BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD

Record 1983/24

Hydrogeology of the Hume Industrial Estate, ACT

by

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Division of Continental Geology

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SUMMARY

A study of both the bedrock and surficial geology and hydrogeology has characterised the potential for groundwater pollution from industry sited in the Hume Industrial Estate.

The bedrock and surficial sediments consist of a bedded sequence of fractured and jointed Deakin Volcanics, overlain by clay, silt, sand and gravel of the Hume, Big Monk, Gigerline and Riverside Pedoderms.

Groundwater is transmitted in both the fractured bedrock and the coarser grained layers of the surficial material; groundwater is recharged from rainfall, via surface infiltration, and discharges into Woden and Jerrabomberra Creeks. The two aquifers are hydraulically connected.

Groundwater chemistry concentrations are variable. Water associated with certain types of aquifers is dominated by HCO_3, while that from other types is dominated by Cl.

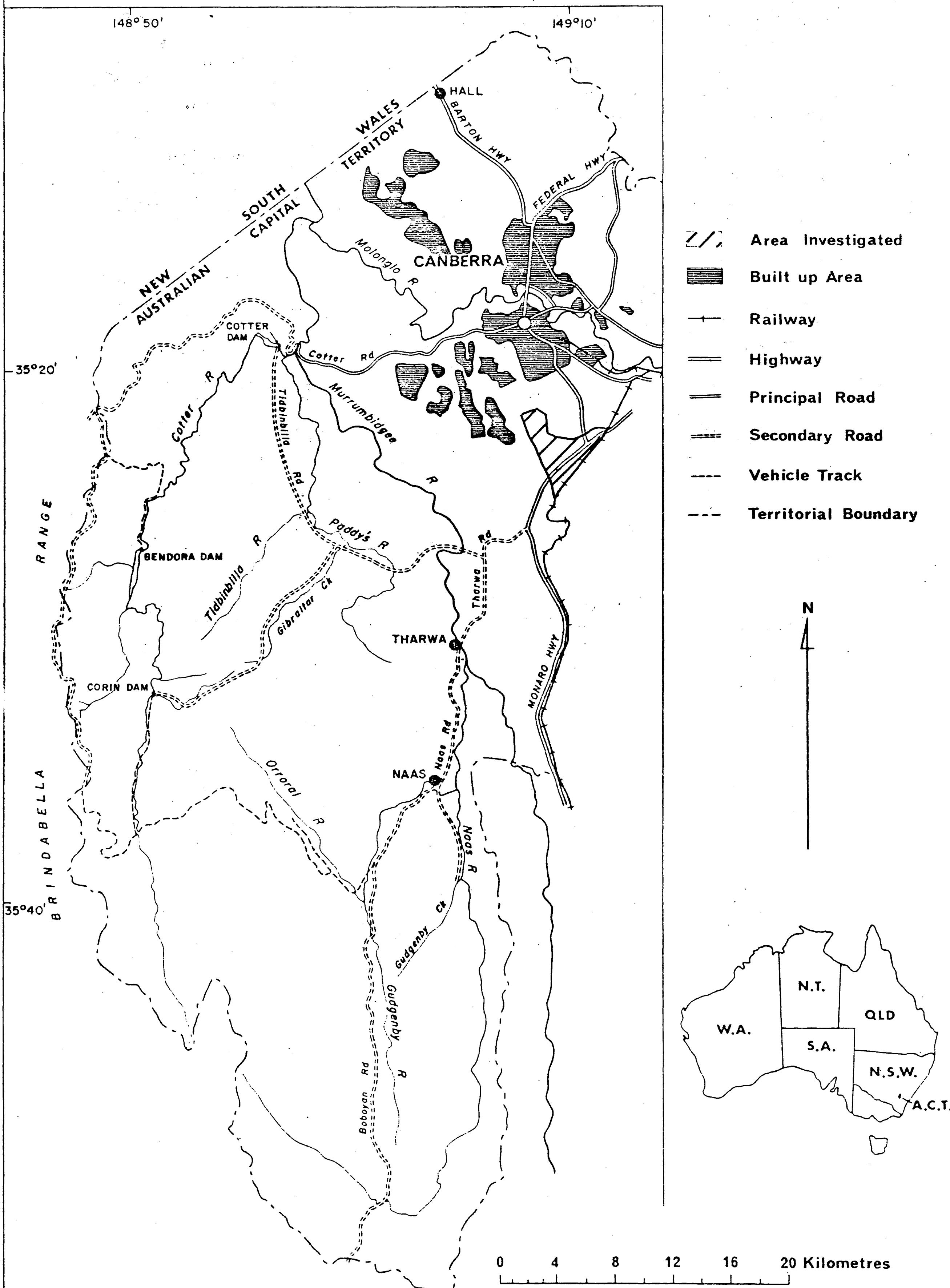
The vulnerability of the groundwater system to possible hazardous or toxic chemical pollution is dependant on the position of the aquifer's recharge area in relation to the pollutant source, and the chemical retention capacity of both the recharge zone and the aquifer.

The vulnerability of the groundwater system is highlighted by the existence of a pollution plume containing D.O.C. values in excess of background, to the north of the I.F.P. timber mill.

It is recommended that care be taken when siting potentially polluting industries and that monitoring of the groundwater system continues.

