MINES FILE 4156/93
WATER AUTHORITY REQUEST 1995/26

Hydrogeology Report 1995/26

# ABORIGINAL COMMUNITIES DRILLING PROPOSAL - EAST KIMBERLEY

by

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Western Australia
Geological Survey
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# ABORIGINAL COMMUNITIES DRILLING PROPOSAL - EAST KIMBERLEY

## INTRODUCTION

In April 1995 the Water Authority of Western Australia requested that the Geological Survey of Western Australia assess potential groundwater supplies in the vicinity of 11 Aboriginal communities in the East Kimberley prior to drilling in July-August 1995 (Figure 1). An inspection by helicopter was carried out of the Aboriginal communities by A. Kern (GSWA), M. Bonacchi (WAWA, Perth) and N. Cull (WAWA, Kununurra) between 30 May and 2 June 1995 to facilitate a drilling is scheduled to start in early July 1995.

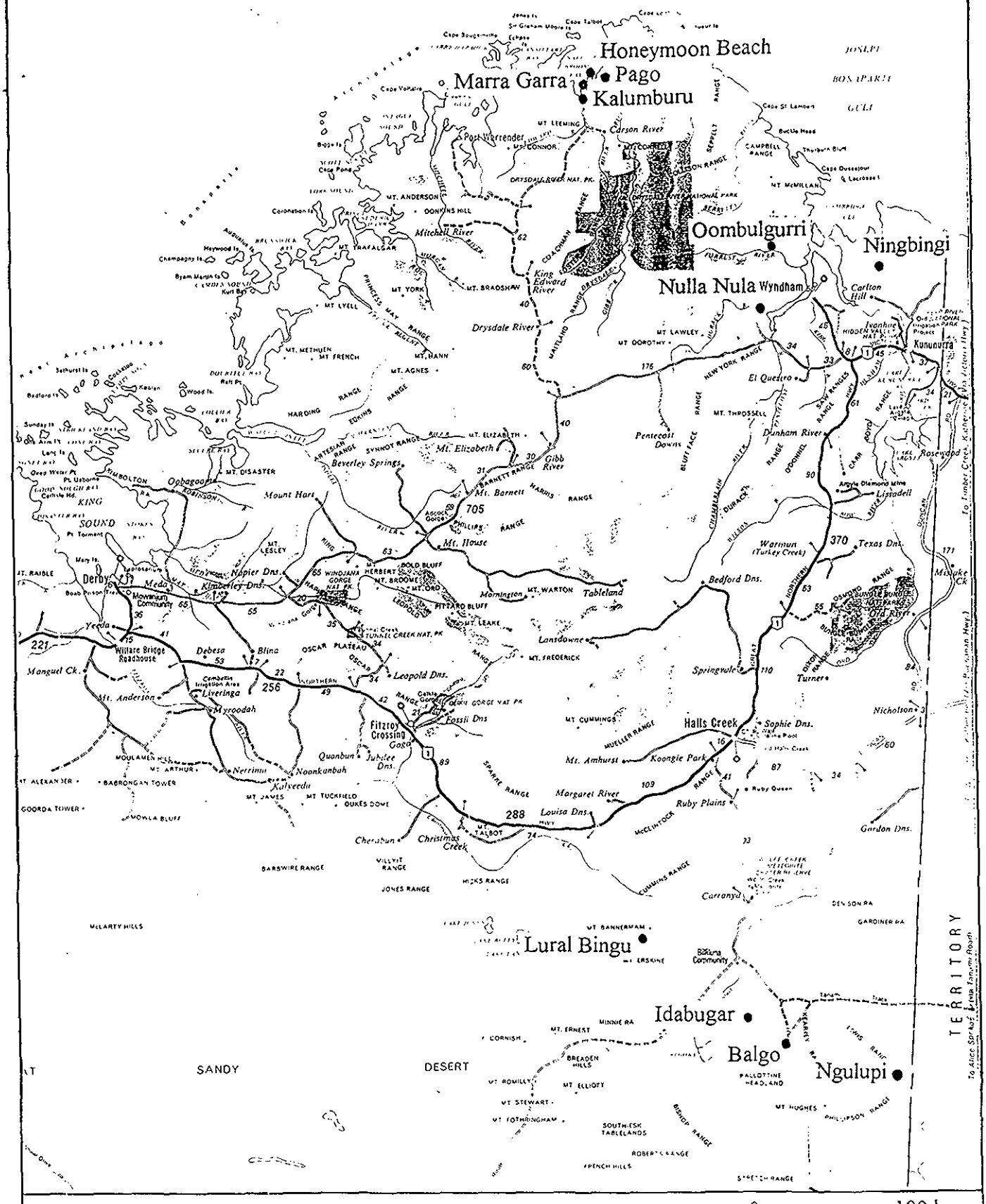
## SETTING

The proposed Aboriginal communities are located in main areas in the East Kimberley (Figure 1). Three communities, Ningbingi, Oombulgurri and Nulla Nula, are situated in the Cambridge Gulf area. Four communities are located in the high rainfall area of the Napier Broome Bay and they are the Pago, Honeymoon Beach, Marra Garra and Kalumburu communities. The remaining Lural Bingu, Idabugar, Ngulupi and Balgo communities are in the arid, southern part, of the East Kimberley.

The physiography, geology and hydrogeology of most proposed Aboriginal communities are extensively outlined in numerous Hydrogeology Reports (Laws, 1987, Martin, 1991 and 1992, Thorpe 1993 and 1994). Consequently this report focuses on the findings of the recent field visit.

## GROUNDWATER PROSPECTS

Up to 6 sites were pegged at each of the proposed communities during the field visit and a pegged site is indicated by a letter and numeric for the year it was pegged (eg. A/95). In order to distinguish the groundwater prospects at each site for different Aboriginal communities a ranking based on hydrogeological factors and a supply greater than 50 $m^3/d$ with a salinity less than 1500 mg/L Total Dissolved Solids (TDS) is used. This ranking is comparable between communities. The ranking of the prospects is subjective and range from good (1) through uncertain or unknown (2-4) to poor (5). If the prospects at particular sites are very similar, a decimal numeric may describe sites with slightly better prospects. The ranking of groundwater prospects does not include factors such as access, distance to community and perhaps cultural constraints, and is intended to be a guide for determining the final drilling sequence.




## GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

| | INITIAL | DATE |
|---|---|---|
| COMP | AMK | 6/95 |
| DRAWN | AMK | 6/95 |
| APVD | | |

**FIGURE 1.**

**LOCATION**

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## NINGBINGI ABORIGINAL COMMUNITY

### CURRENT WATER SUPPLY

Ningbingi is about 60 km north of Kununurra and the original water supply was obtained from Homestead Bore (Figures 1 and 2, Table 1). Exploratory drilling was carried out in 1990 and three bores were drilled but bores 1/90 and 2/90 intersected mainly shale and were abandoned due to poor supplies. Drilling west of the community intersected limestone and bore 3/90 was constructed as a production bore and equipped with a windmill and an elevated watertank. Bore 3/90 was test pumped at 150 $m^3/d$, however the maximum recommended pump rate is 70 $m^3/d$. Groundwater at bore 3/90 is fairly silty with a turbidity of 36 NTU, which is well in excess of the National Health and Medical Research Council (NH&MRC) guidelines (5 NTU). An additional supply of 40 $m^3/d$ or more is required from a standby bore and perhaps an additional production bore.

### TABLE 1. BORE DATA - NINGBINGI

| Bore | Depth (m) | Supply ($m^3/d$) | SWL (m bns) | Salinity (mg/L TDS) | Status |
|---|---|---|---|---|---|
| Homestead Bore | 12.9 | 327 | NA | 290 | ?Aband. |
| 1/90 | 72.0 | 10 | 16.1 | 560 | Aband. |
| 2/90 | 54.6 | 36 | 5.0 | 1800 | Aband. |
| 3/90 | 66.0 | 150 | 6.4 | 300-400 | production |

### REDEVELOPMENT OF EXISTING PRODUCTION BORE

The high turbidity in bore 3/90 is most likely due to poor development at bore completion and absence of gravel pack around the bore casing. The water was still silty during the 14 hour pump-test in 1990. Prior to any additional exploratory drilling bore 3/90 should be redeveloped and, if turbidity remains high, the annulus around the bore casing should be gravel packed. Bore 3/90 should also be tested for 8 hours after the redevelopment.

### PROPOSED EXPLORATORY DRILLING SITES

Four sites in two areas were pegged during the field visit (Figure 2) and numbered A/95 - D/95. Site A/93 (Thorpe, 1993) was repegged as A/95. The remaining sites are in new areas. Site B/93 (Thorpe, 1993) was not visited during the inspection, however it is still a potential site for exploratory drilling. All sites were pegged along photolineaments. Drilling targets are fractured sandstone and limestone of the Lower Carboniferous Burvill Beds and the underlying limestone of the Upper Devonian Ningbing Limestone. The anticipated drilling depth, strata and prospects are summarized in Table 2. There is good access to the community from Kununurra and the proposed sites require minor site preparation.

## GROUNDWATER QUALITY

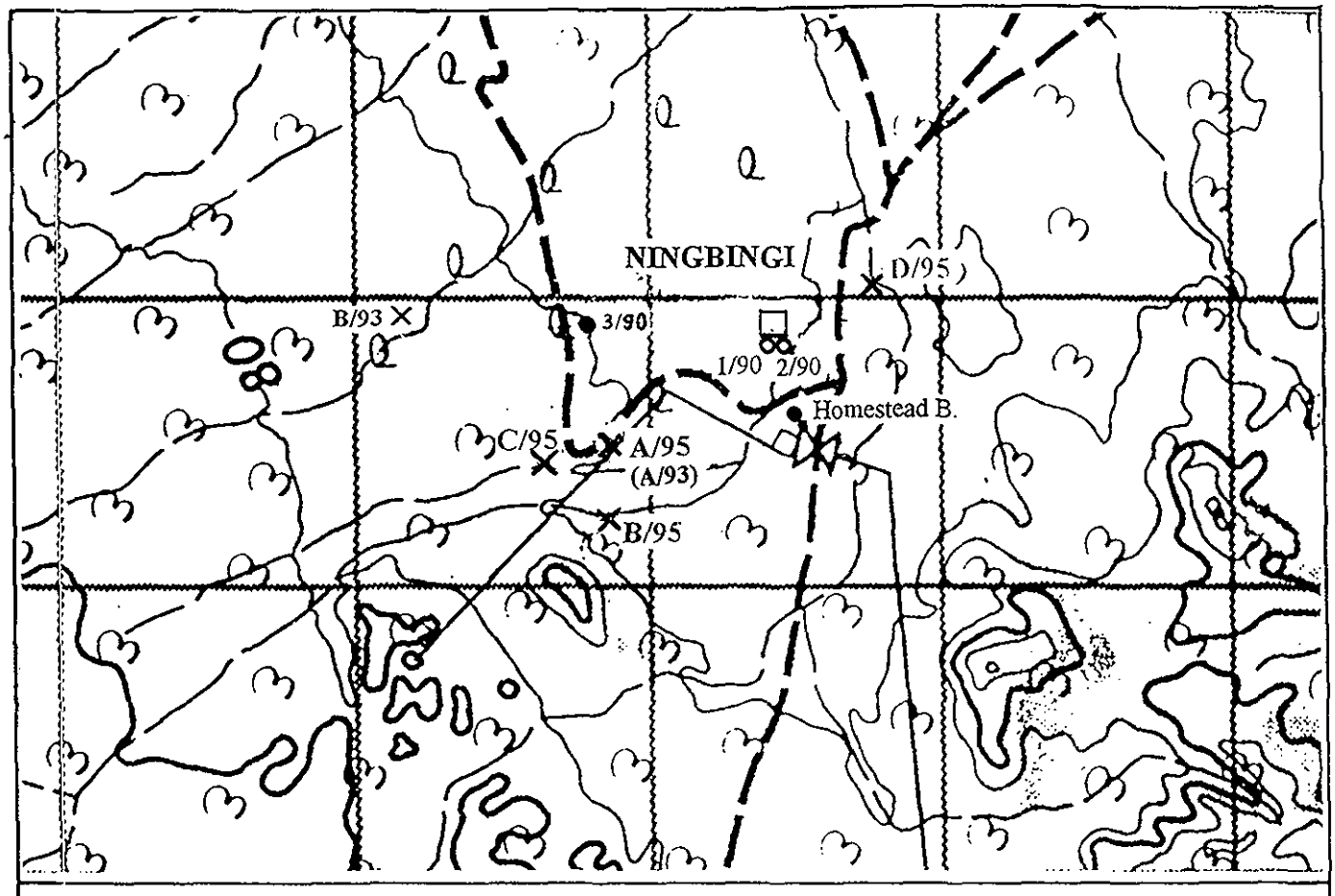
Previous drilling has indicated that groundwater is fresh in the area with a Total Dissolved Solid (TDS) content of less than 500 mg/L.

