PRESTIGE BRICK PROPOSED BRICKWORKS

MIDLAND ABATTOIR SITE - MIDLAND

PILSLEY INVESTMENTS PTY LTD

REPORT AND RECOMMENDATIONS

OF THE

ENVIRONMENTAL PROTECTION AUTHORITY

Environmental Protection Authority
Perth, Western Australia

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Pilsley Investments Pty Ltd trading as Prestige Brick has prepared a Public Environmental Report (PER) for a proposed brickworks at the old Midland abattoir site in Midland. The PER was released for a 10 week public review period concluding on 1 July 1987. The Environmental Protection Authority received 26 submissions.

The Environmental Protection Authority assessment and public submissions raised concerns in the following general areas:

. the impact of air emissions on the surrounding area;

. noise effects on the surrounding neighbours;

. the potential for dust nuisance from traffic and the plant;

. the interactions with planning related matters; and

. the impact on the Helena River floodplain.

While there are potential environmental impacts associated with each of the above, the Environmental Protection Authority considers that the main issue is the potential for damage to vegetation resulting from fluoride emissions from the plant. In its recommendations the Environmental Protection Authority has sought to address this issue in a comprehensive manner.

Following assessment of the PER, the submissions and the additional information supplied by the proponent the Environmental Protection Authority considers that:

. subject to the proponent's commitments given in the PER and in the additional information supplied to the Environmental Protection Authority an the Recommendations made in this Assessment Report the proposal is environmentally acceptable;

. based on the information in the PER there exists a potential for minor injury to vegetation from fluoride fallout from the brickworks. The Environmental Protection Authority considers that this is a realistic assessment. The Environmental Protection Authority emphasises that the fluoride levels which may cause injury to vegetation are considerably lower than those levels which will cause human health affects;

. there is insufficient information in the PER on the means by which the noise emissions from the brickworks will be controlled. However, if appropriate control measures are undertaken, noise emissions can be reduced to an acceptable level;

. there are aspects of the transport of raw materials and brickworks operation which may result in a dust nuisance. The control of this is the responsibility of the proponent; and

. the project may require some minor filling of the Helena River flood plain in the vicinity of the brickworks. It is unlikely that this will have any significant impact on the floodplain or its hydrological characteristics.

Accordingly, the Environmental Protection Authority has made the following conclusions and recommendations:

(1) The Environmental Protection Authority concludes that the proposal as described in the Public Environmental Report (PER) is environmentally acceptable and recommends that it could proceed subject to:

- the proponent's commitments given in the PER and in the additional information supplied to the Environmental Protection Authority; and
- the Authority's Conclusions and Recommendations in this Assessment Report.

(2) Based on the information available to the Environmental Protection Authority recommends that:

- the fluoride mass emission rate from the whole plant should never exceed 1.0 gram/second;
- these emissions should be released to the environment through a stack with a minimum height of 35 m;
- the proponent should monitor the emission rate and supply the results to the Environmental Protection Authority as part of a monitoring and verification programme approved by the Environmental Protection Authority; and
- if, in accordance with Recommendation (3) environmental damage occurs as a result of the brickworks operation, this maximum allowable mass emission rate will be reduced to a level such that the objective of the continuing maintenance of current beneficial uses of the locality is met.

(3) The Environmental Protection Authority recommends that the proponent funds an independent study, to be approved by the Environmental Protection Authority to measure the Ground Level Concentrations (GLC's) of fluoride on areas around the plant, and the associated effects on the environment. For appropriate verification of this study, monitoring will have to commence well before the plant becomes operational. In the event that the Environmental Protection Authority is not satisfied with the assessment of the state of the environment as shown in the results of the study, the Environmental Protection Authority will require the proponent to modify its operations to reduce air emissions to an acceptable level.

(4) The Environmental Protection Authority recommends that the proponent should configure the various parts of the plant so that a scrubber can be retrofitted to Stage 1 should the Environmental Protection Authority consider it necessary.

(5) The Environmental Protection Authority recommends that if the project proceeds to Stage 2 the proponent should maintain the fluoride emissions from the total plant at the mass emission rate set in Recommendation (2).

(6) The Environmental Protection Authority recommends that the noise emissions from the plant will need to be at a level acceptable to the Authority. This will be controlled by appropriate licencing conditions set under the Environmental Protection Act.

(7) The Environmental Protection Authority recommends that should there be a nuisance from dust associated with the brickworks outside the site boundary then the Swan Shire Council and the nominee of the Minister for Transport should inform the proponent to take appropriate action to stop the nuisance occurring.

(8) The Environmental Protection Authority recommends that in the event of the requirement to fill part of the floodplain the proponent should landscape the filled area in a manner which recreates the indigenous floodplain vegetation of that area.

1. INTRODUCTION

Pilsley Investments Pty Ltd trading as Prestige Brick are proposing to establish a brickworks on the Midland abattoir site. Stage 1 of the project is to supply 50 million bricks a year to the local brick market. For the later Stage 2 of the project it is proposed to expand this plant to 100 million bricks a year.

The PER identified the following potential impacts from the project:

. fluoride fallout from the plant;

. the effect of noise on the surrounding neighbourhood;

. generation of dust from transport and plant operation; and

. the effect on the Helena River and floodplain.

2. SITE EVALUATION

The proponent has not evaluated alternative sites in the PER. However, it has evaluated the proposed use of the site for a brickworks in contrast to other alternative uses of the site. The site is attractive to the proponent because of its proximity to major transport routes and utilities.

The Environmental Protection Authority considers that the proposed use of the site is compatible with the industrial zoning of the area. However, this compatibility will be diminished if the emissions from the plant create a negative impact on the surrounding, non-industrial land uses.

3. SUMMARY OF PUBLIC AND GOVERNMENT AGENCY SUBMISSIONS

3.1 INTRODUCTION

A total of 20 submissions were received from the public and Government agencies. Of these 5 were petitions. The names of those who made submissions can be found in Appendix 5.

The majority of submissions covered the following areas:

. air emissions particularly fluoride fallout and its effects;

. noise from the plant;

. dust from operations and transport;

. planning matters; and

. impact on the Helena River and floodplain.

The Environmental Protection Authority considered that some of the submissions were particuluarly well researched and documented and commends those who made such submissions.

3.2 COMMENTS ON SPECIFIC ISSUES

3.2.1 AIR EMISSIONS

The majority of the comments were associated with fluoride and the effects of its fallout. These are summarised below:

- there was disagreement with the value of the fluoride content of the clay used in the calculations in the PER and the proportion of fluoride evolved from the brick during firing;
- the validity and the assumptions behind the numerical modelling technique were questioned;
- the applicability of the atmospheric data used in the model was questioned;
- a fluoride scrubber was recommended to be installed. Alternatively, the reasoning behind not installing a scrubber was challenged;
- the fate of fluoride in the atmosphere and the effects of fluoride fallout on vegetation (both native and introduced), stock and wildlife, humans and buildings etc was questioned. A number of submissions quoted various standards for ground level concentrations of fluoride taken from a range of sources as being applicable to the proposed project;
- compensation was sought by those who consider they may be affected by fluoride fallout; and
- other brick manufacturers canvassed the possibility of avoiding the use of scrubbing technology if Prestige Brick proceeded without a scrubber.

The impact of other air emissions (eg hydrochloric acid, sulphur oxides) was raised.

3.2.2 NOISE

Some submissions suggested that nearby residents will suffer from noise from the plant particularly from tonal noise such as forklift truck bleepers.

3.2.3 DUST

Various submissions disagreed with the PER's assessment that dust from stockpiles, on roads and operations would be manageable.

Two submissions raised the dangers of silicosis from dust.

3.2.4 PLANNING MATTERS

Because of the surrounding land uses some submissions considered that there was no opportunity to create a buffer zone around the plant in which the effects of fluoride and dust fallout would not matter.

The compatibility of the proposed use of the site with surrounding land uses was questioned. This was raised particularly in the context of the potential residential development at Hazelmere.

The appropriateness and integrity of the planning process was questioned in one submission.

3.2.5 HELENA RIVER AND FLOODPLAIN

The potential impact of the plant on the Helena River and the proposed linear park along the floodplain was raised.

The continued availability of the waste water treatment works which treat the effluent from the stockyards was raised. It was stated that the continued use of the treatment works was necessary to prevent contamination of the Helena River from the stockyard runoff.

4. ENVIRONMENTAL IMPACTS AND MANAGEMENT

4.1 FLUORIDE

(a) Most of the public submissions raised concerns with the potential environmental impacts which may result from the fallout of fluoride compounds outside the plant site. These are discussed below in section (b) to (f) and Figure 1.

