

REGIONAL SEDIMENT MANAGEMENT RESEARCH PROGRAM Draft – 1 January 2002

INTRODUCTION

BACKGROUND

The U. S. Army Engineer Research and Development Center proposes a Regional Sediment Management Research Program to provide the Corps of Engineers with the tools and knowledge it needs to manage sediment resources on a regional basis in order to achieve high performance water resources projects that are economically and environmentally sustainable.

Regional Sediment Management (RSM) employs natural processes and human activities to ensure that water resources projects throughout a sediment region affect sediment, and are affected by it, in an economically and environmentally sustainable manner. It recognizes that the region and embedded ecosystems respond beyond the space and time scales of individual projects, and that a proactive regional planning and engineering approach can produce significant national benefits.

A sediment region is defined as the waters of a basin plus tributary and adjacent lands extending from the source of sediment to its ultimate destination. A sediment region may extend from the headwaters of a river to the sea, and include land, riverine, lacustrine, estuarine, littoral, and marine zones. The word regional implies a spatial extent that fully encompasses the region within which the sediment travels, plus a temporal scale long enough to determine its ultimate fate.

This document describes the goals, approach, primary products, and funding of the proposed Regional Sediment Management Research Program (RSMP).

NEED

The Corps of Engineers needs knowledge and tools to manage sediment resources on a regional basis in order to achieve economically and environmentally sustainable water resources projects. These needs are driven by national interests, the Corps' strategic plan, and mission-specific strategies.

Excessive sediment erosion, transport, and deposition are estimated to cause damages of approximately \$16 billion annually in North America.¹ The U. S. spends about \$700 million on dredging. Sediment overloading from land and stream erosion causes significant environmental and economic challenges – excessive sediment in rivers, reservoirs and estuaries may contribute to high turbidity, to loss of flood-carrying capacity and to sediment deposition in navigable waterways. Yet, a shortage of sediment causes coastal erosion, streambank erosion, and wetlands loss in many locations.

Many water resource projects are designed and operated to remedy local sediment problems, sometimes at the expense of creating even larger problems some distance

¹ (Osterkamp, W. R., P. Heilman, and L. J. Lane, "Economic Considerations of Continental Sediment Monitoring Program," *International Journal of Sediment Research*, (4) December 12-24, 1998.

REGIONAL SEDIMENT MANAGEMENT RESEARCH PROGRAM Draft – 1 January 2002

away. Successful project design and operation requires that sediment issues be resolved at both the local and regional levels, yet resource managers lack the information and tools they need to make informed decisions. These challenges adversely effect navigation, flood and storm damage reduction efforts, and environmental quality in water resource projects.

Requirements for the Corps developing regional sediment management capabilities derive from the following:

- The Congressionally-mandated interagency Marine Transportation System (MTS) Task Force report provides a national vision for the MTS of 2020 and recommends R&D on overall effective sediment management, including “. . . holistic watershed and local/regional planning efforts.”¹
- During public listening sessions² held by the Corps around the United States in 2000, Americans said that we should “Analyze water resources comprehensively at a watershed level.”
- The Corps’ Strategic Campaign Plan³ states, “We strive to achieve greater public benefits from enhanced attention to both economic objectives and environmental values as we deliver our projects and services. We take a broad regional approach to the problems we address and provide a forum to bring together all of the federal agencies, state and local governments, and the private sector to find win-win solutions to these problems. We develop and implement comprehensive regional planning tools that can provide a strong scientific background for our decision processes.”⁴
- The Corps strategic plans for navigation, flood and storm damage reduction, and environmental quality identify regional and basin-wide management capabilities as key Future Operating Capabilities.
- USACE Policy Guidance Letter #61 (27 January 1999) directs that, “The Corps will integrate the watershed perspective into opportunities within, and among, Civil Works Programs.”
- A series of Corps’ workshops have identified sediment management and tools for basin-wide analyses as high priority needs in both the short term and long term. A listing of identified specific needs is given in Appendix A.

PROGRAM OBJECTIVES

The overall objective of the RSMP is to provide the Corps of Engineers with the tools and knowledge needed to manage sediment on a regional basis in order to achieve high performance water resources projects that are economically and environmentally sustainable. More specifically, it will seek ways to minimize projects’ disruption of

¹ "An Assessment of the U.S. Marine Transportation System, A Report to Congress", 1999 (Sept), U. S. Department of Transportation, Washington, D.C. (<http://www.dot.gov/mts/report/>)

² “A National Dialogue About America’s Water Resources Challenges for the 21st Century,” U.S. Army Corps of Engineers, Washington, DC, 2001.

³ “Department of the Army Corps of Engineers Civil Works Strategic Plan, FY2002-FY2006”, 1 February 2001.

⁴ 2001 Campaign Plan, U.S. Army Corps of Engineers, 8 May 2001.

REGIONAL SEDIMENT MANAGEMENT RESEARCH PROGRAM Draft – 1 January 2002

natural sediment pathways and mediate natural processes that adversely affect water resource projects' performance or their regional impacts.

Specific goals to achieve this objective include:

1. Provide necessary knowledge and enabling technologies that will lead to improved capabilities for regional sediment management.
2. Provide analytical techniques and models that give the USACE capability to characterize both regional-scale and local-scale project sediment impacts -- sediment yield, transport and fate -- and to evaluate management alternatives.
3. Provide guidance for planning designing, constructing, operating, and maintaining water resource projects to effectively manage sediment from a regional perspective and to manage individual projects within the context of regional sediment management objectives.
4. Produce an information and knowledge (informatics) environment complete with data, software tools, and procedures that facilitates effective Corps business practices and decision-making in regional sediment management.
5. Rapidly and effectively transfer the products from this program to Corps of Engineers personnel, insert its tools into Corps' practices, inform and be informed by stakeholders, and facilitate mutually beneficial exchanges with other organizations.

APPROACH

We will develop the needed knowledge, designs, and tools by obtaining the best available technology from inside and outside the Corps of Engineers and filling the gaps with targeted research and leveraging our partners' efforts.

Needed capabilities for managing sediment regionally have been identified through several Corps' business area workshops, program reviews, meetings with Demonstration Project personnel, and virtual workshop forums. A tabular listing of the identified needs is given in Appendix A. The workshops also identified a priority need for integrated, system-wide tools for environmental modeling, assessment, and restoration based on sound science and engineering principals. The RSMP and a related initiative – the System-Wide Modeling, Assessment, and Resource Management Technologies Research Program (SMART) -- will address those needs in tandem.

RSMP products of knowledge, solutions, and tools will be developed in five Focus Areas corresponding to the specific goals listed above. The Focus Areas are:

1. Processes
2. Modeling and Assessment
3. Engineered Solutions
4. Informatics
5. Technology Transfer and Insertion

Figure 1 below provides a simplified schematic to illustrate how these Focus Areas are related and how information flows among them.

REGIONAL SEDIMENT MANAGEMENT RESEARCH PROGRAM

Draft – 1 January 2002

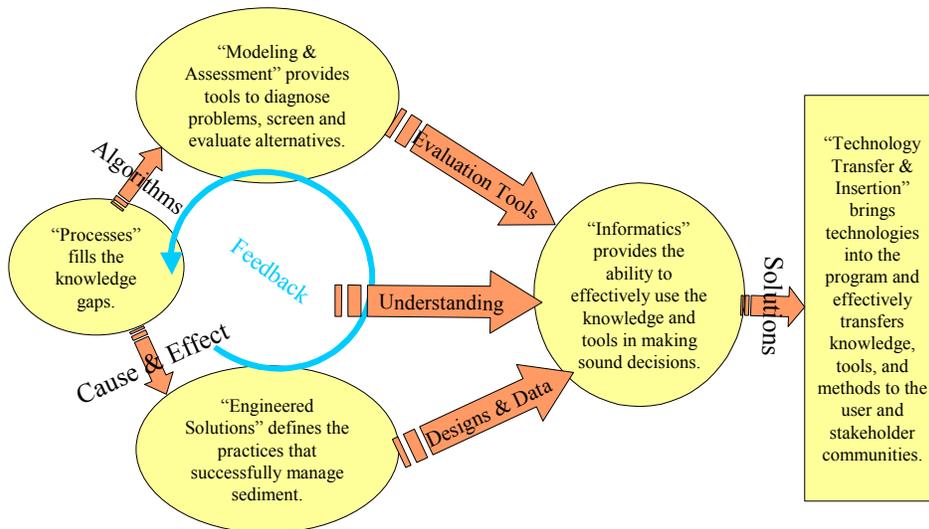


Figure 1. The five Focus Areas work in concert to meet identified USACE needs and achieve program goals.

The RSMP will adopt and adapt existing tools and practices to the maximum practicable extent by coordination with ongoing research in other Corps' research programs, such as those dealing with geospatial technologies, decision support, land management, environmental quality, and dredging; with ongoing demonstration projects such as Demonstration Erosion Control, Great Lakes Sediment Management Program, and National RSM Demonstration Program; and with the programs of other agencies and organizations. Some details of coordination and exchanges are provided in the Focus Area descriptions.

The SMART program cited above and the RSMP have been developed by the same team and are designed to complement each other. While the focus of the RSMP is principally on sediment, it also deals with environmental quality issues related to sediment and sediment transport. The focus of SMART is on environmental modeling tools, including those that evaluate and predict the environmental effects of sediment. Simultaneous execution of these complementary programs will avoid duplication, promote synergy, and leverage investments. Throughout this document the integration of efforts and products with SMART is expressly and tacitly acknowledged. Similarly, this program has been closely coordinated with other research efforts, including dredging-related research, to eliminate duplication and leverage investments.

REGIONAL SEDIMENT MANAGEMENT RESEARCH PROGRAM Draft – 1 January 2002

PRODUCTS

RSMP will provide products in three areas:

1. Knowledge of sediment processes and effects at local and regional scales to make our assessments state-of-the-art and to inform the USACE and its stakeholders.
2. Optimum engineered solutions (nonstructural, structural, and operational) to achieve RSM goals.
3. Tools to assess sediment challenges and to evaluate, select, design, and use management solutions.

Technology transfer mechanisms will be implemented that bring in the best knowledge and techniques to be melded into USACE products and active insertion of all products into USACE practice and national usage.

The primary products and their interdependence are shown in Figure 2.

