Water Column Injury Ephemeral Data Collections:
Deepwater Horizon Oil Spill (DWHOS)

Plan for Adaptive Water Column NOAA-NRDA Sampling (PAWNNS)
Cruise Plan – Hos Davis 1

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Proposed Cruise Dates:

Hos Davis 1 – August 11-21, 2010

Background/Justification

To date there have been significant efforts by both response and damage assessment in the immediate area around the Deepwater Horizon wellhead at MC252 to characterize temporal changes in the spatial extent of oil released as a result of the DWHOS. These efforts have been invaluable for near-field detection of submerged hydrocarbons with heavy reliance on discrete techniques to determine water column concentrations. The need for more synoptic continuous sampling techniques able to provide a clearer overall picture is recognized, but ground-truthing of instrumentation for this purpose has not been completed in enough detail to determine what specific instruments are most appropriate to the task.

This pre-assessment NRDA-focused sampling plan is being conducted in coordination with a Response-focused effort. The fundamental tenet of the overall effort, multi-vessel coordination for concerted sampling efforts to improve spatial and temporal understanding of oil distribution, provides information useful in the evaluating the impact to the ecosystem in and around the spill site. The Response and NRDA sampling teams have been working together to maximize cooperation and minimize conflicts.

The key aspects of collaboration are:

- Data management protocols
- Scheduling and personnel
- Methods development
- Situational awareness

Aspects unique to this NRDA-focused Adaptive Sampling Strategy Plan include:

- Informing specific needs of the damage assessment
- Adaptive sampling strategy using multiple informational sources for location selection
- Variable reoccupation of sampling locations

This plan is another in a series of cruises conducted with an adaptive sampling strategy. The goals of the cruise described herein, as part of the overall Adaptive Sampling Strategy Plan, are to:

1. develop and employ sampling protocols for various continuous sampling instruments in characterizing and measuring oil droplet sizes and numerical densities of particulates (oil, detritus, marine snow, plankton);
2. characterize signals identified by acoustics and fluorescence measurements;
3. obtain data on oil droplet size, water chemistry (oil and dissolved hydrocarbon concentrations), and other particulate (detritus, marine snow, plankton) densities.

Approach: Adaptive Sampling Strategy

Sampling is focused on specific areas and times where subsurface oil would be expected to occur. We have designed an adaptive focused sampling strategy, targeting particular portions of the water column and in areas where oil is detected by indirect sensors or expected based on transport modeling using measured and/or predicted circulation patterns and an understanding of oil transport. Sampling efforts are expected to extend 30-100 nmiles to the SW of the wellhead. Figure 1 shows a modeled distribution of a 30,000 bbl/day release from the well from 3 June to 15 July, sampled on 2 August. Currents used for the simulation are based on the real-time data obtained from ADCPs in the area.

