

Chair
James Johnson, Jr., Ph.D.
Howard University

Vice Chair
Rogene Henderson, Ph.D.
*Lovelace Respiratory
Research Institute*

James Clark, Ph.D.
Exxon Mobil

Michael Clegg, Ph.D.
Univ. of California

George Daston, Ph.D.
Proctor & Gamble

Clifford Duke, Ph.D.
*Ecological Society of
America*

John Giesy, Ph.D.
Michigan State University

Anna Harding, Ph.D.
Oregon State University

Gary Saylor, Ph.D.
Univ. of Tennessee

Herbert Windom, Ph.D.
*Skidaway Institute of
Oceanography*

**REVIEW OF THE OFFICE OF
RESEARCH AND DEVELOPMENT'S
LAND RESTORATION AND PRESERVATION
RESEARCH PROGRAM
AT THE
U.S. ENVIRONMENTAL PROTECTION AGENCY**

Final Report

**BOSC SUBCOMMITTEE ON
LAND RESTORATION AND PRESERVATION RESEARCH**

Dr. Charlie Menzie (Chair), Menzie-Cura and Associates, Inc.
Dr. James R. Clark (Vice-Chair), Exxon-Mobil Research and Engineering Company
Dr. Todd Bridges, U.S. Army Engineer Research and Development Center
Dr. Barry Dellinger, Louisiana State University
Dr. Lynne Haber, Toxicology Excellence for Risk Assessment
Dr. Eugene Keating, Environmental Kinetics, Ltd
Mr. Robert Phaneuf, New York State Department of Environmental Conservation
Dr. Robert Siegrist, Colorado School of Mines
Mr. Tim Thompson, Science, Engineering and the Environment, LLC

EPA Contact

Heather Drumm, Designated Federal Officer
U.S. Environmental Protection Agency

March 23, 2006

BOSC Land Restoration and Preservation Research Program Review Final Report

This report was written by the Land Restoration and Preservation Research Subcommittee of the Board of Scientific Counselors, a public advisory committee chartered under the Federal Advisory Committee Act (FACA) that provides external advice, information, and recommendations to the Office of Research and Development (ORD). This report has not been reviewed for approval by the U.S. Environmental Protection Agency (EPA), and therefore, the report's contents and recommendations do not necessarily represent the views and policies of the EPA or other agencies of the federal government. Further, the content of this report does not represent information approved or disseminated by EPA, and, consequently, it is not subject to EPA's Data Quality Guidelines. Mention of trade names or commercial products does not constitute a recommendation for use. Reports of the Board of Scientific Counselors are posted on the Internet at <http://www.epa.gov/osp/bosc>.

TABLE OF CONTENTS

SUMMARY	1
I. INTRODUCTION	9
I.1 The Land Research Program	9
I.2 The Review Process	12
I.2.1 Review Category: Relevance	14
I.2.2 Review Category: Quality.....	14
I.2.3 Review Category: Performance.....	15
I.2.4 Review Category: Scientific Leadership	15
II. OVERARCHING COMMENTS AND ISSUES	17
II.1 The Land MYP as an Organizing Roadmap and Framework	17
II.2 The Land MYP as a Communication Tool	17
II.3 Emerging Issues.....	17
II.4 Collaboration and Leveraging.....	18
II.5 Development of New Scientists and Engineers.....	18
II.6 Possible Research Gaps Left by Sunsetting or Terminating Programs	19
II.7 Balancing Use of Performance Metrics as Research Drivers.....	19
II.8 Defining Outcomes	20
III. RELEVANCE	21
III.1 Is the research program relevant to and consistent with Agency goals and customer needs, and is it sufficiently flexible?.....	21
III.2 Does the Land MYP have clear goals and priorities, and are these justified and communicated effectively?.....	22
III.3 Are potential public benefits of the program clearly articulated?	23
III.4 Are stakeholders (e.g., program and regional offices) involved in the planning and prioritization of the research?	23
III.5 Is the program responsive to Agency and other stakeholder needs and priorities?	24
III.6 Are outputs from the program used by stakeholders?.....	24
III.7 Is the program well coordinated with outside research organizations, nationally and internationally, to avoid duplication of effort and promote synergistic collaboration?.....	25
III.8 To what extent do research program staff participate on or contribute to Agency workgroups and transfer research products to the program offices, regions, and other clients?	26
III.9 Other key issues not reflected in the above but which reviewers thought should be raised and commented upon.	27

IV. QUALITY	289
IV.1 What process is employed to prioritize research areas and allocate funds?.....	29
IV.2 Does the program use peer review to ensure the quality of its product?	30
IV.3 Does this problem-driven research program conduct internal and external peer reviews of the research?.....	31
IV.4 Does the research program adjust in response to these reviews to maintain quality?.....	32
IV.5 Has the program used competitive, merit-based processes to award extramural funds?.....	33
IV.6 If funds are not awarded competitively, what process does the program use to allocate funds?	33
IV.7 Does this process ensure that quality is maintained?.....	34
V. PERFORMANCE: RESEARCH PROGRAM DESIGN	36
V.1 Does the program have a logical, comprehensive design and an MYP, with clear goals, schedules, and priorities, and is the research program appropriately leveraged and coordinated with others working in these areas?	36
V.2 Does the MYP describe an appropriate flow of work? Does the research address the key research questions? Is the rationale to address the questions clearly articulated?	39
V.3 Does the ORD program use this MYP to address a logical sequence of questions, and does it use the plan as a basis for prioritizing its work?.....	40
V.4 Does the MYP respond to SAB recommendations for developing a holistic MYP from the predecessor plans?	40
VI. PERFORMANCE: TIMELY PROGRESS	41
VI.1 What degree of progress has been made in addressing each of the LTGs and associated key research questions?.....	41
VI.2 How useful is the MYP for mapping progress in the future?.....	43
VI.3 Has ORD’s program clearly articulated its focus and the rationale behind its approach to study these LTGs?.....	43
VI.4 Do these LTGs constitute logical focal points for planning the research and for identifying long-term priorities that meet the scientific needs of the Agency and program customers?	44
VI.5 Has the program made significant progress toward each of the LTGs? Are the questions being addressed in a timely manner?	44
VI.6 Has the program met stakeholder needs in a timely and useful way?	44
VI.7 Is there evidence for application of products and knowledge by clients that would lead toward achieving program outcomes?	45
VI.8 Has the program been effective in developing and communicating outputs that support the risk assessment/risk management process?.....	45
VII. SCIENTIFIC LEADERSHIP	46
VII.1 What leadership role does the Land Research Program and its staff have in contributing to advancing the state of science and practice?	46

BOSC Land Restoration and Preservation Research Program Review Final Report

VII.2 Has EPA collaborated with other agencies (inside and outside the government) in advancing EPA’s research agenda?..... 47

VII.3 Recognizing that other organizations have substantial resources for related work, has ORD allocated its resources to EPA’s best advantage? 48

APPENDIX A: LAND RESTORATION AND PRESERVATION SUBCOMMITTEE MEMBERS 50

APPENDIX B: BOSC LAND RESTORATION AND PRESERVATION SUBCOMMITTEE DRAFT CHARGE 51

APPENDIX C: LIST OF ACRONYMS 61

SUMMARY

This report presents the review conducted by the Board of Scientific Counselors (BOSC) of the Land Restoration and Preservation Research Program (referred to as the Land Research Program or Program) for the U.S. Environmental Protection Agency's (EPA) Office of Research and Development (ORD). The Program supports the Office of Solid Waste (OSW) research needs and three Office of Solid Waste and Emergency Response (OSWER) trust fund programs for which research is authorized: Superfund, Leaking Underground Storage Tank Corrective Action (LUST CA), and the Oil Spills Program. The Multi-Year Plan for the Program (referred to as the Land MYP) is organized around two Long-Term Goals (LTGs):

LTG 1: *Clients request and apply ORD research products and services needed for mitigation, management, and long-term stewardship of contaminated sites.*

LTG 1 is directed primarily at ORD research that supports remediation activities of OSWER and the regions.

LTG 2: *Clients request and apply ORD research products and services needed to manage material streams, conserve resources, and manage waste appropriately.* This LTG supports the prevention research needs of OSW.

The BOSC established the Land Restoration and Preservation Subcommittee (referred to as the Land Subcommittee or Subcommittee) to conduct the program review. This report, drafted by the Subcommittee and approved by the BOSC Executive Committee, addresses a series of charge questions that were developed by EPA in consultation with the BOSC. These questions were structured around the Office of Management and Budget's (OMB) Program Assessment Rating Tool (PART) process related to Relevance, Quality, Performance, and Leadership (OMB Circular M-03-15). The Subcommittee had an opportunity to review several presentations from EPA, review background materials, view posters that presented various aspects of the Program as well as specific projects, hear from Program clients within the EPA program offices, and review the Land MYP. The Subcommittee's review took into account the stated purpose and structure of the Land Research Program as indicated in presentations and articulated in the Land MYP. The Land MYP provides a roadmap to achieving EPA's stated goals related to the Program. The Subcommittee was not tasked to review specific budget allocations or to review the progress of specific projects. Instead, the Subcommittee's review considers the Land Research Program as a whole.

Overall, the Subcommittee finds that the Program is meeting its stated goals and that the Land MYP provides an adequate roadmap for achieving those goals in the future. The Subcommittee was impressed with the relevance, quality, performance, and leadership demonstrated by the personnel and projects that constitute the Land Research Program. The Subcommittee recognizes the diverse nature of these programs and the demands for expertise over a broad range of topics. The Subcommittee commends the efforts of the National Program Director (NPD) of the Land Research Program, Dr. Randal Wentzel; the Designated Federal Officer,

Heather Drumm; and the ORD staff for organizing and presenting information to facilitate the review of the Subcommittee.

While expressing overall approval for the Land MYP, the Subcommittee found that there are places where improvements can be made. A number of overarching comments and issues emerged during the review, and recommendations are provided for each (see Table 1).

Table 1. Overarching Comments and Issues

TOPIC	COMMENT OR ISSUE	RECOMMENDATION
The Land MYP as an Organizing Roadmap and Framework	The Subcommittee members found that the Land MYP achieves its stated purpose of providing a roadmap and framework to achieving EPA’s long-term research goals related to land.	Areas where the Land MYP could be improved include: (1) how the MYP could communicate information more clearly, (2) how future conditions can be better anticipated, (3) how collaborative efforts can be pursued with greater effectiveness, and how certain historical program needs are addressed as programs sunset or are terminated.
The Land MYP as a Communication Tool	The Land MYP is a key communication document and, therefore, the information contained therein should be readily understandable and the goals clearly articulated.	Improve the readability of the report by highlighting the essential features of the Land MYP and minimizing jargon and acronyms. Consider rephrasing the two LTGs to reflect technical or scientific themes inherent in ORD efforts to enhance the success of OSWER programs in Land Preservation and Restoration.
Emerging Issues	The Land Research Program does a good job of focusing on near-term needs but there is a lack of emphasis on emerging issues.	Consider including periodic forecasting of emerging problems that could be examined in a preliminary way to judge their import.
Collaboration and Leveraging	In a time of shrinking resources and considering the multidisciplinary nature of today’s problems, collaboration and leveraging are critically important.	Consider opportunities for collaboration and leveraging at the national and international levels. Enhance the use of Web-based support systems for facilitating multifacility research efforts. Look for opportunities to collaborate with EPA research efforts in Homeland Security and in risk communication.

BOSC Land Restoration and Preservation Research Program Review Final Report

TOPIC	COMMENT OR ISSUE	RECOMMENDATION
Development of New Scientists	New scientists will be needed to replace those who are retiring and to provide expertise in emerging areas.	The MYP should address the current and future processes for replacing retiring expertise and developing new scientists with emphasis on emerging areas. Increase support of university-based research to involve these stakeholders and train future generations of environmental researchers.
Possible Research Gaps Left by Sunsetting or Terminating Programs	There may be gaps and impacts resulting from sunsetting or terminating particular research initiatives, such as the Hazardous Substances Research Centers and the SITE Program. The rationale for program removal or sunsetting should be stated clearly within the Land MYP along with strategies for addressing those gaps if they indeed exist.	If there are recognized gaps associated with sunsetting or terminating programs, these could be prioritized for collaborative research efforts.
Balancing Use of Performance Metrics as Research Drivers	A balance needs to be maintained between the benefits of performance metrics and the costs and potential constraints that these metrics sometimes place on programs.	The Subcommittee acknowledges the interplay of forces regarding performance metrics, but endorses their continued use and suggests that the need for balance be borne in mind.
Defining Outcomes	Little information was presented on connection between short-term outcomes (use of advice and guidance documents) and long-term outcomes (faster, cheaper, better cleanups, or waste minimization).	Consider how the linkages could be made more clear or enhanced in the Land MYP.
Characterization of Uncertainty	Characterizing uncertainty in the assessment techniques and models developed by the Land Research Program is especially important as environmental decisions need to be informed by the uncertainties in the analyses.	Consider how to characterize and communicate uncertainties inherent in assessment methods and models. Explore collaborations with ORD efforts that focus on the analysis and communication of uncertainty. Integrate this information into Agency guidance and rules.

Synopses of the Subcommittee's evaluations for each of the charge questions are provided below. In addition to the recommendations listed in Table 1, suggestions also are made under each charge question for enhancing the Land Research Program in the future. Suggestions also are provided for improving the content and presentation of information in the Land MYP. In the main body of this report, comments and suggestions are repeated where appropriate under the various charge questions. In this Summary section, however, suggestions are made only once and placed under the charge question that is considered most appropriate.

Is the research program relevant to and consistent with Agency goals and customer needs, and is it sufficiently flexible?

The Land Research Program is relevant to ORD's research needs and is consistent with EPA's Strategic Plan. ORD's Land Research Program is pursuing research actively in response to interactions with its primary customers in EPA program offices and regions. It is clear that considerable effort has been devoted to engaging the EPA program offices and regions in the formulation of the Land MYP. The outputs generated by ORD in the Land Research Program are used by other EPA program offices and regions, other federal agencies, states, and responsible and regulated parties. It is much less clear, however, how ORD intends to measure or track such use and incorporate this information into statements about the performance and impact of the program.

The Subcommittee identified the following areas where ORD could consider enhancing the relevance of the Land Research Program and the Land MYP:

- ✍ State the goals and objectives of the Program in terms of their short-term or long-term nature.
- ✍ Articulate the benefits of the Land Research Program within the Land MYP by mapping the goals and activities within the Land MYP to the customer's performance measures.
- ✍ Clarify within the Land MYP who is meant by stakeholders and clients.
- ✍ Identify gaps not being covered by existing projects and the intersections among the projects. Such a gap analysis will position the Program to respond rapidly to circumstances where additional resources or leveraging opportunities present themselves.
- ✍ Emphasize to a greater degree within the Land MYP how and by what means the outputs and products generated from the Land Research Program will be transferred to the field. This includes placing greater emphasis on transferring technologies to the private sector so that they can come into more common use and have greater impact.

How is quality ensured in the awarding of research funds and in research products?

The Subcommittee believes that ORD's Land Research Program continues to generate high quality products and outputs. Quality is ensured, in part, by identifying projects most useful to the clients; such prioritization is achieved through various means including the involvement of senior management and liaisons from client offices to ORD. The Subcommittee found that the routine application of peer reviews by ORD throughout the Land Research Program helps to maintain high quality output. These reviews range from high-level program and organizational reviews of individual guidance documents to publications appearing in peer-reviewed literature, and these reviews apply to various phases of particular products. In the course of this program review, the Subcommittee learned that EPA routinely modifies both the direction of research and specific research products in response to external and internal reviews; however, the MYP would benefit by including more discussion on how this is accomplished. Funds for work conducted outside of EPA are awarded competitively based on merit; however, there is little extramural funding in the Land Research Program. Factors that indicate that quality is being maintained within the Land Research Program include: (1) the credentials of investigators; (2) the selection of appropriate projects to support the goals; (3) the design of the projects; (4) in-place quality assurance systems; and (5) the resulting level of quality evident in the peer-reviewed and well-cited publications of scientific work.

The Subcommittee identified the following areas in which EPA could consider enhancing the quality of the Land Research Program and the Land MYP:

- ✍ Provide greater description of how criteria were used to prioritize needs and projects for both LTGs, but specifically for LTG 2.
- ✍ Incorporate input from outside groups (other government agencies, academia, industry, and other stakeholders), especially for future Land MYPs, and ensure that all valid scientific advice is heard and considered apart from policy issues.
- ✍ Articulate the mechanisms for ensuring periodic quality reviews during the conduct of projects. Such periodic (e.g., quarterly or annual) review and feedback are important for both ensuring that research is on track technically and for feedback from the customer. Where relevant, it may be appropriate to include the customer (e.g., regional staff, state agencies) in the process of obtaining periodic feedback.

