September 30, 1997

EPA-SAB-EEC-97-011

Honorable Carol M. Browner
Administrator
U.S. Environmental Protection Agency
401 M Street, SW
Washington, DC 20460

Subject: Review of the National Risk Management Research Laboratory

Dear Ms. Browner:

At the request of the Office of Research and Development (ORD), the Environmental Engineering Committee (EEC) of the Science Advisory Board (SAB) conducted a review of the Agency's National Risk Management Research Laboratory's (NRMRL) program. The EEC's charge was to review NRMRL'S strategic directions and approach to research within the context of both the 1995 realignment of ORD's organizational structure and its strategic plan. The EEC review focused on:

a) Examining and critiquing the research programmatic directions such as whether NRMRL is pursuing the most appropriate research problem areas;

b) Commenting on strategic directions, e.g. use of its core technical competencies, transition from primarily extramural to an intramural R&D organization, leveraging with other agencies and organization;

c) Reviewing and commenting on the effectiveness of NRMRL's approach to science management, e.g. measures of success and science quality, soundness of peer review process;

d) Examining and critiquing the relationship of NRMRL's risk management research and its intended role in the risk assessment/risk management paradigm; and

e) Reviewing and commenting on the strategic balance for the next decade among pollution prevention, technology development, remediation, and risk management assessment activities.

The EEC met September 25-27, 1996 at the National Risk Management Research Laboratory in Cincinnati, Ohio to review the written materials provided and the presentations made. A writing subcommittee was formed to prepare this report. The EEC approved the NRMRL report June 23, 1997 and the Executive Committee approved the report on July 24, 1997, subject to vettor review and approval (which was obtained on September 30, 1997).

The Committee notes that the NRMRL management diligently prepared for the review and successfully communicated the strategic research and management plans for the laboratory. Therefore, the NRMRL staff are commended for their attention to this review at a time of considerable uncertainty in budgets, laboratory reorganization and the overall strategic planning process at ORD.

Major findings and recommendations of this review are stated below:

a) The Committee concludes that both ORD and NRMRL have made significant progress in research planning since the EEC's strategic research planning commentary (SAB, 1994). It finds that NRMRL's plans are conceptually consistent with ORD's "Strategic Plan". The "Strategic Plan", in turn, is conceptually consistent with risk assessment/risk management paradigm emphasized in the 1983 National Academy of Sciences publication "Risk Assessment in the Federal Government: Managing the Process". Therefore, the Committee concludes that NRMRL has in place a well-understood and coherent intellectual framework for strategic research planning.

b) Regarding research program directions, the Committee concludes that the twelve areas NRMRL has selected are appropriate. They come from the ORD's 1996 Strategic Plan and are consistent with the laboratory's mission. However, the decision-process could benefit from a focused statement of how these topics were selected as opposed to others. Because priorities will change over time, as will resources, NRMRL needs to establish a recognizable decision process detailing those factors that will lead to the addition or subtraction of research elements as needed.

c) Regarding science management, NRMRL has developed certain key elements such as measures of success, peer review and use of teams. However, NRMRL will need to refine each element as the new laboratory paradigm takes effect. Measures of success should be carefully chosen and wisely used.

d) Regarding the utility of risk management research, the Committee commends NRMRL for identifying factors that determine the value of the Agency's risk management goals and the extent to which NRMRL's research can influence or be influenced by them. Two research elements would enhance the capacity of NRMRL to provide the evidence of risk reduction: (1) development of compliance assurance models and methods; and (2) development of measures of environmental and public health improvement.

e) There are opportunities for NRMRL to play a dominant leadership role in both traditional and emerging research areas. Hence it will be prudent to assess these opportunities and to define strategies responsive to EPA's increased emphasis on community-based environmental decision making. For example, drinking water research appears to rank high as a focus in NRMRL's plans. However, its community impact may be more impressive if

concentrated on infrastructure improvement rather than incremental advances in treatment technologies alone.

f) The current de-emphasis on waste management in NRMRL's plans, structure or vocabulary appears to be somewhat short-sighted, particularly when waste management is and likely will remain a significant societal issue and one that occupies the attention and energies of both the public and private sectors. Although pollution prevention or waste avoidance is often considered superior to the remediation approach implicit in most waste management programs, it seems inappropriate to almost abandon the search for innovative solutions within the research agenda of the Agency.

g) Core competencies in technology development and remediation within NRMRL and linkages with similar research programs should be maintained so that the menu of options for treatment and control can continue to expand. Such linkages provide vital feedback mechanisms to the research community, and serve as a reality check and a measure of overall success.

The Committee wishes to note that two important difficulties facing the NRMRL, also face the rest of ORD. First, moving from a largely external research program to a largely internal one is a great challenge in terms of staffing. The laboratory staff that has managed research contracts in the past must now be transformed into scientists and technologists. The question remains - how difficult is this challenge! Second, collaborative research is only one of several means to make this transition. And collaborative research with outside institutions is valuable in its own right. However, the current administrative barriers to doing collaborative research are quite high. These barriers should be reduced as they have become an impediment to conducting the right research the right way.

The Committee appreciates the opportunity to review NRMRL and looks forward to a written response from the Assistant Administrator for ORD.

