Northern Rivers Contaminated Land and Waste Forum

- ACLCA Northern Region - Contaminated Land Seminars 2005, Assessment and Management 10 Years On, Kempsey 18/11/05 and Byron Bay 24/11/05;

- OEH & HAELERN Contaminated Land Workshop, Ballina 23/06/11;

- EHA Environmental Health Regional Seminar, Lismore 28/07/15; and

- MIDROC Contaminated Land Seminar, Local Government and the Effective Management of Contaminated Land, Coffs Harbour 18/02/16
Northern Rivers Contaminated Land and Waste Forum

Environment Protection Authority *

Contaminated land consultants

Site auditors

Local government/ state government agencies

Practitioners

An estimated **12.6 million deaths each year are attributable to unhealthy environments**

15 MARCH 2016 | GENEVA - An estimated 12.6 million people died as a result of living or working in an unhealthy environment in 2012 – nearly 1 in 4 of total global deaths, according to new estimates from WHO. Environmental risk factors, such as air, water and soil pollution, chemical exposures, climate change, and ultraviolet radiation, contribute to more than 100 diseases and injuries.

**Healthier environment: healthier people**

“A healthy environment underpins a healthy population,” says Dr Margaret Chan, WHO Director-General. “If countries do not take actions to make environments where people live and work healthy, millions will continue to become ill and die too young.”
Dozens of programs that deal with climate change, pollution clean-ups and energy efficiency would be wiped out by the administration’s budget, which seeks to demolish parts of the EPA.

The regulator’s funding would be cut by nearly a third under the “America first” budget proposal, which requests $5.7bn for the EPA in 2018 – a $2.6bn cut, or 31%, on its existing budget. Around one in five EPA employees would lose their jobs.
Northern Rivers Contaminated Land & Waste Forum

Practitioner Perspective and Wrap-up

Wednesday 21 June 2017

Marc Salmon, MEIANZ, CEnvP
Principal Environmental Scientist

marc@easterlypoint.com
Contaminated Land Program Overview

- 2 year program (June 2015 to August 2017)
- Grant funded by the NSW EPA with assistance by the NSW Environmental Trust
- Program created and supported by the Bellingen Shire Council for benefit of MIDROC region
Program Objectives

Program focuses identified through interviews and regional needs analysis:

- Improve staff knowledge of contaminated land issues and responsibilities
- Standardise the approach that staff take to considering and dealing with contaminated land matters
- Improved the approach used to collect, store and present contaminated land data

TRAINING / RESOURCES / SYSTEMS

MIDROC Contaminated Land Program
Program Achievements

Training Outputs
- Regional Seminar
- Conditions of consent
- Policy overview
- Data management
- Site investigations
- Legislation overview

eLearning Modules
- Policy and procedures review
- Consultants – Coffey Environments
- Data systems – Sutherland Shire Council
Program Achievements

Practical Assistance

Reviewing day to day matters to show staff first hand how to properly carry out various functions of council

- DA referrals
- Site investigations
- Developing affective conditions of consent or regulatory conditions
- Providing general advice and support as needed
Program Achievements

Other Practical Assistance

EPA and Council joint inspection of all active underground petroleum storage systems in the:

• Bellingen Shire
• Nambucca Shire
• Kempsey Shire
Program Achievements

Other Practical Assistance

Assisted in securing EPA grants for the investigation and removal of inherited underground petroleum storage systems in the council road reserve:

- Bellingen Shire - $150,000
- Nambucca Shire - $240,000
- Kempsey Shire - $90,000
- (Former) Greater Taree City Council - $300,000

Total of $780,000 in grant funding awarded to MIDROC members
Program Achievements

Model Contaminated Land Policy

- Developed to set a *regionally consistent standards* for the following key matter:

1. Site assessment and remediation triggers
2. Consultant standards
3. Clear consultant auditing requirements
4. Record keeping standards
5. Guidance on planning certificates
Program Achievements

Written procedural and guidance resources
Ongoing benefits for the region:

✓ Staff will have a better understanding of the topic and what their responsibilities are in responding to these issues

✓ A series of easy to follow resources will be available to assist staff and standardise the regional approach

