IMPACT OF GROUNDWATER PROTECTION STANDARDS ON UMTRA PROJECT

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ABSTRACT

In September 1987, the U.S. Environmental Protection Agency (EPA) proposed health and environmental standards to correct and prevent groundwater contamination beneath and in the vicinity of the Uranium Mill Tailings Remedial Action (UMTRA) Project sites. The standards, which are consistent with the Resource Conservation and Recovery Act (RCRA), address final disposal, aquifer cleanup, and supplemental standards.

Complying with the proposed standards will result in significant impacts to the UMTRA Project in terms of cost. As a first step toward estimating the total project groundwater restoration costs, the conditions, requirements, and aquifer restoration costs at five sites were considered: Gunnison, Colorado; Riverton, Wyoming; Lakeview, Oregon; Tuba City, Arizona; and Falls City, Texas. For each site, preliminary groundwater restoration schemes were proposed and evaluated, and base costs were estimated in 1988 dollars.

To forecast total project costs, the five site-specific evaluations and their lowest cost estimates were extrapolated to the remaining 19 UMTRA Project sites. To estimate a total program cost based on the lowest site remedial action construction costs described above, the ratio of total program cost to the site remedial action costs for the current UMTRA Project was calculated.

On the basis of the preliminary analyses described above, if aquifer restoration were required at the 24 UMTRA Project sites, the total program cost may be in excess of $1 billion.

BACKGROUND

In 1981, the EPA pursuant to the Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978 (PL95-604) proposed draft standards for the disposal of uranium mill tailings from inactive processing sites. In March 1983, the EPA promulgated the final standards applicable to the UMTRA Project. In response to comments received on the 1981 proposed groundwater standards and in light of additional data and information, the EPA deleted its proposed numerical standards. Instead, the 1983 standards required site-specific analyses of potential contaminants discharge and an evaluation of the significance of such a discharge. Judgements of the need for aquifer protection and/or restoration were to be guided by the EPA's hazardous waste management system and relevant state and Federal water-quality criteria. Decisions on specific actions to protect or restore water quality were to be guided by such factors as the technical feasibility of improving the aquifer, the cost of applicable restorative or protective programs, the present and future value of the aquifer as a water source, the availability of alternative water supplies, and the degree to which human exposure would occur.

On September 3, 1985, the United States Tenth Circuit Court of Appeals set aside the EPA standards applicable to the protection of groundwater. The water protection standards was remanded for further consideration by the EPA in light of the Court's opinion that the 1983 water standards were site-specific rather than of general application as required by the legislation.

PROPOSED GROUNDWATER STANDARDS

In September 1987, in response to the Court's remand, the EPA proposed health and environmental standards to correct and prevent groundwater contamination beneath and in the vicinity of the UMTRA Project sites. The standards address final disposal, aquifer cleanup, and supplemental standards.

The disposal standard incorporates the following:

- RCRA list of hazardous constituents;
- RCRA concentration limits (maximum concentration limits (MCLs), background, or alternate concentration limits (ACLs));
- additional hazardous constituents and MCLs (for molybdenum, radium, gross alpha, uranium, and nitrate);
- RCRA point of compliance;
- performance monitoring during the post-remedial period; and

- corrective action if the standard is exceeded after remedial action is completed.

The cleanup standard requires aquifer restoration to the MCLs and extension of the remedial action for up to 100 years to allow for natural flushing (i.e., passive cleanup).

The supplemental standard provides for alternative actions which come as close to the standards "as reasonable under the circumstances." The supplemental standard may be applied if:

- protection of human health and the environment is assured;
- the aquifer is not expected to become a public drinking water supply;
- the harm of the proposed action clearly exceeds the benefits;
- restoration is technically impracticable from an engineering perspective; or
- the groundwater is Class III.

