Simulation for volume reduction of site remediation at UCP

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1. Introduction

The objective of remedial action is to reduce risks to human health, to acceptable levels by removing the source of contamination [1,2]. A characterization survey, sufficient time, and a proper budget are required after decommissioning work to carry out a final survey in preparing for an unexpected contamination. In this study, the optimized amount of soil waste during site remediation of the Uranium Conversion Plant was evaluated by considering the hop spot concept which was suggested in MARSSIM and geostatistics methods.

2. Methods and Results

2.1 Contamination status of subsurface soil in UCP

The main contaminant at the decommissioning site and buildings was natural uranium. For the site, dose rates were measured with survey meters connected with a GPS (Global Positioning System) during the scoping and characterization survey, and the measured data were used for detecting the existence of hot spots and predicting the contamination levels. The level of contamination for most of the site was around the background level, but that of the soil under the ADU building was contaminated through a sump and trench, which was spilled during plant operation, during a guarantee test of the UCP. The distribution of the contaminated soil under the building was surveyed that soil was contaminated up to 6m from the ground, and the contamination was diffused in flow direction of the underground water. The underground water around the uranium conversion plant was not contaminated based on the surveyed results of below 10ppb. All contaminated soil wastes under the column base was reinforced to support the building. A total of 1,600 m^3 of soil waste was generated and stored in a large scale soil waste container.

2.2 Geostatistics method to estimate radioactivity distribution

Geostatistics extend the statistical framework by providing methods that integrate the spatial structure of the contamination. Most probable estimates of the surface and subsurface radioactivity without sampling can be derived using kriging techniques. Variants of these techniques also give access to estimates of the uncertainty associated with the spatial prediction or the probability to exceed a given threshold [3].

The ISATIS software provides a reliable Gostatistics method for estimating the volume of contaminated soil with a graphical analysis. A spatial analysis of the measured data by kirging and simulation can generate continuous data. The depth distribution of the UCP site was calculated by simulation on a multi Gaussian framework layer by layer from 0.5m to 6m. Figure 1 shows the evaluation results of the subsurface contamination at the Class 1 area of UCP site.

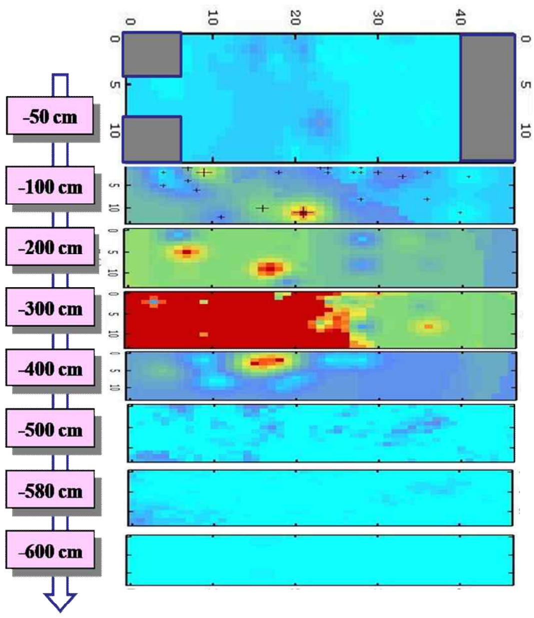

Fig. 1. Simulation results of subsurface contamination level of Uranium Conversion Plant.

2.3 Applying hot spot concept in MARSSIM

MARSSIM has been used at a variety of decommissioning sites to design the survey planning, implementation and data interpretation as the main component of the final status survey. MARSSIM requires a reasonable level of assurance for any small area of elevated residual radioactivity (hot spot) by considering a maximum concentration level and number of hot spots. The elevated measurement compression is performed to demonstrate that the hot spot and concentration do not exceed the $DCGL_{EMC}$ for small areas based on radiological dose consideration [4]. The $DCGL_{EMC}$ can be calculated by the product of the area factor and DCGLw. The RESRAD code was used to generate the area factors. To apply MARSSIM for the limitation numbers of hot spot, a statistical test(WRS test) is required to demonstrate compliance with the release criteria in Class 1 survey unit.

2.4 Concept and results of optimization method

The optimized amount of soil waste during site remediation of the Uranium Conversion Plant was evaluated by considering the hop spot concept which was suggested in MARSSIM and Geostatistics methods. Figure 2 shows the concept used to optimize waste volume during site remediation at the UCP site.

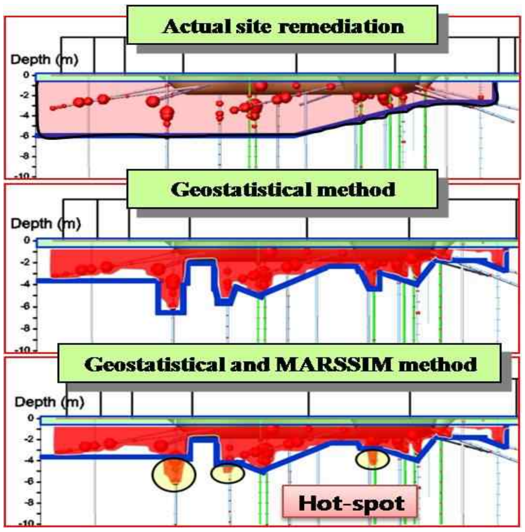

Fig. 2. The optimization concept for remediation

The Geostatistics method can be reduced by around 25%, and a combined method with hot spots in MARSSIM reduced 31% of the waste volume compared with the actual waste volume at the Class 1 area of the UCP site. Figure 3 shows the sampling point for the WRS test for the measurement results of the survey unit exceeding the release criteria at the 5m depth.

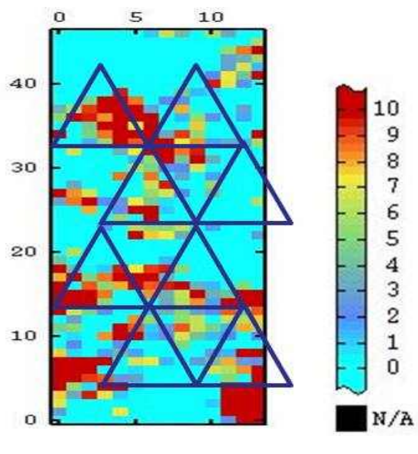

Fig. 3. Sampling point for WRS test

3. Conclusions

The objective of any remedial action is to reduce the risks to human health to acceptable levels by removing the source of contamination. The project period was extended twice for the initial planning because of the unexpected soil contamination under the UCP building. The importance of the characterization survey and optimization of site remediation cannot be overestimated in the decommissioning project. In order to provide a reliable cost and schedule for site remediation, it requires optimization methods as well as appropriate data processing techniques. The optimized amount of soil waste during site remediation of the Uranium Conversion Plant was evaluated by considering the spatial analysis with the hot spot concept in MARSSIM. The combined methods of the hot spot concept in MARSSIM and geostatistics method pave a way to optimization of the site remediation.

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