5/25/2011 DRAFT

The Honorable Lisa P. Jackson
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, N.W.
Washington, D.C. 20460

Subject: Review of EPA's draft Oil Spill Research Strategy

Dear Administrator Jackson:

The Environmental Protection Agency's (EPA) Oil Spill Research Program conducts research under the Oil Pollution Act of 1990. The response efforts to the Deepwater Horizon oil spill highlighted the need for additional research to evaluate new spill response technologies, the implications of deepwater oil spills, the use of dispersants, and the acute and chronic health risks for spill response workers and the public from oil spills and spill mitigation.

To respond to these research issues, the EPA developed the Draft Oil Spill Research Strategy for FY12 through FY15, identifying a research approach on potential human and environmental risks from oil spills and the application of dispersants, surface washing agents, bioremediation agents, and other mitigation measures. The goal of the Strategy is to provide environmental managers with the tools, models, and methods needed to mitigate the effects of oil spills in all environments, emphasizing coastal and inland environments. EPA's Office of Research and Development requested the Science Advisory Board to review and provide advice on the proposed research initiatives, as described in the EPA *Draft Oil Spill Research Strategy.* The SAB Staff Office formed an *ad ho*c panel, the Oil Spill Research Strategy Review Panel, to conduct this review.

The charge to the SAB Panel included questions about the proposed science questions, research activities, and research outcomes outlined in the *Draft Oil Spill Research Strategy.* The Panel held a public teleconference review meeting on April 11 -12, 2011 and a follow-up public teleconference on June 9, 2011.

The SAB acknowledges the thoughtful effort made by EPA to identify research needs for the Oil Spill Program. The *Draft Oil Spill Research Strategy*, referred to hereafter as the "Strategy," proposes EPA activities and identifies possible interagency research activities and collaborations, however, in many places in the Strategy it is not clear which Agency will have primary responsibility for key research activities and how coordination will occur. In addition, it is not clear how the Strategy will be incorporated into the Office of Research and Development's Integrated Trans-disciplinary Research (ITR) approach. EPA should more clearly define its role and responsibilities for research that supports oil spill remediation and restoration as well as its mechanisms for coordination with other agencies. The SAB believes EPA needs to communicate effectively among the interagency partners, collaborators, and oil spill decision makers to develop the needed research. The lack of clarity about which agency is in the lead for a research area, what roles collaborators have, and the scope and goals of the research creates an uncertainty in whether EPA will have the research results it needs to support decision makers during an oil spill response effort. The SAB believes that the EPA should also identify which research needs are priorities and which research projects are short- or long-term research activities.

Although the Strategy was developed before the implementation of ORD's ITR initiative, ORD should incorporate the Strategy into the four integrated programs of the new organization: 1) Air, Climate and Energy; 2) Safe and Sustainable Water Resources; 3) Sustainable and Healthy Communities; and 4) Chemical Safety for Sustainability) and the two cross-cutting areas of Human Health Risk Assessment and Homeland Security Research.

The Strategy briefly outlines four research themes (dispersants, ecosystem impacts, innovative processes and technologies, and human health impacts). The research on dispersants needs to more comprehensively define the efficacy of a dispersant and the ecological and toxicological endpoints that are being evaluated. In addition, dispersants and oil mixtures should be considered as a system, recognizing that dispersants and other agents will perform differently in different environments and when reacting with different oil types.

Assessing the ecological effects of oil spills on shorelines, coastal, and inland oil ecosystems requires a baseline of ecosystem functions. Without baseline monitoring data and information the remediation and restoration efforts are difficult to assess and difficult to quantify. The Strategy should include a plan for baseline data collection, by the EPA or other Agencies and should include the development of indicators that can be used to evaluate post-spill ecosystem response and recovery.

The Strategy should further articulate the research for the key exposure pathways, (i.e., water, food, and sand) for human and ecological exposures. Exposure duration and pathways will vary depending on the exposed population under consideration. Human exposure will vary between oil spill response workers and residents of adjacent communities. Ecological communities and populations will also have different exposure scenarios and pathways that should be considered depending on site of the release and ecological community.

Finally, the panel recognizes that these themes are complex and inter-related. The panel recommends that the Strategy develop approaches for integration of the themes and that the integration be a distinct element of the Strategy.

In closing, the SAB encourages EPA to continue efforts to identify and prioritize oil spill research and collaborate with its interagency partners to develop the best available science to support oil spill response, remediation, and restoration efforts. We appreciate the opportunity to provide advice on this important research and look forward to your response.

Sincerely,

Dr. Deborah L. Swackhamer, Chair
Science Advisory Board

Dr. David T. Allen, Chair
SAB Oil Spill Research Strategy
Review Panel

Enclosure

NOTICE

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Oil Spill Research Strategy Review Panel

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1. Executive Summary

The Environmental Protection Agency's (EPA) Oil Spill Research Program has conducted research since its authorization under in the Oil Pollution Act of 1990. The three primary agencies that the EPA collaborates with on oil spill related research are the United States Coast Guard (USCG), the National Oceanic and Atmospheric Administration (NOAA), and the Department of the Interior's (DOI) Bureau of Ocean Energy Management, Regulation, and Enforcement (BOEMRE). OPA established the Interagency Coordinating Committee for Oil Pollution Research (ICCOPR) to foster cost-effective research mechanisms, including the joint funding of the research and to submit a biennial report to Congress on activities carried out under Section 7001 in the preceding two fiscal years, and on activities proposed to be carried out under this section in the current two fiscal year period.

The role of EPA in this integrated Research program is requiring onshore and offshore non-transportation related facilities to have spill prevention, control, and countermeasure (SPCC) plans and facility response plans, where applicable. EPA sets policy and guidance for the proper use and authority to use products on the National Oil and Hazardous Substances Pollution Contingency Plan Final Rule, Subpart J Product Schedule (40 Code of Federal Regulations Part 300.900). The NCP lists dispersants, surface washing agents, bioremediation agents, surface collecting agents, and miscellaneous oil spill control agents that may be used in response to oil spills on land and on or near waters of the U.S. depending on the product and its proper application (US EPA 2011).

The Deepwater Horizon (DWH) spill highlighted the need for additional research needs for spill response technologies and raised questions relative to the use of dispersants in oil spill remediation, acute and chronic health effects for spill response workers and the public, whether new innovative technologies were available, and what are the most effective steps to restore coastal, shoreline, and inland areas impacted by spills.

To respond to these research issues, the EPA identified a research approach on potential human and environmental risks from oil spills and the application of dispersants, surface washing agents, bioremediation agents, and other mitigation measures for FY12 through FY15. The goal of the research is to provide environmental managers with the tools, models, and methods needed to mitigate the effects of oil spills in all environments, emphasizing the coastal and inland environments. EPA's Office of Research and Development requested the Science Advisory Board to review and provide advice on the proposed research initiatives, as described in the EPA document, *Draft Oil Spill Research Strategy*, hereafter the Strategy. The SAB Staff Office formed an *ad hoc* panel, the Oil Spill Research Strategy Review Panel, to conduct this review.

The Panel held a public teleconference to review the Strategy on April 11 -12, 2011 and a follow-up public teleconference(s) on June 9, 2011. The Panel received technical comments from interested members of the public.

The SAB acknowledges the thoughtful effort that already has been made by EPA to identify the research needs for the Oil Spill Program. However, much work remains. The Strategy presents interagency research activities and possible collaborations, however is not clear what research will be accomplished by which Agency and how the Strategy will be incorporated into the Office of Research and Development's Integrated Trans-disciplinary Research approach. EPA should more clearly define its roles and responsibilities for research that supports oil spill remediation and restoration and its mechanisms for coordination with other agencies. EPA needs to communicate effectively among the interagency partners, collaborators, oil spill decision makers. The lack of clarity about which agency is the lead, collaborators roles, and the scope and goals of the research creates an uncertainty in whether or not EPA will have the research results it needs to support decision makers during an oil spill response effort. The EPA should also identify which research needs are priorities and which are short- or long-term research activities.

Although the Strategy was developed before the implementation of ORD's ITR initiative, ORD should incorporate the Strategy into the four integrated programs of the new organization: 1) Air, Climate and Energy; 2) Safe and Sustainable Water Resources; 3) Sustainable and Healthy Communities; and 4) Chemical Safety for Sustainability) and the two cross-cutting areas of Human Health Risk Assessment and Homeland Security Research.

The SAB acknowledges that there is a great deal of data and information on past oil spill response and remediation. However, we note that the changing practices, increased off shore drilling, and extreme conditions under which the hydrocarbon industry is drilling and exploring will create new information needs. The EPA and its research collaborators will need to be adaptive in approaches to collect, develop, and disseminate the best science to oil spill responders making decision and answering these complex questions.

The Strategy outlines four research themes (dispersants, ecosystem impacts, innovative processes and technologies, and human health impacts).

Dispersants

The research on dispersants needs to clearly define the efficacy of a dispersant and the endpoints that are being evaluated. Dispersants and other agents will perform differently in different environments and when reacting with different oil types. Dispersants are intended to simply change the transport and eventual fate, essentially trading off surface and shoreline ecological impacts for those in water column and benthos. In certain cases, the use of dispersants is an irreversible option that can restrict other cleanup options (e.g., containment, burning, mechanical recovery). Without clear understanding as to tradeoffs and consequence of dispersant use, a rational decision context is unavailable. The research projects described in the Oil Spill Research Strategy should also recognize and address the complexity of dispersant-oil mixtures and other compounds.

Toxicological studies of sub-lethal and chronic exposures to the variable complex dispersant mixtures are necessary. These studies should include naturally dispersed oil, chemical treatment agents alone, and oil mixed with chemical treatment agents for a comparison of actions, effects and impacts. Weathered as well as fresh oils should be employed for all studies, including toxicity studies. Impact areas, such as benthos and shore, should be assessed separately. Adding key population-level effects such as those affecting reproductive success also merit incorporation

Transport and fate studies should include the chemical treatment agents in conjunction with the particular oils with which they would most likely be used. Given trends in offshore oil production, specific environments that should be addressed immediately include cold, high-pressure conditions to model deep-sea applications (such as what occurred with the DWH blowout) as well as cold/under ice applications in or near polar regions.

