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REPORT ON ENGINEERING GEOLOGICAL INVESTIGATIONS
UNDERTAKEN FOR THE MOTHIBISTAD WASTE SITE, KUDUMANE DISTRICT,
REPUBLIC OF BOPHUTHATSWANA

2 - 11/92
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1. INTRODUCTION

At the request of Messrs. Jeffares and Green (Bophuthatswana), Consulting Engineers and Project Managers acting on behalf of the Department of Local Government and Housing - Republic of Bophuthatswana, Partridge, Maud and Associates, Consultants in the Earth Sciences, were commissioned to undertake engineering geological and hydrogeological investigations at a potential waste site situated north-east of the town of Mothibistad (Kudumane District, Taung Region).

The need for a new waste site has arisen as a result of the high pollution potential of the existing waste site, situated north-west of Mothibistad in the Mothibistad dolomitic groundwater Compartment. This groundwater compartment supplies primary water to a number of large settlements, namely Mothibistad, Magobe, Seoding, Ga-Ntatelang, Mokala-Mosesane and Batharos. The pollution of this compartment would have serious repercussions for these settlements. The objective of the present investigation was to locate an area, in close proximity to Mothibistad, where the disposal of waste would have a much lower impact on regional groundwater supplies. To this end a small triangular groundwater compartment, which adjoins the Mothibistad Compartment and the Mapoteng Compartment (Map 1), was identified as potentially suitable; this small triangular compartment is not inhabited at present and is not likely to ever constitute a significant source of water in the regional context.

This report, together with the accompanying map, summarizes the investigations undertaken at the proposed waste site.

2. DESCRIPTION OF THE SITE

The potential waste site is situated 1,5 km north-west of the Mapoteng spring and is located in a small unexploited dolomitic groundwater compartment which is triangular in shape (Map 1). The compartment is bounded to the west by the Mothibistad compartment, while the southern boundary is formed by the Mapoteng groundwater

Compartment; the third side of the triangle, making up the north eastern boundary of the compartment, is formed by an unnamed groundwater compartment.

The potential waste site comprises a relatively flat area adjacent to a poorly defined drainage-line; the site is poorly vegetated and is covered by grasses and scrub.

3. SITE INVESTIGATIONS

3.1. General

The engineering geological investigations undertaken at the Mothibistad waste site were carried out in phases, the output from one phase being used as the input for the next. The investigation comprised an initial assessment of the existing site, situated west of Mothibistad behind the sewage works. This was followed by the interpretation of aerial photography once it became evident that continued use of the existing site would result in a further deterioration of the groundwater quality within the Mothibistad groundwater compartment. The interpretation of aerial photography was undertaken at a scale of 1:30 000 and an area north-east of Mothibistad was selected for further investigations. These investigations comprised test pitting to determine the suitability of the waste site itself, while the boundaries of the surrounding groundwater compartment were verified using geophysical methods. Drilling sites were selected to determine the integrity of the compartment and present groundwater quality within it, and were based on the interpretation of aerial photographs as well as the results of the geophysical survey. A total of seven percussion borehole were drilled; groundwater samples were taken from selected boreholes which were either drilled during this investigation or which were visited during the course of a borehole census carried out to further elucidate relationships between the compartment under investigation and those surrounding it.

3.2. Hydrogeology

The proposed waste site identified during the course of the investigations is underlain by the dolomites of the Ghaap Plateau Formation (Campbell Group, Griqualand West Sequence). Dolomite, being highly susceptible to chemical decomposition, often weathers to form large interconnected cavities within the rock; in areas where groundwater is present at shallow depth, these cavities are often water bearing and provide an excellent source of groundwater (Within the Republic of Bophuthatswana large villages such as Mothibistad, Batlharos, Dinokana and Itsoseng, to name but a few, all rely entirely on groundwater obtained from the dolomite). A characteristic of most dolomitic terrains is the presence of dolerite dykes which transect the dolomite, having intruded along faults and fractures. These dykes often compartmentalize the dolomite into discrete hydrogeological units or compartments. More important from a waste management point of view, however, is the fact that the movement of groundwater between adjacent compartments is usually restricted by these largely impermeable barriers.

3.3. Test pitting

In order to determine the excavation characteristics and depth of available cover material, **eight test pits** were excavated within the soil area identified, with the aid of air-photo interpretation, as being potentially suitable for use as a waste site. The positions of the test pits are shown on Map 1, while the recorded soil profiles are included in Appendix B of this report; the soil profiles were described in detail in accordance with standard procedures i.e. the MCCSSO soil classification. TPI-T

During inspection of the test pits a number of disturbed samples, representative of the various soil horizons present throughout the soil area, was taken and submitted to either the laboratory of Messrs. Jeffares and Green (Bophuthatswana) or the laboratory of Messrs. Soiltech (Pty) Ltd, depending

on the nature of the test required. The tests undertaken included particle size distribution analysis, together with Atterberg Limits determinations, moisture-density determinations at Proctor compactive effort and permeability tests on samples remoulded to 96 % Proctor density. The results of these tests, which are included in Appendix B of this report, are discussed in Section 5.1.

3.4. Geophysical survey

Resistivity and magnetic surveys were carried out within the confines of the groundwater compartment hosting the proposed waste site. The surveys sought confirmation of the bounding dolerite dykes and were used in the selection of drilling positions; a Chemtron G3 magnetometer was used for the magnetic field measurements, while an electrical resistivity instrument manufactured by the CSIR, was used for the electromagnetic survey. While a magnetometer would normally suffice in delineating the dolerite dykes, the inability of this method to locate the eastern lineament identified on the aerial photographs, and interpreted as being the third side to the triangle of the compartment, necessitated the use of resistivity profiling.

The data recorded during the geophysical survey are summarized as plots and are included in Appendix C; the positions of the various geophysical traverses are indicated on Map 1.

3.5. Percussion drilling

A total of seven percussion boreholes was drilled around the perimeter of the groundwater compartment. The main objective of the boreholes was to assess the likely extent of groundwater movement across the dolerite dykes; to this end a borehole was drilled on either side of the dyke and test pumping of the borehole on the inside of the compartment was undertaken, while the water rest level in the adjacent borehole beyond the compartment boundary was monitored.

The drilling was undertaken by Messrs. Aqua Alpha, the annual drilling contractor appointed by the Department of Water Affairs, Republic of Bophuthatswana, for the Rural Water Supply Programme in the Taung Region. The drilling contractor fielded a Super Rock down-the-hole percussion rig with compressed air supplied from a 17 bar Corp. Co. XRH 350 compressor.

Drill chips recovered during drilling operations were logged according to standard procedures and the resultant logs are included in Appendix D; the borehole positions are included on Map 1.

3.6. Borehole census

A census of all existing boreholes and natural water sources within a radius of ± 1 km of the site was undertaken; their positions are shown on Map 1. It should be noted that in the majority of cases the boreholes are equipped with pumps and access to check depth, standing water levels etc., was not readily available. In addition, some of the owners were either absent at the time of the survey or were reluctant to allow us access to their boreholes.

The results of the census are summarized in Table 1, while the original field census data sheets are included in Appendix E of this report.

3.7. Test pumping

A total of two boreholes were test pumped while water rest levels in adjacent boreholes were monitored. The pump tests involved an initial step drawdown test (SDT), comprising four steps of one hour's duration each where feasible, followed by a forty eight constant discharge test (CDT); on cessation of both the SDT and the CDT a recover test was run. The objective of the pump tests was to establish whether or not the dolerite dykes bounding the compartment formed effective aquicludes. |k-

TABLE 1: RESULTS OF BOREHOLE CENSUS CONDUCTED DURING FEBRUARY 1993.

Archive Number [Appendix E]	Borehole Number [Map 1]	Reported Depth [m]	Water Rest Level [m]	Reported Yield [l/s]	Equipment	Remarks
1	13-86278	26,0	16,80	0,1	none	monitoring borehole.
2	13-86275	16,0	3,37	0,1	none	monitoring borehole.
3	13-86276	16,0	4,17	0,1	none	monitoring borehole.
4	4	?	5,67	?	hand pump	private borehole.
5	13-86010*	107,0	?	1,5	none	next to reservoir.
6	6	20,0	?	?	hand pump	private borehole.
7	7	?	4,74	0,8	hand pump	Mapoteng P/S.
8	8	?	?	?	hand pump	private borehole.
9	9	?	?	?	hand pump	private borehole.
10	T10634	?	8,38	?	wind pump	reservoir full.
11	spring	N/A	0,00	± 20,0	N/A	Mapoteng spring.
12	13-86403	40,0	6,95	0,1	none	monitoring borehole.
13	13-86406	35,0	4,37	0,8	none	monitoring borehole.
14	13-86408	31,0	6,34	12,5	none	monitoring borehole.
15	13-86409	31,0	3,80	1,0	none	monitoring borehole.

The test pumping was undertaken by Messrs. D.G.M., the annual test pumping contractors appointed by the Department of Water Affairs for the Taung Region.

Results from the SDT, CDT and recovery tests are summarized in the form of time-drawdown curves and are included in Appendix F.

4. GEOLOGY AND SUBSOILS

4.1. General

The proposed waste site is underlain by dolomites of the Ghaap Plateau Formation, Campbell Group, Griqualand West Sequence. Although impersistent outcrops and/or boulders of dolomite were noted throughout the area investigated, the dolomite is generally overlain by transported and residual materials or by calcrete.

4.2. Subsoils

The area selected for detailed test pitting, based on the interpretation of areal photographs at a scale of 1:30 000, comprises transported soils overlying residual soils in some instances, with hard rock dolomite at depth. Detailed descriptions of the various soil types that occur beneath the proposed waste site are given below :-

Transported soils.

Transported soils of mixed origin - This material generally comprises dry, orange-brown (in profile orange-brown speckled black), loose, intact, silty medium and fine sand with numerous fine chert gravels; the horizon is unlikely to attain a thickness of more than 120 cm with an average of some 80 cm.

Nodular manganocrete - The nodular manganocrete is generally present just below the orange-brown soil discussed above; it comprises abundant medium and fine manganiferous concretions, with numerous fine gravels, which are densely packed in a orange-brown, silty sand; the overall consistency is generally medium-dense to dense; the nodules may be locally cemented into a hardpan layer; the horizon thickness is likely to be of the order of 40 cm.

Alluvial gravels - These were encountered in all but one of the test pits (TP 4) and comprise abundant coarse, medium and fine sub-rounded to sub-angular gravels (predominantly chert) with numerous fine friable manganese concretions which are densely packed in a matrix of orange-brown, silty sand; the overall consistency of the material is usually medium dense; the horizon was noted to be locally calcareous cemented at depth (TP 3 and 5), and is likely to vary in thickness from 50 to 160 cm.

Residual soils

Chert residuum - This material was encountered on the sides of knoll to the south-west of the proposed waste site. The material generally comprises abundant coarse, medium and fine, slab-like gravels, cobbles and boulders of chert which are densely packed in a matrix of silty sand; the overall consistency of the material is usually medium dense; with depth the matrix tends to become more clayey.

Rock

Dolomite - In all but two of the test pits (TP 6 and 8) hardrock dolomite resulted in refusal of the backhoe. The rock is generally bluish-grey in colour, unweathered, fine grained and of hard rock consistency. Of note is the fact that the dolomite encountered at the base of the test pits may represent large boulders or pinnacles, as these were noted in exploratory test pits dug in the vicinity of the dykes.

5. ANALYSIS OF RESULTS

5.1. Laboratory test results

5.1.2. Indicator Tests

The results of the grading and Atterberg Limits determinations reveal that the transported soils of mixed origin blanketing the proposed waste site have a Liquid Limit of 22 and a Plasticity Index of 1,5%; the material classifies in the "SM" group of the Unified Soil Classification (Table 2). A combined sample comprising approximately 50 % transported soils of mixed origin, together with the alluvial gravels, had a Liquid Limit of 22 and a Plasticity Index of 1%; this combined sample classifies in the "SM" group of the Unified Soil Classification and is typical of the material that would be excavated for use as cover material.

5.1.2. Laboratory permeability tests

Three permeability tests were undertaken on samples remoulded to 96% Proctor density. The first sample, taken from Test Pit 2, comprises a 50/50 mixture of transported soils of mixed origin and alluvial gravels; the permeability of the remoulded sample is $6,1 \times 10^{-3}$ cm/s. The second sample taken from Test Pit 5, comprising transported soils of mixed origin only, has a permeability of $3,3 \times 10^{-4}$ cm/s when remoulded to 96 % Proctor density. The final sample taken from Test Pit 7, comprising predominantly alluvial gravels and chert residuum with some transported soils of mixed origin, has a permeability of $2,5 \times 10^{-2}$ cm/s when remoulded to 96 % Proctor density.

It is clearly evident that the materials available on site, when compacted to 96% Proctor density, will not yield impermeable liners; remoulded samples comprising transported soils of mixed origin only, will nonetheless provide the best local materials for such liners.

5.2. Geophysics

The results of the geophysical survey have confirmed the presence of the dolerite dykes. However, owing to the fact that the eastern dyke was thought to be non-magnetic (since the magnetic profiling did not detect it) resistivity profiling was carried out across the lineament noted on the aerial photographs. This, however, failed to detect a discontinuity in the dolomite, and regional aeromagnetic maps were obtained and inspected to establish the approximate dyke position. The dyke being sought was found to be further to the west and magnetic profiling as detailed on Map 1 (magnetic traverses A - H) confirmed its presence in the field.

5.3. Percussion drilling

Four drilling positions were selected initially based on the results of the geophysical survey. The objective of the drilling exercise was to position boreholes on either side of the dykes in the vicinity of the proposed waste site (Test pumping of these boreholes would then enable the potential for movement of water across the dykes to be assessed.) However, two additional boreholes had to be drilled along the western dyke as a result of one of the borehole being dry, while the second borehole, on the eastern side of the dyke, intersected dolerite when it should have intersected dolomite. A third additional hole, which was drilled to only 7 metres, was deemed necessary to explore the eastern lineament i.e. to determine whether the eastern lineament was in fact dyke or not.

The results of the drilling investigation are summarized in Table 3, and comprehensive borehole logs are included in Appendix D.

5.4. Test pumping results

Test pumping of the boreholes drilled during the course of the present investigation of the dolerite dykes bounding the waste dump are

JJM's Comments

1. Dykes are an aquiclude hence chances of pollution of the ~~mapoling~~ ^{Northwest} compartment from the waste dump are remote & minimal.

2. Disadv.

High yielding BH within the compartment comprising the proposed site

$Q \geq 10$
m³/d

$Q_{max} = 22 \text{ l/sec.}$

down tests (SDT), conducted on selected investigations are boreholes and are

the dolerite dyke compartment. The yield of 4,18 mbgl. being an available

0,52 l/s, 0,98 l/s. The drawdown rose back to normal when reached; in the next step; in the next investigation and the

of 0,85 l/s. The test with a drawdown

occurred after 50 minutes of pumping. This sudden drawdown ceased after 80 minutes and the water level reverted back to a semi-equilibrium trend after 150 minutes.

The water level recovery was rapid and complete within 5 minutes of cessation of the test.

The sudden drawdown between 50 and 80 minutes was due to interference produced by a blowing yield test carried out in borehole 13-86408 (\pm 360m to the east).

During the test pumping of borehole 13-86406, the water level in borehole 13-86403 was monitored; this borehole is situated approximately 26m west of borehole 13-86406 (Map 1) and falls within the Mothibistad groundwater compartment.

Between 13-86403 + 13-86406
Note
1. geologies are different
2. yields
3. water strike levels are equal
Note

No lowering of the static water level occurred indicating that there is no interconnection between the aquifers penetrated by these two boreholes. Thus, there is an effective hydrogeological boundary between boreholes 13-86403 and 13-86406. *Lack of hydrogeological continuity does not necessarily mean that (or indicate the presence of an effective hydrogeological boundary.*

5.4.2. Test pumping of borehole 13-86408

⇒ Lack of continuity is a common phenomenon anyway in Zinday Aquifer

This borehole is situated approximately 360m to the east of borehole 13-86406 and is within the compartment that is to be utilized for the waste site (Map 1); this borehole is situated on the western side of the dolerite dyke forming the north-eastern boundary of the compartment.

The borehole depth is 31,6m and after drilling, it had a static water level of 6,3 mbgl. Since the main water strike was at 18 mbgl there is an available drawdown of 11,7m.

A step drawdown test run on this borehole comprised 4 discharge rates of 5,48 l/s, 9,4 l/s, 14,63 l/s and 22,26 l/s. During the 4th step the water level drew down steadily towards the pump inlet. The water level recovery trended back to completion.

A constant rate discharge test was run at 12,97 l/s for 48 hours. The drawdown increased steadily to 6,78m at the end of the test period. The aquifer is well developed as is seen by the transmissivity value of 375m²/d. The water level recovery trended towards completion, signifying that dewatering had not occurred.

Borehole 13-86409 (\pm 33m north-east of borehole 13-86408) as well as borehole 13-86406 (\pm 360m west of borehole 13-86408), were monitored during the test pumping of borehole 13-86408. Only 0,08m of lowering of the static water level occurred during the testing of 13-86408. This is not significant when taking into account the 12,97 l/s test yield of this borehole. Thus an effective hydrogeological boundary is present between these two boreholes. In contrast, monitoring of 13-86406 (\pm 360m to the west of 13-86408) indicated a steadily increasing drawdown to 4,6m by the end of the testing period. This confirms that these two boreholes are, in fact, interconnected within the same compartment.

There is thus evidence for an extensive, shallow, highly transmissive aquifer within the compartment earmarked for the waste disposal site. The testing has, in addition, proved that the two downstream dykes making up the boundaries to the compartment do form aquicludes and as such would effectively inhibit the flow of groundwater into adjacent compartments. The third boundary to the compartment earmarked for the waste site is formed by the dolerite dyke located upslope of the

waste site to the north of Mapoteng; this dyke forms a visible boundary to groundwater as is evident by the emergence of the spring along the contact zone.

TABLE 4: BOREHOLE ELEVATIONS AND REDUCED WATER LEVELS

Borehole Number	Elevation [mamsl]	Water level [mbgl]	Reduced water level [mamsl]	Step between adjacent boreholes [m]	Remarks
13-86403	1219,88	6,95	1 212,93	2,97	Step from inside the triangular compartment to the Mothibistad compartment (E → W).
13-86406	1220,27	4,37	1 215,90		
13-86408	1223,13	6,34	1 216,79	2,52	Step from the unnamed compartment to the triangular compartment (E → W).
13-86409	1223,74	4,43	1 219,31		
Mapoteng spring	1235,12		1235,12		

Further evidence of the compartmentalization of the dolomite by dolerite dykes is highlighted in Table 4. Here, distinct steps in the groundwater levels across the dykes forming the compartment boundaries are further evidence of the dykes forming aquicludes. Inspection of the reduced water rest levels indicate that the flow of groundwater is from the south-east to the north-west (see Map 1 also).