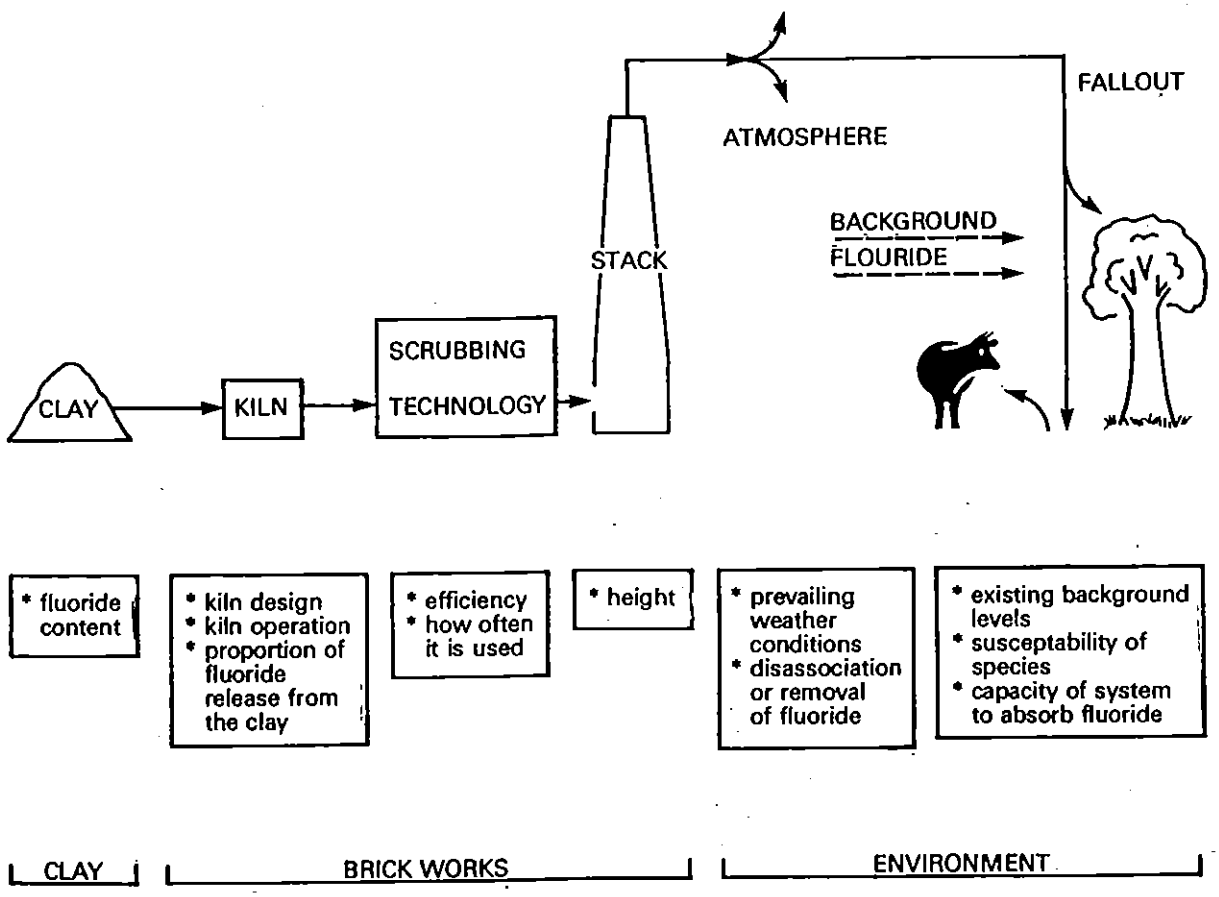

Figure 1. Factors Which Effect the Impact of Fluoride Fallout

(b) There is a long history of fluoride fallout problems associated with brickworks in this State. The Environmental Protection Authority considered this proposed brickworks within the context of other existing operations.

The Environmental Protection Authority is aware that many factors contribute to the amount of fluoride emitted to the atmosphere from brick manufacture. Some of these are:

- the size of the plant;
- the initial fluoride content of the clay;
- the proportion of fluoride which is released from the clay during firing;
- the design and operation of the kiln; and
- the efficiency of any scrubbing technology which has been installed.

(c) Following emission to the atmosphere, various factors effect the concentration of ground level fallout. These are:

- the height of emission above ground level;
- the prevailing atmospheric conditions; and
- the disassociation or removal of the various fluoride compounds in the atmosphere.

(d) At the point of impact the effect of fluoride fallout is dependent upon:

- the susceptibility of the species at the point of impact to fluoride;
- the existing background fluoride levels; and
- the capacity of the ecological system at the point of impact to absorb fluoride without sustaining injury.

(e) In this State two main techniques to limit fluoride impact have been employed by existing brick manufacturers. These are listed below:

- employing scrubbing technologies; and
- aquiring tenure over land to form a buffer zone around existing plants.

It is the Environmental Protection Authority's experience that difficulties have been encountered with scrubbing technologies in this State. They have been found to be inefficient and/or costly to operate and consequently are not favoured by the existing brick manufacturers because they are seen as an impediment to production. A discussion of scrubbing technologies can be found in Appendix 1.

To set the estimated magnitude of the fluoride emissions from the Prestige Brickworks in a regional context it has been estimated that fluoride emissions from existing brickworks in the Midland area (ie the Whitemans/ Midland Brick brickworks) are in the vicinity of 43.9 tonnes per year (t/y). The annual emissions from Prestige Brick Stage 1 are estimated to be 16.5 t/y. This is discussed further in Appendix 2. However, the biological effect of these emissions is determined by the fluoride concentration at ground level. This in turn is determined by the amount the emissions are

diluted in the atmosphere which in turn is a function of the height at which they are released. The Prestige Brick height of emission is up to three times that which occurs at the Midland Brick/Whiteman Brick brickworks. Consequently there is not a comparible ratio between the magnitude of emissions and the GLC's resulting from each plant.

(f) The Environmental Protection Authority has checked the model and data used by the proponent in its determination of GLC's resulting from a maximum fluoride mass emission rate from the plant of 1 gram per second when released from a 35 m stack. The Environmental Protection Authority considers that the results obtained by the proponent represent a reasonable picture of the fallout that could be expected from the plant. The proponent's assessment in the PER is that this should result in minimal injury to vegetation in the area around the plant resulting from its operations. In the Environmental Protection Authority's opinion minimal injury means that in certain areas, particularly in the area surrounded by Bushmead Rd, Stirling Csnt, Wingate Ave and Eric St in Hazelmere; and around Ferguson St and Moore Ave in Midland there may be, on rare occasions, some leaf damage such as yellowing, the edges of leaves dying or some spotting of fruit which may be attributable to fallout from the brickworks. These effects should be only noticeable in the most sensitive species and are not expected to impact most species. A discussion of available criteria and standards for ground level concentrations (GLC's) of fluoride can be found in Appendix 3.

The Environmental Protection Authority's objective is that there should be no unacceptable effect on the beneficial uses of the area around the site from the operation of the proposed brickworks. Beneficial uses of the land which surrounds the plant and are within the area potentially affected by the fluoride fallout are:

. residential dwellings;
. domestic gardens;
. sheep and horse raising;
. racehorse training;
. market gardening;
. industrial; and
. commerce.

In setting this objective the Environmental Protection Authority is aware of two major obstacles to the implementation of this objective. These are:

. the determination of which values of ground level concentration of fluoride and over what time period will cause damage to plant species. There are various standards which are applicable to differing species at differing locations around the world. Some investigative work has also been conducted into the effects of fluoride on Australian species. However the applicability of these various standards, criteria and research findings to the land surrounding the proposed brickworks site in Midland is open to question; and

. the measureability of fluoride related damage to the environment. It is a relatively easy matter to measure fluoride emission from a brickworks at source and from this to determine GLC's at any point of impact. However it is difficult, without properly designed and conducted biological studies to correlate fallout from a source with biological damage.

Because of these obstacles the Environmental Protection Authority has adopted a dual approach to control impacts from air emissions from the proposed plant. This is outlined below.

- the Environmental Protection Authority has determined that the continuing maintainance of the beneficial uses of the area shall be monitored by conducting studies on appropriate indicator species for demonstratable fluoride damage;

- the Environmental Protection Authority has set a fluoride mass emission rate for the whole plant which should never be exceeded. (The mass emission rate is the mass of fluoride emitted per unit time from the brickworks). The Environmental Protection Authority is aware, as has been discussed above, that the fluoride emitted from the brick making process is dependent upon, among other things the fluoride content of the clay used in the process. The Environmental Protection Authority considered that the value quoted in the PER is at the low end of the range of clay fluoride content. The Environmental Protection Authority sought additional information from the proponent on the fluoride levels found in the clays proposed to be used. On the information supplied the Environmental Protection Authority accepts the value quoted in the PER as being realistic. However if the proponent cannot maintain the use of low fluoride clays the Environmental Protection Authority considers that it will have to find alternative means of keeping fluoride emissions within the Environmental Protection Authority's specified mass emission rate. The mass emission rate will be determined from the modelling of the expected fluoride fallout and the guidelines for acceptable fluoride GLC's rate). The actual fluoride mass emission rate will also be monitored; and

- the form and results of the study into the biological impacts of fluoride and the monitoring of the fluoride mass emission rate should be to the satisfaction of the Environmental Protection Authority. Initially the Environmental Protection Authority requires that the proponent reports on the background fluoride levels and quality of the environment around the plant at the commencement of operations, then reports 3, 6 and 12 months after commencement of operations on the results of the biological impacts and the mass emission rate. Following the first year of operation the proponent should report annually or as often as the Environmental Protection Authority requires. If the Environmental Protection Authority is not satisified with the results of the study,the maximum emission rate as a condition of the Licence to Discharge will be reduced.

