Endocrine Disruptor Chemicals as a Rising Compliance Issue

Robert E. Jarrett

Certain classes of chemicals foreign to the human body can interfere with endocrine hormonal systems. Hormones are the master controllers of biochemical processes. A wide range of pathological conditions can ensue at all stages of life. Research has shown these or similar chemicals to be increasing in natural and man-made environments. Some research indicates that wildlife is exhibiting the destructive effects of hormone disruption caused by man-made chemicals. The claim is made that human health is already being adversely affected. Many information gaps exist. Major research and screening programs are under way around the world that could well lead to banning or curtailed use for many heavily used chemicals. Makers and users of chemicals can avoid the embarrassing surprises experienced with previous new environmental issues and control programs by joining in the ongoing issue–framing scientific, legislative, and regulatory processes.
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INTRODUCTION

Is man contaminating the natural environment with chemicals that are disrupting the biochemical processes that maintain healthy life in man and other species? If so, how should they be controlled? These two basic questions lie at the heart of debates and research under way around

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the world. Some authorities emphatically say "yes." Others emphatically say "no." This article will not provide answers. But it does provide background information to aid in understanding the issues, to start participating in the debate, and to prepare for eventual developments. Does that matter? If your organization makes, uses, or regulates chemicals, there is great prospect for it to matter a great deal.

Emerging Issue Theory

There are complicating sociopolitical factors to consider in an already difficult scientific matter. Emerging issues follow a fairly predictable evolutionary path from early recognition of a question through growing controversy to formal action, such as eventual consensus or legislation, and on into management of the aftermath. For environmental issues the latter has been taking the form of complex standard setting and regulation accompanied by rancorous debate. Notice that the idea of contention is prominent.

Already, different parties have introduced new labels like hormonally active agents (HAA), hormonally active chemicals (HAC), and endocrine active compounds (EAC), along with the original term, endocrine disruptor chemicals (EDC).

The conflict aspect will play a significant role in this article's twin premises that (a) government agencies that use chemicals in fulfilling their obligations are highly likely to be faced with mission wrenching and costly requirements regarding some of those chemicals and (b) that those agencies should be participating in the debates and planning for the aftermath, while opportunity exists. Notice also that "issues" and society's "solutions" to them tend to be highly subjective even when the basic problem is objective in nature.

It can be argued that the latter point applies to endocrine disruptor chemicals (EDC). Before discussing definitions, history, implications, and suggestions, an observation is necessary to help put that ensuing discussion in semantic perspective. Already, different parties have introduced new labels like hormonally active agents (HAA), hormonally active chemicals (HAC), and endocrine active compounds (EAC), along with the original term, endocrine disruptor chemicals (EDC). When people play with labels, it usually means they are positioning themselves to argue that proponents of other labels and arguments are somehow irrelevant or off the correct path. This observation is not an accusation, but is something to be alert to, as the next few years unfold.

This article uses a combination of information and ideas from science, political science, lessons seen from prior issues, and plausible forecasting to show how this issue is very much in the second evolutionary zone of growing controversy, while still rooted in the question–framing phase, yet already stretched into the third, solution–forming phase.

Prior Chemical Issue Experiences

For the past three decades of concentrated national attention to environmental problems, whenever science has highlighted another substance or phenomenon as hazardous to human health and life or to environmental resources upon which humans depend, the impacts burst upon the country with seemingly little or no warning. At each such

discovery, whole industries and government agencies had to reorient programs and make immense investments of time and money to respond. Here are some examples from a much longer list: asbestos, beryllium, cadmium, chlorofluorocarbons and halons, chloroform, benzene, depleted uranium, dioxins, lead, methylene chloride, pesticides (various), polychlorinated biphenyls (PCBs), radon, solvents (various), tin, trichloroethylene, and zinc.

Many of these substances were pervasive in commerce, industry, and military systems. Except for naturally occurring radon gas, they were well matched to technical needs. Uses had evolved over decades of successful design and application. Then, one by one, those substances became identified as "criminals" to be avoided, minimized, or rooted out and destroyed. At every turn, well-integrated devices and processes had to be re-engineered and personnel retraining accomplished against artificial deadlines and at great cost in terms of money and distraction. Each time a chorus resounded: "If only we could avoid being similarly surprised in the future, we could save a lot of wasted effort and cost, yet achieved essential protection for our people and the environment!"

