EDITED BY
Sue Lofgren
David Pijawka
Nicholas Hild

NATURAL RESOURCES AND HIGH TECHNOLOGY
KEEPING THEM COMPATIBLE

Conference Proceedings
Governor's Commission on
Arizona Environment
Summer 1984

PUBLISHED BY
School of Public Affairs **and**
Center for Environmental Studies
Arizona State University
and
Governor's Commission on Arizona Environment

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TABLE OF CONTENTS

PAGE

Acknowledgements . . . . . *vii*

The Groundwater Quality Challenge . . . . . *viii*
The Honorable *Bruce B. Babbitt*,
Governor, State of Arizona

Objectives of the Conference . . . . . *xi*
S. Lofgren

SECTION I

TRENDS IN HIGH TECHNOLOGY DEVELOPMENTS:
NEEDS AND OPPORTUNITIES

High Technology Trends in Arizona 2
B. Jarman

Facilitating the "Third Wave" Transition: Industry-
Government Relationships and High Technology 5
G.A. Daneke

The Future High Technology Environment of Arizona 11
C.R. Haden

Technology in Agriculture 14
B.P. Cardon

PAGE

SECTION II

E.P.A. AND RISK MANAGEMENT

EPA and Risk Management: Regulatory Issues 18
J.S. Cooper

SECTION III

HIGH TECHNOLOGY AND ENVIRONMENTAL MANAGEMENT

Introduction 24
B. Kalahar and *D. Pijawka*

High Tech Contamination of Groundwater 28
R. Miller

Issues in Hazardous Waste 33
R.B. Scott

Growth Impacts and High Technology 37
F. Bangs

Regulating Environmental Hazards: Legal/Policy Issues 39
D. Pontius

Issues in Assessing and Managing High Tech 48
J. Andelin

How Safe is Safe? 54
M.A. Anderson

PAGE

SECTION IV

ENVIRONMENTAL MANAGEMENT IN THE PRIVATE SECTOR

Introduction 61
N.R. Hild

Digital Corporation 64
A. Abbott

Honeywell Information 67
R. Hacker

IBM 70
H. Ehrhardt

Intel Corporation 75
T.J. McManus

Motorola 83
M. Chait

SECTION V

RISK MANAGEMENT: TCE AND GROUNDWATER CONTAMINATION

Introduction 87
M. Carlile

TCE: Measuring a Groundwater Contaminant 89
K. Schmidt

PAGE

State Regulatory Response to TCE Pollution 92
P. Beilke

TCE in the Silicon Valley 95
H. Seraydarian

SECTION VI

PUBLIC INVOLVEMENT AND CONFLICT RESOLUTION IN TECHNOLOGICAL AND ENVIRONMENTAL DISPUTES

Introduction 101
S. Lofgren and *D. Pijawka*

The Media and Technological Hazard 103
B. Cuthbertson

Environmental Dispute Resolution 110
E. Patten

SECTION VII

SUMMARY OF THE CONFERENCE

Summary of the Conference 116
J. Dworkin

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The Honorable Bruce B. Babbitt
Governor, State of Arizona

THE GROUNDWATER QUALITY CHALLENGE

There are three events that have taken place in the last week that I believe guarantee that the issue of groundwater, and very specifically, groundwater quality, will be the front burner issue, the most important topic for legislative and political debate in Arizona in 1985. The single most important of those three events is a letter and information form which went out today from the Director of the Department of Health Services to 900 recipients statewide in Arizona. It represents the opening round in an effort by the State of Arizona to begin a serious and comprehensive effort to catch up and get on top of the issue of groundwater quality. The second issue of the past week guaranteed to bring this issue to the forefront is a lawsuit by the Arizona Chamber of Commerce saying, "We don't believe Dr. Novik has the authority to do this and we're going to oppose in the courthouse his attempt to at last bring Arizona up-to-date and to take the initiative in groundwater quality control." The third event was in this morning's paper where there was an article which indicated that Mr. Ruckelshaus and the Environmental Protection Agency have also recognized that the environmental issue of this decade will be groundwater quality. This was accompanied by a statement from the Environmental Protection Agency that the groundwater issue must be addressed not by anonymous bureaucrats in buildings in Washington, DC issuing mandatory directives that will allow all the rest of us to get off the hook and abdicate our responsibility. It is, rather, a statement with which I entirely concur, which says, "the regulation of groundwater resources is uniquely a federal and state responsibility." At the very time Dr. Novik (ADHS) has stepped forward and said, "We are going to assume responsibility," at the very time that the Arizona Chamber of Commerce has stepped forward and said, "We'd prefer to live in the 19th Century, we don't want any regulation," the Federal Government has commendably, and I think properly, said, "We're throwing down the gauntlet to the states, and asking them to assume their responsibility."

We are behind schedule, unquestionably, undeniably. The reason, I think, is in some measure understandable. Groundwater is a rather difficult concept to get a hold of. We all live over groundwater, but we do not fish in groundwater, we do not swim in groundwater; no photographer has yet captured an Arizona sunset reflecting across groundwater. It's out of sight; it's an intangible. We do not really ever see it in its groundwater setting. Understandably we've tended to ignore the reality. We can't ignore that reality any longer. The warning signs are surfacing everywhere. I read a story in the Wall Street Journal last week about Silicon Valley--the mecca of high tech in the United States of America. In areas of Silicon Valley there are bottled water trucks delivering water because the local water company can no longer deliver water that is free of TCE and other solvents. In Southern California there is a crisis brewing over a location known as the Stringfellow Acid Pits, a modest, unobtrusive little dumping ground up in the hills, where dumping has been going on for five or ten years creating an acid plume which is now moving down into the San Fernando Valley creating a nearly insoluble problem.

We have seen the same thing in Arizona. I need not recite all the specifics. TCE in Tucson: Hughes Aircraft solvents were dumped on the ground over the years and are now in the water supply in the City of Tucson. Lloyd Novik brought me a map showing contamination sites over the City of Phoenix. The red markings on that map look like a checkerboard. Contamination sites are pervasive. Wells are being shut down right and left, and we really do not know the extent of the contamination. What we have already discovered, I believe, brings us a crisis of the most urgent proportion. Up north of Globe, mining wastes have created an acid plume which is now moving downhill toward the water supply for the City of Phoenix, formerly known as Roosevelt Lake. In Tucson the mining in Pima County is centered upstream in the Santa Cruz Valley right on top of the gradient for the groundwater supply for the City of Tucson. The mines to date have reacted by saying, "You don't have jurisdiction to look into this issue." Without placing any blame we are revisiting a long history of neglect and inattention.

I suggest that our task now is to get moving, to come together in pragmatic coalition-building, Arizona fashion, and assert our responsibility and see if we can't get this problem under control. We have thought that pollution problems in parts of New York, New Jersey and California have probably been irrevocably and irreversibly damaged. That is not yet the case in Arizona. It will be, however, if we do not have the wisdom collectively, from all sectors, to get together and move on this problem. That is what's behind Dr. Novik's letter this morning. It's a letter which says, "We are going to begin a comprehensive permit process for any entity in the State of Arizona which is dumping toxics or contaminants or creating a situation where they might be leaking from

underground storage tanks or in any other potentially hazardous form." It is a letter which acknowledges, by its very existence, that we have not done an adequate job in the past. It is a letter which says we must collectively begin a permitting process which will bring this matter under control.

The lawsuit by the Chamber of Commerce is very unfortunate. It's my belief that the Chamber's lawsuit is not a reflection, nor represents the position of Arizona businesses. I appeal to every business person in this state to step forward and join us even if the Chamber of Commerce does not. Ultimately this is not only an environmental issue but an economic growth issue. It's an issue which goes to the very core of our ability to attract industry and growth in a dynamic mode by saying, "we're a state which can reconcile environmental reality with business, high technology and development." We're not going to follow in a short-sided response to people like the Chamber of Commerce who say, "tomorrow's profit must be unencumbered whatever the ultimate damage." We believe that we cannot look away, ignore these problems and prosper today and pass all the damage on to the next generation in terms of permanent damage, reduced growth, and less opportunity for our children.

That is the reason that the work of this Commission is so vitally, vitally important. This Commission for some ten or fifteen years has been the meeting place of the responsible center of the Arizona political process. It's been a meeting place for academics, for business and industry, for environmentalists, for political leaders; a place where we can come together and fight, and struggle, and knock heads, and find sensible, pragmatic and reasoned solutions. You have done that year, after year, after year. The deliberations in this Commission have had an enormous impact on the formulation of resource policy and environmental policy in this state.

I believe the groundwater issue may be the biggest challenge that we have faced in the history of this Commission. This issue will be at the forefront of the political and legislative debate. It is essential that every member of this Commission and the groups that you represent wade straight into this battle, arm yourselves with the facts. We must recognize that we must have strong and reasoned and thoughtful regulation, that we can regulate in the interests of all sectors of this state. It will not be done if we allow this issue to degenerate into an ideological, abstract political battle with people pulling philosophy books off the shelves, ignoring the facts and joining battle. It's your responsibility. It's your opportunity. I'm very grateful for everything you've done, urge you to pick this up and look forward to working with you and celebrating your successes.

Sue Lofgren

GOVERNOR'S COMMISSION ON ARIZONA ENVIRONMENT SUMMER CONFERENCE 1984

The Governor's Commission on Arizona Environment was founded in 1965 as an outgrowth of the White House Conference on Natural Beauty. Since that time Arizona's population has almost tripled and the number of environmental issues and their complexity has increased commensurately. Because of this, the Commission's focus has been expanded to address ways to preserve and enhance the quality of Arizona's total environment--land, air, water, health, energy and transportation.

Established by Executive Order of the Governor, its charge is to (1) "act as a clearing house and means of opinion and information relating to the problems of Arizona's environment and the solutions thereof," and (2) "communicate with all sectors of the Arizona population and economy so that conclusions by the Commission will represent as nearly as possible a cross-section of Arizona thought on the subject of environment." Conclusions and data compiled during this process are to be forwarded to the Governor for consideration and action.

At least four workshops are conducted annually by the Commission, which are open to the public, to inform participants and to encourage input of alternative solutions on critical environmental issues. These programs provide and encourage interchange of technical and research data between government, business, educators and citizen groups. The Commission's Summer Conference is its most extensive forum for discussion of specific environmental issues. Some recent topics have been hazardous waste, water quality and quantity, and growth to the year 2000.

Environmental problems along the border are also addressed by means of an annual joint meeting with representatives from Mexican institutions and organizations. These informal discussions afford opportunities for mutual exchange of information and provide the basis for further exploration of possible solutions to identified problems.

The Commission, because of its composition and operation, is quite unique in the nation. The 130 members, appointed by the Governor,

represent a broad cross-section of Arizona, both geographically and by interest. The members are drawn from business, professional, citizen and conservation organizations, as well as governmental and educational entities. Each member is assigned to a committee of his or her choice and serves without any compensation. Committees deal with growth management, health, environmental education, land resources, water, energy and other environmental issues. Committee members develop special reports as well as proceedings, fact sheets, directories, and teaching guides. They also monitor legislation that concerns recommendations that have come from the Commission.

High Technology and Natural Resources: Keeping Them Compatible

As one of the very fastest growing states in the nation, it is not surprising that Arizona is also the recipient of a large share of the fastest growing industry in the United States--high technology.

Over the last few decades, the focus of Arizona's economic base has shifted dramatically from agriculture and mining to services and manufacturing--particularly in the high technology field. Half of the manufacturing jobs in Arizona are in the high tech industry and that total continues to grow rapidly. At the same time, the industry has produced a number of supporting jobs, the suppliers and services needed to sustain it. Jobs in high technology almost doubled between 1975 and 1982.

Arizona is also the seventh most popular state for electronic plants to relocate in. It offers an exceptional business climate, labor, and cost of doing business. It also has excellent research facilities as well as an attractive climate and quality of life.

What this all adds up to is that high technology is big business in Arizona. It is readily apparent that Arizona is well on the way to becoming the "Silicon Desert" of the U.S.!

What are the impacts of high tech locating in Arizona? In particular, what are the impacts of high tech on Arizona's natural resources--its water, air, land and people? Can negative impacts be minimized and effectively managed, and positive ones maximized?

To address the environmental affects of high tech from the past, present and future perspectives, the Governor's Commission on Arizona Environment devoted its 1984 Summer Conference to an exploration of these issues with its theme "Natural Resources and High Tech: Keeping Them Compatible." The following pages are devoted to presentations made at the Conference.

SECTION I

TRENDS IN HIGH TECHNOLOGY DEVELOPMENT

NEEDS AND OPPORTUNITIES

HIGH TECHNOLOGY TRENDS IN ARIZONA

A week ago today I was going from my office in the Capitol Tower over to the Senate, and as I was crossing the old Capitol I heard a young tour guide with a group of tourists clustered around the Great Seal of the State of Arizona, say, "If you will look at that Seal carefully, you will find the base of Arizona's economy." She paused and said to these tourists, "What would you guess is the base of Arizona's economy?" I stopped fast in my tracks almost unbelievable, when the speech of copper, cotton, citrus and cattle began. I thought my first job is educating the tour guides in the Capitol Complex. We have had the opportunity since my taking this position in December, to develop an economic development strategy for the State of Arizona and what we did was take a look at where we were in 1950, where we are today, and our best guess scenario of where we'll be in the year 2000.

If I could set the stage for you about where Arizona is, that is, other than cotton, cattle, citrus and copper, then I would like to talk about, what I prefer to call, advanced technology, and what we anticipate would be a future scenario for Arizona. In 1950, 26.4 percent of the personal annual income of Arizona citizens was directly attributed to agriculture. This is down to 2.4 percent today. At the height of the copper industry, 22,000 miners were at work. Today there are 11,200 persons in this sector. The best case scenario is that 7,000 to 8,000 of those workers will never go back to working in the copper mines in Arizona due to demand problems for copper. With regard to manufacturing (that is so much of this advanced technology area), Arizona has increased its manufacturing base at a time when the rest of the nation has lost manufacturing jobs. In this sector, Arizona has grown from

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DR. BETH JARMAN is Executive Director, Office of Economic Planning and Development, State of Arizona.

5.6 percent of personal annual income to 12.6 percent. But far more startling is that of the 12.6 percentof the annual income, 46 percent of total employment is directly attributed to high technology employment. How does that compare with the United States rate? Compared to the United States as a whole, only 14 percent of the jobs are in high technology employment. Arizona has increased its manufacturing base substantially over the last 30 years and the manufacturing sector has a greater number of people employed in high technology when compared to the national rate.

What is 'high technology'? "High technology" may be an intimidating word to the public in general. People think their lives are going to be taken over by computers and they aren't going to be able to understand what's going on. A better word is an "advanced technology future," in that, it isn't merely computers, nor aerospace engineering, but it is how information is managed across the entire segment of a state or a nation. We're a brain intensive society, we're an idea intensive society, and why we're having such shockwaves through the economy is because people's jobs are less and less oriented to making things. They're more oriented to thinking things, writing things, being creative: an advanced technology society is dependent on a far different base than a traditional industrial oriented society.

For Arizona five categories of economic activities are important: electronics, computers, aerospace, communications, and instrument manufacturers. In the State of Arizona there are over 400 advanced technology companies that are in the business of computers, electronics, aerospace manufacturing and research facilities. In addition, there are approximately 400 computer software companies. In total, these companies employ over 80,000 people and account for nearly 50 percent of the total manufacturing employment in the State. Arizona's advanced technology employment force has increased by 85 percent from 1975 to 1983 and the American Electronics Association is projecting that we will have a 10 percent annual growth rate through 1987.

What are the trends and plans in Arizona? How are we going to meet the challenges of an advanced technology future? In our economic development strategy, four policy items have been identified. One, Arizona is wedded to an advanced technology future; in fact, people are calling this development the Silicon Desert. What is happening in the State? Why does industry locate in a particular place, and what does an industry look for in locating? Advanced technology corporations respond to much different locational criteria than traditional industrial corporations. In Arizona, when we're competing for site selections of a regular industry, the basic concerns are productivity of workers, how the community will receive them if they decide to move, efficiency of transportation facilities and tax considerations. Advanced technology firms are extremely mobile and what they're looking for are educational facilities and the educational quality of the work force, particularly at the university level. To that end, Arizona has contributed $30 million

for the building of an engineering excellence school at Arizona State University. In order to compete we look at Palo Alto in Berkeley, we look at Highway 128 in Massachusetts (MIT and Harvard) and the North Carolina Triangle. The high technology industry is looking at education, quality of life, and an existing trained labor force; taxes is not a significant factor.

Quality of life factors include environmental quality. We just had a company that was deciding to move here, and the firm indicated some hesitancy to do so because of problems with Arizona's water supply and the inability of Arizona to assure adequate ground water supply.

An important goal for Arizona is to create our own high technology companies. An advanced technology industry can become a fortune 500 company within five years from start. Arizona is on the verge of beginning the process of supporting advanced technology start-up companies. The jobs that were created over the last 5-10 years were generated by small businesses rather than the large corporations. Arizona's future is wedded to creating the environment where technology can flourish and ideas can be financed. We are in the throes of creating the Arizona Innovation Center underwritten with public funds out of the Office of Economic Planning and Development, but located in the private sector as a private, non-profit corporation with the intention of doing several things. Fostering an environment in which the creative, innovative people come together providing the capital in which companies can be financed. This is dependent on a very non-traditional kind of financing, financing an idea without collateral. It's hard for banks to make this transition and Arizona is a capital poor state. Arizonans have generally been reluctant to have the private sector committed to any kind of public financing. But we're looking toward being very involved with the private sector in Arizona's high technology future, or advanced technology.

G.A. Daneke

FACILITATING THE 'THIRD WAVE' TRANSITION: INDUSTRY-GOVERNMENT RELATIONSHIPS AND HIGH TECHNOLOGY

Arizona, like much of the "sunbelt," is riding the crest of a massive wave of socioeconomic transition. The hallmark of this transition is, of course, the emergence of various high tech industries (computers, advanced communications, robotics, genetic engineering, etc.). However, these new industries are really only a minor element of this overall transition. Moreover, they are merely means rather than ends, in and of themselves. To fully realize the bounty of these new technological advances requires developing a balance between these and other transition forces. For lack of a better designation, we might use Toffler's (1980) notion of the "third wave" to represent the totality of these transition forces. In very general terms, the "third wave" entails equal portions of human resource, and life-quality development along with high tech. Furthermore, realizing these critical complimentary elements involves not just a fascination with particular high tech products (e.g., computers) but an appreciation of the process of technological innovation itself.

Few, if any, regions of the U.S., or world for that matter, have witnessed the complete breaking of the third wave. As Toffler suggests, we are currently stuck between eras; the "second wave" institutions, industrial processes and byproducts are fighting against the development of new corporate and civic cultures. Arizona, because of its lack of these antiquated institutions and its energetic citizenry is in an ideal position to spearhead these additional ingredients as well, and thus bring to fruition the balanced (socially and economic) transition which Toffler envisions.

DR. GREGORY A. DANEKE is Professor of Political Economy and Business Policy, Arizona State University.

Silicon Valley Fever

Arizona is not alone in its push for a high tech nirvana. Numerous states and localities are rushing to attract new investments, to replace dying "smokestack" industries. Success has not been commensurate with the amount of effort, however. As Irwin Feller (1984, p. 381) suggests, "the euphoria associated with bold new ventures by the states to initiate high technology development can obscure many political and economic realities that condition and constrain them." The Congressional Office of Technology Assessment (OTA)'s comprehensive survey of state and local industrial policies contends that systematic understandings of what works best, is simply unavailable. Without necessarily discounting the value of symbolism for economic development, OTA contends that few of these policy packages are much more than gubernatorial image building. As such, they involve little actual resource commitments and usually result in short-range, high visibility, low substance initiatives (e.g., job creation projects). Even when initiatives are significant, they may fall prey to the following difficulties (Daneke, 1984;Feller, 1984; OTA, 1984; and LaDou, 1984):

1. ignoring the fact that Silicon Valley and Boston's Route 128 grew gradually and naturally with the help of private university research efforts which began in the 1950s;

2. not appreciating that even applied research requires lengthy time periods (sometimes 15 years in the biotech area) to develop marketable products, and thus jobs;

3. failing to recognize the potential environmental, health and safety risks associated with many high tech industries;

4. generating new, lower paying assembly line opportunities or, at best, developing technicians rather than fostering an environment for "creative intelligence";

5. supporting existing industries and actually discouraging the creation of new small scale ventures and innovations;

Finally, and most importantly,

6. by pushing for "quick fixes"; overlooking the difficult and intricate institution building needed to provide the type of cooperative (between business, government and labor) milieu which can sustain long-term innovation and entrepreneurship.

Designing economic development strategies which facilitate a "third wave" transition, let alone sustainable growth, requires a more broad

gauged approach, beyond the bounds of traditional economic thinking. Such an approach must integrate human resource and life-quality enhancement with conventional economic objectives. Moreover, it must focus on the fundamental infrastructure of innovation rather than the mere "high tech" manifestations.

Human Resource Development

As Toffler suggests, in the past, machinery were considered assets, and people were merely expenses. In the future, people are the ultimate asset. Harvard's Alan Kantrow (1983) has called human resource development "the San Andreas fault of innovation policy," implying that there are serious gaps in personnel management programs. These gaps are not just in the area of training more technicians. We need to develop systems which allow individuals to unlock their greatest creative potential.

The current emphasis in many states, including Arizona, on beefing up university technical programs is only a small part of the creative equation. At best, these programs foster process and/or innovative applications within existing industries; they rarely engender totally new products and/or occupations. Few of these programs are in a position to contribute to major breakthroughs, such as the "5th generation computer," and items such as robotics, microprocessors, fiber optics, etc., are already mature industries and/or well along the learning curve. Moreover, many truly new ideas are likely to come from the largely neglected "pure sciences" as from the applied sciences.

Science and engineering, while necessary, are not a sufficient condition for innovation. Business schools need to offer programs in entrepreneurship on the one hand and creative management on the other. Students need to not only learn how to start new ventures, but also manage creative individuals. At present, traditional managers do not know how to nurture, let alone communicate with the scientists within their own research divisions and/or "shunk works" (see Peters and Waterman, 1982, pp. 201-212).

Finally, and perhaps more importantly, universities need to focus on industries for which their state and/or region already has a competitive advantage, and not merely copy programs elsewhere. For example, Arizona's universities should be national leaders in solar energy (both active systems and passive design), tourism, arid land studies, and other areas which will directly contribute to its economy.

Life-Quality Enhancement

The role of environmental and quality-of-life considerations in economic development planning is just beginning to become appreciated. First and foremost, we are becoming increasingly aware that well-being is not purely a matter of dollars and cents. More and more, individuals

make career decisions based upon a variety of intangibles, including the quality of the natural and social environments in the region. This is especially true of those individuals who have the skills which are in demand by high tech firms. A recent study suggested that it may well be Oregon's stringent environmental codes which are attracting high tech investments (Simmons, 1985). Likewise, Arizona's natural beauty and warm climate have certainly contributed to its success in this regard. Thus, it must learn to better safeguard its natural amenities and expand its cultural opportunities, if this success is to continue.

Given the population growth associated with economic development, life-quality enhancement provides a significant challenge. This challenge is made more pronounced by the fact that various high tech industries are not as clean as once assumed. For many, the smokestacks are merely underground. As Joseph LaDou (1984) describes, worker health risks and long-term groundwater pollution are especially acute in the semiconductor industry. States such as Arizona must work conscientiously with these industries to assure that these potential hazards are appropriately managed.

Other problems associated with development may be even more troublesome. Traffic congestion, air quality, etc., are issues which the sunbelt in general and Arizona in particular have continually refused to address. Better land-use and transportation planning, along with tougher auto-emission standards, are required.

Meanwhile, social and cultural opportunities are just beginning to emerge, and may demand greater public as well as corporate support to flurrish. Arizona's metropolitan areas are making significant strides, but have a long way to go to provide the type of cultural amenities of comparable population centers elsewhere in the country. Compare the entertainment section of the *Arizona Republic* with papers in Denver, San Diego, or Dallas to find evidence of this cultural key.

Sustaining Innovation

The most vital ingredient of the third wave future is also perhaps the least tangible. That element is innovation itself. As Nelson and Winter (1977) suggest, "creative intelligence is, in the realm of technology as elsewhere, autonomous, erratic, compulsive and whimsical." While it is true that we know little about the causes of innovation, we are beginning to identify environments in which inventors, entrepreneurs, and new ideas seem to thrive. The obvious factors are such things as: (1) high quality universities; (2) active venture capital markets; and (3) other support systems which aid small business start-ups.

