Report by
THE ENVIRONMENTAL PROTECTION AUTHORITY

MURRAY RIVER WATERFRONT DEVELOPMENT SOUTH YUNDERUP

Department of Conservation & Environment
Perth, Western Australia

BULLETIN 122
OCTOBER 1982

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HON MINISTER FOR CONSERVATION
AND THE ENVIRONMENT

Your Ref.
Our Ref. 168/81

My Dear Minister

The Environmental Review and Management Programme prepared by Sunland Pty Ltd for its proposed Murray River Waterfront canal development has been considered by the EPA following submissions by the public and government departments.

Please find attached the Authority's report. You will note that although water quality has been identified as the principal issue, there are other issues of subsidiary concern which are covered in the Appendix.

I would appreciate it if you would refer the report to the Hon Minister for Urban Development and Town Planning. I also seek your concurrence for publication of the report as Department of Conservation and Environment Bulletin No 122.

Yours sincerely

A R MAIN
CHAIRMAN

11 October 1982

Report by

THE ENVIRONMENTAL PROTECTION AUTHORITY

on

THE MURRAY RIVER WATERFRONT DEVELOPMENT

SOUTH YUNDERUP

DEPARTMENT OF CONSERVATION AND ENVIRONMENT

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C O N T E N T S

FIGURES AND TABLES

1. INTRODUCTION

Sunland Pty Ltd proposes to develop a canal estate on some 70 hectares of land located next to the Murray River 93km south of Perth between Mandurah and Pinjarra. The land, Murrah location 17, lies about 4km west of Ravenswood, fronting onto Yunderup Road South, the main road into the settlement of South Yunderup.

The location is shown in figure 1 and detail of the development in figure 2.

The land is part of the Murray River flood plain and, as may be seen, close to where the river discharges into Peel Inlet. The river at this point is an estuary.

The project envisages a series of interlinked waterways connecting to the Murray River through a cutting to be made via two blocks purchased in Banksia Road. The land to be developed will be elevated using material dredged to form the waterways.

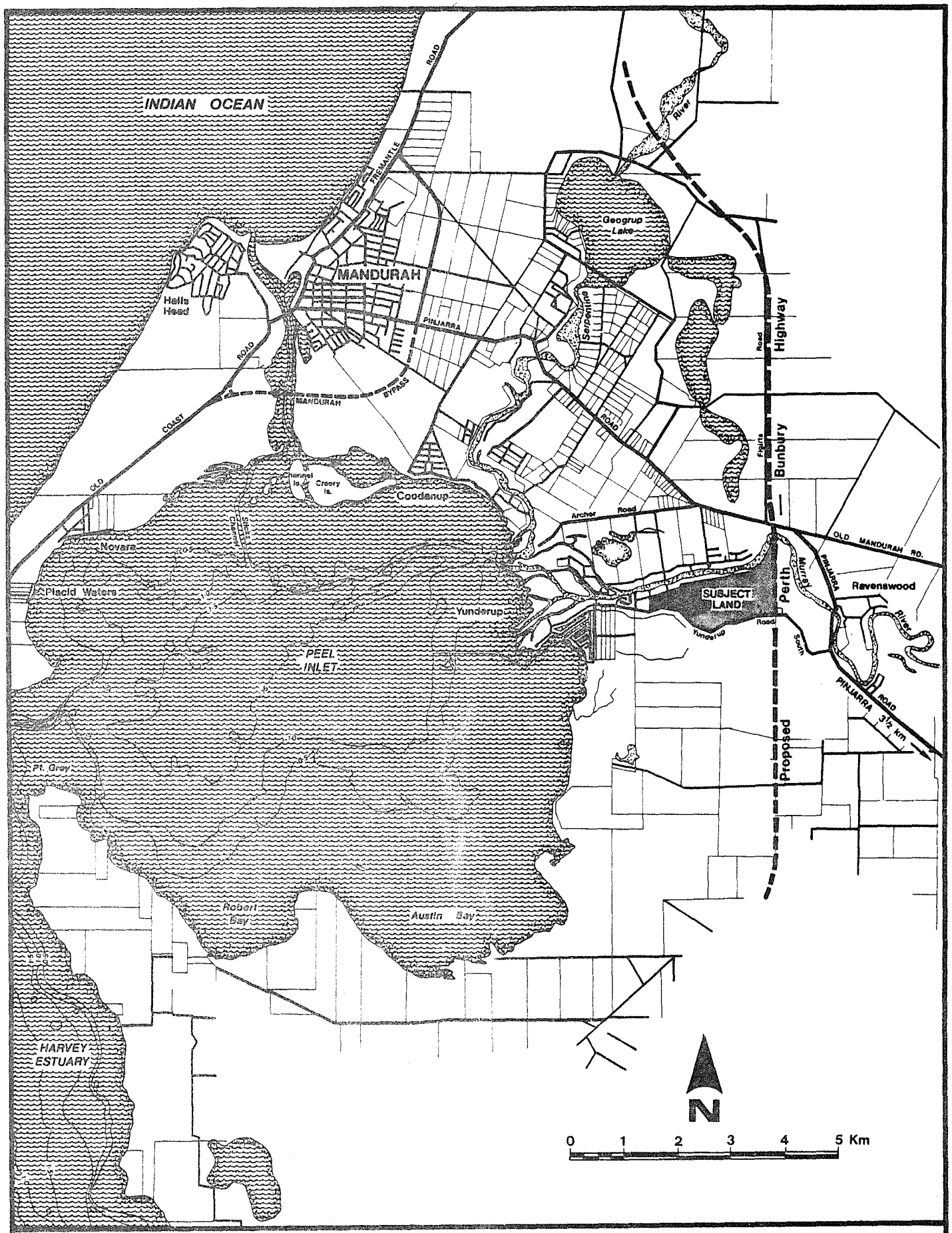
Through the "Canals procedures" the development was referred to the EPA and subsequently the company was asked to prepare an Environmental Review and Manangement Programme (ERMP) which was made available for public and Government review.

The ERMP described the proposal, discussed an alternative dry lot subdivision and argued that an unsewered dry lot subdivision was environmentally undesirable (4.7.2 of ERMP) and that a canal development was to be preferred to a sewered subdivision which would produce higher development densities.

It was also argued that the canal development would be acceptable because the water contained within the canals would be exchanged by normal wind driven forces with the Murray River over a time scale which would be so frequent that algal blooms would not arise.

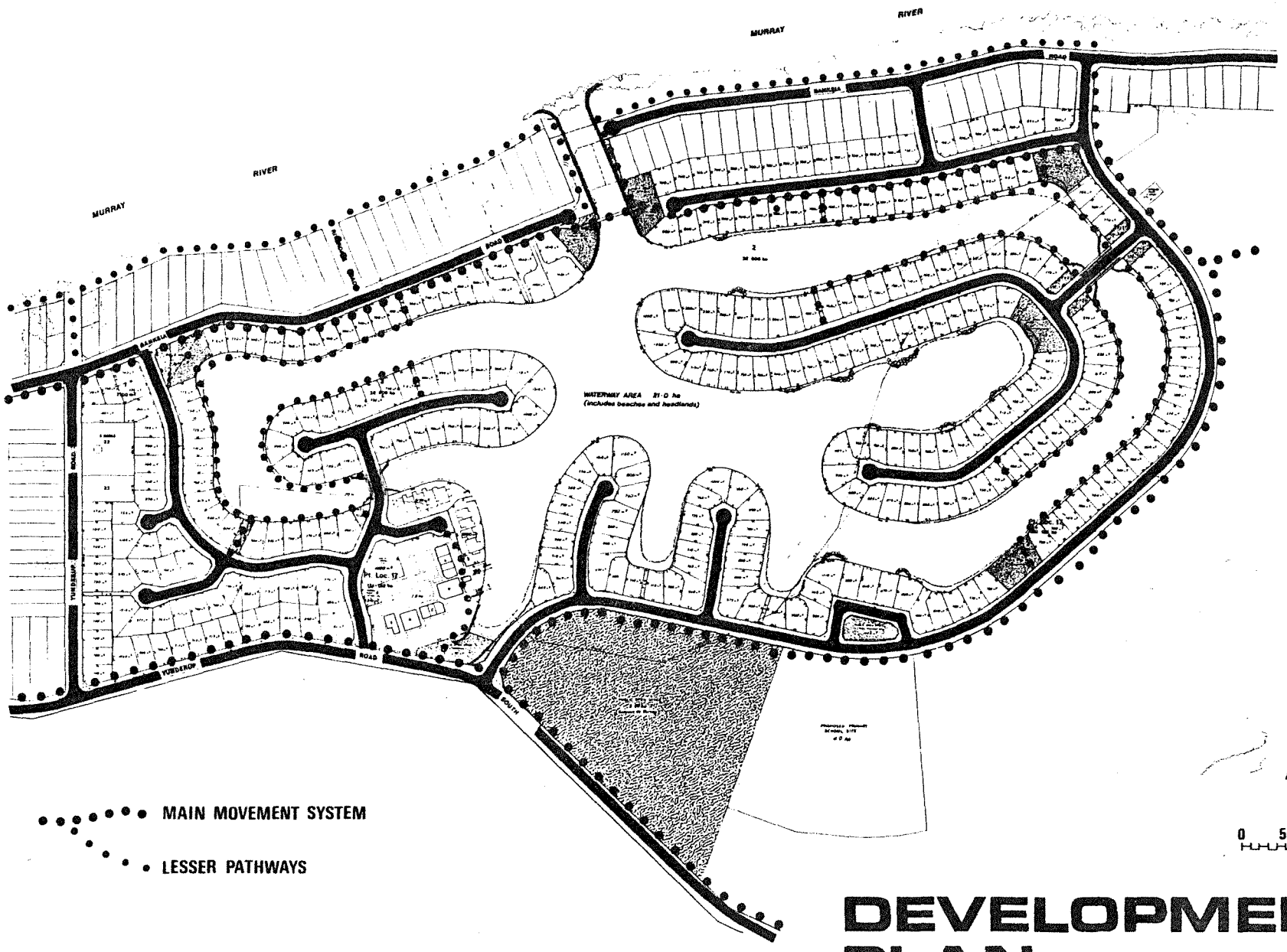
In its review and analysis of the proposal the Authority has identified water quality as the principal issue, particularly because the source water for the canals would be the known poor quality water of the Murray River.

