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.

for Rob Ricker

Federal Trustee Representative

Rob Ricker (NOAA)

Date 7/21/2010

BP Representative

NRDA Specialist

Date 7/20/2010

FOR KOLAMD GUIDRY

Louisiana Trustee Representative

Date
7/29/10

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

Plan for Adaptive Water Column NOAA-NRDA Sampling (PAWNNS)
Cruise Plan – American Diver 1 and Ocean Veritas 9

July 17, 2010

Prepared by: Deborah French-McCay, Jennifer Cragan, Eileen Graham (ASA)

Proposed Cruise Dates:

American Diver 1 – July 17-24, 2010

Ocean Veritas 9 – July 13-17, 2010

Background/Justification

To date there have been significant efforts by both response and damage assessment around the Deepwater Horizon wellhead at MC252 to characterize the spatial and temporal extent of oil released as a result of the Deepwater Horizon Incident. 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 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 potential impact to the ecosystem in and around the spill site. While there are discrete responsibilities and some limitations, the unique nature of this incident requires closer integration of the Response and Assessment. The respective 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 sampling plan include:

- Informing specific needs of the damage assessment

- Adaptive sampling strategy using multiple informational sources for location selection
- Variable reoccupation of sampling locations
- Concentrated effort in the near-field around the source (<20km)

This plan is for the first of a series of cruises to be conducted with a similar approach and adaptive sampling strategy. The goals of the two cruises described herein, American Diver 1 and Ocean Veritas 9, are to

1. develop and test 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 near-field 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 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. The focus of these efforts will be within 20 km of the wellhead.

In situ sensors, such as fluorometers and acoustic techniques identified as capable of detecting submerged 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:

- CTD for salinity, temperature and water density, dissolved oxygen, and fluorescence;
- 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);
- Concentrations of dissolved hydrocarbons (whole, unfiltered samples analyzed for BTEX plus alkyl benzenes and each individual filtrate measured for PAHs);
- Concentrations of suspended sediments and detritus (marine snow);
- Plankton concentrations (live and dead)
- Pyrosomes.

It is envisioned that the following framework will be implemented over the course of several two-week cycles. The first cruise (American Diver 1) will test 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 will be to augment the efforts outlined for this cruise with in-situ instrumentation on an additional boat to provide a more comprehensive adaptive sampling effort through the near real-time integration of in-situ instrumentation with discrete water sampling and ground-truth measurements.

Overall Objective for the American Diver 1 and Follow-on Cruises

Apply in-situ methods to a larger spatial and temporal domain than previously evaluated to continue to characterize and determine the distribution of subsurface oil at and beyond the immediate area of the MC 252 wellhead.

This will be accomplished by augmenting the vessels currently employed in Response (Brooks McCall, Ocean Veritas, discrete water column sampling efforts) with vessels specifically outfitted for broader spatial coverage and enhanced in-situ chemical and physical detection capabilities. Using a multi-disciplinary, multi-timescale approach, sampling efforts will be coordinated among vessels to provide information on timescales which are relevant to discrete sampling efforts (3-4 hours) to address long term modeling/assessment needs (days to months). The end products of this effort will address the following issues related to the Deepwater Horizon Incident:

1. provide data to better inform oil fate and transport models for the near-field area;
2. Near-term determination of biota exposed to dissolved and dispersed oil; and
3. Context for longer-term biological effects models.

Methodology

We will characterize and determine the distribution of subsurface oil at and beyond the immediate area of the wellhead by deploying multiple specialized assets outfitted to work in tandem. We will conduct casts both within the subsurface oil plume, 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 identify the location of the plume. Sites will be chosen based on available data (i.e. currents profiles), modeling results, and onboard detection of potential oil targets. The number of stations sampled will be determined by the extent of the plume, rate of sampling and available crew hours.

Adaptive sampling efforts will be directed based on the following data sources and analyses which indicate the possible presence of submerged 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., the Ridley Thomas, Pisces and/or Bigelow); and
3. Real-time ADCP current data and oil transport modeling utilizing these data.