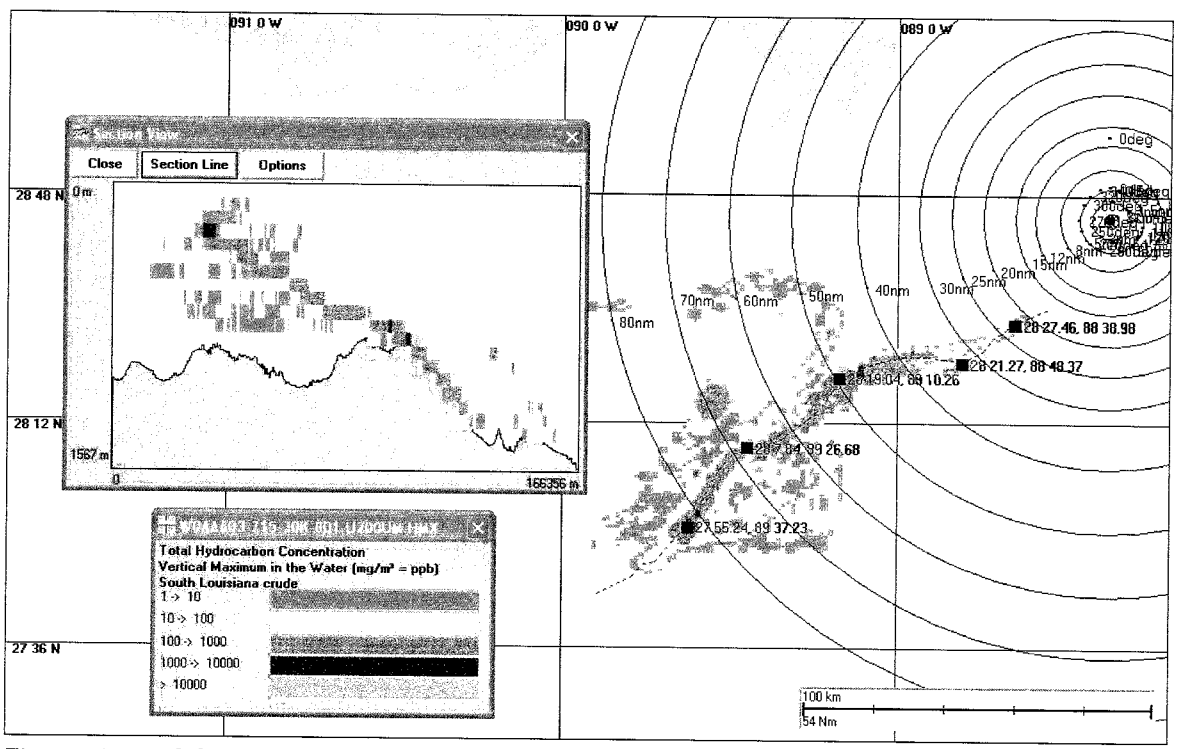

Figure 1. Modeled distribution of a 30,000 bbl/day release from the well from 3 June to 15 July, model output on 2 August.

In situ sensors, such as fluorometers and acoustic techniques identified as capable of detecting subsurface oil at some detection level (concentration threshold) and distance, will be used to

provide information for selecting sampling stations and depths. The following categories of data will be collected by direct sampling and measurements:

- Lagrangian float-based transport of water masses identified as containing dispersed hydrocarbons;
- CTD for salinity, temperature and water density, dissolved oxygen;
- Fluorescence measurements using sensors calibrated for oil;
- Oil droplet size distributions and concentrations (total petroleum hydrocarbons);
- Concentrations of insoluble and semi-soluble hydrocarbons in oil droplets (each filtered sample measured for saturated hydrocarbons and PAHs);
- Whole water samples for measurement of the following chemicals in accordance with the NOAA Analytical Quality Assurance Plan (QAP, provided as an attachment):
    - Extended PAH (parent plus alkylated PAHs)
    - BTEX
    - TPH
    - VOA, TSS, CHN
- High volume (target volume is 20 liters) water samples passed through a filtration system that consists of a vortex separator that captures particles greater than 10 μm in size, a 0.45 μm filter, and finally a polyurethane foam (PUF) cartridge. All fractions are analyzed for extended PAHs. The material collected in the separator is analyzed with the 0.45 μm filter residue as a measure of the fraction associated with particulates as well as semi-soluble hydrocarbons in oil droplets. The filtrate material measured on the PUF cartridge represents the dissolved hydrocarbon fraction.
- Water samples will also be collected for analytical chemistry: PAH (complete suite), BTEX, and TPH using the Portable Large Volume Water Sampling System (PLVWSS) (Payne et al., 1999) to separate the particulate/oil phase trapped on a 0.7 μm glass fiber filter and capture the dissolved phase (filtrate) in 3.8 L (1 gal) I-Chem Certified Clean amber glass jugs.