Is the research program design logical and appropriate?

The Subcommittee finds that the Land Research Program has a logical and comprehensive design for producing knowledge, know-how, and decision-support tools to address and mitigate known current problems (e.g., remediation of leaking underground storage tanks [USTs], remediation of dense nonaqueous phase liquids [DNAPLs] in groundwater, risk, and remediation of contaminated sediment sites) and contribute to the LTGs of the Land MYP. Some aspects of

the Program, however, could be clarified or improved as highlighted in the Subcommittee's recommendations below. The Land Research Program has done an excellent job of coordination and communication between ORD and the program and regional offices that the Land Research Program is intended to support. The research needs presented in the current MYP have been developed in a rational and inclusive manner with consideration of leveraging and coordination with other agencies working in related areas. The Land MYP responds to Science Advisory Board (SAB) recommendations to develop a holistic MYP by combining the Contaminated Sites and Resource Conservation and Recovery Act (RCRA) MYPs. The RCRA component of this Land MYP (LTG 2), however, appears to be emphasized to a lesser level than the contaminated sites component of the plan. The Subcommittee commends EPA and the Land Research Program on the performance of its Technical Assistance Group. Technical assistance provided by ORD provides a vital conduit for EPA researchers to identify and refine research questions.

The Subcommittee identified the following actions that ORD could consider taking to enhance the design and organization of the Land Research Program and the Land MYP:

- ✍ State the Program goals more clearly in terms of their scientific research focus. The goals could be recast in terms of the two major environmental challenges with problems and the scientific advancements needed to aid their resolution then described as subgoals. Projects and outputs could be organized by major problems (e.g., assessment and cleanup of DNAPLs in groundwater, design and operation of landfill bioreactors) along with the planned workflow.
- ✍ Review potential needs related to current issues that cross-cut multiple programs (e.g., biosolids and animal waste application to land, mining and megasites, oil and gas operations, infectious disease agents, beneficial reuse of waste materials, uncertainty in risk assessments, and communication of risk results.
- ✍ Clarify in the Land MYP the sequence of research questions along a timeline and the activities that are to be conducted.
- ✍ Identify, to the extent they exist, the opportunities for staff scientists or engineers to initiate ideas, for example through a seed funding program.

Is the research program making timely progress in addressing key scientific questions and LTGs?

Timely progress is being made on LTG 1; however, some aspects of LTG 2 seem to be lagging behind. The Subcommittee presumes that the apparently slower progress for LTG 2 initiatives is likely related to funding, and/or is an artifact that the research initiatives tracked under LTG 1 are more mature initiatives. Regardless of the reason, the Subcommittee is of the opinion that this disparity could have been addressed in the Land MYP.

The Subcommittee identified the following areas where ORD could consider enhancing the Program's timely progress in addressing key scientific questions:

- ✍ Consider leveraging and collaborating with others so as to ensure timely progress for LTG 2.
- ✍ Improve the process for updating Integrated Risk Information System (IRIS) values for chemicals currently in the database and for developing values for potentially important chemicals not in the IRIS database. The Subcommittee recognizes that this falls only partially within the domain of the Land Research Program.
- ✍ Articulate how planned and future research programs support decision-making on sustainability issues and on life cycle assessment determinations related to solid and hazardous waste management.
- ✍ Update key technology documents related to landfill design. ORD could collaborate with the geosynthetic industry to help fund such work.
- ✍ Identify within the Land MYP the mechanisms for tracking progress for specific projects with respect to the LTGs.

Is ORD playing a leadership role in land research and effectively collaborating with the larger research community?

ORD and the research efforts that currently comprise the Land Research Program historically have provided excellent leadership to EPA, the states, and the regulated community on identifying and addressing environmental problems. The Subcommittee believes it is vital that ORD continue its environmental leadership role to ensure environmental regulations are based on sound science and risk-based understanding. The current Land MYP indicates that ORD will exemplify leadership for the short-term, problem-driven research areas. Examples include the methods for evaluating monitored natural recovery (MNR) in sediments, advective flux through sediment caps, and the models and risk values developed for human health exposure and risk assessment (IRIS/PPRTV [Provisional Peer Reviewed Toxicity Values], IEUBK/AALM [Integrated Exposure Uptake Biokinetic Model for Lead in Children/All Ages Lead Model], and 3MRA [multimedia, multi-pathway, multi-receptor exposure and risk assessment]).

The Subcommittee identified the following areas in which ORD could consider enhancing the Program's leadership role on land research issues:

- ✍ Identify a process for acquiring or developing key leaders for those programs where clear leadership may be lacking. Such leadership should be reflected in personnel, as well as programs. Particular emphasis should be given to leadership in emerging fields.
- ✍ Describe or develop mechanisms for identifying mature research fields, emerging issues, and/or ensuring that the ORD-planned research is not duplicating efforts being conducted by other government or state agencies or by private industry. This could be guided by external peer review by experts drawn from universities, nongovernmental organizations (NGOs), state agencies, and private industries.

BOSC Land Restoration and Preservation Research Program Review Final Report

- ✍ Enhance ORD's position as a global leader by encouraging continued participation in international panels and meetings.
- ✍ Ensure that funding is directed toward areas in which large gains in understanding can be made through research. This involves favoring research areas that are new or emerging over mature areas of research. The Subcommittee recognizes the balance that must be struck between new research and technical assistance.

I. INTRODUCTION

This report presents the results of the review conducted by the Board of Scientific Counselors (BOSC) of the Land Restoration and Preservation Research Program (referred to as the Land Research Program or Program) for the U.S. Environmental Protection Agency's (EPA) Office of Research and Development (ORD).

This report addresses a series of charge questions that were developed by EPA in consultation with the BOSC. These questions were structured around the Office of Management and Budget's (OMB) Program Assessment Rating Tool (PART) process related to Relevance, Quality, Performance, and Leadership (OMB Circular M-03-15). The BOSC formed a subcommittee, the Land Restoration and Preservation Subcommittee (referred to as the Land Subcommittee or Subcommittee) to conduct the program review. The Subcommittee had an opportunity to review several presentations from EPA, review background materials, view posters that presented various aspects of the Program as well as specific projects, hear from Program clients within EPA program offices, and review the Land Multi-Year Plan (MYP). The Subcommittee's review took into account the stated purpose and structure of the Land Research Program as indicated in presentations and articulated in the Land MYP. The Land MYP provides a roadmap to achieving EPA's long-term research goals related to the Land Research Program. The Subcommittee was not tasked to review specific budget allocations or to review the progress of specific projects. Instead, the Subcommittee's review considers the Land Research Program as a whole.

I.1 The Land Research Program

The Land Research Program derives from EPA Strategic Goal 3:

Preserve and restore the land by using innovative waste management practices and cleaning up contaminated properties to reduce risks posed by releases of harmful substances.

The three objectives of Strategic Goal 3 are to preserve land, restore land, and enhance science and research. The Land Research Program supports the Office of Solid Waste (OSW) research needs and three Office of Solid Waste and Emergency Response (OSWER) trust fund programs for which research is authorized: Superfund, Leaking Underground Storage Tank Corrective Action (LUST CA), and the Oil Spills Program. Within OSWER, principal clients of research on contaminated sites include the Office of Superfund Remediation and Technology Innovation (OSRTI), Office of Emergency Management, Office of Underground Storage Tanks (OUST), and Office of Brownfields Cleanup and Redevelopment. Additional research clients include regional offices and states that implement these programs, regulated and responsible parties, and contractors who perform site-specific assessment and remediation.

ORD has organized the Land Research Program around two Long-Term Goals (LTGs):

LTG 1: *Clients request and apply ORD research products and services needed for mitigation, management and long-term stewardship of contaminated sites.*

LTG 1 is directed primarily at ORD research that supports remediation activities of OSWER and the regions.

LTG 2: *Clients request and apply ORD research products and services needed to manage material streams, conserve resources, and manage waste appropriately.* This LTG supports the prevention research needs of OSW.

The Superfund research program associated with LTG 1 is designed to address the most important science issues that affect policy development and program implementation. Because of limited resources, ORD has structured the Land MYP to focus on the types of sites and problems that have higher risks, higher uncertainty, or higher impact in terms of number of sites, proximity to people, or value/size of ecological resources. Emphasis is given to contaminated sediments, groundwater contaminant transport and remediation, and site characterization. The research program also provides site-specific technical support through central call centers and liaisons located in each region. Related risk assessment activities that support identified needs are addressed in a Human Health Risk Assessment MYP. Table 2 provides an overview of research programs associated with LTG 1.

Research associated with LTG 2 addresses waste management, resource conservation, and multimedia modeling. This research supports OSW regulatory activities in areas such as waste-derived products, modeling to support risk assessment activities, landfill issues, and the Resource Conservation Challenge. The oil spill and LUST CA research are small programs focused on client needs for tools, models, and methods to address oil spill prevention and control, and underground storage tank issues concerning chemical fate and transport. Table 3 provides an overview of research programs associated with LTG 2.

Table 2. Research Activities, Outputs, and Short-Term Outcomes to Support LTG 1 (from the Land MYP)

Activities	Outputs	Short-Term Outcomes
Sediments		
☞ Methods and models on extent of contamination.	☞ Advanced fate and transport (F&T) models and tools for bioaccumulative toxic chemicals (PBTs).	☞ Use in guidance and site specific application to reduce uncertainty.
☞ Application of hybrid models to assess persistent PBTs; effects of remediation on biota; bioavailability.	☞ Linkage of residues and effects to biota; effects of resuspension and long-term remediation options.	☞ Use in guidance and in site assessments to reduce uncertainty.

Activities	Outputs	Short-Term Outcomes
☞ Technology development and evaluation of risk management options.	☞ Performance data on <i>in situ</i> methods, dredging residuals, and method development.	☞ Use in guidance and adoption and use in site-specific decisions and Records of Decision (RODs).
Groundwater		
☞ Characterization and analytical tools; vapor intrusion (VI) methods; underground storage tank (UST) fuel transport.	☞ Analytical methods; VI enhanced models and methods; synthesis of fuel F&T models.	☞ Use at site characterization; VI model reduces uncertainty; UST F&T of fuels used in guidance.
☞ DNAPL and inorganics: methods on innovative treatments; performance evaluations; groundwater/stormwater interactions; treatment of fuel oxygenates.	☞ Synthesis report on <i>in situ</i> methods; permeable reactive barrier (PRB) uses, treatment methods for fuel oxygenates.	☞ Remediation guidance, adoption and use at sites and in RODs.
Multimedia		
☞ Analytical and statistical methods development.	☞ Standard sampling and analysis methods.	☞ Use in guidance, standard methods, and site-specific application.
☞ Technical Support Centers (TSCs) use ORD staff and tools to address site-specific issues.	☞ Answer site-specific questions from regional staff.	☞ Regions use improved tools to characterize, assess, and remediate specific sites to reduce uncertainty, time, or expense.
☞ Develop improved methods to mitigate oil spills.	☞ Improved management strategies for oil spills.	☞ Use in guidance, regulation, and site-specific application.

Table 3. Research Activities, Outputs, and Short-Term Outcomes for LTG 2 (from the Land MYP)

Activities	Outputs	Short-Term Outcomes
Resource Conservation		
☞ Develop methods to sample and assess risks from waste-derived products.	☞ Methods and assessments of risk of material reuse.	☞ Supports regulatory and risk management decisions on material reuse.

Activities	Outputs	Short-Term Outcomes
☞ Assess benefits from waste minimization.	☞ National assessment of waste minimization.	☞ Report will focus waste minimization efforts on major waste streams.
☞ Enhanced multimedia modeling applications.	☞ Synthesis report on 3MRA and site-specific demonstrations of its use.	☞ Use in guidance and site-specific application to reduce uncertainty.
Materials Management		
☞ Evaluation of performance of various landfill liners.	☞ Long-term performance evaluations.	☞ Supports guidance and regulations on use of landfill liners.
☞ Research on bioreactor design, operation, and monitoring.	☞ Design manual and synthesis report on landfill bioreactor performance.	☞ Supports guidance and regulations on use of landfill bioreactors.
☞ Research on waste streams and reuse of materials.	☞ Synthesis report on leachates, optimization of combustion systems, reports on material reuse and unique wastes.	☞ Supports guidance and regulations on leachates, unique wastes, combustion, and material reuse.

I.2 The Review Process

ORD is the organization responsible for the conduct of research to strengthen the Agency's science base. ORD's role is to provide critical data, information, and tools to EPA's program and regional offices to support the development and implementation of environmental policies, regulations, and practices.

ORD conducts both problem-driven and core research in land restoration and preservation, largely in support of the needs of OSWER as its principal client. In June 2005, ORD sought an independent BOSC expert review of its Land Research Program. This is driven, in part, by the need to prepare for performance and accountability reports to Congress under the Government Performance and Results Act (GPRA) of 1993.

After consultation with the Agency, the BOSC established the BOSC Land Subcommittee to review and evaluate ORD's Land Research Program. The Subcommittee members communicated through an administrative conference call followed by three formal conference calls that were open to the public. The Subcommittee met with ORD staff, the Acting National Program Director (NPD) for Land, individual researchers, program clients and stakeholders, and members of the public December 13-15, 2005, in Cincinnati, Ohio, to conduct the review and draft a review report for BOSC Executive Committee approval.

BOSC Land Restoration and Preservation Research Program Review Final Report

The Subcommittee was provided with extensive Agency and Program documentation and background information that included the EPA *Strategic Plan* (2003-2008) Strategic Goal 3 for Land; the 2005 Draft MYP for Land Preservation and Restoration; ORD's organizational structure, facilities, and priority-setting strategy; the Program logic model and LTGs; and a compilation of references and sources useful for responding to specific charge questions. During the public teleconferences prior to the meeting in Cincinnati, ORD administrators and managers reviewed the documentation that had been provided to the Subcommittee members and presented briefings on the Land Research Program structure and goals and the PART process. Following the review meeting in Cincinnati, a public teleconference was held to discuss the first draft of the report that was to be presented to the BOSC Executive Committee.

The onsite review was a public process, consisting of overview and explanatory presentations from ORD's Acting Deputy Assistant Administrator for Science, ORD; various Directors from the research laboratories and centers, as well as the Acting NPD for ORD's Land Research Program. The Subcommittee was able to question the presenters fully, and several requests for further documentation and clarification were made to ORD through the Subcommittee Chair and the Designated Federal Officer (DFO). ORD administrators were responsive to these requests.

A significant effort was devoted to the Subcommittee's review of poster presentations by ORD researchers and collaborators. The poster presentations were organized around LTGs 1 and 2 of the Land Research Program. There was excellent turnout and ample opportunity for Subcommittee discussion of the research goals, outputs, and potential outcomes with ORD researchers and poster presenters. Agency program offices as well as state and research partners provided their perspectives on the relevance of the program. There also was an opportunity for public comment and, at the conclusion of the meeting, the Subcommittee provided a summary of the general preliminary findings and impressions gathered during the course of the review.

The Subcommittee was organized into workgroups that had primary responsibility for addressing individual charge questions. These charge questions and the factors to be considered were developed by the BOSC and EPA to structure the Subcommittee's review. The charge questions were organized around the following categories: relevance, quality, performance, and leadership. Performance was considered in terms of overall design and timeliness. Each workgroup worked with information provided by EPA as well as other information that the workgroup obtained to support its review. Each workgroup consisted of three individuals and had a workgroup lead who was responsible for drafting and/or coordinating the preparation of a response to the charge question. The charge questions developed by the BOSC and EPA are given below along with the factors that the Subcommittee was asked to consider.

Although members of the Subcommittee focused on specific questions, all members had an opportunity to review and comment on the materials. As such, the resultant report reflects the consensus views of the entire Subcommittee.

I.2.1 Review Category: Relevance

Charge Question 1: Is the research program relevant to and consistent with Agency goals and customer needs, and is it sufficiently flexible?

This workgroup considered the extent to which the research has been, and plans to be, responsive to Agency and other stakeholder needs and priorities. The workgroup considered ORD's application of processes to adjust to changing priorities and resources to maintain or enhance relevance.

✍ Factors Considered: Is the focus of ORD's Land Research Program relevant to and consistent with the Agency's strategic goals and responsive to recommendations from the Science Advisory Board (SAB) 2004 review of the Contaminated Sites MYP and the Resource Conservation and Recovery Act (RCRA) MYP? Does the Land MYP have clear goals and priorities, and are these justified and communicated effectively? Are potential public benefits of the program clearly articulated? Are stakeholders (e.g., program and regional offices) involved in the planning and prioritization of the research? Is the program responsive to Agency and other stakeholder needs and priorities? Are outputs from the Program used by stakeholders? Is the Program well-coordinated with outside research organizations, nationally and internationally, to avoid duplication of effort and promote synergistic collaboration? To what extent do research Program staff members participate on or contribute to Agency workgroups and transfer research products to the program offices, regions, and other clients?

