Widespread use of bauxite residue, Peel Harvey Coastal Plain Catchment — Extension of approval time limit

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Agriculture Western Australia

Section 46 Report and recommendations
of the Environmental Protection Authority

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Summary and recommendations

Agriculture Western Australia (the proponent) wishes to extend the time limit of environmental approval for the proposed widespread use of bauxite residue within the Peel-Harvey Coastal Plain Catchment (DAWA, 1993). This report provides the Environmental Protection Authority's (EPA's) advice and recommendations to the Minister for the Environment on the environmental factors, conditions and procedures relevant to an extension of the time limit.

Section 46 of the *Environmental Protection Act 1986* requires the EPA to report to the Minister for the Environment on whether or not proposed changes to conditions and procedures should be allowed. In addition, the EPA may make recommendations as it sees fit.

Relevant environmental factors

The EPA's assessment of the proposal in 1993 did not make direct reference to environmental factors. However the EPA considers that the environmental factors relevant to its previous (1993) assessment of the proposal are:

- Surface water quality - phosphorus loss to the Peel-Harvey Estuary;
- Watercourses - changes to soil infiltration rates affecting run-off;
- Groundwater quality - effects on underground water pollution control areas;
- Terrestrial vegetation - impacts on terrestrial and riparian vegetation and flora;
- Estuaries - changes to water quality; and
- Wetlands - impacts due to changes in surface or ground water quality.

These factors have not changed in relation to the proposed extension as there is no change to the proposal assessed by the EPA in 1993.

Conclusions

The EPA has considered the request by the proponent to extend the time limit of environmental approval for the proposed widespread use of bauxite residue within the Peel-Harvey Coastal Plain Catchment and has concluded that a five year extension should be granted.

The EPA believes that the period since the proposal for the widespread use of bauxite residue within the Peel-Harvey Coastal Plain Catchment was originally assessed has not given rise to any changes that would cause the EPA to reconsider its previous assessment of the project or its previous recommendation as to the environmental acceptability of the project.

However the EPA has made some recommendations for changes to the Environmental Conditions of February 1994 which should accompany the proposed extension, in order to ensure that the proposal is managed adaptively according to environmental best practice and to ensure that the conditions reflect the most up to date format and wording of environmental conditions. These recommended changes are discussed in Sections 4.2 and 4.3 of this report.

Conditions

The EPA recommends that the conditions, which are set out in detail in the draft statement contained in Appendix 3, be imposed so as to effectively replace those set out in the statement of February 1994 if the proposed time limit extension for the widespread use of bauxite residue within the Peel-Harvey Coastal Plain Catchment is approved. This new statement would have the effect of :

- extending the time limit of environmental approval;
- incorporating a requirement for an Environmental Management System to be developed and implemented by the proponent;
- incorporating a requirement for a limited quantity of bauxite residue material to be made available by the proponent for widespread use within the first five years of substantial implementation of the proposal, with review by the EPA at five yearly intervals thereafter ;
- updating the format and wording of the statement and conditions of the statement of February 1994 to reflect current standards.

Recommendations

The EPA submits the following recommendations to the Minister for the Environment:

1. That the Minister notes this report is pursuant to Section 46 of the *Environmental Protection Act 1986* and thus is limited to consideration of proposed changes to the original proposal or environmental conditions.
2. That the Minister notes that purpose of the proposed changes is to facilitate an extension of the period available for commencement of implementation of the proposal beyond the five years specified in Condition 7-1 of the Minister's statement of 4 February 1994.
3. That the Minister notes that the EPA has concluded that the proposed extension of the period for substantial commencement of the proposal, for a further five years, is environmentally acceptable subject to the proposed changes to the Environmental Conditions of February 1994 set out in Appendix 3 of this report. In particular these changes include:
    - the inclusion of a new condition requiring an Environmental Management System;
    - the inclusion of a new condition requiring a limited volume of material to be made available for widespread use within the first five years of substantial implementation of the proposal with review by the EPA at five yearly intervals thereafter ; and
    - the updating of the statement and the Environmental Conditions of approval to reflect current practice.
4. That the Minister imposes the conditions and procedures set out in Appendix 3 of this report.

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1. Introduction and background

Agriculture Western Australia (the proponent) wishes to extend the time limit of environmental approval for the widespread use of bauxite residue within the Peel-Harvey Coastal Plain Catchment for a further five years.

The proposal was assessed by the Environmental Protection Authority (EPA) in 1993 at the level of Public Environmental Review. The Western Australian Department of Agriculture (now Agriculture Western Australia) was nominated proponent for the widespread use of bauxite residue within the Peel-Harvey Coastal Plain Catchment.

The Minister for the Environment gave environmental approval for the project, subject to conditions, on 4 February 1994. Condition 7 of the Minister's statement of approval (Appendix 2) set a time limit of five years for commencing the project. After this period, any extension to that time limit would have to occur via a request to change the condition under Section 46 of the Environmental Protection Act 1986.

In accordance with Condition 7, the Agriculture Western Australia has requested that the time limit of approval be extended for a further five years via a Section 46 change to conditions. This request was made on 2 February 1999, prior to the expiry date referred to in Condition 7.

Further details of the proposal and the request for extension are presented in Section 2 of this report. Section 3 discusses environmental factors relevant to the proposal. Section 4 describes the environmental significance of the extension and the need for changes to the Environmental Conditions. Conditions and procedures to which the extended project, should be subject if the Minister determines that it may be implemented are set out in Section 5. Section 6 presents the EPA's conclusions and Section 7 the EPA's recommendations.

Appendix 1 contains the references for the EPA's report, Appendix 2 the Statement of Environmental Conditions of Approval of 4 February 1994 and Appendix 3, the Recommended Environmental Conditions for the extension of approval for the project. Appendix 4 contains the report of Geoprocc Pty Ltd on the EPA's independent review of environmental monitoring and research.

2. The proposal

2.1 Approved proposal

In 1993 the Western Australian Department of Agriculture (now Agriculture Western Australia) agreed to be nominated as the proponent to facilitate the widespread use of bauxite residue in the Peel-Harvey Coastal Plain Catchment. Agriculture Western Australia pursued this proposal in order to fulfil its dual role in the Peel-Harvey Coastal Plain Catchment of developing sustainable agriculture and reducing phosphorus loads to the Peel-Harvey Estuary. In accepting this role, Agriculture Western Australia was expected to be responsible for the marketing of bauxite residue and ensuring that any environmental conditions set by the Minister for the Environment in response to assessment by the EPA were met.

At the time of assessment, the EPA recommended that:

- the broad-scale use of the residue be approved only for use as a soil amendment on properties currently subject to agricultural and horticultural use;
- prior to widespread use of bauxite residue commencing the proponent prepare a Code of Practice for residue use incorporating environmental issues;
- within six months of commencement of widespread use of bauxite residue the proponent develop and implement a research program that evaluates the potential environmental effects for a range of application rates and subsequent soil mixing scenarios; and

- the proponent design and implement a monitoring program that includes, but is not limited to, addressing nominated primary concerns for key sub-catchment and environments in the Peel-Harvey Coastal Plain Catchment.

A more detailed description of the original proposal is contained in the EPA's assessment of the proposal (EPA, 1993) and in the Public Environmental Review (DAWA, 1993). The environmental conditions of approval for the proposal (of February 1994) are contained in Appendix 2.

2.2 Proposed changes to environmental conditions

Condition 7-1 of the Minister for the Environment's statement authorising the proposal (Appendix 2) states that;

7-1 If the proponent has not substantially commenced the project within five years of the date of this statement, then the approval to implement the proposal as granted in this statement shall lapse and be void. The Minister for the Environment shall determine any question as to whether the project has been substantially commenced. Any application to extend the period of five years referred to in this condition shall be made before the expiration of that period, to the Minister for the Environment by way of a request for a change in the condition under Section 46 of the Environmental Protection Act. (On expiration of the five year period, further consideration of the proposal can only occur following a new referral to the Environmental Protection Authority.)

This condition has the effect of requiring a proponent to request a change in the Environmental Conditions to allow for an extension in the five approval time limit, before the expiration of five years from the date of the Minister's Statement.

Since the Minister's approval of 1994, the main operational phase of the proposal has not been able to proceed, due largely to the need to resolve a deed of indemnity between the Government of Western Australia and Alcoa (the source supplier of bauxite residue material). This deed of indemnity, which was finalised in September 1999, indemnifies Alcoa against unforseen consequences arising from the use of bauxite residue in accordance with the conditions set by the Minister for the Environment.

As a result of the delay in the operational phase of the project, the proposal as set out in the Minister's statement is judged by the EPA not to have 'substantially commenced' and accordingly, a request for an extension of the five year approval time limit was submitted by Agriculture Western Australia prior to the expiry date of the five year time limit of 4 February 2000.

Table 1 - Summary of key proposal characteristics

Element	Description
Bauxite residue	The fine and coarse fractions of bauxite residue that are a by-product of the alumina industry. The fine fraction (Red Mud or Alkaloam) is a Bayer process by- product from processing of Darling Range bauxite at Alcoa's alumina refineries at Kwinana, Pinjarra and Wagerup. The Coarse fraction (Residue Sand, Red Sand) is the partially dried residue material as recovered from drying beds. Very alkaline (pH ~10.8) due to the use of caustic soda in the alumina extraction process. The quality specifications for the material to be used are set out in the schedule of the deed of Indemnity between the State of Western Australia and Alcoa of Australia Limited of 6 September 1999.
Uses	Soil amendment
Application rate	To be specified in the Code of Practice for residue use to be approved by the EPA.
Application Limits	Year Total annual application limit (tonnes) 2000 50,000 2001 50,000 2002 75,000 2003 85,000 2004 100,000
Application area	Peel-Harvey Coastal Plain Catchment as defined by Schedule 1 of the *Environmental Protection (Peel Inlet-Harvey Estuary) Policy 1992.*

3. Relevant environmental factors

Section 46 of the *Environmental Protection Act 1986* requires the EPA to report to the Minister for the Environment on whether or not the proposed changes to conditions or procedures should be allowed. In addition, the EPA may make recommendations as it sees fit.

