CONSULTATIVE ENVIRONMENTAL REVIEW

MERU WASTE DISPOSAL FACILITY, NARNGULU
for
THE CITY OF GERALDTON
and
THE SHIRE OF GREENOUGH

JULY 1990

SHIRE OF GREENOUGH

PROPOSED WASTE DISPOSAL FACILITY

CONSULTATIVE ENVIRONMENTAL REVIEW

The Environmental Protection Authority (EPA) invites people to make a submission on this proposal.

The proposal deals with the intention by the City of Geraldton and the Shire of Greenough to develop and operate an integrated waste disposal facility for the Shire of Greenough and the City of Geraldton. The site of the proposed facility is near the locality of Meru, approximately 6km south-east of the Geraldton city centre.

The Consultative Environmental Review (CER) for the proposed project has been prepared in accordance with Western Australian Government procedures. The report will be available for comment for 4 weeks, finishing on Friday, 24th August 1990.

Comments from Government agencies and from the public will assist the EPA to prepare its Report and Recommendations to Government.

Following receipt of comments from Government agencies and the public, the EPA will discuss the issues raised with the proponent, and may ask for further information. The EPA will then prepare its Report and Recommendations to Government, taking into account issues raised in the public submissions.

WHY WRITE A SUBMISSION?

A submission is a way to provide information, express your opinion and put forward your suggested course of action including any alternative approach. It is helpful if you indicate any suggestions you have to improve the proposal.

All submissions received will be acknowledged.

DEVELOPING A SUBMISSION

You may agree or disagree, or comment on, the general issues discussed in the CER or with specific proposals. It helps if you give reasons for your conclusions, supported by relevant data.

You may make an important contribution by suggesting ways to make the proposal environmentally more acceptable.

When making comments on specific proposals in the CER:

- clearly state your point of view;
- indicate the source of your information or argument if this is applicable; and
- suggest recommendations, safeguards or alternatives.

POINTS TO KEEP IN MIND

By keeping the following points in mind, you will make it easier for your submission to be analysed.

Attempt to list points so that the issues raised are clear. A summary of your submission is helpful. Refer to each point to the appropriate section, chapter or recommendation in the CER. If you discuss sections of the CER keep them distinct and separate, so there is no confusion as to which section you are considering.

Attach any factual information you wish to provide and give details of the source. Make sure your information is correct.

Please indicate whether your submission can be quoted, in part or in full, by the EPA and in its Report and Recommendations.

REMEMBER TO INCLUDE

YOUR NAME/ADDRESS/DATE

THE CLOSING DATE FOR SUBMISSIONS IS: FRIDAY, 24TH AUGUST 1990

SUBMISSION SHOULD BE ADDRESSED TO:

The Chairman
Environmental Protection Authority
1 Mount Street
PERTH WA 6000

Attention: Mr Ron Van Delft

THE SHIRE OF GREENOUGH

CONSULTATIVE ENVIRONMENTAL REVIEW

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SUMMARY

The City of Geraldton and Shire of Greenough propose to develop and operate a waste disposal site designed to receive waste from the Shire and the City. It is proposed that the site will receive domestic, septic, liquid and hazardous wastes.

The Meru site which is 6km to the south-west of the City of Geraldton was selected as the best location for the disposal site after consideration of a number of other localities. It was chosen because of the large buffer zone available, its relative closeness to populated areas and the presence of suitable soils to attenuate leachate.

The sanitary landfill and septage disposal facility could be constructed as early as 1991, subject to current discussions between the two Councils. It is proposed that the liquid and hazardous facilities will be constructed at a later date when there is a demand for this type of waste disposal.

The landfill will have a volume of about 3 million m^3, have a refuse depth of 12m or less, be lined with 0.5m clay and be capped with 1m of sand and clay. The septage treatment facility will have the capacity to treat 1,500,000 litres per annum, consist of two sludge collection lagoons, a digestion lagoon and an evaporation lagoon all of which will be lined with clay. The estimated life of the facility will be about 30 years.

The location for the waste disposal site is agricultural land with little conservation value. The site has the potential to impact on the environment by polluting groundwaters and surface waters, producing odour and litter problems. However given proper management practices and proper design of the waste disposal facilities there will be minimal environmental impact.

A water balance study on the site showed little if any leachate will be produced. The landfill will be designed so that any leachates produced will be captured at the base of the landfill and treated appropriately.

Management practices will be designed to limit the production of odours and litter problems. It is proposed that a buffer zone be enforced around the site in which no new residential developments will be allowed. This will result in minimum inconvenience to future residents near the landfill.

It is proposed that the site be returned to agricultural use after waste disposal operations have ceased. The site will be rehabilitated in such a way as to return it to a form close to and compatible to its original contours.

It is the Shire of Greenough's opinion that given proper management the site will have minimal impact on the environment and that it will meet the demands of its ratepayers for safe convenient waste disposal.

1. INTRODUCTION

1.1 THE PROPOSAL

The proposal is to develop and operate a waste disposal site designed to receive wastes from the Shire of Greenough and the City of Geraldton at Narngulu. It is proposed that the facility will receive domestic, septic, liquid and hazardous wastes. The facility will be known as the Meru waste disposal site (see Figure 1.1).

It is proposed that site development begin on a staged basis once the necessary government approvals are gained. Development will be timed to satisfy demand for waste disposal from the Shire of Greenough and the City of Geraldton and be subject to rationalisation of usage of existing sanitary landfill and septage disposal facilities in the region.

1.2 THE PROPONENT

The proponent for this proposal is the City of Geraldton/Shire of Greenough. The proponent's offices are located on Eastward Road, Utakarra.

1.3 NEED FOR THE PROPOSAL

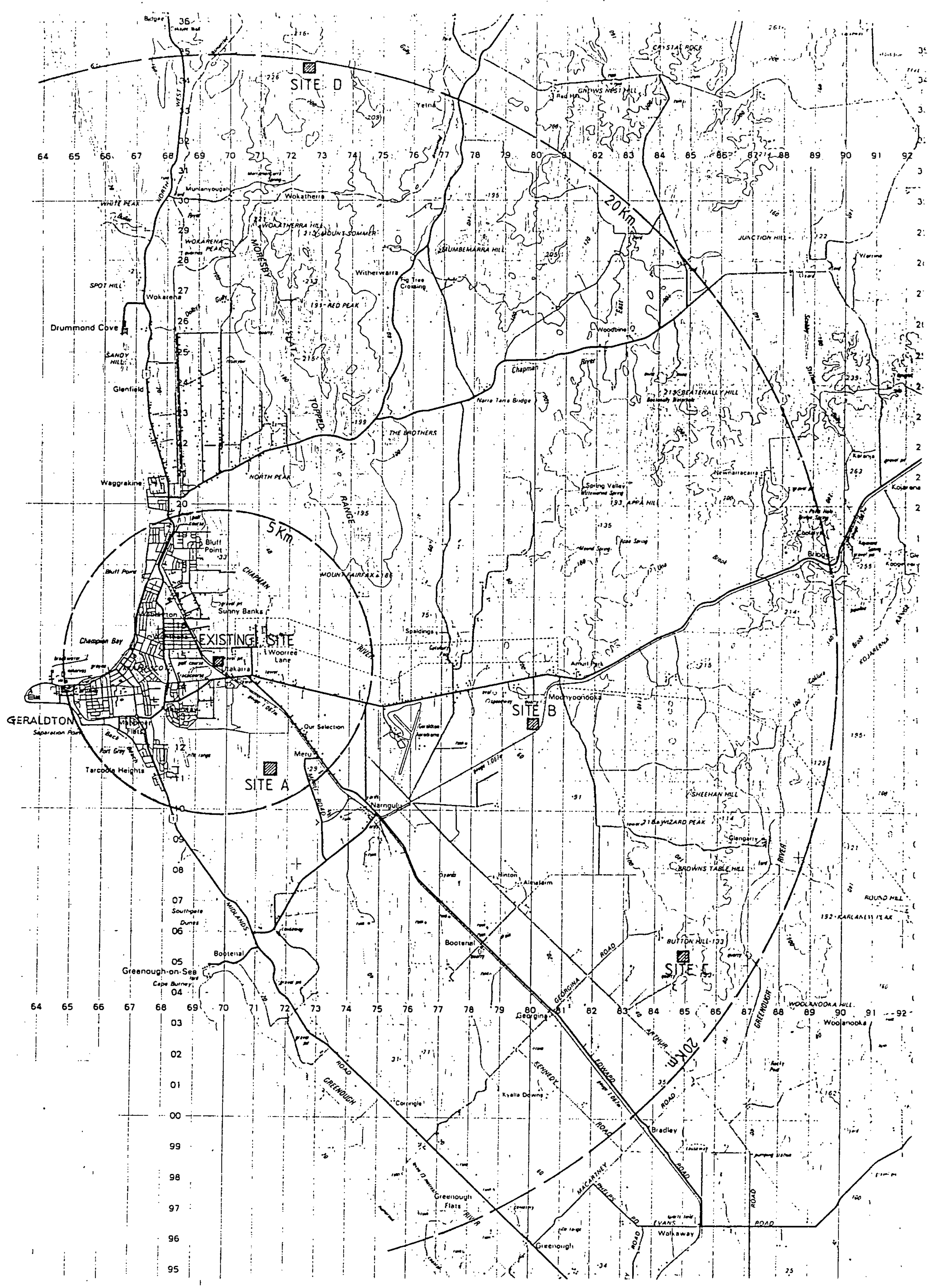
It is proposed that the Meru site will meet the demand for waste disposal from the City of Geraldton and the Shire of Greenough for 30 years. The City of Geraldton's existing landfill site at Flores Road has a project life of 8-10 years, while the Shire of Greenough's site at Moonyoonooka has a life of 2-3 years. The Meru site has been designed to replace these facilities and to satisfy the demand for waste disposal into the future.

1.4 PURPOSE OF THIS DOCUMENT

The Environmental Protection Authority (EPA) has requested that the Shire of Greenough produces this document so that members of the public can be made aware and pass comment on the proposal to develop a waste disposal site at Narngulu.

The EPA is interested in receiving written submissions from interested people on this proposal. A guide to the preparation of a submission is provided at the beginning of this Consultative Environmental Review.

After a period of public review the EPA will prepare its Report and Recommendations on the proposal and the written submissions received by it, for the Minister for Environment. The document will make recommendations to the Minister as to whether the proposal should be allowed to proceed, and if allowed, under what conditions.



SITE LOCATION MAP

Figure 1.1

The Report and Recommendations will be published and any interested party may appeal against any of its recommendations to the Minister within 14 days of its publication. A final decision of the proposal will be made by the Government of Western Australia after consideration of the Minister for Environment's recommendations.

2. ALTERNATIVES

2.1 LANDFILL SITE OPTIONS

Four sites were examined as part of a review of possible landfill sites within reasonable distance of the City of Geraldton. They are as follows:

Gravel quarries situated in a valley on the divide between the coastal plain and the Chapman Valley, a hardrock quarry presently being operated by Readymix, a new Moonyoonooka site which is being used for the extraction of sand and the Meru site which is on farmland 6km south-east of the city (see Figure 1.1).

2.1.1 Gravel Quarries

As the gravel quarries are about 25km from the City of Geraldton they would incur a large daily transportation cost and would require the construction of a major transfer station. The site is also located in the Moresby Ranges which has been recommended for preservation for tourism, consequently the site is considered unsuitable for landfill purposes.

2.1.2 Hardrock Quarry

This site is also some 25km from Geraldton resulting in the need for a waste transfer station. This combined with the fact that the quarry is still operating, which involves blasting, makes the site unsuitable for landfill purposes.

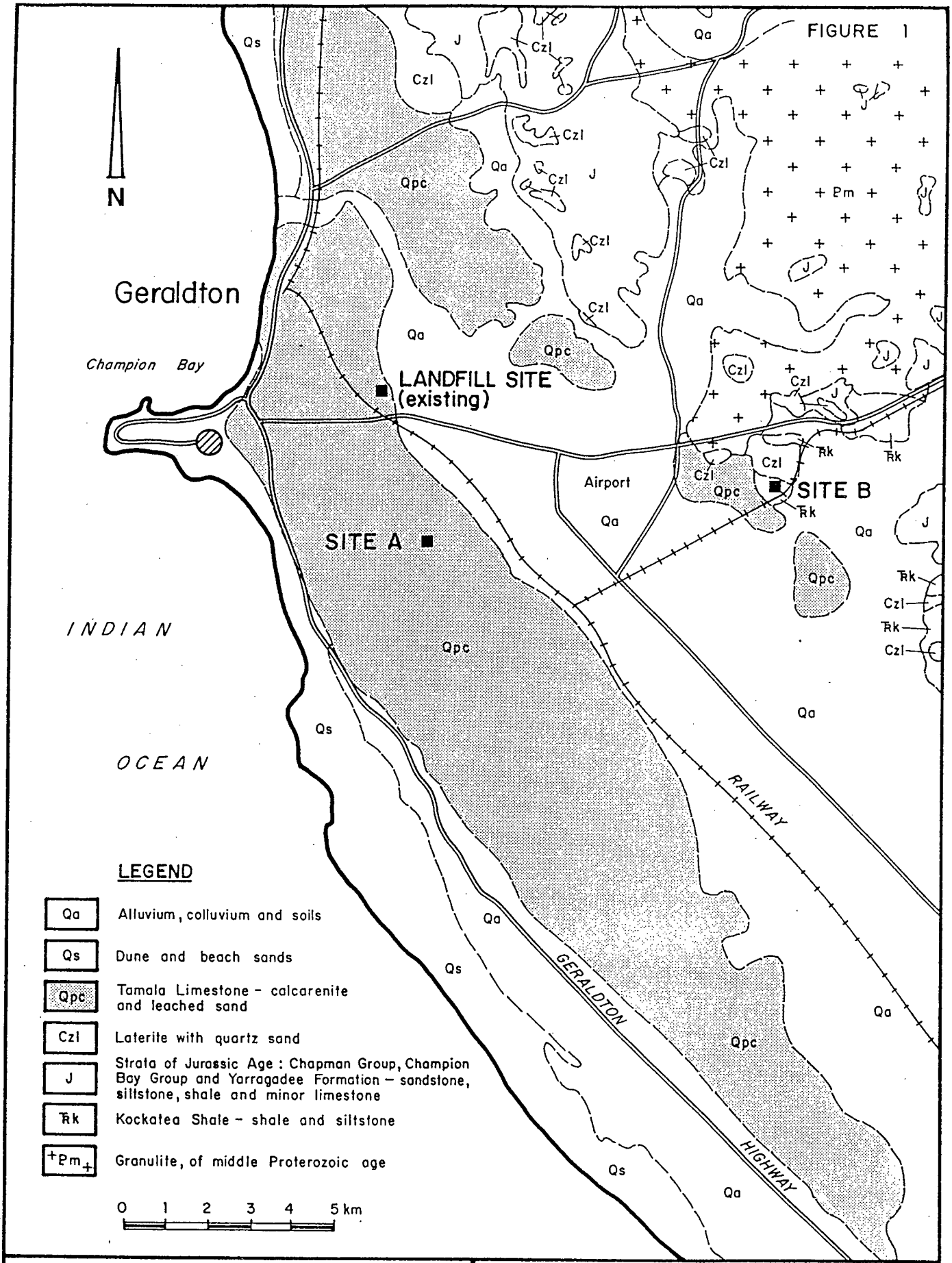
2.1.3 Moonyoonooka Site

This new Moonyoonooka site has the advantage of having an impermeable base of Kockatea Shale, having no sensitive neighbours within 1km and having good access via the Geraldton-Mt Magnet road (see Figure 2.1).

Unfortunately the owner has no desire to sell the site for landfill purposes and the 13km distance makes the expensive operation of a transfer station necessary (nominal distance 8km). For these reasons the site was not considered further.

2.1.4 Meru Site

The Meru site is only 6km from the city centre and thus would not require a transfer station operation. The nearest residential developments are over 1km away. As the area is zoned rural a suitable buffer zone can be established so as to exclude future residential developments. Access is good, particularly if the planned Meru Road can be given priority in construction (see Figure 3.1).



Client : SHIRE OF GREENOUGH

Project : MERU WASTE DISPOSAL FACILITY

Date : MAY 1990

GEOLOGICAL MAP

Figure 2.1

ROCKWATER PTY LTD – SOURCE

Soils over the area consist of alluvium overlying Tamala Limestone (see Figure 2.1). Although these soils will not be impermeable they are expected to have attenuating properties which will limit the potential impact of any leachate generated. Drilling has also shown that soils containing clay will be available for the lining of the sanitary landfill. This material is of sufficient quantity and quality to be used as a liner for the entire sanitary landfill.

For the above reasons this site is considered to be the most suitable and subsequently has been purchased by the proponent.

2.2 SEPTAGE DISPOSAL OPTIONS

At the present moment the City of Geraldton operates a temporary septage disposal site at the Flores Road landfill. This disposal site has a life of three (3) years, as approved by the Environmental Protection Authority. Approval of the temporary site is subject to relocation of the septage facility within three years, to the regional site.