On these factors, Arizona is lagging behind other parts of the country, and thus it has not been a hot bed of entrepreneurship. Its success in attracting high tech firms owes mostly to low-cost labor via "right-to-work" laws (Daneke, 1984). Thus, it gets the manufacturing plants of mature firms, but does not get the main offices of research

shops. More importantly, it does not serve as a spawning ground for new ventures.

Providing a favorable environment for new high tech start-ups or spin-offs may have its costs. Some mature firms are actually attracted to Arizona because it does not have an entrepreneurial environment in which they might loose their best people to new ventures. However, there is mounting evidence to suggest that a highly energized environment serves large and small firms alike (OTA, 1984). Furthermore, such an environment appears to coincide with high levels of corporate social involvement (see Norris, 1984). In Minneapolis, large firms not only help out with community development, they offer assistance to small business start-ups (see Ouchi, 1984). OTA (1984, p. 8) found that these highly successful high tech centers shared the following characteristics:

1. an organizational culture that promotes a common civic perspective and a positive attitude about the region's attributes and prospects;

2. an environment that nurtures leaders, both public and private, who combine an established track record for innovation with a broad view of their community's resources and promise; and

3. a network of business/civic advocacy organizations that attracts the membership of top officers of major companies and receives from them the commitment of time and effort to work on issues of mutual concern, including cooperation with the public sector.

If Arizona is to become a center of innovation, let along achieve the other elements of the third wave future, it must move expeditiously to develop the underlying institutions which support a culture of cooperative capitalism.

CONCLUSION

In sum, the third wave future is, in the words of Toffler, one in which corporations work with communities to pursue "multiple-bottom lines." Once again, a few of the major ingredients in this new calculus are of greater concern for the development of human potential, life-quality opportunities and sustaining the innovation process. The United States generally, and especially Arizona, can serve as global leaders in the realization of the third-wave society. Hopefully, we will accept the challenge.

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C.R. Haden

THE FUTURE HIGH TECHNOLOGY ENVIRONMENT OF ARIZONA

First it must be realized that people will continue to find Arizona a desirable place and, short of being barred at the border, will continue to relocate here in large numbers. The very environment which Arizona seeks to protect is one of the motivations for this migration. A reasonable question to ask, then, is, "What types of jobs will those people find when they arrive?" Will they be high paying, low paying, or will we have to put them on welfare when they arrive? One would hope that the jobs will be good ones. Fortunately, Arizona's attractiveness to people in general is for many of the same reasons that which attracts high tech industry. This type of industry happens to be both high paying and relatively safe for the environment, if properly managed. It is, of course, quite true that even high tech industry produces wastes, as does any type of human intervention into the environment. However, there is every reason to believe that these can be monitored, managed and disposed of in a safe fashion.

If one accepts the fact that high tech industrial growth in Arizona will continue, how do we anticipate which environmental concerns must be addressed? The only way to approximate this is to guess at the directions for industrial growth. There are two specific thrusts which carry somewhat different sets of environmental issues along with them. These are the aerospace and electronics industries.

It is always surprising that so many overlook the aerospace area, at least that mechanically related portion of it, as a growth area. One reason is that California is crowded with this type of industry. The aerospace industry has some problems in that state which are very similar to those of the electronics industry. The cost of living and doing business there makes it increasingly difficult to recruit technical

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people. This industry has at least one additional incentive to move to Arizona. Often, these companies hold large pieces of valuable real estate. Developed many years ago as low density facilities with hundreds of thousands of square feet under roof and only relatively few employees, they are now next door to high rise office buildings. Simply put, they can no longer afford not to put the land to its use of highest value. The alternative will be to move facilities to Arizona to much cheaper land, thereby picking up a very valuable asset and leaving many problems behind.

The environmental problems tied to the aerospace industry are those of large electrical power demands and the process of metal working or finishing. The metalworking process involves much machine work, which requires more power. In that respect, no new problems are added, only larger ones. The chemicals used are those of metal finishing including etching, polishing, anodizing, degreasing, etc. These are only used in small quantities in the state at present, since this industry is relatively small. However, they must be dealt with carefully in the future. Direct air pollution from this industy is relatively small, since smelting, burning of gases or solids, and use of gaseous reaction are not usually part of the process.

The second area of growth is a large extension of what the state has already experienced--electronics. This industry will grow for similar reasons, except that the need to hire technical personnel is emphasized much more and the drive to trade real estate is almost totally absent. Much of Arizona's job growth for the next few years will come from moves by companies from out of state, notably from California. More will be generated by companies already here. The electronics area is so large and diverse that it could be broken into many categories, but this presentation will center its discussion to three fairly broad areas.

First, there will be some growth in the software industry, almost totally generated from within the state. This poses little threat to the environment. The product is completely intellectual. The output is essentially paper (or its more modern form, the recorded disc).

Next, there will be continued growth in the systems area, including computers, military electronics, consumer electronics, and so forth. This is primarily an assembly process where the potential pollutants are relatively modest in volume but nonetheless must be carefully monitored and disposed of. These include TCE and other materials used in printed circuit fabrication using modest amounts of metals, such as copper. These materials are familiar and pose no new problems, only larger ones.

Finally, there is the semiconductor device industry, which will account for the largest growth. Companies already in Arizona, such as Motorola, Intel, National Semiconductor, SGS and others will undergo rapid expansion. Other corporations have already announced plans to come to Arizona. The familiar environmental problems, primarily chemical in nature, will continue and grow in volume. However, new problems will definitely crop up in this industry. For example, the materials of

the next decade will include gallium arsenide, as well as the more familiar silicon. Arsenic then becomes a major component of the base material, as opposed to the minute quantities presently used to "dope" or seed the silicon with impurities. Also, the chemicals used to process the gallium arsenide are generally different than those needed for silicon. This compound is a necessity because of the increased speed it affords over silicon devices. This material poses new problems which must and, certainly, can be handled.

Fortunately, the same high tech industry, which creates a relatively small environmental problem set, also provides large parts of the solutions. One area of help is in sensing. Continuing research for the last decade and more already has allowed application of high technology here. This ranges from the now well known satellite observation capability to less publicized efforts. In one project at Arizona State University, lasers are used to remotely sense stack emissions with great accuracy. In another, sensors made on the subminiature scale, made possible by high technology, are able to accurately sense sugars and other chemicals used in industrial processes.

Another important area is monitoring, data collection, and control. On one end of the spectrum, the microcomputer allows control algorithms and decisions on a local basis at low cost. This local computing power makes possible more precise control, earlier warning of problems, and application of remedies. On the other end of the scale, the supercomputer permits the huge interactive calculations required for large scale detailed environmental modeling. Probably the most heavily used computer in existence is in Colorado and is used by National Oceanic and Atmospheric Administration (NOAA) to model and predict environmental conditions in the atmosphere. Even so, this only allows the creation of a national model with a detail scale of miles. Soon such a model can be constructed on a scale of inches. These same techniques can be applied to modeling multivariable problems involving more of the biosphere, including the earth, its water, and the human intrusions upon it.

Finally, research into disposal techniques and accompanying law and policy is critical. The techniques themselves include chemical fixation and neutralization, filtration processes ranging from mechanical to electrostatic, storage and recycling. The last of these is exceptionally important. If we can make recycling (reprocessing, remanufacturing, etc.) both valuable and viable, industry will then regard its waste as an asset. Then, a large portion of disposal can be converted to reuse. Since price is not always sufficient to assure this, it may be necessary to use law and policy to assure this until research makes price the driving force.

In summary, Arizona faces a decade and more of industrial growth, which will place stress upon its environment. Fortunately, the growth will be in high technology areas, where the environmental problems are serious but manageable. The very technology created by this industry will, in fact, contribute greatly to the management of the problems.

B.P. Cardon

TECHNOLOGY IN AGRICULTURE

One of the anomalies of our civilization is that development in one segment of our society may have a negative impact on another segment. This is particularly true of high technology and the environment. Currently we accept almost as a given that the benefits of high tech development are always offset by a corresponding negative impact on the environment. Whether this is true in every case is immaterial because it is true, enough of the time, so that it is accepted as fact.

How do we correct this negative impact on the environment? Should it be done by eliminating the technology which was developed in the first place? Obviously we don't accept that solution. The solution is simple in concept; to eliminate the negative impact we must do more and better research.

Often environmental research is aimed at preventing the impact of high technology development. To carry out any meaningful environmental research, one needs not only the environmental specialist, but also all of the knowledge input that went into developing the high technology in the first place. In most research organizations addressing environmental problems, this is difficult to achieve not only because of cost but also because of the lack of understanding of the research needed.

As we look to the future, it is pathetically apparent that we are all poor predictors of the future. Clairvoyance isn't a common talent of mankind! Rather than predicting what might happen in the future, we should discuss how we can best organize to meet future challenges, regardless of the specific environmental problem.

What is agriculture today? Briefly, it may look as though agriculture is simple since plants still grow from seeds planted in the ground.

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They still need water and sunlight to develop. Animals supported by feeds were eaten almost since the beginning of recorded time. However, any close look at modern day agriculture indicates that it is truly a high technology industry. Perhaps the best indication of this is the change in the number of people engaged in agriculture production. In 1776 when our country was founded, nine out of ten citizens were farmers. At the time of the Civil War when Lincoln signed the Land Grant Act establishing the land grant system of education in America, about two out of three citizens were farmers. Today less than 2 percent of the population is engaged in the basic production of food and fiber. One person produces enough food and fiber to supply himself and approximately sixty others.

How has this remarkable change come about? It is because of the development of technical agriculture. Agriculture today uses fossil fuel to support its technology. This has not come about because oil companies are ruthlessly marketing their products onto agriculture. Economic forces have forced fossil fuel use. During the late 1970s the Council for Agriculture Science and Technology (CAST) looked at some of these economic factors. CAST reported that during the previous decade it was "recommended" by many environmentalists that agriculture should go back to using the technology of the "horse and mule" and save fossil fuel. The article pointed out that if today's production was farmed by 1910 methods it would require the use of approximately 30 million horses and mules. It would take approximately 20 years, with intensive breeding, to build up that size of an animal work force. Also, when these numbers were achieved, it would require half of the arable land in the U.S. to produce the feed required to sustain them. The article also pointed out that the average wage for a farm laborer was in excess of $26 a day. The amount of work energy that a farm laborer contributes could be purchased as electricity for less than 6 cents. It is obvious that agriculture is not going back to the good old days.

An example of current research relating agriculture and technology is the concern among farmers regarding the possibility of salt drift from the cooling towers at the Palo Verde Nuclear Plant when it opens up next year. Using a grant from Arizona Public Service, the University of Arizona made a study of the possible effect of this salt drift on some crops.

When one considers the land mass in Arizona, and the uses of the land, the magnitude of our environmental problem is obvious. Between 1.2 and 1.3 million acres of land are commercially cultivated in Arizona each year. This is only about 1.6 percent of the total land mass in the state. Since our mission encompasses responsibility for all the land, water, and renewable natural resources within the state as well as the people connected, it is obvious that our research activities are much broader than those relating only to crop production and animal culture.

In summary, note the following three points:

1. Agriculture will not go back to 1910 technology but will continue to get more technical in the future.

2. Research efforts on the agriculture technology to be used in the future must be more complete. We must not only focus on the details of the new technology but also on all impacts this technology will have on the environment.

3. It is essential to marshall and use all the talent which was needed to develop the new technology and focus this same talent on the impact of the new technology on the environment.

SECTION II

EPA AND RISK MANAGEMENT: REGULATORY ISSUES

J.S. Cooper

E.P.A. AND RISK MANAGEMENT: REGULATORY ISSUES

The issue of this paper concerns how to reconcile economic and technological growth with environmental protection. It is probably fair to say that almost everything done at the EPA--and most of what its state counterparts do--involves dealing with the environmental results of economic and technological growth. Whether it is cleaning up the results of our past failure as a society to adequately consider the environmental consequences of technology, or efforts to ensure that current activities will not create new problems now or in the future, the EPA is constantly concerned with the impacts of technology on human health and the environment. This presentation will address both of these aspects--those looking to the past and those looking to the future--in turn. Since the External Affairs Office is the one that is primarily responsible for EPA's dealings with the public, the role of public communications in ongoing efforts to reconcile technological growth and the environment will also be discussed.

It is traditional to start a topic such as this with the observation that environmental protection and economic growth are not incompatible. That is no doubt true. However, if the two were not so often in tension it would not be necessary to say so often that they are not incompatible. At times, it almost seems to be a case of protesting too much, for it is clear that unrestrained economic and technological growth and unrestrained environmental protection would be incompatible. The challenge to society is to eliminate the tension between the two wherever possible, and to strike an appropriate balance in those areas where conflict between the two goals is unavoidable.

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It is clear that such a balance was not adequately struck in the past. Perhaps the clearest example of the failure to adequately consider the environmental effects of our activities is the thousands of hazardous waste sites around the country. The top priority at EPA today is to clean up these toxic waste sites through the Superfund program. The EPA is making substantial progress towards this goal. Environmental assessments, planning and both emergency removal and long-term remedial actions are underway at sites around the country. Resources devoted to the Superfund program have increased dramatically: from $210 million in FY 1983 to $460 million for FY 1984. And $620 million have been authorized for FY 1985. By the end of March 1984, EPA had completed over 200 emergency cleanups, and over 100 more were underway. Long term cleanups will be underway at over 220 sites by the end of FY 1985. Most importantly, the program has developed a healthy momentum and the rate of cleanup is accelerating.

Hazardous waste sites are not the only examples of past neglect which have confronted EPA and our state counterparts. Years of economic and technological growth with insufficient regard to the environment left our air and water unacceptably dirty in many areas. Again, with the strong help of the states, EPA has been able to stem the tide of degradation and has actually seen marked improvements in air and water quality in many areas.

It is, however, in looking to the present and the future that the challenge of reconciling environmental protection and technological growth is most apparent. After all, what's done is done, and we can do little about it except to try to clean up the mess and learn lessons from our past mistakes.

Basically, EPA has a two-step approach to regulation: risk assessment and risk management. This division is critical in terms of balancing environmental protection with technological growth, for while that balance is entirely appropriate at one of the stages, it is absolutely inappropriate at the other.

Risk assessment is the scientific process of identifying a problem and determining its extent. It answers the question, "Is there a problem?" It is absolutely critical that the scientific analysis be pure and not be contaminated by considerations of balancing with economic growth or anything else. There is enough scientific uncertainty in risk assessments as it is because of the enormous complexities of the environmental problems dealt with and the health effects involved. Risk assessments must not be subject to doubt because of suspicions that they are being secretly influenced by various policy considerations. EPA's credibility will be absolutely destroyed if it is suspected that its scientific analyses are influenced by nonscientific considerations.

Once a problem has been identified through risk assessment, the question becomes what to do about it. This is the risk management stage and it is at this stage that policy factors--including the need to balance environmental protection with economic and technological growth--can be

properly considered. The separation of risk assessment and risk management results in a proper division of the roles of the scientist and the policymaker, and allows for a rational approach to regulation.

EPA has major efforts underway to improve both its risk assessment and risk management capabilities. The Office of Health and Environmental Assessment is one of four principal groups analyzing the risks to human health and ecological systems associated with environmental pollutants. Their program is budgeted at close to $12 million to evaluate scientific data and recommend additional research where appropriate. EPA is developing new guidelines for risk assessments for carcinogens and also in other areas. And they are establishing a forum for review of risk assessment issues. One of the tasks of this forum will be to examine selected risk assessments to ensure that they have been done properly. The Agency's Science Advisory Board also plays an important role in ensuring the integrity of its science. Initiatives like these--and those being conducted by and in conjunction with other federal agencies--should go a long way towards stabilizing and improving EPA's approach to risk assessment. Improved risk assessments, in turn, will serve as the basis for improved risk management and, therefore, better regulatory decisions.

As indicated, EPA is also working to improve its approach to risk management. One of the things it learned from reviewing past regulatory decisions is that its decisionmaking has been inconsistent. Individual and aggregate levels of risk that have been considered sufficient to spur action have varied greatly, as have individual and aggregate levels of risk that remained after regulatory action. Cost-effectiveness of different regulatory efforts has varied by several orders of magnitude. Sometimes there is a reason for these differences, such as statutory mandates. But too often there isn't. EPA is taking steps to ensure that better and more consistent information is provided to policymakers to allow more intelligent risk management. In some areas EPA's risk management process is constrained by overly rigid statutory requirements. Some of the proposals currently before the Congress would go even further in the wrong direction. EPA has been working to obtain greater flexibility in its environmental regulation.

What is the role of the public in the balancing process inherent in risk management? EPA is firmly committed to increasing public sophistication concerning risk and public participation in its decisionmaking. This will require improving efforts at risk communication, and the Agency has a long way to go on that score. People don't like risk and are often uncomfortable discussing it. The first public reaction to an environmental problem is frequently a demand to make it go away by reducing risks to zero. Generally, that is impossible. Even where possible, it would often require steps that have other adverse consequences. One of EPA's major challenges is to make the public understand this, and to help translate scientific information concerning risk into terms that are understandable to the general public. This requires

being honest about what EPA does and does not know, and about the trade-offs involved in environmental decisionmaking.

EPA has made substantial efforts in this regard. One good example involves the case of the ASARCO copper smelter in Tacoma, Washington. The smelter there emits a variety of pollutants including arsenic, a carcinogen. Reducing the health risks posed by this smelter to zero might have required shutting down the plant--at a cost of about 500-600 jobs. EPA felt that those exposed to the dangers and possible economic consequences should be given an opportunity to comment on the situation.

Consequently, EPA organized what was for the Agency an unprecedented data blitz--with workshops, speeches and media interviews--to let everyone know what it thought the health hazards were, and to openly acknowledge its areas of uncertainty. Although a decision by ASARCO to close the plant anyway appears to have resolved the issue, EPA learned a lot from its experience in Tacoma. It learned that many people felt intermediate steps could be taken to reduce risk without requiring closure of the plant. And it learned that average citizens were not afraid to jump into discussions about risk at sophisticated levels--discussions which EPA once thought were best left to experts. EPA is encouraged by the Tacoma experience, and plans to use it as a model for the future in continuing efforts to make citizen involvement a cornerstone of risk management efforts.

The area of biotechnology will be a good testing ground for EPA's enhanced efforts at risk assessment and risk management, and also for its attempts to ensure that environmental protection and technological growth remain compatible. Biotechnology is the manipulation of lifeforms for commercial purposes. The most controversial aspect of biotechnology is genetic engineering in which the genetic material of an organism is altered. Genetic engineering includes such techniques as recombinant DNA and cell fusion. Biotechnology is a rapidly growing area which holds forth great promise in such diverse areas as agriculture, energy production, health care and environmental protection to name but a few. However, it also poses the threat of introducing new and uncontrolled organisms into our environment with potentially disastrous results.

Regulation of biotechnology to date has concentrated on experiments in controlled laboratory environments, and much of it has relied upon voluntary compliance by private industry with guidelines developed for government-sponsored research. But the industry is developing rapidly and a potential regulatory gap exists. EPA is working hard to develop its regulatory approach in this area. The challenge is to ensure the adequate protection of human health and the environment without unduly stifling the substantial benefits promised by the industry. This will require advances in risk assessment, in EPA's ability to determine what risks are posed by various genetically engineered organisms, and also in risk management--the development of new regulatory approaches to ensure that the risks posed by this new and exciting technology are

adequately controlled. Biotechnology will also pose a challenge in risk communication, in explaining to the public what is known and not known about the science and in involving the public in the decisionmaking process.

Regulation of biotechnology is, of course, not the only challenge for the future. Although the work will never be completely finished, EPA has made tremendous progress in cleaning up the problems of the 1960s and early 1970s which spurred the passage of the first round of environmental legislation EPA administers. The new problems are less obvious and more complex. They include dealing with toxics in all media. Protecting the quality of groundwater is another key challenge and one that EPA is currently hard at work on. Nonpoint source pollution is another good example of how environmental problems have changed. To date, EPA's water pollution control efforts have focused on point sources of pollution--discharge pipes and the like. That program has been very successful, and nonpoint sources of pollution--such as agricultural and urban runoff--are now the principal source of water pollution in many parts of the country. EPA needs to develop new techniques to deal with these problems.

Dealing with these problems will require even more cooperation between EPA and state and local environmental agencies. One of the Agency's top priorities is to increase delegation of environmental programs to the states. The goal is a system in which the states are generally responsible for day-to-day environmental protection with the federal government providing assistance and oversight.

What can we conclude about the relationship between technological growth and environmental protection? Leaving aside the question of cleaning up the mistakes of the past, the regulatory challenge is to strike a balance in which we can adequately protect human health and the environment without unduly interfering with economic and technological growth. Zero risk is unattainable, uncontrolled risk is intolerable. As with almost everything done in government, the trick is to strike the proper balance. To do so, EPA must rely on the twin techniques of risk assessment to define the problems and risk management to solve them. EPA needs to continue to improve its capabilities in both of these areas. Improved risk communication will also be necessary so that the Agency can inform the public and involve them in its decisionmaking.

SECTION III

HIGH TECHNOLOGY AND ENVIRONMENTAL MANAGEMENT

INTRODUCTION

One of the traditional attractions of high technology has been the widely-held belief that it is a "clean" industry. It is true that high technology plants do not much resemble the smokestack industries of the East and Great Lakes regions. In contrast, they evoke images of landscaped and well organized factories, "clean rooms," and lack of visible air pollution. Politicians nationwide have touted high tech as the key to America's reindustrialization strategy.

The image of high tech as a clean industry is rapidly eroding as environmental quality and health problems have emerged in the industry. For example, leaking underground storage tanks have contaminated groundwater supplies in most areas where high tech firms are concentrated. In 1982, one-quarter of Silicon Valley firms were cited for not pre-treating sewage. The improper transfer and disposal of hazardous wastes is a common management problem. Moreover, while we thought these industries were free from air quality problems we now realize that ozone precursors, or smog-producing emissions, are significant air pollutants. Recent research has also shown that high tech firms experience three times the rate of occupational illness compared to the average manufacturing concern. This may be related to the huge quantity of toxic substances used to make semiconductor chips.

While it is important to continue to encourage high tech development in Arizona, it is also critical to recognize and assess the environmental issues and problems associated with its development so that effective management strategies will be implemented to control the inadvertent

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release of problem substances. By no means are such problems exclusively those of high tech companies nor are they insurmountable. Through proper management, including environmental monitoring, pre-siting analysis, proper containment and release prevention and effective and rapid recovery of released toxic substances, development of high tech can be compatible with natural resources.

Environmental problems associated with high tech were first recognized in groundwater in 1981. Drinking water wells in San Jose near a Fairchild Semiconductor plant were found to be significantly contaminated by 1,1,1-trichloroethane (TCA) and other toxic waste materials. An estimated 14,000 gallons of TCA and 44,000 gallons of other toxics had leaked undetected from Fairchild's underground tank. At least 260 people filed multimillion dollar suits against Fairchild, the water supplier and various other defendants. At least 13 deaths, along with numerous birth defects, cancer, blood diseases and skin disorders are alleged to have been caused from these releases.

More recently, residents of Mountain View, California, discovered that they, too, had been using water tainted with trichloroethylene (TCE). In June 1984 state officials found well-water samples ranging from low concentrations to 400 times the "acceptable" level of TCE. One hundred and twenty (120) other locations of underground storage tank leaks involving toxics were also reported.

TCE was detected in groundwater in Arizona in March 1981 at the Hughes Aircraft facility in Tucson. The plume resulting from the leak covered 4.5 square miles and contaminated at least eight city and sixteen private wells. As a result of this problem, many municipalities in the Tucson and Phoenix metropolitan areas test for such contamination in all their wells, as does the Salt River Project (a local utility) in its irrigation wells. One hundred and fifteen (115) wells have been found tainted by TCE and/or other volatile organics; at least 27 wells are sources of public drinking water.

The deliterious health effects of TCE have been widely debated and are the cause of much scientific uncertainty. It has, however, been associated with liver carcinogenicity in mice when ingested by drinking. A "voluntary action level" for TCE has been set by the Arizona Department of Health Services (ADHS) at five parts per billion but TCE has been found in concentrations exceeding this limit.

Beyond the potential public health problems associated with TCE contamination, there is the issue of reduction of acceptable potable water supplies. Tucson and Scottsdale depend solely on groundwater for drinking, and contamination of their wells may lead to a critically acute water shortage problem. Coincidentally, the two Superfund sites in Arizona contaminated by TCE are in Tucson (Hughes) and Scottsdale (Indian Bend Wash).

