

# **TECHNOLOGICAL REALITY**

**The Limits of Technology  
in Dealing with  
Hazardous Waste Site Cleanups**

**Hazardous Waste Cleanup Project**

June 1993

"One of our biggest problems is the problem represented by the Superfund and some other areas where you've got to fix something that's already happened, where we spend too much money on lawyers, too much money on consultants, the endless decisions. It's almost impossible to get anybody at the local level to agree what the best solution is. And I'm saying all this by way of making a personal plea which is that - to Drew Lewis and to everybody in this audience, if you have specific ideas about what we could do to make the whole management of waste issue better handled by us in a responsible way, not only in terms of getting to decisions, but also in bringing all the affected parties along, I would very much like to have it. I'm just appalled by the paralysis and the political divisions and the fact that the money is being blown. Anybody who has any personal experience and knowledge and opinion on this, this is something that, I think, we are duty bound to do a much better job of and we need all the ideas we can get."

President-Elect Bill Clinton

Economic Summit

Little Rock, Arkansas

December 13, 1992

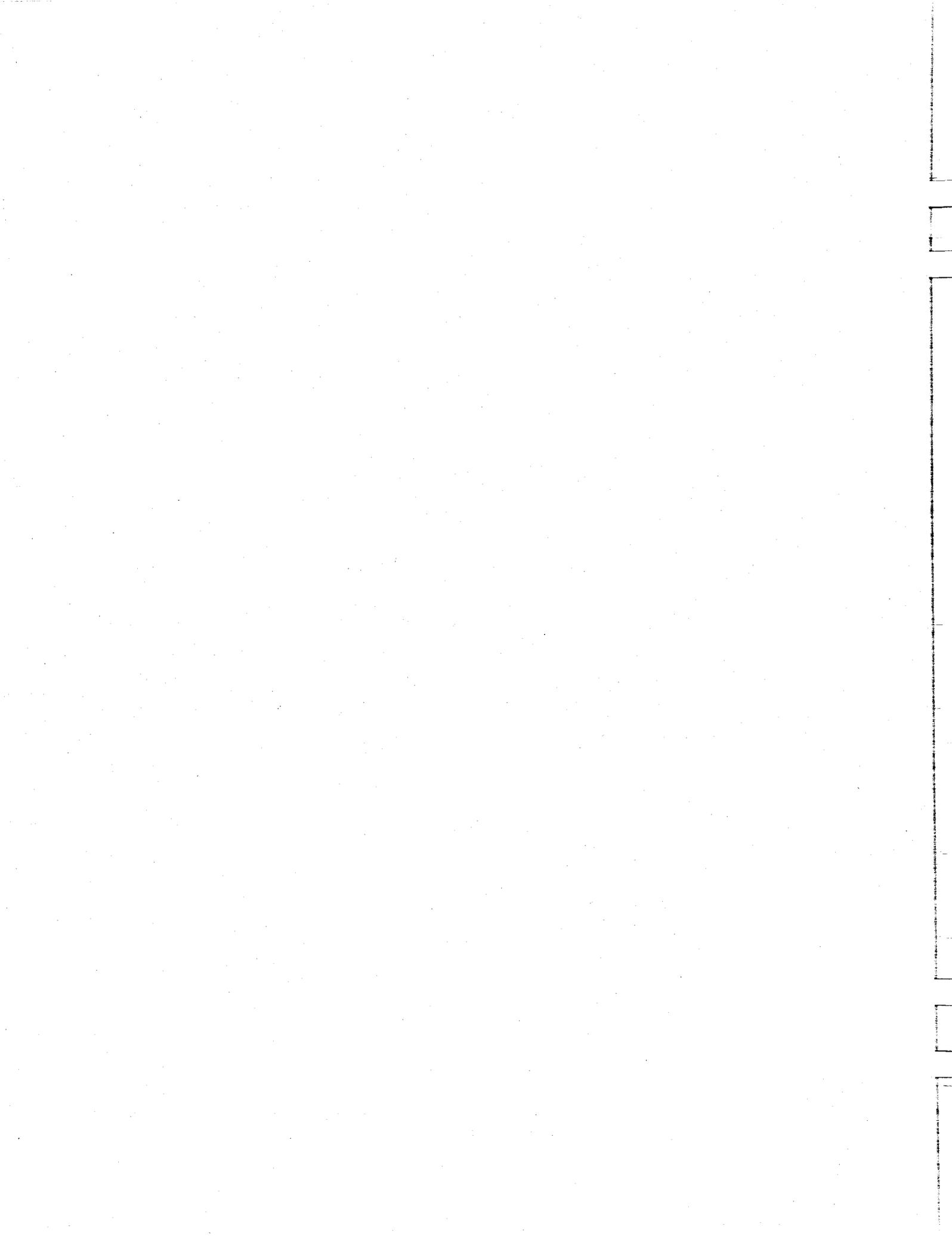
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## **ABOUT THE HAZARDOUS WASTE CLEANUP PROJECT**

The Hazardous Waste Cleanup Project ("HWCP") is a coalition of trade associations in the industrial sector working to improve Superfund, RCRA, and related environmental cleanup programs by focusing on actual risks to human health and the environment, rather than hypothetical risks. The current members of the HWCP are:

Ms. Dina Vizzaccaro  
**American Automobile  
Manufacturers Association**  
Ph: (202) 775-2727

Mr. Bruce A. Steiner  
**American Iron & Steel Institute**  
Ph: (202) 452-7271

Ms. Theresa Pugh  
**American Electronics Association**  
Ph: (202) 682-9110

Ms. Dee Gavora  
**American Petroleum Institute**  
Ph: (202) 682-8475

Ms. Amy Schaffer  
**American Forest  
and Paper Association**  
Ph: (202) 463-2585

Mr. Dell Perelman  
**Chemical Manufacturers Association**  
Ph: (202) 887-1162

Mr. John Arlington  
**American Insurance Association**  
Ph: (202) 828-7112

Mr. Tom Gilding  
**National Agricultural  
Chemicals Association**  
Ph: (202) 872-3873

The HWCP is engaged in the collection and dissemination of information regarding the waste site remedy selection process and particularly seeks to inform policy-makers so that the United States can allocate its environmental resources to situations where the actual risks can be quickly and substantially reduced by the most cost-effective means. In addition to its public information and general education activities, the HWCP is also involved in policy analysis and the convening of meetings, seminars, and workshops with key participants in the Superfund and RCRA processes.