The EPA's assessment of the proposal in 1993 did not make direct reference to environmental factors. However the EPA considers that the environmental factors relevant to its previous (1993) assessment of the proposal are:

- Surface water quality - phosphorus loss to the Peel-Harvey Estuary;
- Watercourses - changes to soil infiltration rates affecting run-off;
- Groundwater quality - effects on underground water pollution control areas;
- Terrestrial vegetation - impacts on terrestrial and riparian vegetation and flora;
- Estuaries - changes to water quality; and
- Wetlands - impacts due to changes in surface or ground water quality.

These factors have not changed in relation to the proposed extension as there is no change to the proposal assessed by the EPA in 1993.

4. Environmental significance of the proposed extension

4.1 General

Discussion

Approval for this project was initially limited to five years, recognising that over time predicted environmental impacts and their significance may change. Over five years, knowledge of the receiving environment may increase as a result of further studies, and the anticipated impacts on this environment may change as a result of increased understanding of interaction between the environment and the proposal. In addition, environmental regulations, standards, guidelines and accepted practices may also change.

In order to assist in the EPA's consideration of the proposed extension of approval, the Department of Environmental Protection (DEP) (on behalf of the EPA) commissioned an independent review of the research and monitoring of trials of bauxite residue use undertaken by the proponent since the 1994 approval. The report on the results of this review, which was conducted by an independent scientist, Dr Robert Gerritse of Geoprocc Pty Ltd, is contained in Appendix 4. The Geoprocc report made a number of recommendations with respect to the proposed extension of approval for the proposal and related monitoring and research. These recommendations are discussed further in other sections of this report.

Assessment

In consideration of the proposed extension and the results of the EPA's review, the EPA formed the view that although there have been some new developments with respect to recognition and understanding of environmental issues and related policy over the past five years there has not been any change which would significantly affect the overall environmental acceptability of the proposal as described in the 1993 PER document.

The EPA therefore considers that, taking into account the environmental factors relevant to the proposal, the conclusions and recommendations of the EPA's 1993 assessment of the proposal are still appropriate and that accordingly the proposed 5 years extension from original expiry date of 4 February 1999 should be granted through a change to the conditions.

The EPA has also made some recommendations for changes to the Environmental Conditions of February 1994 which should accompany the proposed extension, in order to ensure that the proposal is managed adaptively according to environmental best practice and to ensure that the format and wording of the statement and conditions are in accordance with contemporary standards. These recommended changes, which have been agreed by the proponent, are discussed in Section 4.2 and 4.3 of this report.

4.2 Maximum application rates and phased implementation

Discussion

The Geoprocc report, reviewing the research and monitoring of trials of bauxite residue use undertaken by the proponent since the 1994 approval, contained the following recommendations:

5.1 *It is considered that adequate information has been provided, which would allow implementation of a staged approach to the use of bauxite residue in the Peel-Harvey Catchment.*

This approach should involve applying bauxite residue to soils at 20t/ha in a number of selected subcatchments, with more comprehensive monitoring to include groundwater at these sites and also lysimeter measurements.

Monitoring within these subcatchments should occur twice during the winter wet period to the requirements of the DEP and WRC. The first monitoring should be done after a cumulative annual rainfall of 150-200 mm has been recorded and the second at the end of August or beginning of September. Water should be sampled during periods of no rainfall.

The Code of Practice should address the application frequency of bauxite residue at 20t/ha, if decreases in phosphorus concentrations are to be sustainable.

5.1 *Application of amounts of bauxite residue, greater than 20 t/ha, within the Peel-Harvey Catchment should not occur until further investigation has been carried out to evaluate the potential impact of these amounts on groundwater and the environment.*

Further water and soil quality monitoring within the catchments, together with leachability (TCLP) and lysimeters measurements should be carried out to the requirements of the DEP and WRC to assess both the short and long-term impacts of soil amendment with red mud at (cumulative) amounts greater than 20 t/ha.

In recent discussion between the EPA and the proponent, Agriculture WA has indicated that maximum application rate for the bauxite residue to be set out in the Code of Practice required by Condition 3 of the 1994 statement is likely to be significantly lower than those rates proposed in the 1993 PER documentation and in particular will be limited to a maximum single application of 20 tonnes per hectare within a five year period.

Additionally Agriculture WA has agreed to release a limited quantity of material for use in each calendar year, with five yearly reviews of these annual quantities involving the EPA. An agreed additional condition to make this undertaking legally binding is set out in Appendix 3.

Finally Agriculture Western Australia has agreed to conduct further research and targeted environmental monitoring in sub-catchments within the Peel Harvey Coastal Plain Catchment to address the matters raised in the Geoprocc report. This will be carried out as a component of the monitoring and research programmes required by Conditions 4 and 5 of the 1994 statement.

Assessment

Having particular regard to:

- the recommendations of the report to the EPA by Geoprocc, on the review of research and monitoring of trials of bauxite residue use undertaken by the proponent since the 1994 approval;
- advice from the proponent that indicates that maximum application rate for bauxite residue is likely to be significantly lower that the maximum rates suggested in the PER and will be restricted in the first instance, under the proposed Code of Practice, to a maximum single application of 20 tonnes per hectare within a five year period ;
- the proposed new environmental condition which has been agreed between the EPA and the proponent, requiring annual limits on the amount of residue material released; and
- the proponent's undertaking to conduct further research and targeted environmental monitoring in sub-catchments within the Peel Harvey Coastal Plain Catchment as a component of the monitoring and research programmes required by Conditions 4 and 5 of the 1994 statement;

it is the EPA's opinion that the requested extension of the time limit of environmental approval should be granted.

4.3 Changes to other environmental conditions

Discussion

Assessment of this proposal under Section 46 of the *Environmental Protection Act 1986* allows the EPA the opportunity to consider the amendment of other environmental conditions. The Environmental Conditions currently applicable to the widespread use of bauxite residue within the Peel-Harvey Coastal Plain Catchment are included as Appendix 2.

Assessment

The EPA has taken the opportunity to review the Environmental Conditions set on this proposal with a view to:

(a) updating the statement and wording conditions to ensure that they are consistent with current practice ; and

(b) ensuring consistency and compatibility with current environmental protection requirements and expectations for best practice environmental management.

An additional environmental condition has been agreed requiring Agriculture Western Australia to prepare and implement an Environmental Management System (EMS) for the project. This condition is recommended to ensure that (among other things) responsibilities and accountabilities for implementation and continuous improvement of the code of practice and environmental performance are well documented.

The EPA's proposed changes to the existing conditions are set out in greater detail in Table 2. This table should be examined in conjunction with the original Environmental Conditions in Appendix 2 and the recommended draft conditions in Appendix 3. The proponent's commitments, which are the original commitments attached to the 1994 ministerial statement are contained in Appendix 3.

The recommended draft conditions provide for adequate protection of the environment and for efficient and effective environmental auditing of compliance.

Therefore, having particular regard to the;

- the wording and current format of the Environmental Conditions;
- need for compatibility with current environmental protection requirements; and
- requirement for an Environmental Management System;

it is the EPA's opinion that the Conditions set out in Appendix 3 should replace the earlier Conditions and be implemented by the proponent.

5. Conditions

Section 46 of the *Environmental Protection Act 1986* requires the EPA to report to the Minister for the Environment on whether or not the proposed changes to conditions or procedures should be allowed. In addition, the EPA may make recommendations as it sees fit.

In developing recommended conditions for each project, the EPA's preferred course of action is to have the proponent provide an array of commitments to ameliorate the impacts of the proposal on the environment. The EPA acknowledges that the proponent's commitments provided in 1994 will continue to apply to the project and advises that the recommended changes to conditions set out in section 6 supersede the requirement for additional commitments.

The EPA recommends that the conditions, which are set out in detail in the draft statement contained in Appendix 3, be imposed so as to effectively replace those set out in the statement of February 1994, if the proposed time limit extension for the widespread use of bauxite residue within the Peel-Harvey Coastal Plain Catchment is approved. This new statement would have the effect of:

- extending the time limit of environmental approval;
- incorporating a requirement for an Environmental Management System to be developed and implemented by the proponent;
- incorporating a requirement for a limited quantity of bauxite residue material to be made available by the proponent for widespread use within the first five years of substantial implementation of the proposal, with review by the EPA at five yearly intervals thereafter ;
- updating the format and wording of the conditions of the statement of February 1994 to reflect current practice.

6. Conclusions

The EPA has considered the request by the proponent to extend the time limit of environmental approval for the proposed widespread use of bauxite residue within the Peel-Harvey Coastal Plain Catchment and has concluded that a five year extension should be granted.

The EPA believes that the period since the proposal for the widespread use of bauxite residue within the Peel-Harvey Coastal Plain Catchment was originally assessed has not given rise to any changes that would cause the EPA to reconsider its previous assessment of the project or its previous recommendation as to the environmental acceptability of the project.

However the EPA has made some recommendations for changes to the Environmental Conditions of February 1994 which should accompany the proposed extension, in order to ensure that the proposal is managed adaptively according to environmental best practice and to ensure that the conditions reflect the most up to date format and wording of environmental conditions. These recommended changes are discussed in Section 4.1 to 4.3 of this report.

