February 27, 1998

EPA-SAB-EEC-98-005

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

Subject: Review of the Waste Research Strategy of the Office of Research and Development

Dear Ms. Browner:

The Office of Research and Development (ORD) requested that the Science Advisory Board (SAB) review research strategies developed by ORD research coordination teams in consultation with the program offices. The Environmental Engineering Committee (EEC) and a specially established multi-disciplinary Subcommittee reviewed the Waste Research Strategy at a public meeting held June 30-July 3, 1997 at the National Risk Management Research Laboratory in Cincinnati, Ohio.

The EEC was charged to consider whether the strategy clearly captured the environmental problems associated with wastes; identified the high priority topics and applied appropriate emphasis; proposed research activities addressing the highest priority research needs; established clear and reasonable criteria and processes to filter and select the highest priority research; and; clearly identified future directions that are reasonable and appropriate.

General Comments Before addressing the particulars of this strategy, the EEC wishes to note that the existence of a Waste Research Strategy is, in itself, commendable progress. Three years ago, the EEC's strategic research planning commentary (EPA-SAB-EEC-COM-94-004) recommended development of a vision statement; a definition of a mission; an assessment of strengths, weaknesses, external opportunities, and threats; and identification of strategic initiatives and metrics of success. The Subcommittee will now recommend two advancements to the process of research strategy development--the involvement of external organizations in the planning process and transparent documentation of decisions. The Subcommittee also notes ORD's decision to develop a research strategy for waste, while not completely addressing the Committee's concern (EPA-SAB-EEC-97-011) over EPA's decreased emphasis on waste management research, is a positive step.

The Subcommittee commends ORD for its adoption of risk reduction as the cornerstone of its waste research strategy. The risk reduction approach is an improvement over earlier

approaches. If this approach is implemented properly, the effectiveness and impact of ORD's research programs will improve significantly.

The waste research strategy has strengths in some areas and needs improvement in others. In general, implementation of the strategy is likely to produce results that will improve the Agency's capacity to address waste management problems and reduce risks to human health and the environment.

Within the universe of research opportunities considered in the strategy, the programs and projects highlighted are reasonable and largely justifiable. Strategic planning for waste management, however, is a dynamic process that may need revision as new information becomes available.

Specific Findings & Recommendations Major findings and recommendations based on detailed review of the ORD waste research strategy are summarized below:

a) The Subcommittee finds that the set of waste research issues identified by ORD for coverage in the strategy is appropriate and important. However, ORD needs to involve representatives of external organizations in the planning process. External expertise should be drawn from stakeholder sectors such as the academic community, non-profit organizations, other public agencies and the private sector.

b) The risk reduction methodology used in screening waste research issues and topics is adequate but its application process is not clear. The prioritization scheme for research topics should be made more transparent. Lack of transparency may compromise the credibility of an otherwise useful waste research prioritization scheme. The scheme can be made more transparent by documenting how and why specific research topics were assigned various priority levels. The ranks assigned to topics should reflect the hierarchy and criticality of the needs that were identified earlier in the process.

c) It is necessary for ORD to establish linkages between the waste research strategy and parallel efforts within and outside the Agency. Such linkages are expressed in ORD documents only in global terms. If such linkages exist at specific project levels, it may be possible to avoid duplication of efforts or neglect of important issues. Examples of risk reduction efforts outside the Agency are the Risk-Based Corrective Action (RBCA) programs operated by Environmental Protection Agencies of various states; waste management programs of the Department of Energy; and natural hazards mitigation programs of the Federal Emergency Management Agency (FEMA), U.S. Geological Surveys of the National Institute for Standards and Technology (NIST).

d) ORD should include information on current and projected budgets in its research strategy. Budget information is useful for assessing the relative merit of performing research on some waste issues within or outside the Agency.

e) ORD should develop a means of utilizing the results of extramural research in intramural research planning.

f) Considering the large volume of wastes generated each year and the existence of thousands of contaminated sites, better balance between research on risk characterization and technologies for site remediation and waste management should be attained in the strategy.

g) While technical support is extremely important and deserving of much attention, it should not be a major research focus of the strategy. ORD should acknowledge the importance of technical support on waste issues in the Strategy and work with other organizations of the Agency toward its implementation.

The EEC and the Waste Research Strategy Subcommittee appreciate the opportunity to review this strategy and thank ORD personnel for the information they provided during the review process. The SAB looks forward to a written response from the Assistant Administrator for ORD.

Sincerely,

/signed/
Dr. Joan Daisey, Chair
Executive Committee

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

/signed/
Dr. Hilary I. Inyang, Chair
Waste Research Strategy Subcommittee

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ABSTRACT

The Environmental Engineering Committee of the EPA Science Advisory Board reviewed the Waste Research Strategy prepared by the EPA Office of Research and Development. The Committee commends EPA for developing the Strategy, which responds to previous SAB advice (EPA-SAB-EEC-COM-94-004) and decisions (EPA-SAB-EEC-97-011). The Committee also commends ORD for adopting risk reduction as the cornerstone of the Strategy. If this approach is implemented properly, the effectiveness and impact of ORD's research programs will improve significantly. The Committee finds the Strategy has strengths and opportunities for improvement. In general, implementation of the Strategy is likely to improve the EPA's capacity to address waste management problems and reduce risks to human health and the environment.