Upon identification of the location of sample stations and/or transects, using the above data (see specific sampling strategy below), a suite of instrumentation will be deployed to determine the physical, chemical and biological characteristics of the area. Discrete samples will be located in the vertical with the guidance of diagnostic fluorescence measurements and imaging technologies. These samples will be taken to determine the concentrations of chemical components and biota at sampled locations.

The American Diver is being mobilized for approximately 7 days with a departure date of July 17, 2010. This vessel will be outfitted with the following instrumentation complement using methods described here and in appendices:

CTD: We will deploy a CTD profiling package (Malinda Sutor, LSU) equipped with a CTD, chlorophyll fluorometer, CDOM fluorometer, optical backscatter sensor, PAR sensor, and dissolved oxygen sensor (Appendix 1) in vertical profiles to approximately 200 m. There will also be a Seabird 19 Plus CTD which can be deployed to a depth of 6000 meters which will collect CDOM fluorescence, dissolved oxygen, and salinity, temperature, and depth information.

Acoustic Instruments: Under direction of Malinda Sutor (LSU), we will deploy an Acoustic Water Column Profiler (AWCP, 2 frequency, 420 and 778 kHz) and a 1200 KHz ADCP in vertical profiles to approximately 200 m. These will provide data at three frequencies, allowing us to utilize multi-frequency scattering models to identify sources of backscatter and size distribution of scatterers. (See Appendix 1.)

Image-forming Optical Instruments: A color Digital-Automatic Video Plankton Recorder (DAVPR) and an underwater digital holographic imaging camera (Holocam) will be used to survey the distribution of plankton, marine snow, and oil droplets within the near-field region of the well head (Cabell Davis, WHOI). We will tow-yo the DAVPR at 2-4 kts to depths up to 1000m along transects through the near-field region and will deploy the Holocam in vertical profiles and possibly on the DAVPR frame as well. The Holocam is a self-contained holographic camera that can be lowered on the ship's CTD frame or another frame. The internal memory card records the images (taken at specified intervals) for downloading and processing once onboard. See Appendix 2 for a description of the instrument and specifications for the optical instrumentation.

CNES: The Counter Narcotics Environmental Sensor, CNES is a submersible environmental monitoring package that can be used in profiling mode (to 100m depth), for fixed-depth temporal sampling or discrete analysis, and has sensors to measure and log for the following components:

- pH
- Redox, Oxidation Reduction Potential
- Temperature
- Dissolved Oxygen and Oxygen Saturation (Aanderra O_2 Optode)
- Crude Oil (optical sensor) [Turner Cyclops]
- CDOM (optical sensor) [Wetlabs ECO]
- Optical Backscatter
- Chlorophyll (optical sensor)
- Depth

See Appendix 3 for a description of the CNES instrument capabilities. Fred Marin of AIS, a NOAA contractor, will operate the instrument, and perform data processing, backups and storage.

Pyrosome Sampling: Transects to estimate densities of dead floating pyrosomes in the immediate survey area will be performed, as well as specimens collected for size measurements and further identification. See Appendix 4 for the sampling procedures.

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 collect a large enough sample for chemical analysis. 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 1, 2 and 3.

Sampling Plan for the American Diver Cruise 1

Sampling data will be collected at stations placed in areas thought to have deepwater oil contamination and surfacing oil from deepwater plumes, as well as surrounding areas. The design will be to sample near the wellhead down-current from the source. The directions from center 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 a deepwater plume 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 (potentially Pisces, if available)
D. The estimated locations of surface oil calculated from combined down-wind and down-current transport, as calculated by the vector sum of surface current plus 2% of wind speed directed 0°-20° to the right of downwind.
E. Any available aircraft support as to surface oil locations from USCG, Ocean Imaging, or other over flights (possibly completed in support of response operations).

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 include locations between the 2-km and 5 nmile circles, as well as locations outside the 5-nmile circle. Sampling of the freshly-rising oil 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).