## DRILLING REQUIREMENTS

All sites should be drilled to a depth of at least 50 m, and drilling should continue to a maximum depth of about 70 m if open fractures are still intersected and supplies increase. Drilling should stop if the groundwater salinity increases with depth and exceeds 1500 mg/L TDS. Shale and cavernous limestone may present drilling problems and temporary casing may be required.

**TABLE 2. PROPOSED DRILLING SITES - NINGBINGI**

| Site | Coordinates (AMG) | Air-photo series, run, No | Est. drilling depth (m) | Est. depth to watertable (m bns) | Strata | Prospects |
|---|---|---|---|---|---|---|
| **B/93** | 464153 E 8314940 N | WA 2895, 4, 5049-50 | 70 | 5-10 | Fractured limestone and minor shale | 2.2 |
| **A/95** | 464869 E 8314508 N | WA 2743 (C), 1, 5053-54 | 70 | 5-10 | Fractured limestone and minor shale | 2.1 |
| **B/95** | 464877 E 8314212 N | WA 2743 (C), 1, 5053-54 | 70 | 5-10 | Fractured limestone and minor shale | 2.4 |
| **C/95** | 464592 E 8314286 N | WA 2743 (C), 1, 5053-54 | 70 | 5-10 | Fractured limestone and minor shale | 2.3 |
| **D/95** | 465760 E 8315050 N | WA 2743 (C), 1, 5053-54 | 70 | 5-10 | Fractured sandstone, limestone and shale | 3 |




| | |
|---|---|
| X A/95 | Proposed bore site |
| x B/93 | Previously proposed bore site |
| • 3/90 | Production bore |
| o 1/90 | Unsucessful bore (position uncertain) |

**GEOLOGICAL SURVEY OF WESTERN AUSTRALIA**

| | INITIAL | DATE |
|---|---|---|
| COMP | AMK | 6/95 |
| DRAWN | AMK | 6/95 |
| APVD | | |

**FIGURE 2.**

**PROPOSED BORE SITES - *NINGBINGI***

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## OOMBULGURRI ABORIGINAL COMMUNITY

### CURRENT WATER SUPPLY

Oombulgurri is to the west of the Cambridge Gulf and about 40 km northwest of Wyndham on the Forrest River (Figures 1 and 3). At present the water supply is obtained via a pipeline from Camera Pool, located 6.5 km southwest of the community on the Forrest River. The pipeline is in poor condition and access to Camera Pool is difficult to maintain in the wet season. The Forrest River is saline to brackish up to 4 km west of the community. There is a low yielding well which produces brackish water in the dry season at the community. A minimum supply of 400 $m^3/d$ within 1 km from the pipeline or a radius of up to 5 km from the community is required. A desk study to assess the groundwater prospects in the vicinity of the community was prepared in 1994 (Thorpe, 1994).

### PROPOSED EXPLORATORY DRILLING SITES

Six sites in three areas were pegged during the field visit (Figure 3) and numbered A/95 - E/95. Thorpe's (1994) sites A, B, C, and F were pegged as E/95, D/95, C/95 and B/95 respectively. The remaining sites are in new areas. Thorpe's (1984) sites D and E were not visited during the inspection due to difficulty of access to these sites. Drilling targets at sites A/95 and B/95 are alluvial sand and gravel overlying interbedded quartz sandstone and siltstone of the Proterozoic Mendena Formation. Sites C/95-F/95 are located along major lineaments and the drilling target are highly fractured quartz sandstone of the Proterozoic Pentecost Sandstone. The anticipated drilling depth, strata and prospects are summarized in Table 3.

A barge would be required to transport the drilling equipment from Wyndham to Oombulgurri. Sites A/95 and B/95 are readily accessible. Access to sites C/95-E/95 would require upgrading the track to Camera Pool with some site preparation. Access to site F/95 would require major road work.

### GROUNDWATER QUALITY

Fresh groundwater supplies are restricted to the sandstone plateau west of the saline coastal flats (Figure 3). However, groundwater could be brackish along the pipeline route due to potential saltwater intrusion from the tidal Forrest River. The area 5 km north of the community may contain fresh, shallow, groundwater supplies within alluvial deposits associated with the Loombanariga Creek.

### DRILLING REQUIREMENTS

Sites A/95 and B/95 should be drilled into the Mendena Formation underlying alluvial deposits up to an estimated depth of 30 m, and drilling should continue to a maximum depth of about 50 m if open fractures are still intersected and supplies increase. Drilling should stop if the groundwater salinity increases with depth and exceeds 1500 mg/L TDS. Mud rotary drilling

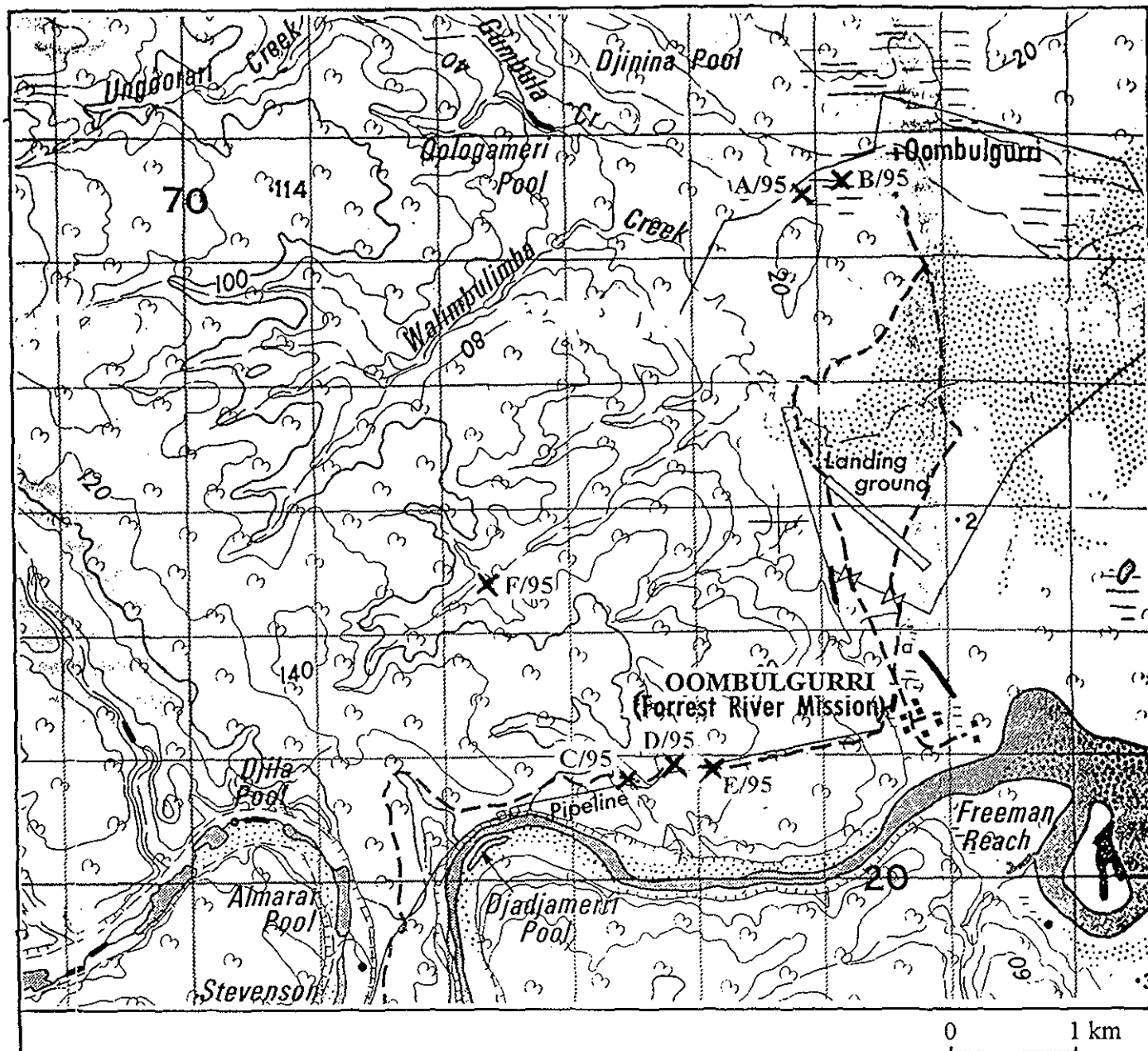
may be required to drill into the thick alluvium, however air rotary with down -the-hole air hammer will be needed to drill into large alluvial boulders and the Mendena Formation.

Sites C/95-F/95 should be drilled to at least 100 m, due to the deep water table at these sites, and drilling should continue to a maximum depth of about 120 m if open fractures are still intersected and supplies increase with depth. Special care should be taken when drilling at sites C/95-E/95 as groundwater could be brackish in this area due to the proximity of the tidal Forrest River. Air rotary drilling with down-the-hole air hammer will be needed to drill into the fresh bedrock.

It is highly recommended to have a hydrogeologist on site during the exploratory drilling to increase the chances of success to meet the large water requirements. Furthermore the service of a hydrogeologist would be justified considering the high costs of transporting a rig by barge.