Shoreline, Coastal, and Inland Effects Research to Inform Oil Spill Decision-Making

The research used to inform the ecological effects of shorelines, coastal, and inland oil spills needs a resource for baseline comparisons. Effective long-term monitoring of the general health and changing conditions in hydrocarbon extraction regions (in this case the US Gulf Coast) should be improved and emphasized. Many natural and anthropogenic disturbances, in addition to oil spill(s), impinge on the Gulf, including climate change, coastal erosion and wetland loss associated with sea-level rise and the diversion of sediment supply and transport to the coast, eutrophication, anoxia, disease, invasive species and over-fishing. At present, it is difficult to always clearly attribute cause to any particular disturbance. To do so in the future will require a long-term and sustained commitment to coordinated integrated natural system research at variety of spatial scales.

As the Agency identifies the baseline information it should consider developing indicators that can be used to evaluate an ecosystem’s response and recovery.

Shoreline, coastal, and inland effects research should better define exposure conditions (spatial/temporal dynamics) and link exposure to ecological effects in order to determine risk accurately. In many cases, these linkages will need to take into account baseline/background environmental conditions and stresses in order to adequately characterize risks from specific spill incidents. Building on key exposure-response relationships from laboratory tests where conditions reflect ambient exposures, risk assessments will be better able to inform risk managers regarding true tradeoffs imposed by various response and restoration actions.

The research issues associated with shorelines, coastal and inland spill impacts needs to be cast in a population/community perspective, with an associated Decision Management Framework (DMF) that considers the background conditions, existing contamination, knowledge of local and regional food webs, and an understanding of the recruitment and refugia potential for local populations, all worked into a strong understanding of population, community and ecosystem recovery capacity. It will be important to link the broad toxicology studies outlined in the dispersant section of the Strategy with endpoints that can support impact assessments and risk assessments at these higher levels of ecological organization. Single species toxicity studies should support endpoints to assess population effects and help risk-based decision-making during an event and as part of restoration efforts.

Innovative Processes and technologies Development

The SAB believes that innovative processes and technologies research should be focused on EPA's regulatory role in certifying or approving various new approaches. EPA should engage federal agencies, states, and industry in their efforts.

If EPA wishes to encourage the development of "new or improved" technologies such as better booms, skimmers, absorbent materials, and underwater collection methods, then specific operational criteria regarding toxicity, biodegradation, and discharges should be clearly developed and made a part of the review and evaluation process.

Human Health Impacts

Much of the human health-related research regarding the Gulf Oil Spill will be conducted by federal agencies other than the EPA. The Strategy principally identifies National Institute of Environmental Health Sciences (NIEHS) and National Toxicology Program (NTP), but also National Institute of Occupational Safety and Health (NIOSH), Substance Abuse and Mental Health Services Administration (SAMSHA), and Centers of Disease Control and Prevention (CDC). Coordination of research with federal partners is strongly encouraged by the SAB as a means for the EPA to access a broad array of expertise and share costs to mutual benefit.

Oil spills contain carcinogens such as polycyclic aromatic hydrocarbons (PAHs), and many of the decisions about acceptable limits of exposure that EPA needs to make are based upon an estimation of cancer risk. The cancer risk model used currently by EPA was developed primarily to assess excess cancer risk from lifetime exposure, whereas oil spill exposure scenarios are typically for much shorter periods of time. The issue is not unique to oil spills – EPA is confronted with a variety of situations in which cancer risks must be estimated for individuals with short-term or intermittent exposure. Development of cancer risk models to address this research need should be a high priority.

The Strategy provides a well-defined research plan related to exposure to air pollutants related to the DWH spill. However, other exposure pathways are not as well defined. Exposure assumptions currently are based upon professional judgment rather than data. The current EPA model for dermal absorption of chemicals has difficulty with PAHs because they lie outside the "effective prediction domain." As a result, the Agency has been thus far unable to develop risk-based criteria for PAHs for swimmers, and human health benchmarks for PAHs remain "under development" A similar observation can be made for exposure assessment as it pertains to beach sand/sediment. Population data on exposure frequency and duration for Gulf Coast visitors and residents, and measurements of dermal contact and incidental ingestion rates needed to derive risk-based criteria for protection of human health, are absent.

Finally, the panel recognizes that these themes are complex and inter-related. The panel recommends that the Strategy develop approaches for integration of the themes and that the integration be a distinct element of the Strategy.

2. Introduction

This report was prepared by the Science Advisory Board (SAB) Oil Spill Research Strategy Review Panel in response to a request by EPA's Office of Research and Development (ORD) to review *the Draft Oil Spill Research Strategy* [insert footnote to SAB webpage].

The Oil Pollution Act of 1990 (OPA 1990; 33USC2701-2761) establishes liability for releases and a fund for responding to oil releases as well as restoring natural resources. Section 2761 of OPA 1990 authorizes research and development in multiple federal agencies, including EPA, and establishes the Interagency Coordinating Committee on Oil Pollution Research (ICCOPR; www.iccopr.uscg.gov).

Research needed to implement OPA is delegated to several federal agencies. EPA carries the responsibility for non-transportation-related onshore facilities and incidents in the Inland Zone. United States Coast Guard (USCG) has responsibility for marine transportation-related facilities and incidents in the Coastal Zone. The Department of Transportation's Office of Pipeline Safety oversees onshore transportation-related facilities. The Department of Interior has responsibility for offshore fixed facilities beyond the coastline. The National Oceanic and Atmospheric Administration is responsible for natural resource damage assessments relating to oil discharges.

EPA responsibility includes requiring onshore and offshore non-transportation related facilities to have spill prevention, control, and countermeasure (SPCC) plans and facility response plans, where applicable. EPA sets policy and guidance for the proper use and authority to use products on the National Oil and Hazardous Substances Pollution Contingency Plan Final Rule, Subpart J Product Schedule (40 Code of Federal Regulations Part 300.900). The NCP lists dispersants, surface washing agents, bioremediation agents, surface collecting agents, and miscellaneous oil spill control agents that may be used in response to oil spills on land and on or near waters of the U.S. depending on the product and its proper application (US EPA 2010).

The OPA authorizes Congress to appropriate up to $22 million per year among the federal agencies. ICCOPR published multi-agency research and technology plans in 1992 and 1997 and is presently developing a third update. The research focus of each agency in the 1997 plan generally aligns with its legal and regulatory authorities.

Prompted by the Deepwater Horizon spill in the Gulf of Mexico and its aftermath, ORD developed a draft research strategy that would address the scientific and technical questions that could enhance EPA's ability to carry out its mission with respect to oil spills both in the short- and longer-term. The draft strategy is framed to identify (1) anticipated decisions that spill responders and policy developers will be required to make; (2) science questions within those identified decisions; (3) research that would address the science questions; and (4) research outcomes that can be used to inform future decisions. The draft strategy is structured to address four themes: dispersants; ecological effects; innovative processes and technologies; and human health effects. Research priorities that are principally the responsibility of other agencies are not included in this draft strategy, but will be considered in ICCOPR planning (see Figure 1-2 in the draft strategy).

The draft Strategy is deliberately not constrained by resource levels. ORD's intent was to develop a strategy that would address the scientific and technical questions that are central to EPA's mission, recognizing that the research could be conducted by various members of the ICCOPR, researchers funded by BP, and others. Implementation of the Strategy would entail coordination with those entities to ensure appropriate collaboration and leveraging.

3. Response to Charge Questions

ORD requested the SAB to comment on the scope, proposed science questions, research activities, and research outcomes outlined in the *Draft Oil Spill Research Strategy.* The Charge to the SAB is provided as Appendix A. Each Charge question is also provided at the beginning of each response. Charge questions 1 and 2 focused on the scope of the Strategy in its entirety and whether the Strategy addressed and discussed the research and science that will be needed to support the Agency's future challenges. Question 3 focused on each of the four research themes and sought SAB advice on whether the project areas under each research theme addressed the key issues, if there are science questions that should be added or deleted from the Strategy, and if the proposed project areas are adequately described. The SAB responses are organized under each of the charge questions and research themes as appropriate.

3.1 Response to Charge Question 1

> *Does the draft Oil Spill Research Strategy encompass the most important research needed to enable EPA to better carry out its mission to prepare for and respond to oil spills, including future challenges such as biofuels discharges? Does the draft strategy appropriately address greener alternatives and innovation?*

The SAB generally agrees that the draft Oil Spill Research Strategy encompasses the important research needed to enable EPA to better carry out its mission. The four research themes presented in the Strategy address important research, however, many of the project areas and associated questions under each of the research themes are rather general and it is unclear how the studies will be designed to enable EPA to carry out its mission. The Strategy needs to specify a plan to integrate data to understand the impacts from previous spills such DWH as it becomes available, and also focus on broader spill response issues in new potential drilling environments. The SAB believes it will be difficult for EPA to assess where the priority research needs exist without a more detailed review and evaluation of current findings from previous, major oil spill studies and assessments of new information generated during the DWH incident. The SAB has identified specific examples of future challenges and additional research needs and included these under each of the research themes of the Strategy. The SAB noted that environmental justice and behavioral science research have limited discussion in the Strategy's research themes.

[Note to reviewers: There were no specific comments received on biofuels]

Consideration of Environmental Justice to Overburdened Communities and Behavioral Sciences

Specifically, the Strategy ignores mention of environmental justice though it is implied in several or the research themes. The SAB believes it is appropriate to include environmental justice consideration within the Shoreline, Coastal, and Inland Effects Section and Human Health Impacts research themes. For example, on Pg 34, the table that addresses the decision context and key scientific questions for "Ecological Ecosystem Services, Health and Well-Being in Gulf Coast Communities." The well-being in Gulf Coast communities would address issues of environmental justice, but there are no key scientific questions listed here related to environmental justice.