Sincerely,

/signed/
Dr. Genevieve M. Matanoski, Chair
Executive Committee

/signed/
Dr. Ishwar P. Murarka, Chair
Environmental Engineering Committee

/signed/
Dr. Frederick G. Pohland, Chair
NRMRL Subcommittee

NOTICE

This report has been written as part of the activities of the Science Advisory Board, a public advisory group providing extramural scientific information and advice to the Administrator and other officials of the Environmental Protection Agency. The Board is structured to provide balanced, expert assessment of scientific matters related to problems facing the Agency. This report has not been reviewed for approval by the Agency and, hence, the contents of this report do not necessarily represent the views and policies of the Environmental Protection Agency, nor of other agencies in the Executive Branch of the Federal government, nor does mention of trade names or commercial products constitute a recommendation for use.

ABSTRACT

At the request of the Office of Research and Development (ORD), the Environmental Engineering Committee (EEC) of the Science Advisory Board reviewed (on September 25-27, 1996) the Agency's National Risk Management Research Laboratory's (NRMRL) program. NRMRL's mission is to conduct research to reduce uncertainties and costs associated with making and implementing environmental risk management decisions. The EEC's charge was to address the following questions:

a) Examining and critiquing the research programmatic directions such as whether NRMRL is pursuing the most appropriate research problem areas;

b) Commenting on strategic directions, e.g. use of its core technical competencies, transition from primarily extramural to an intramural R&D organization, leveraging with other agencies and organization;

c) Reviewing and commenting on the effectiveness of NRMRL's approach to science management, e.g. measures of success and science quality, soundness of peer review process;

d) Examining and critiquing the relationship of NRMRL's risk management research and its intended role in the risk assessment/risk management paradigm; and

e) Reviewing and commenting on the strategic balance for the next decade among pollution prevention, technology development, remediation, and risk management assessment activities.

Key comments include: a) NRMRL has in place a well-understood and coherent intellectual framework for strategic research planning; b) The twelve areas NRMRL has selected seem appropriate and NRMRL will need a decision process leading to the addition or subtraction of research elements as needed; c) NRMRL has developed key science management which will need refinement as each element of the new laboratory paradigm takes effect; and d) The Committee commends NRMRL for identifying factors that determine the value of the Agency's risk management goals and the extent to which NRMRL's research can influence or be influenced by them.

Keywords: research, technology, risk assessment, risk management, peer review, community-based environmental decision-making

U.S. ENVIRONMENTAL PROTECTION AGENCY
Science Advisory Board
Environmental Engineering Committee
NRMRL Subcommittee
June 1997

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1. EXECUTIVE SUMMARY

At the request of the Office of Research and Development (ORD), the Environmental Engineering Committee (EEC) of the Science Advisory Board reviewed the Agency's National Risk Management Research Laboratory's (NRMRL) program. The EEC formed a NRMRL Writing Subcommittee to prepare this report, which has been approved by the EEC and by the Executive Committee of the SAB.

In the "Strategic Plan for the Office of Research and Development" (EPA, 1996a), ORD described the relationship of risk assessment to the risk management process, and emphasized the need for scientific and engineering research to enable sound risk management decisions and actions. Within the framework of that strategic plan, NRMRL's mission is to conduct research to reduce uncertainties and costs associated with making and implementing environmental risk management decisions. NRMRL has therefore developed a research agenda to reduce risk uncertainty that also focuses on those important, relevant issues where it can make a difference.

The EEC was charged with:

a) Examining and critiquing the research programmatic directions such as whether NRMRL is pursuing the most appropriate research problem areas;

b) Commenting on strategic directions, e.g. use of its core technical competencies, transition from primarily extramural to an intramural R&D organization, leveraging with other agencies and organization;

c) Reviewing and commenting on the effectiveness of NRMRL's approach to science management, e.g. measures of success and science quality, soundness of peer review process;

d) Examining and critiquing the relationship of NRMRL's risk management research and its intended role in the risk assessment/risk management paradigm; and

e) Reviewing and commenting on the strategic balance for the next decade among pollution prevention, technology development, remediation, and risk management assessment activities.

According to its 1996 strategic plan for research, ORD has determined that its overall priorities for the next few years are: a) drinking water disinfection; b) particulate matter; c) endocrine disruptors; d) ecosystem risk assessment; e) health risk

assessment; and f) pollution prevention and new technologies.

Other areas of high importance include: a) air pollutants; b) indoor air; c) global change; d) drinking water (in addition to disinfection issues); e) waste site characterization; and f) waste management and site remediation.

NRMRL's research focuses on characterizing pollutant sources that require management; and on identifying, developing, and evaluating cost-effective tools and technologies for prevention, control, restoration, and remediation of environmental contamination that presents high risk, high cost, or that lack effective management alternatives (EPA, 1996a).