A number of other issues of concern to the Authority were identified from reviews by Government departments and Authorities. These have been summarized in the Appendix.



LOCATION

FIG. 1



DEVELOPMENT PLAN

FIG 2

2. ANALYSIS OF THE PROPOSAL

The proposal rests on the fundamental question of water quality. The ERMP reached the same understanding, concluding that the water quality in the canals would be the same as that of the Murray River and, on the basis of a survey in the area said that the water quality of the river was acceptable to the majority of present nearby residents.

The Sunland ERMP treated the issue of water quality in two ways. Firstly relying on the development by Imberger and Associates of an analysis relating to the flushing capacity of the proposed canals and the application of data to that analysis. Secondly on a description by Gordon and McComb, of the water quality of the Murray River based on empirical data.

2.1 Water Mixing and Exchange

Imberger and Associates' investigation examined the flushing capacity of the proposed canal development, estimating the effects of wind mixing, gravitational mixing, tidal mixing, and boat movements as exchange mechanisms. Of these, only wind driven mechanisms were predicted to operate sufficiently well to ensure that water in the canals would remain no longer than two to five days, (with an increase of one to two days in calm times). The objective of demonstrating these times was to show that because the time scale associated with algal blooms was approximately two to five days there would be no great difference between the water quality of the canal estate and the Murray River.

Three wind driven mechanisms were predicted to operate successfully:

i) simple wind stirring (longitudinal surface wind stress) during July to December when the water column in the canals was homogeneous;

and during December to July when canal waters were stratified;

ii) uneven wind mixing during morning easterlies and afternoon sea breezes;

iii) boundary layer intrusion flows in calm and low wind periods.

Two important design parameters were assumed in this treatment. Firstly, a wind speed of 5 ms^{-1}* or greater was used to show that the simple wind stirring (i) and uneven wind mixing (ii) mechanisms produced flushing times between 1-5 days. Secondly for boundary layer intrusion flows (iii) again a wind speed of about 5 ms^{-1} was used to derive the energy component, while the degree of stratification (upon which the boundary layer intrusion mechanism partly depends) was described by a salinity differential of 5 $^{0}/_{00}$** derived from one location in the Yunderup area in one year (1971).

* ms^{-1} = metres per second

** $^{0}/_{00}$ = parts per thousand

These design parameters (5 ms^{-1} and 5 $^{0}/_{00}$) have been examined by the Authority. Taking wind speeds first, the data used by Imberger and Associates were Steedman and Craig's from records at Fremantle and correlated to spot checks made in Mandurah. These statistics were then said to be reinforced by the data collected during the Peel-Harvey Estuarine Study (Table 1 Vol.2 of ERMP). This latter data is however from the Kwinana Air Modelling Study - specifically from the No.4 anemometer at Cape Peron. The important point here is that all this information is derived from stations on the coast, whereas the canal development proposed is approximately 12km inland where a different wind regime might be expected. A search of anemometer files relating to studies being carried out by the Department of Conservation and Environment in the North West Corridor urban planning area and at Kwinana and at Bunbury indicates that whereas anemometers located on the coast (such as the Cape Peron anemometer) recorded wind speeds over a year in excess of 5 ms^{-1} for 53%, 48% and 59% of the time, anemometers a few kilometers inland recorded wind speeds in excess of 5 ms^{-1} for only 22%, 9%, 23%, 19% and 27% of the time during the same period. Again, data obtained at Robert Bay (Peel Inlet) by Black and Rosher (Table 1) indicates substantial decreases in wind speeds inland. Taken together this comparative data means that at the location of the proposed canals the period of time in which winds are below 5 ms^{-1} will be significantly greater than that applied to the analysis. In addition, all the Department's anemometers were on 10m poles and stationed on clear ground; no allowance was made for sheltering effects of houses and trees in the analysis.

The Authority concludes that the frequency of wind at a strength required to induce mixing will be significantly less than that applied to the analysis and that none of the three wind driven mechanisms postulated will flush the canals in the period of 2-5 days estimated in the ERMP.

In addition, the salinity differential of 5 $^{0}/_{00}$ used in calculations for the boundary layer intrusion method is considered not sufficiently representative of conditions in the Murray River from which this design parameter was derived.

2.2 Water Quality

Turning now to the report by Gordon and McComb; a conclusion is that, in terms of nutrient concentrations, water quality of the Murray River is generally poor throughout the year; the water is eutrophic in comparison with fresh water systems. In gathering and testing all available nutrient data the Authority has found that in the long term there is a break in data due to non-comparability in analytical methods. However the long term data available, supported by recent short term measurements from December 1981 to June 1982 (Figures 4.1-4.6) show that the nitrogen/phosphorus relationship supports an increasing production of phytoplankton throughout the estuarine part of the river. The presence of chlorophyll 'a' throughout the water column (Figures 5.1-5.3) reflects this finding and supports the idea that the ratio of nitrogen to phosphorus is the determining factor in productivity despite the depth and opacity of water. Phytoplankton growth occurs throughout the water column.

When appropriate meteorological and water quality data are applied to Imberger and Associates' analysis the Authority finds that, considering the present nutrient status of the Murray River, the order of magnitude approach to the computation of flushing times does not preclude prolonged periods of phytoplankton growth in the canals. The Authority cannot agree with the conclusion that water quality in the canals will remain substantially the same as that of the Murray River.

In addition, the lower reaches of the Murray River exhibit a slow reaction to tidal influences to the extent that exchange takes place with the Peel Inlet over a period in the order of one week even taking into account other mechanisms such as density current exchange and longitudinal dispersion. It would not, in the Authority's opinion be reasonable to assume that these physical processes would always carry exchanged waters away from the canal entrance so that they may not be recycled into the canals. During the critical summer period the lower portions of the Murray River tend to act as a closed body of water.

2.3 Mechanical Mixing

If, as a last resort a mechanical mixing device were used in the canals to induce boundary layer mixing and exchange with the Murray River the Authority believes that:

i) Eutrophic waters from the Murray Estuary would exchange with the canals.

ii) Continuous artificial destratification of canals water would enhance the productivity of phytoplankton by providing nutrients from lower to upper layers.

2.4 Peel Inlet Management Programme

In preparing the ERMP it is the EPA's opinion that the proponents did not give sufficient weight to the fact that in November 1979 Kinnaird Hill de Rohan and Young prepared for the Peel Inlet Management Authority a Peel Inlet Management Programme.

The Kinnaird Hill document proposed the establishment of guidelines for canal developments in the lower reaches of the Serpentine and Murray Rivers and recommended that these areas were unsuitable for development. The document was issued for public comment. Subsequently the Waterways Commission subjected the Kinnaird Hill data and public submissions to investigation and collected further data on water quality. In July 1982 the Waterways Commission commenced its Management Programme through a gazettal under Section 35 (4) of the Waterways Conservation Act, adopting the recommendations of Kinnaird Hill that the lower reaches of the Serpentine and Murray River were unsuitable for canal developments.

