Chapter 3 – Research Planning and Resource Allocation at EPA

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RESEARCH PLANNING AND RESOURCE ALLOCATION AT EPA

3.0 Introduction

The U.S. **ENVIRONMENTAL PROTECTION AGENCY** (EPA) was established in 1970 in response to growing concerns over polluted air, unclean rivers, unsafe drinking water, endangered species, and careless waste disposal. EPA was assigned the task of implementing a broad set of environmental laws, and today it has jurisdiction over more than a dozen federal statutes designed to protect public health and the environment (e.g., the Safe Drinking Water Act and the Clean Air Act). These laws form the legal basis for the Agency's regulatory activities. These laws also authorize Agency research, which provides the scientific underpinning for regulatory decisions. Thus, EPA operates in both a regulatory and a scientific capacity.

EPA research is housed chiefly in the Agency's **OFFICE OF RESEARCH AND DEVELOPMENT** (ORD). ORD's role is to provide EPA with sound scientific information for use in environmental decision-making. Through the development of technical data and scientific tools, ORD research lays the foundation for scientifically defensible environmental policies, programs, and regulations. Comprising seven national Laboratories and Centers across the country, ORD encompasses both human health and ecology research (see Figure 3.1).

The **NATIONAL EXPOSURE RESEARCH LABORATORY** (NERL) is the second largest research organization in ORD, with roughly 400 federal employees at facilities across the country. NERL's organizational structure is shown in Figure 3.1. Based in Research Triangle Park, NC, NERL has six divisions, with diversified research specialties. (see Table 1 on page 3-10). NERL conducts research and development to improve methods, measurements and models to assess and predict human and ecosystem exposure to harmful pollutants and other conditions in air, water, soil, and food. We provide information to increase the accuracy of EPA's exposure and risk assessments for factors that stress the environment, including chemicals, living organisms, changes in land and water use, and changes in climate. NERL also evaluates innovative technologies to improve exposure assessment and provides information on stressor sources, pollutant transport and fate, and human exposure. Our work must be both scientifically relevant and responsive to those in the Agency tasked with making regulatory and policy decisions; thus, our scientists face the dual responsibility of advancing environmental science frontiers while remaining responsive to the program needs and priorities of the Agency.

NERL's mission is to:

- perform high-quality ***research*** to identify, understand and solve current and future problems of human health and ecosystem exposures to environmental stressors;
- provide ***leadership*** in addressing environmental issues; and
- provide ***scientific and technical assistance*** at the local, state, federal, and international levels.

Each of these three functions is described in greater detail below.

