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AN INTEGRATED SIMULTANEOUS APPROACH TO GROUNDWATER REMEDIATION USING ENVIRONMENTAL HAZARD EVALUATION AND REMEDIATION MANAGEMENT ZONE MAPS

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It is well documented that the time and cost of remediation expands exponentially once aggressive cleanup beyond the immediate source zone is required – often after a delay of several years. *Environmental Hazard Evaluation* (EHE) and *Remediation Management Zones* (RMZ) are used to address the common problems of sequential remediation, regardless of the contaminant. This remediation planning approach is applicable to all bodies of groundwater (and soil), whether or not the groundwater is a source of drinking water.

Primary contaminants of concern (COCs) are identified by comparison of initial groundwater data to comprehensive, *Environmental Screening Levels* (ESLs) or other regulatory goals. Investigation is considered complete when the area of contamination that exceeds the ESLs is adequately defined. A comparison of data to more detailed screening levels is then used to identify specific, potential environmental hazards associated with each COC (drinking water toxicity, vapor intrusion, impacts to aquatic habitats, gross contamination, etc.). *Environmental hazard maps* are then prepared to collectively delineate areas of groundwater where specific types of environmental hazards are posed. This information is summarized in a brief EHE report and passed on to the group tasked with development of remedial action plans.

The hazard maps are used to segregate the contaminated groundwater into three separate RMZs based on a prioritization of the hazards posed. RMZ boundaries are either ESLs applicable to the targeted hazards, technology limitations or alternative targets based on site-specific considerations. The zones take into account the nature of the specific hazard posed, threats to active water supply wells and nearby surface water bodies, threats to existing or future buildings that could be affected by vapor intrusion hazards, resources available for cleanup and other site-specific factors as applicable and appropriate. Zone 1, termed the *Source Zone*, is slated for focused, aggressive treatment of primary contaminant source areas as well as hazards that pose imminent threats to human health and the environment. Resources available for cleanup are focused on this area of groundwater. Zone 2, the *Residual Zone*, is slated for passive treatment or aggressive spot treatment to address intermediate priority hazards. Environmental hazards posed by contamination in this zone need to be addressed, but time constraints are less of a burden. In some cases, long-term management and monitoring of this zone may be the most appropriate treatment approach. Zone 3, or the *Attenuation Zone*, exists beyond the Residual Zone and does not exceed ESLs for any of the identified environmental hazards. Monitoring of this area (e.g., via groundwater data or soil gas data) is carried out as needed to ensure that contaminants do not continue to spread away from the Source and Residual Zones and to gauge the effectiveness of treatment initiated in the inner zones.

In sum, remedial strategies are concurrently developed and implemented for each RMZ simultaneously. Use of the EHE and the RMZ approach significantly improves the efficiency and effectiveness of groundwater investigation and cleanup actions.

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