5.5. Chemical test results

Sampling of surface and groundwater sources in and around the proposed waste site was undertaken during the course of the borehole census and/or at the time of test pumping. The objective of the sampling exercise was to establish background chemistry for the groundwater which could then be used to monitor and assess groundwater quality in the future.

The water samples taken during the course of the investigations were

submitted to the laboratories of Messrs. McLachlan and Lazar (Pty) Ltd. and the results of the tests are summarized in Table 5.

With reference to this table it is evident that the groundwater quality is within the required limits for potable water as per the specifications adopted by the Department of Water Affairs in May 1992. However, inspection of bacteriological test results indicates an unacceptably high bacteria count within water from the compartment earmarked for the waste site, as well as in water from the Mapoteng spring, which is the major source of recharge for the compartment. The bacteriological samples are, however, highly susceptible to contamination and the water sources should be resampled to confirm the levels of bacteriological pollution.

6. RECOMMENDATION AND CONCLUSIONS

6.1. General

The waste site identified has some disadvantages in the restricted excavation depth and limited availability of cover material; its main advantage is that it is underlain by a relatively small, unexploited groundwater compartment. The present waste site, situated within a doline to the north-west of Mothibistad, is located in the Mothibistad groundwater compartment which currently supplies primary water to Mothibistad, Magobe, Seoding, Ga-Ntatelang, Mokala-Mosesane and Batlharos. Pollution is already evident within this compartment; concentrations of pollutants are highest in the vicinity of Mothibistad, and it is likely that these will pose a risk to public health in the near future. It is partly for this reason that a new wellfield is being developed currently to supply Mothibistad with water drawn from the unpolluted Mapoteng Compartment. If pollution continues to increase within the Mothibistad Compartment, water supplies to the other villages listed above are likely to become increasingly affected, with potentially serious consequences

TABLE 5: SUMMARY OF WATER QUALITY TEST RESULTS

Constituent	Water source/borehole number					Maximum Permissible Limit
	13-86406	13-86408	Spring	T10634	MOT 4	
Total plate count [no./ml]	> 1 000		5	130		100
E coli [no./ml]	present		present	absent		nil
Total coliforms [no./ml]	14		83	> 1 000		10
Faecal coliforms [no./ml]	1		4	0		
pH	7.53	7.45	7.54	7.5	7.85	5.5 - 9.0
Conductivity [ms/m]	99.9	94.5	67.5	105	72.5	≤ 400
Total dissolved solids	530	540	430	820	480	≤ 2 000*
Total hardness (CaCO ₃)	522	530	371	562	401	≤ 1 300
Total alkalinity (CaCO ₃)	496	492	348	448	340	
Calcium (Ca)	59	73	76	85	70	
Magnesium (Mg)	91	85	44	85	55	≤ 200
Sodium (Na)	21	16.0	13.2	44	5.1	≤ 800
Potassium (K)	1.8	1.3	<0.1	0.8	<0.1	
Bicarbonate (HCO ₃)	605	600	424	546	414	
Carbonate (CO ₃)	nil	nil	nil	nil	nil	
Chloride (Cl)	45	37	18	103	26	≤ 1 200
Sulphate (SO ₄)	20	45	3	41	12	≤ 1 200
Nitrate (NO ₃)	7	0.5	19.4	39	35	≤ 80
Fluoride (F)	0.5	0.3	0.3	0.5	0.3	≤ 3.0
Dissolved iron (Fe)	<0.1	<0.01	<0.01	<0.01	<0.01	≤ 2
Lead (Pb)	<0.01	<0.01	<0.01	<0.01	<0.01	≤ 0.1*
COD	10	<10	10	10	10	≤ 75*

All constituents in mg/l unless otherwise stated.

* - Maximum limit imposed by the Department of Water Affairs (South Africa).

* - as per SABS 241-1971.

for large local populations. The principal sources of this pollution are pit latrines and uncontrolled surface runoff from the urban area, but the existing refuse site will certainly contribute increasingly to this problem if it is kept in its present location.

Of importance, however, is the fact that the new waste site identified should only be brought into operation once the extraction of groundwater from the Mapoteng Compartment commences. This will ensure that the Mapoteng spring, presently the most significant source of recharge available to the small compartment under consideration, is attenuated; present estimates indicate that the extraction from the Mapoteng Compartment is likely to be of a similar order to discharge from the spring. Risks of overflow from the compartment containing the new waste site into the Mothibistad compartment will thus be minimized.

6.2. Existing waste site

As mentioned above the existing waste site, situated \pm 1,5km north-east of the four-way intersection at Mothibistad, has a high pollution potential; it therefore strongly recommended that the existing refuse site be closed as soon as possible and that, if possible, the refuse already deposited be removed and disposed of at a more suitable site. An alternative solution is that the waste site be suitably contained; should the latter option be implemented it is recommended the groundwater quality in the immediate vicinity of the waste site be monitored regularly so that remedial measures can be implemented should leachate be released from the site.

Cover material suitable for containment of the site is available from an existing borrow pit approximately 700m from the four-way intersection along the Mothibistad/Kuruman tar road. The cover material should be compacted in controlled layers not exceeding 150mm thick and should be compacted to a minimum of 96 % Proctor density. The cover material should be landscaped

so as to ensure ponding of water does not occur either on the waste or in close proximity to the waste.

6.3. Excavatability of cover material at the proposed new site

Trenches for waste at the proposed disposal site are unlikely to attain depths in excess of 2 - 3m. Below this depth hard rock dolomite with pinnacles and boulders is anticipated. Of note is large dolomite boulders and pinnacles may protrude into the transported soil.

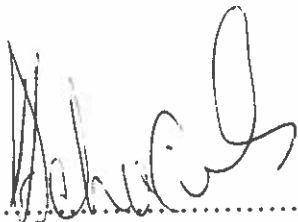
6.4. Cover material at the proposed waste site

Discussions with Mr. M. Cotton of Messrs. Jeffares and Green (Bophuthatswana) have indicated that the waste site design envisaged for Mothibistad will include a 2 - 3 metre high berm around the perimeter of the proposed site with trenches excavated within it; these trenches will be covered with excavated material once they are full. The material excavated from the trenches is thus likely to comprise both orange-brown, silty sand (transported soils of mixed origin) and chert gravels (alluvial); this mixed material is likely to have permeabilities of the order of 10^{-3} cm/s once remoulded to 96 % Proctor density. As the cover material is unlikely to offer any significant resistance to the infiltration of precipitation, it is recommended that the backfill material is well compacted (to a minimum of 96 % Proctor density) and landscaped to ensure that no ponding of water occurs either on or adjacent to the backfilled areas.

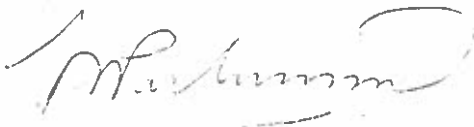
As mentioned above, the site is to be screened by a 2 - 3 metre high berm around its perimeter; material for this berm may be obtained either from the small knoll south-west of the proposed waste site or from the windblown sand that has accumulated against the dolerite dykes.

6.5. Monitoring

While it has been accepted that the groundwater in the small compartment earmarked to host the waste site may become polluted with time, it is recommended that borehole 13-86406 be sampled bi-annually to assess the water quality. This borehole is situated down-slope of the proposed waste site and will readily reflect the effects of leachate emanating from the waste site.

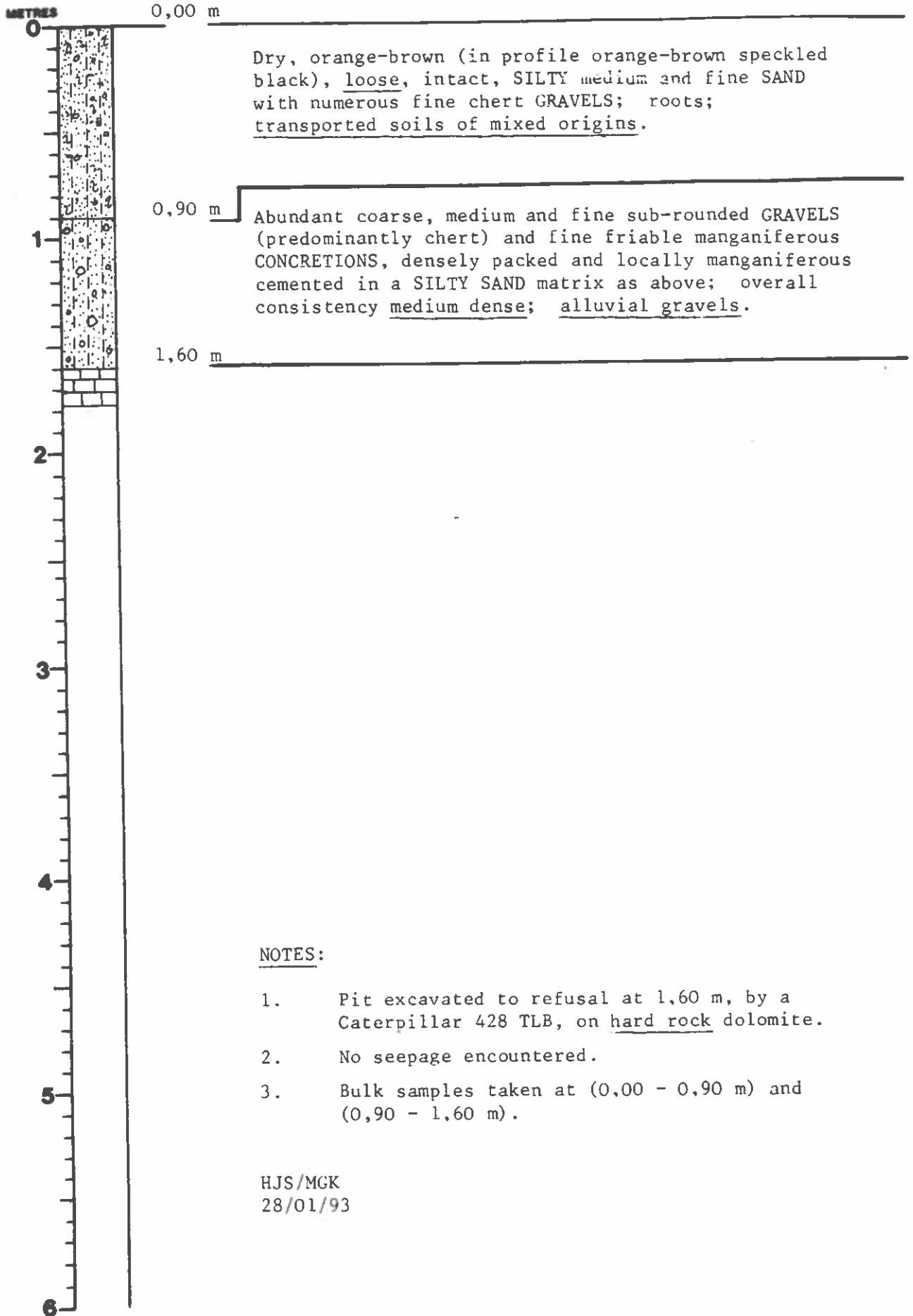


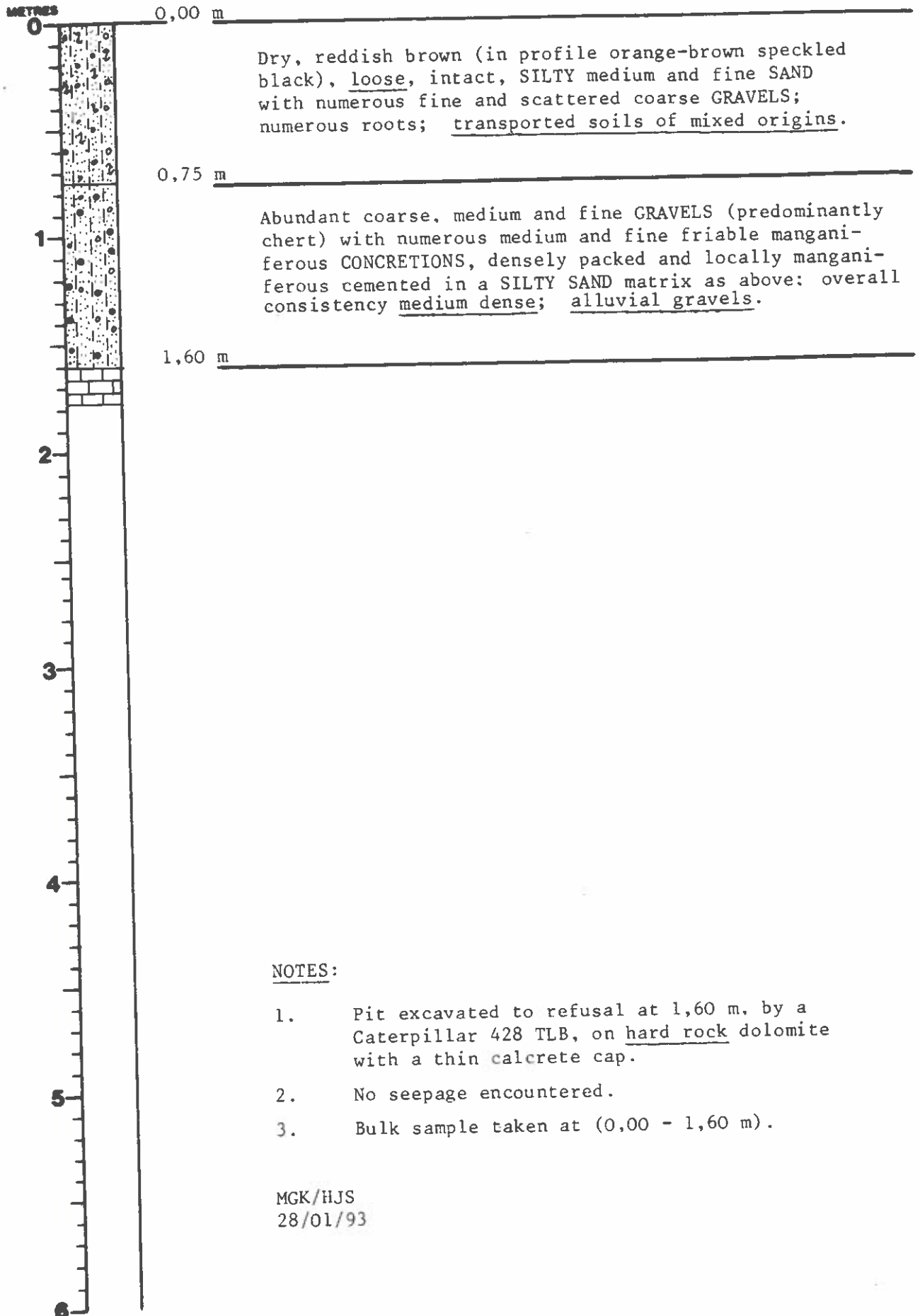
.....
H.J. SCHURINK, Sci.Nat., B.Sc.(Hon).



.....
T.C. PARTRIDGE, Sci.Nat., Ph.D.

APPENDIX - A
SOIL PROFILES





METRES

0,00 m



Dry, orange-brown (in profile orange-brown speckled black), loose, intact, SILTY medium and fine SAND with numerous fine chert GRAVELS; roots; transported soils of mixed origins.

1,20 m Abundant medium and fine manganiferous CONCRETIONS and numerous fine GRAVELS (predominantly chert), densely packed and weakly cemented in a SILTY SAND matrix as above; overall consistency dense; nodular manganocrete.

1,60 m Abundant coarse, medium and fine sub-angular chert GRAVELS, densely packed in a SILTY SAND matrix; overall consistency medium dense; alluvial gravels.

2,20 m

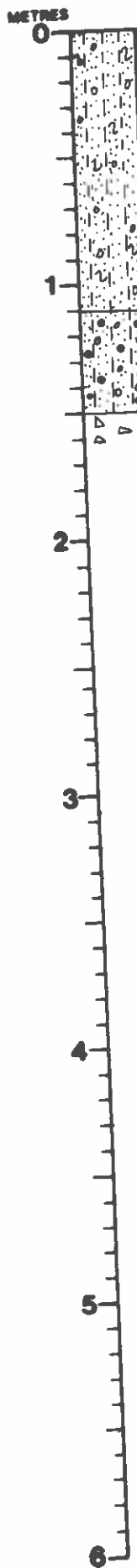
Slightly moist, yellow-brown (in profile yellow-brown mottled buff and speckled black), firm, intact, CLAYEY SAND with numerous angular chert, and occasional vein quartz GRAVELS and hard calcrete NODULES; locally calcareous cemented alluvium.

3,20 m

NOTES:

1. Pit excavated to refusal at 3,20 m, by a Caterpillar 428 TLB, on hard rock calcrete boulders.
2. No seepage encountered.
3. Disturbed sample taken at (2,20 - 3,20 m).

HJS/MGK
28/01/93



0,00 m

Dry, orange-brown (in profile orange-brown speckled black), loose, intact, SILTY medium and fine SAND with numerous fine chert gravels; roots; transported soils of mixed origins.