RECOMMENDATION 2

Based on the information available to the Environmental Protection Authority recommends that:

- **the fluoride mass emission rate from the whole plant should never exceed 1.0 gram/second;**

- **these emissions should be released to the environment through a stack with a minimum height of 35 m;**

- **the proponent should monitor the emission rate and supply the results to the Environmental Protection Authority as part of a monitoring and verification programme approved by the Environmental Protection Authority; and**

- **if, in accordance with Recommendation (3) environmental damage occurs as a result of the brickworks operation, this maximum allowable mass emission rate will be reduced to a level such that the objective of the continuing maintenance of current beneficial uses of the locality is met.**

The second part of the control of the emissions is the determination of the impact of the gaseous emissions from brickworks on the surrounding area.

RECOMMENDATION 3

The Environmental Protection Authority recommends that the proponent funds an independent study, to be approved by the Environmental Protection Authority, to measure the ground level concentrations of fluoride on areas around the plant, and the associated effects on the environment. For appropriate verification of this study, monitoring will have to commence well before the plant becomes operational. In the event that the Environmental Protection Authority is not satisfied with the assessment of the state of the environment as shown in the results of the study, the Environmental Protection Authority will require the proponent to modify its operations to reduce air emissions to an acceptable level.

The PER does not explicitly commit the proponent to the installation of a scrubber in the plant. The proponent has indicated a willingness to install a scrubber if it is demonstrated that a scrubber is required should the plant proceed to beyond Stage 1.

RECOMMENDATION 4

The Environmental Protection Authority recommends that the proponent should configure the various parts of the plant so that a scrubber can be retrofitted to Stage 1 should the Environmental Protection Authority consider it necessary.

RECOMMENDATION 5

The Environmental Protection Authority recommends that if the project proceeds to Stage 2 the proponent should maintain the fluoride emissions from the total plant at the mass emission rate set in Recommendation 2.

4.2 NOISE

During the preparation of the PER the Environmental Protection Authority specifically requested that the proponent investigate the potential for noise impact from the plant in the context of existing background noise. The PER shows that there are existing conditions eg aircraft, road traffic and the Midland Westrail workshops, which may create a noise nuisance. The PER does not contain any information on the likely noise levels from the brick-making process, kiln or vehicles operating in the plant. The PER makes very generalised statements about the possible need for silencing of mobile equipment and the enclosure and insulating of equipment if it is shown to cause noise above an "acceptable standard".

From observations of similar industrial developments the Environmental Protection Authority does not consider that the potential noise emissions from the site will be of such a level that the project should not be allowed to proceed. However, the proponent should satisfy the Environmental Protection Authority that provisions to ameloriate all potential noise emissions are adequate before process operations commence.

RECOMMENDATION 6

The Environmental Protection Authority recommends that the noise emissions from the plant will need to be at a level acceptable to the Authority. This will be controlled by appropriate licencing conditions set under the Environmental Protection Act.

4.3 DUST

The PER has identified potential dust sources as being from process operations and stockpiles. Another potential source of dust is from vehicle movements within, and entering and exiting the plant.

RECOMMENDATION 7

The Environmental Protection Authority recommends that should there be a nuisance from dust associated with the brickworks outside the site boundary then the Swan Shire Council and the nominee of the Minister for Transport should inform the proponent to take appropriate action to stop the nuisance occurring.

4.4 PLANNING MATTERS AND THE HELENA RIVER AND FLOODPLAIN

(a) The Helena River floodplain is the subject of Cabinet endorsed System 6 Red Book Recommendation M33, (see Appendix 4). The objective of this recommendation is to create a Regional Park along the Helena River between the Darlington townsite and the Swan River.

(b) The floodplain land in the vicinity of the proposed brickworks is under a variety of ownership (see Figure 2).

(c) The PER proposes that the land shown as Area A in Figure 2 should be excised from the abattoir site and retained by the Crown. Area B will be transfered from the Crown to Pilsley Investments Pty Ltd. The sale of Area C is being negotiated with Elders Pastoral Co.

(d) Since the release of the PER the proponent has decided that if the Saleyard area is unavailable for Stage 2 of the project there will be the need to extend the plant and an area of hard standing into the area of floodplain shown as areas B & C in Figure 2. The proponent has applied to the State Planning Commission for a rezoning of this area from Rural to Industrial under the Metropolitan Region Planning Scheme and from General Rural to Industrial Development under the Shire of Swan Town Planning Scheme No 9. Initally the rezoning only extended to the point shown in the PER on the southern boundary of the land exchange area. Subsequently, in its rezoning application, the proponent has sought a rezoning of a further 10 m of the floodplain an shown in Figure 2 to accomodate the possible expansion refered to above.

(e) To accomodate this extension of the plant the proponent intends to fill part of the floodplain. This will require the removal of some trees and the extension of some of the fill into the floodplain beyond the WA Water Authority's Recommended Limit of Development. The Recommended Limit of Development is a line on the flood plain determined by the WA Water Authority beyond which it is likely that the land will be inundated by a 1 in 100 year flood.

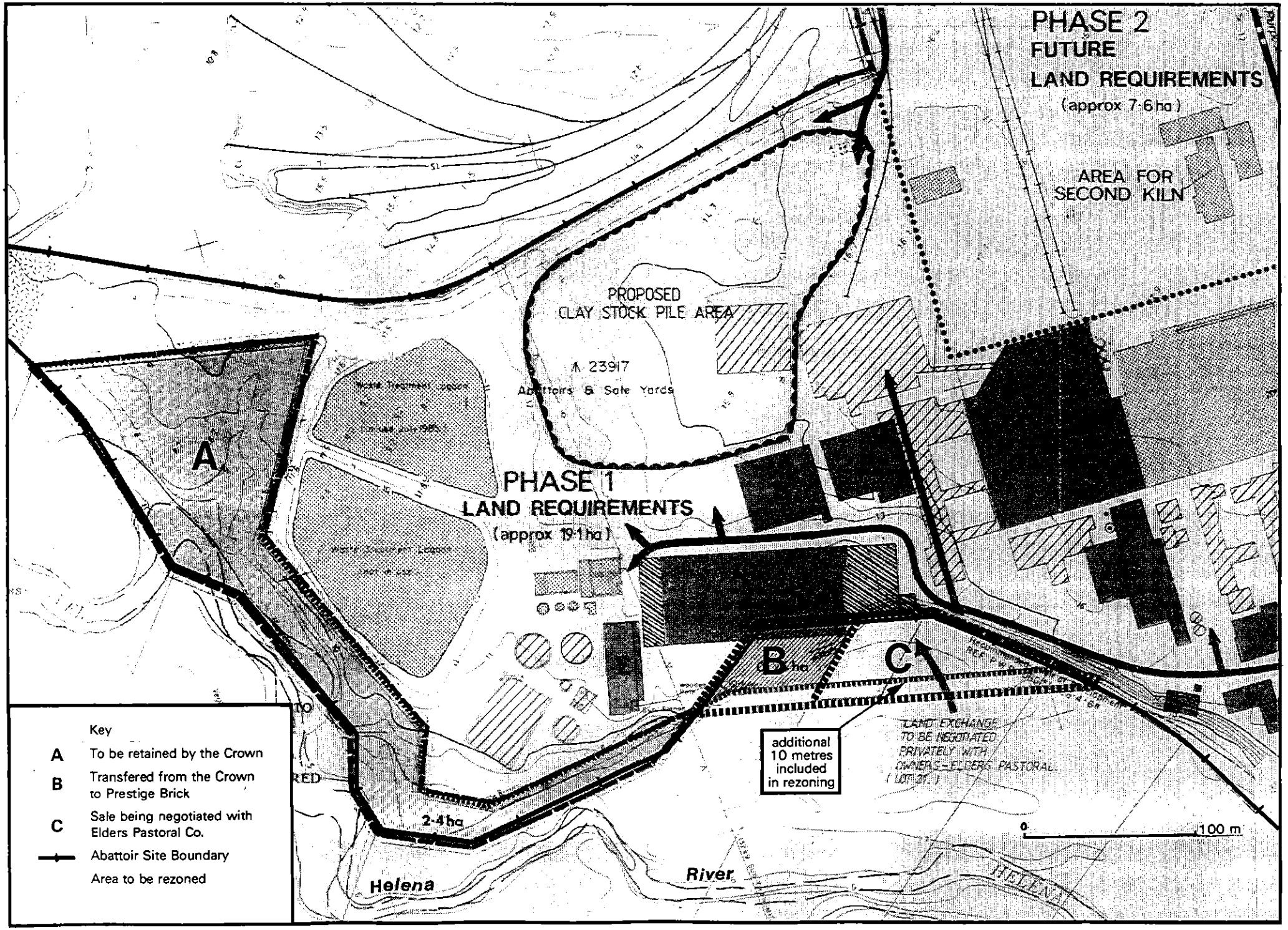

Figure 2 Land Tenure and Rezoning Proposal

The Environmental Protection Authority understands that the proposed extension beyond the Recommended Limit of Development is not major and is not opposed by the WA Water Authority. Furthermore the proponent has undertaken to revegetate the fill to ensure the trees are replaced by suitable trees of the same species. The Environmental Protection Authority has been involved in the negotiations leading up to the setting of the boundary of the site.

