PERMANENT SAFETY MEASURES (MISP): EFFICACY ASSESSMENT THROUGH PUMPING TEST ANALYSIS, GROUNDWATER FLOW MODELING AND ENVIRONMENTAL ISOTOPE INVESTIGATION

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Managing heavy contaminated areas usually require, by the Italian national rules, the emplacement of safety actions in order to avoid the spreading of contaminant plumes and the deterioration of nearby receptors such for examples water bodies (Majone et alii, 2015). Dlgs 152/2006 force to take Permanent Safety Measures, MISP (Messa In Sicurezza Permanente actions) in situations where the level of contamination do not allow feasible and/or economical remediation of polluted groundwater and soils. MISP actions usually make use of physical barrier for contaminants retention, through slurry walls and impermeable barriers reaching down an impermeable natural horizontal barrier, such as a clay zone. This system should effectively impede the groundwater flow. Moreover, MISP are frequently used in combination with surface caps to produce a complete containment structure to prevent inside local recharge and water table (WT) levels rising. Still, most of MISP systems present unwanted behaviors, primarily WT levels inside rising.

A groundwater flow model was setup and calibrated over an extended area by using dataset from 1999 to 2016, the latter including several new piezometer installed in the vicinity of the MISP' slurry walls. A series of pumping test including long duration tests were performed in order to estimate aquifer parameters, and to investigate the potential for water flow through the slurry walls. Five locations along the wall were tested by using internal and external monitoring wells. A transient groundwater flow was developed to simulate the observed WT rise over the last years. Environmental isotopes including δ^2H and $\delta^{18}O$ of H_2O were measured on a monthly basis for a total of six campaigns.

Groundwater flow modeling and pumping test results demonstrated a very good hydraulic seal for the slurry walls. Permeability resulted to be lower than 10^{-9} m/s at all the investigated locations, confirming the parameters required by the MISP project proposal. The rising of the levels inside the MISP were in agreement with an entrance of groundwater from the underlying clay zone and a good agreement was find between the simulations and the measured values over the last years. A reasonable value for the specific yield was obtained. With regards to δ^2H and $\delta^{18}O$, internal and external monitoring wells showed different signals. Moreover, for the external monitoring wells on the west portion of the study site, δ^2H and $\delta^{18}O$ were helpful to demonstrate surface water-groundwater interactions.

The long duration pumping tests and modeling efforts were effective in describing the water dynamic between the underlying clay zone system, the alluvial side aquifer and the run-off

rainwater infiltrations through the capping system. Environmental isotopes confirmed the proposed conceptual model.

References

Mauro Majone, Roberta Verdini, Federico Aulenta, Simona Rossetti, Valter Tandoi, Nicolas Kalogerakis, Spiros Agathos, Sebastià Puig, Giulio Zanaroli, Fabio Fava, In situ groundwater and sediment bioremediation: barriers and perspectives at European contaminated sites, New Biotechnology, Volume 32, Issue 1, 25 January 2015, Pages 133-146, ISSN 1871-6784, http://dx.doi.org/10.1016/j.nbt.2014.02.011.

Decreto Legislativo 3 aprile 2006, n. 152, "Norme in materia ambientale" pubblicato nella Gazzetta Ufficiale n. 88 del 14 aprile 2006 - Supplemento Ordinario n. 96.