The following alternatives have been considered:

(i) Come to an agreement with the Water Authority for all septage to be passed through the sewerage treatment facilities in Eighth Street.

(ii) Establish a temporary facility on the Flores Road landfill site, then establish a new site.

(iii) Establish a new permanent site at the proposed Meru facility.

Of the above, the first option was the most attractive, however, the City of Geraldton has been unable to negotiate such an agreement therefore the proponent has elected to implement option (ii).

3. THE PROPOSAL IN DETAIL

3.1 THE MERU SITE

3.1.1 Ownership

The property, Victoria Location 2268 and Part Victoria Location 2227, was used for farming and was owned by Marsden Pty Ltd. It was then sold to the Shire of Greenough along with surrounding property under a "contract of sale" agreement. Actual transfer of ownership takes place in accordance with the agreement and has not occurred to date (June 1990). The site has a total area of 89.2918ha.

3.1.2 Location

The location of the proposed site is 6km from the centre of Geraldton and is approximately 1km from the buildings comprising the Narngulu Industrial Area (see Figure 3.1).

Some six or seven rural properties are about 1km from the site, however the nearest residential area is over 1km from the site. The nearest planned future residential areas are approximately 800m from the nearest part of the site.

3.1.3 Zoning

The proposed site is on land presently being used for farming purposes, namely sheep grazing. Future zoning for the land will be "Public Utility" (subject to the granting of approval for use as a waste disposal site).

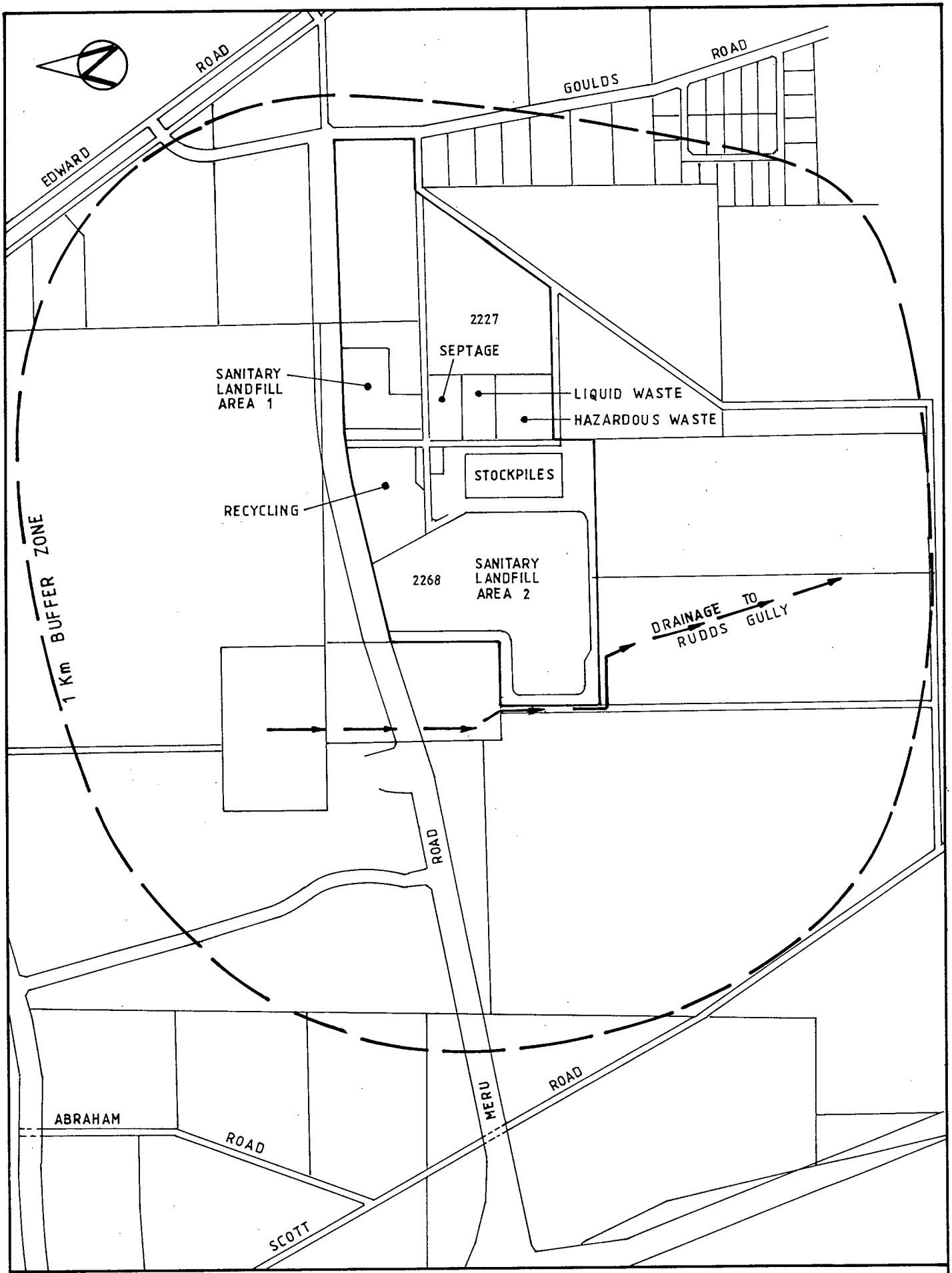
3.2 METHOD OF OPERATION

3.2.1 Site Development

Figure 3.1 shows the proposed development of the site including the planned Marine and Harbours excavation. It is proposed that the facility will consist of a sanitary landfill of 30ha, a septage treatment area of 2ha, a liquid waste area of 2ha, and a hazardous waste area of 4ha. Other areas will be set aside for recycling, bunding and screen planting.

Initially the sanitary landfill and septage treatment area will be developed. When there is sufficient demand the liquid waste and hazardous waste areas will be constructed thus detailed discussion of the design and management of the facility centres on the landfill and septage facilities only.

Site development is discussed in detail in Section 4.



MERU WASTE DISPOSAL FACILITY MAP

Figure 3.1

. **Earthworks**

The land is undulating and from the point of view of visual impact it is desirable to have the landfill final levels at about those existing now. Considerable excavation will be required to create sufficient volume in the facility.

Development will require the removal from site of over 3 million m^3 over the life of the landfill and about 500,000m^3 before the site can operate at maximum capacity. An average of 150,000m^3 per annum after this date must be removed.

The Marine and Harbours Department currently proposes to remove 100,000 to 150,000m^3 of fill for a marina development in Geraldton subject to commercial negotiations. This will be excavated from suitable areas in the north-west corner of lot 2227 (see Figure 3.1). The Shire will opportunistically sell fill throughout the development of the site to remove the required volume.

The septage treatment facility will be designed to have a capacity of 1.5 million litres per annum. After suitable areas are excavated the lagoons are to be lined with low permeability clayey material.

. **Design of Sanitary Landfill**

It is proposed that the sanitary landfill will be developed in stages from the north, southwards. This will be dependent upon removal of fill from the site as will the progressive shape of the excavation.

The landfill is planned to have an average depth of refuse of 12m plus 1m of cover. This will leave finished levels at RL23 and place the floor of the landfill at RL9. It is proposed that 0.5m of compacted clay will be placed at the base of the excavation. This will be slightly sloped to allow for the collection of leachate. Placing the lowest level of the landfill at RL9 gives 5m of alluvium between the refuse and the watertable.

. **Design of the Septage Treatment Facility**

The septage treatment facility will consist of two sludge collection lagoons, a digestion lagoon and an evaporation lagoon. It will be designed to have a capacity of 1,500,000 litres. These lagoons will be lined with 0.5m of compacted clay.

. **Site Access**

Initially it is proposed that access to the site be provided near the south-east corner of the site on available roads off Goulds Road (see Figure 3.1). As development of surrounding land proceeds consideration will be given to the early construction of the planned north-south road linking Karloo with Meru.

. **Site Security**

The individual developments on the site would be fenced with at least 2.4m high security fencing which would also provide a barrier to windblown refuse. This will be done on a staged basis.

3.2.2 Existing Waste Generation

Geraldton and Greenough cater for liquid waste in the form of septage and solid waste which takes the following forms:

(a) Domestic
(b) Garden waste
(c) Commercial
(d) Industrial
(e) Builders' rubble

It is important to separate these categories of waste because certain types are more difficult to handle and transport and therefore affect the economics of developing future waste disposal strategies.

No liquid or hazardous waste is thought to be dumped in currently operating landfills within the two councils. It is assumed that this situation will continue in the medium term. However, allowances have been made to enable construction of suitable facilities to deal with these wastes in the future.

Spot surveys of waste volumes have been undertaken by the City of Geraldton which coupled with generation figures from other similar Western Australian landfill sites, can give some indication of what present and future waste generation figures will be.

. **Domestic Waste Generation**

Geraldton is presently in the process of converting from the old bin system to the 240 litre mobile cart system and although presently using small $15m^3$ compactor truck units, consideration is being given to convert to the larger $19m^3$x6 wheel units. With this in mind the present yearly tonnage is presently 4,725.24 tonnes or a compacted volume of $12,116m^3$.

Greenough has 1,590 domestic services and 40 commercial services which give $7,904m^3$ per year. General domestic service yields an average 20kg per bin so domestic must contribute about 1,653.6 tonnes or $4,240m^3$ per annum and commercial 1,429 tonnes or $3,664m^3$ per annum. Other Council waste collected is $832m^3$ giving a total of $8,736m^3$ per annum.

At present the City of Geraldton has a septage disposal site in Boyd Street. The site is a simple lagooning system which handles about 1,000,000 litres of septage per year from the parts of Greenough and Geraldton which are not deep sewered.

. **Total Present Generation**

Domestic waste can be readily estimated from the number of services handled. Commercial waste can also be estimated in a similar manner. However, other categories of waste delivered on a non-routine basis to the landfill cannot be measured effectively except by weighbridge at the gate. Spot surveys can give some indication but are not reliable because of seasonal variations in some waste streams (ie tree prunings) and development fluctuations (ie builders' rubble etc).

The survey by the City of Geraldton at their Flores Road site which measured the volume of refuse deposited over a 6 month period in 1988 indicates that a total of 25,310m^3 of refuse was deposited. This extended to a 12 month period giving 50,648m^3. Of this waste it can be estimated that 12,116m^3 per annum is domestic waste (the result of one week weighings of compactor vehicles collecting domestic waste).

It is further estimated that other Council waste totalled 7,228m^3 per annum so the breakdown for the City of Geraldton waste is:

Domestic	12,116m^3
Other Council waste	7,228m^3
Other outside waste	31,304m^3
Present Total Yearly Waste at Flores Road	50,648m^3

These figures can be compared with those from other councils in WA and can then be used as a basis for projecting future waste volumes.

. **Comparison With Other Councils**

A study of waste in the Perth metropolitan area shows that waste quantities vary between councils depending on the extent of residential areas, commercial and industrial activity and the amount of redevelopment taking place. With these factors in mind we believe the City of Cockburn would be similar to Geraldton-Greenough in these respects and if we compare total waste generation we obtain the following:

Geraldton-Greenoughs' waste generation per head of population per year is:

$$\frac{59{,}384 \times 0.5}{27{,}200 \times 365} \times 1{,}000 = 3\text{kg per head per day}$$

Cockburn waste generation per head of population is also 3kg per head per day.

It is possible that the waste generated by Geraldton-Greenough could be slightly higher than measured because some commercial and industrial dumping at unmanned Shire of Greenough landfill sites could have been taking place over the six months of the survey.

This could be offset by the density figure for waste of 500kg per m^3 which could be high for Geraldton due to the light equipment used for compaction.

The likely ratios for waste at the landfill is therefore:

(a)	Domestic	1.0
(b)	Garden and household waste	0.7
(c)	Commercial	0.4
(d)	Industrial	0.4
(e)	Builders' rubble	0.5
		3.0

3.2.3 Future Waste Generation

It is likely that both Geraldton and Greenough will be on the 240 litre bin system within the next 2 to 3 years. Detail studies of Australian cities, particularly Western Australian city councils, have shown that waste generation is generally at the rate of 3kg per head per day. The existing waste generation figures for Geraldton and Greenough indicate that these figures are also being experienced in the study area.

For future projection for waste it can be assumed that the waste generation at June 1989 was about 3kg per head per day and that 2.1kg is putrescible waste and 0.9kg is inert materials such as building rubble. Table 3.1 gives the waste generation figures based on these generation rates for both Geraldton and Greenough as well as the combined figures. The waste generation tables assume that waste volumes will increase by 2% per annum over the next 20-30 years.

Growth in demand for septage disposal over the life of the facility is expected to be 50% thus there will be a need to be able to treat 1,500,000 litres per annum.

3.2.4 Planning

The maximum estimated life of the facility will be about 30 years. This is determined mainly by the volume limitations of the sanitary landfill (3 million m^3). It is proposed that the Shire of Greenough begins dumping into the landfill at an annual rate of about 15,000m^3 per annum (see Table 3.1). An alternative may be for the Shire of Greenough to dump in the Flores Road site until its capacity has been reached.

After Geraldton's Flores Road site has ceased operation (approximatley in the year 1998) Geraldton will begin using the facility, resulting in a dumping rate of 90,000m^3 per annum. This should further increase to about 130,000m^3 after fifteen years, given growth in the region. Note that these volumes assume a compaction rate of 0.5 tonnes/m^3. As mentioned in Section 1.3, the timing is subject to change.

It is planned that the septage treatment facility would treat 1,500,000 litres per annum. An estimated 2ha of treatment area will therefore be required. It is expected that treatment would begin in 1996.

No liquid or hazardous wastes are planned to be disposed of at the facility in the medium term. These will be turned away until such time as there are facilities to handle these wastes. In the long term there are plans to construct special waste facilities including the membrane lining of a disposal area. Detail planning for these waste streams will occur when the nature and volumes of these wastes are better known.

3.2.5 Site Operation

The operation of the pit will be arranged so that leachate development is limited. This is to be achieved by working the landfill in stages from the north southwards. As each stage is completed (3-5 years), 1m of surface cover would be placed to ensure maximum runoff of rainfall and maximum evapotranspiration occurs. In addition clayey material will be placed to a compacted thickness of 0.5m at the base of the landfill. Refuse would be laid in strips approximately 60m wide to a compacted thickness of 2m.

Lining, intermediate and cover materials would be obtained from the excavation required for future pit development. Intermediate cover thicknesses would be 150mm and final cover 1m thick.

. Leachate Control

A water balance study was commissioned to evaluate the potential for leachate generated from the Meru landfill site (Appendix 1). The conclusion of the analysis is that little if any leachate will be generated over the life of the landfill. It is expected that no leachate will be generated within the first 10 years of operation as the refuse will absorb all waters that enter the landfill.

The study conservatively assumed an effective cover of 1m composed of sandy material. It is the intention of the proponent to include clay material in the cover thus further enhancing runoff and further reducing the potential for leachate generation.

The landfill will also be lined with available clay material to a thickness of 0.5m and sloped to the centre to allow leachate to be collected by a simple leachate drain feeding to manholes. This leachate will be collected and disposed of by circulating it back over the landfill or alternatively if necessary, treated. It is believed that the above features will ensure that minimal, if any, leachate is generated.

. Drainage

The landfill's finished levels will have a slight rise to prevent flow over the landfill surface. Any collected waterflow will be directed to a natural drainage course flowing into Rudds Gully. This natural drainage will be viewed over the period of development and upgraded to accommodate better flow or possibly revegetated if erosive effects are observed.

. **Dust, Pest, Fire Controls**

The road to the site would be sealed and the below ground level internal roads would be well watered to minimise dust.

Strict management procedures involving covering on a daily basis will minimise the risk of pests and fires.

. **Recycling**

Recycling throughout the region is currently being considered by the Geraldton Recycling Committee. The Committee's conclusions will have bearing on recycling activities at the landfill. In any case the large site permits the installation of recycling facilities as considered appropriate.

. **Gas Control**

As rubbish in the landfill decays it will release methane gases. These gases can prevent the growth of plants, interfering with future rehabilitation, and are classified as greenhouse gases. As a result of the above the proponent will investigate the possibility of controlling the escape of methane gases to the atmosphere. This would involve landfill cover materials being selected and shaped such as to concentrate the gases at specific locations. At these locations the gas emissions would be assessed from time to time and if considered necessary the gas would be collected for use or flared.

. **Screening**

It is proposed that the site will be screened by planting suitable tree species along the boundaries of the site. This along with the low lying nature of the site will ensure that the visual impact of the facility will be minimised.

3.2.6 Traffic Movements

Access will be provided by constructing a sealed road on an existing road reserve off Goulds Road. This will be fed by regional roads already carrying heavy industrial traffic, thus no additional nuisance is predicted. Current traffic volumes are 1,000 vehicles per day on Goulds Road and 2,600 vehicles per day on the Geraldton-Walkaway Road. The anticipated increase in traffic flows is not expected to be more than 200 vehicles per day initially increasing to about 500vpd towards the end of the life of the facility.