1,10 m

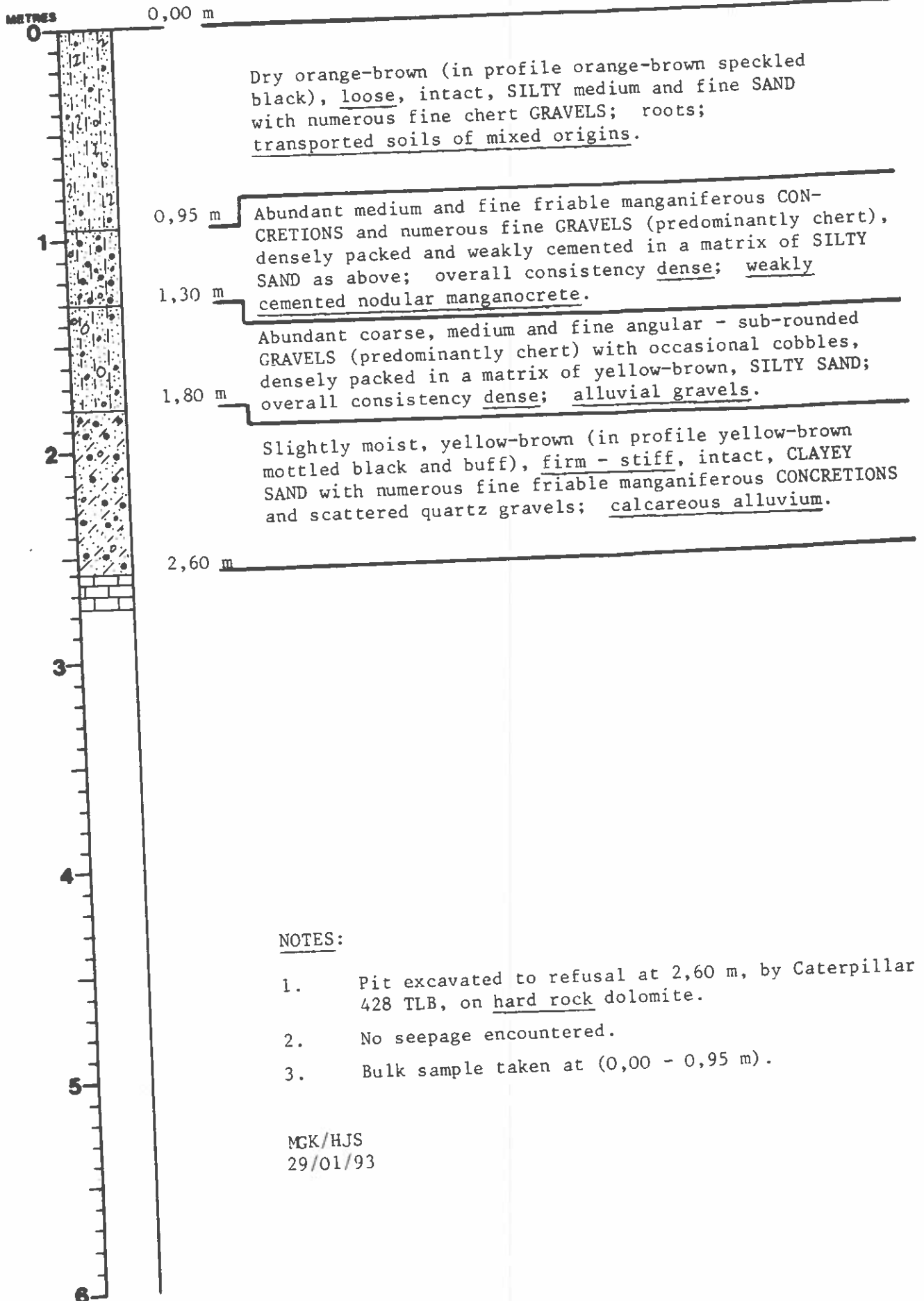
Abundant medium and fine friable manganiferous CONCRETIONS with numerous coarse, medium and fine chert and vein quartz GRAVELS, densely packed and weakly cemented in a matrix of SILTY SAND as above; overall consistency medium dense; nodular manganocrete.

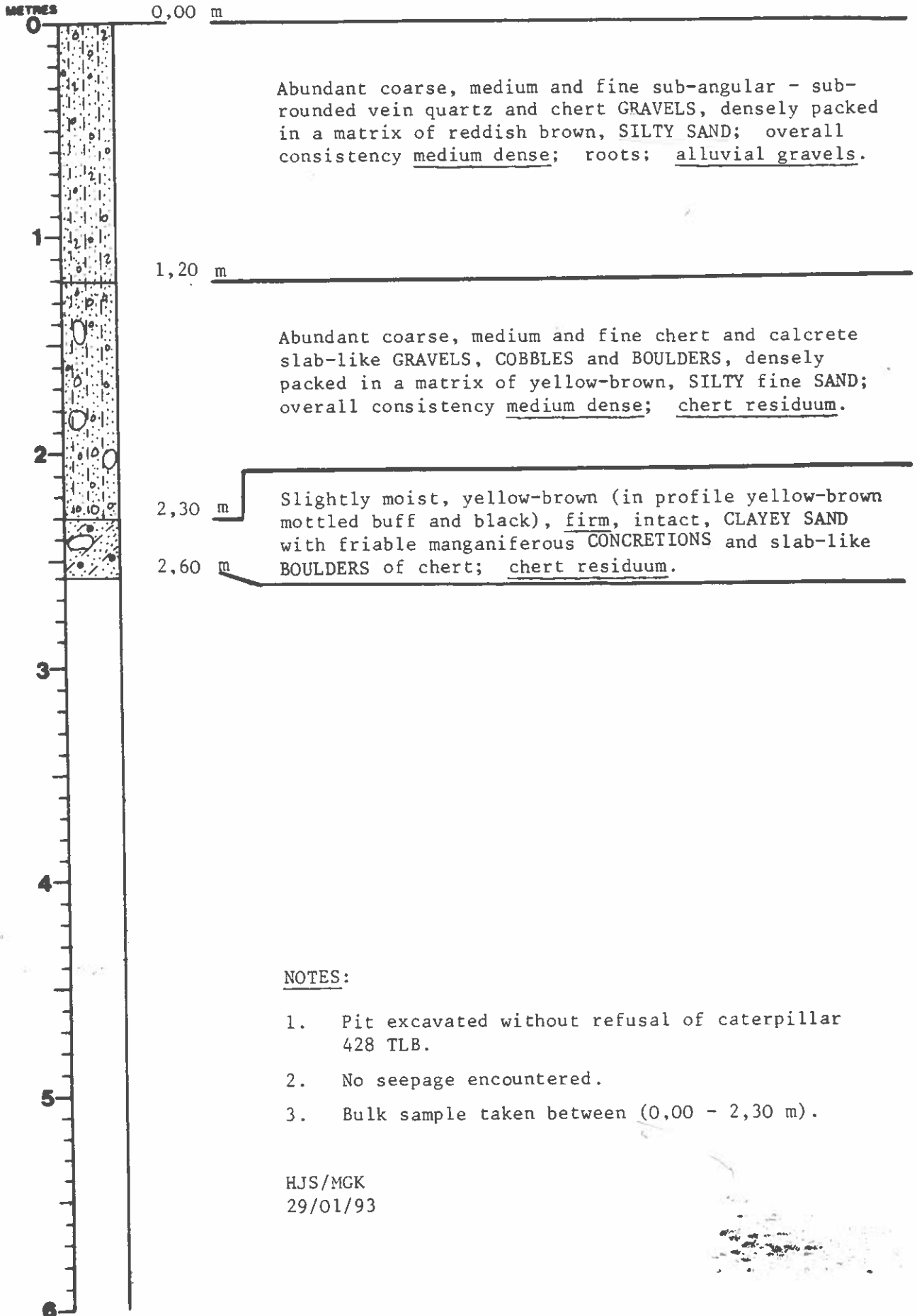
1,50 m

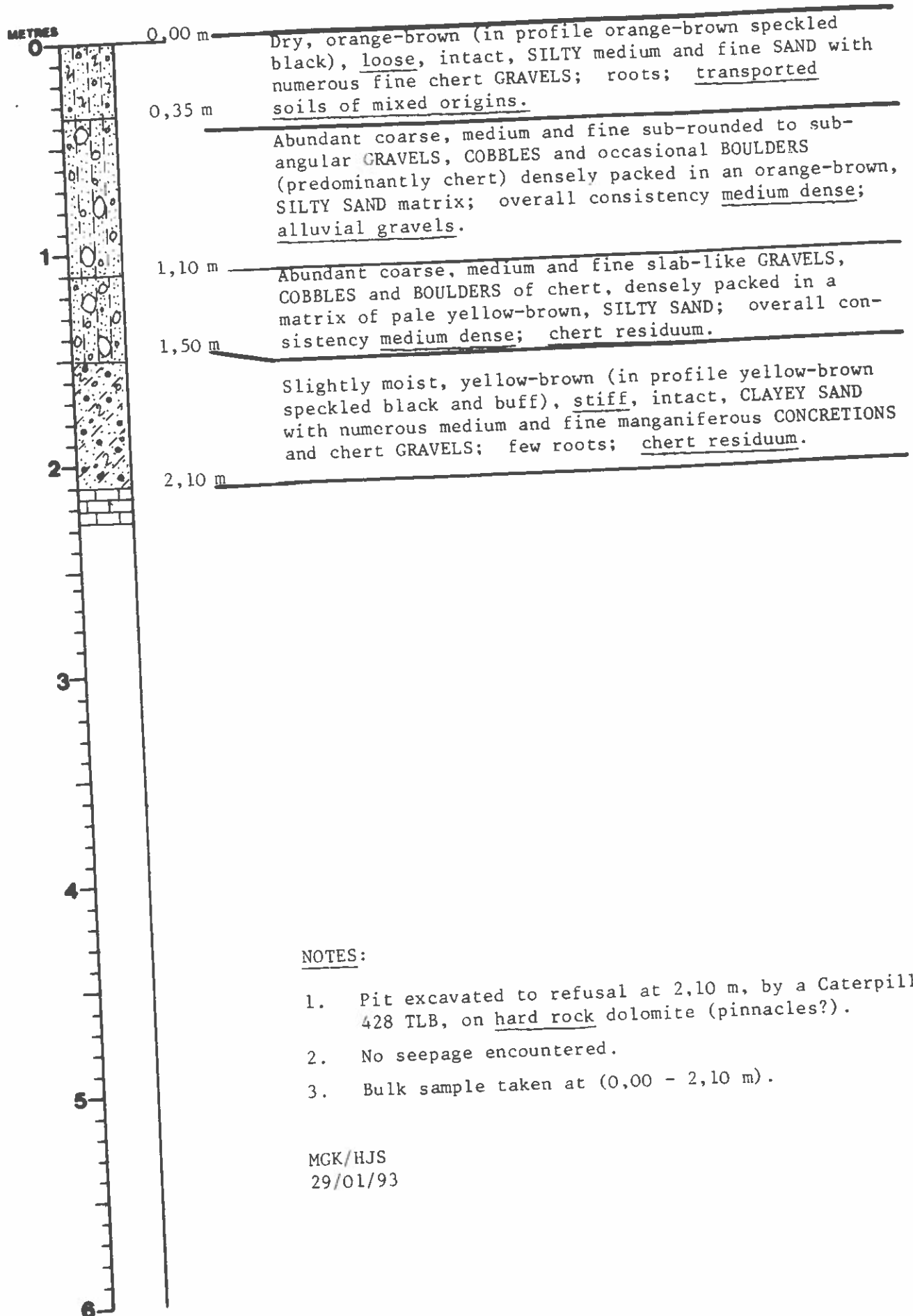
NOTES:

1. Pit excavated to refusal at 1,50 m, by a Caterpillar 428 TLB, on hard rock chert.
2. No seepage encountered.
3. No samples taken.

MGK/HJS
28/01/93



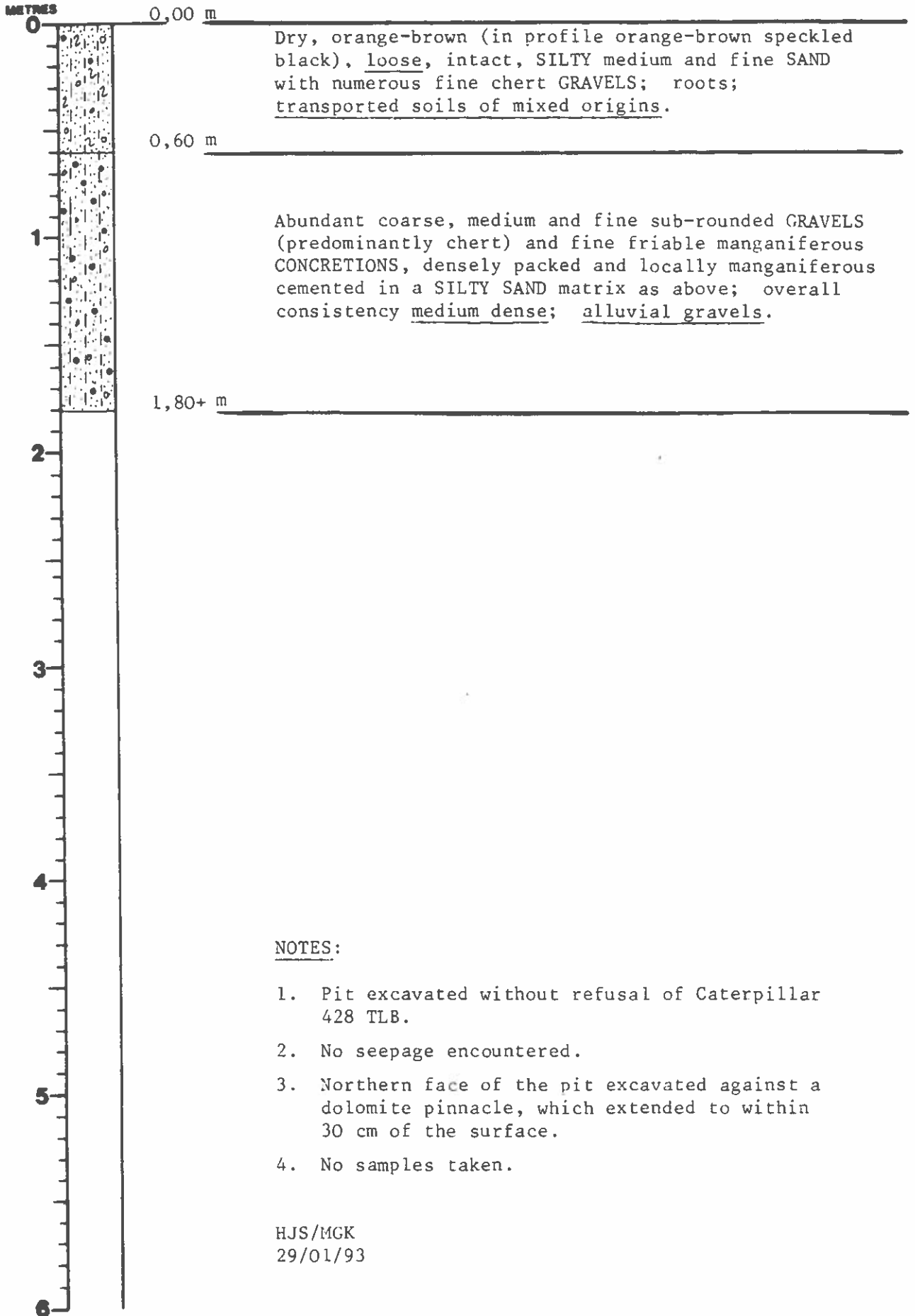




NOTES:

1. Pit excavated to refusal at 2,10 m, by a Caterpillar 428 TLB, on hard rock dolomite (pinnacles?).
2. No seepage encountered.
3. Bulk sample taken at (0,00 - 2,10 m).

MGK/HJS
29/01/93



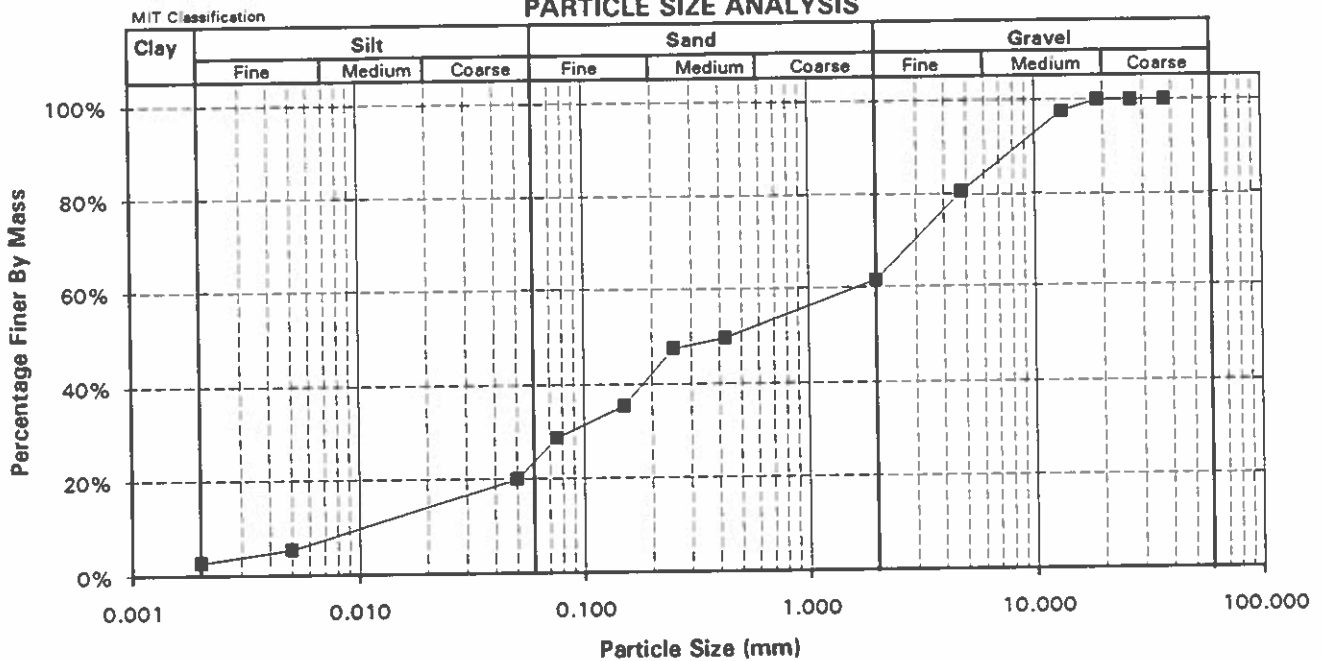
APPENDIX - B
LABORATORY TEST RESULTS



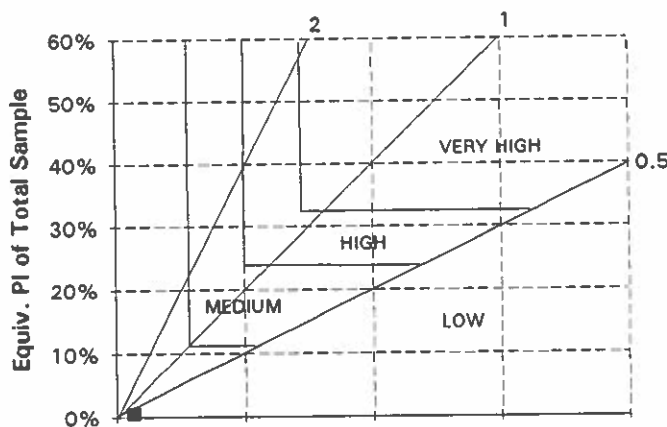
FOUNDATION INDICATOR

Client Project Site	Partridge Maud & Associates Mathibistad Waste	Date Job #	04/02/93 15760					
Test Pos Sample	TP2 Light brown soil	Depth	0-1.6m					
SIEVE ANALYSIS		ATTERBERG LIMITS						
Sieve(mm)	% Passing	Sieve(mm)	% Passing		Test 1	Test 2		
37.500	100%	0.250	47%	Liquid Limit	22.6%	22.1%	PRA Classification	A.2.4
26.500	100%	0.150	35%	Average	22.4%		Unified Classification	SM
19.000	100%	0.075	29%	Plastic Limit	21.5%	21.1%	PI of whole sample	0.5%
13.200	98%	0.050	20%	Average	21.3%		% Gravel	38%
4.750	80%	0.005	5%	Plasticity Index (PI)	1.0%		% Sand	41%
2.000	62%	0.002	3%	Linear Shrinkage	0.0%		% Silt	18%
0.425	50%			Grading Modulus	1.60		% Clay	3%