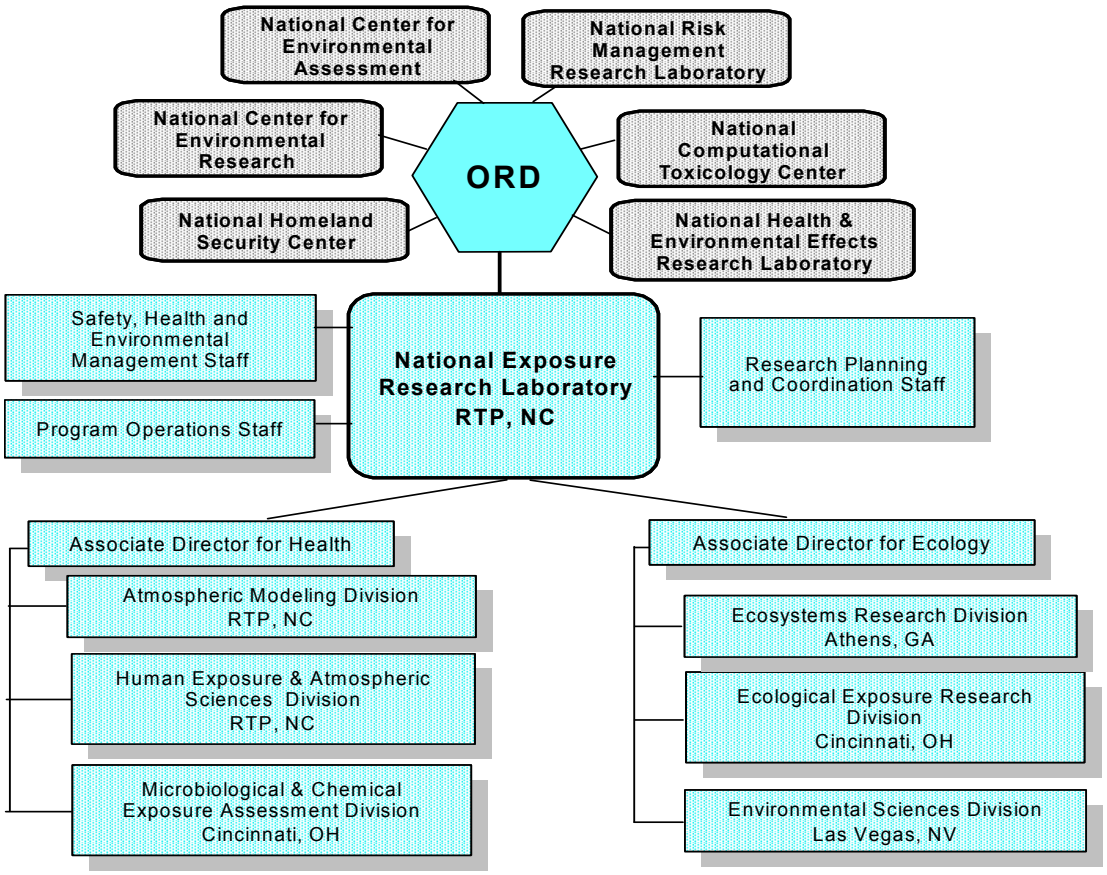


Figure 3.1 Organizational Structure of ORD and NERL

3.1 Research (and Research Planning)

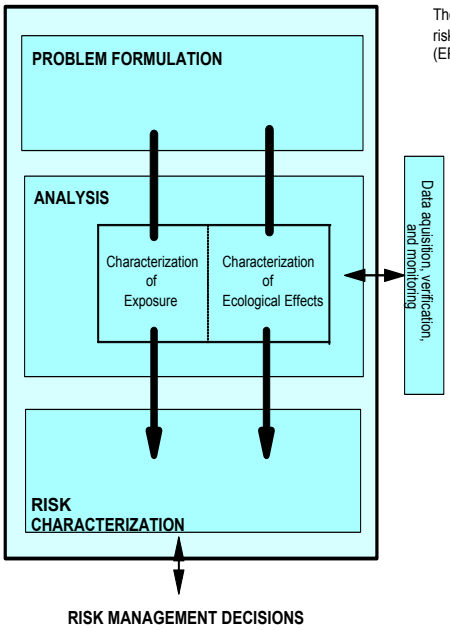
Principles. EPA's research is organized around the principles of **risk assessment and risk management**. Simply put, risk assessment is the process of evaluating the nature, magnitude, and likelihood of an adverse effect following exposure to a stressor (or stressors), such as pollution or habitat loss. Two risk assessment paradigms are depicted in Figure 3.2. Figure 3.2a applies to human health risk assessment, while Figure 3.2b – which conceptually mirrors the human health paradigm – applies to ecological risk assessment.

Risk assessment not only shapes and prioritizes our research agenda, it also is an inherent part of our organizational structure. Figure 3.2c shows how ORD's institutional structure is aligned to comport with the risk paradigm, with each of the four ORD Labs and Centers focusing on a different aspect of risk assessment. NERL's singular focus within ORD is to reduce major uncertainties regarding the ***exposure*** pathways and interface of pollutants on human health and the environment.

Figure 3.2. Risk Assessment and ORD

a. Health Paradigm

b. Ecology Framework



The US EPA ecological risk assessment framework (EPA, 1992)

c. Alignment of ORD Labs / Centers with Risk Paradigm*

National Exposure Research Laboratory	National Health and Environmental Effects Research Laboratory	National Center for Environmental Assessment	National Risk Management Research Laboratory
Research to measure, characterize, and assess exposures and to support compliance with environmental regulations and policies	*Research to identify hazards, formulate the problem, and characterize response*	*Risk characterization and research on risk assessment methods*	*Research and technology transfer to prevent, mitigate, and control pollution*

* ORD's National Center for Environmental Research, which awards grants and fellowships, and its National Computational Toxicology Center, which applies mathematical and computational tools to solve environmental problems, complement the intramural research conducted in the Labs and Centers above.

Planning. No single organization can address every scientific problem in the environmental arena. Like others, EPA must be selective when deciding which issues to tackle, taking into consideration such factors as scientific feasibility, budgetary constraints, and the ability to make a contribution relative to other research institutions that may be working in the same areas.

EPA's research agenda is determined by means of a research planning process involving every organizational level within the Agency. Figure 3.3 is a simplified diagram of the inter-relationships that exist in research planning.

