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EPA AN SAB REPORT: FUTURE ISSUES IN ENVIRONMENTAL ENGINEERING

REPORT ON FUTURE ISSUES AND CHALLENGES IN ENVIRONMENTAL ENGINEERING AND TECHNOLOGY BY THE ENVIRONMENTAL ENGINEERING COMMITTEE

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

May 25, 1995

OFFICE OF THE ADMINISTRATOR
SCIENCE ADVISORY BOARD

EPA-SAB-EEC-95-004

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

Re: Environmental Engineering Futures Report

Dear Ms. Browner:

In July 1992, the Science Advisory Board (SAB) began an initiative, termed the Environmental Futures Project, to advise the Agency on ways to identify future environmental problems and provide the SAB's perspective on emerging environmental issues. The SAB Executive Committee accepted the request and formed the Environmental Futures Committee (EFC) to direct the effort. The EFC in turn requested the standing committees of the SAB to address the charge for areas of their particular expertise and interest, and to produce separate reports which would supplement the overall report on Environmental Futures to be written by the EFC.

The Environmental Engineering Committee (EEC), in response to the opportunity provided by the EFC, chose four issues related to engineering that may emerge in the future. The EEC developed the drivers, scenarios, consequences and recommendations for Agency actions related to each issue. The EEC also developed an approach by which EPA could regularly scan the horizon for future issues. This approach was used in part by the EEC to conduct a supplemental search for potential emerging issues.

The four issues developed in detail are:

a) <u>Issue:</u> How can EPA actions foster environmental quality protection and improvements while helping to assure sustained industrial development in an increasingly competitive manufacturing economy?

<u>Recommendation:</u> Agency decisions concerning clean production technologies should be carefully constructed and balanced so that there are benefits both to the environment <u>and</u> to U.S. industrial competitiveness. Flexibility in achieving the desired risk reduction at a facility could promote deployment of cleaner technologies to replace end-of-pipe control technologies.

b) <u>Issue:</u> How can EPA best respond to increasing societal pressures for the redevelopment of urban industrial sites and remediated land while serving urban needs for environmental protection?

<u>Recommendation:</u> The Agency should ensure that appropriate technology is available and/or deployed to redevelop urban contaminated industrial sites and remediated land; this should be done in a manner that avoids significant environmental exposures and meets intracity needs for development, commerce and conservation.

c) <u>Issue:</u> How can the Agency prepare to address threats posed to human health and natural resources by transient phenomena of natural origin in the face of increasing population and land-use pressures?

<u>Recommendation:</u> The Agency should strengthen its capability and readiness to address potential environmental consequences of natural disasters associated with transient phenomena such as riverine floods considering trends in population growth and inappropriate land use. Associated planning and preparedness can help minimize the potential adverse impacts on natural resources and human health.

d) <u>Issue:</u> How can the Agency address insufficiency in the core technical competencies needed to address both existing and future environmental challenges? Core competencies can be defined as the essential and distinct scientific and technical capabilities that enable the EPA to fulfill its current and future missions.

Recommendation: The Agency should systematically identify and examine the essential and distinct scientific and engineering capabilities (core competencies) needed to address technical aspects of its present and expected future mission and strengthen them where needed.

This report describes these issues, their drivers, and their adverse consequences that could follow without implementation of its recommendations or other mitigating actions.

Based on its experience, the Committee developed a suggested methodology which it believes EPA should seriously consider, when it seeks to identify and analyze futures issues. The methodology should consist of the following elements:

a) EPA should establish "lookout" panels involving experts within and outside the Agency.

b) Panelists should routinely scan their fields to provide observations about new or intensifying issues and their consequences.

c) EPA staff should collect these observations then refer them back to the other panelists for comment.

d) Staff and panelists should select candidate issues using agreed upon criteria.

e) EPA should analyze the selected issues in terms of any existing scenarios and EPA goal statements.

f) EPA, with input from panelists, should recommend near-term actions based on projected futures.

The Committee also identified eight possible additional representative technological concerns regarding the future that warrant EPA attention:

a) Fossil fuel depletion;

b) Major industrial accidents and/or terrorist activities;

c) Accelerating deterioration of urban infrastructure (e.g., pipelines for water, sewage, and fuels);

d) Extremely high cost-benefit ratios of some environmental management strategies;

e) Recognition that environmentally contaminated reservoirs, such as contaminated sediments, may pose greater risk than existing point discharges;

f) Recognition that available technology for the control of some newly recognized pathogens in drinking water may be inadequate;

g) Recognition that electromagnetic radiation from new sources may be a health threat;

h) Recognition that inappropriately deployed industrial-ecology concepts can lead to increased human and ecosystem exposures.

The SAB EEC appreciates the opportunity to scan the environmental future related to engineering and looks forward to your reply to the resulting recommen-dations.

Sincerely,

Dr. Genevieve M. Matanoski, Chair
Executive Committee

Dr. Ishwar P. Murarka, Chair
Environmental Engineering Committee

Dr. Raymond E. Loehr, Chair
Environmental Futures Committee

ABSTRACT

In a July 16, 1993 memorandum, EPA asked the Science Advisory Board (SAB) to develop a procedure for conducting a periodic scan of the future horizon; to identify some important possible future developments; and to carry out in-depth examination of environmental impacts. This report is the response of the Environmental Engineering Committee (EEC) to that request.

In addition to making methodological suggestions, the EEC has recommendations for four issues examined in depth. First, Agency policy options concerning clean technologies need to be carefully constructed and balanced to benefit both the environment <u>and</u> U.S. industrial competitiveness. Second, EPA should ensure development and use of appropriate technology to enable the redevelopment of urban contaminated industrial sites and remediated land. Third, EPA should strengthen its capability and readiness to address potential environmental consequences of natural disasters associated with transient events such as riverine floods in the face of trends in population growth and land use. Fourth, EPA should systematically identify and examine the essential and distinct scientific and engineering capabilities (core competencies) needed to address technical aspects of its present and expected future mission and strengthen them where needed.

Keywords: lookout panels, sustainability, disasters, redevelopment of urban land, core competencies

U.S. Environmental Protection Agency

NOTICE

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

Seven reports were produced from the Environmental Futures Project of the SAB. The titles are listed below:

a) Environmental Futures Committee EPA-SAB-EC-95-007
[Title: "Beyond the Horizon: Protecting the Future with Foresight," Prepared by the Environmental Futures Committee of the Science Advisory Board's Executive Committee.]

b) Environmental Futures Committee EPA-SAB-EC-95-007A
[Title: Futures Methods and Issues, Technical Annex to the Report entitled "Beyond the Horizon: Protecting the Future with Foresight," Prepared by the Environmental Futures Committee of the Science Advisory Board's Executive Committee.]

c) Drinking Water Committee EPA-SAB-DWC-95-002
[Title: " Safe Drinking Water: Future Trends and Challenges," Prepared by the Drinking Water Committee, Science Advisory Board.]

d) Ecological Processes and Effects Committee EPA-SAB-EPEC-95-003
[Title: "Ecosystem Management: Imperative for a Dynamic World," Prepared by the Ecological Processes and Effects Committee, Science Advisory Board.]

e) Environmental Engineering Committee EPA-SAB-EEC-95-004
[Title: "Review of Environmental Engineering Futures Issues," Prepared by the Environmental Engineering Committee, Science Advisory Board.]

f) Indoor Air and Total Human Exposure Committee EPA-SAB-IAQ-95-005
[Title: "Human Exposure Assessment: A Guide to Risk Ranking, Risk Reduction and Research Planning," Prepared by the Indoor Air and Total Human Exposure Committee, Science Advisory Board.]

g) Radiation Advisory Committee EPA-SAB-RAC-95-006
[Title: "Report on Future Issues and Challenges in the Study of Environmental Radiation, with a Focus Toward Future Institutional Readiness by the Environmental Protection Agency," Prepared by the Radiation Environmental Futures Subcommittee of the Radiation Advisory Committee, Science Advisory Board.]

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e) author of Appendix 2:	Redevelopment of Industrial Sites and Remediated Land
a) author of Appendix 3:	Transient Phenomena
b) author of Appendix 4:	Core Competency
d) author of Appendix 5:	Futures Methodology

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1. EXECUTIVE SUMMARY

1.1 Background

1.1.1 Relevant Activities

In a July 16, 1993 memo to Administrator Browner, Mr. David Gardiner, Assistant Administrator, Office of Policy Planning and Evaluation (OPPE), requested that the Science Advisory Board (SAB) assist in the continued development of EPA's capacity to anticipate environmental problems, issues and opportunities. The SAB accepted this request and established an SAB Committee, the Environmental Futures Committee (EFC), to undertake this effort. The EFC was responsible for producing an overall report. Each of the SAB standing committees were invited to contribute in their areas of concern. The Environmental Engineering Committee (EEC) of the SAB accepted this assignment and undertook the following charge:

a) develop a procedure for conducting scans of possible future developments that will affect environmental quality and the nation's ability to protect the environment;

b) identify important possible future developments;

c) select a limited number of possible future developments for in-depth examination;

d) draw implications for EPA and recommend actions for addressing them.

This is an EEC consensus report. To stimulate ideas for the report, individual authors prepared background papers on each major issue discussed in the consensus portion of the EEC report. The EEC incorporated some, but not all, material from the appendices in this report.

1.1.2 The Process Used

The EEC used a multi-step process, including:

a) Brainstorming by EEC members and consultants to identify about 30 environmental issues related to technology development that could become increasingly important in the next 5-30 years.

b) Selection of four important future environmental issues for further discussion and writing:

   1) the impact of EPA striving to balance environmental protection and sustainable manufacturing;

   2) societal pressures for the redevelopment of urban industrial sites and remediated land;

   3) threats posed to human health and natural resources by transient phenomena of natural origin; e.g., riverine floods; and

   4) EPA core technical (scientific and engineering, inclusive of research) competencies.

c) Examination of each of the four issues in terms of:

   1) the current situation;

   2) driving influences or trends;

   3) future scenarios;

   4) key findings, by scenario analyses; and

   5) opportunities to mitigate consequences of adverse scenario outcomes and encourage positive outcomes.

The degree of analysis and assessment needed to rank the issues was considered to be beyond the scope of this Committee effort. However, the four issues selected were of sufficient merit to meet the project objectives.

Concomitantly, the EEC developed an approach by which EPA could regularly scan the horizon for similar emerging issues. It then conducted a supplemental search for emerging scenarios and identified several more examples.

1.2 Summary of Findings for the Four Developed Issues

The following major findings for each of the four selected issues are the basis for the Committee's recommendations to EPA.

1.2.1 How can EPA actions foster environmental quality protection and improvements while assuring sustained industrial development in an increasingly competitive manufacturing economy?

> OECD (Organization for Economic Cooperation and Development) member nations increasingly employ a negotiated compliance style of regulation that establishes environmental targets and enables flexibility in how they will be achieved. (Government Policy Options to Encourage Cleaner Production and Products in the 1990s (OECD, 1992)). This approach may also promote opportunities for source reduction in the U.S., encourage development of cleaner technologies, and may improve industrial competitiveness. Therefore, the EEC recommends that EPA consider this approach in developing policy options concerning clean technologies; options need to be carefully constructed and balanced to benefit both the environment and U.S. industrial competitiveness.

Increase in industrial production can increase wastes. Continued heavy reliance upon command and control, end-of-pipe or specified regulatory compliance requirements on a single-medium, single-point source basis can adversely impact the development and deployment of the cleaner technologies. One instance in which this can occur is when a facility wishes to completely eliminate a point-source air emission by installing a new process, but receives no emission credit for use elsewhere in the facility for reducing emissions well below standards required by regulations. Cleaner technologies are expected to play a crucial role in achieving reductions in pollution sources. Small- and medium-sized enterprises find it difficult to compete, comply with regulatory requirements, and invest in the development of cleaner technologies.

1.2.2 How can EPA best respond to increasing societal pressures for the redevelopment of urban industrial sites and remediated land while serving urban needs for environmental protection?

> **The scarcity and high cost of land in urban areas, coupled with increasing urbanization of the U.S. population, will increase the pressure to redevelop abandoned industrial sites and remediated land. Therefore, the EEC recommends EPA consider policies that encourage efficient and timely redevelopment of such sites in an environmentally responsible manner that prevent adverse exposures. Such policies have the potential to improve the quality of the urban environment, promote commerce, and postpone or reduce development of other land resources.**

Many of the abandoned industrial sites and remediated land, which are not used currently, will need to be redeveloped for use by the growing population in metropolitan areas. Due to perceived and/or real risks in using these lands, redevelopment of these sites is not currently occurring at a pace appropriate for future needs. There is a need to examine both the technical and the policy issues so that redevelopment of these lands can be achieved without adverse exposures to contaminants. EPA has the opportunity to make a concerted effort to formulate policies and develop technical support schemes for integrating site redevelopment issues into current and future regulatory actions.

1.2.3 How can the Agency prepare to address threats posed to human health and natural resources by transient phenomena of natural origin in the face of increasing population and land use pressures?

Transient phenomena, such as riverine floods, can adversely affect the environment and public health much more than do steady state situations. Changes in demography likely will increase the number of people affected by such phenomena. Associated planning can prepare and minimize the potential adverse impacts on natural resources and human health. Therefore, the EEC recommends that EPA strengthen its capability and readiness to address potential environmental consequences of natural disasters associated with such transient phenomena and assume a participatory role with other responsible agencies.

In the absence of significant global climate change, there is no evidence that the frequency of natural disasters will differ significantly in the future from that of past occurrences. However, population growth, capital investment, and increased intensity of land use and management in affected areas have led to significantly increased potential for damage caused by natural disasters.

Recent events, for example, hurricane damage and extreme cold weather in the eastern seaboard states; earthquakes, wild-fires and mudslides in western coastal regions; and unprecedented flooding in central and southeastern regions of the country, all severely impacted human health and the environment. Given increasing intensity of land use and population growth in susceptible areas, potential consequences could be severe unless means to anticipate, prevent or mitigate the environmental consequences of natural disasters are established. In its review, the EEC found little evidence that the environmental aspects of natural disaster events are being comprehensively addressed in a prospective and coordinated manner.

1.2.4 How can the Agency address insufficiency in the core technical competencies needed to address both existing and future environmental challenges? Core competencies can be defined as the essential and distinct scientific and technical capabilities that enable the EPA to fulfill its current and future missions.

Core competencies are the essential and distinct scientific and technical capabilities that enable an organization to fulfill its current and future missions. In the future, the Agency will be under increasing pressure to address more efficiently multi-media pollutants from all sources. The Agency also will be required to respond faster and effectively to broader environmental issues with limited total resources. Therefore, the EEC recommends EPA systematically identify its essential core competencies to do this work and strengthen them where needed.

Responding to legislative mandates is necessary, but will become increasingly difficult if maintenance and improvement of the underlying in-house core competencies are neglected. Regarding future challenges, EPA should examine present technical core competencies in light of its understanding of future needs and, as warranted, modify and/or augment present capabilities so that EPA will have the necessary internal expertise to address future needs.

1.3 Other Possible Scenarios

Using part of the Lookout Panel approach described in Section 3.3.3 below, the Committee identified eight additional concerns about the future to which EPA should give serious attention. These are:

a) Will fossil fuel depletion lead to use of resources having a greater potential for environmental contamination and habitat loss?

b) Will major industrial accidents and/or terrorist activities impacting the environment become major problems for the Agency to address?

c) Will deterioration of urban infrastructure (pipelines for water, sewage, and fuels) increase the potential for serious environmental incidents?

d) Will recognition of the high cost-benefit ratio of some environmental management strategies lead to challenges of EPA's programs?

e) Will environmental contaminant sinks, such as contaminated sediments, be recognized as posing greater risk than existing point-discharges?

f) Will conventional technology for the control of newly recognized pathogens in drinking water be found to be inadequate?

g) Will electromagnetic radiation become widely recognized as a major health threat as new technologies increase sources and exposure, and/or if evidence for adverse effects accumulates?

h) Will industrial-ecology concepts lead to misuse of wastes by industrial/commercial sectors that cause more exposure problems than solutions?

1.4 Lessons Learned on Methodology

The EEC became acquainted with various futures methodologies as it developed this report. Based on this experience, the EEC recommends to EPA a candidate future issues analysis approach that could be used to conduct continual scans of the environmental horizon. The EPA should set up "Lookout Panels" in areas of health, ecology, socioeconomics, and technology. Panelists would periodically provide observations about new or intensifying issues. After interaction and analysis, recommendations for near-term EPA actions would be developed.

In this regard, EEC and EEC consultants served as principals in a test exercise for the approach. Section 3.3 identifies screening elements for the suggested futures approach that emerged from the test exercise.

Because many future developments pose environmental threats, the EEC encourages EPA to further develop and implement methods for systematically scanning the environmental horizon. Such methods will help EPA identify important challenges at the earliest possible time, and could improve EPA readiness both with regard to its ability to anticipate problematic issues and, as necessary, to adopt appropriate strategies aimed at preventing or mitigating possible adverse consequences.

2. INTRODUCTION

2.1 The Charge

A July 16, 1993 memo from Mr. David Gardiner, Assistant Administrator for the Office of Policy, Planning and Evaluation (OPPE) to EPA Administrator Carol Browner requested that the Science Advisory Board (SAB) assist in the continued development of EPA's capacity to anticipate environmental problems, issues and opportunities.

The SAB accepted the request, and formed an Environmental Futures Committee (EFC) to lead the effort. The Futures Project appeared to be a logical extension of the SAB's 1990 report, Reducing Risk (EPA, 1990), which stressed the importance of identifying future potential risks to human health and the environment.

The Environmental Futures Committee asked all the SAB Standing Committees to assist with this effort by developing their own approaches, using scientific and technical expertise to:

a) evaluate baseline information and trends, identifying issues that may be expected in the future to have increasing impacts on human health and the environment;

b) focus on one or more relevant issues; and

c) suggest a procedure by which future environmental concerns can be recognized at an early stage.

2.2 Committee Process

At its October 28-29, 1993 meeting, as described in Section 3, the EEC first conducted a brainstorming session and then narrowed their deliberations to three technical issues. A fourth, cross-cutting issue was added later, as was a commentary on methodology. Initial writing assignments and schedules related to completion of a draft report were established. Designated authors prepared reports which addressed drivers, scenarios, consequences of scenarios, and mitigation of potential impacts. Initially a subset of the EEC, the Environmental Futures Writing Subcommittee (EFWS), was responsible for drafting the report. However, as interactions with the EFC progressed, the report changed to an extent that it became a product of the entire EEC.

The EEC then held three publicly announced conference calls followed by public meetings in February and March, 1994. At these meetings the EEC identified elements for the composite report, summarizing the process, outcomes, and recommendations. (The EEC members and involved consultants are shown in the roster at the front of this report.) The EEC approved the assembled report and submitted it to the EFC for review and vetting on behalf of the SAB Executive Committee.

2.3 Coordination

Close coordination with the EFC was achieved by participation of the initial writing-group chair and vice-chair in EFC meetings where they interacted with invited "futurists" and other experts. Coordination with OPPE was achieved by inviting representatives to attend EEC meetings and participate in conference calls.

3. OUTPUT OF THE PROCESS

3.1 Methodology

After considering a number of options, the EEC settled on an approach to its Futures Project which led to relatively rapid issue selection and a period for preparing and discussing reports on the selected issues. The remainder of Section 3.1 discusses the EEC's initial approach.

3.1.1 "Expert panel" Approach and "Brainstorming"

On October 28, 1993, the EEC identified future challenges with as-yet unanticipated consequences. The discussions were free ranging, i.e., not restricted to specific committee expertise. On October 29, 1993, after an opportunity for reflection and further thought, the EEC re-visited the initial brainstorm list. Using the collective expertise of the EEC, members developed an unprioritized listing of issues that could present future challenges with possible surprises to the Agency.

Subsequently, and with the help of a consultant more familiar with futures work, the EEC ultimately arrived at--and recommends to others--a related, but methodologically more formal, approach for issues selection, the elements of which are discussed in Section 3.3 of this report.

3.1.2 Narrowing the List of Issues

Recognizing practical limits of time, expertise and resources, the EEC developed the following "filtering" criteria to establish a set of issues to address via subtask writing assignments:

a) Is this a new issue? (i.e., likely to necessitate new actions or changes in what EPA is now doing)

b) Is the issue credible?

c) Does the issue focus on science/technology that can be effectively addressed by expertise of the EEC?

d) Are there critical uncertainties that should be addressed?

e) Is the impact of the issue potentially large?

f) Are potential consequences understood?

g) Is the current infrastructure of environmental protection adequate to address the issue?

h) Is the issue redundant to others on the list, or can common issues be categorized into one topical issue that includes the original issues?