✓ MIDROC Subgroup to carry on policy and procedural updates in the long-term
Guidance in 1992

**Guidance in 1992**

<table>
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<tr>
<th>Substance</th>
<th>Health Level (mg/kg)</th>
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</thead>
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<td>Lead</td>
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<td>Arsenic</td>
<td>100</td>
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<tr>
<td>Cadmium</td>
<td>20</td>
</tr>
<tr>
<td>Benzo(a)pyrene</td>
<td>1</td>
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<tr>
<td>PAHs</td>
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</tr>
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</table>
Guidance in 2017

Guidelines made by EPA:
- DEC (2005a) Contaminated Sites: Guidelines for Assessing Former Orchards and Market Gardens;
- DEC (2006) Contaminated Sites: Guidelines for the NSW Site Auditor Scheme;
- EPA (1995a) Contaminated Sites: Guidelines for the Vertical Mixing of Soil on Former Broad-acre Agricultural Land;
- OEH (2011) Contaminated Sites: Guidelines for Consultants Reporting on Contaminated Sites; and
Guidance in 2017

Guidelines approved by EPA:
- NEPC (2013) National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1), Schedule A and Schedules B(1) – B(9);
- NHMRC/NRMMC (2011) Australian Drinking Water Guidelines; and
Guidance in 2017

Technical notes made by EPA:
- DEC (2005b) Information for the Assessment of Former Gasworks Sites;
- DECCW (2010) Vapour Intrusion: Technical Practice Note;
- EPA (2012) Guidelines for the Assessment and Management of Sites impacted by Hazardous Ground Gases;
- EPA (2014a) Best Practice Note: Landfarming;
- EPA (2014b) Technical Note: Investigation of Service Station Sites;
- EPA (2015) Technical Note: Light Non-Aqueous Phase Liquid Assessment and Remediation; and
- EPA (2016) Designing Sampling Programs for Sites Potentially Contaminated by PFAS.
Guidance in 2017

**Schedule B1—Guideline on Investigation Levels for Soil and Groundwater**

**Schedule B2—Guideline on Site Characterisation**
- Appendix A Possible analytes for soil contamination
- Appendix B Data quality objective (DQO) process
- Appendix C Assessment of data quality
- Appendix D Example data presentation on scale drawings and borehole logs
- Appendix E Dioxins and dioxin-like compounds

**Schedule B3—Guideline on Laboratory Analysis of Potentially Contaminated Soils**
- Appendix A Determination of total recoverable hydrocarbons (TRH) in soil
Guidance in 2017

**Schedule B4—Guideline on Site-Specific Health Risk Assessment Methodology**
Appendix A Structure of a risk assessment report

**Schedule B5a—Guideline on Ecological Risk Assessment**
Appendix A Summary of the EILs for fresh and aged contaminants in soil with various land uses
Appendix B Mixtures of chemicals

**Schedule B5b—Guideline on Methodology to Derive Ecological Investigation Levels in Contaminated Soils**
Appendix A Review and comparison of frameworks for deriving soil quality guidelines in other countries
Appendix B Method for deriving EILs that protect aquatic ecosystems
Guidance in 2017

Schedule B5c—Guideline on Ecological Investigation Levels for Arsenic, Chromium (III), Copper, DDT, Lead, Naphthalene, Nickel and Zinc
Appendix A Raw toxicity for arsenic
Appendix B Raw toxicity for chromium (III)
Appendix C Raw toxicity for copper
Appendix D Explanation of the selection of the soil properties that control the added contaminant limits for copper
Appendix E Raw toxicity for DDT
Appendix F Raw toxicity for lead
Appendix G Raw toxicity for naphthalene
Appendix H Raw toxicity for nickel
Appendix I Raw toxicity for zinc
Guidance in 2017

Schedule B6—Guideline on the Framework for Risk-Based Assessment of Groundwater Contamination

Schedule B7—Guideline on derivation of health-based investigation levels
Appendix A1 Derivation of HILs for Metals and Inorganics

Criteria in NEPM? HILs (14 metals, cyanide, PAHs, phenols, OCPs, herbicides, pesticides, PCBs and PBDE flame retardants), soil vapour investigation levels for chlorinated VOCs, HSLs for petroleum compounds (soil, soil gas and groundwater) by depth and soil type, EILs, ESLs, TRHs management limits (17 pages), and GILs (8 pages).