There is no current compliance crisis about endocrine disruptor chemicals, but one will start to emerge within the coming few months to two years.

Another opportunity to avoid being surprised is at hand. As usual, private and public sectors will face similar problems: particularly such critical safety and national defense categories as commercial aviation and military systems which must be in top readiness and working all the time—without uncertainties—while alternatives work out. There is no current compliance crisis about endocrine disruptor chemicals, but one will start to emerge within the coming few months to two years. Informed and uninformed opinions are just as likely to clash in public forums as they have in the past on other issues. Productive conflict can lead to optimum solutions, but evidence indicates that there will be plenty of uninformed and weakly informed input as well.

HEALTH AND ECOLOGICAL SIGNIFICANCE

Endocrine systems are those systems in higher organisms that regulate chemical processes—ensuring that the right things occur at the right times in the right amounts for the body or plant to function properly. Hormones of many kinds produced by various glands and organs move through the body to trigger, conduct, and terminate processes. They typically succeed in their tasks at concentrations that are almost unbelievably low. It takes very little absolute change in the real or perceived (by the body) concentration to have major effects. Directly or indirectly, they control everything, including the obvious ones like behavior, body size and weight, brain development, brain function, cancer, growth/suppression, digestion, embryo and fetus development, immunity, learning and memory, sugar uptake, sex and reproduction, and temperature.

These hormone chemicals perform their jobs by having the correct molecular sizes, shapes, and electrical charges to bond with other body chemicals and cell components. They are the messengers telling what, when, and how much to do.

Man has created new chemicals with very similar structures and has manufactured hormones in large quantities. They get released into the environment for various useful purposes. Unfortunately, some adverse results have been demonstrated and others alleged. **Exhibit 1** reveals how the bad effects can show themselves. These inappropriate results occur when the unnaturally present molecules supplant or add to hormones produced by the body in response to legitimate needs.

One may view the effects of endocrine disruption from a few other angles to get an idea of the wide potential for undesirable possibilities.

1) Leveraging:
   - Multigenerational impacts ("hand-me-down" poisons);
   - Critical timing exposure (prenatal and neonatal options close quickly);
   - Nanodoses (large impacts); and
   - Cumulative effects (exposures can be additive).
2) Selected potential effects:
   - Increased cancer susceptibility;
   - Loss of reproductive potential;
   - Impaired neurological system; and
   - Impaired immune system.

Exhibit 1

Action	Result
Block	Hormone action is prevented by the other chemical blocking the chemical reaction sites
Destroy	Alter hormone to deactivate
Flush-enzyme	Interfere with enzymes that eliminate hormones
Flush-hormone	Accelerate breakdown and elimination
Inhibit	Hormone production or action is reduced, despite need
Mimic / supplant	Body acts on false messages to take action
Stimulate	Amplify effect

The following list indicates the general categories of specific chemicals currently thought to be responsible: chlorinated hydrocarbons, general chlorinated hydrocarbon, pesticides, dioxans, furans, polychlorinated biphenyls, and heavy metals.

While primary concern is for human health, other biological species operate on endocrine system principles, too. One must expect the focus of concern to eventually broaden to cover food animals and crops, then all wild species. In fact, the initial public alarm sounded when some wild animals exhibited reproductive and developmental problems.

The first phase of an issue's life cycle, discovery, started to fade into the second, or more argumentative phase of issue framing.

HISTORY OF THE EDC ISSUE

Basic Concept

The science of endocrinology established long ago that exogenous (originating outside the affected organism) agents can and do interfere with synthesis, secretion, transport, binding action, or elimination of natural hormones in the body, leading to adverse affects. The existence of endocrine disruption is not a question for debate. The question is whether man-distributed chemicals are causing deleterious effects in human and other species.

In the early 1990s, even the popular press carried occasional accounts of scientific studies claiming to find links between man-made chemicals and developmental aberrations in wildlife. *Our Stolen Future* was the seminal document opening the formal public debate.[1] The authors made the following point:

> For all [hormone-dependent] systems, normal development depends on getting the right hormone messages in the right amount to the right place at the right time. As this elaborate chemical ballet rushes forward at a dizzying pace, everything hinges on timing and proper cues. If something disrupts the cues during a critical period of development, it can have serious lifelong consequences for the offspring.