By aggregating common issues under broader subject categories, applying screening criteria, and further discussion, the EEC narrowed the original brainstormed list to three. A fourth was added at the time of the first Subcommittee conference call.

a) Issue #1: EPA's actions that could foster environmental quality protection and improvements while assuring the sustained industrial development in a competitive manufacturing economy.

b) Issue #2: EPA's best response to increasing societal pressures for the redevelopment of urban industrial sites and remediated land while serving urban needs for environmental protection.

c) Issue #3: EPA's preparedness to address threats posed to human health and natural resources by transient phenomena of natural origin;

d) Issue #4: EPA's need to regularly evaluate core technical competencies to address both existing and future environmental challenges. Core competencies are defined as "the essential and distinct scientific and technical capabilities that enable the EPA to fulfill its current and future missions".

The EEC did not attribute an over-arching, prioritized importance to the four selected issues to the exclusion of other potentially significant environmental issues related to engineering and technology. Hence, the EEC recognized that there no doubt are other issues of considerable importance to the Agency which could have been addressed. Indeed, in the latter stages of its work, the EEC identified eight additional future scenarios related to technology which should be of concern to EPA (Table 4). A more comprehensive analysis and assessment by EPA, beyond the scope of this effort, would be necessary to establish national prioritization of these and other possible technological issues.

3.1.3 Trends, drivers, scenarios, consequences and mitigation analyses

A single author, at times using some material supplied by others, prepared background reports for each issue. In developing the reports, authors relied on their own expertise, consultations (with Agency staff, other SAB committee members, and committee consultants), literature resources, Agency assistance (material resources), and other resources.

Attached as appendices are the individually authored background papers on each major issue discussed in this consensus portion of the EEC report. This material was most useful in providing a starting point and stimulating ideas. The EEC incorporated part, but not all of the concepts presented in the appendices in this consensus report.

Appendix 1: Manufacturing Sustainability by Dr. Walter Shaub

Appendix 2: Redevelopment of Industrial Sites and Remediated Land by Dr. Hilary I. Inyang and Lynne Preslo

Appendix 3: Transient Phenomena by Dr. Frederick G. Pohland

Appendix 4: Core Competency by Dr. Wm. Randall Seeker

Appendix 5: Futures Methodology by Mr. Theodore J. Gordon

The efforts of these authors are very much appreciated.

The authors examined the issues in terms of drivers and trends associated with drivers. (Information about drivers and trends specific to each issue can be found in the appended individual reports.) Authors used these drivers and trends to construct futures scenarios, expose consequences, and suggest methods of mitigation.

a) Drivers: identification of drivers (e.g., rate of waste generation) that lead to potentially adverse human health and environmental impacts. The authors identified drivers for each of the issues.

b) Trends: an analysis of current trends in activities that relate ultimately to impacts to human health and the environment. The analysis of each issue included an examination of current trends, and, via scenario development, an examination of possible future trends.

c) Scenarios: models of plausible "futures" (e.g., what if current waste generation rates continue unabated?) and possible impacts that can arise due to the influence of drivers. Because the construction of highly detailed scenarios that fully incorporate all possible drivers is an extremely complex, subjective and time-consuming undertaking, authors abstracted scenarios from literature resources or constructed more simplified scenarios that were exemplary of possible drivers.

d) Consequences: consequences that arise due to potential impacts (e.g., unchecked contamination of land by generated wastes). To the extent time and effort permitted, EEC authors carried out consequence analysis, suggesting possible outcomes of various scenarios.

e) <u>Mitigation</u>: analysis of potential impacts in order to identify means to mitigate undesired consequences (e.g., means to prevent waste generation). For mitigation analysis, EEC authors drew both on the expertise of EEC members and consultants, as well as literature resources.

3.1.4 Guidance

The authors configured and analyzed scenarios using the following EEC guidelines.

a) Develop/utilize scenarios "possible" in a 5- or 30-year time frame and for which Agency management preparation, if desirable, is a reasonable expectation. For example, in the case of "transient phenomena" there is no point in evaluating a scenario that envisages the EPA having to deal with environmental consequences of a large asteroid impact upon earth, as the consequences cannot be reasonably addressed by EPA.

b) Scenarios should be "new", i.e., they should be representative of circumstances that could lead to environmental challenges that the Agency has not yet adequately addressed or would not likely consider at this time.

c) There should be logical reasons for constructing one scenario and not another. The basis upon which the scenarios have been constructed should be described and defensible. For example, examination of currently available information concerning various driving variables may be the basis for constructing scenarios.

An alternative approach may involve use of heuristic reasoning, "scientific intuition" or some other plausible basis.

d) For each scenario constructed and evaluated, possible impacts that could pose hazards to human health and the environment should be identified. These impacts should be examined to understand possible consequences that may arise when and if the impacts occur.

e) Ultimately, through construction and evaluation, scenarios should be able to reveal the readiness, now and/or in the future, of the Agency to implement desirable management practices that can mitigate or reduce adverse consequences or produce benefits associated with the selected scenarios.

3.2 Results

The discussion below summarizes the issues studies.

3.2.1 Issue #1: Environmental protection and manufacturing sustainability

In its analysis, the EEC addressed both "sustainable development" that does not lead to degradation of environmental quality and environmental protection that does not lead to industrial uncompetitiveness. Governments at regional, national and international levels--and the private sector--are responding to the challenge of sustainability by looking for ways to address increasing threats to environmental quality and industrial competitiveness--both in the near- and long-term.

3.2.1.1 Scenarios and drivers.

For this analysis, the background paper used by the EEC relied heavily on Government Policy Options to Encourage Cleaner Production and Products in the 1990s, particularly the following text, which identifies key measures of sustainability (OECD, 1992).

> "...the goals of industrial policy can be achieved while at the same time improving (or at least maintaining) environmental quality and respecting the finite nature of the resource base as a function of time. In a national context, **key measures** of sustainability would appear to be as follows:
>
> - GDP per capita in constant currency units to increase over time;
> - ratio of GDP per capita to the quantity of a contaminant of interest (e.g., NOx in the air, generation of organic liquid wastes, inorganic heavy metals in water or products, pesticides in soils, etc.) to increase over time at a greater rate than GDP per capita over time, and the contaminants of interest should decrease in absolute terms;
> - the use of various raw materials (e.g., wood, water, iron ore, oil, coal, etc.) to be such that their depletion over time is reduced to an environmentally justifiable minimum;
> - output of marketable goods and services per employee (labor productivity) to increase as a function of time;
> - total job creation to increase over time; and

- industry to be able to retain or improve its competitivity with time if and when all of the foregoing conditions are met"

Appendix 1 examines the current situation, trends based on the current situation, future scenarios based on possible future trends, the concept of sustainability, and issues and challenges faced by the manufacturing sector of industry and regulations. To explore future possible environmental problems that pose challenges to realizing sustainable development, the author examined three scenarios by comparing output data that described hazardous waste generation over a period of several decades. One scenario assumed constant hazardous waste intensities, a second assumed a high peak and fall off to a constant level, and a third had a lower peak due to the poorest countries employing the cleanest of existing technologies. Appendix 1 contains details.

A key finding was that to benefit both the environment and U.S. industrial competitiveness in the global marketplace, Agency decisions concerning clean technologies need to be carefully constructed and balanced. One option found to be successful within the OECD is negotiated compliance. In the U.S., this could include consideration of risk-reduction goals based on a multi-media, entire-facility basis. Carefully conceived EPA efforts to conserve resources and protect human health and the environment, and at the same time promote clean technologies, production processes, and products, could meet both desirable regulatory objectives and enhance U.S. industrial competitiveness.

3.2.1.2 Discussion.

The EEC subscribes to the findings and recommendations of <u>Reducing Risk</u> (EPA, 1990). Its recommendations here should be read in the context of a desire to foster risk reduction through pollution prevention, which includes cleaner technologies.

Assuring environmental protection solely by the management of wastes generated in the future poses significant problems for the Nation; mitigation requires the development and deployment of cleaner technologies. The U.S. relies heavily upon command and control, end-of-pipe, specified compliance oriented regulations. For reducing current emissions, continuation of this practice can lead to expending more resources to achieve the same degree of protection then would be needed if waste generation were reduced through the use of cleaner technologies. Implementation of clean technologies should be encouraged by specific incentives.

In the global marketplace, the U.S. share of end-of-pipe environmental control technology is increasing. Data are not available to determine whether the U.S. is having analogous success promoting cleaner technologies and production processes (OTA, 1992). However, small- and medium-sized businesses, which form a substantial segment of the manufacturing industry, are experiencing growing difficulties competing in the international marketplace.

EPA could adopt a strategy for environmental protection that emphasizes the primacy of risk reduction, appropriate regulatory flexibility, willingness to negotiate expectations among all stakeholders, and opportunities to improve competitive positioning of American manufacturing industry in the global marketplace. EPA might choose to negotiate more fully on how an industry will meet risk-based levels, recognizing that an industry ought to have maximal expertise about its own processes. For U.S. industries, the outcome of such a strategy could be improved market share, strengthened ability to mitigate future environmental threats, and promotion of source reduction. Ultimately, environmental policy should recognize that the nation's environmental and economic health are interrelated.

In all three scenarios analyzed by the author of Appendix 1, the quantities of waste generated increased and it was difficult to achieve sustainability because:

a) The complexity, diffuseness and uncertainty of risks associated with manufacturing technology, production processes and products are increasing and the marketplace has globalized; and

b) Present trends in regulatory activity (e.g., single-media, "brightline" standards for each source) could place U.S. industry in a less competitive position in the future, with concurrent loss of jobs and ability to renew capital stock needed to acquire cleaner technologies and production processes (OECD, 1992; OTA, 1993; EPA, 1992).

EPA should consider establishing a vision of sustainability and adopt a creative approach that both demands appropriate environmental performance and promotes cleaner technologies.

3.2.1.3 Possible Agency Actions

To establish such a vision of sustainability, EPA could consider some of the ideas for policy options discussed in the documents used in preparation of Appendix 1:

a) Government Policy options to Encourage Cleaner Production and Products in the 1990s, Organization for Economic Cooperation and Development, Paris, 1992

b) Improving Technology Diffusion for Environmental Protection, NACEPT, EPA, Washington, DC, 1992

c) Industry, Technology and the Environment - Competitive Challenges and Business Opportunities, OTA, Washington, DC, 1993.

3.2.2 Issue 2: Redevelopment of industrial sites and remediated land.

The potential exposure of each segment of the U.S. population to undesirable environmental stressors is location-specific. Therefore the rate of growth and spatial distribution of population within a given region have indirect influences on environmental exposures to various sources of pollutants. Present trends in urban land use restrictions will increase pressure to use abandoned industrial and remediated sites. The prospect of human activity and occupancy at such sites raises environmental and human health concerns.

Appendix 2 examines the current situation regarding abandoned industrial sites and remediated land use, Agency regulatory policies and practices, trends in redevelopment, future scenarios based on possible future population trends, issues and challenges faced by urban planners in addressing land use requirements, and the nature of and means to encourage appropriate redevelopment.

3.2.2.1 Scenarios and Drivers

Two scenarios were investigated. The major driving factors for/against land redevelopment are population increase, socio-economic trade-offs, legal liability, risk acceptability, and advances in technology.

In Scenario 1, inner city dwellers migrate to suburban areas and greener sites. The driving factors are infrastructure decay in inner city areas, increase in crime rates that may be influenced by higher unemployment rates in densely populated centers, and greater availability of white-collar employment opportunities in suburbs. This scenario assumes that the middle class will flee inner city areas to greener outskirts.

In Scenario 2 the population of inner cities increases much more rapidly, while the suburbs experience only moderate population increases. The driving factors are high levels of immigration and high birth rates for population segments in the low income bracket. New residents will initially prefer to settle in large urban areas, where unskilled labor is still in high demand relative to rural and suburban areas. Despite the expected increase in inner city population, the mobility of residents to the suburbs could be impeded by their lack of white-collar skills and financial resources.

The two scenarios each promote the redevelopment of abandoned industrial sites and other sites that are classified as being contaminated. However, the interactions among the driving factors are different. It is possible to construct other scenarios, including ones which are more optimistic about the quality of American urban life, but these two were the only ones addressed by the EEC.

A key finding was that the Agency should ensure that appropriate technology is available and/or deployed to redevelop urban contaminated industrial sites and remediated land; this should be done in a manner that avoids problem environmental exposures and meets intracity needs for development, commerce, and conservation.

3.2.2.2 Discussion

This section briefly discusses the major driving factors for land redevelopment: population increase, socio-economic trade-offs, legal liability, risk and advances in technology. More detail is found in Appendix 2.

The Census Bureau's lowest series estimate of U.S. population for the year 2030, the time frame which corresponds reasonably to the Futures Project analysis period, is 287 million. United Nations estimates show that the percentage of global population residing in cities of 4 million or greater is expected to grow from 15.8 per cent in 1985 to 24.5 in 2025. Similarly, the Census Bureau indicates that in 1990 roughly one-third of Americans lived in central cities, one-third in suburbs, and one-third in rural areas. It appears that a moderate influx of new residents into metropolitan areas and high birth rates among urban residents could cause acute scarcity of space in the cities.

Market forces will play a significant role in land redevelopment in urban areas. Redevelopment activities usually revitalize industries such as construction, insurance, hardware sales, and road construction. Such revitalization leads municipal governments to cherish increases in construction because it reduces unemployment rates. Therefore, municipal governments sometimes use incentives such as tax breaks to retain companies and attract new ones. When municipal governments consider urban infrastructure improvement projects, "enterprise zones", and the assessment of options for promoting sustainable reuse of abandoned industrial sites, closed military bases, and other government property, they also consider policy options involving changes in zoning codes and regulations, lending and insurance practices, and future liability responsibility.

Currently, liability concerns discourage potential developers from purchasing contaminated land for subsequent redevelopment. Some recent state and federal legislative proposals and judicial decisions indicate that liability concerns, which currently impede the transfer and redevelopment of former industrial sites and other types of contaminated land, may wane within the next 30 years.

At the present time, "health-based" cleanup standards have not been achieved in a cost effective manner for soil and groundwater at many contaminated sites. Most types of technology and techniques employed are relatively new, and uncertainties remain. The EEC's position is that the risks to workers in redeveloped facilities and to residents using remediated land should not be increased by the push for redevelopment, rather, that cost-effective technology be applied/developed to reduce exposure and thereby achieve the desired low-risk levels. Exposure can be reduced by clean-up, barriers, and use restrictions.

The Agency needs to review and revise, as needed, current exposure and risk assessment methods for adaptation to redevelopment scenarios. Regulatory agencies also should recognize that there may be different and possibly fewer pathways of exposure and risk at redeveloped inner-city and industrial sites. For instance, since a public water supply is reliably provided, the ground-water pathway may not be of concern at such sites.

3.2.2.3 Possible Agency Actions

Appendix 2 makes recommendations about data needs on site inventory and spatial distribution, site redevelopment and city/regional planning, exposure assessment and site cleanup levels, engineering mitigation schemes for structures, education, research, and in-house expertise. Information gaps are presented in Table 1.

Table 1: Urban Redevelopment Information Gaps

a) Availability of data on population and spatial growth patterns of U.S. cities.
b) Availability of data on the number and distribution of both closed industrial sites and remediated land relative to large population centers.
c) Availability of centralized information resources on liability laws and trends relevant to site redevelopment.
d) Existence of comprehensive schemes for integrating site redevelopment into city and regional plans.
e) Existence of federal policies with adequate latitude for local jurisdictional controls on redevelopment.
f) Availability of technical schemes and research data for addressing issues such as residual contaminant migration, exposure and risk assessments for site redevelopment, relevant cleanup standards, foundation systems in residually contaminated land, occupational health and safety, and environmental equity.
g) Availability of expertise within the EPA to address these issues.

3.2.3 Issue 3: Transient Events

Whether of meteorological or geological origin, natural disasters cause damage to the environment with the extent of damage being directly linked to population, land use practices and structures. A transient phenomenon (e.g., earthquake, wildfire, volcanic eruption, landslide, flood, hurricane, rain storm, tornado, heavy snowfall, etc.) may convert a hazard into an ecological or health and safety catastrophe.

The magnitude and intensity of disaster events are often measured in terms of human health and welfare, as well as environmental perturbations, a domain shared by EPA with other agencies. Appendix 3 addresses issues related to Agency responsibilities and preparedness, primarily in response to anticipated environmental threats posed to human health and natural resources by transient phenomena, vis-a-vis analysis of a selected subordinate - challenges posed by riverine floods.

3.2.3.1 Scenarios and Drivers

Two scenarios were investigated. Scenario 1 assumed that a riverine flood of significant magnitude posed serious environmental threats to a large (or smaller, but intensively utilized or high population density) area occurs under circumstances in which governmental units have not effectively established necessary capability (preparedness) to address the problems and potential consequences. Threats considered in a natural hazards sequence include landslides, debris impacts, erosion, impacts to power supplies, damage to underground utilities, disrupted water supplies, chemical and other contamination, and sewage releases.

The second scenario was essentially the same as the first, except that some level of preparedness at the national level by EPA was presumed. The choice of scenarios was intended to bring out a sense of the nature and potential severity of consequences.

Appendix 3 uses a natural hazards sequence tree to relate disaster events, e.g., intense thunderstorm, to subsequent natural disaster phenomena, e.g., riverine flood, and to ensuing adverse environmental impacts, e.g., contamination of water resources. This analysis was coupled with a detailed examination of pertinent literature concerning actual and potential opportunities to establish and implement appropriate strategies to prevent or mitigate impacts of natural disasters.

A key finding was that environmental consequences of natural disasters, such as riverine floods, are not being adequately addressed by established response protocols and definition of interagency responsibilities. EPA should consider analyzing the serious environmental challenges posed by natural disasters, clearly identify its responsibilities in this area, and proactively develop a program that can anticipate, prevent or mitigate threats to human health and the environment for implementation by collaboration with appropriate agencies.

3.2.3.2 Discussion

Although taken as a whole, there is no evidence that the frequency of natural disasters will differ significantly in the future from that of past occurrences, population growth, capital investment, and increased intensity of land use and management in vulnerable areas have led to significantly increased potential for damage caused by natural disasters. Indeed, steady stressors, such as leachate from a waste disposal site, have received more attention than have the consequences of such natural incidents, largely because they frequently have recognizable and manageable spatial and temporal dimensions.

Recent events, for example, hurricane damage and extreme cold weather in the eastern seaboard states; earthquakes, fires and mudslides in western coastal regions; and unprecedented flooding in central and southeastern regions of the country severely affect human health and the environment. Given increasing intensity of land use and population growth in susceptible areas, potential consequences to the health and environment could be severe, unless means to protect these areas from natural disasters are established.

A National Research Council Report (NRC, 1991) proposed a multidisciplinary program for the government without explicitly defining a role for EPA (There was no EPA representation in the report's development.). The EEC finds that in the area of protection of natural resources, research to improve prediction of hydrologic hazards and impacts on human and natural resources, and coordination and standardization of data collection stand out as potential initiatives related to the mission of EPA.

The EEC recommends that EPA consider proactively addressing the environmental threats posed by natural disasters. Benefits that should be sought include: reduction in life and property losses; marginal land rehabilitation, zoning and conversion; safeguards against transient outcomes, e.g., flood-derived contamination and its micro- and macro-scale effects; provisions for developing hazard-specific data bases and guidance to the public and private sectors; catalysis of research and development for innovative remedial and preventive technologies; and improvement and use of EPA's capabilities as an important contributor to reducing adverse health and environmental impacts of natural disasters and promoting protection for at-risk natural and human populations.

3.2.3.3 Possible Agency Actions

To strengthen its overall state of readiness, EPA could adopt some or all of the options discussed in Appendix 3. Table 2 presents some example options.

Table 2: Example Agency Actions Related to Transient Events

a) Establish an overall vision of a proactive program aimed at addressing environmental threats posed by natural disasters.

b) Obtain data for analyses that address environmental and human health and welfare aspects of hazards. Such data should support risk assessments, mitigation and prevention, emergency response, prediction and warning. Data acquisition, validation, education and technology transfer could be established at EPA.

c) Undertake an internal Agency-wide evaluation of current capabilities related to policies and associated programmatic efforts aimed at mitigating environmental threats posed by natural disasters.

d) Analyze programs external to the Agency and identify relevant programmatic aspects of external programs that can interface, complement or supplement internal agency efforts.

e) Catalyze environmental disaster prevention and preparedness strategy among government agencies. As necessary, expand Agency capabilities and activities where current capabilities prove inadequate.

3.2.4 Issue 4: Core competencies

An important cross-cutting issue that emerged is the Agency's readiness to address technically foreseeable events that fall within the mission of the Agency. Specifically, the concept of "core competency" emerged, as defined below:

> The core competencies are the essential and distinct scientific and technical capabilities that enable EPA to fulfill its current and future missions. Having core competencies supports EPA's ability to approach regulations in an integrated, efficient, cost-effective and harmonized manner and to address multi-pollutant and multi-media problems with the limited resources that will likely be available to the Agency.