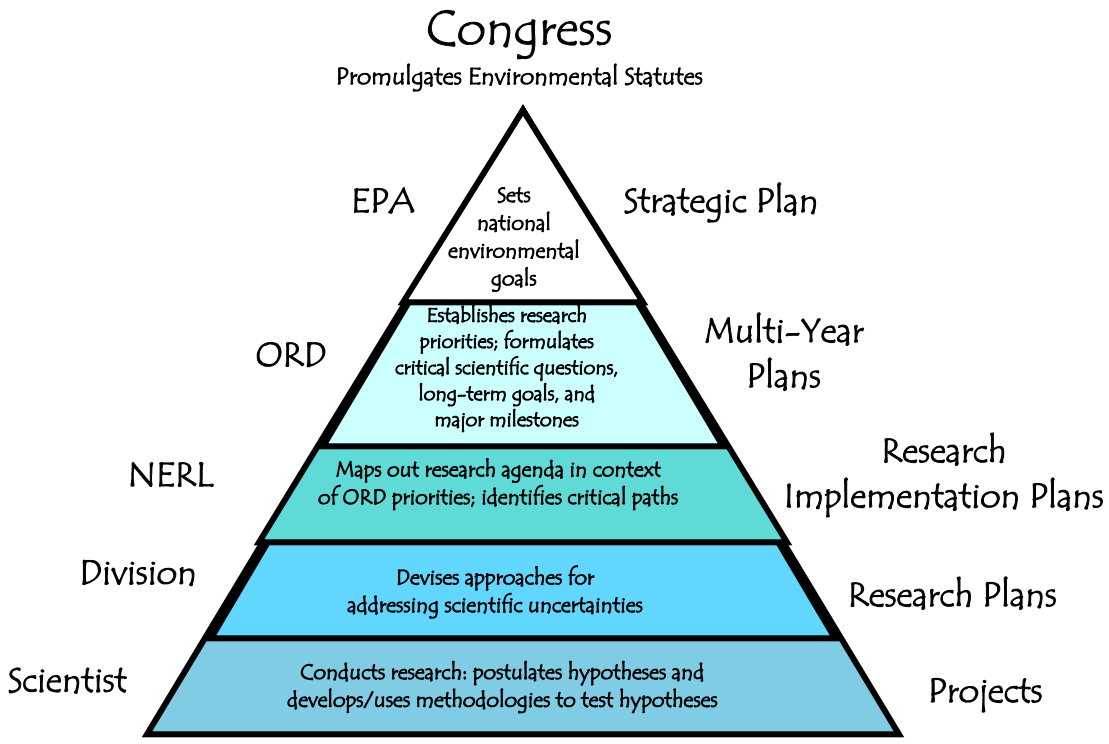


Figure 3.3 Research Planning in EPA

Long-term guidance for research direction is provided by several sources, the most important being **STRATEGIC PLANS**. EPA and ORD each have a strategic plan in which their organizational goals are conveyed. EPA's Strategic Plan is broad in scope, articulating EPA's mission and its national environmental goals, also called Strategic Goals, listed in the box on the next page. The framework for organizing research within ORD is drawn from EPA's Strategic Goals. Each goal is linked to key environmental statutes. For example, *Goal 2: Clean and Safe Water* is aligned with the Clean Water Act and the Safe Drinking Water Act.

ORD's research is driven by EPA's Strategic Goals: we use the goals to systematize the way in which we plan and implement our research, the way we report our research findings and products, and the way we budget our programs. For each goal, ORD commits to reaching certain milestones and delivering specific products within a given time period, thus providing a mechanism for measuring tangible progress toward completion of long-term objectives. This

explicit accountability grew out of the Government Performance and Results Act (GPRA) passed by Congress in 1993. Consequently, the Agency's Strategic Goals are sometimes referred to as "GPRA Goals."

EPA's Strategic Goals	*ORD's Multi-Year Plans**
1. Clean Air and Global Change	**Air** **Global Change**
2. Clean and Safe Water	**Drinking Water** **Water Quality**
3. Land Preservation and Restoration	**Land**
4. Healthy Communities and Ecosystems	**Safe Pesticides / Safe Products** **Ecosystems Protection** **Human Health** **Endocrine Disruptors** **Mercury** Human Health Risk Assessment
5. Compliance and Environmental Stewardship	Economics and Decision Sciences Pollution Prevention

*Those in which NERL plays a role are in **bold** lettering.

For each Strategic Goal, ORD – in partnership with its many stakeholders (EPA regulatory program offices, EPA regional offices, academia, industry, and other government agencies, among others) – identifies research topics considered highest priority. The objective is to focus on environmental problems that pose the greatest risks to people and the environment (using criteria such as severity, permanence, scale), on uncertainties in risk assessment that can be effectively reduced, and on areas that clearly help the Agency fulfill its regulatory mandates. To date, ORD has identified 13 research areas on which to focus its efforts, and for each of these it has initiated a multi-year planning effort to map direction over a five- to ten-year period. ORD's Multi-Year Plans are the products of this effort.

ORD's **MULTI-YEAR PLANS (MYPs)** provide the long-term (5 to 10 years) focus for a given area of research, integrating efforts across all of ORD's Labs and Centers. For each MYP, an ORD team conceptualizes a research framework, identifying key scientific questions. Long-Term Goals (LTGs) are set, as are shorter-term Annual Performance Goals (APGs). Certain measures are put into place at the individual Lab and Center level to gauge progress (termed Annual Performance Measures, or APMs). NERL plays a vital role in the development of the MYPs. All of NERL's research is included in these plans, and we are held accountable for meeting commitments contained in the MYPs. MYPs are intended to be living documents and are updated as needed to reflect the current state of the science, resource availability, and Agency priorities. External peer review of the MYPs helps ensure the quality of the program. One page overviews of the MYPs relevant to this division review can be found in the Appendix to this section.