In general, the Committee concludes that ORD and NRMRL have made significant progress since the EEC's Strategic Research Planning Commentary (SAB, 1994). The 1994 Commentary recommended that EPA adopt and implement a consistent, reliable and comprehensive approach to strategic planning for EPA research and development. The SAB's Research Strategies Advisory Committee favorably reviewed ORD's "Strategic Plan for the Office of Research and Development" (SAB, 1996). NRMRL's plans are conceptually consistent with ORD's "Strategic Plan". The "Strategic Plan", in turn, is conceptually consistent with the widely cited "Risk Assessment in the Federal Government: Managing the Process" (NAS, 1983). Therefore, there is a well-understood and coherent intellectual framework in place for NRMRL's decision-making.

NRMRL management diligently prepared and clearly communicated the laboratory's strategic research and management plans. The participating personnel uniformly supported the laboratory planning and management process. Therefore, the NRMRL personnel are commended for their efforts at a time of considerable uncertainty in budgets, laboratory reorganization and the overall strategic planning process being implemented by ORD. NRMRL has made efforts to develop the conceptual elements of risk management. NRMRL's efforts and the interim efforts of the SAB's Risk Reduction Opportunities Subcommittee have been used to create Figure 1 at the end of this report.

In responding to the charge, the Committee commented upon:

a) research programmatic directions;

b) strategic directions;

c) science management;

d) utility of risk management research; and

e) the laboratory's strategic balance for the next decade.

Crosscutting themes evident in these comments include the benefits of a rational, transparent, decision process; the utility of metrics; the need to maintain core competencies; and the continuing need for improved technology. While much attention has been given to refinement and implementation of the risk assessment paradigm and process, refining the understanding of the risk management paradigm and its implications for research has received less attention.

Regarding research program directions, the 12 areas NRMRL selected are appropriate. However, the decision process--particularly as it relates to balancing short-term and long-term goals--could benefit from a focused statement of how these topics were selected as opposed to others, together with the desired specific research goals. The decision process should be documented well enough that anyone reading it can understand not just what was decided but how and why those decisions were reached. Because priorities will change over time, as will resources, NRMRL needs a recognized decision process detailing those factors leading to the addition or substraction of research elements. These factors should also be chosen both for the perceived criticality of the thrust area and for the potential for NRMRL to actually make a difference.

There are opportunities for NRMRL to play a dominant leadership role in both traditional and emerging research areas. Hence, it would be prudent to assess these opportunities on a continuum, and to define strategies not only consistent with the strategic plan, but those responsive to EPA's increased emphasis on community-based environmental decision making.

NRMRL did not define the current and future core competency needed for EPA in environmental risk management. Nor did NRMRL compare the capabilities of the NRMRL staff with the abilities needed to undertake necessary future research. It is critically important that NRMRL continue with and advance the core capabilities of its staff, so that it can respond to future (and unforeseen) environmental challenges. It is also important that NRMRL address current environmental problems. Therefore, NRMRL should define the current and future core competency needs of the Agency in environmental risk management, and then compare the NRMRL staff capabilities with the types of research prescribed by its agenda. (A useful discussion of core competency may be found in Appendix D to SAB, 1995a).

Regarding science management, NRMRL has developed certain key elements such as: measures of success; peer review; and the use of teams. NRMRL will need to refine each element as the new laboratory paradigm takes effect. Measures of success need to be flexible and applied with purpose clearly in mind. Different measures will apply to different activities and the individual researchers or teams of researchers

involved. Measuring success should be a reasoned and thoughtful process that must be sustained by the scientific and technical community, whether focused on the extent to which the activity achieves an assigned research task, or whether the activity contributes in the broader context of mitigating human and environmental risks. Moreover, effective measurement policies should provide a basis for self-improvement.

Regarding the utility of risk management research, the Committee commends NRMRL for identifying the factors that determine the value of the Agency's risk management goals, and the extent to which NRMRL's research can influence or be influenced by them. Accordingly, the NRMRL risk management plans conceptually fit into the risk assessment/risk management paradigm. The laboratory has clearly identified its role and the focus of its research agenda.

The next logical step will be selecting research topics that fit the agenda. The ultimate challenge is demonstrating that health and environmental risks have been (or will be) reduced. Two activities would enhance the capacity of NRMRL to provide evidence of risk reduction--1) development of compliance assurance models and methods; and 2) development of measures of environmental and public health improvement.

Regarding strategic balance, NRMRL must consider that regional environmental assessments will increase during the next decade as environmental protection moves towards community-based approaches. Dominant factors are likely to be demographic fluidity, infrastructure and natural hazards which, when extended to global dimensions, introduce an array of environmental issues for which control schemes are not currently available. Indeed, the solution to some of the critical environmental and health problems will reside in geographic regions over which the Agency has no jurisdictional authority.

In response to this trend, NRMRL should expand the scope of its pollution prevention and risk management assessment activities. Significant contributions can be made in waste minimization, source characterization, cost analysis, technology verification, and technology transfer.

The current de-emphasis on waste management in NRMRL's plans, structure or vocabulary appears to be somewhat short-sighted, particularly when waste management is and likely will remain a significant societal issue and one that occupies the attention and energies of both the public and private sectors. Although pollution prevention or waste avoidance is often considered superior to the remediation approach implicit in most waste management programs, it seems inappropriate to almost abandon the search for innovative solutions within the research agenda of the Agency.

