Generic and advanced human health risk assessment for brownfield regeneration

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As economies develop and make the transition from heavy manufacturing to specialist manufacturing or services that require less land. Former industrial land can be abandoned as an urban area expands and formerly undeveloped land is built on (CABERNET, 2006; Nathanail, 2010a,b). However land is in limited supply and an ever expanding urban area is sowing the seeds of future problems. Successful cities are characterised by plenty of human-to-human interaction. Even in these days of push-email, mobile phones and video conferencing, much business, entertainment, innovation and retail is done face to face. Reusing former industrial sites is essential if travel times are contained and interaction opportunities encouraged. However many historic industrial activities resulted in chemical contamination of soil and groundwater.

Such contamination can harm human health – especially if the new users of the land are more susceptible than the workers in the former industry. As urban areas grow, there is a need for more housing, schools, playgrounds: children are smaller and more vulnerable to exposure to contaminants. It is essential that redeveloped brownfield sites are rendered safe and fit for the next intended use.

Ensuring land is fit for use begins with a thorough understanding of the history of the site and its geo-environmental setting (Nathanail *et al*. 2007). This understanding arises from a thorough desk study and site inspection that then inform the development of a conceptual model that allows a qualitative risk assessment to be carried out (Nathanail & Nathanail, 2010).

Sites where evidence indicates previous activities may have resulted in contamination require quantitative risk assessment and such assessment requires site specific analysis of soil and water chemistry and ground characterisation. Simple, generic quantitative risk assessment involves comparing site contaminant concentrations with relevant generic soil standards. Substantial exceedance of such standards triggers remediation to reduce the risk site contamination poses to human health. Lower levels of exceedance require more specialist risk assessment to evaluate the need or otherwise for what is usually expensive and often time consuming remediation. Specialist risk assessment removes conservative assumptions in generic assessment criteria and develops a more detailed understanding of a site but at the expense of extra site investigation and monitoring so is not something to be embarked upon lightly.

Generic assessment criteria can speed up, simplify and reduce the cost of risk assessment. As such, they need to be widely applicable and hence must represent soil contaminant concentrations that are definitely safe and pose minimal or no risk to human health. They are generated once, often by government agencies or other reputable organisations, and are widely accepted by regulators and adopted by risk assessors. They need to reflect local soil conditions and climate as well as the characteristics, diet and behaviour of the people, often the children, who will be on the site. As such each country or part of a country needs to develop its own generic criteria; it cannot and should not simply import criteria from another country. However the approach, software and many of the input parameters used in other countries may be adopted and then adapted to local conditions (Cheng & Nathanail 2009).

Specialist, detailed quantitative risk assessment is more time consuming and costly but can demonstrate that remediation is not needed and so it should only be undertaken where it is likely to deliver more benefits than moving straight to remediation. Site specific estimates of contaminant bioavailability based on sequential extraction tests that mimic the human digestive system are widely used to refine assessment criteria. Our

understanding of contaminant uptake by plants grown for food in gardens is poor so site specific measurements of such uptake are a an even more sophisticated refinement of the assessment criteria.

Risk assessment is used in many countries around the world to estimate and then evaluate the risk posed by contamination in soil or groundwater. It can help demonstrate a brownfield site is fit for its intended use despite the presence of some contamination. It can also help inform remediation clean up targets where remediation is necessary and involves source removal, destruction or reduction rather than pathway interruption.

Current thinking of how to remove unacceptable risks involves considering how the remediation can be integrated with other ground engineering required by the project to deliver more sustainable solutions. Sustainable remediation may be a useful context in some legal regimes, such as Part 2A of the UK Environmental Protection Act 1990. For brownfield regeneration remediation should aim to contribute to sustainable redevelopment. Action undertaken for remediation purposes may also provide underground space, the opportunity to install ground source heat pumps, the opportunity to improve geotechnical properties or to construct means of attenuating the effect of peak rainfall events. However a thorough risk assessment is and will remain a component of sustainable urban land reuse (Nathanail *in prep.*).

The views expressed in this essay are the author's own and were prepared for the time, event and likely audience at which they were aired.

References

CABERNET. 2006. *Sustainable Brownfield Regeneration: CABERNET Network Report*. Millar, K., Grimski, D, Ferber, U. & Nathanail, C.P. University of Nottingham. http://www.cabernet.org.uk/resourcefs/427.pdf

Cheng, Y. & Nathanail, C.P. 2009. Generic Assessment Criteria for human health risk assessment of potentially contaminated land in China, *Sci Total Environ*, 408:324–339 DOI:10.1016/J.SCITOTENV.2009.09.021

Nathanail, C.P. 2009. The role of engineering geology in risk-based land contamination management for tomorrow's cities. In: M.G. Culshaw, H.J. Reeves, I. Jefferson & T.W. Spink (eds) *Engineering Geology for Tomorrow's Cities*. Engineering Geology Special Publication 22: 149–158. Geological Society of London, Bath doi: 10.1144/EGSP22.11.

Nathanail, C.P. in prep. The Tenth Glossop Lecture: *Engineering geology of sustainable, risk based land quality management*. (email paul@lqm.co.uk for publication details).

Nathanail, C.P. 2010a. Sustainable Brownfield Regeneration. In: Swartjes, F.A. (ed.) *Dealing with Contaminated Sites: From Theory Towards Practical Application*. Springer, Dordrecht.

Nathanail, C.P. 2010b. Risk based contaminated land management and engineering geology. In: *Proceedings of the 11th Congress of the IAEG: Extended Abstracts volume*, pp 540-546. ISBN 978-0-908960-54-5

Nathanail, J. F., & Nathanail, C. P. 2010. Conceptual site models for potentially contaminated sites. In: *Proceedings of the 11th Congress of the IAEG: Extended Abstracts volume*, pp 536-539. ISBN 978-0-908960-54-5

Nathanail, J. F., Bardos, P. & Nathanail, C. P. 2007. *Contaminated Land Management Ready Reference*, 2nd edn. EPP Publications & Land Quality Press, Nottingham.

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LQM are known for their work in training regulators and consultants and in peer reviewing countless reports for local authorities and developers. They pioneered the use of bioaccessibility in UK human health risk assessment and worked with CIEH to publish generic assessment criteria some 82 common contaminants to complement the screening values for 10 substances published on behalf of the UK government. This has revolutionised and speeded up the assessment of land contamination issues through the planning system.