Appendix 4 provides commentary concerning the need, in the context of environmental futures, for the Agency to systematically identify, examine and appraise core technical competencies. Core EPA engineering examples might be competency for: the improved design and operation of water and wastewater treatment facilities or hazardous waste incinerators and better modeling of pollution transport through groundwater, surface waters, air, or the food-chain.

More complete listings can be found in the SAB document Future Risk (EPA, 1988).

> A key finding is that EPA should systematically identify its core competencies and strengthen them where needed.

3.2.4.1 Scenarios and Drivers

EEC did not use scenario and driver analyses for this issue, rather it drew on the experience of its previous activities.

3.2.4.2 Discussion

In the course of many reviews, the EEC has observed the excessive reliance of EPA staff on contractors in areas of science and technology that seem to be in areas of core competency. The need to attend to increasingly complex, lengthy, and heavily compliance-oriented legislation may have placed a heavy burden upon the Agency. Agency attention is, therefore, focused on the development and implementation of regulations at the expense of maintenance and improvement of in-house core competencies.

There are advantages--regarding both present and future environmental issues--to attending to both regulatory activities and underlying technical requirements. With regard to future challenges, the Agency could undertake a careful examination of technical core competencies and, as warranted, modify and/or augment present capabilities, leveraging across other governmental and private sector activities where appropriate.

3.2.4.3 Possible Agency Actions

To enhance core competence for present and future needs, EPA could consider adoption of some or all of the policy options discussed in Appendix 4 and summarized in Table 3. In general, EEC considers it advisable for the Agency to systematically identify and examine its technical core competencies and make a determination regarding the adequacy of present resources judged against those competencies needed to address both existing and future environmental issues.

Table 3: Example Issues Related to EPA Core Competency

a) As the lead government regulatory agency responsible for protection of the environment, the EPA must, at a minimum, be able to comprehensively address technical aspects of complex environmental issues through strength in core competencies and ensure the technical merits of regulatory activities.

b) EPA should identify and assess for gaps the adequacy of those technical core competency components already in place within the Agency in relation to strategic direction and guidance, as well as emerging issues.

c) A critical element of core competencies is Agency research programs. Emphasis should be placed upon those activities which enable the Agency to: (1) identify key environmental indicators; (2) obtain sound scientific and engineering data; (3) ensure the availability of critically needed, monitoring capabilities; and (4) promote the development and deployment of cleaner technologies, production processes and products.

d) The realization of sound, technical core competencies can enable the Agency to catalyze innovation. Moreover, the realization and identification of core competencies can uncover partnership opportunities with other agencies, industry and academia.

e) Technical core research programs should be integrated by striving to: (1) provide the impetus for development and deployment of innovative cleaner technologies; (2) provide sound technical support regarding regulatory activities of the Agency; and (3) seek to anticipate, identify and productively respond to future environmental threats.

f) EPA needs to work to ensure the optimum (cost-effective, efficient, dependable, and timely) realization of EPA technical core competency requirements necessitated by Agency missions and strategic direction and guidance, taking into account available opportunities to interface, supplement or complement internal technical core competencies with technical competencies that are external to the Agency.

g) The exercise in competency development is not limited to analyzing capabilities and responding to future needs. Rather, it helps to choose investments in future programs wherein there is a higher potential of being successful. Simply put, the exercise provides another dimension for making decisions, i.e., opportunity.

3.3. A Futures Methodology Approach

The EEC learned by doing and in so doing found other approaches that could be usefully incorporated in future undertakings of this nature. The EEC arrived at and recommends the following future issues analysis approach for consideration for use by EPA.

3.3.1 Brainstorming and Criteria-based Selections

The EEC brainstormed to form an initial list of possible environmental engineering issues that might be addressed in the futures study. EEC used criteria to shorten the list to a few significant, representative issues for a more in-depth study. The EEC experience showed:

a) An expert committee process can identify potentially important future issues, but absent some constraining criteria, the list may include items of different levels of generality (e.g., domains of issues, generic issues, specific issues) that are difficult to compare.

b) Many of the items initially suggested for inclusion in the brainstormed list were, strictly speaking, not issues. They were, rather, domains within which any of a number of issues might be found. This led to a number of attempts to group issues and subsume others under more general headings.

c) The development of a formalized approach to score or weight issues is a challenging undertaking and should be pursued both with attention to all stakeholders and in respect to a need to harmonize the process.

Based on these findings, the EEC recommends:

a) Experts involved in brainstorming and/or scanning sessions should be carefully selected and should represent as comprehensive a range of experience as practicable. Expert participants in a brainstorming exercise, are in a sense, the eyes and ears of a "lookout" enterprise.

b) Participants should know the priority-setting criteria before they suggest future issues. Modifications to the proposed criteria set should be pursued until the set is harmonized. The following criteria could be used as an initial basis for development of a harmonized criteria set:

   <u>Scope</u>: If the issue develops, might it affect many people or a few? All other things being equal, one issue may be more important than another if it affects more people.

   <u>Severity</u>: If the issue develops, might its effects be severe (the most severe effect being death or a species loss)?

   <u>Novelty</u>: Is the issue new, or has it already received considerable attention?

Plausibility/probability/certainty: How might the issue develop? What are its chances of developing?

Uncertainty: Are there crucial uncertainties that make an issue important?

Irreversibility: If the issue is not addressed, might its consequence be (largely) irreversible?

Imminence: Is the issue imminent? All other things being equal, a near-term problem is more important than a longer-term one.

Visibility: Is the issue in the public eye? What are the ramifications for addressing the issue?

c) Possibly, in some negotiated and agreed-upon manner, criteria can be weighted. This weighting should be discussed before the actual nomination of issues. As there is considerable disharmony regarding the merits of weighting schemes, it is essential to eliminate or at least minimize subjectivity in weighting decisions to the maximal extent practicable.

d) An alternative approach contemplates that items in the issues list be categorized more loosely, e.g., as high, medium or low priority.

e) To improve the efficiency of the process, when an expert (or stakeholder) panel is asked to nominate issues, the usual rules for brainstorming should be adjusted; rather than opening up the discussion for whatever anyone has to say in any form, the group should be given some structural (not content) guidance. For example, the instruction:

"Please suggest important future issues for EPA. Limit your response to your own experience and background in making these suggestions. Consider the criteria (listed). Please frame your input in the form of an issue rather than a domain, and include a principal consequence in your statement."

f) To mitigate influences of one individual upon another, to the extent possible, suggestions and discussions concerning candidate issues should allow for anonymity. However, some process should be established to resolve ambiguities concerning the meaning or ramifications of individual statements concerning issues.

g) As challenges to the Agency have a dynamic character (new observations and knowledge gives rise to new imperatives), the process of issue development should be repeated at intervals of six months, a year, or some other practical time frame.

3.3.2 Selecting an Approach

If EPA undertakes futures analyses, it may wish to consider the following:

a) To realize their full potential, scenarios, particularly quantitative scenarios, involve great complexity and much time-consuming effort to construct. [NB: Such an undertaking was beyond the scope of the present initiative.] Scanning the environmental horizon by "look out" panels may be a more practical way to get a quick start.

b) In an Agency-wide undertaking, EPA can use scenarios, for example: to trace chains of causality leading to the present; to explore unique future developments and their consequences; to examine the implications of action or inaction and the ranges of possible outcomes; to explore the roles of all stakeholders; and, perhaps most importantly, to further stimulate imagination.

c) The "natural hazard sequence" diagram included in the transient phenomena appendix illustrates an approach to scenarios that has the benefits of displaying the full array of impacts flowing from a single cause, visually presenting the decision "branch points" at which policy intervention may be possible.

d) The methodology used in the present exercise, although placing less emphasis on scenario utility, can be viewed as a prototype for an Agency "expert lookout panel," i.e., in which experts are asked, systematically, to identify important future issues, to select those that appear to be most important through succinct and well-defined screening criteria, and to study those of high priority. Based on the present exercise and retrospective examinations of the process, the Subcommittee recommends a framework for a second generation approach which the Agency might implement as a possible future issues analysis paradigm.

As outlined below, the Agency can design and implement a "lookout" system for detecting and analyzing incipient future developments that might threaten the environment or provide new policy opportunities for the Agency. The Subcommittee suggests that the system, at a minimum, have the following characteristics:

a) draw input from a wide range of sources, considering diversity;

b) operate in a continuous rather than a "one-shot" mode;

c) have a memory, so that suggestions that are set aside today for lack of data or interest can be reassessed in the future;

d) be quantitative, wherever possible;

e) be subject to scrutiny by people outside of the process;

f) have explicit goals; and

g) recognize that many futures are possible.

3.3.3 A Candidate Futures Issues Analysis Approach

One approach would be for EPA to set up "Lookout Panels" in areas of health, ecology, socioeconomics, and technology. Each panel would have some cross-discipline representation. In addition,

a) The process would be conducted by EPA staff, but involve experts within and outside the Agency.

b) Panelists would be contacted periodically to scan their fields and provide observations about new or intensifying issues and their consequences.

c) These observations would be collected and fed back to the other panelists for comment.

d) Candidate issues would be screened against agreed-to criteria. Surviving issues would be analyzed versus any existing scenarios and EPA goal statements.

e) Recommended near-term actions for EPA based on project futures then would be developed.

3.3.4 Pilot Test of Issue Identification

The EEC conducted a test run of the early steps in the above Look-Out Panel Methodology and identified the issues listed in Table 4 for further evaluation by EPA.

Table 4: Additional Technology and Environment Concerns

a) Will fossil fuel depletion lead to use of resources having a greater potential for environmental contamination and habitat loss?

b) Will major industrial accidents and/or terrorist activities impacting the environment reach crisis proportions and become a major focus for the Agency?

c) Will accelerating deterioration of urban infrastructure (e.g., water, sewerage, fuels) increase the potential for serious environmental incidents?

d) Will the high cost-benefit ratio of some environmental management strategies become recognized by the public leading to challenges to EPA's programs? The costs of environmental mismanagement or nonmanagement could become more recognized by the public, thereby either increasing the demand for traditional command and control responses, possibly at the expense of new and innovative pollution reduction and elimination strategies, or decreasing already proven effective strategies.

e) Will environmentally contaminated reservoirs, such as contaminated sediments, be recognized as posing greater risk than existing point-discharges?

f) Will conventional technology for the control of newly recognized pathogens in drinking water be found to be inadequate?

g) Will electromagnetic radiation becomes widely recognized as a major health threat as new technologies increase sources and exposure, and evidence for adverse effects accumulates?

h) Will industrial-ecology concepts lead to use of wastes by industrial/commercial sectors that cause more problems than solutions?

4. SUMMARY AND RECOMMENDATIONS

4.1 Remarks specific to issues analyzed

For the four issues examined, the EEC developed the following serious concerns that need to be addressed by the Agency:

a) Agency decisions concerning clean production technologies need to be carefully constructed and balanced, so that there are benefits both to the environment and to U.S. industrial competitiveness. Flexibility in achieving the desired risk reduction at a facility could promote deployment of cleaner technologies to replace end-of-pipe control technologies.

b) The Agency needs to ensure appropriate technology is available and/or deployed to redevelop urban contaminated industrial sites and remediated land; this needs to be done in such a way that avoids significant exposures and meets intracity needs for development, commerce, and conservation.

c) The Agency needs to strengthen its capability and readiness to address potential environmental consequences of natural disasters associated with transient phenomena such as riverine floods considering trends in population growth and inappropriate land use. Associated planning and preparedness can help minimize the potential adverse impacts on natural resources and human health.

d) The Agency needs to systematically identify and examine the essential and distinct scientific and engineering capabilities (core competencies) needed to address technical aspects of its present and expected future mission and strengthen them where needed.

4.2 Other findings

a) "Lookout Panels" are recommended to EPA in areas of health, ecology, socioeconomics, and technology. Panelists would periodically provide observations about new or intensifying issues. After interaction and analysis, recommendations for near-term EPA actions would be developed. The EEC encourages EPA to improve further means for identifying issues of concern and establishing some agreed-upon criteria for assessing the relative urgency and consequential importance of action to address these issues.

b) The EEC, in its dry run of a portion of the Lookout Panel paradigm, identified another eight scenarios which may benefit from further analysis by others. They appear in Table 4 and should be evaluated by EPA in terms of likelihood, importance, and, if appropriate, mitigation.

4.3 General Remarks

The Agency is commended for its foresight in undertaking this initiative. It provided an opportunity to scan the future and attempt to anticipate potential environmental threats which may pose significant challenges to the Agency to address problems as they arise. Moreover, the members of the EEC thank the SAB and Agency Offices staff for assistance, resources and time commitments that have been useful in the conduct of this initiative.

The SAB/EEC initiative as carried out can serve as a pilot element for the development of a productive process for the Agency in future undertakings of this nature. Although members of the EEC found that scanning of possible futures was challenging, it was only tractable under circumstances in which its focus was limited to just a few issues. The downside of this limitation of the SAB's futures project is the prospect that some issues of importance have been inadvertently overlooked.

Should the exercise be taken up again by SAB, it would be helpful if SAB Standing Committees would interact more at the onset with all of the other SAB Standing Committees to enable cross-comparison of issues, criteria, approach, expertise, and resources. In this manner a more comprehensive integration of ideas, inclusion of areas of importance, and more efficient use of and access to resources, may be realized.

While the committee found forecasting to be a useful exercise in addressing specific issues, a concomitant detailed examination and analysis of current knowledge and historical and current trends is absolutely essential in order to arrive at a comprehensive view of environmental challenges and implications for Agency stance regarding both readiness and action options.

Regarding the issues it addressed, the EEC is encouraged by the prospect that the information generated may provide useful advice to the Agency. The EEC believes that progress aimed at addressing even a limited set of these options can enable the Agency to move towards an enhanced state of readiness and anticipatory posture with regard to future developments.

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Appendix 1: Manufacturing Sustainability

by

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Prepared for

U.S. Environmental Protection Agency
Environmental Engineering Committee
Futures Writing Subcommittee

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THE IMPACT OF STRIVING TO ACHIEVE SUSTAINABILITY ON A MANUFACTURING ETHIC

A. Introduction

The global community has begun to take the view in regard to sustainable development [1,2] that economic growth should progress under circumstances that do not lead to degradation of environmental quality. In response to the challenge to strive towards sustainable development, governments at regional, national and international levels and the private sector have begun to look both in the near- and long-term for ways to attack increasing threats to environmental quality.

This report examines the current situation, trends based on the current situation, future scenarios based on possible future trends, the concept of sustainability, issues and challenges faced by the manufacturing sector of industry and the U.S. EPA, the nature of and means to encourage development and deployment of cleaner technology, and possible options available to the U.S. EPA to bring about progress.

While the concept of sustainable development has been discussed by numerous individuals and organizations, it is not evident that there is a harmonized view of sustainable development. In relation to the imapct of striving to achieve sustainability on a manufacturing ethic, a suggested [3,4] expression of sustainability in a practical context is that:

> "...the goals of industrial policy can be achieved while at the same time improving (or at least maintaining) environmental quality and respecting the finite nature of the resource base as a function of time. In a national context, key measures of sustainability would appear to be as follows:
>
> - o GDP per capita in constant currency units to increase over time;
> - o ratio of GDP per capita to the quantity of a contaminant of interest (e.g., NOx in the air, generation of organic liquid wastes, inorganic heavy metals in water or products, pesticides in soils, etc.) to increase over time at a <u>greater rate</u> than GDP per capita over time, and

the contaminants of interest should ideally decrease in absolute terms;

- o the use of various raw materials (e.g., wood, water, iron ore, oil, coal, etc.) to be such that their depletion over time is reduced to an environmentally justifiable minimum;
- o output of marketable goods and services per employee (labour productivity) to increase as a function of time;
- o total job creation to increase over time; and
- o industry to be able to retain or improve its competitivity with time if and when all of the foregoing conditions are met"

In the long term efforts aimed at development and utilization of cleaner technologies in order to assure cleaner production processes and cleaner products are seen as a means to improve the prospect that environmental quality can be maintained or improved [3]. For the manufacturing sector of U.S. industry, the challenge of striving to achieve sustainability in the long term should lead towards the development and deployment of cleaner technologies, if while doing so, mechanisms are created to ensure that firms can remain competitive. In other words, in concert with an evolutionary shift in industrial posture, the U.S. EPA must adjust its regulatory stance in order to encourage cleaner production and products and to facilitate the introduction of cleaner technology in the manufacturing sector in a manner that does not harm U.S. industry competitivity in the global marketplace.

In the context of this report, cleaner technologies are to be understood as those technologies that can enable cleaner production and products. Cleaner production is meant [3] to reduce energy and natural resource dependent raw material utilization per unit of manufactured product output while at the same time, production, marketing and disposal of (cleaner) products takes place under circumstances in which undesirable environmental perturbations (for example, releases of potentially harmful contaminants) are held as low as practicable.

Factors that influence the development and utilization of cleaner technologies include [3,4]: government signals and actions; raw material, energy, transport and waste disposal prices; attitudes of management and labor, and public demand. Although market penetration at present has not been substantial, cleaner technologies are available, and efforts are underway to promote innovative development and subsequent implementation of newer generations of cleaner technologies [2-5]. Ideally, in a sustainable world economy, it is important [4] that these innovations should not be economically disruptive, e.g., do not impair the competitive position of those industries that perform in an environmentally responsible manner.

B. The existing situation and current trends

As an indication of the complexity of potential industrial impacts, it is reported [5] that:

- about 7 million chemical substances are known
- about 100,000 are available on the market
- these products and other substances (chromium, cadmium, etc.) are used in a growing number of consumption or production sectors: pigments for paints, lubricants, fertilizers, food additives, stabilizers, cleaning or anti-corrosion agents, solvents, medicines, etc.
- The US EPA lists some 500 substances as hazardous, but in practice scarcely more than 100 are covered by standards [NB the EEC list is about 30 items].

It is reported [5] that among developed nations, in spite of measures taken, not only the quantity, but also the toxicity and/or the complexity of wastes being generated have continued to increase, and its processing still places a heavy financial burden on the economy. Taken as a whole, the increasing worldwide inventory of harmful or potentially harmful [solid, liquid, gaseous] wastes [2(a)] poses an increasing threat to environmental quality. This circumstance severely challenges attempts to establish sustainable development.

The present costs of controlling pollution outputs generated can be enormous. A recent U.S. EPA cost assessment study reports [6] that total direct costs of pollution control in the United States were nearly 2.1% of the GNP or, with investments annualized at 7%, ca $115 billion. Moreover, most of these expenditures were made in the private sector, with the largest expenditures in the chemical, petroleum, primary metals, food and paper industries. In addition, [4] a recent U.S. study suggests that about 3% of GDP will be required to attain ambient environmental goals by the year 2005.

It is evident that past practices have lead to enormous costs to society, application of react and control practices, i.e., largely end-of-pipe management, and are likely to increasingly cost society a significant portion of national wealth. A recent study [5] states that prevention of waste formation or "reduction of waste produced" must become a major thrust.

C. Driving variables

It is reported [5] that if present trends in organic chemical and metals processing industries continue, 50% of the products anticipated to be used in 15 year's time do not yet exist! The rate of new product generation with increasing diversity and complexity that accompany a reduction in the overall consumption of natural resources, gives rise to doubts as to whether there can ever be systematic control of their toxicity. Additionally, the recent phase of industrialization has been characterized by marked differentiation of risks [5]: now less probable, but potentially more serious, more diffuse and varied, and more international. It is unlikely that they can be effectively managed without a radical change in traditional patterns of industrial action.

In sum, in regard to the manufacturing sector, major drivers of concerns for actual and potential impacts upon human health and the environment are the amount of wastes and especially their hazardous character, that are being generated and that, absent actions to the contrary, apparently will be generated in increasing amounts in the future.

D. Scenarios of future impacts

A recent investigation of future scenarios of hazardous waste generation has been reported [2]. In view of the foregoing discussions, it is relevant to environmental challenges posed by activities within manufacturing sectors.

The futures scenario that was exercised, modeled hazardous waste generation (WHz) as a function of time calculated as the product of [2]:

$$WHz = WHz/W \times W/GNP \times GNP/capita \times Population$$

Above, WHz/W represents the ratio, hazardous waste generated/material throughput of the economy; W/GNP represents the ratio, material throughput of the economy/GNP; and GNP/capita represents the ratio, GNP/capita. [NB an additional expression, "hazardous waste intensity" was defined as the ratio of annual generation of hazardous waste to GNP].