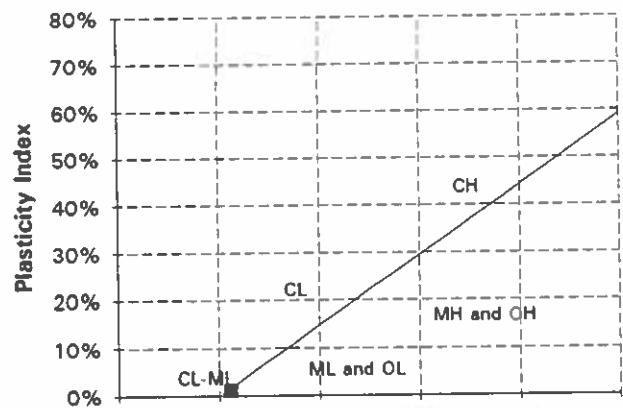
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



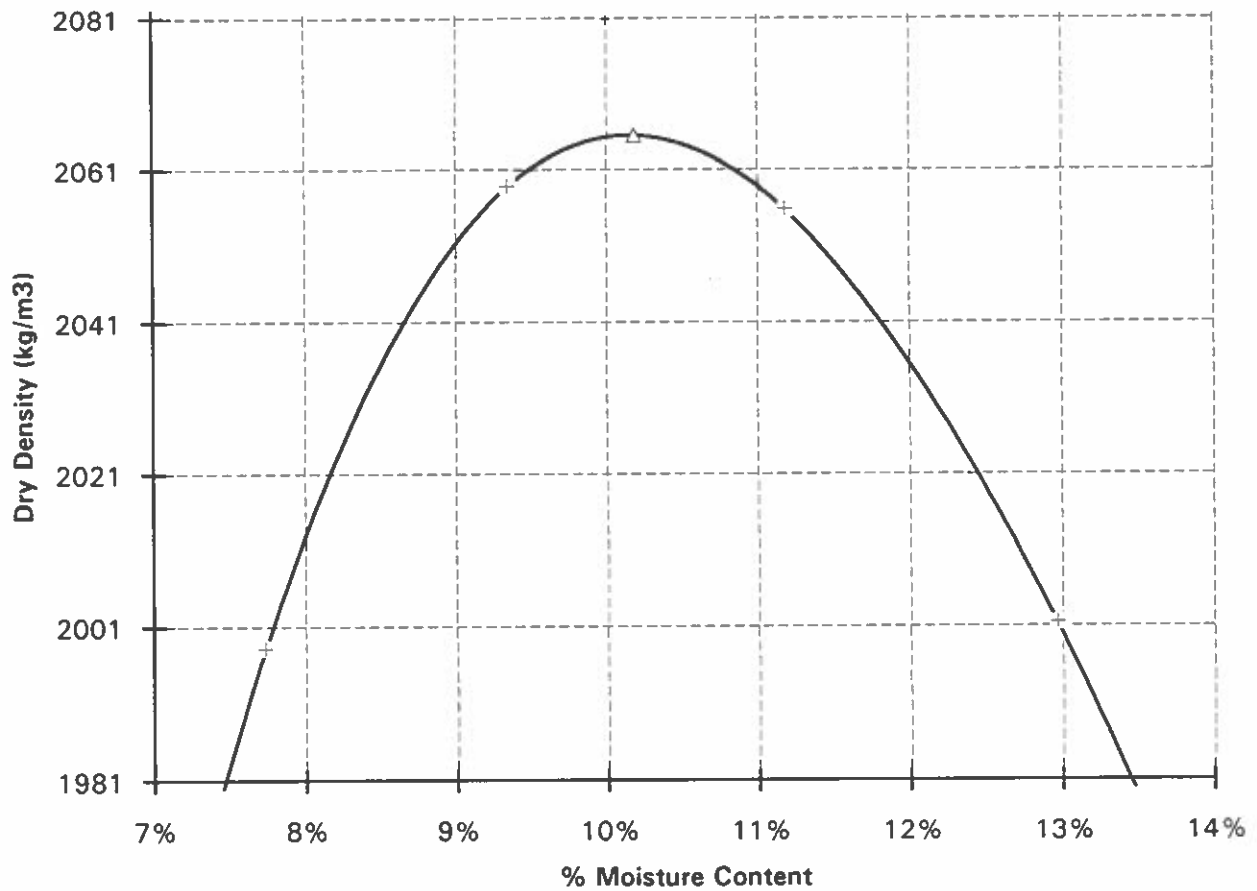
CASAGRANDE 'A' LINE





MOISTURE DENSITY TEST

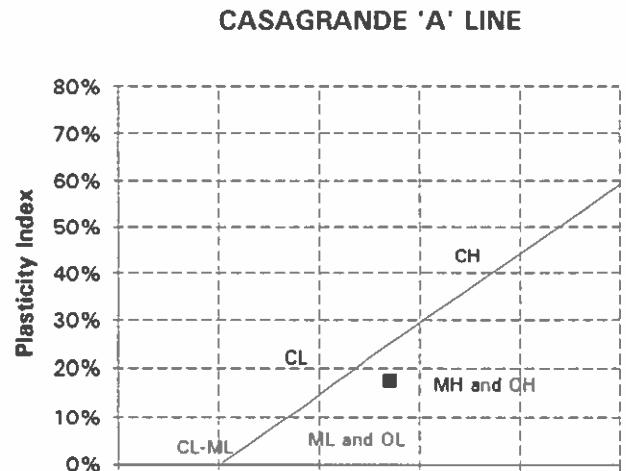
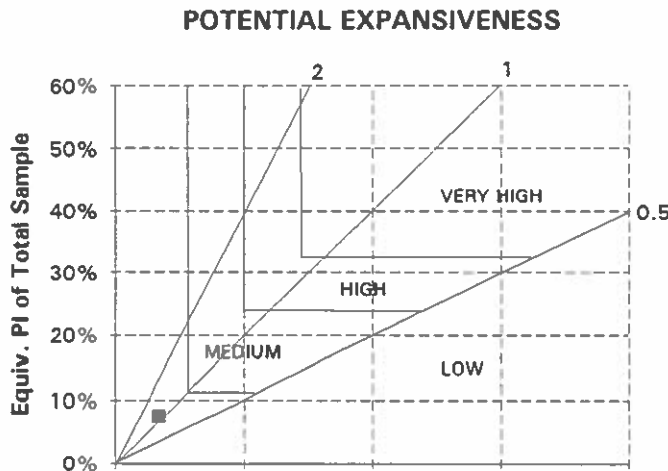
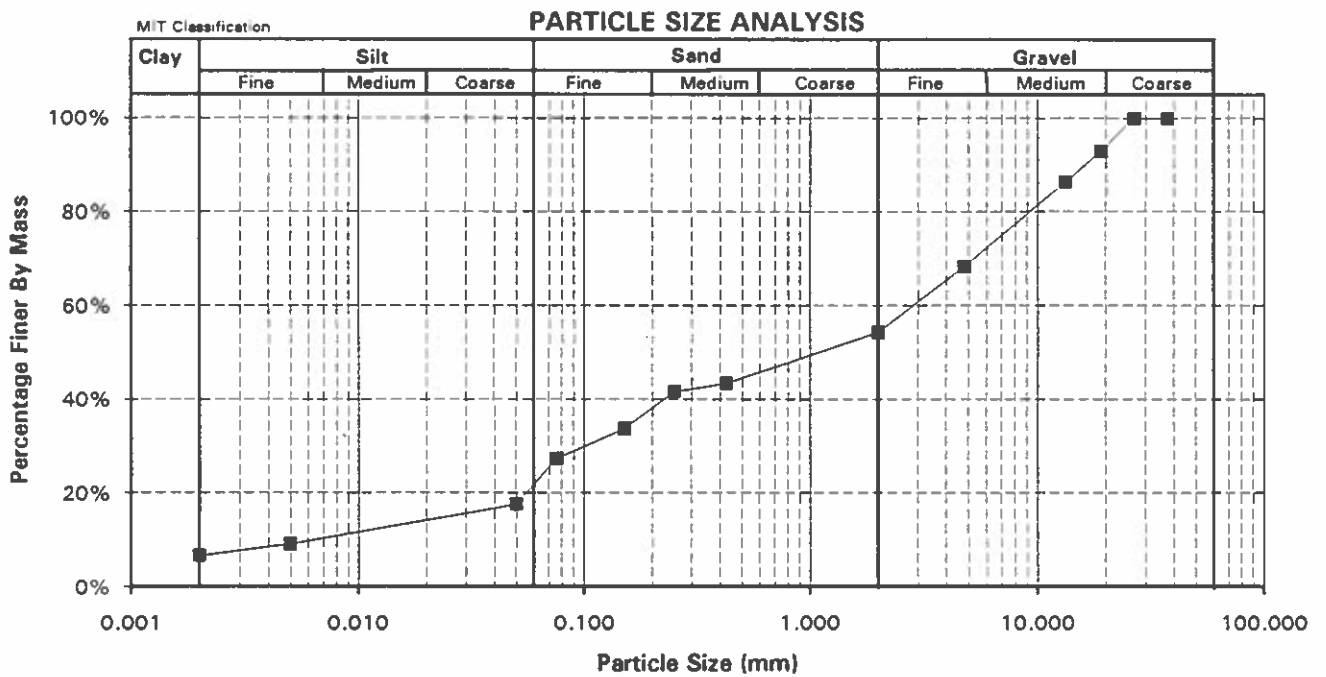
Client Project Site	PARTRIDGE, MAUD & ASS. Mothibistad Waste		Date Job #	02/02/93 15760
Test Pos Sample	TP.2		Depth	0.0-1.6m
	Moisture Content	Dry Density (kg/m ³)	Maximum Dry Density (kg/m ³)	2066
1	9.3%	2058.7	Optimum Moisture Content	
2	11.2%	2055.7		10.2%
3	13.0%	2001.5		
4	7.7%	1998.2		
5				
6				
Compactive Effort Remarks		PROCTOR Unstabilised		





FOUNDATION INDICATOR

Client Project Site	Partridge Maud & Associates Mathibistad Waste			Date	04/02/93		
	-			Job #	15760		
Test Pos Sample	TP3 Light brown soil			Depth	2.2-3.2m		
SIEVE ANALYSIS				ATTERBERG LIMITS			
Sieve(mm)	% Passing	Sieve(mm)	% Passing		Test 1	Test 2	
37.500	100%	0.250	42%	Liquid Limit	53.2%	54.4%	PRA Classification
26.500	100%	0.150	34%	Average	53.8%		Unified Classification
19.000	93%	0.075	27%	Plastic Limit	36.4%	36.6%	Pi of whole sample
13.200	86%	0.050	18%	Average	36.5%		% Gravel
4.750	68%	0.005	9%	Plasticity Index (Pi)	17.3%		% Sand
2.000	54%	0.002	7%	Linear Shrinkage	8.7%		% Silt
0.425	43%			Grading Modulus	1.75		% Clay
							A.2.7
							SM
							7.5%
							46%
							36%
							12%
							7%

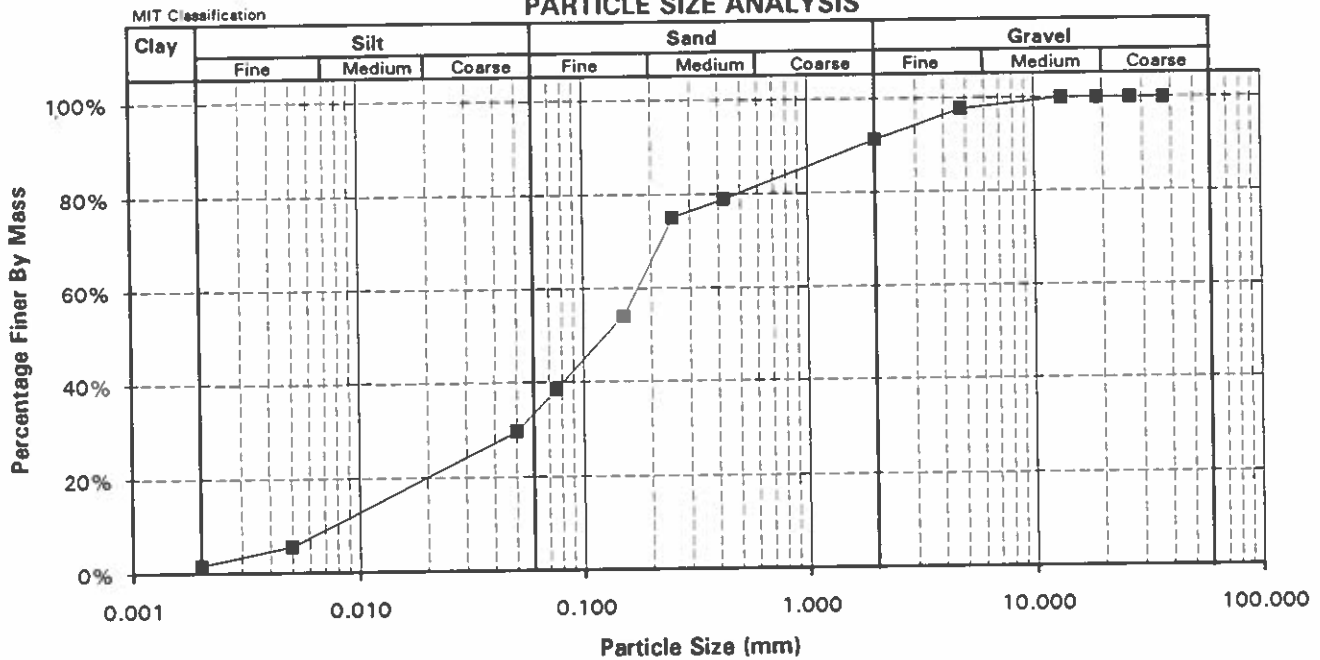




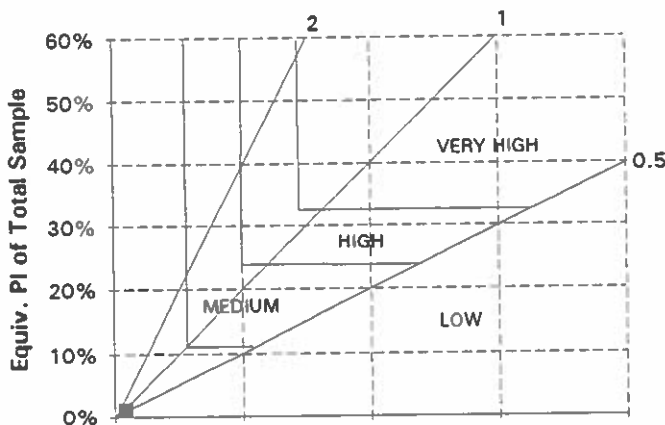
FOUNDATION INDICATOR

Client Project Site	Partridge Maud & Associates Mathibistad Waste		Date Job #	04/02/93 15760				
Test Pos Sample	TP5 Brown soil		Depth	0-0.95m				
SIEVE ANALYSIS				ATTERBERG LIMITS				
Sieve(mm)	% Passing	Sieve(mm)	% Passing		Test 1	Test 2		
37.500	100%	0.250	75%	Liquid Limit	21.9%	21.9%	PRA Classification	A.4
26.500	100%	0.150	54%	Average	21.9%		Unified Classification	SM
19.000	100%	0.075	38%	Plastic Limit	20.1%	20.6%	PI of whole sample	1.2%
13.200	100%	0.050	29%	Average	20.4%		% Gravel	9%
4.750	98%	0.005	6%	Plasticity Index (PI)	1.5%		% Sand	61%
2.000	91%	0.002	2%	Linear Shrinkage	0.0%		% Silt	29%
0.425	79%			Grading Modulus	0.91		% Clay	2%

