



Department of
Environment

Contaminated Sites Management Series

**Bioremediation of
hydrocarbon-contaminated soils in
Western Australia**

October 2004

PREFACE

This document has been prepared by the Department of Environment (DoE) to assist those involved in the management of hydrocarbon-contaminated soils through bioremediation. The contents of this guideline are based on the best information available to the Land and Water Quality Branch at the time of publication.

Enquiries about this guideline may be directed to the Contaminated Sites Section as follows:

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ACKNOWLEDGMENTS

The DEP acknowledges the following organisations for assistance in the preparation of this guideline:

- Australian Contaminated Land Consultants Association (WA) Inc.

LIMITATIONS

The contents herein provide guidance only. Competent persons should be engaged to provide specific advice in relation to the bioremediation of contaminated soils.

This document should be used in conjunction with the texts referenced herein, and any other appropriate references.

These guidelines do not contain occupational safety and health procedures and should therefore not be used as a field manual for sampling. WorkSafe Western Australia should be consulted regarding such requirements.

DISCLAIMER

The information presented in this Document is provided voluntarily as a public service. The information provided is made available in good faith and is believed accurate at the time of publication (or at the time of release on the internet). However, the Document is intended to be a guide only and should not be seen as a substitute for obtaining appropriate advice or making prudent inquiries. The information is provided solely on the basis that readers will be responsible for making their own assessment of the matters discussed therein and that they should verify all relevant representations, statements and information. Changes in legislation, or other circumstances, after the Document has been published may impact on the accuracy of any information or advice contained in the Document and readers should not rely on the accuracy of information presented in this Document.

Information presented in this Document does not constitute, and is not intended to be used as legal advice nor used as an interpretive instrument. In the event of any inconsistency between this Document and relevant legislation, provisions of the relevant legislation will prevail.

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CONTAMINATED SITES MANAGEMENT SERIES

This guideline forms part of a management series developed by the DoE to provide guidance on the assessment and management of contaminated sites in Western Australia.

The Contaminated Site Management Series will contain the following guidelines:

- Assessment Levels for Soil, Sediment and Water
- Bioremediation of Hydrocarbon Contaminated Soils in Western Australia
- Certificate of Contamination Audit Scheme
- Community Consultation
- Contaminated Site Auditor Accreditation Scheme
- Disclosure Statements
- Development of Sampling and Analysis Programs
- Potentially Contaminating Activities, Industries, and Landuses
- Reporting of Known or Suspected Contaminated Sites
- Reporting on Site Assessments
- Site Classification Scheme
- Use of Monitored Natural Attenuation for Groundwater Remediation

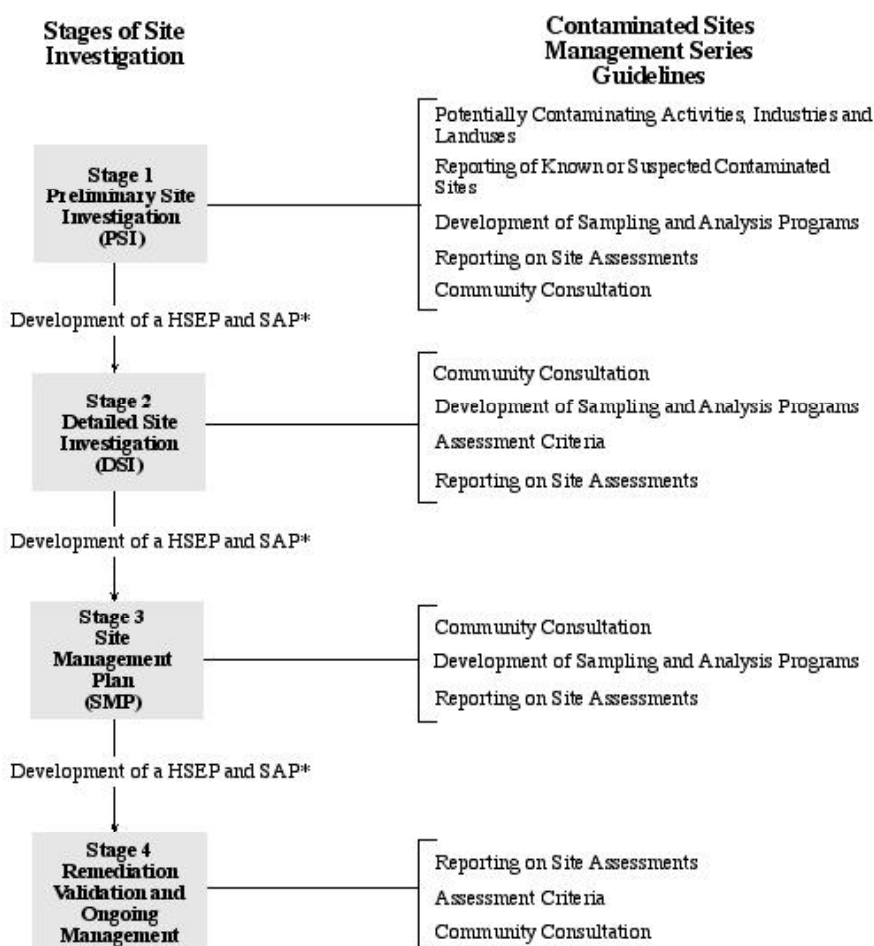
Reference to these guidelines should ensure that the minimum requirements of the DOE are satisfied.

