HYDROGRAPHIC DATA KEY ELEMENT IN *SS JACOB LUCKENBACH* OIL REMOVAL

By Joanna Hawkins

Introduction

Hydrographic data, including multibeam, side scan, and navigation, was a key element in the recovery of more than 100,000 gallons of 'Bunker C' oil this past summer. In the beginning stages of the project, it was only believed that a hydrographic survey would be necessary for the initial assessment of the shipwreck, but there were those who believed the hydrographic data would be an added value throughout the project. Fortunately, they were right. In the end, the data provided by the hydrographers was used in virtually every phase of the project, from discovery to final report.

History of *SS Jacob Luckenbach*

On July 14, 1953, the *SS Jacob Luckenbach* (Figure 1), fully laden with Jeep parts, railroad equipment, and more than 400,000 gallons of 'Bunker C' oil, set sail for Korea from the Port of San Francisco, while the *SS Hawaiian Pilot* was approaching San Francisco on the last leg of her journey from Honolulu. The weather was foggy, light air and gentle swells, the *SS Hawaiian Pilot*, proceeding at 17 knots, sighted the *SS Jacob Luckenbach* on her radar bearing to port, distance 11.8 miles and the *SS Jacob Luckenbach*, preceding at 12 knots, sighted the *SS Hawaiian Pilot* on her radar bearing to starboard, distance 7.9 miles. Unfortunately, the master of the *SS Hawaiian Pilot* assumed that the *SS Jacob Luckenbach* was the San Francisco Lightship and made a slight course adjustment towards her. When the vessels heard each other's fog signals and sighted each other, they found themselves in a crossing situation with collision unavoidable. The *SS Hawaiian Pilot* suffered bow damage. The *SS Jacob Luckenbach* was holed and, due to progressive flooding through openings in the bulkheads between the weather and freeboard decks, the *SS Jacob Luckenbach* sank approximately 30 minutes after the collision. No persons lost their lives and only two persons were slightly injured on the *SS Jacob Luckenbach*.

Figure 1. *SS Jacob Luckenbach*

The *SS Jacob Luckenbach* now lies within the inbound shipping lane in 185 feet of water approximately 17 miles west of the Golden Gate Bridge. This area is part of the Gulf of the

Farrallones National Marine Sanctuary (GFNMS). The GFNMS is one of the largest marine sanctuaries in the world, housing birds, sea otters, sea lions, whales, sharks, and other marine animals. In the last 50 years, the *SS Jacob Luckenbach* has become a favorite for local sport divers, as well as a thriving artificial habitat. She is now the home to a variety of marine species, including octopus, anemone, shrimp, and rockfish.

Oil Spill

Late in November of 2001, a series of winter storms roared out of the Gulf of Alaska and hit the Northern California area. By the end of December the ski operators in the Sierra Nevada's were smiling and there was a collective sigh of relief from various water districts, as the near record snowfall guaranteed the spring runoff would refill the area reservoirs.

However, there was a dark side to these winter storms as oil soaked birds began washing up on a 200 mile stretch of shoreline from Bodega Bay to Pacific Grove (Figure 2). The United States Coast Guard Marine Safety Office (USCG MSO) and the office of Oil Spill Prevention and Response (OSPR) launched an investigation that quickly escalated as each passing storm resulted in more and more oil soaked birds washing up on local beaches. With the leadership of the USCG MSO, these groups working together would soon be know as the Unified Command. The National Oceanic and Atmospheric Administration (NOAA) along with the California Department of Fish and Game (CDFG) joined the investigation. As this is a heavy traffic area for ships, extensive surveillance was initially conducted to investigate the possibility that the source was illegal dumping of oily waste from ships cleaning their tanks.

As part of the surveillance a series of "flyovers" confirmed the existence of a large sheen off of the Golden Gate Bridge. However, no vessels could be coupled with the oil and eventually scientific analysis of the oil, the "chemical fingerprint", would match oil from similar mysterious spills dating as far back as 1991, leading researchers to believe the source was the same. This led to the theory that the seasonal storms may be whipping up the cargo oil contained in one or more of the hundreds of wrecks off the California Coast. Eventually the *SS Jacob Luckenbach* was proven to be the source of these spills. This prompted a multi-million dollar oil removal project.