## ACKNOWLEDGEMENTS

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This paper was developed through the activities of the HWCP's Technology Task Force, and particular thanks are due to each of its members for their guidance and help in drafting this paper. The current members of the Technology Task Force are as follows:

Jerome F. Amber	Ford Motor Company
Nam Baek	Occidental Chemical
Philip H. Brodsky	Monsanto Company
Susan Gilliland	E.I. du Pont de Nemours & Co., Incorporated
William J. Kabbert, II	USX Corporation
Doug McCauley	Reynolds Metals Company
Jim Odendahl	Weyerhaeuser Corporation
Donald Paulson	Ciba-Geigy
Steve Smith	Monsanto Company
Bruce Steiner	American Iron and Steel Institute
Donna Marie Zotter	Bethlehem Steel Corporation
Herschel Vineyard	Exxon Chemical Americas
Ian Webster	Unocal
Matthew Yunaska	Rohm & Haas Company
William McFarland	General Motors Corporation
Dina Vizzaccaro	American Automobile Manufacturers Association

## **EXECUTIVE SUMMARY**

### **TECHNOLOGICAL REALITY: THE LIMITS OF TECHNOLOGY IN DEALING WITH HAZARDOUS WASTE SITE CLEANUPS**

The federal hazardous waste site remediation program must face the reality that, in many situations, there is simply no available technology to achieve the cleanup standards set by EPA. Despite the fact that both industry and EPA have placed major emphasis on the development of innovative cleanup technologies, there are still numerous situations where remediating the environment to the pristine conditions demanded by EPA is impossible. This is true even if costs are completely disregarded. Although the technologies to protect human health and the environment, such as engineering and institutional controls that eliminate human exposure, are available at every site, current technologies cannot always go the extra (but very large) step of achieving EPA's non-risk-based cleanup goals. Recognizing the existence of these limitations is essential to allocating cleanup resources and maximizing the environmental and health benefits of the Superfund program.

The limits of the remediation technologies used in the Superfund program can be exemplified by one of the most common waste site situations: the need to clean up contaminated groundwater. EPA usually mandates "pump and treat," the classic method to purify groundwater by pumping out the water and removing the contaminants through treatment. The problem is that, as demonstrated by practical experience, many contaminants adhere to soil particles or may lie trapped in the bedrock and do not rise to the surface with groundwater as it is pumped out. Thus, it may be impossible to achieve the standards for purification, even if pumping continues indefinitely. The Oak Ridge National Laboratory has recently concluded that "[W]hen large pools of dense non-aqueous phase liquids are present at the bottom of an aquifer, meeting drinking-water standards is unachievable at any cost." After requiring parties to spend many millions of dollars on pump and treat remedies, even EPA has had to acknowledge the problem.

There are many other situations where particular features of the site being remediated impose limits on the technologies that can be successfully brought to bear on the cleanup. This might include intense community opposition to the solution that makes the most environmental sense, or it might include physical characteristics of the site or the contaminated media at the site that impede or prevent the construction or effective implementation of the best technology. For example, incineration of a uniform and technically well-defined industrial waste stream at an industrial facility is often a much easier matter, both technically and politically, than incineration of an unknown mixture of hazardous substances contained in a soil or groundwater medium located near residential areas.

The purpose of this paper is to provide policy-makers with an understanding of the fact that there are technological limitations in the remediation of waste sites, so that all parties can have a better appreciation of the real world constraints facing EPA, DOD, DOE, the States, and the regulated community. In many cases, there is currently no technological magic wand available (at any price) that can make a Superfund site disappear, or render its soil edible and its groundwater drinkable. It is hoped that a practical understanding of the abilities and limits of waste site technologies will allow society to develop a mature, long-term policy by which we can achieve Superfund success through (and devote our remediation resources to) actions that reduce real risks to human health and the environment.

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## TECHNOLOGICAL REALITY

### The Limits of Technology in Dealing with Hazardous Waste Site Cleanups

#### I. Introduction

The remediation of hazardous waste sites, while generally within the reach of current technology, is nevertheless subject to significant technical limitations that cannot be overcome simply by pouring greater and greater amounts of money into the ground. The more experience we gain, the more we learn about the limits of using existing technologies to remediate the complex mix of contaminants commonly found at America's waste sites. For example, as EPA has acknowledged, some groundwater contaminants cannot be completely eliminated, no matter how long we "pump and treat." In other situations, incineration solutions that work on homogeneous industrial waste streams fail in the field because of unexpected interferences from the complex matrix of contaminants found in the soil and debris. Thus, although human health and the environment can be protected at virtually every site by cost-effective institutional and engineering controls, achieving EPA's overly ambitious and non-risk based cleanup goals with current technologies is sometimes simply impossible.

Technical shortfalls in our ability to remediate hazardous waste sites fall into four categories.

- **Characterization Limitations:** There are practical limitations to our ability to totally characterize the nature and extent of the contamination at a hazardous waste site. Remediation studies can often involve costs and delays that are excessive and disproportionate to the real risks presented by a site. In addition, characterization technology is not without its risks. For example, the drilling of monitoring wells to evaluate potential groundwater contamination has reportedly made the situation worse at some sites, by introducing contamination into previously unaffected aquifers.
- **Risk Assessment Limitations:** Even the best toxicology, medical science, and exposure data can only provide us with educated estimates of the risks present at any given site. Risk assessment is the subject of a separate paper by the Hazardous Waste Cleanup Project.
- **Remediation Technology Limitations:** In certain situations, even if cost is disregarded, current

*Real protection of human health and the environment is always achievable. "Restoration" of the environment to pristine conditions sometimes is not.*

*Limitations on characterizing the contamination.*

*Limitations on estimating the true risks.*

***Limitations in achieving  
cleanup standards.***

***Site-specific  
constructability  
limitations.***

***Appreciating the real  
limitations will promote  
a sound long-term  
cleanup policy.***

technology is unable to achieve EPA's overly ambitious cleanup standards. This is particularly a problem at sites where a panoply of contaminants is present, involving mixed media (e.g., soil, water, sludges, etc.). Technology limitations include situations where geologic and chemical processes, and variations in natural settings, impose limitations both on the degree and the rate of cleanup at a site. For example, although EPA commonly requires that contaminated groundwater be pumped out and treated, in many cases such technology will take hundreds or thousands of years to actually clean up the aquifer to EPA standards.