RECOMMENDATION 8

The Environmental Protection Authority recommends that in the event of the requirement to fill part of the floodplain, the proponent should landscape the filled area in a manner which recreates the indigenous floodplain vegetation of that area.

The proponent has given an undertaking that the effluent/wash water from the Saleyards will continue to be treated as at present. In the event that the system as it is presently used is effected by the brickwork's operation, Prestige Brick will be either relocate or re-install the treatment works at its own cost.

5. CONCLUSION

The Environmental Protection Authority has considered the PER, the submissions from the public and Government agencies and sought additional information from the proponent including information on the level of fluoride in the clay proposed to be used in the bricks and other matters.

The Authority considers that there is a potential for impact from fluoride emissions from the process on the areas around the plant. The Authority has set an objective that no environmental damage should result from the operation of the brickworks. The Authority proposes a dual approach to the control of air emissions. This has been accomplished by:

- setting a mass fluoride emission rate for the whole plant which should never be exceeded; and

- recommending that an environmental monitoring programme be set up to monitor the effects of fluoride fallout on the environment and to provide a verification of the acceptability or otherwise of the set mass emission standard.

The Environmental Protection Authority considers that the proponent should furthur address the potential for the creation of noise nuisance from the plant, and has recommended accordingly.

The potential for dust nuisance outside the plant has been considered by the Environmental Protection Authority and recommendations made for its correction.

A range of issues were raised in the public submissions concerning the river floodplain and planning related issues. This proposal will require some rationalisation of the site and a minor encroachment on to the floodplain. This has been traded off against a larger area becoming available the end result of which will provide the basis for a future reservation over the Helena River floodplain.

The Environmental Protection Authority has examined the proposal to construct and operate a brickworks on the old Midland abattoir site. The proposal has some potentially significant environmental impacts. However, it is the Environmental Protection Authority's opinion that these can be managed. Consequently, subject to the above recommendations and the commitments given by the proponent the Environmental Protection Authority finds the project to be environmentally acceptable.

APPENDICES

APPENDIX 1

FLUORIDE SCRUBBING TECHNOLOGY USED IN WA

The purpose of a scrubber is to remove (scrub) fluoride and other potentially hazardous chemicals from the effluent gas stream emitted from a brickworks.

The table below describes the various types of scrubbers which have been used in Western Australian Brickworks.

SCRUBBER TYPE	BRICK PLANT	YEAR	ESTIMATED EFFICIENCY (PER CENT)	STATUS	COMMENTS
Semi fluidised lime bed with lime injected cyclones	Midland Brick	1977	75-95*	Cooperative	*No direct access to scrubber outlets. In situ sampling pipes intake located approximately 0.5 m above outlet-wind effects may divert plume to detriment of accuracy of tests.
New Design	Midland Brick	1978	80-95*		
New Design	Midland Brick	1981	72-96*		
Static Limestone Bed	Monier (Now Metro Bricks) (Armadale)	1978	92	Operative	Company is currently assessing purchase of European designed and improved scrubber for proposed replacement of existing scrubber (existing scrubber has high maintenance cost associated with optimum efficiency).
Flakt Beghouse with lime inject reaction chamber	Whitemans Brick (Now Midland Brick)	1982	97-5	Operative	Condition of licence requires maintenance of 97.5% scrubber efficiency (imposed 1986)
Nil	Cardup Brickworks				Fluorosis detected some years ago in adjacent dairy farm but introduced farm practices has since obviated any recurrence.

APPENDIX 2

FLUORIDE EMISSIONS FROM BRICKWORKS IN THE MIDLAND AREA

The following calculations are designed to give a broad estimate of the possible fluoride emissions per year from existing brickworks in the Midland area and compare these with estimates of the emissions from Prestige Brick. The following calculations are used.

Annual Fluoride Emitted = (A) Average Annual Brick Production
x (Mb) Average mass of a brick
x (Fc) Fluoride content of clay used
x (Fr) Proportion of fluoride released from the brick during firing
x (S) Proportion of fluoride <u>not</u> removed by scrubbers

There is no one value which is applicable for the fluoride content of the clay, the proportion of fluoride released from the brick during firing or the efficiency of scrubbers. Consequently the following figures provide a range of values.

<u>ESTIMATED FLUORIDE EMISSIONS FROM EXISTING & PROPOSED BRICKWORKS IN THE MIDLAND AREA</u>

EXISTING BRICKWORKS (Midland & Whiteman Brick)

Maximum fluoride content of Clays 600 ppm
Estimated maximum production capacity 317 x 10^6 bricks
Estimated maximum potential fluoride emission (unscrubbed) = 586 t/annum

Estimated maximum potential fluoride emission at nominated maximum scrubber efficiency of 97% and 12% retention = 17.6 t/a

Estimated maximum operational fluoride emission at estimated scrubber efficiency of 85% and 12% retention = <u>43.9 t/a</u>*

Ground level emissions - no stack

PROPOSED BRICKWORKS (Prestige)

Stage 1

Maximum fluoride content of clays 230 ppm
Maximum production capacity 50 x 10^6 bricks
Maximum potential fluoride emission (unscrubbed) and 12% retention = 35.4 t/a

Calculated operational fluoride emission unscrubbed and 12% retention with stack to disperse emissions = <u>16.5 t/a</u>**

Stage 2

Maximum production capacity 100 x 10^6 brick
Maximum fluoride content of clays 230 ppm
Maximum potential fluoride emission (unscrubbed)
and 12% retention = 70.8 t/a

Calculated operational fluoride emission
unscrubbed and 12% retention = 33 t/a

With stack to disperse emissions

* Based on the information available the EPA is of the opinion that from the clays used by the various manufactures and the actual scrubber efficiencies it is likely that, in the above table, that the figure given for the Midland Brick/Whitemans Brick brickworks would be closest to that which actually occurs.

** In a similar manner the EPA is of the opinion that the comparable figures in the table above will most likely represent the fluoride emissions from the Prestige Brick plant.

It should be noted however that these values only serve to indicate a broad comparison and should not be quoted as actual annual fluoride emissions.

CALCULATIONS

MIDLAND/WHITEMAN

Combined production capacity 317 x 10^6 bricks
% retention of fluoride in clays 12%
Estimated maximum fluoride emission (unscrubbed)
with 12% retention

$317 \times 10^6 \times 3.5 \times 600 \times 10^6 \times 0.88 \times 10^{-3}$ = 586 t/a

Estimated maximum potential fluoride emission
at nominated maximum scrubber efficiency of 97%
and 12% retention

$317 \times 10^6 \times 3.5 \times 600 \times 10^6 \times 0.88 \times 0.03 \times 10^{-3}$ = 17.6 t/a

Estimated maximum operational fluoride emission
at estimated scrubber efficiency of 85% and 12%
retention

$317 \times 10^6 \times 3.5 \times 10^{-6} \times 0.88 \times 0.15 \times 10^{-3}$ = 43.9 t/a

Ground level emissions - no stack

PROPOSED NEW BRICKWORKS (Prestige)

Stage 1

Production capacity 50 x 10^6 bricks
Maximum fluoride content of clays 230 ppm
Maximum potential fluoride emissions (unscrubbed) with 12% retention

$50 \times 10^6 \times 3.5 \times 230 \times 10^{-6} \times 0.88 \times 1 \times 10^{-3}$ = 35.4 t/a

Calculated operational fluoride emission (unscrubbed) with 12% retention

$50 \times 10^6 \times 3.5 \times 107 \times 10^{-6} \times 0.88 \times 1 \times 10^{-3}$ = 16.5 t/a

Stage 2

Production capacity 100 x 10^6 bricks
Maximum potential fluoride emissions (unscrubbed) with 12% retention

$100 \times 10^6 \times 3.5 \times 230 \times 10^{-6} \times 0.88 \times 1 \times 10^{-3}$ = 70.8 t/a

With stack to disperse emissions

Calculated operational fluoride emission (unscrubbed) with 12% retention

$100 \times 10^6 \times 3.5 \times 107 \times 10^{-6} \times 0.88 \times 1 \times 10^{-3}$ = 33 t/a

With stack to disperse emissions

PREDICTED EFFECTS OF VARIOUS GROUND LEVEL CONCENTRATIONS (GLC'S) OF FLUORIDE

This appendix contains the following documents:

1. 'The Biological Effects of Fluoride' taken from Appendix 1 of the Report and Recommendations by the EPA for the Proposed Aluminium Smelter Kemerton. (EPA Bulletin 214, 1985)

2. Tables copies from the Kemerton Aluminium Smelter ERMP giving various standards or recommendation for fluoride levels for Australian conditions.