3.2.7 Final Restoration

The site will be finished to RL24 with a 1 in 50 slope to ensure that surface waters flow off and around the sanitary landfill. The site will be converted back to agricultural use after restoration is complete.

TABLE 3.1

FUTURE ANNUAL WASTE GENERATION FOR GERALDTON AND GREENOUGH

	GERALDTON					GREENOUGH					
Year	Population	Waste Rate kg per Head	Yearly Tonnage	Yearly Volume	Accumulated Volume	Population	Yearly Tonnage	Yearly Volume	Accumulated Volume	Combined Yearly Volume	Combined Accumulated Volume
1989	20,800	3.00	22,776	45,552	45,552	6,400	7,008	14,016	14,016	59,568	59,568
1990	21,200	3.06	23,678	47,356	92,908	6,528	7,291	14,582	29,598	61,938	121,506
1991	21,600	3.12	24,598	49,196	142,104	6,659	7,583	15,167	43,765	64,363	185,869
1992	22,000	3.18	25,535	51,071	193,175	6,792	7,883	15,767	59,532	66,838	252,707
1993	22,000	3.25	26,092	52,195	245,370	7,131	8,459	16,918	76,450	69,113	321,820
1994	22,000	3.31	26,579	53,159	298,529	7,488	9,047	18,092	94,542	71,251	393,071
1995	22,000	3.38	27,141	54,283	352,812	7,862	9,699	19,399	113,941	73,682	466,753
1996	22,000	3.45	27,703	55,407	408,219	8,255	10,395	20,790	134,731	76,197	542,950
1997	22,000	3.51	28,185	56,371	464,590	8,688	11,105	22,210	156,941	78,581	621,531
1998	22,000	3.59	28,828	57,655	522,245	9,100	11,924	23,848	180,789	81,503	703,034
1999	22,000	3.66	29,390	58,780	581,025	9,500	12,691	25,382	206,171	84,162	787,196
2000	22,000	3.73	29,952	59,904	640,929	10,000	13,614	27,229	233,400	87,133	874,329
2001	22,000	3.80	30,514	61,028	701,957	10,500	14,563	29,127	262,527	90,155	964,484
2002	22,000	3.88	31,156	62,313	764,270	10,867	15,390	30,780	293,407	93,093	1,057,577
2003	22,000	3.96	31,799	63,598	827,868	11,248	16,258	32,516	325,823	96,114	1,153,691
2004	22,000	4.04	32,441	64,882	892,750	11,641	17,166	34,332	360,155	99,214	1,252,905
2005	22,000	4.12	33,084	66,167	958,917	12,049	18,112	36,224	396,379	102,391	1,355,296
2006	22,000	4.20	33,726	67,452	1,026,369	12,471	19,118	38,236	434,615	105,688	1,460,984
2007	22,000	4.28	34,368	68,737	1,095,106	12,907	20,163	40,327	474,942	109,064	1,570,048
2008	22,000	4.37	35,091	70,182	1,165,288	13,359	21,308	42,617	517,559	112,799	1,682,847
2009	22,000	4.46	35,814	71,628	1,236,916	13,826	22,507	45,015	562,574	116,643	1,799,490
2010	22,000	4.55	36,536	73,073	1,309,989	14,310	23,765	47,531	610,105	120,604	1,920,094
2011	22,000	4.64	37,259	74,518	1,384,507	14,810	25,082	50,164	660,269	124,682	2,044,776
2012	22,000	4.73	37,982	75,964	1,460,471	15,328	26,463	52,926	713,195	128,890	2,173,666
2013	22,000	4.82	38,705	77,410	1,537,881	15,864	27,910	55,819	769,014	133,229	2,306,895
2014	22,000	4.92	39,508	79,016	1,616,897	16,419	29,485	58,970	827,984	137,986	2,444,881
2015	22,000	5.02	40,311	80,622	1,697,519	16,994	31,138	62,276	890,260	142,898	2,587,779
2016	22,000	5.12	41,114	82,228	1,779,747	17,589	32,870	65,741	956,001	147,969	2,735,748
2017	22,000	5.22	41,917	83,834	1,863,571	18,205	34,686	69,372	1,025,373	153,196	2,888,944
2018	22,000	5.32	42,720	85,440	1,949,011	18,842	36,587	73,175	1,098,548	158,615	3,047,559
2019	22,000	5.43	43,603	87,206	2,036,217	19,501	38,650	77,300	1,175,848	164,506	3,212,065
2020	22,000	5.54	44,486	88,972	2,125,189	20,184	40,814	81,628	1,257,476	170,600	3,382,665
2021	22,000	5.65	45,370	90,740	2,215,929	20,890	43,080	86,161	1,343,637	176,901	3,559,566
2022	22,000	5.76	46,253	92,506	2,305,435	21,621	45,456	90,912	1,434,549	183,418	3,742,984

4. EXISTING ENVIRONMENT

4.1 GENERAL

In considering waste disposal practices it is necessary to examine the natural environment of the site so as to assess the potential impact of the facility on the environment.

The site has been completely cleared for agricultural use and has no significant remaining native vegetation. It is considered to be a degraded natural environment with little conservation value. Consequently it is believed that the impact of this proposal will be minimal.

4.2 CLIMATE

Aspects of climate such as wind speed and direction, rainfall and evaporation are important when considering issues such as the potential of the facility to generate leachate and the dispersion of odours from the site.

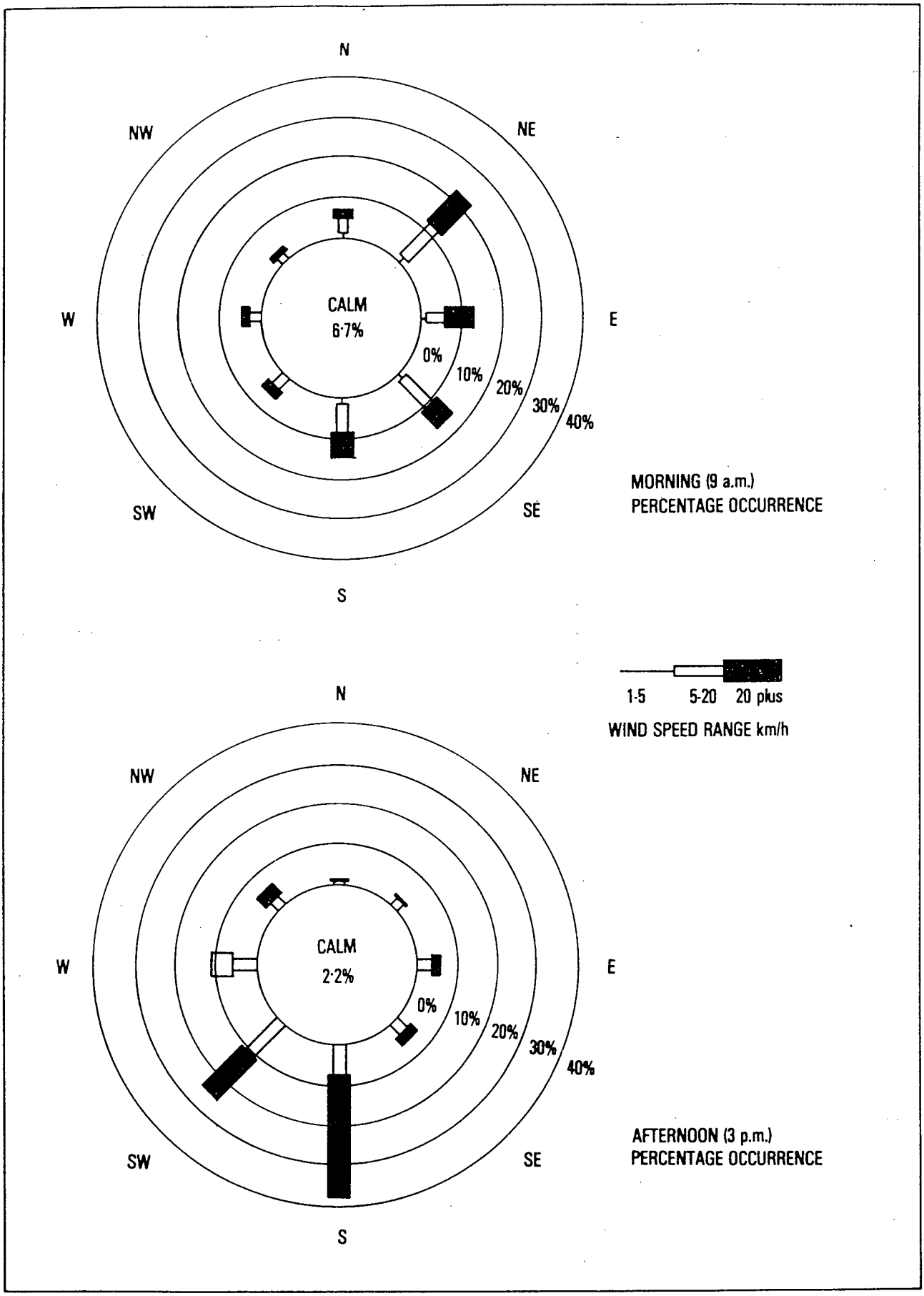
The Geraldton region experiences a dry, warm Mediterranean climate with winter rainfall and hot dry summers. The wind roses for Geraldton airport are presented in Figure 4.1. The prevailing winds at Geraldton are dominated by the local sea and land breeze system. Winds from the south to south-west dominate year round in the afternoons at strengths often up to 50km/h. Light to moderate southerly to easterly winds prevail in the mornings during summer while winter mornings are dominated by light to moderate north-easterlies.

Average annual rainfall is about 500mm with the majority falling from May to October. In June rainfall typically exceeds 100mm and this is the only month during which rainfall exceeds pan evaporation. During summer months little rainfall occurs and temperatures are high thus evaporation vastly outstrips rainfall. An extreme rainfall event in the Geraldton region is a total of 49mm in 72 hours. This represents a one in one hundred year event.

4.3 GEOLOGY

The geology of the site is important when considering the siting of the sanitary landfill as it has an influence on the ability of any leachates generated to reach the groundwater table.

Site investigations including drilling have established that the site has Tamala Limestone overlain by 0-20m of alluvial material. The alluvial material probably arose from the northerly migration of the Greenough River. The Tamala Limestone is a cemented dunal deposit of Quaternary age which forms a belt running along most of the south-west coastline by the Yarragadee Formation.



ANNUAL WIND ROSES FOR GERALDTON

FIGURE 4.1

Source: Kinhill Stearns

Inspection of drill cuttings found that the alluvial material consists of medium to fine sands with interbeds of clay (Appendix 2). The sands have a high silt and clay content in places. From these samples it was concluded that the sediments below the proposed pit have low permeability but will allow vertical drainage.

Analysis of selected sediment samples found that they contained up to 25% clay material. This material consists of the clays kaolinite and montmorillonite (Appendix 2) which are known to have leachate attenuating properties (Griffin and others, 1979).

4.4 HYDROGEOLOGY

The shallow unconfined aquifer beneath the site is the Tamala Limestone. It is a highly permeable and porous geological unit. Drilling encountered the watertable at 17m below surface (RL4). Generally it is underlain by Jurassic age strata which forms the base of the shallow aquifer system.

Groundwater flow beneath the site is toward the south-west being recharged by rain falling on hills to the east. A review of Geological Survey records revealed that waters from a shallow well on the site have salinity values of 1,900mg/l and must be considered brackish. This conclusion is consistent with investigations into groundwater quality relating to industrial development in nearby Narngulu area (Kinhill Stearns, 1985).

There are no bores and wells to the immediate west of the site however those to the south-west and north-west have similar salinity values. These wells are generally suitable for water stock only. Salinity values of about 3,000mg/l are to be expected in the area with localised fresher lenses of water towards the top of the aquifer.

4.5 SURFACE WATERS

No defined water courses cross the site. Site drainage is via a depression along the bottom of the foothills to the west of the site (Figure 3.1). This depression drains into Rudds Gully which ultimately feeds into Greenough River.

4.6 TOPOGRAPHY

Existing surface contours of the site are given in the figure accompanying Appendix 2. The land is gently undulating with the facility being located in a depression. It will be situated to the east of a rise some 20m higher than the site.

4.7 LAND USE

The Meru site is situated 6km south-east of the city centre. The nearest residents are rural holdings along Geraldton-Walkaway Road which are over 1km away from the proposed site. Land within 1km of the site is used for agricultural purposes.

5. POTENTIAL ENVIRONMENTAL IMPACTS

5.1 GENERAL

As the land for the Meru site has been used for agriculture and as most of the surrounding land is also agricultural it is considered that impacts on the natural environment from the development will be minimal. There is potential for impacts such as contamination of groundwaters beneath the site and dispersion of odours and litter by wind however with proper management these will be kept at a minimum.

The Meru site is located a considerable distance from existing residents thus the Shire of Greenough has the opportunity to put in place proper buffer zones. This will ensure that the public are not inconvenienced by the proposal into the future.

5.2 GROUNDWATER CONTAMINATION

It is possible that leachate from the disposal areas may reach groundwaters beneath the site. This has implications to groundwater users to the west as any contamination would move as a plume with the direction of groundwater flow. A typical leachate generated from a sanitary landfill is presented in Table 5.1. If this leachate was to reach any stock bores to the west they could be rendered useless. However, review of Geological Survey records have found no such bores.

Studies on the potential of the site to generate leachate have concluded that little or no leachate will be generated provided that the site is properly managed (Appendix 1). This is because the area experiences relatively little rainfall together with a high potential evaporation. As a result the majority of rain which falls on the site will be returned to the atmosphere via evaporation or evapotranspiration before it has a chance to move into the refuse.

If some leachates were to be released from the facility they would come in contact with clayey sediments that lie between the refuse and the watertable. Studies on these sediments have shown them to contain up to 25% clay material (Appendix 2). This material contains kaolinite and montmorillonite clays which have the ability to attenuate leachates (Griffin and others, 1977). Given that 5m of this alluvium lies between the bottom of the refuse and the groundwater table it is considered that these clays have sufficient assimilation capacity to remove contaminants from any leachates before they reach the watertable. In addition a clay liner composed of the best clay material found on the site will further improve the potential to attenuate the leachate.

TABLE 5.1

TYPICAL LANDFILL LEACHATE[1]

Components	Median Value (ppm)	Ranges (ppm)
Alkalinity ($CaCO_3$)	3,050	0 - 20,850
Biochemical Oxygen Demand (5 days)	5,700	81 - 33,360
Calcium (Ca)	438	60 - 7,200
Chemical Oxygen Demand (COD)	8,100	40 - 89,520
Copper (Cu)	0.5	0 - 9.9
Chloride (Cl)	700	4.7 - 2,500
Hardness ($CaCO_3$)	2,750	0 - 22,800
Iron, Total (Fe)	94	0 - 2,820
Lead (Pb)	0.75	< 0.1 - 2.0
Magnesium (Mg)	230	17 - 15,600
Manganese (Mn)	0.22	0.06 - 125
Nitrogen (NH_4)	218	0 - 1,106
Potassium (K)	371	28 - 3,770
Sodium (Na)	767	0 - 7,700
Sulphate (SO_4)	47	1 - 1,558
Total Dissolved Solids (TDS)	8,955	584 - 44,900
Total Suspended Solids (TSS)	220	10 - 26,500
Total Phosphate (PO_4)	10.1	0 - 130
Zinc (Zn)	3.5	0 - 370
pH	5.8	3.7 - 8.5

1 Adapted from Miller, 1980.

5.3 SURFACE WATER CONTAMINATION

There is the potential for contamination of surface waters which drain off the site into Rudds Gully. Rudds Gully drains to the south ultimately discharging into the Greenough River. The finished levels over the site will have to be made with this impact in mind.

5.4 VISUAL IMPACT

There may be some visual impact from the proposed facility as it will be visible from the north and south. The site will however be shielded from view from the east and the west by gentle rising ground and low hills. As the facilities will be excavated and then returned to original ground levels the development should be unobtrusive after operations have ceased.

5.5 WINDBLOWN REFUSE

It is considered that nuisance from windblown refuse will be minimal. This is because the sanitary landfill will be mostly below ground level and that security fences (2.4m high) will capture the little litter that does get windblown.

5.6 ODOURS

Odours will be created by the operation of the sanitary landfill and the septage treatment facility. Dispersion of odours will be sufficient not to cause nuisance when the strong southerly and south-westerly winds blow. However light east and south-easterly winds will carry odours some distance without sufficient dispersal, thus people downwind may be inconvenienced. With this in mind the site will be managed to minimise odours and sufficient buffer zones will be put in place.

5.7 METHANE GASES

Gases produced by landfills contribute to the greenhouse effect and will inhibit the growth of any vegetation planted over the site after rubbish disposal is completed. Consequently there is a need to consider the management of gases generated from the Meru site in such a way as to avoid discharge to the atmosphere.

6. WASTE DISPOSAL MANAGEMENT

6.1 GENERAL WASTE DISPOSAL PHILOSOPHY

The proponent's general waste disposal philosophy is to meet the demand of its ratepayers into the future for convenient, safe waste disposal at reasonable financial cost. Part of this philosophy is to ensure that potential impacts on the environment from the proposed waste facility are minimised by proper management procedures.