**TABLE 3. PROPOSED DRILLING SITES - OOMBULGURRI**

| Site | Coordinates (AMG) | Air-photo series, run, No | Est. drilling depth (m) | Est. depth to watertable (m bns) | Strata | Prospects |
|---|---|---|---|---|---|---|
| **A/93** | 374909 E 8325544 N | WA 2895, 3, 5085-87 | 50 | 5-10 | Alluvium over sandstone and siltstone | 3.2 |
| **B/95** | 375196 E 8325613 N | WA 2895, 3, 5085-87 | 50 | 5-10 | Alluvium over sandstone and siltstone | 3.1 |
| **C/95** | 373450 E 8320850 N | WA 2895, 3, 5085-87 | 120 | 70-80 | Fractured sandstone | 4.1 |
| **D/95** | 373800 E 8320900 N | WA 2895, 3, 5085-87 | 120 | 70-80 | Fractured sandstone | 4.3 |
| **E/95** | 374094 E 8320933 N | WA 2895, 3, 5085-87 | 120 | 70-80 | Fractured sandstone | 4.4 |
| **F/95** | 372350 E 8322400 N | WA 2895, 3, 5085-87 | 100 | 60-70 | Fractured sandstone | 4.2 |




X A/95 Proposed bore site

Saline coastal flat

**GEOLOGICAL SURVEY OF WESTERN AUSTRALIA**

| | INITIAL | DATE |
|---|---|---|
| COMP | AMK | 6/95 |
| DRAWN | AMK | 6/95 |
| APVD | | |

**FIGURE 3.**

**PROPOSED BORE SITES - OOMBULGURRI**

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TO ACCOMPANY HYDROGEOLOGY REPORT 1995/26

## NULLA NULLA ABORIGINAL COMMUNITY

### CURRENT WATER SUPPLY

Nulla Nulla is about 35 km southwest of Wyndham on the Durack River and the present water supply is carted from a nearby billabong (Figures 1 and 4). The proposed community was inspected in 1987 and 1993 (Laws, 1987 and Thorpe, 1993), but no exploratory drilling has been carried out. A water supply of 40 $m^3/d$ or more is required for the proposed community. Groundwater may not be readily available from the Proterozoic Mendena Formation and if intersected could be brackish. It could be necessary to drill into the underlying Pentecost Sandstone from which the required supply may be obtainable.

### PROPOSED EXPLORATORY DRILLING SITES

Five sites in two areas were pegged during the field visit (Figure 4) and numbered A/95 - E/95. Site A/87 (Laws 1987) or A/93 (Thorpe, 1993) was repegged as A/95. Site B/95 is an alternative site for A/95. There are no photolieamentions to indicate structural features that may enhance the success of these sites, the proposed sites were located to suit the existing and future settlement, and to avoid any possible pollution. Drilling targets at sites A/95 and B/95 are sandstone and siltstone of the Proterozoic Mendena Formation, and if the required yield cannot be obtained in this formation, it may be necessary to drill into the underlying Pentecost Sandstone.

Sites C/95-E/95 were pegged along photolineaments in the Pentecost Sandstone about 2.5 km west of the proposed community. Groundwater should be readily available at these sites. The anticipated drilling depth, strata and prospects are summarized in Table 4.

A barge would be required to transport the drilling equipment from Wyndham to Nulla Nulla. Minor site preparation would be required. On-site supervision of drilling by a hydrogeologist should be provided to assess the results and select additional sites if required.

### GROUNDWATER QUALITY

At the proposed community groundwater may be brackish to saline in the Mendena Formation due to the immediate proximity of the saline coastal flats (Figure 4). Groundwater in the underlying Pentecost Sandstone is likely to be fresh to brackish. In the area to the west the groundwater within the Pentecost Sandstone is most likely fresh except along the tidal Durack River.

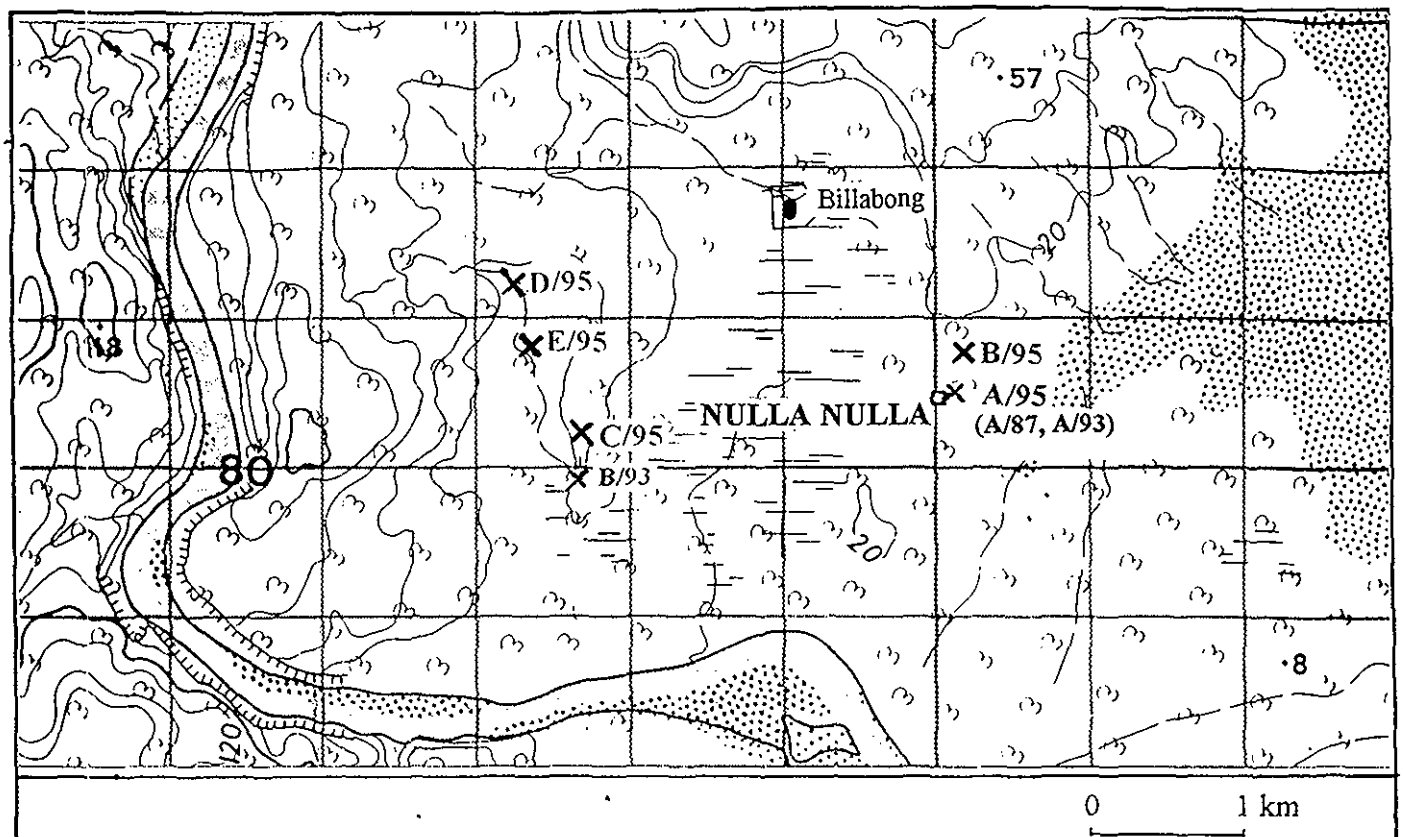
### DRILLING REQUIREMENTS

All sites should be drilled to at least 40 m, and drilling should continue to a maximum depth of about 60 m if open fractures are still intersected and supplies increase. If groundwater is brackish or saline in the Mendena Formation at the proposed community, then drilling should

continue into the Pentecost Sandstone. Air rotary drilling with down-the-hole air hammer will be needed to drill into the fresh bedrock.

**TABLE 4. PROPOSED DRILLING SITES - NULLA NULLA**

| Site | Coordinates (AMG) | Air-photo series, run, No | Est. drilling depth (m) | Est. depth to watertable (m bns) | Strata | Prospects |
|---|---|---|---|---|---|---|
| **A/95** | 370132 E 8280521 N | CAF 4057, 5, 2300-02 | 50 | 10-15 | Sandstone and siltstone over sandstone | 4.1 |
| **B/95** | 370197 E 8280801 N | CAF 4057, 5, 2300-02 | 50 | 10-15 | Sandstone and siltstone over sandstone | 4.2 |
| **C/95** | 367661 E 8280244 N | CAF 4057, 5, 2300-02 | 60 | 12-17 | Fractured sandstone | 3.2 |
| **D/95** | 367291 E 8281261 N | CAF 4057, 5, 2300-02 | 50 | 12-17 | Fractured sandstone | 3.1 |
| **E/95** | 367359 E 8280810 N | CAF 4057, 5, 2300-02 | 50 | 10-15 | Fractured sandstone | 3.3 |




X A/95 Proposed bore site

X B/93 Previously proposed bore site

Saline coastal flat

**GEOLOGICAL SURVEY OF WESTERN AUSTRALIA**

| | INITIAL | DATE |
|---|---|---|
| COMP | AMK | 6/95 |
| DRAWN | AMK | 6/95 |
| APVD | | |

**FIGURE 4.**

**PROPOSED BORE SITES - NULLA NULLA**

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TO ACCOMPANY HYDROGEOLOGY REPORT 1995/26

## PAGO ABORIGINAL COMMUNITY

### CURRENT WATER SUPPLY

Pago is about 20 km north-northeast of Kalumburu and the original water supply was obtained from a shallow well at the Pago Mission (Figures 1 and 5). Following a desk study and a field visit in 1991 (Martin, 1991), four bores were drilled (Table 5). Only bore 3/91 was completed as a production bore but was not equipped, the other bores being abandoned due to lack of water (Gee, 1994). As the yield of bore 3/91 was insufficient a new desk study and an inspection were carried out in 1992 (Martin, 1992). However, the proposed exploratory drilling program only took place in 1993, and 3 exploratory bores were drilled without much success (Gee, 1994). The poor groundwater prospects at Pago is partly due to poor fracturing of the gently dipping quartzite (less than 10°) of the Proterozoic King Leopold Sandstone.

The proposed new living area is situated near bores 1/93 and 2/93, and consideration will be given to equip bore 3/91 in the future. However, before any development proceeds a standby bore will be required with a minimum supply of 40 $m^3/d$, and if possible an additional production bore.

**TABLE 5. BORE DATA - PAGO**

| Bore | Depth (m) | Supply ($m^3/d$) | SWL (m bns) | Salinity (mg/L TDS) | Status |
|---|---|---|---|---|---|
| 1/91 | 19 | Dry | NA | NA | Aband. |
| 2/91 | 37 | Dry | NA | NA | Aband. |
| 3/91 | 61 | 40 | 1.0 | 190-380 | Production |
| 4/91 | 50 | Dry | NA | NA | Aband. |
| 1/93 | 43.5 | 8 | 3.5 | 93 | Production |
| 2/93 | 49.5 | Dry | 2.0 | NA | Aband. |
| 3/93 | NA | NA | NA | NA | Aband. |

### PROPOSED EXPLORATORY DRILLING

Four sites were pegged during the visit in the vicinity of the proposed community (Figure 5) and numbered A/95 - D/95. An additional prospective site was sighted from the helicopter and is referred to as site E. All sites are located along prominent fracture zones. Drilling targets are highly fractured quartzite of the Proterozoic King Leopold Sandstone. The anticipated drilling depth, strata and prospects are summarized in Table 6. There is good access to Pago from Kalumburu but access to the proposed sites is currently difficult and major road work would be required prior to drilling.

## GROUNDWATER QUALITY

Groundwater is likely to be fresh as indicated by previous exploratory drilling (Table 5).