What had been a mainly scholarly debate before 1996 became confounded by claims, counterclaims, demands for action, and cautions against unfounded action. Articles began to appear in scientific, popular, and special interest publications. The first phase of an issue's life cycle, discovery, started to fade into the second, or more argumentative phase of issue framing. However, the arguments did not provide clarity. Skeptics found legitimate weaknesses in data. Scientists pleaded for funds to do better science. Old data were revisited and decades–old observations were reevaluated in terms of the new hypotheses. The following paragraphs in this "history" section attempt to describe the essential context leading up to and including the current situation.

In retrospect, the fundamental questions have been on the table for a long time, though initially discussed largely in terms of "toxic-

ity," which connotes an outright poisoning. This list shows six milestone periods in the twentieth century:

* 1929: Polychlorinated biphenyls introduced;
* 1938: DDT first manufactured;
* 1940s (WWII): First wide-scale exposures to man-made chemicals;
* 1940s-1950s: First human new generation exposed;
* 1950s-1970s: First human new generation born that was exposed in utero (thalidomide);
* 1970s-1990s: First human generation exposed in womb reaching reproductive age (thalidomide).

The first clearly recognized developmental impacts of EDCs were mutations of human children exposed in utero to thalidomide and of birds damaged by DDT and other pesticides. In more recent times, evidence of environmental pathways and undesired impacts has mounted. They include such things as reported irreversible sex changes in snails (male characteristics in females, sterility, and reduced reproduction). Several other species have shown abnormalities attributed to EDC: American bald eagle, cormorants, American alligator (Lake Apopka, Florida), beluga whale (St. Lawrence Estuary), Florida panther (Everglades), California sea lions, Great Lakes Chinook salmon, and trout (United Kingdom). However, those assertions do not prove the point. For instance, strange mutations in some amphibians formerly thought to arise from EDCs are now blamed on a fungus. One of researchers' greatest difficulties has been finding instruments and techniques for working at exquisitely fine concentrations and tolerances for both the chemistry and the biology.

In 1996, the U.S. Congress legislated the study of endocrine disruptors.

Brief Institutional History

As mentioned briefly above, research had suggested that several chemical and natural compounds have the ability to disrupt the endocrine systems of fish, birds, and mammals by mimicking, blocking, magnifying, or otherwise interfering with hormones. At a 1991 Wingspread Conference, a group of scientists suggested similar effects in humans, citing reports of decreasing sperm counts, increasing incidence of reproductive cancers, and reproductive abnormalities in offspring. EDCs were also suspected of interfering with the thyroid system's regulation of development.

In 1996, the U.S. Congress legislated the study of endocrine disruptors. Both the Safe Drinking Water Act and the Food Quality Protection Act mandated that the U.S. Environmental Protection Agency (EPA) develop a screening and testing strategy by August 1998, implement screening and testing by August 1999, and report progress to Congress by August 2000. EPA then formed the Endocrine Disruptors Screening and Testing Advisory Committee (EDSTAC).

During a two-year period, the European Union, Organization for Economic Cooperation and Development, and Japanese government

began similar programs. The United Nations set up a program to evaluate EDCs. Many states indicated desire to regulate endocrine–disrupting chemicals. In 1997, Illinois released a list of 74 suspected endocrine disruptors as the first stage in a state program to manage these chemicals. State officials suggested developing a monitoring strategy before regulation would begin.[2]

In August 1998, EDSTAC released its Final Report describing a multistage program for sorting, prioritizing, testing, and screening over 86,000 chemicals.[3] The program is to determine ecological as well as human health effects. EPA's program started with a focus on high-risk chemicals and chemicals inventoried under the Toxic Substances Control Act (TSCA). Insecticides are particularly high on the list. Industry organizations prepared to comment on EDSTAC's draft report and began taking stock of their chemical inventories to plan for possible regulation. The screening protocol was implemented at EPA's Research Triangle Park Center, North Carolina, though not without heated discussion and some modification.

In February 1999, the U.S. Chemical Manufacturers' Association (CMA) announced, according to the Associated Press, intentions to invest $600 million of research over six years evaluating up to 15,000 chemicals.

EPA is working under the following national policy guidance:

- Legislation:
  Food Quality Protection Act 1996;
  Safe Drinking Water Act 1996.
- EPA:
  Within two years develop screening testing program;
  Within three years implement program; and
  Within four years report to Congress.
- Endpoints:
  Must include estrogenic effects;
  Could include other reproductive hormone effects; and
  Could include nonreproductive hormone effects.