Figure 1

LOCALITY MAP



INTRODUCTION

At the request of the National Capital Development Commission a hydrogeological investigation of the Hume Industrial Estate (HIE), ACT, including areas for future possible development, was undertaken in March and April, 1983. The location of the Estate is shown in Figure 1. The object of the investigation was to provide detailed information on the geological and hydrogeological characteristics of the Estate, particularly in terms of susceptibility to possible groundwater pollution from industries using hazardous or toxic chemicals.

The investigation consisted of field mapping of bedrock and surficial material and the compilation of information contained in reports of studies undertaken at specific sites within the Estate.

Previous Investigations

Hohnen (1973) produced a report on the engineering geology of the proposed Jerrabomberra Industrial Estate, ACT which included the eastern half of the Hume Industrial Estate. This report included logs of 13 augerholes, 11 of which fall within the area of this report.

In 1976, Evans and others studied three alternative landfill sites within the western part of the HIE. This study included the drilling of 16 holes to establish depths to unrippable material. The Mugga South site was favoured by this study and further work was undertaken at that site. An extra 8 drillholes were drilled in 1977, (Evans and Bennett, 1978). Some of these were equipped as groundwater monitoring points. Five additional holes were drilled and equipped in 1981.

In 1978, fifteen holes were drilled in a study of groundwater quality near the Integrated Forest Products' timber mill. That study established the existence of a pollution plume containing Dissolved Organic Carbon values in excess of background, to the north of the mill - see Jacobson and Hohnen (1980).

In 1981, Evans and Sparksman undertook a study for which holes were drilled and equipped for groundwater monitoring purposes adjacent to the Koppers' timber treatment plant (Evans and Sparksman, 1981).

Location of all drillholes were given on Plate 3 and logs of previously unreported holes are given in Appendix 1.

The HIE, about 600 ha in area, lies in the catchment of Woden Creek, a minor tributary of Jerrabomberra Creek. The Woden Creek catchment, about 1500 ha in area, is bounded to the north by the southerly extension of the Red Hill-Mugga Mugga ridgeline, to the west by the Stanley-Wanniassa ridgeline and to the southeast by the Pemberton Hill ridgeline. The relation between the catchment and the HIE is shown in Figure 2. This investigation also includes those parts of the Woden Creek catchment contained within N.S.W.

Figure 2 also shows a basic geomorphic subdivision of the Woden Creek catchment into a lower pediment surface, an upper pediment - bajada surface, and rock outcrop.

GEOLOGY

Bedrock

The rocks of the HIE are a bedded sequence of dacites, rhyodacites, rhyolites, and minor sandstones and shales of the Deakin Volcanics, intruded in the central part of the area by a coarse rhyolite. The rocks are gently folded with a shallow dip to the southeast, and show well-developed joint systems.

The dominant units are massive welded ashflow tuffs which show some foliation near the tops of flows. These ashflow tuffs are generally interbedded with thin volcaniclastics. The volcaniclastic beds of sandstone, shale and agglomerate are laterally discontinuous.

The distribution of rock types is shown in Plate 1.

Surficial Geology

The surficial material has been subdivided into soil stratigraphic units - pedoderms - following the nomenclature of Brewer and others (1970). Where recognised, pedoderms described by Kellett (1981), from the Lanyon area, have been used. A more definitive description of the Hume Pedoderm will be given elsewhere.

Hume Pedoderm

This unit represents the main body of surficial material in the HIE. It is composed of a colluvial component flanking the footslopes of the Pemberton Hill ridge line to the southeast, and an alluvial component distributed on the lower slopes of the western parts of the catchment, (Plate 2). The alluvial component can be subdivided into coarse channel and fine overbank deposit sub-components. The deposits of the Hume Pedoderm are generally well-sorted discontinuous layers of clay, silt, .d and gravel.

Big Monk Pedoderm (Kellett, 1981)

This unit occurs as a small layer in the Mugga South Landfill Site and as such can be disregarded from further discussion. The erosive phase of the pedoderm caused widespread alteration of the Hume groundsurface.

Gigerline Pedoderm (Kellett, 1981)

Sediments of this pedoderm are widely distributed, but generally thin in section. The major impact during Gigerline time was the erosion of the Hume groundsurface and subsequent modification by pedogenesis.

Riverside Pedoderm (Kellett, 1981)

Sediments of the Riverside pedoderm occur as fan material stretching from 'Tralee' station towards the IFP timber mill, as slope deposits high up the footslopes of Pemberton Hill (Tralee gravel quarry), and as deposits associated with the lowest terraces of the major creeks. The deposits are of unconsolidated silty sand with minor gravel.