Figures 1-4 below provide an example for a hypothetical sampling period using data leading up to 1600 CDT on July 10, 2010. Transport modeling indicates a subsurface plume as shown in Figures 1-4. Notice the southeast plume (Figure 1) remains at depth, being composed of primarily small droplets (<100 micron diameter); whereas the southwest plume (Figure 2) is composed of larger droplets (100s of microns in diameter) that rise faster into currents directed SSW instead of SE. The dissolved concentrations from the southeast plume are within and just below the droplets they originated from and in high concentrations; whereas the dissolved concentrations from the southwest plume are well (100s of meters) below the droplets and in more diffuse lower concentrations.

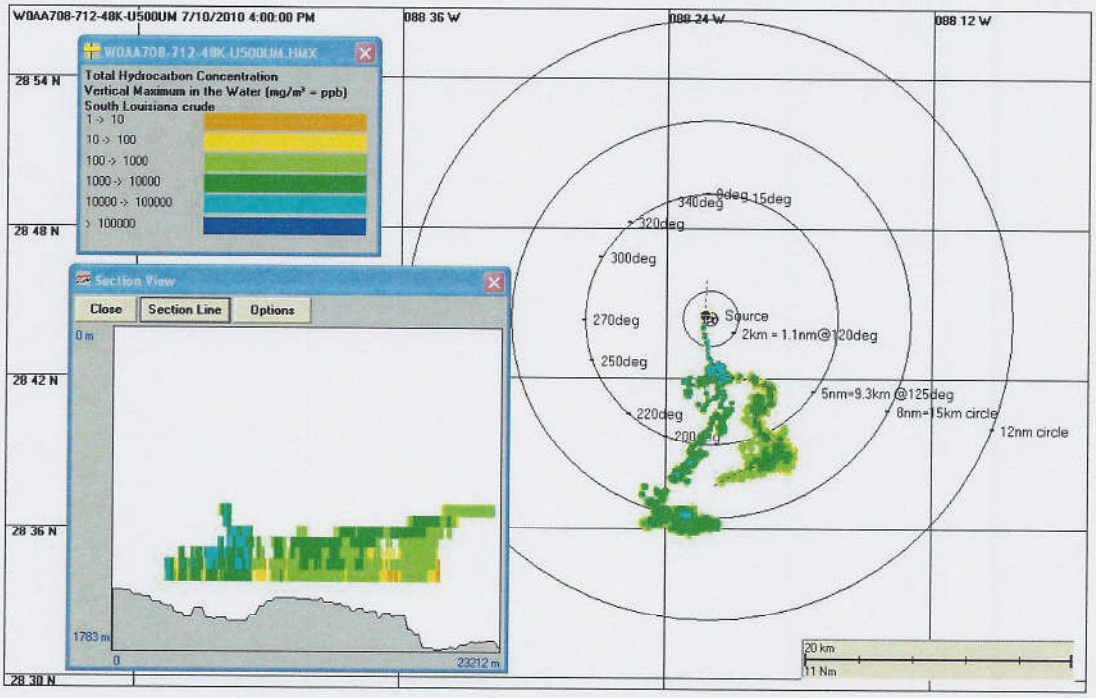

Figure 1. Modeled total hydrocarbon concentrations in oil droplets for Jul 10, 2010 at 1600 CDT – cross-section of SE plume (indicated by the dashed line).