APPENDIX I

THE BIOLOGICAL EFFECTS OF FLUORIDE

APPENDIX I

THE BIOLOGICAL EFFECTS OF FLUORIDE

This Appendix is written for interested members of the public and contains a number of judgements based on the results of a large number of scientific studies. Individuals who may wish to investigate the issues and studies further are referred to Suttie (1977), Weinstein (1977), Smith and Hodge (1979), US EPA (1980) and WHO (1984).

Consideration is given to the effects of exposure to relatively small amounts of fluoride over long periods of time (chronic exposures). These effects are considered to be the most realistic based upon the characteristics of fluoride emissions from modern industrial sources. The effects of exposure to very high concentrations of fluoride, which often result in an almost immediate response (acute exposures), are not considered likely. However, interested individuals are referred to the above publications.

Fluoride is widely distributed in the natural environment, ranking 13th among the elements in order of abundance in the earth's crust. It occurs in rocks, soils, groundwater, surface waters, air, plants and animals. Fluoride is also an important industrial emission which is released when fluoride-containing materials are heated to high temperatures. The main industrial processes involved are coal-fired power stations, aluminium smelters, steel plants, phosphate fertiliser works, brick, tile and glass works, oil refineries and some ore-refining and chemical plants.

Fluoride may be released in a gaseous form or particulate (dust) form. The fluoride-containing dusts released from a short chimney or the roof of a building such as an aluminium smelter potroom are deposited close to the source, but gases may be transported greater distances. Fluoride may be readily transported in the environment and a schematic diagram (Figure I-1) illustrates some of the transport pathways.

1. EFFECTS ON PLANTS

Fluoride is one of the most important air pollutants. In terms of its effects on plants it is regarded as the second most important air pollutant in Europe (Knabe, 1978) and the fourth in the USA (Heck, 1982). It is the most toxic to plants of the common air pollutants, causing injury at concentrations in air about 100 times lower than the rest (e.g. ozone, sulphur dioxide and nitrogen oxides).

Fluoride-containing dusts may be deposited on leaf surfaces but they only slowly enter the plant, particularly under dry conditions or when the dust is relatively insoluble in water. However gaseous flourides such as hydrogen fluorides are very reactive with plant surfaces particularly when moist, and may be deposited on the leaf surface and slowly enter the leaf, or may enter the leaf directly through the breathing pores (stomata). Once inside the leaf, fluoride moves to the tips or perimeter of the leaf where it may accumulate. Fluoride may be lost from leaves by weathering, volatilisation* or growth dilution. Under wet conditions fluoride concentrations in pastures may be halved in 24 hours (Davison and Blakemore, 1979). If sufficient fluoride accumulates it may influence the biochemical functioning of the leaf, cause a yellowing (chlorosis), or kill (necrosis*) parts of the leaf. If sufficient leaf area is killed, leaf drop may occur and if large areas of plant are injured, dieback or even plant death is possible. Fluoride may also cause abnormal fruit development. However, the symptoms of fluoride injury are similar to a number of other plant diseases including some nutrient deficiencies and visible symptoms alone are not diagnostic of fluoride injury (Lacasse and Treshow, 1978).

Fluoride is not usually very mobile in plants. Plants accumulate relatively little fluoride in aboveground parts from soils, although saline soils are an exception to this. Even when leaf fluoride concentrations are high, relatively little fluoride can be found in seeds flowers of fruit. When garden vegetables are exposed to airborne fluoride, leafy vegetables with open leaf arrangements (e.g. spinach) accumulate most fluoride, but plants with closed leaf arrangements (e.g. cabbage, lettuce), flowers (e.g. cauliflower, brocolli), fruit (e.g. peaches, tomato) and root crops (potato, onion) have very little fluoride in the edible parts. Food preparation further reduces this by the practice of discarding the outer leaves which contain most of the fluoride, and washing or peeling which removes fluoride deposited on surfaces.

Plants vary considerably in their sensitivity to fluorides. Some species may show injury to leaves after exposure to concentrations of fluoride in air as low as 0.2 micrograms of fluoride per cubic metre of air (μg/m3) over several months (Sidhu, 1980; Murray, 1984). Other species may be exposed to up to 1000 times this amount without injury (Weinstein, 1977). The most sensitive species to leaf injury are grapevines, young conifer foliage, gladiolus and some cultivars of sorghum (Table I-1). Some groups of eucalypts such as the bloodwoods (e.g. marri) are sensitive to fluoride injury but others such as ironbarks are more resistant. Jarrah may be intermediate in fluoride resistance. In some species injury to fruit may occur without leaf injury. Peach fruit is very sensitive to fluoride but peach leaves are about ten times more resistant.

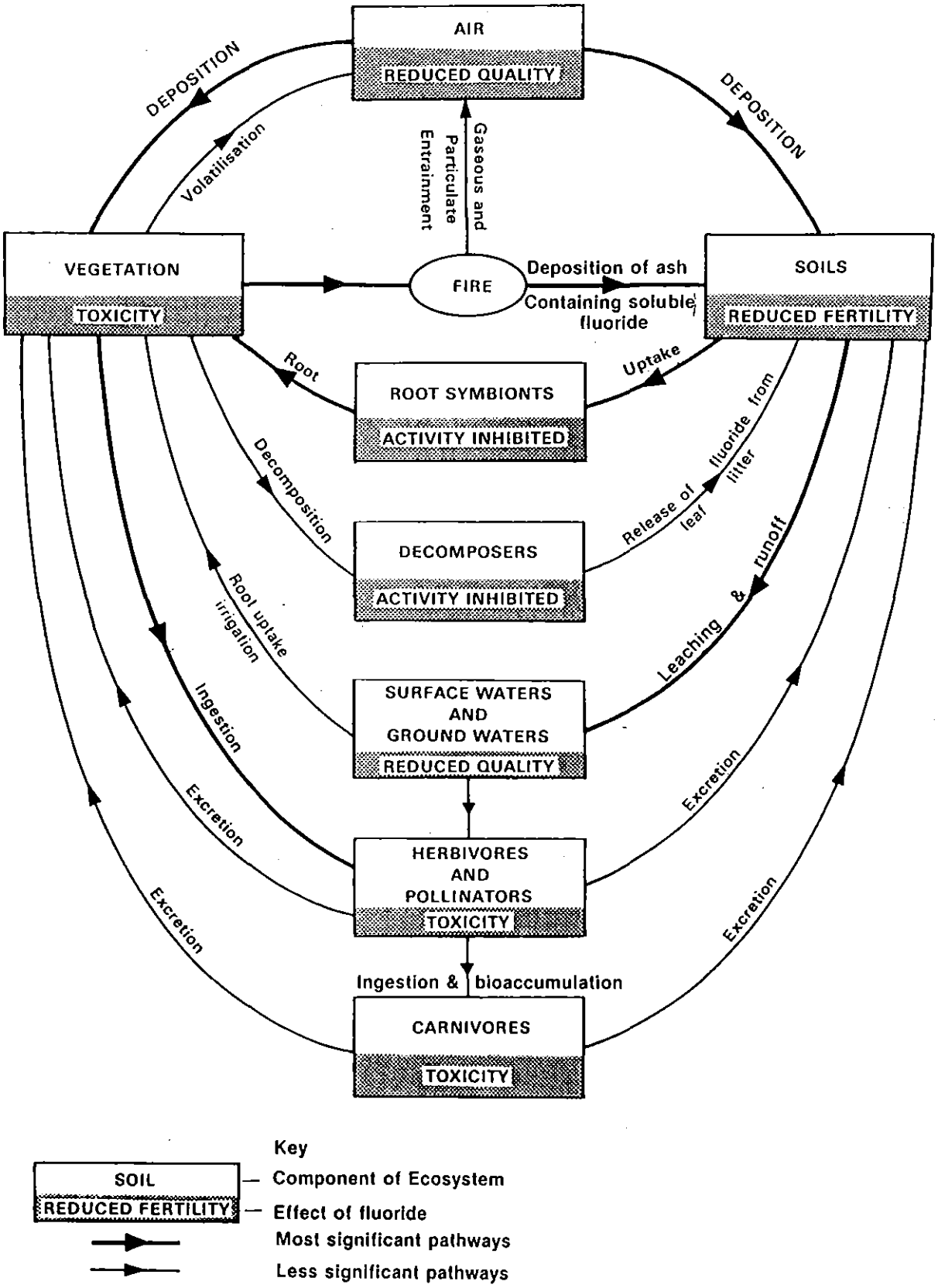

Figure 1-1 — Major Pathways for Fluoride in Ecosystems.