*Scientific leadership and overall coordination of research program areas is the responsibility of **National Program Directors**, who are senior-level scientists tasked with planning and budgeting the program across all of ORD. Their duties include developing and updating MYPs.*

Using ORD's Multi-Year Plans as roadmaps, NERL develops **RESEARCH IMPLEMENTATION PLANS**, bringing the planning process to the operational level within the Laboratory. These Implementation Plans bring a bottom-up perspective to the research planning. They are drafted by a steering committee made up of scientists from each of NERL's six divisions and representatives from appropriate EPA Offices. Divisions are held accountable for addressing the priorities established through the ORD planning process as they develop ways to implement research activities, and it is the scientists who identify the critical paths for resolving the key

scientific questions and who devise the approaches for addressing the uncertainties.

The above description of our long-range planning process is meant to illustrate the interconnectedness of EPA's environmental goals, ORD's research priorities, and the course set by NERL to address these priorities. Shorter-term (annual) research planning also takes place within the Agency, driven in part by the commitments laid out in the Multi-Year Plans (which provide the context for annual planning decisions), but also influenced by emerging issues, research results, and pressing needs identified by Congress, the Administrator, Program and Regional Offices, and scientific staff. Special attention is paid to research required to fulfill a legislative mandate, court order, or Agency commitment; priority setting also takes into account scientific feasibility, budgetary constraints, and our ability to make a contribution relative to other research institutions that may also be working in the same area.

In summary, while the ***problems*** NERL is tasked to solve are defined by the Agency planning process, the ***research agenda for solving those problems*** is determined by NERL and its staff. Although relative emphasis in topic areas may change as ORD priorities shift, as new data or new issues emerge, as court-ordered deadlines are met, or as budgets grow and shrink, substantial efforts are made by NERL to build and maintain research programs that are both relevant to the scientific problem and responsive to Agency needs. The objective is to create an integrated and coherent program, not a collection of disconnected projects.

Core and Problem-Driven Research. Because EPA is a regulatory agency, it is recognized that research must be results-oriented and customer-focused. NERL is a problem-solving organization, and our approach to research – in accordance with ORD – is founded on principles of risk assessment. Rather than characterize our research as basic or applied, we use the terms core and problem-driven. **Core research** seeks to produce a fundamental understanding of the key biological, chemical, and physical processes that underlie environmental systems, thus forging basic scientific capabilities that can be applied to a wide range of environmental problems. Core research addresses questions common to many EPA programs, and they can provide the preparedness needed to confront unforeseen environmental problems. NERL's core research program is contained within two MYPs: Human Health Research and Ecosystems Protection. Two examples of core research in NERL are our efforts to understand human exposure to pollutants and our research to develop the tools needed to describe the exposure pathways of stressors in ecological systems.

Core and problem-driven research are similar, but not equivalent, to basic and applied research. Their complementary nature enhances NERL's ability to address diverse environmental issues. Scientists often pursue both types of research simultaneously, and cross-fertilization is encouraged.

Problem-driven research focuses more narrowly on explicit EPA Program Office needs, such as those motivated by regulatory requirements or court-ordered deadlines. An example is our Particulate Matter research program, in which the fate and transport of airborne particles is being studied to develop predictive models that estimate human exposure to emissions and will inform future evaluations of the National Ambient Air Quality Standards.

Of course, core and problem-driven research are not mutually exclusive. In fact, they are highly complementary and interactive, each informing the other (see Figure 3.4). This blend of core and problem-driven research yields a robust research portfolio that couples a stable core effort with research needs derived from the regulatory mission of the Agency.