3. CONCLUSIONS

In summary;

1) The frequency of wind at a strength required to induce mixing will be significantly less than that applied to the analysis. None of the three wind driven mechanisms postulated will flush the canals in the period of 2-5 days estimated in the ERMP.

2) Nitrogen/phosphorus relationships support an increasing production of phytoplankton throughout the river; the ratio of nitrogen to phosphorus is the determining factor in phytoplankton productivity despite the depth and opacity of water.

3) The Authority cannot agree with the conclusion in the ERMP that water quality in the canals will remain substantially the same as that of the Murray River.

4) Mechanical mixing is no solution to the problem of prolonged periods of phytoplankton growth in the canals.

The Authority has examined the guidelines which were originally established by Kinnaird Hill and adopted by the Waterways Commission and through its own investigations and analysis finds no reason to disagree with the propositions put forward by the Commission.

The Authority agrees with the Waterways Commission that the lower reaches of the Murray and Serpentine Rivers are not suitable for canals developments. The proposed Murray River Waterfront canal development falls within these defined areas.

The Authority advises that the development is environmentally unacceptable.

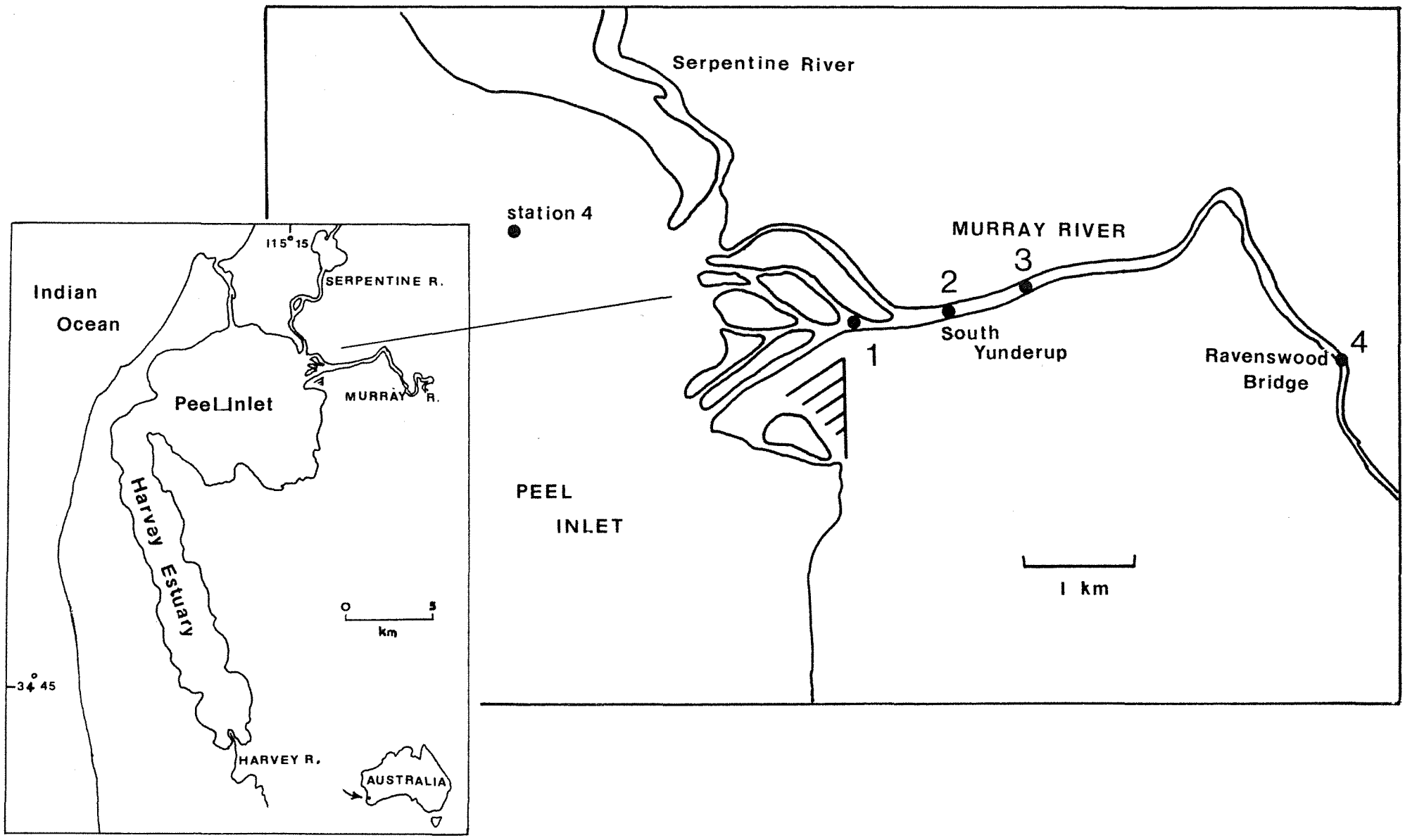
TABLE 1

Year	Month	Mean Wind speed* ($m.sec^{-1}$)	Modal Wind direction** (degrees)	Modal Wind direction (compass)
1977/78	Oct	2.79 (0.93)	210	SSW
	Nov	2.95 (0.67)	240	WSW
	Dec	3.11 (0.36)	210	SSW
	Jan	3.17 (0.66)	210	SSW
	Feb	3.17 (0.74)	90/150	E/SSE
	March	2.51 (0.58)	90/150	E/SSE
	April	2.60 (1.12)	180/210	S/SSW
	May	2.73 (1.09)	270/330	W/NNW
	June	2.12 (0.87)	180/210	S/SSW
	July	2.75 (1.63)	270/300	W/WNW
	August	1.58 (0.35)	90/150	E/ESE
	Sept	2.32 (0.87)	180/210	S/SSW

* Standard deviation in parenthesis

** It should be noted that the mean of wind direction is not a valid method of summary, and hence the mode (i.e. most frequently occurring value) has been tabulated.

Table 1 : Monthly wind speed (mean) and direction (mode) for Robert Bay (Peel Inlet) 1977/78 (after Black and Rosher, 1980.