The Committee now recommends two advancements to the process of research strategy development -- the involvement of external organizations in the planning process and transparent documentation.

Establishing and documenting linkages between the ORD waste research strategy and related efforts within and outside the Agency, will strengthen the strategy. Such description indicates the authors know the field and it reduces the likelihood that efforts will be duplicated or important issues neglected. Examples of such organizations are Risk-Based Corrective Action (RBCA); programs operated by state agencies concerned with environmental protection; the waste management programs of the Department of Energy; and natural hazards mitigation programs of the Federal Emergency Management Agency (FEMA), U.S. Geological Surveys of the National Institute for Standards and Technology (NIST).

The final Strategy should describe how and why specific research topics were assigned various priority levels so clearly that a stranger to the process could pick up the Strategy and understand how each decision was made.

Keywords: waste, research, research planning

U.S. Environmental Protection Agency
Science Advisory Board (SAB)
Environmental Engineering Committee (EEC)
Waste Research Strategy Subcommittee

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1. EXECUTIVE SUMMARY

The Subcommittee commends the Agency for its effort on the development of a comprehensive strategy for conducting waste-related research. This strategic plan is an improvement over earlier plans because a methodology was developed for application to the problem of research issue screening so that intramural research can be focused on critical needs. It is particularly noteworthy that some elements of the Risk Reduction Methodology that is being developed by a diverse panel of the Science Advisory Board have been applied in the development of the ORD waste research strategy. If this effort is sustained within the Agency, the effectiveness of the Agency's internal risk reduction research will be significantly improved. However, it should be recognized that strategic planning for attainment of environmental goals is a dynamic process. As more information becomes available, the plan will need to be revised accordingly.

The Subcommittee found that the waste research strategy has merit in some areas, while it needs significant improvement in others. A brief summary of findings by the Subcommittee on each of the charge questions is presented. Details on these findings and relevant recommendations are provided in various sections of this report.

Charge Question #1 -- *Has ORD clearly captured and presented the environmental problems associated with wastes?*

> **Response:** Yes. ORD has identified significant environmental problems from releases of contaminant by numerous solid waste management units, oil spills, proliferation of human and ecosystem exposure pathways (for contaminants), and existence of thousands of contaminated sites. The effort made by ORD to compile and update this information is commendable.

Charge Question #2 -- *Has ORD identified the high priority topics that need to be addressed? Has too much or too little emphasis been placed on one or another of the topic areas? Do any other major topic areas need to be added?*

> **Response:** Yes. Within the universe of research opportunities considered in the strategy, the programs and projects highlighted are reasonable and largely justifiable. However, the Agency appears to have focused only on its internal customers. If external customers had been involved in the identification and prioritization of research needs, the research priorities might have been different. The Subcommittee recommends that ORD seek input from other stakeholders such as consultants, members of the academic community, non-profit organizations, and private companies so that both internal and external views could be embraced.

The Subcommittee observes that the research strategy emphasizes the study of wastes and contaminated sites before treatment. Considering the fact that the need for waste management and improvement of remediation technologies for contaminated sites is still high, remediation research should not be de-emphasized in the ORD waste research strategy. Technical support is a necessary component of ORD research programs but it should not be ranked with the same criteria that ORD has applied to research topics.

The ORD research strategy is media-focused: groundwater, soils/vadose zone, air (emissions) and active waste management facilities. The Subcommittee believes that some elements of the media-focused approach are important but the cross-media approach is better-suited to ORD's efforts at developing solutions to real-world problems.

Charge Question #3 -- Are the research activities proposed within each topic area addressing the highest priority research needs? Has too much or too little emphasis been placed on one or another of the research activities (topics)? Do any other major research activities (topics) need to be added?

Response: In the groundwater and soils research area of the research strategy, natural attenuation, biotreatment, contaminant fate and transport modeling and site characterization/field screening justifiably, rank highly. Too little emphasis has been placed on waste containment research and potentially useful physico-chemical treatment techniques such as vitrification and stabilization. Additional important topics that are not covered by the strategy are technologies for 'Brownfields' site decontamination and redevelopment; natural hazards effects on waste containment, utilization of wastes; low-level radioactive waste-contaminated sites; and naturally occurring radioactive materials (NORM).

The research topics selected in the waste combustion area have adequately cover research needs on emissions from hazardous waste incinerators, municipal solid waste incinerators, cement kilns, industrial furnaces and medical waste incinerators. Emissions from other types of combustors need to be included. Examples are sewage sludge incinerators and thermal treatment technologies.

The topics listed for current and future research focus in the active waste management research area relate mostly to waste toxicity, modeling of fate and transport processes and waste characterization. These topics are too generic and tend to overlap with the same suite of topics that are categorized under the soils and groundwater areas. In order to improve the effectiveness of control measures for present and future releases of contaminants from active waste management facilities, the Subcommittee recommends that the following research issues be considered for inclusion in the research strategy: contaminant leachability from utilized wastes; long term performance of facilities such as surface impoundments, waste piles and confined disposal facilities (CDSs); and leak control and monitoring technologies.

The topics on ecological, human health and exposure issues are appropriate. They are consistent with some of the recommendations made during ongoing critical review of EPA's exposure and risk assessment methods by the Science Advisory Board. More detailed information about specific research topics are needed to assess the extent to which the projects will reduce uncertainties in the factors needed to address human health and exposure issues.