Table I.1 Relative Sensitivity of some Common Plant Species to Atmopheric Fluoride

	Fluoride Sensitivity		
	Sensitive	Intermediate	Resistant
Apple		*	
Apricot		*	
Bean			*
Cabbage			*
Capsicum		*	
Carrot			*
Cauliflower			*
Celery			*
Cherry		*	
Chrysanthemum			*
Clover (White)		*	
Corn (Sweet)#	*		
Cucumber			*
Eggplant			*
Eucalyptus — marri	*		
— jarrah		*	
Gladiolus	*		
Grapevine	*		
Grapefruit		*	
Lemon		*	
Lucerne			*
Marigold			*
Orange		*	
Pea (garden)			*
Peach (foliage)		*	
Peach (fruit)	*		
Pear			*
Pine # (young needles)	*		
(old needles)			*
Plum #	*		
Potato			*
Potato (sweet)		*	
Rose		*	
Ryegrass			*
Sorghum #	*		
Strawberry			*
Tomato		*	
Wheat		*	

Applies to some varieties or species only.

Reductions in growth or yield may be independent of any visible signs of fluoride injury. Leaves may be injured without affecting growth or yield and *vice versa* (Davison, 1982).

Fluoride is also unique among the common gaseous air pollutants as it may accumulate in vegetation and cause injury to animals when this contaminated vegetation is consumed. In pastures, accumulation of excessive fluoride is of greater relevance than leaf injury, because accumulation of fluoride concentrations which may cause injury to sensitive animals such as dairy cattle usually occurs long before foliar injury is obvious in pasture species. Soils are not normally contaminated to any significant extent by airborne fluoride emissions, as deposition rates are low in comparison with normal background levels and fluoride is readily bound by factors which are present in almost all agricultural soils (Murray, 1984).

Fluoride accumulation in pastures is enhanced by:

- greater concentration of pollutant;
- greater duration of exposure;
- open sward* structure;
- low leaf turnover rate; and
- lack of rainfall.

Fluoride concentrations in pastures may also be increased by the use of phosphate fertilisers which contain up to several per cent of fluoride.

2. CHRONIC EFFECTS ON ANIMALS

Fluoride may be consumed by animals by a number of means. Fluoride may be present in food, water, mineral supplements, drugs, soils or sediments ingested by animals, or air which is inhaled. The inhalation of airborne fluoride and skin absorption account for an extremely small part of the total fluoride ingested around major industrial sources of fluoride, because concentrations of fluoride in air are so much lower than concentrations in vegetation exposed to fluoride. The main sources of fluoride for most animals are fluoride-contaminated food and water, and feed supplements which have not been properly defluorinated (US EPA, 1980).

Animals show a wide range of resistance to fluorides, however much less is known about wildlife than domestic animals. Most studies have been conducted on dairy heifers, the most sensitive of the domestic animals to fluoride. Studies have enabled a list of dietary fluoride tolerances of domestic animals to be compiled (Table I-2).

A proportion of the fluoride ingested by animals is eliminated in faeces, and the proportion depends on the chemical and physical form of the fluoride. Some of the fluoride enters the blood and is later excreted as urine. However a small proportion of the fluoride is bound in hard tissues such as bones and teeth. Only very small concentrations of fluoride occur in milk or the soft tissues such as muscle.

Table I.2 Dietary fluoride tolerances for domestic animals (a)

Animal	Performance (b) (mg/kg)	Pathology (c) (mg/kg)
Beef or dairy heifers	40	30
Mature beef or dairy cattle (d)	50	40
Finishing cattle	100	NA (d)
Feeder lambs	150	ID
Breeding ewes	60	ID
Horses	60	40
Finishing pigs	150	NA
Breeding sows	150	100
Growing or broiler chickens	300	ID
Laying or breeding hens	400	ID
Turkeys (e)	400	ID
Growing dogs	100	50

(a) The values are presented as mg/kg F in dietary dry matter and assume the ingestion of a soluble fluoride, such as NaF. When the fluoride in the ration is present as some form of defluorinated rock phosphate, these tolerances may be increased by 50%.

(b) Levels that, on the basis of published data for this species, could be fed without clinical interference with normal performance.

(c) At this level of fluoride intake, pathologic changes occur. The effects of these changes on performance are not fully known.

(d) Cattle first exposed to this level at 3 years of age or older.

(e) This level has been shown to be safe for growing female turkeys. Very limited data suggest that the tolerance for growing male turkeys may be lower.

NA = Not applicable

ID = Insufficient data

Source : US National Academy of Sciences (1974)

The symptoms of exposure of domestic animals to excessive fluoride for extended periods of time depend on the amount and type of fluoride, the period of ingestion, the age, nutrition and stress level of the animals, and the individual biological response. If domestic animals are exposed to fluoride during the period of tooth development, chalkiness, mottling or thin enamel may result, and affected teeth may be subject to more rapid wear. Skeletal changes may occur and instead of bones being hard and smooth they can become heavy, porous, rough or chalky white. Outgrowth of bones may occur and leg bone tendons may calcify. The animal may be intermittently lame or stiff. When these more severe symptoms occur the animal may eat less and performance may decline.

In order to protect grazing animals, standards have been promulgated based on limiting the fluoride content of the pastures on which the animals graze. These standards are designed to protect dairy cattle on the basis that these are the most sensitive domestic animals, and standards which protect them will also protect all other domestic animals.

The most commonly used standards, used by many countries throughout the world (IPAI, 1981), have been set at a level which would prevent economic damage to cattle, but not to ensure that no signs of fluoride ingestion are observed (Suttie, 1977). These standards propose that fluoride emissions should be regulated so that the fluoride concentration of the forage the animal would eat does not exceed:

- 80 μg/g for more than one month;
- 60 μg/g for more than two consecutive months; or
- 40 μg/g for the yearly average of monthly results.

Some recent studies have suggested that these standards may not provide a sufficient level of protection for dairy cattle under all circumstances. Some authorities (e.g. the State Pollution Control Commission in NSW) use 35 μgF/g as the maximum annual average.

Properties subject to excessive fluoride exposure may be assisted by appropriate management techniques. These may involve:

- suitable pasture management procedures;
- stock and pasture rotation;
- the use of supplementary feed containing low fluoride concentrations;
- the avoidance of dietary supplements, drugs and water containing significant amounts of fluoride; and
- responses to the results of monitoring programmes, which should include fluoride analysis of food and water and regular veterinary inspection.

Pasture management aims to reduce the fluoride concentration by:

- removing fluoride adhering to leaf surfaces by spray irrigation;
- growth dilution of fluoride by encouraging pasture growth;
- avoiding the use of fluoride-containing fertilisers and chemicals; and
- in some cases slashing to remove fluoride accumulated at the apex of pasture grasses. If fertilisers are used, fertilisers containing high fluoride concentrations should be replaced by others containing lower concentrations where possible.

Elevated fluoride concentrations have been measured in many species of wild animals but very little information is available on effects. Reductions in populations of wild birds have been reported around old aluminium smelters in Czechoslovakia (Newman, 1979). Studies of aquatic animals have shown that many environmental factors such as temperature and salinity influence the responses of fish to fluorides. Crustaceans appear to be more resistant to fluoride than fish. Although much more work is required, studies suggest that fluoride concentrations of less than 1.5 mg/L in water have no deleterious effects on aquatic fauna (US EPA, 1980).

Some insects appear to be relatively sensitive to fluoride and honey bees have been killed around old aluminium smelters. Fluoride may reduce growth and reproduction in invertebrates (US EPA, 1980). Effects on ecological relationships involving insects are discussed in the ecosystems section of this Appendix.

3. CHRONIC EFFECTS ON HUMANS

Fluoride may have beneficial or toxic effects on humans depending, among other things, on the quantity of fluoride ingested. Beneficial effects may result from the ingestion of a few milligrams of fluoride per day resulting in a reduction in dental caries (WHO, 1984). Fluoride is added to many public water supplies for this reason. High doses of fluoride may result in detrimental effects. The main sources of fluoride for humans is food, beverages, drugs and dentifrices*. Very small quantities of fluoride are inhaled by people living near fluoride emission sources. The average respiration rate of a person is about 20 cubic metres (m3) per day (WHO, 1984). Therefore, for a resident living in an area with 0.3 (μgF/m3) in air and if all of the fluoride was retained, the daily intake would be 6 μg of fluoride. This is as much fluoride as contained in 6 millilitres (about one hundredth of a pint) of town water when the town water supply is fluoridated at the normal rate (1mg/L). Occupational exposure may result in much higher rates of fluoride intake. Assuming a total respiration rate of 10 m3 during a working day, the daily amount of fluoride inhaled could be as high as 10 — 25 mg, when the air concentration is at the most frequent exposure limits of 1 — 2.5 mg/m3 (ILO, 1980). Depending on hygiene conditions, dust contamination in the industrial setting could also add to the oral intake of fluoride (WHO, 1984).