The text describing this table includes research on how changes in ecosystem services increase or decrease human well being. The paragraph further states this will be a major research effort for EPA that will address specific decision end points. Again, nothing was stated specifically on research topics directly related to environmental justice.

The draft Strategy is also weak on research related to behavioral and social science research. In the recent review of the 2012 EPA research budget review committee, the SAB advised EPA to bring the decision sciences back into ORD and expand its mandate to include the behavioral and social sciences more broadly as an explicit research enterprise. EPA should carefully consider how the behavioral and social sciences can be added to their research agenda, it is especially pertinent when a particular research questions encompasses decision analysis/structuring to risk communication (risk communication was mentioned this morning in preliminary comments) to behavior change and beyond.

The SAB notes that in 2006 the Coastal Response Research Center "held a workshop that included spill response practitioners and researchers from the social sciences in a discussion of risk communication, coordination in spill response and restoration, environmental ethics, valuing natural resources, and the social impacts of spills on communities and subsistence peoples. The workshop organizers stated this was the first of its kind to address these issues:

> "Broadly understood, human dimensions research aims to: 1) Understand human-environment interactions, including: (a) the ecological role of humans as proximate causes of ecosystem stress, and underlying social drivers of those causes, (b) consequences of ecosystem stress for the achievability, sustainability, and tradeoffs among diverse societal objectives, and (c) human mitigative and adaptive responses to ecosystem stress. In addition, 2. Harness this understanding in policy, management, and other governance contexts to balance social and environmental goals in the context of natural resources management." (Kinner and Merten 2006).

Greener Alternatives: Chemistry and Engineering

The SAB recognizes the Strategy's focus on greener alternatives and innovation as a potential strength of the report. However, the focus on greener alternatives and innovation is primarily based on use of green chemistry to develop greener dispersants. The Strategy makes a particular emphasis in several locations that "application of green chemistry principles will provide effective and sustainable products while reducing their toxicity and persistence in the environment." The document thus appears to view green chemistry primarily as developing degradable dispersants that have lessened ecological effect. The SAB recommends the Agency should consider green alternatives in a broader (and more appropriate) context that considers issues of sustainability beyond simply the ecological impact associated with deployment of dispersants.

In green chemistry, risk is minimized over the whole life cycle by reducing or eliminating the hazard. For example, the design of greener dispersants should ensure that material and energy inputs and outputs are as inherently non-hazardous as possible farther upstream in the dispersant's life cycle, for example, in the material extraction, material processing, and material manufacturing life stages. This better integrates with EPA's definition of green chemistry: the design of products and processes that reduce or eliminate the use and generation of hazardous substances. Greener alternatives thus always recognize that creating, handling, storing, and disposing of waste never adds value to a product or service.

The SAB also recommends that EPA consider expanding the Strategy to include relevant principles of green engineering in the Strategy. The SAB recognizes that this is a relatively new approach and we compliment EPA ORD on providing particular care on this topic. Green engineering is the "design, discovery, and implementation of engineering solutions with an awareness of potential benefits and problems in terms of the environment, the economy, and society throughout the lifetime of the design." (Mihelcic and Zimmerman 2010).

Green engineering focuses on avoiding waste in the first place wherever practicable and eliminating the concept of waste wherever possible. Accordingly, the SAB recommends that EPA, even when developing a oil spill response strategy, remain focused as an Agency that it is always a preferred strategy to prevent waste rather than treating or cleaning up waste after it is formed. Furthermore, in green engineering, any separation and purification operations that are proposed while responding to a spill should be designed to minimize energy consumption and materials use. End-of-life issues should also be considered when developing spill strategies that simply transfer a pollutant to another media that perhaps then requires disposal. In addition, design of oil spill response strategies should ensure that all materials and energy inputs and outputs are as inherently nonhazardous as possible and any material and energy inputs should be renewable rather than depleting.

3.2 Response to Charge Question 2

Is the research strategy organized appropriately to frame the questions in a comprehensible manner and to foster collaboration with outside entities as appropriate? If not, how can it be better organized?

In some areas, the Strategy is very clear which agency is performing which research (when discussing funded or planned studies). The Strategy is less clear when the discussion focuses on priority research for which no definitive funding mechanism is identified – and inconsistently which agencies are conducting the research. There is need throughout this document for EPA to clearly define its role and needs as they relate to that role. In so doing, the agency will facilitate interactions and collaborations with their partners through ICCOPR.

EPA states that the draft strategy is framed to identify (1) anticipated decisions that spill responders and policy developers will be required to make; (2) science questions within those identified decisions; (3) research that would address the science questions; and (4) research outcomes that can be used to inform future decisions.

Their research is driven by the decision-making needed to prepare for a response to a release. The SAB notes this driver is in conflict with the hierarchy of pollution prevention. For example, one principle of the pollution prevention hierarchy states that designers need to strive to ensure that all material and energy inputs and outputs are as inherently non-hazardous as possible but important here, a second principle of pollution prevention is that it is better to prevent waste than to treat or cleanup waste after it is formed. Perhaps section 1 of the report should provide more detailed information on whom within the federal government or industry is conducting research to prevent the release of oil. Table 1-1 on page 5 states the Department of Transportation has responsibilities to develop regulations for pipeline spill prevention and supporting the maritime industry with guidance and technology in implementing equipment, systems, and operations to prevent spills. The Strategy does not present any other agency involved in research specifically on how to prevent spills. Including this discussion in context of the research's focus on response to a release, would make the document stronger in terms of how it integrates principles of green chemistry and engineering into the document.

The draft strategy is structured to address four themes: dispersants; shoreline, coastal, and inland effects; innovative processes and technologies; and human health effects. While the SAB found the document well organized and easy to read, however this raises questions about how the Strategy will be implemented within the Integrated Trans-disciplinary Research Approach. EPA ORD reorganized its research from 13 project-areas, defined by specific problems and media-type, into four integrated programs: 1) Air, Climate and Energy; 2) Safe and Sustainable Water Resources (water quality plus drinking water); 3) Sustainable and Healthy Communities; and 4) Chemical Safety for Sustainability) and two crosscutting areas (Human Health Risk Assessment and Homeland Security Research). The Strategy is organized around a traditional "specific problem." While the SAB recognizes that the Strategy was developed before this reorganization, we recommend that EPA structure the Strategy in terms of the integrated research approach. For example, in Section 1 a visual graphic that shows how the four research themes of the Draft Oil Spill Strategy fit within the programs identified in ORD's new organization.

3.3 Response to Charge Question 3

Charge Question 3 addresses science questions and projects described in each of the four research themes. Advisory Report provides responses to specific issues under each the three questions.

Within each theme:

- *a. Do the science questions address key issues that can improve future oil spill prevention and response activities? Please identify additional high priority issues or science questions that should be addressed.*
- *b. Should any of the science questions be deleted based on sufficient existing knowledge, low impact on decision-making, or for other reasons?*
- *c. Are the proposed project areas described adequately to design research projects to achieve the anticipated outcomes? Please identify any project areas that should be refined or important project areas that should be added.*

3.3.1 Dispersants

3a. Do the science questions address key issues that can improve future oil spill prevention and response activities? Please identify additional high priority issues or science questions that should be addressed.

Breadth of Coverage

With improvements in technology, the range of chemical treatment agents has increased. Research in this area needs to include these formulations and examine their interactive effects in conjunction with oils and conditions as appropriate. Transport, fate and effect, and toxicity studies need to include these agents alone, the oil(s) alone, and the resulting complex mixtures. It is agreed that the number of permutations becomes an issue; modeling could provide an overview while more conclusive information would result from follow-up studies.

The list of chemical treatment agents needs to include an ingredient list with the quantities of each component. It is understood that this information will be kept confidential.

Efficacy

Unlike other oil spill response actions dispersants do not reduce the amount of oil in the environment. Instead, dispersants are intended to simply change the transport and eventual fate, essentially trading off surface and shoreline ecological impacts for those in water column and benthos. In certain cases, the use of dispersants is an irreversible option that can restrict other cleanup options (e.g., containment, burning, mechanical recovery). Without clear understanding as to tradeoffs and consequence of dispersant use, a rational decision context is unavailable.

A somewhat trivial definition of efficacy is the degree to which additional oil is dispersed into the subsurface by the use of the chemical treatment agent relative to the non-application. A more comprehensive definition is, however needed that satisfactorily considers the net ecological/toxicological tradeoffs such that overall threat to public health and environmental/natural resource impact can be minimized, and the post-spill ecological recovery rate of an affected area is maximized. This more comprehensive definition requires that, among other things:

- response priorities are clearly defined and articulated in advance of a spill;
- a baseline understanding of the pre-spill environment is available;
- oil/dispersant transport, fate, and eco-toxicity forecast models are available and appropriately matched for a given spill event to predict chemical effectiveness, operational effectiveness, and ecological consequences;
- adequately resolved spatial and temporal monitoring is undertaken; and
- that a scientifically verifiable assessment method is used.

This net cost/benefit definition of efficacy requires that non-commensurate factors (e.g., hydrocarbon chemical composition, life stage sensitivity of particular organisms, temperature, spill size, etc.) be examined within a context that allows decision makers a clear understanding of the critical vs. non-critical factors and how these factors influence each other.

This approach is highly interdependent and complex. Moreover, the response window for dispersant application is often time sensitive, requiring real-time decision making. These situations are often fraught with externalities such as jurisdictional considerations, inadequate information, limited response equipment, regulatory requirements. Pre-authorization is often now granted to a federal On Scene Coordinator (FOSC) without the requirement for further approval, enabling them to make dispersant use decisions in real-time. This effectively forces the FOSC to make dispersant use decisions without adequate a-priori information. Response teams need information on the various combinations and resulting scenarios, otherwise tactical responses can take precedence over more important strategic goals. In these instances real-time situational awareness is needed to avoid the trap of 'winning the battle but losing the war'.