Cleanup operations are underway or proposed for some sites. Testing of groundwater supplies prior to a high tech firm locating in an area and continuous monitoring while the plant operates are desirable.

In addition, Arizona should assess the need for legislation concerning leaking underground storage that requires secondary containment of all new and existing tanks as well as monitoring regulations. These have been promulgated in California.

According to the Governor's Office of Appropriate Technology, California electronics firms dumped 65,000 tons of toxic materials in hazardous waste landfills in 1980 alone. Long-term threats to communities surrounding these landfills are possible. Disposal of hazardous wastes requires trucking hazardous material and incidents of improper handling and disposal have occurred in the southwest. To illustrate, 4,000 residents and school children were evacuated from San Ramon, California in September 1981 due to a tank-truck leak. The State of Arizona through the Department of Transportation is commencing a study on assessing the risks of transporting hazardous materials. The promulgation of permitting standards for substances in industry that may enter the groundwater has also begun here. These initiatives are in the direction of protecting the environment while concomitantly assuring continued industrial high tech growth.

Possibly the most ominous environmental threat associated with high technology industry is that to worker health. While no catastrophic event has yet occurred, the potential for severe consequences to both individuals and to the public stems from hazardous materials used in production. The threat is not just perceived: it is now problematic and it is real. The rate of illness for high tech production workers in California is at least triple that of industrial laborers on the whole. Furthermore, the rate of occupational illnesses that result in loss of work time is also three times that in other industry. That rate cannot be passed off as insignificant and it must be recognized and rectified.

A possible constraint on development in Arizona may be the quality and quantity of available water. High tech firms use large quantities of water: Motorola's Bipolar Integrated Circuits plant in Mesa, Arizona, for instance, uses 3 million gallons of water per day. Water conservation by high tech firms (as well as by other industrial users) is essential for expansion of the industrial base in many arid communities. This challenge has been met by the Tucson IBM facility which has developed a total water reuse and conservation program.

Electricity requirements from high tech firms include the need for stable supplies, high quality, and low price. Of these, supply and quality are most important. The Salt River Project reports that high technology is the highest energy-intensive user in Phoenix, and the need for a stable supply of electricity is increasing rapidly.

Among the possible consequences that go with storage of hazardous wastes used in high tech industries are spills, traffic accidents, explosions and fires. Unfortunately, not all emergency crews are properly equipped or trained to deal with such occurrences. Phoenix Fire Chief Alan Brunacini says of the high tech industry, "There isn't a fire department in the country that has a good knowledge of that industry.

I don't think some of those people [in industry] know what they have." Cooperative training programs between industry emergency response teams and local fire departments should be formed as has been done in the City of Chandler, Intel, General Instrument, and Gould.

The problem is compounded when such materials are transported. Metropolitan areas may be reasonably well prepared for a vehicle accident involving hazardous material, but how will smaller cities such as Kingman or Bakersfield respond? Reports of accidents involving hazardous material transport are increasing at an alarming rate. The U.S. Department of Transportation estimates that at least 15 percent of trucks on the road are transporting hazardous materials and the volume is increasing by 5 to 10 percent annually.

Though the environmental effects of high tech industry may be serious, they are by no means too dire to mitigate. Proper regulation of the industry can adequately prepare a community to prevent potential contamination, or to act promptly if an accident occurs.

The following presentations on groundwater contamination, hazardous waste, growth impacts, and legal/policy issues associated with the environmental impacts of high technology should be of concern to public policymakers.

R. Miller

HIGH TECH CONTAMINATION OF GROUNDWATER

In Spring of 1981, Arizona's first case of groundwater contamination resulting from high tech industry was discovered at the Hughes Aircraft facility in Tucson. Since then the Arizona Department of Health Services (ADHS) has identified more than seventeen cases of groundwater contaminated by volatile organics which are mostly attributable to high tech industries. Fifteen of the sites are located in the two major metropolitan areas of Phoenix and Tucson and a total of 113 wells have been contaminated. Table 1 lists the sites and identifies the major volatile organic contaminants at each site.

Table 1

SITES IN ARIZONA WITH VOLATILE ORGANIC GROUNDWATER CONTAMINATION

Site	Types of Volatile Organic Contaminants (In Order of Concentration)
1. 40th St/Estes, Phoenix	Vinyl Chloride, DCE, Ethylbenzene, DCA
2. Del Rio, Phoenix	DCE, Methylenechloride, DCDFM, Ethylbenzene
3. 19th Ave., Phoenix	Methylene Chloride, Toluene, TCA, Ethylbenzene
4. 27th Ave., Phoenix	Dichloropropene TCA, Methylene Chloride, DCE
5. 52nd St., Phoenix	TCE, TCA, Methylenechloride, DCE
6. Sweetwater, Phoenix	TCE
7. 39th Ave. and Earll, Phoenix	TCE
8. East Lake, Phoenix	TCE

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Table 1 continued

9.	Indian Bend Wash, Scottsdale	TCE, PCE, Chloroform, DCE
10.	Broadway Rd., Mesa	PCE, TCE, DCE, TCFM
11.	Tri-Cities, Mesa	TCE, PCE, TCA
12.	Rural Rd., Chandler	DCE, Chloroform, TCA, Methylenechloride
13.	Phoenix-Litchfield Airport	TCE, DCA, DCE, PCE
14.	Hassayampa	DCE, TCA, TCFM, DCA
15.	Casa Grande	TCE, DCA, PCE
16.	Cortaro	TCE, DCA, Vinylchloride, TCFM
17.	Tucson Airport	TCE, DCE, TCA, Toluene

Volatile organic compounds are used as cleaning solvents by the aerospace and electronics industries. Trichloroethylene (TCE) is the most commonly found contaminant and is usually present in the highest concentrations. Tetrachloroethylene (PCE) and Dichloroethylene (DCE) are other common contaminants (see Table 2).

Table 2

SELECTED CONTAMINANTS FOUND AT GROUNDWATER SITES IN ARIZONA

Compound	Detected Frequency (percent)
Trichloroethylene	82
Tetrachloroethylene	76
1,1-Dichloroethane	71
1,1-Dichloroethylene	65
Trans-1,3-Dichloroethylene	53
Methylene Chloride	47
Toluene	35

In many cases the sources of contamination have not been identified. In fact, groundwater impacts found today may have resulted from disposal activities that occurred twenty to thirty years ago. There are a number of disposal mechanisms with the potential to cause groundwater contamination. These include sanitary landfills, injection wells, surface impoundments and underground storage tanks (see Table 3).

Table 3

SUSPECTED SOURCES OF CONTAMINATION OF GROUNDWATER CONTAMINATION IN ARIZONA

Suspected Source	Percent of Sites
Sanitary Landfills	33.1
Injection (Dry) Wells	24.7
Impoundments	12.7
Tanks and Lines	12.7
Sewage Lines and Effluent	4.2
Burial	4.2
Surreptitious Dumping	4.2
Surface Discharge	4.2

ADHS, the regulatory agency with primary responsibility for groundwater protection, has acted as the lead agency in coordinating local, state and federal responses to groundwater contamination. Their primary goal has been protection of public health and, secondly, protection of groundwater quality. Here, briefly, are ADHS's major activities to date in responding to groundwater contamination:

1. ADHS has established action levels for volatile organic compounds in public drinking water supplies. Action levels are voluntary guidelines for public water suppliers. The levels are set to correspond with the one-in-a-million excess lifetime cancer risk from exposure to contaminants in drinking water. Although action levels are voluntary, public water suppliers throughout the state have been very cooperative in adhering to them.

2. Additional guidance has been provided to suppliers to aid them in their efforts to maintain the quality of public water supplies. The guidance has included defining testing requirements, development of procedures for sampling, reporting, and public notification, steps to ensure safe drinking water supplies such as treatment, blending, or closure, and allowances for short-term use of water exceeding the action level. ADHS has initiated a laboratory certification program to insure that reliable data is generated. The Water Quality Assurance Revolving Fund was established in April 1982 to provide monies to assist in the cleanup or removal of contaminants from groundwater. Eligible applicants include political subdivisions

whose underground source of drinking water has been contaminated as a result of man's activities. Recipients must contribute one-half of the cleanup costs.

3. ADHS has identified the basic steps that need to be taken in response to new cases of groundwater contamination. The objective is to define the magnitude of the problem, identify potential sources and evaluate the feasibility of remedial actions (see Table 4). The remedial investigations have been undertaken by government agencies, water suppliers, and responsible parties. Funding has been provided through RCRA 3012, Superfund, state appropriations and private sources.

Table 4

GROUNDWATER CONTAMINATION RESPONSE STEPS

1 - monitor all drinking water wells to ensure public safety (ADHS provides health guidance, monitoring requirements, and laboratory support)

2 - monitor all other identified wells to further define the extent of contamination and characteristics of plume

3 - evaluate historical and current land use in the area--SIA, landfills, injection wells, complaints

4 - inspect and investigate potential source

5 - conduct extensive monitoring including
- . . shallow and deep soil samples
- . . monitoring wells for vertical testing
- . . measurement of static water levels
- . . analyses for other contaminants

6 - evaluate potential for cleanup of specific significant sources that may be contributing to the contamination

7 - define and evaluate the alternatives for future use of the aquifer including
- . . treatment alternatives
- . . aquifer management
- . . alternative sources
- . . seasonal

8 - select and implement preferred alternative
- . . cleanup/treatment alternatives
- . . aquifer management alternatives

In addition to the necessary actions to correct these existing problems, ADHS has established the framework for an aggressive program to prevent further degradation. Regulations have recently been adopted for two vital preventive programs: the hazardous waste program and the groundwater permits program. The intent of these regulations is to control any discharges that may adversely impact groundwater. Most of the potential source types listed in Table 3 are covered by one or the other of these programs.

Surface water contamination resulting from "high tech" industry has been controlled for a number of years through the National Pollutant Discharge Elimination System and the Pretreatment Program. Discharges in Arizona generally are in compliance with the permits, and with the Arizona Surface Water Quality Standards.

R.B. Scott

ISSUES IN HAZARDOUS WASTE

The handling and disposal of wastes, particularly those which are hazardous, requires strategic planning and management as well as operation involvement at all industrial levels in order to assure protection of employee health, public health, and the environment. The regulations which cover the management of waste within a given operation are complex, extensive and far from reaching their final form. Consequently, the EPA and the state will be amending current regulations as the "state-of-the-art" continues to change. In order for industry to meet these complex regulatory challenges, key management, technical and legal staffs must be allocated to evaluate regulations for impact on each operation and process. Environmental engineering consultants, such as Western Technologies Inc., will play an important role in support of such evaluations.

There is no such thing as "clean industry." Regardless of the product, there are wastes--as air pollutants, wastewaters, or solid wastes. Depending upon the industry, it may be a teacup full of extremely hazardous liquid waste, or it may be thousands of tons per month of nonhazardous solid waste.

The high technology firms have enjoyed the name "clean industry" for some time. Certainly, there are no tall smoke stacks with opaque plumes and no NPDES permits for wastewater discharges. However, in the past twenty years, the high tech industries have steadily evolved into chemical process plants. TV sets are no longer built with vacuum tubes. Instead, rows of circuit boards are neatly lined up and easily and swiftly (and expensively) changed. Large computers are no longer manufactured in tall cabinets with miles of wiring. Instead, computer

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chips are used with fantastic memories and intricate circuitry chemically etched on their surface. Circuit boards are built with accurate and detailed circuits created by electroplating processes. Sophisticated chemicals, both liquid and gaseous, with jaw breaking names, are used to produce the products that we, the public, demand and require.

In the late 1970s and early 1980s, the high technology industry in the Silicon Valley area of California woke up one morning and discovered drum after drum of chemicals sitting around, and thousands of gallons of wastes being dumped into underground tanks or down sewers. Questions began to arise: What is this stuff? Why is it here? How do you dispose of it? What's a Material Safety Data Sheet? Who can we get to take this stuff away? What is "diethylene chicken fat," anyway?

We've all heard of Love Canal, Times Beach in Missouri, Stringfellow Acid Pits in California, and even Globe, Arizona with its asbestos waste problems. As long as man is on this planet, we will find new and innovative ways, and probably repeat some of the old methods, of making messes. Even in the best run plants with staff who are properly trained and environmentally conscious, spills do and will occur. An Arizona high tech firm recently sprung a leak in a process pipe containing a solvent which appeared on EPA's dreaded list of hazardous wastes. The solvent insisted on soaking through joints in a concrete pad and into the ground. The firm wound up digging a sizeable pit to remove the contaminated soil and had it disposed of at an approved disposal site. Another firm used an underground tank for collection and storage of liquid hazardous wastes. It was one employee's task to periodically measure the level in the tank using a metal probe. He would insert the probe through an opening in the top of the tank and bang the probe against the bottom of the tank to assure an accurate level measurement. After years of "banging," a small hole was punched in the tank and some of the liquid waste leaked out. The tank and much of the surrounding soil had to be removed.

New environmental issues will be faced by high technology industry in the not too distant future. Or maybe it would be more accurate to say that some of the old ones will be getting more attention.

The U.S. Congress is presently considering bills which will dramatically increase the number of firms which will be regulated by the Resource Conservation and Recovery Act (RCRA). The present "small quantity generator" definition establishes 1000 kg per month as the borderline. That is, if a firm generates less than 1000 kg/month of hazardous waste, it escapes regulations. The Senate recently reported a bill which would lower that to 100 kg/month, while the House came up with 25 kg/month. This would mean that the corner gas station, the job shop plating bumpers, and dry cleaning establishments will come under some form of hazardous waste regulation.

In another related congressional action, the U.S. Senate just attached LUST to the RCRA reauthorization bill. LUST stands for Leaking Underground Storage Tanks, a new proposed EPA program. EPA reports

that 1.5 to 2 million underground storage tanks exist for gasoline alone. It is estimated that 75,000 to 100,000 of these are now leaking. About one million of the steel tanks now in the ground are more than sixteen years old and unprotected--namely, no double liners and no periodic testing. Even less is known about underground tanks used for pure chemical or hazardous waste storage. Many firms in Arizona are abandoning underground tanks, having them removed, and replacing the facilities with below ground vaults.

Hazardous air pollutants and Test Method No. 25 will become very familiar terms to high tech firms. In many present facilities, solvent degreasers, which are important to the ultra-clean conditions many high tech parts require, are vented via fume hoods and short vent pipes to the atmosphere. Some of the vented chemicals--1,1,1-trichloroethane, methylene chloride, acetone, toluene--may be photoreactive in the atmosphere, forming ozone and what we call "smog." Some degree of emission control will in all probability be required in the future.

The State of Arizona, through the Department of Health Services, has taken the necessary steps to obtain full authorization regarding hazardous waste regulatory activities. Final approval of the state's laws and regulations by the EPA should occur in January 1985. Such approval will enable the EPA to step aside and the Department to run all aspects of the hazardous waste management program in the state. Arizona then will become one of over thirty states which can control its own destiny from a hazardous waste standpoint. This should greatly reduce the confusion and dual agency plan reviews, inspections and enforcement actions.

Hopefully, with this new authority, HDS won't fall into the trap in which EPA appears to be mired--a paperwork maze. An Arizona high tech firm had been working on their Part B hazardous waste permit for months and thought they had finally answered all of the criticisms and comments of EPA. Then, another set of comments arrived from yet another EPA reviewer. Where the application said "test," the reviewer wanted "analyze." The changes were made. Several weeks went by and a revised set of comments were received, this time changing "analyze" back to "test." Neither change was needed and contributed nothing toward hazardous waste management, except frazzled nerves at the plant, a loss of respect for the EPA, and increased sales by the local paper supply house.

The state still has some unfinished business, such as creation of the hazardous waste disposal site near Mobile, Arizona. They've already traveled a long hard road just to get site approval and a qualified contractor. But Arizona industries have an even longer and more expensive road to California, Nevada, or Texas disposal sites. All hope the Mobile site will begin operation before 1986.

The American way of life, as we know it today, depends upon an abundance of manufactured material goods. Their manufacture generates industrial waste as a by-product, some of it hazardous. If we are to

continue to enjoy our present lifestyle, we must begin as a nation and as a state to accept responsibility for working toward solutions of our current environmental problems. It is these solutions that are essential not only for our generation, but for generations to come.

F. Bangs

GROWTH IMPACTS AND HIGH TECHNOLOGY

The topic of this presentation is on the growth impacts of the high tech industry. Are there growth impacts of high tech and can they be quantified? Growth has both physical indices--such as population increase in excess of births-deaths, new development, new jobs, and other indices we measure through income: personal income, retail sales, state and local tax revenues. It is important to understand the multiplier effect in measuring an industry's impact on growth. For every dollar of high tech investment, we get out 1.5 or 1.7 times that amount in our local economy.

High tech firms desire to move to Arizona. But these firms are cognizant of the importance of multipliers and the effect of industrial location on the economy. For communities, before they build the waterline or road, or has its 10A issue tax exempt bonds for a new plant, they may wish to know whether they will get it back.

The College of Business and Public Administration at the University of Arizona has developed a model to answer some of these questions. The model includes the following components: cost side (cost-benefit analysis); actions when firms leave or actions to reduce impacts when they leave.

It is critical for local governments to implement techniques for cost recovery if the costs exceed benefits. These may include exactions for development approval, the use of user charges and special assessments for improvements, development taxes on new growth and development permission based on the planned installation of public infrastructure.

We took the model and increased employment in Maricopa County in SIC code 193738 by 1000 persons, beginning in 1985 and continuing at

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that level through 1995. SIC codes include ordinance-related industries (SIC 19); transportation equipment (SIC 37), and measuring, analyzing and controlling instruments; photographic, medical, and optical goods; watches and clocks (SIC 38).

Technically, SIC 19 no longer exists and industries that were in 19 were moved into either 37 or 38. This combined group is a high tech group, including producers of aircraft equipment, guided missiles, space propulsion units, engineering and scientific instruments, measuring devices and meters, optical and medical and surgical instruments, etc. This group does not include the Motorolas or IBMs, however.

The model shows the following changes:

	Changes in Wage and Salary Employment (000's)	Population (000)	Arizona Personal Income ($ million)
1985	1.690	.668	50.387
1986	2.162	.998	72.156
1987	2.348	1.199	88.805
1988	2.435	1.321	96.675
1989	2.505	1.409	104.683
1990	2.597	1.490	113.156
1991	2.705	1.573	123.500
1992	2.812	1.654	135.227
1993	2.912	1.729	148.078
1994	3.005	1.799	162.023
1995	3.093	1.866	177.054

D. Pontius

REGULATING ENVIRONMENTAL HAZARDS: LEGAL/POLICY ISSUES

This presentation is intended to provide some thoughts on the legal and policy issues associated with "contamination and cleanup" in Arizona, with particular relevance to high tech industries. It is not easy to generalize in this area for most of the federal and state statutes involved are complex, relatively new, and in many cases, still evolving and untested in the courts. Many of the problems never end up in court but are negotiated, which is as it should be. It is always preferable to have a matter resolved before going to court. It is always a roll of the dice when you litigate. Much of what transpires in terms of trying to explain the state-of-the-law is purely conjecture. On a case-by-case basis, all you can do is try to match the appropriate statute to the given situation and then try to figure out what the response will be by the appropriate regulatory agency. Also, many of the major pollution incidents have occurred in the more highly industrialized areas in the east and midwest, and now in the Silicon Valley, although Arizona is starting to make a name for itself as well.

In the past few years--certainly since Love Canal--there has been a profound change in the way this country looks at waste disposal. Suddenly, after years of benign neglect, we have discovered that all of those things we have been putting in the ground and forgetting about are ending up in people's basements and in public and private water supplies, and, in some cases, causing deliterious health effects. The contamination waste problem is widespread and was best described by one federal judge:

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> For fundamental and deeply rooted psychological reasons, as well as more mundane utilitarian considerations, it is characteristic of man to bury that which he fears and wishes to rid himself of. In the past, this ingrained pattern of behavior has generally proved harmless, and, indeed, has often led man to restore to the earth the substances he had removed from it. In today's industrialized society, however, the routine practice of burying highly toxic chemical wastes has resulted in serious threats to the environment and to public health.

In retrospect, it is incredible that it took us so long to realize we couldn't continue those practices, but most environmental issues do not get addressed until they reach crisis proportions. In any event, today, the public awareness is there.

While there will probably always be those who continue to violate the rules out of ignorance or negligence, along with a few "midnight dumpers," most companies want to do what is right, and will therefore not willfully pollute the environment. Given the tremendous costs of cleanup we are seeing, it makes much more sense to be more careful in the future with preventive engineering.

It will become increasingly more difficult to avoid those front end costs, even if one wanted to. The Resource Conservation and Recovery Act (RCRA), and other federal and state programs aimed at implementing the "cradle to grave" concept for hazardous materials, will catch most everyone sooner or later. In addition, the advent of new municipal "pre-treatment" ordinances required by EPA to regulate what is dumped into our public sewer systems should also serve to dramatically reduce the pollutants that ultimately find their way to our water supply from wastewater treatment plants.

The Arizona State Legislature passed its own "Little RCRA" last year and accompanying regulations are now in place to begin the state assumption of the RCRA program. Despite all the political hyperbole at the time, the fact is the new state law is basically identical to the federal law and was required to be "equivalent to and consistent with" that law to become an EPA certified program.

The legislature was persuaded to take a small step beyond the federal law. It authorized the Department of Health Services to consider reporting requirements for so-called small generators of hazardous waste which are currently exempt under federal law. In Arizona, some small generators produce waste that could have a critical impact on our groundwater supplies if improperly disposed. A very small amount of TCE, for example, can go a long way once in the aquifer.

We all know that RCRA and Superfund are not a panacea for solving all hazardous waste problems. There are exemptions, including for mining and refining operations, as well as continuing disputes over what substances EPA considers to be hazardous. Some of these issues are going to be dealt with soon in the Congress when RCRA is reauthorized.

There is no question that the law will be toughened when this is done, exemptions eliminated, and more small generators will be regulated.

Why? Because hazardous waste is indeed perceived by the public--and therefore most politicians of both parties--as a very serious problem. It ranks extremely high on most lists of important issues, right behind crime and the economy. You can hardly pick up a newspaper without reading of yet another hazardous waste problem. The laws and regulations are falling in place both nationally and here in Arizona. Over time, we will regulate most serious waste disposal. A remaining question concerns what level of state and federal fiscal support will be available for aggressive implementation and enforcement of the new laws. Obviously, it will take a continuing commitment and a lot of money to carry out the complex permit system devised for regulating the production, transportation and disposal of hazardous wastes, and even more for enforcement and cleanup efforts.

Some states are reacting aggressively. The California Legislature has just passed a very tough bill in response to serious groundwater pollution problems discovered in the Los Angeles-Riverside County area from acid pits as well as problems in the Silicon Valley. If the bill is signed, it will shut down any hazardous waste site within one-half mile of a drinking water supply by 1988 unless it can be demonstrated that the site is not leaking.

The Arizona Attorney General recently announced a cooperative effort among state agencies to identify violators and crack down on illegal disposal. If the law is strictly enforced with stiff fines and criminal penalties imposed, it will get people's attention in a hurry and go a long way toward gaining voluntary compliance on a broader scale.

What does all of this have to do with high tech industry? This industry currently produces a fair amount of the 50,000 tons of hazardous waste and 6.4 million tons of industrial waste that is estimated to be produced in Arizona every year. We only need look to the Silicon Valley to see what kind of problems can occur with a concentration of high tech when hazardous waste is not controlled. These industries are sophisticated and hopefully have learned a lot in the past few years. They know they are going to be regulated no matter where they locate. They cannot put hazardous waste in the sewers nor in back lot lagoons or leaky underground tanks. Most, if not all, of the high tech industries understand the new laws and are in the process of complying or have complied. There is really no choice today.

With respect to attracting new high tech industry, it seems to me that if Arizona is running a smooth and efficient regulatory program without undue delay and expense to industry, we will attract our share of these industries. Despite what has happened in Silicon Valley and elsewhere, there is no reason not to encourage them from an environmental viewpoint so long as the proper steps are taken to assure compliance.

Most companies would rather work with the state than the EPA. There is a certain amount to be said for knowing your regulators and for knowing what to expect. So, it is in Arizona's interest to get on with its own RCRA program and for industry to urge the legislature to support that effort in the budgeting process. All bureaucracies, by nature, are difficult, but Arizona regulatory agencies have generally worked cooperatively to solve problems.