Copies of these guidelines are available from the DoE's library located at Westralia Square, Level 8, 141 St George's Terrace, Perth, or from the DoE's website at www.environment.wa.gov.au.

STAGED APPROACH TO SITE INVESTIGATIONS

The Contaminated Sites Management Series of guidelines has been developed by the DoE to encourage a consistent approach to contaminated site assessment and management. One of the main focuses of the series is the **staged approach to site investigation**.

The purpose of this flow-chart, which appears in the preface of each of the Contaminated Sites Management Series guidelines, is to highlight to the reader the appropriate reference guideline(s) during each of stages of site investigation.



*Where samples are to be collected a Health, Safety and Environment Plan (HSEP), and Sampling and Analysis Plan (SAP) should be prepared.

TABLE OF CONTENTS

PREFACE	i
LIMITATIONS	ii
DISCLAIMER	
CONTAMINATED SITES MANAGEMENT SERIES	iii
STAGED APPROACH TO SITE INVESTIGATIONS	iv
TABLE OF CONTENTS	v
1. INTRODUCTION	1
1.1 DEFINITION	1
2. BIOREMEDIATION – THE DEPARTMENT OF ENVIRONMENT’S POSITION	2
3. MANAGEMENT OF BIOREMEDIATION FACILITIES	3
3.1 SITE SELECTION	3
3.2 CONSTRUCTION REQUIREMENTS	3
3.3 OPERATIONAL MONITORING REQUIREMENTS	4
4. TEMPORARY STORAGE OF CONTAMINATED SOILS	5
5. VALIDATION REQUIREMENTS	6
5.1 FOR DETERMINING END USE SOIL SUITABILITY	6
5.2 FOLLOWING DECOMMISSIONING ACTIVITIES OF THE BIO – REMEDIATION FACILITY	6
6. TRANSPORTATION REQUIREMENTS FOR CONTAMINATED SOILS	6
7. REPORTING REQUIREMENTS	7
8. LARGE – SCALE BIOREMEDIATION FACILITIES – LICENSING REQUIREMENTS	7
9. STATUTORY ENFORCEMENT	8
10. REFERENCE	9

1. INTRODUCTION

As the number of hydrocarbon contaminated sites identified in Western Australia increases, so too does the need for effective and responsible remediation practices. Soils contaminated by hydrocarbons can be actively remediated via bioremediation, however it is imperative that the bioremediation takes place in a manner that ensures that human health and the environment are not adversely impacted.

This guideline forms part of the *Contaminated Sites Management Series* (available on the DoE website, www.environment.wa.gov.au) and provides information on the management of bioremediation activities for hydrocarbon contaminated soils, and associated obligations under the *Environmental Protection Act 1986* (EP Act).

The information in this guideline is applicable to all sites where bioremediation will take place, however for sites where the total mass of material to be bioremediated is 1,000 tonnes per year or more, then a Works Approval and Pollution Prevention Licence under Part V of the EP Act, relating to prescribed premises, will be required - please refer to Section 8.

This document does not provide guidance on the methods of bioremediation, however information can be found at the following website:

- <http://www.epa.gov/>

1.1 DEFINITION

For the purpose of this guideline, bioremediation is defined as:

“The above-ground remediation of soils to reduce the concentrations of hydrocarbons through biodegradation. The process involves the stimulation of bacteria in the soil, which consume hydrocarbons as an energy source, releasing water and carbon dioxide as the ultimate breakdown products”.

