Network for Industrially Contaminated Land in Africa (NICOLA)

Groundwater Screening Process: Position Paper 2017

1.0 INTRODUCTION

NICOLA supports responsible environmental management and hereby presents a groundwater screening process that provides stakeholders with an outline of critical elements that leaves the choice of site specific screening values to the project team. Groundwater is an important resource that needs protection from contamination. There is a need for a rigorous methodology to determine the potential impact on groundwater resources while balancing the economic development needs of the population. The Framework for the Management of Contaminated Land published by the South African Department of Environmental Affairs in 2010 presented an internationally accepted methodology for risk assessment, consisting of source-pathway-receptor identification. Under the South African National Environmental Management: Waste Act (Act 59 of 2008) soil screening values for a variety of compounds were published based on a standardised protective model for the natural environment (SSV1) as well as an exposure model for humans (SSV2). There is a groundwater component to the soil screening values as incorporated into the SSV1 calculation, but there are no groundwater screening values resulting often in the use of overly conservative drinking water standards to water samples.

Screening is a valuable process to classify sites that need further investigation and also to rule out sites that might be potentially contaminated, but where further action is not required. Based on the risk-based methodology, screening requires the determination of source-pathway-receptor (SPR) linkage or potential linkage. Using drinking water criteria to screen water samples from a potentially contaminated site tends to be overly conservative if there are no receptors consuming the water from the point of sampling. Just as with the soil screening values where a standardised exposure model is used to determine the potential impact that affected soils might have on receptors, groundwater screening exposure models provide for some distance between the receptor and the source. Given the variety of exposure models, different rates of natural attenuation of contaminants, background concentration of certain elements and different receptors, it is not feasible to develop one set of screening values for groundwater. This guideline aims to present methodologies to screen groundwater concentrations at contaminated sites using the risk-based approach.

The basic methodology will involve the sampling of groundwater to determine the source concentrations and if possible sampling the groundwater at either a point of compliance or at a receptor, quantifying the potential pathways and identifying the receptors. Broadly the screening process will be conservative to protect receptors like the natural environment, human health via indirect exposure to affected groundwater (dermal contact, vapour inhalation, ingestion of crops), human health via direct exposure (groundwater ingestion) and the protection of infrastructure like roads, foundations and utilities.

2.0 GUIDELINES FOR GROUNDWATER SCREENING

Groundwater screening to determine whether an impact is occurring or will potentially occur on receptors is not a one size fits all process. NICOLA presents this guideline not as minimum requirements, but as a general outline of best practice. The aim is to develop a process that is flexible enough to allow overview screening, while ensuring that crucial elements are identified and considered during the assessment.

2.1 Conceptual Site Model

To have a meaningful discussion on the impact or potential impact of contamination, a conceptual site model (CSM) is required. The CSM, as discussed in the Framework, is widely accepted as the basis of

presenting data from contaminated sites and the relationship between elements that will define the SPR linkages. It summarises the information that is known and highlights assumptions and is often a pictorial or visual representation. It is useful to present the diagram either as a cross section oriented along the line of most likely exposure to an identified receptor or in some cases a 3-dimensional model helps communicate the various elements to stakeholders. The aim is to generate a fit for purpose pictorial representation and the scale should be indicated to allow the viewer to determine the distances between different elements.

Generating and improving a CSM is an iterative process and the aim is to develop a fit for purpose CSM. It is one of the first steps of any contamination investigation and it will also contain some unknowns. As the investigation progresses the pertinent gaps are addressed by collecting relevant information. For the purposes of this position paper, an initial CSM is generated during Phase I work. The CSM is crucial to identifying the relevant soil screening values to be used. If an investigation also includes water sampling, the proposed methodology is going to require an initial CSM in order to identify relevant screening levels that will have to be used. At the end of a screening process, the CSM needs to be interrogated to ensure that no significant gaps exist.