"War games" research can be used explore likely outcomes as a result of different combinations of events, resources and other factors. A research effort could be undertaken to develop a honed decision tree that identifies specific factors and variables (i.e., surface release vs. subsurface release, deep sea vs. coastal/littoral site). This decision process should provide an assimilative mechanism to integrate new information as it becomes available so that it provides a more complete picture of the remediation approaches and gaps where information is needed. These data and information should be aligned into categories that correspond to oil spill types and circumstances and the decision tree should assist in predicting the environmental and public health outcomes of specific remediation and restoration decision. These simplifying assumptions will enable EPA to define the categories in which to align the research results for use by decision makers. These assumptions should include but are not limited to:

- Seasonal consideration (i.e. anadromous fish migrations)
- Temporal fluctuations (temperature, weather patterns
- Geospatial considerations
- Geology
- Ecoregions/ecosystems (i.e. salt marsh vs. mangrove, vs. forested swamp)
- Oil types (North slope vs. Gulf sweet Crude vs. refined products)
- Type of release (i.e., benthic, surface, inland pipeline)
- Ecosystem recovery
- Potential consequences of remediation choice

Given the complexity of dispersant efficacy, the dispersant research program should be constructed in a manner that works backward from the endpoint, starting first by defining the metrics by which efficacy is judged. Based on this definition, a critical path for research should be defined that identifies obvious knowledge gaps within the various focus areas and ranks them according to importance. These research topics should then be funded at levels proportional to their usefulness. This process can be iterated through repeatedly so that as questions are answered new ones can be examined. Furthermore, this approach should enable responders to efficiently assimilate ongoing scientific research without having to wait for all of the answers. As such, a response to Charge Question 3 (should any of the science questions be deleted) might be: No, rank, research, and re-rank rather than delete.

Transport and fate

Transport and fate studies should include the chemical treatment agents in conjunction with the particular oils with which they would most likely be used. Given the trends in offshore oil production, specific environments that should be addressed immediately include cold, high-pressure conditions to model deep sea applications (such as what occurred with the DWH blowout) as well as cold/under ice applications in or near polar regions.

The conditions of ultra-deep water releases are difficult/costly to reproduce experimentally. Furthermore, the presumably unique interactions of a particular type of oil with a given dispersant would require large permutations of experiments under various environmental conditions. In lieu of an experimental program, an analytical approach involving thermodynamic modeling of molecular interactions can be used to predict dispersant behavior for a given oil type and set of environmental conditions. This can provide a theoretical basis for calculating dispersant-oil dosage control and predicting transport and fate of specific hydrocarbon toxins in subsurface marine environments, instead of just bulk transport models or wave tank experiments.

Currently available spill models such as ADIOS and ADIOS2 are good for surface releases and 2D trajectory modeling, but inadequate for subsurface 3D and 4D transport modeling of dispersed fractions. New research programs should be undertaken to develop 3D& 4D deepwater and under ice transport and fate modeling.

Toxicity

Studies of sublethal and chronic exposures to the variable complex mixtures are necessary. These studies should include naturally dispersed oil, chemical treatment agents alone, and oil mixed with chemical treatment agents for a comparison of actions, effects and impacts. Weathered as well as fresh oils should be employed for all studies, including toxicity studies. Indirect toxic effects should also be considered as should effects resulting from the ethology of native species. Weathered as well as fresh oils should be used with relevant environmental variables (e.g. UV light, temperature, salinity, energy, etc.) that can affect the toxicity and component profile of the complex mixture under consideration. How chemical treatment agents affect the bioavailability and subsequent toxicity of these complex mixtures should be included in research designs. Again, the key term here is permutations, since addressing the variables can become costly. Sensitive life stages of both standard test species and native species (without thought of their economic value) have been used in the past, and their selection in future studies will be an important consideration. Impact areas, such as benthos and shore, should be assessed separately. Adding key population-level effects such as those affecting reproductive success also merit incorporation.

Many biochemical pathways are similar in vertebrates. The information obtained in this testing should be used in conjunction with epidemiology to design human health studies and assess the public health impacts of oil in conjunction with chemical treatment agents. Comparing results obtained in these studies to the status of affected areas prior to the spill underscores the value of acquiring baseline data.

Detailed descriptions of the proposed studies of chronic and sublethal exposures need to include the time frames used in the proposed research. Shorter time frames (i.e. day, week, month, year) may be more manageable, but the DWH event led to continuous applications of dispersants for over 2 months. The descriptions within the document demonstrate the need for a more detailed plan to systematically examine the range of exposures that can be expected from a variable complex mixture of oil and chemical treatment agents to reflect both the duration of application and resulting effects.

Green Chemistry

The discussion of green chemistry applications is narrow in this research theme; it simply proposes to develop dispersants with less ecological footprint. In terms of the dispersants, the research into development of greener dispersants should address life stages associated with premanufacturing and manufacturing of the dispersants. The SAB believes EPA should expand this project area to address environmental impacts associated with the use (or deployment) of a particular chemical or remediation strategy and specifically address issues of end of life.

3b. Should any of the science questions be deleted based on sufficient existing knowledge, low impact on decision-making, or for other reasons?

<u>[Note to reviewers: no specific comments received]</u>

3c. Are the proposed project areas described adequately to design research projects to achieve the anticipated outcomes? Please identify any project areas that should be refined or important project areas that should be added.

Event-based Research Strategy

A lengthy list of research topics can emerge following a large spill in the hope to effectively prepare for every information need and fill all data gaps. These data gaps can provide a stimulus to improve the Agency's ability to organize its preparation. One of the questions that frame SAB comments and advice provides some guidance:
Is the research strategy organized appropriately to frame the questions in a comprehensible manner and to foster collaboration with outside entities as appropriate? If not, how can it be better organized?

The advent of dispersants and other chemical treatment agents (CTA) was accompanied with notable data gaps on their impact on fate, transport, and effects in the various sites where they could be utilized. Much of the focus on this research is to assist response personnel in deciding if these agents should be used, and if so, what would be the likely outcomes. That would suggest that the incident personnel would be able to use a decision tree to guide the nexus of environmental variables, oil characteristics, species sensitivities and interactive effects. To that end, the SAB suggests that the Agency develop an Event-based Research Strategy (EBRS). This approach allows the agency to organize the knowledge available intramurally as well as that from other agencies as it prioritizes research for those areas in which important information is truly lacking. By including milestones, the questions do not need to be answered simultaneously, but coordinated, integrated research can be conducted that focuses on the needs of the Agency as well as other agencies involved during and in the aftermath of a spill.

The report, Understanding Oil Spill Dispersants: Efficacy and Effects (National Research Council, 2005) provides an excellent foundation for establishing this research framework. Among the recommendations articulated in this report is the need to "establish an integrated research plan which focuses on collection and disseminating peer-reviewed information about key aspects of dispersant use in a scientifically robust, but environmentally meaningful context." The report further recommends that this research should "further improve understanding of dispersant effectiveness and the potential impact of dispersed oil at meaningful scales to support decision making in a broader array of spill scenarios, especially those scenarios where potential impacts on one portion of the ecosystem (e.g., water column) must be weighed against benefits associated with reducing potential impact on another (e.g., coastal wetland)."

An event-based dispersant research strategy can be structured according to the basic information that is needed to support response decisions. Along with the basic question of what is the size of the release? The NRC report suggests the following questions:

- Will a mechanical response be sufficient?
- Is the spilled oil or refined product known to be dispersible? And how long before it becomes non-dispersible?
- Are sufficient chemical response assets available to treat the spill?
- Are the environmental conditions conducive to the successful application of dispersant and its effectiveness
- Will the effective use of dispersants reduce the impacts of the spill to shoreline and water surface resources without significantly increasing impacts to water-column and benthic resources

The Deepwater Horizon spill provides a case study of the information gaps for responding to an ongoing deep subsurface release in open water. During the spill the answer to each of these questions was generally either 'no', or 'unknown.' Other scenarios such as spills occurring in ice covered conditions, or of biofuels may present similar knowledge gaps. Thus, the dispersant research programs evolve to match emerging information needs.

Another reason for the development of an EBRS is that it facilitates integrated information applications and research priorities within a section of the Agency. An SAB subcommittee has begun outlining appropriate strategy suggestions along these lines. With the concurrent generation of these plans, points of integration and overlap could emerge more often.

The Agency is asked to review the list of research areas (Appendix C) and prioritize them for research purposes. This prioritization would be a weighting of needs based on application and potential uses rather than a reflection of their scientific value.

3.3.2. Shoreline, Coastal, and Inland Effects Research to Inform Oil Spill Decision-Making

3a. Do the science questions address key issues that can improve future oil spill prevention and response activities? Please identify additional high priority issues or science questions that should be addressed.

Focus of the research needs balance in DWH and non-DWH scenarios, short-term and long-term research focus. The research strategy needs to integrate data and resulting understanding of impacts to ecosystem processes from DWH as it becomes available, and focus on broader spill response issues. It is difficult for the SAB to assess where the priority research needs exist without a more detailed review and evaluation of current findings from previous, major oil spill studies and assessments of new information generated during the DWH incident. Completion of reports and publication of studies initiated during and in the immediate aftermath of the DWH incident and response could alter scientific perceptions of research priorities over the next few years. The EPA research strategy should be flexible enough to incorporate new findings and re-focus as needed. There should be a combination of short-term and long-term efforts, to ensure a diversity of approaches and successful outcomes. Perhaps many of these proposed research areas could be done as pilot projects, to ensure they will deliver needed data and not become sidetracked by confounding factors or insignificant by other research findings.

Although some DWH focus is necessary and justified, the agency is cautioned not to over-invest in studying a single incident. History shows that a DWH scenario is a relatively rare event, once in 30 to 40 year scenario, whereas dispersant use in the US Gulf of Mexico has been once in 3-5 year event. Those oil spill precedents were finite volume spills, 2-5 day local events with same pressing environmental and response issues, but without the “press and political coverage” that follow a major incident. It is likely the next catastrophic spill event will be with a different oil type, different oceanographic and ecological settings, and a different set of operational and logistical constraints brought into play. EPA should learn what it can from DWH, and then be prepared to apply that knowledge in a more generic way.