WATER QUALITY MONITORING SITES

FIG
3

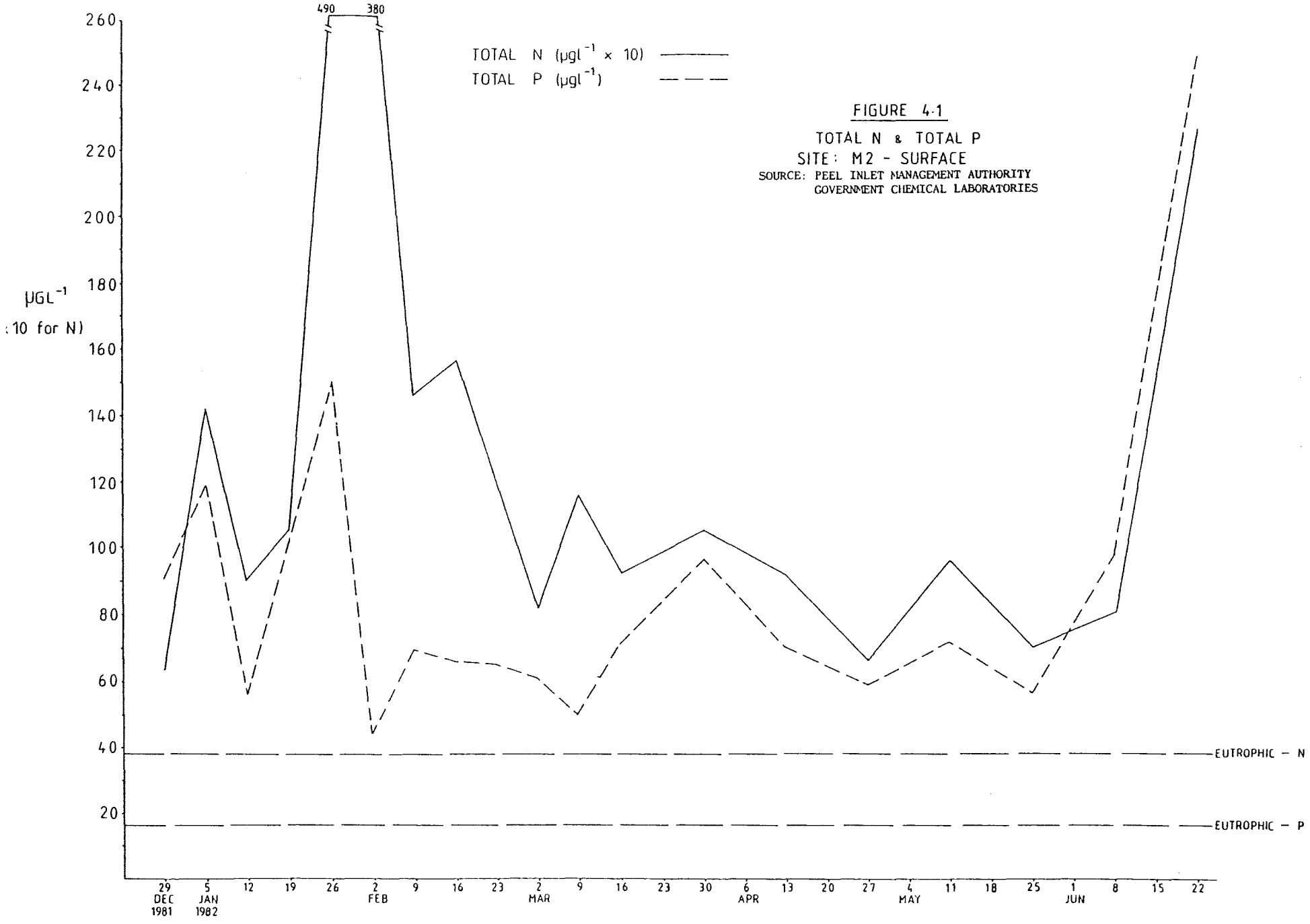


FIGURE 4·1

TOTAL N & TOTAL P

SITE: M2 - SURFACE

SOURCE: PEEL INLET MANAGEMENT AUTHORITY
GOVERNMENT CHEMICAL LABORATORIES

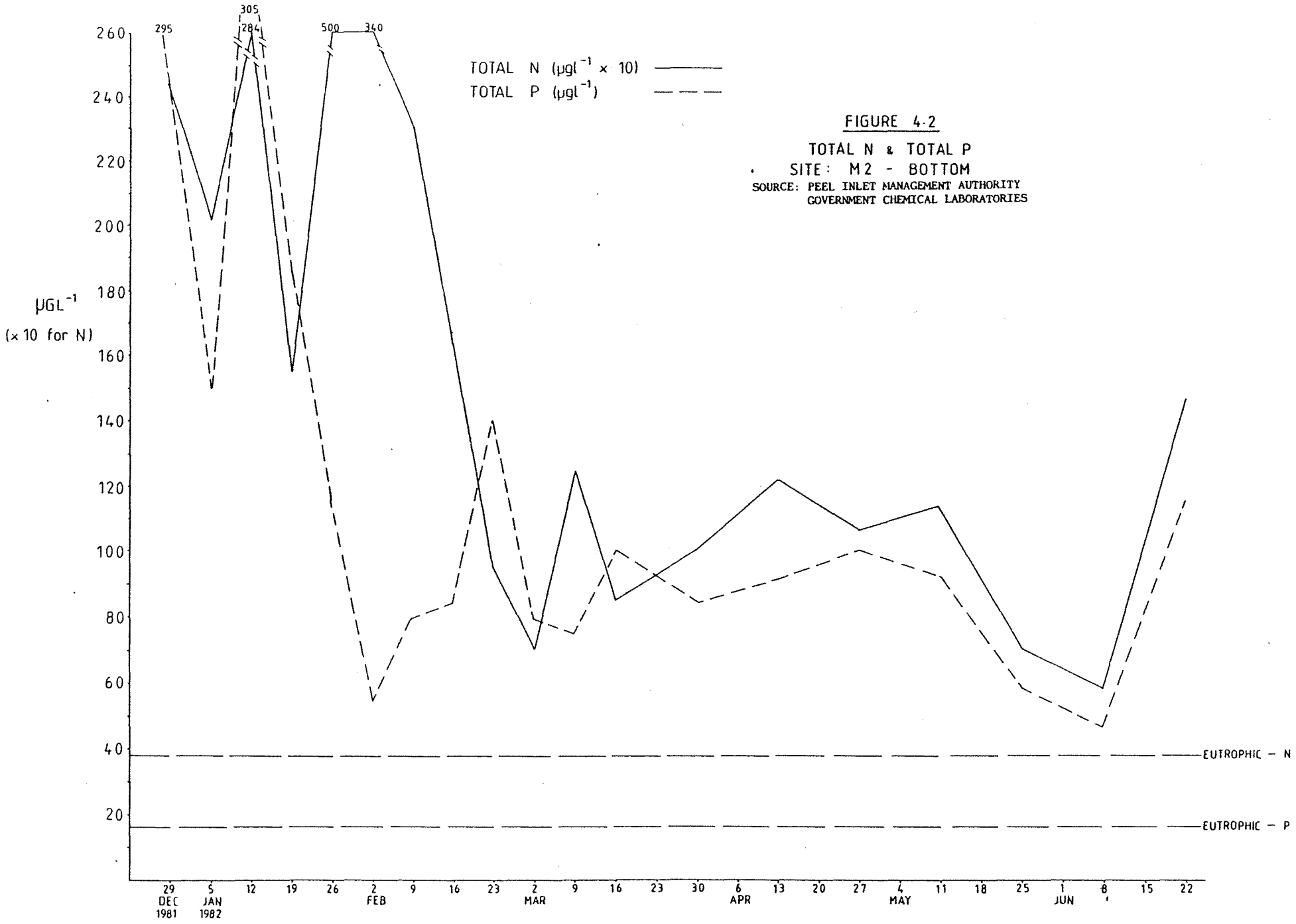


FIGURE 4·2

TOTAL N & TOTAL P

SITE: M2 - BOTTOM

SOURCE: PEEL INLET MANAGEMENT AUTHORITY
GOVERNMENT CHEMICAL LABORATORIES

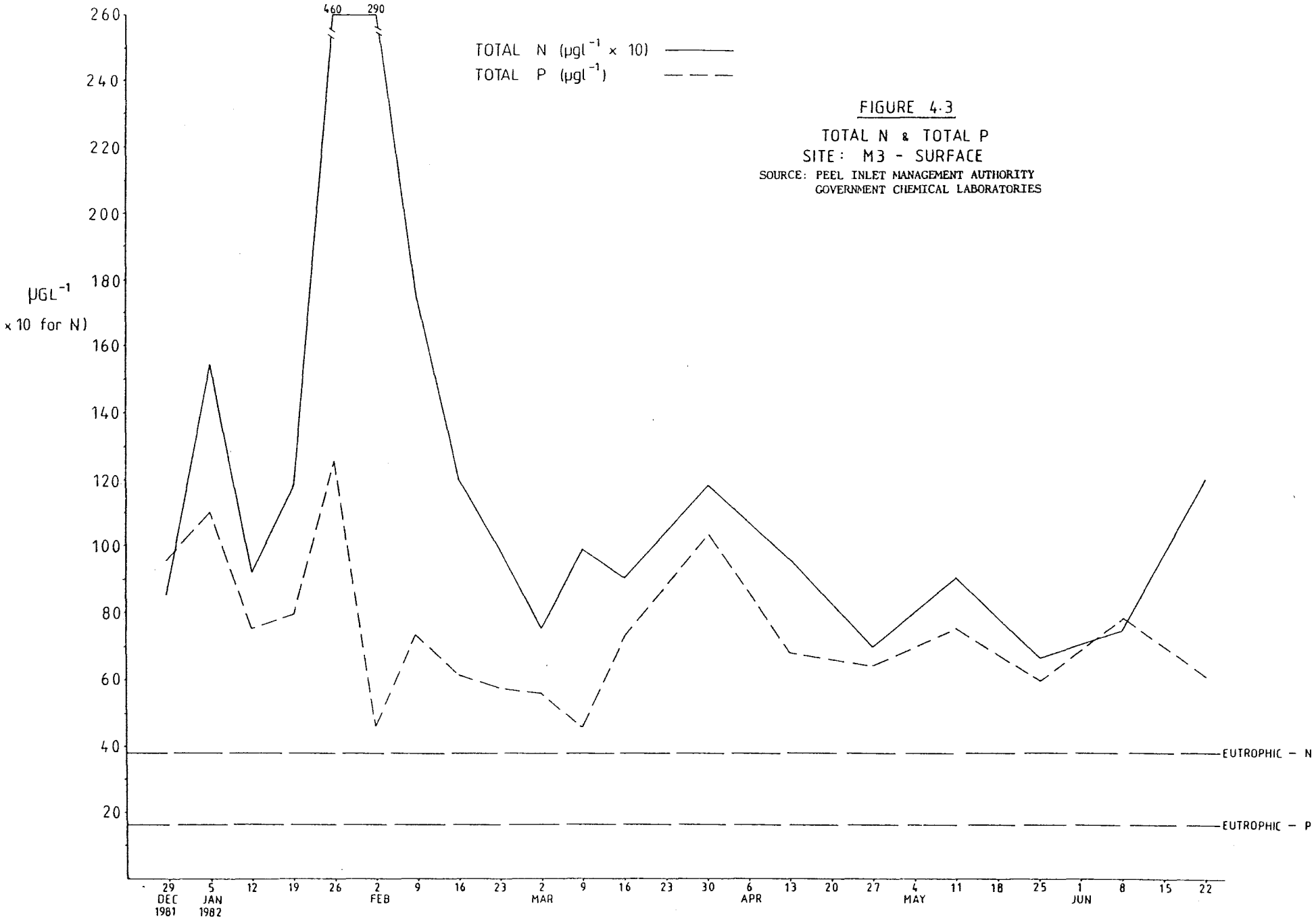


FIGURE 4·3

TOTAL N & TOTAL P

SITE: M3 - SURFACE

