Remediation of Mercury Contamination at a Former ChlorAlkali Plant in NSW Using Integrated Cap and Containment Technologies

Gavan Butterfield (gbutterfield@golder.com.au), Gary Schmertmann, Caroline Vernon, and Frederic Cosme (Golder Associates Pty Ltd., Melbourne and Sydney Offices, Australia)
James Stening (Orica Australia Pty Ltd., Sydney, NSW, Australia)
Alan D Laase (Navarro Research and Engineering, Oak Ridge, TN, USA)

Between 1945 and 2002, a former chlor-alkali plant (FCAP), where mercury cells formed part of a chlorine manufacturing process, was operated by Orica at Botany, NSW. Investigations (2004 to 2008) identified significant concentrations of mercury in soil (including the elemental form), soil vapor and groundwater, centered beneath former cell rooms at FCAP (Block G).

Remediation was regulated by a NSW EPA Management Order. A remedial options appraisal identified the capping and containment of the entirety of Block G (1 hectare) as the most feasible approach. A remediation action plan (RAP) presented a containment system concept design comprising a subsurface vertical barrier wall around the entire site perimeter connected to a capping system incorporating a vapor barrier. Detailed design specified a low permeability (to water and gas/vapour) barrier wall, keyed into low permeability strata beneath the Botany sands aquifer at 20 to 25 m depth.

The barrier wall was installed using cutter soil mixing (CSM) technology. The cutter head injected and mixed site-batched cement grout and bentonite slurry. The barrier wall was formed with 183 interlocking CSM panels to a depth of approximately 25 m. Construction verification occurred in parallel, with ongoing measurements of panel alignment and verticality as well as the collection of in situ ‘wet-grab’ panel samples using a purpose designed probe. These samples were tested for water and vapour permeability and vapour diffusivity compliance. The capping layers and integrated monitoring systems were deployed by specialist contractors. A ‘post-tension’ concrete slab was constructed on top of the cap. Vapor barrier integrity was verified by implementing an air quality sampling program using a novel integrated vapor monitoring system.

Refinement of the local hydrogeological conceptual model had identified two ‘aquifers’ (‘shallow’ and ‘deep’), separated by semi-continuous peat layers. The verification well suite comprised three sets of nested wells targeting both aquifers. Each internal well set was paired with an external equivalent set. Data loggers were deployed.

Interpretation over time identified several data ‘signatures’, which informed assessment of the ‘success’ of hydraulic isolation. These included: (1) an internal increase in water levels related to recharge prior to capping system construction; (2) a reduction in responses to external effects, such as the periodic shutdown of a nearby groundwater treatment plant; (3) pressure equalisation effects following the installation of an internal extraction well; and (4) effects of internal pumping (not evident on external hydrographs). Also demonstrated were a flattening of the internal potentiometric surfaces and increases in external hydraulic gradients.

Specific, measurable and sustained evidence that agreed with predicted patterns of hydraulic head redistribution post installation of the integrated system indicated that the cap-and-containment system met the hydraulic verification requirements. The absence of detectable mercury vapour in the integrated vapour monitoring system verified the efficacy of the vapour

cap. Implementation of the integrated cap and containment system was considered to have rendered the site suitable for the proposed ongoing industrial/commercial land use.