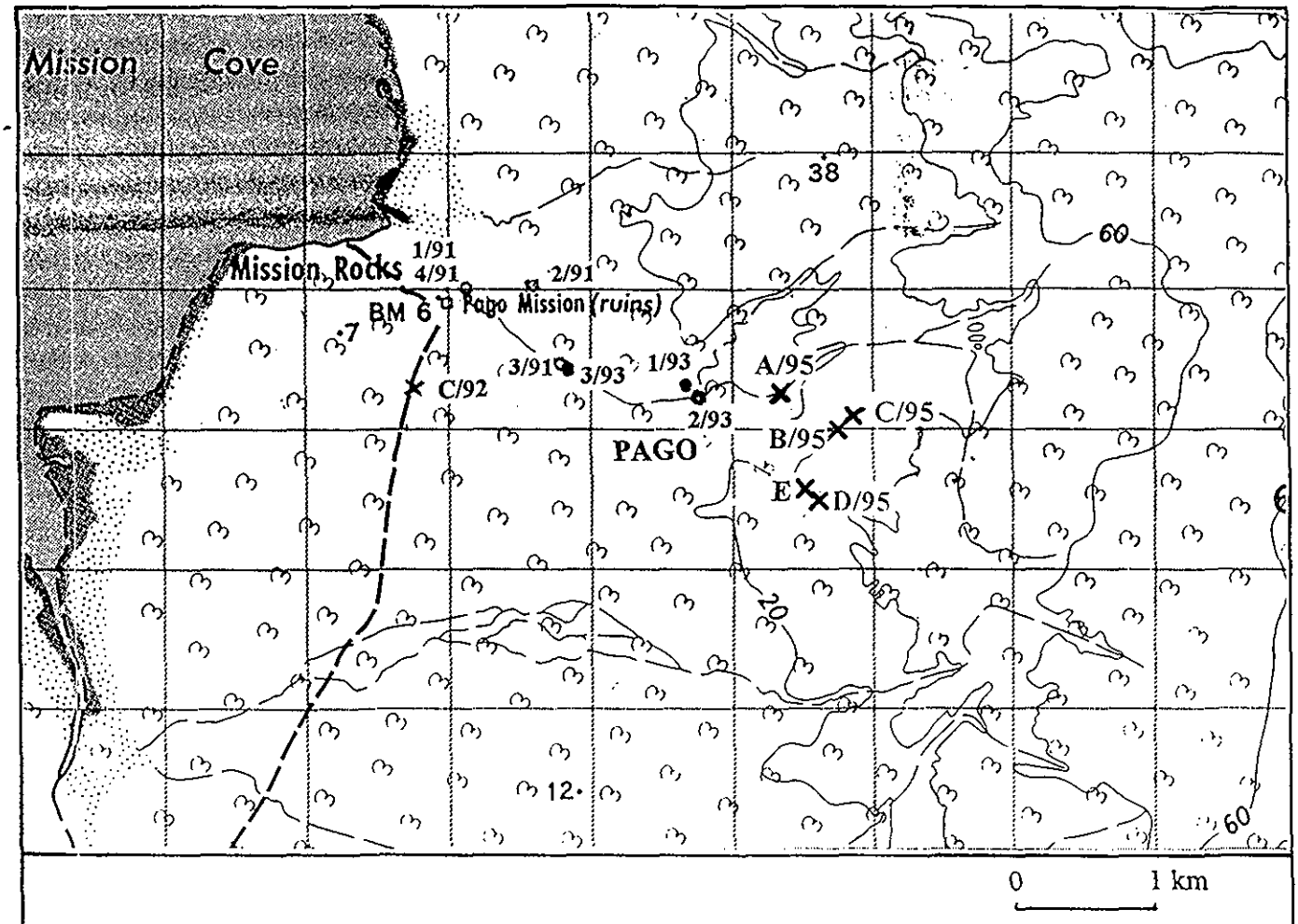
## DRILLING REQUIREMENTS

All sites should be drilled to at least 40 m, and drilling should continue to a maximum depth of about 50 m if open fractures are still intersected and supplies increase. Air rotary drilling with down-the-hole air hammer will be needed to drill into the fresh bedrock. The quartzite is extremely hard to drill and drilling bits will be subject to abrasion.

All proposed sites are site-specific and therefore on-site supervision by a hydrogeologist is recommended.

### TABLE 6. PROPOSED DRILLING SITES - PAGO

| Site | Coordinates (AMG) | Air-photo series, run, No | Est. drilling depth (m) | Est. depth to watertable (m bns) | Strata | Prospects |
|---|---|---|---|---|---|---|
| A/95 | 256343 E 8436292 N | CAF 4080, 2, 047-049 | 50 | 5-8 | Fractured quartzite | 4.5 |
| B/95 | 256678 E 8435984 N | CAF 4080, 2, 047-049 | 50 | 5-8 | Fractured quartzite | 4.1 |
| C/95 | 256854 E 84362104 N | CAF 4080, 2, 047-049 | 50 | 5-8 | Fractured quartzite | 4.2 |
| D/95 | 256608 E 8435500 N | CAF 4080, 2, 047-049 | 50 | 5-8 | Fractured quartzite | 4.3 |
| E | 256500 E 8435572 N | CAF 4080, 2, 047-049 | 50 | 5-8 | Fractured quartzite | 4.4 |




| | | |
|---|---|---|
| X | A/95 | Proposed bore site |
| X | E | Unpegged proposed site |
| X | C/92 | Previously proposed bore site |
| ● | 1/93 | Production bore, not equipped |
| o | 2/93 | Unsuccessful bore |

**GEOLOGICAL SURVEY OF WESTERN AUSTRALIA**

| | INITIAL | DATE |
|---|---|---|
| COMP | AMK | 6/95 |
| DRAWN | AMK | 6/95 |
| APVD | | |

**FIGURE 5.**

**PROPOSED BORE SITES - PAGO**

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## HONEYMOON BEACH ABORIGINAL COMMUNITY

### CURRENT WATER SUPPLY

Honeymoon Beach is located 22 km north of Kalumburu and the present the water supply for the Aboriginal community and the tourist resort is carted from Kalumburu (Figures 1 and 6). An investigation drilling program was called at short notice while drilling at the nearby Pago Aboriginal community in 1993. Three exploratory bores were drilled without much success in the vicinity of Honeymoon Beach (Figure 6 and Table 7). Bore 1/93 only intersected a seepage, while bores 2/93 and 3/93 were dry (Gee, 1994). The poor groundwater prospects at Honeymoon Beach is partly due to poor fracturing of the gently dipping quartzite (less than 10°) of the Proterozoic King Leopold Sandstone. In addition the peninsula on which Honeymoon Bay is located is almost completely surrounded by the sea. The available groundwater, therefore, is mainly from direct recharge from rainfall on the peninsula. A supply of at least 25 $m^3/d$ within 2 km of the community is required to meet the water demand .

**TABLE 7. BORE DATA - HONEYMOON BEACH**

| Bore | Depth (m) | Supply ($m^3/d$) | SWL (m bns) | Salinity (mg/L TDS) | Status |
|---|---|---|---|---|---|
| 1/91 | 49.5 | <1 | NA | 400 | Aband. |
| 2/91 | 54.5 | Dry | NA | NA | Aband. |
| 3/91 | 60.5 | Dry | NA | NA | Aband. |

### PROPOSED EXPLORATORY DRILLING SITES

Four sites were pegged in areas west and northwest of the proposed community (Figure 6) and numbered A/95 - D/95. Sites A/95 and B/95 are situated along a prominent fracture zones while sites C/95 and D/95 are located along minor fractures. Drilling targets are highly fractured quartzite of the Proterozoic King Leopold Sandstone. The anticipated drilling depth, strata and prospects are summarized in Table 8. Access to Honeymoon beach. Access to Honeymoon Beach from Kalumburu is good but access to the proposed sites is currently poor and major road work would be required prior to drilling.

### GROUNDWATER QUALITY

Groundwater is most likely fresh as indicated by previous exploratory drilling (Table 7), except along the coastline were saltwater intrusion occurs.

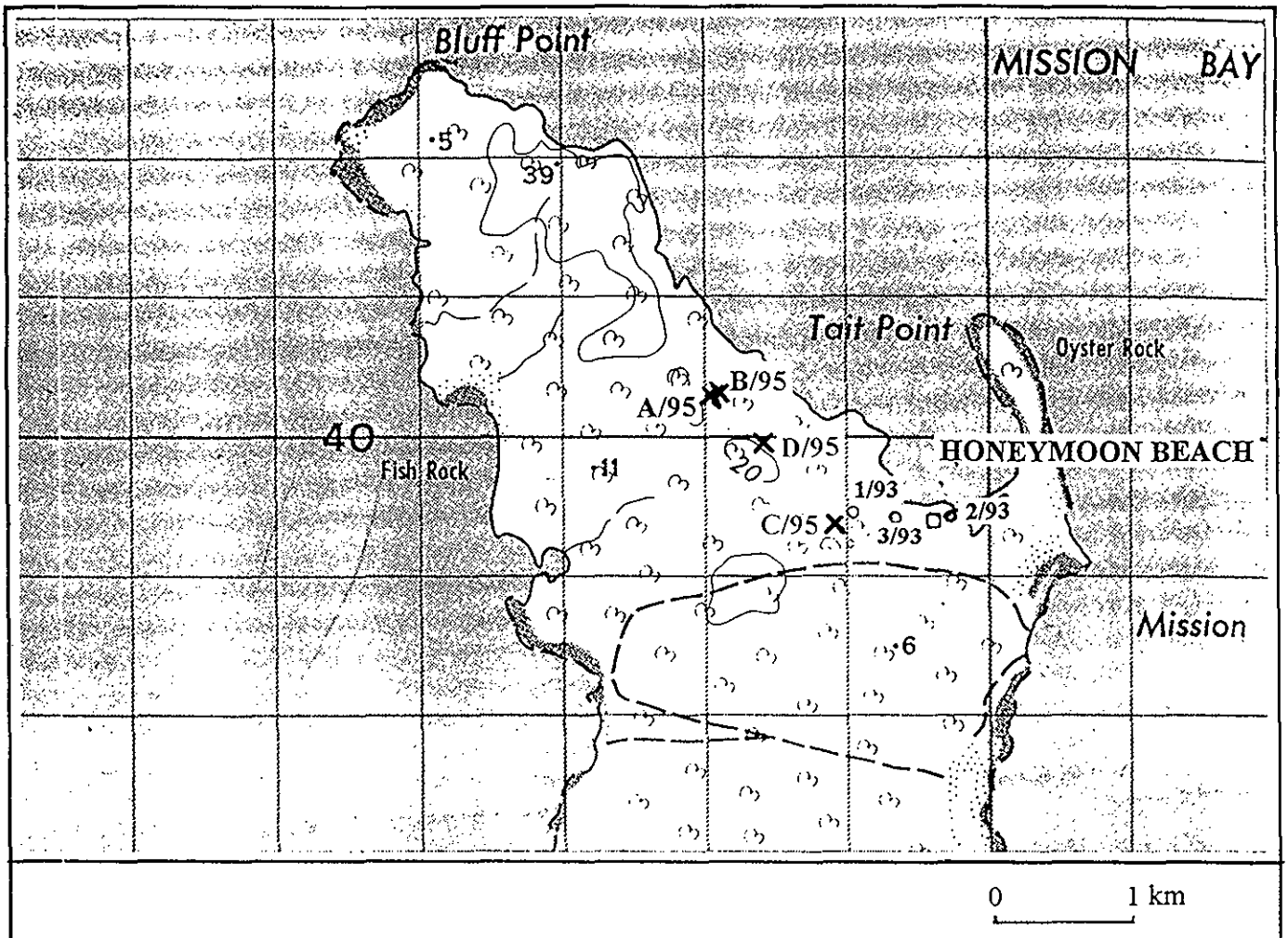
## DRILLING REQUIREMENTS

All sites should be drilled to at least 50 m, and drilling should continue to a maximum depth of about 60 m if open fractures are still intersected and supplies increase. Drilling should stop if the groundwater salinity increases with depth and exceeds 1500 mg/L TDS. Air rotary drilling with down-the-hole air hammer will be needed to drill into the fresh bedrock. The quartzite is extremely hard to drill and drilling bits will be subject to intensive abrasion.