It is envisioned that the following framework will be implemented over the course of several two-week cycles. The first cruise (American Diver 1) tested some of the equipment and approach proposed for the larger Adaptive Sampling Strategy Plan. Analysis of in-situ data during and between cruise deployments will determine the need for additional sampling efforts or any modifications required to increase the value of the data. The overall goal is to perform adaptive sampling through the near real-time integration of in-situ instrumentation with discrete water sampling and ground-truth measurements. Attachments 1-8 describe the equipment and instrumentation to be deployed during the series of cruises encompassing the Adaptive Sampling Strategy Plan.

Overall Objective for the Adaptive Sampling Cruises

Apply in-situ methods to characterize subsurface oil at and beyond the area of the MC 252 wellhead.

The end products of this effort will address the following issues related to the DWHOS:

1. provide hydrocarbon concentration, particle distribution and droplet size data to inform oil fate and transport models for the near-field area;
2. Context for longer-term modeling, including biological and nearshore impacts.

Methodology

We will characterize subsurface oil by deploying multiple specialized assets outfitted to work in tandem. We will conduct casts both within the area of subsurface oil, and outside of it, utilizing an adaptive cruise plan that will be guided by data collected from in-situ instrumentation, as well as oil transport modeling, to sample a range of areas where oil is predicted to exist. Sites will be chosen based on available data (i.e. currents profiles), modeling results, and onboard detection of potential targets. The number of stations sampled will be determined by the extent of the area to be sampled, rate of sampling and available crew hours. It is anticipated that one station per day will be sampled, with approximately 8 stations sampled over the 8 operational days (2 days travel). Stations will be spaced approximately equally along the primary axis (or trajectory) of the model projection with the first station located at approximately 30 nm from the incident site and the final station located approximately 90-100 nm from the incident site (Figure 1). Additional stations using CTD and fluorescence, which may be more rapidly sampled than where water samples are taken, will be used to located subsurface oil and focus further sampling efforts.

Adaptive sampling efforts will be directed based on the following data sources and analyses which indicate the possible presence of subsurface oil:

1. Onboard analysis of in-situ instrument results and discrete sample data from previous sampling and real-time sensors;
2. External acoustics data acquired aboard other vessels (e.g. NOAA response fleet, M/V *Nick Skansi,* if available); and
3. Real-time ADCP current data and oil transport modeling utilizing these data.

At each sample station, the instrument array will be deployed to determine the physical, chemical and biological characteristics of the area. The fluorometer (see description below) will be used to test for positive readings for submerged oil at depth. If the fluorometer does not indicate subsurface dispersed oil, then the sampling location will be shifted up to ~500m outward along the primary axis of the projection and the vertical cast of the fluorometer repeated. This process will be repeated until a positive signal indicating oil on the fluorometer is achieved or a decision is made to move to another primary axis of projection. If a positive signal is acquired, the remaining instruments will be deployed. Up to 8 discrete samples will be collected in the vertical profile with the guidance of diagnostic fluorescence measurements and imaging instruments. These samples will be taken to determine the concentrations of chemical components.

HOS Davis 1 Instrumentation

The Hos Davis is being mobilized for approximately 10 days with a departure date of August 9, 2010. Only day-time operations are planned. For this cruise, the Hos Davis will be outfitted with the following instrumentation complement using methods described here and in appendices noted:

CTD: We will deploy a Seabird CTD profiling package, which can be deployed to a depth of 6000 meters to collect dissolved oxygen, and salinity, temperature, and depth information.

ROV: An ROV will be used to perform vertical profiling and sampling at targeted depths in the water column (See Attachment 6).

Acoustic Instruments: Under direction of Yong Kim (ASA), we will deploy the Acoustic Backscatter Sensor (ABS) in vertical profiles to approximately 1700 m or to near the sea floor. The ABS employs high-frequency (1-5 mHz) acoustic backscatterance to detect and measure concentrations of small particulates, such as suspended sediments and oil droplets. We will test the use of such techniques for detecting the subsurface oil in situ (See Attachment 2).