A description of the three futures scenarios investigated are presented below, while a more complete description and discussion of the model and outcome of the exercise are to be found in the cited reference [2]:

<u>Scenario 1</u>: In this base-case scenario it was assumed that global population trends continue such that global population reaches 8.5 billion by 2025, 10 billion by 2050, and then stabilizes thereafter due to improved standards of living, better education, and birth control; recent medium-term trends in per capita growth of GNP are assumed to continue throughout the next century; and current hazardous waste intensities are assuemed to remain constant over the scenario period.

Scenario 2: In this scenario, it is assumed that the developing world industrializes fast over the next fifty years; it assumes the same population growth as scenario 1; it is assumed that per capita levels of GNP reach $ 20,000 on a global basis by the year 2040; and that thereafter, GNP per capita grows at ca 2% per annum; hazardous waste intensities are assumed to peak at around 10 kg/$K at GNP levels of around $ 4000 per capita. Following this peak, hazardous waste intensities are assumed to fall away towards a constant level of 5 kg/$K by the time per capita GNP reaches $ 15,000 per annum. This scenario is considered reasonably conservative with respect to "present" trends in development.

Scenario 3: (Cleaner Growth) In this scenario, economic growth is assumed to be much slower than in the previous scenario; a global per capita GNP of $ 25,000 is assumed attained; development is assumed to occur over the longer period of a century. A peak value of for hazardous waste intensity of 5 kg/$K is realized, implying that the poorest countries develop by employing the cleanest of existing technologies and processes; following this peak, hazardous waste intensities are assumed to fall away towards a constant level of 0.5 kg/$K (implies more than 90% reductions over existing hazardous waste intensities - a major technological and economic challenge).

The outcome of these future scenarios, modeled according to various inputs [2], indicated that global development based on use of existing technologies, processes, and standards and consumption patterns of the industrialized world can lead to considerable increases in hazardous waste generation. Even the stringent assumptions of a "Cleaner Growth" scenario predicted cumulative, increasing hazardous waste generation and implied increased environmental burdens over the next century. In sum, regardless what scenario was considered, a uniform view emerged: sustainability will require formidable efforts to achieve.

E. Consequences

As a precautionary note, the output of the model should only be viewed as illustrative of possible outcomes and should not be considered to be a predictor of actual outcomes. Given the great uncertainties associated with data availability and quality, simplifying assumptions, and other considerations, the model only has a qualitative value. Nonetheless, it has the potential to serve as one possible means to evaluate need for redirection of manufacturing ethic focus in regard to sustainable development objectives.

Overt consequences of realization of the scenarios examined are that absent measures to the contrary, the cumulative amount of generated hazardous waste is anticipated to continue to increase far into the future. In other words:

The worldwide generation of wastes will increase in a manner that will prove extremely difficult to manage.

Adverse environmental impacts of manufactured products will not be reduced to a justifiable minimum.

Natural resource usage will be less than optimum.

However, of perhaps greater concern, is the observation that <u>all</u> of the model scenarios exercised predict cumulative increases in amounts of hazardous wastes generated in the future. This outcome implies that in order to achieve sustainability, policies aimed at preventing generation of wastes in the manufacturing sector, especially hazardous wastes, likely <u>must be extremely carefully thought out and optimized</u>.

Absent carefully thought out actions taken to ensure waste prevention and at the same time enable economic growth in an environmentally sustainable fashion, the above discussions also suggest the following possible additional implied consequences:

The competitive position of U.S. firms in a global marketplace could be eroded with consequent loss of marketplace penetration opportunities, lost employment, etc.; for example, regulatory policies may be inappropriate: attacking the problem of wastes generated via mandatory end-of-pipe controls may prevent the renewal of capital stock needed to acquire cleaner technologies.

Improvement of standards of living could suffer due to otherwise avoidable generation of wastes and expenditure of more resources than absolutely necessary per unit of actions taken to achieve a desired level of environmental protection.

Absent a strong and predictable regulatory program that encourages movement towards development and deployment of cleaner technologies, industry may continue to opt for more predictable end-of-pipe controls.

Data and information needed to ensure that environmental targets are being met will not be available.

Analysis of issues and mitigating actions

F. Manufacturing Ethic:

In reaction to concerns about the present situation and in consideration of consequences that could arise in the event of occurrence of scenarios described above, an ethic that has seen growing support is that [5] a desired way to manage waste is to prevent its generation and avoid unnecessary depletion of resources and raw materials while reducing the potential for harm to human health and the environment to the maximum extent practicable. Waste prevention can mitigate inadequacies of treatment, storage and disposal facilities.

For the manufacturing sector, this means evolution and innovation in respect to the development and utilization of cleaner technologies and production processes. At present, environmental technology markets are dominated by end-of-pipe control technologies [5]. It is evident that significant changes in the environmental technology market will have to take place in order to shift from a pollution control strategy to a preventive strategy. However, the translation of this ethic into a practical management strategy and actual implementation of measures that can bring about evolutionary changes (i.e., implementation of cleaner technolgies and production processes) in the manufacturing sector of industry has been slow, despite signals of costs and of potential impacts associated with present waste generation practices. Response to a growing demand for integrated cleaner technologies and cleaner production processes depends to a large extent on the renewal of capital stock.

This situation prevails at the present time, despite growing evidence [3,4,5] that pollution abatement and less costly use of resources are feasible and that clean industry and clean products can have distinct competitive advantages in regional, national and international marketplaces. Moreover, technological evolution and innovation are considered [3,4] the key engines for job creation and maintenance or improvement of standards of living, and economic growth in general. The competitive position of individual firms depends increasingly on technological change and adaptation [3]. In turn, these technological changes affect environmental quality and the natural resource base.

The following issues [2-4] must be addressed in order to develop a sense of the impact of sustainability on a manufacturing ethic:

- o A vision of sustainability must be established;
- o A basis to achieve sustainability is needed;
- o A means to measure accomplishment of objectives aimed at achieving sustainability is needed;

- o Enforceable policy instruments are needed;
- o Costs of achieving sustainability must be allocated in an agreed upon manner;
- o Economic characteristics of the private sector must be addressed; and
- o Temporal aspects of sustainability must be addressed.

G. A Vision of Sustainability

Analogous to the efforts of other countries [3,4], the U.S. EPA needs to develop a vision of sustainability in order to promote clean production. Of necessity, it must take the lead and negotiate, publish, administer, implement and adhere to a workable plan of what a sustainable economy is meant to be within specified timeframes.

Absent a vision of sustainability, the U.S. EPA may encounter difficulties both within the Agency and externally, in regard to prospects for implementation of measures aimed at accomplishing objectives that can enable progress towards achieving sustainable development.

In anticipation that the strategic plan underlying a vision of sustainability will be based upon the outcomes of detailed negotiation, it will be necessary for the Agency to organize to act efficiently in ways that reward integrated staff work, and address a crucial need, regarding clean technology and production for negotiated policy stances based upon interdisciplinary foundations. Further study is recommended concerning plan development and its relationship to technology evolution, competitivity, and sustainability.

H. Issues, Challenges and Cleaner Technology

The issues raised and that should be addressed must be viewed in the context of: challenges raised against achieving sustainability; how actions mounted may impact the manufacturing ethic of the nation's industry; and how in turn, any redirection of the manufacturing ethic may affect industrial competitiveness in a global marketplace economy. A harmonious outcome is clearly desirable. It is evident that industry, the U.S. EPA, and others will be challenged to negotiate among themselves agreed-upon, workable and timely arrangements which lead to demonstrable progress towards achieving sustainable development and that at the same time can ensure a competitive marketplace for environmentally responsible firms.

In view of challenges posed to the manufacturing sector, it has been concluded that [3,4] the utilization of cleaner technologies which generate marketable products with concurrent reduction of environmental impacts and natural resource use to justifiable minima are of prime importance. The concept of prevention of waste through the use of cleaner technology is considered to signal [5] minimization of waste at the manufacturing stage by introducing improvements or changes in manufacturing processes and manufacturing technology.

I. Industrial Strategies

The trend [5] to date towards inclusion of environmental considerations in industrial strategies: has been selective, mainly involving end-of-pipe controls (driven by inappropriate regulations and incentives or risk aversion or competitiveness of industries); is installation-size and age dependent (with more progress a newer facilities); is sensitive to economic conditions in the marketplace; has little effect on exports to developing countries; and is influenced by the regulatory environment - regulatory uncertainty drives risk aversion regarding use of new "unproven" technologies.

The role of clean production in enhancing, reducing, or not affecting competition is important: policies for promotion and deployment of cleaner products are neither conceivable nor practical unless closely coordinated with industrial policy in its entire form [3,4]; the process by which firms invest in new technologies is of key importance. In brief, the prime aim of current industrial policy seems to be [3,4] to promote performance, improve labor productivity, and increase the value added (wages paid plus profit before interest and depreciation) of as many enterprises as possible, i.e., to improve their overall competitiveness.

Process changes by a firm usually demand major capital investments and cannot be undertaken "abruptly"; they are instead undertaken only after carefully considering whether investment, installation, and exploitation of new technology will improve the competitivity of the firm in the marketplace. In consequence, such changes are evolutionary, and there is doubt [3,4] as to whether process changes can or should be mandated by regulatory means.

In regard to marketplace competitiveness [7] successful implementation of pollution prevention measures is critically related to industrial profitability - firms are unlikely to pursue preventive measures if profits are not demonstrable at the level of investment and industrial management decisions.

J. Life Cycle Management Strategies

The impact of striving to achieve sustainability on a manufacturing ethic will be realized through private sector initiatives and those of international, nation and regional governments. With respect to the U.S. EPA this may mean the adoption of policies that move the manufacturing sector in a direction that supports the goal of achieving sustainability. Given the increasing globalization of the marketplace, it would not be surprising if in the long term, many of the policy options ultimately adopted by the Agency are in fact somewhat global in aspect. In view of the commonality of long-term sustainability objectives, this has lead to proposals [2-4] that consumer products should be fabricated and placed on the market subject to an integrated life-cycle approach justified by environmentally sound and efficient management principles.

In order to address these proposals a need exists for [3,4] consumer products to be fabricated and placed onto the market subject to an integrated life-cycle management approach that aims to:

- o minimize energy use/(unit of output)
- o optimize efficiency of natural resources use
- o avoid, minimize, remove, or replace inherently toxic, corrosive, flammable and/or otherwise potentially harmful components
- o ensure that in an environmentally sound manner, discarded final products can be reused, reclaimed, recycled or subjected to resource recovery.

Measures aimed at understanding the potential use of cleaner technologies for preventing waste generation throughout the life cycle of a product, inclusive of the manufacturing process, have been and are being encouraged [2-4,5,8]. However, consensus concerning procedure for life cycle analysis, has not been firmly established. More data are needed in order to understand possible cost benefits of use of cleaner technologies.

K. Materials Considerations

Opportunities for employment of cleaner technologies that can lead to cleaner production process might be examined within the context of materials used in production processes. The choice of materials used in manufacturing activities is strongly influenced [2] by commodity prices or ease of transformation in manufacturing.

The need for engineering research aimed at development and use of cleaner technologies, processes and materials has been advocated [9] with the encouragement that general principles must guide the search for substitutes for materials with potentially important environmental effects. Historic examples suggest clear benefits of striving for cleaner technologies, production processes and materials. It has been estimated that if substitution of lead by polyethylene for cable sheathing had not taken place, consumption of lead by AT&T alone might have reached a billion pounds per year [10].

L. Regulatory Issues

It has been suggested that in the private sector [4], that (if less than required by current regulation) the lowest release levels attained by the most progressive firms should become the new standard for all firms in that sector after some 'reasonable' period. It is argued that this approach can encourage innovation, since firms seeking to 'set the standard' and increase their competitivity would invest in cleaner production processes to achieve this goal - environmental performance would be directly related to competition (competition-based standard setting) just as price, quality, performance, reputation, etc. are.

Sectors of the industrial community that might otherwise be regulated, may voluntarily act to achieve desired environmental goals. Voluntary agreements are driven, for example, by public and political pressure, actions taken by competitors in international markets, or threat of tough and enforced laws and regulations. Voluntary industry agreements or initiatives can have a measurable effect on potential environmental impacts.

Development [5] of the world market for clean technology and pollution abatement equipment over the past decade has been largely driven by strong regulations. Countries with the most stringent environmental legislation have taken an early lead in the development of environmental technology and are leading exporters [2-5].

Despite the potential benefits of cleaner technologies relative to end-of-pipe treatment, their use has been relatively limited due to both market and regulatory failures: existing markets for clean technologies are perceived to be relatively small; the availability of cleaner technologies is limited in some areas; higher initial capital costs may be an inhibiting factor; risks and uncertainties are associated with cleaner technologies; manufacturers of end-of-pipe control technologies present obstacles to marketplace entry; and inappropriate regulations encourage use of end-of-pipe treatment systems [2-5].

As regulatory stance can impact costs of implementing cleaner technologies, this too is an issue that must be addressed. Currently, two forms of regulatory style towards industrial sector pollution sources predominate [3,4]: (1) 'specified' compliance, which relies on literally interpreted, formal precise and specific rules, tends towards regulatory uniformity, and often is perceived as adversarial by the regulated community; and (b) 'negotiated' compliance which emphasizes reliance upon general, flexible guidelines, bargaining, allowance for situational non-uniformities in application of regulations, and an accomodative stance toward the regulated community.

The specified compliance style is reported [3,4] to be fairly efficient for implementing regulations and establishing rapid maximization of compliance, but antagonizes the regulated community (which favors flexibility in a manner that offers advantages over competitors) and leads to high compliance costs. This style favors end-of-pipe control technologies in order to meet standards and in the long term is counterproductive: <u>the purchase of end-of-pipe technologies depletes capital that otherwise could be commited for cleaner production technologies</u>. Further progress involving implementation of cleaner technologies may require an alternative regulatory 'negotiated compliance' approach inclusive of credible environmental quality targets which are specific, monitorable and verifiable.

It appears that future progress aimed at achieving sustainability depends on utilization of cleaner production technology and development of cleaner products [2-5] implemented in part through regulations based upon negotiated compliance. The development and use of a negotiated compliance model would be through a systematic consultative and decision-making procedure [4], involving all parties of interest and would emphasise protection of all environmental media through accomplishment of a negotiated set of environmental objectives, which if phased in over an period of time might allow capital stock investments with long lifetimes to be made rationally [3,4].

The negotiated compliance model is seen as a means to encourage industry to move toward [3,4]:

- o in-process recycling, re-use, or recovery
- o changing segments of the productive process itself
- o substituting inputs, e.g., water-based paints instead of solvent-based
- o alteration of the end product itself, e.g., reduction of mercury in batteries while still meeting electrochemical requirements

M. Risk and Liability Issues

The emergence of new materials, increased materials complexity, and an increased extent of dispersion and diffusion of many different products gives rise to increased uncertainties regarding the nature of risks and of consequent liability. Risk impacts generally are becoming more complex, more diffused and more uncertain.

It is reported [3,4] that there is a growing trend toward imposition of strict liability for damage due to environmental auses and that uncertainties in the long-term concerning liability limits for products and waste may catalyze industry action toward adoption and deployment of cleaner technologies with their attendant advantages, e.g., less hazardous emissions, less toxic components, etc. In other words, concerns about liability may prove to be a strong motivator for clean production owing to risk aversion of investors towards firms whose practices may create unwanted or avoidable liabilities. On the other hand [3,4], small- or medium sized firms may see clean technologies as riskier investments (not 'proven' technology) and opt for end-of-pipe technology in strict liability situations.

N. Economic Instruments

Economic instruments can be used [3,4] to:

- o correct imbalances that distort markets, e.g., proper scarcity pricing of natural resources
- o correct failures, e.g., use of the environment as a 'free' dumping ground
- o ensure that public structural projects, such as road building, pay their full environmental costs.

Without comment concerning their desirability, numerous economic instruments can be applied towards accomplishing cleaner technology objectives, e.g., taxes, subsidies, user fees, tradeable use rights, and time. In some instances, an issue to be further addressed [e.g., through careful examination, testing, and evaluation] is uncertainty concerning the actual <u>efficiency</u> of various economic instruments in the marketplace. It has, however, been reported [2-5] that subsidies or perverse incentives (e.g., depletion allowances, agricultural production, and cheap water) have markedly resulted in environmentally damaging practices. Sole dependence upon economic instruments may not go far in achieving sustainability goals owing largely to the volatility of demand and the elasticity of demand to prices in differing sectors [3,4].

Although time will be needed before the results can be fully evaluated, success using economic incentives has depended upon the discounted cash flow cost of correcting an environmental problem being lower over time than proposed charges for continuing undesired behavior [3,4].

O. Competitive Equity Issues

The ability of an individual company to deploy cleaner production technologies is seen to depend on [4]:

- o nature of the firm's industrial process
- o size and structure of the firm
- o attitudes and opinions affecting operation of the firm
- o information available to the firm
- o assests available for cleaner production technologies
- o current regulations and their enforcement

Complaints have been voiced [3,4] that monetary costs of environmental requirements are not uniform for certain sectors, small- or medium-sized enterprises, or even for some countries as compared to others - certain firms argue that their inherent competitivity is harmed by means of actions beyond their control.

One recommendation is that [3]: "To achieve a "level playing field would require governments to perform very precise studies of the average cost differentials and to fashion policies aimed at cutting any imbalances while at the same time tilting towards cleaner production technologies. In other words, once such policies were in force, by choosing cleaner production technologies, a firm could act to achieve a level playing field, by not choosing such technologies, a firm might be at a disadvantage, i.e., not receive tax relief, suffer surcharges, or whatever other financial incentives or disincentives were associated with the policy."

P. Data, Indicators and Information Transfer

The Agency must evaluate its readiness to provide adequate funding over time in order to encourage clean production. It will be essential that research efforts should be monitorable and monitored continuously, with corrective adjustments as needed.

The U.S. EPA must recognize that the public, to the extent provided with reliable information concerning benefits of clean production technologies, may become a more proactive advocate of their siting, deployment, and use. For comparison purposes, this information base can be supplemented with information pertaining to emissions inventories of existing technologies.

A recent report [3] indicates that: "Requirements for public disclosure of industry information about pollutants generated, especially toxic chemical emissions, have been cited as an effective stimulus to industry waste reduction programmes, often involving identification and use of cleaner production. In the United States, for example, public reporting of releases of toxic contaminants as required by law resulted in several major companies announcing drastic toxic waste reduction programmes entailing a variety of measures including cleaner production technologies."

Information transfer and training assistance are considered to be worthwhile undertakings in response to business concerns and the desire to foster utilization of cleaner production technologies.

While industry leaders consider product quality issues to be a driving force in use of cleaner technologies, producers do not evidently hold a widespread belief that eco-labelling of products significantly influences the development and use of cleaner production technologies [3,4].

There seems to be general agreement that in order to evaluate progress towards achieving sustainability, measurable indicators must be developed.

An approach that has been [3,4] recommended is use of an environmental auditing statement based on 'generally accepted environmental auditing procedures' (GAEAP), analogous to 'generally accepted accounting procedures' (GAAP) used by auditors in construction of financial statements found in annual reports of corporations. While, policy could require report of feedstock use, energy consumption, various types of releases, etc. in terms of product sent to market, uniformity of reporting of certain outcomes of a firm's auditing process should be [3]:

> "...balanced against the need to allow a firm's capital investment decisions to rely on its auditing process in order to help make confidential business choices leading to clean production."

The overall objective of information management should be to foster good environmental performance and encourage firms to [3,4]:

- o invest in production facilties which minimise, to the extent practicable, the energy, raw materials, and releases per unit of output sent to market
- o maintain these facilities properly
- o compete to improve these production facilities in order to impove the state of the art for clean production of whatever outputs are to be marketed
- o minimise the use of inherently hazardous substances in marketable outputs or as intermediates

Undoubtedly, additional discussions, study, and testing concerning a variety of issues (e.g., disclosure required of industry and its costs and benefits) are needed in regard to GAEAP. It has been recommended that main categories of a "GAEAP" auditing process in a manufacturing sector firm could include [3,4]:

- o environmental expertise and awareness
- o corporate environmental policy and procedures
- o knowledge of applicable laws, regulations, and government inspection and enforcement approaches
- o internal good housekeeping audits
- o compliance check audits (compliance with existing rules)
- o community outreach and awareness and preparedness for emergencies at local level
- o release reduction/minimisation per unit of product sent to market and recovery of these assets
- o training of managers and internal auditors
- o involvement of the labour force as an active participant
- o assessment of opportunities to implement technologies to cut materials, energy, and releases per unit of product sent to market
- o assessment of products sent to market for their potential effect on man and/or the environment
- o reporting to corporate officers
- o reporting to stockholders and/or the public

Q. Encouraging Cleaner Production

In its report, Government Policy Options to Encourage Cleaner Production and Products in the 1990s, the OECD recommended propositions for encouraging the development and deployment of clean production [3]:

> "Countries should move toward developing a complex policy approach [plan] that should include an agreed and reproducible means to measure the state of the environment and natural resources base, identify potential and real sources of degradation, and monitor these parameters regularly.
>
> Information obtained from monitoring and auditing activities of a firm can encourage clean production.
>
> The negotiated compliance model of regulations is likely to be better at promoting cleaner production than is the enforced compliance model.
>
> Environmental goals could be implemented such that the time to achieve them is negotiated with the regulatory community.
>
> There needs to be an agreed upon and stable mechanism for measuring and reviewing the efforts of the regulatory approaches since regulatory design is neither perfect nor can regulations adjust themselves to new events and situations.
>
> In order to promote clean production, direct tax concessions, accelerated depreciation, and subsidies for end-of-pipe controls should be phased out fairly rapidly.