All proposed sites are site-specific and therefore on-site supervision of drilling by a hydrogeologist is highly recommended to assess the results and select additional sites if required.

### TABLE 8. PROPOSED DRILLING SITES - HONEYMOON BEACH

| Site | Coordinates (AMG) | Air-photo series, run, No | Est. drilling depth (m) | Est. depth to watertable (m bns) | Strata | Prospects |
|---|---|---|---|---|---|---|
| **A/95** | 248050 E 8440290 N | CAF 4080, 1, 041-043 | 60 | 15-20 | Fractured quartzite | 4.2 |
| **B/95** | 248067 E 8440327 N | CAF 4080, 1, 041-043 | 60 | 15-20 | Fractured quartzite | 4.1 |
| **C/95** | 248929 E 8439387 N | CAF 4080, 1, 041-043 | 60 | 10-15 | Fractured quartzite | 4.4 |
| **D/95** | 248405 E 8439516 N | CAF 4080, 1, 041-043 | 60 | 10-15 | Fractured quartzite | 4.3 |




X A/95 Proposed bore site

o 1/93 Unsuccessful bore

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

| | INITIAL | DATE |
|---|---|---|
| COMP | AMK | 6/95 |
| DRAWN | AMK | 6/95 |
| APVD | | |

**FIGURE 6.**

**PROPOSED BORE SITES - HONEYMOON BEACH**

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TO ACCOMPANY HYDROGEOLOGY REPORT 1995/26

## MARRA GARRA ABORIGINAL COMMUNITY

### WATER REQUIREMENTS

The proposed Marra Garra Aboriginal community is about 13 km north of Kalumburu on the coast and at present there is no water supply at the proposed community (Figures 1 and 7). A barge landing will be under construction shortly and will be followed by the building of houses for the new community. A tourist resort is also planed in the future. The current requirements are for a minimum water supply of 25 $m^3/d$ within 2 km of the proposed community.

### PROPOSED EXPLORATORY DRILLING SITES

The groundwater prospects are poor in the vicinity of the Marra Garra community as the peninsula is subject to saline intrusion (Figure 7). Consequently two prospective areas for fresh groundwater were selected further inland, and are situated outside the proposed investigation area. Only one site was pegged during the visit, A/95, the remaining sites were sighted from the air as the ground was too rugged or densely vegetated for the helicopter to land. All sites are located along prominent fracture zones. Access to the proposed sites is currently difficult and some road work would be required. Drilling targets are highly fractured quartzite of the Proterozoic King Leopold Sandstone. The anticipated drilling depth, strata and prospects are summarized in Table 9. Access to Marra Garra from Kalumburu is good but major road work would be required to the proposed sites from the community.

### GROUNDWATER QUALITY

Groundwater is most likely saline at the proposed community as the peninsula is subject to saltwater intrusion. Fresh groundwater occurs further inland, and a decision will need to be made between a long pipeline or relocating the community, particularly if the community may grow to a large size.

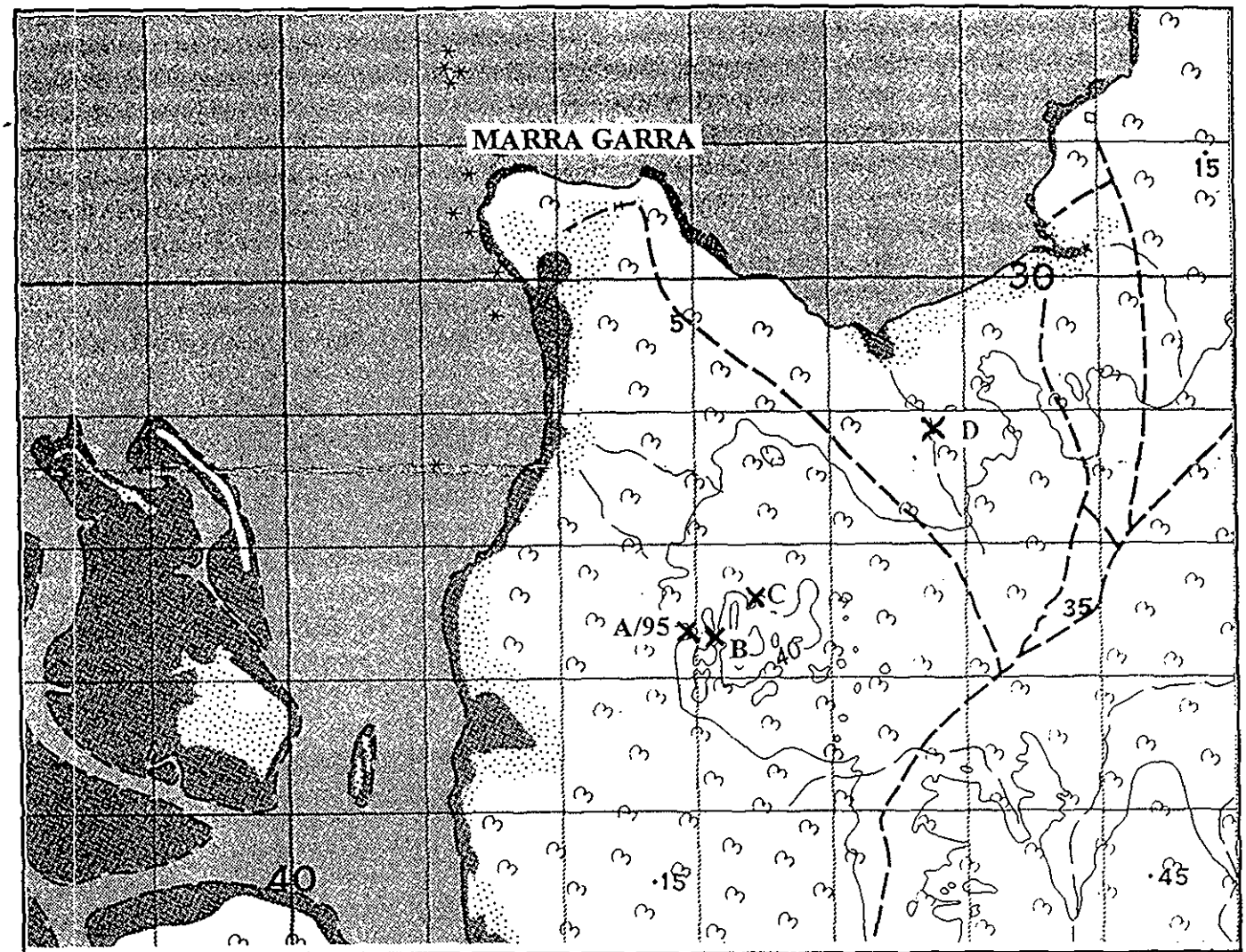
### DRILLING REQUIREMENTS

All sites should be drilled to at least 50 m, and drilling should continue to a maximum depth of about 70 m if open fractures are still intersected and supplies increase. Drilling should stop if the groundwater salinity increases with depth and exceeds 1500 mg/L TDS. Air rotary drilling with down-the-hole air hammer will be needed to drill into the fresh bedrock. The quartzite is extremely hard to drill in the area and drilling bits will be subject to intensive abrasion.

All proposed sites are site-specific and on-site supervision of drilling by a hydrogeologist is highly recommended to assess the results and select additional sites if required.

TABLE 9. PROPOSED DRILLING SITES - MARRA GARRA

| Site | Coordinates (AMG) | Air-photo series, run, No | Est. drilling depth (m) | Est. depth to watertable (m bns) | Strata | Prospects |
|---|---|---|---|---|---|---|
| A/95 | 243042 E 8427317 N | CAF 4080, 2, 251-253 | 60 | 15-20 | Fractured quartzite | 4.1 |
| B | 243129 E 8427299 N | CAF 4080, 2, 251-253 | 70 | 25-30 | Fractured quartzite | 4.2 |
| C | 243470 E 8427631 N | CAF 4080, 2, 251-253 | 70 | 25-30 | Fractured quartzite | 4.3 |
| D | 244813 E 8428857 N | CAF 4080, 2, 251-253 | 60 | 10-15 | Fractured quartzite | 4.4 |




X A/95 Proposed bore site

X B Unpegged proposed site

Saline coastal flat

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

| | INITIAL | DATE |
|---|---|---|
| COMP | AMK | 6/95 |
| DRAWN | AMK | 6/95 |
| APVD | | |

TO ACCOMPANY

FIGURE 7.

PROPOSED BORE SITES - MARRA GARRA

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## KALUMBURU ABORIGINAL COMMUNITY

### CURRENT WATER SUPPLY

At present the water supply is obtained from a large pool in the King Edward River immediately upstream of the community (Figure 8). The water becomes turbid in the wet season. A desk study and a field visit were carried out in 1992 to establish a borefield for the community (Martin, 1992). Exploratory drilling followed in 1993 (Gee, 1994). A total of 5 bores were drilled, 3 bores being constructed as production bores and the remaining two were abandoned (Figure 8 and Table 10). Results from the exploratory drilling have indicated that the better groundwater prospects occur in prominent fracture zones in the Proterozoic King Leopold Sandstone. A total supply of 400 $m^3/d$ is required to meet the water demand of the community. This can partly be met by equipping existing bores.

**TABLE 10. BORE DATA - KALUMBURU**

| Bore | Depth (m) | Supply ($m^3/d$) | SWL (m bns) | Salinity (mg/L TDS) | Status |
|---|---|---|---|---|---|
| 1/93 | 50.0 | <1 | 13.8 | 51 | Aband. |
| 2/93 | 72.2 | 55 | 7.1 | 35 | Production |
| 3/93 | 33.0 | Dry | NA | NA | Aband. |
| 4/93 | 37.0 | 16 | 4.1 | 70 | Production |
| 5/93 | 78.0 | 135 | 5.5 | 30 | Production |

### PROPOSED EXPLORATORY DRILLING SITES

Six sites were pegged in three areas within 3.5 km of Kalumburu (Figure 8) and numbered A/95 - F/95. Sites A/95 - C/95 are situated along the east bank of the large pool at Kalumburu. Site B/95 was not pegged during the helicopter inspection but there is good access to the proposed site by road. Drilling targets are thick alluvial deposits adjacent to the King Edward River and underlain by the Proterozoic King Leopold Sandstone. The alluvium is most likely recharged from the King Edward River and the alluvial material would act as an efficient filter. Sites A/95-C/95 are readily accessible.

Sites D/95 - F/95 were pegged near bores 2/93 and 5/93 situated 2.5 km north of the community. All sites are located along prominent fracture zones . Access to site D/95 and, to a lesser extent, to site E/95 is currently difficult and major road work would be required from the Kalumburu Pago track. The drilling target is highly fractured quartzite of the Proterozoic King Leopold Sandstone. The anticipated drilling depth, strata and prospects are summarized in Table 11.

## GROUNDWATER QUALITY

Groundwater is likely to be fresh as indicated by previous exploratory drilling (Table 10), except along the King Edward River downstream of Kalumburu were saltwater intrusion occurs.

