INTEGRATION OF GEOLOGIC AND HISTORIC ASSESSMENTS INTO THE MARSSIM APPROACH AT COMPLEX SITES

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ABSTRACT

Difficult sites contaminated by radiological wastes require adequate assessment of their geology and use history. Evaluations limited to the near surface may not adequately account for the original placement of contaminants nor their fate and transport through time until remediation. Evaluation of the exposed remedial surface for possible contaminant transport routes into the subsurface helps assure adequate evaluation of the release criterion for the subsurface soil and rock. This paper cites the added value in conducting some surveys not specified by standard radiological practice.

INTRODUCTION

A site’s geologic, historic and anthropogenic features are part of the Historical Site Assessment and Characterization Survey (CS). The evaluation of surficial soils in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) [1] is thorough. [The consideration of contamination on or within structures is not developed in this paper.] Contaminant transport below the surface, exposed later under remediation, may require further evaluations for the CS, or have implications for the Final Status Surveys (FSS) at a complex site. The further CS evaluation and/or FSS implications are due to the site’s complex geologic and/or anthropogenic features. Radiological risks are influenced by geologic or anthropogenic features. The residual site risk could be underestimated or excessive confidence placed on radiological scans or sampling at the surface without adequate consideration of geologic, historic and anthropogenic features. Contaminant transport through the subsurface (in geologic media, such as a buried channel, or in utility pathways, such as granular backfill of sewer line trenches) may require more investigation and may impact either random or biased sampling.

MARSSIM provides statistically conservative procedures to demonstrate that a site does not pose a risk exceeding applicable thresholds. The CS should be complete and broad based to fully implement the MARSSIM approach. The FSS determine whether exposed remediated surfaces have statistically met the release criterion. Geologic investigation can be used to augment radiological surveys to assist in identification of contaminant transport routes across the later exposed surface, especially for difficult to detect radionuclides.

Site Characterization has applicable specialty areas [2] for varied types of projects. This paper is confined to remediation of radiologically contaminated sites. Geologic Site Characterization, as an essential activity of site remediation, has four components: literature search, regional geologic assessment, general field study, and detailed (or specialized) site study [2]. The conceptual (site) model is developed using the critical geologic topics and hazards (e.g., slope failures, flooding, …), which are important to both categorization and classification of a given contaminated site. Site Characterization's components need to be planned and sequenced (or phased) to accomplish all the work that is necessary. Yet the phases for completing the latter three components of geologic site characterization (regional geologic assessment, general field study, and detailed site study) are interdependent upon the data collected, data analyses and impact on remediation. Assessing the waste's fate and transport within the scoping study, certainly, is an important element related to the geologic characterization. Using conclusions of the site's geologic conditions is inherent in progressing to the site's remedial design. When the conceptual model's features are accepted, the site characterization is no longer "conceptual" nor a "model." Upon developing the site's data and acceptance of the geologic conditions and other constraints at some finite scale, the conceptual model becomes the site's developed *geologic system* and/or *design character*. St. Louis District has meshed geologic, geohydrologic, and pedologic evaluation with the waste assessment to best resolve significant contaminant caches. This resolution affects both CS and FSS.

Detailed Assessments

MARSSIM develops Data Quality Objectives and generates the number of samples per unit area based upon the exposed surface area, variability of site contaminant concentrations, applicable remedial goals, scan sensitivity of the contaminant or its surrogate, and the statistical assurance associated with the alpha and beta values selected. Nonparametric statistics may increase the sampling density to assure that the release criterion is met. Some sites, while following the MARSSIM procedure, may challenge the assurance of the release criterion. These challenging sites occur due to a variety of complexities. Some features or processes that make a site complex include: long and varied site use; plant processes that segregate contaminants; transport media that segregate contaminants; a segregated contaminant with scan sensitivity below its Remedial Goal (RG); geologic and/or anthropogenic features that vary to the extent that random sampling does not assure detection; and, varied pathways into the subsurface such that surficial sampling does not assure adequate information for the subsurface.