7. Recommendations

Section 46 of the *Environmental Protection Act 1986* requires the EPA to report to the Minister for the Environment on the environmental factors relevant to the proposal and on the conditions and procedures to which the proposal should be subject, if implemented. In addition, the EPA may make recommendations as it sees fit.

The EPA submits the following recommendations to the Minister for the Environment:

1. That the Minister notes this report is pursuant to Section 46 of the *Environmental Protection Act 1986* and thus is limited to consideration of proposed changes to the original proposal or environmental conditions.
2. That the Minister notes that purpose of the proposed changes are to facilitate an extension of the period available for commencement of implementation of the proposal beyond the five years specified in Condition 7 of the statement of approval (February 1994). .

3. That the Minister notes that the EPA has concluded that the proposed extension of the period for substantial commencement of the proposal, for a further five years, is environmentally acceptable subject to the proposed changes to the Environmental Conditions of February 1994 set out in Appendix 3 of this report. In particular these changes include

   - the inclusion of a new condition requiring an Environmental Management System;
   - the inclusion of a new condition requiring a limited volume of material to be made available for widespread use within the first five years of substantial implementation of the proposal with review by the EPA at five yearly intervals thereafter ;
   - the updating of the statement and standard environmental conditions of approval to reflect current practice.

4. That the Minister imposes the conditions and procedures set out in Appendix 3 of this report.

Table 2 - Summary of proposed changes to Environmental Conditions.

Orig. cond.	Requirements (summarised)	Evaluation	Recommended change / new wording of condition
N/A	Proponent Name	Name change on page 1 of the statement to reflect current proponent agency title. The Department of Agriculture was renamed Agriculture Western Australia in 1995.	Agriculture Western Australia
2		Revised condition to reflect contemporary format and wording of standard environmental conditions	**1 Implementation** 1-1. Subject to these conditions and procedures, the proponent shall implement the proposal as described above (see 'Proposal'). 1-2. Where the proponent seeks to change any aspect of the proposal as documented in this statement in any way that the Minister for the Environment determines, on advice of the Environmental Protection Authority, is substantial, the proponent shall refer the matter to the Environmental Protection Authority. 1-3. Where the proponent seeks to change any aspect of the proposal as documented in this statement in any way that the Minister for the Environment determines, on advice of the Environmental Protection Authority, is not substantial, those changes may be effected.

Orig. cond.	Requirements (summarised)	Evaluation	Recommended change / new wording of condition
1		Revised condition to reflect contemporary format and wording of standard environmental conditions	**2 Proponent Commitments** 2-1 The proponent shall implement the consolidated environmental management commitments documented in Schedule 2 of this statement. 2-2 The proponent shall implement subsequent environmental management commitments which the proponent makes or has made as part of the fulfilment of conditions and procedures in this and any previous statement issued for this proposal.
6		Revised condition to reflect contemporary format and wording of standard environmental conditions	**3 Proponent** 3-1 The proponent for the time being nominated by the Minister for the Environment under section 38(6) or (7) of the Environmental Protection Act 1986 is responsible for the implementation of the proposal until such time as the Minister for the Environment has exercised the Minister's power under section 38(7) of the Act to revoke the nomination of that proponent and nominate another person in respect of the proposal. 3-2 Any request for the exercise of that power of the Minister referred to in condition 3-1 shall be accompanied by a copy of this statement endorsed with an undertaking by the proposed replacement proponent to carry out the proposal in accordance with the conditions and procedures set out in the statement. 3-3 The proponent shall notify the Department of Environmental Protection of any change of proponent contact name and address within 30 days of such change.

Orig. cond.	Requirements (summarised)	Evaluation	Recommended change / new wording of condition
7	Project to be commenced within five years or the approval shall lapse and be void.	Requested time limit extension should be granted. The project should now substantially commence within five years of the revised Ministerial Statement.	**4 Commencement** 4-1. The proponent shall provide evidence to the Minister for the Environment within five years of the date of this statement that the proposal has been substantially commenced. 4-2. Where the proposal has not been substantially commenced within five years of the date of this statement, the approval to implement the proposal as granted in Statement Number 339 (4 February 1994) shall lapse and be void. The Minister for the Environment will determine any question as to whether the proposal has been substantially commenced. 4-3. The proponent shall make application to the Minister for the Environment for any extension of approval for the substantial commencement of the proposal beyond five years from the date of this statement at least six months prior to the expiration of the five year period referred to in conditions 4-1 and 4-2. 4-4. Where the proponent demonstrates to the requirements of the Minister for the Environment on advice of the Department of Environmental Protection that the environmental parameters of the proposal have not changed significantly, then the Minister may grant an extension not exceeding five years for the substantial commencement of the proposal.

Orig. cond.	Requirements (summarised)	Evaluation	Recommended change / new wording of condition
8		Revised condition to reflect contemporary format and wording of standard environmental conditions	**5 Compliance Auditing** 5-1. The proponent shall submit periodic Compliance Reports, in accordance with an audit program prepared in consultation between the proponent and the Department of Environmental Protection. 5-2. Unless otherwise specified, the Chief Executive Officer of the Department of Environmental Protection is responsible for assessing compliance with the conditions, procedures and commitments contained in this statement and for issuing formal, written advice that the requirements have been met. 5-3. Where compliance with any condition, procedure or commitment is in dispute, the matter will be determined by the Minister for the Environment.

Orig. cond.	Requirements (summarised)	Evaluation	Recommended change / new wording of condition
N/A		New standards condition to provide for an EMS	**6 Environmental Management System** 6-1 In order to manage the environmental impacts of the project, and to fulfil the requirements of the conditions and procedures in this statement, within 12 months following the commencement of the widespread use of bauxite residue as a soil amendment, the proponent shall demonstrate to the requirements of the Environmental Protection Authority on advice of the Department of Environmental Protection that there is in place an environmental management system which includes the following elements: 1 An environmental policy and corporate commitment to it; 2 Mechanisms and processes to ensure: (1) planning to meet environmental requirements; (2) implementation and operation of actions to meet environmental requirements; (3) measurement and evaluation of environmental performance; and 3 Review and improvement of environmental outcomes. 6-2. The proponent shall implement the environmental management system referred to in condition 6-1.

Orig. cond.	Requirements (summarised)	Evaluation	Recommended change / new wording of condition
3		Revised condition to reflect contemporary format and wording of environmental conditions	**7 Code of Practice** 7-1 To ensure responsible use and reflect management changes found necessary as a result of monitoring, the proponent shall, prior to the widespread use of bauxite residue as a soil amendment, prepare a Code of Practice, to the requirements of the Environmental Protection Authority, incorporating environmental issues which include consideration of the following: (1) dust control during transport and application; (2) assessment of optimum application rate based on changes to pH; (3) separation distance, necessary to protect flora and water quality, between areas where bauxite residue is applied and areas of remnant vegetation or watercourses ; and (4) frequency of review to incorporate management recommendations gained from experience and monitoring of bauxite residue use. 7-2 The proponent shall review the Code of Practice at a frequency determined in accordance with condition 7-1. 7-3 The proponent shall monitor and ensure compliance with the environmental aspects of the Code of Practice prepared in accordance with Condition 7-1.

Orig. cond.	Requirements (summarised)	Evaluation	Recommended change / new wording of condition
4		Revised condition to reflect contemporary format and wording of environmental conditions	**8 Evaluation of Effects of Application Rate and Soil Mixing Scenarios** 8-1 To evaluate the variation in environmental effects arising from application rates and soil mixing scenarios, the proponent shall, within six months following the commencement of widespread use of bauxite residue for soil amendment, develop a research program which includes an evaluation of the following potential environmental effects for a range of application rates and subsequent soil mixing scenarios: (1) changes to soil permeability; (2) changes to surface water run-off flow patterns and volumes; and (3) changes to pH of surface water run-off; to the requirements of the Environmental Protection Authority on advice of the Water and Rivers Commission. 8-2 The proponent shall implement the research programme required by condition 8-1. 8-3 The proponent shall make available to the public, results from the research programme required by condition 8-1 to the requirements of the Environmental Protection Authority.

Orig. cond.	Requirements (summarised)	Evaluation	Recommended change / new wording of condition
5	Monitor catchments with a high proportion of the area amended by bauxite residue to assess environmental impacts and confirm predictions at the time of assessment.	Revised condition to reflect contemporary format and wording of standard environmental conditions.	**9 Catchment Monitoring** 9-1. Within six months following the commencement of widespread use of bauxite residue as a soil amendment, the proponent shall design a monitoring programme to monitor key catchments with a high proportion of their area amended with bauxite residue, and key environments in the Peel-Harvey Coastal Plain Catchment. This programme shall address the following matters: (1) adequacy of measures to protect remnant vegetation; (2) impacts from changes in pH and Aluminium concentrations in the catchment on wetlands; (3) changes to surface water run-off flow patterns and volumes, and the effects of these changes on wetlands and drainage water quality; and (4) monitoring of ground and surface water quality parameters, including pH, heavy metals, turbidity and radioactivity, to confirm predictions in the Public Environmental Review document and the assessment report; to the requirements of the Environmental Protection Authority on advice of the Water and Rivers Commission. 9-2. The proponent shall make available to the public annually, results from the monitoring programme required by condition 9-1. 9-3. The proponent shall review and re-submit the monitoring programme every five years until such time as the Environmental Protection Authority determines that further monitoring is not required. 9-4. The proponent shall implement the monitoring programme required by conditions 9-1 and 9-3.