A groundwater CSM should include the following elements and more where relevant, with an indication for each on the level of assumptions that were made or what the source of the information is (published maps, reports etc):

- Groundwater environment
    - Background water quality
    - Soil profile
    - Thickness of vadose zone
    - Underlying geology
    - Different aquifers with rest water levels and hydraulic properties, if more than one
    - Confining layers
    - Groundwater gradient(s)
- Actual or potential sources
    - Related infrastructure above or below ground
    - Activities that might have an impact on groundwater quality
    - Primary sources that are causing the contamination. Examples are waste storage ponds, slimes dams, leaking storage tanks and associated infrastructure (above and below ground), agricultural chemicals (fertilizers, herbicides and pesticides), septic tanks etc.
    - Secondary sources that result from the release of chemicals from primary sources, but which will act as long term sources for groundwater contamination even after the primary source has been removed or addressed
    - Natural secondary sources of contamination caused by human activities like saline intrusion due to water abstraction close to the ocean or acid mine drainage from mine discard dumps
- Contaminant pathways
    - Vadose zone through which vapours emanating from groundwater can reach receptors or utilities
    - Groundwater flow to abstraction points
    - Groundwater flow to aquifers
    - Groundwater surface water interactions
- Receptors
    - Humans through indirect contact (dermal exposure, vapour inhalation etc)
    - Humans through groundwater ingestion
    - Surface water ecosystems or marine environments
    - Surface ecosystems
    - Aquifers

2.2 Groundwater Screening Decision Flow Chart

The screening process can start in a variety of ways and the aim is to use the data from a site to determine potential SPR linkages in the context of the CSM. The flow chart presents a decision tree that

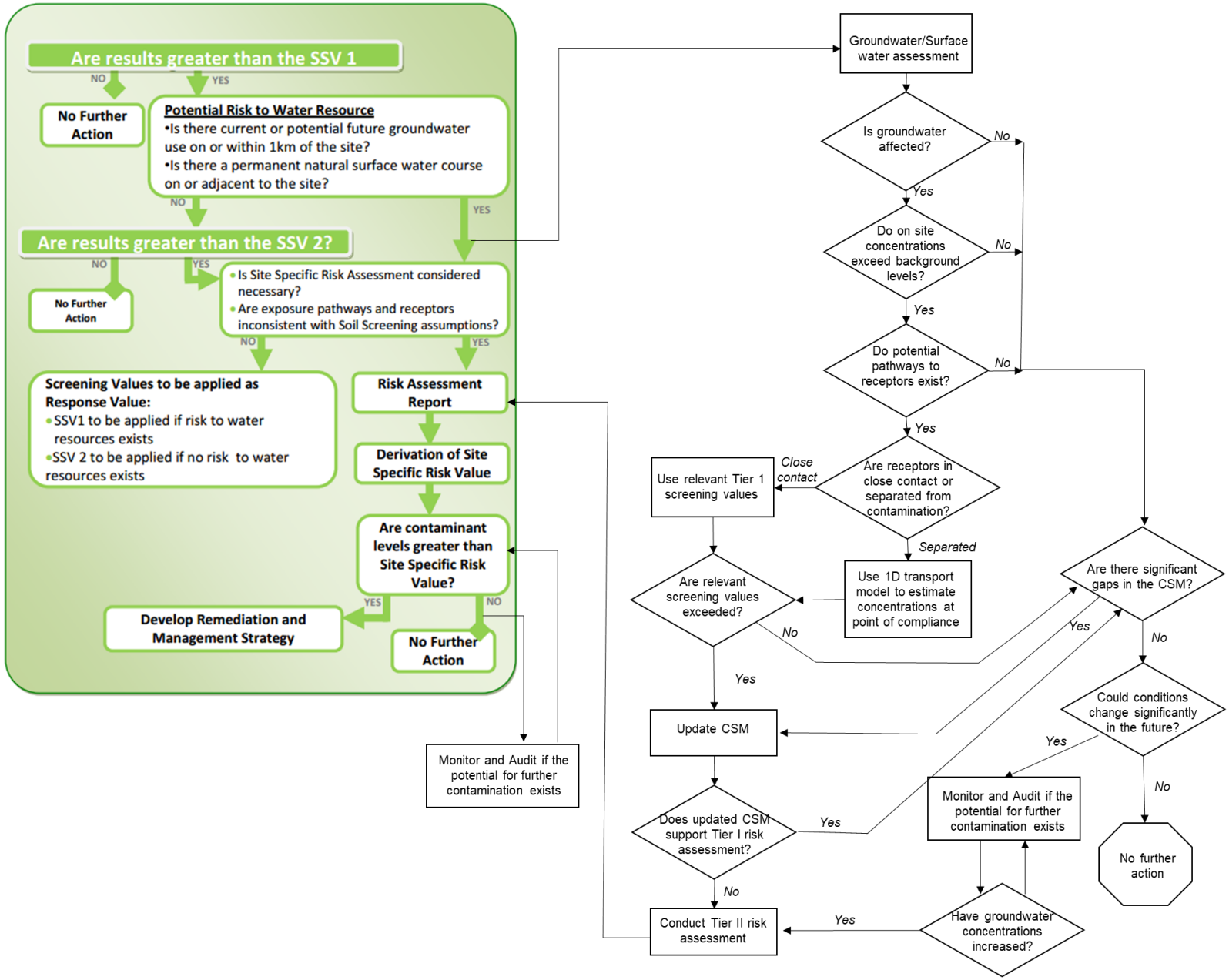
aims to guide practitioners and reviewers through the screening process. The groundwater screening process links to the screening presented in the Framework where the initial assessment identifies the need for groundwater screening assessment either through soil samples that exceed SSV1 or through sampling of water (groundwater or surface water) at the site. If sampling results show that water is not impacted, no further assessment is required. There are cases where the groundwater is impacted, but what the sampling finds can be regarded as background concentrations, either from anthropogenic sources or naturally elevated concentrations. In such a case the screening needs to take background concentrations into account. If the site is not contributing to those elevated compounds, or if its contribution is insignificant, no further action for the site in question can be motivated. However, if there is an impact to receptors action might be required by either the party that is the source of the contamination or the Catchment Management Agency.