6.2 REGIONAL COUNCIL

The City of Geraldton and the Shire of Greenough have formed a Regional Council Steering Committee. Currently the Regional Council constitution is being formulated for full implementation by 1991.

The proposed relationship would involve sharing on a per capita basis the cost of acquiring, developing and running the site. This would result in significant savings by both councils as they could combine their existing waste disposal operations.

The Regional Council would have the power to set budgets, prepare and implement waste disposal strategies from the point of receival of waste, and prepare guidelines for appropriate development and operation of all facilities.

6.3 RECYCLING ACTIVITIES

Recycling will become more and more important in the future and thus the proponent intends to make provision for recycling facilities. Limited recycling already occurs within the Shire in commodities such as car bodies.

In the future recycling of select products such as paper, glass and cans may be profitable providing citizens co-operate by carrying out the sorting of these materials at source. Currently these operations are not economic unless they are conducted on a large scale. The Regional Council may incorporate recycling in its waste disposal strategy when it becomes economic to do so. Steps that will be carried out are summarised below:

- Establish what commodities in the waste stream are to be targeted for recycling. This could include glass, cans, paper, plastics, metals, tyres, cars.

- Define and establish a reliable market for the commodities. This will be a difficult aspect of the recycling.

Establish a collecting system. At a minimum this would include depots conveniently placed at the new landfill and for certain commodities, shopping centres. At best the collection system would incorporate collecting from the source (homes).

6.4 METHANE RECOVERY

For environmental reasons the proponent is to consider designing the Meru landfill so as to collect or flare-off methane gases produced by the landfill. In doing so the proponent creates a potential fuel source that could be utilised by industry in the area. The Narngulu Industrial Area is about 1km from the landfill site. In future years given growth in the region there is a possibility that it may become economically viable for a suitable industry to utilise this fuel source.

7. ENVIRONMENTAL MANAGEMENT AND MONITORING

7.1 LEACHATE CONTROL

The Meru waste disposal site is to be designed and managed in such a way as to minimise the production of leachates. This combined with the attenuating properties of soils beneath the site and a climatic regime which will minimise waters moving through the waste materials leads to the conclusion that little leachate will be generated from the site.

Clayey soils will be put aside during the excavation of the sanitary landfill and the septage treatment areas. These will then be used to line the base of these facilities to a compacted thickness of 0.5m. In the event that there is not enough of this material on-site additional clayey material will be sourced from elsewhere. The clay liner will be slightly sloped to allow the collection of any leachate generated into a simple leachate collection system. This leachate will be disposed of by circulating it back over the landfill or alternatively treated if necessary.

The landfill will be excavated in stages. As each stage is completed 1m of surface cover containing sand and clay will be placed to ensure maximum runoff of rainfall and maximum evapo-transpiration occurs. Finally the surface of the landfill will be sloped to limit surface flows of waters over the landfill and ensure maximum runoff.

7.2 ODOUR CONTROL

In the future there is the potential for the public to be inconvenienced by odours produced by the septage treatment facility and the sanitary landfill. Presently, however, there are no residences within 1km and all land within this area is used for agriculture or industry. This allows the Shire of Greenough the opportunity to create a buffer zone around the Meru facility from which residences will be excluded. In this way members of the public will not be inconvenienced by the proposal.

It is proposed that a minimum buffer zone of 1,000m be enforced around the facility. The buffer zone is shown in Figure 3.1. The Shire of Greenough is committed to allowing no new residential developments within this area.

The Shire is also committed to minimising odours produced from the facility by proper management practices. This includes daily covering of the working face of the sanitary landfill and immediate covering of wastes such as crayfish, fish and chicken wastes, and tallow and woolscour wastes to avoid excessive odour generation.

7.3 LITTER CONTROL

It is intended that site management and the construction of a 2.4m fence around the site will prevent a litter problem from occurring. The amount of airborne litter will be limited by daily covering. Litter that does

become airborne should be caught on the 2.4m fence. Given that the surrounding land will be agricultural, any litter that does escape will cause minimal inconvenience.

7.4 MONITORING

The proponent proposes to install one multiport monitoring bore down gradient and to the west of the site. This bore will be designed to detect any pollutants that may enter the shallow aquifer beneath the site. It is proposed that groundwater samples be taken twice a year for analysis. Parameters set by the Health Department will be analysed.

In the event that contamination is detected the Shire will assess the implications of contamination with regard to any users of groundwaters in the area. Appropriate action will then be taken in consultation with the Health Department and the Environmental Protection Authority.

7.5 SCREENING

A screen of trees will be planted on the northern and southern boundaries of the disposal facility to minimise the visual impact of the facility's operations and to act as a windbreak. The proponent has compiled a list of the species that will grow successfully in the area. Trees will be selected from this list for planting at the Meru tip.

7.6 FUTURE WASTE STREAMS

The proponent proposes that the site be able to receive liquid and hazardous wastes in the future. Information about the nature and volume of these wastes is not available as they are not currently being dumped in the area's existing disposal facilities.

When this information becomes available the Shire will formulate management practices and design facilities to receive these wastes. This information will be made available to the relevant authorities.

7.7 REHABILITATION AND END USE

It is proposed that the site be returned to agricultural use after waste disposal operations have ceased. The site will be rehabilitated in such a way as to return it to its original contours and to minimise the volume of surface waters which could flow over it.

The sanitary landfill will be capped with a 1m surface layer of sand and clay and be finished to a slope of about 2% to enhance water runoff. The site will then be suitably fertilised and seeded ready for agricultural use.

8. COMMITMENTS

The proponent is committed to minimising the potential environmental impacts of the Meru waste disposal facility at Narngulu. Consequently it makes the following commitments:

(1) The proponent commits to lining the sanitary landfill and septage treatment plant with clay prior to wastes being placed in the facility. This will be done to the satisfaction of the Environmental Protection Authority, the Health Department and the Water Authority.

(2) The proponent commits to capping the sanitary landfill and the septage treatment plant with 1m of clay material and sand and finishing it with a 2% slope. This will be done to the satisfaction of the Environmental Protection Authority and the Health Department.

(3) The Shire of Greenough commits to putting in place a buffer zone around the Meru facility in which all new residential developments will be excluded until the end of the working life of the facility. This will be to the satisfaction of the Environmental Protection Authority.

(4) The proponent commits to the construction of a 2.4m high fence around the facility. This will be done to the satisfaction of the Health Department.

(5) The proponent commits to management practices which will limit the production of leachate, odour, and litter and limit the potential for fire and pest problems. This will include daily covering of refuse. The above will be done to the satisfaction of the Health Department and the Environmental Protection Authority.

(6) The proponent commits to installing one multiport bore west of the site and using it to conduct a sampling programme to detect any groundwater contamination emanating from it. This will be done to the satisfaction of the Environmental Protection Authority and the Health Department.

(7) The proponent commits to planting a suitable screen of trees around the boundaries of the site. This will be done to the satisfaction of the Environmental Protection Authority.

(8) The proponent commits to supplying details of the volume and nature of any hazardous and liquid wastes and the design of facilities to receive these wastes prior to them being received by the Meru facility. This information will be submitted to the Environmental Protection Authority and the Health Department.

(9) The proponent commits to rehabilitating the site back to level in accordance with the Management Plan for its use as agricultural land. This will be done to the satisfaction of the Environmental Protection Authority.

9. CONCLUSION

It is the proponent's opinion that the proposed Meru waste disposal site will have a minimal impact on the environment given the series of commitments made in this document. Potential environmental impacts will be minimised by the provision of adequate facilities to receive the wastes and proper management over the life of the facility.

It is the proponent's conclusion that this new waste disposal facility will meet the demands of ratepayers of the City of Geraldton and the Shire of Greenough for safe, convenient waste disposal into the next century.

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APPENDIX 1

WATER BALANCE STUDY

GREENOUGH LANDFILL EVALUATION

WATER BALANCE ANALYSIS

For leachates to be generated rainwater must enter the landfill, percolate through the waste and eventually pass out of the waste as leachate. Whether rainwater enters the waste depends on a balance between the rainfall and the overall natural losses which occur due to runoff and evapotranspiration. This is defined by the equation

$$\text{Leachate} = \text{percolation} = P - R/O - AET - \Delta ST$$

where
P = precipitation
R/O = runoff
AET = actual evapotranspiration
ΔST = the change in storage of moisture in the soil.

In the management plan it is proposed to grade the surface to falls of 2% and the cover is up to 0.5m of clay material overlain with 0.5m of loamy material. Runoff is assumed as 20% of the precipitation.

The storage capacity of the cover material is assumed to be 250mm/m over a 0.6m depth or maximum of 150mm. The minimum to which the stored water can be drawn down is 75mm/m or 45mm for a 0.6m thickness. (This is a conservative assumption as the management plan calls for 1m of cover which would give greater storage.)

The potential evapotranspiration is derived from the empirical formula Thornthwaite developed, which is

$$PET = 1.6 \left[\frac{10 \times Ta}{I_H}\right]^a$$

where
PET = potential evapotranspiration in cm/month

Ta = mean monthly air temperature (^oC)

I_H = annual heat index = $\sum_{i=1}^{12} \left[\frac{Tai}{5}\right]^{1.5}$

$a = 0.49 + 0.0179 I_H - 0.0000771 I_H^2 + 0.000000675 I_H^3$

To the above must be applied a correction factor for the number of daylight hours per month over or under 360 hours.

Applying the above to monthly figures for Greenough is given in Table A1 to arrive at PET. Tables A2 and A3 give the water balance figures for two sets of assumptions.

The analysis shows that little if any leachate will be generated. On the assumptions used in Table A2 no leachate is generated in any month other than August where 8mm is generated. If the assumptions are altered to include for 1m of cover no leachate is generated and if the assumptions are made more conservative with coefficient of runoff reduced to 0.15 and effective cover thickness reduced to 0.5m, 21mm of leachates are generated in both the months of July and August.

It is concluded from the water balance that with careful management conditions can be created where little or no leachate will be formed. This is particularly true of the first ten years of the finished landfill when any percolation into the waste will be absorbed by the waste.

- Under the assumption in Table A2, 2400m^3 of leachate would be generated over the full 30ha site per annum

- Under the assumption in Table A3, 12600m^3 of leachate would be generated per annum.

TABLE A1

EVALUATION OF EVAPOTRANSPIRATION

Months	Average Temperature (^{o}C)	Eqn 10^{-4} I_H	Eqn 10^{-3} PET	Sunshine Correction Factor 30^{o} South	Final PET (mm)
January	25.2	11.31	12.06	1.16	139.9
February	25.6	11.59	12.46	1.11	138.3
March	24.0	10.52	10.91	1.03	112.4
April	20.8	8.48	8.31	0.96	78.0
May	18.3	7.00	6.24	0.89	55.6
June	15.9	5.67	4.67	0.85	39.7
July	14.3	4.84	3.76	0.87	32.7
August	14.3	4.84	3.76	0.93	34.9
September	15.2	5.30	4.26	1.00	42.6
October	17.7	6.66	5.83	1.07	62.6
November	20.4	8.24	7.81	1.14	89.0
December	23.3	10.06	10.27	1.17	120.1

Average = 19.58 I = 94.51

$$a = 0.49 + 0.0179I_H - 0.0000771I_H^2 + 0.000000675I_H^3$$

$$a = 0.49 + 1.69 - 0.69 + 0.57 = 2.06$$

TABLE A2

WATER BALANCE (INITIAL ASSUMPTION)

Month	Precipitation	P(1-Cr/o)*	Soil Storage**		Soil Storage	Percolation	Actual Evapo-transpiration	Potential Evapo transpiration
January	6	5	67	=	54	0	18	140
February	14	11	54	=	45	0	20	138
March	15	12	45	=	45	0	12	112
April	25	20	45	=	45	0	20	78
May	72	58	45	=	47	0	56	56
June	112	90	47	=	97	0	40	40
July	95	76	97	=	140	0	33	33
August	66	53	140	=	150	8	35	35
September	30	24	150	=	131	0	43	43
October	20	16	131	=	105	0	42	63
November	10	8	105	=	84	0	29	89
December	6	5	84	=	67	0	22	120
		378	1010 1388		1010	8	370 1388	

* Assume coefficient runoff 0.20
** Assume sand silty loam 0.6m thick

TABLE A3

WATER BALANCE (ALTERNATIVE ASSUMPTION)

Month	Precipitation	P(1-Cr/o)*	Start of Month Soil Storage **		Soil Storage End of Month	Percolation	Actual Evapo-transpiration	Potential Evapo transpiration
January	6	5	55	=	44	0	16	140
February	14	12	44	+	38	0	18	138
March	15	13	38	=	38	0	15	112
April	25	21	38	=	38	0	21	78
May	72	61	38	=	43	0	56	56
June	112	95	43	=	98	0	40	40
July	95	81	98	=	125	21	33	33
August	66	56	125	=	125	21	35	35
September	30	25	125	=	107	0	43	43
October	20	17	107	=	86	0	38	63
November	10	9	86	=	69	0	26	89
December	6	5	69	=	55	0	19	120
		400	866 1266		866	42	360 1268	

* Assume coefficient of runoff of 0.20

** Assume sand silty loam 0.5m thick

APPENDIX 2

ATTENUATION STUDY

THE ABILITY OF CLAY MINERALS PRESENT TO ATTENUATE LEACHATE

Analysis using x-ray diffraction techniques determined that the clays present in soils beneath the proposed sanitary landfill site are mostly kaolinite with some montmorillonite.

Clays such as these are known to attenuate leachates of the type produced by sanitary landfills (Griffin and others 1977, Griffin and others 1976, Newman 1981). They are able to adsorb the cationic heavy metals such as lead, cadmium, zinc, copper and mercury and the anionic heavy metals chromium IV and arsenic to varying degrees depending on the pH of the leachate.

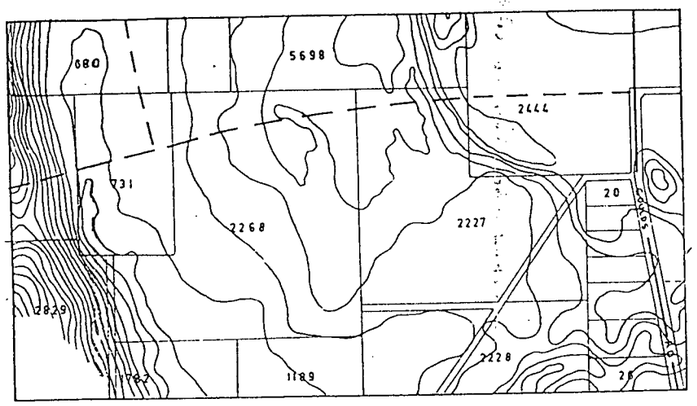
Other chemical compounds such as potassium ammonium, magnesium, silicon and iron are also attenuated by clays but to a lesser degree than heavy metals which are strongly attenuated. However sodium, chloride and water-soluble organic compounds are relatively unattenuated. Microbial degradation in soils would most likely have a greater effect on the concentrations of organic compounds in leachate.

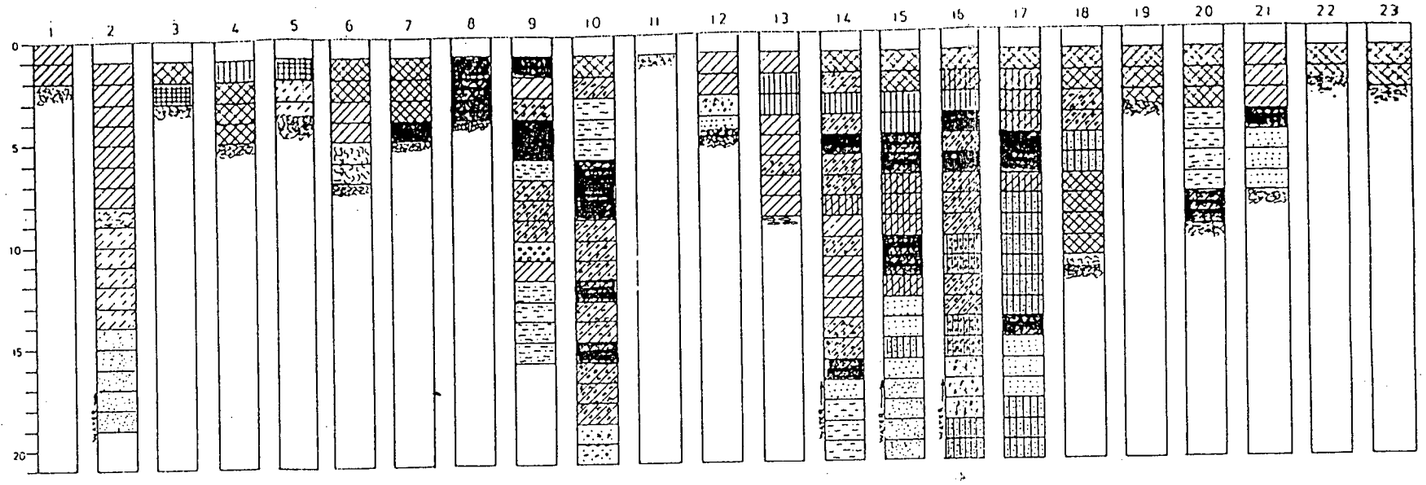
Experimentation has shown that heavy metals replace calcium, boron and manganese that are bound within the lattice of the clays. Of the common clays montmorillonite, kaolinite and illite, montmorillonite has the most attenuating capacity followed by illite and kaolinite which have about the same capacity. Ideally a mixture of these clay types should be present to give good attenuating potential as they have slightly different attenuating characteristics. For example kaolinite and illite have significantly better attenuating properties for silicon than montmorillonite.

