations regarding disaster debris disposal. These companies were in charge of maintaining waste operations in accordance to the approved waste management plans. The disaster waste was collected, taking to staging stations, examined and finally sent to the proper disposal facility.

The waste anticipated can be separated into categories depending on the make-up of the waste and the destined disposal facility; these categories include solid waste, recovered oil, oily water and liquid waste, and animal carcasses. Solid waste includes oil contaminated material such as sorbents, debris and personal protective equipment, as well as non-contaminated solids, such as those materials required by the support operations. In the period ending November 28, 2010, 76,893.5 tons of oily solids and 10,481.1 tons of solid waste were collected and taken to municipal solid waste landfills.[2] Oily water represents oil-water emulsion from skimming operations – this water can undergo oil recovery or reclamation processes to separate the oil from the water. The oil can be reused – effectively, it has been recycled – while the water is seen as decontamination water, a liquid waste. Approximately 31 percent of emulsified oil was sent to processing facilities for recovery.[3] Liquid waste is water with oil sheen or that contains a small amount of oil droplets.[4] It can result from storm water that has come into contact with oil, decanted water or water from decontamination processes. Oily water and liquid wastes are transported via vacuum truck to the approved liquid disposal facilities; as of November 28, 2010, 448,118 BBLs and 744,966 BBLs were

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[1] "Weekly Waste Tracking Cumulative Report," *BP International, Ltd.*, 17 Oct 2010. http://www.bp.com/genericarticle.do?categoryId=9034343&contentId=7063466.
[2] "Waste, Oil Recovery, and Disposal Summaries," *BP International, Ltd.*, 26 Oct 2010. http://www.bp.com/genericarticle.do?categoryId=9034343&contentId=7063466.
[3] "Emulsified Oil Sent for Oil Recovery," *BP International, Ltd.*, 4 September 2010.
[4] "Weekly Waste Tracking Cumulative Report."

disposed of respectively. Animal carcasses resulting from the oil spill are handled and disposed of by US Fish and Wildlife Service.

The solid waste generated from the clean-up and support operations will be classified as exploration and production (E&P) waste, and it is not expected to be hazardous – though all waste streams will be profiled to ensure this is true. Toxicity Characteristic Leaching Procedure (TCLP) is performed for volatiles, semi-volatiles and metals and the EPA independently tests the stream to verify these results. Hazardous waste has not been found thus far, though minor problems with waste management have been detected during EPA waste facility assessments.[5] The characterized solid waste will be sent to RCRA subtitle D landfills, and all locations that have been identified and approved for disposal are listed on the waste management plans for each incident command site.[6,7]

Environmental Justice

The large amount of waste generated by the oil spill has created some concern in the communities surrounding the landfills approved to receive the waste. Many of the identified landfills are in low-income communities and/or are communities with a majority population of people of color.[8] This has raised environmental justice issues, as these communities are ones that historically had to accept a disproportionate amount of both solid and hazardous waste. BP has issued exemptions to some of the communities originally identified on the waste management plans, further increasing concern over fairness and social justice. No community wants to deal with the influx of disaster waste resulting from the oil spill; this is especially true for communities who have dealt with the immense amount of debris resulting from Hurricane Katrina, as many of the same communities are affected by the oil spill. For these communities, landfill capacity is crucial to maintain in the case of another disaster. Environmental justice is a national priority supported by Executive Order 12898, which directs attentions towards minority and low-income populations who bear higher burdens in regards to environmental risk, and it is necessary to plan waste management accordingly.[9]

Waste Diversion

There have been efforts to minimize the amount of waste generated from the clean-up activities. As of November 28, 2010, 1828.4 tons of materials have been recycled or recovered. The Mobile Waste Management Plan identifies source reduction, reuse, recycling, treatment and disposal as methods to manage waste. These options are listed in order of preference – effectively prioritizing diversion over disposal.[10] However, "initially, the primary effort will be to collect, contain and remove all contaminated materials as quickly as possible," a priority that may not permit the implementation of waste diversion techniques during the disaster waste management process.[11] The Houma Waste Management Plan lists similar goals in terms of waste management, and also cites Louisiana state debris regulation as governing factors over the waste operations.