I.2.2 Review Category: Quality

Charge Question 2: How is quality ensured in the awarding of research funds and in the research products?

This workgroup considered the process that the Program uses to prioritize research areas and allocate funds. Does this process ensure that quality is maintained? Does the Program use peer review to ensure the quality of its products?

✍ Factors Considered: Does this problem-driven research Program conduct internal and external peer reviews of the research? Does the research Program adjust in response to these reviews to maintain quality? How are any adjustments documented? Has the Program used a competitive merit-based process to award extramural funds? If funds are not awarded competitively, what process does the Program use to allocate funds? Does this process ensure that quality is maintained?

I.2.3 Review Category: Performance

Charge Question 3: Is the research program design logical and appropriate?

This workgroup considered the goals and priorities of the draft Land MYP, including the selection of LTGs, linkage of the LTGs to desired outcomes, and responsiveness to key science questions and Agency and Program priorities.

- ✍ **Factors Considered:** Does the Program have a logical, comprehensive design and an MYP, with clear goals, schedules, and priorities? Is the Program leveraged appropriately and coordinated with others working in these areas? Does the MYP describe an appropriate flow of work? Does the research address the key research questions? Is the rationale to address the questions clearly articulated? Does the ORD Program use this MYP to address a logical sequence of questions, and does it use the plan as a basis for prioritizing its work? Does the MYP respond to SAB recommendations for developing a holistic MYP from the predecessor plans?

Charge Question 4: Is the research program making timely progress in addressing key scientific questions and LTGs?

This workgroup considered the degree of progress that has been made in addressing each of the two LTGs and associated key research questions and the usefulness of the MYP for mapping progress in the future.

- ✍ **Factors Considered:** Has ORD's Program clearly articulated its focus and the rationale behind its approach to study these LTGs? Do these LTGs constitute logical focal points for planning the research and for identifying long-term priorities that meet the scientific needs of the Agency and Program customers? Has the Program made significant progress toward each of the LTGs? Are the questions being addressed in a timely manner? Has the Program met stakeholder needs in a timely and useful way? Is there evidence for application of products and knowledge by clients that would lead toward achieving program outcomes? Has the Program been effective in developing and communicating outputs that support the risk assessment/risk management process?

I.2.4 Review Category: Scientific Leadership

Charge Question 5: Is ORD playing a leadership role in land research and collaborating effectively with the larger research community?

This workgroup considered the leadership role of the Land Research Program and its staff in contributing to advancing the state of science and practice. Has EPA collaborated with other agencies (inside and outside the government) in advancing EPA's research agenda? Recognizing that other organizations have substantial resources for related work, has ORD allocated its resources to EPA's best advantage?

BOSC Land Restoration and Preservation Research Program Review Final Report

- ✍ Factors Considered: The degree to which this Program and its staff are identified as leaders in the field; inclusion of ORD staff in national and international science and technology professional bodies; effectiveness of communication and collaboration with clients and stakeholders; coordination and leveraging with related research programs; and participation of ORD staff and inclusion of ORD products in program guidance and practice.

II. OVERARCHING COMMENTS AND ISSUES

A number of overarching comments and issues emerged during the discussions of the charge questions by the Subcommittee. Because these touch on many of the questions related to relevance, quality, performance, and leadership they are highlighted here. They reflect the Subcommittee's more important and universal comments and recommendations.

II.1 The Land MYP as an Organizing Roadmap and Framework

The Land MYP achieves its stated purpose of providing a roadmap and framework for achieving EPA's long-term research goals related to land restoration and preservation.

The Subcommittee's comments in this section and in the sections devoted to the charge questions focus on four major areas: (1) how the Land MYP could communicate information more clearly; (2) how future conditions can be better anticipated and taken into account; (3) how collaborative efforts can be pursued with greater effectiveness, and (4) how certain historical program needs are addressed as programs are sunset or terminated.

II.2 The Land MYP as a Communication Tool

The Land MYP is a critically important communication tool. The Subcommittee identified two areas where the Land MYP could be more effective at communication. The first area is concerned with readability. Because the Land MYP is nested within and derives from EPA's *Strategic Plan*, there is a considerable amount of cross-walking among various hierarchies (i.e., plans within plans and goals within goals). There also are many acronyms that need to be tracked. Any effort to highlight and put forward the essential features of the Land MYP would assist the reader in following the connections between the two critical LTGs and the plans for their implementation across ORD and through collaborations. Perhaps much of the background material leading up to the current Land MYP and the context for the Land MYP could be shortened to a few sentences and the details placed in an appendix.

The second issue concerns the phrasing of the two LTGs. The Subcommittee recognizes the history of their derivation but judged that they could be rephrased to reflect technical or science goals inherent in ORD's efforts to enhance the success of OSWER programs in land preservation and restoration. This is discussed at greater length in Section V of this report.

II.3 Emerging Issues

Emerging issues need greater consideration and increased emphasis. The Subcommittee recognized that the Land Research Program is doing a good job at addressing and working toward resolving the current and anticipated near-term needs of the clients. The Subcommittee

concluded, however, that there was a lack of emphasis on forward-thinking research and development to address emerging issues and environmental issues of the future. Moreover, there was not a process for how such research and development might be incorporated into project planning and execution. As discussed in all of the following sections, this issue bears on relevance, quality, performance, and leadership. The Land MYP could consider the inclusion of periodic forecasting of emerging problems that could be examined in a preliminary way to judge their import and serve as an initial basis in prioritizing research efforts.

II.4 Collaboration and Leveraging

More emphasis should be given to collaboration and leveraging. The Subcommittee recognizes that the efforts reflected in the Land MYP and in the posters demonstrate the importance of collaboration and leveraging with other government agencies and with the private sector. The Subcommittee strongly endorses collaborations and leveraging with a broad range of entities and recommends that leveraging and collaboration also be continued and expanded on the international level (e.g., the European Union, North Atlantic Treaty Organization [NATO], and Canada).

With respect to facilitating greater collaboration and leveraging, the Subcommittee notes the value of making greater use of Web-based research/information tools. Project- and Program-specific sharing of research results, discussions, and other information through the Web is becoming an increasingly valuable means of enhancing the performance of multidisciplinary and multifacility projects.

The Subcommittee identified a few EPA programs where collaboration would benefit the Land Research Program but where such collaboration currently is not mentioned. The first involves research related to human behavior, because many of the issues involved with remediation of contaminated sites and waste management have a significant human component. The Subcommittee encourages ORD to explore opportunities for collaboration within EPA efforts focused on human behavior and risk communication. Opportunities for social or economic research seem most ripe for projects related to LTG 2, where forward-thinking research can assist in waste stream management issues. This issue is described in greater detail in the Relevance charge questions.

Another potential area for collaboration involves the National Homeland Security Research Center (NHSRC) in ORD. There likely will be numerous opportunities for leveraging with that center in achieving the goals of the Land Research Program, for example in such areas as detectors and decontamination methods.

II.5 Development of New Scientists and Engineers

To maintain its critical role as a leader in environmental research, the Subcommittee recommends that the MYP include the goal of acquiring key staff members who are leaders in their mission fields, and that ORD continue to develop and mentor new scientists and

engineers to replace those who may be retiring in the next decade. The Subcommittee recognizes this is occurring to some degree at the various ORD laboratories/centers but wants to emphasize the importance of this for the long-term success of the Land Research Program. The Subcommittee views this as particularly important for emerging issues to ensure that EPA maintains a leadership position and will be able to support the program offices as these needs emerge.

II.6 Possible Research Gaps Left by Sunsetting or Terminating Programs

Recognized gaps resulting from sunsetting or terminating programs should be prioritized for collaborative research efforts. The Subcommittee raised questions about possible research gaps and associated impacts of sunsetting or terminating particular research initiatives, such as the Hazardous Substances Research Centers (HSRCs)¹ and the Superfund Innovative Technology Evaluation (SITE)² Program. The Subcommittee recognizes that such actions may be related to planned phase out as well as economic realities, maturation of programs, or legislative mandates. In this regard, the Subcommittee reiterates the importance of pursuing collaborative research projects. The Subcommittee knows that the Land Research Program has pursued opportunities for collaboration; however, at a time of shrinking resources, there is a particular need to take advantage of such opportunities. If there are recognized gaps associated with sunsetting or terminating programs, these could be prioritized for collaborative research efforts. Conversely, ongoing evaluation of projects and programs should consider whether some have reached maturity and should be sunsetted.

II.7 Balancing Use of Performance Metrics as Research Drivers

A balance should be struck between conforming to performance metrics and stimulating needed research. The Subcommittee acknowledges the interplay of forces regarding performance metrics. Such metrics are an important part of reviews of Agency performance and can play a significant role in objectively evaluating performance and quality. Conversely, the time spent developing metrics and addressing whether metrics are being achieved can be burdensome to customers (e.g., regions and states) with limited resources and, taken to extremes, can remove resources unnecessarily from accomplishment of program goals. It also is recognized that research, even applied research, often is not linear. Overly goal-driven and metric-driven research can impede progress by forcing thinking and efforts into narrow streams and short-term efforts, and limiting “outside-the-box” and innovative thinking that ultimately

¹ The Hazardous Substances Research Centers, a grants program for hazardous waste research and technical outreach, which has a long and distinguished record of success, is coming to an end this year. This program funded five regional consortia of universities since approximately 1980. Each center focused its research and outreach efforts on regional environmental issues. Many important and seminal developments came from these centers. It was one of EPA’s most productive research programs and definitely its most productive center program.

² The SITE Program is scheduled for termination next year. It has been an extremely successful component of EPA’s Superfund research for more than 20 years. Most, if not all, of the site remediation techniques employed today are the result of research and evaluations performed under SITE.

may lead to the most productive solutions. Nonetheless, the Subcommittee encourages EPA's continued efforts in this area.

II.8 Defining Outcomes

Outcome-oriented research should be encouraged. The Subcommittee concurred with the outcome-oriented approach; however, little information was presented on connection between short-term outcomes (use of advice and guidance documents) and long-term outcomes (faster, cheaper, better cleanups or waste minimization). The latter area is particularly important in looking at measures of performance, and in many cases could be tied with particular current projects.

III. RELEVANCE

The Subcommittee was asked to address the following charge question: **Is the research program relevant to and consistent with Agency goals and customer needs, and is it sufficiently flexible?** The Subcommittee considered the factors identified by the BOSC and EPA, and these factors are presented in the form of questions. The Subcommittee believes that the Land MYP is relevant to ORD's research needs and is consistent with EPA's *Strategic Plan*. The Subcommittee noted the areas where the Land MYP and the Land Research Program have done a good job and identified areas where the Land MYP could be enhanced.

III.1 Is the research program relevant to and consistent with Agency and customer needs, and is it sufficiently flexible?

Recognizing that the Land Research Program tries to balance strategic and tactical needs in a world of budget uncertainties, the Subcommittee commends EPA for its considerable effort in writing the MYP for Fiscal Year (FY) 2006 to 2011.

Three members of the Subcommittee were on the 2004 SAB panel that reviewed the MYP and noted that the Agency has done an excellent job of combining the Contaminated Site MYP and the RCRA MYP into a single document. In general, the combining and reorganization of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and RCRA Lands MYP provide a defensible framework for organizing ORD research programs that support overall Agency strategic goals. Whereas the SAB commented that the previous MYP framework lacked sufficient detail and transparency that clearly describes how the various categories of research programs (i.e., short-term versus long-term, core versus problem-driven) are integrated effectively to meet specific ORD LTGs or Agency strategic targets, the MYP for FY 2006 through 2011 and supporting material provided to the Subcommittee allowed for a fairly comprehensive analysis of the underlying assumptions and decisions that formed the plan.

As the SAB recommended, the MYP presents its research programs in a manner that is consistent with and comparable to the OMB PART. In general, each individual research activity was reviewed based on the specific investment criteria for relevance, quality, and performance in OMB Circular M-03-15 (dated June 5, 2003). Some of those decisions are justified better than others; these are explored further below. Annual Performance Goals (APGs) and Program metrics are improved notably over the previous plans, but the Subcommittee notes that metrics still are defined fairly broadly and echoes the SAB in encouraging EPA to continue to explore and develop APGs.

The Land MYP responds to the SAB's recommendation for a detailed description of how the Land MYP framework facilitates the selection and prioritization of specific research activities. The Land Research Program also responds credibly to the Agency's shorter term, tactical problems identified by the regions.

The BOSC Subcommittee identifies the following areas where EPA could consider enhancing the Land MYP. The Land MYP was not as responsive to the SAB's call for more strategic, forward-looking research on emerging issues. This is identified as an overarching issue and has been discussed. The Land MYP could use additional work in translating how the prioritization of research results in the distribution of resources across long-term goals and themes. The SAB report commented on this, and although the Subcommittee believes the MYP does describe how priorities are selected, the plan still does not include a clear statement of how the allocations occurred and does not set timetables or solid metrics for accountability.

III.2 Does the Land MYP have clear goals and priorities, and are these justified and communicated effectively?

It is clear from the information provided to the Subcommittee that ORD's Land Research Program is pursuing research actively in response to interactions with its primary customers in the program offices and regions. The goals proposed in the Land MYP, however, are not reflective of the level of effort and productivity of the Program. The subgoals of the LTGs should reach beyond the objective of utility and include such objectives as advancing the relevant science and engineering, increasing the accuracy of risk assessments (i.e., reducing the reliance on conservative defaults), reducing the uncertainty associated with risk assessments, and developing innovative risk management technologies. Although the Subcommittee expects that these specific motivations are present in those responsible for executing the research within ORD, the Subcommittee recommends that these motivations be given a more prominent and obvious position within the goal statements.

Effort also should be focused on mapping these broad objectives to the performance measures used by the sponsoring program offices. For example, in the case of OSRTI, these performance measures include elements related to risk management decision-making, site closure, and acres of land or number of sites ready for reuse. In general terms, goals can be related to money or time saved, the magnitude of risk reduction per level of effort or resources expended, tons recycled, and other such results. The Subcommittee recognizes the challenges inherent in developing more specific and focused goals for the Program; however, the Subcommittee expects that the effort devoted to reworking these elements of the plan will become evident in more effective communication of the benefits and relevance of the work that ORD is doing in support of its customers. Whereas the broader goal statements (e.g., LTGs) will, by their very nature, be more qualitative, translating these goals into more practical objectives (e.g., APGs) should include more quantitative interests to enable tracking of progress toward the achievement of all the goals within the Land Research Program.

The Subcommittee offers several recommendations for enhancing the Land MYP. The goals and objectives of the Program could be related and described better in terms of their tactical or strategic nature. Tactical goals are those that target near-term outputs and benefits, whereas strategic goals and research target the problems of the future. Additional consideration should be given to leveraging and innovation for organizing ORD research. The Subcommittee especially commends ORD for taking advantage of leveraging opportunities through teaming and partnerships with other organizations pursuing similar activities, and the Subcommittee

encourages efforts to continue to seek and expand the use of leveraging opportunities to advance the interests of its customers.

Although there is some evidence within the Land MYP that innovation is an interest being pursued within the Land MYP, the Subcommittee believes that a more prominent position should be given to this structuring element of the research enterprise. With regard to finding approaches to facilitate and prioritize innovation within the Land Research Program, the Subcommittee recommends that consideration be given to devoting a certain portion of the Program budget to projects that would be competed within ORD. Proposals submitted by teams of researchers could be judged on the basis of any number of criteria that are designed to foster the goals of the Program and ORD. Such criteria could include innovation, inter-laboratory teaming, and multidisciplinary teaming. The opportunity to compete for resources will provide an additional incentive for promoting new ideas and new approaches for executing research. This could involve establishing a seed money approach.

III.3 Are potential public benefits of the program clearly articulated?

The articulation of potential public benefits is an important communication issue. Although the benefits of the Program are described in several places within the MYP, the Subcommittee believes that improvements can be made in clearly articulating what these benefits are in a manner that would elevate this element of the Land MYP. As discussed above, mapping the goals and activities within the Land MYP to the customer's performance measures will provide one means for accomplishing this, in addition to other recommendations made previously. The Subcommittee strongly endorses the approach in the Land MYP that relies on multiple layers or tiers of goals (e.g., LTG, APG, Annual Performance Measure [APM]) and benefits, and the Subcommittee is certain that by expending some additional effort, the MYP will communicate those benefits more effectively.