Core competencies in technology development and remediation within NRMRL and linkages with similar research programs should be maintained so that the menu of options for treatment and control can continue to expand. Such linkages provide vital feedback mechanisms to the research community, and serve as a reality check and a measure of overall success.

2. INTRODUCTION

2.1 Background

In late 1995, the EPA Office of Research and Development (ORD) realigned its organizational structure using risk assessment and risk management as organizing principles for a nationwide laboratory system, including the National Risk Management Research Laboratory (NRMRL). Since publication of "Risk Assessment in the Federal Government: Managing the Process" (NAS, 1983), much attention has been given to refinement and implementation of the risk assessment paradigm and process, respectively. Although many of the activities of EPA and other regulatory agencies at the Federal, state and community levels involve risk management, refining the understanding of the risk management paradigm and its implications for research has received less attention.

In the "Strategic Plan for the Office of Research and Development" (EPA, 1996a), ORD described the relationship of risk assessment to the risk management process, and emphasized the need for scientific and engineering research to enable sound risk management decisions and actions. NRMRL's mission is to conduct research to reduce uncertainties and costs associated with making and implementing environmental risk management decisions.

NRMRL's research focuses on two important areas: first, characterizing pollutant sources that require management; and second, identifying, developing, and evaluating cost-effective tools and technologies for prevention, control, restoration, and remediation of environmental problems that are high risk, high cost, or that lack effective management alternatives. NRMRL catalyzes development and commercial application of cost-effective management alternatives through joint efforts with public and private sector partners, through programs to verify performance and cost of innovative technologies, and through independently-conducted research activities. NRMRL also provides technical assistance and technical information transfer in support of improved risk management decisions.

The NRMRL research program is in a state of transition. In addition to the organizational realignment mentioned above, other factors have suggested major redirections for the research program. These include changes in ORD program priorities, e.g., emphasis on airborne fine particle research and de-emphasis on hazardous waste research; major funding reductions over the last two years; the loss of key personnel with reduced opportunity for replacement; the need to shift emphasis from management of research and development conducted extramurally to the conduct of research and development intramurally; the use of teams to facilitate research planning and implementation; and the implementation of expanded guidelines on peer

review and quality assurance of ORD research.

2.2 Structure of the National Risk Management Research Laboratory

In realigning its organizational structure using the risk assessment and risk management paradigm, ORD used the following "building blocks" to form the new National Risk Management Research Laboratory (NRMRL):

- Air and Energy Engineering Research Laboratory in North Carolina
- Risk Reduction Engineering Laboratory in Ohio
- Risk Reduction Engineering Laboratory in New Jersey
- Robert S. Kerr Environmental Research Laboratory in Oklahoma
- Headquarters Liaison Office in the District of Columbia

Moreover, NRMRL remains geographically dispersed, and now consists of:

- Water Supply & Water Resources Division
- Land Remediation & Pollution Control Division
- Sustainable Technology Division
- Air Pollution Prevention & Control division
- Subsurface Protection & Remediation Division
- Technology Transfer & Support Division
- Technology Coordination Office.

Many contemporary environmental problems require interdisciplinary solutions, thereby encouraging the coordination of the combined talents of a team. While NRMRL includes some researchers who find success mainly in individual endeavors, most are productive on team(s). Often the specificity (or cross disciplinary breadth) of a research topic is the criterion of assignment or assumption of a topic to or by either an individual investigator or a team of researchers.

The EEC observed several indications that NRMRL was increasing the use of teams, especially multi-disciplinary teams. Some of these observations were:

a) the teamwork evidenced by the laboratory leadership at the review meeting;

b) the laboratory's efforts to develop a meaningful risk reduction paradigm;

c) the laboratory leadership is interdisciplinary;

d) the Table of Organization names the four members of NRMRL's Research Planning Coordination Team who serve on the ORD Research Coordination Teams (RCT), and the RCTs work across ORD and with the

program offices to develop research strategies implementing the ORD Strategic Plan.

2.3 Environmental Engineering Committee Review of the National Risk Management Research Laboratory with Charge

The National Risk Management Research Laboratory (NRMRL) requested that the Environmental Engineering Committee (EEC) of the Science Advisory Board (SAB) review its strategic directions and approach to research within the context of both the 1995 realignment of ORD's organizational structure and its strategic plan. On September 25, 26 and 27, 1996, the EEC met in Cincinnati, OH to consult with representatives of NRMRL and its component divisions, i.e., air pollution control, subsurface protection and remediation, sustainable development, technology transfer and support, and water supply and water resources. The EEC designated a NRMRL Writing Subcommittee, consisting of EEC members, consultants and a Designated Federal Official from the SAB, listened to overview presentations, discussed the documentation accompanying the presentations, and provided a verbal synopsis of findings and recommendations, to Agency staff before adjourning. This report presents the Committee's major findings and recommendations and responds to the original charge to the SAB/EEC posed by NRMRL, namely:

a) Examine and critique the research programmatic directions being taken by NRMRL, such as whether NRMRL is pursuing the most appropriate research problem areas within the framework of the ORD Strategic Plan, and how well NRMRL's research relates to EPA's increased emphasis on community-based environmental decision-making.