Orig. cond.	Requirements (summarised)	Evaluation	Recommended change / new wording of condition
N/A		New condition to limit the annual volume of material applied with provision for a five yearly review by the EPA. Amounts permitted for the first five years and the boundary of the proposal area is set out in Schedule 1	**10 Total Annual Application Limit and Review** 10-1. As a precautionary measure, and to allow for adaptive management of the widespread use of bauxite residue for soil amendment, the proponent shall limit the total amount of material applied to the Peel – Harvey Coastal Plain catchment area shown in Figure 1 of Schedule 1. The total annual application limits for each calendar year are as shown in Table 1 of Schedule 1. 10-2. Prior to the end of the year 2005, the proponent shall recommend to the Environmental Protection Authority, the proposed total annual application limits for the following five years, based on the results of the research and monitoring programme referred to in Conditions 8 and 9. 10-3. Upon receipt of the recommendations referred to in Condition 10-2, the total annual application limits for the following five years will be determined by the Environmental Protection Authority on advice of the Water and Rivers Commission. 10-4. The procedure referred to in Conditions 10-2 and 10-3 for determining the total annual application limits shall be repeated at five-yearly intervals from the date of this statement until such time as the Environmental Protection Authority determines that this is no longer required.

Appendix 1

References

Agriculture Western Australia (AgWA) (1999), *Widespread use of bauxite residue, Peel-Harvey Catchment (Statement 339) Performance and Compliance Report (Draft),* January 1999.

Department of Agriculture Western Australian (DAWA) (1993), *Use of Bauxite Residue in the Peel-Harvey Coastal Plain Catchment,* Public Environmental Review, April 1993.

Environmental Protection Authority (1993), *Widespread use of bauxite residue, Peel-Harvey Coastal Plain Catchment: Report and Recommendations of the Environmental Protection Authority.* Environmental Protection Authority Bulletin 714, November 1993.

Appendix 2

Statement of Environmental Conditions of Approval

(4 February 1994)

Ass # 766

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State # 339

WESTERN AUSTRALIA

MINISTER FOR THE ENVIRONMENT

STATEMENT THAT A PROPOSAL MAY BE IMPLEMENTED (PURSUANT TO THE PROVISIONS OF THE ENVIRONMENTAL PROTECTION ACT 1986)

WIDESPREAD USE OF BAUXITE RESIDUE
PEEL-HARVEY COASTAL PLAIN CATCHMENT (766)

DEPARTMENT OF AGRICULTURE

This proposal may be implemented subject to the following conditions:

1 Proponent Commitments

The proponent has made a number of environmental management commitments in order to protect the environment.

1-1 In implementing the proposal, the proponent shall fulfil the commitments (which are not inconsistent with the conditions or procedures contained in this statement) made in the Public Environmental Review and in response to issues raised following public submissions. These commitments are consolidated in Environmental Protection Authority Bulletin 714 as Appendix 1. (A copy of the commitments is attached.)

2 Implementation

Changes to the proposal which are not substantial may be carried out with the approval of the Minister for the Environment.

2-1 Subject to these conditions, the manner of detailed implementation of the proposal shall conform in substance with that set out in any designs, specifications, plans or other technical material submitted by the proponent to the Environmental Protection Authority with the proposal. Where, in the course of that detailed implementation, the proponent seeks to change those designs, specifications, plans or other technical material in any way that the Minister for the Environment determines on the advice of the Environmental Protection Authority, is not substantial, those changes may be effected.

3 Code of Practice

A Code of Practice should be developed to ensure responsible use and reflect management changes found necessary as a result of monitoring.

3-1 Prior to the commencement of widespread use of bauxite residue, the proponent shall prepare a Code of Practice incorporating environmental issues which includes, but is not limited to consideration of the following:

(1) dust control during transport and application;

(2) assessment of optimum application rate based on changes to pH;

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- 4 FEB 1994

(3) separation distance, necessary to protect flora and water quality, between areas where bauxite residue is applied and areas of remnant vegetation or watercourses ; and

(4) frequency of review to incorporate management recommendations gained from experience and monitoring of bauxite use.

3-2 The proponent shall review the Code of Practice at a frequency determined in accordance with condition 3-1.

3-3 The proponent shall monitor and endeavour to ensure compliance with environmental aspects of the Code of Practice.

4 Evaluation of Effects of Application Rate and Soil Mixing Scenarios

An evaluation of the variation in environmental impacts which depend upon application rate and soil mixing scenarios is necessary.

4-1 Within six months of the commencement of widespread bauxite residue use in the Peel-Harvey Coastal Plain Catchment, the proponent shall develop a research programme which includes, but is not limited to an evaluation of the following potential environmental effects for a range of application rates and subsequent soil mixing scenarios:

(1) changes to soil permeability;

(2) changes to surface water run-off flow patterns and volumes; and

(3) changes to pH of surface water run-off;

to the requirements of the Environmental Protection Authority on advice of the Chemistry Centre of Western Australia.

4-2 The proponent shall implement the research programme required by condition 4-1.

4-3 The proponent shall make available to the public results from the research programme required by condition 4-1.

5 Catchment Monitoring

Key catchments with a high proportion of their area bauxite residue amended and key environments should be monitored to assess environmental impacts and confirm environmental impact assessment predictions.

5-1 Within six months of the commencement of widespread bauxite residue use in the Peel-Harvey Coastal Plain Catchment, the proponent shall design a monitoring programme which includes, but is not limited to addressing the following concerns for key sub-catchments and environments in the Peel-Harvey Coastal Plain Catchment:

(1) adequacy of measures to protect remnant vegetation;

(2) impacts from changes in pH and Aluminium concentrations in the catchment on wetlands;

(3) changes to surface water run-off flow patterns and volumes, and the effects of these changes on wetlands and drainage water quality; and

(4) monitoring of ground and surface water quality parameters, including pH, heavy metals, turbidity and radioactivity, to confirm predictions in the Public Environmental Review document and the assessment report;

to the requirements of the Environmental Protection Authority on advice of the Chemistry Centre of Western Australia.

5-2 The proponent shall make available to the public annually results from the monitoring programme required by condition 5-1.

5-3 The proponent shall review and re-submit the monitoring programme every five years until such time as the Environmental Protection Authority determines that further monitoring is not required.

5-4 The proponent shall implement the monitoring programme required by conditions 5-1 and 5-3.

6 Proponent

These conditions legally apply to the nominated proponent.

6-1 No transfer of ownership, control or management of the project which would give rise to a need for the replacement of the proponent shall take place until the Minister for the Environment has advised the proponent that approval has been given for the nomination of a replacement proponent. Any request for the exercise of that power of the Minister shall be accompanied by a copy of this statement endorsed with an undertaking by the proposed replacement proponent to carry out the project in accordance with the conditions and procedures set out in the statement.

7 Time Limit on Approval

The environmental approval for the proposal is limited.

7-1 If the proponent has not substantially commenced the project within five years of the date of this statement, then the approval to implement the proposal as granted in this statement shall lapse and be void. The Minister for the Environment shall determine any question as to whether the project has been substantially commenced. Any application to extend the period of five years referred to in this condition shall be made before the expiration of that period, to the Minister for the Environment by way of a request for a change in the condition under Section 46 of the Environmental Protection Act. (On expiration of the five year period, further consideration of the proposal can only occur following a new referral to the Environmental Protection Authority.)

8 Compliance Auditing

In order to ensure that environmental conditions and commitments are met, an audit system is required.

8-1 The proponent shall prepare periodic "Progress and Compliance Reports", to help verify the environmental performance of this project, in consultation with the Environmental Protection Authority.

Procedure

1 The Environmental Protection Authority is responsible for verifying compliance with the conditions contained in this statement, with the exception of conditions stating that the proponent shall meet the requirements of either the Minister for the Environment or any other government agency.

2 If the Environmental Protection Authority, other government agency or proponent is in dispute concerning compliance with the conditions contained in this statement, that dispute will be determined by the Minister for the Environment.

Kevin Minson MLA
MINISTER FOR THE ENVIRONMENT

- 4 FEB 1994

Appendix 3

Recommended Environmental Conditions

Statement No.

RECOMMENDED ENVIRONMENTAL CONDITIONS

STATEMENT TO AMEND CONDITIONS APPLYING TO A PROPOSAL (PURSUANT TO THE PROVISIONS OF SECTION 46 OF THE ENVIRONMENTAL PROTECTION ACT 1986)

WIDESPREAD USE OF BAUXITE RESIDUE
PEEL-HARVEY COASTAL PLAIN CATCHMENT

Proposal: The widespread distribution and use of bauxite residue from Alcoa of Australia's Kwinana, Pinjarra and Wagerup refineries for the purposes of soil amendment for the currently approved land use activities on the Swan Coastal Plain portion of the catchment of the Peel Inlet and Harvey Estuary. This area is defined in Schedule 1.

The proposal involves the arrangements for distribution, the loading and the transport of the material from the refineries and the application of the material on individual landowners' properties.

Proponent: Agriculture Western Australia

Proponent Address: Baron Hay Court, South Perth WA 6151

Assessment Number: 1266

Previous Assessment Number: 766

Previous Statement Number Statement No. 339 published on 4 February 1994

Report of the Environmental Protection Authority: Bulletin 982

Previous Report of the Environmental Protection Authority: Bulletin 714

The implementation of the proposal to which the above reports of the Environmental Protection Authority relate is now subject to the following conditions and procedures which replace all previous conditions and procedures:

Procedures

1 Implementation

1-1 Subject to these conditions and procedures, the proponent shall implement the proposal as described above (see 'Proposal').