Similarly for water quality guidelines. Plus EPA waste guidance, CRC CARE, other state's guidance, USEPA, European, ground gas, health documents, IARC, ITRC, et cetera, et cetera, et cetera, et cetera ...
SEPP 55 - 17 Guidelines and notices: all remediation work

(1) All remediation work must, in addition to complying with any requirement under the Act or any other law, be carried out in accordance with:
(a) the contaminated land planning guidelines, and
(b) the guidelines (if any) in force under the CLM Act, and
(c) in the case of a category 1 remediation work - a plan of remediation, as approved by the consent authority, prepared in accordance with the contaminated land planning guidelines.
Guidance non-compliance - inappropriate use

Former broad-acre agricultural sites have generally been considered unsuitable for residential development. Previous agricultural practices, particularly the regular application of persistent chemicals, may have caused some of these sites to have elevated levels of metals and pesticides. The soil contamination at these sites is characteristically widespread, with relatively low concentrations of contaminants confined to the surface soils. But the soil contamination needs to be reduced to even lower levels so that these sites do not pose a threat to residents who live on or near them in future.

The guidelines are aimed at environmental professionals or council staff who want to investigate the feasibility of using vertical mixing, whether for large development projects or single building allotments. Vertical mixing of soil is essentially the process of remediating contaminated surface soils by mixing them with cleaner soils found at greater depths.
Vertical mixing

Why is vertical mixing allowed, when “dilution is not the solution to pollution”? 
**Vertical mixing**

Prerequisites include that the land does not have any ‘hot spots’.

“If isolated hot spots are identified at a site, the EPA recommends further sampling to define the extent of these hot spots. Small volumes of contaminated soil should be remediated/managed by other means, e.g. excavation and treatment or, where permitted, disposal at a controlled landfill”.

EPA’s position:
- no vertical mixing to reduce contaminant levels except under the prerequisites in the guidelines and in line with the purpose of the guideline,
- contamination around sheds and mixing sites would be classified as hot spots, which can’t be included in vertical mixing, and
- vertical mixing is only applicable for low level contaminants associated with broad acre agriculture.
Guidance non-compliance – lack of design process

NEPM describes that the investigation components of a site assessment are:
- establishing the objectives of the site assessment;
- desktop study and detailed site inspection;
- compiling a site history from relevant site-related information;
- development of a conceptual site model (CSM), identification of data gaps;
- development of data quality objectives (DQOs);
- design of a sampling strategy and optimisation of a sampling and analysis quality plan (SAQP);
- data collection (delineation of potential and known contamination);
- data validation, analysis and interpretation (including risk assessment and iterative development of the CSM); and
- coherent presentation and reporting.
US EPA Triad is designed around the concept of managing decision uncertainty.

It draws on advancing science, technology, and practitioner experience to perfect strategies for making sitework more defensible (both scientifically and legally), more resource-effective, and more responsive to stakeholder expectations.
Guidance non-compliance - criteria

Basis for assessment criteria
• Table listing all selected assessment criteria and references
• Rationale for and appropriateness of the selection of criteria
• Assumptions and limitations of criteria
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<table>
<thead>
<tr>
<th>CHEMICAL</th>
<th>&gt;C10 - C16 Fraction</th>
<th>F2&gt; C10 - C16 TPHs minus naphthalene</th>
<th>&gt;C16 - C34 Fraction</th>
<th>&gt;C34 - C40 Fraction</th>
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<td>-</td>
<td>-</td>
</tr>
<tr>
<td>HSL commercial, sand 1 - &lt; 2 m</td>
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<td>no limit</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>HSL commercial, sand 2 - &lt; 4 m</td>
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<td>no limit</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>HSL commercial, sand 4+ m</td>
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<td>no limit</td>
<td>-</td>
<td>-</td>
</tr>
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<td>Eil, coarse grained</td>
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<td></td>
<td>1,700</td>
<td>3,300</td>
</tr>
<tr>
<td>Management limits, coarse</td>
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<td></td>
<td>3,500</td>
<td>10,000</td>
</tr>
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## Monocyclic Aromatic Hydrocarbons