IMPACTS TO THE UMTRA PROJECT

Complying with the proposed standards will result in significant impacts to the UMTRA Project in terms of costs. As a first step toward estimating the total project groundwater restoration costs, the conditions, requirements, and aquifer restoration costs at five sites were considered: Gunnison, Colorado; Riverton, Wyoming; Lakeview, Oregon; Tuba City, Arizona; and Falls City, Texas. For each site, preliminary groundwater restoration schemes were proposed and evaluated, and base costs were estimated in 1988 dollars.

The site-specific aquifer restoration base costs were developed in a four step process:

- development of a conceptual model of contaminant distributions and hydrological and geochemical properties, boundaries, and conditions;
- application of the Random Walk Algorithm (Illinois State Water Survey, 1981) to calibrate the model against the distribution of field-measured groundwater quality;
- application of the Random Walk Algorithm to simulate various aquifer restoration scenarios to determine an efficient scenario(s) and associated design parameters;
- estimation of aquifer restoration costs based on the simulated scenarios, design parameters, and assumptions.

The development of the conceptual model required a determination and application of key hydrological and geochemical parameters that control the movement of contaminants, and the distribution of the source of these contaminants as a function of time. The contaminants that were considered are those with concentrations greater than the proposed MCL and greater than the background concentration in the area hydraulically downgradient of the source area (i.e., the tailings pile). The spatial distributions of these contaminants were idealized so that the solution of the solute transport equation would fit the contaminant distributions. In this case, idealizing the contaminant distributions meant assuming that the plume was axisymetric. The final step in developing the conceptual model was to determine appropriate values or ranges of values for the various input parameters. The input parameters were the direction and rate of groundwater flow, the aquifer thickness, hydraulic conductivity, storativity, porosity, the temporal distribution and location of the contaminant source, the range of longitudinal dispersivity, the range of transverse dispersivity, the range of the retardation coefficient, and the distance to the groundwater discharge boundary.

The Random Walk Algorithm simulates the movement of a contaminant mass. During any given time step, the movement of each particle is influenced by the direction and magnitude of the velocity, normal distributions around the magnitude of the two dispersivity values, and the location and strength of extraction wells or trenches and injection wells.

The parameter values and ranges and the initial and boundary conditions developed from the conceptual model were applied in the calibration procedure. In the calibration, the parameter values were kept constant except for the longitudinal and transverse dispersivities and the retardation coefficients. These values were varied to find the set of parameter values that provided the best correlation between observed concentrations and calculated concentrations. These values were varied until an "adequate" calibration was produced.

The treatment options (see Table I) simulated for aquifer restoration included:

Option 1: Extract until MCLs are satisfied, treat if necessary, and discharge.

Option 2: Inject lixiviant (i.e., an agent which enhances mobility), extract until MCLs are satisfied, treat if necessary, and discharge.

Option 3: Extract until MCLs can be satisfied with natural flushing (treat if necessary) and discharge.

Option 4: Inject lixiviant, extract until MCLs can be satisfied by natural flushing (treat if necessary) and discharge.

Options 3 and 4 included an evaluation of a combination of active restoration and passive restoration in a ratio

TABLE I

Aquifer Restoration Description and Duration

Site	Treatment Option	Contaminants	Duration of active restoration (yrs)
Gunnison	1	selenium, uranium cadmium, nitrate	30
Gunnison	2	selenium, uranium cadmium, nitrate	6
Gunnison	3	selenium, uranium, cadmium, nitrate	25
Gunnison	4	selenium, uranium cadmium, nitrate	5
Riverton	1	uranium, molybdenum	100
Riverton	2	uranium, molybdenum	24
Riverton	3	uranium, molybdenum	60
Riverton	4	uranium, molybdenum	16
Lakeview	1	arsenic, cadmium, chromium, molybdenum, selenium	28
Lakeview	2	arsenic, cadmium, chromium, molybdenum, selenium	16
Tuba City	1	cadium, selenium, uranium, nitrate	35
Tuba City	3	cadmium, selenium, uranium nitrate	25
Falls City	1	uranium, radium, molybdenum	more than 100
Falls City	3	uranium, radium, molybdenum	100

(active:passive) sufficient to meet the MCLs within 100 years.