b) Review and comment on NRMRL's strategic directions as a research laboratory organization, including NRMRL's use of its core technical competencies and whether they require expansion, addition, or consolidation to accomplish NRMRL's mission; NRMRL's approach to transition from a primarily extramural management organization to an intramural research and development organization; the roles of partnerships in NRMRL's R&D program and the soundness of NRMRL's approach to using them; and NRMRL's ability to leverage its programs and resources with other agencies and organizations having similar but not identical research missions (e.g., DOE, DOD, state agencies, and agencies of other nations).

c) Review and comment on the effectiveness of NRMRL's approach to science management, such as its measures of success and science quality; the soundness of NRMRL's peer review process; the use of teams to facilitate research planning and implementation; and NRMRL's use of

its facilities in the conduct of its R&D program.

d) Examine and critique the relationship of NRMRL's risk management research to the intended role of risk management in the risk assessment/risk management paradigm.

e) Review and comment on the strategic balance needed in NRMRL for the next decade among pollution prevention, technology development, remediation, and risk management assessment activities (e.g., source characterization, cost analysis, technology verification, and technology transfer).

3. COMMENTS ON NRMRL'S STRATEGIC DIRECTIONS AND APPROACH

3.1 General Comments

Based upon its review of materials made available and the quality presentations, it was clear to the Committee that the NRMRL management diligently prepared for the review and successfully communicated the strategic research and management plans for the laboratory. Therefore, the NRMRL personnel are commended for their efforts at a time of considerable uncertainty in budgets, laboratory reorganization and the overall strategic planning process being implemented by ORD. Moreover, the participating personnel presented a united front in its support of the laboratory planning and management process. What follows is a consensus position established by the Committee after due consideration of the resources made available and discussions with the NRMRL staff.

3.2 Research Programmatic Directions

The creation of the ORD Strategic Plan provides a baseline for future decision-making on research programmatic direction. Within the risk assessment/risk management paradigm in which ORD currently operates, NRMRL has attempted to select its research agenda to reduce risk uncertainty in areas that pose the greatest human and environmental risks, and to focus on issues that are important, relevant and where it can make a difference. Accordingly, NRMRL plans to emphasize certain of ORD's (EPA/ORD 1996) overall priorities; these are:

a) drinking water disinfection;

b) particulate matter;

c) endocrine disruptors;

d) ecosystem risk assessment;

e) health risk assessment; and

f) pollution prevention and new technologies.

Other areas of high importance include:

a) air pollutants;

b) indoor air;

c) global change;

d) drinking water (in addition to disinfection issues);

e) waste site characterization; and

f) waste management and site remediation.

The distribution of resources described in NRMRL's FY 97 Research Plan appears adequate to address the specific topics selected for emphasis. However, a focused statement of how these topics were selected as opposed to others, together with the desired specific research goals, would have been beneficial, particularly in regard to schedules for attaining a balance between both short-term and long-term goals. Such an initiative of selecting goals and setting schedules of achievement will need to include attention to engineering issues and implementing tactics, which can also serve as one index of the relative success of the research agenda. Moreover, in anticipation of changes in priorities consonant with available resources and topical urgency, a recognized decision process should be in place which details those factors leading to the addition (or substraction) of research priorities. NRMRL documents reviewed by the EEC were clear and well written, but neglected to document the decision process. As a result, it is possible to identify the laboratory's priorities and to have some sense of the factors which influenced those choices, but it is unclear how the priorities were established. These factors should also be conditioned not only by the perceived criticality of the thrust area, but by the potential for NRMRL to actually make a difference.

There are opportunities for NRMRL to play a dominant leadership role in both traditional and emerging research areas. Hence, it would be prudent to assess these opportunities on a continuum, and to define strategies not only consistent with the strategic plan, but those responsive to EPA's increased emphasis on community-based environmental decision-making. This linkage with community-based environmental decision-making is still at an early stage and will require considerable effort, because such decision-making involves many non-technical aspects that may be more critical to the ultimate success of the concept. Whereas drinking water appears to rank high as a focus in NRMRL's plans, its community impact may be more impressive if concentrated on infrastructure improvement rather than incremental advances in treatment technology. Hence, issues that could constitute the arena of such a focus are, for

example, system rehabilitation techniques, application of geographic information systems (GIS), maintenance cost modeling, system deterioration rate modeling, city planning effects on distribution efficiency, and pipe deterioration effects on drinking water quality, all of which would invite and promote collaboration with local and regional constituencies.

Within a more global perspective also embraced by the ORD strategic plan, but not explicitly evident in NRMRL's research plan, are similar opportunities for community-focused initiatives. For example, natural hazards can impose dramatic impacts on human welfare and natural ecosystems. Beyond the Horizon (SAB, 1995b) provides such a focus, with, for example, floods being shown to impose major environmental/health impacts that could serve as a basis for a prospective EPA program initiative and leadership position.

Finally, the current de-emphasis on waste management in NRMRL's plans, structure or vocabulary appears to be somewhat short-sighted, particularly when waste management is and likely will remain a significant societal issue and one that occupies the attention and energies of both the public and private sectors. Although pollution prevention or waste avoidance is often considered superior to the remediation approach implicit in most waste management programs, it seems inappropriate to almost abandon the search for innovative solutions within the research agenda of the Agency. Preventive programs are unlikely to be effective as sole control measures for all wastes, and NMRML could exploit its past emphasis and established expertise to help develop, share and apply those innovations for waste management necessary to "prevent, mitigate and control pollution".