A high level of technical understanding of the contaminants involved and bioremediation processes is assumed in this guideline.

2. BIOREMEDIATION – THE DEPARTMENT OF ENVIRONMENT’S POSITION

If properly managed, bioremediation is an environmentally sound, simple and cost effective method of reducing the concentrations of the majority of constituents of petroleum products. These products are typically found in soil and groundwater at sites where fuels have been stored, such as service stations, fuel depots, generator rooms and refineries, or where waste hydrocarbons are produced, such as car repair shops and car dealers.

The DoE supports the use of bioremediation for hydrocarbon contaminated soils where the contaminated soil can be treated to enable it to be used as a resource (e.g. backfill), to reduce disposal of soil to landfill and where works are managed so as not to pose a risk to the environment or human health.

The DoE does not consider the stockpiling and tilling of hydrocarbon impacted soils as an acceptable remediation method. This process merely changes the form of contamination to the vapour phase rather than reducing the total load into the environment.

The measures that are required to manage bioremediation at a site will depend on the types and concentrations of contaminants, as well as the proximity of the site to nearby sensitive receptors.

The DoE does not endorse bioremediation of hydrocarbon impacted soils in residential areas due to public concerns with issues such as odour, dust and noise emissions. If there is no viable alternative, such as transporting contaminated soils to a suitable bioremediation facility, then the DoE may consider a proposal for bioremediation if it demonstrates adequate safeguards to control, minimise and monitor any emissions. (This could include using an enclosed bio-cell with controls to reduce noise as well as the filtering and treatment of vapours prior to venting off).

3. MANAGEMENT OF BIOREMEDIATION FACILITIES

The initial design and ongoing management of bioremediation areas must be carefully considered when evaluating alternative remedial strategies. Incorrect siting and management of such facilities can introduce contamination into previously unaffected areas, which can present a potential risk to human health and the environment through soil, water and air. The following strategies should be particularly considered in all bioremediation scenarios.

3.1 SITE SELECTION

A poorly sited and/or constructed bioremediation facility can result in the transfer of contaminants from the source material to surrounding natural uncontaminated soils, groundwater and air, thereby creating new contamination issues as well as creating a potential risk to nearby sensitive receptors.

The following site characteristics should be considered prior to establishing a bioremediation facility:

- flat or gently sloping site;
- site is located such that, in the event of accidental discharge, contaminated material will not readily access adjacent soil, surface water or groundwater;
- suitable geological conditions (e.g. soils with low permeability);
- sufficient distance from surface water bodies (the DoE recommends that treatment sites should be at least 50 m from surface water bodies);
- sufficient separation of treatment cell from groundwater (the DoE recommends that bioremediation occur only where groundwater is at a depth of greater than 3 m below ground surface);
- sufficient distance from potential discharge pathways such as drains, soak wells, service trenches; and
- sufficient distance from odour sensitive receptors, e.g. any occupied (full or part-time) premises (the DoE recommends that this distance is greater than 50 m).

3.2 CONSTRUCTION REQUIREMENTS

A properly constructed bioremediation facility is imperative to ensure containment of contaminated materials. As a minimum, the DoE recommends that the following are considered when designing bioremediation facilities:

- Site must be adequately fenced to prevent public access. Appropriate signage (e.g. warning of contamination/excavation, providing site contact details, etc.) should also be provided.

- The base and bunding of the bioremediation facility should be constructed in accordance with *Water Quality Protection Note Lining systems to contain contaminants. (DoE 2004)*.
- Stormwater runoff should be diverted so as not to flow onto the treatment facility.
- Leachate and stormwater runoff containing contaminant levels likely to cause environmental harm must not be discharged from the facility. All leachate runoff should be directed to, and contained within, an impermeable leachate collection system with adequate capacity. Leachate may be treated, recycled into the bioremediation area or disposed of at an appropriate off-site location. If leachate is to be disposed of off-site it will be classified as a Controlled Waste and must be transported in accordance with the *Environmental Protection (Controlled Waste) Regulations 2001*.
- Air emissions - As the more volatile constituents of hydrocarbon contaminants tend to be removed by volatalisation during aeration of the bioremediating material, emission of volatile organic compounds (VOCs) may need to be monitored, controlled and/or treated. In the event that the concentrations and mass of VOCs being emitted into the air are likely to pose a risk to human health and/or the environment, then control measures such as covering the facility, as well as installing a vapour recovery and treatment system, will be required.
- Dust - Dust emissions should be minimised during construction and operation of a facility via appropriate dust suppression methods. A combination of the following techniques is likely to be the most effective: wind fencing, watering to damp down areas, hydromulching, chemical stabilisation and covering with chipped vegetation.
- Noise – The degree of noise concern will depend upon the location of the site in relation to nearby properties. Noise from machinery required to till bioremediating material may be an issue. Operations must comply with the *Environmental Protection (Noise) Regulations 1997*. Information on Noise Regulations should be obtained from local government authorities.
- Excavations - In all cases where excavation works are proposed, all works should be conducted in accordance with *Code of Practice – Excavation – Worksafe Western Australian Commission – December 1996*.