1-2 Where the proponent seeks to change any aspect of the proposal as documented in this statement in any way that the Minister for the Environment determines, on advice of the Environmental Protection Authority, is substantial, the proponent shall refer the matter to the Environmental Protection Authority.

1-3 Where the proponent seeks to change any aspect of the proposal as documented in this statement in any way that the Minister for the Environment determines, on advice of the Environmental Protection Authority, is not substantial, those changes may be effected.

2 Proponent Commitments

2-1 The proponent shall implement the consolidated environmental management commitments documented in Schedule 2 of this statement.

2-2 The proponent shall implement subsequent environmental management commitments which the proponent makes or has made as part of the fulfilment of conditions and procedures in this and any previous statement issued for this proposal.

3 Proponent

3-1 The proponent for the time being nominated by the Minister for the Environment under section 38(6) or (7) of the Environmental Protection Act 1986 is responsible for the implementation of the proposal until such time as the Minister for the Environment has exercised the Minister's power under section 38(7) of the Act to revoke the nomination of that proponent and nominate another person in respect of the proposal.

3-2 Any request for the exercise of that power of the Minister referred to in condition 3-1 shall be accompanied by a copy of this statement endorsed with an undertaking by the proposed replacement proponent to carry out the proposal in accordance with the conditions and procedures set out in the statement.

3-3 The proponent shall notify the Department of Environmental Protection of any change of proponent contact name and address within 30 days of such change.

4 Commencement

4-1 The proponent shall provide evidence to the Minister for the Environment within five years of the date of this statement that the proposal has been substantially commenced.

4-2 Where the proposal has not been substantially commenced within five years of the date of this statement, the approval to implement the proposal as granted in Statement Number 339 (4 February 1994) shall lapse and be void. The Minister for the Environment will determine any question as to whether the proposal has been substantially commenced.

4-3 The proponent shall make application to the Minister for the Environment for any extension of approval for the substantial commencement of the proposal beyond five years from the date of this statement at least six months prior to the expiration of the five year period referred to in conditions 4-1 and 4-2.

4-4 Where the proponent demonstrates to the requirements of the Minister for the Environment on advice of the Department of Environmental Protection that the environmental parameters of the proposal have not changed significantly, then the Minister may grant an extension not exceeding five years for the substantial commencement of the proposal.

5 Compliance Auditing

5-1 The proponent shall submit periodic Compliance Reports, in accordance with an audit program prepared in consultation between the proponent and the Department of Environmental Protection.

5-2 Unless otherwise specified, the Chief Executive Officer of the Department of Environmental Protection is responsible for assessing compliance with the conditions, procedures and commitments contained in this statement and for issuing formal, written advice that the requirements have been met.

5-3 Where compliance with any condition, procedure or commitment is in dispute, the matter will be determined by the Minister for the Environment.

6 Environmental Management System

6-1 In order to manage the environmental impacts of the project, and to fulfil the requirements of the conditions and procedures in this statement, within 12 months following the commencement of the widespread use of bauxite residue as a soil amendment, the proponent shall demonstrate to the requirements of the Environmental Protection Authority on advice of the Department of Environmental Protection that there is in place an environmental management system which includes the following elements:

1. An environmental policy and corporate commitment to it;

2. Mechanisms and processes to ensure:

   (1) planning to meet environmental requirements;

   (2) implementation and operation of actions to meet environmental requirements;

   (3) measurement and evaluation of environmental performance; and

3. Review and improvement of environmental outcomes.

6-2 The proponent shall implement the environmental management system referred to in condition 6-1.

Conditions

7 Code of Practice

7-1 To ensure responsible use and reflect management changes found necessary as a result of monitoring, the proponent shall, prior to the widespread use of bauxite residue as a soil amendment, prepare a Code of Practice, to the requirements of the Environmental Protection Authority, incorporating environmental issues which include consideration of the following:

(1) dust control during transport and application;

(2) assessment of optimum application rate based on changes to pH;

(3) separation distance, necessary to protect flora and water quality, between areas where bauxite residue is applied and areas of remnant vegetation or watercourses ; and

(4) frequency of review to incorporate management recommendations gained from experience and monitoring of bauxite residue use.

7-2 The proponent shall review the Code of Practice at a frequency determined in accordance with condition 7-1.

7-3 The proponent shall monitor and ensure compliance with the environmental aspects of the Code of Practice prepared in accordance with Condition 7-1.

8 Evaluation of Effects of Application Rate and Soil Mixing Scenarios

8-1 To evaluate the variation in environmental effects arising from application rates and soil mixing scenarios, the proponent shall, within six months following the commencement of widespread use of bauxite residue for soil amendment, develop a research program which includes an evaluation of the following potential environmental effects for a range of application rates and subsequent soil mixing scenarios:

(1) changes to soil permeability;

(2) changes to surface water run-off flow patterns and volumes; and

(3) changes to pH of surface water run-off;

to the requirements of the Environmental Protection Authority on advice of the Water and Rivers Commission.

8-2 The proponent shall implement the research programme required by condition 8-1.

8-3 The proponent shall make available to the public, results from the research programme required by condition 8-1 to the requirements of the Environmental Protection Authority.

9 Catchment Monitoring

9-1 Within six months following the commencement of widespread use of bauxite residue as a soil amendment, the proponent shall design a monitoring programme to monitor key catchments with a high proportion of their area amended with bauxite residue, and key environments in the Peel-Harvey Coastal Plain Catchment.

This programme shall address the following matters:

(1) adequacy of measures to protect remnant vegetation;

(2) impacts from changes in pH and Aluminium concentrations in the catchment on wetlands;

(3) changes to surface water run-off flow patterns and volumes, and the effects of these changes on wetlands and drainage water quality; and

(4) monitoring of ground and surface water quality parameters, including pH, heavy metals, turbidity and radioactivity, to confirm predictions in the Public Environmental Review document and the assessment report;

to the requirements of the Environmental Protection Authority on advice of the Water and Rivers Commission.

9-2 The proponent shall make available to the public annually, results from the monitoring programme required by condition 9-1.

9-3 The proponent shall review and re-submit the monitoring programme every five years until such time as the Environmental Protection Authority determines that further monitoring is not required.

9-4 The proponent shall implement the monitoring programme required by conditions 9-1 and 9-3.

10 Total Annual Application Limit and Review

10-1 As a precautionary measure, and to allow for adaptive management of the widespread use of bauxite residue for soil amendment, the proponent shall limit the total amount of material applied to the Peel – Harvey Coastal Plain catchment area shown in Figure 1 of Schedule 1. The total annual application limits for each calendar year are as shown in Table 1 of Schedule 1.

10-2 Prior to the end of the year 2005, the proponent shall recommend to the Environmental Protection Authority, the proposed total annual application limits for the following five years, based on the results of the research and monitoring programme referred to in Conditions 8 and 9.

10-3 Upon receipt of the recommendations referred to in Condition 10-2, the total annual application limits for the following five years will be determined by the Environmental Protection Authority on advice of the Water and Rivers Commission.

10-4 The procedure referred to in Conditions 10-2 and 10-3 for determining the total annual application limits shall be repeated at five-yearly intervals from the date of this statement until such time as the Environmental Protection Authority determines that this is no longer required.

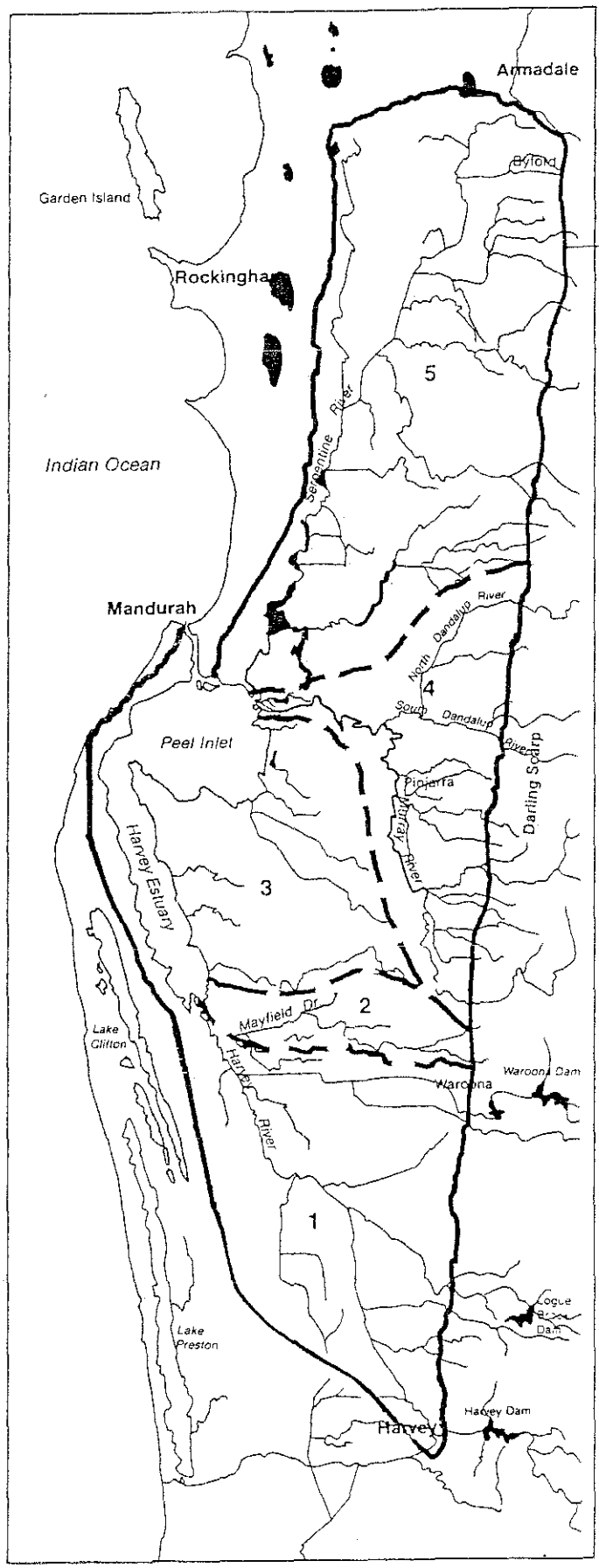
Schedule 1

Figure 1 (attached)

The attached plan shows for illustrative purposes, the boundary of the Swan Coastal Plain catchment of the Peel Harvey estuary system. The precise location of the boundary is set out in Schedule 1 of the Environmental Protection (Peel Inlet-Harvey Estuary) Policy 1992.