3.3 Strategic Directions

As an extension of the previous theme of searching for logical opportunities to provide focus to the overall research agenda, particularly as NRMRL transitions from an external research management organization to one performing intramural research, it is important to recognize the significance of this shift and the challenges it portends. "Fad" research topics or topics that complemented in-house research were historically managed through extramural research programs. The advantage was the ability of EPA to control and focus the research, such that programmatic goals and milestones were met. The disadvantage was that there was not always open competition, and that research talents often remained dormant or unproved as Agency "researchers" honed their managerial skills. Personnel that directed and managed research conducted by extramural investigators may not be able to become productive researchers within an in-house system, even with appropriate mentoring.

3.3.1 Core Competencies

A key missing link in the planning exercise undertaken by NRMRL was a definition of the current and future core competencies needed for Agency in environmental risk management, and a comprehensive comparison with the capabilities of the current NRMRL staff and their ability to undertake the types of research that will be necessary in the future. In some ways, it is more important for NRMRL to continue with and advance the core capabilities of its staff so that it can respond to future (and unforeseen) environmental problems than it is to address specific environmental problems. For example, the study of formation and control of chlorinated dioxin from combustion sources is not only important today to support the regulatory development for hazardous waste combustion rules, but because it enhances the expertise of the laboratory on the formation and control of all types of trace air toxics in all types of combustion systems. Because combustion will remain the primary world energy source for the foreseeable future, this expertise must be maintained and expanded. In the same vein, the NRMRL should define the other core competencies that are required both now and in the future to carry out the total mission and goals of the laboratory. The laboratory plan then should address how to move in the strategic directions as well as how to maintain and cultivate the core competencies critical for the future. It is equally essential for the laboratory to assess its current capabilities. The EEC is aware of the fact that the NRMRL has begun to survey its staff to determine what capabilities are thought to exist, but the EEC did not review the processes being used in this survey. This survey must be well thought out and directed towards obtaining a critical assessment of the real capabilities. It needs to address whether the laboratory has the right type of people, how will the people align with the future high priority research areas, and what types of core competency need to be nurtured and/or developed for the future.

The laboratories that now constitute NRMRL have some highly competent and recognized researchers, with staffing levels commensurate with the previous role of research management. About 23% of the degreed staff have Ph.D. degrees, with a broad degree distribution in the supporting disciplines, i.e., 49% in engineering, 18% in physical sciences, 9% in life sciences, 5% in business administration, 4% in natural resources, 3% in social sciences and 12% in other specialties. It is also commendable that in-house expertise has been supplemented with a large number of visiting scientists and post-doctoral fellows. Moreover, as budgets shrink, establishing partnerships with other agencies will become even more important. Therefore, NRMRL should define the core competencies and alliances that are required both now and in the future to carry out its mission and goals. Such a laboratory plan will be crucial in addressing implementing tactics consistent with the overall strategic directions.

Considering the emerging focus of NRMRL on ecosystem-type environmental issues, recruitment of or fortification with appropriate disciplines should be an element of future personnel allocation efforts. Here again, resources are unlikely to be available to NRMRL to satisfy all of its important research mandates. Hence,

collaborative programs with other agencies, and extension of participation in inter-agency science forums beyond policy-level personnel to researchers and technical analysts, will be necessary. Some examples of where NRMRL's research interests and laboratory plans intersect with those of other agencies include:

a) Natural Hazards (NIST and USGS)

b) Global Change/Tropospheric Ozone (NASA and NOAA)

c) Ecosystem Restoration (USDA and USBR)

d) Indoor Air (Center for Indoor Air)

e) Contaminated Sediments (US Army Corps of Engineers, WES)

Several forces such as budget cuts, the growth of the extramural grants program, and scrutiny of contracting procedures are acting to push the NRMRL into an in-house research posture with substantially fewer cooperative agreements and less contractor support. The Committee finds that these forces and the consequent reactions could insulate NRMRL intramural research from the benefits and synergism that extramural research provides, and slow the pace and credibility of scientific and technological advances. This is a particularly vexing issue, given that the pendulum of change from extramural to intramural research has apparently swung so far as to stifle efforts to provide some moderation. Hence, the laboratory needs to develop a plan that fosters a balance between the in-house agenda and cooperative, collaborative and integrated research with outside researchers as a top priority. Increased funding of the grants program has directly reduced the ability of the ORD to conduct cooperative research, and NRMRL must rethink how to use all available and potential funding mechanics to accomplish its agenda and avoid the insularity that discourages researchers from working with their external scientific and engineering counterparts. This will require development of implementing mechanisms beyond the use of requests for proposals or workshops ensuring interaction of various researchers on specific topic areas.