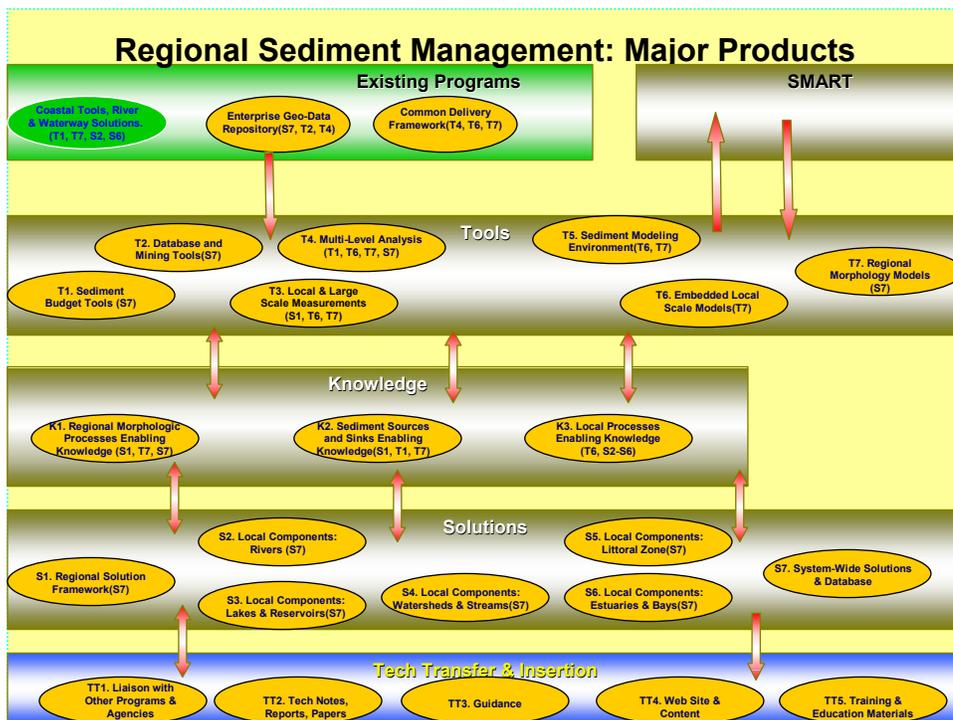


Figure 2. Primary RSMP products. Connectivity is denoted by the numbers following each product title, which indicate the other products that depend at least in part on the named product. Examples of products from other programs that are needed by RSMP are shown at the top, as is the mutual dependency between RSMP and SMART.

**REGIONAL SEDIMENT MANAGEMENT
RESEARCH PROGRAM
Draft – 1 January 2002**

BENEFITS

Expected benefits of the RSMP products and knowledge include:

- Enhanced environmental protection & restoration in Corps' projects
- High performance navigation, flood/storm damage reduction, multipurpose and restoration projects.
- Optimization of multiple projects that permit more high performance, environmentally sustainable projects at no increase in cost to nation.
- Improved Corps' and stakeholder understanding of sediment resources issues.

FOCUS AREA DESCRIPTIONS

The following pages describe the five Focus Areas' objectives, approach, major products, coordination with other efforts and organizations, and funding. Each Focus Area is divided into a set of integrated Topic Areas. Each Topic Area will be addressed by one or more Work Units in the proposed program.

FY02 funded Topic Areas are marked. Other Topic Areas will be funded in subsequent years. Work unit descriptions are contained in Appendix B.

REGIONAL SEDIMENT MANAGEMENT RESEARCH PROGRAM Draft – 1 January 2002

FOCUS AREA: A. Processes

OBJECTIVE: Provide necessary knowledge and enabling technologies that will lead to improved capabilities for regional sediment management.

Specifically, this Focus Area will define: 1) Local- and regional-scale sediment production, transport, storage, and diagenesis processes within a regional sediment system; 2) How these sediment processes are affected by phenomena over a range of spatial and temporal scales; and 3) How these sediment processes affect and are affected by engineering works within the regional sediment system. Thus, it will fill the gaps in science that the other Focus Areas will need in order to successfully advance the Corps' capabilities in regional sediment management and provide knowledge needed by Corps and stakeholders.

GENERAL APPROACH: The various technical challenges for research on regional sediment processes may be organized in a variety of ways, including regional environments (e.g., terrestrial, coastal, atmospheric), civil works project types (flood damage reduction, navigation, environmental restoration, coastal storm protection), spatial scale, and /or temporal scale. This Focus Area is organized around two distinctive temporal scales in an effort to achieve maximum integration of engineering and scientific disciplines. This approach will collectively and synergistically contribute knowledge, better methods, and data sources for the management of sediment in a holistic regional context. The two time scales are long-term, from 10's of to 100 years and up, and short-term, from minutes to 10's of years.

An important aspect of this work will be to provide the parametric descriptions and linkages needed to ensure that the descriptions provided for short-term processes ultimately scale up to yield the long-term results that have been observed in nature. Improved knowledge of short-term processes are a building block for better descriptions of long-term processes.

PRIMARY PRODUCTS: Products of knowledge, methods/algorithms, and data will supply Focus Areas B (Modeling and Assessment) and C (Engineered Solutions). Improved understanding of processes will also contribute to the education component of Focus Area E (Technology Insertion and Transfer). Products will take the form of Technical Notes, Technical Reports, Engineer Manual updates, web content, workshop and training materials, journal papers, and data sets. Individual products are listed by topic below.

WORK DESCRIPTION

Area 1: Long-Term Dynamics of Large-Scale Sediment Systems

This research area will cover description and forensic analysis of the dynamics of sediment processes and systems, the influences of large-scale phenomena and human activity on the sediment region, the impacts of processes on engineering works in a system, and impacts of engineering works on processes within a system for the long-term

REGIONAL SEDIMENT MANAGEMENT RESEARCH PROGRAM Draft – 1 January 2002

(10's – 1000's of years). Construction, operation, and maintenance of major Federal projects began more than 150 years ago. The large-scale system response to some of these projects extends to the regional and continental scales, far exceeding local project authority and dimensions.

Using historical and present-day information, this research area will address questions such as:

- What are the major sources and sinks of sediment in large-scale systems, their linkages by processes, and their relative magnitudes?
- How do large-scale sediment systems react to and recover from large magnitude external inputs (e.g., floods, earthquakes, hurricanes, eruptions, cyclic weather patterns) in terms of changes in frequencies and rates of sediment processes, formation of geomorphological features and directions of system evolution?
- How do the underlying geology and geologic control features as well as other environmental conditions affect regional-scale sediment transport processes?
- What are the controlling parameters and dependencies affecting sediment erosion, transport, and deposition for mixed fine and coarse sediments? How and at what time frame do the several sediment components move through the sediment region from uplands to the coast?
- How do headward erosion, sheet and rill erosion, channel width changes, bank erosion, riparian landslides, and channel migration affect erosion, transport, deposition, diagenesis, release of nutrients/contaminants (through bioturbation and agricultural inputs), and changes to habitat areas such as sandbars, chute channels, and submerged vegetation beds in the entire sediment region?
- What changes in sediment production, transport, storage, and diagenesis occur in rivers and along coasts when an ice cover forms and breaks up?
- What are the spatial and temporal and geomorphologic and environmental response of engineering works (land use, soil conservation, dams, locks, bridges, levees, bank stabilization, grade control structures, urbanization, channelization, dredging, reservoir sedimentation, etc.) on sediment and nutrient processes and sub-systems throughout the sediment system? (Joint effort with the Engineered Solutions Focus Area.)

Products will address field needs 10, 14, 20, 25, 27, 28, 29, 39, 62, 63, 64, 68, 69, 74, and 100 as listed in the field needs Appendix and supply the other Focus Areas with knowledge. Specific components of each product will include the description and examples of concepts, methods, and data sources necessary to achieve each of the tasks identified.

Topic Areas:

Topic Area A1.1: Forensic Analysis of System Controls and Response

Long-term historical data provide a significant resource for evaluating how regional systems respond to large-scale controls, such as geologic features and engineering works.

* Topic Areas with an asterisk will be funded in FY02.

REGIONAL SEDIMENT MANAGEMENT RESEARCH PROGRAM Draft – 1 January 2002

Through a forensic study of sediment system response, this Topic Area will determine the magnitude and spatial extent of how these large-scale controls affect geomorphic and ecosystem evolution within the sediment system.¹

- Product A1.1.1: Identification of major sources and sinks of sediment in the regional system (input to Focus Areas B, C, and E)
- Product A1.1.2: Controlling parameters and dependencies for geomorphologic and environmental response of the regional system (input to Focus Areas B, C, and E)
- Product A1.1.3: Implications of meeting long-term sediment management goals in the regional system (joint with Focus Area C)
- Product A1.1.4: Scaling relationships to characterize large scale processes from small scale process descriptions

Topic Area A1.2: Forcing of Regional Sediment Processes

Examination of long-term weather patterns by the climate change community is revealing the existence of cycles, such as El Nino, that have implications on long-term RSM practices and strategies. Based on what is being learned in the weather-related scientific community, and examination of available long-term tide, wind, flooding, freeze/thaw, and wave data, this Topic Area will characterize regional-scale response to shelf- and continental-scale processes, changing climate patterns, and storm cycles.

- Product A1.2.1: Climate Patterns and Storm Cycles: Implications for Regional Processes (input to Focus Areas B & C)
- Product A1.2.2: Regional Geographic Controls on Hydrodynamic Processes (input to Focus Areas B, C, and D)
- Product A1.2.3: Impact of large storms and floods on morphologic response (input to Focus Areas B, C, and D)

***Topic Area A1.3: Formation and Evolution of Morphologic Features**

Morphologic features within the watershed, such as gullies, stream and river channels, headward erosion, nearshore berms, placed dredged material, etc. have a significant role in regional sediment management. How these features form and evolve as a function of the controlling processes (e.g., currents, waves, winds, precipitation, groundwater seepage, water table, snowmelt, storms, floods, ice freeze/thaw cycles) is critical in determining the sediment yield of the system. Engineering works such as reservoir operations, dams, biostabilization of streambanks, and structure removal also play a role in determining the creation and evolution of these features. This Topic Area will determine the relationship between sediment processes and these morphologic features and engineering controls.