III.4 Are stakeholders (e.g., program and regional offices involved in the planning and prioritization of the research?

It is clear from the Land MYP that considerable effort has been devoted to engaging the program offices and regions in the formulation of the MYP. Some confusion arises from identifying states and regulated and responsible parties and contractors performing work at sites as additional "clients" of the Program. It is unclear what, if any, distinction the Program would want to make between a user and a customer in this context; however, it does not appear that these other clients were engaged directly in the formulation of the Land MYP. Some clarification of terms and wording and the process and objectives of the engagement with customers and users would be useful. Some additional points of clarification that would be useful to have in the Land MYP include: (1) the reason for different sets of criteria being used by the workgroups and the Research Coordination Team (RCT); (2) the extent to which the customers were engaged in regard to the specific nature of the outputs/products the research would produce; (3) whether the customers were engaged on the issue of scheduling of research products; and (4) the degree to which ORD follows up to ensure customer satisfaction.

Relatively infrequent, direct reference was made to peer-review papers as products within the Land MYP (i.e., Table 4 in the Land MYP). Given the impressive bibliography listing such outputs that was provided to the Subcommittee, it is clear that ORD places a priority on the generation of such products. The Land MYP would benefit from including more detail about the nature of the individual projects ongoing within the Program and the specific nature of the products these projects are expected to produce. This additional detail will enable more effective communication of the goals that a particular project is serving, the specific objectives of the project, and the purpose each product serves with respect to the goals of the Program. In this connection, it might be beneficial to develop a technology transfer plan for individual projects, or perhaps a group of closely related projects, that would help in communicating the purpose, goals, and advantages served by each output/product. The Land MYP should help communicate how the range of outputs and/or products serves the interests of the customers and ORD's mission.

III.5 Is the program responsive to Agency and other stakeholder needs and priorities?

As discussed previously, some clarification of terms and relationships is necessary within the Land MYP as concerns the distinction, if any, between customers, clients, and stakeholders. The plan uses all three terms, sometimes in reference to the same group or organization. The Land MYP clearly has been developed using information gained through interaction with the program offices and regions, but the plan is less specific on how feedback will be generated from the customers while the MYP is being executed. There are several mechanisms by which ORD could solicit such input, including the use of interim progress reviews and reports and the formulation of user groups of program and regional staff who could be attached to a specific project or set of projects to serve the role of a "sounding board" that researchers could use to adjust their plans.

In any event, the Land Research Program would benefit from including a mechanism for identifying the need for mid-course corrections that engages the customers in the decision-making regarding the need for those corrections and what specific corrections should be made. The Land MYP makes reference to a process by which it would be updated, but there is no discussion of what specific events would trigger the need for such an update or how such an update would be accomplished. Some additional discussion of this subject is warranted. It also is unclear to the Subcommittee what process the Program uses to develop annual plans for executing the research outlined within the MYP. Some description of this process would be beneficial.

III.6 Are outputs from the program used by stakeholders?

It is evident that the outputs generated by ORD in the Land Research Program are used by other EPA program offices and regions, federal agencies, states, and responsible and regulated parties. It is much less clear how ORD intends to measure or track such use and incorporate this information into statements about the performance and impact of the Program. The

Subcommittee recognizes the challenges involved in developing metrics for gauging the performance or benefit of the type of necessary research being performed in the Land Research Program; however, the modifications discussed earlier with regard to the goals of the Program should help communicate and track performance. Some discussion of mechanisms that ORD could use to solicit feedback from the customers on the quality of its products would provide a benefit to the Program.

III.7 Is the program well coordinated with outside research organizations, nationally and internationally, to avoid duplication of effort and promote synergistic collaboration?

Implementing a program with the scope of the Land Research Program requires several levels of coordination and integration. The first level of coordination/integration occurs within ORD itself. From this perspective, the Land MYP would be a more effective tool if it contained a listing of each of the individual projects that included some description of the project team, the project's objectives, how those objectives will be accomplished, what outputs/products it will produce, and when. It might be useful to identify specific research programs for specific topics (e.g., sediments within the Land MYP). Alternatively, these research programs could be appended to the MYP. This level of information will make it more apparent how the laboratories/centers within ORD and other organizations within and outside EPA are coordinating and interacting. As noted previously, the Subcommittee believes that ORD research will benefit (i.e., resources can be stretched further) from increased collaboration and coordination among the ORD laboratories/centers. The problems being addressed by the Land Research Program are inherently multidisciplinary, which identifies the need for multidisciplinary teams.

The Subcommittee offers the following recommendations to enhance the Land MYP. Mechanisms such as workshops and cross-teaming that can help foster multidisciplinary approaches across laboratories/centers and with groups external to EPA should be pursued. A gap analysis will position the Program to respond rapidly to circumstances where additional resources or leveraging opportunities present themselves. A few examples of existing gaps include tools for assessing risks from bioaccumulation and trophic transfer of metals and organic compounds that are metabolized (e.g., polycyclic aromatic hydrocarbons). Efforts that are mature and therefore where resources could be reallocated also could be identified. The MYP also could identify potentially valuable intersections wherein work ongoing within one area could and should be shared through direct interaction with other areas of active research. For example, the beneficial use of treatment products created from contaminated sediments shares an intersection with activities, goals, and research related to waste minimization and recycling.³

³ Another example is the intersection between use of amendments and beneficial use of wastes (bauxite, redmud, fly ash, in cement manufacture) and other materials (e.g., zero valent iron) for use as amendments in the reactive barriers (vertical barriers in the case of groundwater treatment and horizontal barriers in the case of active sediment caps). There also are shared interests in the area of contaminant bioavailability in contaminated sediments and the focus on the interaction between contaminants and minerals in the case of subsurface groundwater contamination. Lessons learned from approaches and techniques used to advance the concept of monitored natural attenuation (MNA) for groundwater sites has clear cross-over potential for advancing the development of MNR for contaminated sediment sites.

The Subcommittee recommends continued support for efforts whereby ORD gains access to field sites that clearly will advance research objectives. This occurs to some degree through the Strategic Environmental Research and Development Program (SERDP) and through technical assistance support from ORD to site managers. The Subcommittee views this as an important aspect of the Land Research Program and it should be highlighted in the Land MYP. Coordination and teaming with organizations outside EPA would maximize benefits to the customers of the Land Research Program. There is considerable, positive evidence in the material provided to the Subcommittee that ORD is coordinating its efforts with other government organizations and NGOs. The FRAMES memorandum of understanding (MOU) is an excellent example of such coordination and the benefits that can be derived. The coordination meeting held in September 2005 between EPA, the U.S. Army Corps of Engineers (USACE), and the U.S. Navy to begin the process of more active coordination on contaminated sediments research is another positive example. ORD involvement in SERDP and the Environmental Security Technology Certification Program (ESTCP) is positive action that should be expanded, as these programs represent a substantial leveraging opportunity as well as an opportunity to benefit from teaming with scientists and engineers in other organizations that share similar research interests and objectives. ORD and the customers of the Land Research Program clearly recognize the benefits that would be derived from active teaming with other organizations. The Program would benefit from mechanisms that encourage both management and individual researchers to coordinate, collaborate, and team with others both inside and outside EPA to the benefit of Program. The Land MYP could include a mechanism for capturing and tracking these interactions. Mechanisms, such as MOUs, interagency agreements (IAGs), and cooperative research and development agreements (CRADAs), would help facilitate coordination efforts among other federal agencies and industry.

III.8 To what extent do research program staff participate on or contribute to Agency workgroups and transfer research products to the program offices, regions, and other clients?

It is apparent that Program staff participates and contributes to Agency workgroups and transfers research products to the Program's clients to a large degree. The benefit of research is realized only if the technology advanced by the research is transferred to field use. This fact makes the subject of technology transfer critical to the success of the Land Research Program and ORD. As such, the Land MYP could emphasize to a greater degree than it currently does how and by what means the outputs and products it generates from the Land Research Program will be transferred to the field. Although there may be cases in which direct participation might not be required (e.g., where ORD is used in a review capacity), it would be reasonable to expect that these cases would be very much in the minority, given the central role that the technology produced by the Land Research Program has in Agency guidance and rules. The program offices are considered customers because ORD is offering something of value to the programs.

Conflicts in time and interests can emerge when ORD staff members are providing technical support to the regions and programs while they also are working on specific research projects. This should not be viewed as a conflict; there is a natural symbiosis to this relationship. Researchers gain access to field sites and a perspective on how to make their research outputs

relevant, and the field elements gain access to expertise. There are clear challenges presented in regard to technical support from ORD (e.g., how to maintain some continuity in support over the long term on a site or project). ORD should consider how to incentivize scientists/engineers and their managers to support this form of the business practice that provides such real opportunities for technology transfer.

The issue of research product integration raises the question of how the performance measures that ORD uses to rate staff members (i.e., for pay increases, awards, and promotions) are aligned with the measures of performance the program offices and regions would use to rate the services and products provided to them by ORD. For example, differences in how ORD and its customers value field support compared to publishing a journal paper will create unnecessary tensions in the relationship. An open discussion between ORD and the programs on this matter would facilitate an alignment of interests within the MYP. Although a discussion of such issues is beyond the scope of the MYP, the Subcommittee notes it here to call attention to the issue and to motivate some consideration of the matter by ORD management.

One mechanism by which relevance can be assured and technologies can be transitioned effectively to the field is through the use of user groups for specific projects as discussed previously. The Land MYP should give some attention to strategies to transfer technologies to the private sector as a means of facilitating technology transfer.

III.9 Other key issues not reflected in the above but which reviewers thought should be raised and commented upon.

III.9.1 Uncertainty Analysis

The importance of uncertainty analysis and reduction are recognizable themes in ORD's program. ORD needs to increase investment in developing its capability to characterize uncertainty in its assessment techniques and models, but also to invest in the development of techniques and approaches that will facilitate the acknowledgment and integration of uncertainty in Agency guidance and rules. The efforts ongoing in uncertainty analysis in vapor intrusion modeling and the effort to use the 3MRA model to accomplish a comparative risk reduction analysis of waste minimization goals are positive examples of the needs that would be served from such an investment.

OSWER has a clear need for research focused on characterizing and reducing uncertainty in risk assessments and decision-making. This interest facilitates the transparency mandate that increasingly is important in rulemaking.

III.9.2 Flexible Approaches

Flexibility, defined in terms of adaptability and nimbleness, is a critical need for all programs, primarily because of the fact that conditions and circumstances motivating the research are fluid, resulting in change to which the Program must respond. Given the considerable amount of effort the Agency invested in interactions among its various elements (i.e., ORD, the program offices,

and the regions) it is unlikely that the same mechanism that the Agency used to generate the Land MYP can be used to make mid-course adjustments as the Program experiences unexpected successes and failures and new problems emerge. The Land MYP would benefit from a discussion of how these events and changes in condition will be incorporated and integrated within the base plan in an adaptive and timely fashion.

IV. QUALITY

The Subcommittee was asked to address the following charge question: **How is quality ensured in the awarding of research funds and in the research products?** The Subcommittee believes that the Land Research Program will lead to quality products and outputs. This is revealed primarily by the work that has been accomplished. The Subcommittee noted the areas in which the Land MYP and the Land Research Program have done a good job at identifying how quality will be ensured and identified areas where the MYP and the Program could be enhanced. The Subcommittee's review of this category is organized around the factors that the Subcommittee was asked to consider. These are framed as questions about various aspects of achieving and ensuring acceptable quality of the products and outputs of the research.

IV.1 What process is employed to prioritize research areas and allocate funds?

The Land MYP discussed separate approaches that are used to prioritize research areas and allocate funds between research support to the Superfund Program (the focus of LTG 1) and the RCRA Program (the focus of LTG 2). Because separate approaches were used, the processes for the two goals are discussed separately. In addition to the separate processes used to obtain input, the Land MYP was developed by a team that included senior management and liaisons from client offices to ORD, taking into account comments from the SAB review of the MYPs.

IV.1.1 Long-Term Goal 1

A detailed, iterative process was described for prioritizing the work under LTG 1 (for Superfund-oriented research). The process began with previously developed needs lists, deleting needs that had been met, and adding new needs. Input was obtained from EPA offices (i.e., OSWER and ORD) and regions, including regional technical workgroups. Advisory groups were established in five areas (sediment; groundwater; engineering, contaminant, and soil treatment; site characterization and methods; and human health risk assessment). Each advisory group reviewed the research program and research needs under its topic and ranked the research projects based on: (1) feasibility and timeliness, (2) applicability across sites/assessments, and (3) importance to several regions or programs. This ranking exercise served as input to the RCT in the overall program ranking, which also considered the expertise of ORD, strategic direction, and resource issues. In addition, the Land MYP noted that the input from the technical workgroups was used to shift the research in a number of cases where the current research did not meet identified needs.

The Subcommittee noted that this extensive prioritization effort was useful in obtaining information and priorities from EPA program offices and regions. This process appeared to be effective for incorporating advice from internal technical experts in the prioritization. Although these groups should have had the expertise to identify similar work going on elsewhere, explicit incorporation of input from outside groups (e.g., other government agencies, academia, industry,

and other stakeholders) would have been useful. Whereas it is appropriate that EPA determine its own research agenda, additional input from outside of the Agency (e.g., by the SAB, the BOSC, SERDP, Council on Environment and Natural Resources [CENR], National Academy of Sciences [NAS], and others), particularly early in the process, would be useful to ensure that key research priorities are identified and to minimize duplication of work by other agencies (or to ensure that any such duplication is intentional).

The Land MYP provided sufficient information on the criteria used in the regional prioritization exercise, including the appendices identifying the highest priority issues. The Subcommittee recognizes that useful information on prioritization can be obtained using both qualitative and quantitative prioritization approaches, and does not see a need to recommend a standardized prioritization approach.

IV.1.2 Long-Term Goal 2

The Land MYP noted that, unlike Superfund work, RCRA programs tend to be coordinated at the national level, and so most of the needs assessment and prioritization took place at the national level. Regional and headquarters personnel were requested to provide research needs, and representatives from all RCRA divisions met to prioritize the list, based on the following criteria: (1) Resource Conservation Challenge (RCC)-related projects; (2) cost; (3) leveraging; (4) duration, with shorter preferred; (5) quantifiable outcomes related to RCRA's strategic goals; (6) clearly and narrowly defined scope; and (7) regional priority. The overall prioritization placed heavy weight on the ability to complete the specific product deliverable within 2 years.

The criteria used for the prioritization within LTG 2 are articulated clearly, but the rationale for the criteria is not addressed fully in the MYP, and is not always obvious. For example, the RCC is noted as a top priority, but is not described further (except in context) in the Land MYP. There is a strong emphasis on short-term projects (1-2 years) of narrow scope. There clearly is a value in defining projects in sufficiently narrow chunks so that they can be completed and allow the Agency to progress to the next step or other issues. The Subcommittee agrees, however, with the SAB statement that the plan should include some focus on emerging issues and longer term horizons. Breaking major long-term projects into smaller subprojects, in which results can be obtained within a short time period, can be useful in reconciling the desire for short-term results with the need for longer term vision and planning.

IV.2 Does the program use peer review to ensure the quality of its products?

It is clear that peer reviews are used throughout the Land Research Program, which helps to ensure quality. These reviews range from high-level program and organizational reviews of individual guidance documents to publications appearing in peer-reviewed literature, and these reviews apply to various phases of particular products. The EPA *Science Policy Council Peer Review Handbook*, a published document that provides specific guidance for individuals involved in ORD research product peer reviews, was provided for the Subcommittee's consideration.

The Land RCT acts as an ongoing mechanism for peer feedback and review agents for ORD by helping to determine key research questions, taking a lead role in prioritizing research, planning resources across ORD, and facilitating communication of research results to clients. The Land RCT thus was seen to play a key role in facilitating communication of the various product activities both across the ORD laboratories and centers and among ORD, OSWER, and regional offices. The Land RCT is composed of representatives from ORD laboratories and centers, OSWER, and the EPA Lead Region for EPA's Strategic Goal 3 for Land. The RCT meets via biweekly or monthly teleconferences and in-person as needed. The Land RCT arranges or manages activities to assist in planning and communicating the Land Research Program and to ensure that information moves both up and down the management chains within OSWER and ORD through its frequent teleconferences and *ad hoc* meetings, helping to ensure the quality of the peer review input to the ORD.

IV.3 Does this problem-driven research program conduct internal and external peer reviews of the research?