3.4 Science Management

NRMRL's approach to science management contains some key elements that include measures of success, peer review, and the use of teams for research and planning. This is a step in the right direction, but each of these elements will need to be refined as the new laboratory paradigm takes effect. Hence, the Committee concluded that the organizational goals and metrics of success need to be restructured in order to be more effective in planning NRMRL activities. The organizational goals defined in the NRMRL plan are not really goals, but rather are more a listing of activities that will

be undertaken by NRMRL. For example, increasing and strengthening in-house research is what will be done, not the actual goal. Therefore, NRMRL would be better served by the plan if the goals were explicitly defined to address the underlying rationale for these activities, e.g., why does NRMRL want to strengthen in-house research? Is it to improve the core competency of the staff or to better serve the Agency? Is it to minimize the amount of extramural expenditures, or to improve efficiency and flexibility in responding to the needs of the Agency? Why does NRMRL want to implement an internal grants program? Why does NRMRL want to develop strategic partnerships to leverage work? Why leverage with agencies of other nations?

By defining why the laboratory wants to increase and strengthen in-house research, the laboratory can more effectively define the appropriate metrics of success to indicate whether goals are being achieved. For example, if the actual goal is to increase core competencies so that NRMRL can more effectively respond to Agency needs, then increasing in-house research will be measured in a unique manner related to this particular goal. Definition of the underlying rational for each of the activities (currently called organizational goals) is a necessary step in defining the appropriateness of associated activities and measures of success.

Measures of success also need to be flexible and applied with purpose clearly in mind. Different measures will apply to different activities and the individual researchers or teams of researchers involved. For example, numbers of peer-reviewed publications, numbers of citations, status in the research community and impact of contributions on policy or implementing actions can all be applied as measures of success. These metrics need to be tempered, however, by a realization that certain research, e.g., computer model development, is prone to yield many opportunities for publication, while other efforts, such as field testing or laboratory exploration, may yield fewer papers but yet have a profound effect on the advancement of science and technology. Hence, measuring success should be a reasoned and thoughtful process, that must be sustained by the scientific and technical community, whether focused on the extent to which the activity achieves a assigned research task, or whether the activity contributes in the broader context of mitigating human and environmental risks. Moreover, effective measurement policies should provide a basis for followup program planning and resource allocation in the final analysis.

Finally, success and its measure can apply individually as well as collectively. Often the specificity (or cross disciplinary breadth) of a research topic is the criterion of assignment or assumption of a topic to or by either an individual investigator or a team of researchers. The current laboratory staff and facilities are reflective of both types, with certain researchers finding success mainly in individual endeavors, while others are most productive as a team. There is probably still room for both, although many contemporary environmental problems require interdisciplinary solutions, thereby encouraging the coordination of the combined talents of a team.

Within an outcomes assessment perspective, research issues of narrow scope may be best explored by individual scientists or engineers, with the results subjected to broad peer review. Similarly, crosscutting issues, such as ecosystem restoration, are likely best dealt with by multidisciplinary teams, but again subjected to the rigors of broad peer review. In either case, special attention needs to be placed on selecting and sustaining the peer review process on a continuum, and providing the facility support requisite for successful achievement.

3.5 Utility of Risk Management Research

It is particularly commendable that NRMRL has identified the variety of factors that determine the value of the Agency's risk management goals, and the extent to which NRMRL's research can influence or be influenced by them. Accordingly, the NRMRL risk management plans adequately fit into the risk assessment/risk management paradigm, at least in concept. As shown in Figure 1 (an adaptation, with modifications, from NRMRL's presentation materials), the laboratory has clearly identified its role, with asterisks presumably indicating the focus of its research agenda.

3.5.1 Beyond Engineering

Figure 1 describes activities suited to a risk management laboratory rather than a highly focused engineering laboratory. Since the SAB report, Future Risk, was published in 1988, NRMRL has conceptualized a broader approach to risk reduction. NRMRL has not explored all these options, or any one of them in depth. However, NRMRL has broadened its understanding of the need for both engineered and non-engineering options over the last decade. Recent EEC reviews of the SITE program and the Pollution Prevention Research Strategy document captures some of the progress and some of the difficulties. Among the ten recommendations highlighted in Future Risk were:

a) EPA should shift the focus of its environmental protection strategy from end-of-pipe controls to preventing the generation of pollution; and

b) to support this new strategy, EPA should plan, implement, and sustain a long-term research program.

In discussing the second recommendation, Future Risk, identified candidate core research areas related to risk reduction, including: risk communication, incentives for risk reduction, education and technology transfer, and environmental management and control systems (the latter are largely engineering).

In 1990, the SAB published Reducing Risk. While this report is perhaps most

frequently cited for supporting comparative risk, the Strategic Options Subcommittee considered ways to reduce risk. Among the Subcommittee's recommendations were:

a) EPA should establish priorities based on the potential for risk reduction;

b) In order to reduce risk and prevent pollution in a significant way, EPA must substantially broaden its kit of environmental protection tools.

3.5.2 Options for Research Organization

It is legitimate to ask whether EPA should take on the diverse and more general risk management areas or be a highly focused engineering laboratory. Alternatively, a new risk management laboratory could be created--even a “virtual” laboratory--to address the new areas. However, the EEC did not directly address these questions, because it was not charged to do so.