It makes good sense to do a good job of controlling environmental pollution. Most industries come to Arizona because of its excellent environment and lifestyle, but that will not continue if we fail to do a good job of regulating. We are beginning to manage our water quantity problems and we must give the same level of effort to our water quality problems as well.

There needs to be a suitable place to put the hazardous waste that is produced. The absence of a first-class hazardous waste site in Arizona is a serious deficiency which will hopefully be corrected in the near future. The expense in transportation and packaging of this waste is significant and no doubt contributes to illegal dumping, so it is important that a hazardous waste site be developed in Arizona in the near future. The legislature was bold enough to take the heat and pick a site a few years ago and hopefully, it won't be long before there is a site convenient to most Arizona industry.

There is, however, a growing concern over the entire question of land disposal of hazardous waste. As the amount of waste continues to grow, the problem increases.

We have been squandering our water resources for many years and only recently caught on to the value and, indeed, the necessity of recycling and reusing our wastewater. The same recycling attitude is emerging about solid waste, including hazardous waste. We cannot bury it all, nor should we.

The Arizona Chamber of Commerce is embarking on what will hopefully be the first step toward a viable waste exchange program in this state. There is evidently a lot of value in some of this waste, and maybe the free enterprise system can find a way to make it profitable.

As mentioned, RCRA is in the process of being amended and some of those proposed changes would limit land disposal altogether for some types of hazardous waste. Those who have an interest should get involved in the discussions and see if the changes are feasible. The legislature should take a look at this question as well and determine if legislative authority is necessary or if incentives should be provided.

Jay Lehr, national expert on water quality, painted a fairly rosy picture in 1983 as to our ability to cope with groundwater pollution problems before they reach the disaster level. He claims that only about one percent of our national groundwater supply is currently contaminated and that, at the most, probably only another one percent will be polluted before the problem can be brought under control in the next decade

or so. The people in Tucson or those living near Indian Bend Wash in Phoenix and Scottsdale may not be comforted by that fact.

Dr. Lehr is basically correct. We have discovered the problem and it is now occupying a major place in the national political arena. The average citizen understands that our water supply is vital to health and survival. While there is not the same level of debate over these issues as there is over wilderness areas and parks, or protecting endangered species, it is a gut issue for people regardless of political persuasion.

That is not to say that there is not industry concern about what type of programs Arizona should develop. The Chamber of Commerce and the industry are vigorously contesting the adoption of the new state groundwater quality permit program. They have gone to court, claiming these regulations go too far and exceed the Department of Health Service's authority over non-point sources of disposal as well as other aspects of groundwater quality regulation.

Last year, Dr. Lehr said that Arizona is now one of the most progressive states in the county with its new groundwater protection program. I believe his statement was a bit premature. It remains to be seen whether this new program will survive the current political and legal attack it faces and be implemented. On paper, the permit program is very comprehensive and far-reaching and will, if implemented, do a great deal to prevent future disposal practices that could lead to water contamination from sources other than those regulated under the RCRA program.

The program is prospective in nature and seeks to reduce or eliminate pollution from new and existing sources. It will take a long time to implement even if the proposed rules survive or if new legislation is enacted. There is no question that the current state law is unclear and clarification of who has what authority is needed. The ultimate question is: Do we want a council made up in large part of industry representatives setting policy or should it be done by a department such as DHS? That debate will continue this year in the legislature.

There is an active campaign underway to legislate water quality protection by initiative in 1986. This is not the way to resolve these problems. Certainly, the threat of an initiative could prod the legislature to act, but the results in an area this complicated are unpredictable. One way or the other, Arizona is going to embark in the next few years on a major effort to regulate discharges and disposal of pollutants to our water.

An equally important question, however, concerns what to do about all the existing problems. Cleaning up our existing water quality messes (and we are finding new ones every day in Arizona and elsewhere) and assessing legal and financial responsibility is an enormous task that presents even more of a challenge to policymakers, lawyers and judges than that of devising future programs.

There is Superfund, of course. In 1980, Congress enacted the Comprehensive Environmental Response Compensation and Liability Act

("CERCLA") to compliment RCRA and provide a fund for EPA to pay for remedial measures where there is an imminent risk to the public health or the environment. Obviously, Superfund has its limitations. It is currently funded to only $1.6 billion, and so far, only a few of the most serious sites known to exist have been designated for Superfund status. And it is a difficult and time-consuming process to qualify a site.

In Arizona, there is no separate fund for the cleanup of non-Superfund sites, as has been established in other states. There is a state water quality assurance revolving fund established to provide money to political subdivisions for cleanup of contaminated groundwater for potable consumption, but is insufficient for most purposes.

Under Superfund, the appropriate state must agree to put up a percentage of the matching money for the cleanup and mitigation plan. Thus, if a site is not designated for Superfund, the problem may go unresolved unless the state can take enforcement action and find a responsible party who is able to pay the cleanup costs. For example, it sometimes requires drilling numerous test and monitoring wells to trace pollution, a very expensive process.

Congress is probably going to beef up this fund to $10 billion or so over the next few years, but even that will not be enough to deal with all the known problem sites in a timely fashion. There are thousands of abandoned sites and at least 30,000 hazardous waste dumps. An outdated estimate put the cleanup bill for just the known sites at $50 billion.

In Arizona, only three sites have been designated so far. They include: Indian Bend Wash in the Phoenix/Scottsdale area due to the TCE discovered there; the Hughes-Airport TCE problem area in Tucson; and the Globe asbestos site. Without Superfund, the state must either forego cleanup or pursue a civil action and seek injunctive and monetary relief against owners of contaminated sites and landfills, including, presumably, some municipalities.

The Superfund approach is to identify the problem, develop a clean-up and mitigation plan to alleviate it as soon as possible, then determine who is legally responsible and attempt to recover the costs from those parties. Despite the extremely broad language of the law, it is not an easy task to prove legal culpability, particularly since the activities in question usually occurred years ago. These often involved disposal of a variety of different products by a variety of different companies.

There are few easy-fact situations in hazardous waste cases. It is not as simple as A suing B, claiming B is maintaining a nuisance or is polluting A's water supply. In many cases, B acquired the property from someone else, who may have acquired it from another who owned it when the alleged pollution occurred. The issues are complex. Did the purchaser acquire the property with knowledge of the past practices that occurred there? Did he assume responsibility for those practices or did he, in fact, continue some of these or even different activities? Were those activities illegal at the time? Did they make inquiries or should they have made inquiries when they purchased the land?

Chances are, these and any number of other facts will make for a complicated and technically complex lawsuit, one that will be protracted and cost a great deal for all concerned. In addition, what is the proper corrective action and level of damages? Should we spend millions to decontaminate the water to drinking water status, or is it enough to contain the problem from spreading further?

Is it enough in some cases merely to prevent additional leaching and not require expensive excavation even if the water supply will be contaminated to some extent? Just how clean is clean is a question that is hotly debated between the EPA and industry.

What other damages are appropriate for the neighboring landowners or the government? Must the responsible parties provide an alternative water supply when one has been contaminated? Finally, is the state liable for allowing the polluting to continue without enforcement, as in some cases may have occurred?

There are any number of problem sites in Arizona besides the Indian Bend Wash and the Hughes situations. Industries will be asked to fork up substantial sums of money to remedy past disposal practices, even if the practices were inadvertent or were considered acceptable at the time. Congress made RCRA and Superfund retroactive to cover activities that preceded enactment. Fair or not, it is apparently the law.

The courts are getting increasingly tough on defendants in such civil actions, but there are still many gray areas when it comes to finding who is responsible and for how much. Legal questions remain concerning strict liability, joint and several liability in apportioning damages and successor owner liability.

In the early 1970s a landfill in New Jersey accepted for disposal about nine million gallons of assorted industrial and chemical wastes. Later, the landfill operation ceased and the property was subsequently sold. The new buyers knew the site had been used as landfill, but did not inquire as to whether hazardous wastes had been deposited there.

In the early 1980s, contaminants began to show up. Arsenic, lead, benzene, vinyl chloride, and other equally attractive substances were found in significant quantities, leaching from the fill in an ever expanding plume into the local drinking water aquifer. This aquifer supplied water to numerous private wells and about ten wells from the adjoining city. Many of these wells became unusable and others would become so in a matter of time.

The city and the EPA sued the original owners, as well as the current owners of the landfill. EPA sought a preliminary injunction based on the RCRA standard that there was an imminent and substantial danger of serious contamination and threat to public health and the environment. The remedy sought was in the form of an injunction, but would have required the defendants to pay for an extensive hydrological study of the area in order to devise a strategy to contain and mitigate the pollution and protect the water supply. They also asked that the

defendants pay the costs of obtaining an alternative water supply for those affected.

In this case, the trial court denied the injunctions. On appeal, the Court of Appeals affirmed the District Court decision, but did say that RCRA and the Safe Drinking Water Act did provide sufficient authority to allow for this kind of equitable relief.

The Appeals Court said that the trial court may have had valid reasons for denying an injunction in this case. The decision may have been influenced by the fact that the EPA had subsequently amended the lawsuit and brought in all of the other parties who may have disposed of hazardous waste in the landfill, in addition to the two owners. The Court mentioned the fact that the current and previous owners may not have had the financial ability to pay those costs and that Superfund, which had been subsequently enacted, provided EPA a method for proceeding and seeking reimbursement from those found to be liable.

In addition, the Court found that the statutes may also be used against dormant waste disposal sites through the restraining of further disposal--in other words, "leaking" is a form of continuous disposal from the landfill. In this way, the government can seek relief from a current owner of the property who had nothing to do with the original sin.

The Court also said that the sale of the property did not relieve the original owners of their accountability. In this instance, the Court found important the fact that the subsequent owners were sophisticated buyers who obtained the property for lower price and should have had knowledge of what was in the landfill, or at least have made inquiries. Thus, the issue of a subsequent owner's knowledge or level of sophistication may be the key to determining his liability.

This case is illustrative of how difficult it is to sort out blame and achieve the proper result in one of these complex contamination cases.

If it is true, as some believe, that we are just beginning to see the tip of the iceberg in the form of contamination of our groundwater aquifers, particularly in the urban areas of the state, consultants and lawyers will be busy over the next few years. We certainly have our share of landfills, and they are generally located in the floodplains where access to the hydrological cycle is almost certain. It is amazing that we put our waste sites in the worst possible spots, but we did.

One reason we are hearing the "tip of the iceberg" scenario is that we are consistently finding more contamination. Several out-of-state major developers who are considering locating in Arizona want to check water quality very thoroughly. Even DHS will admit that the current level of public and private water testing is woefully inadequate.

There should be much more testing of public and private water supplies around the state. Many private wells and smaller water companies are rarely tested and certainly not for everything we now know exists. Adequate testing should be emphasized over the next few years.

Despite Jay Lehr's optimism in 1983, concerning the future of water quality, there are still major contamination cleanup problems ahead to

correct. These efforts will surely tax our ingenuity and most obviously our pocketbooks.

There is no question that we have to do more to regulate groundwater quality in the future. The public will demand it and it is in our economic interest to do so; it is central to our ability to grow and attract new industry and yet maintain our quality of life. There is no reason we cannot resolve both industry's and environmental concerns. Again, it is a question of providing the same level of commitment to water quality as we have had to provide to our water quantity management issues.

J. Andelin

ISSUES IN ASSESSING AND MANAGING HIGH TECH

The Office of Technology Assessment

The Office of Technology Assessment (OTA) is one of four analytical agencies supporting the U.S. Congress. It is ultimately governed by a Board of Directors, consisting of twelve Members of Congress--split evenly between the House and the Senate, and between Republican and Democrat. The breadth of political views of the Board has given it both the freedom to recognize and explore diverse viewpoints and responsibility to do so in the most objective way it can. This is further encouraged by the Advisory Council, made up of scientific and technical leaders from around the country.

OTA undertakes its technology assessments at the request of committees, not individual members, focussing on the policy issues relevant to the jurisdiction of the requesting committees. This requires not only an analysis of the technical aspects of the problem, but also a careful investigation of the economic, environmental, and political ones as well. The issues that reach OTA's attention can rarely be resolved on technical grounds alone. In fact, they can rarely be fully resolved even if all aspects are taken into account. OTA can almost always, however, sort the facts upon which everyone agrees from assumptions and philosophical interpretations that may be controversial. Experience shows that this can dramatically elevate the level of debate and may even accelerate the decisionmaking process itself.

From OTA's earliest days, it has incorporated extensive external reviews into each of its major studies, including an advisory panel that follows the complete study from beginning to end and dozens of other reviewers for specific chapters or issues. OTA is careful to include

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representatives of all major stake-holders for a given issue--including industry, academia, not-for-profit organizations, citizen groups, state and local government, and, informally, any relevant federal agencies. Only in this way can OTA be sure that they have considered a broad enough range of viewpoints and that each final report is as objective as possible.

Recent OTA Reports

Several recent reports are relevant to the issue of keeping natural resources and high technology compatible. Here are a few results.

1. Technology, Innovation and Regional Economic Development[1]

   State and local governments, universities, and private sector organizations nationwide have generated hundreds of initiatives to attract and support high technology industry. Though too recent and too varied to evaluate systematically, the initiatives have resulted in some new linkages between government, universities and industry.

   For most communities, the greatest opportunity may lie in encouraging business innovation from within, rather than trying to attract businesses from other regions. Important to this end are good communication links, both formal and informal; a labor force with varied skills, including managers and entrepreneurs; a supporting technical infrastructure, including existing industry, universities, experts and advisers; financial capital; and close and persistent community efforts.

   High technology industries grew faster in the last decade than other industries and are likely to be one of the faster growing sectors in the next decade. Nonetheless, because of the small size of this sector today, only 8-9 percent of new jobs are predicted to be in high tech industries themselves (using a broad definition of high tech industries). More jobs will be created in other industries that incorporate high tech products in their processes or products.

   An extensive federal effort to promote regional high technology development is not necessary, but better coordination of existing programs is.

2. Technology and Management Strategies for Hazardous Waste Control[1]

   The Environmental Protection Agency's (EPA) regulations for hazardous waste management do not effectively detect, prevent, or control the release of toxic substances into the environment,

particularly over the longer term. EPA's risk assessment procedures for selecting Superfund sites and for developing RCRA regulations have serious technical inadequacies that weaken protection of the public.

Financial restraints and lack of technical resources will make it difficult for states to fulfill their increased responsibility for waste management policy. Ten to forty billion dollars will be needed for cleaning up the 15,000 uncontrolled sites of previous disposals so far identified.

Millions of tons of federally unregulated or exempted hazardous wastes are disposed of in sanitary landfills (meant for ordinary solid wastes) and pose substantial risks. Years or decades from now, cleaning up a site and compensating victims might cost 10-100 times today's costs of preventing releases of hazardous wastes.

3. Water-Related Technologies for Sustainable Agriculture in U.S. Arid/Semiarid Lands[1]

In some areas, improved irrigation management may compensate for decreasing availability of affordable water. In other areas, irrigation agriculture may gradually decline, and in some cases is likely to cease altogether due to water-related problems. Simultaneously, those agricultural systems based on natural precipitation (dryland and range-land agriculture) are likely to increase in importance.

Existing and emerging technologies have potential for sustaining the long-term productivity of arid/semiarid agriculture. Successful application is site-specific, however, and depends on understanding the hydrologic cycle and other natural processes involved.

Complex and changing legal, institutional, and economic issues affect water use and technology adoption. Incompatible, incomplete, and unsynthesized data make it especially difficult to identify and verify water-related potentials and impacts of specific technologies.

Federal programs would be more effective if they were adjusted to reflect the importance of the western mountain snowpack on arid/semiarid lands water production.

The states can use assistance in developing computerized water resources data bases to improve capacity for local and regional water planning and management.

In addition to these three published reports, *Technology to Measure, Monitor, and Mitigate Groundwater Contamination,*[2] will be released

in October. It, too, makes the point that prevention of groundwater contamination in the first place is far more cost effective than cleanup afterwards. It also concludes that, due to the site specific nature of groundwater problems, the primary federal role is one of support to the states--setting standards and guidelines, funding, research and development, and information dissemination.

Guidelines

From these reports, and other OTA work, some broad guidelines for analysis stand out--as do some comments that are specific to the compatibility of natural resources and high technology industry.

First, one must carefully ascertain the question(s) being asked. That is not always as simple or straightforward as it sounds. And it is important to revisit the questions as the analysis progresses, to be sure that they are still the right ones and that the information being gathered and the hypotheses being tested address them.

For example, one must look in particular at three issues: 1) jobs, 2) pollution and 3) control.

1) Where will jobs come from? Certainly some will come directly from high technology industry. Arizona's high technology employment has been growing rapidly and seems likely to continue to do so. More jobs will come from nonhigh tech industries that incorporate high tech products into their processes and products, and still more will be ordinary jobs in ordinary industries.

2) What about pollution? Some will come from new high tech industry. But if standards for new sources of pollution are followed, less pollution will come from new industry than already exists from past industrial practices, whether high tech or not. One must analyze both the pollution that already exists and the potential additional pollution from new industrial activities.

3) Finally, we must look at control. Who will define the balance between economic growth and adverse environmental impacts? The federal government? State and local governments? Some combination? Jurisdictional boundaries rarely match the geographic or political boundaries of the problem. Since people's values are not all the same, the outcome of a decision will depend on who controls it.

Risk Assessment

Once the questions are established, the analytic process gets easier for a while. It is the part referred to as risk assessment, in which one

collects data (often by discipline or region), disaggregates it, sorts facts from probabilities from values, than reaggregates the results according to the questions asked (the policy issues). A few points need to be emphasized here.

First, if it is to be valuable to decisionmakers or risk managers, a risk assessment must be carried out with imagination and honesty; second, its results must be presented clearly and in a value-free manner, structured by the decisions to be made. For example, honesty requires that the jobs multiplier goes both ways. Dependence on an industry whose total employment impact is large compared to its direct employment is fine when it is growing, but painful if it shrinks. We would also reexamine water priorities, and the competition between agriculture, domestic use, recreational and esthetic activities, and industrial needs.

Imagination would remind us that the larger problem of pollution and use of resources may be the influx of people and their needs for water and transportation, not new industry.

An imaginative analysis might also lead to new issues. For example, biotechnology, a rapidly growing sector of high technology industry, has its own special resource needs--specifically, diverse biological material. Maintaining these resources could question national, regional, and international priorities for preservation of plant and animal species, and might lead to their reexamination.

Decisionmaking and Risk Management

Risk assessment is not an end in itself; the end of the process is the successful implementation of wise decisions--risk must be managed. Thus, the results of risk assessments need to be conveyed to decisionmakers. Results are most readily understood and used if they are explicitly structured according to the decisions that might be made and the jurisdictions of possible decisionmakers. The latter usually requires that we understand the political boundaries and possible opportunities for and the barriers to cooperation across them. Results are most used when they are written clearly and objectively.

Those issues for which the facts are clear are usually settled well before this point, as are those for which, independent of factual knowledge, a concensus of values can be reached. The hard issues are those where technical uncertainty allows different conclusions, depending on differences in values.

There is no rule that guarantees that satisfactory resolution of such issues is possible, but experience indicates that resolution is more likely if a thorough and credible risk assessment informs the debate. Given that decisions must be made and programs implemented in the face of differing value judgments before the "facts" are clear, the need for credibility goes beyond the risk assessment itself if the decisions are to stick. It is important that decisions are perceived to be arrived at

fairly, and that there is a clear process for modifying the decision at a later date if better information suggests. A sense of fairness is enhanced if communication channels can be kept open between experts and non-experts and between different sides of the issue. If the outcome of the issue is really important, a conservative approach to implementation, keeping options open until uncertainties are resolved, can often garner the broadest support.

In sum, most difficult decisions are made on values, well before the facts are clear. Given this, the decisions will be wiser, and maybe even easier, if the underlying facts, uncertainties, and values are clearly delineated, and if fair estimates are made of the effects resulting from today's decisions.

FOOTNOTES

[1]These are OTA published reports and may be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

[2]This report is scheduled for publication around the end of October 1984 and will be available from Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

M.A. Anderson

HOW SAFE IS SAFE?

At issue in many discussions of the waste disposal practices of particular industries, or the track record of the EPA in protecting the environment are some basic questions which--in a slightly different form--we face in our daily lives:

. . Just how safe should we be?
. . Which hazards must we at all costs avoid?
. . Which risks can we live with--even if we'd prefer not to?

There is no real argument about the goal of protecting the environment. But there is very definitely an argument about where we should draw the line, how cautious we should be in defining environmental standards. That's what much of the debate about the environment involves. One of the most basic responsibilities of the EPA is to define what is safe and what is not; to define which substances are hazardous, and which--though perhaps a nuisance--we can live with. When Congress drew up the legislation for RCRA, it instructed the EPA to act when there is an "imminent threat to the public health." Similarly, the Toxic Substances Control Act directs the EPA to prevent "unreasonable risks" to the nation's health. Thus, in carrying out its responsibility to protect our health and the environment, one of the agency's most important tasks is to assess risks, their probability and their severity, and to decide which substances should be considered hazardous.

How that judgment is made is an intensely practical matter, which will have consequences for many of us. This year, for example, the EPA is being asked to define criteria to determine "how clean is clean"

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under Superfund. Guidelines about which chemicals can safely be put in land-disposal facilities are being reassessed. And the EPA is conducting risk assessments on more than a dozen chemicals, including dioxin. Such decisions are fundamental in the effort to protect the environment and ourselves. In order to set environmental priorities, there has to be some determination of which substances pose the greatest threat, and require immediate action.

The problem is that while the definition of what constitutes a "significant" or a "negligible" risk, a "tolerable" or an "unacceptable" risk is so important, the determination of what is acceptable is, finally, a political judgment. Scientists can tell us something about the likelihood and the severity of the risk posed by particular substances, but they cannot tell us whether--on balance--what is an acceptable risk. This is not a debate over scientific standards, but a fundamental choice.

We can choose as a nation to be very cautious, and to put tight constraints on the production of any substance that generates dangerous byproducts. We could decide that unless manufacturers (and the EPA) are able to determine as a matter of national policy confidently that a substance and its byproducts are safe, they should be considered hazardous. The people who take this position point out that while the links between environmental hazards and disease are not entirely clear today, they may become tragically obvious in the future. Others reply that it is unrealistic to try to eliminate risks. Certain risks are the price we pay for living in a technologically advanced society. Testing requirements already pose an enormous burden on industry. If we regulate any further, product innovation may be stifled. Besides, the advantages of some substances far outweigh their possible hazards.

. . Weighing the benefits of chemicals against the hazards they pose, should we continue to use them?
. . Are we setting environmental safety standards that are unrealistically high; higher than the risks we take in daily life?
. . When we are certain about the severity and the probability of the risk posed by particular substances, is it better to be safe than sorry?
. . Where as a nation should we draw the line on safety standards?

First, let us define some key words:

Risk in a simple explanation is the potential for or probability of harm.

Risk Assessment is the research and evaluation to characterize human risk attributable to exposure to a particular entity--in this case, a toxic substance or hazardous situation.

In risk assessment, we rely on scientific activity and scientific judgment.

Risk Management is the evaluation of:

(1) the significance of the assessed risk,
(2) the benefits to be derived from the toxicant, and
(3) the means and costs from limiting its use.
(These often determine regulatory decisions about the toxicant.)

Risk Management relies on political and social judgments.

In the June, 1982, edition of *Risk Analysis Journal*, there is an excellent article which describes the results of a research study of risk perceptions, both of safety experts and of lay persons. The study is divided into four basic parts:

1. Unknown, new or not observable risk/feeling of dread.
2. Known, old or observable risk/feeling of dread.
3. Known, old or observable risk/controllable, not dreaded.
4. Unknown, new or not observable risk/controllable, not dreaded.

Items noted in this risk perception research study are as follows.

Part 4. Food Coloring
Saccharin
Microwave Ovens
Marijuana

Part 3. Fireworks
Football
Alcohol
Surgery

Part 2. Dams, Bridges
National Defense
Nerve Gas
Dynamite
Fire Fighting

Part 1. Lasers
Nuclear Power
Asbestos
Pesticides, Herbicides, DDT

It is interesting to note that hazardous waste and other environmental issues were not included in the study. However, the important conclusion of the research is that where dread and perceived risk is high, the public demands and gets regulations of the issue.

A few examples of life experiences involving the roles of science in the risk assessment and risk management process are listed below.