The total study magnitude is huge, with some 86,000 to 87,000 chemicals in substantial commercial/industrial use to be screened. Fortunately, a sizable fraction of those have the wrong chemical structure characteristics to be of concern. However, the first–priority list still contains some 15,000 substances.

As of April 1998, news reports had EDSTAC on schedule. Barring unforeseen delays, EPA was to have implemented its screening program under TSCA and the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) by August 1999. The initial sorting and prioritizing stages might take several years, delaying actual restrictions and bans. However, if states were to begin monitoring suspected chemicals before federal regulation starts, control programs could begin as soon as test results come in. Environmental interest groups may also pressure EPA to take action on certain chemicals as early as during the testing stage.

In February 1999, the U.S. Chemical Manufacturers' Association (CMA) announced, according to the Associated Press, intentions to invest $600 million of research over six years evaluating up to 15,000

chemicals.[4] The focus is whether EDCs are threats to human health, especially in causing cancer or infertility. Clearly, CMA gauged the fundamental questions to be of extreme import—not ones to be avoided.

Unofficial comments pointed to problems arising in conducting the screening. The science available in 1999 was simply not strong enough to do the job called for in the protocol to meet the congressional mandate. On– the–shelf studies were of variable reliability. Many substances and endocrine systems were not well enough understood to permit making trustworthy conclusions. Reliable animal models for evaluating human effects were inadequately reliable for immediate use in testing given chemicals for hormonal effects. Human experimentation was not and is not an ethical possibility. Though mining of clinical health records might shed some light, sorting out the confounding influences of thousands of life variables would not be possible.

It will take 20 years or more to complete study of human endocrine systems in sufficient detail to properly understand them, even without the issue of EDCs.

Those dilemmas led the CMA, National Institute of Environmental Health Sciences, and EPA to cosponsor the two-day Workshop to Evaluate Research Priorities for Endocrine Active Compound Risk Assessment Methods at the end of August 1999. Fifty recognized experts from academia, industry, and government comprised four working panels to address preselected questions designed to elicit full discussion of national research agenda issues and suggest approaches to their solutions. Two pairs of panels each received the same questions, in order to see how they might validate each other's conclusions. The author attended as one of about 20 observers. Discussions and report-outs were intense and serious. The competition of ideas ensured that results would not be "according to the book."

This author came away with six overall conclusions.

1. The information needs to permit truly rigorous decision making are extensive and expensive. Major gaps are found in:
   a. Understanding basic physiological processes;
   b. "Receptor" site knowledge;
   c. Chemical competitive, additive, subtractive, and synergistic phenomena;
   d. Specific effects of exogenous EDCs (whether identical / similar to natural human hormones or to other animal, industrial, or plant hormones);
   e. Activity of cancer–affecting hormones;
   f. Criteria for defining good versus bad health results within the range of observations;
   g. Criteria and standards for extrapolating data with reasonable plausibility; and
   h. Tools for disciplined risk analysis and decision making.
2. The science is excellent in some areas, but very spotty, given the large number of chemical families and specific compounds to be tested. Technology is only beginning to produce the esoteric tools and procedures required for much of the work.

3. Valid animal models are needed for all potentially involved endocrine systems, but few validated ones exist or are fast enough to be useful.
4. It will take 20 years or more to complete study of human endocrine systems in sufficient detail to properly understand them, even without the issue of EDCs.
5. Industry is uncomfortable with the uncertainties, neither wanting to harm people nor to become embroiled in nonbeneficial technical and financial burdens.
6. The work panel report-outs gave little hope for good technical strategies in the near future.

The National Research Council released a report late in 1999 concluding that the case against EDCs in the environment had not been proven.[5] This is not surprising, given results of the research priorities workshop. It does support a conclusion that, like global warming, a great deal more argument should be expected.

To help close science gaps and ensure good science, the National Toxicology Program issued a call for nominations of scientists to form a select peer review panel.[6] The panel will review studies for evidence that EDCs do or do not have effects at doses below the thresholds used in standard toxicology studies.

PLAUSIBLE FUTURE CONSIDERATIONS

August 2000 is rapidly approaching. Congress will be waiting for its report. Special interest groups will be anxious for the report. Some of the latter already issued emotional appeals in 1999 (no citations given, in order to avoid any partiality). At this point it is possible to suggest some directions activity might take and to propose sensible response preparations.