SOURCE: PEEL INLET MANAGEMENT AUTHORITY
GOVERNMENT CHEMICAL LABORATORIES

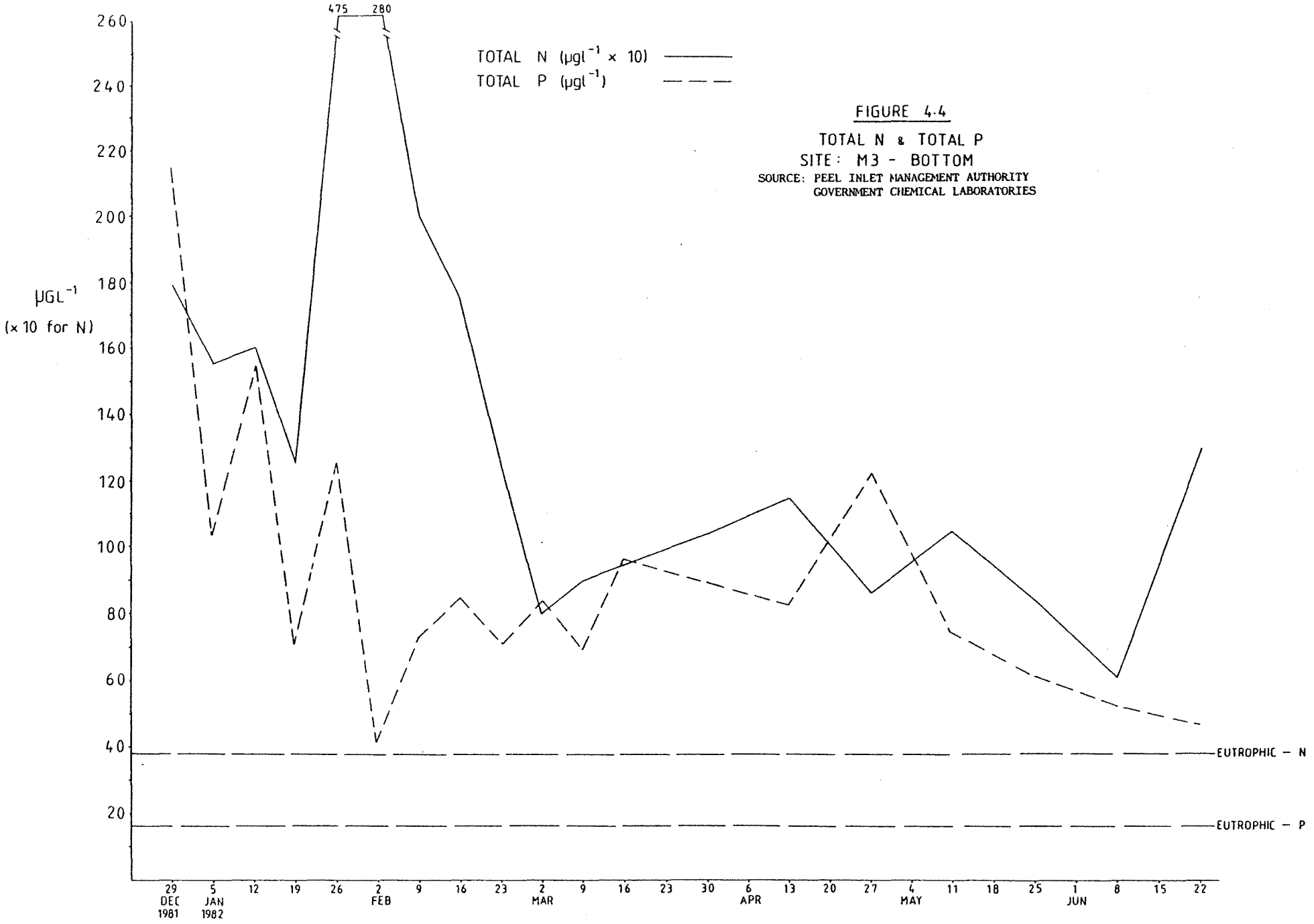


FIGURE 4.4

TOTAL N & TOTAL P

SITE: M3 - BOTTOM

SOURCE: PEEL INLET MANAGEMENT AUTHORITY
GOVERNMENT CHEMICAL LABORATORIES

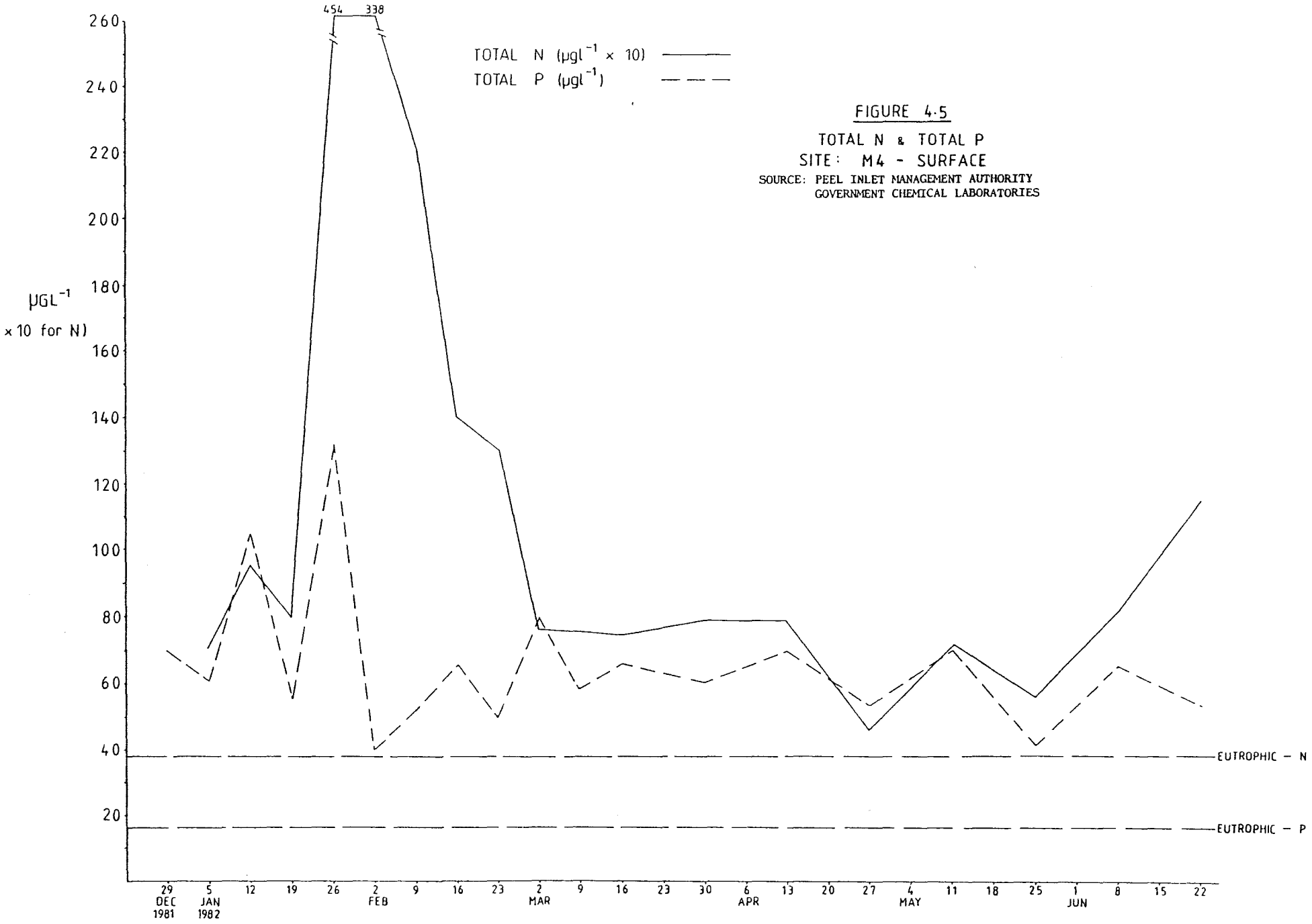


FIGURE 4·5

TOTAL N & TOTAL P

SITE: M4 - SURFACE

SOURCE: PEEL INLET MANAGEMENT AUTHORITY
GOVERNMENT CHEMICAL LABORATORIES

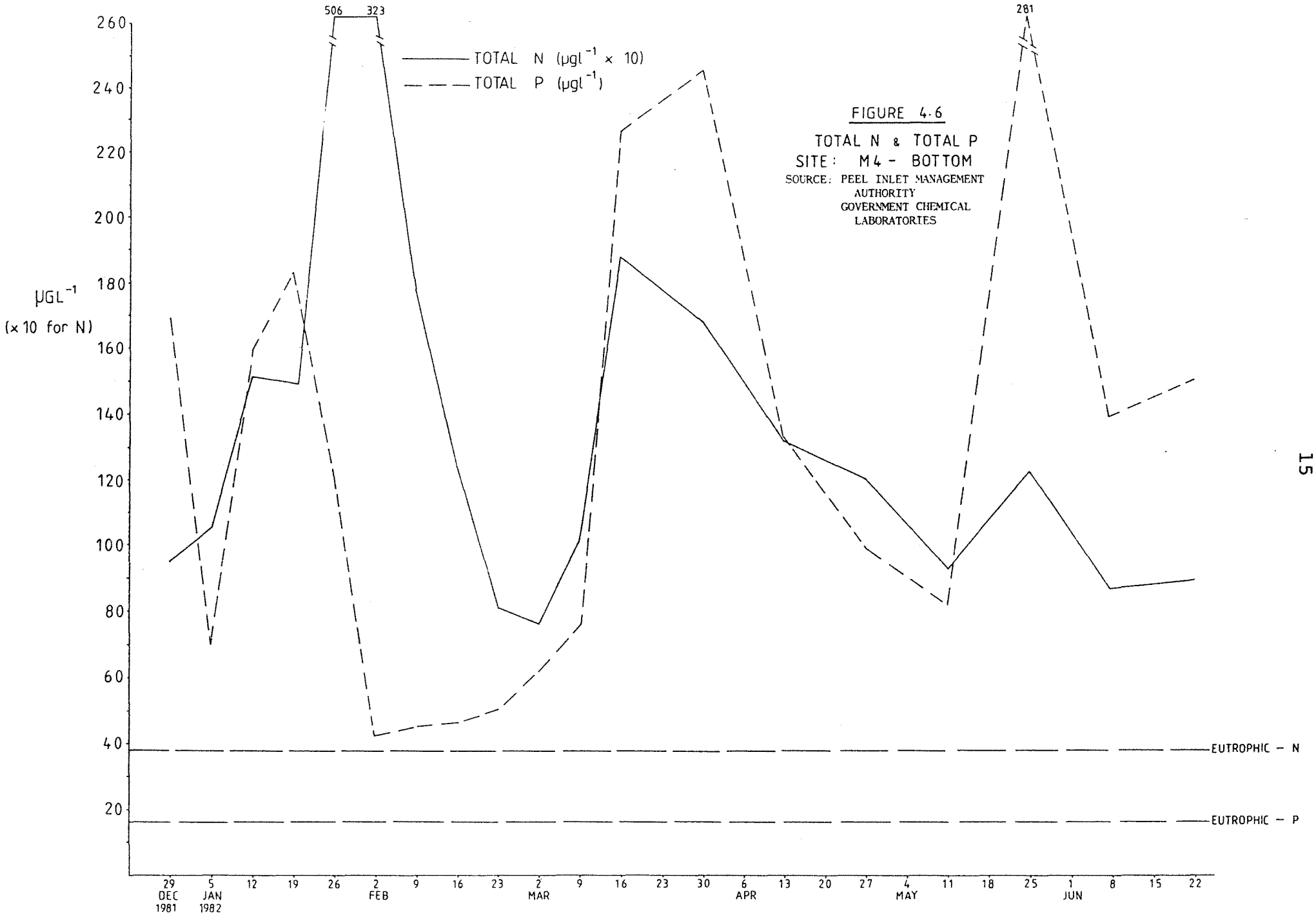


FIGURE 4.6

TOTAL N & TOTAL P