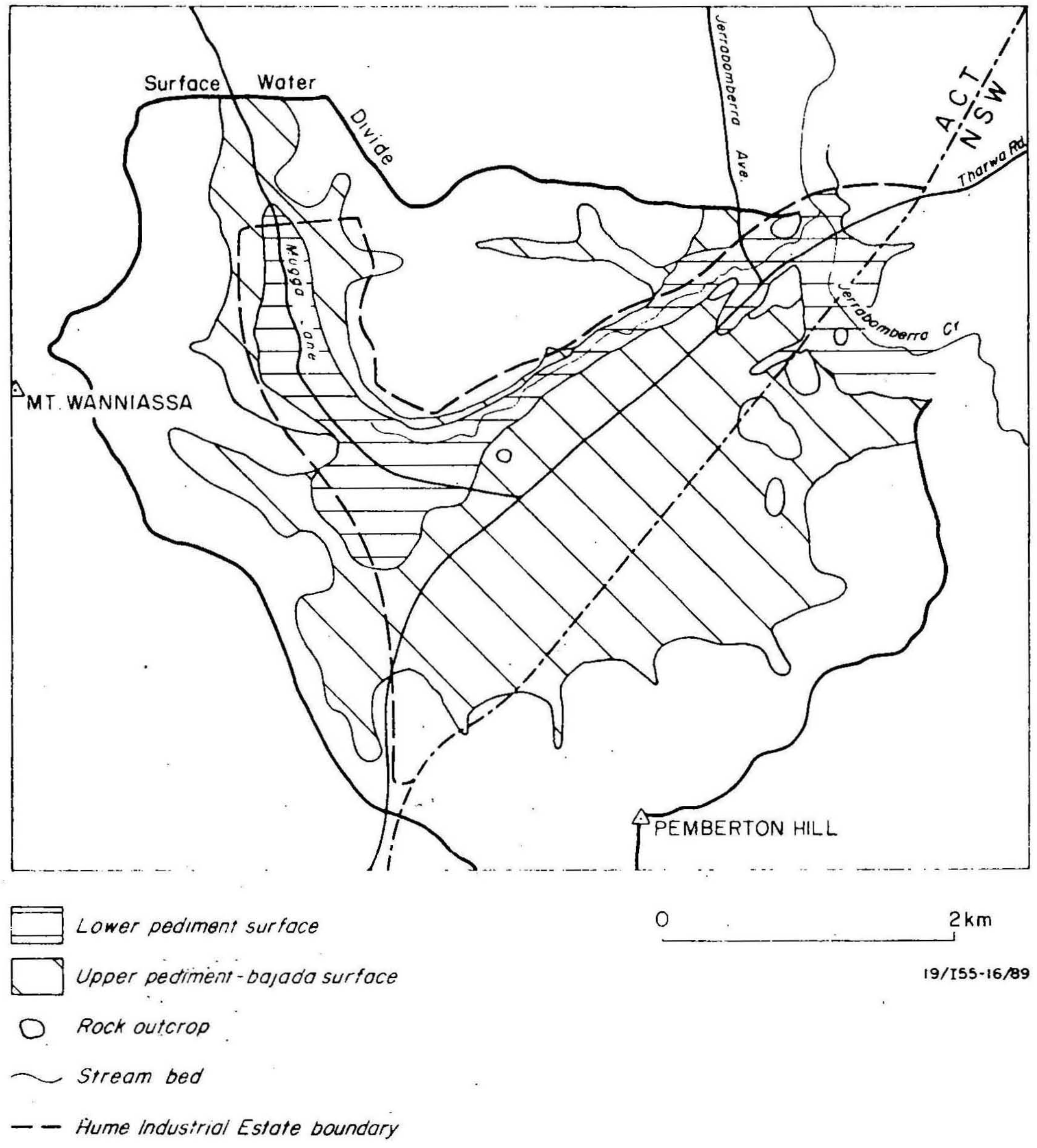


Fig.2 Relationship between the Hume Industrial Estate, Woden Creek catchment and simple geomorphic surface

HYDROGEOLOGY

Groundwater is transmitted both by segments of the surficial cover and the bedrock, and the two systems are interconnected.

Water occurs in the joints and fractures of most of the rock types encountered in the HIE. Owing to the higher frequency of joints and fractures towards the top and bottom of rock units, relatively large quantities of water may be found in these zones. Where the rock will not allow the water to pass through, upwards flow will occur, until a permeable pathway is encountered, usually in the overlying surficial material.

Only sparse data on the distribution of fracture permeability are available, so only a general statement of bedrock hydrogeology is possible. However, it is a reasonable assumption that the bedrock can and does transmit water.

Recharge to the fractured bedrock aquifer occurs in areas where open fractures are exposed to surface water, for example, rock outcrops and areas of thin skeletal soils, and where surficial aquifers are in hydraulic connection with open bedrock fractures. This latter recharge mechanism is assumed to occur throughout the HIE although specific sites have not been identified.

The fractured bedrock aquifer discharges into the surficial material in the lower portions of the catchment, and ultimately into Jerrabomberra Creek.

The coarser-grained, well-sorted layers of surficial material, in both the colluvial and alluvial components of the Hume Pedoderm, and within the Riverside Pedoderm transmit water.

Aquifers within the Hume Pedoderm can be divided into two groups. The first group comprises the unaltered Hume pedoderm coarse-grained beds of the channel deposit sub-component together with the colluvial component. The second group of aquifers is associated with an increase in permeability due to modification of Hume material by Gigerline pedogenesis in the Gigerline lower catenary position. These later occurrences tend to occur in present day stream channels.

Recharge to the surficial aquifers is by direct infiltration of rainwater or surface water through the surface soils or through the beds of channels transmitting water. Recharge to deeper surficial aquifers is by infiltration from above, provided moisture is available. Some recharge occurs from underlying fractured bedrock aquifers.

Discharge from the surficial aquifers is to stream channels in the lower portions of the catchment. Most discharge will occur from springs in the bed of Woden Creek. Springs also occur higher in the catchment in response to vertical flow caused by constriction of the aquifer. Where hydraulic conditions permit, some surficial aquifers discharge into the underlying fractured bedrock aquifer.

Residence times in aquifers are unknown.

In summary, the HIE can be viewed as being composed of two aquifer systems separated by a layer that in places allows water to pass through in either direction. The groundwater system discharges to Jerrabomberra Creek.

No groundwater is currently being used for any purpose within the Woden Creek catchment, though two farm bores (B47, B48) did draw on both the fractured bedrock and surficial aquifers in the past.