Figure 2. Oiled Murre

Multibeam Survey

As the number of oiled birds mounted, so did the pressure from the Unified Command. On February 7, 2002, Fugro West's office in Oakland, California, received a call from the USCG

MSO requesting an urgent proposal to conduct a survey of the *SS Jacob Luckenbach*. A proposal was prepared and submitted that same afternoon to conduct a side scan sonar search of the estimated wreck location. At 07:15 the next morning, Fugro received a call to attend a meeting at 10:00 that same morning. After a lengthy meeting to review their objectives and schedule, Fugro was requested to re-submit the proposal to include multibeam bathymetry and to also increase the search area to include the possible anchor spread of a salvage barge. The proposal was re-submitted and within a few hours Fugro received a call from the USCG contracting office with notification of award and a reminder that they were already behind schedule.

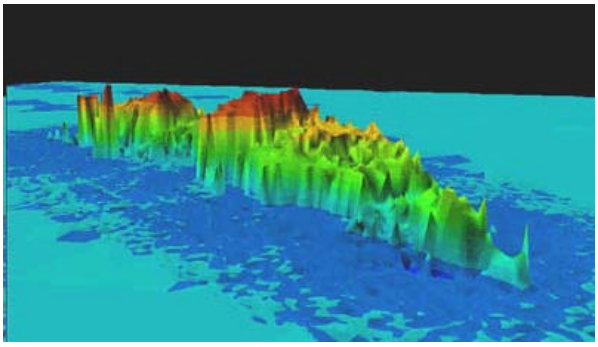

Figure 3. 3-D Image from Multibeam

Within 48 hours Fugro had chartered the research vessel *White Lightning* and assembled all necessary equipment and personnel in the Bay Area. Dockside mobilization commenced on February 11, 2002 and within 36 hours the equipment was installed and calibrated. Fieldwork commenced immediately after final equipment calibrations. A standard grid pattern was set-up and subsequently adjusted in the field to accommodate the prevailing wind and sea conditions. The wreck was located on the first pass and final adjustments were made to the grid pattern. The 100kHz side scan fish was initially towed high in the water column to minimize the possibility of snagging until a clearer picture of the wreck orientation and debris field were determined. A 500kHz fish was then deployed and flown at a more traditional distance above the bottom. Within 10 days of completion of fieldwork, six separate charts were delivered, including 3-D Images (Figure 3) and Contoured Bathymetry, Seafloor Features, Side Scan Mosaics and 3-D Image Video.

Manned Submersible Survey

The USCG MSO also contracted with Deep Ocean Engineering Research (DOER) to visually investigate the wreck from a submersible. After several attempts that were hampered by strong currents and poor visibility, the crew was able to determine that the *SS Jacob Luckenbach* had broken into three pieces and that the wreck was heavily encrusted with nearly 50 years of marine growth (Figure 4).

Figure 4. Midship Photo from Submersible

Oil Removal Operations

In May of 2002 the USCG MSO awarded a contract to Titan Maritime, based out of Florida, to conduct an underwater assessment of the *SS Jacob Luckenbach* and remove any recoverable oil from her tanks. Titan Maritime teamed with PCCI, Global Diving and Salvage, and Crowley Marine to survey the extent of the wreck and remove the oil. This was accomplished by utilizing a saturation diving team, surface and sub-surface navigation, and a Remotely Operated Vehicle (ROV). All the necessary equipment was mobilized on Crowley's 400-foot barge, the 450-10 in Seattle, Washington. This same barge was used as the platform to recover the Ehime Maru off the coast of Hawaii the previous year. Mobilization of the barge was a huge effort taking nearly two weeks to retrofit and secure the necessary equipment.