Smoking (an item in Part II of the research) includes a known risk and a feeling of dread. Smoking is hazardous to your health, proved many times in many scientific studies. The Surgeon General of the United States tells us this on television. Cigarette packages warn of the danger. However, many adults knowingly accept the risk understanding that they are going to die of lung damage or complications from smoking.

Is it not then remarkable that anyone continues to smoke? Smokers perceive the benefits from smoking as outweighing the risk of dying from it. Many people would say, "I am going to die anyway from some cause and it might as well be from smoking."

Saccharin, the artificial sweetener, is another example. The public outcry over the Food and Drug Administration's proposed saccharin regulations prompted that agency to re-evaluate their position despite scientific evidence that the sweetener is an animal carcinogen lacking demonstrable benefits to humans.

The public had another perception. There are benefits to diabetics or to people trying to lose weight and these benefits are perceived as outweighing the risks. People will accept the risks if the accompanying benefits are great enough.

Seat belts are yet another risk assessment example. Promotional efforts to get motorists to use seat belts have failed. Even with advertising and buzzer systems, fewer than 15 percent of America's drivers "buckle up for safety." Policymakers criticize the public for failing to appreciate the risks of driving and the benefits of seat belts. Research shows that people often disregard very small probabilities and there is a small probability of having a fatal accident on a single automobile trip.

So policymakers asked the question, "Would people change their habits if the probability of danger were explained in a multiple trip perspective?" In over 50 years of driving (40,000 trips), the probability of being killed is 1:100 and of sustaining a disabling injury is 3 in 10. Research showed that people would start using seat belts if the information was explained this way and media campaigns are beginning to reflect this change in the perceived assessment of the problems.

There are, of course, even more controversial subjects which are being analyzed with risk assessment/risk management techniques.

Asbestos is often in the news. Many years ago, when work was being done on coal miner's or black lung disease research, the asbestos research of Irving Selikoff was gaining recognition. No offense to Dr. Selikoff, but it would not be expedient for him to say that one fiber of asbestos is not hazardous to your health. He has done excellent work on asbestos and its related health hazards but he does not follow risk assessment processes in the same way as those being regulated do. Asbestos abatement companies feel that much should be done, but why wouldn't they say that? Recently, a prominent engineer spoke at the

University of Arizona on asbestos. He stated that some types are more problematic than others and that some fibers over a micron in length are little to no problem because lungs would expel them.

There was a question earlier in this conference on testing. Testing procedures for asbestos once required by the EPA have been re-evaluated and are shown to be inadequate--perhaps even useless. Yet results from such tests forced many school districts to make costly changes. Did we not make matters worse by asking for removal of asbestos from schools? Why did we not proceed slowly, assess the risks of individual problems and repair the worst first, allowing science and technology to catch up with the "problem"? Is one fiber harmful? A more important consideration or question is, what size particle causes a problem? Scientific research has already shown that minute fibers were the "culprits" in lung assaults of other fibers and particles. Would it not have been better to assess specific risks, take care of immediate-danger problems and plan for the future? How can one side of the fence in Globe, Arizona be safe for the people and the other side not?

PCB's are yet another perception problem. They have not yet been proven to be a carcinogen. Research results are not conclusive. They do sometimes produce an acute chloracne condition for people who come in contact with them. Even in the Yusho, Japan incident, health complications from ingestion disappeared with time. Now, owners of PCB equipment are being asked to spend dollars to eliminate them, yet not much research has been done on alternatives to PCB's. A real problem would occur if PCB transformers or equipment were in a fire where incomplete combustion occurred producing dioxins and furans as by-products. Yet how do we arrange for disposal? We incinerate it! Are there not more problems from byproducts now than when the PCBs were in the transformers?

Why did we not develop a step-by-step answer beginning with existing landfill problems and perhaps later phasing into equipment? By that time, perhaps more inclusive evidence would be available to make better decisions on where and how money would be spent on the problem--if indeed it had been shown by then to be a real problem.

What these examples are meant to point out is that scientific evidence of risk is often ignored if a person is willing to personally accept the risk or is unwilling to change the opinion he already has formed on the subject.

As many of you already know, I have strong opinions--both personal and professional--on environmental issues and on the scientific risk assessment of them, but here I want to share some thought provoking questions and not personal opinions. Consider the following in respect to your own opinions or perceptions:

. . If EPA regulations were more site specific, would they not eventually control the real risks and not the perceived ones?

- . . Can we rely on the public's judgment? Are we, the public, informed of the true risks of disposal practices like landfills? Burial was a 4.2 percent on Dr. Miller's chart of suspected sources of contamination, yet regulations are more stringent for burial than for sanitary landfills which was 33 percent of the source.
- . . Should we, as a nation, be formulating regulations based on dread and without adequate knowledge of the chemical or toxicant?
- . . Doesn't it seem sometimes that we are taking the shotgun approach? Are we not shooting dollars and information out there but leaving some uncovered areas? Will these be more hazardous than the ones we are "handling"?
- . . Are results from scientific experimentation reliable? Are animal studies enough? Is the risk greater because we can now detect smaller amounts of contaminants than we were able to detect before? Technology has advanced so we can analyze a water sample for contaminants in one part per billion amounts. Isn't it possible that these amounts could have been in the water for decades and now, since minute quantities can be detected, they "present" a risk? Would it be expedient for research to find that a chemical had no hazard? Why spend dollars to reduce a contaminant from one part per million to one part per billion if another site has a one part per hundred contamination problem?
- . . Will we ever allow dollars to be used where they are most needed--in a situation that was based on risk assessment and not our risk perceptions?
- . . Will the media ever begin to report the information on a chemical from a true risk perspective?
- . . Is every spilled or leaked chemical an imminent hazard or a death-defying incident?
- . . Finally, will we really allow anyone, including scientists, to assess for true risks and, if we do, will we believe the results of their future studies if they prove contrary to what we already believe?

I am delighted to have the opportunity to make this presentation. There is so much information I would like to share but I will conclude by saying that risk estimation or assessment is not a concept of the future--it is here and now. And it is a relatively new approach for regulatory agencies. The one opinion I will share with you today is that the use of risk assessment and then risk management techniques in developing plans of action on chemical uses and hazardous wastes is a giant step in the right direction, especially in attracting new businesses to our great state. For years, businesses have followed risk assessment and management practices and it is past time that the agencies who regulate these businesses begin the same process.

SECTION IV

ENVIRONMENTAL MANAGEMENT IN THE PRIVATE SECTOR

N.R. Hild

INTRODUCTION

Potential problems related to the high technology industry must be looked at as a joint responsibility of all of us. In his first major policy speech after taking the reins of the EPA, for the second time, William Ruckelshaus called for a "revitalized partnership between the Federal Government and scientists ...." He made a strong plea for a "unified approach to assessing dangers of cancer-causing chemicals and other toxic pollutants ..." urging university and business researchers to help provide "the rigorous scientific analysis the government needs to ally the public's health fears." "Nothing," he said, "will erode public confidence faster than the suspicion that political considerations and other policy issues influenced regulations on scientific matters."

Mr. Ruckelshaus concluded by noting that the government must tell the public "it is difficult if not impossible" to establish "an adequate margin of safety, because of scientific uncertainty." "But," he noted, "the country won't recover it's equilibrium without a concerted effort to more effectively engage the scientific community."

Lead: An Example Not To Be Followed

One year later, despite finding no scientists, toxicologists or medical doctors to publicly support what Mr. Ruckelshaus cited as "evidence there is a direct relationship between lead in gasoline and the amount of lead in human blood," he introduced a proposal to reduce the amount of lead in gasoline by 91 percent by 1986.

No one doubts there is a necessity to reduce airborne lead from automotive sources, but the cause and effect simply has not been shown

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scientifically. Rather than take a brute force attitude, however, researchers who welcome the opportunity to be a part of the "scientific community effectively engaged" might find this approach to a solution unacceptable as a model, especially for high technology problems.

According to newspaper reports, a number of people close to Mr. Ruckelshaus have confided that a simple analysis of the problem has shown that the use of leaded gasolines in vehicles intended to use non-leaded gasolines has contributed significantly to the problem. People are buying the cheapest gas at the pump, and that is the leaded gas. If, as is proposed, the costs must equalize anyway, doesn't it make sense to pass regulations which require the price of unleaded and leaded gas to be equal right now? This would provide a "windfall" fund for President Reagan without the dreaded need to increase taxes and provide an opportunity to test the assumptions that lead emitted will decline as a result. There is no direct cost to consumers except those who must use the leaded gasolines in older engines, and the oil companies do not incur costs of converting refinery capabilities to the tune of $575 million.

The point is, we need a way of looking at "what we don't know we don't know" if we are allowed the opportunity to attract high technology.

Relevance to High Technology

The focus of these presentations is the way high tech industries perform environmental tasks of which you may not be aware. The industry environmental and health concerns get a substantial press for all the problems they have but not too much is known about their on-going programs, and it is these programs that we need to tell the public if we are to bring more high tech industries into Arizona.

As noted above, what we all need--including our regulatory community--is an opportunity to learn a lot more about "what we don't know we don't know." In using the lead issue as an example, the message is that where high tech industry and government meet, a lot more effort needs to be used in learning about "what we don't know we don't know" before more regulations are passed.

It seems that regulators and the regulations they write at EPA fall into the common trap of trying to cover all the bases without knowing where all the bases are. Industrial managers do a good job of working very hard at finding answers to what they don't know, but those same people do a pathetic job of answering questions about what they don't know they don't know.

What We Don't Know We Don't Know

In helping to explain that apparent double talk, Stan Davis, who originated the idea that we don't do a good job of managing what we don't know we don't know, uses the Sir Arthur Conan Doyle example in a Sherlock Holmes mystery where the Constable asks Holmes: "Is there

anything else you want to draw my attention to?" to which Holmes replied: "Yes, to the curious incident of the dog in the nighttime."

The Constable said: "The dog did nothing in the nighttime," to which Holmes replied: "That was the curious incident."

What this shows, analogously, is that we have not yet developed the ability to perceive what others have not. That we researchers, consultants and industrial environmental professionals may need to be given the time to look at the assumptions and so-called facts in a different way than is pre-supposed by regulations to determine "what it is we don't know we don't know."

We must be allowed to use good research techniques from which risk assumptions are extrapolated, particularly before regulations are written, to cover the fear of the unknown not being covered. If there is a message in what we have to say, it is that these industries that comprise the high technology manufacturing processes of the future are already wrestling with the fear of the unknown consequences on a daily basis. They are, in fact, trying to come to grips with "what they don't know they don't know" before wheels are set into motion that may cause an environmental or health problem.

The High Technology Focus

Having focused on the general theme that there is much going on in these industries that is not publicized which benefits the environment and society in general, let's turn to some specific examples of how the potential concerns for high tech environmental solutions can become a shared concern, not just a "we versus them" or "they versus us" problem. In doing this, we can make some assumptions based on the fact that this conference is good evidence that 1) Arizona wants to attract more high technology industry to locate in our state; 2) the myriad of legislators, public officials, state and federal regulators, high tech representatives, researchers and members of the general public that are in attendance want to jointly take responsibility for the future environmental conditions that may be changed as a result; and 3) that all of the previous bad publicity can be erased as a stigma of the high tech industries if we all work together to keep problems from arising and solve those that inadvertently do.

Regulators and the regulated community alike must accept this responsibility. The time for politics, for over-zealous regulation to cover the fear of the unknown or to be able to point fingers at "bad guy industry" is past. We are all here as proof that this is a new beginning, so let us get on with it. The University stands ready to provide research that truly meets Mr. Ruckelshaus' speech objectives, if we are allowed. As a group of qualified and concerned participants, we can handle environmental and health concerns if we accept it as our responsibility; not "us versus them"!

A. Abbott

DIGITAL CORPORATION

This is perhaps the first opportunity Digital has had to contribute to an environmental seminar in the western region of our country. Digital Equipment Corporation is a manufacturer of computer and computer peripheral equipment. In the Phoenix metropolitan area, Digital operates two high volume manufacturing locations. The North Phoenix site assembles modules, terminals and printers; printed circuit boards and other electroplated products are produced at the Tempe facility. As would be expected, it is around the Tempe facility that Digital focuses the majority of its Arizona environmental compliance strategy.

This presentation will highlight the environmental programs at the Tempe facility, emphasizing program costs for a medium-sized facility, discuss improvements that are being implemented, and express some concerns.

In July of 1982, the Arizona Department of Health Services and the U.S. Environmental Protection Agency's Region IX requested that Digital-Tempe submit its RCRA part B storage facility application. A six-month period is allowed for assemblying pertinent information; the entire period was required to integrate the plans and procedures with several hundred pages of site specific information and blueprints. The request for Tempe was the first within Digital Equipment Corporation and has focused substantial upper level management attention on the administrative process.

Overall, the application process has proceeded smoothly. Approximately nineteen months have passed in the comment/response cycles, evaluation, draft permit and a public hearing. We believe the administrative process is nearly complete and are currently awaiting final notification by the Arizona Department of Health Services.

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Many of the manufacturing processes at the Tempe site involve electroplating. Consequently, large volumes of metal-bearing rinse water, cleaning solutions and electroplating waste are generated that require treatment before discharge. Within the facility, 10,000 square feet are dedicated to elementary neutralization pre-treatment processes complete with chrome reduction and chelated and ammonical copper treatment. The original equipment has allowed us to consistently meet the industrial wastewater effluent standards in the electroplating subcategory and, more recently, in the metal finishing subcategory. Two separate projects are currently upgrading the existing equipment. Still greater metal removal efficiency, reduction in the susceptibility to internal system upsets and enhanced process control are the long term goals.

Last Spring we began expanding the manufacturing capacity of the plant. An integral part of the expansion is the installation of two ultrapure water systems and additional wastewater treatment capability. New, traditional-type wastewater treatment equipment includes enhanced sludge decant, batch treatment, acid hold and floor spill capacity, and an electroless nickel treatment system.

The larger of the two ultrapure water systems has been designed from the ground up for reclaim/recycle. "High conductivity" deionized water containing up to fifty parts per million of certain heavy metals will be recycled through the equipment, again producing ultrapure water in a closed loop design. An anticipated 56 million gallons of water will be saved over a five-year period.

Equipment and operating costs for environmental compliance can be significant even for a medium-sized facility. In 1979, the installed cost for the original wastewater treatment equipment was approximately $900 thousand. When first notified in 1982 that our RCRA part B permit application was going to be called in, we anticipated $50 thousand for related expense; to date we have spent $30 thousand. Enhancement projects to the existing wastewater treatment equipment are valued at $60 thousand. Four hundred thousand dollars worth of new wastewater treatment equipment is being installed as the manufacturing capacity of the plant is increased. Although primarily related to manufacturing, the recycle ultrapure system will cost in excess of $750 thousand. Altogether, Digital-Tempe has invested about $1.4 million in environmental compliance with another three-quarters of a million dollars in related recycle equipment. The annual operating expense for our environmental programs is in excess of $500 thousand, or about $1 thousand per employee per year (exclusive of labor, power and depreciation).

Finally, I would like to address a number of concerns. Digital-Tempe falls under the metal finishing subcategory within the Clean Water Act. Having completed the total toxic organics (TTO) background monitoring survey in March at a cost of $8 thousand, we are concerned about indications that the EPA is asking municipalities to use different sampling techniques and frequencies than are required for industrial dischargers. If, in an effort to meet their additional requirements, the

local sewage authority in turn imposes these requirements on the discharger, two differing sets of TTO regulations may develop. The issue of TTO limits is still rather controversial. In the short-term, Digital Equipment Corporation will continue to perform the biannual TTO analyses rather than submit solvent management statements.

Arid region water conservation is an issue of concern to all. We chose to install the large recycle ultrapure system with more than just the originally intended use in mind. It will form the basis of future treated industrial effluent recycling projects. While 100 percent recycle probably is not possible for our facility, with additional pre-treatment equipment ahead of the recycle ultrapure system a 25-35 percent plant recycle rate could be obtained--cooling towers, drag-out printed circuit board rinse feed, etc. The installation of large scale recycle equipment, particularly as retrofit, can be an extremely expensive proposition. This has direct impact on manufacturing cost, which is a major concern to U.S. high tech industy engaged in a very competitive international market. We encourage federal and, in particular, state and local regulatory and water utility agencies to develop financial incentives to stimulate interest in and the installation of water reuse systems.

One last point of concern dealing with water conservation--green belt easements. Numerous industrial parks require the maintenance of grass and trees within utility easements. In a recent twelve-month period, Digital-Tempe used 2.9 million gallons of water, or about 80 percent of total landscape water, to maintain such an easement. It would, perhaps, be appropriate for the directors of Arizona's water management districts and municipal planners to encourage industrial park developers to permit desert landscaped easements rather than green belt easements.

HONEYWELL INFORMATION

Many of our problems are similar to those that were enumerated earlier. One of the biggest problems is the fact that we were all part of a moving target--the body of knowledge for the whole regulatory area is changing constantly, both as to how you solve the problems using these regulations and how you identify the problems. One of our concerns always is trying to stay up with new information and remain cognizant about what is going on. For instance, we subscribe to the *Environment Reporter* from the Bureau of National Affairs which provides digests of the current legal and scientific information that is available. It provides publication of the rules and regulations that come out--not only from the federal government, but also the state's rules and regulations. It is a very useful tool. Certainly, at seminars such as this, I've already obtained a few new ideas talking about problems with peers. Other seminars around the country are essential to providing this vital knowledge and exchange. At Honeywell, we have a Corporate Manager of Environmental Affairs who also is trying to help us all stay up with current regulations and data. Based on these kinds of "looks ahead" we then try to evaluate what our environmental needs are and attempt to identify new problems. To do this, we run surveys to keep up with the chemicals that are being used in the plant, how they are being used, making sure the storage and labeling are proper, meeting all regulatory requirements.

On occasion, we have to try to anticipate where the regulations are heading. A good example, I think, is the electroplating standards, which were mentioned by Digital Equipment in their presentation. EPA played with those standards for the better part of five years. During

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this time they would publish them, then they would cancel them, then repropose them, and then they would do something else to them. And the compliance standards kept changing, but yet the date when they were supposed to go into effect remained fixed. We had meetings in our corporation among the six or eight plants that had those kinds of problems, assessing where we felt they were going, what we thought we would have to do. We chose our target of two to three parts per million where we thought the regulations were heading, and that is just about where they did end up. We started looking ahead, trying to make sure we were in line to meet those requirements because, really, the time that was left to actually bring effluent into compliance after the regulations were finally approved--if you started then, you would really have a difficult time meeting the regulations since they were finally effective last April 27, 1984.

As a part of that evaluation technique, we put inputs into the regulatory process. Trying to help state and federal agencies to understand what's going on in the regulated world will help EPA effectively write regulations which can be met and allow a meaningful accomplishment when they are finished.

One of our prime thrusts in our industry is to eliminate what you might call "bad chemicals" as much as possible. These are the ones that would either have been identified as potential carcinogens or harder to handle or for some reasons were put on regulatory lists. Once identified, we do our best to eliminate them from process. As an example of how this works, several years ago our electroplating was changed to electrolessplating. In the early 1970s, as a part of the proposal and evaluation of what Maricopa County should do for air pollution requirements, they adopted the rules which differentiated between nonexempt and exempt solvents and how our industry would handle them and what effluent limits there would be on them. It was then that exempt solvents had a much different set of regulations then nonexempt solvents and that, ultimately, was what really was the driving force for TCE to be moved out of the workplace.

Starting about 1972 or 1973, we eliminated a chemical called copper phosphate. It in itself is not a bad chemical. It is relatively neutral, it is not required to be recognized in our processes by regulation, but, in itself, if it gets into any of our industrial wastewater it makes it more difficult for us to treat the other constituents and meet those requirements. So, within the next year, that chemical will disappear from our processes and help us meet regulatory needs.

Every time we have a spill or another environmental incident, we fill out an internal report. That report allows us to investigate it, to evaluate what caused it, whether or not we should make any engineering changes, any process and procedure changes and should we report it to one of the governmental agencies that requires it. Therefore, I think one of our biggest thrusts over the period of the past few years has been to reduce the amount of chemicals that are sent out for disposal

which I would class as going to a secure landfill. I have a chart here (not available) which shows what has happened. The orange colors correlates to 100 percent, so that it is all based on percentage at that point. The orange is the amount that goes for disposition to the landfill, the blue is the chemicals that are treated and the red is the reclaimed, so if this position went from 48.3 percent in 1980 all the way down to 4.6 percent by 1984, I am currently forecasting that by mid-1985 that number will be down to about 1/10 of one percent, or some small number like that. The treated waste went from 41 percent up to 79 percent and the reclaimed from 10 percent to 15 percent. So that is one of the most effective ways to try to keep "bad chemicals" out of the environment.

In summary, our chief thrust is to eliminate sources of potential spills, eliminate problem chemicals, change chemical types to those that are less of a problem, reclaiming as many chemicals as possible, treating to change hazardous chemicals to other forms and reduce the amounts that are required to go for burial as a final disposition.

H. Ehrhardt

IBM

Since Dr. Hild mentioned some of our environmental programs in the corporate facilities, I'm sure our East Fishkill, New York plant appreciates the publicity. It is important to address three areas. First, to talk about IBM's environmental organization and our policies. Secondly, to show our approach for problem identification, prevention, investigation, and recovery. Finally, I would like to address one of this morning's topics dealing with what environmental factors we at IBM consider when locating a new facility.

Our organizational structure is that each of the IBM sites has an environmental engineering department. The Tucson facility, with over 5,000 people, is a fairly small IBM site. At this site, we have five environmental engineers: the East Fishkill, New York plant has about 80 people involved, not only in the engineering but also the laboratory and so on, with environmental affairs. That department's main responsibility is compliance with all environmental regulations, not only governmental regulations, but also corporate guidelines. That involves, of course, interface with the local agencies, the state agencies, and the regional federal agencies.

Secondly, that staff does engineering design and support for all the water, wastewater, waste and chemicals (that is, virgin chemicals), storage, distribution, collection and treatment facilities.

Finally, and most important, in some cases our charter is to implement the programs needed to prevent the problems from arising as opposed to reacting to the problems once they have arisen. The corporate environmental structure exists also to support each local environmental organization at our IBM facility, giving some engineering and

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advisory guidance to the existing sites. One of their prime missions, however, is development of new sites. They also control the corporate-wide studies, contracts, and are the interface with the federal government on corporate issues.

Another important aspect of their jobs is to provide corporate focus to top management about the environmental concerns so that the top management has to look not only at the bottom line dollars but also at what are the exposures IBM is facing in the environmental field? This is consistent with corporate policy which, by the way, is not a new policy. It was set out by our chief executive officer about fifteen years ago. It is basically five statements and these apply not only to U.S. plants but worldwide.

The first statement is that you must meet or exceed all applicable government regulations. It wouldn't be an environmental statement if it didn't have that one in it. Secondly, utilize nonpolluting technologies to minimize energy and materials consumption wherever possible. This is especially aimed at new product design and manufacturing process design. Thirdly, minimize dependence on terminal waste treatment through recovery and reuse of air, water materials. To give you a couple of examples, in the Tucson plant we have a solvent recovery facility to remove solvents from the air off one of our manufacturing processes operating at excess of 99 percent effectiveness.

Of course, most everyone has heard about our "zero discharge" wastewater treatment and recycling programs. Finally, for our liquid solvents, we have a program to send them offsite for liquid recycling as opposed to sending them out-of-state for disposal. The fourth policy is to assist government and other industries in developing solutions to environmental problems where our expertise can be of benefit.

The final policy is somewhat unique, and that is, we will develop our own standards wherever government regulations do not exist. This means, when a plant is considering taking some internal manufacturing actions, they have to evaluate that action not only based on what the government regulations say, but also, does it meet the company standards, and finally, is it the right thing to do considering the environment?

Some of the corporate standards we have developed include an environmental impact assessment program which is described in a later section. We also have our own discharge criteria, for discharging into air or water, and that also includes monitoring requirements. Finally, our own waste management requirements which not only includes the handling of the waste, but also design criteria, chemical storage and distribution facilities and wastewater treatment facilities.

Basically, IBM is determined to control the chemicals it generates as waste effluents whether or not they are classified as hazardous waste. As far as identifying problems and trying to prevent them, we have two programs we rely on to control our chemistry, to identify problems and prevent them. We have to know what our chemistry is, where it is, and

plan for it in advance. This program is called the Environmental Impact Assessment Program. Basically, this is an internal assessment of every product and process prior to the installation of that process. The assessment looks at the chemical, water, air energy requirements, as well as the waste generation, attempting to minimize the consumption of the resources and plan the facilities to supply the required services, and to handle the waste.