## DRILLING REQUIREMENTS

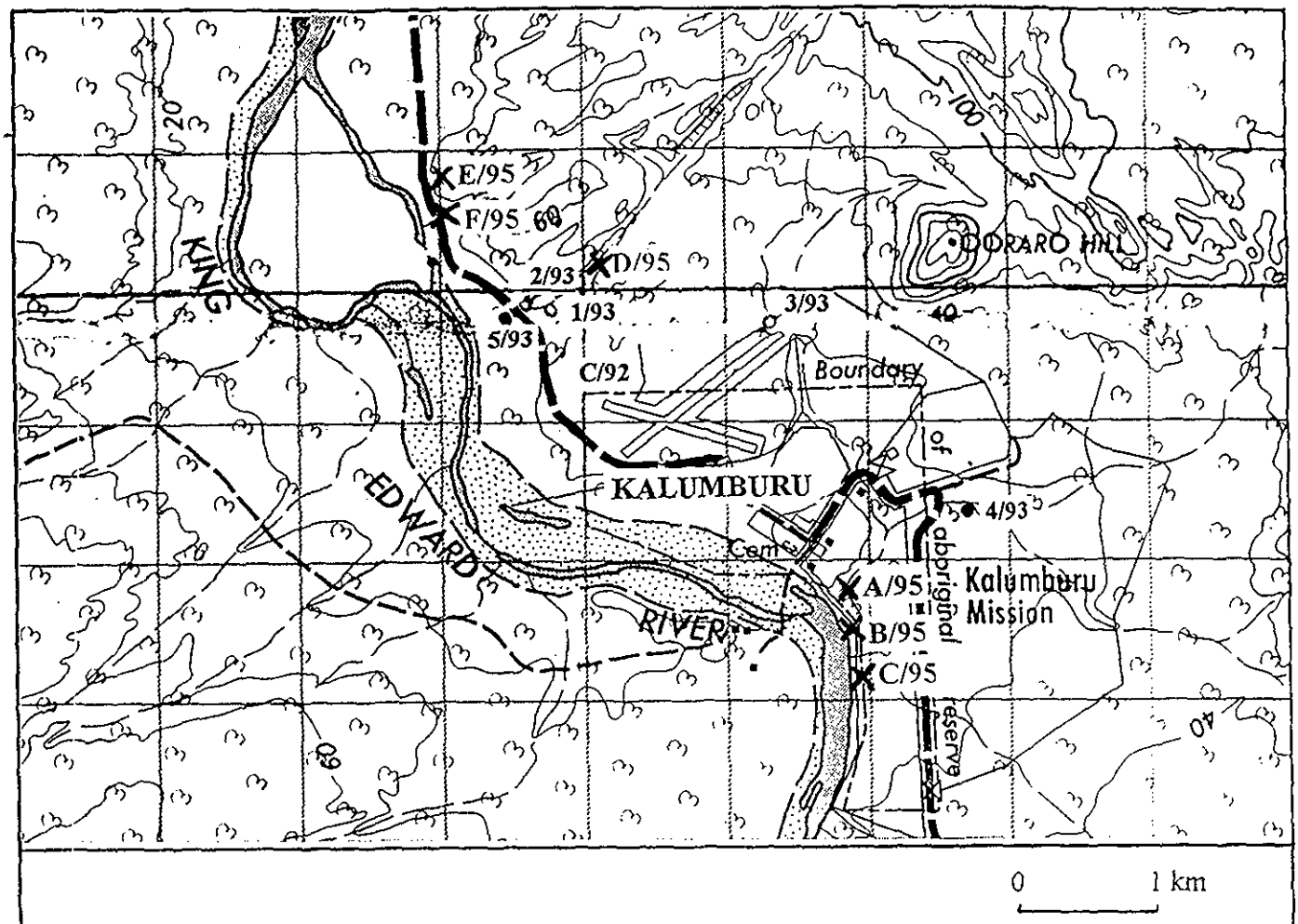
Sites A/95-C/95 should be drilled into the King Leopold Sandstone underlying the alluvial deposits up to an estimated depth of 30 m, and drilling should continue to a maximum depth of about 50 m if open fractures are still intersected and supply increase. Mud rotary drilling may be required to drill into the thick alluvium, but air rotary drilling with down the hole air hammer will be needed to drill into the fresh King Leopold Sandstone.

Sites D/95-F/95 should be drilled to at least 50 m, and drilling should continue to a maximum depth of about 60 m if open fractures are still intersected and supplies increase. Drilling should stop if the groundwater salinity increases with depth and exceeds 1500 mg/L TDS. Air rotary with down-the-hole air hammer will be needed to drill into the fresh bedrock. The quartzite is extremely hard to drill and drilling bits will be subject to intensive abrasion.

On-site supervision by a hydrogeologist should be provided while drilling at sites D/95-F/95 to select additional sites if required.

TABLE 11. PROPOSED DRILLING SITES - KALUMBURU

| Site | Coordinates (AMG) | Air-photo series, run, No | Est. drilling depth (m) | Est. depth to watertable (m bns) | Strata | Prospects |
|---|---|---|---|---|---|---|
| **A/95** | 245841 E 8417804 N | WA 2425 (C), 2, 5012-13. CAF 4080, 3, 097-099. | 30 | 4-6 | Alluvium over quartzite | 2.1 |
| **B/95** | 245850 E 8417500 N | WA 2425 (C), 2, 5012-13. CAF 4080, 3, 097-099. | 30 | 4-6 | Alluvium over quartzite | 2.2 |
| **C/95** | 245909 E 8417185 N | WA 2425 (C), 2, 5012-13. CAF 4080, 3, 097-099. | 30 | 4-6 | Alluvium over quartzite | 2.3 |
| **D/95** | 244117 E 8420185 N | WA 2425 (C), 2, 5005-06. CAF 4080, 3, 097-099. | 60 | 8-10 | Fractured quartzite | 3.3 |
| **E/95** | 242956 E 8420840 N | WA 2425 (C), 2, 5006-07. CAF 4080, 3, 097-099. | 60 | 6-8 | Fractured quartzite | 3.1 |
| **F/95** | 242985 E 8420529 N | WA 2425 (C), 2, 5006-07. CAF 4080, 3, 097-099. | 60 | 6-8 | Fractured quartzite | 3.2 |




| | |
|---|---|
| X A/95 | Proposed bore site |
| X C/92 | Previously proposed bore site |
| ● 4/93 | Production bore, not equipped |
| ○ 1/93 | Unsuccessful bore |

**GEOLOGICAL SURVEY OF WESTERN AUSTRALIA**

| | INITIAL | DATE |
|---|---|---|
| COMP | AMK | 6/95 |
| DRAWN | AMK | 6/95 |
| APVD | | |

TO ACCOMPANY

**FIGURE 8.**

**PROPOSED BORE SITES - KALUMBURU**

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## LURAL BINGU ABORIGINAL COMMUNITY

### CURRENT WATER SUPPLY

The proposed Lural Bingu Aboriginal community is on the south slope of Mt Bannerman, about 150 km southwest from Halls Creek (Figures 1 and 9). The present water supply is obtained from a rockhole which is replenished by an intermittent creek. Groundwater is readily available from the Early Permian Poole Sandstone and the underlying Grant Formation. A stratigraphic bore, BMR Mt Bannerman 3, was drilled in the vicinity of the rockhole, however there are no hydrogeological data. A supply of at least 40 $m^3/d$ is required within a radius of 2 km of the proposed community.

### PROPOSED EXPLORATORY DRILLING SITES

Two potential sites, A/95 and B/95, were pegged upstream of the proposed community (Figure 9). These sites are not site-specific. Drilling targets are quartzose sandstone of the Poole Sandstone. The regional watertable could be quite deep (70-90 m) at the proposed community. As the Poole Sandstone has only a maximum thickness of 100 m it may be necessary to drill into the underlying Grant Formation to obtain the required supply. The anticipated drilling depth, strata and prospects are summarized in Table 12. There is a good sand track to the proposed community from Carranya Roadhouse (Wolfe Creek Meteorite Crater). The proposed sites are readily accessible.

### GROUNDWATER QUALITY

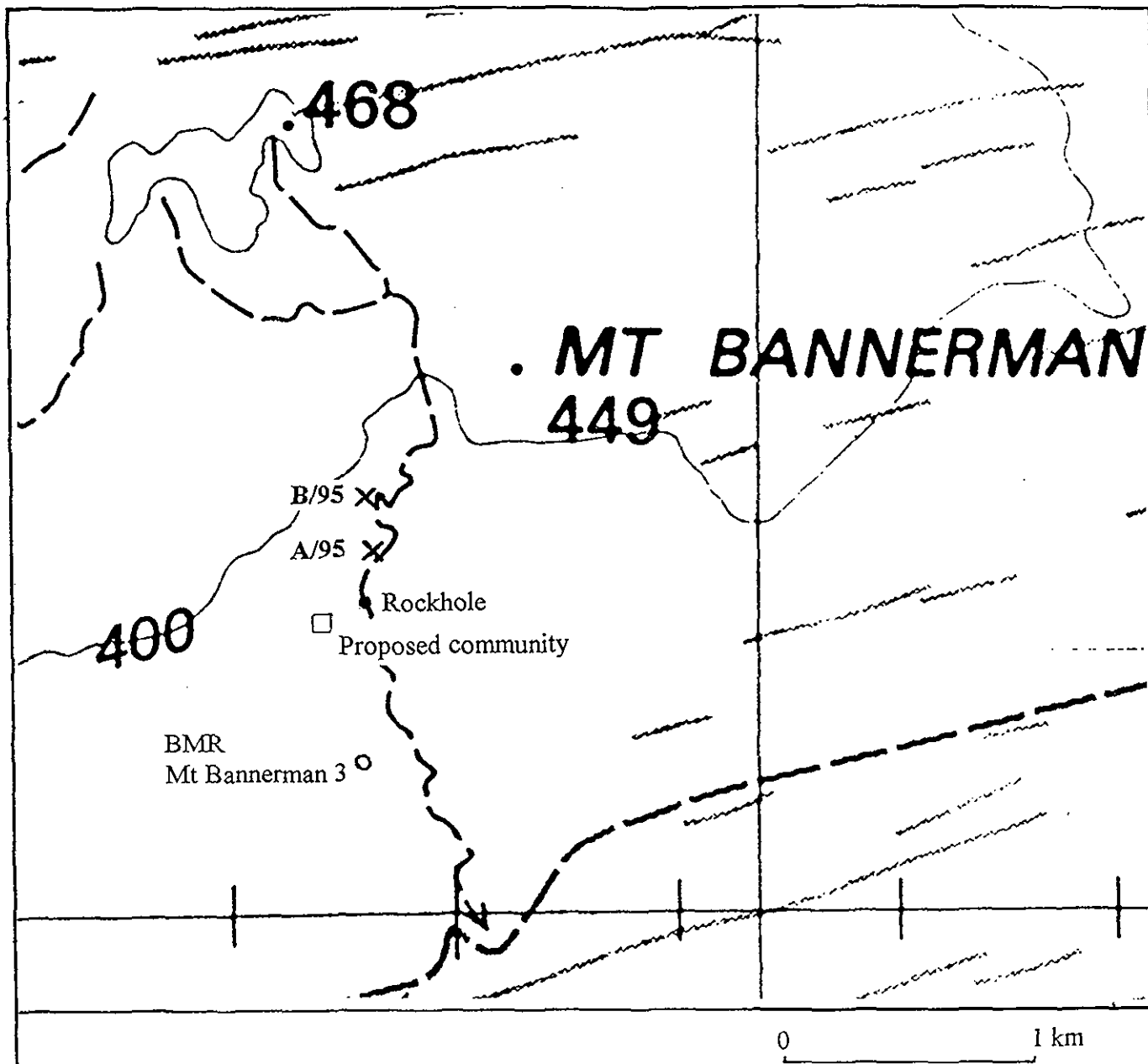
Groundwater in the Poole Sandstone and underlying Grant Formation is likely to be fresh, with a Total Dissolved Solids content of less than 1000 mg/L.