If the concentrations found at the site exceed background levels, the screening progresses to the next step to identify pathways. If a water sample is contaminated, but it can be concluded that no significant pathway to a receptor exists or will potentially develop, then the screening process is complete. Before no further action is recommended, a critical review of the CSM needs to be completed to identify crucial assumptions that might change the outcome of the assessment.

If pathways to receptors exist or could potentially develop, the relative position of the receptors needs to be considered. If the receptors are present on site or in close contact to the contamination, the screening can progress using relevant levels. The assessment must justify why certain levels are used. If, for example, receptors are drinking water at the site, local drinking water guidelines can be used. In the case where contaminants are not listed in local guidelines, it is up to the practitioner to source defensible international levels to use as screening and to include a discussion on the reasoning for using these levels. If after screening the levels are found to be acceptable, the project team needs to review the CSM for critical gaps and if they are satisfied that none exist, the screening is complete.

There are many permutations of the CSM being incomplete and therefore the CSM review is a crucial step in the process. Consider, for example, if there is a potential that levels might increase in the future, because the implication would be that receptors will be affected in time to come. In this example the review of the CSM might find it inadequate and a more sophisticated assessment might be required or a monitoring and audit plan might be implemented.

If there is some form of separation between sources and receptors with the potential for SPR linkage to develop, groundwater screening needs to take this into account. At the time of screening it is not necessary to develop complicated models, but a first pass model should be used. The choice of model is left to the project team and its use should be justified in the assessment. The aim is to use critical site information to model attenuation and then to screen using relevant levels as discussed above. All screening levels are based on some form of model as discussed in the Framework and the proposed approach here is to modify simplistic models for the site to allow screening. Note that this approach - at a screening level - does not support using complex models as a first step, because that falls under advanced risk assessment like Tier II. If the screening of the modelled values is acceptable for the site relevant levels, then the assessment of gaps and potential changes can take place. If all the conditions have been met for screening, then the site can be screened out. If the simplistic model's output exceeds the identified screening levels, the CSM needs to be reviewed and improved. Before moving on to Tier II risk assessment, the project team or practitioner needs to consider whether the updated CSM does not support Tier I screening with the identified levels relevant to the site. If so, then it might still be possible to screen the site out. If the updated CSM does not support Tier I, the site progresses to an advanced level of assessment as described in the Framework.