- Product A1.3.1: Mechanics of formation for morphologic features (input to Focus Areas B, C, and D)

**REGIONAL SEDIMENT MANAGEMENT
RESEARCH PROGRAM
Draft – 1 January 2002**

- Product A1.3.2: Evolution of and controlling processes for morphologic features within the sediment system, particularly in response to projects (joint with Focus Area C and input to Focus Areas B, C, and D)
- Product A1.3.3: Determination and description of the roles of soil mass movements (landslides, debris flows, etc.) on medium-scale sediment systems (input to Focus Areas B, C, and D)
- Product A1.3.4: Behavior of sediment in receiving waters (downstream, in-reservoir, and upstream) (input to Focus Areas B, C, and D)

Area 2: Short-Term Dynamics of Local-Scale Sediment Processes

Despite more than a century of research on sediment processes, there still exist a number of knowledge gaps regarding key sediment processes. This effort will focus on filling the knowledge gaps in the description and analysis of short-term (minutes to 10's of years) sediment processes. This type of information is also required for project design, operation, and optimization. An improved, gap-filling description for several processes will be provided to answer questions such as:

- What are the basic processes that mobilize, transport, and erode sediment through the sediment region?
- What are the processes affecting water quality and turbidity associated with sediment in transport? How do these affect the local and/or regional ecosystem?
- How do cohesive sediments aggregate, settle, and form fluid mud and deposited beds? How are those sediments reentrained into the water column?
- How are nutrients mobilized and transported in the sediment system? Are contaminated sediments in the bed or channel more readily mobilized in a area with a sediment deficit?
- How do freeze/thaw cycles, wind, rainfall, and snowmelt affect overland erosion?
- What are the dominate processes in bluff, bank, and cliff erosion? How do human activities affect them?
- What is the relative contribution of wind to total sediment transport in various environments?
- How do extreme events contribute to sediment mobilization and transport?
- How can the physics of sediment processes, which occur at very small spatial and temporal scales, be described at larger scales and lower resolution?

This research area will focus on short-term temporal sediment processes in order to provide the parameterizations necessary for long-term characterizations. Topic Areas will address needs 8, 22, 61, 67, 82, 83, 86, and 99 listed in the field needs Appendix.

Topic Areas:

The work on sediment processes has been divided into two Topics based on dominant physical and chemical processes, but will be coordinated by the Focus Area manager to ensure an integrated approach and unity of findings. Allocation of funds will be based on the largest and most profound knowledge gaps.

REGIONAL SEDIMENT MANAGEMENT RESEARCH PROGRAM Draft – 1 January 2002

Topic Area A2.1: Sediment Processes

This Topic Area will fill knowledge gaps in our understanding of the processes of sediment erosion/suspension/liquefaction, transport by air/water flow, settling/sliding/flowing, deposition, and consolidation/diagenesis.

Products include:

- Product A2.1.1: Determination of the relative importance of various sediment processes, the paths of sediment transport, and key sediment sources and sinks in watersheds for periods less than decades (input to Focus Areas B, C, & D)
- Product A2.1.2: Algorithms for quantifying the processes that influence retention, transport, and sorting of sands and silts/clays from sediment mixtures. (input to Focus Area B)
- Product A2.1.3: Algorithms quantifying transport of sediment during extreme events and how they may contribute to long term effects. (input to Focus Area B)
- Product A2.1.4: Algorithms for cohesive sediment aggregation processes and calculation of settling, fluid mud formation, and deposition. Algorithms for cohesive sediment reentrainment and erosion. (input to Focus Area B)
- Product A2.1.5: Effects of biological processes on sediment transport – bioturbation of beds, agglomeration by feeding/filtering, gas formation, organic coatings and algal mats. (input to Focus Area B)
- Product A2.1.6: Bed formation processes – layering, hindered settling, and consolidation. (input to Focus Area B)
- Product A2.1.7: Laboratory and field data sets on environmental forces and sediment transport. (input to Focus Areas B, C, and D)

***Topic Area A2.1a: Sediment Processes – Non-cohesive**

***Topic Area A2.1b: Sediment Processes – Cohesive**

Topic Area A2.2: Sediment and Water Quality

This Topic Area will focus on the contributions of sediment to water quality problems, including turbidity and its effects and nutrients attached to the sediment particles.

- Product A2.2.1: Identify the source(s) and prioritize sediment-related water quality problems within watersheds (input to Focus Areas B and C)
- Product A2.2.2: Simple methods for determining the processes, morphologic conditions, and sediment characteristics that result in nutrient losses associated with bed and bank erosion versus deposition, sediment burping, and bed bioturbation (input to Focus Areas B, C, & D)
- Product A2.2.3: Determination of the influence of water quality (temperature, chemistry, specific conductance, organic solids, etc.) and microbial activity on sediment storage and diagenesis over timescales of 1-10 years (input to Focus Areas B, C, & D)

**REGIONAL SEDIMENT MANAGEMENT
RESEARCH PROGRAM
Draft – 1 January 2002**

CONNECTIONS TO OTHER EFFORTS:

- Corps of Engineers
 - National Shoreline Erosion Study (led by IWR)
 - National Regional Sediment Management Demonstration Program
 - Coastal Inlets Research Program (CIRP)
 - General Investigations R&D Program work units
 - District studies (e.g., Demonstration Erosion Control (DEC))
 - Dredging Operations and Environmental Research (DOER) Program
- U.S. Geological Survey (e.g., Hurricane and Extreme Storm Impact Studies, National Mapping and Remotely Sensed Data, National Geospatial data, biological resources information)
- Bureau of Reclamation (e.g., water quality, water resource management, and ecology studies)
- USDA National Resource Conservation Service (Sedimentation Lab and others)
- USDA-Forest Service (Rocky Mountain Research Station)
- Environmental Protection Agency (e.g., NPS and TMDL programs)
- DOE/Sandia National Laboratory (e.g., environmental, geoscience and the environment programs)
- Storm Forecasting Center in Miami, Florida

REGIONAL SEDIMENT MANAGEMENT RESEARCH PROGRAM Draft – 1 January 2002

FOCUS AREA: B. Modeling and Assessment

OBJECTIVE: Provide analytical techniques and models that give the USACE capability to characterize both regional-scale and local-scale project sediment impacts -- sediment yield, transport and fate -- and to select and evaluate management alternatives.

GENERAL APPROACH: A suite of tools will be gathered, developed and integrated into an Regional Management System (RMS). The tools and models will represent the action of single and/or multiple projects plus cumulative effects at the scale of the natural physical processes and the zones of influence of the projects and can be used to evaluate alternatives which are described by the Focus Area C, Engineered Solutions. These tools will permit evaluation of sediment inflow, transport, deposition, and erosion under the no-action scenario plus both soft and hard engineered solutions, with the aims of high performance water resource projects with minimum overall costs and maximum environmental enhancement.

The end user will be able to evaluate sediment region alternatives in three application levels, employing a phased array of tools appropriate to the problem and stage of study.

PRIMARY PRODUCTS: Products from this Focus Area will consist of tools for modeling and assessment of alternatives. Tools will be developed using improved knowledge and algorithms from Focus Area A, Processes; feature designs and their effects from Focus Area C, Engineered Solutions; and software tools from Focus Area D, Informatics. All products developed within the M&A area will, where practicable, be backward compatible with legacy technology. In addition, all new products will be fully coordinated with developments in other RSM Focus Areas and SMART. Individual products are listed by topic below. Tools will be documented in Technical Notes, user manuals, web content, and online help systems. Independent peer review of the tools and their verification and validation will be accomplished by the program and by journal publications.

WORK DESCRIPTION

Level One: Screening Tool

The Level One product will consist of a screening level tool easily used by any practitioner. It will involve simple models and relationships for sediment source identification, qualitative sediment budget development, and historical trend analyses. It will be operated via a graphical user interface (created in Focus Area D) with web connectivity for data mining. This tool will be such that it may be applied easily to a large area using readily available digital data. The user will highlight an area on a map of the US and the program will retrieve the appropriate topographic, hydrographic, soils, land use/land cover, and climatological data for any region in the Continental US. The user may then rapidly alter land use, land cover, conservation practices, meteorology, climatology; add project features such as locks, dams, channel improvement, and river

REGIONAL SEDIMENT MANAGEMENT RESEARCH PROGRAM Draft – 1 January 2002

training or coastal works; and simulate catastrophic events such as forest fires, landslides or hurricanes. “Hotspots” in a region will be readily identified using a simple visual method such as shades of green, amber and red. Areas of low sediment yield/movement/accumulation will be displayed as green, moderate by amber and acute by red. Water quality components will be added in cooperation with other R&D programs. Many components will be GIS-based and will be drawn from existing work, such as the National RSM Demonstration Project in the Corps' Mobile District and elsewhere. The Level One tool will be developed in concert with the Informatics Focus Area.

Topic Areas are:

*Topic Area B1.1 Screening System

Existing algorithms for sediment yield, movement and deposition will be evaluated and modified as necessary for inclusion in the Level One screening level tool. Data from the Processes and Engineered Solutions Focus Areas plus data mining tools from the Informatics Focus Area will be incorporated. The Informatics Focus Area will supply a common Graphical User Interface (GUI) for easy use of the screening level tool. The tool will allow rapid import of existing data and identification of potential sediment problem areas.¹

- Product B1.1.1: SBAS. Sediment budget analysis system for regional scale sediment, nutrient and contaminant budgets. This existing program, developed under the General Investigations R&D program and the Coastal Inlets Research Program, will be modified to apply to any region in a sediment region. Supports needs 1, 8, 30, 53, 56, 69, & 71 as shown in the field needs Appendix.
- Product B1.1.2: Regional Sediment Screening System. This GUI-based system will allow rapid import of existing data and identification of potential sediment problem areas. General treatments and their system-wide effects can be applied and qualitatively evaluated under various scenarios of present or proposed conditions. Project features and their impacts can be evaluated in series or parallel mode. Supports needs 1, 6, 18, 20, 21, 50, 61, 71, 75, & 77 as shown in the field needs Appendix.