SITE: M4 - BOTTOM

SOURCE: PEEL INLET MANAGEMENT AUTHORITY
GOVERNMENT CHEMICAL LABORATORIES

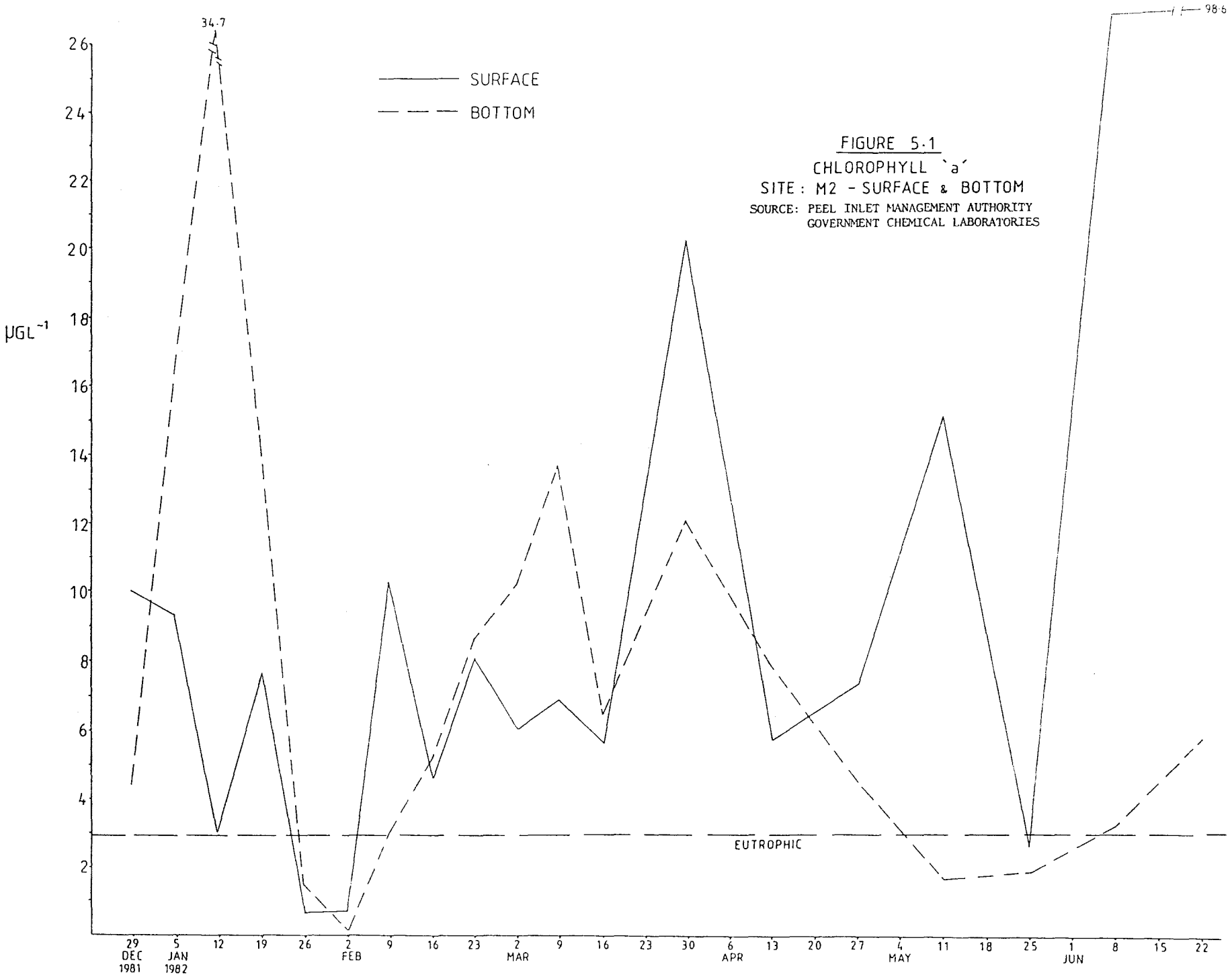


FIGURE 5.1

CHLOROPHYLL `a´

SITE : M2 - SURFACE & BOTTOM

SOURCE: PEEL INLET MANAGEMENT AUTHORITY
GOVERNMENT CHEMICAL LABORATORIES

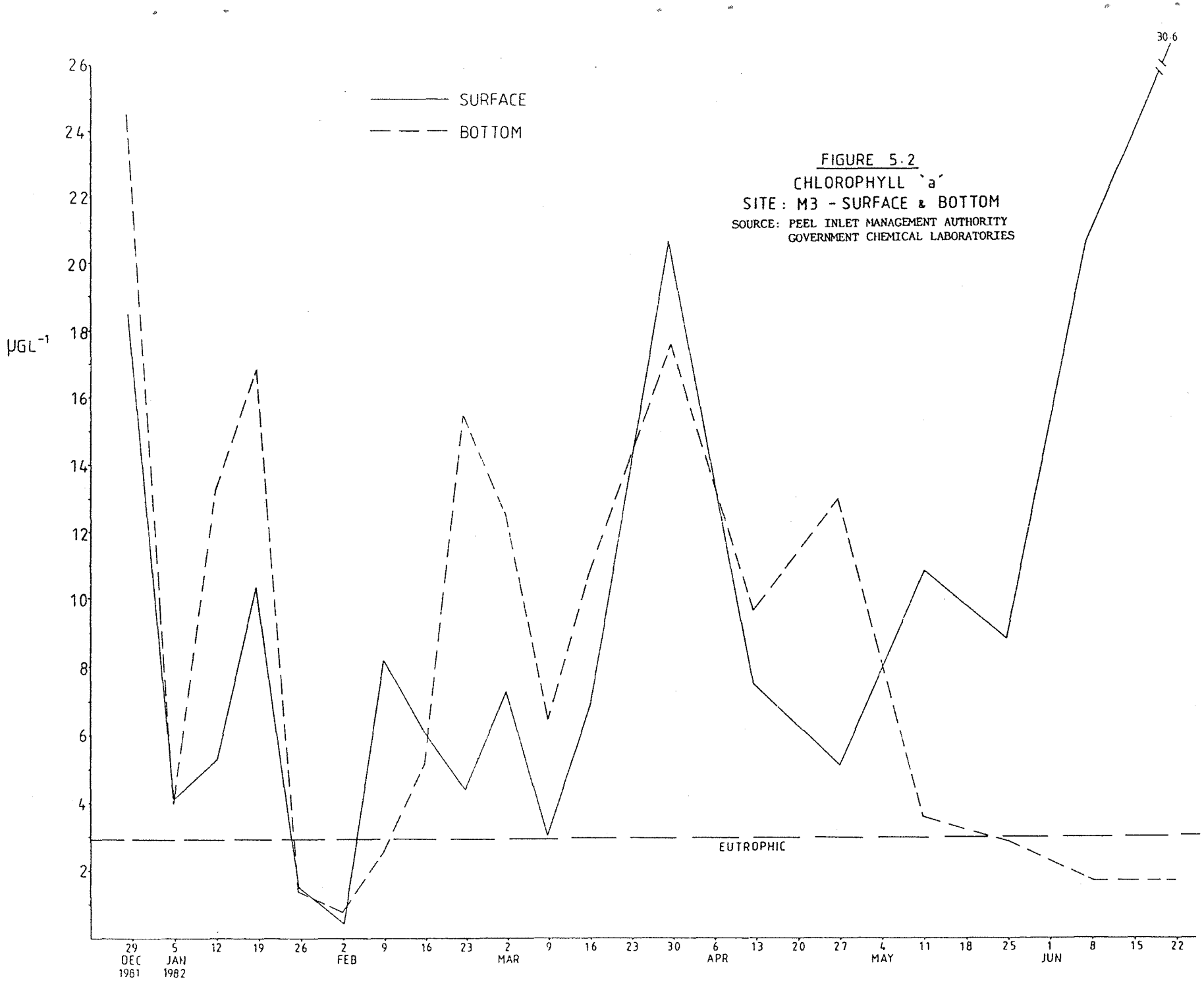


FIGURE 5.2

CHLOROPHYLL `a'

SITE : M3 - SURFACE & BOTTOM

SOURCE: PEEL INLET MANAGEMENT AUTHORITY
GOVERNMENT CHEMICAL LABORATORIES