Charge Question #4 -- *Are criteria and processes used to filter and select the highest priority research clear and reasonable?*

Response: ORD has significantly improved its methodology for prioritizing its program activities. The waste research strategy is conceptually consistent with ORD's strategic plan. Information presented to the Subcommittee confirms that risk reduction potential was considered as a screening tool in the prioritization of waste research topics. However, although the methodology and criteria are structurally reasonable, their application is not sufficiently transparent. More detailed information on how and why specific research topics were assigned various priority levels would have been useful. Such information could help ORD in the demonstration of the extent to which the ranks assigned to research topics reflect the hierarchy and criticality of the needs identified earlier in the process. The Subcommittee recommends that alternative and/or future funding sources be identified for high priority topics that are not covered in the current research strategy.

Charge Question #5 -- *Are the future directions for research in the program clearly identified in the plan and are they reasonable and appropriate?*

Response: The future direction of research areas has been clearly identified in the plan. The reasonableness and appropriateness of the future directions of research could not be credibly evaluated by the Subcommittee because it lacked information on the availability of the "critical mass" of the internal ORD experts and projected budgets for the future.

The Subcommittee recommends that ORD integrate information on core competencies from its overall Strategic Research Plan into its waste research strategy. A system should be developed for utilizing the results of extramural research in intramural research planning.

2. INTRODUCTION

The Office of Research and Development (ORD) of the U.S. Environmental Protection Agency developed a research strategy to address waste-related environmental problems through fiscal year 2000. The research strategy was presented to the Environmental Engineering Committee (EEC) of the Science Advisory Board (SAB) for review. Several documents listed in Chapter 5 of this report were provided to the EEC members prior to the July 1, 1997 review meeting at U.S. EPA's National Risk Management Research Laboratory (NRMRL) in Cincinnati, Ohio. In preparation for the July 1, 1997 meeting, a telephone conference call was held on June 13, 1997, during which U.S. EPA senior personnel presented elements of the waste research strategy and responded to inquiries by EEC members and consultants. More detailed presentations were made by ORD staff in Cincinnati. This report has been prepared to communicate the consensus comments in response to the five-point charge given to the Subcommittee.

In general, the primary objective of the waste research strategy is to apply ORD's strategic planning principles, goals and ranking criteria to its internally-driven effort toward establishing priorities for waste-related research. As expressly stated in the Executive Summary of the research strategy document, ORD will use this strategy to select and focus on the most important research areas. ORD also hopes that stakeholders outside ORD can use this strategy to identify research needs and priorities. Following its internal screening process, during which some research topic areas were filtered out, ORD decided to group its waste research projects into five categories:

a) Contaminated sites - groundwater

b) Contaminated sites - soils/vadose zone

c) Emissions from waste combustion facilities

d) Active waste management facilities

e) Technical support

Thirty nine (39) research projects were initially identified. Among the parameters stated by ORD as being included in the criteria for ranking these projects were uncertainty in risk assessment, efficacy and cost-effectiveness of risk management technologies, and the broad applicability of methods and models. The non-science criteria included administrative priority, Program Office priority, regulatory or legal mandates, priorities within the Agency, Congressional directives, FY 98 area for new funding and Committee on Environment and Natural Resources (CENR) research priority. Table 1 provides the research project topics or task areas within the five program (topic) areas and their overall rankings.

ORD requested a review of the waste research strategy by the EEC. The Waste Research Subcommittee has herein provided responses to the following five-point charge:

a) Has ORD clearly captured and presented the environmental problems associated with wastes?

b) Has ORD identified the high priority topics that need to be addressed? Has too much or too little emphasis been placed on one or another of the topic areas? Do any other major topic areas need to be added?

c) Are the research activities proposed within each topic addressing the highest priority research needs? Has too much or too little emphasis been placed on one or another of the research activities? Do any other major research activities need to be added?

d) Are criteria and processes used to filter and select the highest priority research clear and reasonable?

e) Are the future directions for research in the program clearly identified in the plan and are they reasonable and appropriate?

The Subcommittee considers it appropriate to provide a written evaluation of both the waste research strategy development process and the topics selected. To the extent possible, comments are provided as recommendations which ORD may consider in its on-going effort to develop and refine its waste research strategy.

Table 1. Selected ORD Waste Research Program Research Activities

Research Topic Areas (In Priority Order)	RESEARCH ACTIVITIES BY RISK PARADIGM CATEGORIES					
	Risk Assessment			*Risk Management*		
	Exposure Assessment	Toxicity Assessment	Risk Characterization	Remediation & Restoration	Control	Monitoring
Contaminated Sites - Ground Water	- Environmental Fate and Transport Modeling (7)* - GW Exposure Factors / Pathways (21)	- Mixtures Toxicology (26) - Ecological Risk Assessment Methods (38) - Human Dose-Response Models for Mixtures (3)		- Natural Attenuation (2) - Abiotic Treatment of GW (9) - Biotreatment of GW (16) - Containment of GW (17) - Demonstration/ Verification of Innovative Remediation Technologies (27)		- Subsurface Characterization (6) - Field and Screening Analytical Methods for GW (5) - Demonstration/ Verification of Field Monitoring Technologies (27)
Contaminated Sites - Soils / Vadose Zone	- Estimating Human Exposure & Delivered Dose (1) - Estimating Soil Intake and Dose -Wildlife Species (3)	- Ecological Screening Tests to Measure the Effectiveness of Treatment (18) - Mixtures Toxicology (34)		- Biotreatment of Soils (3) - Containment of Soils (18) - Demonstration/ Verification of Innovative Remediation Technologies (27) - Abiotic Treatment of Soils (31) - Oil Spills (36)		- Field Sampling Methods (8) - Field and Screening Analytical Methods for Soils (9) - Sampling Design (22) - Demonstration/ Verification of Field Monitoring Technologies (27)
Emissions from Waste Combustion Facilities	- Indirect Exposure Characterization/ Modeling (13) - Indirect Pathway Risk Assessment Methods (11)	- Movement of Bioaccumulative Chemicals in Food Webs (33) - Dose-Response of Key Contaminants (24)			- Emissions Prevention and Control (12)	- Continuous Emissions Monitoring (CEMs) Methods (23)
Active Waste Management Facilities	- Multimedia, Multipathway Exposure Modeling (14) - Environmental Fate and Transport; Physical Estimation (25)	- Developing Provisional Toxicity Values for Contaminants (18)			- Waste Management (36)	- Waste Characterization and Sampling (32)