HYDROCHEMISTRY

Groundwater chemistry of the different aquifers within the catchment is highly variable (Figure 3). Total dissolved salts concentrations range between 100 and 1500 mg/L.

Figure 3 shows the chemical variation expressed on an expanded Durov diagram, within which two groups of groundwater chemistry can be seen. The first is a HCO_3 dominated group that appears to correlate with water that has been recently recharged to the groundwater system. The second group is Cl dominated groundwater that appears to correlate with older water in relatively unaltered Hume aquifers. This would be consistent with there having been high levels of Cl in the Hume Pedoderm which was then removed from some aquifers by leaching during Gigerline Pedogenesis, and with the Gigerline modified Hume aquifers having short response times to recharge.

Groundwater from fractured bedrock aquifers will inherit water chemistry from its recharge zone, but with increasing time in the aquifer concentrations of dissolved constituents will increase.

Previously unreported chemical analyses used in Figure 3 are given in Appendix 2.

POSSIBLE POLLUTION OF GROUNDWATER BY HAZARDOUS OR TOXIC CHEMICALS

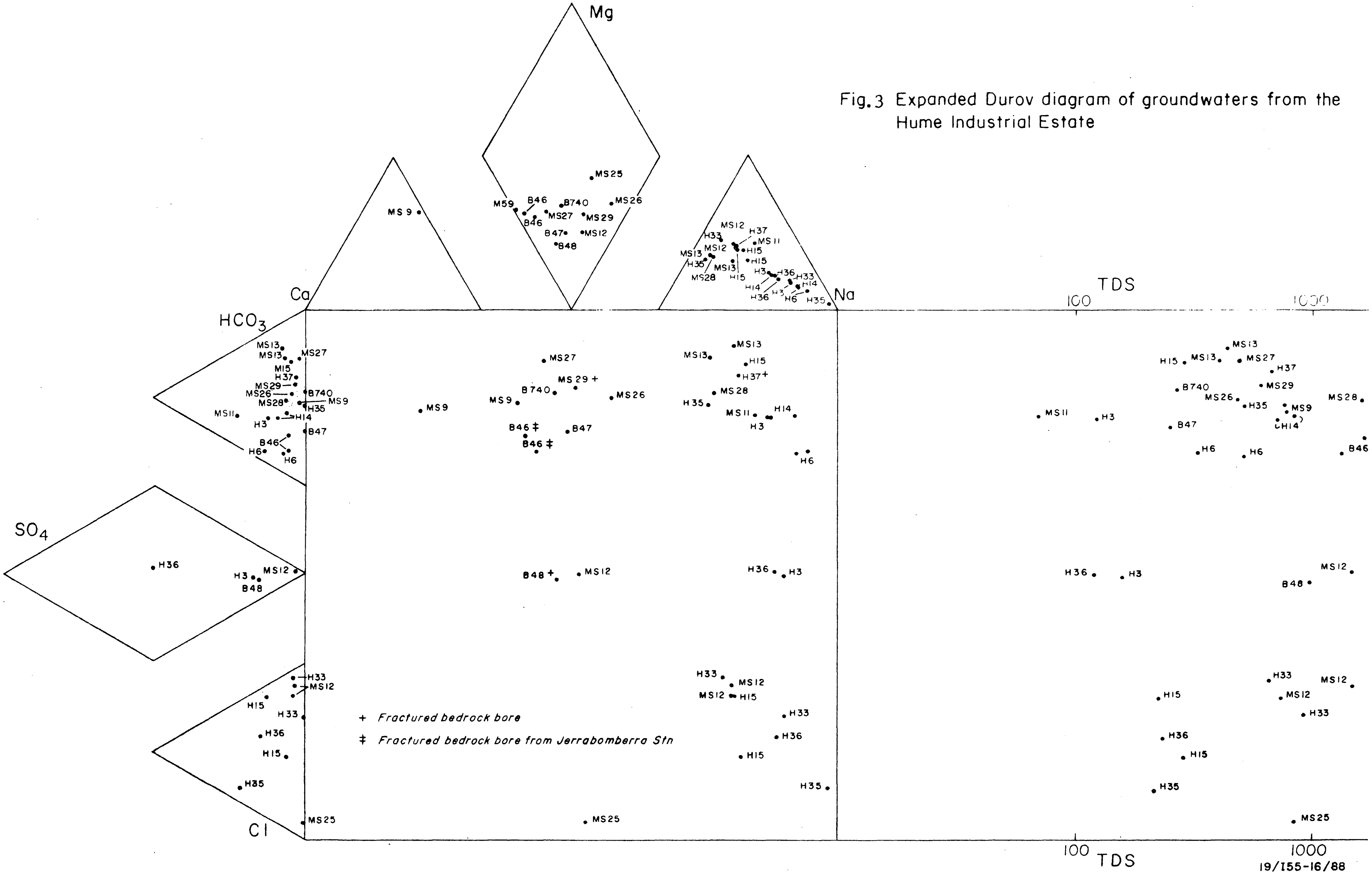
The rate of transport of hazardous or toxic chemicals by groundwater is dependent on several factors; they include absorption, precipitation, biological decomposition and dispersion. In general, all factors lead to a retardation of pollutant movement. However specific mechanisms can increase pollutant flow velocities, for example, anion exclusion.

The rate of pollutant transport is also dependent on the initial concentration of the pollutant, which in turn is determined by the abovementioned factors applied to the recharge zone, and the position of the recharge zone in relation to the pollution source.