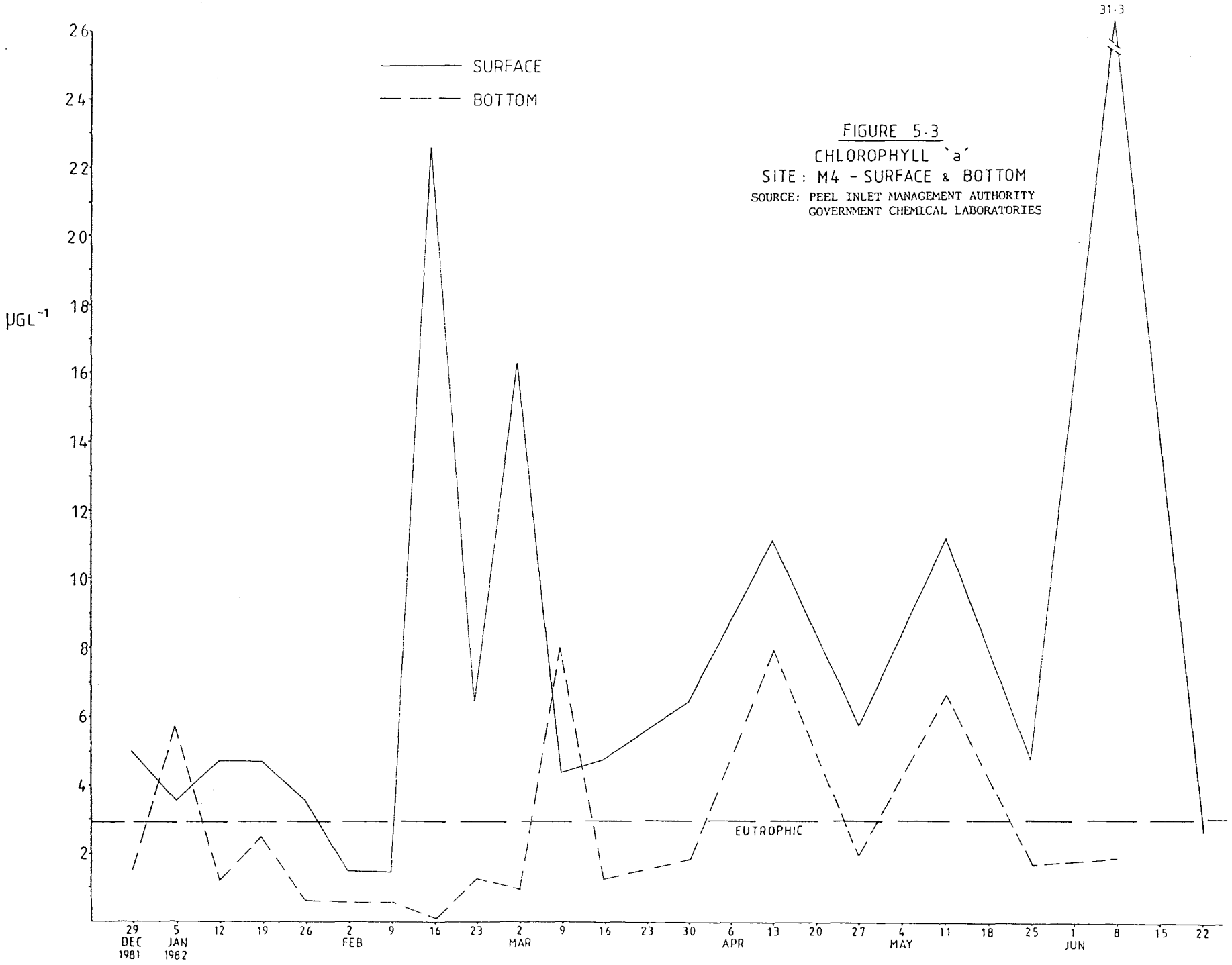


FIGURE 5.3

CHLOROPHYLL `a´

SITE : M4 - SURFACE & BOTTOM

SOURCE: PEEL INLET MANAGEMENT AUTHORITY
GOVERNMENT CHEMICAL LABORATORIES

APPENDIX

The Authority has concluded that on the principal issue of water quality, the proposed development is environmentally unacceptable. Apart from this, other matters of subsidiary concern were identified through reviews by Government departments and authorities. These have been summarized in this appendix.