Image-forming Optical Instruments: A LISST-DEEP will be used to survey the distribution of oil droplets in situ. We will deploy the sensor in vertical profiles on the CTD or on the ROV along-side the ABS. The internal memory card records the data for downloading and processing once onboard. See Attachment 4 for a description of the instrument and specifications.

Fluorometers: The Turner Cyclops fluorometer (Attachment 5) and the Chelsea Aquatracka (Attachment 1) can be used in profiling mode (to full ocean depth), to detect fluorescence from submerged oil and/or dissolved components.

Discrete Water Sampling: Samples will be taken to test for the presence of oil and dissolved hydrocarbon components. Water samples at depth will be taken with a rosette sampler that can collect multiple samples at various depths and also collect a large enough sample for chemical analysis. Alternatively, samples will be taken by bottles attached to the ROV. Water samples will be collected for analytical chemistry: PAH (complete suite), BTEX, and TPH using the Portable Large Volume Water Sampling System (PLVWSS) (Payne et al., 1999) to separate the particulate/oil phase trapped on a 0.7 μm glass fiber filter and capture the dissolved phase (filtrate) in 3.8 L (1 gal) I-Chem Certified Clean amber glass jugs. The sampling methodology for discrete water sampling for these parameters will follow procedures outlined in Attachments 9, 10 and 11.

As a methods comparison, water samples also will be filtered at 10% of the stations using the High Volume Filtering technique which employs a coupled with a polyurethane foam (PUF) cartridge and a vortex separator (Attachment 8). In summary, the high volume (target volume is 20 liters) water samples are passed through a filtration system that consists of a vortex separator that captures particles greater than 10 μm in size, a 0.45 μm filter, and finally a polyurethane foam (PUF) cartridge. All fractions are analyzed for extended PAHs. The material collected in the separator is analyzed with the 0.45 μm filter residue as a measure of the fraction associated with particulates, as well as semi-soluble hydrocarbons in oil droplets. The filtrate material measured on the PUF cartridge represents the dissolved hydrocarbon fraction.

Lagrangian Floats: The Webb Research Corporation APEX float is an autonomous drifting profiler used to measure subsurface currents and make profile measurements. Two such Lagrangian floats will be deployed to track the movement of water identified as being in the submerged oil plume. The location

for the deployment of these floats will be determined based on fluorometer signal readings during vertical casts. The float contains a CTD, which profiles the water column during descent and ascent. We will attach CDOM fluorometers (as available by cruise time) to the floats to track the presence of a fluorescence signal indicative of oil. Floats will be deployed for 2 days, then retrieved and data stored on the CTD and fluorometer will be retrieved. (See Attachment 3).

Radiometer: UV light measurements will be taken using the BioOPS profiling reflectance radiometer supplied by Biospherical Instruments (BSI). Vertical profiles from 0 to 5 m will be made in daytime (see Attachment 7).

Sampling Plan for the Hos Davis Cruise 1

Sampling data will be collected at stations placed in, and surrounding, areas thought to have deepwater and surfacing water masses containing oil released from the incident site. The design will be to sample down-current from the source. The locations will be focused in areas identified by:

A. The cumulative down-current direction (over time), as indicated by transport modeling using the current data measured at the DeepDriller III ADCP, the ADCP array deployed at 3 nmiles west of the Wellhead, and other ADCPs in nearby areas. Transport modeling will include rising speeds using modified Stokes Law for assumed droplet size distributions based on measured and estimated droplet sizes.
B. Targets identified with CTD, DO, and/or fluorescence measurements, both on the cruise and from other vessels (at time or in previous cruises). For example, fluorescence profiles and other sensors have indicated the presence of oil between 1100 and 1400 m, which is consistent with modeling results using the approach outlined in bullet A above.
C. Targets identified with various acoustical techniques, both on the cruise (high frequency) and from other vessels (as available).