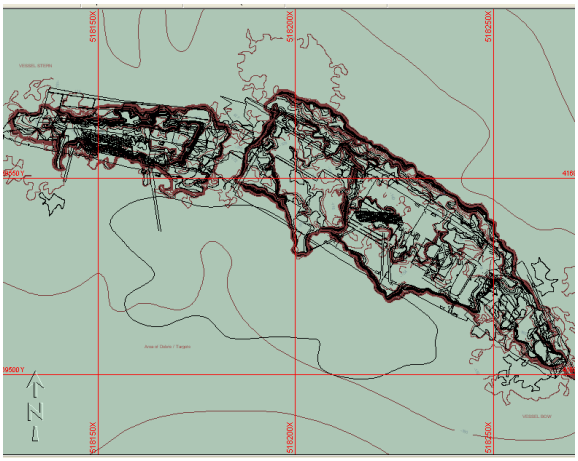

Figure 5. Multibeam Contours in HYPACK

Mobilization of the hydrographic equipment consisted of integrating a Trimble Differential Global Positioning System (DGPS) with a KVH GyroTrac compass, an ORE Trackpoint II Plus underwater tracking system, and Coastal Oceanographic's HYPACK data acquisition and navigation software. The 'Nav Shack' was setup between the 'Dive Shack' and the 'ROV Shack' and integrated with direct communications between all three. The divers and ROV were fitted with responders to direct and track their positions. The multibeam data collected by Fugro was brought into HYPACK as a geo-referenced background image along with the NOAA chart of the area (Figure 5). In the ship editor program, the barge was created to scale with the positions of the anchors, deep-sea dive bell, surface dive stage, and the ROV deployment area. This allowed the Hydrographer to position the barge directly over the wreck at the correct angle to the prevailing seas. This data was also used prior to mooring to determine the best positions for the six-point anchoring system. As each anchor was dropped, the anchor and position was marked in HYPACK. This allowed a constant visual on the angle, and subsequent tension, of each anchor wire.

The first few weeks of the project were hampered by weather. During the down time, the Hydrographer worked with an engineer from PCCI, naval architects based in Virginia, to improve the image of the shipwreck. PCCI, prior to the start of the project, had created a 3-D model of the *SS Jacob Luckenbach* from engineer drawings found on microfiche.

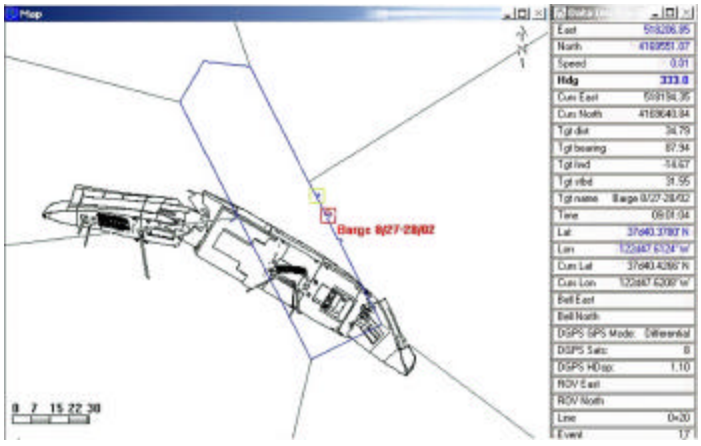

Figure 6. 2-D Image with Barge overlay in HYPACK

The model was created in Solid Edge, a program typically used to create mechanical parts. To have a more accurate picture of the position and orientation of the wreck, the multibeam data was used to adjust the 3-D model. The 3-D image was exported out of Solid Edge as a 2-D plan view image, then imported into AutoCAD and overlaid with the contours. The image was then checked for correct position and angle of the wreck. It was noted that the model was not entirely accurate. The necessary changes to the 3-D model were made and another 2-D image was exported. In AutoCAD, the 2-D image was exported out as a geo-referenced image and brought into HYPACK as background (Figure 6). This background image was utilized throughout the duration of the project to position the barge, divers, and ROV.