■ **Site-Specific/Practical/Constructability**

**Limitations:** There are many situations where particular features of the site being remediated impose limits on the technologies that can be successfully brought to bear at that site. This might include intense community opposition to the solution that makes the most technical sense (e.g., incineration at the site, or exhumation and transportation of the waste through the community to an off-site disposal facility), or it might include physical characteristics of the site or the contaminated media at the site that impede or prevent the construction and effective implementation of the best technology.

The purpose of this paper is to provide policy-makers with an overview of the latter two categories of limitations: remediation technology limitations and site-specific/practical limitations, leading to an appreciation of the real-world constraints facing EPA, DOD, DOE, the States, and the regulated community. In many cases there is currently no technological magic wand available (at any price) that can make a Superfund site disappear or render its soil edible and its groundwater drinkable. It is hoped that a practical understanding of the abilities and limits of waste site technologies will allow society to develop a mature, long-term policy by which we can achieve Superfund success through (and devote our remediation resources to) actions that reduce real risks to human health and the environment.

## **II. Background**

### **A. Setting Superfund Site Cleanup Standards**

#### **1. Initial Congressional Intervention**

During the early years of the Superfund program, cleanup efforts focused more clearly than they do now on the identification and elimination of immediate threats to human health and the environment. The more egregious sites and risks were

to be tackled first, and from 1980 to 1985 remediation efforts primarily involved exposure reduction or pathway elimination. Examples included surface removal actions, waste containment and site security. Although these measures were basic and relatively inexpensive, they were cost-effective and eliminated the majority of the actual human health risks posed by these sites. During this time, Superfund program managers and potentially responsible private parties began to ask the question: "How clean is clean?"— i.e., what degree of final site remediation is appropriate, and should the costs at a site be doubled, tripled, or multiplied ten-fold so as to remove the minimal potential risk remaining at the site?

At the end of the first five years of the program, at a difficult time for EPA, Congress stepped in and amended CERCLA by enacting the Superfund Amendments and Reauthorization Act of 1986 (SARA). Most important, Congress added CERCLA Section 121, entitled "Cleanup Standards." Section 121 is a long provision, containing a grab-bag of phrases from multiple and not necessarily consistent sources, by which Congress attempted to answer the question: "How clean is clean?" Unfortunately, Congress acted in a volatile political atmosphere, with limited data as to the achievability and societal cost associated with any given cleanup standard. With the benefit of six years of experience, most knowledgeable observers now recognize, or are beginning to recognize, that this "Cleanup Standards" provision is resulting in non-cost-effective cleanup levels that, if applied consistently throughout the American environment, would be enormously expensive,<sup>1</sup> with very little incremental protection to human health and the environment.<sup>2</sup>

## **2. Overly-Conservative Implementation of SARA**

As an organization under fire, EPA has reacted to the demands to "do something" about hazardous waste site problems by implementing the cleanup standards provision of SARA in the most restrictive and conservative fashion possible. For example, although the first portion of the cleanup provision (Subsection 121(a)) directs EPA to make certain that remediation solutions are cost-effective, EPA has down-played that section and has emphasized Subsection 121(b), which specifies that the agency should favor "permanence" and "treatment" in selecting hazardous waste site remedies. As interpreted by EPA, this provision drives cleanups toward incineration and destruction technologies, even though they may not be cost-effective and may be unnecessary, and even

*Early 1980s were characterized by more cost-effective protective actions.*

*SARA Section 121 – Congress tries to answer: How clean is clean?*

*EPA implementation: "permanence" becomes paramount . . . greatly increasing costs and delays.*

*ARARs have become an end in themselves.*

*Example: Achieving ARARs even where the groundwater is otherwise totally unusable.*

though cost-effective and environmentally protective containment or in-situ technologies are often available.

The second most important phrase in the cleanup standards provision of SARA (as implemented by EPA) is the provision that directs the agency to make sure that cleanups comply with all legally "applicable or relevant and appropriate requirements" ("ARARs") developed under other federal and state environmental laws. Compliance with ARARs has become an end in itself, even where such efforts involve extraordinary additional costs with no environmental benefit. Rigid adherence to ARARs over the past six years may have accomplished little more than to significantly delay cleanups, while driving up costs.

As an example of the application of ARARs, a site might have groundwater contaminated with mercury, a contaminant that is found often at Superfund sites.<sup>3</sup> Under the Safe Drinking Water Act there is a federal standard for the maximum allowable amount of mercury in drinking water of 0.002 milligrams per liter, or 2 parts per billion.<sup>4</sup> Under Superfund EPA can automatically adopt this drinking water standard as an ARAR that must be achieved in the cleanup of the groundwater, even if that groundwater is not, or cannot be, used for drinking water because of salinity, prior contamination, or location (and despite the fact that simple institutional controls could prevent the use of that water for drinking purposes).

As another example of the application of ARARs, a site in New Jersey might have soil that is contaminated with chromium, a contaminant that is found frequently at Superfund sites.<sup>5</sup> There are no federal or state ARARs promulgated for cleanup of chromium in soil, but the State of New Jersey has a guidance value, used under its Environmental Cleanup and Responsibility Act, of 100 milligrams of chromium per kilogram of soil.<sup>6</sup> That state guidance value would probably be adopted by the EPA as a cleanup standard that must be achieved at the site,<sup>7</sup> even if it were located in a remote area and completely secure from any human exposure.