Observations and Possibilities

Also, some public and scientific interest groups may demand inclusion of additional chemicals.

The August 2000 study report might have to dwell so heavily on the weaknesses in ability to differentiate between the guilty and the innocent that few, if any, parties will be satisfied. Delays will cause sighs of relief among those with big money at stake. Delays will cause activists and cynics to claim conspiracy. Scientists in the field may experience two conflicting stresses: anticipation over prospects for adequate research funding countered by the pain of accusations of having failed society. The stage is almost set for interesting happenings. Therefore, a quick review of the emerging issue theory section might be in order.

Individual U.S. states and some foreign nations could decide to control or ban specific substances under existing or new laws before EPA's processes are complete. Other unknown factors include how long the public review processes will take and which substances will eventually be controlled or dropped from consideration. Also, some public and scientific interest groups may demand inclusion of additional chemicals. However, the amount of scientific concern, financial support, and mul-

tinational interest surrounding this issue makes some sort of action inevitable. Inaction doesn't seem like an option.

In keeping with societal habit, one can expect many conflicting arguments over basic criteria for "guilt and innocence," the actual risks posed by each designated chemical, how soon action must be taken, who will pay the bills and how to handle the international trade aspects. One can expect to be faced with managing three broad categories: labeled guilty, labeled innocent, and labeled innocent under a cloud of conflict and controversy. The latter can't be discounted as frivolous, yet neither should aggressive investments be made in what could become false positives. Reasoned caution will be required. The cases of DDT and the apple pesticide ALAR show how somewhat similar situations can have quite opposite endings. DDT remains a legitimately shunned material despite its obvious value in combating malaria. ALAR was roundly accused, yet judged innocent about one year after massive outcries. The story of phthalates, as plasticizers in toys or as used in dental materials, may not be over yet.

No one judgment will fit all. Consider the numbers. The 15,000 under priority screening will sooner or later be sorted into definitely guilty, maybe guilty, and not guilty. Of the remaining 71,000 to 72,000 substances to be evaluated, a very large number is certain to be innocent of any suspicion. Nevertheless, initial identification of the "priority" group implies the possibility of a group of lesser, but real concern for later scrutiny.

Given tools and finances, it takes two to five years to evaluate a given chemical.

The gray categories will be available as foci for heavy subjective and objective argument regarding the wisdom of investing resources in detailed study, instituting preventive controls versus after-proof controls, and disregarding them altogether.

Given tools and finances, it takes two to five years to evaluate a given chemical. That implies that completion of the current EPA screening program can't provide a firm scientific basis for the first regulatory programs before mid-2002. Evaluation of mixtures is harder, longer, and more expensive. Since humans live in a rich intentional and unintentional mixture of chemicals, the literature increasingly calls for such studies. One would be wise to expect pressure for important decisions to be made in a relative absence of information.

Again, consider the numbers. Even if no more than 1 percent of the priority 15,000 significant use chemicals (150 of the 15,000 or 0.17 percent of 86,000) were to be found guilty of such high risk as to justify intense control, that could generate major dislocations in private and public sector production and operations. The short list near the beginning of Prior Chemical Issue Experiences contains 20 individual chemicals and groups. Requirements to remove them from use or to greatly reduce their use, while instituting worker / user protections overlapped a good bit, but didn't occur simultaneously. As it was, industry, commerce, and government (including the courts) experienced turmoil excess costs in rush efforts to correct risk-laden situations.

How much greater might the turmoil be were 20, 40, 80, or 150 problems to be announced at one time? No, it would not be similar to announcing the

early, pages-long lists of hazardous wastes or of the relatively few Toxic Reporting Inventory (TRI) substances. The first entailed only end-of-life-cycle controls. Most TRI substances had long been subject to controls and reduction attempts.

The prospect is for life–cycle redevelopment and retrofitting of products and processes, not to mention discard and destruction of selected products already in use.

In this case, laws and regulations will follow immediately, but not without contention, because views and fears vary in content and intensity.

SUMMARY ALTERNATIVE SCENARIOS

The near future could see one or a combination of these four scenarios unfolding.