Level Two: Alternatives Analysis

Level Two tools will incorporate more sophisticated calculations in a decision-support framework created by Focus Area D. It will offer practitioners more sophisticated analysis options so that the red/amber/green areas identified during Level One analysis can be further evaluated. In this level, an expert system will provide practitioners with the best available information on existing and proposed sediment management features as defined by the Engineered Solutions Focus Area. The expert system will contain a repository of available data and suggest sediment control techniques and their expected effectiveness for a given set of parameters and geographical location. Photographs will

¹ Topic Areas with asterisks will be funded in FY02.

REGIONAL SEDIMENT MANAGEMENT RESEARCH PROGRAM Draft – 1 January 2002

be available where appropriate. In addition, more complex tools will allow application of the indicated techniques or combination of techniques and fill in technology gaps in our current capabilities. This will allow the effectiveness for each combination to be evaluated, allowing alternative schemes to be readily evaluated and compared for both cost and effectiveness.

Topic Areas are:

Topic Area B2.1 Expert System

This topic will develop an easy-to-use expert system for rapid access to guidance on sedimentation problem solutions, complete with description, applicability, pictures and design specifications. It will be a joint effort with the Engineered Solutions Focus Area and Informatics Focus Area, with the latter creating the framework and interface and the former populating the database; while this Focus Area will insert the analysis and comparison tools.

- Product B2.1.1: Expert Local Reference System. Easy-to-use expert system for rapid access to guidance on sedimentation problem solutions, complete with description, applicability, pictures and design specifications. Supports needs 8, 18, 43, 61, & 98 as shown in the field needs Appendix.

***Topic Area B2.2 Regional Morphology Models**

An overarching model or models characterizing regional-scale sediment mobilization, movement, and deposition over long time scales will be developed. They will accumulate/extrapolate results from successively smaller scale calculations, using the concepts employed by the Cascade model for coastlines. Existing models (such as Cascade) will be improved as needed and new models developed for other areas if necessary. The regional-scale models will draw heavily on processes and scaling knowledge provided by the Processes Focus Area and the detailed modeling capabilities provided by Topic Area B3.1.

- Product B2.2.1: Cascade-C. A regional shoreline change model for prediction of longshore extent of engineering activities on time scales from years to decades. It will span multiple barrier islands, mainland features, and inlets and allow engineering activities on the adjacent shoreline to be modeled. This existing model, developed under the Coastal Sedimentation and Dredging Research Program, will be upgraded. Supports needs 1, 2, 15, 23, & 81 as shown in the field needs Appendix.
- Product B2.2.2: Cascade-I. A regional model to evaluate watershed, riverine, lacustrine, and estuarine engineering effects over the sediment region on time scales from years to decades. It will allow system analysis of addition or removal of features such cutoffs, reservoirs, channel improvements and changes in inflowing sediment loads. Supports needs 1, 2, 12, 20, 30, 50, 56, 61, 75, 77, 82, & 98 as shown in the field needs Appendix.

REGIONAL SEDIMENT MANAGEMENT RESEARCH PROGRAM Draft – 1 January 2002

* Topic Area B2.3 Sediment Environmental Effects

Modeling approaches will be developed to analyze the environmental effects of sediment resuspension, transport and deposition, specifically on habitat and aquatic species, including comprehensive evaluation for a range of Total Maximum Daily Load (TMDL) metrics appropriate for sediment. This work will be shared with the SMART program and closely coordinated with other programs in environmental quality.

- Product B2.3.1: TMDL Evaluation Models. Models for use in determining sediment-related TMDL criteria, sources of sediment, and sediment region sensitivity to changes as they affect TMDL's. Supports needs 1, 6, 8, 9, 50, 53, 71, 75, 89 & 98 as shown in the field needs Appendix.
- Product B2.3.2: Model for Project Effects on Habitat. Existing models will be improved to determine quantities of sediment re-suspended by navigation and flood/storm damage reduction projects, where the sediment re-deposits, and how both affect and are affected by aquatic habitat. Supports needs 11, 75, 87 & 89 as shown in the field needs Appendix.

Level Three - Design for Regional Management

For detailed analysis, users will employ complex multi-dimensional models and algorithms to evaluate individual sites or areas, design project features and feed information back to Level Two analysis. Examples of features to be analyzed include wetland/buffer zones, training works, dams, and channels, which will be characterized by sediment yield, transport, bed, bank, and shoreline effects.

Topic Areas are:

* Topic Area B3.1 Improved Multi-Dimensional Sediment Processes Models.

Existing models will be enhanced with improved physics, more efficient computational methods, and better connectivity/interoperability. Many of these models have been developed under other programs, and need only be adapted here to support regional applications. The WMS/CASC2D/GSSHA suite will be enhanced by the addition of additional in-stream transport functions and an improved overland erosion/transport routine. The models will be operated to generate data sets that can be used by Topic Area B2.2 to parameterize sediment processes.

- Product B3.1.1: Improved Models for Wetland Restoration & Design. Enhancements to existing models will allow detailed evaluation of wetland restoration on sediment interception and water quality function. Supports needs 1, 3, 6, 8, 9, 50, & 53 as shown in the field needs Appendix.
- Product B3.1.2: Multi-Dimensional Morphology Change Models. Simulation of hydrodynamic and morphologic changes at a project-level scale for long time periods will provide input to the Cascade-type regional-scale models. Supports needs 2, 13, 15, & 82 as shown in the field needs Appendix.
- Product B3.1.3: Improved WMS & SMS Models. Enhancements to the computational models supported by these systems will allow detailed evaluation of wetland restoration on sediment interception and water quality function.

REGIONAL SEDIMENT MANAGEMENT RESEARCH PROGRAM Draft – 1 January 2002

Analysis of regional sediment transport and WQ using 3-D models will be possible. Supports needs 1, 3, 6, 7, 8, 9, 13, 50, 53, 75, 87, 88 & 89 as shown in the field needs Appendix.

Topic Area B3.2. Model Uncertainty

Total uncertainty in the sediment model results will be quantified, including the uncertainty in input data, boundary conditions, algorithms and their parameters, and basic understanding of the processes. Tools will be developed to allow calculation of error bars on the final model results.

- Product B3.2.1: Guidelines for evaluating the uncertainty of input data, including topography, hydrography, water level, discharge, sediment quantity, and sediment characteristics, as they are derived from various measurement methods and sources. Produced in cooperation with Engineered Solutions topic C8. Supports all modeling needs cited here and in field needs Appendix.
- Product B3.2.2: Model Uncertainty Calculator. Computational tool that calculates error bars on results of the sediment models developed/adapted by this program. Supports all modeling needs cited here and in field needs Appendix.

Topic Area B3.3 Model Selection & Guidelines.

Data sets and criteria for model evaluation will be developed. A comprehensive document will be prepared to give guidelines for testing and selection of the appropriate model and assessing model applicability for various solutions and regions.

- Products B3.3.1: Model Test Data and Criteria. Analytic solutions, lab data, and field data sets appropriate for model testing and evaluation, plus criteria for judging model performance against them.
- Product B3.3.1: Model Selection Rules. A rule-based system for selecting the model(s) most appropriate for a given site, processes, and problem. Advantages and disadvantages will be given along with guidelines on parameter selection and warnings against inappropriate uses.

CONNECTION TO OTHER EFFORTS:

- Corps of Engineers
 - US Army Corps of Engineer District offices will be asked to assist in testing and debugging Beta versions of the various models.
 - Coastal Inlets and Dredging Operations and Environment Research Programs models will be adapted as needed
 - General Investigations Research Programs models will be adapted as needed.
- U.S. EPA: detailed data set for the South Fork of the Broad River, in Georgia.
- USDA National Resources Conservation Service: Tifton, GA field station
- US Geological Survey Community Models Program
US Bureau of Reclamation

REGIONAL SEDIMENT MANAGEMENT RESEARCH PROGRAM Draft – 1 January 2002

FOCUS AREA: C. Engineered Solutions

OBJECTIVE: Provide guidance for designing, constructing, operating, and maintaining Corps of Engineers water resource projects and monitoring sediment responses to effectively manage sediment from a regional perspective, and manage individual projects within the context of regional sediment management objectives.

The Focus Area will address five principal needs:

1. Source control on Corps' projects and outside areas that affect Corps' projects (e.g., watershed best management practices (BMP's), stormwater management, vegetation buffers, land use),
2. Impoundment management (e.g., dam construction and removal, sediment removal and relocation, shoreline stabilization, restoration, sluicing, bypassing, downstream flow control),
3. Channel and shore modification (e.g., stabilization of bed, banks, and shores, training structures, flood control and navigation facilities, buffer design) in all geographic zones to maintain key sediment transport and morphological processes,
4. Project site operations, sediment handling and use (e.g., water level and flow control, bypassing, trapping, transport, turbidity management, ecological restoration, beach and bank fill) in all geographic zones,
5. Integrated systems of components that monitor and manage water and sediment over a sediment region, including measurement methods to define sediment behavior and projects' performance.

GENERAL APPROACH: Efforts in this Focus Area will focus on best engineering practice solutions to regional and long-term sediment management needs. It will produce guidelines to design and manage projects in a manner that optimizes project performance at not only the traditional project level, but also at the large-scale, long-term, multi-purpose level. Such a systems approach for regional sediment management will consider cumulative impacts of Corps' activities on major morphologic bodies consisting of interconnected watersheds, rivers, reservoirs, estuaries, inlets and shorelines with the objective of maximizing environmental and economic benefits and maintaining the health of embedded or overlying ecosystems.

Many regional sediment management actions can be selected (with varying levels of certainty of success) using existing technologies while the RSM R&D program improves those technologies and develops new alternatives. Thus, a two-phase sequence to the development of regional sediment management solutions will be accomplished. Early efforts will focus on formulating generalized guidelines on best present site-specific practices that address regional sediment management objectives. Early development of guidelines will provide immediate capabilities to users through the Informatics and Technology Infusion and Transfer Focus Areas initial products. Out-year efforts will build upon newly developed analytical and decision support tools and improved understanding of underlying processes as developed in the other Focus Areas of the program. Work will be leveraged against research in other Corps Programs, and

REGIONAL SEDIMENT MANAGEMENT RESEARCH PROGRAM Draft – 1 January 2002

by Corps' projects such as the RSM National Demonstration Program as discussed below.