When cleaner production technologies and methods are proposed as part of a siting or licensing procedure, the time for granting or denying approval should be limited to some reasonable value.

Careful application of economic tools can be used to 'level the playing' field.

Imposition of strict and joint liability for environmental damage can be a very strong motivator for clean production.

In addition to funds directed at manufacturing sectors, more funds should be directed at how cleaner technologies can be implement:d in the agricultural and transport sectors.

A steady campaign to transfer information indicating the virtues of preventive environmental management to the public (via schools, news media, industry circulars, etc.) should be established.

It is desirable to establish 'hot-lines' to provide information regarding cleaner production technologies.

Information about environmental and natural resources issues should be introduced into the curricula of educational establishments at all levels from elementary to university.

Governments should examine procurement practices and requirements to ensure that unintended impediments to clean production are eliminated and that purchasing decisions and requirements are designed to encourage cleaner technologies and products."

Based on the above discussions, and in a manner that complements actions proposed elsewhere, the EPA chould seek to foster any or all of the follc ng recently r commended optic s that support development and deployment of cleaner production technologies [3,4]:

Whatever negotiated vision of sustainability is established, it must be measurable according to some agreed upon basis and applied to clearly identified environmental indicators of progress.

The Agency should cooperate to ensure that near- and long-term plans for the economy should incorporate reasonable time-frames and goals for achieving sustainability.

Means should be available to identify any 'new' environmental problems that may emerge.

Milestones and a time-table for achieving sustainablity are needed.

A regulatory mechanism could be deloyed that favors cleaner production technologies over end-of-pipe solutions.

Existing economic incentives that favor end-of-pipe solutions over cleaner production technologies could be eliminated and those that promote development and deployment of cleaner production technologies could be established and implemented.

The Agency could seek to foster the development and promote adoption of generally accepted environmental auditing procedures that both allow firms to retain some auditing information as confidential and maximize chances of firms choosing cleaner production technologies in investment decisions.

In some specific instances, the Agency could seek to cooperate with other governments in development of consensus approaches to cost effectively attack problems.

Mechanisms are needed to engage both the regulated community and other 'stakeholders' in negotiating approaches aimed at specific problems.

Voluntary agreements could be encouraged where feasible.

Encourage most of the regulated community to perform better than required, since 'best performance' might eventually be taken as a general standard thus giving the firm that achieves it first a competitive boost.

Specialised approaches aimed at meeting the needs of small- and medium sized enterprises may be advisable.

Use of a regular means to monitor progress and report results to the public.

Enforcement of liability laws for environmental damage.

A strong, stable mechanism for regulatory review and, when needed, to initiated regulatory reform.

Regular use of information mechanisms to inform the public about environmental risks and promote favorable public opinion concerning cleaner production technologies.

Incorporation of cleaner production technology concepts into educational programs at all levels of education.

Employment of means to favor demand for cleaner products to the extent practicable.

Judicious use of economic instruments to achieve a 'level playing field'.

Proactive research and development concerning cleaner production technologies.

If possible, promotion of life-cycle costing for all capital cost allocations.

Removal of government impediments to development and deployment of cleaner production technologies.

Government procurement initiatives that promote cleaner production technologies and products.

Support for technology transfer mechanisms to stimulate utilization of cleaner production technologies in the U.S. and abroad.

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SOCIETAL PRESSURES FOR THE REDEVELOPMENT OF INDUSTRIAL SITES AND REMEDIATED LAND

Prepared for

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A. GLOBAL GOAL

The U.S. Environmental Protection Agency (U.S. EPA) is primarily responsible for developing technical and regulatory schemes for protecting human health and the environment. During the past fifteen years, the Agency has orchestrated efforts to identify and mitigate both environmental and human health risks. With all other factors held constant, the potential for environmental and human health damages is directly proportional to the level of exposure to stressors. Consequently, the Agency has justifiably considered exposure assessment as an important element of risk assessment.

The potential exposure of each segment of the U.S. population to undesirable environmental stressors is location-specific. Therefore, the rate of growth and spatial distribution of population within a given region have indirect but profound influences on human and environmental exposure to various sources of pollutants. The rate of change and distribution pattern of population depend on a host of socio-economic factors, the interactions of which change dynamically with time. A deep appreciation of the relationships between socio-economic factors and environmental stress factors, the probable future bounds for the variability of these relationships, and the trend of evolution of environmental control technologies will enable the Agency to develop appropriate schemes for mitigating risk.

The scarcity and high cost of land in urban areas, coupled with increasing urbanization of the U.S. population, will increase the pressure to redevelop abandoned industrial sites and remediated land. Within the next thirty years, one of the following scenarios is likely to develop in metropolitan areas.

- Increase in the population density of suburban centers and greener sites at the expense of the proximal inner city areas.
- Retention of large populations by inner city areas with only moderate increases in the population of suburban areas.

The occurrence of any of these two scenarios will result in the scarcity of land within and/or near metropolitan centers. Consequently, many of the abandoned industrial sites and remediated land which are presently fallow due to real or perceived risks and liability will likely be developed. The interactions of the driving factors for site redevelopment in both scenarios are largely different although there are some common elements. The driving factors include prospective increase in profits to site developers, advances in site remediation technology, population increase, socio-economic trade-offs, and increase in the magnitude of liability risk acceptable to developers and buyers as land scarcity drives up housing costs. The U.S. EPA needs to develop proactive schemes to address both the policy and technical issues that will attend this category of land recycling.

B. BACKGROUND ON SITE INVENTORY

There is an exceedingly large number of contaminated sites in the United States. GAO (1993a) estimates that 3,400 facilities out of about 4,300 in the RCRA universe may be releasing waste into the environment. The Department of Defense (DOD) controls about 10,924 active hazardous waste sites at more than 1,800 domestic military installations in the United States (Sidel, 1993). Table 1 (Chu et al., 1992) shows the distribution of 7,150 former military sites by state of location. A component of the comprehensive plan of the DOD Installation Restoration Program (IRP) is the redevelopment of remediated sites. GAO (1993b) reports that the U.S. Department of Energy (U.S. DOE) estimates that it may close about 1,700 facilities within the next 30 years. Presently, the US DOE has approximately 4,000 sites to remediate, and it is also estimated that more than 250,000 underground storage tank sites presently need to be cleaned up (HMCRI, 1993). Briefing statements released by U.S. EPA (1991b) indicated that its Superfund Program has evaluated 31,000 sites out of a total universe that could exceed 50,000. Between 250 and 300 of these sites require remedial actions each year.

In addition to the sites mentioned above, several former industrial sites are located in metropolitan areas. In many cases, the businesses that once occupied them have left for other regions that may have better economic prospects. In some cases, these businesses operated outdated industrial plants and could not meet pollutant emission requirements of sensitive, highly populated areas (e.g., the Los Angeles Basin).

Adequate data collection on the proximity of abandoned and remediated sites to metropolitan areas has not been conducted by appropriate agencies. Nevertheless, it is generally observed that most industrial cities in the northern region of the United States and some southern and western cities have very high concentrations of abandoned sites. These cities include Chicago, Boston, Detroit, Philadelphia, Washington, D.C., Pittsburgh, New Orleans, Miami, Los Angeles, and smaller cities such as Omaha, Fargo and Des Moines. It is a fair assumption that more than 90% of the leaking underground storage tank sites that will be remediated are located within metropolitan areas. There is a high probability that the redevelopment of a significant proportion of the different categories of sites discussed above will become very attractive within the next thirty years. Among the structures that will be built on such sites are residential houses, parking garages, warehouses, tunnels, roadways, monuments and office buildings.

C. SCENARIOS

In Scenario 1, inner city dwellers will migrate to suburban areas and greener sites. The driving factors for this scenario are infrastructure decay in inner city areas, increase in crime rate that may correspond with higher unemployment rates in city centers, and greater availability of white-collar employment opportunities in city suburbs. In essence, this scenario hinges on the justifiable assumption that the middle class, which has the luxury of means, will flee the inner city areas to greener pastures. The capability to flee undesirable conditions will determine the population zonation pattern envisaged in Scenario 1. The most probable consequences of this scenario are itemized below.

- Equilibration of population densities over large regional areas.
- Decrease in the tax base of inner cities as they retain residents that are mostly within the low income bracket.

Table 1. Inventory of formerly used defense sites (Chu et al. 1992).

STATE	NUMBER OF SITES	STATE	NUMBER OF SITES
Alabama	130	Montana	106
Alaska	547	Nebraska	105
Arizona	182	Nevada	43
Arkansas	91	New Hampshire	26
California	847	New Jersey	122
Colorado	97	New Mexico	226
Connecticut	35	New York	268
Delaware	29	North Carolina	94
District of Columbia	20	North Dakota	67
Florida	518	Ohio	82
Georgia	101	Oklahoma	87
Hawaii	378	Oregon	123
Idaho	66	Pennsylvania	110
Illinois	72	Rhode Island	56
Indiana	69	South Carolina	100
Iowa	35	South Dakota	92
Kansas	119	Tennessee	63
Kentucky	24	Texas	323
Louisiana	73	Utah	34
Maine	97	Vermont	13
Maryland	74	Virginia	172
Massachusetts	233	Washington	284
Michigan	138	West Virginia	23
Minnesota	63	Wisconsin	67
Mississippi	132	Wyoming	70
Missouri	85	Territories	139
		TOTAL:	7,150 sites

- Attraction of cottage industries to inner cities will occur due to new incentives that will be provided by city administrators. These industries will need space for facilities and, consequently, former industrial sites and remediated land will become prime redevelopment targets.
- Land will also become scarce and expensive in suburban areas, in consistence with increased demand that will result from the influx of new residents.

In Scenario 2, the population of inner cities will increase excessively while the suburbs experience only moderate population increases. The driving forces for this scenario are high levels of immigration and high birth rate of population segments in the low income bracket. These new residents will initially prefer to settle in large urban centers, where unskilled labor is still in high demand relative to rural and suburban areas. Also, it is generally believed that ethnic ties to earlier immigrants to U.S. cities promote the congregation of new immigrants in the inner cities. Despite the expected increase in the population of inner cities, the mobility of residents to the suburbs in reasonably large numbers could be impeded by their lack of white-collar skills and financial resources. This scenario is likely to produce the following consequences within the next 30 years.

- A population imbalance in favor of inner city areas in large metropolitan areas.
- Socio-economic and environmental pressures will force city planning units of metropolitan governments to seek novel ways of maximizing the use of central urban space, including former industrial sites.
- Developers will capitalize on the exceedingly high demand for housing business centers, and perhaps light industrial facilities in central urban areas by purchasing and redeveloping former industrial sites and remediated/contaminated land.
- Increased utilization of underground space in areas of high population density.

The two scenarios that are discussed in the preceding paragraphs will each promote the redevelopment of abandoned industrial sites and other sites that are presently classified as being contaminated. However, the interactions among the significant driving factors discussed in Section D are largely different. An appreciation of these factors is a requirement for the development of adequate schemes to respond to policy and technological needs.

D. MAJOR DRIVING FACTORS FOR LAND REDEVELOPMENT

The major driving factors for land redevelopment are population increase, socio-economic trade-offs, legal liability and risk acceptability, and advances in technology.

1. Population Increase

The total population of the United States, as of August 1, 1993, is estimated by the Census Bureau (1993a) at 258,479,000. This population represents a 3.7 percent increase over the 1980 estimate by the same Bureau. The middle series projection (Census Bureau, 1993b) indicates that the U.S. population will increase by 50 percent from about 255 million in 1992 to 383 million by the year 2050. This is based on assumptions of 2.1 births per woman, an average life expectancy of 82.1 years by 2050, and an annual net immigration of 880,000. The lowest series estimate for the year 2030, the time frame which corresponds reasonably to the Futures Project analysis period, is 287 million. This is based on assumptions of 1.8 births per woman, an average life expectancy of 75.3 years, and an annual net immigration of 350,000.

Estimates by the United Nations (1985) show that in 1980, only 15.8 percent of the global population resided in cities of 4 million and above. By the year 2025, about 24.5 percent of the global population will reside in megacities. 'ithin our context, each megacity comprises the inner city and the suburbs. Population distribution data (Census Bureau, 1993c) indicate that out of a total U.S. population of about 249 million in 1990, 78.8 million and 79.4 million resided in central urban and urban fringes (comparable to suburbs), respectively. Although future urbanization rates are expected to be higher in the developing countries than in the United States, even moderate influx of new residents into metropolitan areas and high birth rates of people who reside in those areas are likely to cause acute scarcity of urban space in most cities.

It should be noted that the population will not necessarily increase in all U.S. cities. Furthermore, the spatial distribution of population within each metropolitan area (conglomerated cities and suburbs) is a more relevant parameter than the population itself, to the two scenarios outlined above. In Table 2, data for some very large U.S. cities indicate average annual population growth rates that range from 0.2% for Pittsburgh, Pennsylvania to 3.33% for Phoenix, Arizona. In Scenario 1, it is envisaged that for most U.S. cities, large segments of the city population will move to suburbs and other lower density areas within the metropolitan areas.

The resulting spatial zonation pattern of population will vary from pockets of affluence dispersed within urban blight to concentric rings in which the segments with longer radii are inhabited by residents with better economic resources. New York represents the former, and Minneapolis exemplifies the latter. Essentially, the suburbs and cleaner enclaves within metropolitan areas will need land for both residential and business real estate, a situation that will increase the scarcity and cost of land. A direct consequence will be an increase in the pressure for the redevelopment of the increasing number of brown sites in the suburbs. Also, Scenario 1 will eventually lead to the redevelopment of abandoned and remediated sites even in the inner city areas that may experience significant population flight.

In Scenario 2, the inner cities will retain larger segments of the projected increases in population. This situation could be promoted by improvements in the implementation of socio-economic schemes such as affordable housing, environmental sanitation, crime control and underground space development. The enhancement of the desirability of residing in city core areas will increase the demand for, and costs of real estate dramatically. Even in the absence of this factor, new immigrants are likely to be trapped in inner city areas (for example, South Central and East Los Angeles) for a number of years for socio-economic reasons. The immigration rate to which reference is made above, will sustain high population densities in city cores thereby building pressure for the redevelopment of abandoned sites. In the scenario, the lower density of population in the suburbs may increase the attractiveness of the latter sites for new industrial plants, as exemplified by present-day Oklahoma City and Milwaukee. In Scenario 2, this spatial model will become more ubiquitous.

2. Socio-economic Trade-offs

Market forces will play a significant role in land redevelopment in urban areas. Construction and industrial activities often effect immediate impacts on employment rates. City planners may be inclined to weigh employment goals against potential environmental concerns. For private developers, zoning and tax concessions, which could be the instruments of enticement, could make the redevelopment of former industrial sites attractive. The high rates of housing and real estate development in U.S. cities relative to available space will promote this type of land recycling. Data presented in Table 2 show 1992 housing and population data compiled from information gathered by ULI (1993) for some major U.S. cities. The number of new housing units built in 1992 exceeded 20,000 in some U.S. cities. While these data do not show housing imbalance in favor of inner cities, it is fair to assume that increase in housing and real estate development will translate to the development of brown sites in most parts of cities owing to the finite number of regular sites available.

Redevelopment activities usually revitalize industries such as those in construction, insurance, hardware sales, and road construction. Construction activities are generally labor-intensive and thus can provide employment for a large number of laborers. Municipal governments will continue to cherish increases in construction activities because the latter can reduce unemployment rates. Interestingly, Table 1 shows that California has the highest number of reclamable military sites. California also has very high unemployment rates. The expected translation of this situation to many regional cities of the United States will constrain municipal governments to provide incentives to developers in schemes constructed to reduce unemployment in inner city areas. Incentives will most likely be highest for the development of abandoned industrial sites. This is particularly likely in Scenario 1 which involves the flight of manufacturers and economically buoyant persons to the suburbs or richer city enclaves. Tax breaks constitute an example of an incentive which municipal governments will use to arrest the flight of companies and attract new companies and residents. These schemes imply that space will become scarce again, leading to the development of most available spaces.

Incidentally, most major cities in the United States are currently initiating urban infrastructure improvement projects. One of the important elements of these plans is the attraction of manufacturing companies, most of which usually need considerable space for plants and offices. One of such cities is Detroit, Michigan. In addition, the current U.S. Administration plans to develop "enterprise zones" in inner city areas. The President's Council on Sustainable Development (SCTF, 1993) is currently assessing options for promoting sustainable reuse of abandoned industrial sites, closed military bases and other government property. These options include changes in zoning codes and regulations, lending and insurance practices, and future liability responsibility.

Economic considerations have already made California's Abandoned Site Project management team consider contaminated site redevelopment as a viable option in cases that incorporate appropriate schemes to mitigate human health risks. Anderson and Hatayama (1988) describe plans to redevelop a Bethlehem Steel Company site in South San Francisco, and a Hercules Powder Company Site in Hercules, both in California. A number of other case-histories in the United States are described by U.S. EPA (1986). The locations, characteristics and post-redevelopment landuse of some of these sites are presented in Table 3. Within the next thirty years, this practice will become widespread in the United States, in conformity with the trend in European countries (particularly, Britain), where land is very scarce in metropolitan areas.

3. Legal Liability and Risk Acceptability

Currently, liability concerns discourage potential developers from purchasing contaminated land for subsequent redevelopment. Zimmerman (1992) reports that numerous court decisions have supported laws that hold purchasers of contaminated property liable for incidents of contamination regardless of whether or not environmental problems stem from prior use of such properties by previous owners. Potential developers are currently cautious about acquiring contaminated property because commercial general liability (CGL) insurance policies which they hold, contain exclusion clauses for damage from such pollution incidents. Some states have enacted legislation (Greenthal and Millspaugh, 1988), exemplified by New Jersey's Environmental Cleanup Responsibility Act (ECRA), which outlaws the transfer of contaminated property. In most other states, developers can purchase contaminated property and assume the associated liability risks. In a discussion of this issue, McGregor (1988) notes that potential developers could consider deducting cleanup costs from the sale price of properties during the negotiation stage.

The liability concerns which currently impede the transfer and redevelopment of former industrial sites and other types of contaminated land, may wane significantly within the next thirty years. There are some indicators that changes in regulatory climate will favor land redevelopment. As reported in the Inside EPA (1993), some Congressional members have contemplated the developement of a Superfund Reauthorization bill that will include regulatory support for the redevelopment of urban industrial sites. The U.S. Supreme Court sided recently (Schulte, 1993) with a South Carolina businessman against the State of South Carolina in an environment-related litigation over his right to determine the beneficial landuse for his property.

Table 2. Population and housing data for 1992 for some major U.S. cities. (compiled from ULI, 1993).

CITY	POPULATION		1992 HOUSING DATA	
	1992 (Thousands)	Average Annual Growth 1980-92 (Percent)	Number of Units (Thousands)	New Units in 1992 (Thousands)
Atlanta, GA	2,932.0	2.70	1,216.0	26.0
Chicago, IL	7,400.0	0.30	-	24.2
Columbus, OH	1,418.2	1.10	577.3	8.4
Detroit, MI	4,361.2	0.20	1,725.4	14.7
Jacksonville, FL	935.0	2.20	396.5	5.8
Miami, FL	1,993.8	1.72	790.7	8.0
Nashville, TN	1,028.0	1.60	233.2	1.9
New York, NY	7,388.5	0.40	2,986.3	2.4
Philadelphia, PA	4,916.6	0.30	1,939.4	12.3
Pittsburgh, PA	2,322.2	0.20	960.0	5.4
Washington, DC	4,074.0	1.90	1,597.0	21.9
Dallas/Ft. Worth, TX	4,042.6	2.72	1,686.6	20.8
Houston, TX	3,900.0	1.70	1,546.7	18.8
Los Angeles, CA	9,087.0	1.60	3,221.2	11.3
Phoenix, AZ	2,236.0	3.33	836.4	17.7
St. Louis, MO	2,452.0	0.26	1,025.2	5.3
San Francisco, CA	3,786.0	1.30	1,546.1	8.9
Seattle, WA	2,888.4	2.10	1,194.4	26.4

Table 3: Characteristics of some redeveloped sites in the United States.