Thus one can identify some fundamental concepts that help to clarify an aquifer systems vulnerability to pollution from a point source.

1). Position of recharge area relative to pollutant source. Ideally, potentially polluting industries should be placed as far away from aquifer recharge points as possible. If this is not realistic, as in the case of the Hume area with it's widely distributed recharge zones, then the potential pollutant source should be isolated from the recharge zone by both impervious seals and relevant management procedures.

Fig. 3 Expanded Durov diagram of groundwaters from the Hume Industrial Estate



2). The chemical retention capacity of the recharge zone. If one recharge zone has a higher retardation effect on pollutants, than another, then the aquifer fed by the first recharge zone would be less vulnerable to substantial pollution than an aquifer fed by the latter recharge zone. This concept is negated if the retention capacity of a recharge zone is saturated by continued additional pollution; that is, a distinction is made between pollution from point sources that occurs as an isolated event as opposed to continuous pollution. Recharge zones high in clay, organic and hydrated oxide contents would optimise retention and safeguard the aquifer. However, due to their very nature as areas of high infiltration capacity, recharge zones are usually low in these attributes, as are those recharge zones associated with the HIE. To develop this concept further would require a quantitative knowledge of the recharge zones' retention capacity in terms of specific elements or compounds.

3). The chemical retention capacity of the aquifer. If an aquifer has a high chemical retention capacity, pollution will be less widespread, than in an aquifer with a lower retention capacity. It is impossible to quantify the retention capacity of the HIE aquifers with the limited data available. It can be said, however, that the surficial aquifers would have a much higher retention effect than the fractured bedrock aquifer.

The question of vulnerability has to be considered in terms of the end point of the groundwater.

Two factors are pertinent to groundwater in the HIE. The first is the groundwater as a resource. At present groundwater in the Hume area is unused and undeveloped. However, pollution of an undeveloped aquifer should not be acceptable. The vulnerability of the groundwater resource is measured in terms of the nature of the recharge zones. The second is the groundwater as the baseflow component of surface water. The vulnerability of the surface water, Jerrabomberra Creek for instance, is measured in terms of the total groundwater system. Hence the groundwater resource is more vulnerable to pollution from point source discharges within the HIE than is Jerrabomberra Creek.

If a near surface aquifer system is vulnerable to pollution, then any vegetation that draws on that groundwater is also similarly vulnerable.

A ranking of the relative vulnerability of the different areas, as depicted on Plate 2, can be made. In general,

$$J > A = E > D2 > D1 = C > F$$

where area J is the most vulnerable, and area F is the least vulnerable. The order of rank may change if excavations are available to shorten pollution pathways.

CONCLUSIONS

1). Groundwater is encountered in both surficial and fractured bedrock aquifers. Recharge to surficial aquifers generally occurs on the upper pediment-bajada surface, and to fractured bedrock aquifers generally in areas of rock outcrop. Interflow occurs between aquifers, both upwards and downwards depending on hydraulic gradients.

2). Woden Creek is maintained by significant discharge from groundwater. All groundwater drains to Jerrabomberra Creek. Residence times in aquifers are unknown.

3). The groundwater, as a usable resource, is vulnerable to pollution via point sources, both large and small, and isolated or continuous. Jerrabomberra Creek is vulnerable to groundwater-transmitted pollution from (more) substantial and continuous point sources in the Hume Industrial Estate.

4). Potentially polluting industries should be isolated from recharge zones, as much as possible, either by location or site preparation.

5). All industries involving hazardous or toxic substances should be required to make detailed submissions concerning the soil retention characteristics and groundwater flow-paths of their sites, and in the light of these findings, site management practices. The issue of interim leases until site management plans have been reviewed should be explored.

REFERENCES

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Evans, R., and Bennett, D.G., 1978 - Geological and geophysical investigation of the proposed Mugga South Landfill Site, ACT, 1977. Bureau of Mineral Resources, Australia, Record 1978/69.

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APPENDIX I

Logs of previously unreported boreholes

Mugga South Landfill Site

MS 25 (Hollow-flight augered)

0.00 - 0.50	Light grey silty sand, rock fragments
0.50 - 2.00	Yellow-brown silty sand
2.00 - 4.00	Grey clay, some quartz sand. Sesquioxide patches
4.00 - 5.60	Grey clay, carbonate nodules
5.60 - 6.40	Yellow-grey mottled gravelly clay
6.40 - 7.00	Yellow-brown fine sand
7.00 - 7.50	Olive gravelly silt
7.50 - 8.00	Extremely weathered bedrock, fractured

Auger refusal

Hole cased to 7.50m

MS 26 (Hollow-flight augered)

0.00 - 0.50	Light grey silty sand
0.50 - 1.50	Light grey clay
1.50 - 1.90	Gravelly clay
1.90 - 5.00	Light brown clay sand
5.00 - 6.00	Olive-yellow mottled clay, gravelly at base
6.00 - 6.40	Coarse sand
6.40 - 7.50	Olive-yellow mottled clay

Auger refusal

Hole cased to 7.00m

MS 27 (Solid-flight augered)

No core

Auger refusal 9.80

Hole cased to 9.80m

MS 28 (Solid-flight augered)

No core

Auger refusal 9.60

Hole cased to 9.60m

MS 29 (Tungsten bit drilled)

0.00 - 10.50	No core
10.50- 15.55	Moderately weathered bedrock, fractured

Hole cased to 10.50m, open to 15.55m

MS 30 (Rotary air drilled)