Experimentation has shown that municipal leachates are moderately to highly attenuated by passage through relatively low percentages of clay minerals. This is partially due to soils with low clay content having higher hydraulic conductivities allowing the leachate to pass through the soil column and coming in contact with more clay minerals. It has been found that an 80cm thick layer containing 10% montmorillonite can adequately attenuate the majority of hazardous chemicals found in municipal leachates. No figures were found for thickness layers for kaolinite however it would need to be significantly thicker than 80cm due to its relatively small attenuating properties.

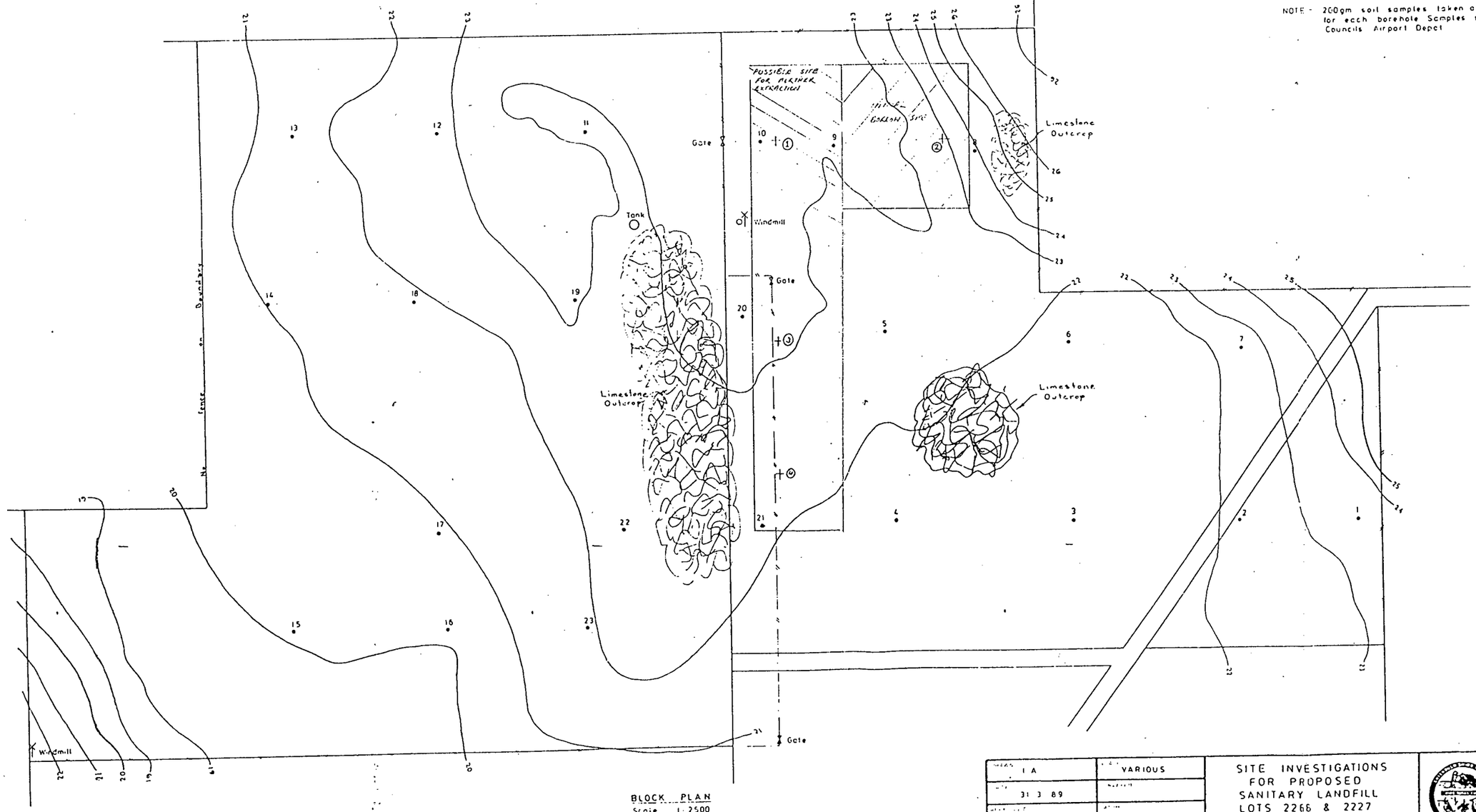
The soils at the Greenough landfill should have good attenuating properties for landfill leachates due to the presence of montmorillonite and kaolinite. Typically these soils have a 10% clay content which appears to be mostly kaolinite which has a comparatively low attenuating capacity. As a result a significant thickness of soil will need to be left between the bottom of the landfill and the water table for leachates to be properly attenuated.

SITE PLAN
Scale 1:10000





NOTE - 200gm soil samples taken at 1m intervals for each borehole Samples stored at Councils Airport Depot



BLOCK PLAN
Scale 1:2500

DRAWN: I A	DRAWING NO: VARIOUS	SITE INVESTIGATIONS FOR PROPOSED SANITARY LANDFILL LOTS 2266 & 2227 NARNGULU	SHIRE of GREENOUGH
DATE: 31 3 89	MAPPING NO:		
CHECKED:	JOB NO: 2315		DRAWING NO: 29 - 89 - 018

PROPOSED NARNGULU TIP SITE - SOIL INVESTIGATIONS

ANALYSIS OF SEDIMENTS IN THE PROPOSED SANITARY LANDFILL SHIRE OF GREENOUGH

Note: The clay content for each interval is approximated in the following manner. Where a sediment type is denoted as; 1) well sorted - it may contain 0-5% clay,
2) moderately sorted - it may contain 5-10% clay,
3) containing minor clay - it may contain 10-15% clay,
4) containing clay i.e. sand and clay - it may contain 15-20% clay.

X-ray powder diffractometry was used to determine the types of clay present in the following samples, report attached;

Hole 10 - 9m Interval (kaolinite)
Hole 14 - 14m Interval (kaolinite)
Hole 17 - 13m Interval (kaolinite)
Hole 18 - 8m Interval (kaolinite)
Hole 20 - 9m Interval (kaolinite, montmorillonite)

The percentage composition of the clay size fraction in each of these intervals was also calculated, report attached;

Hole 10 - 9m Interval (3.9%)
Hole 14 - 14m Interval (21.0%)
Hole 17 - 13m Interval (16.5%)
Hole 18 - 8m Interval (23.3%)
Hole 20 - 9m Interval (4.1%)

SEDIMENT LOGS

Hole 8

Interval	Sediment Type	Sorting
1-2m	Fine quartz sand	(well sorted)
3m	Fine quartz sand	(well sorted)
4m	Fine quartz sand	(well sorted)

Hole 9

Interval	Sediment Type	Sorting
1m	Fine-medium quartz sand	(moderately sorted)

2m	Fine-medium quartz sand	(moderately sorted)
3m	Medium-coarse quartz sand	(moderately sorted)
4m	Medium-coarse quartz sand	(moderately sorted)
5-6m	Medium-coarse quartz sand	(moderately sorted)
7m	Medium quartz sand	(well sorted)
8m	Medium quartz sand	(well sorted)
9m	Medium quartz sand	(well sorted)
10m	Quartz gravel	(moderately sorted)
11m	Medium quartz sand	(well sorted)

Hole 10

Interval	Sediment Type	Sorting
1m	Medium quartz sand	(well sorted)
2m	Gravelly quartz sand	(moderately sorted)
3m	Sandy quartz gravel	(moderately sorted)
4m	Coarse quartz sand	(poorly sorted)
5m	Coarse quartz sand	(poorly sorted)
6m	Fine-medium quartz sand	(moderately sorted)
7m	Fine quartz sand	(well sorted)
8m	Fine-medium quartz sand	(moderately sorted)
9m	Medium-coarse quartz sand	(moderately sorted)
10m	Medium-coarse quartz sand	(poorly sorted)
11m	Medium-coarse quartz sand	(poorly sorted)
12m	Fine-medium quartz sand	(well sorted)
13-14m	Medium-coarse quartz sand	(moderately sorted)
15m	Medium quartz sand	(well sorted)
16m	Fine-medium quartz sand	(moderately sorted)

Hole 12

Interval	Sediment Type	Sorting
1-2m	Fine-medium quartz sand	(well sorted)
3m	Gravelly quartz sand	(poorly sorted)
4m	Fine-medium quartz sand	(moderately sorted)

Hole 14

Interval	Sediment Type	Sorting
1m	Silty fine quartz sand	(well sorted)
2m	Silty fine quartz sand and clay	(moderately sorted)
3m	Silty fine quartz sand and clay	(moderately sorted)
4m	Medium quartz sand (minor clay)	(moderately sorted)
5m	Fine-medium quartz sand	(moderately sorted)
6m	Silty fine quartz sand (minor clay)	(moderately sorted)
7m	Silty fine quartz sand (minor clay)	(moderately sorted)
8m	Silty fine quartz sand (minor clay)	(moderately sorted)
9m	Silty fine quartz sand	(well sorted)
10m	Silty fine quartz sand	(well sorted)
11m	Medium quartz sand	(well sorted)
12m	Medium quartz sand	(well sorted)
13m	Fine-medium quartz sand and clay	(moderately sorted)
14m	Fine-medium quartz sand and clay	(moderately sorted)
15m	Medium quartz sand	(well sorted)
16m	Medium quartz sand	(well sorted)

Hole 17

Interval	Sediment Type	Sorting
1m	Silty fine quartz sand	(well sorted)
2m	Silty fine quartz sand and clay	(moderately sorted)
3m	Silty fine quartz sand and clay	(moderately sorted)
4m	Silty fine quartz sand and clay	(moderately sorted)
5m	Fine-medium quartz sand	(moderately sorted)
6m	Fine-medium quartz sand	(moderately sorted)
7m	Silty fine quartz sand and clay	(moderately sorted)
8m	Silty fine quartz sand and clay	(moderately sorted)
9m	Silty fine quartz sand and clay	(moderately sorted)
10m	Quartz silt and clay	(well sorted)
11m	Silty fine quartz sand and clay	(moderately sorted)
12m	Silty fine quartz sand and clay	(moderately sorted)
13m	Silty fine quartz sand and clay	(moderately sorted)
14m	Fine-medium quartz sand	(moderately sorted)

15m	Coarse quartz sand	(moderately sorted)
16-17m	Medium-coarse quartz sand	(moderately sorted)

Hole 18

Interval	Sediment Type	Sorting
1m	Silty fine quartz sand	(moderately sorted)
2m	Silty fine-coarse quartz sand	(poorly sorted)
3m	Coarse quartz sand	(poorly sorted)
4m	Silty fine-coarse quartz sand	(poorly sorted)
5m	Fine-medium quartz sand (minor clay)	(poorly sorted)
6m	Fine-medium quartz sand (minor clay)	(moderately sorted)
7m	Fine-medium quartz sand (minor clay)	(moderately sorted)
8m	Fine-medium quartz sand and clay	(moderately sorted)
9m	Silty fine quartz sand	(well sorted)
10m	Fine quartz sand	(well sorted)
11m	Fine-coarse quartz sand	(poorly sorted)

Hole 19

Interval	Sediment Type	Sorting
1m	Medium quartz sand	(well sorted)
2m	Fine quartz sand	(well sorted)
3m	Fine-medium quartz sand	(moderately sorted)
3.5m	Fine-medium quartz sand	(moderately sorted)

Hole 20

Interval	Sediment Type	Sorting
1m	Fine-medium quartz sand	(moderately sorted)
2-3m	Fine-medium quartz sand	(moderately sorted)
4m	Medium-coarse quartz sand	(poorly sorted)
5m	Coarse quartz sand	(poorly sorted)
6m	Coarse quartz sand	(poorly sorted)
7m	Medium-coarse quartz sand	(poorly sorted)
8m	Medium-coarse quartz sand	(moderately sorted)
9m	Medium-coarse quartz sand	(well sorted)

Hole 21

Interval	Sediment Type	Sorting
1m	Fine-medium quartz sand	(well sorted)
2m	Fine-medium quartz sand	(well sorted)
3m	Fine-medium quartz sand	(moderately sorted)
4m	Fine-medium quartz sand	(moderately sorted)
5m	Silty fine quartz sand	(well sorted)
6m	Fine quartz sand	(well sorted)
7m	Fine quartz sand	(well sorted)

DATE: 20th April, 1990
REFERENCE No.: XRD 90210

REPORT ON: X-RAY DIFFRACTION ANALYSIS

FOR: Maunsell &Partners Pty. Ltd.
220 St. George's Terrace
Perth, W.A. 6000

PREPARED BY:

W.J. Chang, B.Sc.,Ph.D.,Dip. Mtlgy.
Department of Geology
The University of Western Australia

REQUEST

Five soil samples designated Hole #10-9M, Hole #14-14M, Hole #17-13M, Hole #18-8M and Hole #20-9M were submitted for qualitative X-ray diffraction (XRD) analysis with special reference to clay minerals.

SAMPLE PREPARATION

All samples were dispersed in water with ultrasonic agitator for 5 minutes. The clay fraction of each sample was then collected. Preferred orientation samples were prepared by drying clay fraction of each sample onto cermic sample holders.

X-RAY DIFFRACTOMETRY

X-ray powder diffraction patterns were recorded at room temperature using a Philips PW1700 automatic diffractometer. X-rays generated from a copper X-ray tube operated at 45kV and 40mA were diffracted by a graphite monochromator for the production of monochromatic radiation. Both pulse-height discriminator and automatic diverging slits were used. The specimen was scanned at 1^{o} per minute for 2θ range from 2^{o} to 45^{o}.

The positions and intensities of the diffraction lines were calculated using an on-line computer. Diffraction results were searched through 4,000 reference patterns of minerals which are stored in the memory of the computer.