In addition, EPA needs to remain flexible and able to pursue new avenues of research that may only become apparent after the work has begun. Research teams need to be able to adjust their work plans in out years to follow up on unexpected results or new ideas that stem from earlier study.

For inland spills, where EPA has the On-Scene Coordinator (OSC) role and may drive assessment activities, other types of research may be needed. EPA OSCs are responsible for leading response and initial restoration activities for any number of petroleum products, non-petroleum oils, and other liquids transported in bulk by vessel, pipeline, or rail. Research to support these products will likely require outcomes and results that have broader applicability, as it is not possible to cover all combinations of inland habitats and potential spill products. Research should yield more generally applicable results that can be used to characterize diverse environmental fate processes, exposure-response relationships, or environmental transport modes. EPA is encouraged to think broadly when developing research programs to support the range of activities that might be needed in this area, and to work closely with other state and federal agencies in identifying key areas of uncertainty or knowledge gaps that provide the greatest benefit for the investment.

Address a Variety of Constituents and Response Options

Oil spills, particularly blowouts like the DWH spill, contain much more than oil. There are other complex constituents and gases present in these releases. The research strategy only briefly touches on alternative components, but these can be a significant aspect of a blowout scenario. EPA's significant research and development opportunity should be used to address the pressing issues of spills and emergency response in a broader context. Attention should be given to potential environmental impacts of these other constituents as part of an overall research strategy. In addition, the draft Oil Spill Research Strategy should include scrutiny and investigation of potential impacts on inland, shoreline and coastal communities for the diverse response strategies identified as worthy of consideration (solidifiers, sorbents, burning, bioremediation treatments), with the same depth of effort as was outlined for dispersants. Acute and chronic toxicity, population and community impacts, fate and transport, biodegradation, and bioaccumulation will all be important considerations for any response technology used to prevent oil from reaching an area or as part of a clean-up strategy. The impacts of any spill treatment that is not fully recovered after application will be questioned before and after its use, so EPA should be proactive in gaining the same level of detail on all response technology options as was outlined for dispersants.

Population, Community, and Ecosystem Effects Assessments

The research issues associated with shorelines, coastal and inland spill impacts need to be cast in a population/community perspective, with an associated Decision Management Framework (DMF) that considers the background conditions, existing contamination, knowledge of local and regional food webs, and an understanding of the recruitment and refugia potential for local populations, all worked into a strong understanding of population, community and ecosystem recovery capacity. This must be coupled with strong exposure characterizations that take into account oil type, dispersant type, loading, and hydrology; and broader principles that facilitate assessments from diverse spill situations. These types of considerations will take EPA in a different (and much needed) direction compared to agency efforts during recent spill events such as the DWH in the

Gulf of Mexico and Enbridge pipeline spill in the Great Lakes Region. EPA responsibilities and capabilities should go beyond a focus on dispersants or single species lab tests for oil toxicity and not rely on NOAA and trustee agencies for assessments of population and ecological issues. There is a research need and an agency need to enhance scientific capabilities to go beyond simple toxicity benchmark assessments, and make risk management and response clean-up decisions based on endpoints of ecological significance.

The inland, shoreline and coastal areas most susceptible to spill impacts support complicated and diverse communities. Understanding of oil fate and effects will require effort at the population level and above—preferably community and ecosystem. It will be important to link the broad toxicology studies outlined in the dispersant section of the Draft Oil Spill Research Strategy with endpoints that can support impact assessments and risk assessments at these higher levels of ecological organization. Single species toxicity studies should support endpoints to assess population effects and help risk-based decision-making during an event and as part of restoration efforts. For example, dispersant use is part of broader tradeoff decisions, which need to be cast as population and community assessments for exposed systems to help decide if dispersants are to be used or not. New research should support assessments of rates of population and community recovery from various chemical exposures, helping to assess response, clean-up and restoration tradeoffs.

3b. Should any of the science questions be deleted based on sufficient existing knowledge, low impact on decision-making, or for other reasons?

The draft research strategy refers to assessing impacts at the ecological services level of organization, however this topic needs greater elaboration to focus the write-up, defining more specifically EPA goals for research conducted in this area and the types of work that would be sponsored. The discussion of "ecosystem services" is very limited and very tenuous given where EPA stands on their current ecosystem services research strategy. It sounds good, but is too fuzzy to move forward for near-term decision-making. The SAB recommends that EPA further integrate the Oil Spill Research Strategy with the ecosystems services components within the ORD's Sustainable and Healthy Communities Research Program. For example, the strategy lists use of population density as an ecosystem service predictor, which is a weak endpoint for many organisms and ecosystem functioning. Wetland function and coastal and inland habitat effects are mentioned as a pressing research need, where efforts could generate data consistent with risk-based decision-making. However, greater detail is needed to assess the direction and value of this research area.

3c. Are the proposed project areas described adequately to design research projects to achieve the anticipated outcomes? Please identify any project areas that should be refined or important project areas that should be added.

The SAB recognizes that ORD and EPA have yet to divide responsibilities across federal agencies for sponsored research. The SAB review is thus limited to identifying key research needs and then highly recommending that all these areas be addressed through a rigorous and transparent science integration effort involving all agencies. This is similar to recommendations from the SAB consultation of Ecosystem Services Research Program. Identifying research needs is only a start. It is the extent of coordination and leveraging with other research organizations that will lead to efficient and effective use of research funding. Until the details of implementation and coordination are worked, successful resolution of the uncertainties identified as research needs remains tentative.

Interactions with Other Agencies

The SAB believes that the interaction and integration with other research agencies and institutions that is carefully thought out, transparently leveraged and coordinated, and built on the expertise and capabilities of each party is critical to the success of the EPA research and development program. Details on these planned interactions and collaboration are important in order for others to understand the basics of this research strategy. Oil spill sites usually do not have boundaries—what occurs in estuarine and intertidal areas is directly connected to nearshore, coastal waters, and all are connected to the open ocean. It will be important that ecosystem studies reflect this connectivity and address it through cooperation and coordination among the agencies and institutions working in these areas. Such multi-agency interactions are especially important for this section of the research strategy, where details on collaboration and leveraging are key to understanding how EPA investments and activities will advance the diverse uncertainties associated with complex ecological issues.

Better Characterize Exposure and Effects Linkages.

Shoreline, coastal, and inland effects research should have an emphasis to better define exposure conditions (spatial/temporal dynamics) and link exposure to ecological effects in order to determine risk accurately. In many cases, these linkages will need to take into account baseline/background environmental conditions and stresses in order to adequately characterize risks from specific spill incidents. Building on key exposure-response relationships from laboratory tests where conditions reflect real world exposures, risk assessments will be better able to inform risk managers regarding true tradeoffs imposed by various response and restoration actions. The exposure response data need to be linked to environmental models such as National Oceanic Atmospheric Administration fate models, National Marine Fisheries Service fish population dynamic models, and other modeling tools used by response and restoration authorities to implement plans. The EPA needs diverse and integrated models and scenarios for differing ecosystem types and their unique food webs to support rapid to mid-term response decisions. The assessments need to support scenarios with differing types of oils, dispersants, and chemical response or clean up agents. Within each scenario, the models should take into account expected background or reference site conditions and a means to understand likely interactions with other common and pervasive stressors (e.g., toxics, nutrients, anoxia; severe events (i.e., hurricanes); invasive species). These efforts can build upon resources such as existing sediment resuspension models for better risk prediction or models of groundwater-surface interactions in coastal areas (e.g., potential contamination of aquifers**)**

Improved Risk Characterization and Communication
EPA should support development of risk-based decision-making strategies for spill response, identifying and assimilating necessary risk-characterization data to meet the requirements of the resource managers, and then enhance the risk assessment and risk communication process with more efficient and effective processes. This will require some research in the area of best processes for risk assessment and risk communication, as well as enhancing the approaches and tools utilized in risk-based decision-making. The risk decisions outlined in Table 3-1 are policy driven, which is a needed area of emphasis, but this research strategy needs to articulate areas such as the DMF and associated "delisting" criteria and the science needed to fill the gaps for those decisions. Perhaps resources such as AOC BUIs would be a useful template.

Proposed research on risk communication and tradeoffs will require input from trustee agencies such as NOAA and NMFS as well as work with States. EPA is not a natural resource trustee, but has role in response technologies and response planning to reduce impacts on environmental resources deemed priorities by resource trustees. The goal would be to avoid excessive and intrusive clean-up efforts driven by visible sheen from shoreline oiling in cases where there may be little support for these efforts based on habitat destruction, food web contamination, and inherent recovery potential from sheen exposures.

Risk Characterization is a key area of expertise within EPA. Research on how to bring together and quantitatively express environmental fate and effects data, generalized and site-specific modeling, exposure and transport assessments to set meaningful and realistic restoration and recovery goals could greatly enhance EPA leadership and credibility in this area. It will be important to work with other federal agencies with expertise in modeling, fate and transport, offshore oceanography, etc, to ensure needed and relevant data are available to support risk characterization efforts. EPA has the experience base and leadership role in pulling the relevant information together and generating meaningful and relevant risk characterizations that could serve as the underpinning of multi-agency risk assessments and risk management decisions during and after spill events.

3.3.3 Innovative Processes and Technologies Development

3a. Do the science questions address key issues that can improve future oil spill prevention and response activities? Please identify additional high priority issues or science questions that should be addressed.