EPA has a very thorough peer-review program for completed products, incorporating both internal and external reviews. Although it is not described in the Land MYP, the overall approach to peer review was described in EPA's Science Policy Council *Peer Review Handbook* that was provided to the Subcommittee and in discussions with EPA staff. Peer review is applied to a variety of items, ranging from peer review of the entire research programs of ORD divisions, to review of individual modules, software programs, guidance documents, and analyses. All ORD products and some ORD work plans undergo internal and/or external review. Work plans undergo external peer review if the work is highly complex or controversial. The size and form of the review varies depending on the type and significance of the item being reviewed. Minor items may undergo brief written reviews, whereas peer review meetings may be convened for more significant items. Particularly significant items may undergo review by the SAB. Some items may undergo multiple rounds of review, either as the document is revised in response to review, or in modules if a document or piece of software is in development.

Peer review of the problem-driven research associated with the Land Research Program was demonstrated to be a key element in efforts supporting internal research by records reviewed by the Subcommittee members. ORD laboratories and centers conduct peer reviews of their research divisions on a regular basis, but each may approach this activity somewhat differently. As an example, the National Health and Environmental Effects Research Laboratory (NHEERL) used selected external panels based on their expertise and availability to conduct onsite, 3-day peer-review meetings. Laboratory division management then developed action plans based on suggestions made by the panels for allocating resources over 5 years.

IV.4 Does the research program adjust in response to these reviews to maintain quality?

EPA routinely modifies both the direction of research and specific research products in response to external and internal reviews. This is exemplified by EPA's response to both SAB comments on earlier drafts of the MYP and EPA's response to the SAB of the 3MRA model, as well as the response to other SAB reviews and external peer reviews. Modifications in response to external peer review comments often are documented extensively in "dispositions of external comments," which either note that the recommended changes were made or provide the reason for not making the changes. In some cases, EPA policy is cited as the reason for not making the recommended changes. Although policy reasons may be appropriate for not applying peer review recommendations, care should be taken to ensure that valid scientific advice is not being dismissed inappropriately because of "policy considerations."

Although much of the information provided by EPA focused on the competition for initial funding and peer review of the final product, there was relatively little mention of ongoing evaluation. Such periodic (e.g., quarterly or annual) feedback is important to ensure that the research is on track technically and that it addresses the customers' (e.g., regions, program offices) needs. Such feedback apparently does occur, as documented elsewhere in the Land MYP in the form of the regional technical workgroups and the RCT; the importance of these reviews in ensuring ongoing quality should be noted. In particular, ensuring that feedback from the regions and other customers is taken into account with Program changes would be particularly useful. At the EPA research division level, ORD uses the PART to evaluate programs in four areas: purpose/design, strategic planning, program management, and program results. In addition, the annual Science To Achieve Results (STAR) Grant workshops provide ongoing review and communication of extramural research results. Where relevant, it might be appropriate to include the customer (e.g., regional staff, state agencies) in the periodic feedback. Formal mechanisms for ongoing review of contract research were not provided.

Quality can be viewed, in part, in terms of what the Program delivers to its clients. This includes elements of priority and performance in addition to the basic quality of the work. Although they were not specific to the quality of the individual projects, the Land MYP provided several examples in which the RCT addressed priorities set by regional workgroups, by either noting that the prioritized work currently is ongoing and shifting effort among projects, or the work is being addressed by other EPA offices. These examples illustrate adjustments made early in the planning process in response to reviews. Ongoing feedback regarding the direction and progress of research is provided by the regional workgroups, including quarterly meetings. The RCT also incorporates formal annual reviews and communication up and down the managerial chain and with the regions and OSWER, together with frequent teleconferences, ongoing review, and feedback of the research program. No information, however, was provided regarding how this advice is incorporated into ongoing course corrections, and whether the level of review and discussion is adequate to identify any needed course corrections. Progress on individual projects, however, is evaluated against APMs.

IV.5 Has the program used competitive, merit-based processes to award extramural funds?

Although it is recognized that “extramural funds” can apply to in-house work, the Subcommittee has chosen to follow the plain English definition of extramural funds as those being used to fund work conducted outside EPA. Section IV.6 addresses awards of funds for work being conducted within EPA.

There appears to be very limited extramural funds in the Land MYP. The MYP notes that there are no STAR resources in the research program for EPA’s Strategic Goal 3 (i.e., land preservation and restoration) under EPA’s overall strategic goals, although the results of a few related STAR grants were included in the presentation materials. The Land MYP also mentioned Small Business Innovation Research (SBIR) contracts. It was not clear whether any STAR grants or SBIR contracts are considered to be part of the Land MYP. Although such grants and contracts could be of value, it appears that the Agency has chosen to leverage its funding in this area by providing input to other agencies on funding, rather than directly sponsoring research efforts. The Land MYP did note that academic research is supported by direct funding of the National Institute of Environmental Health Sciences’ (NIEHS) Superfund Basic Research Program (SBRP); this work is coordinated with EPA. Reference also was made in the presentations to the leveraging of resources with other federal agencies. In particular, EPA provides input to the U.S. Department of Defense (DOD) as part of the SERDP and ESTCP grant programs. No information was provided, however, regarding whether any of these grant programs include any short- or long-term research activities related specifically to the LTGs listed in the Land MYP. The budgeted extramural funds include funding of in-house researchers who do not count as full-time equivalents (FTEs). The HSRC grants, formerly funded through the Land Research Program, also were awarded through a competitive process.

Other funds for work conducted outside of EPA are awarded competitively based on merit. This includes contracting and other assistance, such as grants and cooperative agreements. Contracts for research support (e.g., analytical support) typically are awarded via Requests for Proposals or Requests for Quotations. For some contracts used by the Land Research Program not only is the initial contract competed, but contracts are awarded to multiple sources so that individual blocks of work can be competed among multiple vendors.

IV.6 If funds are not awarded competitively, what process does the program use to allocate funds?

This question was interpreted by the Subcommittee to apply to funding within EPA. Staff members noted that extramural components of ORD’s in-house Land Research Program generally are awarded competitively, as are contracts for research support.

IV.7 Does this process ensure that quality is maintained?

Several lines of evidence indicate that quality is being maintained, which suggests that the underlying process is effective. Among the considerations in maintenance of quality are: (1) credentials of investigators; (2) whether appropriate work is selected in support of short- and long-term goals; (3) whether research studies are designed and conducted appropriately; (4) other quality assurance systems; and (5) the resulting level of quality evident in the publications of scientific work.

Quality is maintained by the leadership of investigators with strong credentials. As evidence of these strong credentials, information provided to the Subcommittee shows that ORD staff involved in the Land Research Program participate on numerous editorial boards and academic committees; have served on peer review panels, NAS committees, and in leadership positions of professional societies; and have won a number of external (non-EPA) awards. In addition, a number of internal EPA awards, including gold, silver, and bronze medals, have been awarded to researchers connected with the Land Research Program. Quality also is ensured through the use of expert panels that provide review. An example is the international panel of experts selected by ORD to provide an independent assessment of the state-of-the-science and practice with respect to dense non-aqueous phase liquid (DNAPL) source remediation efforts.⁴

Quality of products and outputs relates, in part, to the degree to which they meet the expectations and needs of the users. There appears to be strong evidence that the clients find the products and outputs helpful at the project level; the clients also find the technical support provided by the Technical Support Centers (TSCs) to be very helpful. In fact, there is a strong demand for these services from the user groups, indicating that they are considered valuable and of high quality.

Quality also is indicated through the design and conduct of projects and the production of specific products and outputs. The Subcommittee relied on poster presentations as the major source of information informing this review. The 3MRA poster presentation provided an overview of a project that the Subcommittee judged to be well conceived and appropriately designed. In addressing client needs for LTG 2, greater connection could be made to address bulk resource conservation issues, including source reduction (aside from toxic materials) and recycling. Similarly, there was no mention of needs related to landfill construction, although such research clearly is important and work is ongoing. Posters were presented on innovative, well-leveraged projects regarding landfills as bioreactors and other issues of landfill design—projects that address clear customer needs, but such needs were not articulated in the MYP. The Subcommittee was impressed with the design and conduct of projects illustrated in the poster presentations. The Subcommittee accepts this as strong evidence for a sound underlying process that is delivering quality products and outputs.

EPA provided information on a number of mechanisms in place to ensure quality. As discussed above, ORD conducts an extensive peer review program, both on final products and overall

⁴ EPA/600/R-03/143, December 2003. The DNAPL Remediation Challenge: Is There a Case for Source Depletion?
<http://www.epa.gov/ada/download/reports/600R03143/600R03143.pdf>

research programs. EPA also has extensive documentation of quality systems for laboratory work, including quality management plans. Quality assurance (QA) programs are applied both to in-house and extramural research. For each organization, an overall Quality Management Plan is required initially, followed by the development of individual QA Project Plans for individual projects. These activities are designed to ensure that data collected are scientifically sound, legally defensible, and of known and acceptable quality for their intended use.

Finally, the record of publication of intramural and extramural scientific work also is evidence that quality is being maintained. EPA provided a bibliometric analysis of 1,141 papers on topics related to the Land Research Program by intramural and extramural EPA researchers from 1995 to 2005. The 1,141 papers published from 1995 to 2005 that were covered by Thomson's Web of Science were cited 14,477 times in the journals. Of these papers, 1,030 (90.3%) have been cited at least once in a journal. Quality tool of benchmarking was accomplished using Thomson's Essential Science Indicators (ESI) and Journal Citation Reports (JCR). A summary of noteworthy information from the analysis included:

- ✍ More than one-quarter of the land/remediation publications are highly cited papers.
- ✍ The land/remediation papers are cited more highly than the average papers.
- ✍ Nearly one-quarter of the land/remediation papers are published in very high impact journals.
- ✍ Twenty of the land/remediation publications qualified as hot papers.
- ✍ The authors of the land/remediation papers cite themselves less than the average self-citation rate.

In addition to the quality of peer-reviewed publications, ORD technical protocols and guidance have resulted in appropriate application of technology. These technical protocols and guidance are used extensively as resources at sites across the United States.

V. PERFORMANCE: RESEARCH PROGRAM DESIGN

The Subcommittee was asked to address the following charge question: **Is the research Program design logical and appropriate?** The Subcommittee believes that the Land MYP does have a logical and comprehensive design for research. The Subcommittee noted the areas where the Land MYP and the Land Research Program have done a good job with respect to the design of the projects and presented comments related to areas in which approaches could be clarified and the designs potentially could be improved. The Subcommittee's review of this category is organized around several factors that the Subcommittee was asked to consider. These are framed as questions that relate to various aspects of achieving the design of the Land Research Program.

V.1 Does the program have a logical, comprehensive design and an MYP with clear goals, schedules, and priorities, and is the research program appropriately leveraged and coordinated with others working in these areas?

The Land Research Program does have a logical and comprehensive design for research to work toward producing knowledge, know-how, and decision-support tools to address and mitigate known current problems (e.g., remediation of USTs, remediation of DNAPLs in groundwater, risk and remediation of contaminated sediment sites) and contribute to the LTGs of the Land MYP. Some aspects of the Program, however, could be clarified or improved as highlighted below.

V.1.1 Goals

With respect to design as well as other aspects of this program review, the Subcommittee believes that the Program goals could be stated more clearly in terms of their scientific research focus. The two LTGs presented in the Land MYP are as follows:

LTG1: Clients request and apply ORD research products and services needed for mitigation, management, and long-term stewardship of contaminated sites.

LTG2: Clients request and apply ORD research products and services needed to manage material streams, conserve resources, and appropriately manage waste.

These two LTGs reflect the Program's underlying purpose, which is to maintain core expertise and to carryout research so that questions raised by the program and regional offices can be answered effectively in a timely fashion. Unfortunately, the phrasing of these two LTGs does not translate logically into research program planning or evaluation of performance. Moreover, they do not possess attributes that enable metrics to be developed and applied readily for assessment of progress toward goal achievement.

Given the breadth in the Land Research Program, it is recommended that the LTGs be revisited both in formation and structure. It might be suggested that the two LTGs in the current MYP be recast in terms of the two major environmental challenges, with problems and the scientific advancements needed to aid their resolution then described as sub-goals. Such an approach then would have two high-level goals as stated in the current plan, but have explicit sub-goals. For example, LTG 1 might be restated as: “Development of validated knowledge, techniques, and tools to identify, assess, and remediate contaminated sites.” Sub-goals then could include problem-oriented activities similar to the themes. For example, a sub-goal might be focused on DNAPLs in groundwater or petrochemicals from USTs (both impact to groundwater and vapor intrusion).

V.1.2 Program Structure, Design, and Schedule

The organization of research projects by elements of the risk assessment and risk management paradigm is reasonable; however, in organizing the work being completed, as revealed by the numerous APGs (38) and APMs (140) (Table 4 in the Land MYP), the MYP does not reveal a clear schedule for workflow to an endpoint. It would be clearer to organize projects and outputs by major problems (e.g., assessment and cleanup of DNAPLs in groundwater, design and operation of landfill bioreactors). This would enable articulation of clear goals tied to resolving a given environmental issue or problem fully through a research program effort according to a timeline with mid-course and final deliverables. For example, the posters presented during the face-to-face meeting in Cincinnati did not include timelines or anticipated completion dates.

The Subcommittee recognizes there is disparity between LTGs 1 and 2 that reflects the funding for these two goals and the nature of the programs associated with the goals. The bulk of the Land Research Program appears to be oriented to the current LTG 1, which focuses on contaminated sites.

The Program design and research clearly are problem-driven, and research questions are posed to guide the research approach and anticipated outputs. The Subcommittee notes, however, that the research (i.e., as presented in the poster session) is not clearly hypothesis driven. In addition, the bulk of the research is short-term problem driven and designed to answer questions posed by the program or regional offices. Possible limitations and/or gaps with respect to the current design include: (1) relatively light treatment of some current land-related issues that the Subcommittee members thought were important; (2) little emphasis on emerging issues; and (3) insufficient use of all leveraging opportunities.

Some key research areas that are not being addressed to a significant degree in the current MYP include research to address risk assessment/risk management questions concerned with biosolids and animal waste application to land, mining and megasites, oil and gas operations, infectious disease agents, and beneficial reuse of waste materials.

There is an apparent gap in the MYP concerning longer-term research and visionary thinking. Projects and activities that confidently will yield results in 1 to 2 years are favored. Likely because of budget and resource limitations, the science questions and recent and ongoing

research appears focused on short-term program support. In contrast there is little evidence of longer-term basic or applied research or a process by which science from other programs or agencies will be infused for this purpose. This is a deficiency called out by the SAB in its recent review of the Contaminated Sites and RCRA MYPs, and it appears that this deficiency persists in the current integrated MYP.

The Subcommittee commends EPA and the Land Research Program on the performance of its Technical Support Group. This group of ORD staff works with EPA staff at the regional and program level on specific projects. The Land MYP identified technical support as a critical component of the Land Research Program, and this was supported strongly in the presentations by ORD staff and by the statements of the user groups. The Technical Support Group is consistent with the current LTGs and provides benefits not only as support services but also to research initiatives. The technical support function can be a vital conduit for ORD researchers to identify and refine research questions. In addition, access to real-world problems and sites can enable environmental investigations and technology demonstrations.

The use of expert panels to define the state-of-the-science and identify research needs and approaches in specific research areas (e.g., DNAPLs in groundwater, contaminated sediments) represents an excellent means to ensure that important questions are being addressed appropriately (e.g., the DNAPL Source Zone panel and report published in 2003). These panel efforts also can reveal emerging issues and help guide forward-looking research. The Land Research Program is encouraged to employ these types of expert panels broadly across all facets of the Program.

V.1.3 Leveraging and External Funding

The Land Program appears to have done an excellent job of coordination and communication between ORD and the program and regional offices that the Land Research Program is intended to support. The research needs presented in the current MYP have been developed in a rational and inclusive manner with consideration of leveraging and coordination with other agencies working in related areas. Many of the research activities involve investigators from multiple laboratories or centers with expertise in multiple disciplines. There were several examples of how research teams have been assembled to include staff members with education and expertise in the physical sciences and engineering along with the biosciences to attack key questions. This teaming approach across laboratories/centers and disciplines is excellent and should be encouraged.

Some ORD researchers collaborate with investigators from other agencies, universities, and private industry, and to a limited extent, seek and receive funding from other sponsors (e.g., SERDP, ESTCP). The EPA Land Research Program is a highly leveraged program. Collaborations with regional offices and specific sites have enabled field investigations and technology development research to occur. EPA researchers have exploited this in the past, notably through the SITE Program, but also through other *ad hoc* relationships. EPA research scientists who want to maintain a large research program or conduct basic research are forced to seek outside research support from other agencies through interagency transfer (e.g., DOD's SERDP and ESTCP). This represents an important opportunity for EPA researchers, because

they can supplement their research by expanding the scope or adding collaborators. It appears, however, that relatively few EPA researchers take advantage of these opportunities. More EPA investigators should be made aware of these opportunities and encouraged to seek supplemental funding for their work.