* Equals the ordinal rank of each research activity across the entire Waste Research Program based on the science plus ranking factors.

3. RESPONSES TO SPECIFIC CHARGE QUESTIONS

3.1 Charge 1: Coverage of Environmental Problems Associated with Wastes

3.1.1 "Waste Research" as a Misnomer for Issues Covered

The title of the program, "waste research" is a misnomer, considering the issues covered. The broad areas of research covered are contaminated sites (groundwater and soils), emissions from waste combustion facilities, and active waste management facilities. "Waste and Site Remediation Research" is considered a more appropriate title than "Waste Research" for the suite of environmental issues covered.

3.1.2 Research Needs Identification Process

In the oral presentations and the research strategy documents, ORD identified several significant environmental problems relevant to "waste research" programs. Among these problems are releases of contaminants by numerous solid waste management units, oil spills, proliferation of human and ecosystem exposure pathways (for contaminants), and existence of thousands of contaminated sites. The effort made to compile and update these data is commendable. However, the involvement of non-EPA personnel in the research needs identification process was lacking. Moreover, the needs discussed were not strongly linked to the reduction of risks or waste management problems discussed.

3.1.3 Implications and Adequacy of the Research Issue Classification

The titles used to classify research issues broadly should reflect those issues; otherwise research inventory takers may erroneously assume (using the titles) that specific issues have been covered by ORD's strategy. The classification system used by ORD is largely media-focused: groundwater, soils/vadose zone and air (emissions). Although elements of this approach are important, focus on issues and/or techniques across various media seems more consistent with an approach directed at finding solutions, e.g., "improvement of containment systems for waste." The latter may involve consideration of cross-media pollution problems such as contaminant releases to the atmosphere, groundwater and vadose zone.

3.2 Charge 2: Identification of High Priority Areas

3.2.1 Agency Program Office Research Preferences versus National Waste Research Needs

Within the universe of research opportunities considered in the strategy, the programs and projects highlighted are reasonable and the justifications are adequate. However, ORD appears to have focused only on internal customers. If representatives of external customers such as the

general public, engineering firms and the regulated community had been involved in the prioritization of research needs, the research priorities might have been different. For example, "Brownfields" characterization is an issue for which these external stakeholders frequently seek technical support. In the waste research strategy, there should be better communication of the linkage between ORD/Agency Program Office research preferences and the identified national waste research needs. Then, it would be possible to evaluate the effects of implementation of the agency-preferred research tasks on national waste management problems.

3.2.2 Non-utility of Research Area Prioritization

ORD has identified four groupings of research issues which it refers to as research topic areas. Ranking of the categories is less useful than ranking of the specific research projects that constitute the categories. It is difficult and perhaps meaningless to establish the importance of groundwater contamination research relative to soil contamination research on a national basis. If both problems are desegregated into various aspects, it may be easier to weigh them relative to one another. In this regard, the issue ranking approach adopted by ORD is superior to the category ranking approach.

3.2.3 Balance of Risk Characterization with Risk Mitigation

Figure 1 is a representation of the risk control scheme favored by ORD. An analysis of how the research issues that rank highly in Table 1 fit into Figure 1 indicates overemphasis on