The SAB believes that innovative processes and technologies research should be better focused on EPA's regulatory role in certifying or approving various new approaches. EPA should engage federal agencies, states, and industry on their ideas and focus on regulatory role to see what criteria might be applicable regarding toxicity, biodegradation, bioaccumulation, discharges, etc. If EPA wishes to encourage the development of "new or improved" technologies (such as better booms, skimmers, absorbent materials, and underwater collection methods), then specific operational criteria (regarding toxicity, biodegrading, discharges, etc.) should be clearly developed and made a part of the review and evaluation process. In this way, companies and inventors can begin to meet specified defined goals or regulatory mandates. This could be partially achieved through the development of an open database that more explicitly defines what the EPA mandates as sufficient "effectiveness" of the different existing and new or developing methodologies, and specific areas where regulatory mandated improvements need to be made. An example of this would be a new super technology for water/oil separation that allows highly efficient large/small scale skimming operations to operate at very low oil to water ratios, with low hydrocarbon residuals in the wastewater and over a very wide range of sea states and wave sizes. During DWH the surface oil skimmer ***A Whale***, a refitted and converted oil tanker designed to capture and separate 300,000 to 500,000 US gallons of oil per day was not used during the DWH response. The vessel stores the captured crude and returns the processed seawater to the sea, however the discharge of the separated water did not meet EPA criteria discharge criteria. Other skimmers failed to work well or worked but had to return to port in slightly rough conditions.

There are questions concerning worker safety during cleanup operations. Materials applied by spray equipment to stop oil spreading and reduce vapors are available today. Their use has been stymied by lack of comprehensive fate and effects data generated by vendors and specific to environmental fate and effects criteria to meet approvals. EPA research and development program should not focus comprehensive testing only on dispersants and the fate of the dispersed oil. These alternative technologies offer real advances if the response community gets information to tackle fate and effects issues of products like solidifiers, spreaders, and sorbents.

Technology transfer on new ideas needs to start at home, ORD needs better way to keep management and policy makers informed of state of the science and actively working with the oil spill community in the intervals between major spill events.

Effective long-term monitoring of the Hydrocarbon Extraction Regions (in this case the US Gulf Coast) general state of health and changing properties should be improved and emphasized. Many natural and anthropogenic disturbances, in addition to oil spill(s), impinge on the Gulf, including climate change, coastal erosion and wetland loss associated with sea-level rise and the diversion of sediment supply and transport to the coast, eutrophication, anoxia, disease, invasive species and over-fishing. At present, it is difficult to always clearly attribute cause to any particular disturbance. To do so in the future will require a long-term and sustained commitment to coordinated integrated natural system research at variety of spatial scales. Thus, monitoring should provide pre-event baseline data, direct event hazard mitigation relevant data (for both pollutant location and syn-event mitigation objectives), and post-event recovery and restoration purposes. These would be in addition to necessarily limited ship based campaign measurements. Depending on the objectives improved monitoring could include sensors on gliders, autonomous underwater vehicle (AUVs), moorings, as well as aerial and satellite based observations. However, in regions like the US Gulf Coast the hydrocarbon extraction industry already has platform based real-time monitoring capabilities for their own management purposes that could be piggy-backed upon to provide a relatively low cost background environmental sensor network for both ocean and atmospheric pre, syn-, and post-event monitoring purposes.

Monitoring should not only include tracking of the pollutants and dispersants fate but also include relevant methods for monitoring the biological systems responses and health (both human and non-human). Monitoring and effective reporting would also allow the general public knows how their money is being well spent.

3b. Should any of the science questions be deleted based on sufficient existing knowledge, low impact on decision-making, or for other reasons?

The Strategy also references the value of the baffled flask efficacy test. EPA presented this new test and justification for why it is better than the swirling flask test at a spill conference in 2001. However, the agency has not yet adopted this as policy. If the new research and development strategy takes 10 years to impact policy and management decisions after the research has been completed, EPA will not be seen as a significant source of new science and technology. EPA itself, however, should work on those facets of new technology that will allow new technology meet regulatory criteria, not necessarily invent completely new technologies itself.

3c. Are the proposed project areas described adequately to design research projects to achieve the anticipated outcomes? Please identify any project areas that should be refined or important project areas that should be added.

A "net environmental cost/benefit analysis" type process should be developed and implemented in the evaluation of old, new, and improved technologies and methods and their combinations (this is usually implicit in evaluations but perhaps it should be explicit). In the event that public health and safety needs to be addressed as part of a new technology, a mechanism by which these potential risks can be assigned and evaluated for both planning and development and the ultimate response should be developed. As part of this, there could be an assessment of the relative impact of the clean up method over simply leaving the natural system to recover on its own. One example of this would be the pros and cons of wide spread habitat destruction of wetlands to remove small amounts of hydrocarbon contamination in contrast to just letting nature deal with it over a period time.

Various studies (i.e., bioremediation and thermal treatments) are framed in the negative, assessing the potential impacts or downsides of the approaches. The SAB believes the research should assess tradeoffs, pros and cons of these technologies to provide oil spill responders with information to support the choice of a remediation technology. The Oil Spill research Strategy should not have a negative bias towards all oil spill response efforts but perhaps define which one might be better utilizing a under specific conditions (perhaps defining with a series of examples what the pros and cons of the various methodologies are and potential regulatory problems).

Research on other response strategies could be reworked and refocused to follow many of the research themes identified for dispersants – toxicity and biodegradation, bioaccumulation etc. data are need for chemical agents used in solidifiers, bioremediation, and surface washing. Fate and transport studies and modeling for these diverse agents are also needed. Dispersants need not be singled out when EPA may be able to promote more comprehensive assessments of a much broader range of spill response technologies. The impacts of any spill treatment that is not fully recovered after application will be questioned before and after its use, so EPA should be proactive in gaining the same level of detail on all response technology options.

Another example of a type of net environmental cost/benefit analysis would be the development of a clearer total "life-cycle management" ethos. This could include the choice of greener clean up materials/methods, their method of utilization (i.e. some materials/methods may be better choices for different types of hydrocarbons or situations than others), and their subsequent greener active disposal by humans or passive degradation in the environment if not fully recovered. For example, research into better mechanical containment and removal technologies may generate a greater net benefit in the long run when compared to the wide spread application of dispersants and generation of oil dispersant complexes who's fate/toxicity is not well understood. This would emphasize what already seems to be a strong attempt to make the cleanup process more environmentally sensitive.

This is also similar to what is currently being promoted in some industries or at least individual companies where there is a no-landfill or incinerator policy. Not all materials or methods can or should be managed in the same way. Examples of choices for mechanically recoverable systems could be the following:

1) Better materials or systems that are more effective, can be easily cleaned in environmentally sensitive way, and then reused in a later incident. The separated hydrocarbons could be recycled or sent to a suitable power station for disposal. This would include the development of better booms and skimmers that work under a wide range of sea states etc.

2) Technologies made of easily recyclable materials that are then actually recycled. For example, boom materials made of soft recyclable absorbant poly-carbonate plastics in the BP Gulf oil spill were removed and separated from hard booms by (Heritage Environmental) the soft materials where centrifuged clean and the hydrocarbon waste then handled separately (Mobile Fluid Recover), the plastic was melted and densified (Lucent polymers), and then utilized by supplier of General Motors for making plastic components for the Chevy Volt.
3) Made of environmentally low impact (green) absorbent materials such and peat moss or other natural absorbants and then disposed of in such a way as to not further impact the environment such as would occur if partially hydrocarbon contaminated materials were either land-filled, openly burnt, or even incinerated. For example, could purposefully (applied absorbants) and accidentally (wetland derived materials) contaminated natural materials also be mostly centrifuged clean the hydrocarbons recovered and then all the materials either recycled or burnt in a power station with an advanced scrubber system thus generating some power while being disposed of greenly?

Examples from other research themes Include

- The table on ecological systems effects (p.30) states one decision context is "What remediation options have minimal impact on coastal and inland ecosystems? " The SAB believes that this decision context should have language added so it is clear that minimal impact occurs through the end of life, that is, "What remediation options have minimal impact on coastal and inland ecosystems over the life cycle of the remediation option (through use and end of life).

- There is lots of language in the Technologies Development section is focused on end of life issues of what do to with spent absorbents. However, the language used in the report does not use proper life cycle thinking terminology, which would incorporate wording of determining environmental impact at the end of life.

- Page 43, Innovative Processes and Technologies Development states "In consideration of the physical/chemical treatment approaches, a lifecycle assessment will be conducted including the materials, effectiveness of treatment, by-product management, and ultimate disposition." This life cycle assessment should also look at ecosystem impact during the use phase of the approach; i.e., does use of the approach result in greater harm to ecosystems. On page 46, there is a longer description related to "Research to design innovative and more benign (green) approaches to address oil spill mitigation and remediation "I think this statement needs to clearly state environmental impact on existing ecosystems that are impacted during the operation and use life state. (Research to design innovative and more benign (green) approaches to address oil spill mitigation and remediation over the complete life cycle).

A Possible Event Management based Strategy

The Oil Spill Research Strategy's general philosophy for remediation and restoration process is to strive for more environmentally low impact for the project described in the Innovative Processes and Technology Section. However the project areas descriptions section of the Strategy are disjointed and could possibly be improved by restructuring the text into a more sequenced approach to identify the type of incident and the technological improvements that are required to meet this philosophy. This could also be in the form of a separate implementation plan or guideline that minimizes the both the spread of the pollution and the deleterious impacts and cost of the clean-up efforts. An example, of an event management based approach is provided in Appendix 2. This example describes five stages of oil spill response, the integration of among agencies, and response question that should be considered in each stage

3.3.4 Human Health Impacts

As a general comment, it appears from this section that much of the human health-related research regarding the Gulf Oil Spill will be conducted by federal agencies other than the EPA. The Strategy principally identifies National Institute of Environmental Health Sciences (NIEHS) and National Toxicology Program (NTP), but also National Institute of Occupational Safety and Health (NIOSH), Substance Abuse and Mental Health Services Administration (SAMSHA), and Centers of Disease Control and Prevention (CDC). Coordination of research with federal partners is strongly encouraged by the SAB as a means for the EPA to access a broad array of expertise and share costs to mutual benefit. However, the way that the collaborating is addressed in the write-up of this section makes review of the proposed research strategy challenging. As written, it is often difficult to determine which federal agency is charged with conducting the research in each of the described areas, as well as the level of commitment of the federal partners to complete their portions of the research. Language such as "The NTP *is considering* further toxicology studies in three main areas …" and "NTP *will likely* lead research on oil, dispersants, oil-dispersant mixtures and combustions from oil burning." [emphasis added] contributes to an uneasy ambiguity pervasive in this entire section. The EPA has definitive information needs in all of the research areas presented. However, it is not clear whether the research objectives of the EPA and its federal research partners are entirely congruous, and as a result, whether research by the partners, even if completed, will fully satisfy EPA's needs. It is also unclear in the document what would happen if partners decided not to pursue some or all of their portion of described research, for example due to changing budget priorities within their agency. Would EPA assume responsibility for that research or would it be dropped from the research strategy?