Table 1

Calendar year	Total annual application limit (tonnes)
2000	50 000
2001	50 000
2002	75 000
2003	85 000
2004	100 000



Catchment	Area (ha)	Cleared area (ha)	% cleared
1	53,995	41,454	76.8
2	11,044	10,139	91.8
3	26,365	21,296	80.8
4	32,366	29,149	90.0
5	78,645	48,962	62.3
Total	202,415	151,000	74.6

Figure 1

Location map of Peel-Harvey Estuary System and boundaries of the Coastal Plain Catchment and Sub-catchments

Schedule 2

Proponent's Consolidated Environmental Management Commitments

(4 February 1994)

WIDESPREAD USE OF BAUXITE RESIDUE PEEL-HARVEY COASTAL PLAIN CATCHMENT (766/1266)

AGRICULTURE WESTERN AUSTRALIA

Environmental Management Commitments

WIDESPREAD USE OF BAUXITE RESIDUE
PEEL-HARVEY COASTAL PLAIN CATCHMENT (766)

DEPARTMENT OF AGRICULTURE

WIDESPREAD USE OF BAUXITE RESIDUE, PEEL-HARVEY COASTAL PLAIN CATCHMENT (766)

WESTERN AUSTRALIAN DEPARTMENT OF AGRICULTURE

The West Australian Department of Agriculture will accept commitments binding it to:

1 Commencing negotiations with Alcoa of Australia Limited which, if successful, will produce a Code of Practice and management structure enabling the widespread use of bauxite residue for nutrient control in the Peel-Harvey coastal plain catchment.

2. Maintaining, in conjunction with other agencies and institutions, and to the satisfaction of the EPA, a program of strategic monitoring of residue use and its benefits and impacts, under the program established through the Codes of Practice.

3. Providing the EPA and the general public with regular reports outlining the use and distribution of bauxite residue, under the program developed above and produce a major review of the program for EPA assessment within ten years.

Appendix 4

Geoprocc report on review of environmental monitoring and research

The effects of applying bauxite residue to soils in the Peel-Harvey Coastal Plain on water quality in the Meredith Main Drain

A review and assessment of reports submitted by the proponent

by

Robert Gerritse
Geoprocc Pty Ltd
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Wembley Downs WA 6019

prepared for

Department of Environmental Protection
Westralia Square
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Perth WA 6000

May 2000

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1. BACKGROUND AND EPA OBJECTIVES

In the late seventies, the (then) Estuarine Impacts Branch of the EPA in WA initiated and has since maintained a longterm research program on the contribution of agricultural fertilizers in the Peel-Harvey catchments to eutrophication of waterways (Birch, 1982). A paired catchment study into the mechanics of leaching of phosphorus in soils near the Meredith Drain was one of many catchment studies (Gerritse&Schofield, 1989; Pech, 1995).

In 1982, Barrow proposed the use of caustic residue from bauxite for improving the chemical and physical properties of sandy soils (Barrow, 1982).

The widespread use of bauxite residue or red mud to ameliorate soils in the Peel-Harvey Coastal Plain Catchment and diminish phosphorus inputs to waterways was proposed to the EPA in 1992 by the WA Department of Agriculture in a PER. The Environmental Impact Assessment (EIA) procedure was concluded in November 1993 with a report and recommendations by the EPA to the Minister of the Environment. The EPA qualified the proposal of Agriculture Western Australia (AgWest) for the widespread use of bauxite residue as environmentally acceptable, subject to a number of conditions. These conditions are outlined in four recommendations in the EIA report of November 1993 (Appendix 1).

A key condition to address concerns about potential impacts on water quality was that AgWest implement a monitoring program for water quality and surface hydrological characteristics in catchments, were red mud is applied. It was recommended that the results of the monitoring programme be reviewed every five years to satisfy the objectives for the EPA assessment of the widespread use of bauxite residue in the Peel-Harvey catchment. These objectives are that:

(a) the material does not cause contamination; and
(b) there is a reduction in phosphorus export to the Peel-Harvey Estuary.

Since 1993 AgWest has produced several reports, which suggest that:

(a) the application of bauxite residue in the Meredith Main Drain catchment is not causing contamination of water resources; and
(b) there is a reduction of phosphorus export to water resources.

The Meredith Catchment area is about 4300 ha of which 2500 ha is farmland. A total of about 30000 tons of red mud has been applied. Most fields were amended at 20 t/ha. One part of one field (30 ha)received 80 t/ha and one strip of 20 m by 50 metres received 200 t/ha. These larger amounts were applied in experimental projects prior to the Development of the Code of Practice.

2. PURPOSE OF THE PRESENT EVALUATION

To provide sufficient information to the Environmental Protection Authority for consideration when providing advice to the Minister under section 46 of the EP Act on the extension of time limit of approval for the widespread use of bauxite residue in the Peel-Harvey Coastal Plain.

Specific objectives of this review are to determine whether:

- The monitoring programme is likely to be adequate to detect any significant changes in water quality as a result of the application of bauxite residue in the Meredith main drain Catchment
- The existing water quality data indicate any significant change in water quality.
- The extent of the monitoring programme is sufficient to provide confidence that application of bauxite residue in other catchments will exhibit similar results.

3. OUTLINE OF EVALUATION REPORT

This report will discuss aspects of the use of bauxite residue in soils of the Peel-Harvey Coastal Plain in the following order:

1. Adequacy of the environmental monitoring programme in relation to the EPA's objectives, control or baseline data and to the sampling protocol.
2. Significance of accumulation of contaminants (including heavy metals) in soils and leaching into groundwater and surface water.
3. Comparison of data collected for the Meredith Drain with baseline/control water quality data in the Peel-Harvey catchment and comparison of water quality of the Meredith Main Drain with Australian Water Quality Guidelines for Fresh and Marine Waters (ANZECC 1992).
4. Significance of reduction in phosphorus in the Meredith Main Drain.
5. Conclusions and Recommendations.

4. EVALUATION

4.1 ADEQUACY OF ENVIRONMENTAL MONITORING PROGRAMME

The emphasis of the monitoring programme has always been on water quality of surface waters. Widespread use of bauxite residue in the Meredith catchment at 20 t/ha started in 1994. Drains, groundwater and other water bodies in the Meredith Catchment and in neigbouring catchments, that had not been treated with red mud, were monitored from 1/1/95 to 31/12/97 (Rivers, 1998). Waters were samples weekly in the winter period and monthly in the summer period. In the winter period, samples were taken as much as possible at the peak of storm events. Samples were analyzed unfiltered. Results indicate no significant differences in concentrations of nutrients and toxic metals between the Meredith Main Drain and other waterways in the Peel-Harvey catchment.

The main objection against using only results of monitoring water quality data to evaluate leaching of contaminants from red mud, is that slow migration of a range of contaminants in soils is not picked up in the relatively short period (1995-1999) of monitoring drain water. Mobilities of many toxic metals and metalloids in soils, relative to water, range from about 0.01% to >10% (Gerritse et al., 1982). For an average depth to water table of 0.5-1m, this means that travel times in soils to drains in the Meredith Catchment of toxic metals and metalloids added with red mud, could range from as little as a few years (e.g. F and B) to well over a 100 years! Mobilities often decrease strongly with increasing pH and organic matter content of soils and increase with increasing salinity (ibid.; Gerritse & Van Driel, 1984).

Leaching studies in lysimeters, containing Gavin and Joel soils from the Meredith Catchment (Summers et al., 1996), indicate no significant leaching of toxic metals (other than in the initial turbid effluent) over a period equivalent to between 5 and 10 years recharge of rainfall. However, leaching was not continued for a sufficient length of time to allow complete migration of toxic metals through the columns and thus transfer times in the catchment soils to be estimated. For instance (Gerritse, 1996a; Gerritse, 1996b) in the case of cadmium, a travel time of about 270 days can be expected for the 9.5 cm long lysimeters of Summers et al. (1996), operated at a leaching rate of 95 cm in 90 days . Leachate was only collected for a period of 90 days and distributions of toxic metals in profiles of the lysimeters were not determined. This means that available lysimeter results are also not conclusive with regards to the long-term (> 5 to10 years) discharge of toxic metals from soils in the Meredith Catchment. Lysimeter studies of red mud amended soils by Vlahos et al. (1989) are also not helpful in this respect, though do mention leaching of fluoride.

Summary:

The current monitoring programme focuses to a large extent on monitoring surface water quality to evaluate leaching of contaminants from bauxite residue. Water quality monitoring in itself is inadequate to evaluate long-term impacts of the use of bauxite residue. Slow migration of contaminants may not be detected in the relatively short periods of monitoring drain water.