#### **B. Technological Limitations Are Not Considered**

The problem with automatic application of standards developed under different statutes for different purposes is that those standards, despite the "relevant and appropriate" language, often have nothing to do with the realities of the site being remediated, and often may be an impediment to the remediation. First, the standards may have been set using exaggerated notions of risk in other contexts, and simply will not be necessary to achieve protection of human health and

the environment under actual conditions at the site. Second, the standards may not be achievable at the site, either because technologies have not yet been developed that can achieve them under any circumstances, or because real-world factors at a specific site (such as community opposition or serious construction or materials handling difficulties) impede the ability of developed technologies to achieve them.

**Because such technology limitations are not routinely considered in the cleanup standards setting process, standards are often set that reflect idealistic notions of purity, but which do not provide incremental risk reduction and often simply cannot be met. The result is often a non-cost-effective remedy and time-consuming failure.**

As discussed above, the remainder of this paper covers two types of technology limitations, the inability to achieve cleanup standards because the technology does not yet exist (remediation technology limitations), and technical, political, and constructability limitations on the use of existing technology (site-specific/practical/construction related limitations).

### **III. Limits on Remediation Technology: Inability to Meet Cleanup Standards**

#### **A. General**

Once the immediate removal of surface tanks and drums is completed, the contamination at the typical hazardous waste site presents a problem of multiple unknown contaminants in an unknown and complex sub-surface environment. Such wastes rarely come in clear and uniform streams, e.g., "API Separator Sludge...RCRA waste code K051." Waste site wastes are virtually never the same as such process waste streams for which rigid standards are set under other laws and for other circumstances, such as the requirement to be treated to achieve the Best Demonstrated Available Technology level set for each waste stream under the RCRA Land Disposal Restrictions. Many of the ARARs come from statutes, such as RCRA and the Clean Water Act, that are designed to prevent the release of waste to the environment, rather than to retrieve and remediate pre-existing environmental contamination. Prevention is much more cost-effective than remediation, and it is far easier to keep emissions and effluents within specified levels than to clean the environment up to those levels once it has become contaminated. In some cases, the technology simply does not exist to do the job.

For example, returning to the chromium and mercury hypotheticals discussed above, a recent study by Arthur D.

*Site-specific cleanup standards are frequently set with no real consideration of whether the technology can actually achieve such standards.*

*It is much easier to prevent the release of pollutants than to retrieve or remove pollutants from the environment.*

***A.D. Little study found no evidence that selected chromium and mercury cleanup standards have ever been achieved in full scale practice.***

***Groundwater cleanups usually involve "pump and treat."***

***Oak Ridge finding: Most RODs require pump and treat until drinking water standards are achieved.***

Little found that for both of those chemicals, under typical soil and groundwater conditions, there is considerable uncertainty as to whether the cleanup standards selected could be achieved by any existing treatment technology. The A.D. Little study concluded that there was no evidence found that those theoretical standards have been achieved in the real world and the best that can be said is that laboratory and pilot scale tests indicate the potential that they could be met.<sup>8</sup>

#### **B. Groundwater Cleanups**

EPA has said that groundwater contamination is present at more than 70% of the sites on the National Priorities List and at almost 50% of the permitted RCRA disposal facilities.<sup>9</sup> At sites where the agency has reached the remedy selection stage, EPA has usually chosen to deal with groundwater problems through a methodology commonly called "pump and treat." In that methodology, wells are drilled into the contaminated aquifer and groundwater is pumped to the surface, presumably bringing with it the subsurface contaminants. The extracted groundwater is treated and then either discharged to close-by surface waters or re-injected to the sub-surface. Until recently it had been believed that the constant removal of contaminated groundwater from the aquifer and its replacement with clean water, either from re-injection, or from natural sub-surface flow, would result in cleansing the aquifer to acceptable levels.

In setting the cleanup standards for the aquifer, EPA has generally automatically chosen levels of contaminants that are required for drinking water. So confident have EPA personnel been of the merits of the technique of pumping and treating that researchers at the Oak Ridge National Laboratory found in surveying EPA's Records Of Decision ("RODs") that most RODs simply state that pumping and treating will continue until drinking water standards are reached, without presenting any analysis that this goal can actually be achieved.<sup>10</sup>

Thus, although the pumping and treating of contaminated groundwater can in certain circumstances be an appropriate method for protecting human health and the environment, in many other circumstances the pump and treat technology sometimes simply cannot achieve EPA's cleanup goals. **Despite EPA's faith in the technique, and after hundreds of millions of dollars have been spent in pumping and treating countless gallons of groundwater, researchers have reported, based on experiences at numerous sites, that the technique cannot return the environment to a "pristine" condition.** In spite of intense searching, the Oak Ridge National Laboratory researchers were unable to locate

a single aquifer in the United States that has been confirmed to be successfully restored through pumping and treating.<sup>11</sup> EPA, which has also become aware of problems with pumping and treating based on its own site evaluations, recently acknowledged that these pump and treat cleanups "identified hydrogeological and contaminant characteristics, as well as system design factors, that **may** impede the ability of extraction systems to achieve appropriate cleanup levels over the entire area of contamination."<sup>12</sup>

Scientists have so far identified the following potential reasons for the failures of the pump and treat methodology.<sup>13</sup>

- **Binding to Soil:** Particularly where contaminants have been present for a long time, they tend to adhere to particles of soil and to resist being drawn up by the groundwater flow created by the pumping process. Because the contaminant cannot be removed from the groundwater any faster than it is released from the soil, the attainment of cleanup levels is rate limited by the process of diffusion. Under these circumstances the cleanup process can take thousands of years.
- **Channelization:** The pumping process causes the groundwater to flow through those soils that have the highest permeability (i.e., those which impede the flow the least) and contaminants in soils with lower permeability are not picked up by the groundwater extraction.
- **Non-Aqueous Phase Liquids:** Certain contaminants, called non-aqueous phase liquids (NAPLs), do not mix with water. If they are denser than water (DNAPLs), they will sink downward through groundwater and will be more responsive to gravity than to the flow established by pumping. If they are lighter than water (LNAPLs), they will tend to float on top of the groundwater and pumping may simply remove the groundwater from beneath them while they remain in place.
- **Gradual "Recontamination":** Whether bound to the soil, floating, or sunk to the bottom of the groundwater, NAPLs do dissolve very gradually, over very long periods of time. Thus, after pumping stops, groundwater that has reached a certain level of cleanliness can become recontaminated, perhaps even to its original levels.