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2.3 Source-Pathway-Receptor Identification and investigation Checklist

Desk top review	**Y**	**N**	**NA**
Site location			
History of contamination incidents/events.			
Identification of all known anthropogenic, on and off site, potential sources of contamination (stockpiles and/or infrastructure related with the storage and handling of potential contaminants) that could negatively impact water quality.			
Key assessment questions			
Are there known releases or records of historical contamination within the investigation area?			
Are there visible signs of contamination?			
Is there a potential for a subsurface source of contamination and reason to suspect that the likelihood of a release of a contaminant may have occurred?			
Is there information to suggest that the stockpiles and/or infrastructure related with the storage or handling of potential contaminants has a high probability of resulting in the release of contaminants? (Landfills, Mine dumps, pit latrines, old fuel storage infrastructure etc.)			
Has the type of contamination expected/confirmed been identified?			
Are there local and or international standards/guidelines for specific chemicals/elements related to the expected/confirmed contamination and are they relevant to the site setting?			
Site inspection and Hydrocensus			
Confirmation of sensitive receptors and identification of previously unknown receptors?			
Hydrocensus within 500m-1000m (varies between types of contaminants, size of plume and geohydrological characteristics of the investigation area).			
Are there groundwater abstraction boreholes or sensitive ecological receptors located within the hydrocensus investigation area?			
Has sufficient information from boreholes been gathered, especially their use; ingestion, irrigation, showers and toilets etc?			
Nature of water use: when is the period of highest use and volumes			
Depth of the borehole and water rest levels			
Date of installation			
Key receptor questions			
Are there residential areas located immediately adjacent or down gradient of the investigation area?			
Are there any other possible receptors located on or off site that may be impacted by the migration of a contaminated plume?			
Are there any other potential sources of contamination in the vicinity of the investigation area that may impact on the results of the investigation?			

3.0 RESOURCES

The following list of resources could be used to develop groundwater screening techniques. NICOLA does not endorse any product or process and has not assessed the relevance of any exposure model.

- http://www.gsi-net.com/en/software/free-software/mass-flux-toolkit.html
- Alberta Soil and Groundwater Tier 1 Remediation Guidelines. http://aep.alberta.ca/land/land-industrial/inspections-and-compliance/alberta-soil-and-groundwater-remediation-guidelines.aspx
- Canada Guidance Document on Federal Interim Groundwater Quality Guidelines Contaminated sites NOV2012. http://esdat.net/Environmental%20Standards/Canada/Fed/Fed%20Interim%20GW%20En14-91-2013-eng.pdf
- CRC CARE 2016, Flux-based groundwater assessment and management, CRC CARE Technical Report no. 37, CRC for Contamination Assessment and Remediation of the Environment, Adelaide, Australia. http://www.crccare.com/publications/technical-reports
- Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand (Revised 2011). Module 5 Tier 1 groundwater acceptance criteria. http://www.mfe.govt.nz/publications/hazards/guidelines-assessing-and-managing-petroleum-hydrocarbon-contaminated-sites-new
- NICOLE Risk Assessment Comparison Study, 2004. http://www.nicole.org/uploadedfiles/2004-Risk-Assessment-Comparison-Study-finalreport.pdf
- South African Framework for the Management of Contaminated Land, March 2010. http://sawic.environment.gov.za/documents/562.pdf
- South African National Environmental Management: Waste Act (Act 59 of 2008)
- South African National Water Act (Act no 36 of 1998)
- RBCA Fate and Transport Training, 1999. https://nepis.epa.gov/Exe/ZyNET.exe/1000061X.TXT?ZyActionD=ZyDocument&Client=EPA&Index=1995+Thru+1999&Docs=&Query=&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&IntQFieldOp=0&ExtQFieldOp=0&XmlQuery=&File=D%3A%5Czyfiles%5CIndex%20Data%5C95thru99%5CTxt%5C00000014%5C1000061X.txt&User=ANONYMOUS&Password=anonymous&SortMethod=h%7C-&MaximumDocuments=1&FuzzyDegree=0&ImageQuality=r75g8/r75g8/x150y150g16/i425&Display=hpfr&DefSeekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%20page&MaximumPages=1&ZyEntry=1&SeekPage=x&ZyPURL
- UK Groundwater Risk Assessment Guidance. https://www.gov.uk/guidance/groundwater-risk-assessment-for-your-environmental-permit#generic-quantitative-risk-assessment
- USEPA Risk Assessment Guidance https://www.epa.gov/risk