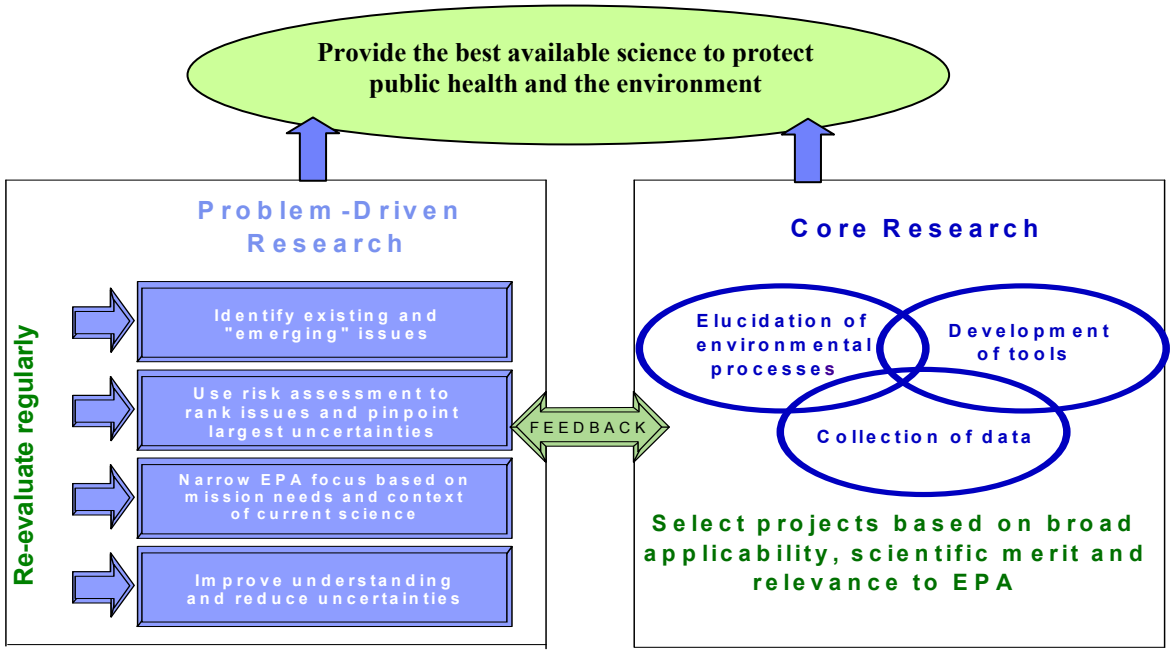


Figure 3.4. The Relationship between Problem-Driven and Core Research

3.2 Leadership

NERL provides vital leadership in the environmental research arena, and our scientists are active in the scientific community at many levels. Within the Agency, examples of leadership include the following:

- shaping the research agenda by contributing to research planning and coordination exercises;
- participating in the development of ORD Research Plans and Strategies; and
- representing the Agency on workshops and task forces addressing major risk assessment, public health, and environmental issues.

Outside EPA, we seek to influence the direction and priorities of environmental research worldwide. Examples include:

- steering collaborative research efforts at the national and international levels;
- participating on international planning committees and research review panels;
- serving on advisory boards of other major agencies and organizations; and
- acting as adjunct faculty members at major universities.

3.3 Scientific and Technical Assistance

As part of our mission, NERL responds to diverse requests for scientific advice and technical consultation, both within and outside EPA. We provide technical support to the Agency by advising EPA Program Offices and Regional Offices on scientific matters, by serving on Agency workgroups, and by helping develop testing and risk assessment guidelines. We bring our

expertise to bear at the national and international level by organizing scientific workgroups and symposia, and by serving in professional and scientific societies and on publication boards. We provide guidance to local, state, tribal, and international governments and other federal agencies, informing them on issues of environmental importance and enabling them to implement more effective environmental programs. We work to establish partnerships with corporate, public, private, and educational sectors and assist them in setting and achieving environmental goals. We provide technical training and developmental opportunities for senior scientists as well as post doctoral candidates and students. By sharing our skills and knowledge, we enhance the ability of other organizations to protect public health and the environment, and we serve as an important catalyst for scientific and technological progress.

3.4 Resource Allocation

Each year, EPA receives funding from Congress, from which it develops a budget and provides a funding target to ORD, which in turn provides a funding target to NERL. When approved by the President and Congress, the enacted budget serves as the blueprint for all Agency activities.

NERL resources are aligned by Multi-Year Plans. These resources pay for everything from critical services, such as IT support, to special facilities, such as our Aquatic and Terrestrial Culture and Maintenance Facility. In recent years, NERL's resources have remained relatively fixed, and this trend is not expected to improve. Therefore, a flat budget is assumed when planning research (funding ***priorities*** may shift, however, affecting individual research areas). This means that if expenditures – and research – are allowed to grow in one area, then spending – and research – in another area must shrink. Additionally, EPA has imposed a limit on NERL FTEs (full-time equivalents), and each division is required to operate with an FTE ceiling, affecting the division's ability to hire.

There are explicit limitations – mandated by law – on spending and obligating funds. The law states that spending (by ***any*** agency) cannot exceed the amount appropriated by Congress. This means that NERL cannot

- apply for grants from other agencies or institutions
- increase our permanent technical support staff through the use of external resources.

However, NERL scientists are encouraged to collaborate with others. Through external partnerships, resources may become available to NERL by means of Interagency Agreements, for example, which foster research across federal agencies, and Cooperative Research and Development Agreements, which allow us to work with industry on issues of mutual interest.