Although some success has been achieved, the Oak Ridge National Laboratory has concluded flatly:

**When large pools of DNAPLs are present at the bottom of an aquifer, meeting drinking-water standards is unachievable at any cost.<sup>14</sup>**

*Oak Ridge was unable to find even one aquifer that has been successfully restored via pump and treat.*

*Problems with pump and treat:*

- *Binding*
- *Channelization*
- *Non-Aqueous Phase Liquids (NAPLs)*
- *"Recontamination."*

*Oak Ridge: When large pools of DNAPLs are present "meeting drinking-water standards is unachievable at any cost."*

***EPA agrees:  
No field demonstrations  
have ever removed  
DNAPLs to drinking  
water standards.***

***Mixed Waste: Waste that  
is both radioactive and  
chemically hazardous.***

***Virtually no permitted  
technologies exist for  
mixed waste.***

EPA has had to agree. Regarding DNAPLs, the EPA acknowledged in January 1992 that "to date there have been no field demonstrations where sufficient DNAPL has been successfully recovered from the sub-surface to return the aquifer to drinking water quality."<sup>15</sup>

Besides not achieving what it is supposed to achieve, pumping and treating can sometimes have negative effects on the area's ecology, and where mistakes are made, can actually exacerbate the problem. Thus, dewatering from pumping can cause serious land subsidence and other ecological damage. For example, pumping at the IBM site in San Jose, California, is reported to have resulted in the dewatering of an aquifer.<sup>16</sup> Additionally, drilling too deep or lowering a water table too much can cause a NAPL pool of contaminants to migrate to a deeper aquifer. For example, at the Department of Energy's Savannah River site in South Carolina, where pumping has gone on for five years, evidence of movement of contamination to deeper aquifers is reported.<sup>17</sup>

### **C. Mixed Waste**

Another remedial problem that current technology cannot handle is the problem of "mixed waste," i.e., waste that contains both radioactive and hazardous components, usually not physically separable from each other. It is estimated that as much as 98% of the nation's mixed waste is in the custody of the Department of Energy, as a legacy of practices during atomic weapons production activities. This waste is present at many locations and in multiple media (i.e., groundwater, lagoons, dirt, sludges, tanks, etc.). There are also at least eight non-DOE Superfund sites that contain mixed waste in a variety of media.<sup>18</sup>

The problem with mixed waste is that, for the radioactive components of the waste, treatment or destruction technologies do not exist. Nor have technologies yet been developed which can, in most cases, succeed in separating the radioactive from the hazardous components of the mixed waste.<sup>19</sup>

At present, radioactive waste can only be dealt with by removing it from the site and transporting it to permanent storage facilities. Yet the Resource Conservation and Recovery Act (RCRA), which governs the treatment, storage and disposal of hazardous wastes, prohibits the long-term storage of most hazardous wastes. And most facilities which are permitted under RCRA to treat or destroy hazardous wastes are specifically prohibited from taking in radioactive wastes and in a practical sense could not do so. For example, an incinerator that burned mixed waste to destroy the hazardous components

would likely end up as a radioactive incinerator, and during the incineration process radioactivity might be released to the surrounding environment.

The result of this combination of technological deficiencies and regulatory requirements is that for most sites containing mixed wastes there are at the moment no solutions. Yet to simply store the waste at the site while solutions are developed is illegal under RCRA. Recognizing this dilemma, Congress, in the Federal Facility Compliance Act of 1992, gave Federal facilities with mixed waste sites a three-year grace period to come into compliance with RCRA regulations that prohibit the storage of mixed wastes.<sup>20</sup>

#### **IV. Site-Specific Limitations on Technology Use**

##### **A. On-site Incineration**

At many manufacturing facilities, incineration of hazardous wastes has long been an appropriate and approved method of managing those wastes. In addition, on-site incineration allows companies to retain institutional control over their wastes.

Increasingly, however, hazardous waste incineration at Superfund sites has become a popular remedy with the EPA. **Through October 1990, on-site incineration had been selected at 59 Superfund sites,<sup>21</sup> and in October, 1991 EPA identified at least 14 active vendors who were able to bring "transportable" incinerators to hazardous waste sites.<sup>22</sup>** Incineration is often favored by the Agency because it can destroy a wide range of contaminants, including many of those that are found in soil, with efficiencies greater than 99.99%. Thus, through the remedy selection process discussed earlier, the Agency can establish cleanup standards more stringent than needed to protect human health and the environment, and feel assured that there is a technology capable of meeting those standards.

However, selecting a remedy that can technically achieve a destruction standard does not guarantee that the job will get done. There are many time-consuming and costly real-world, site-specific obstacles that get in the way of the typical on-site incineration Superfund project. Since cost and practicality are not usually considered by the Agency as it establishes cleanup standards for a site, those obstacles are often not fully anticipated.