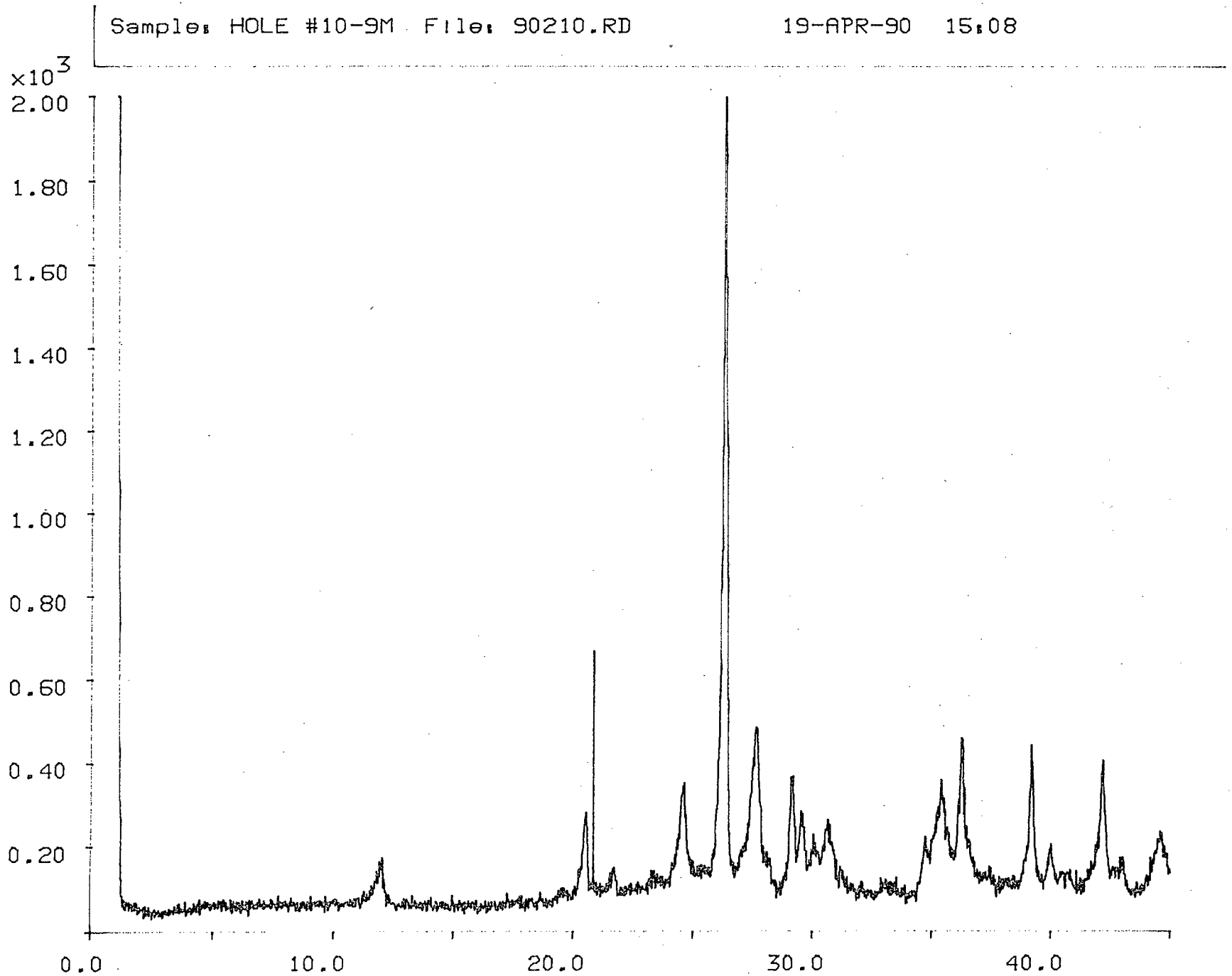
RESULTS AND INTERPRETATION

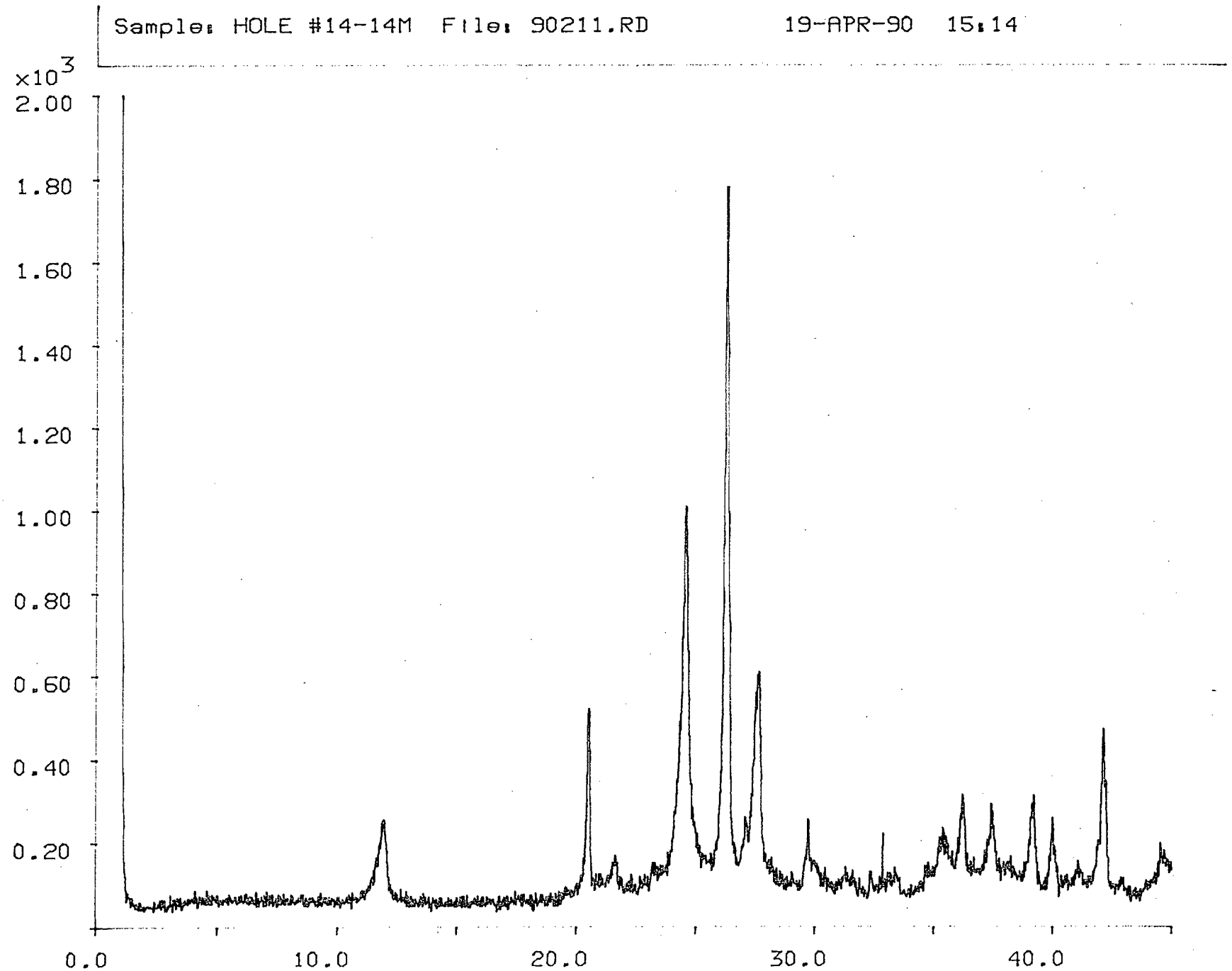
Results from XRD automatic computer Search/Match process are shown in attached graphs. Table 1 summarizes these findings as well as the amount of clay in each sample.

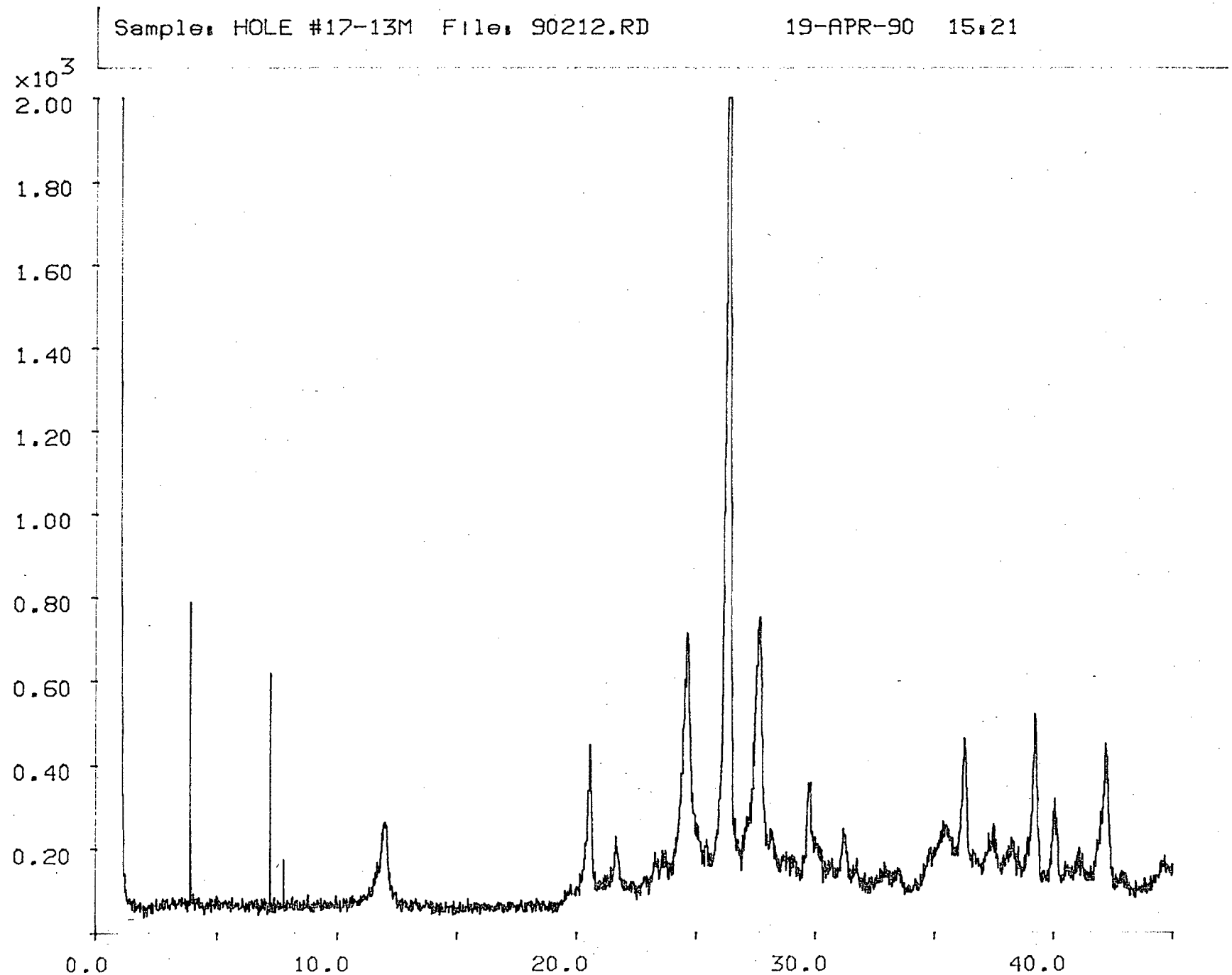
Table 1. Amount of clay and crystalline phases in the clay fraction of analysed samples.

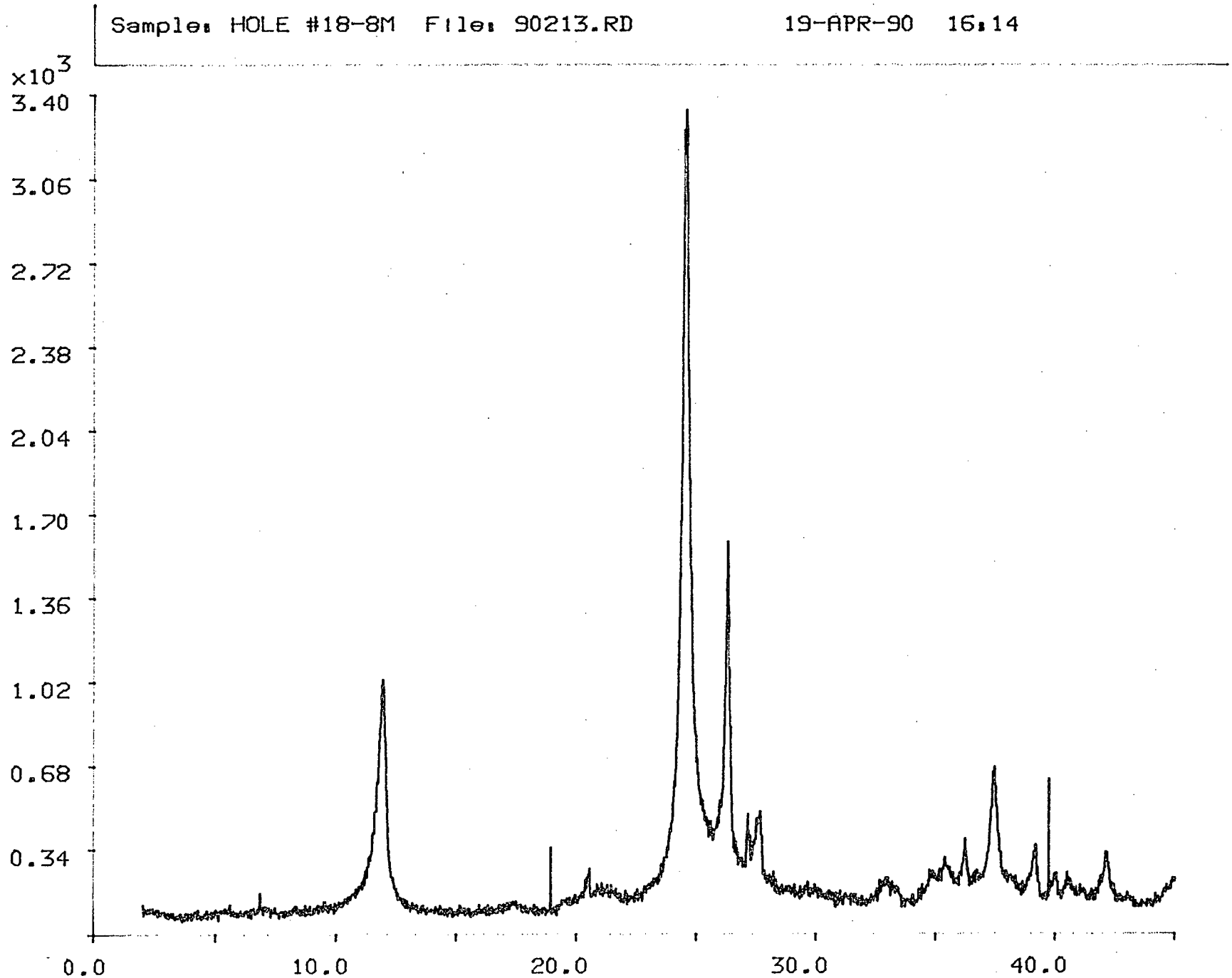
Sample	Clay (wt.%)	Remarks
Hole #10-9M	3.9	Mainly quartz and kaolinite, with small amounts of albite
Hole #14-14M	21.0	Mainly quartz and kaolinite, with small amounts of albite
Hole #17-13M	16.5	Mainly quartz and kaolinite, with small amounts of albite.
Hole #18-8M	23.3	Mainly kaolinite, with small amounts of quartz and albite
Hole #20-9M	4.1	Mainly quartz, kaolinite and montmorillonite, with small amounts of albite, biotite and hematite.