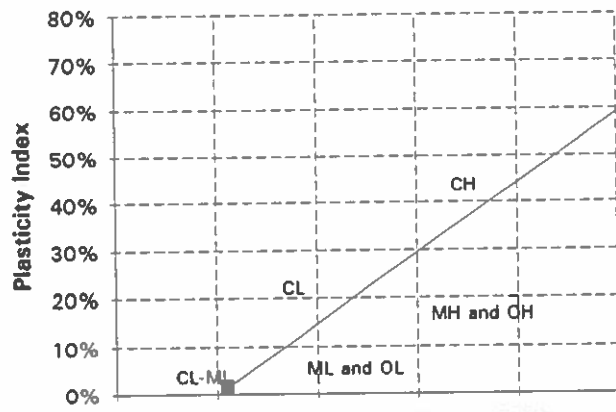
PARTICLE SIZE ANALYSIS



POTENTIAL EXPANSIVENESS



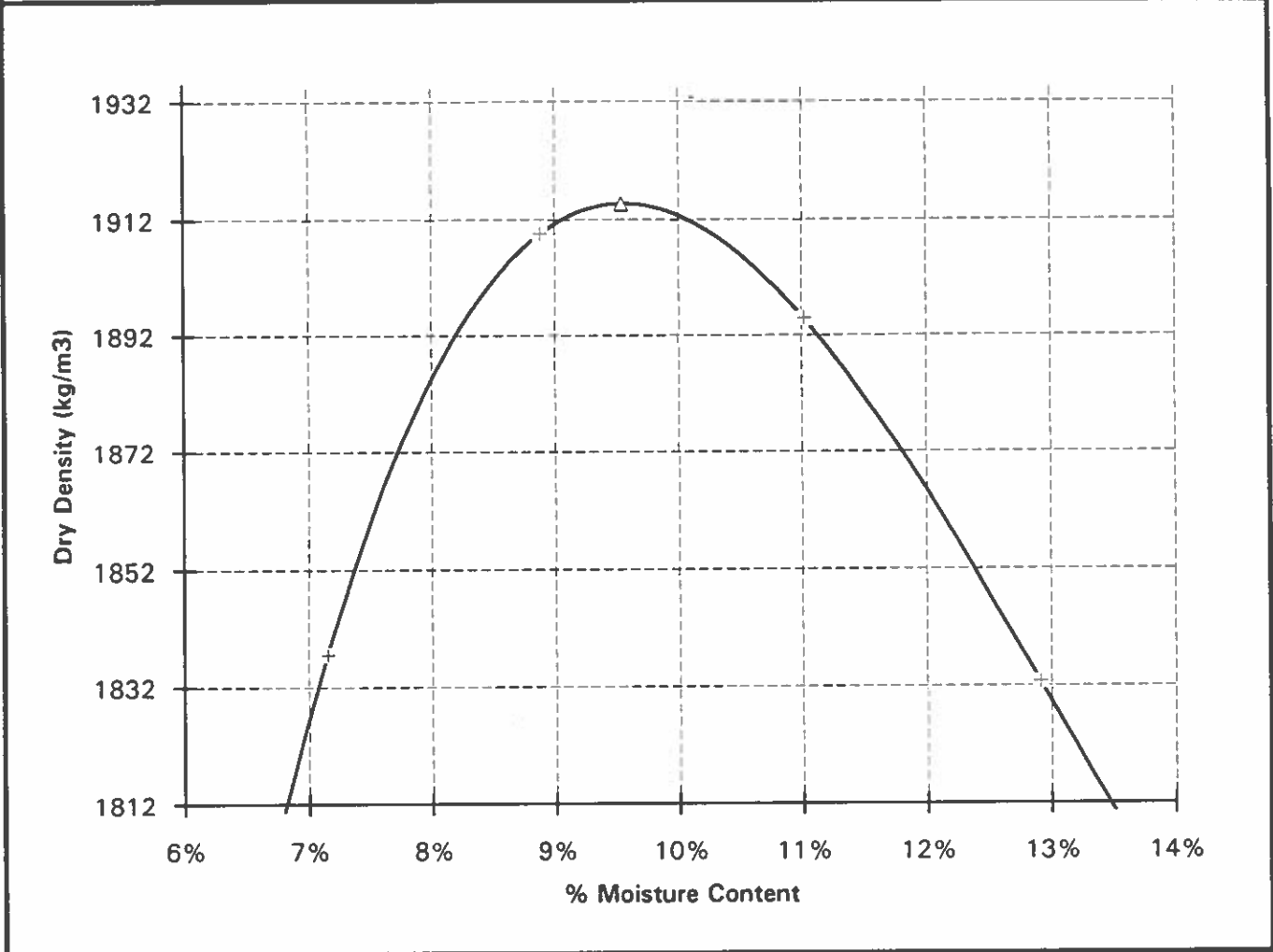
CASAGRANDE 'A' LINE





MOISTURE DENSITY TEST

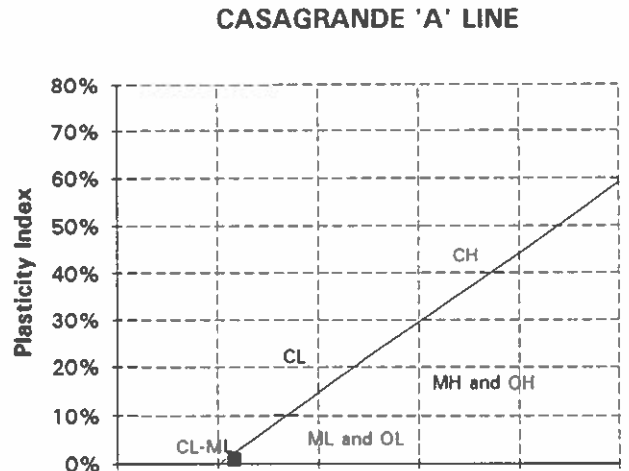
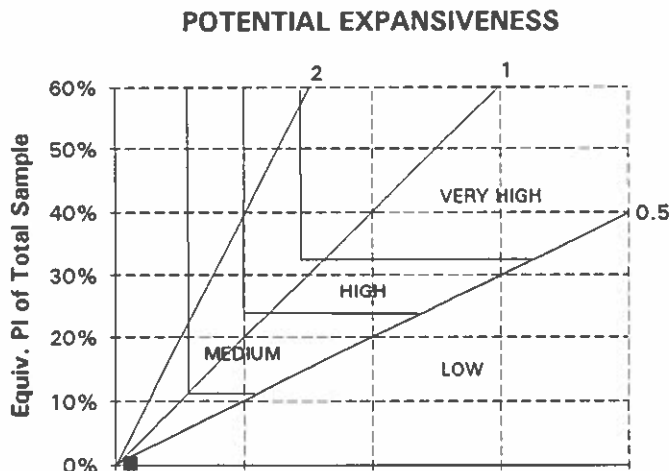
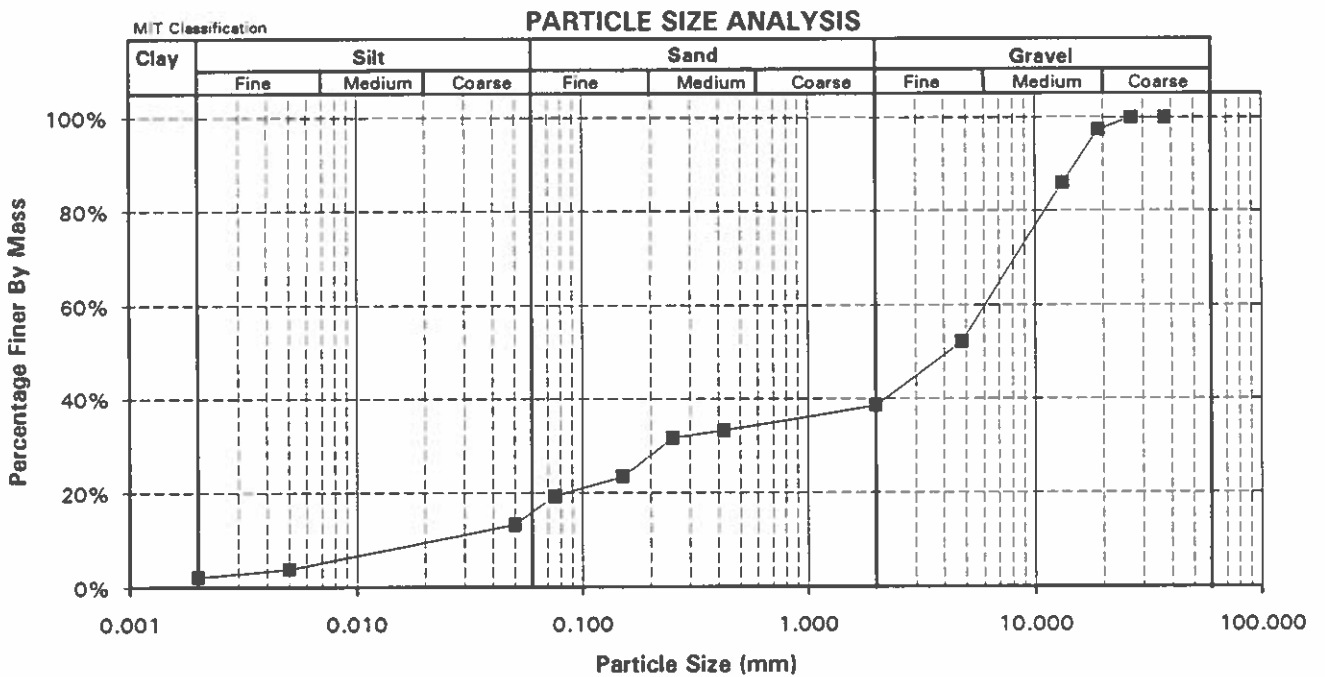
Client Project Site	PARTRIDGE, MAUD & ASS. Mothibistad Waste		Date Job #	02/02/93 15760
Test Pos Sample	TP.5		Depth	0.0-0.95m
	Moisture Content	Dry Density (kg/m3)	Maximum Dry Density (kg/m3)	1915
1	11.0%	1894.9	Optimum Moisture Content	
2	8.9%	1909.5		
3	12.9%	1832.7		
4	7.2%	1837.6		
5				
6				
Compactive Effort Remarks	PROCTOR Unstabilised			





FOUNDATION INDICATOR

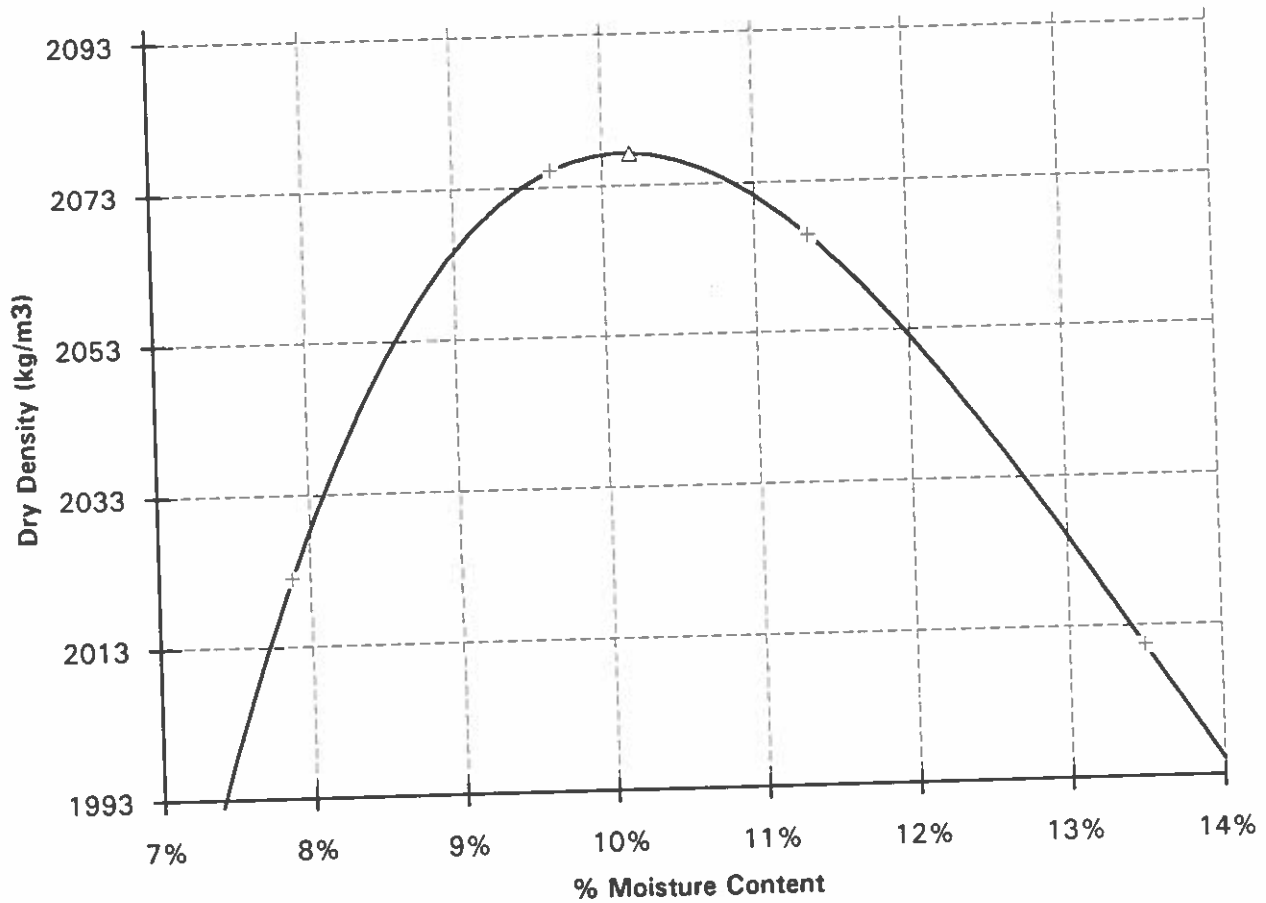
Client Project Site	Partridge Maud & Associates Mathibistad Waste			Date Job #	04/02/93 15760	
Test Pos Sample	TP7 Brown soil			Depth	0-2.1m	
SIEVE ANALYSIS				ATTERBERG LIMITS		
Sieve(mm)	% Passing	Sieve(mm)	% Passing		Test 1	Test 2
37.500	100%	0.250	32%	Liquid Limit	23.4%	23.1%
26.500	100%	0.150	23%	Average	23.2%	
19.000	97%	0.075	19%	Plastic Limit	22.2%	22.5%
13.200	86%	0.050	13%	Average	22.3%	
4.750	52%	0.005	4%	Plasticity Index (PI)	0.9%	
2.000	39%	0.002	2%	Linear Shrinkage	0.0%	
0.425	33%			Grading Modulus	2.09	
				PRA Classification	A.1.b	
				Unified Classification	SM	
				PI of whole sample	0.3%	
				% Gravel	61%	
				% Sand	25%	
				% Silt	12%	
				% Clay	2%	





MOISTURE DENSITY TEST

Client Project Site	PARTRIDGE, MAUD & ASS. Mothibistad Waste	Date Job #	02/02/93 15760
Test Pos Sample	TP.7	Depth	0.0-2.1m
	Moisture Content	Dry Density (kg/m³)	Maximum Dry Density (kg/m³)
1	11.4%	2065.8	2077
2	13.5%	2010.4	
3	9.7%	2075.2	Optimum Moisture Content
4	7.9%	2022.0	
5			10.2%
6			
Compactive Effort Remarks	PROCTOR Unstabilised		



APPENDIX - C
GEOPHYSICAL SURVEY TEST RESULTS

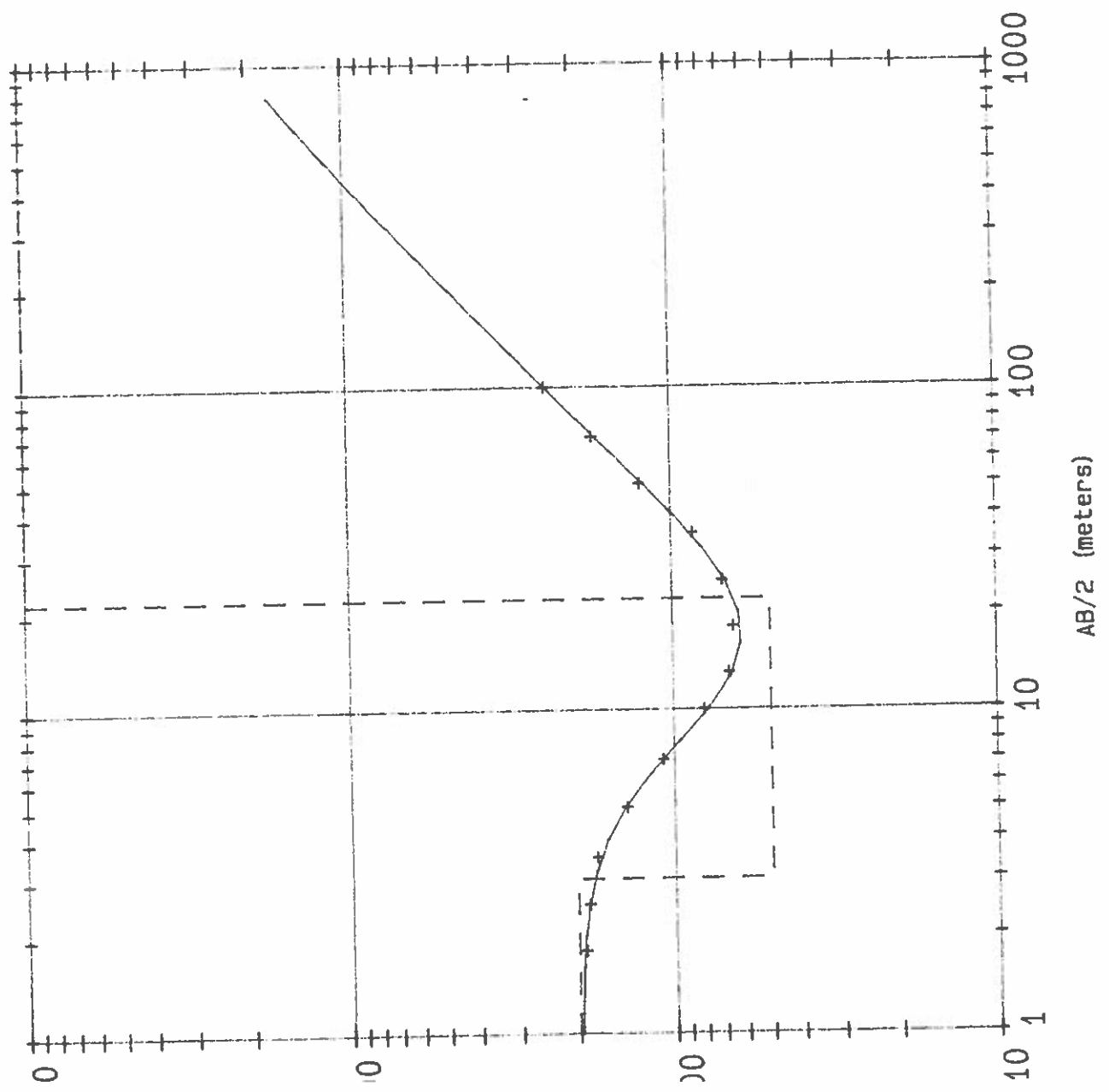
+ Field data
 — Computer model
 - - - r model