Site Owner (or Name) and Location	Residual or Original Contamination	Principal Exposure Reduction Measure	Post-Development Land Use	References
Boucher Landfill site Huntington Beach, California U.S.A.	Petroleum refinery wastes (benzene, tuluene, etc.)	Excavation of highly contaminated material, prior to building construction	Residential building (288 units)	Anderson and Hatayama 1988
Bethlehem Steel Company site, South San Francisco California, U.S.A.	Heavy metals (zinc and chromium,), acids and PCB.	Excavation, dewatering, and a 1-foot soil cover.	12-story office building	Anderson and Hatayama 1988
Hercules Powder Company site, Hercules, California, U.S.A.	Heavy metals (Lead and zinc) and organic explosives	Excavation of the primary source and excapsulation of residuum.	Single-family houses, parks, schools, and playgrounds on an extensive area	Anderson and Hatayama 1988
Kellog Terrace, Gfeller Development Company, Yorba Linda, California, U.S.A.	Lead, arsenic and aliphatic and aromatic hydrocarbons.	Excavation prior to construction.	Residential condominiums (224 units)	U.S. EPA . 1986.
Annapolis Road sites, Baltimore, Maryland, U.S.A.	Organic solvents, zirconium, corrosive liquids, and cadmium.	Removal of drums, pumping of waste liquids and groundwater, and excavation of debris prior to construction	Office building that houses the Maryland Department of Health and a neighborhood park	U.S. EPA. 1986
Miami Drum site, Miami, Florida, U.S.A.	Spills containing phenols, heavy metals, oil and grease, and pesticides.	Excavation of highly contaminated debris, in situ treatment of groundwater, and non-removal of marginally contaminated geo-materials.	Maintenance facility for the Dade County Transit Authority	U.S. EPA. 1986
Gas Works Park, Seattle, Seattle, Washington, U.S.A.	Hydrocarbons including polycyclic aromatics (PAHs); residues from gas production; and miscellaneous waste materials.	Excavation of highly contaminated soil; on site burial of demolition wastes; and surface restoration for revegetation.	Public Park	U.S. EPA. 1986
New York State Electric and Gas Corporation site, Plattsburgh, New York, U.S.A	Coal tar migration into the subsurface.	Removal of contaminated sediment and construction of slurry wall.	Recreation Park	U.S. EPA. 1986

Recently, the State House of Pennsylvania passed two bills aimed at promoting the redevelopment of abandoned sites. In one of the bills, legislators seek to limit liability for purchasers of former industrial sites. The second bill would limit environmental liability for development agencies that provide loans to developers of abandoned properties. The Pennsylvania Senate is considering other bills which would exempt candidate sites from stringent cleanup specifications and provide grants for clean up of industrial sites, respectively. In general, the legal liability climate is changing in favor of site redevelopment.

4. Advances in Technology

It has not been possible to attain desirable cleanup standards in a cost-effective manner at many contaminated sites. For sites at which groundwater is contaminated, pump-and-treat schemes are most often used in remediation. Unfortunately, there is a limitation on the level to which a site can be cleaned up using technologies that are based on the removal of contaminants by hydraulic pressure differential. Other cleanup technologies such as electrokinetics, steam flushing and surfactant-enhanced soil washing have been proven to be adequate only in bench-scale studies and controlled field experiments. Federal regulations for site remediation tend to promote the implementation of "best available technology", most of which are very new. Residual concentrations which may remain at prospective sites for redevelopment are still of concern to developers and potential owners. Long-term exposure of housing residents to residual contaminants is still a major concern even if such a concern is not supported by exposure assessments and toxicological evidence. Given the current regulatory climate and available technology, perfect cleanup is not achievable, thus a combination of risk management and remedial technology management should be employed in the redevelopment land for beneficial uses.

Contaminant cleanup technologies are evolving at a rapid enough pace to lay credence on the assumption that within the next thirty years, it will be possible to remove residual concentrations of contaminants cost-effectively. This implies that at a large number of sites, the post-cleanup risk assessments will indicate potential human exposures that are low enough to support the redevelopment of the sites concerned. It is reasonable to expect that in thirty years, the fear factor will dissipate substantially, in response to improvements in public education and awareness on environmental issues.

Urban cores and suburbs will be linked by high speed transportation within the next few decades. This situation will follow the trend set by Japan in response to high urban population. It will be possible for residents of inner city areas to work in far-flung places and vice-versa. This development is likely to favor Scenario 2. A large segment of the city population will prefer to reside where social services are plentiful but commute to work in the suburbs and beyond. A plausible argument can be made to support the contrary: in the sense that computer information systems will advance to the extent that wherever one lives, social services will be available. However, the affordability factor and the desirability of ethnic community support systems will place constraints on deviations from Scenario 2. Essentially, the expected implementation of large-scale mass transit technologies exemplified by high speed magnetically levitated trains (MAGLEV), will indirectly enhance the conditions that characterize Scenario 2.

E. DESIRABLE SITUATION AND GOALS

The occurrence of either of the two scenarios discussed above will result in increased pressure for the redevelopment of former industrial sites and remediated land. It is desirable that schemes be developed for monitoring the evolution of socio-economic and technological conditions, and developing programs to forestall environmental and human health problems that may arise.

The redevelopment of brown sites has both economic and indirect environmental benefits. In the preceeding sections, the driving factors which include socio-economic advantages from the perspectives of the state and local agencies, and developers have been discussed. In environmental protection terms, it is worthy to note that the development of remediated sites (brown fields) implies the conservation of clean sites (green fields), a situation that is desirable with respect to overall public interest. It is within U.S. EPA's mission to ensure that redevelopment is implemented with safeguards against environmental and human health damage. Toward this end, the existence of the following situations within the next thirty years is desirable.

- Availability of data on population and spatial growth patterns of U.S. cities.
- Availability of data on the number and distribution of both abandoned and operating industrial sites relative to large population centers.

- Availability of centralized information resources on liability laws and trends relevant to site redevelopment.
- Existence of comprehensive schemes for integrating site redevelopment into city and regional plans.
- Existence of federal policies with adequate latitude for local jurisdictional controls on redevelopment.
- Availability of technical schemes and research data for addressing issues such as residual contaminant migration, exposure and risk assessments for site redevelopment, relevant cleanup standards, foundation systems in residually contaminated land, occupational health and safety, and environmental equity.
- Availability of expertise within U.S. EPA to address these issues.

Unfortunately, these desirable situations will not evolve unless the leading environmental control agency, the U.S. EPA takes the initiative to develop internal programs and form appropriate partnerships for addressing the issues discussed in the next section.

F. ASSESSMENT OF U.S. EPA'S READINESS, AND RECOMMENDATIONS

Some elements of U.S. EPA's programs are adaptable to schemes that can address some aspects of the issue of industrial and contaminated site development. However, in general, available schemes are inadequate for achieving the goals outlined in Section E. U.S. EPA's readiness in key policy and technical areas are briefly discussed below. Recommendations are also made on approaches to developing and implementing schemes to address relevant issues.

1. Data Needs on Site Inventory and Spatial Distribution

U.S. EPA (1986) documented some case-histories involving site redevelopment in the United States. Subsequently, this issue has gone forward without adequate tracking by the Agency. In addition, information on important parameters such as the total number of industrial sites in cities and their spatial distribution within such cities is lacking. Some military sites which are candidate sites for redevelopment may currently be exempt from U.S. EPA regulations. Nevertheless, information needs to be collected because a central repository for this information is needed. With respect to data collection, the recommendations outlined below are made to improve U.S. EPA's readiness.

- Establishment of alliance with municipal governments to acquire and analyze location and site characterization data on abandoned industrial and closed military sites on a continuing basis.
- Use of Geographic Information Systems (GIS) to reference the location of remediated and industrial sites relative to large population centers.
- Compilation and storage of data on site-specific problems, risk management decisions and liability laws that are relevant to the redevelopment of sites. Collaboration with the States and local authorities is essential.

2. Site Redevelopment and City/Regional Planning

The U.S. EPA has hitherto played no role in providing guidance to local governments and the states in the area of planning although those plans, when implemented, have significant bearing on environmental pollution and hence, human health. At a minimum, an advisory role by the Agency on City Planning and Zoning activities may enhance the implementation of reasonably uniform policies on site redevelopment across the country. This participation would also indirectly benefit other aspects of the Agency's budding programs for local communities, exemplified by Environmental Equity. In this regard, the following recommendations are made.

- Development of schemes to help local agencies in the formulation of zoning regulations to protect environmentally sensitive sites from excessive redevelopment.
- Involvement of the Agency in sustainable development forums that address the interrelationships among site redevelopment, urban renewal, legal liability, risk management, employment and transportation system efficiency.

3. Exposure Assessment and Site Cleanup Levels

Currently, cleanup levels for contaminated sites vary from one state to another. The issue of "how clean is clean?" has still not been settled yet. Existing cleanup standards have been largely developed without consideration of future landuse and risk management. The expected increase in remediated land redevelopment is a compelling argument for the integration of future landuse into contaminant cleanup standards for land. For sites that are candidates for future development, such cleanup standards should be credibly tied to the numerical regime of the risk of exposure of future residents or workers to residual levels of contaminants. Since the risk level depends partly on the design conservatism of yet-to-be-determined structural configurations, exact apriori analyses are not attainable. Nevertheless, information on the numerical regime of health risk will suffice as the basis for specifying relevant cleanup standards.

Both deterministic and probabilistic methods of risk assessment have been advocated for inclusion in U.S. EPA's risk management strategy for contaminated sites. Equation 1 represents the general configuration of the current U.S. EPA exposure assessment numerical relationship. It is herein used only for illustrating the relationship between exposure and facility design. There are several other exposure equations.

$$IN = [(C)(IR)(EF)(ED)]/[(BW)(AT)] \qquad (1)$$

IN = intake = amount of a specific chemical in a contaminated medium taken (mg/kg of body weight/day).

C = concentration = average chemical concentration contacted over the exposure period (mg/l, mg/mg).

IR = intake rate (or contact rate = amount of contaminated medium contacted per unit time or event) (mg/day or L/day).

EF = exposure frequency (upper bound value), (day/year).

ED = exposure duration (upper bound value), (years).

BW = body weight = average body weight over the exposure period, (kg).

AT = averaging time = time period over which exposure is averaged = exposure duration for non-carcinogens and 70 years for carcinogens, (years).

At any residually contaminated site that is a candidate for redevelopment, the parameters C, and EF, depend indirectly on the facility type and configuration, and the time of occupancy, respectively, of the facility constructed on the site. The residual concentration and transport characteristics of contaminants across the structural components into inhabited spaces affect exposure indirectly through direct effects on parameter C. Exposure is also affected by the type of structure. Over a reasonable time period (e.g., 1 year), people spend more time in residential housing than in warehouses and parking ramps. Equation 1 illustrates that this situation affects the exposure frequency. These factors should be considered by the U.S. EPA in the development of cleanup standards for contaminated sites slated for redevelopment. In general, the following recommendations are made.

- Review of current exposure and risk assessment methods to assess their adaptability to site redevelopment schemes.
- Development of numerical regimes of human health and environmental risks for redevelopment to provide developers with general data (with a caution that site-specific assessments are necessary).
- Assessment of the occupational health and environmental equity issues that are associated with site redevelopment.
- Specification of cleanup standards based on potential site reuse.

4. Engineering Mitigation Schemes for Structures

A preliminary analysis of the geoenvironmental engineering aspects of contaminated site development was made by U.S. EPA (1993). However, comprehensive geotechnical schemes have neither been developed yet by the Agency nor implemented widely by industry. During the past decade, the U.S. EPA in collaboration with local and other federal agencies, has developed geostructural systems for controlling human exposure to radon and its decay products at problematic sites. The conceptual configuration of one of these systems is shown in Figure 1. Other configurations and techniques are illustrated and discussed by U.S. EPA (1991b) and Murane (1993). Although some of these schemes may be adaptable with modifications, to mitigating residual contaminant transport in the vapor phase from soils into inhabited space, additional schemes need to be developed by the U.S. EPA.

Residual contaminants can migrate in the vapor, liquid and solid phases at contaminated sites under suitable geohydrological and other environmental conditions. The geotechnical design of the structural foundation system is also one of the determinants of contaminant migration potential. Realizations at gas stations above leaking tanks indicate that flaws in buildings can serve as conduits for contaminant entry. The development of such flaws in the long-term in structures can be enhanced by the structural instability of foundation site soils. Unfortunately, contaminated soil strength which will be an important parameter with respect to the stability of structural foundations in reclaimed industrial and contaminated sites, is not of significant concern in current U.S. EPA site assessment schemes.

The recommendations for improving the Agency's readiness in the geoenvironmental area are as follow:

- Development of general schemes for relating the design of geotechnical foundation schemes to exposure parameters.
- Integration of foundation stability assessments into contaminated site characterization schemes.
- Collaboration with the external geotechnical community to develop and evaluate protective foundation schemes for structures on reclaimed industrial sites as a natural follow-up to the issues discussed in U.S. EPA (1993).

5. <u>Education, Research and In-house Expertise</u>

In some cases where the potential exposure levels will be proven to be insignificant, some prospective residents of houses built on remediated land will still be fearful of residing in such houses. Community education schemes are recommended to minimize the fear factor where risks have been successfully mitigated.

The high prospects for large-scale land redevelopment in the U.S. requires that research be conducted on several relevant topics among which are the following.

- Contaminant attenuation characteristics of building materials.
- Effects of residual contaminants on soil strength.
- Barrier and sealants for controlling contaminant entry into structures.
- Identification and assessment of exposure scenarios relevant to contaminated site development.
- Interactions of socio-economic factors in contaminated site development.

- Comparative economics and environmental benefits of green versus brown sites development.
- Automatic sensing systems for contaminants in inhabited spaces.

The implementation of the recommendations made in this section will require the retention of a critical mass of in-house expertise by the Agency in relevant disciplinary areas. Unfortunately, most of the relevant issues need to be integrated directly into U.S. EPA's programs and hence, cannot be effectively managed by external contractors on a continuous basis. In addition, some of the issues involve the creation of policies which have significant technical components.

The Agency's laboratory personnel, technical analysts and work program managers are unlikely to cover all the technical grounds necessary to develop effective policies and technical schemes to address the issue of site redevelopment. These issues involve contaminant migration modeling, geotechnical reliability analysis, socio-economic theory, spatial data analysis, toxicology, soil and groundwater reclamation science, and geohydrology as major disciplinary areas. While the Agency retains expertise at the program management level in these areas, hands-on analysts with expertise on the issues described above are very few at the Agency. In particular, geotechnical expertise is almost non-existent in the entire Agency, perhaps due to the fact that relevant issues have traditionally been treated marginally within the general framework of environmental engineering. An improvement in in-house expertise is recommended. The Agency also needs to improve its collaborative efforts with other federal agencies such as the National Science Foundation and the National Institute of Health.

G. CONSEQUENCES OF DELAYED ACTION

The U.S. EPA needs to formulate policies and develop technical support schemes for integrating site redevelopment issues into its current and future regulatory and technical support programs. The undesirable consequences of delaying action until the occurrence of any of the two scenarios discussed above are outlined below.

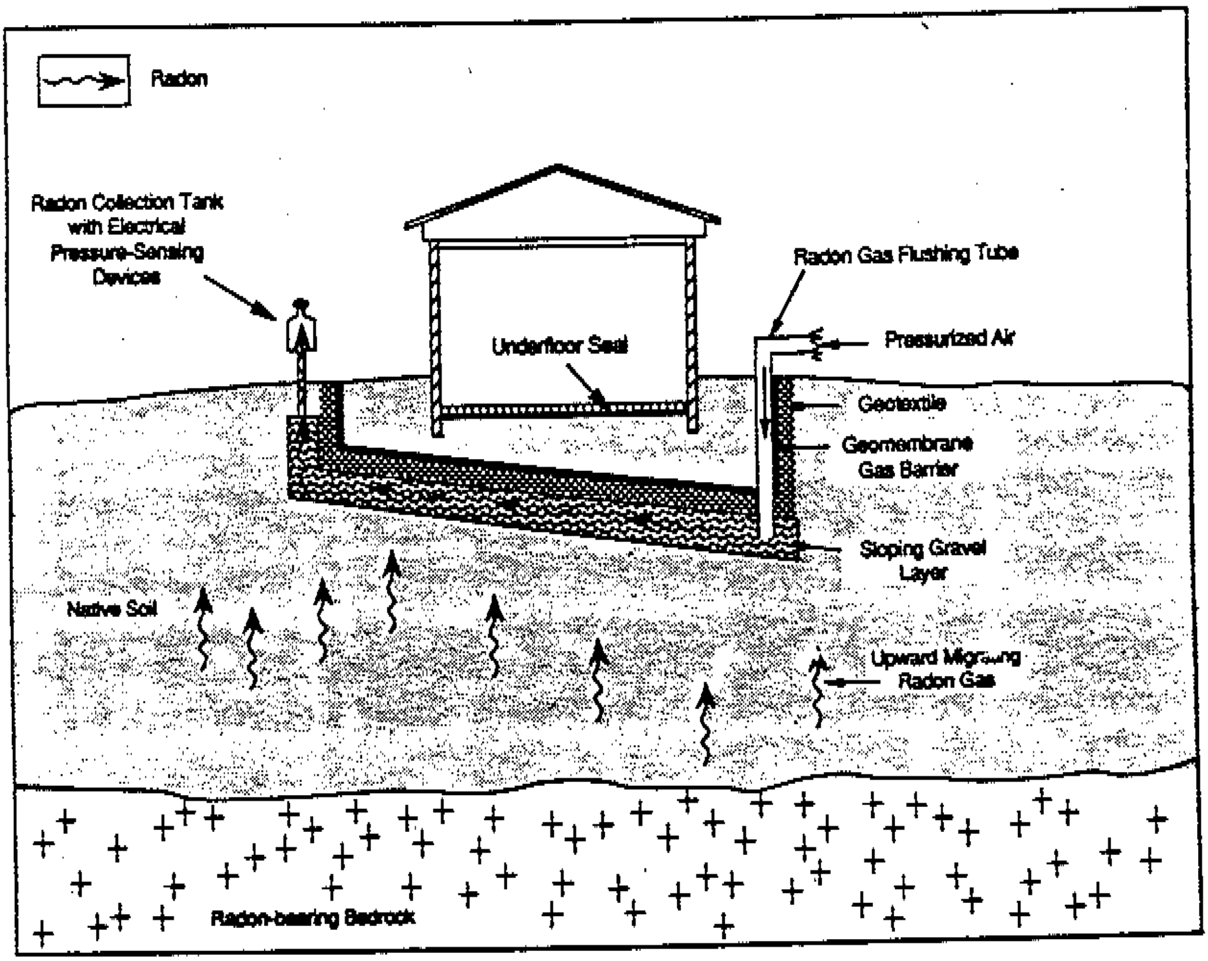

Figure 1. A conceptual scheme for controlling radon entry into a residential structure.

- The Agency will be forced to develop remedial rather than preventive schemes for mitigating potential harzards from reuse of abandoned and remediated industrial sites and installations.
- Liability concerns may force developers to target greener sites which can be spared instead of abandoned industrial sites and remediated land which can be beneficially utilized.
- It would take several years to appreciate the relevant occupational health hazards subsequent to uncontrolled redevelopment activities.
- The Agency would miss an opportunity to contribute to urban renewal projects which will eventually influence its programs such as Environmental Equity and Risk Assessment.
- Employment opportunities which would be created by urban site redevelopment projects would be missed.

H. CONCLUSIONS

Redevelopment of former industrial sites and other sites that may not be entirely clean will become more prevalent within the next thirty years. Changes in regulatory climate, socio-economic factors, risk acceptability and technological advances will serve as catalysts for this category of land recycling. Currently, the U.S. EPA does not have adequate policy and technical schemes to address the issues that will emerge. Considering that proactive schemes are generally more cost-effective than remedial schemes, the U.S. EPA has unique opportunities to develop schemes apriori to support and control the aspects of this issue that will fall within its mandate of protecting human health and the environment. Such schemes, if implemented wisely, can serve the interest of the U.S. public without stifling economic growth. This objective is relevant to the overall concept of sustainable development.

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Appendix 3: Transient Phenomena

by

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Final Draft of SAB EEC Futures Project
Report on Transient Phenomena

Sub-Task Group Member: F. G. Pohland
March 7, 1994

Global Goal

With prime responsibility for safeguarding and enhancing the quality of the environment and protecting human health, the U.S. Environmental Protection Agency (EPA) must develop a state of readiness to respond to any natural or anthropogenic threats, however engendered. Those threats that are posed on a continuum have received more attention from both prevention and remediation perspectives, largely because they frequently have recognizable and manageable spatial and temporal dimensions. On the other hand, less predictable transient phenomena, whose consequences may be shorter lived but much more severe and devastating, are often only considered in passing and unfortunately then only in a reactionary mode after the fact. This latter dilemma is exacerbated by the frequent division of responsibility and authority when disaster strikes, and the ability of available resources to take responsive action.