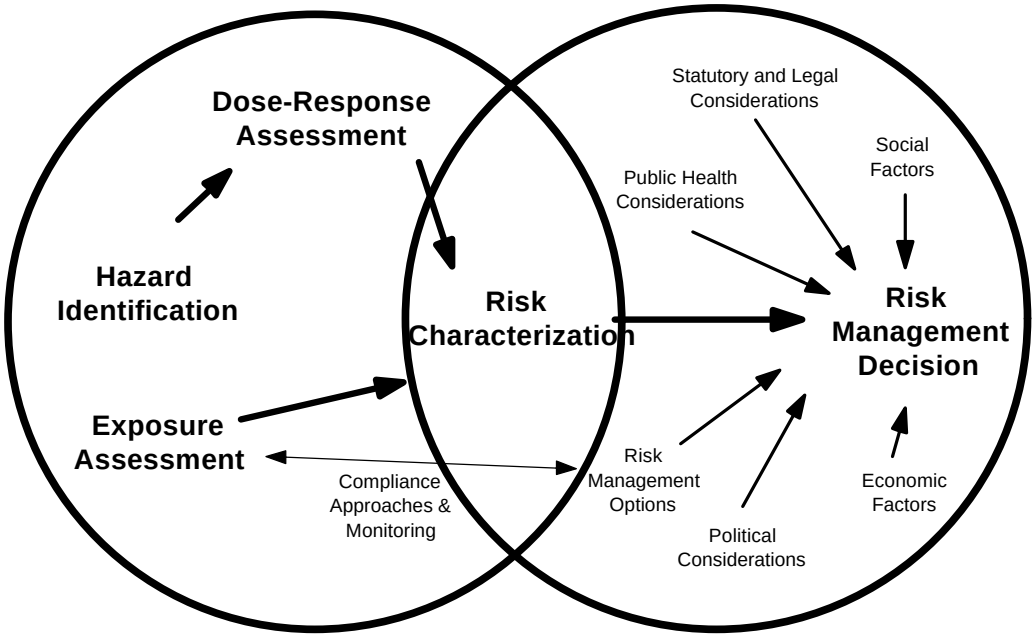

Figure 1. Conceptual risk control scheme adopted by U.S. EPA's Office of Research and Development (ORD)

risk characterization. Few of the highly ranked issues can be regarded as risk mitigation. The current strategy emphasizes the study of wastes and contaminated sites before treatment. Considering that in many cases, the decision has already been made to remediate pollution at contaminated sites, and that characterization alone is not the solution, research on technologies for site cleanup should not be de-emphasized within ORD programs.

3.2.4 Linkages among Parallel Programs

There should be more linkages among ORD research issue plans and with research of other agencies. For example, the National Institute of Environmental Health Sciences (NIEHS) performs basic toxicology work for the Superfund office. In addition, the EPA Hazardous Substance Research Centers perform several aspects of site characterization and cleanup research. Although it is mentioned that these and other programs were considered, it is not clear why specific research topic areas that appear to fit those programs were also ranked highly in ORD's Waste Research Program.

3.3 Charge 3: Utility of Selected Research Topics

3.3.1 Topics on Ecological Issues

The aspects of research included in the strategy on ecological issues are appropriate. Although there was a sense that ecological issues should play a larger role in comparison with human health concerns in the development of waste site remediation standards, the specific research focus of the ecological aspects included is vague. For instance, on the topic of chemicals in food webs, what specifically will be done? Will the focus be on plants, invertebrates, fish, mammals or birds? The Subcommittee would like to encourage the use of the Agency's Ecological Risk Assessment Guidelines as a template for identifying ecological risk assessment needs. In addition, the Subcommittee calls to the attention of the waste research strategy planners a recent study (C & EN, 1997) of fish in 25 streams in 31 states by the U.S. Geological Survey. Several pesticides and phenol compounds in biological tissues were correlated with estrogen and testosterone in fish. These hormones in fish are significant with respect to reproductive ability. Some useful information may be gained from this and other studies by ORD.

It was difficult to follow the path of selection of ecological issues from the broader set of waste-related problems summarized and the specified criteria. The future directions of ecological research, generally are appropriate, except that restoration of damaged ecosystem is not covered.

3.3.2 Topics on Human Health and Exposure Issues

The proposed program in the area of health risks of chemical mixtures could possibly satisfy the high risk and high uncertainty criteria, but lack of information on specific research

projects planned within the issues listed makes it difficult to confirm the potential for reduction of uncertainty.

The future directions of human health and exposure research listed are appropriate. They are consistent with some of the recommendations made during ongoing critical review of EPA's exposure and risk assessment methods by the Science Advisory Board.

3.3.3 Topics on Soil and Groundwater Issues

The description of groundwater contamination (pages 27 and 33) in the Strategic Plan should be expanded to include:

a) the state of groundwater contamination in the United States (with references);

b) discussions of uncertainties with respect to detection and quantification of contaminants in groundwater and effectiveness of remedial action; and

c) the fact that groundwater may be the slowest resource to recover naturally.

It is not clear how the priorities were assigned to the sub-topics within the groundwater area. For example, why are subsurface contaminant containment and its associated aspects ranked below characterization, modeling, field screening methods and biotreatment? Characterization of dense non-aqueous phase liquids (DNAPLs) is an important research focus, but improvement of the cost-effectiveness of containment technologies and associated long-term performance assessments is equally important.

Modeling of fate and transport of contaminants ranks high in the plan, and certainly is an ORD research strength. However, rather than focus on modeling in general, efforts should be devoted to developing models for specific media that have not been adequately covered by existing models. Examples are karst terrain and fractured bedrock. There are numerous fate-and-transport models for porous media, and consumption of limited resources by research producing marginal increases in precision and accuracy of porous media models is not justified.

Demonstration and verification of innovative groundwater remediation and monitoring technologies should be coordinated with other ongoing activities, such as the demonstrations at Dover and McClellan Air Force Bases, the projects at the University of Waterloo and Rice University, and other initiatives. It is also considered useful to assess the relationship between these efforts and the activities that EPA conducts under its SITE program. The criteria and processes used to filter and select highest research priority topics in the soil and groundwater area are justified. However, it is difficult to reconcile the final rankings, because the rationale for assigning scores or ranks to the topics considered is unclear.