PRIMARY PRODUCTS: Products from this Focus Area will consist of designs, operational methods, and maintenance techniques to accomplish sediment management and monitor its effects. Those products will be conveyed in (1) short how-to technical guidance documents in the form of Technical Notes and input to web-based applications (see Informatics) that provide users with the guidelines, criteria, and tools to identify problems, define system boundaries given regional and project objectives, and to select management measures that optimize project objectives from a regional perspective; (2) revisions to EMs, ERs, and other technical design guidance documents; (3) workshop and training materials, and (4) input to the Processes, Modeling and Assessment, and Informatics Task Areas so that the effects of structures and nonstructural management measures can be considered in terms of their impact on processes, analyses, and decision-making.

WORK DESCRIPTION

Topics in this Focus Area are organized primarily on the basis of physiographic/ecosystem units to facilitate technology infusion, but work will be coordinated by a capstone topic. In addition, the capstone topic will integrate technologies and guidelines developed for the individual ecosystems. Wetlands management solutions tend to be unique within each ecosystem type, so those solutions will be a component of each ecosystem-based topic and coordinated through the capstone topic. A topic on measurement/monitoring methods rounds out the Focus Area. Topics are:

*Topic Area C1. Optimal System-Wide Sediment Management

This work will manage and integrate the individual components into a system-wide perspective to manage sediment globally. It will identify the interactions among projects and regional sediment processes, and apply solutions to optimize regional sediment needs. The regional effectiveness of sediment management practices will be evaluated.

Products include:

- Product C1.1 Guidelines for Successful Sediment Management – A series of Tech Notes and Guidance Updates will define sediment manage successes and what made them successful.
- Product C1.2. A sediment management framework – a step-by-step process for planning, designing, constructing, operating, and maintaining system components that contribute to overall management of sediment in a region. Will include a list of stakeholder agencies.
- Product C1.3. Solutions database – a source of successful project components that work under prescribed conditions and from which can be drawn suggested solutions.

**REGIONAL SEDIMENT MANAGEMENT
RESEARCH PROGRAM
Draft – 1 January 2002**

- Products C1.4. Component solutions. Focused research and demonstrations will contribute component solutions to the framework and database.
- Product C1.5. Costs and Benefits database. A database of the costs and benefits of management solutions will be created to support planning, engineering, and operations efforts.
- Product C1.6. Business Processes Support. Support will assist HQUSACE in defining practices and processes across business areas that facilitate regional management.
- Product C1.7. Case studies. Demonstration projects and Pilot studies validating and employing RSMP products to help solve regional challenges.

***Topic Area C2. Measuring and Monitoring Sediment**

Advances in satellite, global positioning, photographic, and acoustic technology for ascertaining sediment transport and yield on regional scales will be evaluated and adapted and new technologies developed for regional sediment monitoring. Technical advances in the areas of sensor and data processing technology will be developed and tested in demonstration projects. Data produced in this work will serve as input to all other topics in this Focus Area. Data analysis and handling methods will be transferred into the Modeling and Assessment and Informatics Focus Areas for tools implementation. It will depend on leveraging efforts with demonstration projects and draw heavily from other programs, notably Surveying and Mapping.

Products include:

- Product C2.1. Sediment measurement and monitoring methods plus data analysis tools for both local and regional application.

CONNECTION TO OTHER EFFORTS:

- Corps of Engineers
 - Section 32 and 227 Erosion Protection Programs
 - Great Lakes Sediment Study
 - Chesapeake Bay Program
 - National RSM Demonstrations
 - Coastal Inlets Research Program (CIRP)
 - General Investigations R&D Programs -- EMRRP, FDRP, etc.
 - District studies (e.g., Demonstration Erosion Control (DEC))
 - Dredging Operations and Environmental Research (DOER) Program
- Environmental Protection Agency (non-point source (NPS) and TMDL programs).
- U.S. Geologic Survey (regional data collection and monitoring)
- U. S. Bureau of Reclamation (reservoir management).
- U.S. Department of Agriculture and National Resource Conservation Service (land use and BMP's]
- U.S. Forest Service and Bureau of Land Management (watershed management efforts for NPS)

**REGIONAL SEDIMENT MANAGEMENT
RESEARCH PROGRAM
Draft – 1 January 2002**

- U.S. Fish & Wildlife and National Marine Fisheries Services (dam removal, environmental impacts, etc.)
 - Federal Emergency Management Agency (e.g., sediment needs in flood and storm damage reduction, and post-event repair)
 - National Oceanic and Atmospheric Administration (e.g., National Marine Fisheries Service, coastal monitoring & measurement, data archiving)
- State and Local Organizations (demonstrations, watershed management initiatives, etc.)

**REGIONAL SEDIMENT MANAGEMENT
RESEARCH PROGRAM
Draft – 1 January 2002**

FOCUS AREA: D. Informatics

OBJECTIVE: Produce an informatic environment complete with data, software tools, and procedures that facilitates effective Corps business practices and decision-making in regional sediment management.

The tools provided will be useful to decision support in all aspects of sediment management including planning, design, construction, and operations. In each of these management areas, USACE will be able to perform alternative analyses using a variety of tools from simple decision support tools to the most comprehensive numerical modeling systems.

GENERAL APPROACH: The produced environment will include database tools to house existing and collected data, screening and higher level numerical models, and decision support tools (with seamless linkages to GIS) that can assist managers, stakeholders, and technical specialists in using the various field, analytical, and numerical data to make decisions. The informatics and decision support tools will be graphically based and, where appropriate, web-enabled using a combination of in-house and commercial products. This Focus Area will be responsible for fielding integrated, interoperable suites of the tools and data developed in the other Focus Areas of the program.

The general approach will be to develop management tools for every aspect of the regional sedimentation problem. The developments will be pursued in two thrusts: 1) easily implementable tools based on the best practice currently available but not widely publicized or implemented and 2) development of more comprehensive tools that implement new technologies developed in the other Focus Areas of the program. Both will leverage significant developments recently made by the Corps and other agencies in the informatics and decision support arena. In some cases very little development is needed to adapt existing tools to provide powerful regional sedimentation solutions. In others, there are few existing protocols or applications that can provide starting points, thereby necessitating more extensive development.

Sediment management informatics includes the ability to process and analyze data, conduct analytical and numerical simulations, design and evaluate engineering solutions, and manage sediment related operations. Each of these require the use of geospatial tools for mapping and analysis, databases for data storage and analysis, modeling tools for simulation, and decision support tools to assist management decisions. Fortunately, there has been much development in Geographic Information Systems (GIS) and environmental models that can be used to start our development process. In each, there are market dominant software and hardware systems that reduce the need for applications on multiple platforms. Additionally, there are emerging metadata standards across these industries that simplify software development.

PRIMARY PRODUCTS: The products will be developed and fielded in phases following the approach given above. Specific products for each unit are listed by topic below.

REGIONAL SEDIMENT MANAGEMENT RESEARCH PROGRAM Draft – 1 January 2002

It is clear that GIS applications (such as those written for ESRI products like ArcInfo and ArcView) are and will be useful for many of our mapping and spatial data interpretation needs. The acceptance of GIS in Corps business practices is apparent. Therefore, the development path is rich for tools that require such geospatial capability. However, GIS is not ideally suited to 3-dimensional (3-D) or transient data, which is why environmental modelers have developed specific systems for their purposes. In the hydroenvironmental modeling field, the Corps' Watershed Modeling System (WMS) and Surface Water Modeling System (SMS) provide a basis for multi-dimensional and transient modeling tools. The Corps' Water Management System (CWMS) provides one-dimensional modeling tools. All of the new sedimentation management tools will be implemented so as to make the best use of these products (and enhancements thereto made within this program).

In the end, the tools will run on field personal computers using industry standard operating systems and software applications. Further, the developed applications will be web-enabled to facilitate connectivity to remote databases and web access. Data, models, and decision support tools will be accessible over the Internet. Additionally, computing resources that exceed the desktop will be accessible over the Internet in a manner that is user-friendly to both technical and administrative personnel. Developments in the Land Management System (LMS), among others, will serve as a basis for developments in this area.

WORK DESCRIPTION:

Work will be accomplished in the following topics.

***Topic Area D1: Database Tools for Data Storage and Mining**

A standard database template will be developed to support RSM goals. This system will include support for multiple data types including spatially and temporally variant data sets. Typical RSM data sets include bathymetry, topography, discharges, water surface elevations, sediment sizes and loads, dredging volumes, economic information, modeling output, etc. These data sets must support modeling and decision support at both large regional scales and at smaller geographical but potentially more data intensive local scales. The database tools will provide efficient connectivity between decision support tools, computational models, locally accessed data and larger corporate scale data repositories. Furthermore, the database tools will include the development of adequate meta-data that facilitate data mining and solution archiving. These tools will be established through leveraging and collaboration with the Geospatial R&D Program to insure maximum synergism. Tri-Service GIS/CADD and other industry standards will be used.

- Product D1.1: Database Schema
- Product D1.2: Modeling Metadata Standards
- Product D1.3: Integration between local and remote databases
- Product D1.4: Prototype operational database

REGIONAL SEDIMENT MANAGEMENT RESEARCH PROGRAM Draft – 1 January 2002

***Topic Area D2: Decision Support Tools for Multi-Level Analyses**

This topic will develop decision support (DS) tools specific to RSM. These DS tools will work at both local and regional scales. They will provide quick, screening level solution recommendations (and caveats) as well as more accurate and resource-intensive design-level recommended solutions. The DS tools will provide the integration framework between the database system described in topic D1 and the numerical modeling tools developed in the Modeling and Assessment Focus Area and described in topic D3. Alternatives analyses will be conducted using various DS tools such as Monte Carlo simulation. The products will be capable of decision support at the initial assessment and at follow-up evaluations under adaptive management. The work will be performed jointly with the Modeling and Assessment and Engineered Solutions Focus Areas, with the former contributing assessment components, the latter contributing data, designs, and lessons learned, and this work providing the user interface, mining, knowledge management, and decision components.

- Product D2.1: Decision Support Framework
- Product D2.2: Visualization Tools
- Product D2.3: Alternative analysis tools

***Topic Area D3: Informatics Tools for System Wide Numerical Simulation**

Numerical simulation tools developed in the Modeling and Assessment Focus Area will include support for local as well as regional scale problems. Numerical simulation tools will be complemented by tools and procedures produced here that enable interoperability and model-to-model connectivity so that models of different scales and scopes can be integrated into a seamless decision making system. Simulation tools will use data stored in the database system described in topic D1 as simulation input and write results to the database for decision support as well as data mining purposes. This unit will concentrate on the combination of information technology and modeling outputs, along with alternatives analysis. Tools that can handle multiple conceptualizations will be a central focus.