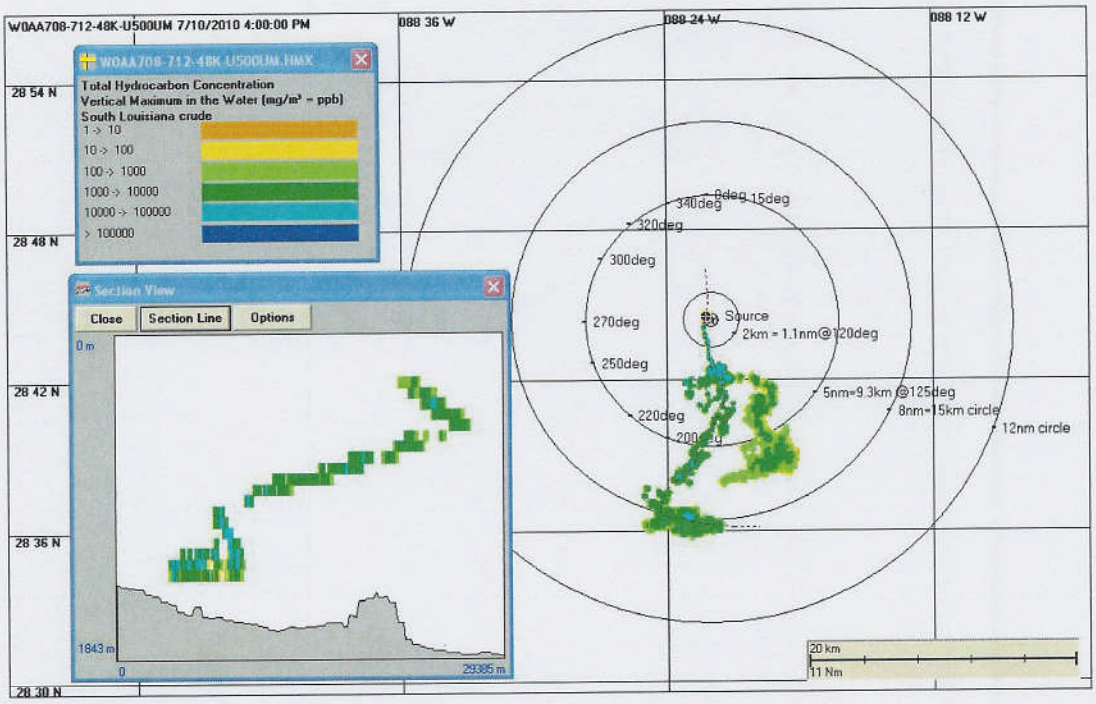

Figure 2. Modeled total hydrocarbon concentrations in oil droplets for Jul 10, 2010 at 1600 CDT – cross-section of SW plume (dashed line).

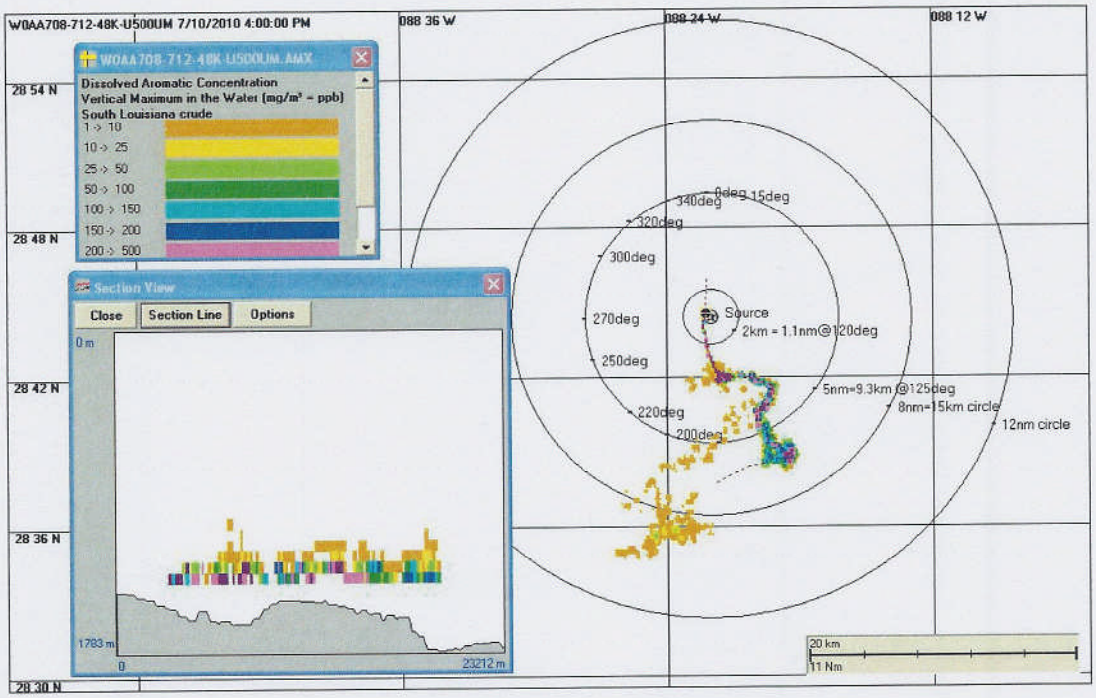

Figure 3. Modeled dissolved aromatic concentrations for Jul 10, 2010 at 1600 CDT – cross-section of SE plume (dashed line).