1. Flood Plain Impact

The improved flood escape south of Yunderup Canals which is required if the existing floodway is to be filled by this development, has not yet been provided, and there is an objection to its provision by the controllers of the land on which it must be located. Until this matter is resolved, any development of the Sunland property would increase the flood height at existing developments to an unacceptable level and should not therefore be approved.

2. Soil Stability of the Project Site

The project area comprises a wide range of soil types, some of which are not suited for building or wall foundations and others which are easily moved by wave action.

An experienced soils engineer would need to be present throughout the work project to control the disposition of the excavated soil.

The earthworks would require close and detailed planning, expert management and continuous skilled supervision in order to obtain safe and stable building sites.

This supervision must considerably exceed that normally given to a residential development and it is unlikely that adequate control would be possible under the dredging option, which also does not make the 100 mm sand cover a practical concept.

3. Retaining Walls

The detail shown in the ERMP for the 'deep wall' retaining wall raises some concern as the underwater slope could comprise fine material which would erode under wave action in a 30-year design life. If the project proceeds, the designer will have to give further thought to this point. The implied presence of a launching ramp at some lots requires further explanation.

No clear details have been given for the connecting channel and river confluence. There the deep wall detail would require modification to give assurance of a 100 year design life.

The beach and revetment wall detail raises a number of problems - particularly as the developer proposes to transfer the responsibility for stabilising this beach, and thus the wall, to a public authority which may not have the resources to undertake management at a time that it is required.

A small zone of the sandy beach would receive all the normal wave impacts and would move in response to them because of wave obliquity. Regular and co-ordinated maintenance would be necessary as well as strict regulation of use of the beach. This is not assured in the project description.

4. Mooring Jetties

If mooring jetties are to be permitted at beach wall sites then canal widths are insufficient in terms of the Canals Assessment Guidelines. A mooring zone boundary is some 19.5 metres from the property line and combined with a navigation width of 16 metres, a necessary width of 55 metres between property boundaries is established. Some canals are less than 40 metres in width. The mooring needs of hammerhead blocks with frontages of less than 10 metres further complicate the assessment of adequate water space.

5. Entrance to River

The project could add as much as 20% to the tidal compartment upstream from the river entry point and this influence would not be minor. Much greater attention should be given to assessing and designing water flow at the river confluence if the project proceeds and it may be desirable to realign the entrance from its indicated perpendicular position.

6. Monitoring and Contingency Plans

The monitoring programme proposed in section 6.2.1 of the ERMP seems to be mainly aimed at the river near this site, and is much less than that which was implied in Appendix A to be necessary.

The assessment of water circulation in the ERMP has been provided in such general terms that the developer, if authorised to proceed with the project, should be required to offer a comprehensive water quality and water circulation monitoring programme within the estate and additionally should be required to offer a firm programme of alternate works with secure guarantees, as a contingency course to be undertaken should the predicted circulation and quality levels not occur.

Some of the optional methods available for the construction of retaining walls, protection against wall erosion, and compaction of earth fill, may require a programme of monitoring by measurement to confirm their performance - should the project proceed.

7. Services and Drainage

If the project proceeds some of the details provided relating to water supply and sewerage are not satisfactory and would require attention at detailed design stage.

The drainage system has the potential to minimise the intrusion of debris and pollutants provided that the many traps and baffles are regularly cleared and maintained. However that maintenance must be to a standard which is likely to exceed that normally provided by Local Authorities. It would be necessary for the Local Authority (as the Drainage Authority) and the Waterway Manager to clearly agree on the performance maintenance to be undertaken if the pollution interception systems are to produce the desired result of pollutant-free canal waters.

8. Beachfront Ownership

The proposal to have a strip of public land and public beach on the canal frontage of most blocks in the development is contary to the recommendations of the Canals Advisory Committee. A group of Government Officers which carried out an inspection tour of eastern states canals was told that "intrusions" onto the waterfront boundary of private property was a source of contention between individuals in one comparable canal development.

This concept also tends to confuse the issue of management of use of this beach and the various responsibilities for its stability. Within the ERMP, the suggestion that the beach will be the resting place of small boats will tend to obstruct the other suggested use as a pedestrian route - and both would act against the recommendation of the environmental consultant in Appendix D, item 4.4 - that sedge communities should be established on this beach to ensure its stability in the longer term.

There is at present no clear allocation of responsibilities on natural beaches and river shores and it would be improper to extend the problems of ensuring stability on those shores using various forms of public funds, to beaches within an estate which the general public will perceive to be private. It

would be preferable that the canal water frontages are privately owned so that there can be no doubt about the rights of use and the responsibility for shore maintenance.

9. Water Resources

With regard to the shallow aquifer, the consultant's report in the ERMP is quite cursory and the conclusions are based on a number of assumptions. There is no mention of the quality of the shallow groundwater under natural conditions and whilst the value of this resource is probably very limited even if of good quality, brackish water incursion beneath the entire development must be accepted if the project is to be approved.

Reticulation of major public open space and selected parks is envisaged from a single deep bore. It is also proposed to establish ground cover on residential lots from temporary reticulation from this bore. Before the project is approved, the developers should be required to:-

1) determine the quantity and quality of groundwater required for irrigation of public open space, parkland etc from the deep bore.

2) carry out a detailed hydrogeological study including field investigations and test drilling, to demonstrate that the required groundwater will be available for abstraction without causing deleterious effects on the aquifer or other users.

If the project is subsequently to be approved, that approval should be subject to the developer formally agreeing to:-

1) carry out at the request of the Minister for Water Resources an approved monitoring programme to check the effect of withdrawal of groundwater from the deep aquifer and provide annual reviews of their performance by a competent hydrogeologist.

2) modify the strategy of groundwater development to prevent unacceptable deleterious effects to the aquifer, if in the opinion of the Minister for Water Resources, the groundwater monitoring indicates that unacceptable deleterious effects are occurring or are likely to occur, as a result of the developer's activities.

10. Water Quality and the Fishery

The developer should more accurately quantify the project in terms of river volume proportion and tidal compartment proportion, as the impact of adding 20% by volume of lesser quality water (should the proportion be correct and the quality lessened) to water that is already poor in quality, must be significantly detrimental to the river as a whole.

The Peel-Harvey estuary into which the Murray River runs, supports the most important commercial estuarine fishery in Western Australia. The principal fish species caught are sea mullet, yellow-eye mullet and cobbler of which sea mullet and to a lesser extent yellow-eye mullet have been shown to spend part of their life cycle in the river systems. In addition, the Murray River supports a significant commercial and recreational prawn fishery.

According to Appendix B of the ERMP, the Murray River is considered to be in a eutrophic state with chlorophyll levels at some sites in summer approaching those present during large scale diatom blooms in the Peel Inlet. Low oxygen levels in the bottom waters during summer are accompanied by high levels of nitrogen and phosphorus which may serve as nutrients for phytoplankton blooms.

Fish kills in the Murray River, which have included commercially important species, have been reported annually during recent years and degradation of phytoplankton blooms leading to high ammonia levels and lack of oxygen have been suggested in Appendix B of the ERMP to be their most likely cause.

Any further lowering of the water quality in the Murray River may thus lead to conditions which are unsatisfactory for fish life for longer periods than have been encountered so far.

11. Loss of Foreshore Reserve

In order to open the waterway to the Murray River, the developers propose to construct an entrance channel across Reserve 26735. Reserve 26735 has been progressively acquired under the provisions of Section 20A of the Town Planning and Development Act. It has long been the policy that such reserves are to be retained for the purpose for which the land was vested in the Crown. Where a land exchange is proposed, an area of equal value must be provided as a replacement.

12. Reduction in Road Width

In order to maintain access to lot 2, Banksia Road is proposed to be reduced in width to 16 m at the "bend". This will require the approval of the Minister for Town Planning.

13. Rise in Ground Water Table

The possibility of flooding of low land in Banksia Terrace due to a rise in groundwater caused by filling has not been addressed. It is probable that subsoil drainage along the backs of existing lots will be required.

14. Gated Communities

The developer proposes boom gates across the road to restrict access to islands however this would also restrict access to public roads and public open space and would be disadvantageous to service and emergency vehicles.