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5 "EPA Waste Staging Area Assessments," *EPA*, 6 October 2010. http://www.epa.gov/bpspill/waste.html.
6 "Recovered Oil/Waste Management Plan Houma Incident Command," *BP International Ltd.,* 22 April 2010. http://www.bp.com/genericarticle.do?categoryId=9034343&contentId=7063426
7 "Solid Waste Management Plan, Mobile Sector," *BP International Ltd.,* 25 August 2010. http://www.bp.com/genericarticle.do?categoryId=9034343&contentId=7063426.
8 Robert D. Bullard, "BP's Waste Management Plan Raises Environmental Justice Concerns," Dissident Voice. 29 July, 2010. http://dissidentvoice.org/2010/07/bp's-waste-management-plan-raises-environmental-justice-concerns/ .
9 Executive Order 12898
10 "Solid Waste Management Plan, Mobile Sector," 11.
11 Ibid

Louisiana has state regulations in place promoting waste diversion. The state experienced a previous influx of disaster debris waste in the aftermath of Hurricane Katrina and realized the need to reduce materials entering landfills. Senate Bill (SB) 583 entails the creation of a comprehensive debris management plan with the goal to "reuse and recycle material, including the removal of aluminum from debris, in an environmentally beneficial manner and to divert debris from disposal in landfills to the maximum extent practical and efficient which is protective of human health and the environment."[12] SB 583 prioritizes waste management practices for debris in this order: "recycling and composting; weight reduction, volume reduction; incineration or co-generation and land disposal" to the extent they are "appropriate, practical, efficient, timely, and have available funding."[13] In addition, Louisiana also has a specific regulation (LA RS:30:2413.1) enforcing 50% reduction of disaster debris by weight and volume prior to disposal. This can be achieved through chipping, grinding, and recycling, creating a product can be used for mulch, input to compost, daily cover and fuel.[14]

On September 10, 2010 BP issued a recycling strategy of its own, explaining methods they were researching or undertaking to recycle or reuse any disaster waste. The preferred method for recycling solid wastes, including booms, absorbents and segregated plastics, is a waste-to-energy process. The waste is incinerated to create energy that is added to the local energy grid.[15] A recycling process creating new plastic products requires a longer time to organize and implement, more preprocessing and more permitting work, and for these reasons, BP chose not to pursue this venue.[16]

2. Looking Forward

Though there exists a nod towards waste diversion in the waste management plans, the only quantitative regulation for disaster debris management is Louisiana's LA RS:30:2413.1, which enforces a 50% reduction of disaster debris by weight and by volume before it can be permanently disposed in the landfill. With no representative to enforce these policies, there is no incentive to keep in mind all other prioritizations of waste management technique during a hectic spill effort where efficiency is necessary to appease the public eye.

In order to achieve waste diversion it must be integrated into the waste management plan and taken into account while creating the national and area contingency plans. All processes involved in oil spill cleanup, from the research and development of cleanup technologies to the use of these techniques in the field must be critically examined for sustainability. Incentives to research and develop effective, environmentally-friendly cleanup technology must be created, as very little new technology has been developed prior to the Deepwater Horizon incident.[17] Source reduction, composting and recycling require planning and proper infrastructure to be undertaken effectively. Without preapproved technologies that facilitate diversion of waste from landfills and an indication that these technologies are environmentally friendly, the conventional methods will be used; it is rarely feasible to instate new technologies during the clean-up operations.

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[12] "Recovered Oil/Waste Management Plan Houma Incident Command"
[13] Ibid
[14] Ibid
[15] "Deepwater Horizon MC 252 Recycling Strategy," *BP International Ltd.,* 3 September 2010. http://www.bp.com/sectiongenericarticle.do?categoryId=9034343&contentId=7063419.
[16] Ibid
[17] "Response/Clean-Up Technology Research and Development and the BP Deepwater Horizon Oil Spill," 4.

A large percentage of the disaster waste results from sorbent booms; 14 million of feet of boom were deployed.[18] These booms are made of plastic, either polypropylene or polyethylene, but cannot be recycled to create a post-consumer plastic product; BP's recycling method of choice is waste-to-fuel technology where saturated booms are processed to create energy.[19] Still, many booms have already been placed into landfills and to be recycled. The booms must absorb enough oil and in a uniform manner to be considered for boom-to-fuel recycling.[20] Sorbent booms are mainly used in shoreline clean-up activities, where the oil has been emulsified as it travels from the incident site to the sea surface and then to the shore and many booms are not saturated enough to be used in the fuel generation process. An additional problem with the booms is ineffective use of booms and overuse of booms – in this response a large amount of boom was used to protect against oil reaching the shorelines in unnecessary locations. While the presence of booms may comfort for stakeholders and the public, unnecessary booms can pose more problems for the environment and they increase waste.[21] Education about boom use to all levels of responders is necessary to rectify these notions.