No core

0.00 - 20.00	Alluvium
20.00 -21.00	Bedrock

Total depth 21.00m, water struck 12.50 m
Aquifer - Gravelly sand, minor clay.
Hole cased to 21.00 m

MS 31 (Rotary air drilled)

0.00 - 10.00 Refuse

Hole cased to 10.00m

MS 32 (Rotary air drilled)

0.00 - 1.85 Slopewash
1.85 - 8.46 Layered sand, fine gravel, clay
8.46 - 9.00 Highly weathered bedrock

Hole cased to 8.50m

MS 33 (Rotary air drilled)

No core

Hole cased to 14.00m

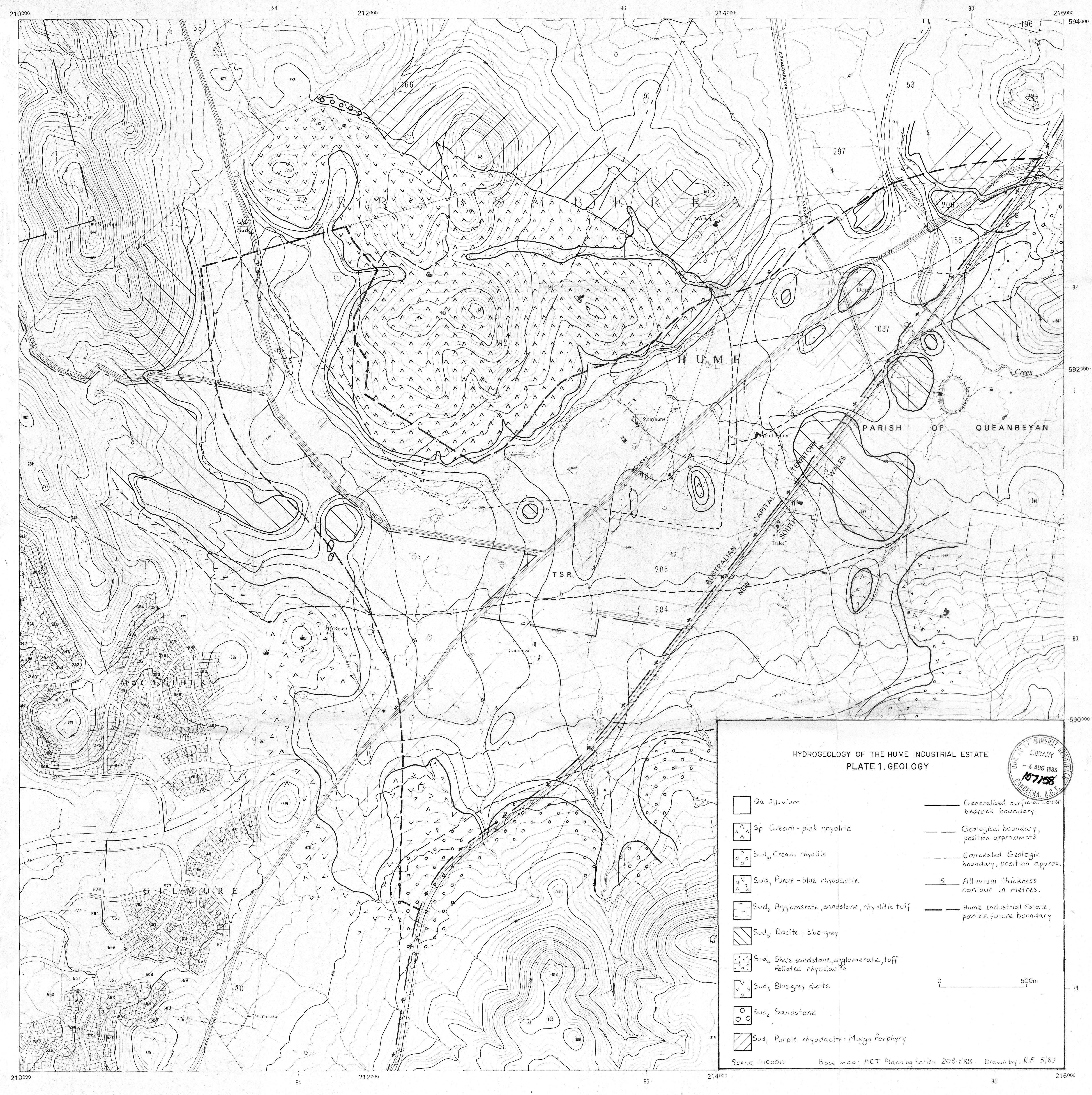
APPENDIX II

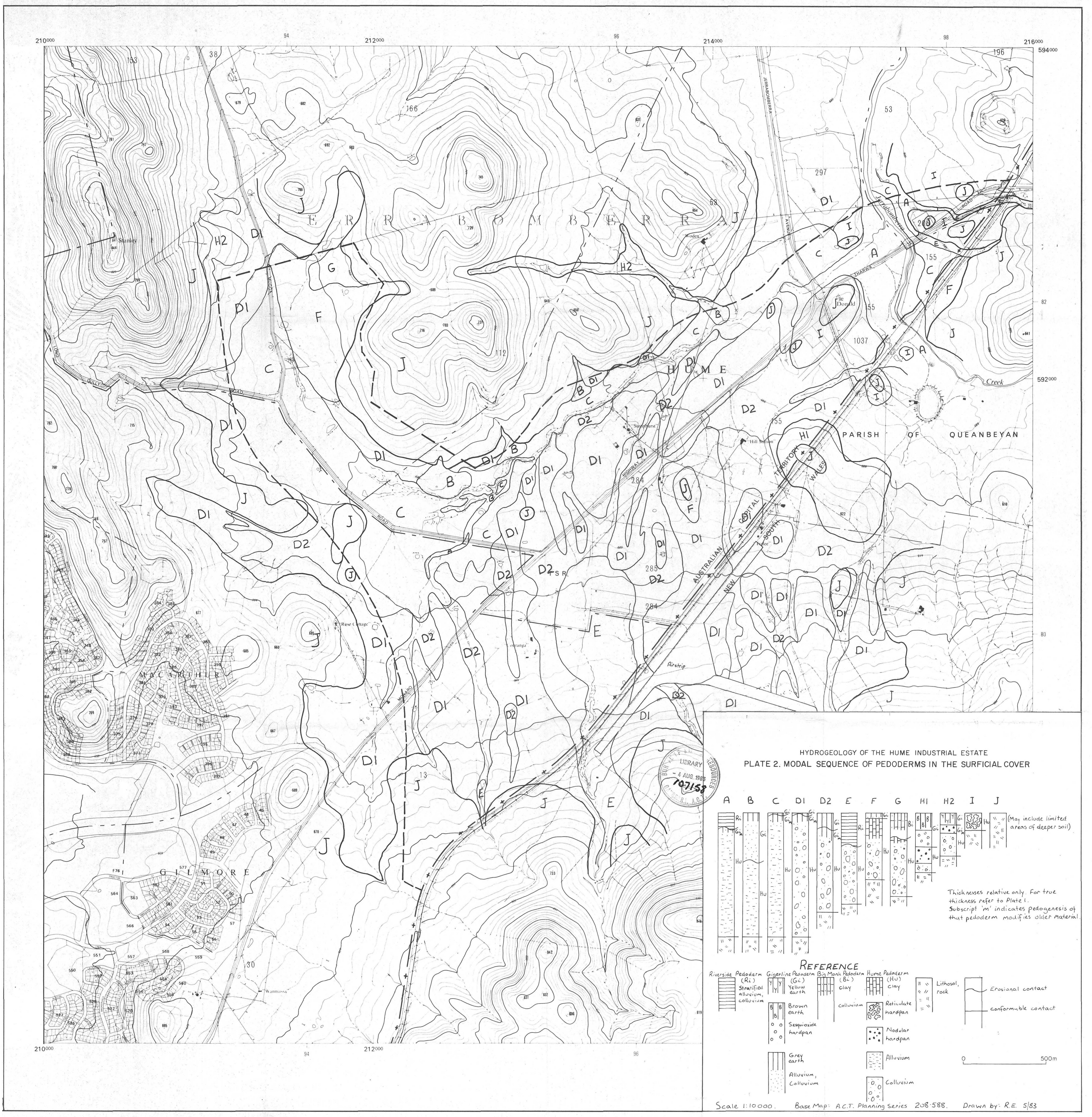
Previously unreported chemical analyses

Borehole	Ca	Ma	Na	K	HCO_3	SO_4	Cl	pH	EC
47	32	12	34	1	105	-	32	6.8	460
MS30	1	2	16	2	20	10	6	6.6	98
MS12	131	62	191	2	225	10	125	6.9	2340
H33	14	9	154	2	70	-	76	6.8	1500
H35	23	8	51	28	63	-	14	6.6	870
H36	4	2	28	2	6	10	4	5.8	215
H37	34	22	130	2	274	10	36	7.0	1130
MS25	57	65	101	5	9	-	86	5.9	1360
MS26	31	31	75	1	186	8	33	6.8	810
MS27	73	34	57	3	431	10	39	7.1	810
MS28	95	37	230	1	654	48	120	7.3	1740
H3	5	3	53	3	34	10	20	6.4	294
MS29	49	29	69	1	215	8	33	6.8	1005
H6	9	5	114	4	95	10	36	6.6	865
H14	13	8	165	2	167	12	40	7.3	1360
H15	13	7	57	1	188	8	17	6.6	505
740	31	16	33	1	121	-	22	6.8	470

\- Not detected

All values in mg/l, except pH and EC (μSm/cm)