Since environment and human health are inextricably linked, with one affecting the other directly and indirectly in cause/effect relationships, the imposition of a transient phenomena as a driver may convert a hazard into a catastrophe. The magnitude and intensity of these events are often measured in terms of human health and welfare, as well as environmental perturbations, a domain often shared by EPA with other agencies. Yet EPA has not been an active player or led the pertinent agenda for natural hazard preparedness and/or mitigation, and it is currently not positioned to participate effectively either in developing policy or providing assessment and technological guidance.

Issues

The issues involved with transient phenomena include those elements of natural hazards that manifest themselves in threats to the environment and to public health and welfare. Although these phenomena encompass a broad array of events, including those triggered or driven by hydrological phenomena, e.g., river and coastal floods or tropical cyclones, and those consequenced by geological phenomena, e.g., earthquakes, volcanic eruptions or landslides, the selected subordinate issue and its plausible and important scenarios will deal specifically with the former, *vis-a-vis* riverine floods, and vulnerabilities expressed in terms of risks to populations and the environment as well as approaches to their mitigation.

Background

There are many compelling reasons to consider transient phenomena, such as floods, as a new and important area for EPA to embrace, and in that role help avert the consequences that often transform such hazards into disasters. Indeed, beyond the direct impacts on lives and property, there remain many indirect consequences that are often too obscure or subtle to receive adequate attention, whether driven by accidental releases of contaminants into the environment or malicious and/or opportunistic dumping. The implications of such scenarios are far-reaching and cannot be attended to properly in the disorder associated with the flood event, which often obliterates facts and disallows reasoned and reliable accounting.

Each year natural disasters kill thousands of people and inflict billions of dollars in economic loss. In 1987, the United Nations General Assembly adopted a resolution declaring the 1990s the International Decade for Natural Disaster Reduction (IDNRD). The U.S. Congress endorsed the concept in resolutions passed the following year, and a U.S. National Committee was formed to develop a program for the nation. In a National Research Council report (NRC, 1991), the Committee proposed a multidisciplinary program that integrates hazard and risk assessments; awareness and education; mitigation; preparedness for emergency response, recovery and reconstruction; prediction and warning; strategies for learning from disasters; and international cooperation. Nowhere in this report was a role for EPA explicitly defined, and visible EPA representation in its development and presentation was absent. Yet the area of mitigating and reducing the impacts of natural disasters, i.e., *protection of natural resources, research to improve prediction of hydrologic hazards and impacts on natural resources*, and *coordination and standardization of data collection*, stands out as initiatives within the mission of EPA.

A disaster is said to occur when an extreme event coincides with a vulnerable situation - surpassing society's ability to control or survive the consequences (The World Bank, 1991). Not every crisis is a potential disaster, but accelerated changes in demography and economic trends often disturb the balance, thereby increasing risks. Moreover, natural disasters are often caused at least partly by man-made changes in the natural settings adjacent to a vulnerable environmental compartment, e.g., a river, and there is evidence that worldwide incidence of deaths from extreme weather events (typhoons, hurricanes, floods and draughts) has increased by 50 percent on average each decade between 1900 and 1990, accelerating significantly since 1950 (OFDA, 1990).

Likewise, the damage caused by such events has escalated - increasing faster than population growth - with economic costs per decade increasing exponentially. Hence, there appears to be an apparent correlation between the frequency and severity of a natural disaster and environmental degradation, whether expressed in destruction of vegetative cover or in terms of landless squatters who concentrate in fragile, often marginal and orphaned areas, including those prone to flooding.

Floodplains particularly are at risk from riverine flooding and although they occupy only a small fraction of most urbanized areas, they tend to be proportionately more developed. For example, only 9.4% of the Boston urbanized area is in the floodplain, but this area accounts for 19.1% of the total developed area (Palm, 1990). This is compared to Denver where 50.5% is in the floodplain but contains 62.2% of the total developed area, and to Phoenix with 18.4% in the floodplain, but accounting for 89.2% of the developed area. Hence, urbanization in flood-prone areas has predictable consequences, whether manifested in accelerated runoff from rainfall events or water quality deterioration due to translocation of pollutants from urban sources. These and other ramifications can be anticipated and often translate in terms of adverse impacts on human health and the environment as depicted by the hazard sequence tree for thunderstorms in Figure 1.

Accounts of the <u>consequences</u> of flooding in the U.S. and throughout the world, as exemplified by the recent floods along the Mississippi River where property damage exceeded $10 billion and large portions of the nine contiguous states were declared federal disaster areas (National Geographic, 1994), and the recent flooding along the Rhine, Danube and smaller rivers in Germany, France, Belgium and the Netherlands (Reuters

News Service, 1993), underscore the urgency of attention to floods as a representative new horizon of EPA concern. The challenges of safeguarding populations from hazardous materials swept away by flooding along the Mississippi, monitoring pollutants from unidentified sources, and restoring the integrity and dependability of wastewater and drinking water services constitute only a few issues on an agenda for action that involves short-term and long-term implications for both policy and technological decisions. Congress has mandated attention to such natural hazards, and EPA has a vital role to play in its evolution.

Goals

To effectively contribute to an action plan for assessing and providing potential remediation of the consequences of natural hazards in the area of floods, and to act consonant with its mission as the lead environmental agency of the nation and in accordance with the NRC Report recommendations, EPA will need to expand its current activities and develop appropriate policies and strategies to address environmental and health/welfare aspects of:

- Hazards and Risk Assessments
- Mitigation and Prevention
- Emergency Response
- Prediction and Warning
- Data Acquisition and Validation
- Education and Technology Transfer

Whereas floods can serve as a representative example, the effort should embrace the entire range of those natural disasters creating environmental risks.

Objectives

Whereas the consequences of flooding (or other hazards) are evident, as is the often lack of coordinated planning for or reacting to a given scenario, the benefits derived from a proactive program in accordance with the indicated goals could include:

- Reduction in life and property losses
- Marginal land rehabilitation, zoning and conversion
- Safeguards against flood-derived contamination and its microscale and mesoscale effects on human and natural resources
- Provisions for developing flood-specific data bases and guidance to the public and private sectors
- Catalysis of research and development for innovative preventive and remedial technologies.
- Beneficiation of EPA's image as important contributor to reducing impacts of natural disasters and promoting a safer future for impacted populations.

Strategies and Methodologies

To effectively address the assessment and ability to respond to transient phenomena such as natural disasters, it is considered prudent for EPA to recognize the breadth and depth of cause/effect relationships inherent in particular driver events. This requires not only a sufficient understanding of the event, but how it manifests itself within the arena of impact. Therefore, an environmental impact assessment could be the primary focus, allowing ancillary issues to play out as a particular scenario unfolds.

There is already considerable understanding of the phenomena that may create natural disasters, and a wide array of published literature is available. Likewise, there is guidance for policy makers and planners to better understand and mitigate natural disasters (United Nations, 1991). These sources not only deal with floods, but with the array of possibilities either alone or in combination. In addition, there are detailed reports of various natural disasters that provide retrospective opportunities to learn from related experiences, whether a Valdez grounding, infrastructure collapse, a Bophal industrial disaster, or a terrorist action. Each such disaster tends to provide new insights and horizons not otherwise recognized; in the case of the Mississippi floods, subsequent assessments revealed both microscale and macroscale impacts, including, for instance, the unknown consequences of excessive fresh water discharges on saline environments from the Gulf of Mexico, around the tip of Florida, and up the Northeast Coast and the nearly million metric tons of nitrate were transported in the process (USGS, 1993). Moreover, in all such circumstances, a range of scenarios can evolve between a state of preparedness to one of non preparedness at the opposite extreme. Hence, it would be instructive to develop cause/effect matrices within these two bounds, identifying the drivers creating the potential hazard, and evaluating the environmental impacts accordingly.

The natural hazards sequence tree approach previously introduced (Figure 1) could be used to reveal direct and indirect causal factors that could trigger possible adverse impacts. Then by using a network analysis (Westman, 1984) incorporating the vulnerable environmental compartments (e.g., water supplies, aquatic ecosystems, etc.), the initial and final effects, controlling mechanisms, and possible corrective action, adjusted in terms of magnitude, importance and probability of occurrence as dictated by the particular selected preparedness scenario, the most drastic output would be determined for the case of non preparedness, while the others would be some increment thereof and lessening with degree of preparedness.

The product of such a network analysis could be articulated in the form of a hazard summary directed at the environmental compartment of focus, arrayed in terms of magnitude, importance and estimated probability, and fortified by pertinent descriptive comments drawn from antecedent knowledge and experiences. If extended to other disasters besides floods, it could take the form of a disaster effects matrix showing likely damage, loss, shortage, etc. consequenced by the respective disasters on various system components, as "what if" scenarios are imposed. Such an approach has been advocated for water utilities (Shimoda, 1994) to establish protocols and action plans for emergency preparedness and response (Table 1).

Since environmental impact assessment involves crossdisciplinary expertise and focus on health and natural resources often within the domain of the missions of other federal and state agencies, responsibility for developing and implementing strategies and methodologies should be shared, but EPA should assume a leadership role on issues involving assessment of environmental consequences of the various transient phenomena.

Such coordination is vital, so that the established FEMA, NOAA, and Corps of Engineers programs for emergency response, prediction and warning, and mitigation, respectively, can be broadened to embrace a responsibility to acknowledge, prevent or mitigate also the *environmental consequences* of transient phenomena.

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Figure 1

NATURAL HAZARDS SEQUENCE TREE (after May, NRC)

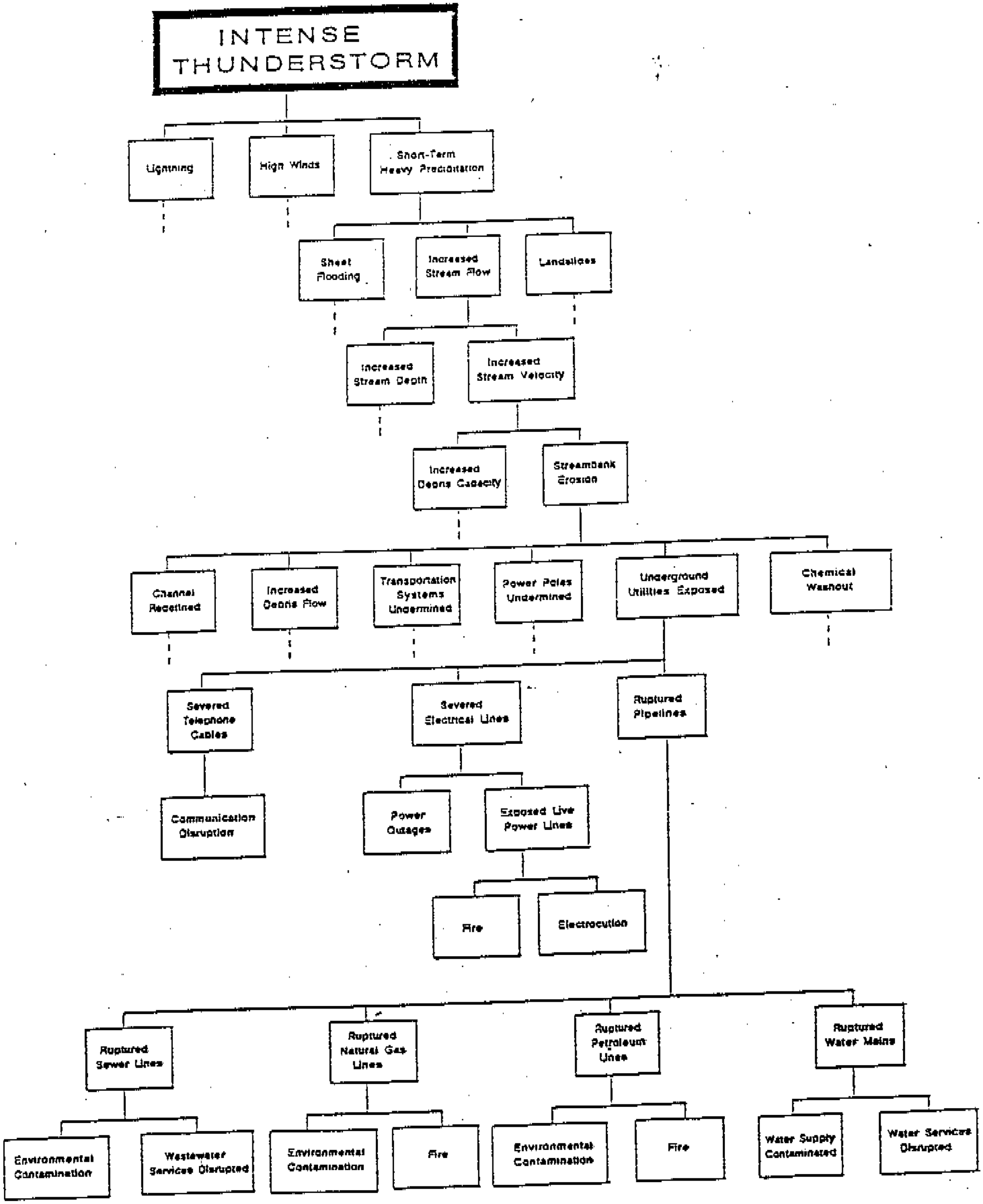

Table 1

Disaster Effect Matrix Showing Likely Damage, Loss, or Shortage Resulting from Hazards [Shimoda, 1994]

System Components	Earthquakes	Hurricanes	Tornadoes	Floods	Forest or Brush Fires	Volcanic Eruptions	Other Severe Weather	Water Borne Disease	Hazardous Material Spill	Structure Fire
Administration/operations										
Personnel	•	•					•	•		
Facilities/equipment	•	•	•	•	•	•				•
Records	•	•	•	•	•					•
Source water										
Watersheds/surface sources		•		•	•	•		•	•	
Reservoirs and dams	•	•		•				•	•	
Groundwater sources				•					•	
Wells and galleries	•	•	•	•		•	•		•	
Transmission										
Intake structures	•		•	•		•	•			
Aqueducts	•									
Pump stations	•	•	•	•	•	•	•		•	
Pipelines, valves	•						•			
Treatment										
Facility structures	•	•	•	•	•	•	•			•
Controls	•	•	•	•	•	•	•			•
Equipment	•	•	•	•	•					•
Chemicals	•	•	•	•	•					•
Storage										
Tanks	•	•	•		•	•	•	•	•	•
Valves	•						•			
Piping	•						•			
Distribution										
Pipelines, valves	•	•					•	•	•	
Pumper PRV stations	•	•	•	•	•	•	•			•
Materials	•	•		•	•					•
Electric power										
Substations	•	•	•	•	•		•			•
Transmission lines	•	•	•	•	•		•			•
Transformers	•	•	•	•	•	•	•			•
Standby generators				•						•
Transportation										
Vehicles		•	•	•	•		•			
Maintenance facilities	•	•	•	•	•		•			•
Supplies		•		•	•					•
Roadway infrastructure	•			•		•	•			
Communications										
Telephone	•	•	•	•	•		•			•
Tow-way radio										
Telemetry	•		•	•	•	•	•			

Appendix 4: Core Competency

by

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Core Competency

Prepared for the SAB/EEC Futures Project

Introduction

The purpose of the EPA SAB Environmental Futures Project is to assist in the continued development of EPA's capacity to anticipate environmental problems, issues, and opportunities. The Environmental Engineering Committee has focussed on three scenarios that might occur in the future, analyzed the consequences of these scenarios if EPA continued on their current course of action, and has made some recommendations on how EPA could more appropriately respond to these future issues resulting from the scenarios. These scenarios are clearly not the only scenarios that could happen in the future. Nonetheless, it is crucial for the EPA to be ready for any foreseeable or unforeseeable event that falls within the mission of the agency. Since no scientific method exists to truly predict what scenario will occur, a solid foundation of underlying skills, knowledge, technology, and science which enable Agency to deliver the products and services suitable to respond to any plausible scenario, is needed.

The concept of core competency has been developed and used by industry and other agencies to represent those necessary underlying skills, knowledge, technology and science to carry out their mission (see attachment). The definition of core competencies adopted here is as follows:

> "the essential and distinct scientific and technical capabilities that enable the EPA to fulfill it's current and future missions."

This paper will focus on the need to systematically analyze and define those core scientific and technical competencies needed by the Agency to respond to problems, issues, and opportunities in the future, and to define a process to continue the study.

Drivers

Reduced resources will likely be available to the EPA in the future to address environmental issues. At the same time there will be significant pressure on the Agency to approach regulations from a holistic approach i.e., address multimedia pollutants from all sources using not just end of pipe control but true pollution prevention. Hence with less resources the EPA will have to marshall multi-disciplinary teams to address multi-pollutant problems. In addition, there is a need for even more rapid response to environmental problems associated with transient phenomenon such as natural disasters and terrorism, since in these instances, there is little time to conduct studies and develop expertise after the transients occur. Thus in the future, the Agency must be able to respond faster to broader environmental issues but with less resources.

There will be a significant need to extract information from ongoing activities and advances taking place outside of the Agency due to the availability of less resources at the EPA to address broader issues. It is important to determine what other agencies are doing in the environmental field in order to avoid duplication of effort and to determine if the EPA should develop its own core competency in certain areas or rely on others. The concept of virtual companies could be applied to government agencies i.e., the EPA could serve the role as a clearinghouse and coordinator of all environmental activities for all other agencies. Nonetheless, the Agency will need to have the skilled expertise to be able to recognize and to use these external resources and advances. In addition, an infrastructure will be needed to allow the use of information generated by other agencies and to use the core competencies of other agencies particularly with less overall funds.

Scenarios

The scenario that arises from these drivers is that in the future, EPA will have less resources with which to deal with broader multimedia pollutant issues and must deal with some of them in a more rapid fashion due to their transient nature. The Agency will lose core competency that is needed to address these new problems. Other government agencies will play a much more significant role in environmental research and development.

Consequences

The consequence of this continued loss of competencies will be the following:

1. Loss of capability to serve customers. Understandably, "technology alone cannot solve environmental problems", as suggested in the Environmental Futures Project joint WRI and EPA study. On the other hand, another issue that emerged from the same study is "despite the potential of innovative technologies to improve environmental quality in many instances, this potential may not be fully realized." Unless critical expertise and technologies are defined and nurtured, the EPA will not have the capability to respond effectively, regardless of the legislation and regulations that exist.

The EPA's products and services are typically regulations, procedures, scientific knowledge, technologies, and deployment services. The level of competence needed to deliver such products is built over many years. It is not equivalent to building widgets, nor is it equivalent to simply responding to customer requests. Customers include those who pay for, use, and/or benefit from products and services. Therefore, the EPA customers are many, including Congress, taxpayers, industry, academia, and most importantly, the public at large. The very nature of the work requires that the Agency develop a strategic vision, and prepare itself now for the types of products, services, research and development needed to assure a healthy nation. It is equally important that the Agency not overlook, or simply take for granted current competencies required for the future. Only through careful study and analysis will the critical competencies be identified and developed.

2. Inadequate basis for decision-making. If evidence exists that current competencies are not being adequately funded, the EPA will not be in a position to fully carry out its responsibilities. The possibility exists that the competence will be lost in Congressional budget debates. Particular emphasis should be placed on those competencies which cut across national programs and their applications. For example, DOE Defense Programs identified materials as critical to both defense and non-defense applications. They believe that they must stay on the cutting-edge of materials science to fully address civilian and economic competitiveness as well as weapon stockpile problems. Of course, not all technical capabilities can be equally funded, especially with declining budgets and tighter resources. Nor should they be. This type of approach to defining those competencies which are critical to EPA's future provides a basis for decision-making and priority-setting, elements which are essential to the current management approach within the EPA.

3. Short-term approaches and solutions. Prahalad and Hammel suggest that, "If core competencies are not recognized, individual units will pursue only those innovation opportunities that are close at hand-- marginal product-line extensions or geographic expansions." Related to the EPA, unless competencies are identified and developed, programs may pursue only those solutions that are relative to the specific problem at hand, perhaps overlooking a more global, future need that could be addressed with a shift in program definition and priority, and thereby simultaneously building future competencies. It is this type of comprehensive view of Agency-wide competencies that will sustain the Agency as the respected leader. According to the final Megatrends report,

"Comprehensive, multi-disciplinary, and integrated solutions will be necessary to solve future environmental problems."

4. Lack of science transferred to technology. The Megatrends report also identified seven critical challenges the Agency will face in the future. Challenge #5 outlined in the report states, "To create a world-class scientific capacity within EPA in order to give the Agency the ability to develop and utilize new knowledge and to serve as a catalyst for technology innovation critical to achieving the nation's environmental objectives." The authors of this report have recognized the need to identify and maintain the scientific knowledge base and technologies to carry out the EPA mission.

Mitigating Actions

1. Identify critical core competencies. The EPA's primary mission is to protect the environment and the health and safety of all Americans. Over the years, EPA-sponsored programs and activities have been able to respond to key developments and events to assure environmental health and safety. However, it is simply not enough to assume that the future quality of EPA response will equal those of the past. In fact, one premise is that unless critical competencies which are needed to anticipate significant impacts and carry out future programs are defined and nurtured, the opposite will occur. Objectives should be developed for building competencies in line with strategic directions and vision, and investments must continue to be made to ensure the Agency's viability in these critical areas.

As a regulatory agency, the EPA is responsible to the public to implement Congressional legislation. As a result, the programs are structured according to the legislative acts, and in the last five to ten years, the focus of the work has shifted from ensuring a scientific base for environmental protection to developing, implementing, and monitoring regulations. The agency's effort to strengthen and even maintain current competencies has gotten pushed to the "back burner" as Congress foisted more regulatory activity related burdens onto an increasingly over stretched EPA. The question now is to what extent will the Agency be able to respond to future events and uncertainties when most of its focus has turned to regulation development and its enforcement? What scientific and technical expertise, knowledge, and capabilities are being lost or ignored in the quest to simply regulate?

2. Identify critical core research. One critical component of maintaining core competencies is to maintain critical core research programs. The Agency must provide a leadership role by formulating and executing a core research program that help solve environmental problems associated with all types of industrial, commercial, and municipal operations well into the next century. As the scenarios defined in this study have shown the future holds potentially new problems that are yet to unfold for both the U.S and the world. New technologies and manufacturing processes will be required to respond to these problems. The developed countries cannot solve global environmental problems alone. Environmentally acceptable control measures and technologies must be developed and deployed in a cost effective manner by the developing nations to prevent the continued deterioration of the global environment. However, these new problems will also generate a new opportunity for U.S. industry. The national and international market for environmentally acceptable technologies will grow rapidly in the next decade. For example, reduced imports of petroleum products and the export of environmental technologies could help to reduce this country's trade deficit.

The EPA has a unique mission to protect the environment and must establish core research programs in several key areas. This core research must be crosscutting. Basic processes that are common to numerous emissions issues should be addressed concerning all-gaseous, liquid and solid effluent and wastes. For example, research on the formation and destruction of a particular by-product can be applicable to a wide range of processes. The application of knowledge generated by a basic research program will identify and facilitate the solution of environmental problems of the next twenty years.

The EPA should maintain a solid core research program with the following objectives: 1) drive pollutant reduction technology to the limit of technical and economic feasibility; 2) develop the capability to predict the amount of all pollutants present in the effluent streams of all sources; 3) promote pollution prevention and the development of low pollutant technology for existing and new advanced systems; 4) provide a science and technology base for regulations.

The EPA is the only Agency with the authority to regulate all industrial, commercial, and municipal systems that have the potential to emit pollutants in harmful concentrations. Also, the Agency has the unique mission to protect human health and welfare and to conserve the environment. In certain areas the EPA is cooperating with other countries to control pollutants that transcend national boundaries. A core research program must be started by the Agency to generate basic information that will: 1) provide the impetus to develop new technologies; 2) help the development of future regulation by providing a sound scientific base, and 3) help to identify and solve environmental problems created by future developments.

The EPA core research program should be focussed on prevention, and must be distinguished from the efforts of other agencies. More importantly, the plan must concentrate upon preventing pollutant formation thereby avoiding the additional complexity and expense of downstream controls. In addition, the results of the research must be quantifiable. The plan should be closely coupled with real world problems and be applicable to all industrial operations and pollutants. It should generate identifiable products in both the near and the long term. These products may be procedures, solutions to problems or prototype pollution control systems and therefore, the results of the research plan will be readily quantified.

The core research program should be based upon two components, cornerstones (applied system specific development projects) and a keystone (broadly based fundamental research). Cornerstones are vertically integrated development projects targeted at specific problems with outputs including new systems; retrofit technologies, and design procedures. The keystone is the heart of the plan. It includes basic and engineering research programs that have long-term applicability to a wide range of problems.

<u>3. Adopt management approaches which use the core areas.</u> Simply the identification of these critical areas will not suffice. Only if the Agency uses the information when making management decisions such as establishing strategic directions and plans, investments and disinvestments, alliances and partnerships, and identifying process reductions and organizational streamlining, will the information be of value. Programs which add to the scientific base in at least one of these critical areas should become high-priority. Additionally, the critical areas can be exploited to identify new programs and applications to respond faster to broader issues.

Metrics should be implemented to determine the accuracy of the identified areas and to provide management with facts to consider when making decisions. A critical metric is the extent to which the results of the research areas are transferred to others who can use the information to develop proprietary products and procedures. Industry must take part, but the EPA provides an impartial role ensuring that the benefits of this important core research program are readily available.

The EPA must assume a corresponding leadership role with the participation of industry and other societal factors. There must be a balance between in-house and extramural activities, depending on where the core competency lies. The technical leadership resides within the EPA laboratories, and the EPA must make a long-term commitment to research to attract and retain top flight researchers to assume this leadership role.

Recommendation

In order to more rapidly respond to multimedia emissions with less resources, the agency must fully define and invest in the Agency's core and research competencies. To fully define the critical core and research competencies for the future, the following process is recommended:

1) Analyze Current Programs and Future Scenarios for Competency Components

This step provides the analysis required to understand technical capabilities, technologies, and other expertise required to successfully address both current programs and future scenarios within the Agency. Once all the components are defined, they are aggregated to identify clusters and similarities so that higher-order groupings can be defined. These groupings become one input to defining critical competencies for the Agency (Set A).

2) Generate Strategic Directions

Strategic planning should run parallel to the step above. However, since the information from this process should be considered in planning, this step refers only to strategic guidance and directions. Needed here are upper management and planners views of the futures with the most probable potential, issues that will face the Agency, and their vision of the Agency's new mission and management principles. A second input data set is generated (Set B).

3) Benchmark Industry, Other Agencies and Academia Competencies

In this step the Agency compares the critical competencies from step one to those that industry, other government agencies and academia believe to be important. Naturally, a federal Agency should not duplicate their competencies. Instead, duplications should be identified, questioned, and appropriately assigned. Critical gaps should be identified and discussed, and new slants on older technologies should be investigated. This provides the third set of input data (Set C).

4) Reconcile Input Data to Determine EPA Core Competencies

Bring the three data sets together to define the EPA Core Competencies. Contrasts and comparisons should be made across data sets to identify critical areas. This step, in particular, should be conducted with a number of customer representatives to achieve consensus on the areas. This process is similar to the one successfully implemented by Sandia National Laboratories. More recently, DOE is applying similar concepts in their decision-making processes.

Attachment

Definitions

Business Core Competency Definition. According to Prahalad and Hammel, "Core competencies are the collective learning in the organization, especially how to coordinate diverse production skills and integrate multiple streams of technologies." (Harvard Business Review, May-June 1990). Core competencies are not only technical capabilities, but are the unique combination of several components (e.g., capabilities, technologies, facilities, communication streams, skills, expertise, systems, etc.) that enable an organization's products and services to surpass others. They create the differentiating edge needed to create and capture a market.

DOE's Core Competency Definition. In a report dated January 15, 1993, from the DOE Assistant Secretary of Defense to the Secretary of Energy entitled, "Core Competencies Required to Fulfill the Strategic Vision of the Defense Laboratories", core competencies are defined as, "the essential and distinct scientific and technical capabilities that enable the Defense Laboratories to fulfill their defense-related DOE mission responsibilities."

EPA's Core Competency Definition. Prahalad and Hammel's definition is applicable to industry and the marketplace, the DOE definition applies to government agencies and their need to remain the central repository of scientific intelligence in support of their mission, and therefore more applicable to our task. Also, this project has an emphasis on the future. Therefore, the definition of core competencies adopted here is as follows:

> "the essential and distinct scientific and technical capabilities that enable the EPA to fulfill it's current and future missions."

Appendix 5: Futures Methodology

Recommended Issue Identification and Assessment System
Possible Structure and Operation of an EPA "Look-Out" Panel

by

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Prepared for the EEC Futures Project

Recommended Issue Identification and Assessment System

Considering the lessons learned by the EEC Futures Writing Committee, we recommend that the Environmental Protection Agency implement a system for detecting and analyzing incipient future issues. The system should have the following characteristics; it should:

draw input from a wide range of sources.

operate in a continuous rather than a "one-shot" mode.

have a memory, so that suggestions that are set aside today for lack of data or interest can be reassessed in the future.

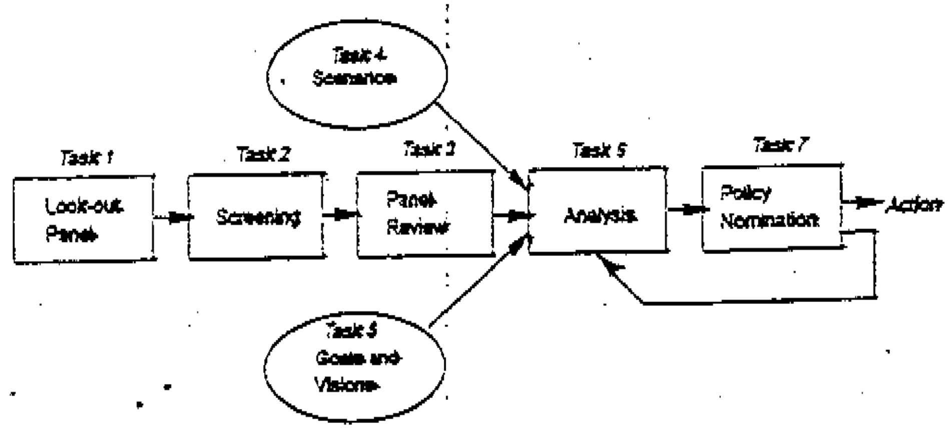
be quantitative, wherever possible.

be subject to scrutiny by people outside of the process.

make goals explicit.

recognize that many futures are possible.

One such system is illustrated and described below. We envision this system being run by EPA staff and involving experts both from within and outside



A System For Anticipating and Evaluating Future Environmental Issues

Gordon

the agency.

The central purpose of the panel illustrated in Task 1 is to identify issues, trends and developments that could have a significant impact on the nation's environment or EPA's mission, strategies, or objectives.

The panelists would be contacted on-line, through the mail, or by fax to scan their fields and provide observations about new or intensifying issues that might face EPA. They are also asked for judgments about plausible goals for the Agency and the environment and possible means for achieving these goals. (1)

Because the number of respondents is usually small, a "look out" panel will not produce statistically significant results; in other words, the results provided by the panel will not predict the response of a larger population or even the findings of a different panel. They represent the synthesis of opinion of the particular group, no more or less.

The results produced by an EPA "look out" panel will depend on the knowledge and cooperation of the panelists; for this reason, it is essential to include persons who are likely to contribute valuable ideas. In a statistically based study such as a public opinion poll, participants are assumed to be representative of a larger population; in panels of this sort, non-representative, knowledgeable persons are needed. The EPA laboratory directors, division chiefs, state environmental personnel, representatives of environmental action groups might be invited to participate.

The screening step, Task 2, would employ criteria of the sort the EEC has found useful in assessing the priority of issues, such as:

scope (i.e. the number of people affected)
severity
novelty
plausibility/probability/certainty
uncertainty
irreversibility
imminence
visibility/publicity

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(1) Some of the material describing the panel is drawn from letter from T. J. Gordon to Dr. Ray Leohr of the SAB.

The issues of Task 1 would be screened according to such criteria and the top rated set fed back to the panel in Task 3. Here the panelists would be asked to comment on issues suggested earlier by others on the panel.

Those issues surviving scrutiny would flow to Task 6, Analysis. This quantitative assessment work would be accomplished by staff, appropriate Scientific Advisory Committees and outside consultants. It would be, at this stage, an early evaluation of the extent of the problem and result in recommendations about the need for future data collection, study, and policies.

The analysis would be conducted against the backdrop of the reference scenarios developed in Task 4 and goals and vision of the future environment developed in Task 5.

Task 4, Scenarios, involves the production and maintenance of a set of scenarios that capture the evolution of drivers and environmental prospects in the United States and other countries; it also is the home of quantitative environmental models and monitored environmental variables that can be used in analyses of future issues. It would be accomplished by staff.

The goals and vision statements of Task 5 represent the desired future state of the environment. Again, these visions would, to the extent possible be in quantitative form and maintained by staff.

Policies suggest by the Task 6 analysis would tested analytically and submitted to the panel for qualitative judgment in Task 7. Those policies that are found to bring the expected future state closer to the desired goals and visions would be recommended for action.

Possible Structure and Operation of an EPA "Look-Out" Panel

The central purpose of an EPA "look-out" panel would be to identify trends and developments that could have a significant impact on the nation's environment or EPA's mission, strategies, or objectives. (1)

Picture the panel in operation. Participants seldom meet face to face; rather they are asked on-line, through the mail, or by fax to provide several kinds of judgments:

> They are asked to scan their fields and provide observations about *de novo* or intensifying issues that might face EPA.
>
> They are asked for judgments about plausible goals for the Agency and the environment and possible means for achieving these goals.
>
> They are asked to comment on the observations about issues, goals and policies made by others on the panel.
>
> In some instances they are asked to provide data, if available, to back up their positions.

From a substantive standpoint the issues addressed by the panel are associated with the environment or EPA's policies and regulations. The issues can focus on essentially any topic; for example highly technical discussions about risk and dosage to discussions about the future political force of a "environmental justice" movement. The geographic scope of the panel's activity concentrates on the US but world issues are fair game if, in the end the US might be affected.

The time horizon is flexible. On the one hand the panel doesn't move so far out that the discussion becomes esoteric; on the other hand the panel includes issues- no matter what their timing- that could be mitigated by immediate action. The rule of thumb is that "we go out in time as far as is necessary to identify problems that could or should trigger action tomorrow."

With this image in mind some daunting questions arise:

> Just how can the participants be chosen? What should be their range of expertise? Should they be specialists or generalists? Should there be a fair sampling and representation of various view points in the make-up of the

panel? Should all panelists be scientifically or technically oriented? How can the public participate?

If the panel is large, how can the right question be asked of the right person to avoid burdening every one with the chore of reviewing every question? What questions should be asked?

What media should be employed? E- mail communications are preferred, not only because of the low cost of transmission but because electronic responses are much easier to collate. But *requiring* communications by e-mail will effectively deny access to many people who might have great deal to contribute.

The Millennium Project Feasibility Study (conducted by the United Nations University under contract to the US EPA) defined three kinds of questions might be asked of participants in a panel of this sort (2):

forecasts of the occurrence of future developments. Forecasts of future developments call for answers about when an event is expected to occur or about the future value of some trend or parameter. We include here observations about some worsening aspect of the environment and speculation about its possible consequences.

the desirability of some future state. Questions dealing with desirability ask for judgments about whether an event **ought** to occur, and the basis for the recommendation.

the means for achieving or avoiding a future state. Questions dealing with policy involve the traditional reporter's questions about implementation seem appropriate here: who, what, when, where, and how much? But to this set we must add: To what end. In other words, questions about policy ought be linked closely to the objectives sought and the likelihood that any policy will, in fact, accomplish its intended goals.

These three types of questions may require different kinds of experts. The likelihood questions may involve hands-on experience and intimate knowledge of the frontiers of research. The desirability questions may involve a moral, political or social dimension quite distinct from the disciplinary expertise involved in judging likelihood. The policy question may involve knowledge of the art of the possible and political savvy.

With the advent of the wide use of Internet and electronic bulletin boards, one is tempted to simply say, "Let the discussion of these sorts of questions be wide open. Use little structure. Let the conversation flow as it may." This, I think, will not prove to be efficient. Rather, I recommend a structure based on the Delphi method developed at RAND in the early 60's and used many times since.

The RAND researchers explored the use of expert panels to address forecasting issues. Their reasoning went something like this: experts, particularly when they agree, are more likely than non experts to be correct about questions in their field. However, RAND (and many others) found that bringing experts together in a conference room introduces factors that may have little to do with the issue at hand. For example, the loudest voice rather than the soundest argument may carry the day; a person may be reluctant to abandon a previously stated opinion in front of his peers. The give and take of such face to face confrontations often gets in the way of a true debate.

The Delphi approach was designed to eliminate the principle obstacles to conference room meetings of experts. In most applications:

> Several rounds are employed; general questions are asked in the first round.
>
> In a second round, reasons for extreme positions are sought.
>
> These reasons are fed back to the group in a third round with instructions to reassess positions in view of the reasons for extreme opinions.

To encourage a true debate, independent of personalities, anonymity is required in the sense that no one knew who else is participating. Further, to eliminate the force of oratory and pedagogy, the reasons given for extreme opinions are synthesized by the researchers in order to give all of them equal "weight". These aspects: anonymity and feedback represent the two irreducible elements of a Delphi study.

In the early days driving toward a consensus was important. Today, consensus is less important for many investigators than it used to be; now a useful product of such studies is crystallization of reasons for dis-sensus. Furthermore, this process is now seen as no more or less than a systematic means of synthesizing the judgments of experts- the aggregate judgment representing a kind of composite expert composed, in the domain of interest, of the expertise of all of the participants.

Some researchers have found that Delphi when used in forecasting does not provide more accurate answers than other methods and that consensus occurs as a result of pressure brought on participants that have extreme opinions. (Woudenberg, 1991) Even if this is so, our application here is more modest that accurate forecasting: it is simply an efficient way to gather, synthesize, and explore expert opinion.

There are major difference between a "classical" Delphi and the use proposed here. First, we are not very concerned with forecasting accuracy; rather we want to surface observations about possible deleterious developments and engage in a structured, multi-disciplinary discussion, about the potential evolution and consequences of the developments. Second, this is not seen as a "one-shot" study, but rather an on-going, continuous inquiry. But the process uses anonymity and feedback to advantage.

Because the number of respondents is usually small, a "look out" panel will not produce statistically significant results; in other words, the results provided by the panel will not predict the response of a larger population or even the findings of a different panel. They represent the synthesis of opinion of the particular group, no more or less. The value of a this work will rest with the ideas it generates, both those which evoke consensus and those that do not. The arguments for the extreme positions also represent a useful product. This will not be a substitute for analysis, it will provide only an early warning, or hints that deserve follow up.

The results produced by an EPA "look out" panel will depend on the knowledge and cooperation of the panelists; for this reason, it is essential to include persons who are likely to contribute valuable ideas. In a statistically based study such as a public opinion poll, participants are assumed to be representative of a larger population; in panels of this sort, non-representative, knowledgeable persons are needed. So the first problem to be addressed is how to select potential participants. The EPA laboratory directors, division chiefs, state environmental personnel, representatives of environmental action groups all come to mind.

But how about "unknown" people who are outside of the normal lines of communication but who may be able to contribute new and valuable perceptions? Here are some suggestions:

use bulletins boards to identify contributors who have something to say

get recommendations from university professors about bright students

advertise for participants

Detailed design, of course, will rest with the EPA staff. But here are some thoughts about ***structure and operations*** to trigger discussion:

The panel is made up of invited expert participants, from EPA, the environmental community as well as the public, primarily from the US but other countries may be represented as well.

Anonymity (in the sense that comments will be unattributed) is promised and feed back of information is used in sequential questionnaires.

Panelists are encouraged to initiate contact whenever they see looming issues.

Non EPA personnel are paid for their time and communications costs.

The panel operates continuously.

Questionnaires are drafted by staff and send to the participants by fax, e-mail and mail.

One part of every questionnaire will request perceptions about newly observed nascent issues; another part will request comments issues reported by others in earlier rounds. Questions may also be included seeking judgments about goals and contemplated policies.

A "filtering" system will be used by staff to assure that the right questions go to the correct persons, while not missing the opportunity to gain contributions from those outside of the topic area.

Review of responses is careful; reports are made periodically and provided to the panelists.

Also, consider the possibility of:

establishing a set of indicators, the future of which can be assessed by the panel in view of the issues they discuss.

an annual meeting of participants

Ted Gordon
January 25, 1994

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(1) In this discussion, I have used the term "look-out" as a substitute for the more usual term "environmental scanning" to avoid the potential confusion in the use of word "environmental" in this context. "Environmental scanning" encompasses the total environment surrounding an activity: economics, markets, technology, social change, regulation, etc.

(2) T Gordon and J Glenn, "Issues in Creating the Millennium Project." United Nations University, funded by US EPA, October, 1993. Some of the material in this paper is drwan from this source.