In June the project was hit by a series of storms that brought over 20 foot seas and winds up to 70 knots (Figure 7). The salvage master and the captain of the barge, with the hydrographer, used the information from the navigation system to monitor not only our position but the positions of the anchors as well. Because the anchor positions were marked as they were dropped, we were able to determine if the anchors had been or were starting to drag from the severe seas. Using the overlay of the barge in relation to the wreck we were able to determine whether we were moving relative to it. During the peak of the storm, the port bow anchor fairlead was ripped from the deck and the wire snapped. The winds were slamming against the port side and pushing the barge. Only the starboard bow and port breast anchor were holding her now. While monitoring the barge position, the Hydrographer was able to predict what would happen next and give the barge captain a bit of warning. The starboard bow anchor was dragging and all of the weight was now on the port breast anchor. It wasn't going to hold. The captain was able to have the Gladiator, the tug continually attached and anchored in front of the barge, to pull her anchors and keep the barge stable by going ahead into the weather. Just then, the port breast anchor snapped. Unable to hold position, and minus two anchors, there was no choice but to cut the other four anchors loose and head for cover in Drake's Bay. The following day, the storm had blown itself out and we headed in to San Francisco where the necessary repairs were made to the barge and new anchors were found. We were back on station within a few days.

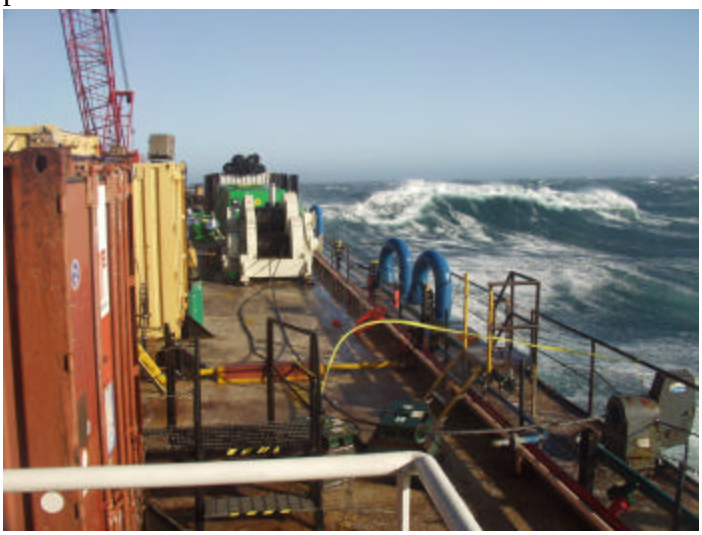

Figure 7. Stormy Seas

After that bit of excitement, many of the crew had a newfound respect for the information hydrographic data can provide. The information was then utilized on a daily basis by the salvage master, divers, engineers, barge crew and, of course, the ROV operator.

The ROV was fitted with a responder to track position and mark debris and obstructions found. This technique is a standard in ROV operations to not only feed accurate positions of seafloor features, but as a safety net, in the event that the ROV was fouled or the umbilical was cut.

During submersible operations conducted by DOER, two responders were dropped at the bow and stern of the wreck. The responders were two inches in diameter, about 8 inches long and suspended about two feet above the seafloor with small fishing buoys. The responders were placed to help position the barge over the wreck. The ROV operator, supported by the navigation system, was able to locate and retrieve these responders.

The barge crew checked the position of the barge and angle of the anchor wires at will, after the previous storm. During subsequent storm events the anchor wire tension was monitored closely.

The engineers from PCCI used the information provided by the divers, and supported by the navigation, to make changes and additions to the 3-D model. For example, as the heat pumps were mounted on the side shell, they were built and added to the model in Solid Edge (Figure 8). An image was generated daily to illustrate progress.