EPA staff is involved in research programs administered by other agencies, such as DOD SERDP and ESTCP, and NIEHS' SBRP. It appears that these other agencies provide funding to universities, national laboratories, and private industry, but not to EPA laboratory or center researchers associated with the Land Research Program. Land Research Program personnel help define the research needs and provide proposal and in-progress reviews.

Within the MYP, there is a lack of clarity regarding the value and importance of intramural versus extramural research activities and the level of resources allocated to internal versus external research. It appears, however, that there may be a significant imbalance in internal and external research, with internal applied research and technical support by EPA staff being the dominant component. The internalization of the Land Research Program can be viewed as potentially problematic, as it can result in a loss of external research infrastructure. It also results in a loss of training of the next generation of research scientists and engineers at universities. The absence of any substantive resources provided for STAR grants and fellowships that directly support the Land Research Program is a deficiency that should be rectified.

As noted earlier, the success and impact of the research conducted under the Land Program can be measured by the volume and quality of peer-reviewed publications generated.

V.2 Does the MYP describe an appropriate flow of work? Does the research address the key research questions? Is the rationale to address the questions clearly articulated?

The Land MYP does describe a flow of work to address research questions that were developed in a clearly stated process (i.e., needs identification and prioritization). For example, Table 4 in the Land MYP provides extensive detail regarding APMs for different APGs for the two LTGs. It is not completely clear, however, how work flows to answer a research question completely, or what work depends on other work, and how activities are sequenced and integrated.

The Land MYP describes how research needs are identified and activities are prioritized. It does not describe, however, how research is evaluated as it progresses and whether there are go/no-go decision points that are applied routinely. The use of in-progress reviews and go/no-go decision points should be used routinely, and this should be articulated clearly in the MYP.

V.3 Does the ORD program use this MYP to address a logical sequence of questions, and does it use the plan as a basis for prioritizing its work?

The Land MYP has a logical *set* of questions structured generally around elements of the risk assessment/risk paradigm framework, but the *sequence* of questions along a timeline and the activities that fall out from it are not completely clear. As noted above, the sequence, interdependence, and integration of research activities and efforts are not completely clear. The Land MYP does appear to be used to prioritize its work with heavy input from the program and regional offices. It is not clear what, if any, work can be initiated by the staff scientist or engineer, for example, through a seed funding program. This would be valuable to provide incentives to staff and to enable an award-for-performance system.

V.4 Does the MYP respond to SAB recommendations for developing a holistic MYP from the predecessor plans?

The MYP does appear to respond to the SAB recommendations to develop a holistic MYP by combining the Contaminated Sites and RCRA MYPs; however, the RCRA component of the combined Land MYP appears to be emphasized to a lesser extent than the contaminated sites component of the plan. As noted above, the contaminated sites activities are more numerous (as measured by APGs and APMs). This may or may not be a reflection of the relative importance or attention given to the two areas as integrated in a new single MYP.

The SAB advised allocating or reallocating resources to longer-term research (i.e., more than 10 years) as well as emerging environmental issues. Some of the SAB recommendations were addressed in the Land MYP, but not in a comprehensive or significant manner. For example there is little research ongoing or planned that could be considered long-term research, and only a limited level of work focused on the suggested emerging environmental issues.

VI. PERFORMANCE: TIMELY PROGRESS

The Subcommittee was asked to address the following charge question: **Is the research Program making timely progress in addressing key scientific questions and LTGs?** The Subcommittee believes that timely progress has been made on LTG 1. Some aspects of LTG 2, however, seem to be lagging behind. The Subcommittee noted the areas in which the Land MYP and the Land Research Program have done a good job with respect to timely progress and presented comments related to areas in which there is potential for improvement. The Subcommittee presumes that the slower timeliness for LTG 2 initiatives likely is related to funding and/or is an artifact (i.e., the research initiatives tracked under LTG 1 are more mature initiatives). Regardless of the reason, the Subcommittee is of the opinion that this disparity could have been addressed in the Land MYP. The Subcommittee's review of this category is organized around several factors that the Subcommittee was asked to consider. These are framed as questions that relate to various aspects of achieving the design of the Land Research Program.

VI.1 What degree of progress has been made in addressing each of the LTGs and associated key research questions?

The Subcommittee commends EPA on the good progress it has made in addressing the LTGs and the key science questions identified in the Land MYP. Although the Subcommittee had difficulty assessing progress made in the Program based on the documentation provided, it was the general consensus of the Subcommittee members that ORD's work is being sought after actively and used by stakeholders to answer the key science questions associated with each goal on essential environmental projects across the nation, reflecting a good degree of progress being made in addressing the LTGs and key research questions.

Research related to VI is an example of excellent progress being made on research in support of LTG 1. The Land MYP is anticipating a number of outputs in FY 2006 that will support ORD's clients on VI issues. The Subcommittee considers this work to be timely and scientifically sound. The Subcommittee notes that the states just now are starting to make VI assessments at RCRA and CERCLA cleanup sites. The Subcommittee recognizes that this work is critical in providing necessary science and technology support to the end users of this information.

It is the consensus of the Subcommittee members that ORD research has contributed substantially to the science and technology supporting decision-making by EPA programs and the Agency's external stakeholders. The Land Research Program reflected in the Land MYP and revealed in the project-specific posters reflect attention toward addressing the key science questions of the LTGs on projects and issues that are critical to EPA's overall mission. The Subcommittee expresses concern, however, that imposed and impending budget constraints could impact severely ORD's ability to meet the demands of all of EPA's important or critical program areas. The Subcommittee sees evidence of these budget stresses in what appears to be a "trailing" approach for ORD in supporting the needs of OSW with respect to the RCRA D

Program area and its RCC. Further evidence of this is seen in the disparity of the budgeted funds and FTEs assigned to LTG 2.

As mentioned previously, the Land MYP does not provide sufficient detail to explain why the majority of the outputs and outcomes associated with LTG 2 generally appeared to be delayed toward the end of the planning period. The appearance of LTG 2 as secondary to the work in LTG 1 in the Land MYP can be inferred from review of Table 4 in the Land MYP. This contributed to the Subcommittee's opinion that timely progress is not being made in support of science questions tied to LTG 2, the goal in support of the needs of EPA's OSW. This opinion is supported further by the Subcommittee's evaluation of the appendices of the Land MYP and from review of the information provided to the Subcommittee during the poster session. The Subcommittee thought that this apparent lag in research support for LTG 2 might be attributed to the newer EPA OSW Program initiatives, such as the RCC. The Subcommittee recommends that ORD give consideration to leveraging and collaborating to ensure timely progress for LTG 2.

An example of slow progress being made toward the LTG 2 outcomes is the work related to assessing human and ecological exposure from the use of coal ash residue in beneficial roadway construction. In this case, reportable outcomes are planned for FY 2009. With the RCC advocating beneficial use of waste stream-derived materials, and with many of the states entertaining such beneficial use applications today, this assessment tool would be helpful to decision-makers now but could be outdated in 2009.

Another example in which LTG 2 work appears to be lagging current needs is the assessment of risks associated with electronic waste (e-waste). Many states and communities already are addressing e-waste recycling and handling programs. It would be desirable to have had the results of the e-waste research in advance or concurrent with the development of programs to manage these wastes.

The above concerns for appearance of lagging outcomes for LTG 2 should not overshadow the significant scientific and engineering work being done by ORD. Overall, the Subcommittee recognizes the extreme breadth of ORD's dynamic research program, which is designed to serve the many branches of the Agency and its need to obtain input from its many clients. The Subcommittee acknowledges that the draft Land MYP stated that many of ORD's clients (i.e., EPA program offices, regions, and states) still are evaluating the highest priority material streams, and they anticipate that the current research programs under LTG 2 might need to be revised based on this input. This perception of a lagging progress towards LTG 2 could be, perhaps, an artifact of this missing input from ORD's clients with respect to the science and technology needs to support the RCC still being sought after by ORD, as mentioned in the MYP.

The Land MYP notes the importance of Integrated Risk Information System (IRIS) values and efforts to increase throughput and development of new/updated values. Although IRIS falls primarily within the Human Health Risk Assessment MYP, the Subcommittee wishes to emphasize the importance of a faster process for updating IRIS values and the development of new ones.

VI.2 How useful is the MYP for mapping progress in the future?

The Land MYP outlines a process for mapping future research progress that is called for in the draft plan. The Subcommittee considers the timeframe charted in Table 4 of the Land MYP a more short-term future perspective. The Subcommittee also was of the opinion that the Land MYP needs to incorporate more information and direction defining a longer-term future to better allow ORD to ramp up to meet the future demands associated with emerging technologies. This could be accomplished by having ORD project what long-term needs are anticipated from its current Land Research Program by the Agency. Although the posters contained useful information describing the research initiatives, there was less evidence for integration of the longer term or future discussions on all of the posters. Some did address future directions, but in many cases this largely highlighted that a report was due at some point or that the program would carry on to support certain activities.

VI.3 Has ORD's program clearly articulated its focus and the rationale behind its approach to study these LTGs?

The Subcommittee believes that the Land MYP provides the rationale behind its approach to study the LTGs. As discussed earlier, however, the LTGs do not lend themselves to assessing an approach to judge progress; the Subcommittee has suggested how they can be stated more clearly in terms of science goals.

From a review of the *Strategic Plan*, it is clear that much of OSW's future regulatory program is focused around the RCC, which advocates sustainability approaches to waste management methods. The Land MYP could have been written to integrate more effectively the visions addressed in the *Strategic Plan* with respect to the Summary of Research Activities, Outputs, and Short-Term Outcomes addressed in Tables 2 and 3 of the Land MYP. This concern was supported further by the Subcommittee's review of the posters associated with LTG 2. The Subcommittee members thought that more could have been said about how the planned research programs provide support to decision-making on sustainability issues and the use of life cycle assessment determinations related to solid waste management. For example, the posters addressing the use of the 3MRA model could have discussed more thoroughly the application of this tool in supporting the RCC and other Program initiatives under LTG 2. The Subcommittee recommends that future MYPs give more consideration to how the Program can assist more effectively in implementing the RCC and sustainability program directives that are represented more thoroughly in the *Strategic Plan*.

The ORD research program in late 1980s and 1990s provided stakeholders with a tremendous number of technical research documents and substantial guidance on proper design and construction of modern landfill liner and final cover systems. This information was critical to EPA's external stakeholders in ensuring the proper design and construction of environmental containment systems. The Subcommittee acknowledges that the landfill design and construction industry has evolved tremendously over the last 10 to 15 years. EPA, however, has not updated these widely used and relied upon guidance documents to support the current state of practice for

designing modern environmental containment systems. Although the Land MYP's Appendix A referenced this, there was little or no evidence of this work being underway on the posters beyond the work being done on alternative cover systems and the efforts associated with evaluation of liners being used in landfill cover systems. The Subcommittee recognizes this as a simple technology update task that is best done under the oversight of ORD to ensure an objective assessment of these concerns. ORD should collaborate with the geosynthetic industry to help in funding such work.

VI.4 Do these LTGs constitute logical focal points for planning the research and for identifying long-term priorities that meet the scientific needs of the Agency and program customers?

The issue of the vagueness of the LTGs already has been discussed. The Subcommittee commends EPA on the enormous progress that has been made in addressing multiple environmental problems through the application of the Land Research Program. The importance of this progress is reflected in the research efforts that have been focused on addressing complex scientific and technology-related problems at high-priority sites identified by EPA's program and regional offices and external state stakeholders. As mentioned above, however, it is unclear, based on the Land MYP, how the progress is made on individual problems as they relate to the stated LTGs, associated objectives, and sub-objectives. This difficulty of assessing progress arose out of the absence of clear definition/discussion within the Land MYP as to how progress was to be addressed/tracked under the LTGs.

VI.5 Has the program made significant progress toward each of the LTGs? Are the questions being addressed in a timely manner?

The Subcommittee believes that significant progress is being made towards achieving LTG 1 and its supporting science questions are being addressed. As mentioned above, however, the Subcommittee did find it difficult to see timely progress being made toward achieving LTG 2, specifically with respect to research that would be supportive of the RCC. Again, the Subcommittee noted that judging progress in terms of product use is difficult at best.

VI.6 Has the program met stakeholder needs in a timely and useful way?

For LTG 1, the Program is meeting the stakeholder needs in a timely and useful way. Based on review of the posters, the research conducted under LTG 1 is making its way to end users. An example of this is the work being conducted on characterizing contamination and the associated risks at contaminated sites, which is answering questions and concerns that are critical to helping all stakeholders to work smarter and more efficiently and keep remedial costs to a minimum as needed.

The progress being made in meeting stakeholder needs under LTG 2 is more difficult to assess and was not readily apparent from a review of the information contained in the MYP. Under LTG 2, most of the current and planned work evolves around research addressing leaching data and research associated with hard-to-treat wastes. Although this information will be useful in making beneficial use determinations and answering waste deposition issues, the Subcommittee believes that the current and planned work shown for LTG 2 in Appendix A could do a better job in responding to clients' needs.

There are some positive examples of progress to cite in LTG 2. Most notably is the work being done on bioreactor landfill. ORD already has produced a document that addresses approaches to monitoring and evaluating bioreactor landfill performance. This information is useful to the states that are authorizing bioreactor landfill operations and will help to ensure some standardization to monitoring the parameters of these disposal facilities so that the data being collected under research, demonstration, and development (RD&D) projects for bioreactor landfill operations can be used most effectively for future regulatory decision-making.

VI.7 Is there evidence for application of products and knowledge by clients that would lead toward achieving program outcomes?

Under LTG 1, work products are being developed in a timely way to characterize contaminated sediments accurately and quickly. These work products are sought actively by clients to achieve contaminant cleanups quickly as a Program outcome.

Under LTG 2, work products (e.g., the interim report on landfill bioreactor design manual) characterize the optimum operating and monitoring approaches of bioreactor landfills. These work products are relatively timely and will help states and facility owners pursue RD&D permitting of these forward-thinking land disposal options.

VI.8 Has the program been effective in developing and communicating outputs that support the risk assessment/risk management process?

The Program has been effective in developing and communicating outputs that support the risk assessment/risk management process. Examples include the work on assessment of bioavailability and resuspension of contaminated sediments and metal speciation and bioavailability in the risk assessment/risk management paradigm. Another example is the independent expert panel on DNAPLs, which provided key input to the Agency on how this type of contamination should be addressed.

VII. SCIENTIFIC LEADERSHIP

The Subcommittee was asked to address the following charge question: **Is ORD playing a leadership role in Land research and collaborating effectively with the larger research community?** The Subcommittee believes that ORD historically has assumed a leadership role and should continue to do so. The Subcommittee's review of this category is organized around several factors that the Subcommittee was asked to consider. These are framed as questions that consider various aspects of leadership in applied scientific research.

VII.1 What leadership role does the Land Research Program and its staff have in contributing to advancing the state of science and practice?

ORD and the research efforts that currently comprise the Land Research Program historically have provided excellent leadership to EPA, the states, and the regulated community on identifying and addressing environmental problems, and the Subcommittee believes it is vital that ORD continue its environmental leadership role. Such leadership provides the credibility needed to have research products widely accepted, not only within the Agency but by other entities affected by environmental regulation. The Subcommittee submits that this is the role ORD must continue to play and believes that, within the current Land MYP, ORD exemplifies leadership for the short-term, problem-driven research areas. Examples include the methods for evaluating monitored natural recovery (MNR) in sediments, advective flux through sediment caps, and the models developed for human health exposure (IRIS/PPRTV, IEUBK/AALM, and 3MRA).

The Subcommittee recommends that, as part of the Land MYP, the Agency identify a process for identifying and acquiring the key leaders for those programs where clear leadership may be lacking. Leadership should be reflected in personnel as well as programs. The Agency has well-respected leaders in many of the environmental programs presented in the Land MYP, but in other program areas there did not appear to be a clear assignment of experienced personnel. For example, in the Contaminated Sediments initiative, the overall Program would benefit by the addition of expertise in coastal engineering. In the interim, until the Agency can acquire and/or develop internal expertise and leadership, the Land Research Program could benefit from collaborating with leading experts outside of EPA. For example, the dredging research and assistance programs (e.g., resuspension, sediment profile imaging [SPI], and capping) would benefit by leveraging the considerable work conducted in these fields by the USACE and the U.S. Navy, or by engaging external leaders from academia and industry. Although adding FTEs might not be the most efficient use of Agency resources, the Land MYP should identify this need and state that the key leadership positions will be filled by retaining the appropriate external (outside EPA) resources.