### DRILLING REQUIREMENTS

All sites should be drilled to at least 100 m, and drilling should continue to a maximum depth of about 120 m if insufficient supply is obtained. Drilling should stop if the groundwater salinity increases with depth and exceeds 1500 mg/L TDS. Air rotary drilling could be suitable with down-the-hole air hammer if the formation is cemented, but this is unknown.

TABLE 12. PROPOSED DRILLING SITES - LURAL BINGU

| Site | Coordinates (AMG) | Air-photo series, run, No | Est. drilling depth (m) | Est. depth to watertable (m bns) | Strata | Prospects |
|---|---|---|---|---|---|---|
| **A/95** | 306975 E 7845684 N | WA 2737, 7, 5254-56 | 120 | 70-90 | Sandstone, minor siltstone and shale | 2.1 |
| **B/95** | 306892 E 7846091 N | WA 2737, 7, 5254-56 | 120 | 70-90 | Sandstone, minor siltstone and shale | 2.2 |




X A/95 Proposed bore site

**GEOLOGICAL SURVEY OF WESTERN AUSTRALIA**

| | INITIAL | DATE |
|---|---|---|
| COMP | AMK | 6/95 |
| DRAWN | AMK | 6/95 |
| APVD | | |

**FIGURE 9.**

**PROPOSED BORE SITES - LURAL BINGU**

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TO ACCOMPANY HYDROGEOLOGY REPORT 1995/26

## IDABUGAR ABORIGINAL COMMUNITY

### WATER REQUIREMENTS

The proposed Idabugar Aboriginal community is located on the south slope of Mt Mueller, about 180 km south from Halls Creek (figures 1 and 10). At present there is no water supply at the proposed community. Groundwater is readily available from the Late Carboniferous to Early Permian Grant Formation which is up to 600 m thick in the area. A supply of at least 40 $m^3/d$ is required within a radius of 2 km of the proposed community.

### PROPOSED EXPLORATORY DRILLING SITES

Two potential exploratory drilling sites, A/95 and B/95, were pegged upslope of the proposed community (Figure 10). These sites are not site-specific. Drilling targets are quartzose sandstone of the Grant Formation. The anticipated drilling depth, strata and prospects are summarized in Table 13. There is a good sand track to the community from Billiluna. the proposed sites are readily accessible.

### GROUNDWATER QUALITY

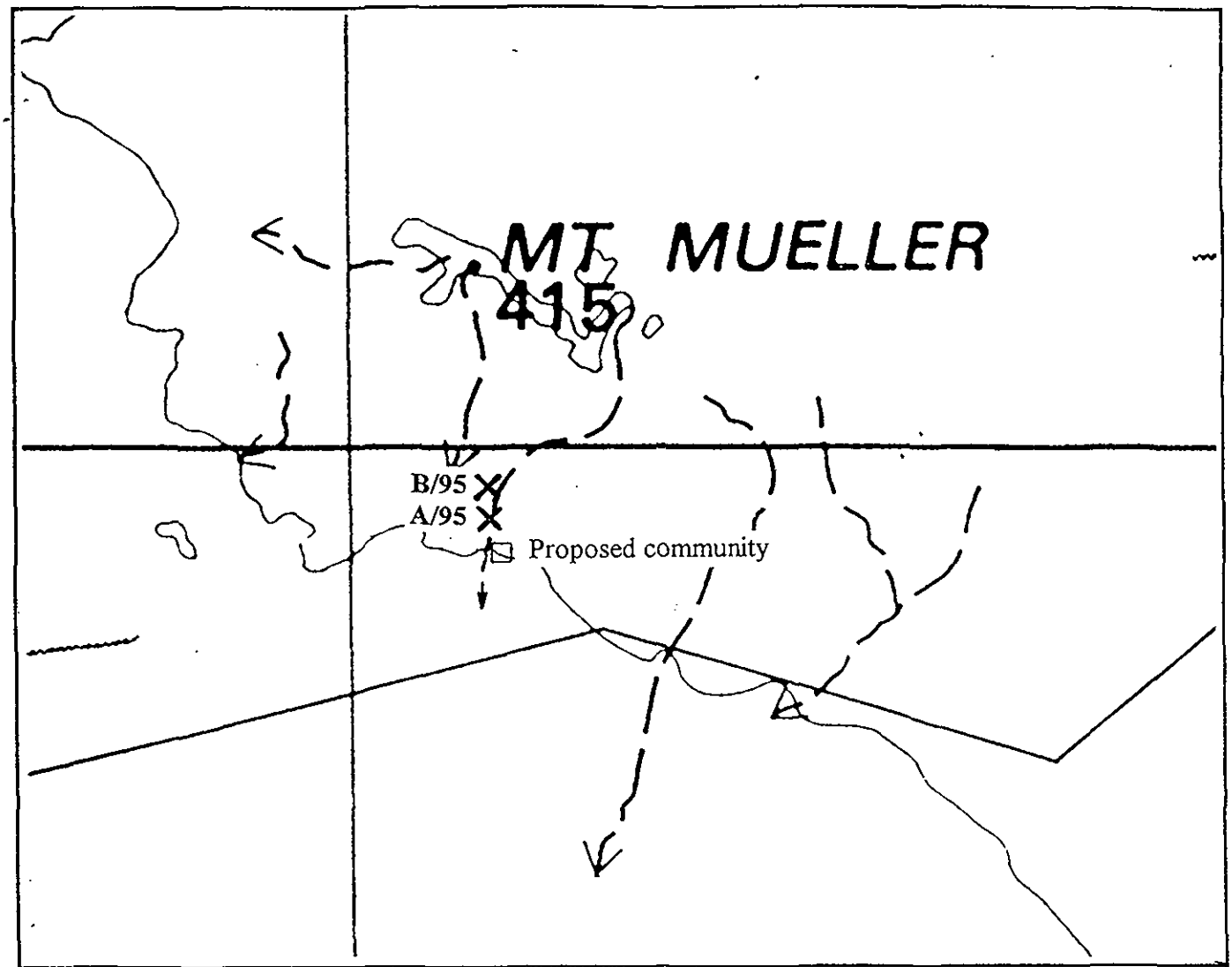
Groundwater in the Grant Formation is likely to be fresh, with a Total Dissolved Solids content of less than 1000 mg/L.

### DRILLING REQUIREMENTS

All sites should be drilled to at least 80 m, and drilling should continue to a maximum depth of about 90 m if open fractures are still intersected and supplies increase. Drilling should stop if the groundwater salinity increases with depth and exceeds 1500 mg/L TDS. Air rotary drilling could be suitable with down-the-hole air hammer if the formation is cemented, but this is unknown.

TABLE 13. PROPOSED DRILLING SITES - IDABUGAR

| Site | Coordinates (AMG) | Air-photo series, run, No | Est. drilling depth (m) | Est. depth to watertable (m bns) | Strata | Prospects |
|---|---|---|---|---|---|---|
| **A/95** | 371079 E 7799484 N | CAF 193, 8, 86-88 | 90 | 40-50 | Sandstone, minor siltstone and shale | 2.1 |
| **B/95** | 371042 E 7799714 N | CAF 193, 8, 86-88 | 90 | 40-50 | Sandstone, minor siltstone and shale | 2.2 |




✕ A/95 Proposed bore site

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

| | INITIAL | DATE |
|---|---|---|
| COMP | AMK | 6/95 |
| DRAWN | AMK | 6/95 |
| APVD | | |

FIGURE 10.

PROPOSED BORE SITES - IDABUGAR

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## NGULUPI ABORIGINAL COMMUNITY

### CURRENT WATER SUPPLY

The community is located 105 km southeast of Balgo (Figure 1) and the original water supply was obtained from Carrs Bore situated approximately 1 km south of the homestead (Figure 11 and Table 14). Carrs Bore was abandoned following water supply problems and a second bore was drilled alongside and equipped with a windmill. The new bore has been used by the community until it encountered mechanical and structural problems, and now it is used for stock only. A production bore, 1/92, was drilled about 200 m west of Carrs Bore, but unfortunately the bore yield is unknown. This bore was cased with PVC but it has not been equipped yet. Bore data indicate that groundwater is readily available from the Devonian Lucas Formation which is up to 1000 m thick in the area.

A supply of at least 40 $m^3/d$ is required to meet the water demand within 2 km of the community.

**TABLE 14. BORE DATA - NGULUPI**

| Bore | Depth (m) | Supply ($m^3/d$) | SWL (m bns) | Salinity (mg/L TDS) | Status |
|---|---|---|---|---|---|
| Carrs Bore | 45.7 | 400 | NA | Potable | Abandoned |
| "Windmill Bore" | NA | NA | NA | NA | For stock |
| 1/92 | 25.0 | NA | 12.3 | 1700 | Not equipped |

### PROPOSED EXPLORATORY DRILLING SITES

Three sites were pegged in two areas near the proposed community (Figure 11) and numbered A/95 - C/95. Sites A/95 and B/95 are situated in the vicinity of Carrs Bore while site C/95 is located about 1 km north of the community. Drilling targets are sandstone and siltstone of the Lucas Formation, which at sites A/95 and B/95 is overlain by highly porous calcrete. The anticipated drilling depth, strata and prospects are summarized in Table 8. There is a good sand track to the community from Balgo and the proposed sites are readily accessible.

Bore 1/92 should be pump-tested prior to any additional drilling at the community.

### GROUNDWATER QUALITY

Groundwater is likely to be fresh to marginal as indicated by previous exploratory drilling (Table 14).