Long-term leaching of contaminants can be assessed by using lysimeters to measure leachate volume in conjunction with water quality monitoring.

4.2 SIGNIFICANCE OF ACCUMULATION AND LEACHING OF CONTAMINANTS

Red mud, once incorporated in a soil, can be considered as a continuous low-level slow-release source of minor and trace elements, which, depending on the amount applied per unit area of soil and on background soil concentrations (Tables 1 and 2), equals or exceeds the background release rate from soils. Rate of leaching will be governed by adsorption to iron and aluminium oxides in soils (for fluoride and oxyanions: Gerritse, 1996a) or organic matter (for metals: Gerritse, 1996b&c). Travel times to groundwater and surface water in catchments with sandy soils can vary from days to years to centuries or more, depending on rates of input and soil properties (Gerritse, 1982, 1990, 1996a).

Concentrations of metals resulting from the Toxic Characteristics Leaching Procedure (=TCLP: US-EPA method 1311, USEPA 1996) applied to red mud are given in Rivers (1997) and can be considered to approximate concentrations, leached from red mud in a field situation, as long as the extracting solution remains sufficiently acidic. Method 1311 was designed for the evaluation of leaching characteristics of materials in sanitary landfills. In the method, the material to be tested is extracted with sodium acetate in a solids –solution ratio of 1:20 (by weight) at an initial pH of either 4.93 or 2.88, depending on whether the material reacts acid or alkaline. No information is given in the report (Rivers, 1997) on the pH of the extracting solution or the pH of the final solution, in which concentrations of metals were analyzed. This information is critical to the interpretation of the test results, as the red mud material is strongly alkaline. From the information presented sofar and assuming TCLP leachate concentrations, where no concentrations are given, to be equal to the minimum levels of detection, it can be argued that at full surface coverage with red mud (e.g. an amendment of 250t/ha of red mud), the concentrations of a number of toxic metals in drain water from soils could exceed ANZECC criteria for fresh/marine waters (Table 1). It can also be argued that the accuracy of the TCLP method is questionable when used on strongly alkaline material such as red mud. Other methods, such as the SPLP extraction method using mineral acids (USEPA method 1312, USEPA, 1996), could give a better approximation of the leachable fraction.

Inputs to soils of trace and other elements with red mud, atmospheric precipitation and with various fertilizers are compared in Tables 2 and 3. Data show that for a soil amendment with 20 t/ha of red mud, inputs of some contaminants (Cd, Zn, Hg, F) are of the same order as inputs from other sources. Increases in the amounts of contaminants, added with an amendment of 20 t/ha, are often of the same order (Th, Cd) as in the uncontaminated surface soil or less (U). Data supplied in the PER of 1993 indicate that, for a dose of 20 t/ha, soil criteria for toxic metals are never exceeded. For a dose to soil of 200 to 250 t/ha of red mud, ecological investigation levels (EIL's) for soils and guidelines for maximum concentrations in agricultural soils, particularly acid sandy soils, could be exceeded for Cd, Cr, Se and F (PER, 1993; Van Den Berg, 1993; NEPC, 1999). Also Th concentrations would then increase well in excess of background and accumulation of ^{228}Ra in crops and cattle could become an issue.

Summary:

Based on data from TCLP tests, reported by Agriculture WA, the concentrations of some heavy metals in drain water could exceed the ANZECC guidelines for fresh/marine waters, if the widespread application of bauxite residue was to occur at 250t/ha.

However, the TCLP data reported are not reliable as there is uncertainty in the test method used to determine the leachability of metals from the bauxite residue. The leaching tests are to be carried out in accordance with USEPA method 1311, USEPA 1996. This test, although designed to assess the leaching of materials in sanitary landfills under acidic conditions (pH 4.9), has been widely used for assessing leachability of other materials. The control of pH conditions during the test is important, if reliable data are to be obtained. It is questionable whether the TCLP test when used on extremely alkaline material such as red mud (approximately pH 12) is appropriate for predicting the leachable fraction from red mud.

It is recommended that these aspects be considered when interpreting the reported TCLP data in terms of leachable contaminants under field conditions.

Data from reports of AgWA also indicate that for a total dosage exceeding 200 to 250 t/ha of bauxite residue, soil concentrations for Cd, Cr, Se and F could exceed guidelines for agricultural sandy soils.

4.3 COMPARISON OF DATA FOR THE MEREDITH DRAIN WITH OTHER WATER BODIES

Time courses of data on water quality from 1/1/95 to 31/12/97 (Rivers, 1998) show spikes in concentrations of all monitored species, which, in many waterways of the Peel-Harvey catchment, cause average monitored concentrations of Al, Cd, Cu, Pb and Zn to exceed ANZECC guidelines (Rivers, 1998). Results of monitoring after 1/1/98 were not available for this review.

Drains and other water bodies in the Meredith and other catchments were sampled once a week in winter and once a month in summer. In winter the practice was to sample at the peak of storm events as much as possible. Samples were never filtered. This would explain the anomalous spiky nature of the data. It also means that the reported concentrations overestimate the true solution concentrations. ANZECC guidelines are for 'solution' concentrations. Proper centrifugation or filtration procedures are essential in obtaining a representative solution phase.

Details of the sampling and analysis protocol for trace (toxic) metals are not given in the reports. Contamination free procedures, specially prepared acid washed sampling equipment and use of high-purity reagents are essential. It should be noted, in this respect, that Gerritse et al. concluded in 1998, that solution concentrations of Zn, Cd, Pb and Cu in the Peel-Harvey Estuary and its tributaries are within ranges that apply to other rivers in developed areas and that concentrations of Cd are relatively high (Gerritse et al., 1998a). Cadmium is likely to be derived from phosphatic fertilizers (Gerritse, 1990; Gerritse, 1996a). Solution concentrations of metals measured by Gerritse et al. in the Peel-Harvey catchment, are in many cases on average more than an order of magnitude less than reported by Rivers (1998).

A relationship between turbidity and metal concentrations would appear likely, but is not readily evident from the data (Rivers, 1998) and needs to be explored further. Rapid changes in solution concentrations are also evident from groundwater monitoring data. Rapid changes can be expected to occur in ephemeral groundwater, but not in a permanent water table, where all changes to groundwater quality are strongly buffered.

Turbidity and electrical conductivity (EC) in the Meredith Drain are increased by several orders of magnitude above the usual increases with the first run-off from winter rain (Gerritse&Schofield, 1989), but only in the first year after application of bauxite residue. This is explained by the sodic nature of bauxite residue, which causes peptisation of clay particles and dissolution of humic matter. The sodic nature of bauxite residue can also be expected to cause a strong increase in solution of soil organic matter through transformation of Ca-humates to Na-humates. This is, however, not reflected at all by data for colour in the Meredith Drain. It is probable that the analyses for colour are affected by the relatively high background turbidity. Analysis of dissolved organic carbon (DOC or TOC) would have been more useful in this respect.

Trace metals often form strong complexes with DOC and increases in DOC in drains are associated with increases in solution concentrations of many metals, though free (=unbound) metal concentrations can be more than an order of magnitude less than total metal concentrations. Concentrations of total metals in drains and streams with high DOC concentrations can then overestimate toxicity levels, which are based on maximum allowable free metal concentrations (ANZECC Water Quality Guidelines, 1992).

Summary:

There has been no significant change after 3 years to the water quality in the Meredith Drain in the Peel-Harvey Coastal Plain at the trial application of 20t/ha of bauxite residue.

4.4 Significance of reduction in phosphorus in the Meredith Main Drain

A review of drain water quality data indicates that phosphorus levels have decreased after applications to soils of bauxite residue at 20t/ha.

Red mud amendment adds substantial amounts of iron and aluminium oxides to soils (Table 1). The adsorption of phosphate is increased in proportion to the iron and aluminium content of a soil (Gerritse, 1996a, 1998b). Increases in travel times in soils of phosphate from addition of red mud can be estimated with an empirical equation (Gerritse, 1996a). Retention times of phosphate in soils, calculated for inputs from fertilizer in soils, are given in Table 4 for amendments with red mud of 20 and 250 t/ha. Calculations are for the time it takes to saturate the added red mud with phosphate for net fertilizer inputs of 5 and 15 kg/P/ha/year and a recharge from rainfall of 35 cm/year (Gerritse & Schofield, 1989; Gerritse, 1996d). Much greater input rates of phosphorus are associated with horticultural land use (> 200 kg P/ha/yr – Gerritse, 1982). Retention of phosphate in soils decreases rapidly with increasing rates of input.

Red mud is defined to be saturated when adsorption of phosphate from fertilizer input decreases to less than 99% (=onset of breakthrough: Gerritse, 1996a). Results in Table 4 show that for an amendment with red mud of 20 t/ha, phosphate will be significantly retained in soils for between 2 and 8 years, for net inputs of P with fertilizer of 5 to 15 kg/ha/year. This confirms results from monitoring key field trials, suggesting applications of red mud of 20 t/ha would need to be reapplied after at least five years in order to maintain the desired reduction of phosphorus in run-off (EIA, 1993 – p2).

For a soil amendment with red mud of 250 t/ha and input rates of P between 5 and 15 kg/ha, retention of P increases to between about 50 and 200 years, decreasing to between 5 and 10 years for inputs of P of 200 kg/ha/year (Table 4). Concentrations of phosphate in drains after soil amendment with red mud can be expected to run down until saturation of the red mud adsorption sites occurs after the estimated retention times. Following saturation, added phosphate will soon leach to drains again and, in a few years, reach the same levels as before amendment.