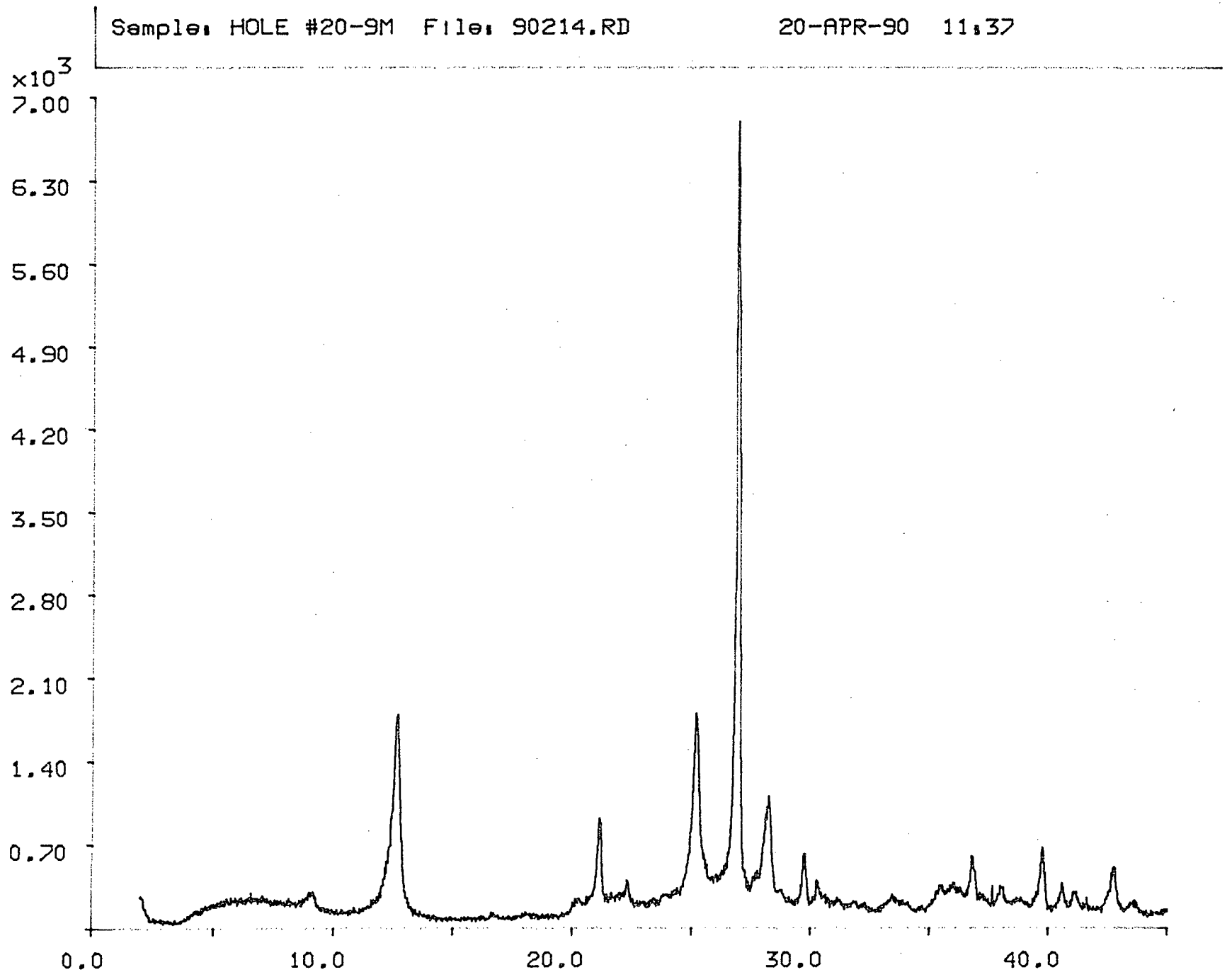
Wei-Jui Chang

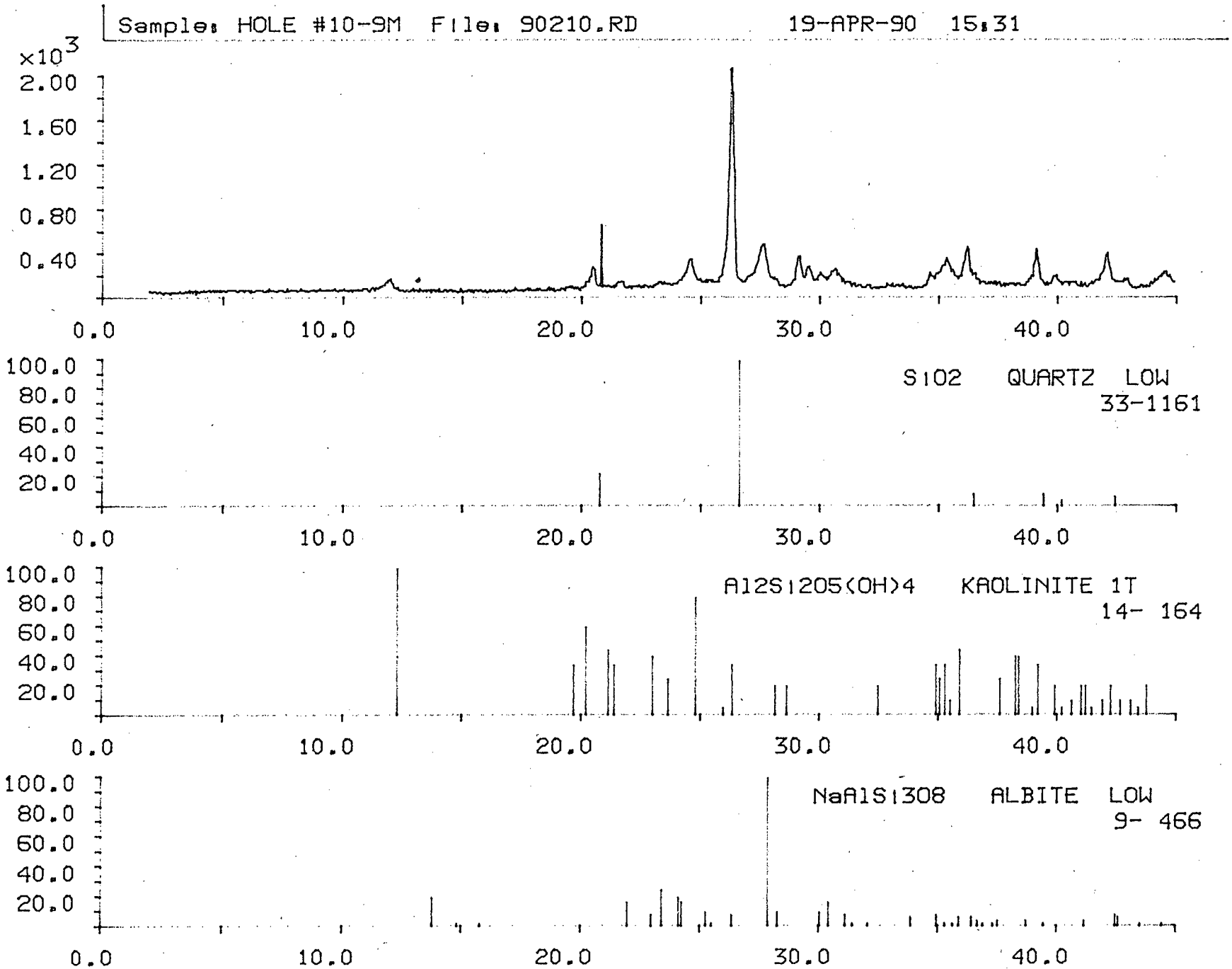

Sample: HOLE #10-9M File: 90210.RD 19-APR-90 15:08
x10^3
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.0
10.0
20.0
30.0
40.0

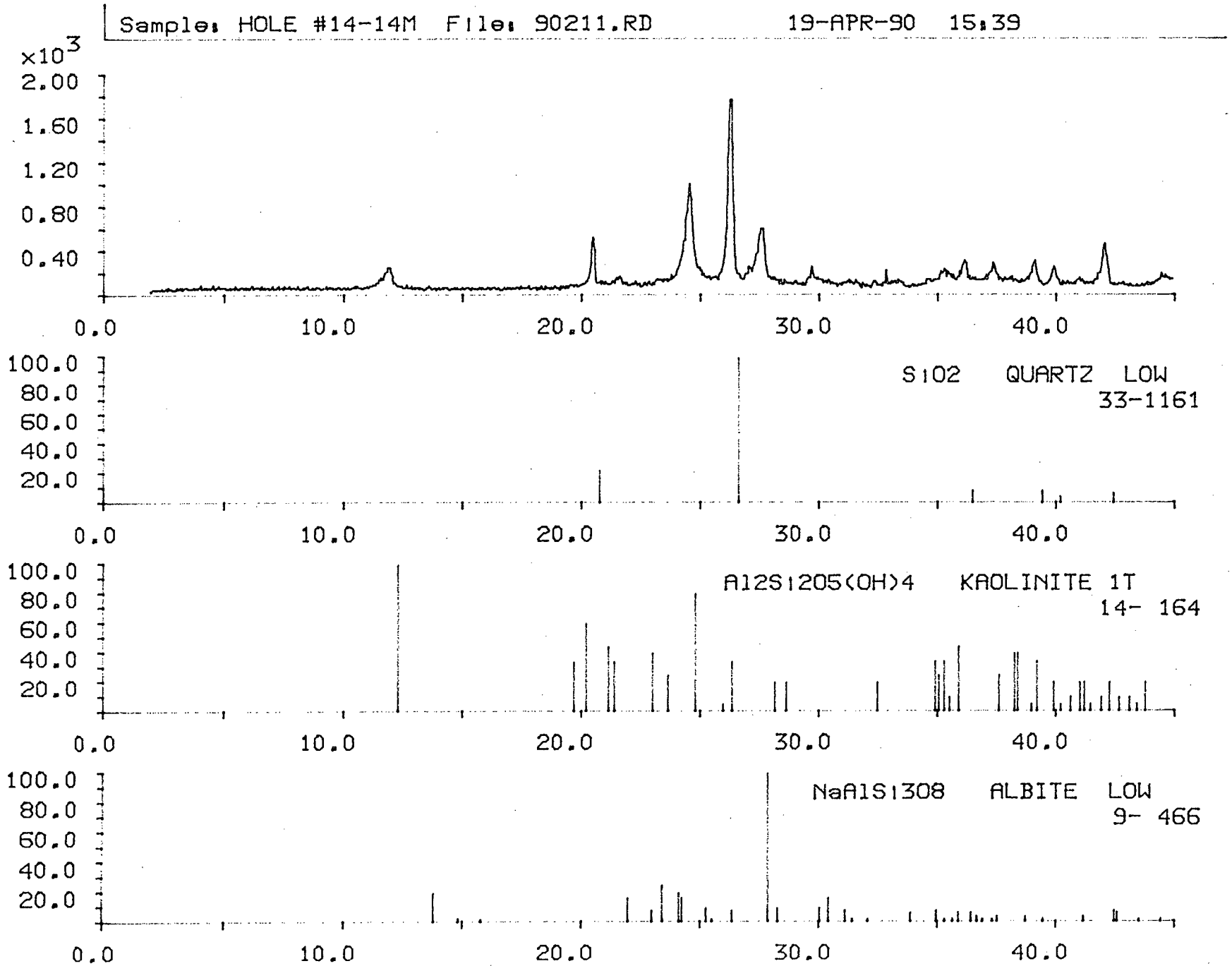

Sample: HOLE #14-14M File: 90211.RD 19-APR-90 15:14
x10^3
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.0
10.0
20.0
30.0
40.0

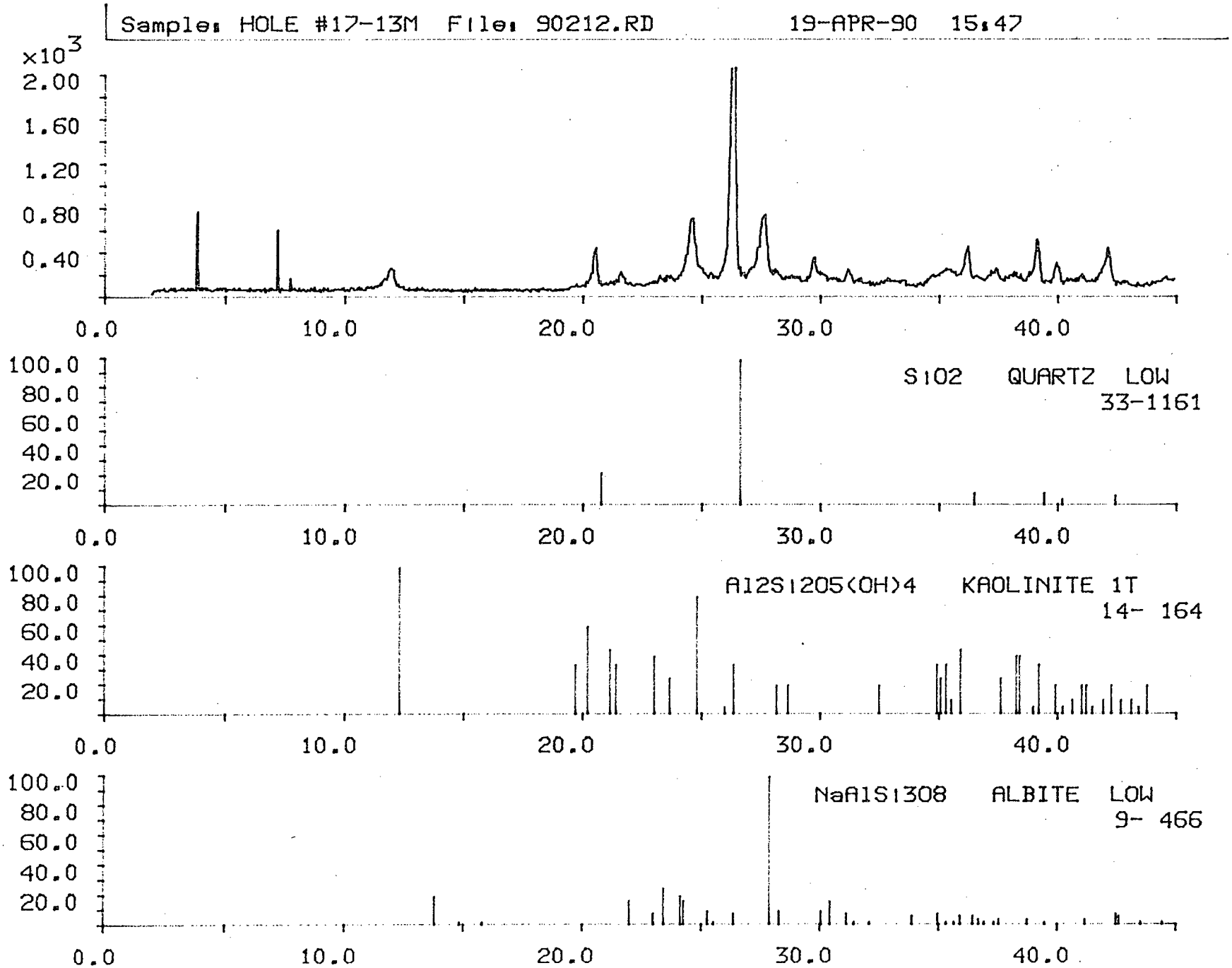

Sample: HOLE #17-13M File: 90212.RD 19-APR-90 15:21
x10^3
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.0
10.0
20.0
30.0
40.0


Sample: HOLE #18-8M File: 90213.RD 19-APR-90 16:14
x10^3
3.40
3.06
2.72
2.38
2.04
1.70
1.36
1.02
0.68
0.34
0.0
10.0
20.0
30.0
40.0


Sample: HOLE #20-9M File: 90214.RD 20-APR-90 11:37
x10^3
7.00
6.30
5.60
4.90
4.20
3.50
2.80
2.10
1.40
0.70
0.0
10.0
20.0
30.0
40.0


Sample: HOLE #10-9M File: 90210.RD 19-APR-90 15:31
x10^3
2.00
1.60
1.20
0.80
0.40
0.0
10.0
20.0
30.0
40.0
100.0
80.0
60.0
40.0
20.0
SiO2 QUARTZ LOW
33-1161
Al2Si2O5(OH)4 KAOLINITE 1T
14- 164
NaAlSi3O8 ALBITE LOW
9- 466


