**ACCESS NUMBER: 30012**

**STUDY TITLE**: Generic Plume Modeling Study

**REPORT TITLE**: A Numerical Mud Discharge Plume Model for Offshore Drilling Operations

CONTRACT NUMBER: 14-12-0001-30012

SPONSORING OCS REGION: Gulf of Mexico

APPLICABLE PLANNING AREA: All

FISCAL YEAR OF PROJECT FUNDING: 1983

COMPLETION DATE OF REPORT: July 1985

COST: FY 1983: $10,800

CUMULATIVE PROJECT COST: $10,800

PROJECT MANAGER: B. Johnson

AFFILIATION: U.S. Army Engineer Waterways Experiment Station

ADDRESS: P.O. Box 631, Vicksburg, MS 39180

PRINCIPAL INVESTIGATOR*: R. Multer

KEY WORDS: North Atlantic; South Atlantic; Mid-Atlantic; Eastern Gulf; Central Gulf; Western Gulf; Southern California; Central and Northern California; Gulf of Alaska; Kodiak; Cook Inlet; Shumagin; North Aleutian Basin; St. George Basin; St. Matthew Hall; Navarin Basin; Norton Basin; Hope Basin; Barrow Arch; Diapir Field; physical oceanography; model; drilling discharges; eddy; sediment; deposition; transport

**BACKGROUND**: Predictive models are useful tools for managers to simulate certain conditions or events associated with environmental impacts. Plume discharge models are often used to predict the fate of discharged materials from offshore oil and gas drilling operations. Most presently used models are complex and require considerable input data and computer time to operate. Therefore, the U.S. Department of the Interior was prompted to fund the development of a less cumbersome plume discharge model able to run on desktop microcomputers. This report involves the modification of an existing generic plume model to fit the needs of management personnel.

**OBJECTIVES**: (1) To modify the existing model to allow consideration of sediment distribution with respect to depth; (2) to incorporate a nonconstant definition of eddy diffusion into the model; (3) to incorporate an algorithm into the model to compute the total sediment flux at various downstream distances; (4) to incorporate an algorithm into the model to compute the rate of deposition; and (5) to adapt the model for execution on a microcomputer.

**DESCRIPTION**: An existing model of drilling discharge plumes was modified to run on microcomputers. The report detailed the mathematical derivations of the model and includes a description of the computer programs written to execute the simulations. Certain analytical shortcuts were taken to reduce the complexity and render the computations more amenable to small memory computers.

**SIGNIFICANT CONCLUSIONS**: The revised model includes only the major physical parameters necessary to predict the behavior of a discharge plume during the "passive diffusion" phase. More sophisticated models of sediment diffusion are available which can also simulate earlier plume phases such as "convective descent" and "dynamic collapse", but such models require considerable manpower and computer time. This model should provide sufficient power for cursory or preliminary evaluations using desk-top microcomputers.

**STUDY RESULTS**: The basic model employed in this study was the steady state, three-dimensional, transport diffusion equation. Three primary components of the equation are downstream advection, vertical sedimentation, and eddy diffusion. Computational effort was considerably reduced by separating the equation into two partial differential equations. One equation, solved analytically, models the effect of lateral diffusion. The other equation, solved numerically, models the interaction of settling, longitudinal transport, and vertical diffusion. Assumptions for the model require that the velocity field is time-invariant and constant in magnitude and direction; the depth of fluid is also constant; and the planar region occupied by the fluid is assumed to be a half-plane. The boundary conditions for the free surface must specify that there is no flux across a free surface. It must be assumed that all free sediment settles to the bottom and is not resuspended.

The computer programs written to execute the model are in two parts: FRNT which sets up the problem, and MODEL which performs the computations. The model system requires a minimum of 16 input variables including: depth; mean current velocity; friction factor; longitudinal distance between stations; lateral distance between stations; number of stations in vertical, horizontal, and lateral directions; mass flux or concentration boundary condition; number of size fractions; and settling velocity for at least one size fraction. During program execution the user is prompted by questions for each input category. This model allows for inflow of new material through a window beginning at some user-defined elevation above bottom. The printout will include tables of mass flux and concentrations at various depths and downstream locations. A table of deposition rates, given as mass per unit area per unit time, will also be generated.

**STUDY PRODUCT**: Multer, R. 1985. A Numerical Mud Discharge Plume Model for Offshore Drilling Operations A final report by the Hydraulics Laboratory, U.S. Army Engineer Waterways Experiment Station for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Region, Metairie, LA. NTIS No. PB86-245099. MMS Report No. 85-0046. Contract No. 14-12-0001-30012. 33 pp.

*P.I.'s affiliation may be different that that listed for Project Manager.