Leadership in emerging fields is lacking, and the Subcommittee recommends that ORD address this in the Land MYP by identifying as a goal the need to hire these key resources. As noted previously, these emerging areas include those identified by the SAB review of the previous

MYP (e.g., long-term management of drainage from abandoned mines as well as water and air emissions from large mining waste disposal sites; mitigation of environmental impacts of mining operations; and nanotechnology) and other issues identified by this Subcommittee (e.g., management of water and air emissions from natural gas extraction).

VII.2 Has EPA collaborated with other agencies (inside and outside the government) in advancing EPA's research agenda?

EPA has a long history of collaboration with other federal and state agencies. The Subcommittee lauds these efforts, but believes even more is needed. That the Agency is interacting within and outside the government is reflected in the list of collaborating agencies, which was provided in Appendix C of the Land MYP. The conference on contaminated sediments issues held in Narragansett, Rhode Island, which included EPA, the USACE, and the U.S. Navy, is an excellent example of the kind of communication and collaboration that should continue to be encouraged during the development of future MYPs.

Although the Agency has made, and continues to make, considerable efforts to integrate its work with those of other government agencies, the MYP would benefit by articulating a plan or mechanism for identifying mature research fields and/or ensuring that the ORD-planned research is not duplicating efforts being conducted by other government or state agencies or by the private sector. The Subcommittee noted that there is duplication of existing or mature research in the current Land MYP. As mentioned in Section IV.2 of this report, the Subcommittee recommends that ORD's planned research be externally peer reviewed prior to compilation of the Land MYP. The peer-review panels should be comprised of individuals from universities, NGOs, state agencies, and private industries⁵ and should be empowered to evaluate planned research critically, allocate among the planned research programs, and assist the Agency in identifying mature versus forward-looking critical research.

EPA's leadership extends well beyond the borders of the United States. The human health and ecological risk assessment paradigms, and approaches for management of contaminated sediment and air, water, groundwater and landfills are copied or emulated throughout the world. The Subcommittee recommends that the Land MYP reflect this global role in environmental management. The Subcommittee notes that ORD staff members are engaged actively in the appropriate national science and technical professional bodies. The Subcommittee encourages increased involvement in international research initiatives, as this is an important means of leveraging programs.

⁵ Both the Board of Scientific Counselors and the Science Advisory Board include representatives from the private sector.

VII.3 Recognizing that other organizations have substantial resources for related work, has ORD allocated its resources to EPA's best advantage?

The Subcommittee suggests that, with the emphasis in the Land MYP on short-term, problem-driven research, ORD may not have allocated its resources to EPA's best advantage. Furthermore, it would be helpful to understand in the Land MYP where ORD funds are needed to fill a clear research need, and where other funding sources are being used and/or leveraged to accomplish similar work. Wherever possible, the Subcommittee encourages EPA to consider devoting resources toward defining and researching emerging issues or planning for leveraging of current work across areas (e.g., MNA applied to mining sites).

During the formulation of the Land MYP, EPA could determine whether similar work is being funded by other government agencies and/or the regulated community. This part of the planning process is articulated in OMB Circular M-03-15, and, if a research topic is being funded elsewhere, ORD might consider this as a factor when allocating its resources. For example, the Land MYP lists sediment research programs that relate to fate and transport modeling, sediment sampling, MNR measurements through radioisotope measurements, resuspension in dredging, post-dredging residuals, and the application of SPI to benthic infaunal recovery—all of which have been used and developed extensively within the Superfund Program by other federal agencies (e.g., USACE, U.S. Navy), state agencies (e.g., Michigan Department of Environmental Quality [DEQ], Oregon DEQ, Wisconsin Department of Natural Resources, and Washington State Department of Ecology), and private responsible parties at multiple sites throughout the country.

ORD's efforts have contributed substantively to the Subcommittee's understanding of contaminant fate and transport in sediments. Examples of past "gold standard" ORD-funded programs include the Equilibrium Partitioning model, and the Hydrologic Simulation Fortran Program. These were cutting-edge, forward-looking development efforts that contributed significantly to the science of sediment management.

In evaluating effective allocation of resources, the Land MYP should distinguish between the otherwise unfunded research needs that ORD is meeting and those needs that are funded through other mechanisms. The Subcommittee describes here the situation for sediments, as some members of the Subcommittee are familiar with work in that area; similar comments might apply to other parts of the Land Research Program. Fate and transport modeling has been done at the Hudson River, the Lower Fox River, the Housatonic River, and more recently has been initiated at the Passaic River and the Lower Willamette River. Most of these modeling efforts have been developed as part of the Superfund Program with the Agency in a lead development role. The Land MYP states that ORD has a role in the development of modeling for these sites, but what is less clear in the MYP is to what degree ORD research funds are needed at those sites. All of the sites listed have identified responsible parties, from which the EPA funds its efforts through the cost-recovery mechanisms in Superfund; thus, the fate and transport modeling program is leveraged through indirect funding from the responsible parties. In that case, ORD should consider that program leveraged and allocate those resources to other research needs. To the

extent that ORD resources are funding work that is not covered by cost recovery (or by internal Agency contracting mechanisms when conducting region-specific work), then it is appropriate for the Land MYP to cover those cases.

As noted in the SAB review of the MYP and this Subcommittee program review, funding mature research areas is not the best allocation of scarce resources. The Subcommittee provided but one example here and recognizes that ORD is in a better position to identify similar programs that may be present in the Land Research Program. Dredging resuspension is an example of a well-developed and mature field of investigation that might not rise to the level of needing additional research efforts. Resuspension has been the subject of ongoing work by the USACE^{6,7} and others.^{8,9,10} SPI has been used to evaluate changes in disturbed benthic communities for over 30 years, and has been the subject of numerous review papers on relating benthic recovery post-disturbance.^{11,12,13}

In the end, the question still is, “are the resources allocated appropriately?” To the degree that any of the identified work is being funded through other mechanisms (e.g., Superfund cost recovery) or has been well documented by other agencies and/or private industry, ORD should examine critically in the Land MYP if it is making the best allocation of EPA’s resources. To the degree that there is an otherwise unfunded need, it is appropriate to state how the MYP fills that gap.

⁶ Herbich JB, Brahme SB. 1991. Literature Review and Technical Evaluation of Sediment Resuspension During Dredging. Contract Report HL-91-1. Vicksburg, MS: U.S. Army Engineer Waterways Experiment Station. January.

⁷ USACE 2000a. Estimating Dredging Sediment Resuspension Sources. ERDC TN-DOER-E6 April 2000. Available online at <http://el.erdc.usace.army.mil/dots/doer/technote.html>.
USACE 2000b. Assessment of Potential Impacts of Dredging Operations Due to Sediment Resuspension. ERDC TN-DOES-E9. May 2000. Available online at <http://el.erdc.usace.army.mil/dots/doer/technote.html>.

⁸ Hayes DF, Wu P. 2001. Simple Approach to TSS Source Strength Estimates. In: Western Dredging Association Proceedings, WEDA XXI, Houston, TX, June 25-27, 2001.

⁹ Hayes DF, Crockett TR, Ward TJ, Averett D. 2000. Sediment Resuspension During Cutterhead Dredging Operations. *Journal of Waterway, Port, Coastal and Ocean Engineering* 2000;126(3):153-161.

¹⁰ Anchor. 2003. Literature Review of Effects of Resuspended Sediment due to Dredging Operations. Prepared for Los Angeles Contaminated Sediments Task Force. June 2003.

¹¹ Rhoads DC, Cande S. 1971. Sediment Profile Camera for *In-Situ* Study of Organism-Sediment Relations. *Limnology and Oceanography* 1971;16:110-114.

¹² Rhoads DC, Germano JD. 1982. Characterization of Organism-Sediment Relations Using Sediment Profiling Imaging: An Efficient Method of Remote Ecological Monitoring of the Seafloor (Remots™ System). *Marine Ecology Progress Series* 1982;8:115-128.

¹³ Rhoads DC, Germano JD. 1986. Interpreting Long-Term Changes in Benthic Community Structure: A New Protocol. *Hydrobiologia* 1986;142:291-308.

**APPENDIX A: LAND RESTORATION AND PRESERVATION
SUBCOMMITTEE MEMBERS**

Charlie Menzie, Ph.D., Chair

Menzie-Cura & Associates Inc.
2 West Lane
Severna Park, MD 21146
410-987-7272
camenzie@menziecura.com

James R. Clark, Ph.D., Vice-Chair

Exxon Mobil Research & Engineering Co.
3225 Gallows Road, Room 3A412
Fairfax, VA 22037
703-846-3565
703-846-6001 fax
jim.r.clark@exxonmobil.com

Todd Bridges, Ph.D.

U.S. Army Engineer Research and
Development Center
Waterways Experiment Station (EP-R)
3909 Halls Ferry Road
Vicksburg, MS 39180-6199
601-634-3626
todd.s.bridges@erdc.usace.army.mil

Barry Dellinger, Ph.D.

Department of Chemistry
413 Choppin Hall
Louisiana State University
Baton Rouge, LA 70803
225-578-6759
barryd@lsu.edu

Lynne Haber, Ph.D.

Toxicology Excellence for Risk Assessment
(TERA)
2300 Montana Avenue, Suite 409
Cincinnati, OH 45211
513-542-7475 ext. 17
haber@tera.org

Eugene Keating, Ph.D.

Environmental Kinetics, Ltd.
1687 Camden Court
Arnold, MD 21012
410-757-6713
gene@environmental-kinetics-ltd.com

Robert Phaneuf

New York State Department of
Environmental Conservation
Division of Solid and Hazardous Materials
Bureau of Hazardous Waste and Radiation
Management, 9th Floor
625 Broadway
Albany, NY 12233-7258
518-402-8594
rjphaneu@gw.dec.state.ny.us

Robert Siegrist, Ph.D.

Colorado School of Mines
Environmental Science and Engineering
204 Coolbaugh Hall
Golden, CO 80401-1887
303-384-2158
siegrist@mines.edu

Tim Thompson

Science, Engineering and the Environment,
LLC
4401 Latona Avenue NE
Seattle, WA 98105
206-619-4109
tthompson@seellc.com

APPENDIX B: BOSC LAND RESTORATION AND PRESERVATION SUBCOMMITTEE DRAFT CHARGE

1.0 Objective. The objective of this review is to evaluate the relevance, quality, performance, and scientific leadership of ORD's Land Preservation and Restoration Research Program. The panel's evaluation and recommendations will provide guidance to the Office of Research and Development to help:

- plan, implement, and strengthen the program;
- compare the program with programs designed to achieve similar outcomes in other parts of EPA and in other federal agencies;
- make research investment decisions over the next five years;
- prepare EPA's performance and accountability reports to Congress under the Government Performance and Results Act; and
- respond to evaluations of federal research such as those conducted by the Office of Management and Budget (OMB highlights the value of recommendations from independent expert panels in guidance to federal agencies^{1,2}).

2.0 Background Information. Independent expert review is used extensively in industry, federal agencies, Congressional committees, and academia. The National Academy of Science has recommended this approach for evaluating federal research programs.³

Because of the nature of research, it is not possible to measure the creation of new knowledge as it develops—or the pace at which research progresses or scientific breakthroughs occur. Demonstrating research contributions to outcomes is very challenging⁴ when federal agencies conduct research to support regulatory decisions, and then rely on third parties⁵—e.g., OSWER and the EPA Regions—to conduct remediation or other actions to demonstrate environmental improvements. Typically, many years may be required for practical research applications to be developed and decades may be required for some research outcomes to be achieved.

Most of EPA's environmental research programs investigate complex environmental problems and processes—combining use-inspired basic research^{6,7} with applied research, and integrating several scientific disciplines across a conceptual framework⁸ that links research to environmental decisions or environmental outcomes. In multi-disciplinary research programs such as these, progress toward outcomes can not be measured by outputs created in a single year. Rather, research progress occurs over several years, as research teams explore hypotheses with individual studies, interpret research findings, and then develop hypotheses for future studies.

In designing and managing its research programs, ORD emphasizes the importance of identifying priority research questions to guide the research. Similarly, ORD recommends that its programs develop a small number of performance goals which serve as indicators of progress. Short-term outcomes are accomplished when research is applied by specific clients to strengthen environmental decisions or regulations. These decisions and resulting actions (e.g., the reduction

of contaminant exposures or the restoration of ecosystems) ultimately contribute to improved environmental quality and health.

In a comprehensive evaluation of science and research at EPA, the National Research Council recommended⁹ that the agency substantially increase its efforts to explain the significance of its research products and to assist clients inside and outside the agency in applying them. In response to this recommendation, ORD has engaged science advisors from client organizations to serve as members of its research program teams. These teams help identify research contributions with significant decision-making value and help plan for their transfer and application.

For EPA's environmental research programs, periodic retrospective analysis at intervals of four or five years is needed to characterize research progress, to identify when clients are applying research to strengthen environmental decisions, and to evaluate client feedback about the research. Conducting program evaluation at this interval enables assessment of research progress, the scientific quality and decision-making value of the research, and whether research progress has resulted in short-term outcomes for specific clients. Such an assessment also allows a prospective evaluation to ensure programmatic themes and priorities are linked to strategic goals and outcomes, and the rationales justifying the program are effectively developed and communicated.

A description of the OSTP/OMB *Research and Development Investment Criteria* is included in Appendix I.

3.0 Draft Charge Questions for ORD's Land Research Program

In your review of the draft Land Multi-Year Plan (MYP), also consider additional information from the EPA Strategic Plan, the SAB review of the Contaminated Sites and RCRA MYPs, and other documents and presentations submitted as background information. The BOSC is asked to provide comments on the following areas to assist in assessing the program's relevance, performance, quality, and leadership, retrospectively, and its proposed directions and management priorities, prospectively:

Relevance

1. Is the research program relevant to and consistent with Agency goals, customer needs, and is it sufficiently flexible?

Please comment on the extent to which the research has been, and plans to be, responsive to Agency and other stakeholder needs and priorities. Please comment on ORD's application of processes to adjust to changing priorities and resources to maintain or enhance relevance.

? **Factors to Consider:** Is the focus of ORD's Land Research Program relevant to and consistent with the Agency's strategic goals and responsive to recommendations from the SAB 2004 review of the Contaminated Sites and RCRA MYP? Does the program MYP have clear goals and priorities and are these justified and communicated effectively? Are

potential public benefits of the program clearly articulated? Are stakeholders (e.g., Program and Regional Offices) involved in the planning and prioritization of the research? Is the program responsive to Agency and other stakeholder needs and priorities? Are outputs from the Program used by stakeholders? Is the Program well-coordinated with outside research organizations, nationally and internationally, to avoid duplication of effort and promote synergistic collaboration? To what extent does research program staff participate on or contribute to Agency work groups and transfer research products to the program office, regions, and other clients?

Quality

2. How is quality ensured in the awarding of research funds and in the quality of research products?

Please comment on the process the program uses to prioritize research areas and allocate funds. Does this process ensure that quality is maintained? Does the program use peer review to ensure the quality of its products?

- ? **Factors to Consider:** Does this problem-driven research program conduct internal and external peer reviews of the research. Does the research program adjust in response to these reviews to maintain quality? Has the program used competitive merit based process to award extramural funds? If funds are not competitively awarded, what process does the Program use to allocate funds? Does this process ensure that quality is maintained?

Performance

3. Is the research program design logical and appropriate?

Please comment on the goals and priorities of the draft Land MYP, including the selection of long-term goals (LTGs), linkage of the LTGs to desired outcomes, and responsiveness to key science questions and Agency and Program priorities.

- ? **Factors to Consider:** Does the Program have a logical, comprehensive design and a MYP, with clear goals, schedules, and priorities? Is the research program appropriately leveraged and coordinated with others working in these areas. Does the MYP describe an appropriate flow of work? Does the research address the key research questions? Is the rationale to address the questions clearly articulated? Does the ORD Program use this MYP to address a logical sequence of questions and does it use the plan as a basis for prioritizing its work? Does the MYP respond to SAB recommendations for developing a holistic MYP from the predecessor plans?

4. Is the research program making timely progress in addressing key scientific questions and LTGs?

The draft Land MYP has identified two Long-Term Goals, under which key science questions are aligned. Please comment on the degree of progress that has been made in addressing each of the Long-Term Goals and associated key research questions and usefulness of the MYP for mapping progress in the future.