Sample: HOLE #14-14M File: 90211.RD 19-APR-90 15:39
x10^3
2.00
1.60
1.20
0.80
0.40
0.0
10.0
20.0
30.0
40.0
100.0
80.0
60.0
40.0
20.0
SiO2 QUARTZ LOW
33-1161
Al2Si2O5(OH)4 KAOLINITE 1T
14- 164
NaAlSi3O8 ALBITE LOW
9- 466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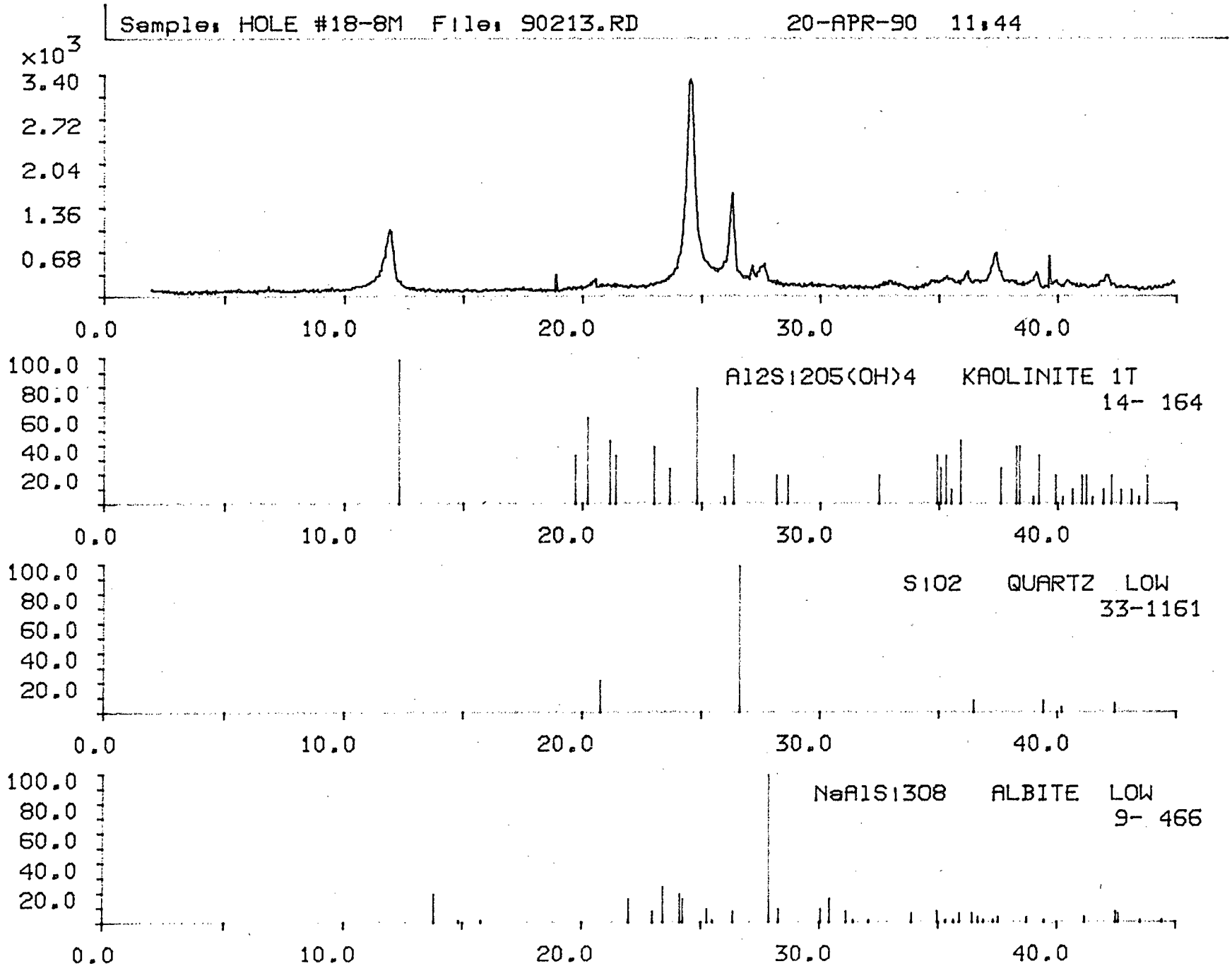
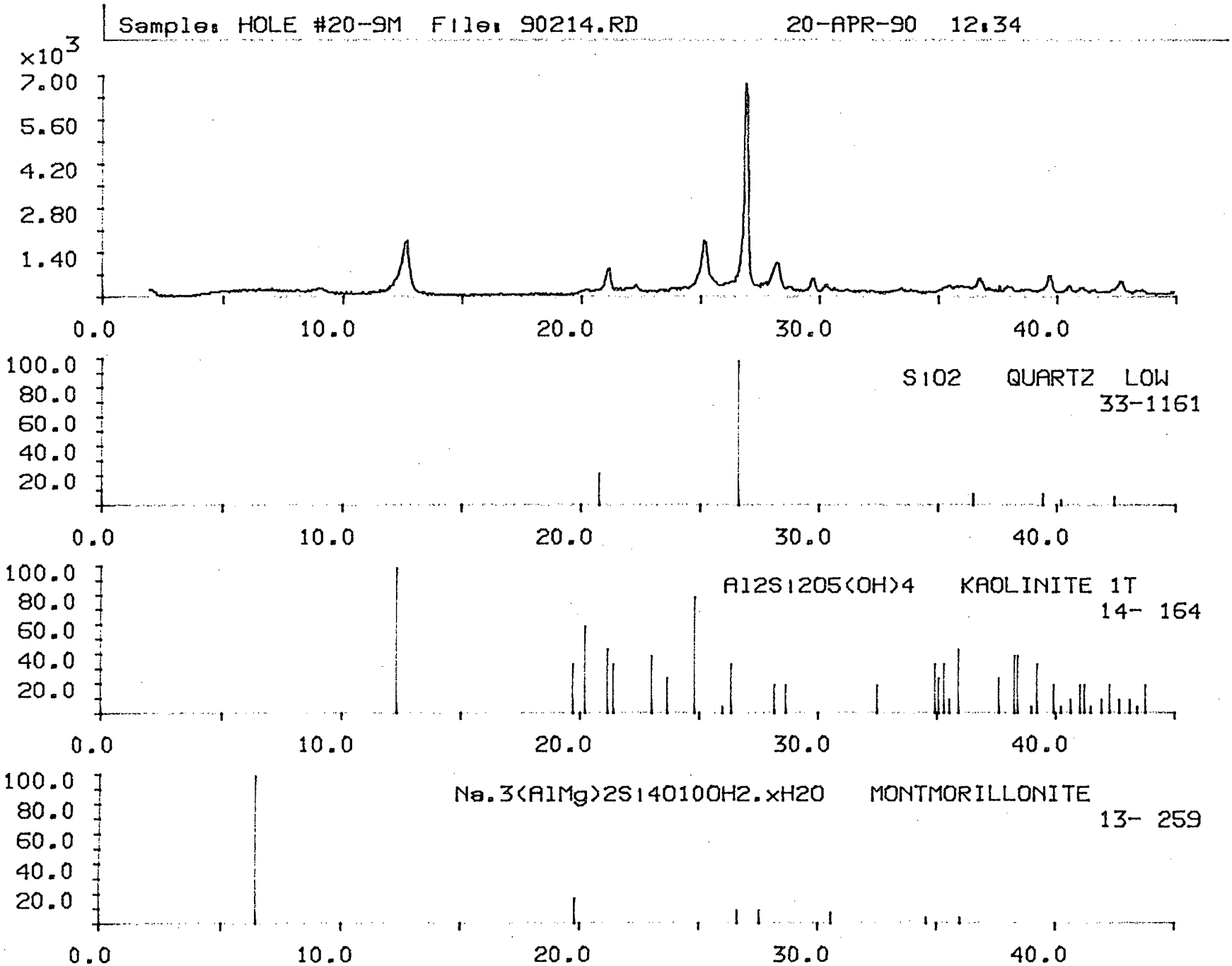
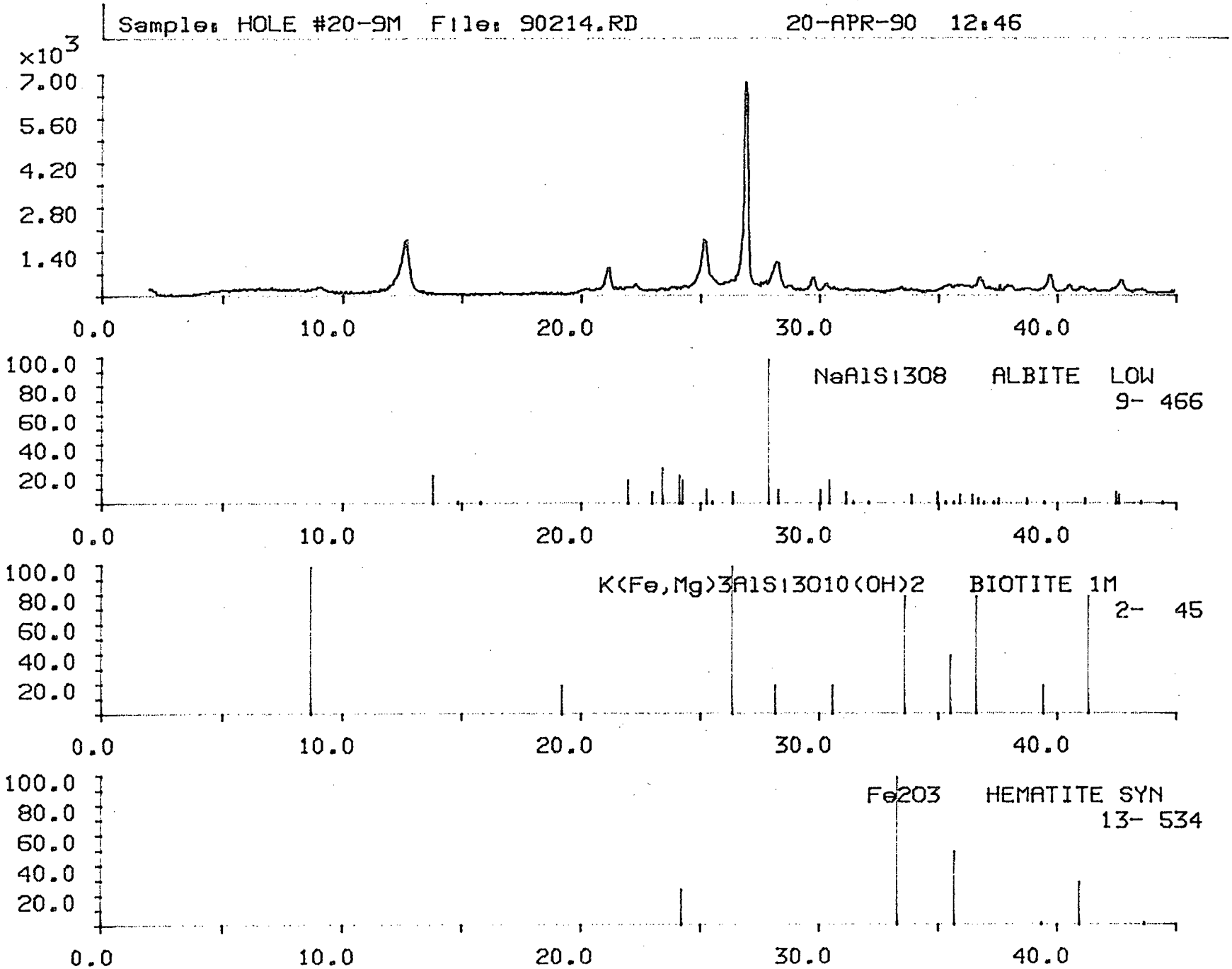
x10^3
2.00
1.60
1.20
0.80
0.40
0.0
10.0
20.0
30.0
40.0
100.0
80.0
60.0
40.0
20.0
SiO2 QUARTZ LOW
33-1161
Al2Si2O5(OH)4 KAOLINITE 1T
14- 164
NaAlSi3O8 ALBITE LOW
9- 466


Sample: HOLE #18-8M File: 90213.RD 20-APR-90 11:44
x10^3
3.40
2.72
2.04
1.36
0.68
0.0
10.0
20.0
30.0
40.0
100.0
80.0
60.0
40.0
20.0
Al2Si2O5(OH)4 KAOLINITE 1T
14- 164
SiO2 QUARTZ LOW
33-1161
NaAlSi3O8 ALBITE LOW
9- 466


Sample: HOLE #20-9M File: 90214.RD 20-APR-90 12:34
x10^3
7.00
5.60
4.20
2.80
1.40
0.0
10.0
20.0
30.0
40.0
100.0
80.0
60.0
40.0
20.0
SiO2 QUARTZ LOW
33-1161
Al2Si2O5(OH)4 KAOLINITE 1T
14- 164
Na.3(AlMg)2Si4O10OH2.xH2O MONTMORILLONITE
13- 259


Sample: HOLE #20-9M File: 90214.RD 20-APR-90 12:46
x10^3
7.00
5.60
4.20
2.80
1.40
0.0
10.0
20.0
30.0
40.0
100.0
80.0
60.0
40.0
20.0
NaAlSi3O8 ALBITE LOW
9- 466
K(Fe,Mg)3AlSi3O10(OH)2 BIOTITE 1M
2- 45
Fe2O3 HEMATITE SYN
13- 534

APPENDIX 3

CER GUIDELINES

GUIDELINES FOR THE NOTICE OF INTENT ON THE PROPOSED WASTE DISPOSAL SITE AT NARNGULU

1. CONTENTS

These guidelines identify the issues that should be addressed in the Notice of Intent (NOI) for the abovementioned proposal. The issues outlined below are not intended to be exhaustive and additional issues can be included.

The NOI contents should be concise, accurate and should be written in such a way as to be understood by the general public. Ancillary or lengthy information may be included in technical appendices. The document should include any specific information requested by government departments.

All applications seeking approval to establish a waste disposal facility shall be accompanied by a detailed management plan, developed in accordance with these guidelines. The purpose of such a document is to allow all relevant authorities and selected members of the public, to evaluate the proposed waste disposal facility.

2. SUMMARY

The NOI should contain a brief summary of:

- salient features of the proposal
- reasons for the proposal.
- investigations undertaken and proposed.
- alternatives considered.
- description of receiving environment.
- analysis of potential impacts and their significance.
- environmental monitoring, management, safeguards and commitments.
- conclusions.

3. INTRODUCTION

3.1 The Proponent

- name, address, telephone number etc.

4.2 Need for and Timing of the Proposal.

- reasons for the proposal.
- constraints on current methods of disposal and reasons why not selected.
- objectives of proposal.
- timing of proposal.

3.3 Relevant statutory requirements and approval procedure.

3.4 Purpose and structure of NOI.

4. ALTERNATIVES

The rationale for choosing the options should be clear. A comparison of these alternatives in the context of the stated objectives of the proposal should be included as well as respective costs and benefits.

4.1 Description of alternative disposal methods considered and reasons why not adopted.

4.2 Description of alternative sites considered and reasons why not selected.

5. DESCRIPTION OF THE PROPOSAL

5.1 Proposed Site.

5.1.1 Ownership

. copy of vesting order or title.

5.1.2 Location

. distance from nearest town boundary

.. distance from nearest residential dwellings

5.1.3 Zoning

. site zoning or designation

. present and future zoning of adjacent areas.

5.2 Proposed Method of Operation.

5.2.1 Site Development

. preparatory earthworks removal and excavation

. site access and control

. internal roads construction and maintenance

. site security fencing

. vehicle washdown facilities.

5.2.2 Planning

. estimated lifetime of facility

. estimated volume of waste

. estimated space available.

5.2.3 Operation

. method of operation

- compaction
- cover material
- recycling.
- design of lagoons
- design of pit

. control measures for

- surface water run off
- leachate
- dust
- pests
- fire
- gas and odour
- screening.

5.2.4 Waste Streams

- definite
- potential (ie future)

. types of waste
. quantity of wastes.

Hazardous waste should be regarded as a separate issue. Each specific type of hazardous waste should be addressed separately or the site should be designated as unsuitable for the disposal of hazardous wastes.

5.2.5 Types of Waste Excluded

. solid

. liquid

. instruction for disposal of excluded wastes.

5.2.6 Traffic Movement

. access route(s)

. present traffic flow

. anticipated future traffic flow.

5.2.7 Final Restoration

. final contours

. proposed after use.

6. EXISTING ENVIRONMENT

The NOI should provide an overall description of the environment and an appraisal of physical and ecological systems likely to be affected by the proposal. It should concentrate on the significant aspects of the environment likely to be impacted by the development. (i.e. in particular the processes sustaining the system). Conceptual models or diagrams should be used to illustrate and synthesize the interaction between physical and biological processes that are essential in the maintenance of habitats and resources.

6.1 Summary of Description of the Environment Likely to be Affected.

6.1.1 Description of factors which are likely to be affected by or have an impact on the proposal (i.e. ground water resources, water courses, vegetation, landform, reserves, EPA Red Book Areas, fauna, aesthetics, dominant wind direction, proximity to housing historical, archaeological and ethnographic sites, etc).

6.1.2 Description of specific components of proposal which will have an effect on the environment (eg access, disposal methods, changed land use, fire control, litter control). Describe how these components might affect the environment.

7. ENVIRONMENTAL IMPACT OF THE PROJECT

This is the most important section of the NOI and the discussion should show the overall effect of the proposal on the ecosystem and surroundings during implementation of the project, utilisation of the facility for waste disposal, and during and after rehabilitation.

The objective is to predict potential impacts on the environment. The resilience of the systems identified in the existing environment, to natural and man induced pressures, should be assessed. Impacts should be quantified where possible. Criteria for making assessments of the significance of impacts should be outlined. Compliance with relevant standards should be demonstrated. It will be necessary to determine impacts on individual components of the environment before an overall assessment of the potential impact of the proposal is made. The impacts of each waste stream should be discussed separately.

7.1 Description of how specific environmental components will be affected by the proposal (eg geological considerations: dune systems, topography).

7.2 How specific components of the proposal which will have an effect on the environment (eg positioning of waste, increased access to the area).

7.3 Assessment of unavoidable deleterious effects on the environment (eg vegetation changes, physiographic changes, etc).

7.4 Comment on whether the proposal is consistent with conservation values indicated in EPA Red Book.

7.5 Hydrological considerations

- distance between groundwater and waste
- maximum groundwater levels
- groundwater movement direction and pattern
- location of any groundwater withdrawal areas
- proposed monitoring bores
- estimate of quantity and quality (chemical constituents and concentration) of leachate entering groundwater
- collected leachate disposal methods.

7.5.1 Likely effects of the project on groundwater resources, water courses and drainage systems.

7.5.2 Proposed sampling programme.

7.6 Summary of environmental components for which environmental impact can be minimised by management.

8. **WASTE DISPOSAL MANAGEMENT**

8.1 General waste disposal management philosophy. Include separate discussion of management for each waste stream.

8.1.1 General philosophy.

8.1.2 Statutory procedures under which the project will be undertaken.

8.1.3 Liaison with other Local Authorities and private industry regarding the use and management of the facility.

8.2 Specific Objectives

8.2.1 Compliance with State Government notification, advice, guidelines, proposals and/or strategies.

8.2.2 Other specific objectives

8.3 Community Involvement.

8.3.1 Community acceptance of the proposal.

8.3.2 Community involvement (eg liaison committees).

8.4 Recycling Activities.

8.4.1 Recycling projects included (eg separation at source).

8.4.2 Recycling projects considered. Reasons why not included.

8.5 Feasability of Methane recovery and electricity generation systems.

9. ENVIRONMENTAL MANAGEMENT AND MONITORING

The purpose of the management and monitoring programme is to demonstrate amelioration of environmental impacts. Authorities responsible for management, administration, costs and funding including long-term contingencies should be clearly identified. Monitoring results should lead to amendments in the management plan and the manner in which this takes place should be emphasised. Environmental safeguards including contingency planning for untoward and/or infrequent events should be included. Procedures for reporting the results of monitoring and management to appropriate authorities should be given.

9.1 Specific proposals for managing the project to minimise impact on the environment. eg. rehabilitation and end use, stabilisation of waste disposal area, odour control, litter control, prevention of pollution, capping or lining of site etc. Ongoing management responsibility following closure of site. Management for each waste stream should be discussed.

9.2 Proposals for Monitoring.

9.2.1 Proposed monitoring during use of the site (eg, bores for monitoring water pollution, complaints record etc).

9.2.2 Ongoing monitoring proposals after closure of site to ensure long-term prevention of water pollution and other environmental pollution.

10. PROPOSED TIMETABLE

10.1 Schedule timing for proposal.

10.2 Need for such timing.

11. COMMITMENTS

It is important that specific commitments are given to all components and procedures of the management and monitoring programme. These should be listed.

12. CONCLUSION

An assessment of the environmental acceptability of the project in terms of its overall environmental impact and in the context of the proposed management programme should be given.

13. REFERENCES

14. GLOSSARY (Definitions of Technical Terms, Abbreviations)

15. NOI GUIDELINES

16. APPENDICES

16.1 Vesting order or title.

16.2 Present and future zoning.

16.3 Operation parameters, current and future contours etc.