In addition to salaries and benefits, travel, and operating expenses (for such things as equipment, equipment maintenance, supplies, training, etc.), NERL's resources sustain its in-house research. These funds are generally referred to as "research support." Additional funds, referred to as "above research support" become available to the Laboratory from time to time as the result of Agency initiatives in specified high-priority research areas. These resources are used to augment or leverage our in-house efforts and can be applied to:

- support contracts (used, for example, for analytical services, information technology, and field studies);
- competitive cooperative agreements with academic institutions (used, for example, to

train post-doctoral candidates); and
- interagency agreements (used to fund collaborative research across federal agencies).

With certain exceptions, such as computer support, most resources are managed by the divisions themselves.

NERL does not have its own extramural grants program. EPA research grants are handled by ORD's National Center for Environmental Research and are not administered by NERL. However, funds may be targeted to topics of importance to NERL, thereby expanding our science and technology base and leveraging our research.

DIVISION	LOCATION	RESEARCH FOCUS
Atmospheric Modeling and Analysis Division (AMAD)	Research Triangle Park, NC	Develops advanced air quality models that can simulate the transport and fate of multiple pollutants in the atmosphere, and performs analyses of air pollution problems.
Ecosystems Research Division (ERD)	Athens, GA, NC	Performs research on approaches to multimedia modeling for landscape, nutrient and chemical stressors of ecosystems.
Ecological Exposure Research Division (EERD)	Cincinnati, OH	Conducts laboratory and field studies aimed at providing research products that enable the Agency to conduct predictive and retrospective exposure assessments.
Environmental Sciences Division (ESD)	Las Vegas, NV	Develops methods for characterizing chemical and physical stressors. Develops landscape and regional assessment capabilities through the use of remote sensing and advanced spatial analysis techniques.
Human Exposure and Atmospheric Sciences Division (HEASD)	Research Triangle Park, NC	Characterizes aggregate human exposure from all sources and the emission and movement of pollutants through the atmosphere.
Microbiological and Chemical Exposure Research Division (MCEARD)	Cincinnati, OH	Conducts research to measure, characterize, and predict the exposure of humans to chemical and microbial hazards. This research provides information on environmental pathways by which hazardous contaminants are transported via air, water, food, and soil to populations at risk.

TABLE 1: Research Focus of NERL's Health and Ecology Divisions

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National Research Council (NRC), *Risk Assessment in the Federal Government: Managing the Process*, Washington, DC, National Academy Press, 1983.

National Research Council (NRC), *Science and Judgment in Risk Assessment*, Washington, DC, National Academy Press, 1994.

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APPENDIX - ORD'S MULTI-YEAR PLANS

ORD's Multi-Year Plans (MYPs) provide the framework for Agency research, integrating efforts across all of ORD's National Laboratories and Centers and focusing on a 5- to 10-year planning window. The MYPs serve three principal purposes:

1. to describe the future direction of ORD's scientific programs,
2. to document the significant planned outputs of ORD's programs, and
3. to communicate ORD's scientific intentions within and outside the Agency.

Each MYP identifies key science questions relevant to a given research topic and establishes several Long-Term Goals (LTGs) that define success. Achieving these goals is dependent on a series of associated research outputs that represent significant, tangible milestones along critical paths of scientific discovery.

MYPs are "living documents" that are updated to reflect the current state of the science, resource availability, Administration initiatives, and Agency priorities. Each MYP is aligned with one of the Agency's five Strategic Goals below. (For more on EPA's Strategic Goals, see the next page.) Efforts within the MYP are overseen by an ORD National Program Director, with the work performed across multiple divisions in NERL, across other ORD Labs and Centers, and by grantees funded through EPA's National Center for Environmental Research (NCER).

EPA GOAL 1: CLEAN AIR AND GLOBAL CLIMATE CHANGE

Particulate Matter
Air Toxics
Global Change
Ozone

EPA GOAL 2: CLEAN AND SAFE WATER

Drinking Water
Water Quality

EPA GOAL 3: LAND PRESERVATION AND RESTORATION

Land

EPA GOAL 4: HEALTHY COMMUNITIES AND ECOSYSTEMS

Safe Pesticides/Safe Products
Ecological Research
Human Health Research
Endocrine Disruptors
Mercury
Human Health Risk Assessment

EPA GOAL 5: COMPLIANCE AND ENVIRONMENTAL STEWARDSHIP

Economics and Decisions
Pollution Prevention

EPA's strategic goals

EPA has established five long-term, results-based strategic goals. Each goal was developed with the advice and participation of our governmental partners and stakeholders. By focusing on a small number of outcome-oriented goals, we hope to continue to achieve better environmental results, stronger and better partnerships with federal, state, tribal, and local government entities, and wiser use of tax dollars. These goals describe the results we seek, and they shape the way we plan, budget, and account for our work. Our five goals are:

GOAL 1: Clean Air and Global Climate Change

Protect and improve the air so it is healthy to breathe and risks to human health and the environment are reduced. Reduce greenhouse gas intensity by enhancing partnerships with businesses and other sectors.