Science Proves Basis Links

In this case, laws and regulations will follow immediately, but not without contention, because views and fears vary in content and intensity. Funds will flow, perhaps sparingly, but with regularity to support research. Chemicals will come under control a few at a time. The concept of "environmental justice" (EJ) will be invoked to carry protection to the less articulate sectors of society. This aspect will impinge on many governmental agencies at federal, state, and local levels. An example would be Housing and Urban Development, owner and seller of homes and apartments that contain or are near sites containing suspect or accused chemicals.

Science Is Dilatory

Public furor is likely to guarantee that many innocent chemicals become subject to compliance requirements and some guilty ones escape in the confusion and recriminations. EJ concepts will be applied, but probably unevenly.

Science Proves Innocence for Folk "Gangsters"

Conspiracy theories concerning protection of special interests and payoffs will make life difficult for makers and users of the chemicals that "everybody knows" are dangerous. Since a null hypothesis can't be proved, controversies will rise and fall with regularity. EJ will be invoked, again, but resources will be drawn away from legitimate EJ cases where people are actually at risk from other substances.

Science Proves Effects for Many Chemicals

This fourth case will see a worldwide attack on the problem, including Third World demands that industrialized nations quit inhibiting Third World development by shipping them EDC–containing products and wastes. Major medical and industrial fixes will be sought, but in the context of job and trade security. Environmental justice will be demanded domestically and internationally.

Any number of refinements and additions could be added to these scenarios. They are given here only to suggest the more prominent ways in which U.S. society could act and respond. By extension, industry and government entities can begin to see where they will play.

GENERAL IMPLICATIONS AND OPPORTUNITIES

While not new, this issue remains in the early stages of recognition by most of the public. Active participation in discussion and rule-making processes is still possible to (1) ensure critical economic and operational capabilities are not harmed, and (2) avoid ill-considered investments and schedules. Government operating agencies, in particular, need not wait until industry and regulatory communities have resolved issues to their satisfaction and then suffer the consequences without representation.

Public works construction and utility operation could easily face new, complex considerations added to risk assessments required for construction and operating permits.

Substances being tested for endocrine disrupting characteristics are common in modern industry. These chemicals may be found in industrial processes and products, stockpiled for contingency use, dispersed in waste disposal or cleanup sites, and integrated in military materiel. They may or may not cause workplace hazards as well as regulatory liabilities. Restrictions or bans on these chemicals may create delays and increase costs for civilian and military agency training and operations. Product developers could face serious technological constraints when developing new or modifying old goods and services. For example, the Army depends heavily on insecticide chemicals to prevent disease on the battlefield. For these chemicals even to be listed as a high priority for testing and possible control is of immediate mission management concern.

Public works construction and utility operation could easily face new, complex considerations added to risk assessments required for construction and operating permits. The public could well demand that no health or ecological threats may arise from activities resulting in any chemical exposure. Risk assessment procedures would then change accordingly.

Aside from protection of the public through regulatory compliance and pollution prevention initiatives, employees' personal health protection implications are potentially extensive, as equipment, facilities, and waste sites continue in use or are eliminated. If proven, negative health effects suffered by employees could substantially add to the cost of in-service and post-service health care.

Matrix of Potential Impacts for Defense Sector: One Example

A conceptual projection of how designation of a sizable number of EDCs could affect a major government agency can be seen below. The Army is the example agency. Given the number and ubiquity of man-produced chemicals in use, many will almost certainly be shown to have the negative effects alleged (see Observations and Possibilities). Further, materiel uses all technologies, so must of necessity involve most of those same chemical compounds in some fashion. The conceptual display for the Army, based on experience with other controlled chemicals, forecasts some of the missions likely to be affected and in what areas. Personnel in each functional area need to be prepared to participate in whatever evolves to be their appropriate response roles.

Exhibit 2

Mission Activity	Legal Compl (controlled/ proscribed)	$ costs	Force Health Protection	Disposal	Clean-up
R&D					
Initial R&D	X	X	X	X	X
Substitution develop.	X	X	X	X	
Requalification		X			
Acquisition	X	X	X		
Logistics					
Old stocks	X	X	X	X	X
Substitution stocks		X			
Maintenance	X	X	X	X	X
Operations					
Training	X	X	X	X	X
Redeployment	X		X		
Medical					
Standards	X	X	X		
Testing & records	X	X	X		
Technical support	X	X	X	X	X
Training	X	X	X	X	X
Preventative progs.	X	X	X	X	X
Clinical	X	X	X		
Public affairs	X EXPLANING		X		
Base operations					
Dir. pub. wks.	X	X	X	X	X
Env. programs	X	X	X	X	X
Corps of Engrs et al.	X	X			X
Defense sales	X	X	X	X	

Source: 7

A table similar to **Exhibit 2** can be used as the starting point for ferreting out the ways in which an organization is likely to be affected. That can then be used to work down one level of detail at a time to identify the individuals whose missions are likely to be affected and to outline the nature and timing of anticipatory policy and action they should undertake.