3.3 OPERATIONAL MONITORING REQUIREMENTS

In the event that soils to be bioremediated contain substances in concentrations and mass that have a potential to pose a risk to human health and the environment, site monitoring may be required. Requirements for air quality monitoring will vary

according to site characteristics (e.g nature of contaminated material, location of receptors). Proponents must prepare a monitoring plan as part of the remediation action plan for review and approval by the DoE prior to commencement of bioremediation activity.

Concentration of chemicals within soils should be monitored regularly to demonstrate that bioremediation is occurring at an acceptable rate. If bioremediation is occurring at too slow a rate, alternate remedial options should be considered.

4. TEMPORARY STORAGE OF CONTAMINATED SOILS

The DoE acknowledges that in some cases, contaminated soil may need to be stockpiled on-site awaiting either transport to a suitable bioremediation or disposal facility, or while awaiting laboratory analysis results to determine the soil's contamination status. In these cases, the DoE recommends that containment measures be implemented to prevent odours, vapours, soil particles and leachate from the stockpiled soils migrating off-site or to underlying soil and groundwater. To reduce adverse impact to the surrounding environment, temporary stockpiled soils should remain on-site for the shortest practical time after being excavated.

5. VALIDATION REQUIREMENTS

5.1 DETERMINING END USE SOIL SUITABILITY

- Stockpile sampling of bioremediated soils to determine their acceptability for landfilling should be undertaken in accordance with the *Guidelines for Acceptance of Solid Waste to Landfill* (DEP October 2002).
- To determine the class of landfill to which soil can be disposed, please refer to the *Landfill Waste Classification and Waste Definitions 1996 (as amended)* (DEP 2002).
- The number of samples collected and analysed for the validation of bioremediated and stockpiled soils should be in accordance with *Guidelines for Acceptance of Solid Waste to Landfill* (DEP 2002). To determine the suitability of bioremediated soils for use as an ongoing resource, analytical results should be compared to appropriate site specific criteria. To meet the DoE's requirements for clean fill, contaminant levels should be less than, or equal to, the site specific criteria adopted for the site. Site specific criteria must demonstrate that residual contaminant levels will not pose a risk to human health and/or the environment, including leaching to groundwater beneath the site.

- Although visual and olfactory observations are relevant, confirmatory analytical assessment of the soil is required to validate the performance of the bioremediation event. All laboratory analyses should be reported as per *Reporting on Site Assessments* (DEP 2001).

5.2 VALIDATION FOLLOWING DECOMMISSIONING OF THE BIO - REMEDIATION FACILITY

On completion of bioremediation and removal of the remediated soil, the natural ground surface beneath the bioremediation area will need to be validated by sampling and analysis to ensure that no leaching of hydrocarbons into in-situ soil has occurred. Sampling and analysis should be conducted as per *Development of Sampling and Analysis Programs* (DoE 2001) with laboratory results initially compared to *Assessment levels for Soil, Sediment and Water – version 3* (DEP 2003).

Groundwater monitoring will be required for those sites where impacted material has leached to underlying soils and the potential exists for groundwater to be impacted.

6. TRANSPORTATION REQUIREMENTS FOR CONTAMINATED SOILS

Where a contaminated site is located such that an on-site bioremediation facility is inappropriate, then contaminated soil will need to be transported off-site for treatment and/or disposal.

The transportation of contaminated soils is regulated under the *Environmental Protection (Controlled Waste) Regulations 2001*.