Foremost among the obstacles is public opposition. Right or wrong, the "not in my back yard" syndrome means that people simply do not want hazardous waste incinerators

*But RCRA does not allow long term storage as the answer.*

*Incineration is a known and valuable solution for industrial wastes.*

*However, use of incineration at Superfund sites often raises practical problems.*

***Communities often prefer capping and containment.***

***Physical and chemical characteristics of the waste site media can cause tough technical problems for the incineration "solution."***

***The example of MOTCO.***

operating at Superfund sites in their neighborhoods. **Given the choice of eliminating risk to human health by capping, containment, and engineering/institutional controls versus incineration, many communities are beginning to express preference for containment.** In addition to the dioxin cases discussed later in this paper, there have been cases where public opposition has led to long and costly delays in incineration projects. For example, it has been reported that even though New York state officials favor the use of transportable incinerators to help remediate the state's 550 known hazardous waste sites, none has yet been put to work in the state. Community opposition has so far prevented the use of transportable incinerators in four New York communities where that remediation method was planned.<sup>23</sup>

Even where public opposition is not mounted against on-site incineration, there are other site-specific factors that are often overlooked in the remedy selection process but that can impede the efficiency of the process and/or the achievement of the desired cleanup standards. Some of these factors include:

- Foreign objects (e.g., rocks, drums, auto bodies) in what was expected to be soil (or liquids) of uniform consistency able to be fed to the incinerator without interruption or special treatment.
- Styrene tars in a lagoon, seemingly pumpable directly to the incinerator while covered with liquid, but which turn into a stringy, stretchy, non-pumpable "mess" when exposed to air.
- Metals (e.g., arsenic and lead) in contaminated media that is being incinerated to destroy organic contaminants, with the risk that these metals will volatilize during the incineration process and escape through the incinerator stack to the atmosphere. Even if they do not volatilize, they will remain in the incinerator ash, requiring further treatment.

The MOTCO Superfund site at La Marque, Texas, is a timely example of how things can go wrong at an incineration project site, even after the work has started. The MOTCO site was used from 1959 to 1968 for recycling styrene tars, disposal of industrial wastes, and as a state permitted waste disposal facility. The site has seven unlined waste pits with average depths of fifteen feet, containing contaminated rainwater, layered over organic liquids and soils, on top of sludges and tars. There are also contaminated soils all around the pits, as well as organic compounds, including DNAPLs, in the groundwater.

Remediation of the site is being conducted by a coalition of private companies who are Potentially Responsible Parties (PRPs) at the site. In 1988 a contractor was selected by the PRPs to construct and operate two incinerators at the site to burn the contents of the waste pits and the soils from within one foot of the pit boundaries. A contract to do the work for \$30 million was executed and by 1990 both incinerators had been constructed and had begun operation.

Then, in 1991, the contractor, claiming that the types and amounts of wastes at the site were much different than it had been led to expect, abandoned the project and sued the PRPs for \$56 million (on top of the \$20 million that had already been paid). The PRPs do not agree that the contractor's claims are valid. No remedial work has been accomplished since the contractor left the project, and the PRPs are now conducting a new bid solicitation to engage another contractor to work on the site.

The PRPs have also petitioned EPA to change the design that governs the remedial work to be done at the site. The PRPs' suggested changes would reduce the time needed to complete the project from eleven years to four years, primarily by stabilizing, isolating, and capping on site the contaminated soils and sludge solids and surrounding the stabilized and capped material with a slurry wall to prevent the migration of contaminants. All remaining contaminated liquids, which present the most residual concern regarding possible migration, would be removed from the pits and taken to an off-site commercial hazardous waste incinerator.

According to the PRPs' petition to EPA, the amended solution would be equally protective of human health and the environment as would the original plan to incinerate all of the pits' contents. The amended solution is likely to increase public acceptance of the remedy, since the time and amount of incineration, as well as the total time for the project, would be significantly reduced.

### **B. Dioxin - A Special Case of Waste**

Dioxins are unintended byproducts formed during the manufacture of various chemicals. They are also formed during the incomplete combustion of chlorinated compounds. U.S. manufacturing of dioxin-containing products at all but ultra-trace levels has essentially ceased, but the nation has been left with what the EPA estimates to be 500,000 tons of dioxin-contaminated materials.<sup>24</sup> More than 98% of that amount is dioxin-contaminated soil with the rest being stored, processed material.<sup>25</sup> About 100 waste sites across the country

***MOTCO: Enormous unexpected costs associated with incineration.***

***The dioxin problem.***

*Re-evaluating the risks.*

are considered to be seriously contaminated, and 18 of those are Superfund sites.<sup>26</sup> Undoubtedly the best known is the entire town of Times Beach, Missouri, which in 1982 was discovered to be contaminated with dioxin as a result of used oil having been sprayed on its roads, and which the EPA paid its residents \$33.1 million to vacate in 1983.

Based on initial results from animal studies that indicated dioxin to be the most potent carcinogen ever evaluated by EPA,<sup>27</sup> dioxin has been treated as a special waste since the 1970s. However, according to Congress' Office of Technology Assessment (OTA), studies of humans exposed to low doses of dioxin have not demonstrated excess cancers among these groups.<sup>28</sup> One recent study of chemical workers exposed to continuing relatively high doses of dioxin does however suggest some association between high exposure and carcinogenic effects.<sup>29</sup> In 1991, the Administrator of the EPA ordered an agency-wide review of dioxin and its risks. That review is ongoing.

In the meantime, the long-held belief about dioxin's ability to cause cancer even in very low doses led Congress to ban its disposal by landfill and led the EPA to establish extraordinarily stringent standards for cleaning up contaminated sites, essentially requiring complete destruction of the dioxin molecule.<sup>30</sup> So far, the only way those levels of destruction of dioxin in soil have been achieved is through incineration. The Agency has also required that dioxin being disposed of at commercial disposal facilities be incinerated. In both cases the incinerator used must be capable of destroying 99.9999% of the dioxin in the material it is burning.<sup>31</sup> That level of destruction is within the limits of incineration technology and a number of incinerators in this country routinely have been incinerating polychlorinated biphenyls (PCBs), which also must be incinerated to those levels, since 1981.<sup>32</sup>