A second system is called a Chemical Authorization System. We call it the CAS--everybody needs an acronym or two. Basically, IBM uses a wide range of chemicals. Tucson uses everything from dish detergent to hand creams to glues, organic solvents, acids, and compressed gases. Prior to ordering any chemical, the individual user in a department, typically, must be authorized by five organizations which creates some bureaucracy, but we feel it's essential to make sure the necessary precautions are taken. Those signoffs include: safety, industrial hygiene, environmental organization, medical and chemical control.

The second aspect of controlling chemicals is to control our waste. We rely on corporate contracts for waste disposal and recycling. That means the IBM-Tucson can't just go out and say, "Yes for sure, we will use the newly planned Arizona hazardous waste disposal site," unless it meets corporate approval. Some of the things corporate looks at, and the IBM criteria that must be met in order to get a contract is, of course, the entire design and operation, the financial stability of the disposal vendor, and, of course, whether or not the proper permits are obtained.

A second aspect of waste control is striving to incorporate total recycle concepts into new facilities wherever it is feasible. This typically means dealing with the site and specific wastewaters expected to be effluent. Tucson is an example where we manage to accomplish that goal.

Some people, especially even some of the industries, may wonder why IBM would choose to take some of these rather extraordinary measures. First of all, we recognize that the handling of industrial wastewaters and chemical waste is a rapidly evolving field and we are determined to stay at the forefront of that field. To do this, we feel that we have to set our own standards which may be higher than some of the existing ones. We believe the right thing to do for everyone's interest is to ensure that the environment is protected and because it is, we've chosen to control our own chemicals wherever possible.

As far as the problems of conservation and recovery, I would like to give a case history of a problem we faced at IBM-Tucson. An example I've chosen is our response to what was a potential or perceived problem, the groundwater contamination in the Tucson airport area. We have a leased facility located northeast of the airport, but it was included in the circle drawn for the Superfund investigation which centered on contamination to the southwest of the airport. We had no onsite wells that relied on the city's services. Because we had no knowledge of what

was under our site, we brought in a consultant to do a hydrogeological history review of the area, and to get all available public information on TCE or other potential contamination sources. The consultants reviewed IBM's chemical usage, disposal history, spill history, and finally developed a test plan so that we could establish the conditions of the groundwater under our site.

Their study came back showing that there was a low potential for any contamination under our site from any of the known sources of contamination previously and there was no potential that IBM has caused any contamination (we had been there approximately five years). They indicated that the only way for sure to know what's under a site is to put in a program that includes monitoring wells and some soil borings. Thus, we made a decision to go forward with that program, even at the risk of finding something from some unknown source that we would have to react to once we put in the wells. We took the well plan, reviewed it with the county health department, state health department, Arizona's Department of Water Resources, and reviewed the consultant's well construction methods and their testing methods so we could work in conjunction with them. The next step was to put in four wells, all of which resulted in tests showing no contamination.

Following that, the state came in and we also allowed them to take samples out of our wells so that they could confirm our results for their use in their Superfund investigation. Now that there is a baseline established, ongoing monitoring is occurring to detect any changes. It's now standard policy at all IBM sites to install pre-construction monitoring wells before buildings are started. All existing facilities have had to go in and document the groundwater condition under their sites.

Also, I chose this as a somewhat typical example. IBM's response to most of our environmental problems (normally, it's an immediate response), is in some cases a brute force response. We go out and get the necessary expertise and manpower. Expense is not one of our primary considerations when we are responding to an environmental problem. One of the big benefits we have is the tremendously effective corporate support. If we have a problem, or think we might have a problem that needs looking at, we know we can go to corporate, and the money will be available. We also try to cooperate with the regulatory agencies, and typically, in my opinion, at least, the solutions we find have been effective.

I also was asked to address the site selection process. Looking at the environmental constraints that IBM evaluated for the Tucson facility, is an example of what we would do in any other facility. The first and foremost thing we look at is, what are the limitations on growth? Some of the potential environmental constraints is the water supply. Obviously, this is a major Arizona concern, one that IBM placed high on our priority. Air limitations, nonattainment areas, complicated permitting and possibly restriction on growth are other items to look at. Also, sewer capacity is something that can be a constraint if you are within

the city limits. We look at what is the hazardous waste handling capacity in an area and, in all honesty, because IBM has corporate contracts that was not one of the major concerns we looked at in Arizona.

Finally, we do an environmental impact assessment of the site chosen to evaluate the archeological impact, hydrogeological concerns, land use history, etc. This was done in Tucson by a consulting group. When we look at the ability to obtain permits, there are several things that can impact this. First of all, we need to know how many agencies get involved. Multiple agencies impede the permit progress due to conflicting priorities, conflicting "turf," and often, conflicting regulations. One effective agency dealing with the permits is in everyone's best interest. Part of that solution is also a consistent set of regulations between state and federal or local and state. Also, the responsiveness of the agencies (I mentioned that multiple agencies slowed it down). It has been our experience with ADHS, DWR, Pima County Air Quality and Wastewater, that they have had an excellent response when we go forward to them. Also, we look at the "flexibility" of the permits. We need this because IBM is a leader in a very dynamic business. I'd like to give you an example. What can now be handled on our $1,500 personal computer that sits on a desk top was handled twenty years ago by a quarter acre of equipment costing $9 million, staffed by sixty people. In twenty-five years, the cost of a hundred thousand multiplications on a computer has gone from $1.26 to under a penny. To help bring this into perspective, equivalent progress in the transportation area would mean that you could now fly around the world in 24 minutes for $3.00; your car would cost $200.00 while getting 550 miles per gallon. The only drawback is you wouldn't be able to fit into either of them. This kind of progress means our facilities are in constant state of change. Thus, the permit structures have to accommodate this change and be flexible or it can impose restrictions on high technology companies ability to compete. If we feel we cannot obtain permits we will look elsewhere for property. The permit structure must accommodate change and, so far, we have found the state and county regulations in Arizona have accommodated us.

Finally, how effective are the local regulations? IBM supports effective regulations in environmental areas. We have submitted public comments in support, for example, of the hazardous waste regulations. To be effective the regulations have to be flexible and they have to be consistently applied. We are going to follow our own policy, which in some cases may be more strict than existing regulations. We feel that if everyone took similar precautions, we could be spending more time discussing how to protect the environment, rather than how to clean it up. We know that effective regulations can help force those necessary precautions to be taken.

T.J. McManus

INTEL CORPORATION

Intel is a worldwide semiconductor manufacturer. The mainstay of Intel's business is the development and manufacture of integrated circuits through advanced technological processing on silicon wafers and other appropriate media. In addition to the production of microintegrated circuits, commonly referred to as computer chips, Intel produces components, printed circuit boards, and computer systems.

Intel makes the computer chips in the United States and ships the completed wafers to the Far East and the Caribbean for assembly into components. Printed circuit boards and systems are manufactured in the United States and overseas. Intel is currently completing construction on a new chip fabrication facility in Israel. Design centers are operated in Europe, Israel, the Far East and the United States to provide appropriate chip architecture to meet the demands of users worldwide.

Intel computer chips are used in wide variety of products. We are one of the major producers of the microprocessor used in the personal computer industry. Intel also manufacturers the controls which operate the solid-state electronics of one of the major U.S. car manufacturers.

Intel In Arizona

Intel's U.S. manufacturing facilities are operated in Arizona, California, New Mexico and Oregon. The Arizona site consists of two campuses located in the Phoenix metropolitan area. The Deer Valley campus is located along I-17 north of Phoenix. This facility provides a systems development center, sales support, internal communication and computer facilities, and other internal support groups.

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The major manufacturing facility at the Arizona site is located in Chandler. This facility consists of a major chip wafer manufacturing facility and a support building. Intel's FAB 6 has operated in Chandler since 1980. We have recently started construction of a $90,000,000 expansion at the Chandler campus to house Intel's first U.S. based automatic assembly and testing operation. These facilities will be on-line in 1985.

Waste Production

Intel's waste production is associated with wafer fabrication and components assembly. The fabrication of computer chips requires the use of acids for etching and solvents for cleaning. It should be noted that the primary solvents for Intel's wafer fabrication are isopropyl alcohol, xylene and acetone. These manufacturing operations are conducted under hooded operations which are exhausted through a scrubber system. During each step of wet processing, rinsing with demineralized water is performed with this rinse water discharged to an on-site wastewater treatment system.

The concentrated waste acids and solvents are collected separately for off-side treatment and disposal. Due primarily to the characteristics of corrosivity and ignitability, these waste acids and solvents must be managed as hazardous waste. Therefore, the primary wastes generated in a wafer fabrication facility are as follows:

1. Exhausted fumes.
2. Demineralized rise waters used after selected wet processing operations of either acids or solvents.
3. Concentrated waste acids or solvents.

Component assembly results in the production of either plastic or ceramic parts. The leads on the plastic parts are lead soldered. This operation results in waste lead solder which can be recycled, and miscellaneous rinse waters. The ceramic parts are tin plated. The plating operation produces the following:

1. Acid fumes which require exhausting.
2. Rinse waters which require treatment.
3. Concentrated acid and tin plating baths.

In comparison to wafer fabrication, the assembly operation produces significantly less volume of wastewater, air emissions and other wastes. An Intel fabrication facility would produce approximately 80,000 cubic feet per minute (cfm) of exhaust, which would be scrubbed prior to discharge to the atmosphere. An individual residence would operate an air conditioning system which recirculated approximately 3,000 cfm.

The wastewater neutralized on site is approximately 150,000 gallons per day and is typically discharged to the local publicly owned treatment works (POTW). The City of Phoenix operates over 100,000,000 gallons per day of treatment capacity. Several thousands gallons of waste acid are produced each month which require off-site treatment and disposal. Approximately 1,000 gallons of waste solvent are generated on a monthly basis.

Environmental Compliance Framework

The primary framework on environmental compliance is established by federal environmental control regulations. These regulations are further refined and expanded through the development of state and local regulations. The primary environmental legislation and regulations which provide the environmental framework for Intel are:

1. Clean Air Act
2. Clean Water Act
3. Resource Conservation and Recovery Act

The Clean Air Act controls the air emissions from our fabrication and assembly operations. The primary concern is acid fumes which are treated via wet scrubbing. The level of generation of organics are not sufficient to require controls at this time.

Intel operates on-site wastewater treatment facilities which typically discharge to the local POTW. For wafer fabrication, we are controlled by the semiconductor subcategory of the Electrical and Electronic Component Point Source Category. These regulations require that solvent management plans be implemented to prevent the discharge of selected toxic organics to the local POTW. The assembly operations come under the Metal Finishing Point Source Category, which requires control of both organics and metals. The primary source of Intel's metals is from the tin plating operation; however, tin is not considered to be a major toxic metal and is not currently listed in pretreatment standards for Metal Finishing.

The Resource Conservation and Recovery Act (RCRA) covers the management from "cradle to grave" of hazardous waste. The primary source of hazardous waste generation is wafer fabrication. Intel currently collects the concentrated waste hydrofluoric acid and has this material hauled off-site for treatment and disposal. This material is a hazardous waste due to corrosivity and the presence of fluoride. The other source is the waste solvents which are either recycled or hauled off for treatment and disposal.

The majority of the environmental programs established by the U.S. Environmental Protection Agency are currently being implemented by state environmental agencies. In Arizona, the Clean Water Act and the Resource Conservation and Recovery Act regulations are enforced by the

Arizona Department of Health Services. The Maricopa County Air Quality Board is responsible for enforcing the Clean Air Act regulations.

Local compliance issues center on the management of site storm water and wastewaters which are discharged to a POTW. In the case of our Chandler campus, the sewer use ordinance established by the City of Chandler sets the framework for environmental compliance of this waste source. The City of Chandler also controls storm water through a city ordinance. Through the federal, state and local agencies, the environmental framework is established which Intel has to operate. The appropriate regulation or ordinance sets the baseline which must be maintained. It is from this baseline that Intel has established our worldwide program for environmental compliance.

Intel's Environmental Philosophy and Commitment

Intel has established the following environmental philosophy:

1. Anticipate changes in both manufacturing technology and environmental regulation. Therefore, provide flexibility in the environmental control facilities.

2. Use the appropriate federal, state or local environmental regulation as the minimum standard for environmental compliance. Implement systems and programs to achieve higher standards where possible.

3. For overseas facilities, design environmental control systems to meet the strictest standards established by either the U.S. government, Intel, or the foreign government.

An environmental philosophy is not implementable unless there is a commitment from the corporation. Intel has provided the commitment by structuring the environmental component within the Facilities group, which has the responsibility for new construction and the operation of all existing facilities. Intel's commitment is further reflected in the fact that the Manager of Corporate Environmental Affairs meets on a quarterly basis with the Chairman of the Board and other key executives to review our environmental program. When necessary, the commitment for manpower, funding and other resources can be made directly from the top.

Intel's Environmental Solution

The solution to environmental compliance rests with the components of equipment and manpower. Where possible, facilities are designed and installed to abate pollution. The more complex component is the development and implementation of a management system which includes the

routine testing and maintenance of the pollution control facilities. The following sections describe Intel's commitment.

Environmental Control Equipment

To control air emissions, Intel operates wet scrubbing systems and receives permits for all major pieces of equipment, including the emergency power generators which are used to supply back-up power and also our back-up fire water sprinkler systems. The majority of Intel's fabrication facilities, including FAB 6 in Arizona, is constructed such that separate ductwork is installed to collect fume exhaust from solvent operations. In the event that stricter volatile organic compound (VOC) controls are implemented, Intel can rapidly mobilize and install charcoal scrubbing systems. At the present time, Intel's solvent exhausts are discharged through the wet scrubber because the A levels are well below any existing limits. In addition, Intel is converting to the new plasma etch technology in manufacturing which should further reduce the VOC emissions.

The wastewaters generated by the Intel fabrication facilities are acid rinse waters and generated as a result of producing the high purity water required for manufacturing. These wastewaters require neutralization to a pH from 6.0 to 9.0 prior to discharge to a local POTW. The treatment process is simple in comparison to the treatment provided by the local POTW to process municipal wastes. Intel installs systems which include sophisticated controls to insure that the proper pH is maintained.

For our metal plating operations, metals removal is provided along with the neutralization component. With the installation of a new automatic plating line in our facility in Manila, Intel is installing a new wastewater treatment system. Intel has installed an extremely sophisticated system to remove these metals prior to discharge to the local municipal treatment plant. This treatment facility exceeds the Philippines standards and represents state-of-the-art metal treatment currently available in the United States.

One of the key components in achieving compliance with the wastewaters discharged to a local POTW is the proper management of solvents. Intel has worked hard with the manufacturers who supply our processing equipment such that failsafe systems exist to prevent improper discharge of solvent wastes. In addition, each new piece of equipment installed in the manufacturing process, is inspected by personnel familiar with both the safety and environmental aspects to insure that the equipment is connected properly. All of our wastewater discharges have been sampled and it has been determined that the organic solvent concentration is well below the current limit.

Intel has established a position on hazardous wastes that we will only operate as a generator. We do not want to operate a treatment, storage or disposal facility. This decision requires strong management

control and monitoring to track our activities. From an equipment standpoint, each of our facilities is provided with a self-contained drum storage facility for hazardous wastes. In addition, Intel is in the process of retrofitting all underground solvent tanks which are currently not vaulted with secondary containment. We have made a commitment of over $1 million to this program because we feel that this is the best method of prevention.

From an equipment standpoint, Intel provides the state-of-the-art in pollution control. In addition, we are constantly improving our monitoring and automatic alarm systems to provide early warning on any problems. At most of our facilities, these alarm systems are tied into a central control system which is monitored continuously. This insures that when an alarm is annunicated, there is a response.

Management System

The management system for Intel's environmental compliance program consists of the following key items:

1. Personnel
2. Inspection Programs
3. Environmental Technology/Management Groups
4. Spill Control Teams

Personnel

The key to the development and implementation of a management system is the personnel. Intel has committed that at each of our domestic sites there is at least one full-time Environmental Engineer. Typically, we operate with two Environmental Engineers. At all five of our major international manufacturing facilities, we have one person designated to handle environmental matters.

Inspection Programs

Intel operates the following environmental inspection programs:

1. Semi-annual corporate environmental compliance evaluation.
2. Semi-annual Mr. Environment evaluation.
3. Routine site inspections.

The corporate environmental compliance program is initiated by the Corporate Manager of Environmental Affairs and includes a detailed inspection of each facility to determine that the site is in environmental compliance. The items inspected include the environmental control facilities, sampling and analysis reports, permits, Mr. Environment program, system to track state and local environment legislation and

regulations, and environmental records. At all of the U.S. facilities, this evaluation is performed twice per year. Depending on the nature of the operations, the international facilities are evaluated on an annual or semi-annual basis.

The Mr. Environment program centers primarily on the environmental control facilities. Semi-annually, the Site Environmental Engineer performs a detailed inspection to insure that all of the environmental control equipment, maintenance procedures, and other programs are in proper order. Any action items which result from this evaluation are tracked on a monthly basis until the item is completed. There are several key compliance items which require more frequent review. For example, the Site Environmental Engineer must more routinely confirm the following:

1. Are any drums in the hazardous waste storage area getting close to the 90 day limit? (RCRA)
2. Are there any problems with the pH control systems for the wastewater neutralization facility?
3. Are the level alarms operational on waste storage tanks?

These are some of the key issues which may result, if not properly operating, in the facility going out of compliance on a specific item. Therefore, a routine inspection program which ranges from weekly to monthly is implemented by each of the Site Environmental Engineers to verify compliance. Typically, these items are on routine maintenance and inspection programs by maintenance personnel. The Site Environmental Engineer is acting as a back-up to verify that everything is operating properly.

Environmental Technologies/Management Groups

Intel has established several committees and task forces to address environmental issues. All of the domestic site engineers meet on a quarterly basis to review programs and to draft appropriate policies and procedures for implementation. On an annual basis, the international environmental engineers meet with the domestic environmental engineers and review our programs and progress.

There is a special environmental control group associated with wafer fabrication. The primary thrust of this group is to stay abreast with new technology developments in manufacturing. Representatives from Safety, Environmental, Technology Development and Manufacturing are represented in this group which meets monthly. The objective is to provide an early warning system, such that an appropriate environmental controls can be implemented or modifications to manufacturing processes can be instituted in order to appropriately abate pollution.

As an example of a special task force, the economic and liability issues associated with hazard waste disposal are significant. A special

task force has been developed to evaluate vendors and establish national contracts for recycle, disposal and emergency response.

Spill Control Teams

Inevitably physical handling of chemicals and the use of equipment to transfer chemicals can result in spill instances. We typically install alarms and automatic shutdowns in order to minimize the impact and size of the spill. Since one cannot predict when and how a spill will occur, it is imperative that spill teams be available to respond. Intel has made a major commitment and currently operates spill teams at all of our major U.S. manufacturing facilities. The spill teams are geared to provide containment and cleanup for any spill up to a 55 gallon drum. As directed by on-site Emergency Coordinator, any spills in excess of a 55 gallon drum will either be contained or cleaned up. If only containment is provided, an outside contractor will be called to perform the cleanup.

At our Chandler, Arizona facility the spill teams are established and operate on a 24 hour basis using paging systems. In additional, the spill team has equipment stored at strategic locations and a mobile unit to respond to a spill event. This team undergoes routine training and is now scheduled to undertake a simulated spill where video tape equipment will be used to document the response. These tapes will be used to provide training as new people are added to the spill team, and also to provide refresher training for current members.

Whenever there is a spill event, there is always the concern about the environment. Most of this concern centers in the ground water and soils medium. Intel has therefore established a corporate policy that at all existing and new locations which are either owned or leased by Intel and upon which we perform manufacturing operations which use chemicals, we do perform a baseline ground water and soil sampling program. This established the conditions at the site prior to the operation of Intel facilities. If there is a spill incident, it is therefore relatively simple to determine whether there has been any degradation of what was the original site conditions.

Summary

Intel has established major programs for the implementation and achievement of environmental compliance. We use the existing regulations as our medium standard. We strive to achieve a compliance level above that which is currently required and design our facilities in anticipation of changes in either manufacturing processes or environmental regulations.

The key to the success of our program centers on the commitment throughout the whole corporation to environmental compliance. The state-of-the-art pollution control equipment is installed and a comprehensive management system is in place to provide the solutions.

M. Chait

MOTOROLA

The subject of this presentation by management is problem identification, prevention, investigation and recovery in the private sector. For the manager of environmental matters in a high tech frim, the problem is easy to identify: it is the relentless onrush of technology. That unlucky individual must--simultaneously--remain current with three different developing technologies.

The first challenge is knowledge of environmental regulations, or perhaps it should be called the technology of the acronym. These highly technical legal documents cannot be understood individually by either the technologist or the lawyer without a team discussion including each discipline. Keeping up with these rapidly developing regulations takes a good deal of study.

For the Environmental Manager busy consulting with lawyers and regulators in an attempt to understand the regulations, there is the ever present danger that he will be left in the technological dust of the high tech industry that employs him. The Environmental Manager must know what his employer does for a living before he can understand what the environmental regulations imply.

Lastly, there is the challenge of the technology of control equipment. This technology is changing rapidly but can be characterized as "always working better in theory than in practice."

The following case histories are illustrative. In April 1983, EPA published wastewater effluent standards for the semiconductor industry. Limitations were set on "total toxic organics" (TTOs). Because EPA was late with standards and had been sued, compliance was required in about one year instead of the three years granted previously. TTOs turned

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out to be the sum of some thirty organic chemicals. The EPA development document said all the industry had to do to comply with the regulation was "properly manage our solvents."

Environmental managers looked at the list of chemicals and recognized that the few that were used were all chlorinated degreaser solvents. The initial reaction was that the industry already did manage their solvents, collected all spent solvents separately, and sold them to a reclaimer. Motorola had volunteered to participate in the EPA study to develop standards for the semiconductor industry several years before they were published. At that time, EPA had found phenol and several chlorinated solvents in Motorola's wastewater. Motorola traced the source to a class of materials called photoresist strippers purchased from various suppliers. Because these materials were used hot and were corrosive, they could not be blended with the remainder of the used solvent and were discharged into the waste water. Because of Motorola's participation in the EPA study, they knew enough about their own technology to recognize the need for either collection of the strippers, or substitution. Motorola chose to collect the spent material in a corrosion resistant collection system with an installation cost of $300 thousand. Motorola found the best way to dispose of the material they collected involved incineration at Houston, costing approximately $150 thousand per year.

In another example, Motorola decided in 1979 to finish a building started years earlier but whose construction was halted by the recession of late 1974. It was decided to place two semiconductor manufacturing areas in this building and to do so within one year.

One of the environmental challenges to this course of action lay in the murky pages of the Clean Air Act and various regulations, and "Interpretive Letters" from EPA which implemented this legislation. Maricopa County, Arizona, did not meet the national standard for ozone and therefore was a nonattainment area which evoked limitations on major sources of volatile organic compounds (VOC). In 1979 a major source was one which had the potential to emit (with no controls and at full production) over 100 tons per year of VOC. A court decision (Alabama Power) has since changed that definition. The EPA Interpretive Letter mentioned earlier stated that after July 1, 1979, in those states which did not have an approved implementation plan, no permits could be issued for major new sources in nonattainment areas. Therefore it was important to determine if the new area would be a major source of VOC. This determination was somewhat hampered in that the production processes were still under development and were not defined until after the July 1 deadline. However, Motorola's best guess was that the new areas were major sources and required a major source permit.

A major source in a nonattainment area required the installation of the "Lowest Achievable Emission Rate" (LAER) equipment. Motorola looked to other firms and found that no one else in the semiconductor industry was building a major new source in a nonattainment area.

After looking at a number of control technologies, Motorola chose carbon absorption and designed a system patterned after solvent recovery systems used in chemical process industries. The only problem was that the solvent recovery systems were all designed for a few solvents, at relatively high concentrations. The emissions from the new production facility were anticipated to involve many solvents at low concentrations.

Therefore, based on a regulation whose provisions were still being debated and on a guess as to what their production process would be, Motorola committed to $1.7 million worth of control equipment they only thought would work. Despite being twice too big (process change to a water base photoresist developer process), the system did work, although only in the labor intensive manual mode because of the sizing problem.