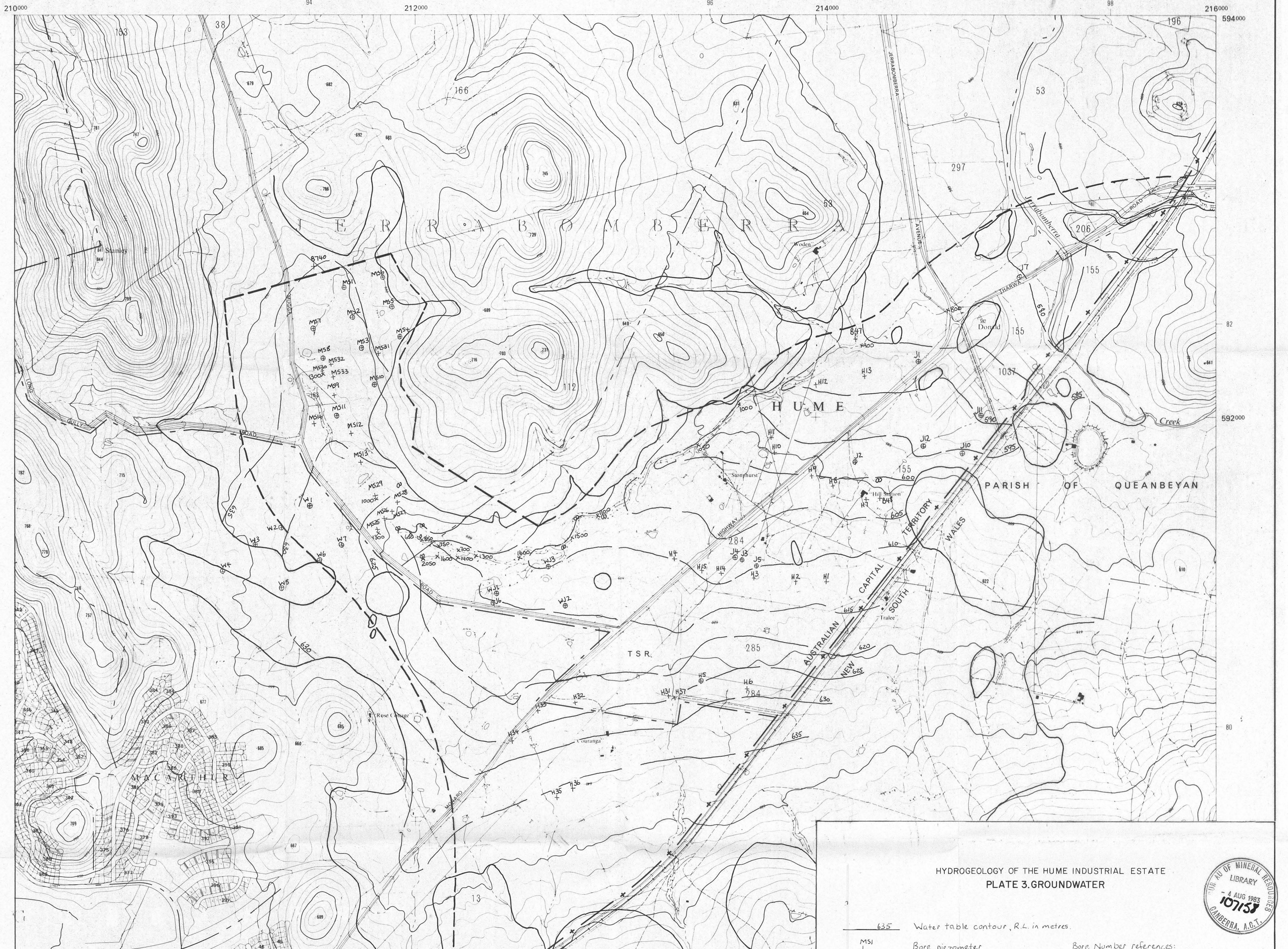

HYDROGEOLOGY OF THE HUME INDUSTRIAL ESTATE
PLATE 1. GEOLOGY
BUR. OF MINERAL RESOURCES LIBRARY - 4 AUG 1983 107158 CANBERRA, A.C.T.
Qa Alluvium
Sp Cream-pink rhyolite
Sud10 Cream rhyolite
Sud7 Purple-blue rhyodacite
Sud6 Agglomerate, sandstone, rhyolitic tuff
Sud5 Dacite - blue-grey
Sud4 Shale, sandstone, agglomerate, tuff Foliated rhyodacite
Sud3 Blue-grey dacite
Sud2 Sandstone
Sud1 Purple rhyodacite: Mugga Porphyry
Generalised surficial cover-bedrock boundary.
Geological boundary, position approximate
Concealed Geologic boundary, position approx.
5 Alluvium thickness contour in metres.
Hume Industrial Estate, possible future boundary
0
500m
SCALE 1:10,000
Base map: ACT Planning Series 208·588.
Drawn by: R.E 5/83
HUME
PARISH OF QUEANBEYAN
AUSTRALIAN CAPITAL TERRITORY
NEW SOUTH WALES
MACARTHUR
GILMORE
TSR
Creek
Stanley
Stonyhurst
Hill Station
Tralee
Rose Cottage
Wanniassa
210000
212000
214000
216000
594000
592000
590000



HYDROGEOLOGY OF THE HUME INDUSTRIAL ESTATE

PLATE 2. MODAL SEQUENCE OF PEDODERMS IN THE SURFICIAL COVER

Scale 1:10000. Base Map: A.C.T. Planning Series 208·588. Drawn by: R.E. 5/83



HYDROGEOLOGY OF THE HUME INDUSTRIAL ESTATE

PLATE 3. GROUNDWATER

635	Water table contour, R.L. in metres.
MS1 +	Bore, piezometer
J6 ⊕	Bore, piezometer – abandoned.
ꝏ	Spring – flowing 3/83
1050 ×	Sample site showing E.C. in μSm/cm.

Bore Number references:

W1-7, WJ1-3, MS1-6	Evans R. et al, 1978 – BMR Record 1978/68.
MS7-14	Evans and Bennett – BMR Record 1978/69.
MS25-33	This report
J1-7, 10-12	Hohnen – BMR Record 1975/36
H1-15	Jacobson and Hohnen – BMR Record 1980/56
H31-37	Evans and Sparksman – BMR Prof. Op. Geol. GS 81/013
B47, 48, 740	BMR bore data sheets.

0 500m

SCALE: 1:10 000. BASE MAP: ACT PLANNING SERIES 208.588. DRAWN BY: R.E. 5/83.