Mothibistad Waste Site

East 10m

GEOLOGY

Dolerite/Dolomite

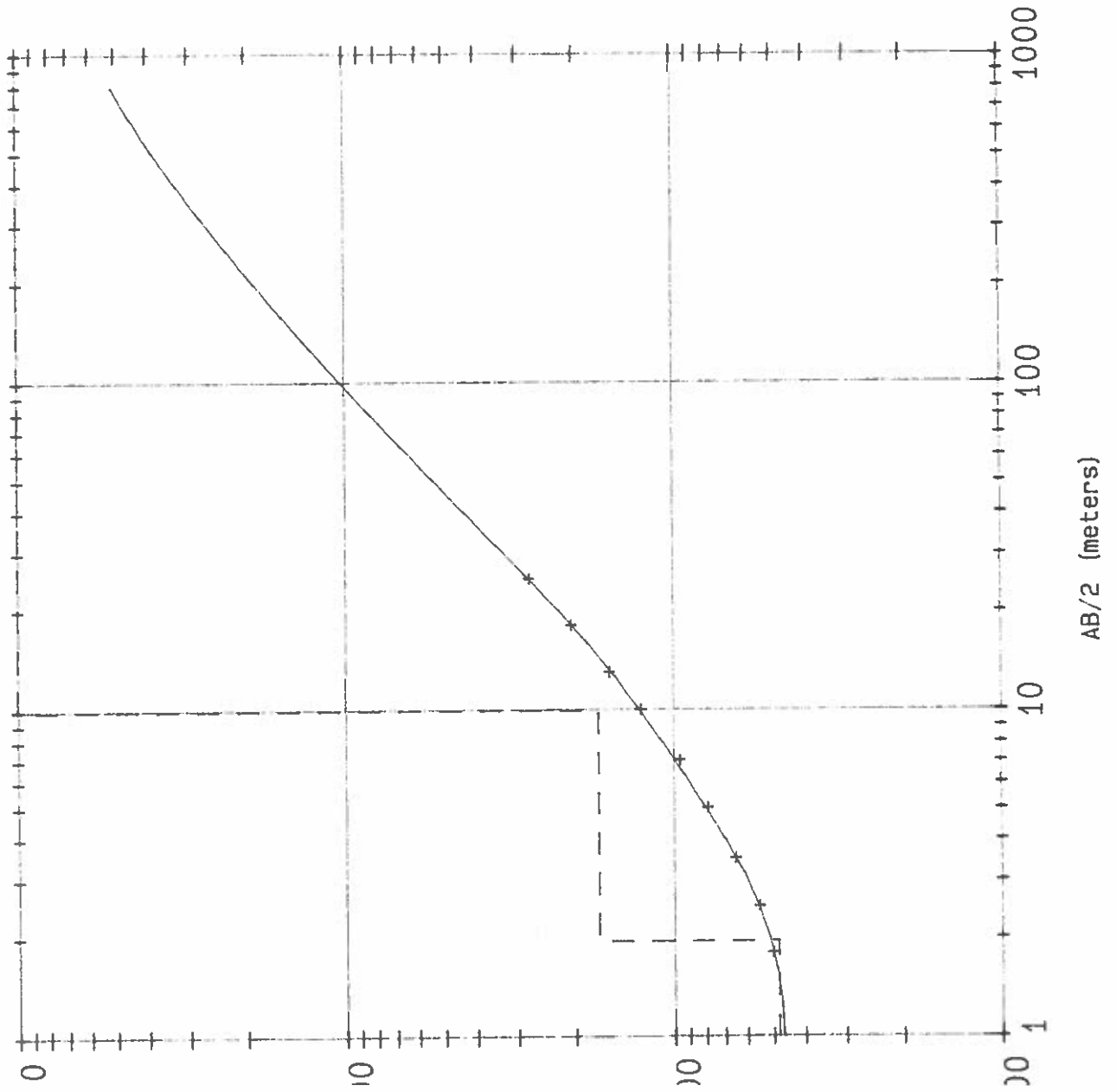


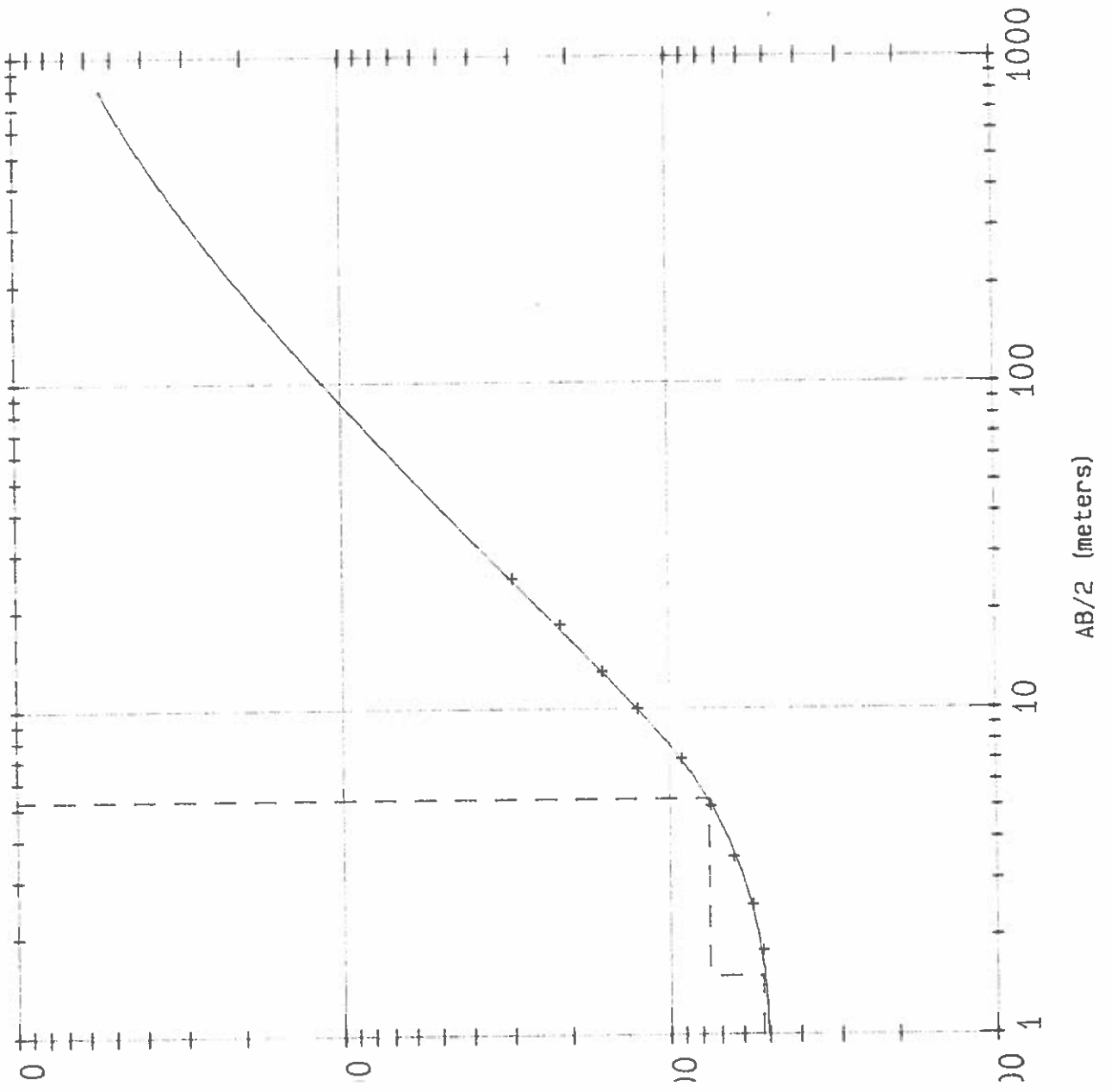
+ Field data
 — Computer model
 - - - d - r model

Mothibistad Waste Site

P (B) 50m

GEOLOGY
 Dolomite





+ Field data
 — Computer model
 - - - d - r model

Mothibistad Waste Site

P (B) 55m

GEOLOGY
 Dolomite

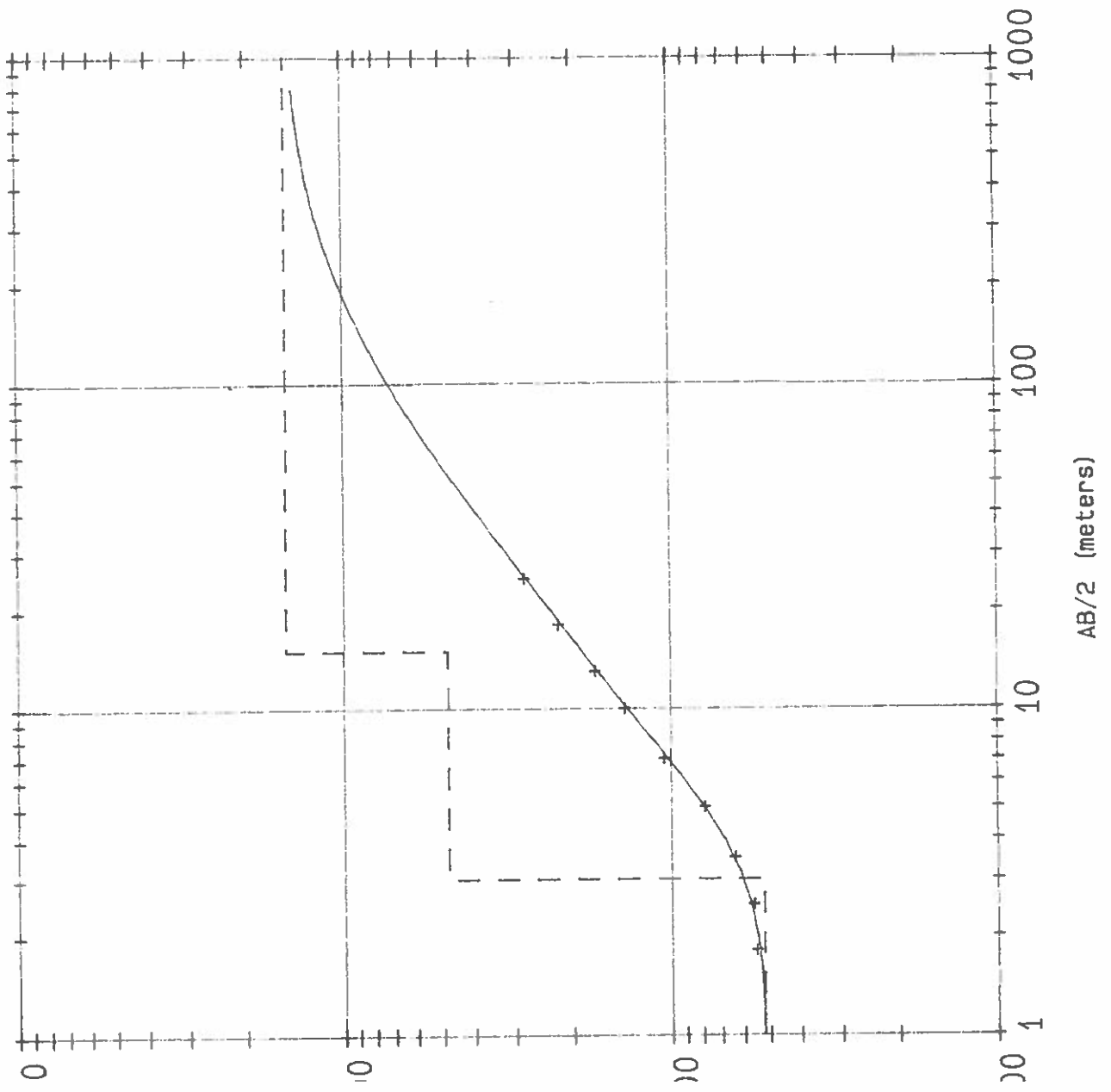
AB/2 (meters)

+ Field data
 — Computer model
 - - - d - r model

Mothibistad Waste Site

P (B) 60m

GEOLOGY
 Dolomite

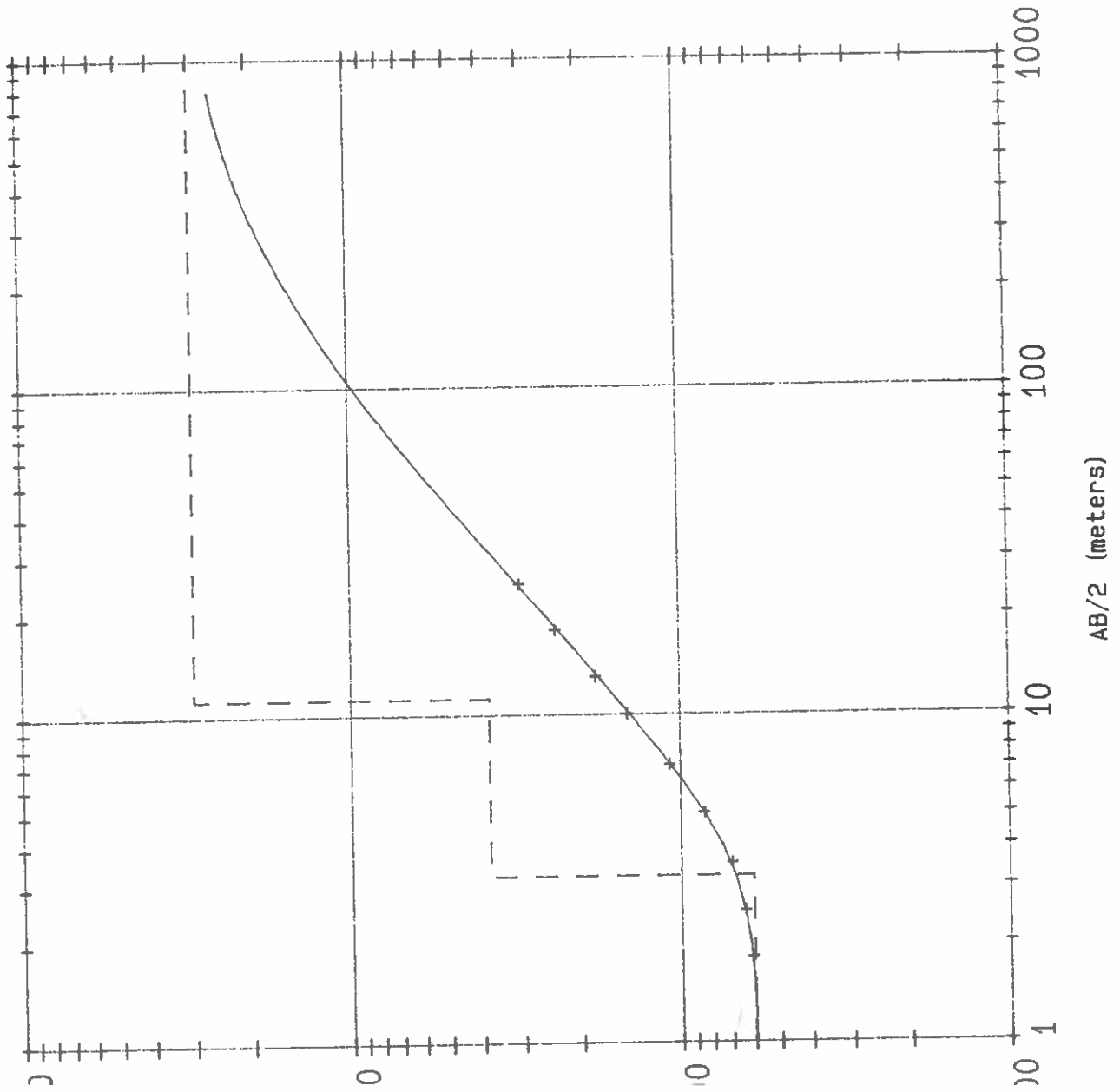


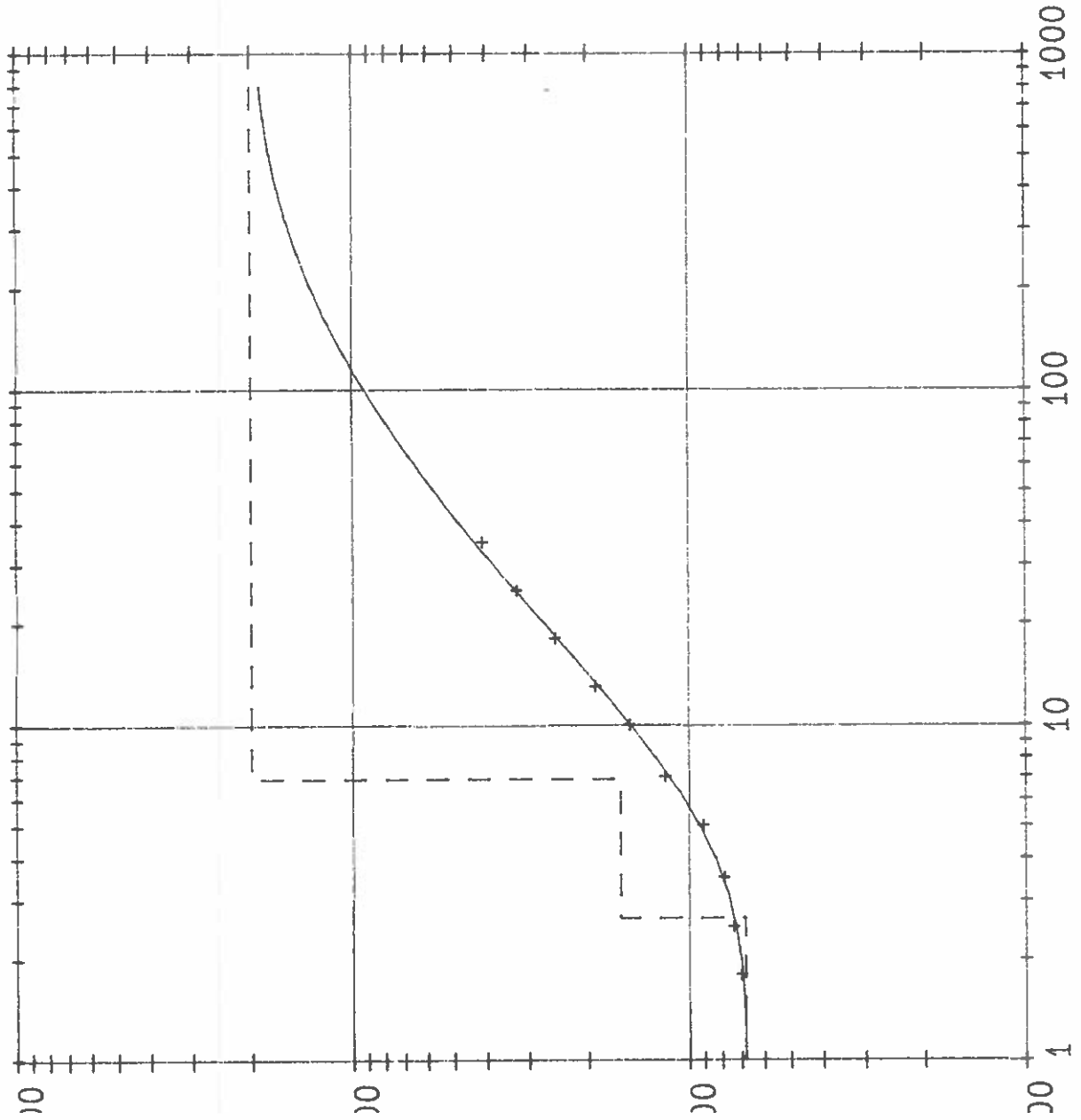
+ Field data
 — Computer model
 - - - r model