If oil is released at the source at any time, in view of the 2-km exclusion zone and 5-nmile safety zone imposed by the Incident Command Response Group (ICRG), the sampling stations will involve locations between the 2-km and 5-nmile circles, as well as locations outside the 5-nmile circle. Sampling of the freshly-rising oil (if present) plume will be focused near the 2-km circle in the down-stream direction unless currents are strong at the time of sampling (in which case sampling will also be performed further from the well). Otherwise, and when no oil is being released from the source, sampling will focus on locations outside the 5-nmile circle in areas identified as containing oil (see Figure 1).

Personnel for American Diver

7 NOAA contractors:

Dr. Yong Kim (ASA), Chief Scientist
Dr. Theodore Kanellopoulos (LISST technician)
Acoustics (ABS) technician: Steve Shuttles (Green Eyes Observing)
2 NOAA Water Samplers: Kevin Cranna (Dade Moeller) and Sean Leatham (Dial Cordy)
1 NOAA CTD technician: Audra Burchfield (Dial Cordy)
1 NOAA Data Manager: Ahn Lee

3-4 ROV Technicians
1 CTD Technician (CSA)
1 Survey/Navigation technician (CSA)
2 ENTRIX employees
Boat Crew (Captain, mate, deck hands)

Vessel
Operations will be completed on the HOS Davis.

Estimated Costs:

HOS Davis Costs	Hrs/Days/Trips	Day/Hr Rate	Total
HOS M/V Davis Mobilization / Preparation	1	$189,200	$189,200
CSA Labor	[redacted]	[redacted]	$107,800
Welding / Materials estimated	1	$74,800	$74,800
CSA Lease Equipment	1	$9,900	$9,900
Mako ROV Preparation	1	$70,400	$70,400
Other Leased Equipment	1	$36,300	$36,300
Other Direct Costs	1	$19,250	$19,250
Total			**$507,650**
Field Survey Costs	**Hrs/Days/Trips**	**Day/Hr Rate**	**Total**
HOS M/V Davis	12	$53,321	$639,857
NOAA Labor (days):			
Yong Kim	[redacted]	[redacted]	$24,000
CTD Technician	[redacted]	[redacted]	$24,000
ABS Technician	[redacted]	[redacted]	$12,000
LISST Technician	[redacted]	[redacted]	$18,000
Water Sampler	[redacted]	[redacted]	$12,000
Water Sampler	[redacted]	[redacted]	$12,000
Data Manager	[redacted]	[redacted]	$21,000
Entrix Labor (days):			
Integral	[redacted]	[redacted]	$14,501
Entrix	[redacted]	[redacted]	$12,211
Misc Costs Sample Handling	1	$11,000	$11,000
Equipment Purchases			
Apex Drifters	1	$45,401	$45,401
Turner Cyclops 7 Fluorometers (2000m)	1	$55,534	$55,534
Travel	1	$20,000	$20,000
Total			**$921,504**
TOTAL			**$1,429,154**

Days/Trips based on 1/dy Mob, 10dys Fid, 1dy demob
Labor is estimated cost and hours
Fuel & Lube estimates included in day rate

Vessel Costs for standby not included
Standby costs for Equipment are not included

Budgeting

The Parties acknowledge that this budget is an estimate, and that actual costs may prove to be higher due to a number of potential factors. As soon as factors are identified that may increase the estimated cost, BP will be notified and a change order describing the nature and cause for the increase cost in addition to a revised budget for BP's consideration and review.

Safety Plans

BP's full operations and safety plan is attached as Attachment 14. In addition, the NOAA incident site safety plan (which all NOAA employees and contractors must sign prior to the cruise) is attached (Attachment 12).

Transfer of the shared electronic media in the onboard equipment to each of the party's hardware for retention and use.

Upon return to port, the vessel Operations Manager shall produce identical copies of the raw and processed electronic media generated during the cruise and deliver one of those copies each to NOAA (or its QA contractor) and to ENTRIX.