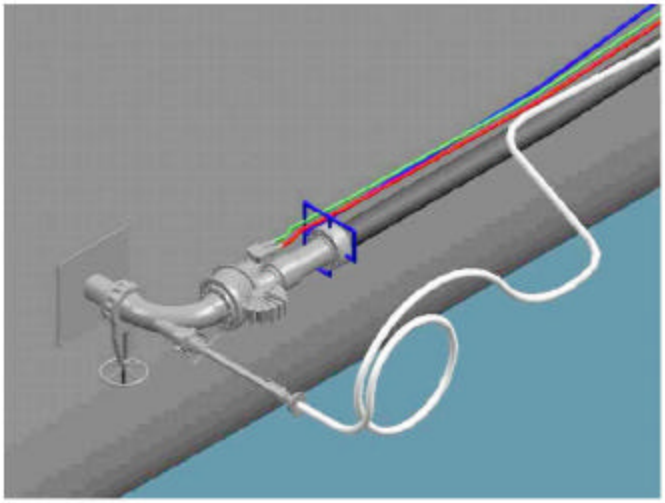

Figure 8. Heat Pump Generated in Solid Edge by PCCI

The dive supervisor used the information to track and direct the 'sat divers' in the daily operations. The navigation system was used to position the dive bell directly over the part of the wreck that was scheduled for the day. The dive bell is a pressurized chamber used to transport the divers from the surface to working depth. We were usually within a few feet and avoided bouncing the bell off the wreck. This was accomplished with the depth telemetry from the responder mounted on the bell. The divers would receive an image at the end of each day from the hydrographer displaying the area covered.

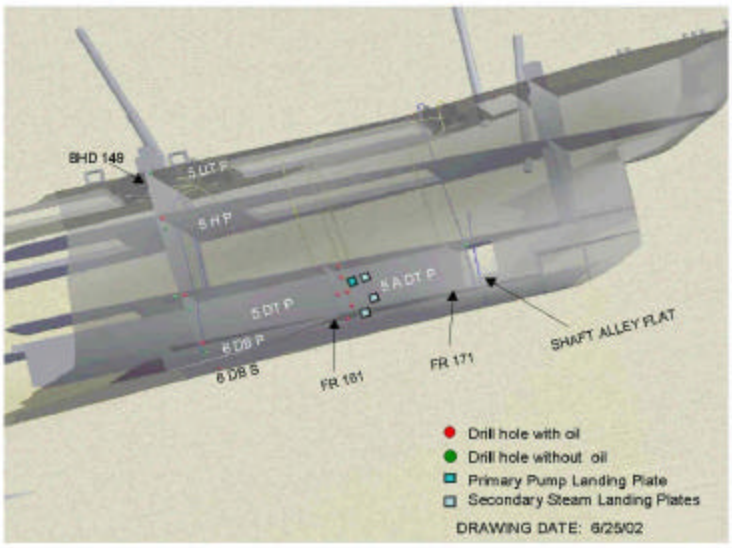

Figure 9. Example of Daily Report Illustration by PCCI

The salvage master used the information provided in several ways. First, the information provided support and direction in the planning of daily operations. Then, at the end of each day, the information was integrated into the daily report sent to the Unified Command on shore (Figure 9). The salvage master also used the navigation suite to monitor the barge and anchor positions as

dictated by the project and weather. The navigation images inspired confidence by corroboration on site and at the command center. Client confidence was boosted through the illustrations provided by the hydrographer and engineers.

Summary

The hydrography incorporated into this project was not used in the traditional sense. It was not used to gather large data sets, as in nautical charting surveys for NOAA, but rather to verify assumptions. Verifying these assumptions was vital to this project. It may not have been the heart of the project or the most critical element, but by the end, hydrography had turned into a safety net used by all. The navigation suite was on 24 hours a day, everyday. It was the first and last system looked at each day, and often throughout the night.

In the past, marine salvage operations were generally one-dimensional. The combination of several disciplines of marine science on one project was unusual. With the success of the *SS Jacob Luckenbach*, a new standard has been developed. There are hundreds of shipwrecks in United States waters containing oil, many of which could be leaking now or may leak sometime in the future. The *SS Jacob Luckenbach* can, and should, be used as a template for future projects, utilizing the information that hydrography can provide.

Acknowledgements

Special thanks goes out to Jim Grant from Fugro West for his excellent input on the multibeam survey. Your words set the tone for the paper.

Petty Officers Angie Vallier and Mark Jimenuz from the MSO San Francisco for your endless knowledge and limitless support before, during, and after *SS Jacob Luckenbach* project.

Tim Beaver of Global Diving and Salvage, Inc. and David Stirling of Titan Maritime for your quirky humor and belief in the benefits of hydrography.

The 40 plus crewmembers involved in the *SS Jacob Luckenbach* Oil Removal Project that made the 120 days at sea, not only a learning experience, but also an enjoyable one.