The EEC recognized within the context of Figure 1, further evidence both that ORD has been responsive to the SAB advice, and that the laboratory management has developed a clear grasp on major trends in risk reduction. The latter was perhaps most striking to those EEC members who also served on the SAB’s Integrated Risk Project’s Risk Reduction Options Subcommittee. Management’s participation in the NRMRL review was very impressive. Each of the many managers present voiced an understanding of the laboratory’s mission, priorities, and challenges in a coherent and consistent way. The management and research staff gave every appearance of being able to operate as a true team.The EEC was more concerned with helping this team get on with the work at hand than in conceptualizing alternative approaches to structuring laboratories.

The EEC recognizes that ORD faces certain challenges. Chief among these are the difficulties of moving from a largely external research program to a largely internal one, and reducing the institutional barriers to collaborative research between ORD laboratory and external organizations.

NRMRL also faces the challenge of a broader notion of risk management. The EEC favors this broader notion and is encouraging NRMRL to grow along these multidisciplinary lines. The EEC did not consider another reorganization as a means to perform risk reduction research.

The EEC favors NRMRL adopting the broader view of risk reduction shown in Figure 1. The EEC anticipates that the multidisciplinary work will prove stimulating to the NRMRL. Clearly it has the potential to improve the utility of the engineering work and, in some cases, provide non-engineering alternatives.

3.5.3 The Next Step

The next logical step will identifying research topics that fit into this agenda. The ultimate challenge in this process will be to demonstrate that health and environmental risks have been (or will be) reduced when the agenda and its research tasks are implemented. Hence, two activities identified as components of the risk assessment/risk management paradigm that would enhance the capacity of NRMRL to provide evidence of risk reduction include: first, development of compliance assurance

models and methods; and second, development of measures of environmental and public health improvement.

The risk reduction options listed with the effort to “Identify and Evaluate Risk Management Options” in Figure 1 reflect the option categories identified by the Risk Reduction Options Subcommittee of the SAB’s Integrated Risk Project. This project is ongoing, and the results are likely to be useful to NRMRL in its efforts to select specific and cross category options for risk reduction.

3.6 Strategic Balance for the Next Decade

As highlighted in the recent NACEPT report on “Promoting Innovative Approaches to Environmental Protection” (EPA, 1996b), a community-based approach mandates a reorientation of traditional media-based programs to the more holistic, multi-media imperatives of specific environmental settings. Accordingly, the NRMRL must strive to strike a strategic balance between the various facets of such a scenario, with the inevitability that regional-type environmental assessments will increase during the next decade. Dominant driving factors are likely to be demographic fluidity, infrastructure and natural hazards which, when extended to global dimensions, introduce an array of environmental issues for which control schemes are not currently available. Indeed, the solution to some of the critical environmental and health problems will reside in geographic regions over which the Agency has no jurisdictional authority.

In light of the scenario outlined above, it will be important for NRMRL to expand the scope of its pollution prevention and risk management assessment activities, because significant contributions can be made in these areas, whether concentrated on waste minimization or source characterization, cost analysis, technology verification, or technology transfer. Although this would suggest a decreasing emphasis on technology development and remediation within NRMRL, core competencies in technology development and remediation within NRMRL and linkages with similar research programs should be maintained so that the menu of options for treatment and control can continue to expand. Such linkages provide vital feedback mechanisms to the research community, and serve as a reality check and a measure of overall success.

Figure 1. **The overall risk assessment/management paradigm and the activities/issues involved in effective program implementation (adapted with modifications from Figure 2 in 1997 Update to ORD's Strategic Plan (USEPA 1997)**

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APPENDIX A - MATERIALS REVIEWED

The following materials were available to the Environmental Engineering Committee for use in the review of NRMRL.

1. Documents Relating to Community Based Environmental Protection
   a) Edgewater consensus
   b) ORD document
   c) NACEPT Report, “Promoting Innovative Approaches to Environmental Protection,” 1996

2. Documents relating directly to the NRMRL review
   a) August 12, 1996 letter transmitting:
      1) Charge for the NRMRL review
      2) Strategic Plan for the Office of Research and Development (EPA/600/R-96/059, May 1996)
      3) Review of the Strategic Plan for the Office of Research and Development by the Research Strategies Advisory Committee (RSAC) of the Science Advisory Board (EPA-SAB-RSAC-LTR-96-004, March 1996)
      4) Promoting Innovative Approaches to Environmental Protection: A Summary of Recommendations from the National Advisory Council for Environmental Policy and Technology (EPA 100-R-96-013, June 1996)
      5) Federal Register notice for the meeting
   b) September 4, 1996 letter transmitting documents on:
      1) Overview of NRMRL
      2) In-House support
      3) Research teams
      4) Peer review
      5) Internal grants
      6) QA/QC
      7) ORD Research Planning/Prioritization
      8) Current NRMRL Research Focus & Program Directions
      9) Measures of Success/Outputs
   c) Overheads distributed September 26, 1996
   d) Leader’s Handbook for Quality Integration of the Atlantic Fleet provided by Dr. Pojasek.
   e) Sub-agenda for Division Director Panel, distributed by Dr. Oppelt

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PREPARED BY THE NRMRL SUBCOMMITTEE OF THE ENVIRONMENTAL ENGINEERING COMMITTEE (EEC)