Natural attenuation and biotreatment justifiably rank very high in the strategy. However, the Subcommittee is concerned that other promising technologies have been overlooked. Are there other applied research or technical support programs that deal with vitrification, stabilization, etc., within the Agency? There is general relegation of site (soils and groundwater) research to lower ranks without adequate explanation. Other issues that are not embraced include: "Brownfields" site contamination, remediation and control; natural hazards effects on waste containments; utilization of wastes; low-level radioactive waste-contaminated sites; and naturally occurring radioactive materials (NORM). The success of the future research focus areas listed will depend on the specific projects selected. The exclusion of issues, such as those mentioned above, from both the current and future research plans should be explained.

3.3.4 Topics on Active Waste Management Facilities

It is correctly stated in the waste research strategy document (page 172) that "the current regulatory approach to the management of hazardous wastes is considered extremely burdensome and costly to the U.S. economy." It is further stated that relevant "regulations are considered overly conservative and not well-founded on risk." The research plan presented on active waste management facilities covers issues that are not specifically targeted at reducing the problem that has been described. The topics listed for the current and future research focus mostly relate to waste toxicity, modeling of fate and transport processes, and waste characterization. It can be argued that all of these topics are only indirectly relevant to a research plan that would address the control of present and future releases of contaminants from active waste management facilities. Furthermore, they tend to overlap with the same suite of topics that were categorized under the soils and groundwater areas.

The types of active waste management facilities that are to be addressed should first be identified. Are they the thousands of surface impoundments that are known to leak? What about waste piles from mining wastes? Is the long-term performance of confined disposal facilities (CDFs) addressed elsewhere? Do holding tanks for liquid wastes at industrial plants leak? After justifiable selection of the types of waste management facilities and identification of knowledge gaps in technologies that could control releases and hence reduce risks, ORD could then select topics with an appropriate focus.

It was estimated (U.S. EPA, 1992) that by the year 2000, the generation rate of municipal wastes in the United States will be about 222 million tons per year. Society is increasingly faced with the problem of low toxicity, high volume wastes, some of which have potential as partial replacement for traditional construction materials. Lack of a knowledge on contaminant leachability from composite construction materials that contain some of these low toxicity materials have interfered with potentially beneficial utilization of these materials. Therefore, the Agency should include this issue in its research plans and relevant technical guidance initiatives.

3.3.5 Topics on Waste Combustion

If de-emphasis of combustion research is because waste incineration has been relatively well addressed compared to other types of combustion, an appropriate focus for the current combustion research component of the strategy should be the characterization of emissions from a diversity of sources. The plan addresses emissions from hazardous waste incinerators, municipal solid waste incinerators, cement kilns, industrial furnaces and medical waste incinerators, but it does not include emissions from other waste combustors such as sewage sludge incinerators or thermal treatment technologies, including thermal desorbers or oxidizers for treatment of contaminated soils. Although it would be logical to include these topics in this strategy, oral discussion indicated that they were not considered in the development of this research strategy.

The strategy does not go into detail on the issues involved in waste combustion, nor does it document the importance of the issues with statistics or other metrics. However, it does correctly identify the research priorities which are, in order of priority; emission prevention and control, indirect exposure characterization/modeling, indirect pathway risk assessment methods, continuous emissions monitoring methods, and studies of the movement of bioaccumulative chemicals in food webs. Although the titles of these subject areas do not adequately describe the detailed research priorities, the more detailed breakdown included in the strategy provides some insights and reflects a strong grasp of the subject matter.

The high priority should be characterization of emissions from waste combustors, and development of a better understanding of how the combustion process leads to formation of pollutants. While incineration is a highly efficient method of organic waste destruction, it still represents a source of direct introduction of pollutants into the environment. This residual is emitted as organic by-products, with only 20-50% of the emissions being chemically characterized. While this is similar to other combustion sources, characterization of emissions should be a priority for waste combustors (and other combustion sources). Determining the origin of these emissions so that they can be prevented and controlled is the logical progression for the research.

Several tasks were identified that relate to better assessment of exposure and risk. The results of the WTI risk assessment clearly identified these weaknesses in the risk assessment procedure. Of these, gas-solid partitioning and local terrain models may be the most important. Gas-solid partitioning of semi-volatile pollutants controls their uptake into the food chain and ultimately the route of human exposure.

Development of Continuous Emission Monitors (CEMs) for dioxins and mercury continues to be a real need, but could be better accommodated by long-term, high-risk research studies funded through the grants program and/or NSF.

Major concern with the combustion emissions strategy is lack of definition of which combustion sources are included. Emissions from hazardous waste, municipal waste, medical waste, sewage sludge, and contaminated soil thermal treatment technologies should be included. The data will be more meaningful if they are generated in combination with data from other combustion sources suspected of emitting toxic combustion by-products. Coordination with EPA's air toxics program is indicated.

3.3.6 Inclusion of Technical Support in Waste Research

Technical support is a program that should apply to all areas of ORD's research effort. The same criteria can not be credibly used to rank it along with research areas or topics. Therefore, it is considered inappropriate to include it as one of the areas of major research focus. While technical support is extremely important and deserving of much attention, it should not be a major research focus of the strategy. ORD should acknowledge the importance of technical support on waste issues in the strategy and work with other organizations of the Agency toward its implementation.

