Appendix to Joint Development Agreement for the DHS/ADAC

This Appendix ("Appendix") is by and between Monterey Bay Aquarium Research Institute, with its principal place of business located at 7700 Sandholdt Rd., Moss Landing, CA 95039, a California nonprofit public benefit corporation ("MBARI"), and Woods Hole Oceanographic Institution, with its principal place of business located at 266 Woods Hole Road, Woods Hole, Massachusetts, 02453 ("WHOI") a private, nonprofit Massachusetts institution to the Joint Development Agreement ("Agreement") for the DHS/ADAC with effective date as of May 24, 2017.

Except as set forth in this Appendix, the Agreement is unaffected and shall continue in full force and effect in accordance with its terms. If there is conflict between this Appendix and the Agreement the terms of the Agreement will prevail.

On May 18th 2018 MBARI and WHOI jointly proposed to the DHS/ADAC a funding request to support the integration of WHOI's line-capture Whisker Box and DUSBL devices onto MBARI's Long Range AUV. MBARI engineers will design how the WHOI components can be integrated onto the LRAUV. Integration of these components onto the LRAUV will support WHOI's DHS supported mission to detect oil under floating sea ice during the period 9/1/18-11/30/19. The specific tasks are:

a. Design bracketry to mount the WHOI Whisker Box and DUSBL into the nose of the LRAUV. (80 hours)

b. Support the test and validation the Whisker Box and DUSBL (13 hours)

Appendix to MBARI/WHOI LRAUV agreement – 16 January 2019

On January 16th, 2019 WHOI requested access to the fabrication drawings and solid models of MBARI's Launch And Recovery System (LARS) for the LRAUV. WHOI plans to fabricate a slightly modified version to aid the launch and recovery of the DHS/ADAC funded LRAUV.

Appendix to MBARI/WHOI LRAUV agreement – Planned work for Year 6, 31 January 2019

On January 31th, 2019 MBARI proposed to the DHS/ADAC a funding request to support the integration of a camera system, refinements to the line capture/acoustic homing system and operational support for oil spill detection off Santa Barbara California and under-ice testing at a TBD location. All travel expenses to be paid by ADAC. The acoustic homing system modifications will require outside support from IntuAware.

This work will support WHOI's DHS supported mission to detect oil under floating sea ice during the period 9/1/18-11/30/19. The specific tasks are:

a. LBL Navigation
    i. Work with IntuAware and create a new navigation mode to navigate using Long Base Line acoustic beacons.
    ii. Conduct at-sea tests using WHOI supplied LBL transponders
b. Oil plume tracking
    i. Help IntuAware modify existing MBARI plume tracking algorithm and LRAUV vehicle code to work for oil leak plumes

ii. Conduct at least two multi-day sea tests of plume tracking missions from Moss Landing using chlorophyll as the oil proxy.
iii. Pack up the WHOI/DHS LRAUV into shipping crates for WHOI to ship to Santa Barbara or TBD Gulf of Mexico location.
iv. Support a five days of LRAUV operations offshore Santa Barbara or TBD Gulf of Mexico location with at least one person on-site plus vehicle remote piloting from MBARI.

c. Under-ice
i. Support a three-day deployment at a TBD frozen lake with one person on-site.
ii. Modify existing LRAUV missions to perform acoustic homing using the WHOI DUSBL.
iii. Implement acoustic abort and return home mission.
iv. Perform at least two test deployments using acoustic homing with image validation and acoustic abort and return.

Appendix to MBARI/WHOI LRAUV agreement – Planned work for Program Year 7, July 1, 2020

1) Plume mapping
   a) Plume Model
      i) Develop standalone application for a static model on BSC
      ii) Augment SeaOwl component to ingest external LCM data in simulate hardware mode - Port existing ocean data sim engine (subset of internal sim) to BSC
      iii) Refine model for three different static plumes
      iv) Refine model to change dynamically
   b) On-board Plume Mapping
      i) Refine existing plume mapping behavior
      ii) Test in Monterey with model and upwelling
   c) Refine BSC environment for external users
   d) Generate example BSC app + documentation
2) Upgrade vehicle systems
   a) Multibeam sonar integraiton
      i) Mechanical integration
      ii) Software integration (power, missions, behavior, timekeeping, automated wpt ingest from MB system
      iii) Develop mapping behavior with MB System input
   b) Inertial Navigation System (INS) integration
      i) Mechanical integration
      ii) Software integration (alignment behavior, power, depth, nav, ethernet, DVL, GPS ephemeris)-
   c) Circular DUSBL
      i) New double ping option, and some format changes
      ii) Sea trials, testing and refinement
3) Operations Support
   a) New England under ice
   b) Prep, travel (3 engineers), operations
   c) Great Lakes under ice
   d) Prep, travel (3 engineers), operations
   e) Barrow sea tests
   f) prep

Monterey Bay Aquarium Research Institute

By: _____

Name: _____

Title: _____

Woods Hole Oceanographic Institution

By: _____

Name: _____

Title: