Shaping Our Environmental Future:

Foresight in the Office of Research and Development

Office of Science Policy
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U.S. Environmental Protection Agency
Washington, DC 20460

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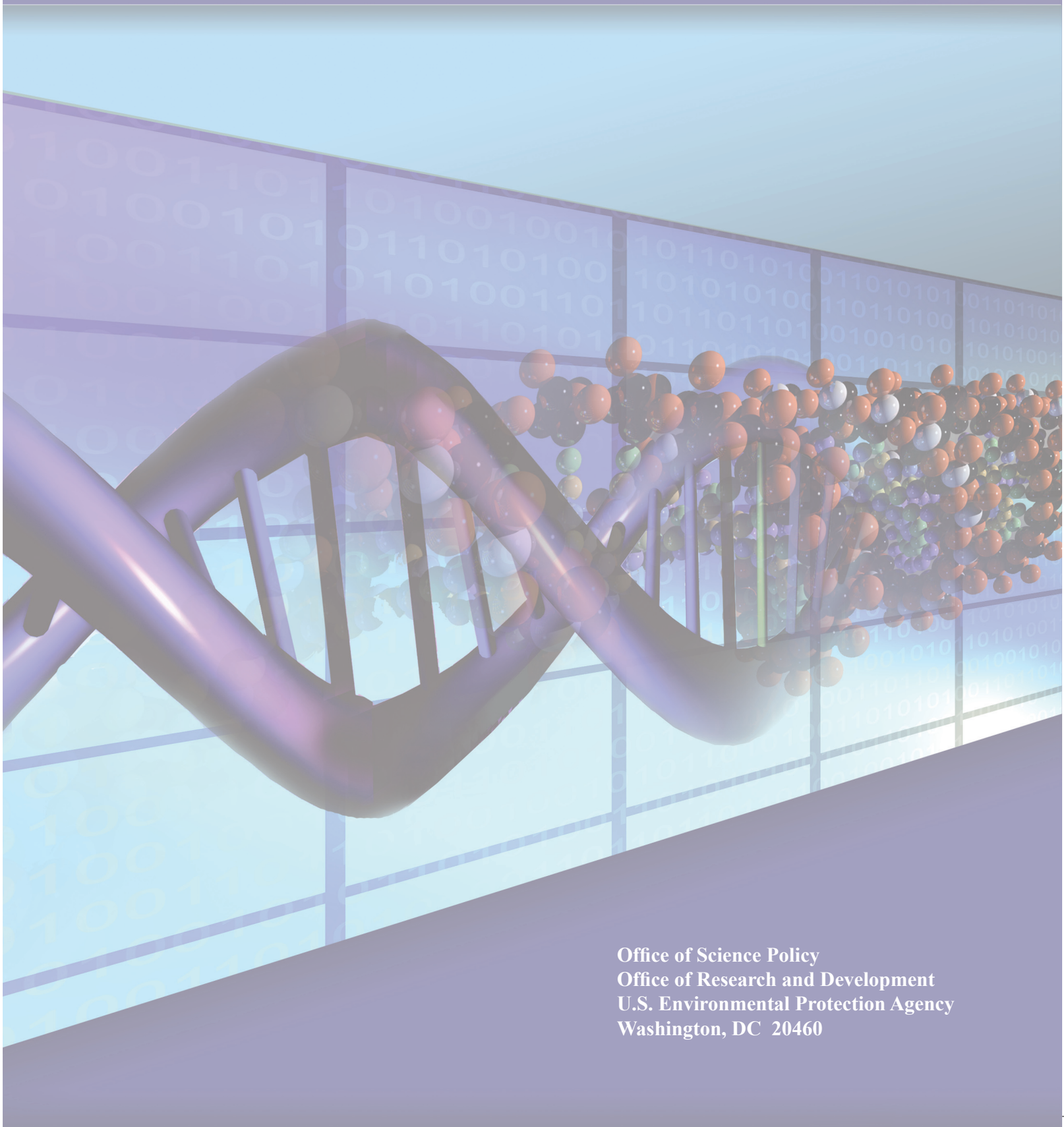

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Introduction

When we contemplate the future of the environment, we often think of the potential negative impacts of population growth and development on our limited natural resources. Where there are negative impacts, however, there also are opportunities to re-examine personal and institutional assumptions that frame our outlook on environmental issues. **Futures analysis** (futures), or foresight, can provide a platform to engage in strategic conversations to better understand uncertainty and shape a sustainable future. The future can take a variety of forms based on chance, cumulative or systemic forces and, most importantly, individual choices. This is why we use the plural term "environmental futures," indicating numerous possible outcomes.

Futures analysis is a structured, time-tested process that uses a variety of analytical tools to help organizations understand, anticipate and influence the events and conditions of tomorrow.[1] Since the 1970s, the U.S. Environmental Protection Agency (EPA) has explored ways to use futures analysis in an effort to anticipate environmental challenges and opportunities. Although the Office of Research and Development (ORD) and other Agency offices have made some important strides in the area of futures analysis, its full benefits remain elusive. Administrator Stephen Johnson summarized the need for increased foresight quite well: "Failure to look beyond present conditions only ensures that emerging problems will be more difficult to address and that opportunities may be missed. We have made steady progress over the past few years to encourage the use of futures analysis, and this work must continue in our strategic planning."

The strength of futures analysis lies in the ability of an organization to identify, monitor and adapt to the forces that drive change. These **driving forces** may include: globalization, growth or recession economics, population dynamics, land-use planning, consumer and cultural behavior and technological advances (e.g., nano-, bio- and information technologies).

As drivers evolve over time, **trends** take shape. The interaction of these trends affects the Agency's ability to achieve critical mission outcomes. Understanding emerging trends will help ORD position itself to work with its clients and partners to:

- Anticipate and prepare for surprise disruptions and transformative effects of technology;
- Minimize unintended consequences of public policies, corporate investments or personal activities;
- Inform the public to help them make personal decisions about environmental protection; and
- Shape a national environmental agenda that will usher in a **sustainable** future.

ORD is committed to using futures analysis, as outlined in its 2001 *Strategic Plan*. Goal 5 of the plan states: "ORD will evaluate opportunities for and will conduct research to anticipate and assess future environmental stressors—whether human health or ecological—before their effects adversely impact people or the environment." The steps ORD will take, as identified in the *Strategic Plan*, are to: (1) understand and use foresight techniques; (2) stimulate dialogue both inside and outside EPA on future environmental developments and their significance; and (3) conduct futures analyses for a few key environmental issues.

This document examines how futures analysis can enhance ORD's research planning and development of science policy; describes approaches that ORD will take to implement its office-wide futures activities; provides examples of past applications; and represents a point of departure for a continuing course of action to inform planning and policy. Whereas this document was written specifically for use and implementation by ORD, the content is of broader application and may offer helpful guidance in establishing futures efforts in other organizations.

> "…our planning must truly be strategic and include consideration of emerging challenges and opportunities. Rather than react or confront problems out of necessity, we should try to anticipate them and adapt our programs accordingly."
>
> **Stephen L. Johnson, Administrator, U.S. EPA**

[1] National Academy of Public Administration, Remembering the Future: Applying Foresight Techniques to Research Planning at EPA, p. 46, 1999, http://71.4.192.38/NAPA/NAPAPubs.nsf/0/da8632b75b9325ca8525688700744518?OpenDocument.

ORD Futures

"The phonograph is of no commercial value."

Thomas Edison, 1880

"There is no reason for any individual to have a computer in the home."

Ken Olsen, President of Digital Equipment Corporation, 1977

The quotes in the text box[2] demonstrate how *predictions* can project what is known as "the illusion of certainty."[3] Such categorical statements, often made with unwavering conviction, seem to make sense in the present tense, but they can prove to be wholly inaccurate. Futures analysis does not rely on singular predictions of the future. Instead, a variety of techniques is combined to illustrate different scenarios and their relative probabilities, allowing ORD decisionmakers to make more informed choices.

Better anticipatory abilities can help ORD pursue proactive, creative and effective solutions that will not only be protective, but also can influence environmental trends in more positive directions. Applying these foresight principles will strengthen ORD efforts to use **systems thinking** to examine all facets of an issue (e.g., the positive *and* unintended implications of various technologies); analyze workforce, equipment and infrastructure needs for the next generation of environmental research and development; and promote a culture in which change is anticipated, prepared for and embraced.[4]

ORD can use analysis of emerging health and ecological trends to prioritize research programs and set clear strategic goals. Because a variety of perspectives is needed to conduct robust futures analysis, emerging issues also provide ripe opportunities for ORD to collaborate with EPA regions and program offices and with other federal agencies. ORD can work with regional offices and other partners to conduct regional analyses. Ecosystem-level foresight presents a special challenge for EPA because, for many people who live within the boundaries of a priority ecosystem, it may be a luxury to focus on anything but the most immediate community concerns. (See the Pennsylvania Department of Environmental Protection's project description on page 8.) Another excellent example of interagency futures work is the effort led by the U.S. Department of State called Project Horizon. This project will be described in more detail later in this document (page 8).

Within the budget and strategic planning processes, futures projects are ideal sources both of new ORD budget initiatives and of potential research projects to consider when revising Multi-Year Plans (MYPs). Both processes—budget initiatives and MYP updates—are designed to consider new cross-ORD proposals, and they will facilitate the systematic integration of futures in research planning.

Roles and Responsibilities

Before describing how ORD can incorporate futures into its research programs, it is useful to describe the roles and responsibilities of the various groups involved. Common approaches found in the literature are described throughout the roles and responsibilities section and are further detailed later in this document. These approaches are: *scanning, Delphi process (expert interviewing), trend analysis,* and *scenario development.* Although it is important to note that these individual techniques can provide information to expand our perspective and yield insights about the future that are valuable for long-term planning, these methods are complementary and are best used in concert.

Office of Science Policy

ORD's *Strategic Plan* Goal 5 designates the Office of Science Policy (OSP) as the lead for ORD foresight activities. OSP provides tools, support and leadership to the process, coordinates interaction between the groups and individuals involved, and tracks the success of ORD's futures efforts. Because futures projects generally are not designed to

[2] Quotes displayed on the Futures homepage of EPA's Office of the Chief Financial Officer: http://www.epa.gov/cfo/futures/.
[3] Global Business Network, http://www.gbn.com/.
[4] Adapted from: Introduction to Futures Research, Coates and Jarratt, Inc., 1999.

yield immediately measurable benefits, it can be difficult to evaluate a given activity. ORD can measure its success by evaluating: (a) the extent to which participants' perceptions have changed; (b) the extent to which decisions and actions have changed; and (c) the long-term accuracy of models or scenarios that provide the basis for decisions.

Foresight Working Group
The Foresight Working Group (FWG) is an ORD extension of the Agency-Wide Futures Network that was established by the Office of the Chief Financial Officer in 1999. The FWG focuses on research-oriented issues, specifically addressing ORD's long-term (i.e., 5- to 20-year) research planning needs. FWG members include representatives from a broad spectrum of ORD organizations. OSP serves as the chair of the FWG. The FWG analyzes initial results from the application of futures techniques and identifies and develops emerging issues of critical concern. The FWG also may conduct research into specified issues as needed.

Cross-Agency Workgroups
OSP coordinates the formation of cross-Agency workgroups in conjunction with the existing Agency-Wide Futures Network to explore topics that appear the most promising based on input from the FWG and the ORD Science Council (e.g., life cycle analysis of alternative fuels). Individuals generally self-select for participation on the workgroups. Examples of cross-Agency workgroups include ORD's efforts to understand the future science policy and regulatory implications of genomics and nanotechnology. OSP also has solicited the assistance of external subject matter experts to examine the future environmental policy ramifications of these technologies. In addition, OSP has assisted other government agencies in identifying emerging trends and encouraging public sector long-term planning. OSP continues this effort to facilitate a dialogue among interested stakeholders as part of its overall futures program.

ORD Science Council
The ORD Science Council (SC) serves as a scientific resource to the ORD Executive Council and provides a forum for identifying, discussing, reviewing, integrating and directing the development of science and science policy. The SC serves as the senior body of ORD scientists and engineers, may provide guidance to OSP and the FWG and considers work products and recommendations. The SC, including the National Program Directors, may evaluate material and recommendations from the FWG as it prepares initiatives, updates MYPs and provides recommendations on ORD's scientific direction to the ORD Executive Council.

Futures Methodologies

Scanning
Scanning is a systematic review of data, trends and events relevant to a topic of interest.[5] In a general sense, scanning can provide leads or reveal "weak signals" of environmental change that may be important to investigate. Some of the greatest environmental benefits and/or risks potentially flow from technologies or economic systems that ostensibly have little to do with environmental protection. A pilot ORD scanning effort in 2001 involved the development of a Web-based search tool ("Webspider") to scan journals and "gray literature" for emerging issues. The scans were restricted to nine areas, or domains, that were based on the futures work of the American Council for United Nations University Millennium Project[6]:

- Conflict and Governance
- Population, Education and Human Welfare
- Science and Technology
- Regional and International Economics
- Natural Resources and Environment Energy
- Social and Cultural Issues

[5]Found at: http://www.epa.gov/osa/genomics.htm.
[6]Found at: http://www.acunu.org/.

- Agriculture and Food Security
- Communications and Transportation
- Energy.

Scanning outputs or "leads" were considered for further investigation. Examples of leads included self-healing infrastructures, distributed sensor networks and disruptions in the hydrologic cycle. Each of the leads (approximately 100) was ranked on a scale from 1 to 5 using the following criteria: *novelty, scope, severity, visibility, timing, probability and overall relevance* to ORD and EPA. The leads were chosen by a librarian, and the rankings were produced by external subject matter experts. These issues were considered relevant based on their potential for far-reaching environmental and health impacts, scope and overall scale.

Scans should begin with topics that are most likely to be important to ORD and the Agency, initially using the topics from the United Nations University Millennium Project. The list can be expanded or contracted as the scan progresses and new information comes to light. To add credibility to continuing efforts, management and expert stakeholders should be involved in developing the information that will drive the scanning process. Data are collected from journals, meetings, online sources, books, opinion letters and other sources.

Figure 1 lists the ranking criteria. These criteria were developed by OSP through an iterative trial and error process in its 2001 pilot scanning. Using the Ranking Criteria, each review analyst will choose a number from 1 to 5 to assign a value to an issue, based on his/her best professional judgment.

Following the review, a summary report will be created to identify important trends, themes and issues that have emerged and present a range of views on the potential severity of the problems and their likelihood of occurrence. Guidance, based on the scan, may include monitoring the issue, forming a cross-Agency workgroup to provide further analysis or providing input to planning exercises, such as developing initiatives.

Ranking Criteria

	Minimum Allowable Ranking Value	Maximum Allowable Ranking Value
Novelty	1 = old hat	5 = never been seen before
Scope	1 = affects almost nobody	5 = affects everybody
Severity	1 = slight effect	5 = human fatality, ecological disaster
Visibility	1 = of little interest	5 = of great interest
Timing	1 = 20+ years into the future	5 = imminent
Probability	1 = little chance of happening	5 = already an issue or certain to happen
EPA/ORD Relevance	1 = no EPA/ORD authority	5 = full EPA/ORD authority

Figure 1. Ranking Criteria for Scans

Delphi Process: Personal Interviews and Remote Surveys[7]

Although scanning can help researchers identify and describe multiple issues of concern, the results usually require further analysis. At this point, Delphi techniques can add significant value. Using Delphi techniques, researchers can consult a diverse group of experts to explore the timing, probability, importance and implications of emerging environmental challenges and opportunities.[8] Methods, such as *personal interviews* and *remote surveys*, can be used to complement scanning results and other futures analyses by providing a low-cost means of soliciting the opinions of subject matter experts external to EPA. Both methods lend

[7] Adapted from: Introduction to Futures Research, Handout #12, pp. 1-2, Coates and Jarratt, Inc., 1999.
[8] National Academy of Public Administration, Remembering the Future: Applying Foresight Techniques to Research Planning at EPA, prepared for EPA Office of Research and Development, p. 51, November 11, 1999.

the same results but require different means of personal interaction with participants (e.g., face-to-face vs. remote). It is important to note that consensus is not a necessary objective of the Delphi process. (See Appendix D for a sample interview guide.)

Personal Interviews
The personal interview is no more than a structured dialogue, which can be conducted with individuals and/or groups. Facilitating a dialogue with a group of experts can be costly, but the results can allow researchers to extract more detailed information on a single topic. A personal interview allows a greater diversity of techniques, especially for those interviewees who benefit from visual or kinetic stimuli. For example, a researcher might place a map in front of experts when asking questions about the various environmental implications of suburban sprawl. Researchers then will use quantitative methods to analyze and summarize the survey results, highlighting any patterns or consensus.

Interviewing is a necessary first step in the scenario-building process. For the EPA Scenario Project in 2000, ORD participated in a cross-Agency team that interviewed managers about the future of the environment and the issues that "kept them awake at night." From these interviews, common themes and drivers can be gleaned and provide the basis for scenario development.

Remote Surveys
As an alternative, researchers can gather information remotely by mail, e-mail, fax or telephone. First, each expert panelist responds to a standardized survey, and researchers collate the results. Second, researchers ask any outlier respondents to further explain their answers. When researchers send the second round of questions, these outlier explanations should be included with a summary of the first-round results. The second round usually will demonstrate a movement toward consensus or a majority opinion, although minority opinions should be represented fairly in the summary data.

The benefits of a remote Delphi survey include:

1. Minimizing travel and audiovisual recording costs;
2. Ensuring that all relevant voices are heard and their comments are included;
3. Preventing high-prestige or especially vocal panel members from dominating conversations; and
4. Presenting information in a clear and transferable form.

Some disadvantages of the remote Delphi survey include:

1. Framing an effective question can be difficult (e.g., some futures researchers will pack too many items or ideas into one questionnaire, creating bias and/or confusing responses);
2. Government surveys are restricted by the Paperwork Reduction Act;[9] and
3. Project delays can be caused by waiting for responses.

Reporting the Results of Personal Interviews and Remote Surveys
The *State of the Future* report, published by the American Council for the United Nations University, is an excellent example of how results from a Delphi survey can be presented in a useable format.[10] The report provides statistical analysis of the responses, written commentary by the respondents and common themes that emerged from the interviews. For ORD, the FWG will generate a list of key experts in relevant disciplines who will be interviewed on their chosen topics. The FWG staff will use quantitative methods to analyze and summarize the survey results. Survey results then can be used by the FWG in deciding whether to elevate issues to the SC.

Analyzing Trends[11]

Monitoring and projecting trends can add analytical rigor to both scanning and interviewing. The FWG will play a critical role in identifying trends and bringing relevant

[9]Found at: http://www.archives.gov/federal-register/laws/paperwork-reduction/.
[10]Found at: http://www.acunu.org/millennium/.
[11]Adapted from: Introduction to Futures Research, Handout #4, pp. 1-2, Coates and Jarratt, Inc., 1999.

information to the attention of ORD decision-makers. A **trend** is a statement of the direction of change in the forces shaping the future, and it takes shape when a **driver** changes over time (e.g., economic growth or population) or when multiple drivers interact. A trend does not have to be dynamic—it also can be stable and continuous through time. Trends can be *extrapolated* using simple mathematical projections based on time-series variables. For more accuracy, multivariate models can be produced that require more complex calculations.

Steps To Interpret Trends[12]

1. **Identify and state the trend.** Give the trend a name and a verb. State the direction of change. For example, "The U.S. population grew by at least 10 percent during the 1990s."
2. **Document for credibility.** You must validate trends just as you must validate data in your scientific research, using numbers, graphs and verifiable documentation.
3. **Explore potential countertrends.** Identify countertrends that may reduce, reverse or alter the course of your original trend. For example, if one trend states that the U.S. population is aging steadily, whereas another trend states that hundreds of thousands of young immigrants are moving to the United States each year, the first trend is weakened by the second.
4. **Generate implications.** Identify the implications of the trend for the future of the environment and the future of the Agency. Will this trend affect the research you do now, or the research you plan to do later? To avoid bias, explore implications and actions in a group setting. Consider implications that are (a) obvious, (b) possible and (c) speculative. Explore how different parts of the Agency might be affected and how they could better prepare for potential implications.
5. **Determine options.** Identify the research needs or how to develop more knowledge in a particular area. Once you have adequate knowledge, identify what individuals, organizations or the Agency can do *now* to avoid a bigger problem later. Describe the appropriate actions, the obstacles to achieving these actions and the risks associated with inaction.

Trend Analysis in Action

The Office of Solid Waste and Emergency Response (OSWER) Technology Innovation Program launched a strategic monitoring and trend analysis project to develop foresight on emerging issues that could impact waste management and cleanup programs.

The OSWER scanning database and analytical papers can be accessed from an EPA workstation at:

http://intranet.epa.gov/swerrim2/policy_v2/smtpa_v2/index_SMT.htm

http://www.cluin.org/emergingtrendsdb/default.cfm

Building Scenarios[12]

Every component of futures analysis discussed previously can inform the **scenario** development process. Scenarios are images of the future—narratives that are intended to help organizations reduce the uncertainty of the future. They are qualitative projections of possible future conditions based on variations in key drivers of change, including social, technological, economic and institutional drivers. Scenarios can be more global in scope and based on the interaction of broadly defined drivers (e.g., economic growth or the extent of shared values and willingness to face common challenges together [See Figure 2]). Issues also can be narrower in scope (e.g., the long-term implications of pharmaceuticals in the water supply) and based on more specific drivers. Scenarios answer the "what if?" questions and, most importantly, they should be relevant and plausible to be effective and useful.

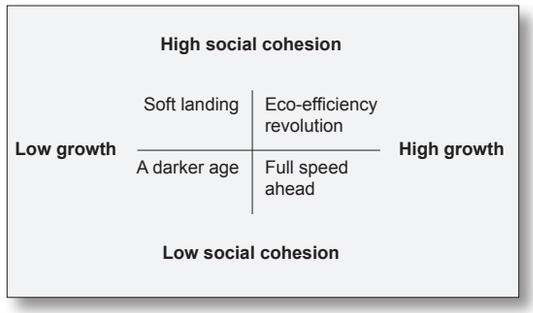


Figure 2. Alternative Scenarios Matrix (Olson and Street, 2002)

The Scenario Method

The simplest method for creating scenarios is to take two or more critical uncertainties (drivers) about the future and arrange them into a matrix. The number of drivers you choose will dictate the number of scenarios (e.g., four drivers = 2^4 scenarios). Three to five scenarios probably are the optimal and most

[12]Adapted from: Introduction to Futures Research, Instructors' Notes, Coates and Jarratt, Inc., 1999.

manageable number with which to work. In the "possibility space" created by the two axes, the uncertainties will intersect to yield four possible scenarios of the future, as depicted in Figure 2 (from EPA's 2000 scenario project).[13] The axes were chosen based on deliberations by the Scenario Team to reflect two uncertainties that are largely out of EPA's control. It can be difficult, however, to identify the most significant and informative uncertainties. Interviewing experts about their key future uncertainties may provide good leads.

Scenarios should be accompanied by a thorough discussion of the assumptions behind them (e.g., ORD's budget remains constant) and the logic behind the storylines. Using these four primary techniques for futures research, ORD can conduct the kind of anticipatory planning necessary to encourage creativity, innovation and adaptability.

From the scenarios, ORD can develop strategies that address opportunities and threats presented in each of the scenario "worlds." For instance, to use the Olson-Street example illustrated in Figure 2, a robust strategy would be characterized by its effectiveness in each of the four worlds (i.e., each quadrant): Soft Landing, Eco-Efficiency Revolution, A Darker Age, and Full Speed Ahead. From these strategies, an organization can identify specific organizational capabilities needed to implement the strategies effectively.

Step-by-Step Approach to Scenarios[14]

1. **Assemble a diverse workgroup.** A diverse group of perspectives will add to the richness of the scenario development process.
2. **Decide on the question to be answered or issues to be resolved.** Depending on the question, scenario planning might not be the preferred method, particularly if the issue is based on small change (e.g., a small organizational change vs. understanding future global changes or the future of environmental protection).
3. **Determine the length of the horizon for the analysis.** Five, 10 or 25 years in the future are some standard timeframes. Longer timeframes, however, may be appropriate in some instances. (The National Aeronautics and Space Administration [NASA] developed a 200-year strategic plan.)
4. **Identify the audience.** Decide who will be affected and have an interest in the possible outcomes. Identify their current interests, and whether and why these interests have changed over time. This typically is done through the interviewing process.
5. **Brainstorm and map trends.** Assess to what degree these trends will affect your research question. Describe each trend, how and why it will affect the organization and what the future directions seem to be.
6. **Find key uncertainties.** Map the driving forces on two axes, assessing each force on an importance and predictability scale. Discard all driving forces that are considered unimportant. Forces that are relatively predictable (e.g., population growth) can be included in the narratives, so the scenarios should not be based on these. At this point, identify any linkages between driving forces and rule out any scenarios that are implausible or not comparatively distinctive enough to pursue.
7. **Choose the most important drivers.** In the case of the EPA scenarios, "economic growth" and "social cohesion" were chosen to highlight the profound effect that each can have on the environment, but are not given a lot of consideration in EPA decisionmaking.
8. **Identify the extremes** of the possible outcomes of the two axes and check the dimensions for consistency and plausibility.
9. **Characterize the scenarios**, plotting them in a matrix. Optimally, two to four scenarios are constructed. Choose scenarios that offer the most variability but are plausible, even in their extremes. Avoid the absolutes (i.e., pure best-case and worst-case scenarios).

[13] A full explanation of this scenario exercise is provided in: Foresight: The U.S. Environmental Protection Agency, Olson RL, Street A, p.3, 2002, http://www.epa.gov/osp/futures/epafrst.pdf.
[14] Wikipedia, http://www.en.wikipedia.org/wiki/scenario_planning#scenario-planning.

10. **Write plot lines for the scenarios**. Create narratives that describe what has happened and possible reasons for the proposed situation (i.e., how and why the "world" came to be). (Plot lines were fleshed out using Groupware software, an electronic Delphi process.)
11. **Assess the scenarios**. At this step, test to see if the scenarios are relevant and representative of plausible outcomes. (Note: EPA scenarios ended at this step.)
12. **Develop quantitative methods.** This step is important, but not entirely necessary. It can be a time-consuming and rate-limiting step. Models and quantitative analysis, however, can add to the credibility and scientific rigor of the scenarios.
13. **Converge toward decision scenarios.** Retrace the steps above in an iterative process until you reach scenarios that address the fundamental issues facing the organization. Try to assess upsides and downsides of the possible scenarios.
14. **Develop and test strategies.** Identify ones that work in each of the decision scenarios.
15. **Identify the capabilities needed to implement strategies.** Determine whether the organization possesses the infrastructure and human capital needed to implement the strategies successfully.

Scenario Development Examples

Willamette Basin Alternative Futures Analysis[15]

The Willamette Basin Alternative Futures Analysis, funded by EPA and carried out by the Pacific Northwest Ecosystem Research Consortium, was conducted by scientists at ORD's Western Ecology Division, Oregon State University, the University of Oregon and several other institutions. The analysis was designed to help local communities make informed decisions about land and water use. The three alternative futures were compared to present-day (ca. 1990) and historical (pre-Euro American settlement, ca. 1850) landscapes (see Figure 3). The likely effects of each alternative future were evaluated on four endpoints: terrestrial wildlife, water availability, small streams, and the Willamette River.

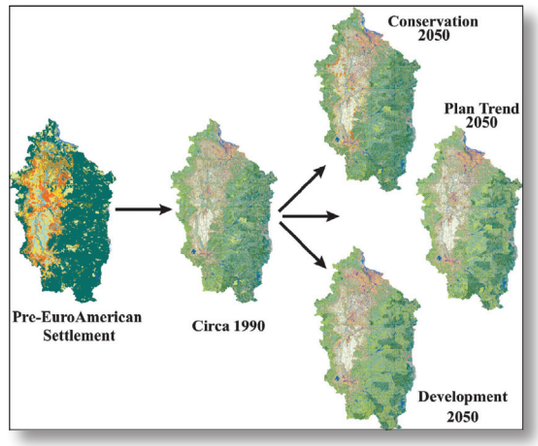


Figure 3. Trajectories of Landscape Change in the Willamette River Basin, From Pre-Euro American Settlement, to Circa 1990, to Three Alternative Futures for 2050

Pennsylvania Department of Environmental Protection Cooperative Agreement

ORD established a cooperative agreement with the Pennsylvania Department of Environmental Protection (PA DEP). PA DEP is exploring the development of indicators of future environmental quality. Researchers also are using ORD's Regional Vulnerability Assessment (ReVA) and are developing futures scenarios to inform land use planning decisions (http://www.epa.gov/reva/). The project will be completed in December 2006.

Project Horizon

Since September 2005, ORD has participated in Project Horizon, which brings together U.S. Government senior executives from global affairs agencies and the National Security Council to conduct long-term, interagency strategic planning. The purpose of the project is to develop realistic interagency strategies and identify capabilities in which the U.S. Government should invest to prepare for the unforeseen threats and opportunities that will face the nation over the next 20 years.

Phase I – Scenario Development: During this phase, the Core Team, comprised of 14 federal agencies, systematically created the set of

[15]Found at: http://www.epa.gov/wed/pages/projects/alternativefutures/twopager.pdf.

five Project Horizon scenarios. This involved conducting broad research in a range of global affairs domains and approximately 200 interviews with senior executives from the participating agencies and global affairs experts from academia, think tanks and the private sector. The team captured a preliminary set of nearly 300 initial drivers, which they distilled into 85 final drivers. These drivers, according to the research, are the factors in the future operating environments that will be most important for the U.S. Government. The 85 drivers then were further collapsed into four "dimensions" that determined the bounds of the Project Horizon planning space, which is the array of 16 possible worlds formed by all possible permutations of the four dimensions ("Challenge to the Nation State Power and Influence," "Gap in Global Standard of Living," "U.S. Economic Competitiveness," and "Perception of Serious Threat to U.S. Security and/or Quality of Life"). Descriptions of the 16 worlds were presented to the Senior Principals Board, and five were recommended for full development.

For each of the five final scenarios, the Core Team ensured thorough treatment of each driver across the five worlds. The team developed fictional narratives based on the characteristics of each of the five worlds.

Phase II – Interagency Planning: The Core Team planned and conducted three interagency strategy workshops. More than 200 executive-level individuals from both inside and outside the government participated in the course of the three workshops. During the workshops, participants were assigned to a single scenario, assuming roles as part of an interagency planning team. Team members were asked to immerse themselves in that world and develop an in-depth understanding of the challenges and opportunities that it presents for the U.S. Government. Each team developed interagency capabilities that it considered most critical to meet the unique demands of its particular world. The strategies of each team were stress-tested across the other four scenarios to identify those capabilities that were considered most "robust."

The participants in the strategy workshops identified 147 raw capabilities. The Core Team synthesized the raw capabilities into 33 clusters of like capabilities. From these, the team derived the 10 strategic interagency capabilities most needed by the U.S. Government to operate most effectively in a global affairs environment.

Phase III – Knowledge Transfer: The purpose of this phase was to provide the participating agencies with the knowledge necessary to conduct their own internal, scenario-based strategic planning using the Project Horizon scenarios. Led by each agency's Core Team members, knowledge transfer workshops were held to present the mechanics of the scenario-based planning process, the Project Horizon scenarios themselves and the ways in which agencies can use these tools in their respective organizations.

Phase IV – Agency-Specific and Linkage Analysis: ORD hopes to continue its interagency collaboration to improve planning across the government and to disseminate the Project Horizon results and methodology across EPA.

Limitations

Futures analysis is not without limitations. It is important to manage expectations and be clear about what the process is designed to accomplish. Futures analysis uses a variety of analytical tools to help organizations understand, anticipate and influence the events and conditions of tomorrow. It is inherently about reducing uncertainty; so why are some not satisfied with even the most rigorous futures research?[12]

- **Unsatisfied quest for a single answer:** *Decisionmakers in most large organizations are rewarded for understanding a problem, knowing the facts, having the right numbers, justifying a solution and executing an immediate plan of action.*

Futures analysis is not a precise, predictive science. A single conclusion is not the goal. By illustrating a variety of possible futures along with their relative probabilities, foresight will help to clarify uncertainty, identify forces of change, identify positive and negative implications and describe possible alternatives for action. The principal goal is to enhance the quality and effectiveness of long-term decisions by providing sufficient information and alternatives about the future.

- **Doubt that futures activities are directly useful:** *Following a futures workshop, many people will ask: "How can I use this now?" or "How can this improve my work and my role in the Agency?"*

As individuals, we constantly make long-term plans in spite of uncertainty. We often apply basic elements of foresight in major life choices to avoid future threats and to capitalize on future opportunities. Consider the research and deliberation that goes into choosing an educational degree, pursuing a certain career path, investing in real estate, saving money for retirement and committing to a medical insurance program. Nevertheless, futures analysis must be conducted in a more systematic and strategic fashion if it is to facilitate effective planning at the organizational level.

- **Distrust of open-ended approaches:** *The structure of a futures workshop or research plan may differ from the* modus operandi *of some individuals or groups. Some audiences may distrust methods that do not approach a problem or issue in a familiar or standardized manner.*

Futures analysis frequently uses scientific concepts and tools but it also draws from other disciplines, including the social sciences. The process depends on broad explorations to bring fresh perspectives to a given problem or issue. Futures analysis earns credibility from the openness and thoroughness of its data collection and evaluation.

- **The desire to quantify uncertainty:** *Some people believe that quantifying uncertainty somehow reduces the uncertainty and makes it possible to make a decision.*

Once again, futures activities do not strive to predict the future with absolute certainty. They seek to explore uncertainties, tease out relevant patterns and themes and examine the consequences of the positive and negative outcomes of different scenarios.

Conclusion

Whereas ORD and other Agency partners have made some important strides in the area of futures analysis, the full benefit of futures research remains elusive. Administrator Stephen Johnson summarized the need for increased foresight quite well: "Failure to look beyond present conditions only ensures that emerging problems will be more difficult to address and that opportunities may be missed. We have made steady progress over the past few years to encourage the use of futures analysis, and this work must continue in our strategic planning."

The 21st century has arrived and brings with it unprecedented innovation and change that will continue to challenge EPA's ability to protect human health and the environment. The need for ORD to help the Agency prepare for rapid and unexpected change is evidenced by the August 2005 Hurricane Katrina disaster. Futures analysis can help EPA prepare for such unforeseen events.

Futures analysis holds great promise in our work to shape a sustainable environmental future. The techniques described in this Handbook, if institutionalized, can position ORD and EPA to capitalize on creative opportunities, anticipate environmental threats and identify least-cost alternatives. Foresight can strengthen our efforts to proactively safeguard a healthy environment for the American public, for the international community and for those future generations who will inherit our air, water and land—in whatever state we choose to pass on to them.

In closing, futures analysis can provide an improved understanding of the forces that drive environmental change and the resulting trends and patterns. Although it is not possible to eliminate uncertainty, futures analysis will improve the Agency's ability to anticipate and prepare for the potential consequences of today's actions and to shape a sustainable future. By applying this approach, ORD intends to meet its strategic objective to "...anticipate and assess future environmental stressors—whether human health or ecological—before their effects adversely impact people or the environment."

"We do so much to prepare our children for the future, but are we doing enough to prepare the future for our children?"

Larry Chalfan, CEO
Zero Waste Alliance

Appendix A

Glossary[16]

Driving Force (driver): An event, person, product or general direction of change that influences the environment, the Agency or society at large. The rapid pace of information technology development, for example, is a driving force on many fronts.

Futures Analysis: A structured process that uses a variety of analytical tools to help organizations understand, anticipate and influence the events and conditions of tomorrow.

Implications: Consequences of a trend or change—usually specified as consequences for individuals, the Agency, industry or society. Initial implications are easier to identify than long-term or wildcard implications.

Issue: A conflict of interests or values. Unlike *problems*, which have solutions in theory, an issue cannot be resolved as long as competing values or interests remain. However, a temporary balance of interests regarding an issue may be found.

Scanning: All agencies and businesses operate within an external environment that is largely beyond their control, but not beyond their influence. Scanning takes account of what is happening, and what is likely to happen, in the external environment that might have an effect on the Agency. It is a systematic and continuous review of information about current scientific, technological, sociological and institutional developments relevant to EPA and the environment.

Scenario: A story, narrative or picture of the future after there has been time for interesting changes to take place. This tool is commonly used to present alternative images of what an ecosystem, agency, society or industry may look like in the future. Scenarios usually focus on long-term implications.

Stewardship: "To EPA, environmental stewardship means everyone taking responsibility for environmental quality in every aspect of our lives—in our jobs, at home and in our communities. It means not just minimizing environmental impacts, but preventing them. It means not just protecting the environment, but improving it" (Administrator Johnson). *Stewardship* includes EPA initiatives that motivate and empower individuals, communities, businesses and/or governments to take environmental leadership without EPA intervention.

Sustainability: If stewardship activities are the *means*, a sustainable future is the end goal. Environmental sustainability entails satisfying the needs of the current generation without compromising the ability of future generations to provide for their own needs. It requires that we live and work in a way that enhances, rather than diminishes, an ecosystem's biological integrity and diversity, its ability to recover from impact and its ability to provide ecosystem services indefinitely into the future.

Systems Thinking: Expanding and deepening the frame of reference for a given subject to take account of the numerous interactions and implications that may not be obvious at first. This differs from strict *analysis*, which seeks to isolate a given subject into small, easily understood parts—often ignoring crucial interconnectivities with other objects/subjects.

Trend: A statement of the general direction of change in the *driving forces* shaping the future of an organization, region or other entity, usually gradual, long-term or cumulative.

Wildcard: An unforeseeable event or outcome. Although these cannot be predicted, prudent organizations can prepare in advance to manage alternative future directions and outcomes.

[16]Many of these definitions are adapted from: Introduction to Futures Research, Coates and Jarratt, Inc., 1999.

Appendix B

Understanding How Issues Develop: Timing Matters

To understand how environmental issues might develop, there are three major points to consider: (1) rate of change; (2) opportunities to intervene; and (3) public awareness.

1. **Rate of Change.** Identifying the rate of environmental change associated with a particular stressor, or set of stressors, is an exercise that can inform ORD's strategy formulation and research planning. As illustrated in Figure B-1, environmental change rarely occurs in an obvious and predictably linear fashion. Instead, environmental conditions can change in such a slow and incremental fashion that they garner little public attention (e.g., suburban sprawl). Environmental systems also can respond to stressors with step change, exponential change and/or tipping points (e.g., ecological thresholds).

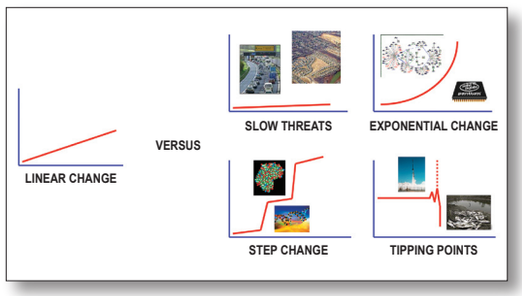


Figure B-1. Threats Emerge at Different Rates—Timing Matters[17]

2. **Opportunities To Intervene.** Prevention of environmental damage is a principal goal of futures analysis, regardless of the rate of change. If ORD is armed with an effective early warning system, EPA will be better prepared to take early action against environmental stressors before significant ecological damage and/or human suffering occur (Figure B-2). In the long run, preventing environmental damage will save the Agency time and money, allowing EPA and its partners to invest a greater portion of their resources in positive environmental change (i.e., restoration and sustainability).

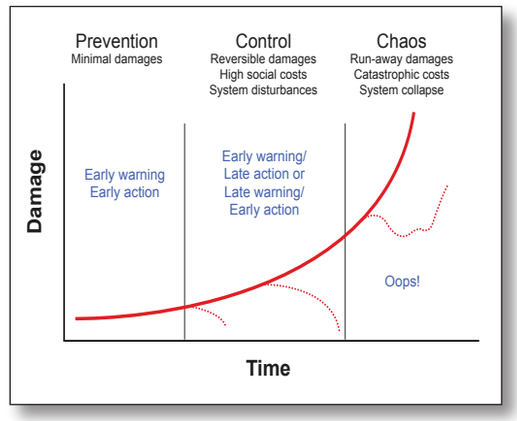


Figure B-2. Opportunities To Intervene—A Case for Early Warnings and Early Actions[17]

3. **Public Awareness.** Figure B-3 illustrates how environmental change can attract public attention over time. Depending on the severity of environmental change, this process can span from a few months to more than 50 years. Often, the greatest opportunity to frame an issue lies at the bottom of the curve, before rival interest groups have staked out their positions (e.g., genetically modified organisms and nanotechnology).

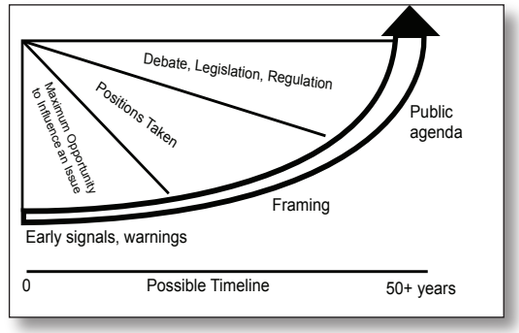


Figure B-3. Public Awareness of an Issue[18]

What drives an issue up the public agenda curve? [1]

- *Disastrous events (man-made or naturally occurring)*
- *Harm to vulnerable groups (children, elderly, the poor)*
- *High-profile individuals adopting and advocating for the issue*
- *Interest groups using rhetoric to "frame and name" the issue*
- *Growing constituencies demanding change*
- *Social change leading to new attitudes and behaviors*
- *Technological change leading to new knowledge and perspective*
- *Action by decision-makers*

[17]Adapted from: S&T Challenges in the 21st Century: Strategy and Tempo, Rejeski DW, http://www.wilsoncenter.org/docs/staff/Rejeski_stratempo.pdf.
[18]Adapted from: Introduction to Futures Research, Instructor's Notes #6-7, Coates and Jarratt, Inc., 1999.

At first, early warning signals may become apparent to a small number of groups or individuals in the form of personal experiences, intuition and/or limited scientific evidence of change. As more information becomes available, experts begin to communicate about the emerging issue. At this early stage, ORD can study the trends in research publications that circulate on a given subject to inform its futures analysis. ORD also can identify experts for interviews or surveys.

The issue, however, could remain under the general public's radar until one of three things happens: (1) the problem is framed in bold terms that people can understand; (2) a popular individual publicly adopts the issue; or (3) a trusted group or information source stresses the need for action. After any of these stages, decisionmakers may begin to flesh out their positions, and the issue can become a priority on the public agenda, where it is communicated more widely.

In our era of rapid systemic change, the "strategy and tempo" challenges facing government agencies are very real.[17] In other words, the rate of innovation in the private sector continues to increase at unprecedented rates (especially in information technology), making it more difficult for government agencies to keep pace. In response, EPA needs to ensure that its current planning adequately accounts for new and potential market developments because these trends can change the nature of environmental challenges quickly. ORD can take leadership in this area by conducting futures analysis that will inform anticipatory planning across the Agency. In fact, one of the primary goals of ORD's current strategic plan is to do just that: anticipate future environmental issues before their effects adversely impact people or the environment.

The better we can understand and evaluate various future possibilities, the better we can prepare, and the better we can protect human health and the environment. Although precaution and prevention are ideal, in some cases, environmental events and conditions will be beyond the control of EPA or its partners; therefore, the work that ORD will conduct in the area of futures research will help EPA to prepare and respond as early as possible. In many cases, however, EPA can take strategic and proactive steps with its partners to influence future outcomes. ORD can use futures analysis and the scientific research that follows to influence infrastructure, products and processes that will make environmental sustainability a practical reality.

Space: National vs. Regional

Futures analysis and planning can serve different purposes on different spatial scales. On the national or global level, EPA can use foresight to address emerging health and ecological trends in its Agency-wide *Strategic Plan*. ORD can do the same when formulating research strategies that bridge desired environmental outcomes with long-term and annual performance goals.

Additionally, foresight offers benefits at regional and local levels. Particularly at the ecosystem level, ORD laboratories and centers can further the Agency's mission by conducting futures analysis and working with regional stakeholders to take collaborative action. Ecosystem-level foresight presents a special challenge for EPA because, for many people who live within the boundaries of a priority ecosystem, it may seem to be a challenge to focus on anything but the most immediate community concerns. In such cases, foresight can add significant value by enabling more effective **stewardship** on the part of local and regional stakeholders. ORD's assistance in *anticipating* future opportunities and risks will help communities make proactive choices that improve their environment and, more importantly, prevent pollution in the first place.

EPA's Innovation Action Council has set a vision of environmental stewardship in which all parts of society actively take responsibility to improve environmental quality and, ultimately, achieve sustainable results.[19] If

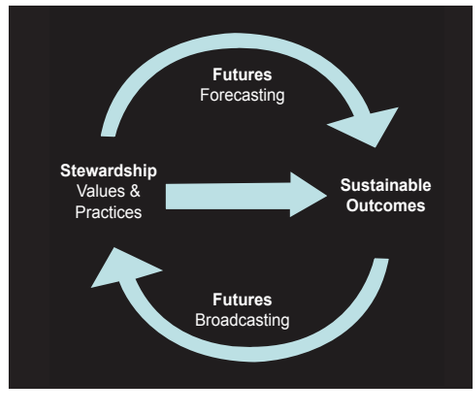
[19] Everyday Choices: Opportunities For Environmental Stewardship. Report to Stephen L. Johnson, Administrator, U.S. Environmental Protection Agency, EPA Innovation Action Council, November 9, 2005.

environmental sustainability is our destination, stewardship values and practices constitute a powerful vehicle to carry our nation from here to there.

Using both **forecasting** and **backcasting**, ORD futures analysis can support the continuous improvement and effectiveness of EPA stewardship efforts.