3.4 Charge 4: Appropriateness and Implementation of Research Topic Prioritization Scheme

3.4.1 Use of the Risk Paradigm

The ORD has significantly improved its methodology for prioritizing its program activities and it is commendable that the risk paradigm has been adopted as the foundation for structuring ORD's research programs. The waste research strategy is conceptually consistent with ORD's strategic plan. Information presented to the Subcommittee confirms that risk reduction potential was considered as a screening tool in the prioritization of waste research topics. A refined research strategy should include an analysis of the areas of the risk paradigm in which USEPA and external organizations need strengthening. Although, these areas vary from one issue to another, such variabilities need to be communicated and addressed.

3.4.2 Transparency of the Process

Although the methodology used for waste research prioritization is structurally appropriate, its implementation is not sufficiently transparent. More detailed information on how and why specific research topics were assigned various priority levels need to be documented. To what extent do the rankings assigned reflect the hierarchy and criticality of needs identified earlier in the process? Others should be able to apply the methodology and arrive at a reasonably similar set of waste research priorities. The transparency of the application of the methodology is a determinant of the extent to which ORD can successfully defend its research priorities.

3.4.3 Utilization of Gathered Information

ORD presented referenced information, especially on the inventory of waste/contaminated sites and expressed missions of other agencies. The categories of research performed by other agencies and other organizations within EPA are identified. However, the utility of these external research efforts with respect to EPA's research mission was not adequately communicated. For example, it was mentioned that the Agency for Toxic Substances and Disease Registry (ATSDR) is involved in toxicological database development, and that one of its mandates is "to provide EPA with critical health-based information so that clean-up decisions that are effective and protective to public health can be made." Is there a relationship between the high ranks assigned by ORD to human exposure and toxicological research and possible inadequacies also addressed in related to ATSDR research?

3.4.4 Weighting of Criteria as a Reflection of Critical Needs

The fifth stage of ORD's Waste Research Ranking Scheme illustrated in Figure 2 is the prioritization of research activities. Ordinal rankings of the activities were developed using three criteria: uncertainty in risk assessment, efficacy and cost-effectiveness of risk management technologies, and broad applicability of methods and models. This approach has merit, but the relative importance of each of the three evaluation criteria should be made explicit. Weighting of the criteria may produce results that are more reflective of ORD's risk management needs. Currently, the assumption (which may be justifiable) is that the three criteria have equal weights.

3.4.5 Identification of Alternative Funding for Non-covered High Priority Areas

ORD generally considered funding limitations, in-house expertise and capacity to perform waste research, although this was done on a rather generic basis. During the vetting process (especially, the science-plus evaluation), there was the possibility that certain research needs with high risk reduction potential were eliminated. High utility research issues and associated activities that "fall off the table" should be addressed in other programs or considered in subsequent plans for the Waste Research Strategy.

3.5 Charge 5: Clarity of Future Research Directions

3.5.1 Use of Research Products as Input to the Next Planning Process

In each of the four major research focus areas, the connection between the results of the initial research program and the plan for subsequent research activities should be refined. In the strategy document, it is difficult to establish the connection. Perhaps some of the issues will be adequately addressed by a 3-year program but, ORD's projections should be expressed despite the uncertainties associated with such prediction.

3.5.2 Intramural versus Extramural Research Programs

The ORD has operated an elaborate extramural research program on issues that overlap, or at least intersect, those that are covered by this intramural research strategy. In the strategy document reviewed, it was not clear whether this relationship was considered. How does ORD decide to classify topics for extramural research? Are the products of the extramural research effort used in internal research prioritization? The Subcommittee recommends that a system be developed for utilizing the results of extramural research in intramural research planning.

3.5.3 Intramural Research Personnel Issues

The plan is mostly silent on ORD's capacity to perform intramural research in the areas selected. The availability of the "critical mass" of internal experts is an important determinant of the potential success of the program. It would be helpful for ORD to integrate information on core competencies from its overall strategic research plan into the waste research strategy. Recently, the National Risk Management Research Laboratory (NRMRL) has advertized vacancies for post-doctoral researchers, which could augment internal research expertise.

3.5.4 Budget Estimates as an Index of Research Strategy and Schedule

The extent to which the available or projected budget affected the research prioritization process is not clear. If the scope of essential research tasks is limited by budget constraints, such tasks should be identified, transferred to a program that can support it, or tagged for coverage in a subsequent program.