Mothibistad Waste Site

P (B) 65m

GEOLOGY
 Dolomite





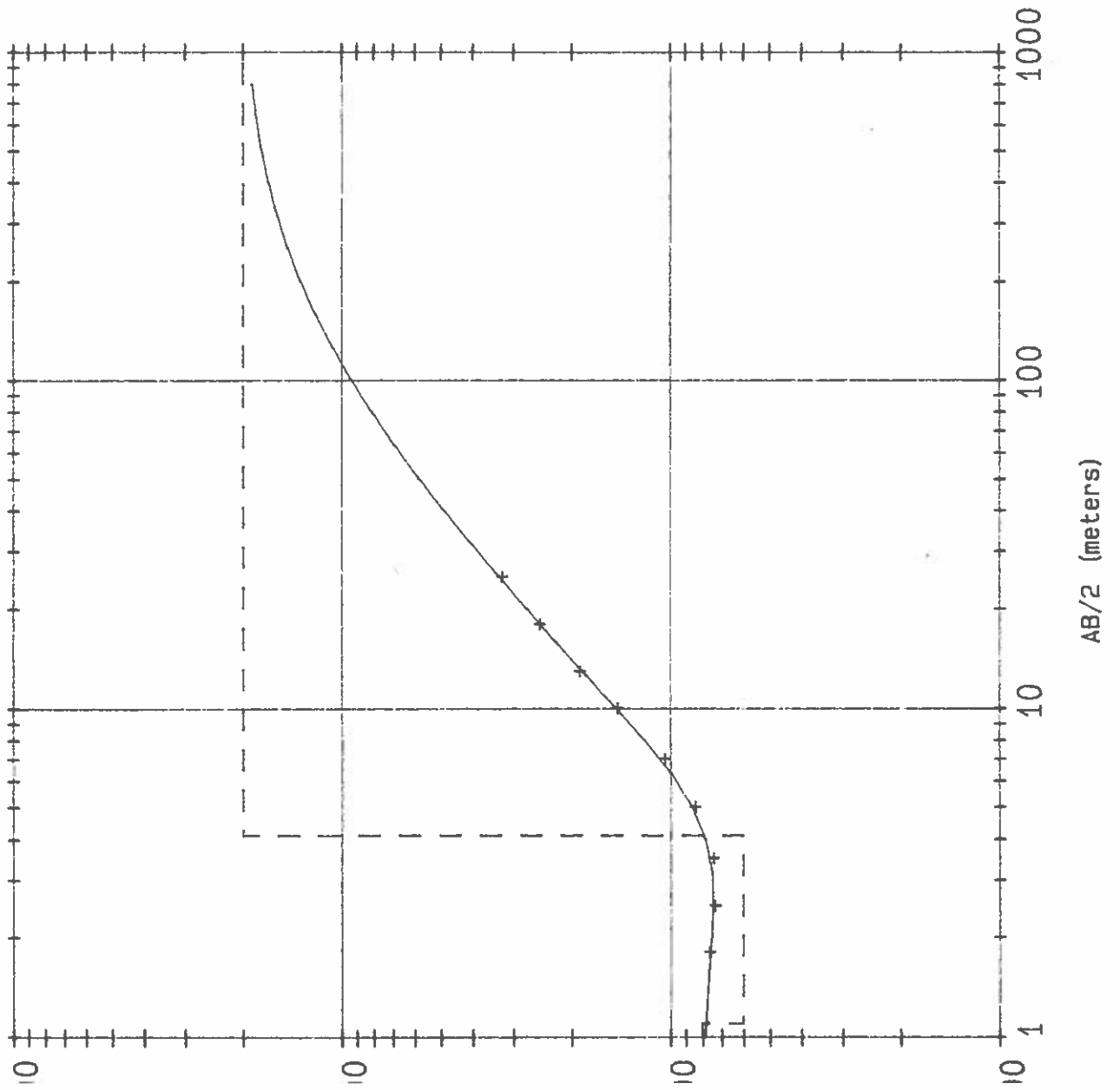
+ Field data
 — Computer model
 - - - d - r model

Mothibistad Waste Site

P (B) 70m

GEOLOGY
 Dolomite

AB/2 (meters)



+ Field data
 — Computer model
 - - d - r model

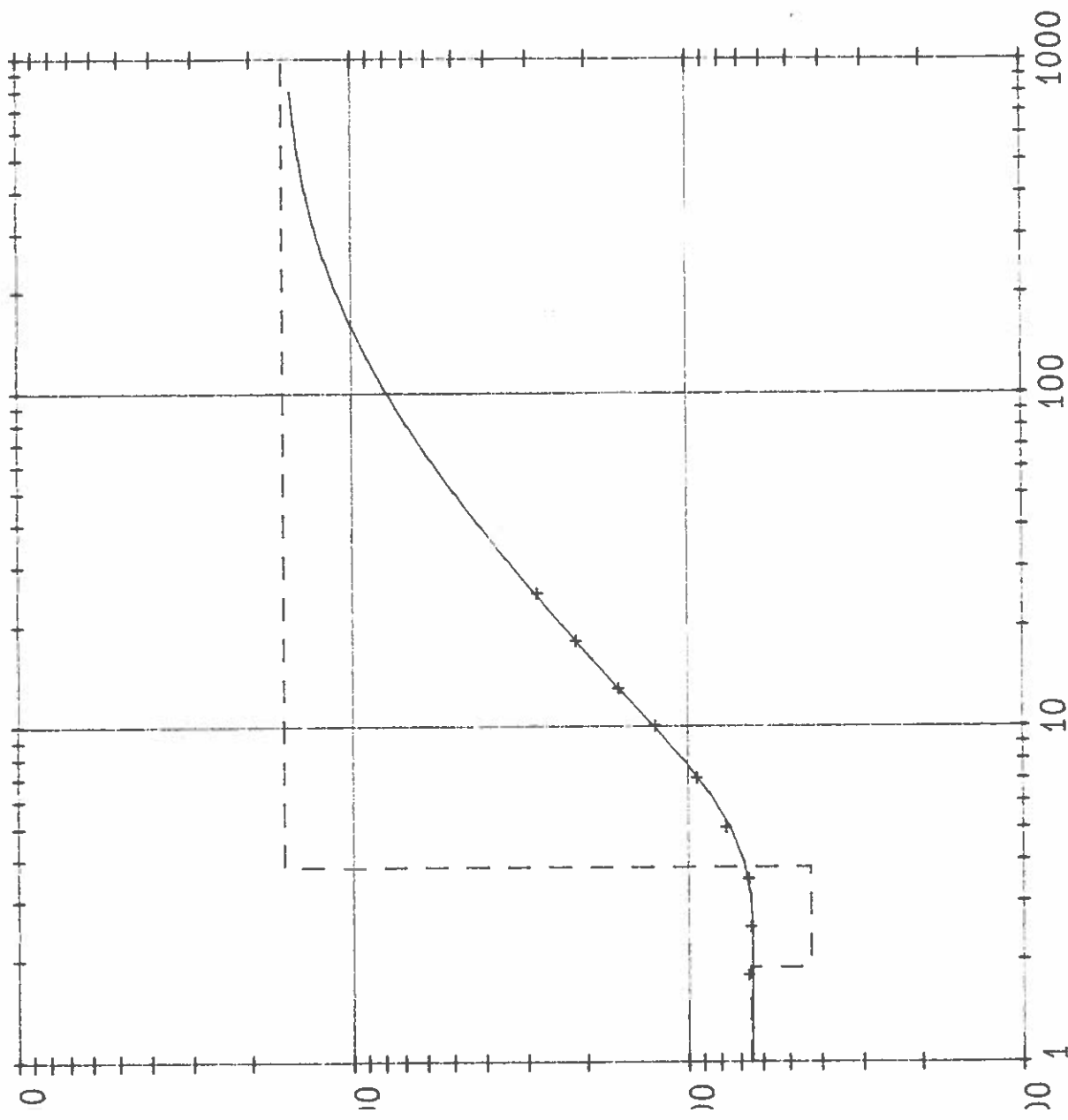
Mothibistad Waste Site

P (B) 75m

GEOLOGY

Dolomite

AB/2 (meters)



+ Field data
 — Computer model
 - - - d - r model

Mothibistad Waste Site

P (B) 80m

GEOLOGY
 Dolomite

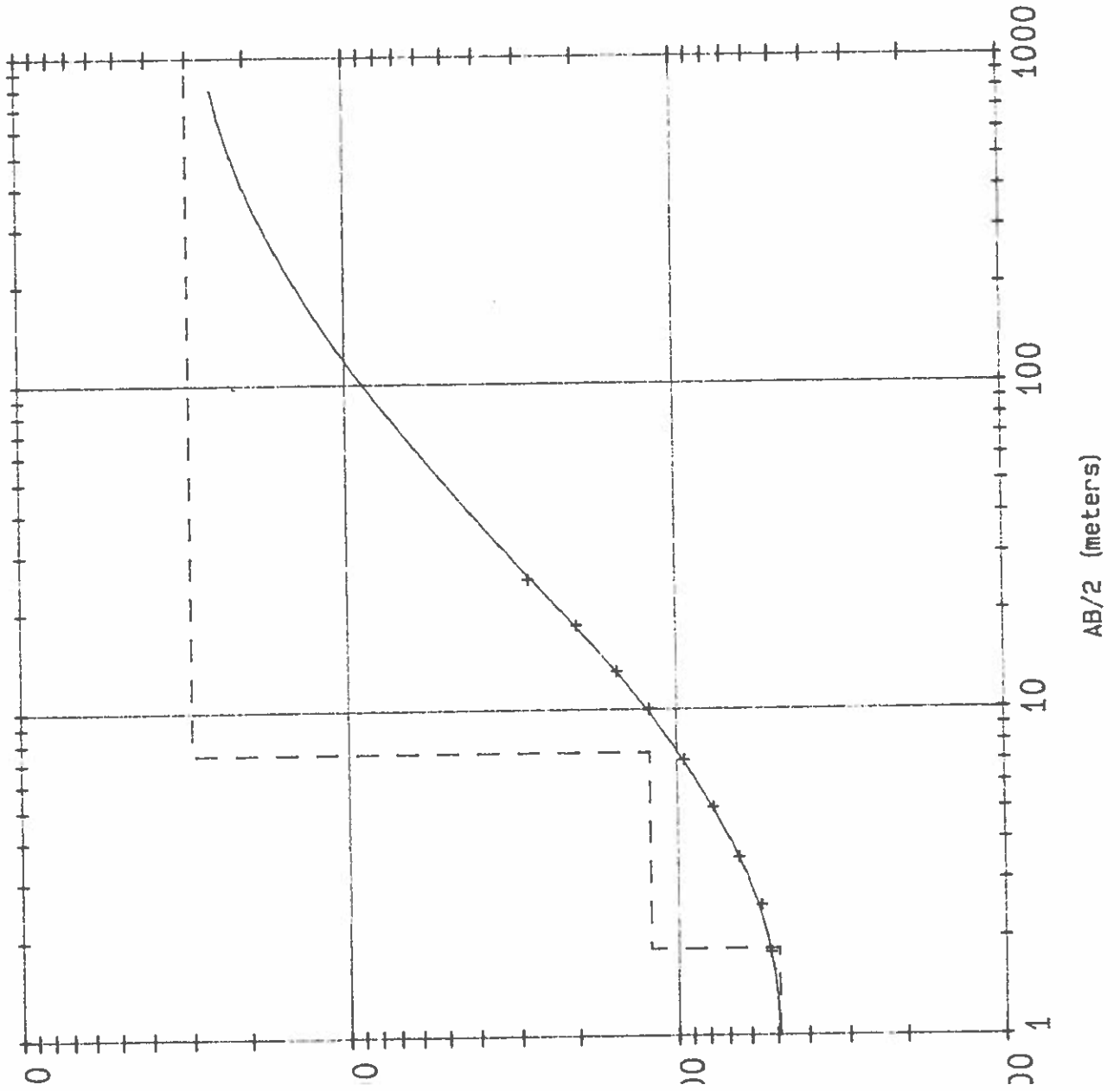
AB/2 (meters)

+ Field data
 — Computer model
 - - - r model

Mothibistad Waste Site

P (B) 85m

GEOLOGY
 Dolomite



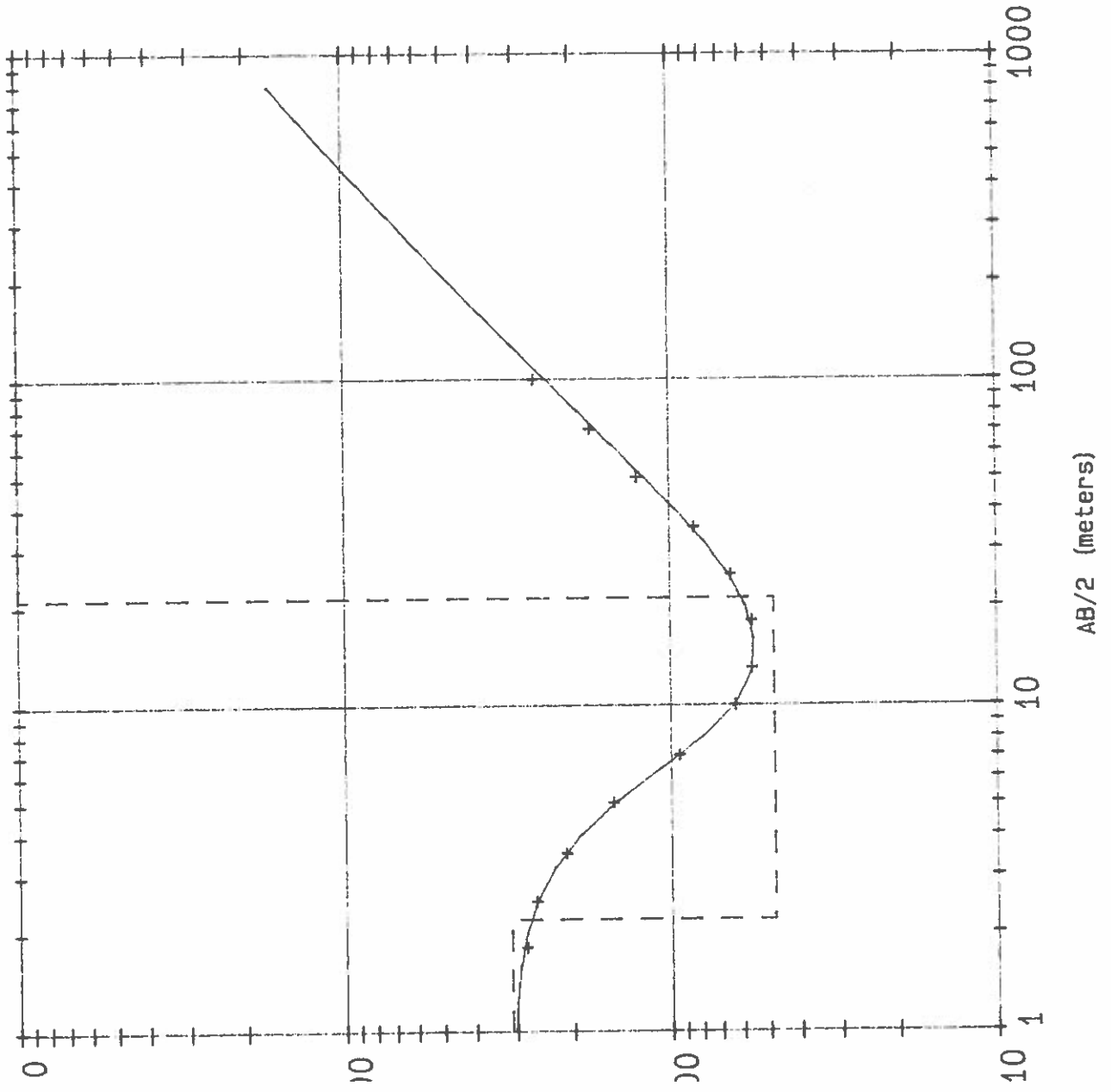
+ Field data
— Computer model
- - - r model