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<th></th>
<th>&gt;C10 - C16 Fraction</th>
<th>F2&gt; C10 - C16 TPHs minus naphthalene</th>
<th>&gt;C16 - C34 Fraction</th>
<th>&gt;C34 - C40 Fraction</th>
</tr>
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<tbody>
<tr>
<td>Benzene</td>
<td>950</td>
<td></td>
<td>500&lt;sup&gt;6&lt;/sup&gt;</td>
<td>0.001</td>
</tr>
<tr>
<td>Toluene</td>
<td>-</td>
<td></td>
<td>-</td>
<td>0.8</td>
</tr>
<tr>
<td>Ethylbenzene</td>
<td>-</td>
<td></td>
<td>-</td>
<td>0.3</td>
</tr>
<tr>
<td>Xylenes</td>
<td>350 (as o-xylene)</td>
<td></td>
<td>-</td>
<td>0.6</td>
</tr>
<tr>
<td>Xylenes</td>
<td>200 (as p-xylene)</td>
<td></td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Styrene (Vinyl benzene)</td>
<td>-</td>
<td></td>
<td>-</td>
<td>0.03</td>
</tr>
</tbody>
</table>

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Easterly Point Environmental
Guidance non-compliance - sampling

Hotspot size and shape

EPA 1995 describes that the minimum sampling points required for site characterization are based on detecting circular hot spots with a 95% confidence level, using a systematic sampling pattern, in the case of Table A, a square grid sampling pattern.

Notes that Table A “is not the EPA’s blanket approval and that investigators must be prepared to defend the appropriateness of applying Table A only”.

**Sampling Grid Based on Site Size (Table A, 1995)**

<table>
<thead>
<tr>
<th>Size of the site (hectare)</th>
<th>Number of sampling points recommended</th>
<th>Equivalent sampling density (points/hectare)</th>
<th>Diameter of the hot spot that can be detected with 95% confidence (metre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.05</td>
<td>5</td>
<td>100.0</td>
<td>11.8</td>
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<td>0.1</td>
<td>6</td>
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<td>15.2</td>
</tr>
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<td>7</td>
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<td>19.9</td>
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<tr>
<td>0.4</td>
<td>11</td>
<td>27.5</td>
<td>22.5</td>
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<td>22.1</td>
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<td>0.7</td>
<td>17</td>
<td>24.3</td>
<td>23.9</td>
</tr>
<tr>
<td>0.8</td>
<td>19</td>
<td>23.8</td>
<td>24.2</td>
</tr>
<tr>
<td>0.9</td>
<td>20</td>
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<td>25.7</td>
</tr>
<tr>
<td>1.5</td>
<td>25</td>
<td>16.7</td>
<td>28.9</td>
</tr>
<tr>
<td>2.0</td>
<td>30</td>
<td>15.0</td>
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<td>2.5</td>
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<td>31.5</td>
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<td>13.3</td>
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<td>11.6</td>
<td>34.6</td>
</tr>
<tr>
<td>5.0</td>
<td>55</td>
<td>11.0</td>
<td>35.6</td>
</tr>
</tbody>
</table>
Some statistics for sampling

Site assessment can be likened to two tasks; map the different geology or strata, and then characterize the different geology or strata.

The mapping occurs through the selection of sampling locations \((x, y \text{ and } z)\), and the characterization through selection of samples for appropriate analysis.

The first task can include the use of hotspot defined sampling grids, whereas the characterization includes selection of an appropriate number of samples for analysis.
Sample points required based on hotspot shape