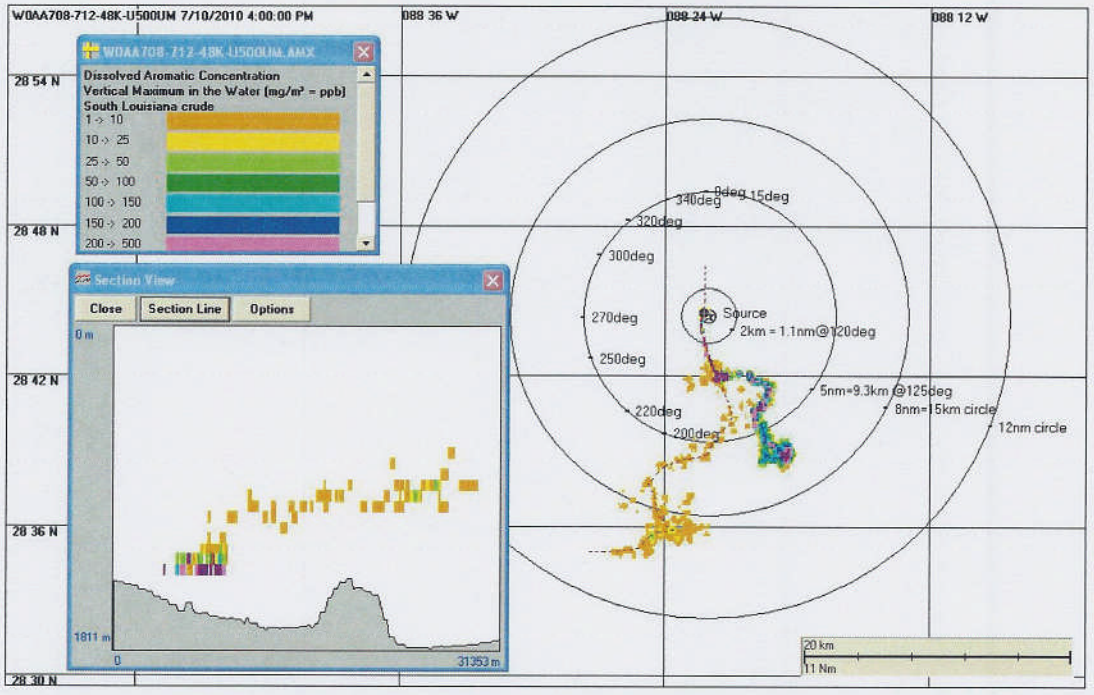

Figure 4. Modeled dissolved aromatic concentrations for Jul 10, 2010 at 1600 CDT – cross-section of SW plume (dashed line).

Figure 5 shows the area of sampling that would occur in this situation, between 135 deg and 200 degrees from the source and at a distance of up to about 10 nmiles. Transects will be made using the DAVPR, tow-yoing to 1000m at a speed of ~3 kts (see Appendix 2) to map droplets and plankton in the zone of interest. During daytime transects, pyrosome counts will be completed. Vertical profiling will be performed using the CTD package (to 200m), the CNES package (to 100m), the Holocam (combined with the CTD or CNES package, or full depth if with water sampling cast), and water sampling (to full depth) for chemistry, CNES and FlowCAM zooplankton analysis from the discrete samples. Where permitted, the high-frequency acoustics package will be combined with the CTD cast (to 200m depth) or CNES cast (to 100m) to map potential zooplankton and oil targets. It is anticipated that the transects will alternate with the vertical profiling, allowing data downloads and analysis between sampling periods. Sampling protocols will be worked out in this shake-down cruise for the combination of investigators and instruments deployed, to evaluate the most efficient and productive approaches and sequences for subsequent days and cruises.