Source reduction is defined as "altering the design, manufacture, or use of products and materials to reduce the amount and toxicity of what gets thrown away." [22] When trying to achieve sustainability, source reduction is the most effective way to reduce waste. It requires the assessment of all stages of a product, from design to manufacture, use and disposal and the determination of what inputs can be eliminated or changed to decrease toxicity. Critical thinking and careful planning are therefore essential in this process. Waste management must be considered during emergency planning and response; the focus of a cleanup effort is often centered on removing the oil from the environment as quickly as possible. While this is crucial, the disposal of the waste generated in consequence to this response is significant in both amount and how it affects the surrounding communities. There are a variety of ways to achieve source reduction -- sorting non-contaminated waste from support operations at the response, being mindful of reusing booms not saturated enough to be recycled, and using more sustainable cleanup technologies are examples.

Waste characterization

It is important to characterize the solid waste so we know the percentages of each product in the stream past the current classifications: solid waste, oily solid, liquid waste, oily water, and animal carcasses. For example, oily solids can be categorized into containment booms, sorbent booms, personal protective equipment, oily sand, oily vegetation and so on. Knowing what materials create the bulk of the waste can help planners to determine the best methods to decrease the waste, what technologies to research and develop that will reduce waste, and how far-reaching any changes made to the process will be; it allows responders to perform source reduction in an informed manner for maximum diversion. Characterization will allow planners to quantify how far-reaching changes will be and therefore present substantiated supporting reasons for change. This data will require planning to create categories that represent the diversity of the waste and a method to accurately record the data, but the data will allow the further optimization of a disaster response plan.

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18 BP Final Report
19 "Deepwater Horizon MC 252 Recycling Strategy"
20 "Waste and Material Tracking System and Reporting Plan," *BP International, Ltd.*, 19 October 2010. http://www.bp.com/genericarticle.do?categoryId=9034343&contentId=7063426.
21 "Recommendations of the Joint Industry Oil Spill Preparedness & Response Task Force*", P. 78*
22 "Municipal Solid Waste," *EPA,* 21 June 2010. http://www.epa.gov/epawaste/nonhaz/municipal/index.htm.

Alternative Technologies

The National Contingency Plan (NCP) is the US Government's blueprint for emergency preparedness in responding to oil spills; it was created and augmented in response to Clean Water Act and the Oil Pollution Act. Subpart J of the plan is the NCP product schedule, a list of products used to clean oil discharges, with the purpose of aiding federal on-screen coordinators and regional response teams to use the most appropriate products during their response effort.[23] There is a variety of products on the schedule and they vary in terms of conventionality, toxicity and sustainability; many products exist in each category: dispersants, surface washing agents, surface collecting agents, bioremediation agents, and miscellaneous oil spill control agents. [24]

Sorbents are defined and included in the NCP Subpart J as "inert and insoluble materials that are used to remove oil and hazardous substances from water;" the category includes organic materials such as peat moss and cellulose fibers, mineral compounds such as volcanic ash or perlite, and synthetic products like polypropylene, the main material filling booms in this cleanup.[25,26] Sorbents are not required to be included on the NCP Product Schedule if they meet the regulations set by the EPA.[27] Vendors can receive a letter from the EPA stating their sorbent meets regulatory criteria and can share this letter with the Federal On-Scene Coordinator to allow the use of their sorbent. Chemical, non-inert sorbents are the only ones listed on the product schedule under the label miscellaneous oil spill control agents. If the product schedule exists to aid responders in choosing cleanup materials, the relative invisibility of most sorbents fosters the continual use of conventional plastic sorbents.

The product schedule contains some alternative technology products, but they are not being used on a larger scale in the spill effort. Bioremediation agents are an example of alternative technologies, they have their own category on the NCP Product Schedule, but there has been little indication of the use of these tools. Bioremediation agents aid the bacterial degradation of petroleum hydrocarbons, boosting or fostering the natural response to oil in the environment. They either contain hydrocarbon-degrading bacteria or nutrients or enzymes that facilitate the growth of these bacteria. Increasing the natural degradation of oil decreases the oil that must manually be removed and ultimately reduces waste going to the landfill.