Laboratory

All VOC and water chemistry samples (filters and water samples) for PAH will be sent to Alpha Analytical Laboratories in Mansfield, MA. The RP may take additional unfiltered and toxicity water samples at selected locations, which are not part of the cooperative sampling. These samples will be sent to a laboratory of their choosing. ENTRIX will provide all related sampling supplies for their samples. Some of these unfiltered water samples may also be used for TSS/CHN, PAH/TPH, and dispersant analyses, and if completed, the data will be shared with NOAA and other trustees.

Distribution of Laboratory Results

Each laboratory shall simultaneously deliver raw data, including all necessary metadata, generated as part of this work plan as a Laboratory Analytical Data Package (LADP) to the trustee Data Management Team (DMT), the Louisiana Oil Spill Coordinator's Office (LOSCO) on behalf of the State of Louisiana and to ENTRIX (on behalf of BP). The electronic data deliverable (EDD) spreadsheet with pre-validated analytical results, which is a component of the complete LADP, will also be delivered to the secure FTP drop box maintained by the trustees' Data Management Team (DMT). Any preliminary data distributed to the DMT shall also be distributed to LOSCO and to ENTRIX. Thereafter, the DMT will validate and perform quality assurance/quality control (QA/QC) procedures on the LADP consistent with the authorized Quality Assurance Project Plan, after which time the validated/QA/QC'd data shall be made available to all trustees and ENTRIX. Any questions raised on the validated/QA/QC results shall be

handled per the procedures in the Quality Assurance Project Plan and the issue and results shall be distributed to all parties. In the interest of maintaining one consistent data set for use by all parties, only the validated/QA/QC'd data set released by the DMT shall be considered the consensus data set. The LADP shall not be released by the DMT, LOSCO, BP or ENTRIX prior to validation/QA/QC absent a showing of critical operational need. Should any party show a critical operational need for data prior to validation/QA/QC, any released data will be clearly marked "preliminary/unvalidated" and will be made available equally to all trustees and ENTRIX.

Reference:

Payne, J.R., T.J. Reilly, and D.P. French, "Fabrication of a Portable Large-volume Water Sampling System to Support Oil Spill NRDA Efforts," in *Proceedings of the 1999 Oil Spill Conference*, American Petroleum Institute, Washington, D.C., pp. 1179-1184, 1999.

Attachments:

Attachment 1. Chelsea Aquatracka Fluorometer
Attachment 2. Acoustic Backscattering Sensor (ABS)
Attachment 3. Lagrangian Floats
Attachment 4. LISST-DEEP
Attachment 5. Turner Cyclops Fluorometer
Attachment 6. ROV
Attachment 7. Radiometer
Attachment 8. Large Volume Method for analysis of organic compounds with low detection limits
Attachment 9. PLVWSS sampling protocols in support of NRDA Cruises_050510
Attachment 10. Quality Assurance Guidelines for NRDA Water Column Chemistry
Attachment 11. Water Sample Handling Procedures 2010-06-11_jrp
Attachment 12. NOAA-NRDA_MC_252_Site_Safety_Plan_5.13.10
Attachment 13. NRDA_Field_Sampler_Data_Management_Protocol_7_5_2010
Attachment 14. CSA-Davis HSE Plan Rev 005_Final
Attachment 15. MC252_Incident_SIMOPS_Plan_
Attachment 16. Transfer of Personnel and Material at Sea 070510
Attachment 17. MC252 HSSE Incident Reporting Final 02 May 10 rev 1
Attachment 18. MC252 Analytical QAP V2.1

Approvals

Approval of this work plan is for the purposes of obtaining data for the Natural Resource Damage Assessment. Parties each reserve its right to produce its own independent interpretation and analysis of any data collected pursuant to this work plan.

Joyce Meley	Joyce Miley	Aug 20, 2010
BP Representative	Name	Date
	Tom Moore	Aug 20, 2010
Federal Representative	Name	Date
FOR ROLAND GUIDRY	KAROLLEH DEBUSSCHERE	AUG. 25, 2010
Louisiana Representative	Name	Date