SECTION V

RISK MANAGEMENT:
TCE AND GROUNDWATER CONTAMINATION

M. Carlile

INTRODUCTION

Trichloroethylene (TCE) is a volatile organic substance--a cleaning solvent used since the 1920s--to clean everything from heavy industrial equipment to clothes dry cleaning and is even used in the process of decaffeinating coffee. TCE is only one of a whole class of compounds known as volatile organics--all man-made. In the past, the aerospace and electronics industries have commonly used TCE as a degreaser, and prior to the 1970s, large quantities of used TCE were disposed of in landfills, surface impoundments and abandoned wells.

TCE, in particular, has been showing up in well testings in Arizona; wells in direct relation to dumping and disposal sites. Many of the man-made volatile organics, like TCE, are considered to have significant health risks when ingested by humans. The presence of TCE in our water supplies is of great concern. Although the health effects of low concentrations of TCE in drinking water are uncertain, the EPA has established a "suggested no adverse response level" of 4.5 parts per billion in drinking water. The Arizona Department of Health Services, in cooperation with other government agencies and private industrial firms has launched an effort to identify the areas in Arizona where groundwater has been affected by volatile organics and other contaminants.

The contamination level used by ADHS is volatile organics found at greater than five parts per billion in drinking water. TCE has been discovered exceeding that level in at least 117 wells in the central urbanized areas of Arizona. At this time, 13 sites yielded 75 wells in Maricopa County contaminated with TCE and 3 sites with 42 wells have been discovered in the Tucson basin.

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TCE is a classic case in assessing high tech environmental impacts. It has been detected in the groundwater in nearly all areas where high tech firms are concentrated. It is difficult to manage and expensive to clean up. The following presentations deal with the risk assessment and risk management issues related to TCE.

K. Schmidt

TCE: MEASURING A GROUNDWATER CONTAMINANT

I want to share with you some ideas from a groundwater hydrologist's viewpoint. I'll tell you what I think we've learned about TCE and what this has meant to our profession and in our understanding of groundwater. The influence of TCE in understanding groundwater chemistry has been substantial in recent years. First, when we started discovering TCE in groundwater we found out a lot more pollution was going on than we knew about before. Probably our major constituents we historically focused on were the inorganics and our drinking water standards were based on inorganics. The major constituent, as a lot of you know, is nitrate. The difficulty with nitrate is that it has a natural source and almost every other inorganic has a natural source in rough materials or some other media. When TCE came along it was unusual because it ruled out a natural source possibility because it was a man-made contamination. We then had to focus our research on the source. It wasn't a question of "Is it natural or not?" which, for inorganics, is difficult to answer.

Secondly, we learned something about trace organics that was surprising. Historically, hydrologists knew that material would move through the soil, it would be absorbed or broken down, or volatilized; it would not, however, get in the groundwater. TCE, among a few other constituents, proved that these solvents will readily move into and through the groundwater. In fact, groundwater will be an ideal preservation material for some of these trace organics, being cool and dark--characteristics that are ideal in preserving these materials compared, for example, with a surface reservoir.

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Thirdly, we started working with smaller levels of measurement units. We used parts per million and, over the years, to be metric, we changed that to milligrams per liter. We're now measuring levels at the parts per billion or microgram unit. In the case of some of the other trace organics, there's evidence suggesting we're going to go to even smaller units in the future. It makes you sit back and think: "What are the drinking water standards going to look like in 50 years?" You who have not reviewed or are not familiar with the drinking water standards should look at this. In a short period of time, the number of organic chemicals expanded tremendously and, if this trend continues, life is going to get very complicated because we're going to be talking about thousands of constituents and minute, minute units.

The other thing TCE taught us is that we need new and innovative sampling approaches because we are not used to sampling materials primarily in groundwater that have volatilized. We know about chemicals such as nitrate--that after collection, the sample had to be kept cool and so forth; but, certainly in the old days, fifteen or twenty years ago, we used to collect one bottle, throw it in the back of the pickup and deliver it to the laboratory three or four months later. Now we have so many bottles you can't put them in a pickup. It's made life very, very complicated. We have to undertake certain sampling procedures for volatiles that obviously we didn't have to worry about with chloride.

The next point is that TCE made a revolution in the groundwater profession; a fantastic revolution that is hard for me to tell you about. Five or ten years ago, 90 or 95 percent of the people working in the groundwater hydrology profession worked with water quantity and there were two major tasks. What we were trained to do was to find water, to develop groundwater, to develop wells (something we're still doing), and to study drainage (where you have shallow water and want to drain land, and so forth). These were some major concerns historically. Groundwater at that time was just a small part of groundwater work; it was something you collected a few samples because it would tell you something about the groundwater system or you could find out its suitability for drinking water based on testing for those few constituents known at that time.

Now, in just a few years, by far the majority of people working on groundwater are working in water quality and pollution. This caught our profession totally unprepared because we had no academic programs focusing on this. We still do not have these in the United States. There's a school in Canada in Waterloo that has a program focusing on groundwater pollution monitoring, but we really have no such comprehensive academic programs anywhere in the United States. There seems to be a twenty- to thirty-year lag that may appear before our academic programs start to get in line with this kind of training. Old guys like me learn by trial and error; we need a better, more intentional type of training. It leads to the next question of the qualifications of people doing these studies because all of these problems--including TCE--have

been like the gold rush. We're going through a lot of trials and tribulations and trial and error. The approaches of some of the regulatory agencies historically have had serious problems investigating groundwater pollution and in responding to problems. The answer to solving some of the problems is not to make cookbooks and to make rules and develop structures that impede scientific investigations. The taxpayer pays for some of the trial and errors, industries are paying a lot of money for substantial trial and error and for things that we shouldn't be doing. Groundwater people have told managers and Congress that we need thousands more hydrologists to do these studies. There seems to be an apparent slowness in response to a serious need.

I want to talk briefly about cleaning up TCE and protecting groundwater. TCE has been identified as being difficult to handle. There are many cleanup projects ongoing and we are pumping out TCE in both California and Arizona. We're doing two primary things with it. We're air-stripping it, which appears to be relatively easy; it may be expensive, but it's much easier than some of the other trace organics we have in the water, such as pentachloraphenal, and other substances that are not as volatile. In some ways, once we pump TCE out, it becomes relatively easy to remove from water. We're successfully air-stripping it at sites, and we are successfully land-spraying the water and volatilizing TCE at least at one site in California. It appears we can handle TCE relatively easily, technically, compared to other organic pollutants. Our great problems in reclamation occur when we get into complicated systems; in other words, the simpler the system is, the more it's like a sandbox--uniform sand in a box. The more the system resembles uniformity, the easier it is to deal with. The more complicated the system, the more difficult it becomes to implement a successful reclamation project. This is because we have to first learn how the system works and reacts.

Groundwater protection/prevention is going to be the best strategy in the long-term. What a contrast it is compared to ten or twenty years ago when we thought that "you don't want to put in the monitor well because you might find "something." I think the current approach is, "Yes, it may cost a little bit of money to put in a monitor well, but the overall cost saving is going to take place if we can identify these problems early." That is where we're headed in the future: to identify problems early, to pre-empt them from happening; and, if they do happen, to monitor them as soon as possible and find those strategies that will minimize overall costs. As far as costs for reclamation, at least one site in California is probably approaching $30 million. Another site in California is approaching over $20 million. So we're spending large dollars at some sites and they have yet to clean up the groundwater.

There is no project in America where we've cleaned up the groundwater totally because they haven't been doing it long enough. Cleanup is going to take twenty, thirty, forty, fifty, or sixty years of time. We're not going to clean up massive thousands or tens of thousands of acre feet of water instantaneously.

STATE REGULATORY RESPONSE TO TCE POLLUTION

There is considerable discussion about the mistakes of the past that have resulted in the contamination of groundwater throughout the nation. Plans for the future emphasize steps to prevent any further degradation of this valuable resource. With increasing commitments from industry and the renewed determination of regulatory agencies, preventive actions should be more effective in the future. But today we are just beginning to identify the problems that have been caused by past activities. The most prevalent contaminant in trichloroethylene, TCE, a volatile organic used as a degreaser since the 1920s. It has been used by a number of industries including the aerospace and electronics industries.

TCE was first found in Arizona as the result of an EPA field investigation at the Hughes Aircraft facility located near the Tucson International Airport in March 1981. Subsequent sampling conducted in the area defined a contaminant plume(s) that covered 4.5 square miles. To date, eight city and sixteen private wells have been affected by the contamination.

Since 1981, extensive sampling for TCE and other volatile organics has been conducted in various locations throughout the state, primarily in the two major metropolitan areas. Selected municipalities including Tucson, Phoenix, Scottsdale, Tempe, Mesa, Chandler and Goodyear have sampled all of their drinking water supply wells. The Pima County Health Department has initiated a long-term sampling program for semi-public and private wells. A regional utility, the Salt River Project (SRP) has tested more than 100 irrigation wells in the Phoenix area. The Arizona Department of Health Services has sampled over 500 wells, including public, private irrigation and industrial wells. Of an estimated

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800 wells sampled to date, approximately 115 of them have been found to be contaminated by TCE and/or other volatile organics. At least 27 of those wells serve as sources of public drinking water supplies. The primary risk management issue that must be addressed with the discovery of TCE in groundwater relates to the health risk posed by its presence in drinking water supplies.

The health effects of TCE in drinking water are not really known. Although laboratory studies have shown that it can cause cancer in mice, there has been no observed correlation between human exposure and an increased incidence of cancer. Still, due to TCE's potential carcinogenicity, there is widespread public concern and a preference for its concentration in drinking water to be zero.

The Arizona Department of Health Services has, therefore, established an "action level" for TCE in public water supplies of five parts per billion. It represents the level at which one may expect to observe one excess case of cancer in a population of one million consuming two liters of water per day over a 70-year lifetime. Additionally, guidelines have been developed for public water suppliers which establish requirements for testing, sampling procedures, reporting and public notification, and alternatives for corrective action. The action level and guidelines are strictly voluntary, not enforceable.

The TCE guidelines for public water suppliers provide another mechanism for risk management. They allow for seasonal usage of drinking water in excess of the action level. Since the excess cancer risk assessment is based upon long term exposure, it is possible to increase the level of exposure for limited periods of time without increasing the overall risk.

The City of Tucson has discontinued use of all of their contaminated wells. The City of Phoenix is blending three wells, has closed three wells, one well has been approved for seasonal usage, two wells are less than the action level and a tenth well is pumped into an irrigation canal in exchange for more suitable water from Salt River Project. The City of Tempe has closed two contaminated wells. The City of Scottsdale has closed two wells but is building a treatment facility to remove TCE from one well.

In implementing the guidelines, two other issues related to risk assessment were encountered. First, when a public water supplier is asked to close a well because of contamination by TCE at concentrations in excess of the voluntary action level, that source of drinking water may be replaced by surface water. Treated surface waters often contain trihalomethanes (THMs) which are also suspected carcinogens. The enforceable drinking water standard established for THMs poses a greater health risk than the one in a million (10^{-6}) excess cancer risk. So, by requiring closure of a well due to TCE, a public water supplier may be forced to substitute surface water which could pose a greater health threat.

Second, the City of Scottsdale began construction of an aeration tower to treat water from one of their contaminated wells. An aeration tower transfers the volatile TCE from the water to the air. There was considerable concern about the air quality impacts associated with such a treatment technology. ADHS established an acceptable air concentration equivalent to the 10^{-6} excess cancer risk. Computer modeling was conducted to simulate the release and dispersion of TCE into the air. As a result, operational limitations have been placed on the treatment facility to achieve acceptable air quality.

Another significant risk associated with the contamination of groundwater is the reduction in the quantity of acceptable water. Arizona is highly dependent upon groundwater as a source of drinking water. Some municipalities such as Tucson and Scottsdale are totally dependent upon groundwater at this point. Although the Central Arizona Project will provide some relief, it is difficult to predict the extent to which groundwater usage can be replaced by surface water. In the meantime, a number of questions regarding the management of our groundwater resource remain unresolved. Can we afford to allow the contaminants to remain in the groundwater and possibly migrate to impact additional wells? Is it most cost-effective to simply treat the water if and when we want to drink it? Do we have the luxury to be able to sacrifice certain areas of an aquifer?

Determining the answers to these questions may be a lengthy and costly process. Plumes of groundwater contaminants have been compared to the plumes emanating from smoke stacks. But, since the plumes move far underground, definition of their behavior requires extensive investigations. In Arizona, three Superfund projects are currently underway. The estimated costs of the remedial investigations and feasibility studies (RI/FS) range from $500 thousand to $1.3 million.

The objectives of the RI/FS are: 1) to identify pollution sources for cleanup and cost recovery; 2) define the extent and characteristics of the contaminant plume(s); and 3) to evaluate the alternatives for corrective action. To date, no major cleanup projects have been implemented in Arizona. The Air Force has developed a conceptual design for cleanup at the Hughes Aircraft facility in Tucson. The project would involve pumping the contaminated groundwater, treating it and reinjecting it back into the ground. The cost estimates exceed $10 million and the project duration ranges from ten to twenty years.

Ultimately, the solutions to groundwater contamination must be cost-effective but also take into consideration the protection of the public health and the availability of an adequate water supply. Although there are still many unknowns, it is hoped that through the ongoing remedial investigations and the implementation of remedial actions we will learn enough to achieve a well-balanced approach to correction.

H. Seraydarian

TCE IN THE SILICON VALLEY

What I would like to do is talk about what I refer to as not "silicone or silicon valley," but I call it the "South Bay" problem because I'd rather not criticize any group. It is a geographic problem just as are the problems in Arizona. My first direct involvement with the problem occurred less than two months ago. I was invited to a public meeting on the evening of July 3rd by a group called the Toxics Coalition. There are a lot of groups in California; there's the Toxics Alliance, the Toxics Coalition, Citizens for Better Environment that are all over the place. Generally, they're fairly effective. This one consists of not only environmental groups but some labor groups, too, and they're concerned about groundwater contamination and worker exposure in the South Bay area.

The format for the meeting was somewhat different than the ones I normally attend. They had myself and two Congressmen; they had about an hour and a half time where people made presentations about their concerns. Then they had a list of demands. I learned a number of things. The most difficult thing in that type of forum is to say "no." But I got pretty good at it and I did have the opportunity to say "yes" to a few things and one of those general "yeses" was that EPA would get more involved in Silicon Valley (for a number of reasons we had not been involved historically). The only thing that exceeds the number of associations in California is the number of state and regional agencies they may or may not be involved in these types of environmental problems. Once we did agree to get involved on July 3rd, we did our own assessment of the problem. We had been invited to return within 45 days to speak to the community again. They compromised a little on the

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format, but not that much. Originally they said we'd have some time to present our view of the problem. They limited that to 15 minutes.

The Southern Bay area is a lovely area of California. San Francisco is to the north. What we have is a groundwater problem, but fortunately groundwater is not the sole source of water supply. We do have areas that use only groundwater but in most cases groundwater is mixed with surface water; there are critical recharge zones. The groundwater basin (shown in slides) has been managed for years, basically for the same reasons that you had early water management in Arizona--you were worried about the supply. When it was overused (they started to see some signs years ago), they then created a district to worry about groundwater management. What we tried to do was provide a broad view of the problem and its complexity by looking at the number of different groups that dealt with water supply.

It turns out there are a number of municipalities or water purveyors who handle water in the South Bay. We tried to analyze the relationship between surface water and groundwater use, and, in most cases, there was some mixture. In some areas it was 100 percent surface water use. However most people perceived they were drinking contaminated water when that was far from the case. In fact, a poll done in the South Bay found that 75 percent of the people believed they were drinking contaminated groundwater.

The major water supply wells exist all over the South Bay, and the deeper ones are further north. In the South Bay the aquifer is less confined, so it may be more problematic, but you can see that there are a number of wells that draw on and force the groundwater. Generally they have taken the same approach there that is taken in Arizona--if you identify a contaminated well, you shut it down and you use another one. Therefore, the situation is not absolutely critical. What does complicate the situation is the fact that there are a number of small community and noncommunity wells. There are some elaborate state definitions for a small well, but, basically, its collection is less than 200 gallons per minute. There are also a number of private wells: to date we do not have a good handle on those locations. We have identified the contaminated wells in the area and there are not that many to date, but, some of them are major water supply wells.

The first ones were identified in the South Bay. IBM first identified a problem on the east coast as part of a nationwide survey, identified a problem in the South Bay, and immediately took action. Likewise, Fairchild undertook some major efforts to identify problems on their site. Those early hazard identifications in 1980 and 1981 resulted in some action by one of the regional agencies that I'll describe later. But what has caused the most concern lately is the contamination of private wells (as was mentioned earlier, we are getting more and more sophisticated in our analytical identification techniques). In Mountain View recently they identified 35 private wells that were contaminated. These were shut off. Bottled water was provided immediately. There was a dramatic call for

"Superfunds," but the industry responsible decided to pay for the bottled water and for the connections to an alternative water supply.

Since EPA agreed to get involved in South Bay, one of the first things to be done was to assess some of the sites that we knew about. We have identified a number of sites that we feel are significant enough to rank as "Superfund" sites. Our approach is a regional one. It is similar to that of Arizona where we know of some contaminant sources but we don't know about all the sources, so the problem is looked at regionally. What complicates the situation in South Bay is the fact that, historically, before it was a high tech concentration, it was basically agricultural land and there are a number of agriculture wells both in the shallow and the deep aquifer. What remains as a concern now is the fact that they can act as conduits between a contaminated shallow aquifer and the deep aquifer. One of the agencies has just committed to undertake a program to seal those wells. Unfortunately, they don't have good information on where they all are located and that is a major complicating factor in the South Bay. It will be essential to deal with those interconnections to solve the long-term problem and protect the very valuable deep groundwater aquifer.

What we recognized was that there was a key regional agency that had undertaken a massive effort to deal with the problem. When they first became aware of the problems in 1981, they undertook a regional survey and in 1982 they mailed questionnaires to all the likely industries focusing on leaking underground storage tanks. If you go back into the history of South Bay and the move toward underground tanks, the regional fire departments and environmentalists were influential in developing policies for burying storage tanks. In the long-term, it resulted in problems for groundwater quality. The agency sent questionnaires to over 2,000 facilities. There was a very good response rate (about 70 percent sent back the necessary information). Based on the survey, they identified close to 400 facilities with a number of tanks that potentially could result in problems. Using some discretion, they decided to require further investigation of those facilities that handled more than one percent solvent in those tanks, either as product or waste. Subsequently, they required 96 facilities to undertake some subsurface investigation. Of those 96, it turned out that 75 facilities did have soil and groundwater contamination from the tanks.

Recent discussions with industry indicate that it wasn't always a leaking tank that caused subsurface contamination. They, in fact, found total integrity in some of the tanks. Some of the practices that the facility undertook just in the use of the tank were problematic. The numbers are very confusing in the South Bay because people confuse the leaking tanks with some other sources of contamination, and, to date, there has been very little effort to compile this information so the public has a clear understanding of the problem.

EPA is now trying to facilitate coordinating a number of state and regional agencies. Without naming them all, let me just point out some

California history. The railroad once ran the state at the turn of the century. When they decided on their organizational structure the idea was that no one agency would ever have a monopoly power. Groundwater quality is the responsibility of the Regional Water Quality Control Board, two agencies in the Department of Health Services, the Santa Clara Valley Water District, the County Health Department (which has independent authority), and the City Manager's Association. These organizations have been incorporated into a task force that was just recently organized. The objectives is to coordinate the efforts of the agencies that are concerned with dealing with the pollution sources, and those agencies that are concerned with dealing with water supply. It turned out though that while they were trying to coordinate, they were not always communicating effectively.

We also have what I think is a very positive situation with industry. They were aggressive on some very specific sites and, in general, they are concerned about the problem. They've put some effort into the regional problem, and they were directly involved in helping develop a local hazardous materials ordinance which, hopefully, will do something to prevent future problems.

What I want to talk about is a preventive program and some California initiatives. Now, I know most people from Arizona don't like to hear things about California. I felt the same way before I got there and, honestly, California is long on legislation and initiatives, but sometimes they're a little short on implementation. If I compare relative problems in relative effectiveness I feel that in many cases Arizona is much more effective. What they did locally was develop an ordinance that dealt with leaking underground storage tanks. This requires an inventory permit by local agencies and double containment or leak detection. Every city in that county except one that has no industry has adopted the ordinance. Jumping on the bandwagon, the state has also passed two bills regulating tanks at the state level. That is appropriate because this problem may be even bigger in Los Angeles than it is in South Bay. The same regulatory approach was used for underground tanks: the two state bills deal with an inventory, with standards and permits for facilities; they require inspections and monitoring and they will probably result in additional contaminated sites being identified. I'm assured that at least with more tanks there's going to be more protection involved, but I don't know if that will deal with the management practices which has resulted in problems.

In addition to the California initiatives, there will be some federal initiatives such as "LUST"--the regulation of leaking underground storage tanks. I would have preferred that they called it "MUST" (managing underground storage tanks). Right now there's a provision attached to the Superfund Bill and there's one attached to the Safe Drinking Water Act to deal with leaking underground tanks. So I assume there will be a federal program soon. If these programs are consolidated, there will probably be an inventory requirement for inspections,

standards for both existing and new tanks, requirements for financial assurances if the tank leaks, response money set aside for EPA or a state agency (if it turns out there are problems) and there will probably be requirements for proper closure and corrective action if a problem is identified. At the national level, there will be greater efforts made to deal with problems with underground tanks which relate to the high tech industry. Tanks are used both for products and for waste streams.

SECTION VI

PUBLIC INVOLVEMENT AND CONFLICT RESOLUTION IN TECHNOLOGICAL AND ENVIRONMENTAL DISPUTES

S. Lofgren and *D. Pijawka*

INTRODUCTION

The various speakers of the Conference gave participants insight as to:

- . . what was meant by high tech, its trends in Arizona, and the incentives or advantages that Arizona has to attract the industry;
- . . the magnitude and nature of environmental problems in the high tech industry;
- . . how these problems are prevented or managed by regulatory agencies and by the industries themselves; and,
- . . what can be learned from other places such as the Silicon Valley as Arizona moves towards becoming the Silicon Desert.

The presentations in this section address the role of the public in resolving environmental problems rooted in technology.

- . . What type of informational and educational programs are most effective in helping public understanding of risk?
- . . In what ways and to what degree does public perception of risk differ from those of regulatory officials or scientists, as presented in the previous day's discussions?
- . . How does the media influence risk perception and what role has the media played in technological disasters?

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DAVID PIJAWKA was Vice Chairman of the Conference and is with Arizona State University.

- How can environmental problems be resolved when they are often based on value differences and inherent distrust of regulatory authorities?
- How can the public be involved in the decisionmaking process in an environment replete with scientific uncertainties and confusion over risk assessment?

B. Cuthbertson

THE MEDIA AND TECHNOLOGICAL HAZARD

In natural disasters, such as hurricanes and earthquakes, the media are routinely used as a source of information about impending disasters, the disaster event and its aftermath, the progress of recovery efforts, and disaster prevention measures. Given the consensual definitions that usually develop about the nature of natural disaster agents, their consequences, and what to do about them, the use of the media for these purposes seems appropriate and beneficial.

But what about technological disasters? The media cannot warn individuals about a disastrous event that has already occurred neither can it monitor the recovery progress of individuals who may not suffer ill effects for twenty to thirty years. Furthermore, it cannot serve as a definitive source of information on a disaster agent--is it hazardous or not--the circumstances under which health effects might occur, what is appropriate to do about the situation, and who is responsible for the crisis. These are matters of variable definition, even among scientific experts.

How have the media generally made sense of and presented variably defined technological disasters? And how have individuals, not being able to turn to the media for definitive information on the disaster agent and its consequences, interacted with the media? It is my intention in this presentation to provide a descriptive understanding of the routine practices through which the media and other technological disaster participants interactively adapted to two variably defined disasters.
I will use examples from two case studies--the Globe asbestos and the Scottsdale pesticide issues. The Globe asbestos problem emerged in November 1979 when the Arizona Department of Health Services officials

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inadvertently discovered inordinate amounts of asbestos in the sewage system of a mobile home subdivision constructed on the site of an abandoned asbestos mill and directly adjacent to three other mills (one operative) and two asbestos tailing piles. The Scottsdale pesticide situation developed in the late summer of 1978 when residents living next to federal Indian lands leased to nonIndian cotton growers began complaining that heavy applications of agricultural pesticides on cotton crops were adversely affecting their health. In both issues, differing definitions developed concerning the nature and health consequences of the disaster agent.

The Media

The media, in this case primarily the metropolitan and local newspapers covering the two issues, reported the pesticide and asbestos issues through dramatically presented victim/villain scenarios. These scenarios emerged through the media's use of thematic emphases and format.