- Product D3.1: Analysis tools that integrate local and global modeling
- Product D3.2: Model integration protocols
- Product D3.3: Screening level analysis tools
- Product D3.4: Integration of model I/O with database tools

Topic Area D4: Web Based Framework for Informatics

All informatic and decision support tools will integrate state of the art web features. This will allow data from various locations to appear to the user as being local. All transactions will use secure transaction protocols to insure the security of the data. All tools will also incorporate individual user profiles so that each user is presented with a unique and configurable view. Web-based tools will allow users to access data located in local and remote databases as well as decision support and modeling results.

**REGIONAL SEDIMENT MANAGEMENT
RESEARCH PROGRAM
Draft – 1 January 2002**

- Product D4.1: Unique, configurable web-portal to DS tools
- Produce D4.2: Web based access to all decision support and modeling results

The work will be accomplished in phases. Phase 1 will consist of working with field focus groups to identify key elements of our business practices that must be automated or improved, to identify promising tools or technologies that can be fielded quickly until more comprehensive tools are developed, and to produce alpha versions of tools that will be field tested. Phase 2 will refine the developments of Phase 1 based on user tests and advances in the other Focus Areas, and begin the development of more comprehensive products in consultation with users. Phase 3 will consist of final field testing and fine tuning developed technologies. It will also include the release of the software products and training.

CONNECTION TO OTHER EFFORTS: The products developed in this Focus Area will be based on technologies developed in other Focus Areas of this program as well as those developed in XMS, SMART, LMS, and CWMS. Research in this Focus Area will be closely associated to other USACE research programs (DOER, CIRP, EMRRP, FDRP, Geospatial, etc.). Reimbursable projects with Districts and other sponsors including the USEPA will provide test beds for the developed software and a substantial leveraging of funds.

**REGIONAL SEDIMENT MANAGEMENT
RESEARCH PROGRAM
Draft – 1 January 2002**

FOCUS AREA: E. Technology Transfer and Insertion

OBJECTIVE: To insert the products (knowledge, models, designs, decision tools, databases) from the Regional Sediment Management Research and Development Program into USACE practice, to inform and be informed by stakeholders and the public, and to facilitate mutually beneficial exchanges with other organizations.

GENERAL APPROACH: An improved definition of needs, evaluations of product usability, and methods for technology insertion will be obtained from USACE field and headquarters staff. New knowledge and capabilities will be “pushed” to USACE end users within the context of their business processes and with minimal disruption to their operations and minimal training requirements. This requires a systematic approach for delivery of a technology product line that is consistent and predictable for all products and services, and builds off a common USACE IT framework that is common across multiple product lines. Educational materials will be generated and published in forms appropriate for stakeholder use. Field reviews of products will be facilitated.

PRIMARY PRODUCTS: This Focus Area will provide some end user products in and of itself, such as the RSM web site, and some internal products, such as guidance for product planning. It will also provide services that enable successful transfer of products from other program work units. Individual products are discussed by Topic Area below.

WORK DESCRIPTION:

Formation of Review and Advisory Groups: A Division-office and HQUSACE Management Group, a District-level Field Review Group, and focus sub-groups of users will be formed. Visits and liaison with other agencies, such as the U. S. Geological Survey and National Resource Conservation Service will be facilitated. Program and product review procedures will be formalized.

Life Cycle Planning: This technology insertion approach needs a life cycle plan that serves as the overarching context for all products and services that emerge from the RSM investment. Each specific report, database, analysis tool and/or service also has a life cycle plan that is tiered off this overarching plan, but covers only the specifics related to new capability. The overarching plan needs to be developed in the first year of the program (although the plan will continue to evolve throughout the life of the program), so that each specific product life cycle plan lies within this common context.

Product Delivery Guidelines: Another critical initial effort is the product delivery guidance process and specifications. This guidance will describe how capabilities move from R&D, through a testing and acceptance, to fielding and support. This guidance will spell out required documentation and metadata for each capability at each step in transition from R&D through testing, verification, acceptance, fielding, upgrades and support. This effort will also need to have a primary thrust in the first year of the

REGIONAL SEDIMENT MANAGEMENT RESEARCH PROGRAM Draft – 1 January 2002

program, so that the guidance is consistent for all capabilities emerging from the program. This effort will require an effort beyond guidelines – there will also be a formal acceptance procedure, so that new functions and capabilities that are “pushed out” to the field have fully met operational requirements for the product line and can be confidently supported and sustained for field usage. Thus, one phase of this effort will involve a formal acceptance of products/capabilities as having met RSM documentation and performance standards.

Customization Requirements: Many products require special adjustments for implementation at specific sites. To the greatest extent possible, the design of the capabilities will be sufficiently flexible that technology insertion can occur without special coding and linking or process changes in operational workflows. But processes do differ between different field operations, as do some of the underlying business tools. Thus, some tweaking will be necessary to achieve successful technology implementation at specific field sites (e.g. across a Division, at a specific District, or for a Corps of Engineers business partner). These requirements may be partially anticipated in a technology delivery plan, but will be implemented under the Corps’ technical support programs.

Training Materials/Services: The product delivery guidance will include requirements for training materials. Wherever possible, training materials will be available within the context of field operations, so that resources are available when and where most relevant. For some new capabilities, there will also be requirements for workshops and courses – so one aspect of technology insertion will be to examine the training requirements. To the extent possible, these requirements should be kept to a minimum – capabilities will be fielded with embedded self-teaching/self-learning modules that are available within context. The extent of the training requirements will be identified in the life cycle plan for each capability – but formal training events will logically cover all fielded (or soon to be fielded) capabilities within the RSM product line.

System Interfaces and Linkages: New knowledge and capabilities will be presented to the field flow through existing processes and computational/communication resources of the field. Linkage and interface requirements will be identified in the life cycle plans, and then feed back into the Informatics Focus Area efforts. The technology delivery concern is ensuring that the downstream requirements (and changes in these requirements) are appropriately considered in the design and development of RSM products.

Marketing: Marketing efforts for RSM products will include: (1) a suite of web services (including pushing relevant information to field operators that help shape and receive RSM capabilities), (2) flyers, newsletters and technical notes that describe the technology program and emerging capabilities from the program, which would all also be web accessible, (3) presentations and papers at USACE and scientific forums, and (4) visits to Corps’ offices and other agencies.

REGIONAL SEDIMENT MANAGEMENT RESEARCH PROGRAM Draft – 1 January 2002

Technical Assistance: Access to expertise will be provided in several forms (e.g. telephone, email, web services, visits to field sites) to ensure that technical assistance be accessible, responsive, and informed. Formal technology assistance programs such as WOTS, DOTS and CAPS have been successful, and the requirements for expert assistance related to RSM will be accommodated by the most relevant existing program or by the establishment of program that covers all Civil Works technology efforts. Procedures will be implemented during the life of this program to ensure the assistance program sustains responsiveness and continuously improves the RSM products.

Technical Editing and Publishing: Technical editing is required for reports, embedded learning aids, flyers, and some aspects of web services. Both funding and time for technical editing will be considered in the life cycle plans. The work will be directed and funded from this Focus Area. Final publication will be supported here.

Post Implementation Evaluation: A consistent process to evaluate if benefits are being realized and to quantified will be instituted. Different types of products and services will require some differences in metrics for evaluation – and these metrics will be identified in the product life cycle plans. The metrics selected will allow for comparisons. For example, if investments in one area yield orders of magnitude more benefit than investments in another area, then the evaluation results will allow for such comparisons. However, some investments, such as increased understanding of processes, may yield primarily indirect benefits. Therefore, evaluations will also require some variation in metrics. To reduce the cost of evaluations, most of the metrics used will be automatically gathered during operations, with results easily retrieved from a website and available when needed by field personnel and project and program managers.

Topic Areas are:

✧ **Topic Area E1. Product Life Cycle Planning**

- Product E1.1: Product Line Life Cycle Plan. This is the overarching planning document for all RSM products and services. This plan includes a preliminary assessment of all capabilities to be developed by RSM and an overall assessment of the RSM investment in relation to the USACE business processes that will be supported and enhanced by this investment. Specific sections include (1) the life cycle management process for RSM technologies, (2) metrics for evaluating the costs/benefit of these technologies from a USACE perspective, (3) procedures for technology acceptance into field operations, and (4) sustaining requirements and costs for operation and enhancement of RSM capabilities. Also included will be the template to be used for life cycle plans for specific capabilities within the RSM product line.
- Product E1.2: Specific Capability Life Cycle Plans. For each specific product emerging from the RSM program, a life cycle plan will be generated that follows

REGIONAL SEDIMENT MANAGEMENT RESEARCH PROGRAM Draft – 1 January 2002

the template in the entire RSM Product Line Plan. These plans are tiered off the Product Line Life Cycle Plan, so very little boilerplate information is required. Rather, the plan only cover the specific issues associated with the specific product or service. Cost/benefit for this specific capability and post-implementation evaluation is a necessary component of each plan. These efforts will be funded from this Focus Area and executed by the contributor within the appropriate RSM Work Unit.

- Product E1.3: Product Delivery Specification Guide. This is a document that describes how RSM products are to be linked into the RSM product line. These specifications will include guidance on design and documentation for all products and services, and specific instructions on acceptance testing requirements. Outcomes of the acceptance testing will provide feedback to developers (in terms of design/operational and documentation issues) and to end users (in terms of operational uses and constraints). Example specifications are to be included as appendices to this document – which will be web-enabled and accessible in a context relevant manner.
- Product E1.4: Acceptance Testing Plan. This is a dependable process of use evaluation and acceptance testing to be delivered seamlessly into field operations. This testing requires a plan that is employed consistently for each capability emerging from the RSM investment. This plan will identify the procedures and milestones to be used for acceptance testing, mechanisms for performing the testing, and estimates on time and equipment and other resources necessary to conduct this testing. Initially, the testing plan will also require establishing some testing facility, but because of the physically distances separating developers and users, and the need for web-accessible products, this facility will allow for web-based testing from sites remote from a primary (or secondary) facility.
- Product E1.5: Acceptance Testing Facility. Acceptance testing in a formal context will require access to testing expertise and facilities. The requirement for facilities and expertise will be identified in the Acceptance Testing Plan – but will then need to established and managed. In addition, an acceptance testing expert is needed to advice on testing processes and ensures standards are met and sustained.
- Product E1.6: Test Results Documents. The results from acceptance testing will become a standard product for each RSM capability. These results may require reworking capability designs – so the testing will be done earlier enough in the design/development cycle to allow for adjustments/corrections. These results will be published in a web-accessible form, and reported at program reviews.