Another type of alternative oil spill cleanup technology that has been developed are alternative sorbents and booms that are more facilitate to recycling and composting than the conventional and widely-used plastic booms. Natural fiber booms and loose absorbents can be used to absorb the oil and can subsequently be composted, resulting in degradation of the hydrocarbons and an end product that can be used or sold as a soil amendment. Loose sorbents can be left in the environment utilizing hydrocarbon degrading bacteria to eliminate the crude oil; this provides a low-technology solution that requires little manpower and can reduce potential ecosystem disturbances. Currently regulation dictates that all sorbents must be removed from oil spills and disposed of properly, but

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23 "National Oil and Hazardous Substances Pollution Contingency Plan Overview," *EPA*, 17 March 2009. http://www.epa.gov/oem/content/lawsregs/ncpover.htm#key.

24 "National Contingency Plan (NCP) Subpart J – Product Schedule," *EPA,* 7 October 2010. http://www.epa.gov/oem/content/ncp/index.htm.

25 "Product Categories under the National Contingency Plan Subpart J," *EPA*, 17 March 2009. http://www.epa.gov/oem/content/ncp/categories.htm.

26 "Subpart J, National Contingency Plan," 7 October 2010. http://www.epa.gov/ceppo/web/content/ncp/.

27 Ibid

organic loose sorbents can degrade naturally with the oil and should be reconsidered for their sustainable and low-impact nature.[28] The relative invisibility of natural sorbents due to their absence on the product schedule makes them an unlikely choice to be utilized during the response effort, despite the fact that they are defined in Subpart J on the NCP.

Though responders to an oil spill can survey the LC50s of all products, which will give them insight into the toxicity of the product, there is no indication on the product schedule of which products are local, natural, or otherwise sustainable. Similarly, though the effectiveness of each product must be proven under laboratory protocol developed by the EPA, there is also no evidence as to the relative efficacy of the various technologies or how they will perform in the field. In the case of bioremediation agents, laboratory testing may yield significantly different results than field testing but laboratory testing is still all that is required for placement on the product schedule.[29] In order to get a better idea of the effectiveness of various bioremediation agents, the EPA performed a literature review on bioremediation through peer-reviewed and non-peer reviewed (investigations by governmental agencies observe bioremedial approaches to oil spills but are not published) literature. This report concluded:

> *"If there is any hope for advancement of commercial bioremediation, especially estuaries, experiments based on sound scientific principles are needed. Unfortunately, due to the extreme resource intensiveness of field studies, the benefit accruing to testing one bioremediation agent is only applicable to the one product being tested, not to the overall science of bioremediation. Testing products in the field is not within the purview of the federal government unless such a test has the potential of advancing science in terms of general microbiological and engineering principles."*[30]

Field testing for bioremediation agents is difficult due to the complex nature of the relationship between microbes and their environment. However, field testing for sorbents provides more benefits because ease of application, biodegradation time, amount of oil absorbed, amount of oil retained, and other factors can be observed and taken into account during these tests.

Replicated, randomized and scientifically sound studies on sustainable alternative technologies will allow oil spill responders to determine what products are best to use by revealing the relative benefits and problems with various products. If non-conventional, environmentally-friendly technologies are proven to be effective, they will be used in oil spill response, increasing the sustainability of the operations as a whole and decreasing the negative impact on the local environment and communities. The size of this oil spill reveals the importance of emergency preparedness in this arena. A sustainable response is important in the case of future disasters and increasing sustainability advances science in terms of engineering principles without doubt.

At this point BP has sealed the initially leaking well and created a relief well; the amount of oil is not increasing at the incident site. The cleanup effort will now be focused on reducing the amount of oil in the environment to the degree possible. Of the total oil spilled during the incident, 26% of the oil still remains – this is a larger amount that the total amount of oil released in the Exxon Valdez spill. The time since the accident on the Deepwater Horizon rig and the knowledge gained

[28] "National Contingency Plan (NCP) Subpart J – Product Schedule,"
[29] Xueqing Zhu, Albert d. Venosa, and Makram T. Suidan, "Literature Review on the Use of Commercial Bioremediation Agents," *EPA*, July 2004. http://www.epa.gov/osweroe1/docs/oil/edu/litreviewbiormd.pdf.
[30] Ibid

through experience during the cleanup effort creates a less hectic environment where scientific field testing can now be undertaken. As new and alternative forms of technology are created to address oil spills, they must be examined and scientifically tested for effectiveness; advancing technology cannot be ignored because conventional technology works in the expected way. With testing of various products and technologies comes validity and visibility that will allow the creation of an optimized oil spill response regimen where feasible alternative, sustainable products can be added to the oil spill cleanup toolbox.