These problems could be largely eliminated if the document narrative focused first and foremost on human health impact research needs from the EPA perspective, expanding upon the key questions posed in the summary tables derived from the process depicted in Figure 5-1. This should result in a clearer, more coherent description of the research strategy in this area. Planned collaborative research by partner agencies that could meet some of the EPA research objectives is certainly worth mentioning, but as a secondary point at the end of the discussion of each research topic, as appropriate.

3a. Do the science questions address key issues that can improve future oil spill prevention and response activities? Please identify additional high priority issues or science questions that should be addressed.

The science questions presented address key issues that can improve future oil spill response activities. Research to improve prevention of oil spills was not included in this section. Several high priority science questions are missing from this section in the following areas:

Estimating Cancer Risk

The oil spills contain carcinogens such as polycyclic aromatic hydrocarbons (PAHs), and many of the decisions about acceptable limits of exposure EPA needs to make are based upon estimation of cancer risk. The cancer risk model used currently by EPA was developed primarily to assess excess cancer risk from lifetime exposure, whereas oil spill exposure scenarios are typically for much shorter periods of time. For example, the scenario contemplated by EPA in developing their risk-based criteria for oil exposure on gulf beaches assumes a total exposure duration of 90 hours for a child (www.epa.gov/bpspill/health-benchmarks.html). As a matter of expediency, cancer risks in situations of short-term or intermittent exposure are assumed to be reduced proportionally to the fraction of lifetime exposed, even though experimental evidence suggests that this may be not valid for most carcinogens (Halmes et al. , 2000)

The issue is not unique to oil spills – EPA is confronted with a variety of situations in which cancer risks must be estimated for individuals with short-term or intermittent exposure. Development of cancer risk models to accomplish this should be a high priority.

The most extreme case of short-term exposure is a single event. Although there is a general reluctance to consider, let alone quantify, cancer risk arising from a single event, there is a substantial literature demonstrating the production of skin cancer in mice from a single application of a PAH, raising the question of whether there are some limited duration, high-exposure scenarios associated with oil spills that might lead to elevated skin cancer risk. In order to answer that question, sound potency estimates for skin cancer [specifically] from short duration dermal contact with PAHs are needed.

Exposure Assessment

The only well-defined area of research related to exposure in this section relates to improvements in monitoring air pollutants related to the DWH spill. There are other key questions that are missing. With respect to water exposure, for a swimmer, the "risk driver" is most likely to be cancer risk from dermal contact with PAHs. The current EPA model for dermal absorption of chemicals has difficulty with PAHs because they lie outside the "effective prediction domain." As a result, the Agency has been thus far unable to develop risk-based criteria for PAHs for swimmers, and human health benchmarks for PAHs remain "under development" (www.epa.gov/bpspill/health-benchmarks.html). There is brief mention of dermal bioavailability research to be conducted by NTP, but specifics, or even mention of which chemicals from oil would be addressed are missing, so it is impossible to determine from the strategy whether planned research would address this key issue.

A related issue with respect to swimming and other potential recreational contact with water is that exposure assumptions such as frequency and duration, as well as incidental ingestion rate of water, are largely guesswork. Exposure assumptions currently are based upon professional judgment rather than data. A similar observation can be made for exposure assessment as it pertains to beach sand/sediment. Population data on exposure frequency and duration for Gulf Coast visitors and residents, and measurements of dermal contact and incidental ingestion rates needed to derive risk-based criteria for protection of human health, are absent.

Consumption of Gulf seafood is another logical potential pathway of exposure. Current information regarding seafood consumption patterns, particularly by Gulf Coast communities with high or subsistence consumption rates is needed.

Risk Communication

This area is ostensibly included, but is not. There is a section on risk communication in the human health section, but it describes the need for better communication rather than actual risk communication research. Research in this area should be considered a priority, because how the information is presented may have effects on how communities perceive their risk. There has been research conducted in risk communication by Department of Homeland Security (not specifically on oil spills but on how to handle communication during a crisis). EPA should explore the efforts of DHS in this area and select components that may be useful here.

Environmental Justice

Similarly, the issue of environmental justice is not mentioned at all, though many communities affected by oil spills in the past, including those affected by the DWH spill, are environmental justice communities. There are two large social/behavioral studies being conducted by CDC and SAMHSA (as described on page 53). While there is not a lot of detail provided about these two interesting studies, it would appear that, some aspects of environmental justice could be incorporated, depending upon the populations being targeted here. It is good to see social/behavioral research included in this document. Some effort should be made to ensure that environmental justice topics are covered within both studies.

3b. Should any of the science questions be deleted based on sufficient existing knowledge, low impact on decision-making, or for other reasons?

The section on risk communication as an activity should be deleted and the section re-focused on risk communication research (as discussed above). The problem formulation section discusses three objectives of the EPA research grants program. Presumably, this is referring to the current Science to Achieve Results Request for Proposals. The three objectives are: 1) development of innovative mitigation technologies; 2) development of effective chemical dispersants, and 3) understanding ecosystem impacts. These are important research objectives, but are not germane to the human health impacts section. They should be moved elsewhere in the document.

3c. Are the proposed project areas described adequately to design research projects to achieve the anticipated outcomes? Please identify any project areas that should be refined or important project areas that should be added.

Many of the key science questions and associated questions are rather general, and it is unclear how studies might be designed to address them. For example, one of key science questions is “What model toxicology systems should be used to evaluate oil spill dispersion?” and the corresponding anticipated outcome is “Identification of the key health effects of these mixtures in model systems will provide information on what health effects such mixtures might cause in humans.” The accompanying narrative text is not particularly helpful in describing how projects could be created to answer the specific question – what model systems should be used for toxicology studies of oil and dispersants?

Further, description of proposed research projects is sufficiently vague that their potential contribution to evaluation of human health impacts is difficult to judge. For example, CDC and SAMHSA received $13M from BP to conduct behavioral health studies (p. 53). Is it all for workers (CDC is specifically for works but does not indicate population for SAMHSA study). Another example is on page 55. Is there a research project designed to look at children and fetuses? This is the first mention of these vulnerable populations. No agency is identified. Is this a project or an idea being considered/developed? In general, the topic of community epidemiological studies and susceptible populations are mentioned but there do not appear to be any definitive efforts planned to study them.

Several important project areas could be added (see also response to a., above). Risk communication research is particularly important. It is stated in the document that more risk communication *research* is needed, but that is not what is described on in this section pages 60-61. While is important to conduct better risk communication, the means of determining what is “better” is through research. As mentioned earlier, considering what other agencies have done in this area – DHS in communicating risk during a crisis – would be helpful. A description of the DHS work and any additional work being planned or considered by EPA should be included. The section describes developing an effective communication plan, which is a good thing, but that is different from conducting research in risk communication. In defining "risk communication," topics in risk perception and behavior should be included. Some of these issues may be incorporated into the discussion of the social/behavioral studies being conducted by CDC and SAMHSA as discussed on page 52 of the Strategy.

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Appendix A: EPA's Charge to the Oil Spill Research Strategy Review Panel

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460
OFFICE OF RESEARCH AND DEVELOPMENT

March 25, 2011
MEMORANDUM

SUBJECT: Request for review of the *Draft Oil Spill Research Strategy*

FROM: Cynthia Sonich-Mullin, ORD Coordinator for the BP Spill,
Deputy Director for Management /**Signed**/
National Homeland Security Research Center

TO: Thomas Carpenter, Designated Federal Officer
EPA Science Advisory Board Staff (1400R)

This memorandum requests that the Science Advisory Board (SAB) review and comment on the EPA Office of Research and Development's (ORD) *Draft Oil Spill Research Strategy* dated January 12, 2011. The purpose of the draft strategy is to describe a comprehensive research program that would enable EPA to continually improve in meeting its mission to prepare for and respond to oil spills.

Background

EPA has authority and regulatory responsibility for multiple aspects of preparing for, preventing, and responding to spills of petroleum and other oils under several laws and regulations. One major EPA responsibility is stipulated in the Oil Pollution Prevention regulations (40 CFR part 112), requiring onshore and offshore non-transportation related facilities to have spill prevention, control, and countermeasure (SPCC) plans and facility response plans, where applicable. Another major regulation, the National Oil and Hazardous Substances Pollution Contingency Plan (40 CFR part 300), covers responses to oil releases and assigns primary response roles to EPA (generally for inland zone discharges) and the Coast Guard (generally for coastal zone discharges). The Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE, formerly Minerals Management Service) is generally responsible for operations on the outer continental shelf.

The Oil Pollution Act of 1990 (OPA 1990; 33USC2701-2761) was passed in the wake of the Exxon Valdez spill to establish, among other things, liability for releases and a fund for responding to oil releases as well as restoring natural resources. Section 2761 of OPA

1990 authorizes research and development (R&D) in multiple federal agencies, establishes the Interagency Coordinating Committee on Oil Pollution Research (ICCOPR; www.iccopr.uscg.gov), and authorizes up to $22 million per year among the federal agencies subject to appropriation. ICCOPR published multi-agency research and technology plans in 1992 and 1997 and is presently developing a third update. The research focus of each agency in the 1997 plan generally aligns with its legal and regulatory authorities, although in some cases, OPA 1990 assigns particular R&D roles to specific agencies.