Strict occupation hygiene measures ensure that fluoride concentrations in potrooms of modern aluminium smelters remain within acceptable limits. Monitoring of fluoride in the urine of potroom

workers indicates the margin of safety, ensuring that occupational hygiene is maintained at all times.

Fluoride concentrations are high in some foods, especially canned fish and tea. The ingestion of vegetables grown around fluoride emission sources has been estimated to increase fluoride intake of local residents by about 1.7% when the water supply is not fluoridated or 1% when the water supply is fluoridated (WHO, 1984).

Rainwater collected from roof areas for drinking water around fluoride emission sources may contain increased fluoride concentrations. Normally rainwater contains very low concentrations of fluoride in rural areas except where the rocks and soils have high natural fluoride concentrations. The fluoride concentration which ultimately may be measured in tap water depends on many factors such as the rate of fluoride deposition on the roof, and cannot be predicted with any certainty, but monitoring may be used to indicate whether unacceptable levels are being approached and other supplies may be arranged.

4. CHRONIC EFFECTS ON ECOSYSTEMS

4.1 AGRICULTURAL ECOSYSTEMS

The effects of fluoride on agricultural ecosystems are better known and understood than on natural ecosystems because the former are usually less complex than natural ecosystems and more studies have examined agricultural ecosystems. The effects of fluoride in agricultural ecosystems are determined by:

- factors relating to fluoride exposure such as the chemical and physical form of the fluoride, the concentration, duration of exposure and how exposed the ecosystem is, i.e. whether it is physically shielded; and
- factors relating to the response of the ecosystem, such as the sensitivity of the ecosystem components or processes during the period of exposure.

In the case of grazing areas, forage species accumulate a level of fluoride which causes damage to sensitive grazing animals such as dairy cattle, before any injury is visible to the pasture, although sensitive trees such as some conifers and marri, and some garden plants such as grapevines and gladiolus, would probably show symptoms of fluoride injury. However the same exposure conditions do not necessarily have the same response. Pastures with rapid growth do not accumulate fluoride concentrations as high as pastures with no growth, such as dryland pastures during summer. Cropping areas subject to frequent cutting such as lucerne, do not accumulate as much fluoride as crops which are harvested once, such as sorghum. Forage crops which are spray irrigated with water with low fluoride concentrations do not accumulate as much fluoride as trickle irrigated crops of pastures because fluoride is washed off the leaf surface by the irrigation water.

The harvested parts of root, grain and fruit crops do not accumulate fluoride to a significant extent as most fluoride is taken up by leaves and remains there, so, providing fluoride does not otherwise influence yield or quality, it has no effect on these crops.

4.2 FOREST PLANTATIONS

Forestry areas are subject to management which reduces the impacts of fluoride. When trees are being planted in an area subject to fluoride input, the genetic stocks of trees may be selected to ensure that they are productive at the concentrations expected, in the same way that trees to be planted in an area subject to other stresses (e.g. low nutrients, high salinity) would be selected, and managed to minimise that stress.

In established forests the impact of fluoride can be significant when concentrations are high. Economic damage has resulted from the effects of fluoride on sensitive tree plantations in some areas of the world when major emission sources have been constructed in very close proximity to these forests.

4.3 MARINE ECOSYSTEMS

Natural areas are often more complex and the effects of fluoride in these environments are less well understood. Liquid effluents containing fluoride are pumped into marine ecosystems in many parts of the world. Fluoride may accumulate in the water, flora, fauna and sediments. Some aquatic organisms are sensitive to fluorides, depending on the species and acclimatisation. Crustaceans such as crabs and prawns are tolerant of high fluoride levels in sea water. High fluoride concentrations may accumulate in edible tissues of crabs during exposure, although these quickly return to normal values in clean water (Moore, 1971). The most sensitive aquatic organisms appear to be filter-feeding molluscs. Marine organisms appear to be more tolerant of fluoride than freshwater organisms, perhaps because sea water usually contains up to ten

times as much fluoride as fresh water. Most studies which have shown toxic effects of marine organisms have all used concentrations which exceed 5 ppm in sea water. Many studies using much greater concentrations than this have found no effects (US EPA, 1980; WHO, 1984).

4.4 FRESHWATER ECOSYSTEMS

A wide variety of freshwater fauna have been exposed to a range of fluoride concentrations in the water and results have shown that there are large differences between species in fluoride tolerance and that other environmental conditions have a considerable influence on the response. Concentrations up to 1.5 ppm in water appear to have no adverse effects on freshwater fauna (US EPA, 1980), but little information is available on the effects of fluoride on freshwater ecosystems.

4.5 NATURAL FOREST ECOSYSTEMS

Trees are exposed to greater amounts of fluoride than shrubs or grasses, and the air within a forest has lower concentrations of fluoride than the air above it, because fluoride is highly reactive and is removed from air by exposure to foliage.

In forest ecosystems fluoride accumulates in leaves and may be transferred to the soil surface with litterfall. As a result of this and dry deposition directly to litter on the soil surface, fluoride concentrations in plant litter may be considerably higher than in green leaves (Murray, 1985). It is possible that when these fluoride concentrations are particularly high there may be some inhibition of litter decomposer activity due to toxic effects on the soil organisms. However the most significant feature of nutrient cycling in these forest ecosystems is fire, which results in the release of nutrients to the soil for root uptake by the flora.

Fluoride is released from plant litter by fire and it has been estimated that about 70% is exported from the ecosystem as gaseous and particulate fluoride, with 30% remaining as ash. High soluble fluoride concentrations occur in the ash and have been found to measure about 1600 μg/g after a bushfire around an aluminium smelter. These concentrations could also impede germination and seedling growth for a period of time but rainfall will ultimately leach the water-soluble fluoride into the soil. Most soils have a high capacity to bind fluoride in an insoluble and unavailable form, and the factors responsible for this are iron, aluminium, calcium and other agents.

Some sandy soils lack these factors and may not have this capacity, and consequently there maybe some potential in these soils for fluoride to be taken up by roots, or leached to groundwaters.

Fluoride was used for many years as a fungicide and so it is possible that high concentrations of fluoride at the soil surface may influence soil fungi and other microorganisms which assist plants to survive in low nutrient soils, but there is no direct evidence of this.

Fluoride has been used commercially as an insecticide and has been shown to alter the growth and reproduction of some insect species feeding on plants containing high fluoride concentrations (Laurence, 1981). Major outbreaks of insect attacks occurred in forests around aluminium smelters and it has been suggested that fluoride-insect interactions were responsible (Alcan Surveillance Committee, 1979).

It is also possible that fluoride could interact in some way with pathogens such as *Phytophthora cinnamomi* which may induce dieback and other forest diseases but there is no information available to assess this possibility.

A number of studies have suggested that fluoride is accumulated along food chains, but there is little evidence in relation to the ecological consequences of this bioaccumulation. Fluoride is known to occur naturally in organic forms such as fluoroacetate (the active ingredient in the poison, 1080) and a number of West Australian plant species contain this poison (poison peas of the genera *Oxylobium* and *Gastrolobium*). About fifteen years ago it was suggested that agricultural plants could produce fluoroacetate from fluoride in the air but extensive field and laboratory studies have been unable to find this compound in vegetation exposed to fluoride (Weinstein, 1977). The absence of reports of organofluoride toxicity in domestic animals grazing around major fluoride emission sources also implies that the original suggestion that agricultural plants could produce this poison when exposed to fluoride was incorrect.

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A9.2 OVERSEAS STANDARDS OR RECOMMENDATIONS

Substance	Country, State or Organisation	Fluoride Level µg/m³	Fluoride Level ppb	Averaging Time
Fluorides, gaseous as HF	Kentucky[1]	0.82	1	1 month
Fluorides, as HF	New Hampshire[1]		1	1 month
Fluorides, gaseous as HF	New York[1]		1	30 days
Fluorides, as HF	Tennessee[1]	1.2	1.5	1 month
Fluorides, gaseous as HF at STP	Texas[1]		1.0	30 days
Fluorides, gaseous as HF at STP	Washington[1]	0.5		March 1 to October 3
Hydrogen Fluoride	Canada[2]	0.2	0.2	70 days
		0.35	0.4	30 days
Hydrogen Fluoride	Commission[3] of the European Communities	0.4*		30 days
		0.3*		growing season
		0.8**		30 days
		0.5**		growing season
		2.0***		30 days
		1.4***		growing season
Hydrogen Fluoride	International[3] Union of Forest Research Organisations	0.3		1 year

* For protection of very sensitive plants.
** For protection of sensitive plants.
*** For protection of less sensitive plants.