*Topic Area E2. Technology Transition Services

- Product E2.1: Marketing Plan. RSM represents a significant strategic investment for USACE, and a strong marketing plan is needed to explain this strategy to the USACE workforce, identify the intended benefits and products, provide status information on RSM efforts, and communicate with USACE sponsors, partners

**REGIONAL SEDIMENT MANAGEMENT
RESEARCH PROGRAM
Draft – 1 January 2002**

- and potential new customers. Components of this marketing plan include web services and strategy, marketing documents, interagency liaison and other marketing activities (e.g. displays, presentations, forums).
- Product E2.2: Web-Services and Services Plan. The RSM investments will primarily be marketed, fielded, updated and supported through web-based services. These services will be identified in the various life cycle and marketing plans – but will require an ongoing work effort to sustain and support. This RSM web services are also themselves a product of the RSM investment. Services will include calendars for RSM events and product development/completion/upgrade plans, document (briefing, notes, reports, papers, etc) access, information push and pull services, and customization of user profiles (e.g. the RMS portal). Designing and sustaining these services will require a plan and a sustained level of effort.
 - Product E2.3: Software Distribution Center. A center will be established for distributing the tools developed by the program, providing user training, and providing consulting support for beta testing and initial applications.
 - Product E2.4: Post-Implementation Evaluation Plan and Evaluations. Fielded technologies may or may not be achieving their anticipated benefits. This plan will identify a methodology to collect and evaluate the success of RSM capabilities in meeting USACE operational needs and in enhancing USACE operational capabilities. The plan will include means for identifying and achieving necessary corrections in product or service design, implementation or field site preparation that will enhance the value of these fielded capabilities.

The Technology Delivery and Insertion element for RSM will parallel the requirements for other USACE technology programs. Thus, many of the costs for this component can be shared across programs, except those costs that are specific to unique capabilities within the program. The dollars identified for RSM will increase only minimally when the same investment is used for other USACE programs. Total costs for Technology Insertion and Delivery is estimated at about 10 percent.

CONNECTIONS TO OTHER EFFORTS: The connections described in the other topics will be facilitated and coordinated in this Focus Area to ensure that coverage is complete but not redundant. The ERDC Technology Office will be engaged to ensure the broadest applicability and usefulness of the Focus Area efforts.

**REGIONAL SEDIMENT MANAGEMENT
RESEARCH PROGRAM
Draft – 1 January 2002**

APPENDIX: Field Needs in Sediment Management

At workshops and program reviews, in an online virtual forum, and in one-one-discussions, needs for sediment-related knowledge and engineering tools were solicited from Corps of Engineers district, division, and headquarters personnel. The results of those solicitations in terms of high and medium priority needs are listed in Table A1 below. Work Units are listed in Appendix B.

Table A1. RSM FIELD NEEDS FROM WORKSHOPS, MEETINGS, AND VIRTUAL FORUMS

NO.	RESEARCH AND DEVELOPMENT NEEDS	SOURCE (workshop or meeting)	MET BY TOPIC NO.	PRODUCED BY WORK UNITS	SUPPORTED BY WORK UNITS
1	Regional scale hydrologic and sediment models for handling RSM scale problems	Coastal	B2.2	b4, b1	a1, a2, b2, b3
2	Engineer and geological time-scale merging, non-linear dynamic modeling, across time and spatial scales.	Coastal	A1.1 B2.2	a1, a5, b4	a2
3	Improve two dimensional hydrodynamic/sediment transport models	Inland	B3.1	b2, b3	a3, a4, a5, a6, a7
4	Probabilistic forecasts	Inland	A1.2, B3.2		b1-b4, a3,
5	Tweak existing models to run for a certain area (small project land area), how good will they be over a large area?	Navigation	B3.3		
6	Need more universal models that can provide good info on a regional basis		B2.2	b1-b4	a1-a7
7	Need three dimensional model to accurately portray sediment and water split	Navigation	B3.1	b3	a3-a7
8	Consideration of TMDL	Inland	B2.3, B3.1	b2 +	
9	Fate and transport of contaminated sediment	Inland			
10	Greater emphasis on watershed scale, ecosystem based habitat evolution models	Navigation	SMART		
11	Development of aquatic habitat evaluation models that will allow quantification of habitat values in large open river habitats	Navigation	SMART		
12	Long time scale geomorphic evolution model	Coastal	B2.2	b1, b4	a1, a2
13	Three dimensional evolution model	Coastal	B3.1	b3	a2, a3-a7
14	Combined cohesive bed downcutting and sand cover model	Coastal	B3.1	b3	a4, a7
15	Combined model for short term event and long term erosion	Coastal	B3.1, B2.2	b1-b4	a1-a7
16	Need process-based n-line model, capable of modeling erosion of cohesive bluffs and nearshore	Navigation	B2.2	b4	a3
17	Micro models, what is the repeatability of a reach of river in a micro (moveable bed) model? If I form a channel in the model and start the flow ten times for the same conditions, do I get relative results?	Navigation	NOT		
18	Sediment rate models, more user friendly (usable by district folks or consultants, rather than just run by WES)	Navigation	B3.1, B3.3	d2-d3	e2, e3
19	Better tools for unsteady flow 2D for movable bed streams for field level use	Urban	B3.1	b3	a4
20	Development of an easily applied method to identify and quantify priority water quality problems within watersheds and development of remedial actions to address priority issues.	WQ	SMART		d2, d3

**REGIONAL SEDIMENT MANAGEMENT
RESEARCH PROGRAM
Draft – 1 January 2002**

NO.	RESEARCH AND DEVELOPMENT NEEDS	SOURCE (workshop or meeting)	MET BY TOPIC NO.	PRODUCED BY WORK UNITS	SUPPORTED BY WORK UNITS
21	Develop and adopt standards to facilitate merging data	Navigation	D1 & Geospatial	"Common Delivery Frmwk."	d1, e1
22	Impact of fines in beach nourishment and dredging on water quality and ecological resources (turbidity)	Coastal	A2.2, C6, SMART		a7
23	Tools for evaluating future condition of offshore borrow areas	Coastal	B1.1	b4, b5	d1-d3
24	Research in associating watershed activities and dredging	Navigation	A1.1	a1 +	
25	Focus water quality research on a watershed scale	WQ	SMART		b2
26	Need to better understand the best way to use dredged material beneficially and return sediments to littoral systems	Navigation	C1		c1
27	Impact of reservoir operations on streambank erosion	Inland	A1.1, C1		a1, c1
28	System and local effects of stabilization structures	Inland	A1.1, B1.1	c5, c6	c1, c5, c6
29	Effects of structures removal	Inland	B1.1, B2.2		c1
30	Better sediment transport / geomorphic assessment tools for planning and environmental issues	Urban	B1.1, B1.2	b1-b5	d1-d3
31	Simpler, less expensive options for approaching beach fill designs ("More money for sand and less money for study")	Coastal	B2.1, C1		b1, b5, c1
32	Shore protection, including beach renourishment and hurricane protection	WQ	C1		c1
33	What is suitable beach placement material (disposal, beach nourishment?) Effect of various percentages of fines on longevity, quality, etc. of material placed in the littoral system. Cross over with environmental issues.	Coastal	A1.1, A2.1, B2.1, B2.2, C1		c1
34	Increase longevity of beach fill projects to reduce nourishment cycles (Placement, fill size, auxiliary structures, etc)	Coastal	A1.1, A2.1, B2.1, C1		c1
35	Optimization of beach nourishment material sizing	Coastal	A1.1, A2.1, B2.1		c1
36	Design and use of more natural approaches to shore protection, such as reefs and headlands	Coastal	A1.3, B2.1		a1, a2, c1
37	Locating and designing deposition basins for inlets	Coastal	B2.1, B3.1, C1		c1
38	Role and design of wetlands for erosion control purposes	Coastal	B1.1, B2.1, C1		b2, c1
39	Physical processes related to biostabilization of streambanks (selection and design criteria)	Inland	A2.1, B2.1, C1	c5	c1, b5
40	Bank protection and grade control technical transfer	Inland	C1, E2	c5	c1, e2, e3
41	Reduction of watershed sediment yield/pollutant through channel stabilization	Inland	C1	c5	c1
42	Improve SAM (relative stability of the family of stable channel solutions)	Inland	B1.1	b5	
43	Improve stable channel design techniques, watershed approach to stabilization	Inland	B1.1, C1		c1
44	Update of nonstructural measures	Inland	C1	c5	c1
45	How to use dredged sediments to produce desirable habitat	WQ	B2.1, C1, SMART		c1
46	Economical and reliable method of removing sand blockage at stream mouths	Urban	B2.1, C1		c1
47	Develop flood control maintenance techniques for sediment removal in channels	Urban	B2.1, C1		c1
48	Multi-objective planning	Inland	B2.1 +		b5, d2
49	Techniques to foster a systems approach to develop sediment management measures in coastal and inland areas	Navigation	C1, E2		b5, e2