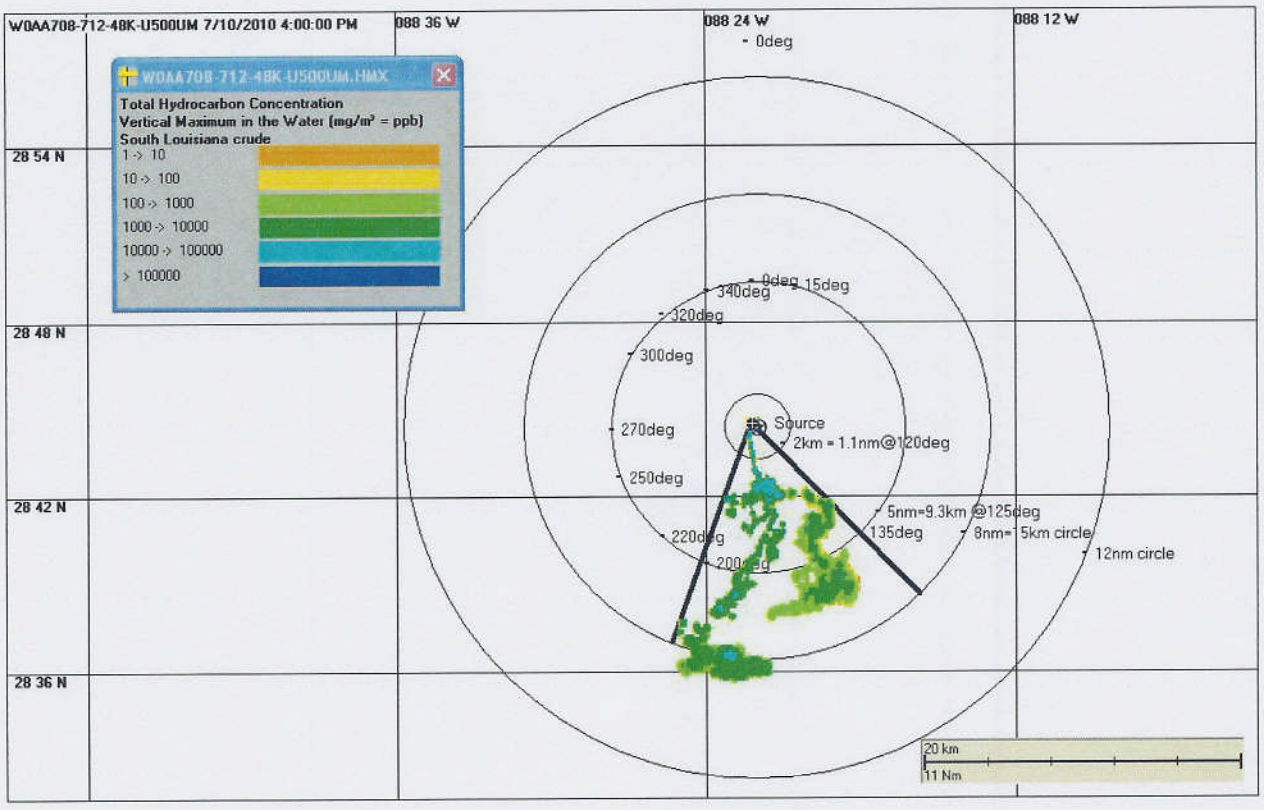

Figure 5. Area of adaptive sampling to occur within the 135 degree and 200 degree radials.

The vessel will coordinate with SIMOPS as it approaches the area, according to current guidance received from SIMOPS. No acoustical techniques will be employed within the 5 nmile circle without permission from SIMOPS.

We plan 6 days of sampling, 1-2 stations per day sampling a range of depths covering the entire water column. We estimate up to 200 discrete water samples (whole water) and approximately 30 filtered water samples will be taken.