*Opposition to  
incineration of dioxin.*

Yet ten years after the dioxin issue became widely publicized as a result of Times Beach, the public controversy over, and opposition to, dioxin incineration has **resulted in almost nothing being done to deal meaningfully with the problem.** Only one dioxin-burning incinerator at a hazardous waste site has been approved for anything other than test burns or incineration of small amounts of material. That one dioxin incinerator was approved only after a court fight and many years of local opposition, first to the concept and then to the specific incinerator.<sup>33</sup> Attempts to stop the incinerator through court challenges have continued since its operations were initially approved. Until recently, because of the likelihood of strong public opposition, only one of the handful of fixed commercial incinerators capable of doing the job had

even asked the EPA for a permit to incinerate dioxin. The first dioxin permit was not granted to such an incinerator until July 1991.<sup>34</sup> That incinerator completed one commercial incineration of dioxin materials in February 1992 and has since voluntarily suspended dioxin incineration while the state reviews the public policy implications associated with being the nation's only permitted commercial dioxin incinerator.<sup>35</sup>

Even EPA, which for a time successfully operated its own incinerator burning dioxin materials in Missouri, was denied a permit to continue operating by the state. As a result, EPA has been paying approximately \$5 million a year to store dioxin materials at a facility in Texas.<sup>36</sup> At Times Beach, in the almost ten years since the residents were evacuated, public opposition to incineration has delayed EPA's planned implementation of that solution. Present plans are for an incinerator to be operating on site by 1994 or 1995 and a contract has been awarded to achieve that end.

Because of all of this, the 500,000 tons of dioxin and dioxin-contaminated waste is still out there, some of it in drums, but much of it still in the ground where it first came to EPA's attention.

## **V. Summary**

A number of examples have been given in this paper to highlight the limitations of present-day technologies in achieving the hazardous waste site cleanup standards that are established by EPA's standard-setting process and procedures. The examples given are not all-inclusive. Complexity is more the norm than the exception at Superfund sites. Wastes are not found in forms that are amenable to textbook treatment methods. They are found in soil, in liquids above and below the ground, or in sludges contained in tanks or drums. Usually they are found mingled with other wastes. Sometimes, the right way to treat one of these wastes is exactly the wrong way to deal with the waste with which it is mingled.

The EPA standard-setting process frequently ignores, or at best underestimates, the difficulty of such complexities. Standards that are set under other statutes, for very different regulatory situations, are sometimes impossible to achieve in the typical hazardous waste site environment. Or, if they can be met, it is only at costs that are greatly disproportionate to the degree of risk reduction that is achieved when compared to other less costly alternatives.

*Times Beach at a virtual standstill.*

*Dioxin: Buying time through storage.*

*Superfund wastes are complex.*

***Facing up to technological limits will promote the selection of realistic and protective cleanup standards.***

Faced with difficulties in meeting overly stringent cleanup standards through the use of known treatment technology, the EPA often resorts to on-site destruction through incineration as the remedy of choice, feeling assured that most contaminants found at hazardous waste sites can be successfully destroyed by high temperature. Even then the answer is often not that simple. A number of factors can work to deter the efficiency of the incineration solution, from local public opposition to site-specific, construction-related or operational problems. If such problems arise, cleanups can be seriously delayed or even stopped in their tracks. Then, because EPA has established such stringent, unrealistic cleanup standards that no other technology can meet them, the result is that nothing is accomplished.

## ENDNOTES

1. Hazardous Waste Cleanup Project "Sticker Shock: Recognizing the Full Cost of Superfund Cleanups" (June, 1993).
2. See the Hazardous Waste Cleanup Project, "Exaggerating Risk" (June 1993).
3. Arthur D. Little, Technology Capabilities Versus Superfund Cleanup Requirements: Is There a Gap? Report to Coalition on Superfund, Reference 66252 (February 1992), Table 2-1 (showing that mercury in groundwater was estimated by EPA to be found at 101 of the then 1211 NPL sites, or 8%).
4. 40 C.F.R. § 141.62(b).
5. Arthur D. Little, Technology Capabilities Versus Superfund Cleanup Requirements: Is there a Gap?, Report to Coalition on Superfund, Reference 66252 (February 1992), Table 2-1 (showing that chromium in soil was estimated by EPA to be found at 310 of the then 1211 NPL sites, or 26%).
6. Id. at 19.
7. 40 C.F.R. §300.400(g)(3) allows a category of "to be considered" (TBC) for advisories, criteria or guidance developed by EPA or states that may be useful in developing CERCLA remedies.
8. Arthur D. Little, Technology Capabilities Versus Superfund Cleanup Requirements: Is There A Gap? Report to Coalition on Superfund, Reference 66252 (February 1992), p.31.
9. U.S. EPA, Considerations in Groundwater Remediation at Superfund Sites and RCRA Facilities — Update, Directive 9382.1-06, Office of Solid Waste and Emergency Response (OSWER) (May 27, 1992), p. 2.
10. Curtis C. Travis and Carolyn B. Doty, Can Contaminated Aquifers at Superfund Sites be Remediated? 24 Env't Sci. & Tech 1465 (1990).
11. Id.
12. U.S. EPA, Considerations in Groundwater Remediation at Superfund Sites — Update, p. 3.
13. For a more complete and technical discussion of these reasons, See Doty and Travis, The Effectiveness of Groundwater Pumping as a Restoration Technology, Oak Ridge National Laboratory (ORNL/TM-11866) May, 1991) pp. 33-38.
14. Id. at 37.
15. U.S. EPA, Estimating Potential for Occurrence of DNAPL at Superfund Sites, Publication 9355.4-07FS, Office of Emergency and Remedial Response (Jan. 1992), p. 1.
16. Doty and Travis, The Effectiveness of Groundwater Pumping as a Restoration Technology, pp. 41-42.
17. Id.
18. U.S. EPA, Assessment of Technologies for the Remediation of Radioactively Contaminated Superfund Sites, Document EPA 540/2-90.001, Office of Solid Waste and Emergency Response, Office of Radiation Programs, January 1990 (determined by counting non-DOE, mixed waste sites listed in Appendix B).
19. Summary of Discussion, Hazardous Waste Action Coalition Mixed Waste Forum, Washington, D.C., March 20, 1992.
20. Federal Facility Compliance Act of 1992 (Pub. L. 102-386, 106 Stat. 1505), § 102(c)(2)
21. U.S. EPA, Innovative Treatment Technologies: Overview and Guide to Information Sources, Document EPA/540/9-91/0002, Office of Solid Waste and Emergency Response (October 1991), p. 2-3.
22. Id.
23. Gannett News Service, "Transportable Incinerators Going Nowhere in NY," September 1, 1992.