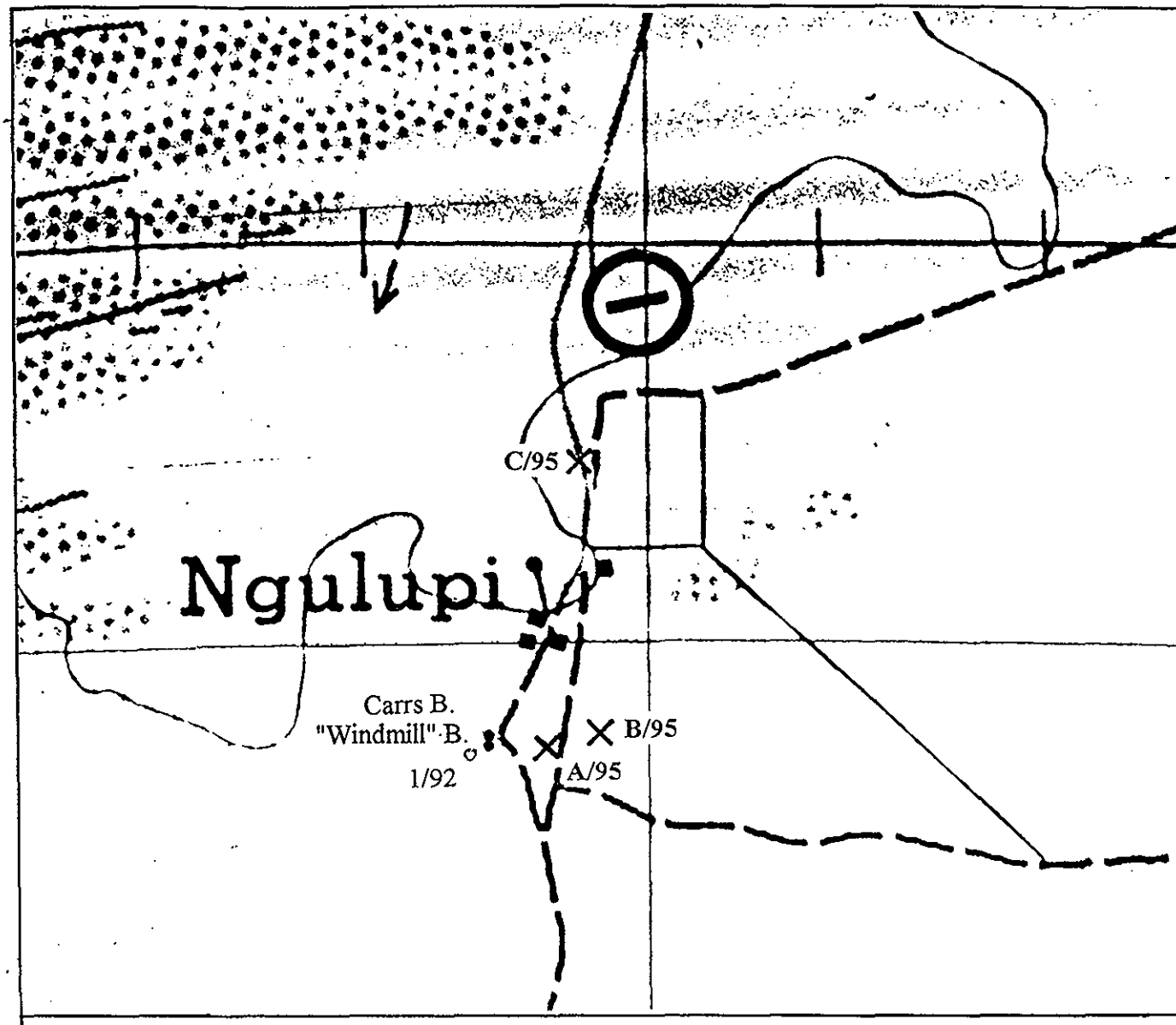
Nitrate concentration in groundwater could be high at the Ngulupi community due to the abundance of termite mounds and nitrogen fixing mulga. Studies have indicated that there is a strong link between the presence of termite mounds and mulga, and high nitrate concentration in groundwater (Jacobson et al., 1990). Air-free water samples should be taken for an accurate analysis for nitrate.

## DRILLING REQUIREMENTS

All sites should be drilled to at least 50 m, and drilling should continue to a maximum depth of about 60 m if open fractures are still intersected and supplies increase. Drilling should stop if the groundwater salinity increases with depth and exceeds 1500 mg/L TDS. Air rotary drilling could be suitable with down-the-hole air hammer if the formation is cemented, but this is unknown.

### TABLE 15. PROPOSED DRILLING SITES - NGULUPI

| Site | Coordinates (AMG) | Air-photo series, run, No | Est. drilling depth (m) | Est. depth to watertable (m bns) | Strata | Prospects |
|---|---|---|---|---|---|---|
| **A/95** | 489233 E 7729207 N | | 60 | 12-15 | Calcrete over sandstone and siltstone | 2.1 |
| **B/95** | 489520 E 7729297 N | | 60 | 12-15 | Calcrete over sandstone and siltstone | 2.2 |
| **C/95** | 489555 E 7731410 N | | 60 | 12-15 | Sandstone and siltstone | 2.3 |




| | |
|---|---|
| X A/95 | Proposed bore site |
| • | Production bore |
| o 1/92 | Production bore, not equipped |

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

| | INITIAL | DATE |
|---|---|---|
| COMP | AMK | 6/95 |
| DRAWN | AMK | 6/95 |
| APVD | | |

**FIGURE 11.**

**PROPOSED BORE SITES - NGULUPI**

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TO ACCOMPANY HYDROGEOLOGY REPORT 1995/26

## BALGO ABORIGINAL COMMUNITY

### CURRENT WATER SUPPLY

Many bores have been drilled at the Balgo Aboriginal community to meet the water demand (Figure 12 and Table 16). The current scheme consists of two production bores, 1/79 and 1/86, but both production bores occasionally yield unacceptable high concentration of nitrate and bore 1/86 recently experienced water supply problems. A new bore was drilled in the middle of the sport's oval in 1992, but has not been equipped. Drilling results indicate that groundwater is readily available from the Permian Poole Sandstone underlying the younger Noonkanbah Formation. The watertable is deep at the community, ranging in depth from about 85 m in Eileens' and Tylers' Bores in the north to 109 m in bore 1/83 in the south.

An additional supply of 400 $m^3/d$ of good quality water is required to meet the demand of the community.

**TABLE 16. BORE DATA - BALGO**

| Bore | Depth (m) | Supply ($m^3/d$) | SWL (m bns) | Salinity (mg/L TDS) | Nitrate (as $NO_3$ mg/L TDS) | Status |
|---|---|---|---|---|---|---|
| Chapel No 1 | 122.0 | 436 | ?114.0 | NA | | Aband. |
| Eileens B. | 100.6 | NA | 85.3 | NA | | Unknown |
| Tylers B. | 100.0 | NA | 85.3 | NA | | Unknown |
| 1/79 (Chapel No 2) | 136.3 | 600 | 105.6 | 810 | 15-119 | ?Production |
| 1/83 | 138.6 | 400 | 109.5 | 780 | 13-15 | Aband. |
| 1/86 | 146.5 | 480 | 104.4 | 730 | 14-114 | Production |
| "Oval B." | 125.0 | NA | ?85.0 | NA | | Not equipped |

### PROPOSED EXPLORATORY DRILLING SITE

A potential drilling site, A/95, was pegged near bore 1/83 during the recent site-visit (Figure 12). Site A/95 is suitable for a replacement bore for bore 1/83. Bore 1/83 encountered water supply problems within a few years of the bore completion. The bore was redeveloped and the annulus between the casing and the wall was gravel-packed in 1985, but apparently the bore has not been in use since it was rehabilitated. It is likely to be more economic to drill a new bore nearby than attempt to rehabilitate bore 1/83. The anticipated drilling depth, strata and prospects are summarized in Table 17.

The new bore referred to as the "Oval Bore" should be pump-tested prior to any additional drilling at the community. Special care should be taken during the test by taking water samples for nitrate analyses as the groundwater could be contaminated from sewage. If the nitrate

concentration is too high at the "Oval Bore" then drilling a new production bore at site A/95 is recommended.

## GROUNDWATER QUALITY

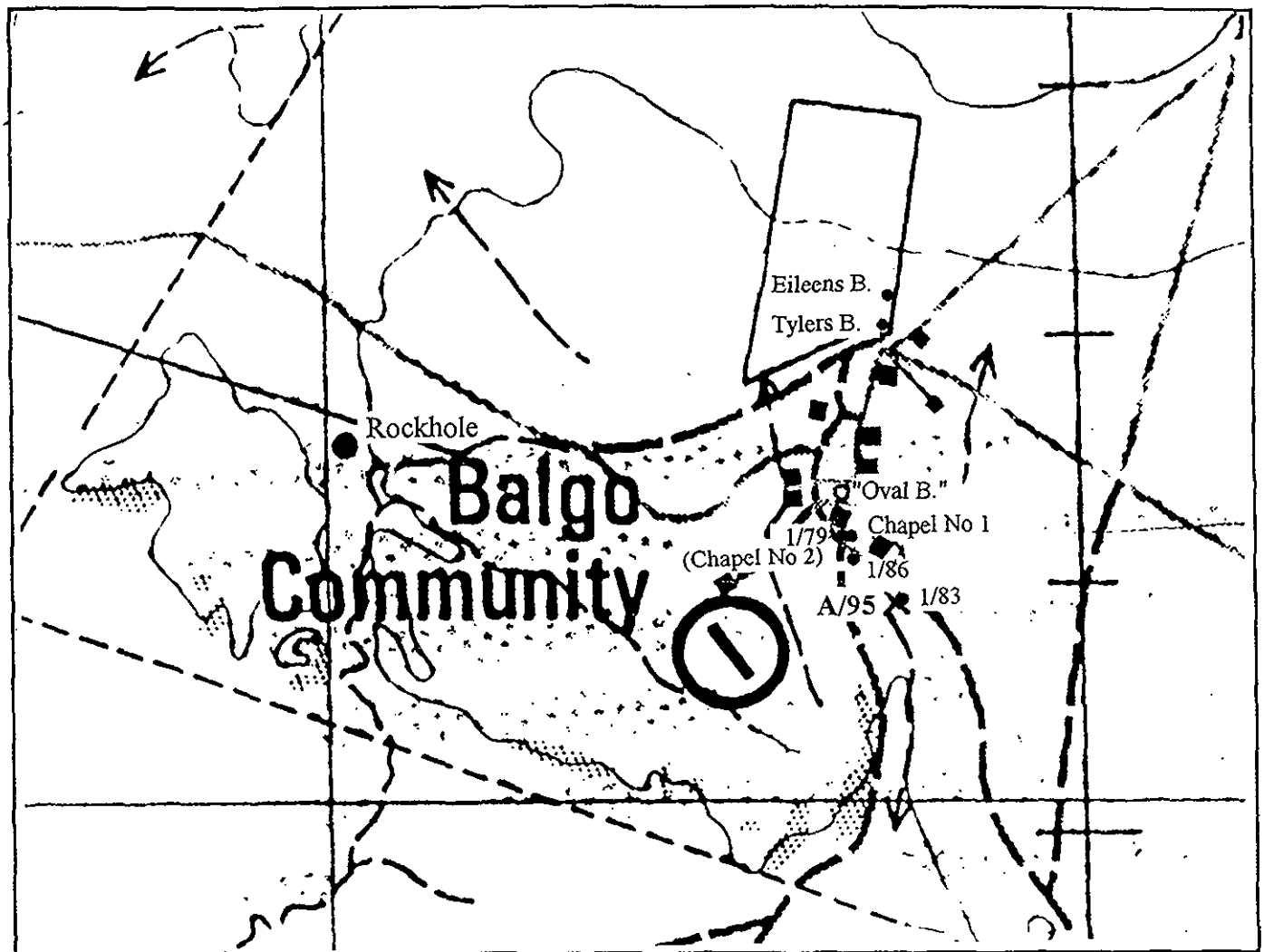
Groundwater is likely to be fresh as indicated by previous exploratory drilling (Table 16). The high nitrate concentration in bores 1/79 and 1/86 probably reflects poor bore construction (eg contamination through the annulus) and it should be considered to drill replacement bores on higher ground outside the community. High nitrate concentration could occur in groundwater at the "Oval Bore" as it is located in the middle of the community.

## DRILLING REQUIREMENTS

The proposed bore at site A/95 should be drilled to at least 140 m, and drilling should continue to a maximum depth of about 150 m if open fractures are still intersected and supplies increase. Drilling should stop if the groundwater salinity increases with depth and exceeds 1500 mg/L TDS. Air rotary drilling could be suitable with down-the-hole air hammer if the formation is cemented, but this is unknown.

### TABLE 17. PROPOSED DRILLING SITE - BALGO

| Site | Coordinates (AMG) | Air-photo series, run, No | Est. drilling depth (m) | Est. depth to watertable (m bns) | Strata | Prospects |
|---|---|---|---|---|---|---|
| A/95 | 395500 E 7771500 N | WA 3396, 3, 5240-42 | 150 | 110 | Siltstone and shale over sandstone and siltstone | 2 |




X A/95 Proposed bore site

• Production bore

○ Production bore, not equipped

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

| | INITIAL | DATE |
|---|---|---|
| COMP | AMK | 6/95 |
| DRAWN | AMK | 6/95 |
| APVD | | |

**FIGURE 12.**

**PROPOSED BORE SITE - BALGO**

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