St. Louis District builds upon the four components of Site Characterization in both waste and geologic assessment. Eastern US FUSRAP sites may be more complex (compared to Western US sites) in urban impact, and in determining the conceptual site model's waste and geologic characteristics. Eastern US sites may have more developed depositional and erosional surfaces, higher precipitation (resulting in geohydrologic complexities), longer use histories and greater anthropogenic site impacts, varied waste placement over differing time intervals, and more extreme ranges of waste transport. One FUSRAP site had continuous commercial activity over one hundred fifty years. FUSRAP activities at the noted site lasted less than two decades, yet demolition, reconstruction, and varied processes have occurred for the succeeding forty years. This site history and geology makes it significantly more difficult to define areas that are contaminated and makes remediation of the site considerably more complex.

The advantage of a conservative statistical (MARSSIM) approach for surficial soils may be lessened by potential waste migration along channels or lineations. A linear route of waste migration along a now buried past stream channel or through granular backfill of a utility corridor reduces the effectiveness of even increased surficial sampling points. While a lineation truly has three dimensions (instead of the mathematical concept of one dimension), the lineation’s areal extent over a surface is quite small. Adding to the difficulty are wastes, such as Thorium-230, that are difficult to accurately measure at concentrations just above its RG by NaI field scan unless detectable surrogates exist. Surrogates may be less viable if any segregation process has separated the contaminants.

St. Louis District carefully adds detailed topics to CS. The District includes detailed assessments of: historic, air photo, and geologic literature reviews, geohydrologic assessment of the design character, and hypotheses for waste transport. Preferential Pathway Surveys (PPS) aid resolution before the FSS by assuring that the final exposed surface is mapped. Mapping of preferential pathways allows the geologist to aid the health physicist in assuring that the survey unit lacks routes across the exposed surface that may have transported contaminants to a subsurface cache or from a subsurface source. PPS are a benefit for remediation of difficult to detect radionuclides, such as Thorium-230. PPS concluding that the movement of contaminants has occurred may be sampled consistent with approaches used with elevated areas of contamination to determine whether remediation is appropriate or whether the release criterion continues to be met.

These added careful assessments for the CS may be argued as being required by the present MARSSIM. This paper cites the detailed assessment to assure effective implementation of the MARSSIM approach for areas and features that are not otherwise easily statistically quantified. These PPS are particularly important for subsurface soils given the lack of detection assurance for some contaminants. The careful assessments are neither time-consuming nor labor intensive. Each assessment is limited to that which is appropriate for the site in question.

A debate on meeting the 95% upper confidence limit for an exposed surface with or without PPS is not intended. The FSS is complete without the PPS. The intent is not to add more procedures to the FSS. The PPS raises the confidence that contaminants did not cross the exposed surface en route from a source or to a contaminant cache. The exposed surface may quickly and easily be mapped by a geologist, who has developed the art of noting migration routes across the exposed surface. The PPS qualitatively bolsters the assessment that the site has been properly remediated.

Teamwork between the health physicist and geologist has proved invaluable at a complex, urban, chemical plant to complete remediation beyond the 95% confidence level. Without this attention in the CS and before the FSS, the 95% confidence could be achieved statistically, but with the potential for residual doubt on the part of some stakeholders.

CONCLUSION

St. Louis District, as a team, has demonstrated added value in applying geologic and historic assessments to the CS. These assessments enhance the MARSSIM approach, aid the design evaluation of the remediation, and assure that the fate and transport of contaminants in the subsurface is adequately resolved. The PPS aid the FSS by mapping the exposed remediated surface. The joint use of the PPS and scan mapping assure that the risk of significant contamination below the surface has met the release criterion.

REFERENCES

1. U.S. Department of Defense, et al., “Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM),” NUREG-1575, Revision 1 (August 2000).
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