<table>
<thead>
<tr>
<th>Hotspot shape</th>
<th>f</th>
<th>Ratio</th>
<th>Number required</th>
<th>Increase in number</th>
</tr>
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<tbody>
<tr>
<td>Circular</td>
<td>0.05</td>
<td>1.08</td>
<td>21.6</td>
<td>-</td>
</tr>
<tr>
<td>Tear drop</td>
<td>0.05</td>
<td>1.25</td>
<td>25</td>
<td>16%</td>
</tr>
<tr>
<td>Unknown</td>
<td>0.05</td>
<td>1.4 - 1.5</td>
<td>28 - 30</td>
<td>30% – 39%</td>
</tr>
<tr>
<td>Elliptical</td>
<td>0.05</td>
<td>1.8</td>
<td>36</td>
<td>67%</td>
</tr>
</tbody>
</table>

f = target area expressed as fraction of site size (5%); Ratio from Ferguson 1992 and Beck 2013; Number of sample point for 1 ha; Increase in number from a circular target; Ratio for unknown target varies between Ferguson 1992 and Beck 2013.
The diameter of the hotspot is the critical aspect, not the number of samples. If the shape of the site means more samples to achieve the required grid, so be it. Does not include targeted locations!
Number of samples? EPA 1995/AS 4482.1 – 2005:

\[ n = \frac{(Z_{1-\alpha} + Z_{1-\beta})^2 \cdot s^2}{(C_S - \bar{x})^2} \]

\[ n = \frac{6.2 \cdot s^2}{(C_S - \bar{x})^2} \]

With alpha (\(\alpha\)) value and beta (\(\beta\)) value used to calculate the combined risk value (CRV).
Number of samples? USEPA 2006:

\[ n = \frac{\left( Z_{1-\alpha} + Z_{1-\beta} \right)^2 \cdot s^2}{(C_s - \bar{x})^2} + \frac{Z_{1-\alpha}^2}{2} \]

\[ n = \frac{6.2 \cdot s^2}{(C_s - \bar{x})^2} + 1.4 \]

With alpha (\(\alpha\)) value and beta (\(\beta\)) value used to calculate the CRV. Additional factor means two samples are the minimum number.
n - number of samples;

\( \alpha \) 0.05 alpha at 95% confidence level;

\( Z_{1-\alpha} \) 1.645 from table of z for selected alpha or beta;

\( \beta \) 0.2 beta at 80% confidence level;

\( Z_{1-\beta} \) 0.842 from table of z for selected alpha or beta;

s - sample standard deviation;

C - criterion; and

\( \bar{x} \) - sample arithmetic average.
Number of samples? Provost 1984 MPE method:

\[
n = t_p^2 \times \frac{s^2}{E^2}
\]

- \(n\): number of samples;
- \(t_p\): \(t\) value at 95% confidence level;
- \(s\): sample standard deviation; and
- \(E\): maximum probable error (Margin of error).
Number of samples? Standardised form using RSD and MPE, e.g. USEPA ProUCL:

\[ n = t_{95\%}^2 \times \left( \frac{s/\bar{x}}{t_{95\%} \times \left( \frac{s}{\sqrt{n}} \right)/\bar{x}} \right)^2 \]

- \( n \) number of samples;
- \( t_{95\%} \) \( t \) value at 95\% confidence level;
- \( s \) sample standard deviation; and
- \( \bar{x} \) sample arithmetic average.
USEPA ProUCL 5.1 sample size estimator *:

\[ n = t_{95\%}^2 \times \left( \frac{\text{RSD}}{\text{MPE}} \right)^2 \]

* Sample size for estimation of mean, based on specified values of decision parameters/DQOs:

- Confidence coefficient: 95%
- Allowable error margin: 35%
- Estimate of standard deviation: 100%
- Approximate minimum sample size: 34
Calculated sample numbers based on RSD and MPE values:

<table>
<thead>
<tr>
<th>RSD</th>
<th>10 MPE</th>
<th>15 MPE</th>
<th>20 MPE</th>
<th>25 MPE</th>
<th>35 MPE</th>
<th>50 MPE</th>
<th>75 MPE</th>
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<td>1,539</td>
<td>685</td>
<td>387</td>
<td>248</td>
<td>128</td>
<td>64</td>
<td>30</td>
<td>18</td>
</tr>
</tbody>
</table>
How you sample is critical!

For all assessments, a “weight of evidence” approach is required.

Includes appropriate sampling with use of field screening (visual, olfactory, PID, etc.), appropriate logging of samples and testpits/bores, sampling “inside” of stockpiles, etc., e.g. Vic EPA 2009 soil sampling guideline.
“IN GOD WE TRUST; ALL OTHERS MUST BRING DATA.”
- W. EDWARDS DEMING
Marc Salmon
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