**Technical Directive for Contract No. EP-C-11-020**

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| Date of Request: | January 5, 2017 | NRMRL ID#: |  | |
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| Technical Directive Sequential No. |  | FY |  |

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| Completion of Technical Directive Due **ON OR BEFORE**: | February 17, 2017 |

**TD description:**

The USEPA’s Office of Air and Radiation is responsible for reporting the nation’s annual anthropogenic greenhouse gas emissions to the United Nations. Research conducted by the USEPA suggests that emissions of methane (CH4), a potent greenhouse gas, from water impoundments (i.e. reservoirs) may be the third most important anthropogenic CH4 source in the US. There are relatively few reports of CH4 emission rates from US reservoirs in the literature, however, and national scale emission estimates are highly uncertain. In the summer of 2017 ORD will begin the National Reservoir Survey (NRS), a 3-year field sampling campaign to produce an unbiased estimate of reservoir-CH4 emissions for the US.

ORD has substantial experience executing national scale surveys through the National Aquatic Resource Survey (NARS) program. NARS surveys are designed to assess the status of the nation’s coastal waters, lakes and reservoirs, rivers and streams, and wetlands. NARS utilizes a Generalized Random Tessellation Stratified (GRTS) survey design which provides a probabilistic subsample of the resource (i.e. lakes and reservoirs) with strong spatial balance. NARS survey designs are typically stratified by 9 US Ecoregions, allowing statistical comparison among different regions of the country.

A critical piece of any GRTS design is the sample frame, which is a GIS file containing the entire population of interest. For example, the sample frame for the lake and reservoir NARS-survey is the National Hydraulic Database (NHD) which contains the size and locations of all lakes and reservoirs in the US. Unfortunately, the NHD does not reliably distinguish between lakes and reservoirs and therefore cannot be used to support a GRTS design for the NRS (i.e. reservoirs only, no lakes).

In the absence of a comprehensive sample frame for US reservoirs, we propose to use the GRTS design for the 2012 National Lakes Assessment (NLA), a component of the NARS program, as the sample frame for the NRS. 642 of the 1000 water bodies sampled in the 2012 NLA were classified man-made water bodies (Fig. 1). These 642 man-made water bodies (i.e. reservoirs) represent a probabilistic and spatially balanced subset of all reservoirs in the US. We propose to use these 642 reservoirs as the sample frame for the NRS.



Figure 1. 642 water bodies classified as man-made during the 2012 NLA.

The NRS survey design will be executed using the spSurvey package in R, treating the sample frame as a finite resource. Since the sample frame (2012-NLA reservoirs) is already a subsample of US water bodies, the inclusion probability of each reservoir (i.e. weight) derived from the 2012 NLA GRTS design must be considered in the NRS design. We specifically seek assistance in executing the NRS design, including guidance on properly addressing the weights.

The NRS design will allow for an estimation of the central tendency and variance of reservoir-CH4 emission rates (mass/unit time/unit area) at the Ecoregion and national scales. Our objective, however, is to estimate the total flux of CH4 from the nation’s reservoirs, which requires an estimate of both emission rate and reservoir surface area. We propose to estimate the total surface area of US reservoirs at the Ecoregion and national scales using the results from the 2012 NLA. Extent estimates can be made using functions in the spsurvey package. We specifically seek assistance in estimating US reservoir surface area using the results of the 2012 NLA­.

**Deliverables:**

The contractor will provide R code for executing the NRS survey design and estimating US reservoir surface area.

**Hours:**

The government estimates that this work will require 40 hours of the contractor's time.