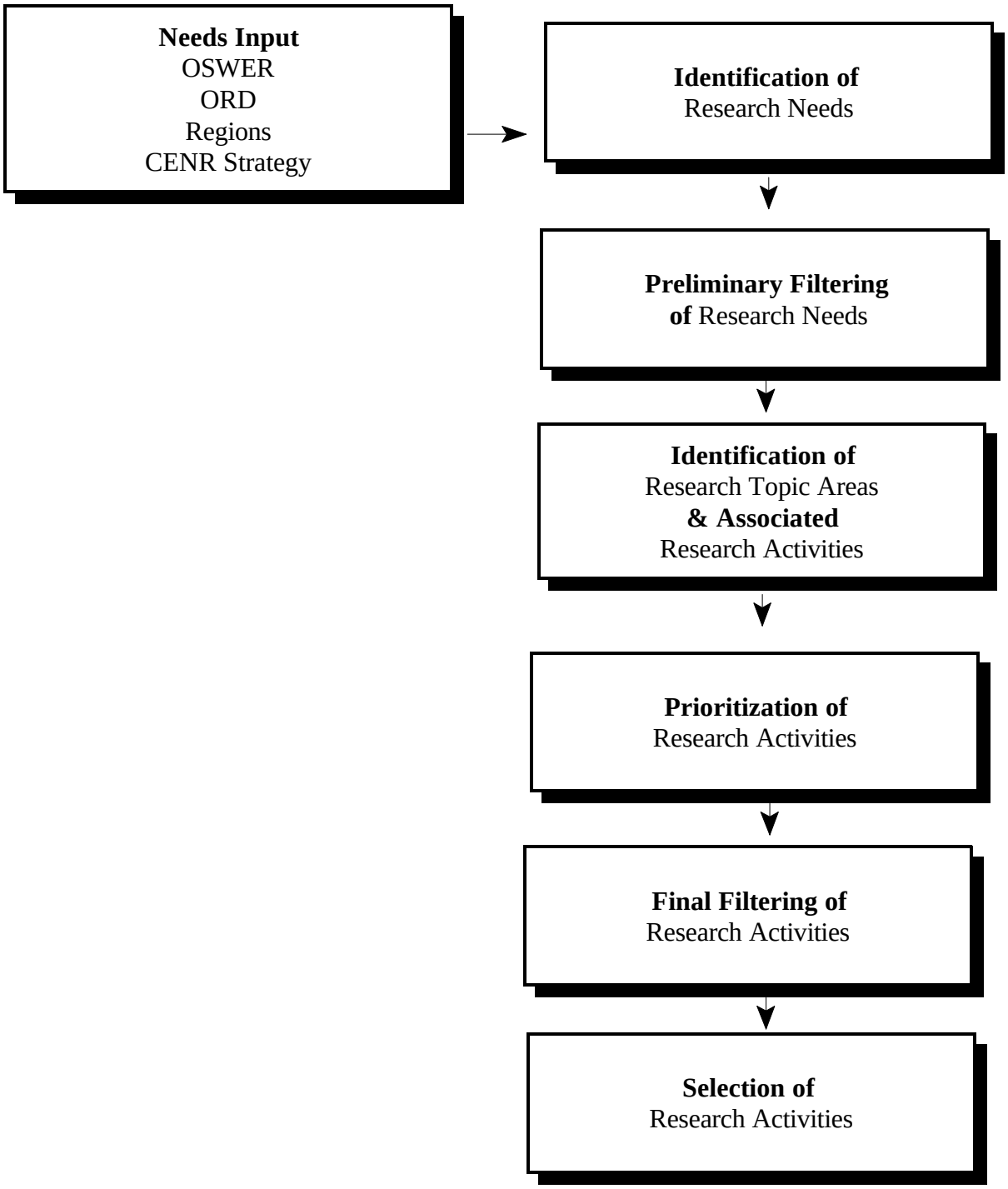

Figure 2. ORD's waste research ranking flow chart (EPA 1997c)

Appendix A - Glossary

ATSDR = Agency for Toxic Substances and Disease Registry
C & EN = Chemical and Engineering News
CDF = Confined Disposal Facility
CEM = Continuous Emission Monitor
CENR = Committee on Environment and Natural Resources
DNAPL = Dense Non-Aqueous Phase Liquid
NIEHS = National Institute of Environmental Health Sciences
NORM = Naturally Occurring Radioactive Material
NRMRL = National Risk Management Research Laboratory
NSF = National Science Foundation
ORD = Office of Research and Development
PM = Particulate Matter
SITE = Superfund Innovative Technology Evaluation
WTI = Waste Technology Institute

Appendix B - EPA Documents Provided for Review

U.S. EPA. 1996. Promoting innovative approaches to environmental protection. A Summary of Recommendations from the National Advisory Council for Environmental Policies and Technology. EPA/100/R-96/003. U.S. Environmental Protection Agency, Washington, DC

U.S. EPA. 1997a. Waste research strategy. A Briefing Book for the Science Advisory Board Review. U.S. Environmental Protection Agency, Washington, DC

U.S. EPA. 1997b. Science to Achieve Results (STAR). Program Description Outline. Office of Research and Development, U.S. Environmental Protection Agency, Washington, DC

U.S. EPA. 1997c. Waste Research Strategy. External Review Draft. Office of Research and Development, U.S. Environmental Protection Agency, Washington, DC

U.S. EPA. 1997d. Update to ORD's strategic plan. EPA/600/R-97/015. Office of Research and Development, U.S. Environmental Protection Agency, Washington, DC

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U.S. EPA. 1986. Municipal solid waste landfill survey. Draft. Office of Solid Waste, U.S. Environmental Protection Agency, Washington, DC

U.S. EPA. 1992. Characterization of municipal solid waste in the United States: 1992 update. EPA/530/S-92/019. Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, DC.

NSTC. 1995. A national R&D strategy for toxic substances and hazardous and solid waste. Toxic Substances and Hazardous and Solid Waste Subcommittee, Committee on Environmental and Natural Resources, National Science and Technology Council, Washington, DC.

C&EN. 1997. Endocrine disruption may be occurring in U.S. fish. Chemical and Engineering News, May 12, pp. 28.

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United States Environmental Protection Agency
Science Advisory Board Washington, DC
EPA-SAB-EEC-98-005 February 1998

A REVIEW OF THE WASTE RESEARCH STRATEGY OF THE OFFICE OF RESEARCH AND DEVELOPMENT

PREPARED BY THE ENVIRONMENTAL ENGINEERING COMMITTEE (EEC)