24. U.S. Congress, Office of Technology Assessment, Dioxin Treatment Technologies - Background Paper, OTA-BP-0-93, p. 1 (November 1991).
25. Id.
26. Id.
27. Id. at 2.
28. Id.
29. Id.
30. The working standards are 1 part per billion (ppb) in residential areas (see, e.g., EPA Region 6, Record of Decision: Vertac, Inc., EPA/ROD/RO6-90/056, Sept. 27, 1990) and 20 ppb in industrial or non-residential areas (see, e.g., EPA Region 7, Record of Decision: Syntex Facility, EPA/ROD/RO7-88, May 5, 1988).
31. 40 C.F.R. § 264.343(a)(2).
32. Rollins Environmental Services, Inc. began commercially incinerating PCBs on March 12, 1981 at its facility in Deer Park, Texas. United Press International, Dateline Houston (March 12, 1981).
33. Vertac Site Contractors was granted a "Dioxin Certification" to incinerate dioxin wastes at the Vertac Site in Little Rock, Arkansas in February, 1992. Recent court challenges have focused on the fact that the monitoring and analysis for the incinerator test burns were performed on surrogate chemicals other than dioxin. Bureau of National Affairs, Environment Reporter, "Appeals Court Upholds Stay on Injunction, Allows Continued Burning by Vertac Incinerator," March 5, 1993, p. 2868.
34. Aptus, in Coffeyville, Kansas has the permit (Aptus is owned by Westinghouse).
35. Bureau of National Affairs, Environment Reporter, "Kansas Delays Decision on Need to Modify Aptus Facility's Permit For Dioxin Incinerator," March 26, 1993, p. 3058.
36. The EPA has been paying about \$5 million per year simply to store drums of dioxin at a storage facility in LaPorte, Texas.

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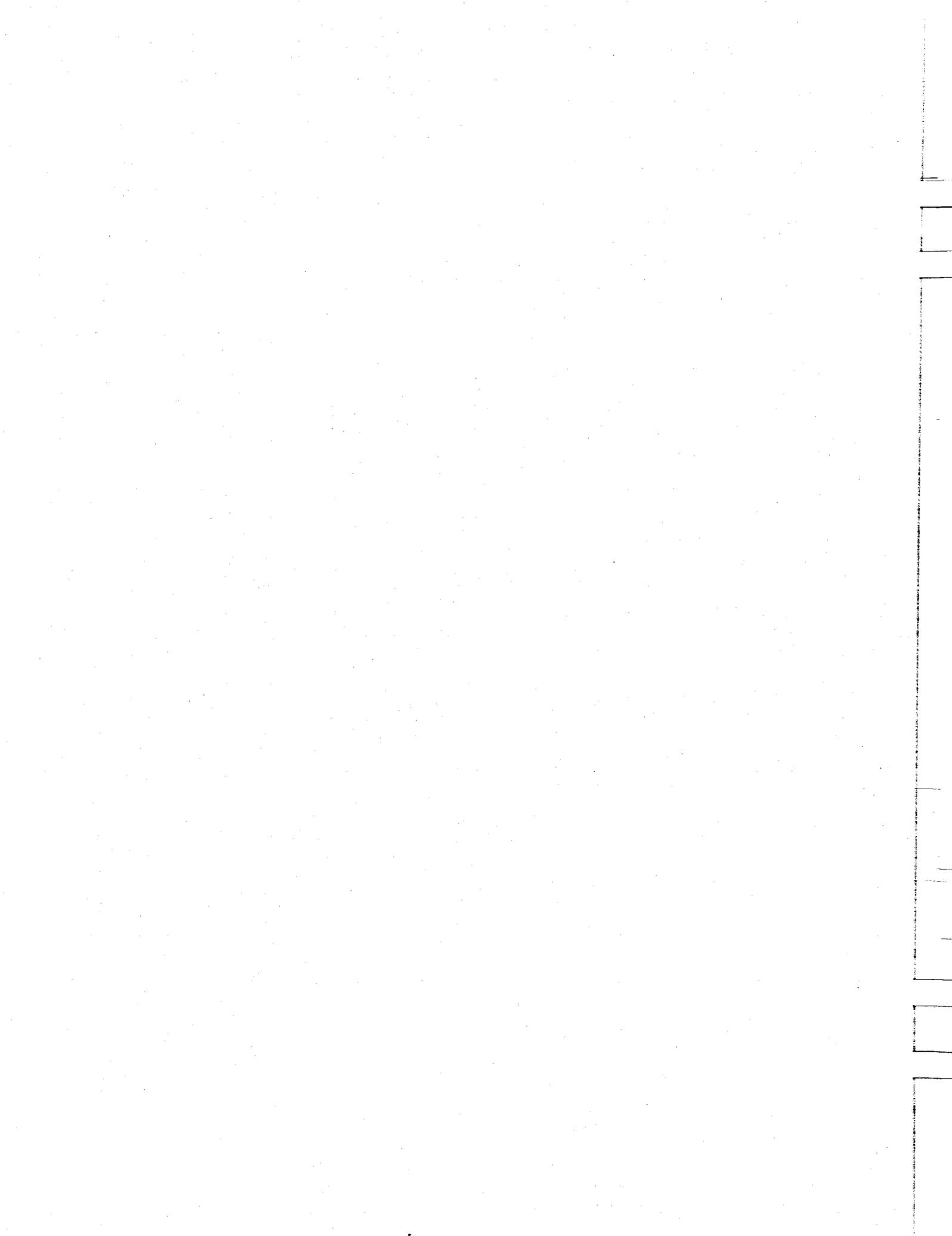
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c/o Morgan, Lewis & Bockius • 1800 M Street, N.W. • Washington, D.C. 20036 •  
Telephone: (202) 467-7575 • FAX: (202) 467-7176