CLOSING THOUGHTS

First, this article actually presents a positive thesis, despite the frequent negatives and frightening remarks. Time, but not excess time, remains for reasoned, deliberate preparation for what are likely to be hard bargaining times ahead regarding endocrine disruptor chemicals, by that or any other name. The public sector cannot afford to miss still open opportunities to help shape and manage this issue in objective, responsible ways.

Second, it will not work to try avoiding the issue or its subissues, as they emerge. Opportunities to support correct actions and to reshape bad actions are transitory.

Third, addressing subjective issues openly and early is likely to be more important than focusing on objective questions. The latter resolve themselves, if a calm subjective atmosphere can be established.

Fourth, chemicals are ubiquitous in the residential, working and, recreational environments. As EDCs come more into the limelight as a public issue, employees are likely to bring the health worries to work. Unlike many environmental issues, this one cannot be seen as only external. For example, legislative, regulatory agencies' personnel will be personally concerned.

Exhibit 3. Addtional Sources of Information

EPA Endocrine Disruptor Information	**http://www.epa.gov/opptintr/opptendo/**
EDC Screening Program	**http://www.epa.gov/scipoly/oscpendo**
EDSTAC news	**http://www.epa.gov/scipoly/oscpendo/history**
EDSTAC history page	**http://www.epa.gov/scipoly/oscpendo/history/index.htm**
EPA Joint FIFRA/Scientific Advisory Panel and Scientific Advisory Board for Endocrine Disruptor Screening	**http://www.epa.gov/opp00001/SAP/may/members.htm**
Federal Register	**wais.access.gpo.gov**
Federal Web Locator	**http://www.law.vill.edu/fed-agency/fedwebloc.html**

Fifth, analyze and do contingency planning ahead of the crowd, but run neither ahead of nor behind it. In their own reactions to previous environmental programs, federal agencies have often gotten into avoidable, costly false starts and had to restart or they have delayed to the point that they had to engage in costly, disruptive late starts.

Last, federal agencies would be well advised to (1) task an internal group to champion their interests; (2) provide input to screening and testing program decisions; (3) formally track new developments; (4) inventory likely intra-agency problem areas; (5) formulate and update contingency plans; and (6) participate in every federal, state, and local hearing and comment process open to them. Those actions are cheap insurance for the long haul. They need not be expensive, and they can be scaled up or down as conditions warrant.

Exhibit 3 contains websites with pertinent information. ❖

REFERENCES

1. Colborn, T., Dumanoski, D., & Myers, J.P. (1996). Our stolen future. New York: Dutton, p. 46.

2. Ilinois EPA. (1997, February). Illinois EPA Strategy. Endocrine Disruptors. Table 1.

3. Endocrine Disruptor Screening and Testing Advisory Committee (EDSTAC). (August 1998). Final Report. EPA: Office of Prevention, Pesticides, and Toxic Substances, ES-1 through ES-16 and Chapter 7, 4 and 9. [On-line]. Available at http://www.epa.gov/scipoly/oscpendo/history/exesum14.pdf.

4. Hebert, H.J. (1999, February 1). $1.2B spent for chemical safety. Associated Press news release.

5. NRC Committee on Hormonally Active Agents in the Environment. (1999). Hormonally active agents in the environment. National Academy of Sciences Press, Executive Summary. [On-line]. Available at http://www.nap.edu/books/0309064198/html/1.html. The Executive Summary expresses overall conclusions. Each chapter addresses a separate technical area, without there being a concluding chapter.

6. National Institute of Environmental Health Sciences, NIH; National Toxicology Program. (2000, January 6). Solicitation of Comments on Proposed Peer Review of Low-Dose Issues for Endocrine Disruptors. 65 Federal Register, 784–787.

7. Jarrett, R.E., Young, G.D., & Landholm, M.J. (1999, March). Endocrine disruptor chemical management: The next big environmental program. 25th National Defense Industry Association Environmental Conference Proceedings, Denver (pp. 138–143).