Computer simulation of phosphate movement in the Meredith Drain Catchment indicates that, on run-down after stopping inputs, phosphate concentrations in drains decrease by about 50% in 2 years and 90% in 15 years (Gerritse&Schofield, 1989). Experimental data on run-down of phosphate concentrations after stopping inputs or amending soils with red mud confirm results of computer simulation (Gerritse & Schofield, 1989; Rivers, 1998).

Summary:

Phosphate concentrations are significantly decreased in drains after amendment of the sandy soils in the Meredith Catchment with bauxite residue.

4.5 CONCLUSIONS

- Monitoring data show conclusively that within a period of three years (1/1/1995-1/1/1998), since applying red mud at about 20 t/ha to about 33% of soils (≈ 56% of arable soils) in the Meredith Catchment, no adverse changes have occurred in local water quality. The monitoring frequency and comparison with water quality data of other drains and waterways in the Peel-Harvey Coastal Plain Catchment appears to be statistically sound and sufficient for the purpose of detecting leaching of contaminants from catchment soils. The monitoring method is not sufficient for detecting significant run-off in storm events of contaminants with fine particulate matter.
- A link between application of red mud and increased turbidity and organic carbon concentrations in drains is evident, but has not been quantitatively explored.
- It is not possible to determine/predict the long-term impacts to groundwater from the reported data. The existing monitoring programme is inadequate for the evaluation of long-term (greater than 5 years) impacts of bauxite residue. Results from lysimeter and extraction studies have been inconclusive in this respect. Transfer functions of contaminants could have easily been obtained from well designed lysimeter and/or soil adsorption experiments and could then have been used to predict long term migration of contaminants from red mud in soils.

- Monitored data for toxic metals and metalloids in surface waters and groundwaters of Peel-Harvey Coastal Plain appear to overestimate the true and toxicologically effective solution concentrations.
- The relative impact of amending soils with red mud on soil concentrations of a number of toxic metals and metalloids appears to be small. It would be useful, however, for a more complete and statistically sound evaluation of the relative increases of contaminants in soils, to have a more extensive and (statistically) representative list of background concentrations in the unamended soils and in red mud.
- The extraction protocol (TCLP) for estimating leachable fractions of contaminants from amended soils should be improved to account for the alkaline nature of red mud. The TCLP method is considered crucial in estimating the potential long term impact of soil amendment with red mud on water quality.
- Phosphate concentrations are significantly decreased in drains after amendment of the sandy soils in the Meredith Catchment. However, the decreases in phosphate concentration in drains for soil amendments with red mud of 20 t/ha, are only sustainable if amendments are repeated (at least) every five years for net inputs of P from fertilizer of 5 to 15 kg P/ha/year and more frequently for higher rates of input of fertilizer P.
- Soil concentrations of Cd, Cr, Se, F and Th could become critical for amendments with red mud of >200 t/ha.

5. RECOMMENDATIONS

5.1 It is considered that adequate information has been provided, which would allow implementation of a staged approach to the use of bauxite residue in the Peel-Harvey Catchment.

This approach should involve applying bauxite residue to soils at 20t/ha in a number of selected subcatchments, with more comprehensive monitoring to include groundwater at these sites and also lysimeter measurements.

Monitoring within these subcatchments should occur twice during the winter wet period to the requirements of the DEP and WRC. The first monitoring should be done after a cumulative annual rainfall of 150-200 mm has been recorded and the second at the end of August or beginning of September. Water should be sampled during periods of no rainfall.

The Code of Practice should address the application frequency of bauxite residue at 20t/ha, if decreases in phosphorus concentrations are to be sustainable.

5.2 Application of amounts of bauxite residue, greater than 20 t/ha, within the Peel-Harvey Catchment should not occur until further investigation has been carried out to evaluate the potential impact of these amounts on groundwater and the environment.

Further water and soil quality monitoring within the catchments, together with leachability (TCLP) and lysimeters measurements should be carried out to the requirements of the DEP and WRC to assess both the short and long-term impacts of soil amendment with red mud at (cumulative) amounts greater than 20 t/ha.

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Table 3. ANZECC&ARMCANZ and NHMRC guidelines for maximum concentrations in water.

Compound	units	water type				
		Fresh	Marine	Potable	Irrigation	Livestock
pH		5.5-8.0*	6.5-8.5*	6.5-8.5	4.5-9.0	
EC	mS m^{-1}	<150		150	crop -specific	300-2000
Na	g m^{-3}			180	crop -specific	800
K	g m^{-3}					20
Ca	g m^{-3}					1000
Mg	g m^{-3}					250-600
Cl	g m^{-3}			250	crop -specific	1000
S-SO4	g m^{-3}			170		340
N-NO3	g m^{-3}	0.1-0.75		10		30
N-NO2	g m^{-3}			1		10
N-NH4	g m^{-3}					
P	g m^{-3}	0.005-0.1				
F	g m^{-3}			1.5	1	2
B	g m^{-3}			0.3	0.5	5
Mo	g m^{-3}	0.007*		0.05	0.01	0.01
Al	g m^{-3}	0.01*	0.01*		5	5
Ga	g m^{-3}	0.004*	0.004*			
Ba	g m^{-3}			0.7		1
Zn	g m^{-3}	0.005-0.05	0.05	3	2	20
Cd	g m^{-3}	0.0002-0.002	0.002	0.002	0.01	0.01
Pb	g m^{-3}	0.001-0.005	0.005	0.01	0.2	0.1
Cu	g m^{-3}	0.002-0.005	0.005	1	0.2	0.5-5
Fe	g m^{-3}				1	
Mn	g m^{-3}			0.5	0.2-2	
As	g m^{-3}	0.05	0.05	0.007	0.1	0.5
Se	g m^{-3}	0.005	0.07	0.01	0.02	0.02
Hg	g m^{-3}	0.0001	0.0001	0.001	0.002	0.002
Cr-VI	g m^{-3}	0.01	0.05	0.05	0.1	1
Sb	g m^{-3}	0.03	0.5	0.003		
V	g m^{-3}	0.1*	0.1*		0.1	0.1
Be	g m^{-3}	0.004			0.1	
Ni	g m^{-3}	0.015-0.15	0.015	0.02	0.2	1
Co	g m^{-3}				0.05	1
U	g m^{-3}			0.02	0.01	0.2
gross α	Bq m^{-3}			100	500*	500*
gross β	Bq m^{-3}			100	500*	500*
Ra^{226}	Bq m^{-3}			500	5000*	5000*
Ra^{228}	Bq m^{-3}			500	2000*	2000*
U^{238}	Bq m^{-3}			250	200*	200*
* guidelines suggested in ANZECC&ARMCANZ draft document of July 1999 – not endorsed						

Table 4. Amounts of some major and minor elements in surface soils (10 cm A_1 horizon) of the Meridith catchment and added with bauxite residue (red mud). Comparison with inputs from rainfall and fertilizer.

element	in surface soil (kg/ha)	added to soil (in kg/ha) with a Red Mud dose of:		in rainfall:	in P fertilizer at 20 kg P/ha/yr
		20 t/ha	250 t/ha	kg/ha/5 yrs	kg/ha/5 yrs
Fe	7000	5000	62500		2
Si	63 10^4	2200	27500		10
Al	2000	1800	22500		5
C-organic	56000	100	1250		
Ca		600	7500	50	20
Ti	1400	500	6250		
Na	<1400	300	3750	250	
K-total	70	140	1750		
K-sol	<140	0.6	7.5	15	
Cl	<1400	20	250	500	
S-SO4	<1400	10	125	50	
Br	<140	0.4	5	1.25	
adapted from: Williams, 1974; Hingson & Gailitis, 1976; Gerritse & Schofield, 1989; PER, 1993.					

Table 5. Concentrations of trace elements in surface soils (10 cm A_1 horizon) of the Meredith Catchment and in bauxite residue (red mud). Comparison with inputs from rainfall and fertilizer.

element	in surface soil (kg/ha or *MBq/ha)	added to soil (in kg/ha or * MBq/ha) with a Red Mud dose of:		in rainfall	in P fertilizer at 20 kgP/ha/yr
		20 t/ha	250 t/ha	kg/ha/5 yrs	kg/ha/5 yrs
F		24	300		10
Cr		6	75		0.05
Th	10*	5-30 (20-120)*	62.5-375 (250-1500)*		0.005
Ba		2.4	30		
Zn		0.6	7.5	10	0.5
Cu		0.6	7.5	0.15	0.05
As		0.6	7.5		0.005
Co		0.6	7.5		0.005
U	75*	0.5-1 (6-12)*	6.25-13 (75-150)*		0.05
Pb		0.2	2.5	0.5	0.05
Sn		0.2	2.5		
Cd	0.3	0.1	1.25	0.025	0.05
Mo		0.04	0.5		0.005
Be		0.02	0.25		
Sb		0.01	0.125		
Hg		<0.001	<0.012		0.0005
B		<0.4	<5		0.005
Se		<0.2	<2.5		0.005
Ni		<0.1	<1.25		0.005

adapted from: Williams, 1974; Gerritse *et al.*,1990; PER, 1993; Gerritse, unpubl. CSIRO data on red mud (U, Th) and Gavin and Joel soils (U, Th, Cd).

Table 6. Retention times for phosphate in red mud amended soils

net P input	red mud amendment	P adsorption coefficient	retention time
kg P/ha/year	t/ha	A_f*	years
5	20	250	5
5	20	350	8
5	250	250	120
5	250	350	190
15	20	250	2
15	20	350	3
15	250	250	50
15	250	350	80
200	20	250	<1
200	20	350	<1
200	250	250	6
200	250	350	10
* as defined in Gerritse,1996a and Gerritse *et al.*,1998b.			