RESEARCH PROBLEM AREAS
HAZARDOUS WASTE RESTORATION

BACKGROUND

As part of an effort to develop a Research and Development Strategy for the Colorado Center for Environmental Management, the Task Force members developed the following unprioritized list of problem areas addressing hazardous waste issues that warrant research and innovative technology development. Several resources were utilized in identifying these areas of unsolved problems in hazardous waste restoration. Along with the experience and knowledge of the members, reports such as "Colorado Environment 2000" by the Colorado Health Department, the EPA studies "Setting Environmental Priorities for Metro Denver and Unfinished Business: a Comparative Assessment of Environmental Problems" along with the September 1990 follow-up assessment by the Science Advisory Board, and several documents listing hazardous waste research needs were reviewed. The first two of these reports reflect input from public groups, education, industry and governmental groups.

ACID MINE DRAINAGE

Acid mine drainage is a serious problem related to many of the mining areas in Colorado. The waters are very acidic, and heavy metal contents are far in excess of standards for human health and aquatic needs.

The source of these contaminated waters is the extensive underground workings in sulfide ores, and the waste rock and mill tailings produced during the mining operations. Ground and surface waters in contact with the underground waters and surface deposits become acidic and dissolve large amounts of the natural heavy metals in the rocks. These contaminated waters then enter surface streams in much of the mountainous areas in Colorado. Estimates are that 1,300 miles of mountain streams and rivers are impacted by acid mine drainage.

The challenge in Colorado (and other states with similar problems) is to find ways to reduce the amount of loading of these metals to the streams and thus increase the quality and use of the ground and surface waters. Creative methods of treatment that do not produce large amounts of heavy metal laden sludge which require disposal are most desirable to address this problem. Where sludge is created, treatment and disposal techniques maximizing benefits while minimizing adverse impacts, must be developed.

MONITORING

Environmental protection and clean-up activities are seriously compromised at the very first stages of the effort. The lack of accurate, reproducible, speedy, and cost effective methods and analytical tools to characterize and monitor contamination requires extensive research to further develop:

- Analytical methods that can effectively characterize contaminants on complex soil, air and water matrices including mixed hazardous and radioactive waste.
- Monitoring techniques that provide real-time and in-situ physical, chemical, biological, hydrological, geological data to characterize and monitor remediation effectiveness and progress as well as supporting fate transport and exposure models.

- Statistical, surrogate identification, quality assurance, and modeling tools are needed that can assist in ensuring representativeness and cost effectiveness of monitoring systems.

REGULATORY PROCESS AND PUBLIC INVOLVEMENT

Environmental restoration and waste management activities are driven by the regulatory process. There is much evidence that untutored public opinion and not regulations prevent, or at best, slow down environmental cleanup. There is apprehension by the public in the regulatory process and its results. Research should be done to:

- Verify risk, rather than based on "perceived risk," by conducting research on health effects of long-term, low-level exposure(s) of multiple chemicals via multiple media and the impact of pollution on the environment.

- Verify that the Colorado and federal regulatory processes are addressing the high risk benefit areas.

- Define changes to the process to cause more emphasis on risk reduction.

- Search for ways to obtain more appropriate and meaningful participation of the general public in the decision process, such as including the regulated community in the development/implementation of environmental restoration and waste management regulations.

SOIL REMEDIATION

Contamination by various hazardous and radioactive materials in soil and sludges exists at many locations in Colorado. The contamination has resulted from a variety of operations including storage and evaporation ponds, liquid storage tanks, and the surface and subsurface disposal of liquid and solid waste. Because of the actual or potential migration of these substances, technologies are needed to characterize and remediate the contaminated soil in a manner which effectively protects the environment.

Three areas for soil remediation research are: (1) containment, (2) retrieval and treatment, and (3) in-situ treatment. Containment is viewed as a passive methodology for existing waste sites or sites containing treated wastes. Retrieval and treatment implies the removal of the contaminated material and treatment by chemical, biological, or physical methods to destroy or stabilize the contaminant against its movement in the environment. In-situ treatment, often the most preferred technology, is designed on a site specific basis and may include one or more chemical, biological, or physical technologies. Of importance in all these remediation research areas is research on effective, nonintrusive characterization that does not under or over state the contamination problem, and a regulatory framework that is user-friendly and allows relatively unambiguous decisions on "how clean is clean."

WASTE MINIMIZATION

Waste minimization is concerned with reducing process wastes of all kinds. These include hazardous and toxic materials from existing and conventional processing operations as well as developing new processing techniques and technology which result in minimizing these waste materials. Naturally, the preferred approach is to develop technology which creates minimum or no pollution in the first place. However, since this is an ideal approach there needs to be

technology developed for minimizing that which is already produced. Such technology involves concentrating and isolating hazardous and toxic materials, recycling waste components and products, removing toxic and hazardous materials from discard portions, lowering the level of toxicity to acceptable levels, developing the technology for these processes, and transferring this technology to industry.

Examples of waste minimization would include recovering valuable components from already discarded dumpsites, removing toxic components from discharge areas, and the development of safe handling procedures and technology for hazardous materials such as fibers, whiskers, particulates, carcinogens, poisons, etc., such that there will be a minimum of these materials released into waste streams. Since all industrial processes produce waste of some kind, all industries will play an important role in the minimization of wastes.

NON-POINT SOURCE DRAINAGE

Colorado water quality has been degraded by several pollution sources, most notably non-point or area sources (i.e., abandoned mines and agricultural runoff), individual septic systems in certain locations with poor soils particularly in mountainous counties, and urban runoff from rain and snow melting on city streets. These pollution sources are spread over large areas and are under the influence of many individuals which make them particularly difficult to control. Research done in Colorado on these problems will certainly be useful here as well as in other areas of the country.

GROUNDWATER

A major concern for environmental problems in the State of Colorado is the effects of contaminants in groundwater. The sources of contamination range from local sources such as underground storage tanks (USTs) to areawide sources such as farming operations with nitrate contamination and potentially pesticide /herbicide contamination.

There are several areas which require additional study to determine the corrective actions for the remediation of this type of environmental problem:

1. Source removal: Additional techniques are needed which will remove or isolate the source of the contamination. This corrective action can prevent further contamination while technology is developed to remediate the existing pollutants in the groundwater. This technique can be aided by the control of surface water infiltration through capping systems.

2. Barrier system: In some cases a barrier system will help to contain the contamination or prevent contamination from reaching a particular area of concern.

3. Pump and treat: A pump and treat system is utilized at some locations due to the type of contamination and the risk to the surrounding environment. This system pumps the groundwater, provides for treatment of the groundwater to remove the contamination, and then either discharges the groundwater back to the aquifer or discharges to a surface water. Extensive research is needed to identify appropriate treatment technologies including chemical, physical, and biological techniques.

In addition, areas that need research and development in conjunction with existing expertise in this area include the following:

1. Modeling of the groundwater system which allows for easier identification of contaminant pathways.

2. Factors and prediction techniques which affect contaminant transport. This would include hydrologic cycle, meteorologic effects, geohydrology, solubility and density effects of contaminants, and fate of pollutants which include degradation, equilibrium partitioning, hydrolysis and diffusion/dispersion effects.

3. Additional information needs to be developed to determine the correlation between the field and laboratory techniques. This would include methods for groundwater well installation, decision-making process for location of wells, and field sampling techniques.

4. The last area that should be investigated is the prediction of contaminant transport. A more reliable system needs to be in place which will allow better prediction of fate and transport of a combination of different contaminants.

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