GOAL 2: Clean and Safe Water

Ensure drinking water is safe. Restore and maintain oceans, watersheds, and their aquatic ecosystems to protect human health, support economic and recreational activities, and provide healthy habitat for fish, plants, and wildlife.

GOAL 3: Land Preservation and Restoration

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.

GOAL 4: Healthy Communities and Ecosystems

Protect, sustain, or restore the health of people, communities, and ecosystems using integrated and comprehensive approaches and partnerships.

GOAL 5: Compliance and Environmental Stewardship

Improve environmental performance through compliance with environmental requirements, preventing pollution, and promoting environmental stewardship. Protect human health and the environment by encouraging innovation and providing incentives for governments, businesses, and the public that promote environmental stewardship.

ORD MYPs Supported by AMAD Research

The following pages contain short summaries of the ORD MYPs under which AMAD conducts its research program.

Goal 1: Clean Air and Global Climate Change Research
Problem-Driven Research

CLEAN AIR RESEARCH AND DEVELOPMENT MULTI-YEAR PLAN

Background
Clean air benefits both human health and the natural environment, and EPA's goal is for the air in every American community to be safe and healthy to breathe. Children, the elderly, and people with respiratory ailments are special beneficiaries of clean air and should be protected from potentially harmful exposures to air pollutants. ORD research provides the foundation for EPA regulatory decisions and policies about air pollution. The NERL is approaching air pollution research from a multi-pollutant perspective, including all elements of research related to Particulate Matter (PM), ozone and other toxic air pollutants (air toxics).

Long-Term Goals (LTGs) in which NERL is Involved

All of EPA's Clean Air research falls under one or both goals below.

LTG 1: Reducing uncertainties in standard setting and air quality management

Research in this area supports the development of the National Ambient Air Quality Standards (NAAQS) and other regulatory actions as well as developing the tools that states and municipalities require to implement the standards.

LTG 2: Reducing uncertainties in linking health and environmental outcomes to air pollution sources.

Research in this area links specific sources to specific health effects while considering the various pollutants involved in order to provide the information to more effectively and efficiently regulate these sources.

NERL's Research Program in Clean Air
Within the framework for protecting the public health and the environment, there are several key linkages. They are: source to environmental concentration to exposure to dose to outcome. The NERL laboratory's efforts are focused on characterizing the environmental concentrations of pollutants, developing air quality models to estimate environmental concentrations, developing the chemical analysis and measurement tools to link environmental concentrations to sources through source apportionment and receptor modeling, applying these source apportionment techniques through collaboration with ORD health scientists, measuring personal exposure of humans to air pollutants and estimating personal exposure through the use of exposure models. Currently, a particular emphasis is being placed on roadways as a source of pollution.

Results from NERL's PM research are used by EPA's Office of Air and Radiation (OAR), which is responsible for developing regulations and providing the tools necessary to implement them, and EPA's Regions. Intramural PM research is leveraged several EPA supported grants.

Goal 1: Clean Air and Global Climate Change Research
Problem-Driven Research

GLOBAL CHANGE MULTI-YEAR PLAN

Background

In February 2002, President Bush announced the formation of a new management structure, the Climate Change Science Program (CCSP), to coordinate and direct the US research efforts in the areas of climate and global change. EPA's Office of Research and Development (ORD) conducts global change research to understand the implications of climate change and variability on air and water quality, ecosystems, and human health in the U.S.

Long-Term Goals (LTGs) in which NERL is Involved

Four LTGs have been identified for Global Change research, two of which involve NERL:

LTG 2: Air Quality

Provide the approaches, methods and models to quantitatively assess the effects of global change (climate change, land-use change and UV radiation changes) on regional air quality, identify technology advancements and adaptive responses and quantify their effect on, and feedback from, emissions and air quality, and develop and apply tools to integrate global change effects across environmental media.

LTG 3: Ecosystems

Build the capacity to assess and respond to global change impacts on fresh water and coastal ecosystems. Ecosystem research and assessment activities are focused on four areas: aquatic ecosystems in selected watersheds, coastal aquatic ecosystems, climate change effects on invasive species distributions, and coastal and freshwater ecosystem services.

NERL's Research Program in Global Change

NERL's project, titled Climate Impact on Regional Air Quality (CIRAQ), examines the potential affects of global climate change scenarios on regional tropospheric air quality in North America for ozone and fine particles. Scenarios are examined by developing meteorological, emissions, and air quality modeling simulations for grid-based domains covering the U.S. and southern Canada. Multi-year length simulations are generated for present and future (2050) conditions. NERL work has also evaluated impacts on coastal aquatic ecosystems by developing and applying methods for evaluating the effects of altered temperature and flow regimes, pollutant loads, sea level rise and altered UV exposure on estuaries and coral reefs.