**REGIONAL SEDIMENT MANAGEMENT
RESEARCH PROGRAM
Draft – 1 January 2002**

NO.	RESEARCH AND DEVELOPMENT NEEDS	SOURCE (workshop or meeting)	MET BY TOPIC NO.	PRODUCED BY WORK UNITS	SUPPORTED BY WORK UNITS
50	Tools to better formulate and evaluate beneficial use projects in context of regional sediment management	WQ	B2.1, B2.2, C1		b5, d2
51	Greater emphasis on developing applications for remote sensing and GIS for broad watershed analysis and planning	Navigation	C2	c2, c4	c3
52	Build a giant GIS historical database that can document environmental change before 1960s (pre National Environmental Policy Act), in various sensitive or national asset and high growth regions of the US and territories. Database should address many types of questions and can be used in both contemporary studies/projects as well an ongoing related research, efforts. Data drawn from all known existing GIS databases at state, agency, and national levels.	WQ	D1, C2		d1, "geospatial enterprise sys."
53	Quantify morphological and environmental benefits	Inland	B2.1, SMART		b5
54	Studies aimed at providing information needed to help plan, on a watershed basis, for the establishment and use of mitigation banks	WQ	C1		c1
55	Establish national (interagency) sediment database	Urban	D1 +		d1
56	Decision making tools for regional scale, long period context	Coastal	B2.1	b1, b4, b5	c1, d1-d3
57	Develop corporate GIS system for RSM, project tracking, and project O&M	Coastal	D1, Geospatial		d1, "geospatial enterprise sys."
58	Need GIS or some other tool to quantify problems and anticipate impacts from the remedial fixes on a system scale	Navigation	B2.1, B2.2		b5, "geospatial enterprise sys."
59	Research in area of dredged material disposal is vital, Management of dredged material, both noncontaminated and contaminated sediments continues to be important.	Navigation	NOT		a1-a3, a7
60	How to justify expenditures of funds for beneficial use of dredged sediments (when a cost increase would be experienced)?	WQ	NOT		
61	Easy to use tools that assess cause of erosion or deposition	Navigation	B2.1, B2.2	b1, b4, b5	a1-a5, d3
62	Role of climatic trends, variability, and global change in driving longer term coastal evolution, storm patterns, and risk/uncertainty. What does it mean in terms of Corps activities?	Coastal	A1.2		a2, a3
65	Better understanding of land based migratory bird habitat needs along river corridors for use in planning watershed based habitat restoration projects	WQ	NOT		c1
66	Need strategic research in all aspects of beach nourishment, research needs for understanding ecological and physical effects of these projects.	Navigation	A1.1, A1.3, A2.1, C1		a1
67	Cross shore transport flux rates for sediment between the beach and shelf	Coastal	A2.1		a3
68	Definition of natural streambanks	Inland	A1.3		a2
69	Tools to identify defining events for channel morphology	Inland	B2.2	a2, a3, b3	
70	Update and improve sediment transport tools for channel stability and maintenance (include silt and clay)	Urban	A2.1, B3.1	b2, b3	a4, a7, d3
71	Long range (more than three months) sediment forecasting	Inland	B2.2, B3.2	b1, b4	
72	Level of sophistication in characterizing physical processes	Inland	A1.3, A2.1	a1-a7	

**REGIONAL SEDIMENT MANAGEMENT
RESEARCH PROGRAM
Draft – 1 January 2002**

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73	Outside the surf zone coastal processes and impact on sediment distribution	Coastal	A1.2		
74	Debris flow (frequency and quantity)	Inland	X		
75	Source of sediment. Whose sediment are you handling or remediating?	Navigation	A1.1, B3.1		b1, b2, b3, b4
76	Tools for sediment transport through reservoirs to improve downstream channel conditions	Urban	C1		c1, b1
77	Identify sediment transport trends on some scale (watershed, district, project) and organize in a standard way to identify areas of concern, such as sediment budget GIS	Navigation	B1.1	b5	
78	Hydrologic/hydraulic impacts of wetlands	Inland	B3.1, C1	b2, b3	
79	Better spatial definition of hydrologic and sediment processes	Inland	C2	a3	a2
80	Beach profile survey technique at the level of accuracy of sled surveys but not as expensive. Technology must be one with high QC in hands of AEs.	Coastal	C2	c2-c4	
81	Cheaper, faster geophysical technologies for defining offshore borrow areas to limit need for coring	Coastal	C7	c2-c4	
82	Sediment transport pathways	Coastal	A1.1, A2.1, C2		c2, c3
83	Sediment transport for ungaged/flashy basins	Inland	A1.2, C2	c2, c3	
84	Sediment transport data collection	Inland	C2	c2, c3	
85	Bed load and suspended sediment measurement techniques	Inland	A2.1, C2	c2, c3	
86	Fluvial and coastal sediment transport rates. Define specifically suspended load, unmeasured load, bed load. Specify bed load, near bed load, or shape of suspended load transport.	Navigation	A2.1, C2	c2-c4	
87	Need tools to accurately measure sediment load including bed load and suspended load at various depths to see how suspended load varies with depth.	Navigation	C2	c2, c3	
88	If I want to divert sediment, need to know what water depth is carrying the sediment I want		A2.1, C2	b3, c3	
89	Need to know the basics, how much sediment is moving	Navigation	C2	c2-c4	
90	Public outreach communications and training tools. "How to live with the coast" stuff	Coastal	E2	e2	a1, c1
91	Get O&M folks to buy into the RSM plan.	Navigation	E2 +	e2	
92	Include other resource agencies to provide regional view	Navigation	E2 +	e2	
93	Other agencies in charge of managing land use (probably NRCS or others) should be involved in RSM, this is where much of littoral material is generated.	Navigation	E2	e2	
97	Focus water quality research on a watershed scale	WQ	SMART		
98	Establish tools for determining sediment removal based on water quality, O&M, and risk aspects	Urban	B1.1, B2.1, B3.2		b5, c1
99	Outside the surf zone coastal processes and impact on sediment distribution	Coastal	A1.2		
100	Identify sediment transport trends on some scale (watershed, district, project) and organize in a standard way to identify areas of concern, such as sediment budget GIS	Navigation	A1.3, B1.1, C2		c2-c4, "geospatial enterprise sys."
101	3D numerical model of hydrodynamics coupled to sediment scour and deposition to produce sediment transport data for projects cohesive and non-cohesive.	HQ/Field	B3.1	b3	a3, a4, a7

**REGIONAL SEDIMENT MANAGEMENT
RESEARCH PROGRAM
Draft – 1 January 2002**

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102	3D fine scale (near field) numerical model to show interaction between structures and river (inlet)	HQ/Field	B3.1	b3	a3
103	Expand sediment models to include wave action for coastal channels and ship waves.	HQ/Field	B3.1	b3	
104	Expand sediment models to be able to model long term effects – for rivers, e.g. one can use CH3d for a few days but it's hard to model a year—thus a switch to HEC-6 using CH3D to get flow and sediment distribution to impact to HEC-6 models.	HQ/Field	B2.2	b1-b4	a1, a2, a5
105	Ability to measure total load in fluvial stream. Define suspended load, unmeasured load, bed load.	HQ/Field	C2	c2-c3	
106	Inland navigation needs better math models to predict sediment deposition under various conditions.	HQ/Field	B3.1	b3	a4
107	Continuing Authorities Program (CAP) study budgets are limited and can't support extensive beach modeling. It would be helpful if some thought could be given to these smaller type beach investigations and guidance provided on the appropriate level of detail concerning beach and storm modeling, needed survey, level of economic analysis, etc.	HQ/Field	B1.1 +		b5
108	Effect of grain size distribution and particle characteristics on beach sand stability due to forces in the long and on/off shore directions would be useful.	HQ/Field	A2.1		a2, c1
109	Much of our coastal and estuarine work deals with restoring tidal flushing to coastal wetlands and salt ponds. Sediment movement is a very important consideration in this work as well as at navigation projects. Sediment transport research and improvement in models such as the TABS model would be useful.	HQ/Field	A2.1, B3.1	b3	c6
110	Dredge material disposal and beneficial uses of dredge material are also an important area for research. In particular, we have been using the STFATE model for our Providence River Dredging Project. Further research into erosion processes related to dredge material disposal is warranted.	HQ/Field	A2.1		a3, a7
111	The impact of jetties on adjacent beaches has become a matter of significant local concern. Further consideration of cost-effective means of sand bypassing, or study of the relative merits of this and other means of periodic channel maintenance coupled with beach nourishment would be useful.	HQ/Field	C1		c1
112	Need to develop engineering guidance on the erosion behavior of mixed sediments. The present approach involves case specific testing or modeling. The objective should be to develop something along the lines of the Shields Curve, but it would need to factor in the effects of various mixtures. As a first step taking a sands of known grain size and behavior and doing a series of flume tests with increasing concentrations of different fine fractions may be an approach to consider.	HQ/Field	A2.1		a7

**REGIONAL SEDIMENT MANAGEMENT
RESEARCH PROGRAM
Draft – 1 January 2002**

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113	Conduct a workshop with non-Corps players to make sure we know what they have and how they help us, how we can help them.	HQ/Field	E2	e2	

**REGIONAL SEDIMENT MANAGEMENT
RESEARCH PROGRAM
Draft – 1 January 2002**

APPENDIX B: Work Unit Descriptions

The table below lists funded work units and Principal Investigators.

Work Unit	Area/Program/Work Unit Title	Lead Lab	Lead PI
RSM-a1	Geomorphic Response of Regional Sediment Systems	GSL	Smith
RSM-a2	Formation & Evolution of Morphologic Features	GSL	Smith
RSM-a3	Sand Transport During High Energy Events	CHL	Miller
RSM-a4	Mixing & Deformation of Alluvial Bed Surfaces	CHL	Copeland
RSM-a5	Spatial & Temporal Transport Processes in Systems Context	CHL	Biedenbarn
RSM-a6	Freeze-Thaw Effects on Soil & Bank Erosion & Stability	CRREL	Gatto
RSM-a7	Effect of Organics on Fine Sediment Beds	CHL	Parchure
RSM-b1	Regional Morphology Model	CHL	Scott
RSM-b2	Overland Flow, Transport, and Morphology Model	CHL	Downer
RSM-b3	Multi-Dimensional Sediment Model	CHL	Berger
RSM-b4	Screening Tools	CHL	Rosati
RSM-c1	Integration of Engineered Solutions	CHL	Davis
RSM-c2	Measuring & Monitoring at Large Scales	EL	Kennedy
RSM-c3	Measuring & Monitoring at Local Scales	ITL	Eng
RSM-c4	Morphologic Response Test Bed Database	CHL	Curtis
RSM-d1	Database Tools for Data Storage and Mining	ITL	Dent
RSM-d2	Multi-Level Analysis Framework	CHL	Wallace
RSM-d3	Graphical User Environment for RSM	CHL	Richards
RSM-e1	Product Life Cycle Plan	CERL	Goran
RSM-e2	Technology Transfer Services	CHL	McAnally
RSM-e3	Models Distribution & Training Center	CHL	Donnell
	New Starts FY04-06	TBD	TBD