Prompted by the Deepwater Horizon spill in the Gulf of Mexico and its aftermath, ORD assembled a team to develop a draft research strategy that would comprehensively address the scientific and technical questions that could enhance EPA's ability to carry out its mission with respect to oil spills both in the short- and longer-term. The draft strategy is framed to identify (1) anticipated decisions that spill responders and policy developers will be required to make; (2) science questions within those identified decisions; (3) research that would address the science questions; and (4) research outcomes that can be used to inform future decisions. The draft strategy is structured to address four themes: dispersants; ecological effects; innovative processes and technologies; and human health effects. Research priorities that are principally the responsibility of other agencies are not included in this draft strategy, but will be fully considered in ICCOPR planning (see Figure 1-2 in the draft strategy).

The draft strategy is deliberately not constrained by resource levels. Our intent was to develop a strategy that would address the scientific and technical questions that are central to EPA's mission, recognizing that the research could be conducted by various members of the ICCOPR, researchers funded by BP, and others. Implementation of the strategy would entail coordination with those entities to ensure appropriate collaboration and leveraging.

Specific Request

ORD requests that the SAB comment on the scope, proposed science questions, research activities, and research outcomes outlined in the *Draft Oil Spill Research Strategy*. Comments from the SAB will be considered during the development of the final strategy document.

We appreciate the efforts of the SAB to prepare for the upcoming review of the *Draft Oil Spill Research Strategy*, and we look forward to discussing the plan in detail on April 11-12, 2011. Questions regarding the enclosed materials should be directed to Patricia Erickson at erickson.patricia@epa.gov or 513-569-7406.

Charge Questions

1. Does the draft Oil Spill Research Strategy encompass the most important research needed to enable EPA to better carry out its mission to prepare for and respond to oil spills, including future challenges such as biofuels discharges? Does the draft strategy appropriately address greener alternatives and innovation?

2. Is the research strategy organized appropriately to frame the questions in a comprehensible manner and to foster collaboration with outside entities as appropriate? If not, how can it be better organized?
3. Within each of the research themes:
   a. Do the science questions address key issues that can improve future oil spill prevention and response activities? Please identify additional high priority issues or science questions that should be addressed.
   b. Should any of the science questions be deleted based on sufficient existing knowledge, low impact on decision-making, or for other reasons?
   c. Are the proposed project areas described adequately to design research projects to achieve the anticipated outcomes? Please identify any project areas that should be refined or important project areas that should be added.

Attachment: *Draft Oil Spill Research Strategy*

Appendix B: Event-based Research Strategy Research Areas

Research areas to be addressed in for the Oil Spill Research Strategy

- Include benthos and polar regions
- Broaden scope to consider all chemical treatment agents (CTA)
- When assessing dispersants/chemical treatment agents, consider them in conjunction with oil
- Assess CTA effectiveness, toxicity independently, that of oil independently, and the resulting complex mixture
- Include transport, fate and effects in studies
- Include sublethal, chronic and indirect toxic reactions
- For toxicity studies, consider most sensitive life stages of standard test species as well as native species in areas of interest without regard for their economic importance
- Consider using modeling to facilitate and confirm tests
- Work on defining *efficacy*
- Include bioavailability when assessing CTA effects
- Weathered and fresh oils should be used in studies
- A range of oils should be used for assessing CTA
- A spectrum of environmental variables (salinity, UV, energy, temperature, etc.) should also be considered in testing
- Consider toxicity testing with metrics that can be translated across a range of taxa
- Time of CTA use is another variable to be considered, as well as the volumes in relation to that of oil
- How do the CTA function with biofuels?
- How is biodegradation affected with CTA?

Appendix C: A Possible Event Management Based Strategy

Although the general philosophy of making the whole cleanup process more environmentally low impact seems a good way to go the format of the Technology Section was a little choppy and could possibly be improved by restructuring of the text into a more sequenced approach to this type of incident and the technological improvements that are required to meet this strategy. This could also be in the form of a separate implementation plan or guideline that minimizes the both the spread of the pollution and the deleterious impacts and cost of the clean-up efforts. Presumably, the EPA would be coordinating with a wide range of other parties in the implementation efforts. It is assumed here that basic pre-event monitoring is being undertaken to provide relevant base-line data. This data needs to be defined and relevant cost effective monitoring strategies developed (see above). The EPA's integration with other agencies needs to be highly streamlined because too many issues are highly crosscutting. Indeed, the whole event response needs to be integrated across different governmental agencies, the hydrocarbon industry, other outside research organizations and interest groups, and environmental and recycling industries. It would also be helpful to have a summary available and referenced of the lessons learned in the last year since the DWH (Deep Water Horizon) incident. Some examples are given in this text but they are hardly an exhaustive summary.

Stage 1- Primary Close to Source Containment and Mitigation. For deep-water blowouts, the primary and most cost effective defense is preventing and containing the sources of the trouble before the hydrocarbons disperse and cover large areas of Open Ocean and coastline. Under ice this may be the only practical way to mitigate problems. While beyond the direct mandate of the EPA it seems clear that, excellent well management practices need to be followed and regulated, the blow out preventer operation must be greatly improved under all likely adverse conditions and their correct installation monitored (one report by a Norwegian concern suggests the type utilized in the Gulf Horizon well only works 45% of the time), and that the BOP and sub-sea collector systems over the well or other surrounding blow-out regions should be dove tailed to facilitate rapid deployment. Can, for example, the BOPs be designed so the well can be temporally or permanently capped, the hydrocarbon plume be physically contained, collected, and processed in an environmentally/economically sensitive way within days of the initial event?

It is also possible that the immediate problem will spread beyond the local wellhead area. As one example of a worse case example, what happens if the blowout breaks the geological formations around the well, resulting in a totally unconstrained blow out and a long-term distributed leak system over approximately 2 kilometers of seabed? In such an event a successful relief well would presumably eventually stop the blow out. Usually this works with one relief well, but it takes a long time. For the Macondo prospect or

Gulf Horizon well, the relief well was nearly ready when it appeared to be better to cap the well at the subsea wellhead. A second well was underway in case the first relief well failed.

Stage 2- Near Event Containment and Mechanical Skimming- Very large regions of ocean surface (100's km2) and ultimately shoreline became contaminated during the US Gulf event. If primary subsea containment at the wellhead is not immediately effective can secondary physical containment and physical removal at the surface where most hydrocarbons rise to be made more effective to minimize contaminant spread. For example, if boom placement or operation was not optimal, why not? How much oil reached the surface outside the booms? Not enough booms soon enough, or plenty of booms but not good information where to put them? Could a combination of oceanographic and contaminant plume monitoring and modeling allow the initial ocean surface impact region (initially probably only in the region of a few10s km^2 or less) to be predicted based on ocean current and weather conditions and then more effectively physically contained. Is this, when combined with improved physical skimming and almost total removal of the oil, the most cost effective and environmentally safe methods when compared to the utilization of dispersants? Is an improved skimmer system like that promoted by "Kevin Costner" a way to go?

In addition, how much oil that reached the water surface went through/under booms? Were there gaps in booms through which surface oil escaped? If oil goes under or round booms, can the boom design be modified to make them more effective and gaps eliminated even under poor sea state and weather conditions?

Deep-water plumes- How dangerous are deep-water plumes and are they associated with the generation of oxygen depleted dead zones? – A deep plume of certain volatile components seems to have existed in the DWH incident but do they need special attention, monitoring and mitigation? How are they generated (i.e. are solubility effects or are dispersants involved?)? If they are a result of dispersants? Without dispersants, do more pollutants that are volatile make it to the water surface where they can be dealt with or naturally broken down? How are deep-water plumes to be dealt with if they are dangerous and not generated by dispersants? Dead zones already occur in the US Gulf due to other factors such as eutrophication and resulting anoxia. Would adding oxygen and further nutrients to a Gulf type system help or make things worse? Again, this presumably would be a multi agency endeavor (EPA, NOA, Coast Guard).

Stage 3 –Poorly confined hydrocarbon open water mitigation of hydrocarbons (i.e. dispersants skimmers, absorptive materials etc.). In the unlikely event that the near event containment strategy is 100% successful then existing and improved technologies will have to be applied over large open regions of water before the pollution hits the coastline regions. Once again, improved monitoring can play a role in managing and observing the pollutants distribution and the efficacy of the different mitigation methods such as the application of dispersants. Can advanced techniques such as spectral analysis for surface hydrocarbon distributions and composition play a role? Under these conditions there may be an important tradeoff between improving aerial coverage and effectiveness for mechanical skimmers and the utilization of safer dispersants etc.

Stage 4 – Shore, wetland and estuary and clean up strategies. A clearer description of the current methods and potential areas where the most improvements are thought to be easily made would be helpful. Is it just the utilization of low impact green materials that is the main areas of improvement? In lagoons and estuaries is there a problem with partially degraded oil deposits on the seabed or is it just removal from beaches and wetlands that needs to be addressed? Would adding nutrients to a US Gulf type coastal system help or harm a system already suffering from eutrophication and anoxia.

Are booms effective enough in near shore environments and if not can they be made more effective, is the building of temporary sand berms to exclude oil from wetlands a simple cost effective and environmentally sensitive method? Generally sorbents and solidifiers relying on “natural materials” sounds good but historical issues regarding preferential rates of biodegradation and oxygen consumption reduce the practicality of these resources (applies to open water as well as costal applications); some of the wording in the “green technologies” section needs to be spread throughout document in describing needed work in all technology areas, not just dispersants.

Is the physical/chemical removal of oil from solids/equipment (perhaps even soils ?) a way to go? It is possible to utilize steam or supercritical H_2O to clean things very well but it gets expensive. Could you centrifuge soils, sand and wetland materials to get the hydrocarbons out and then replace the materials back where they came from.

Stage 5 – Post-event natural system restoration and recovery strategies and associated monitoring. This is a whole ball of wax in itself but certainly the US Gulf has suffered both physically over the years with coastal wetland destruction (partially associate with sediment supply issues) as well as biological network destruction/degradation on and offshore. Restoration is going to have to focus on the system as a whole in an integrated way and efficient monitoring will have to be in place to evaluate the effectiveness of such efforts.

In addition, could relatively energy efficient methods such as increasing sediment supply from the Mississippi River (which due to canalization now ends up in deep water) help rebuild wetland and marsh habitats with little human intervention other than sediment diversion in the delta region?