Goal 4: Healthy Communities and Ecosystems
Problem-Driven Research

ECOLOGICAL RESEARCH MULTI-YEAR PLAN

Background

The goal of EPA's current Ecological Research program is to protect, sustain, and restore the health of natural habitats and ecosystems. Research is aimed at strengthening our ability to assess and compare risks to ecosystems, to protect and restore them, and to track progress in terms of ecological outcomes. EPA's current Ecological Research program concentrates primarily on aquatic rather than terrestrial or agricultural resources. Accordingly, the legislation most relevant to this program is the Clean Water Act. This water-centric focus is the result of policy decisions from the mid-1990s, which were based on fiscal constraints that led to reduced emphasis on issues such as ozone effects or nutrient dynamics in forests and on agricultural lands.

Long-Term Goals (LTGs) in which NERL is Involved

Four LTGs govern most of the ecological research conducted prior to 2009, the first three of which include NERL research:

LTG 1: Ecological Condition and Accountability: The states and tribes use a common monitoring design and appropriate ecological indicators to determine the status and trends of ecological resources. Policy makers can evaluate the impact of National policy on ecosystem condition.

LTG 2: Diagnostics: Managers and researchers understand links between human activities, natural dynamics, ecological stressors, and ecosystem condition

LTG 3: Forecasting: Environmental managers have the tools to predict multi-stressor effects on ecological resources to assess vulnerability and manage for sustainability.

LTG 4: Restoration: Managers have scientifically defensible methods to protect and restore ecosystem condition

NERL's Program in Ecological Research

NERL's research program prior to 2009 focuses on strengthening the scientific basis to adequately assess and compare risks to ecosystems, to protect and restore them, and to track progress in terms of ecological outcomes. In LTG 1, NERL develops landscape indicators to determine the status and trends of the condition of ecological resources nationwide. In addition, NERL develops models and evaluates national data to improve national air quality policies, and to determine the effectiveness of existing policies at protecting ecosystems. NERL research in LTG 2 focuses on diagnosing the causes of impaired ecosystem condition. Approaches run from molecular to remote sensing sciences. In LTG 3, NERL focuses on research to forecast

the impacts of development or mitigation (alternative future) scenarios on ecosystems and the impacts of multiple stressors on ecosystems.

New Ecological Research Program Directions

The Ecological Research Program (ERP) is setting a new strategic direction to meet compelling needs for better understanding the implications of human impacts on ecosystems and the resources they provide. The processes and functions of ecosystems, the foundation of our health, livelihoods, and well-being, are now at risk worldwide. By 2009, the ERP will transition its focus to analyses of ecosystem services. Research will focus on providing insights, information, and methods that enable decision-makers to assess the benefits of ecosystem services to human well-being. The goal is to secure the integrity and productivity of our ecological systems over time and at multiple scales, by transforming the way decision-makers understand and respond to environmental issues, thereby making clear the ways in which their policy and management choices affect the type, quality, and magnitude of services we receive from ecosystems -- such as clean air, clean water, productive soils, and generation of food and fiber.

This new focus will be founded on ERP's extensive experience in environmental monitoring and assessment (EMAP), landscape ecology (NERL), modeling ecological stressor-response relationships (NERL), assessing vulnerability to natural and human stressors over regional scales (ReVA) (NERL), and developing alternative future scenarios (NERL). It also reflects increased emphasis on ecological forecasting previously described in the ERP's 2003 Research Plan.

Long-Term Goals (LTGs) in which NERL is Involved: There are five new LTGs and NERL will provide scientific input and expertise in all of them.

LTG 1: Decision Support Platform: By 2014 ORD will provide an innovative online decision support platform that offers EPA, Regions, States, local communities and resource managers the ability to integrate, visualize, and maximize use of diverse data, models and tools at multiple scales to generate alternative decision options and understand the consequences of management decisions on the sustainability of ecosystem services, their value and human well-being.[1]

LTG 2: National Mapping and Inventory: By 2013 ERP will deliver a publicly accessible, scalable, national atlas and inventory system for selected ecosystem services that can be quantified directly or indirectly across the U.S. to be used by the Agency, NGO's, and other decision makers to support prioritizing policy and management actions and their consequences.

LTG 3: Nitrogen Assessment: By 2013 ERP will provide an assessment of the positive and negative impacts on ecosystem services resulting from changes in nitrogen loadings from major source categories to support policy and management decisions in EPA's Offices of Air Resources and Water.

[1] This long-term goal integrates the products of the other four long-term goals

LGT 4: Wetlands Assessment: By 2013 ERP will provide guidance and decision support tools to target, prioritize, and evaluate policy and management actions that protect, enhance, and restore ecosystem goods and services of wetlands at multiple scales.

LTG 5: Community Based Demonstration Projects: By 2013 ERP will complete 4 site-specific demonstration projects that illustrate how regional and local managers can use alternative future scenarios to proactively conserve and enhance ecosystem goods and services in order to benefit human well-being and to secure the integrity and productivity of ecological systems.