1. **Forecasting.** When *forecasting*, one asks, "Based on choices we already have made or forces beyond our control, where are we going?" Given EPA stewardship priorities, foresight techniques can project and assess the extent to which selected practices will move our nation toward sustainable outcomes.

   Futures analysis also can identify unforeseen opportunities and obstacles that might affect the success of current stewardship approaches.



2. **Backcasting.** When *backcasting*, one asks, "Where do we want to be in the future, and what steps must we take to get there?" The Innovation Action Council identified six broad systems in which sustainability is desirable: air, ecosystems, energy, land, materials and water. Given EPA's specific sustainability targets, futures analysis can help identify the portfolio of activities that would be necessary for long-term results.

Appendix C

Futures at EPA: A Brief History

1975: The Office of Pesticide Programs commissioned the report: *Alternative Futures for Environmental Policy and Planning: 1975–2000*

1993: Futures Study Unit established within the former Office of Policy, Planning and Evaluation

1995: Science Advisory Board's *Beyond the Horizon* report released, advocating futures and early warning for EPA

1999: Intra-Agency Futures Network established

2000: EPA Scenarios completed and presented to the Innovation Action Council

2001: Office of Research and Development/Office of the Chief Financial Officer (ORD/OCFO) Cooperative Agreement with the Woodrow Wilson International Center for Scholars to improve foresight in public agencies and identify emerging issues

ORD Cooperative Agreement with Pennsylvania Department of Environmental Protection to develop alternative futures for the Pennypack Watershed using ORD's Regional Vulnerability Assessment (ReVA) methodology

2002: ORD's Western Ecology Division cosponsors alternative futures scenarios for the Willamette Valley

2003: Office of Solid Waste and Emergency Response strategic monitoring and trends analysis project

OCFO Futures intramural grants competition

2004: Innovation Action Council Futures Interviews (update of 2000 process)

2005: Project Horizon begins

2006: Cooperative Research and Development Agreement pending with the University of Tennessee to develop a methodology to rank emerging issues in terms of how much they will impact human health and/or the environment

Appendix D

Sample Interviewing Guide

The following is a sample interviewing guide used in the EPA 2000 Scenario Project.

EPA Strategic Interviewing Guide

Initial Short Answer Questions

Circle the appropriate response. Take brief notes on any comments your interviewee makes about why the future may be better or worse.

1. *Twenty years from now, do you think the overall state of the environment in the United States will be better than it is today, about the same or worse? Why?*

   Circle the response: Better Same Worse Don't Know

2. *Consider the global environment, including global commons such as the atmosphere and oceans, and the situation in other countries around the world. Twenty years from now, do you think the overall state of the global environment will be better than it is today, about the same or worse? Why?*

   Circle the response: Better Same Worse Don't Know

3. *Twenty years from now, do you think the public's commitment to environmental values and environmental protection is likely to be stronger than it is today, about the same or weaker? Why?*

   Circle the response: Stronger Same Weaker Don't Know

4. *Twenty years from now, do you think public support and approval for EPA's work is likely to be stronger than it is today, about the same or weaker? Why?*

   Circle the response: Stronger Same Weaker Don't Know

5. *Twenty years from now, is EPA likely to emphasize voluntary compliance more than it does today, about the same as today or less than today? Why?*

   Circle the response: More Same Less Don't know

6. *Twenty years from now, is EPA's emphasis on multimedia or cross-media approaches likely to be stronger than it is today, about the same as today or weaker than today? Why?*

   Circle the response: Stronger Same Weaker Don't Know

Open–Ended Questions

Main Question 1

What are the two biggest long-term environmental concerns for your (office, division, region, etc.) and how has the nature of the most pressing environmental problems changed since your career began at EPA?

Possible Follow-On Question (to ensure that Question 1 is answered)

Of all the issues to address in the year ahead, which ones "keep you awake at night" because they could have the most impact on environmental conditions 10 or 20 years from now?

Main Question 2

What do you think the Agency needs to do differently to better address these two concerns?

Possible Follow-On (to prompt a fuller response)

Probe for other areas of change that may be needed to address these concerns, such as new personnel with new kinds of skills, new internal organizational arrangements, new forms of cooperation with outside organizations or new kinds of research and development.

Main Question 3

Are there some emerging or potential environmental problems that you think deserve more attention now so that society can respond to them before *they become serious instead of playing "catch up" with them after they emerge?* (Go beyond what your program is responsible for and beyond what the Agency deals with today. Address any environmental problems you think may be significant in the future.)

Follow-On Questions (to inquire further if your interviewee names a problem)

What could society do to avert this problem?
How might this problem affect EPA?
Can you envision a potential role for EPA?

Main Question 4

If you looked back from 2020 and described EPA's triumph, what would be the story?

Follow-On Questions

What are the obstacles to accomplishing this triumph story?
How can we overcome some of these obstacles?

Main Question 5

If you looked back from 2020 and described EPA's failure, what would be the story?

Follow-On Question

What are the most critical actions that EPA, as a whole, should take to ensure that such a failure does not occur?

Main Question 6

Assume a future situation in which the Administration and the Congress are highly supportive of EPA. In those favorable circumstances, what are the most important changes the Agency as a whole could make to become much more effective in carrying out its mission of environmental protection?

Follow-On Question

Prompt your interviewee to address other areas of improvement, such as changes in budget priorities, organizational structure, internal operations, use of information technology, relationships with other agencies and levels of government, public information and education, and research and development.

Main Question 7

What other factors should EPA consider to facilitate the process of futures thinking? Is there a question that has not been asked in the course of this interview?

Appendix E

Additional Resources

Prominent foresight-related Web sites at EPA:

Office of the Chief Financial Officer:
http://www.epa.gov/ocfopage/futures/links.htm

Office of Research and Development:
http://www.epa.gov/osp/efuture.htm
http://www.epa.gov/sustainability/

Key research activities inspired by environmental foresight:

Nanotechnology: http://es.epa.gov/ncer/nano/
Computational toxicology: http://www.epa.gov/comptox/
Genomics: http://www.epa.gov/osa/genomics.htm

EPA Office of Solid Waste and Emergency Response, Technology Innovation Program, scanning database and analytical papers (only accessible from an EPA workstation):

http://intranet.epa.gov/swerrim2/policy_v2/smtpa_v2/index_SMT.htm
http://www.cluin.org/emergingtrendsdb/default.cfm

Office of Research and Development's Strategic Plan (See Goal 5):

http://epa.gov/osp/strtplan/documents/final.pdf

Office of Administration and Resources Management Workforce Assessment Project Scenarios:

http://www.epa.gov/epahrist/workforce/wap.pdf

Office of Air and Radiation:

http://www.epa.gov/radiation/index.html

Appendix F

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