Where soils contain concentrations of contaminants that allow acceptance at Class I, II or III Landfills as per *Guidelines for Acceptance of Solid Waste to Landfill* (DEP 2002), no controlled waste permit is required.

Where soils contain concentrations of contaminants above the solid waste acceptance criteria for Landfill Class III, then soils must be transported in accordance with the *Environmental Protection (Controlled Waste) Regulations 2001*. These regulations require carriers to be licensed and the load accompanied by a controlled waste tracking form. For further information, please contact the Controlled Waste section of the DoE.

When transporting contaminated soil, the DoE recommends transport occur in such a manner to prevent contaminated soils from spilling, discharging or falling from the vehicle (e.g. securing/tarping of all loads).

7. REPORTING REQUIREMENTS

There is currently no statutory requirement to notify the DoE prior to commencement or completion of a bioremediation activity, unless the site processes a volume greater than 1000 tonnes per year and holds a licence under the *Environmental Protection Act 1986* (if unsure please contact the local DoE office). However, if bioremediation is being undertaken as part of a contaminated site investigation/remediation, the DoE recommends inclusion of the chosen remediation option including bioremediation in the site management plan and/or remediation action plan.

On full completion of the bioremediation event, the results should be incorporated into the validation report. The DoE's guideline entitled *Reporting on Site Assessments* (DEP 2001) details the DoE's reporting requirements.

When proposing bioremediation at a site, the following information should be provided to the DoE:

- site contact details during and after normal office hours;
- volume of contaminated soil to be bioremediated (m³);
- origin of contaminated soil;
- contaminant types and concentrations;
- location of bioremediation facility (including address and certificate of title, soil type, depth to groundwater, proximity of surface water, proximity to odour - sensitive premises);
- map of treatment area with sampling locations;
- management strategy (e.g. tilling, frequency, application rate of nutrients, management of wastewater, dust, emissions, restriction of site access);
- monitoring program (soil, groundwater, air); and
- estimated duration of operation.

8. LARGE - SCALE BIOREMEDIATION FACILITIES - LICENSING REQUIREMENTS

Where more than 1000 tonnes per year of hydrocarbon contaminated soil is being considered for bioremediation, a Works Approval to construct the facility, and a Pollution Prevention Licence to operate the facility will be required. The relevant Premises Category is 61A (Solid waste facility: premises on which solid waste produced on other premises is stored, reprocessed, treated or discharged onto land – 1000 tonnes or more per year). To obtain an application form and further information please refer to www.environ.wa.gov.au/downloads/1208_GLS02.pdf or contact the local DoE office. In setting up a facility, particular consideration should be given to Section 3 of this document.

9. STATUTORY ENFORCEMENT

In the event that these guidelines are not considered, and bioremediation treatment results in a breach of the *Environmental Protection Act 1986*, such as:

- direct or indirect alteration to the environment which is to the environment's detriment or degradation;
- detrimental effect to any beneficial use (e.g. impacts groundwater to such a degree that it can no longer be used for domestic irrigation); or
- causes or is likely to cause waste to be discharged (including the emission of noise or odour),

the DoE may pursue enforcement options under the *Environmental Protection Act 1986*. Additional enforcement and penalties may also apply once the *Contaminated Sites Act 2003* is proclaimed.

10. REFERENCES

Department of Environment (DoE) (August 2004) *Water Quality Protection Note – Lining systems to contain contaminants.*

Department of Environmental Protection (DEP) (December 2003) *Draft Assessment Levels for Soil, Sediment and Water.*

Department of Environmental Protection (DEP) (2001) *Landfill Waste Classification and Waste definitions 1996 (as amended).*

Department of Environmental Protection (DEP) (2002) *Guidelines for the Acceptance of Solid Waste to Landfill.*

Department of Environmental Protection (DEP) (2001) *Development of Sampling and Analysis Programs.*

Department of Environmental Protection (DEP) (2001) *Reporting on Site Assessments.*

Government of Western Australia (2001) *Environmental Protection (Controlled Waste) Regulations 2004.*

Government of Western Australia (1997) *Environmental Protection (Noise) Regulations 1997.*

Government of Western Australia (2001) *Environmental Protection Regulations 1987 as amended.*

Government of Western Australia (1996) *Code of Practice – Excavations.*

Standards Australia AS 4482.1 *Guide to the sampling and investigation of potentially contaminated soil. Part 1: Non volatile and semi volatile compounds Part2: Volatile substances*