For each scenario, the flow rates to wells(s) and trench(es) were estimated; the duration needed to meet standards and the yields of contaminants as a function of time were calculated; and the number the location of well(s) and trench(es) were varied until the most efficient scenario was identified. The results of these preliminary aquifer restoration simulations were then used for base cost estimation.

The items factored into the base cost estimates included:

- well or trench installation, operation, and maintenance;
- transportation from extraction systems to treatment plant and from treatment plant to discharge point;
- treatment plant installation, supplies, operation, and maintenance;
- of or cases with lixiviant injection, injection wells or trenches installation, operation, maintenance, and chemicals;
- monitor well installation;
- monitor well sampling and chemical analysis (quarterly);
- sampling and chemical analyses of treatment plant influent and effluent (daily)
- supplying alternate water sources, when necessary; and
- disposal of treatment wastes from plant.

In order to forecast total project costs, the five site-specific evaluations and their lowest cost estimates were extrapolated to the remaining 19 UMTRA Project sites. Factors that control the costs in the site-specific evaluation were determined and ranked. For each of the 19 remaining sites, the cost-controlling factors were evaluated to determine the closest match to one of the five modelled sites. For this extrapolation, it was assumed that 25 percent of the costs were fixed and 75 percent were dependent on the total mass of contaminants in the groundwater and soil. Because the level of technical information available for each site varies, confidence in extrapolating restoration costs also varies. Additionally, the sites which were specifically modelled offer a higher degree of precision regarding restoration, duration, and other factors.

To estimate a total program cost based on the lowest site remedial action construction costs described above, the ratio of total program cost to the site remedial action costs for the current UMTRA Project was calculated. The current UMTRA Project site remedial action cost is the cost of tailings pile remedial action at the 24 UMTRA Project sites. The total project cost includes: site remedial action cost; site characterization planning and design development; site acquisition; technology development; pilot scale testing; economic evaluation and optimization; cost estimating; environmental health and safety; and technical

TABLE II

Estimated Costs by Site

Site	COST SUMMARY Base	COST SUMMARY Project
Ambrosia Lake, New Mexico	47	108
Belfield, North Dakota	5	
Bowman, North Dakota	7	17
Canonsburg, Pennsylvania	9	20
Durango, Colorado	11	26
Falls City, Texas	348	800
Grand Junction, Colorado	6	15
Green River, Colorado	24	55
Gunnison, Colorado	24	55
Lakeview, Oregon	18	41
Lowman, Idaho	7	17
Maybell, Colorado	6	14
Mexican Hat, Utah	80	184
Monument Valley, Utah	27	62
Naturita, Colorado	4	10
Rifle, Colorado (New)	4	10
Rifle, Colorado (Old)	4	9
Riverton, Wyoming	15	35
Salt Lake City, Utah	5	11
Shiprock, New Mexico	6	15
Slick Rock, Colorado (North Continent)	4	9
Slick Rock, Colorado (Union Carbide)	4	10
Spook, Wyoming	54	124
Tuba City, Arizona	25	57
TOTALS	444	1171

and managerial supervision. Based on progress to date, the site remedial action construction cost multiplied by a factor of 2.3 yields the total project cost.

CONCLUSIONS

On the basis of the preliminary analyses described above, if aquifer restoration were required at the 24 UMTRA Project sites, the total program cost may be in excess of $1 billion (1988 dollars) (Table II). This estimate includes the cost-influencing assumptions that active restoration would be required at every site. The use of alternate concentration limits, supplemental standards, or passive restoration would reduce costs. However, other factors such as applicability of state standards or surface-water discharge requirements would increase costs .

Because aquifer restoration of inorganic constituents has not been accomplished at the scale potentially required for the UMTRA Project sites, and because of the quality of the data base and preliminary nature of the modelling, additional evaluation will be undertaken to refine the total program cost estimates.

REFERENCES

1. Illinois State Water Survey, "A 'Random-Walk' Solute Transport Model for Selected Groundwater Quality Evaluations," Illinois Department of Energy and Natural Resources, ISWS/BUD-65/81 (1981).