



Development of “Fish-on-a-Chip” for Evaluation of Toxicity of Elutriates from Dredged Materials

Dredging Operations Environmental Research (DOER) Program

U.S. ARMY CORPS OF ENGINEERS

BUILDING STRONG®

Focus Area

Risk Management

Problem



Water column toxicity testing of elutriates from dredged materials is a necessary and time-consuming step for the evaluation of dredged materials for potential beneficial use when constituents of potential concern (COPC) are present in the material. This testing requires significant effort, time, funds, and materials including: the acquisition and/or rearing of live organisms, such as the fathead minnow (*Pimephales promelas*) or the daphnid (*Ceriodaphnia dubia*) for freshwater sediment; multiple exposures lasting between 48 – 96 hours; large volumes of both sediment and site water; and multiple personnel necessary to set-up, maintain and assess these exposures. Therefore, an alternative testing strategy (ATS) that could reduce the volume of test materials needed, reduce the need for and use of vertebrate test animals, and provide a high-throughput screening methodology would decrease the costs of water column toxicity testing of elutriates and expedite decision-making.

Study Description

We propose the use of an “on-a-chip” methodology for screening elutriates from dredged material by developing a customized “fish-on-a-chip system”, using cells derived from key tissues from fathead minnow (FHM). This unique application methodology will be tested using parallel acute exposures of both the customized “fish-on-a-chip” system and FHM larvae to 3 chemicals, representing classes commonly found in dredged materials, and then evaluated in elutriate from dredged materials. This research effort will be conducted over three years, involving four distinct tasks: **1)** A literature review on the use of *in vitro* new approach methodologies (NAMs) and alternative testing strategies (ATS) in environmental samples, engagement with regulatory federal agencies and USACE stakeholders, and development of a protocol for FHM acute tests for institutional animal care and use committee (IACUC) approval (year 1); **2)** Development of 4 new FHM cell lines (kidney, gill, gastrointestinal tract and ovaries) and successful transfer and co-culture of developed cell lines to Integrated discrete Multiple Organ Culture (IdMOC) plates (year 2); **3)** validation of “fish-on-a-chip” technology via comparison to standard FHM larvae toxicity tests for select chemicals (year 2 and 3); and **4)** validation of “fish-on-a-chip” technology via comparison to standard Acute toxicity FHM toxicity test with sediment elutriates (year 3).

Products

In year 1, a technical report outlining the literature review on the use of NAMs in elutriate and dredging material testing, which will include COP findings and steps for technology transfer, will be produced. Furthermore, a protocol for the FHM larvae acute toxicity tests will be submitted to the IACUC for approval. A technical report detailing the methodology and results of FHM tissue specific cell line development and transfer to IdMOC plates will be produced at the end of year 2. Finally, at the conclusion of year 3, a peer reviewed manuscript will be developed based on the results of the acute toxicity assays with select chemicals, and both intermediate and final results will be presented to stakeholders, other agencies, and external groups, via meetings and professional conferences (such as Society of Environmental Toxicology and Chemistry (SETAC)).

Summary

Water column toxicity testing of elutriates from dredged materials is a necessary but expensive step for the evaluation of dredged materials for determination of suitability for unrestricted open water disposal or aquatic beneficial use of the material. The goal of this proof-of-concept study will be to provide the evidence for the use of a “fish-on-a-chip” system for high-throughput screening of dredged materials that could ultimately reduce the number live vertebrate test animals and lower the costs associated with water column toxicity testing for dredged materials.



Balancing operational and environmental initiatives and meeting complex challenges of dredging and dredged material placement in support of the navigation mission.