Infrastructure

Composting involves decomposition of organic matter by microbes; essentially, it is a form of ex-situ bioremediation. The variables that control degradation, including moisture, ratio of nutrients, and temperature, can be controlled to cultivate the decomposition, which ultimately produces humus, a beneficial soil amendment that can be sold for a profit. Bioremediation has been shown to successfully increase decomposition petroleum hydrocarbons in soil.[31,32] Oily vegetation and debris, as well as debris chippings and grindings, can be composted, removing the oil and producing a viable end product outside of a landfill. If natural fiber sorbents are used to capture oil, often they too can be composted.

In order to compost debris, composting facilities must exist close to the incident site to prevent compromising the sustainability and financial viability of the effort. Otherwise, the costs (both monetary and carbon costs) of transporting the organic disaster debris to the facility will decrease the sustainability of the operations. The creation of a composting facility can be profitable and environmentally-friendly through the composting of green waste and food waste from residential and commercial activities.

Few Gulf Coast cities have infrastructure supporting waste diversion, so even their non-disaster recyclable and compostable waste enters landfills. The hurricane-prone Gulf Coast must consider their landfill capacity because it is increasingly important for these cities to maintain space in their landfills for future disasters. Hurricane debris waste significantly decreases landfill capacity – specifically in the case of Hurricane Katrina – and these same communities are affected by this oil spill. It is not only prudent but also environmentally just to facilitate diversion of waste from these landfills to maintain capacity in preparation for any future disaster.

3. Conclusion

The size and severity of the Gulf Oil Spill called for a large-scale response and remediation effort. The actual clean-up and the support operations that facilitated the response generated waste that needed to be sorted and disposed of according to government regulations. Much of the waste has been sent to landfills near to the regional response locations. In an effort to be environmentally conscious and sustainable in remediation operations, a goal of waste diversion has been recognized, in waste management plans, in Louisiana Senate Bill 583, and Louisiana Bill LA R.S. 30:2413.1. These prioritize source reduction, composting and recycling as disposal methods for the generated waste.

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[31] KS Jorgensen, J Puustinen, A.M. Suortti, Bioremediation of Petroleum Hydrocarbon-Contaminated Soil by Composting in BioPiles," *Environmental Pollution* 2, no 107, (2000): 245-254. doi:10.1016/S0269-7491(99)00144-X .

[32] Ronald M. Atlas, "Petroleum Biodegradation and Oil Spill Bioremedation" *Marine Pollution Bulletin* 4-12, no 31 (2000):178-182. doi:10.1016/0025-326X(95)00113-2.

However, to successfully divert waste, especially during a clean-up operation where efficiency is essential, planning is necessary. The nature of waste diversion of this oil spill disaster requires many players – on-scene coordinators, waste management contractors and their personnel, trash haulers, composting and recycling facilities, the surrounding community members, etc. These players must all coordinate successfully in order to achieve an environmentally sustainable and economically viable reduction of waste disposed into the landfills. This cannot be done without the proper planning and assessment of all resources and facilities before and during the spill response.

4. Summary

The size and severity of the Gulf Oil Spill called for a large-scale response and remediation effort. The actual clean-up and the support operations that facilitated the response generated waste that needed to be sorted and disposed of according to government regulations. Much of the waste has been sent to landfills near to the regional response locations. In an effort to be environmentally conscious and sustainable in remediation operations, a goal of waste diversion has been recognized, in waste management plans, in Louisiana Senate Bill 583, and Louisiana Bill LA R.S. 30:2413.1. These prioritize source reduction, composting and recycling as disposal methods for the generated waste. However, to successfully divert waste, especially during a clean-up operation where efficiency is essential, planning is necessary. Source reduction is entirely a product of planning. Furthermore, recycling and composting must be facilitated through the materials used in the clean-up effort. A significant portion of the solid waste comes from absorbent booms, which are filled with plastics. These booms cannot be composted, but there exists natural sorbent material and natural sorbent booms that can. Furthermore, the correct infrastructure must be in place to allow composting; there are few composting facilities near the gulf coast. These structures must be preemptively established to allow waste diversion.