Thematic Emphases. Usually based upon a medium's view of its role in reporting the news, thematic emphases provide a general focal point from which the media understand a technological disaster and supply the underlying rationale for what to report. In the case of agricultural pesticides, for example, the metropolitan newspaper developed a thematic emphasis following in the tradition of investigative reporting in which a newspaper informs society about instances in which officials may have been derelict in their duties to protect the public. Accordingly, the metropolitan newspaper presented the pesticide situation from the standpoint that state regulatory agencies did not have proper control over the use of pesticides because they were dominated by powerful agricultural interests concerned with profit, not public health.

Interpreting and presenting technological disasters through specific themes directs article content in certain directions rather than others. For instance, in the pesticide case, the content of metropolitan newspaper articles generally focused on indications of vested interests, such as alleged links between agribusiness representatives and state regulatory officials, agribusiness interest in profit, and purported instances of agribusiness representatives engaging in bribery, lying, and irresponsible behavior. Content was also directed at any accountability among state regulatory officials. The metropolitan newspaper's thematic emphasis therefore indicted a specific villain, the agribusiness community, and blamed a specific derelict protector, the state's pesticide regulatory agency.

Thematic emphases, especially those that have identified a villain and derelict protector, may also involve the media in supporting the true victimization of individuals exposed to the disaster agent. This is usually done through providing numerous accounts of the individuals' symptoms and/or any indications of the disaster agent being authentically hazardous. When the technological disaster involves individuals with no

physiological symptoms or for whom disastrous health effects may occur only at some future date (as in the asbestos issue), the media support true victimization through individuals' emotional accounts, such as stress, fear, and anger over possible health consequences. They may also include descriptions of the ill effects suffered by individuals who had been exposed to the disaster agent in other locales, for example, ship builders who at one time had worked with asbestos.

Format. Format, consisting of how material is organized and presented, also has an important influence on the reporting of environmental problems. For example, in accordance with journalistic ideals of objectivity, newspapers usually attempt to present "both sides" of an issue. Reporting both sides in variably defined problem areas, especially in conjunction with thematic emphases, generally results in material being organized and presented in an "us vs. them" adversary format. In both the asbestos and pesticide situations, the format was public health vs. economic livelihood, resulting in statements on the nature and consequences of the disaster agent--expert, official, and unofficial--being presented in a point/counterpoint, recontextualized fashion. For example, a focus on presenting opposing sides to the question of whether or not a real health hazard existed recontextualized the pesticide problem into an odor problem or a health problem, an allergy problem or a physiological problem, a labeling problem or an application problem, and the possibility that individuals would view the problem as multifaceted, involving all of the above aspects, was diminished.

Media emphasis on objectivity and reporting the "facts" also relates to the practice of event-centered reporting, which centers on theme-related occurrences and often overshadows the complexities of issues. For example, the media in the pesticide issue covered health studies as they were being carried out and monitored study results for proof that a hazard existed. Through thematic emphases, however, inconclusive or contradictory study results were attributed more to agency incompetency or possible deception than to the difficulties involved in obtaining valid information on technological disaster agents. A focus on objectivity and factual reporting can also promote the use of numerous statistics and official quotes, giving a semblance of veracity to issues that are often not definitive.

The dramatic, sometimes sensationalistic format that reports on technological disasters exhibit is influenced not only by media format and thematic emphases but also by the media's status as a competitive business enterprise concerned with making reports interesting and entertaining. It also emerges in relationship to media representatives' beliefs that dramatic presentations will increase public awareness of a possible hazard and encourage public outrage over perceived injustice. An example of dramatic media format is the September 1982 metropolitan newspaper series on "Asbestos: The deadly dust," graphically illustrated with a skull and crossbones. One preview of the series stated that the newspaper would take readers into the "lethal world of asbestos"

(*Arizona Republic*, September 4, 1982, CL-42); another preview was labeled "Asbestos: Danger and death in the air and everywhere (*Arizona Republic*, September 11, 1982, G-6). In a dramatic, true victimization perspective, mortality, not immunity, is the order of the day.

Interaction with the Media

That the issues were reported through particular thematic emphases and a dramatic, adversary format, had important implications for how the various individuals involved in the issues were able to interact with and use the media. The expedite an understanding of media/public interaction plus the emergence of controversy over true victimization, the major participants involved in the two issues have been assigned to victim categories.

Primary Victims

Primary victims are those individuals who live within a technological disaster site or within a designated disaster zone around the site. Two general types of primary victims emerged--hazard-endangered and hazard-denial victims.

Hazard-Endangered Victims. Hazard-endangered victims generally consider the disaster agent a definitive threat and are concerned and anxious over their own and their family's welfare. Not being able to obtain definitive information on the health consequences of the disaster agent from the media or elsewhere and often frustrated by officials they perceive as unresponsive to their plight, hazard-endangered victims turn to certain media as their only means of establishing a feeling of control over their situation. To hazard-endangered victims, the media become a resource for calling attention to and getting something done about their problem. To claim media attention, however, hazard-endangered victims must stress their victimization. The the pesticide case, this meant focusing on their illness experiences and the hazardous nature of pesticides; in the asbestos case, this meant emphasizing negative emotions and future calamitous health effects. In a sense, hazard-endangered victims had to stress the most adverse aspects and possibilities of their situation in order to optimize their position.

Hazard-Denial Victims. Hazard-denial victims may live in the same situation defined by hazard-endangered victims as threatening, but they do not view the disaster agent as dangerous or they consider themselves invulnerable to any ill effects. Hazard-denial victims often feel they are the true victims in the disaster situation, and one of the ways they feel victimized is by the media. They feel that the media's sensationalized reporting has ruined their property values and given their community a bad image. Also, because their perceptions of the situation do not fit media emphases and format (they don't demonstrate victimization by the

disaster agent), they feel left out, not able to have their side of the story presented by the press.

Controversy develops between hazard-endangered and hazard-denial victims over the issue of media attention. Hazard-denial victims are relieved when media attention dies down; hazard-endangered victims are disappointed. Hazard-denial victims begin to view hazard-endangered victims' demonstrations of victimization as "phony" or "opportunistic" quests for media coverage; hazard-endangered victims consider hazard-denial victims' belief about the disaster agent and the media hurtful to their cause.

Secondary Victims

Secondary victims are those individuals who see themselves as victims of the public acknowledgement of a disaster. Whether they are alleged perpetrators of the technological disaster, officials, or simply members of the general community in which the disaster site is located, they feel they are involuntarily suffering adverse consequences as a result of media portrayals of the disaster.

Perpetrator Victims. Perpetrator victims, exemplified by agribusiness representatives in the pesticide case and asbestos industry members in the asbestos case, are those individuals and groups allegedly responsible for "committing the crime," for instance, negligently disposing of toxic wastes or violating pollution standards. They experience considerable distress over being portrayed by the media as villains and over being accused of intentionally endangering human health for a profit. From their standpoint, the disaster agent is a beneficial product they have used for many years with no ill effects. They do not believe or feel it is hazardous; accordingly, dramatic media presentations of the hazardous nature of the disaster agent and its ill effects seem particularly ludicrous and nonsensical.

Perpetrator victims generally deal with the disaster situation and their portrayal as villains by routinely using statements like "The media blew it all out of proportion," "It is a media problem," or "The media overdid it to scare people and make news." From their perspective, these statements are not excuses or rationalizations; they are legitimate responses that serve, along with accompanying anger, as public disclaimers of their media-labeled villainy. Statements critical of the media also provide perpetrator victims with a rallying point for joining with other perpetrator victims to obtain access to the media for their side of the story or to secure proof that the disaster agent is definitively nonhazardous.

Controversy develops between perpetrator victims and the officials or environmentalists they see as opportunistic and overzealous and as using the media to stir up an unnecessary crisis. Controversy also develops between hazard-endangered and perpetrator victims; hazard-endangered victims become resentful of being labeled irrational,

inauthentic victims, and perpetrator victims become resentful of being labeled profit-minded, uncaring villains. Activities on both sides are directed toward acquiring proof for their side of the story and obtaining media access.

Bystander Victims. Bystander victims are community members who feel their community has been unjustly stigmatized by the media's portrayal of the technological disaster in the public arena. For example, residents of the local community in the asbestos situation felt embarrassed by metropolitan and national media presentations and angry at the effects of negative publicity on the community's welfare. Community members' anger and embarrassment were not focused on ameliorating the hazardous situation or supporting hazard-endangered victims; they were channeled into efforts to clear the community's name. These efforts included signing petitions that were presented to the Governor asking for a public declaration of the city's safety and supporting a local study legitimating the nonhazardous consequences of local asbestos.

Continued Interaction

As the technological disasters emerged, controversy itself became a resource for media presentations. Through thematic emphases and format, media attention dramatically focused on opposing sides. For example, in the pesticide situation angry homeowners were presented on one side and the agribusiness community on the other. Disagreement between the two sides was described in adversary terms like "battle," "foes," conflict," and "fight." By mid-November 1978, the metropolitan newspaper reported that the "crop-dusting furor" had intensified to a point "where fuming homeowners are battling farmers and fliers over chemicals and aerial spraying methods" (*Arizona Republic*, November 16, 1978, p. B-1). And, one year after the emergence of the issue, the metropolitan newspaper carried a series of four articles on the issue captioned "Pesticide Battle Growing in Scottsdale" and illustrated the series with a graphic drawing depicting a fist raised against a spraying airplane (*Arizona Republic*, September 2, 1979, p. A-1).

Conclusion

In two particularly complex and ambiguous technological disasters, routine media practices in organizing and presenting the situations and other participants' practices in relationship to the media exacerbated any initial disagreement over the nature and health consequences of the disaster agents.

Together, the media and other technological disaster participants created controversy with the following agenda: a cognitive agenda focusing on the issues of true victimization, blame, and the role and use of the media; an emotional agenda of anger, irritation, aggravation, frustration, and resentment; and a behavioral agenda directed at proving the

correctness of particular viewpoints on the nature and health consequences of the disaster agent and/or getting specific sides presented in the media.

Positions became entrenched, and open, nondefensive communication was virtually nonexistent. Participants, official and unofficial, did not develop the generally shared perspectives and cooperative task-sharing necessary to respond effectively to the disaster situation, explore conditions leading to their occurrence, and design strategies preventing future, similar situations.

The issues were prolonged--the pesticide issue, four years, the asbestos issue five years--and not completely resolved; neighborhood and community solidarity was disrupted; and few beneficial structural changes were made.

In a highly technological society complex technological disasters like the pesticide and asbestos situations, will continue to occur. At the same time, a majority of people will depend upon the media to keep them informed of possible health threats and the issues that develop around them. It is therefore imperative that the media reflect upon the emphases and format they utilize to interpret and present technological disasters and consider whether practices suitable for reporting other types of issues are relevant for present-day technological disasters. By engaging in self-reflection, the media may find that utilizing victim/villain themes and an adversary format does not encourage the public's understanding of complex environmental problems or facilitate constructive social action to remediate and prevent those problems.

It is also imperative that other technological disaster participants reflect on media presentations and their interaction with those presentations. They should consider whether they have come to take for granted and expect news on disaster situations to be presented in a dramatic, adversary manner. More importantly, they should examine how they have come to interact with and use media presentations and the implications that follow.

ENVIRONMENTAL DISPUTE RESOLUTION

Handling conflict and solving problems is always a challenge. We know this from evidence in our personal lives: different interests, different values, preconceptions, misconceptions, misinformation, no information. It is much worse when we're dealing with issues surrounding high tech. We're dealing with toxics which few can pronounce, much less understand, and with complex situations, with technical answers that are unavailable or contradictory, and with the byproducts of all this: fear and irrational reactions.

The siting of the hazardous waste facility in Mobile, Arizona gives us a good example. The local people were hostile to the idea. They hadn't been involved in planning and rumors were rampant. There were many legitimate issues that needed resolution such as transportation corridors and flood protection. But human concerns, though not always rational, dominated the meeting. A little lady with a brown beret pulled down to her ears got up and said she was dead-set against the facility because her pigs would get radiated. She had lost her faith to believe what the government would tell her.

Problem solving is difficult. The deck seems stacked against making important decisions. Thus far we have not been very successful in siting facilities or in resolving how hazardous waste should be handled and disposed of. But if we look at how we go about making decisions, we can see that there is room for a great deal of improvement.

We often rely on a bureaucratic process with rules and regulations that always seem either too weak or too strong, inappropriate or impossible to implement when applied to a given situation. Because of this, good working relationships are hard to come by.

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Public participation often consists of a public hearing where conflicting positions are presented. There is no interchange of ideas, interests have been further polarized, and the decisionmaker is left to come up with a plan that will likely make everyone mad. This often leads to another modern decisionmaking tool: the lawsuit. Former IBM Chairman Frank Cary is said to have remarked, "My lawyers have an unlimited budget, and every year they exceed it." It's a way of life. There are instances when litigation cannot be avoided, but an atmosphere for cooperation in the future is often lost in the process.

It is fairly obvious that some new approaches are needed. Many are being tried, often on a local basis, that are yielding results. One in particular might be called the common sense approach. It is more formally referred to as "natural resource conflict resolution" and is being practiced by a handful of firms scattered across the states. Often, it is done on a more informal basis, but not often enough. The key is to bring all the interests together, to open lines of honest communication where the real issues can be discussed and where the participants can work together towards an acceptable, if not optimum, solution.

This is not as easy as it sounds. We all know of instances when a task force or advisory group is formed, or a public participation process is initiated, and ends up being just as frustrating and nonproductive as the other avenues mentioned. The process can vary, but certain key elements must be incorporated if there is to be a likelihood of success.[1]

What are these elements? Let's talk about them for a few minutes and then look at a couple of examples that will bring them into focus.

1. <u>To Find a Good Solution, You Have to Understand the Problem</u>.

   This seems obvious, but often we don't really assess a situation thoroughly before jumping to conclusions. You need to define the parameters of the problem. Do your homework. Like a good reporter, ask who? what? where? when? and why? Only after a well-researched assessment should the various interests be approached to participate in the problem-solving process.

2. <u>Establishing Communication Based on Respect and Trust is Essential to the Process</u>.

   When a group has been brought together, you need to set the ground rules based on mutual respect. Make them understand that differences on issues are expected and healthy, and that personal attacks are not. There needs to be an understanding that human relationships are as important as technical data. A little social time certainly doesn't hurt.

3. Planning a Process Where the Real Issues, Rather Than the Participant's Positions, Are Discussed Leads to Better Solutions.

   This is the prime point. With the group, you must develop a method for breaking off fighting over their established positions and, instead, identify what they need from a solution.

4. Lack of Information and Failure to Agree on the Validity of Available Information Encourages Conflict.

   This also is a crucial point. Often each interest has its own set of facts. This is where technical groups may be called in to assess data or provide new information necessary for decisions. It is often a time-consuming phase.

5. Ownership in the Process Leads to Problem Solving.

   Group members should be involved every step of the way and confer with their constituencies as progress is made. This includes formulating alternatives and recommendations. The results coming from a group process have much more validity with the various interests than any decision decreed from above, even though it might well be the very same plan.

Another factor not listed as a key element but which is important concerns who is facilitating the process. We need trained personnel in the agencies and within industry, as well as the rest of the private sector.

Two quite different examples that demonstrate the successful application of these principles follow. The first is the Denver Metropolitan Water Roundtable which was set up to address the problem of supplying water to the growing Denver area from the western slope. An intense dispute and the subject of costly litigation, this particular case was facilitated by a natural resource conflict resolution firm called ACCORD. ACCORD has a long history of this kind of mediation in Colorado.

They began with a three-month period of dispute analysis. What were the key issues? Who were all the interests involved? After painstaking research, 30 east and west slope government and water interests, environmental, agricultural and neighborhood representatives were selected for the roundtable, chaired by the Governor. They were policymakers rather than technicians. Extremists were avoided. The group set up the groundrules--for instance, no media at the meetings, no substitutes, no personal attacks.

ACCORD's next task was to develop a method to eliminate fighting over established positions and, instead, to define what each side needed from a solution. They decided to set up four balanced groups. Each

group developed a list of needs and interests which were then discussed and combined into one comprehensive list. This provided a laundry list of criteria by which to judge any suggested solution. They next worked towards a set of agreements in principle--a consensus process--including ideas such as "Denver does truly face a water shortage," and "Conservation must be included in any plan." Sounds a bit like motherhood, but the discovery of how much the participants actually agree is important.

At this point, they analyzed available data and set up technical committees to fill in the gaps. The next stage was the development of different proposals and included several intense (and tense) negotiating sessions. Because of the background work, an acceptable plan finally emerged. The blueprint is complete, but the job of implementing will be tough. Communication will have to continue or the harmony will rapidly evaporate.

This was a broad-brush summation of a process that took several years and was very complex, but it points out the importance of key elements.

The second example is in a completely different vein. It is one group's answer to frustrations with Superfund and the slow progress being made cleaning up hazardous waste sites. The group is called Clean Sites, Inc., and was spearheaded by the Conservation Foundation, an organization keenly interested in dispute resolution. The Board is chaired by Russell Train and is a mix of industrial, environmental and educational leaders. The purpose of Clean Sites, Inc. is to clean up waste sites. It is not intended to supplant the Superfund activities, but to complement them. Their goal includes 20 sites this year and 60 each succeeding year. There is not time to go into detail, but it's a unique and interesting project. Several items that are relevant will be highlighted here.

First, they, too, did their homework before deciding on how to proceed. Clean Sites, Inc. discovered that the key problems were not the same as they had anticipated. For instance, the accepted notion had been that Superfund would run into bottlenecks because of the lack of trained manpower, equipment and technical skills. In fact, it was the managerial skills intended to interact with the many constituencies--affected citizens, levels of government, other private parties, and so forth--that was delaying cleanup.

This discovery, combined with their other findings, influenced how Clean Sites, Inc. set up their organization. They decided on three operating divisions, each with its own advisory board of experts. One is a coalescing/dispute resolution group. The second is a group to evaluate the technical and scientific adequacy of the cleanup, and the third to oversee cleanups.

The first group is responsible for convening the appropriate parties for a particular problem site, for negotiating financial arrangements, and working with the many local interests on a case-by-case basis. Clean

Sites, Inc. thinks this will provide the framework for success. Their procedures follow the above principles.

Arizona is ready for this type of problem solving. We have sat down together and hammered out consensus plans. The Arizona strip legislation process, the development of our Groundwater Management Act, the process that led to Plan 6 as an alternative to Orme Dam all made use of some of the principles mentioned in this presentation.

By bringing together diverse interests in the hope that discussion will lead to some consensus, to some common ground, we are making a real contribution. We need a more structured conflict resolution process when specific problems have to be resolved. This is certainly worth some consideration.

FOOTNOTE

[1]Adapted from Carpenter, Susan, and W.J.D. Kennedy. (1984). Managing Conflict by Applying Common Sense. *Harvard Negotiation Journal* (in press).

SECTION VII

SUMMARY OF THE CONFERENCE

J. Dworkin

SUMMARY OF THE CONFERENCE

I'd like to begin first by congratulating the organizers and the facilitators of this conference, because I think that they did an outstanding job at helping to provide understanding about the boundaries of the problem of high tech and natural resources and what we are faced with in the future. What are the boundaries of this problem or issue of natural resources and high tech, keeping them compatible? First, we learned something about what high tech is or is not. The first thing I learned is that it probably is not either cattle, copper, cotton or citrus. High tech represents such technologies as aerospace and computers, producing semiconductors and software. Some may not want to call it high tech; some may prefer to call it advanced tech. Some of these high tech industries may be indigenous industries; some may be imported to the state. They may come to Arizona because they have escaped from California or they may come because they are attracted to Arizona. Some of the other things we've learned about the high tech industry is that it's growing, although we are not sure about the rate of growth. High teck industries will come to Arizona in one shape, fashion or form. They will certainly solve some problems: they will provide jobs for those people coming to Arizona. These industries will use resources: they will use our air and water, they will use our land, and they will, in the future, use our new hazardous waste site. However, in the process of using these resources and the process of providing benefits to the State of Arizona, they will have impacts on the environment.

The other important thing we've learned is that the impacts may have advantages and be positive impacts to the environment. There may

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also be adverse impacts, but they are certainly not predetermined. We will have some say into what those impacts are or can be and their magnitude.

What did we learn about the environment or about natural resources? We talked about natural resources and the environment in three different settings or ways. First, we talked about the environment in terms of the past. That is, what industrial behavior did or did not do in the past, not only in terms of what high tech did with the use of their environment, but also what medium technology or low technology or perhaps agriculture or some other sector of the economy did, in terms of producing environmental degradation, urban sprawl, air pollution and water pollution. We also learned something about the enormous costs in cleaning those past problems. That process, though, of making those mistakes in the past, has led to some beneficial affects. That process has led to increased environmental awareness knowledge.

Those past mistakes have been a laboratory for learning experiences. They've taught us some things about how to clean up contamination, what works, what doesn't work, and in regulation. But, of course, we've also been told "You ain't seen nothin' yet!" We may not be dealing in teacups of units of pollution; we'll be dealing in eyedroppers or I guess "misters" of contaminated substances. These may be deadly toxic. We have to keep those lessons learned about the past with some degree of skepticism on how useful they will be in the future.

We've learned other lessons in addition to the scientific and technological lessons--lessons that may in fact serve us for a longer period of time. We've learned lessons about communications; that we need to keep communications open, that government and industry and the public must continue to talk to each other. We've learned that values are involved in decisionmaking. Values are involved at really every stage of the process. We've become more sophisticated in learning about how decisionmaking takes place and what the role of the public and other stake holders or interest groups are.

The second way we've talked about the environment is in terms of site selection. What are the requirements of an industry deciding to move to Arizona? What resources should we use in attracting high tech industry to Arizona, both in terms of physical resources (land, water, air) and in terms of the institutional infrastructure? How cooperative are government agencies? How easy is it to go through the permitting process? What kinds of transportation infrastructure is available or will be put into place in the future? What kinds of research and educational facilities are available? The latter factors are as, if not more critical, than the former.

Finally, the area of the environment which we focused on most was the environmental impacts of high tech in the future? And, I want to emphasize again that these impacts are not predetermined, that we all--industry, government, the public--have a role in determining the

form and seriousness of these impacts. Perhaps the easiest answer, when I looked at the question: natural resources and high tech--keeping them compatible, would be to attract firms, and only firms like IBM which are anxious, willing and able, have the money and resources to protect environmental quality and to cooperate with agencies and the public. But Arizona will not only be attracting firms like IBM--the problems of the past will not be the problems of the future. There is rapid technological change in the industry, the chemicals that are used will change, the scientific information changes. Some firms will not be as anxious, willing or able to be at the forefront of protecting the environment as they produce their products. Therefore, we will need and continue to need active public involvement and active public agencies to be involved in protecting the now well-established public value for a quality environment. This will mean establishing new standards and controls as is occurring in Arizona. It may mean in some cases, and I would hope, limited amounts of litigation. It will hopefully mean other approaches and incentives, packages which will use the carrot rather than the stick. It will certainly mean that the new strategies of risk assessment and risk management will continue to be a part of that process. It also will mean, hopefully, that there will be new strategies and approaches to identify risks that may not even be out there in the present, but will be out there in the future. This will require increasing scientific staffing of public agencies and approaches that will produce effective monitoring programs that will be able to identify problems as they arise or prevent problems from emerging.

Lastly, at any conference of this size and nature and complexity, there were, of course, points of disagreement. We certainly don't want to mislead the Governor into thinking that we all entirely agree about everything that was said here in the last day or so. I will briefly point out some of the points of disagreement in no particular order of importance.

First, how do and should values be used and processed in the decisionmaking process? Are values at all used in risk assessment? Do values only take a role in risk management, or in implementation? These were issues which were raised by numbers of the speakers and about which there seems some disagreement.

Secondly, whether and under what conditions will the public be willing to accept that a particular strategy adopted or a particular solution to the problem will, in fact, produce a one-in-a-million excess of cancer deaths or incidents of disease. There was certain disagreement about whether or not that's possible in any public participation program or whether that's a useful thing to encourage.

Thirdly, how slowly or quickly should we proceed in proposing and, particularly, adopting solutions in the face of scientific uncertainty, changing or evolving institutions, and changing technologies.

Finally, to what extent should solutions be national, state-wide, or site-specific? Although we have disagreed, at least on these points and

certainly many others, the most important lesson that it seems to me we have learned is that we can work together, learn from each other, talk, socialize, eat and still walk away and have credibility and respect for one another.