Sources :

1 Hodge, H.C. and Smith F.A. (1970). "Air Quality Criteria for the Effects of Fluorides on Man" Journal of the Air Pollution Control Association, 20(4).

2 Frank Murray, pers comm.

3 Halbwachs, G. (1984) "Organismal Responses of Higher Plants to Atmospheric Pollutants : Sulphur Dioxide and Fluoride." In Air Pollution and Plant Life (ed M. Treshow) 1984.

A9.1 AUSTRALIAN STANDARDS OR RECOMMENDATIONS

Receptor		Standard or Recommendation
Native Vegetation	1.	0.50 µg/m³, 90 days - sensitive native species can show damage
	2.	0.50 µg/m³, 90 days - "local objective"
	3.	0.50 µg/m³, 90 days - where superficial visual damage can be tolerated
		0.20 µg/m³, 90 days - to give overall protection regardless of normal stress
Cultivated species grape vines, stone fruits, trees, flowers	3.	0.1 µg/m³, averaged over the growing season
	1.	0.5 µg/m³, maximum monthly - species intermediate in sensitivity
		0.1 µg/m³, maximum monthly - sensitive species such as gladioli and stone fruits
Forage crops	3.	40 ppm average expressed as fluoride by weight on a dry leaf basis for any 12 consecutive months
		60 ppm each month for two consecutive months (with 12 month average still not to exceed 40 ppm)

Sources : 1. State Pollution Control Commission (1980). Pollution Control in the Hunter Valley with Particular Reference to Aluminium Smelting 2nd ed., August 1980.

2. Victorian State Environment Protection Policy (1981). "The Air Environment". Victorian Government Gazette, 63.

3. Air Pollution Control Council of WA (1983). Recommended Guidelines to Limit (a) Ambient Air Quality for Hydrogen Fluoride to Protect Vegetation (b) Fluoride in Forage to Protect Grazing Animals.

APPENDIX 4

SYSTEM 6 RECOMMENDATION M33

From: EPA (1983) - 'Conservation Reserves for Western Australia as recommended by the Environmental Protection Authority. The Darling System. System 6'. Report No 13, Department of Conservation and Environment, Western Australia.

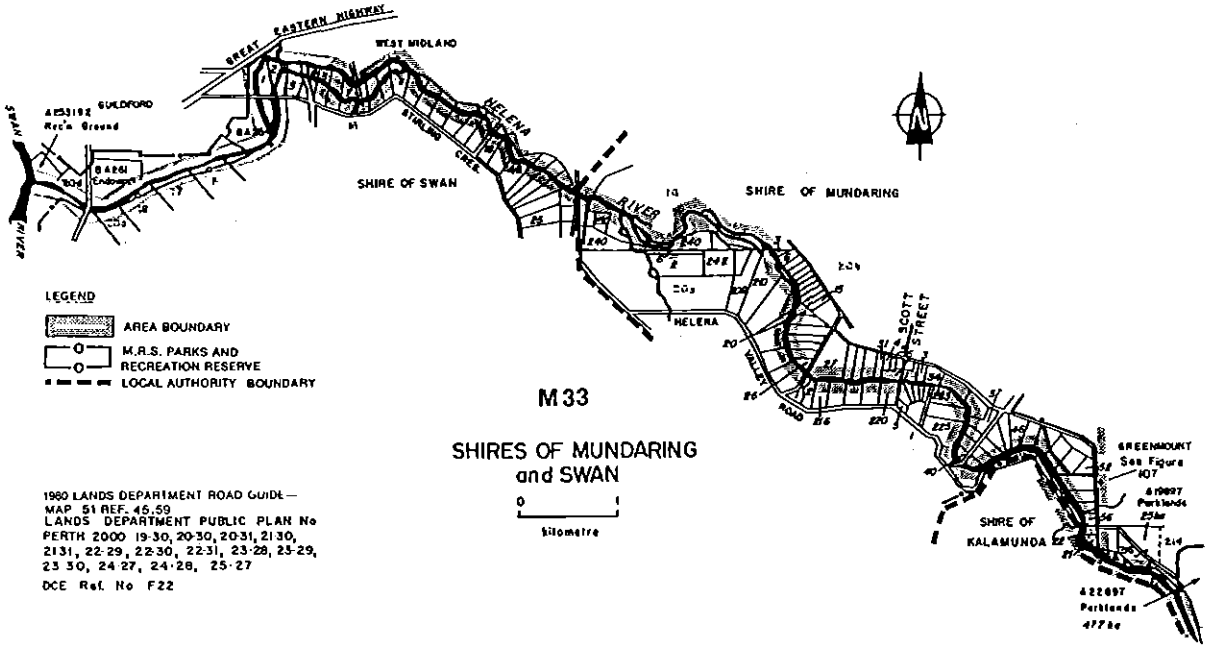

Figure102

M34 HELENA VALLEY

The recommended area comprises Reserves A21314 and A30200, for National Park, both vested in the National Parks Authority; A23981, for Park, C8006, for Recreation, C19897, for Parklands, and C20765, for Recreation and Bird Sanctuary, all vested in the Shire of Mundaring; A7890, for Surveys Standards Area, vested in the Lands Surveyors Licensing Board; A22835, for Parks and Recreation, vested in the Minister for Works; A24182, for Park, C22897 and C23118, for Parklands, and A23537, for National Park, all not vested; C32890, for Water Supply, and part of C5342, for Camping, both vested in the Minister for Water Resources; C10488, for Education Purposes, vested in the Minister for Education; C27154, for Parks and Recreation, C16922, for Recreation and Water Supply, and C17343, for Public Utility, all vested in the Shire of Kalamunda; part of State Forest No. 54 (but not including the Jacoby land); vacant Crown land (part of Location 975); part of Helena Location 20a adjacent to and east of Ridge Hill Road, lots 1, 2, 11, 12, 263 to 265, 281 to 285, 320, 321, 324, 325, 327, 330 to 333, 336 to 338, 341 to 343, 352 to 362 (Helena Location 20a), lots 7 to 12 (Location 1290), lot 17 (Location 1763), part of lot 119 (Location 1532), lot 3 (Location 119), lot 2 (Location 120), Locations 213, 561, 711, 999, 946, 965, 968, 1181 and part of Locations 963, 972, 1298, 1033 and 1345, all owned by the MRPA; and lots 253 to 258 and part of lots 252 and 351 (Helena Location 20a), lot 4 (Location 119), lot 1 (Location 120), Swan Location 1722, part of Locations 351 and 1763 and all of Locations 455, 982, 5687 and 5688, all privately owned freehold land (Figure 103). Most of the area is "reserved" for Parks and Recreation under the Metropolitan Region Scheme.

The MRPA's Report "A Review and Planning Strategy" for the Eastern Corridor affects this area.

Public access to parts of the area is restricted by the Public Works Department's Catchment Zone regulations for the Goldfields Water Supply Catchment Area. These restrictions are satisfactory in view of the conservation value of that portion of the Helena Valley, since management for water purity requires minimal disturbance of the environment. There are SEC lines in the area. There may be requirements for a major road along the Helena Valley and a controlled access highway between Sawyers Valley and Bushmead, across the northern section. The area contains residential areas, small farms and orchards.

A range of vegetation types occurs in the area. The forests and woodlands are variously dominated by jarrah, marri, wandoo and flooded gum, and there are areas of heath, especially in granitic soils where many plant species typical of the Darling Scarp are found. The portion of the Helena River which lies upstream from the small pumpback dam is particularly valuable, as parts are still in excellent condition and several rare species of flora are to be found there. Although some sections have been burnt too frequently and are in need of careful management, the area as a whole has extremely high conservation value for both flora and fauna. Recreation activities within this portion should therefore be restricted to those which do not diminish its conservation value.

APPENDIX 5

LIST OF PERSONS OR AGENCIES WHICH HAVE SUBMITTED COMMENTS ON THE PER TO THE EPA

1. L & P Baker
2. B W Clark
3. J T Cooper
4. D Gray
5. C Lane (Mr)
6. C Lane (Mrs)
7. T K Sangalli
8. J K Watson
9. K A Adam & Assoc
10. Guildford Association
11. Guildford Grammar School
12. Guildford Study Group
13. Metro Brick
14. 'Midland'
15. Midland Brick Pty Ltd
16. Petition Midvale 16 signatures
17. Petition Midland 20 signatures
18. Petition Hazelmere 14 signatures
19. Petition Midvale 26 signatures
20. Petition Hazelmere 71 signatures
21. Royal Australian Chemical Institute
22. WA Wildflower Society
23. Department of Occupational Health, Safety and Welfare of WA
24. Main Roads Department
25. State Planning Commission
26. Water Authority of Western Australia