- ? Factors to Consider: Has ORD's Program clearly articulated its focus and the rationale behind its approach to study these long term goals? Do these LTGs constitute logical focal points for planning the research and for identifying long-term priorities that meet the scientific needs of the Agency and Program customers? Has the Program made significant progress toward each of the long-term goals. Are the questions being addressed in a timely manner? Has the Program met stakeholder needs in a timely and useful way? Is there evidence for application of products and knowledge by clients that would lead toward achieving program outcomes? Has the Program been effective in developing and communicating outputs that support the risk assessment/risk management process?

Scientific Leadership

5. Is ORD playing a leadership role in Land research and effectively collaborating with the larger research community?

Please comment on the leadership role the Land research program and its staff have in contributing to advancing the state of science and practice. Has the EPA collaborated with other agencies (inside and outside the government) in advancing the EPA's research agenda? Recognizing that other organizations have substantial resources for related work, has ORD allocated its resources to EPA's best advantage?

- ? Factors to Consider: The degree to which this program and its staff are identified as leaders in the field; inclusion of ORD staff in national and international science and technology professional bodies; effectiveness of communication and collaboration with clients and stakeholders; coordination and leveraging with related research programs; and participation of ORD staff and inclusion of ORD products in program guidance and practice.

4.0 Potential Peer-Review Panel Approach for Program Review

- ? Hold up to three conference calls in the month preceding a face-to-face meeting.
- o allows the ORD to present background materials to the Peer-Review Panel
 - o allows the Peer-Review Panel to review and comment on the charge
 - o allows the Peer-Review Panel to ask clarifying questions about the program under review
- ? The Contractor shall distribute background materials and documents requested by the Peer-Review Panel in advance of the progress review.

BOSC Land Restoration and Preservation Research Program Review Final Report

- ? The Peer-Review Panel Chair makes review and writing assignments to Panel members in advance of a face-to-face meeting.

- ? Hold a 2-3 day face-to-face meeting for the Program review at a location where a critical mass of ORD scientists is located.
 - o The first 2 days of the meeting will involve ORD presentations and poster sessions.
 - o On the morning of the third day of the meeting, the Peer-Review Panel prepares a draft report that addresses all of the charge questions.
 - o It is a goal to have a draft report available for circulation and comment at the end of the face-to-face meeting.

- ? If needed, hold 1-2 conference calls to finalize the report at least one month after the face-to-face meeting.
 - o It is a goal to have a final report approved by the Peer-Review Panel available to ORD within one month following the face-to-face meeting.

References

- ¹ Budget Data Request 04-31. Executive Office of the President, Office of Management and Budget. March 22, 2004. Completing the Program Assessment Rating Tool (PART) for the FY06 Review Process, pages 50-56.

- ² Memorandum for the Heads of Executive Departments and Agencies. Executive Office of the President, Office of Management and Budget. June 5, 2003. FY 2005 Interagency Research and Development Priorities, pages 5-10.

- ³ Evaluating Federal Research under the Government Performance and Results Act (National Research Council, 1999).

- ⁴ The House Science Subcommittee. Letter to Dr. Bruce Alberts, President of the National Academy of Sciences, from F. James Sensenbrenner, Jr. and George E. Brown. October 23, 1997.

- ⁵ The Government Performance and Results Act: 1997 Government wide Implementation Will Be Uneven. U.S. General Accounting Office. (GAO/GGD, 1997)

- ⁶ Building a Foundation for Sound Environmental Decisions. National Research Council, 1997.

- ⁷ Renewing the Compact between Science and Government, Stokes, D.E., in 1995 Forum Proceedings, Vannevar Bush IIC Science for the 21st Century. Pages 15-32. Sigma Xi, 1995.

- ⁸ Risk Assessment in the Federal Government: Managing the Process. National Research Council, 1983.

- ⁹ Strengthening Science at the U.S. Environmental Protection Agency. National Research Council, 2000, p. 141.

**Appendix I:
OSTP/OMB Research and Development Investment Criteria**

The Relevance, Quality, and Performance criteria apply to all R&D programs. Industry-relevant applied R&D must meet additional criteria. Together, these criteria can be used to assess the need, relevance, appropriateness, quality, and performance of federal R&D programs.

I. Relevance

R&D investments must have clear plans, must be relevant to national priorities, agency missions, relevant fields, and “customer” needs, and must justify their claim on taxpayer resources. Review committees should assess program objectives and goals on their relevance to national needs, “customer” needs, agency missions, and the field(s) of study the program strives to address. For example, the Joint Department of Energy/National Science Foundation (DOE/NSF) Nuclear Sciences Advisory Committee’s Long Range Plan and the Astronomy Decadal Surveys are the products of good planning processes because they articulate goals and priorities for research opportunities within and across their respective fields. Programs that directly address Presidential priorities may receive special consideration for support, with adequate documentation of their relevance to those priorities.

OMB will work with some programs to identify quantitative metrics to estimate and compare potential benefits across programs with similar goals. Such comparisons may be within an agency or among agencies.

- A. Programs must have complete plans, with clear goals and priorities.** Programs must provide complete plans, which include explicit statements of: -specific issues motivating the program; -broad goals and more specific tasks meant to address the issues; -priorities among goals and activities within the program; -human and capital resources anticipated; and -intended program outcomes, against which success may later be assessed.
- B. Programs must articulate the potential public benefits of the program.** Programs must identify potential benefits, including added benefits beyond those of any similar efforts that have been or are being funded by the government or others. R&D benefits may include technologies and methods that could provide new options in the future, if the landscape of today’s needs and capabilities changes dramatically. Some programs and sub-program units may be required to quantitatively estimate expected benefits, which would include metrics to permit meaningful comparisons among programs that promise similar benefits. While all programs should try to articulate potential benefits, OMB and OSTP recognize the difficulty in predicting the outcomes of basic research. Discovery is a legitimate object of basic research, and some basic research investments may be justified on external judgments of the opportunity for discovery.
- C. Programs must document their relevance to specific Presidential priorities to receive special consideration.** Many areas of research warrant some level of federal funding. Nonetheless, the President has identified a few specific areas of research that are

particularly important. To the extent a proposed project can document how it directly addresses one of these areas, it may be given preferential treatment.

D. Program relevance to the needs of the Nation, of fields of science and technology, and of program “customers” must be assessed through prospective external review.

Programs must be assessed on their relevance to agency missions, fields of science or technology, or other “customer” needs. A customer may be another program at the same or another agency, an interagency initiative or partnership, or a firm or other organization from another sector or country. As appropriate, programs must define a plan for regular reviews by primary customers of the program’s relevance to their needs. These programs must provide a plan for addressing the conclusions of external reviews.

E. Program relevance to the needs of the Nation, of fields of science and technology, and of program “customers” must be assessed periodically through retrospective external review. Programs must periodically assess the need for the program and its relevance to customers against the original justifications. Programs must provide a plan for addressing the conclusions of external reviews.

II. Quality

Programs should maximize the quality of the R&D they fund through the use of a clearly stated, defensible method for awarding a significant majority of their funding. A customary method for promoting R&D quality is the use of a competitive, merit-based process. NSF’s process for the peer-reviewed, competitive award of its R&D grants is a good example. Justifications for processes other than competitive merit review may include “outside-the-box” thinking, a need for timeliness (e.g., R&D grants for rapid studies in response to an emergency), unique skills or facilities, or a proven record of outstanding performance (e.g., performance-based renewals).

Programs must assess and report on the quality of current and past R&D. For example, NSF’s use of Committees of Visitors, which review NSF directorates, is an example of a good quality-assessment tool. OMB and OSTP encourage agencies to provide the means by which their programs may be benchmarked internationally or across agencies, which provides one indicator of program quality.

A. Programs allocating funds through means other than a competitive, merit-based process must justify funding methods and document how quality is maintained.

Programs must clearly describe how much of the requested funding will be broadly competitive based on merit, providing compelling justifications for R&D funding allocated through other means. (See OMB Circular A-11 for definitions of competitive merit review and other means of allocating federal research funding.) All program funds allocated through means other than unlimited competition must document the processes they will use to distribute funds to each type of R&D performer (e.g., federal laboratories, federally funded R&D centers, universities). Programs are encouraged to use external assessment of the methods they use to allocate R&D and maintain program quality.

B. Program quality must be assessed periodically through retrospective expert review.

Programs must institute a plan for regular, external reviews of the quality of the program's research and research performers, including a plan to use the results from these reviews to guide future program decisions. Rolling reviews performed every 3-5 years by advisory committees can satisfy this requirement. Benchmarking of scientific leadership and other factors provides an effective means of assessing program quality relative to other programs, other agencies, and other countries.

III. Performance

R&D programs should maintain a set of high priority, multi-year R&D objectives with annual performance measures and milestones that show how one or more outcomes will be reached. Metrics should be defined not only to encourage individual program performance but also to promote, as appropriate, broader goals, such as innovation, cooperation, education, and dissemination of knowledge, applications, or tools.

OMB encourages agencies to make the processes they use to satisfy the Government Performance and Results Act (GRPA) consistent with the goals and metrics they use to satisfy these R&D criteria. Satisfying the R&D performance criteria for a given program should serve to set and evaluate R&D performance goals for the purposes of GPRA. OMB expects goals and performance measures that satisfy the R&D criteria to be reflected in agency performance plans.

Programs must demonstrate an ability to manage in a manner that produces identifiable results. At the same time, taking risks and working towards difficult-to-attain goals are important aspects of good research management, especially for basic research. The intent of the investment criteria is not to drive basic research programs to pursue less risky research that has a greater chance of success. Instead, the Administration will focus on improving the management of basic research programs.

OMB will work with some programs to identify quantitative metrics to compare performance across programs with similar goals. Such comparisons may be within an agency or among agencies.

Construction projects and facility operations will require additional performance metrics. Cost and schedule earned-value metrics for the construction of R&D facilities must be tracked and reported. Within DOE, the Office of Science's formalized independent reviews of technical cost, scope, and schedule baselines and project management of construction projects ("Lehman Reviews") are widely recognized as an effective practice for discovering and correcting problems involved with complex, one-of-a-kind construction projects.

A. Programs may be required to track and report relevant program inputs annually.

Programs may be expected to report relevant program inputs, which could include statistics on overhead, intramural/extramural spending, infrastructure, and human capital. These inputs should be discussed with OMB.

B. Programs must define appropriate output and outcome measures, schedules, and decision points. Programs must provide single- and multi-year R&D objectives, with annual performance measures, to track how the program will improve scientific understanding and its application. Programs must provide schedules with annual milestones for future competitions, decisions, and termination points, highlighting changes from previous schedules. Program proposals must define what would be a minimally effective program and a successful program. Agencies should define appropriate output and outcome measures for all R&D programs, but agencies should not expect fundamental basic research to be able to identify outcomes and measure performance in the same way that applied research or development are able to. Highlighting the results of basic research is important, but it should not come at the expense of risk-taking and innovation. For some basic research programs, OMB may accept the use of qualitative outcome measures and quantitative process metrics. Facilities programs must define metrics and methods (e.g., earned-value reporting) to track development costs and to assess the use and needs of operational facilities over time. If leadership in a particular field is a goal for a program or agency, OMB and OSTP encourage the use of benchmarks to assess the processes and outcomes of the program with respect to leadership. OMB encourages agencies to make the processes they use to satisfy GPRA consistent with the goals and metrics they use to satisfy these R&D criteria.

C. Program performance must be retrospectively documented annually. Programs must document performance against previously defined output and outcome metrics, including progress towards objectives, decisions, and termination points or other transitions. Programs with similar goals may be compared on the basis of their performance. OMB will work with agencies to identify such programs and appropriate metrics to enable such comparisons.

IV. Criteria for R&D Programs Developing Technologies That Address Industry Issues

The purpose of some R&D and technology demonstration programs and projects is to introduce some product or concept into the marketplace. However, some of these efforts engage in activities that industry is capable of doing and may discourage or even displace industry investment that would occur otherwise. Programs should avoid duplicating research in areas that are receiving funding from the private sector, especially for evolutionary advances and incremental improvements. For the purposes of assessing federal R&D investments, the following criteria should be used to assess industry-relevant R&D and demonstration projects, including, at OMB discretion, associated construction activities.

OMB will work with programs to identify appropriate measures to compare potential benefits and performance across programs with similar goals, as well as ways to assess market relevance.

A. Programs and projects must articulate public benefits of the program using uniform benefit indicators across programs and projects with similar goals. In addition to the public benefits required in the general criteria, all industry-relevant programs and projects

must identify and use uniform benefit indicators (including benefit-cost ratios) to enable comparisons of expected benefits across programs and projects. OMB will work with agencies to identify these indicators.

B. Programs and projects must justify the appropriateness of federal investment.

Programs and projects must demonstrate that industry investment is sub-optimal to develop a technology or system and explain why the development or acceleration of that technology or system is necessary to meet a federal mission or goals.

C. Programs and projects must demonstrate that investment in R&D and demonstration activities is a more effective way to support the federal goals than other policy alternatives.

When the federal government chooses to intervene to address market failures, there may be many policy alternatives to address those failures. Among other tools available to the government are legislation, tax policy, regulatory and enforcement efforts, and an integrated combination of these approaches. Agencies should consider that the legislation, tax policy or regulatory or enforcement mechanisms may already be in place to achieve a reasonable expectation of advancing the desired end.

D. Programs and projects must document industry or market relevance, including readiness of the market to adopt technologies or other outputs.

Programs must assess the likelihood that the target industry will be able to adopt the technology or other program outputs. The level of industry cost sharing or enforceable recoupment commitments in contracts are indicators of industry relevance. Agencies must be able to justify any demonstration activities with an economic analysis of the public and private returns on the public investment.

E. Program performance plans and reports must include “off ramps” and transition points.

In addition to the schedules and decision points defined in the general criteria, program plans should also identify whether, when, and how aspects of the program may be shifted to the private sector.

APPENDIX C: LIST OF ACRONYMS

3MRA	Multimedia, Multi-Pathway, Multi-Receptor Exposure and Risk Assessment Model
AALM	All Ages Lead Model
APG	Annual Performance Goal
APM	Annual Performance Measure
BOSC	Board of Scientific Counselors
CENR	Committee on Environment and Natural Resources
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CRADA	Cooperative Research and Development Agreement
DEQ	Department of Environmental Quality
DFO	Designated Federal Officer
DOD	Department of Defense
DOE	Department of Energy
DNAPL	Dense Nonaqueous Phase Liquids
EPA	Environmental Protection Agency
ESI	Essential Science Indicators
ESTCP	Environmental Security Technology Certification Program
EU	European Union
F&T	Fate and Transport
FACA	Federal Advisory Committee Act
FTE	Full-Time Equivalent
FY	Fiscal Year
GPRA	Government Performance and Results Act
HHRA	Human Health Risk Assessment
HSRC	Hazardous Substance Research Center
IAG	Interagency Agreement
IEUBK	Integrated Exposure Uptake Biokinetic Model for Lead in Children
IRIS	Integrated Risk Information System
JCR	Journal Citation Reports
LTG	Long-Term Goal
LUST CA	Leaking Underground Storage Tank Corrective Action
MNA	Monitored Natural Attenuation
MNR	Monitored Natural Recovery
MOU	Memorandum of Understanding
MYP	Multi-Year Plan
NAS	National Academy of Sciences
NATO	North Atlantic Treaty Organization
NGO	Nongovernmental Organization
NHEERL	National Health and Environmental Effects Research Laboratory
NHSRC	National Homeland Security Research Center
NIEHS	National Institute of Environmental Health Sciences
NPD	National Program Director
NSF	National Science Foundation
OMB	Office of Management and Budget
ORD	Office of Research and Development.
OSRTI	Office of Superfund Remediation and Technology Innovation

BOSC Land Restoration and Preservation Research Program Review Final Report

OSW	Office of Solid Waste
OSWER	Office of Solid Waste and Emergency Response
OUST	Office of Underground Storage Tanks
PAH	Polycyclic Aromatic Hydrocarbon
PART	Program Assessment Rating Tool
PBT	Persistent Bioaccumulative Toxic Chemical
PRB	Permeable Reactive Barrier
PPRTV	Provisional Peer Reviewed Toxicity Values
QA	Quality Assurance
RCC	Resource Conservation Challenge
RCRA	Resource Conservation and Recovery Act
RCT	Resource Coordination Team
RD&D	Research, Demonstration, and Development
ROD	Record of Decision
SAB	Science Advisory Board
SBIR	Small Business Innovation Research
SBRP	Superfund Basic Research Program
SERDP	Strategic Environmental Research and Development Program
SITE	Superfund Innovative Technology Evaluation
SPI	Sediment Profile Imaging
STAR	Science To Achieve Results
TSC	Technical Support Center
USACE	United States Army Corps of Engineers
UST	Underground Storage Tank
VI	Vapor Intrusion