Sampling Plan for the Ocean Veritas 9

While the American Diver is mobilizing, NRDA representatives will be deployed on the Ocean Veritas. The Ocean Veritas cruise 9 departs July 13, 2010 for four days of sampling in support of compliance monitoring activities. The Holocam and the CNES will be deployed with appropriate technical staff (C. Davis and F. Marin) to collect data in vertical profiles as described in Appendices 2 and 3. Station locations will be among those selected by the Ocean Veritas cruise chief scientist, sampling at as many stations as feasible considering time constraints and safety concerns. The instruments will be deployed to their maximum depth tolerance (CNES) and to the full depth (Holocam), as possible without disrupting the Ocean Veritas 9 cruise plan.

Personnel for American Diver
8 NOAA contractors
1-3 ENTRIX employees
1 Navigation technician
2 deck hands
1 Industrial Hygienist (supplied by BP)
6 Boat Crew (Captain and mates)

Personnel for Ocean Veritas 9
4 NOAA contractors

Vessel
Operations will be completed on the American Diver and the Ocean Veritas. The American Diver is already contracted under the VOO, and so costs are not included below. The Ocean Veritas costs are covered by Response under another budget. Thus, only personnel and equipment costs are included here.

Estimated Costs: American Diver Cruise 1 and Ocean Veritas Cruise 9

Item	Unit Cost	Unit/Type	Number	Total Cost
Vessel Rental		Days	7	(under VOO)
Mobilization *Invoiced separately by Entrix	$193,625	Quantity	1	$193,625
CNEs (prep)	$4,000	Quantity	1	$4,000
CNEs Direct Cost (Other)	$150	Quantity	1	$150
CNEs Tech	$800	Quantity	15	$12,000
Travel	$3,000	Quantity	1	$3,000
FlowCam	$1,500	Quantity	1	$1,500
High Freq Acoustics	NC			
Mobilization	$2,700	Quantity	1	$2,700
Sutor + 2 techs	$2,400	Days	13	$31,200
Dr. Sutor Data Report Prep	$9,840	Quantity	1	$9,840
Dr. Jim Payne PLVWSS	$150	Days	7	$1,050
Dr. Jim Payne	$2,000	Days	7	$14,000
DAVPR - Rental	$7,600	Quantity	1	$7,600
DAVPR - Misc	$2,500	Quantity	1	$2,500
Cabell Davis Travel	$3,000	Quantity	1	$3,000
Holocam	NC			
Dr. Cabell Davis	$2,000	Days	14	$28,000
CTD/Rosette + Bottles	$7,500	Quantity	1	$7,500
CDOM ECO Fluorometer	$5,000	Quantity	1	$5,000
NOAA sampling Tech	$1,000	Days	7	$7,000
Data Manager	$1,000	Days	7	$7,000
Deck Hand	$1,000.00	Days	7	$7,000
Entrix Staff * Invoiced separetly by Entrix		Days	7	$0
Navigation Tech (CSA)	$1,500	Days	7	$10,500
IH	1500	Days	7	$10,500
Estimated Total				**$368,665.00**

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 6. In addition, the NOAA incident site safety plan (which all NOAA employees and contractors must sign prior to the cruise) is attached (Attachment 4).

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.

Appendices:

1. Appendix 1 – Sutor Optics and Acoustics
2. Appendix 2 – Davis VPR and Holography
3. Appendix 3 – CNES Specifications
4. Appendix 4 – Pyrosome Sampling Plan

Attachments:

Attachment 1. PLVWSS sampling protocols in support of NRDA Cruises_050510.pdf

Attachment 2. Quality Assurance Guidelines for NRDA Water Column Chemistry Cruise 1 on the M/V American Diver

Attachment 3. Water Sample Handling Procedures 2010-06-11_jrp .doc

Attachment 4. NOAA-NRDA_MC_252_Site_Safety_Plan_5.13.10.pdf

Attachment 5. NRDA_Field_Sampler_Data_Management_Protocol_7_5_2010

Attachment 6. *M/V Jack Fitz* NRDA Cruise 3 HSE Plan Rev 003 Final

Attachment 7. M C 252_Incident_SIMOPS_Plan_

Attachment 8. At sea sample transfer memo

Attachment 9. MC 252 incident reporting document

Attachment 10. MC 252 Analytical QAP V1