Mothibistad Waste Site

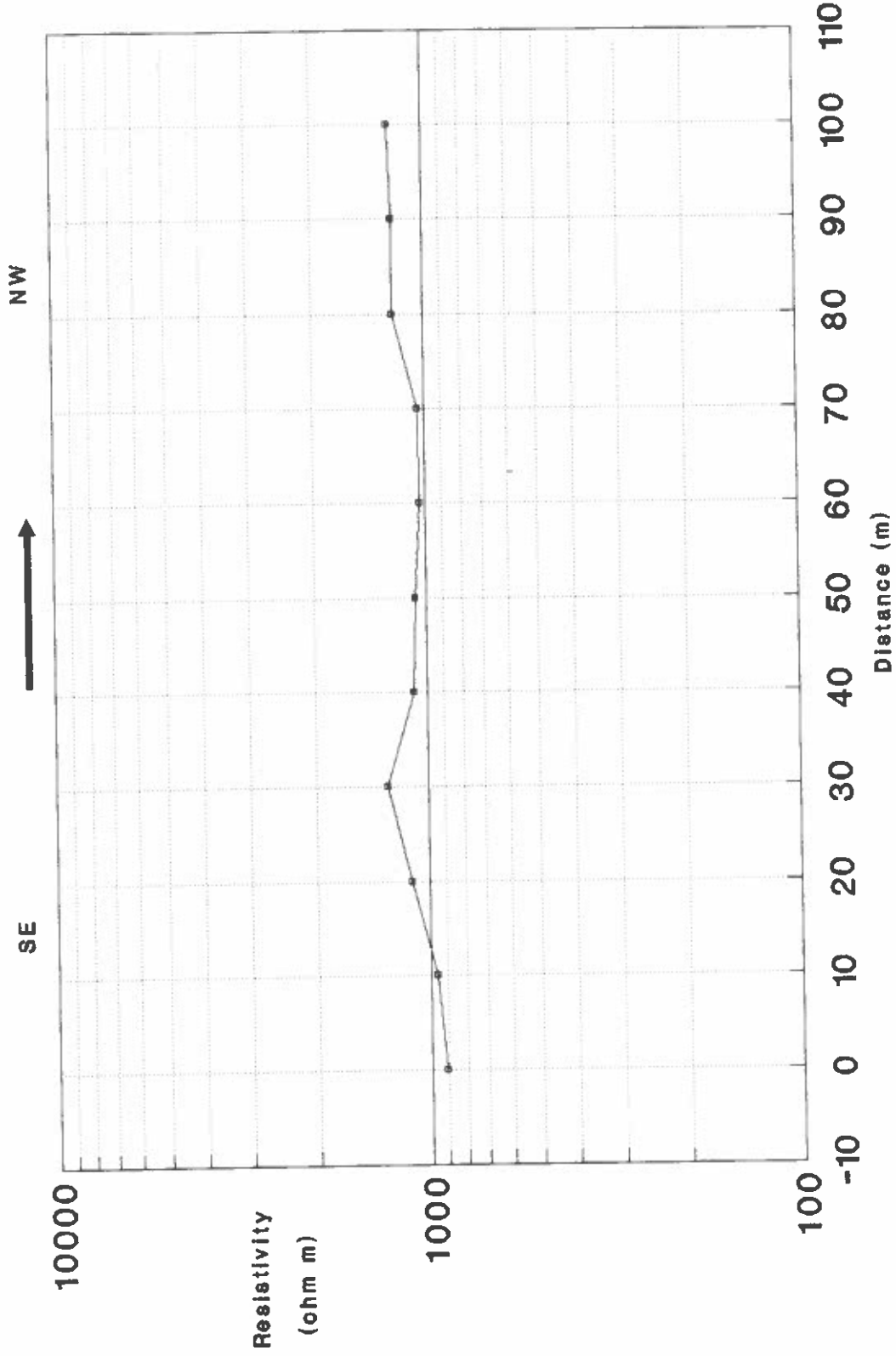
West 4m

GEOLOGY

Dolerite/Dolomite

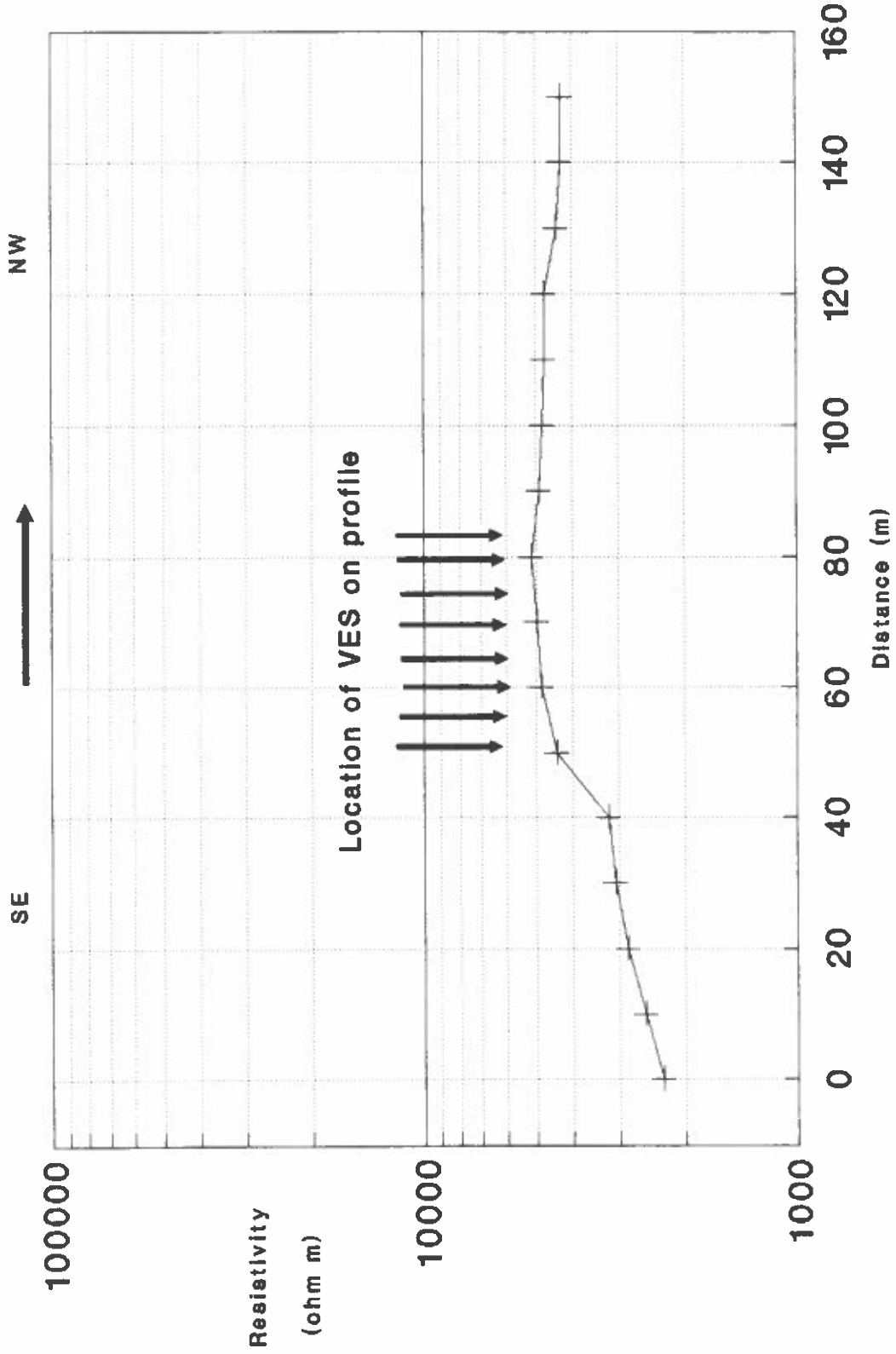


Mothibistad Waste Site
Wenner configuration resistivity profile
Profile A



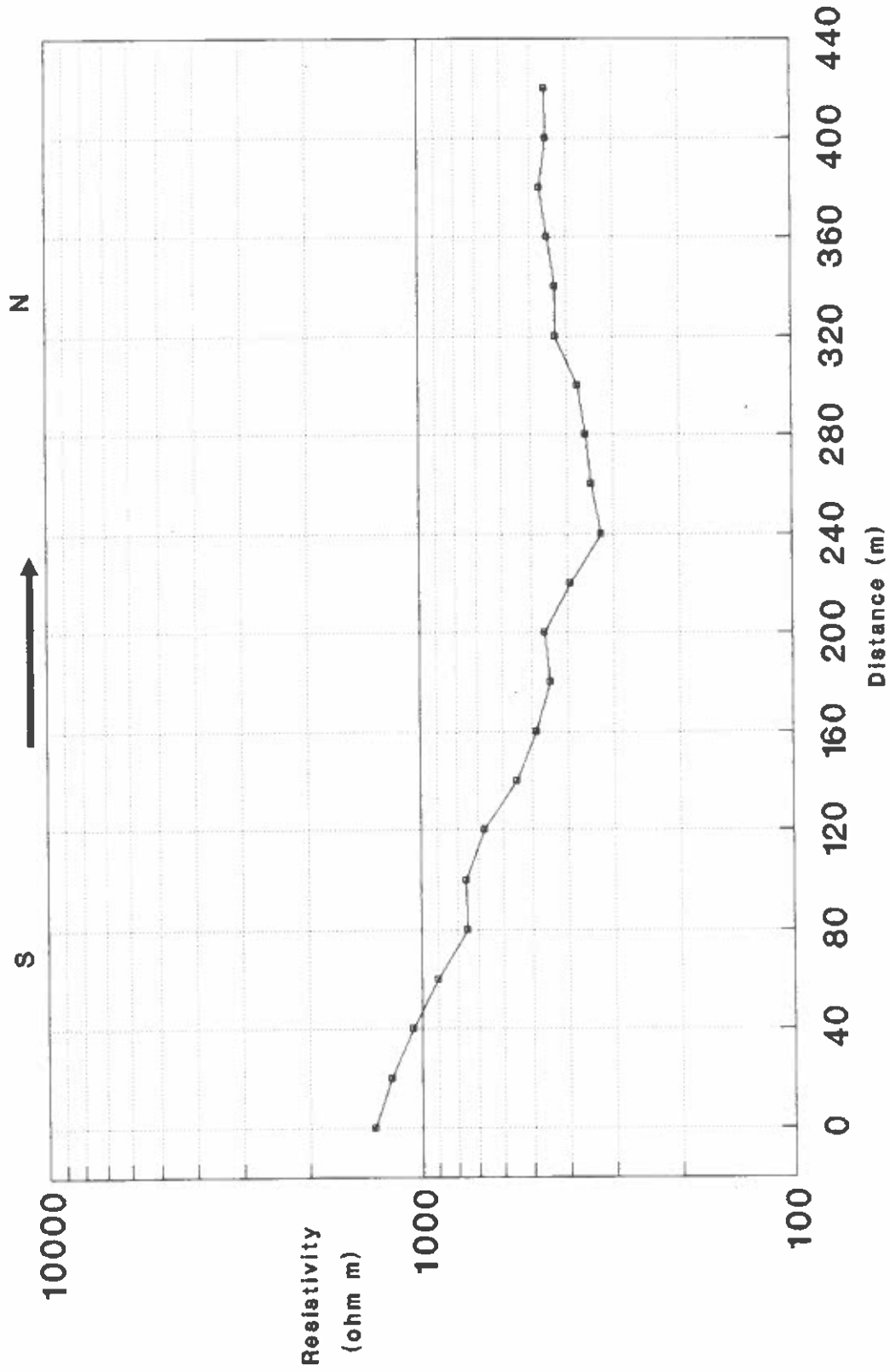
AM-MN-NB-20m with 10m station intervals

Mothibistad Waste Site
Wenner configuration resistivity profile
Profile B



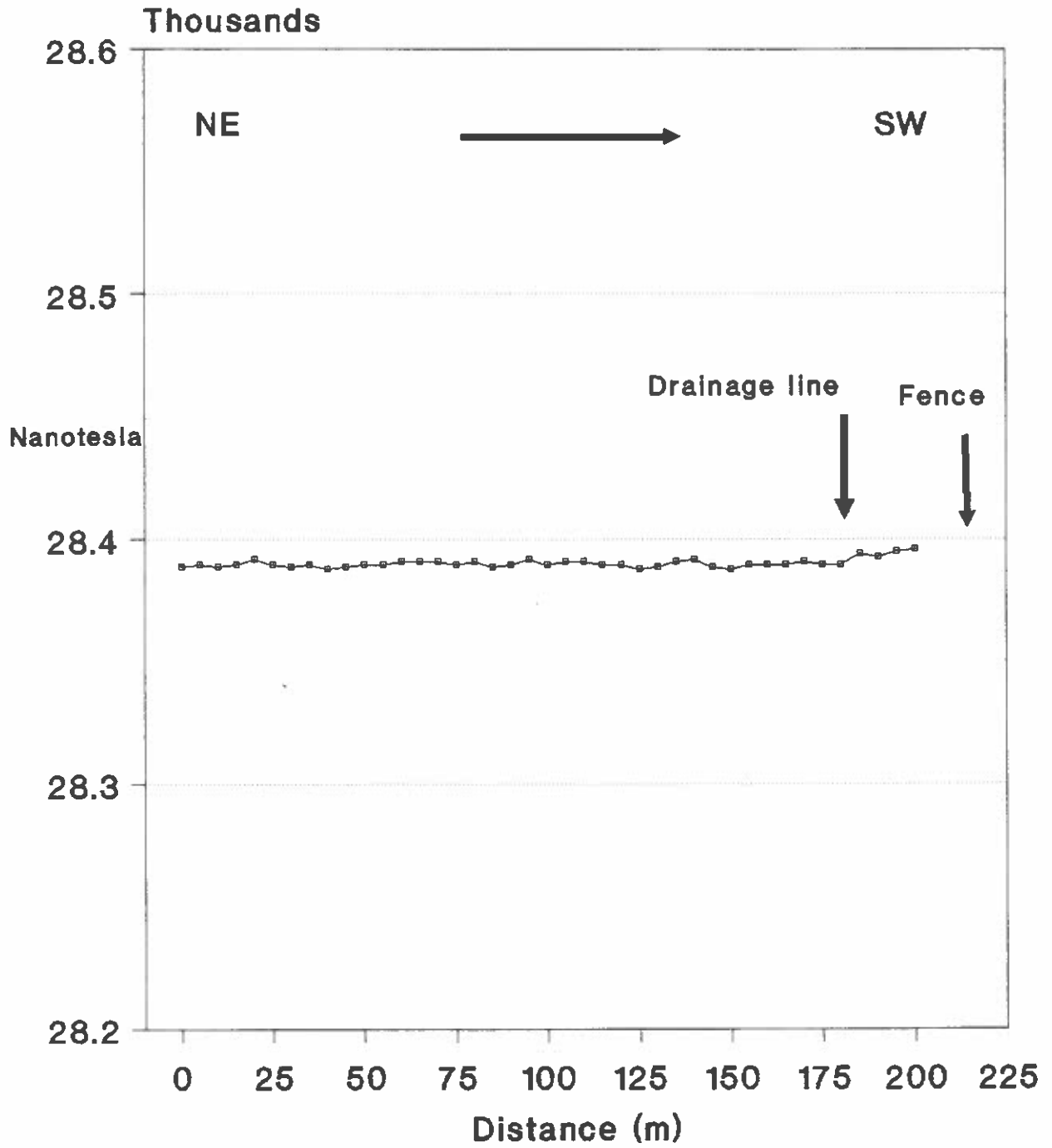
AM-MN-NB-20m with 10m station intervals

Mothibistad Waste site
Wenner configuration resistivity profile
Profile C

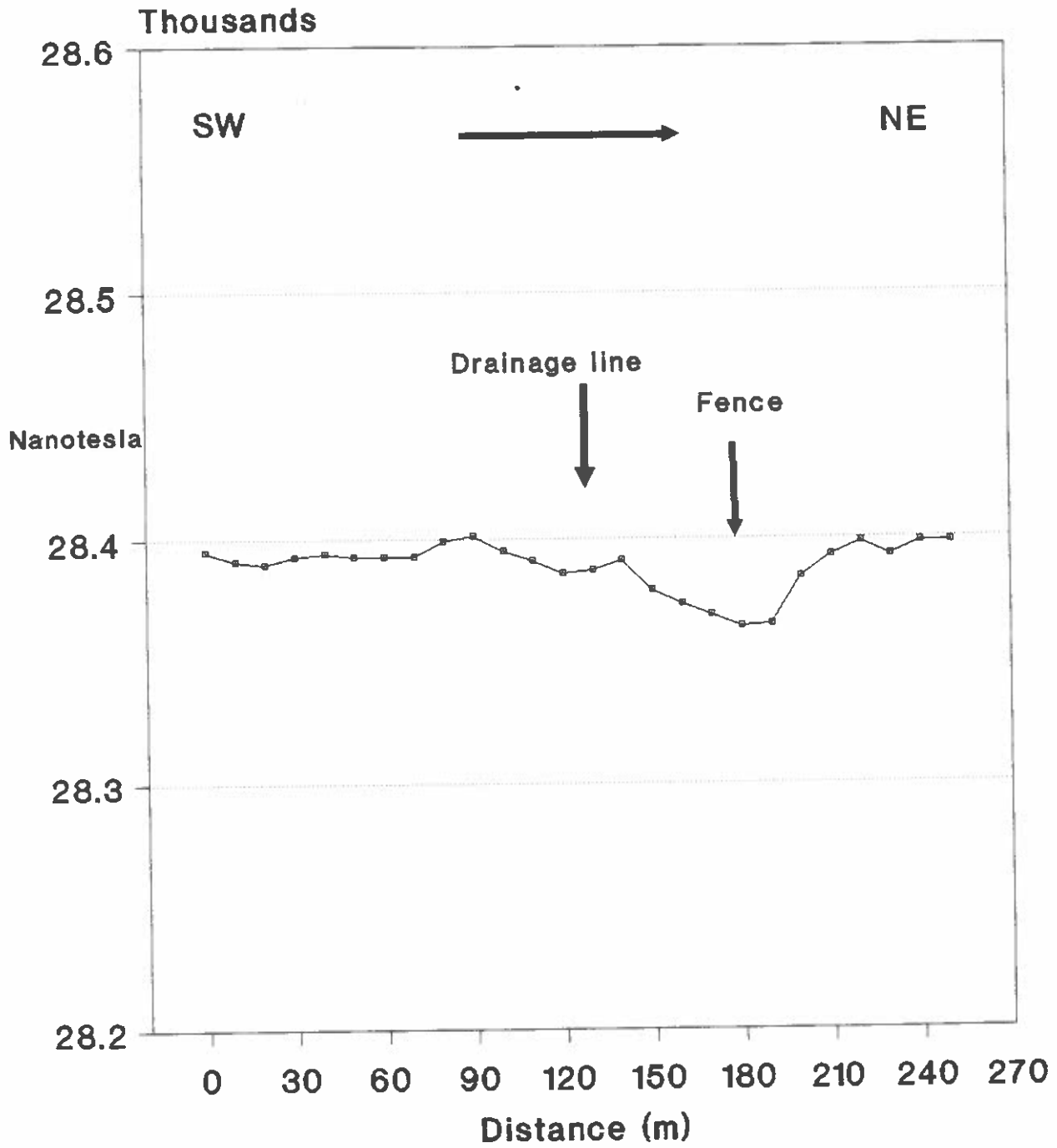


AM-MN-NB-20m with 20m station intervals

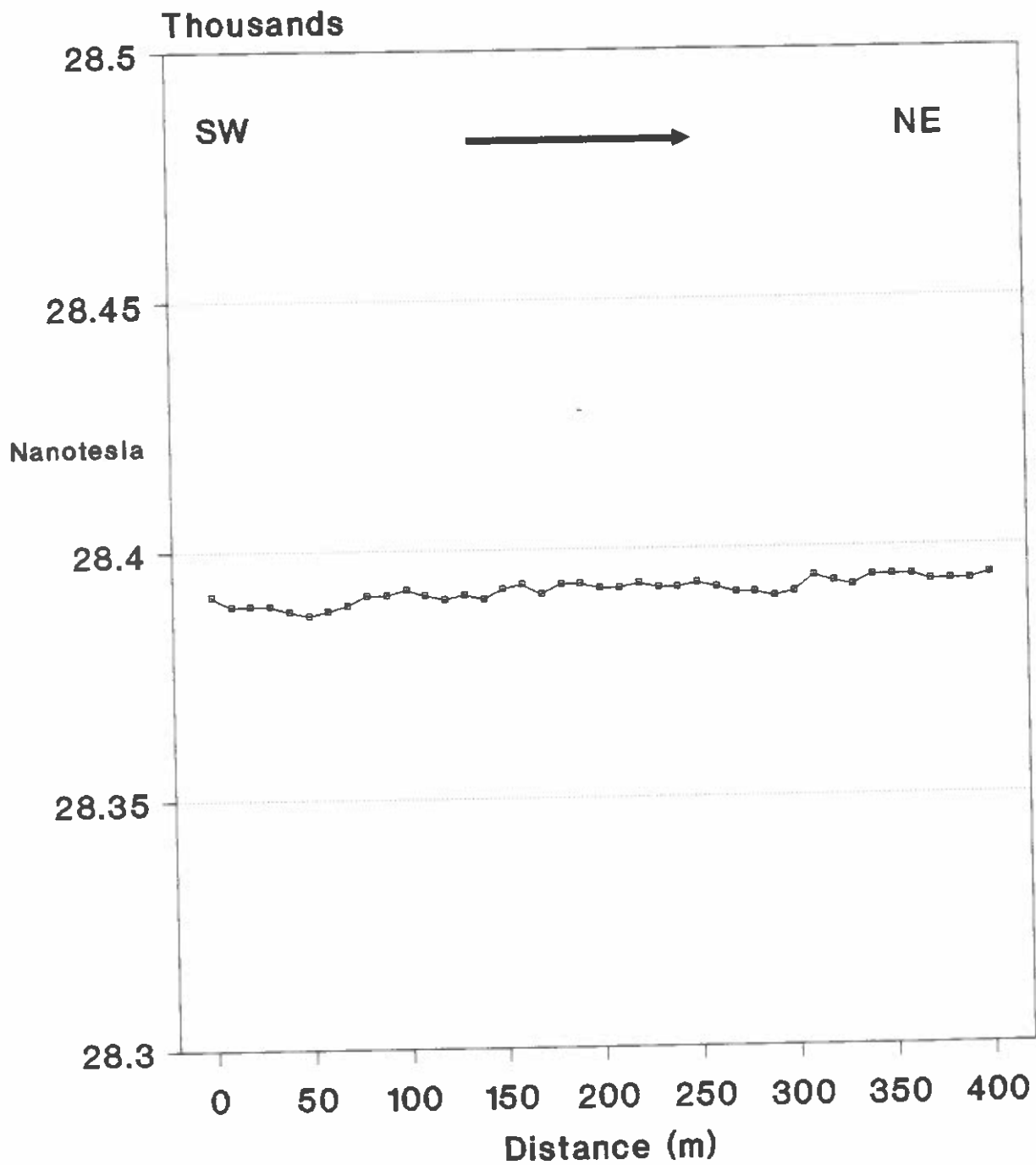
MOTHIBISTAD WASTE SITE
Magnetic traverse T#11



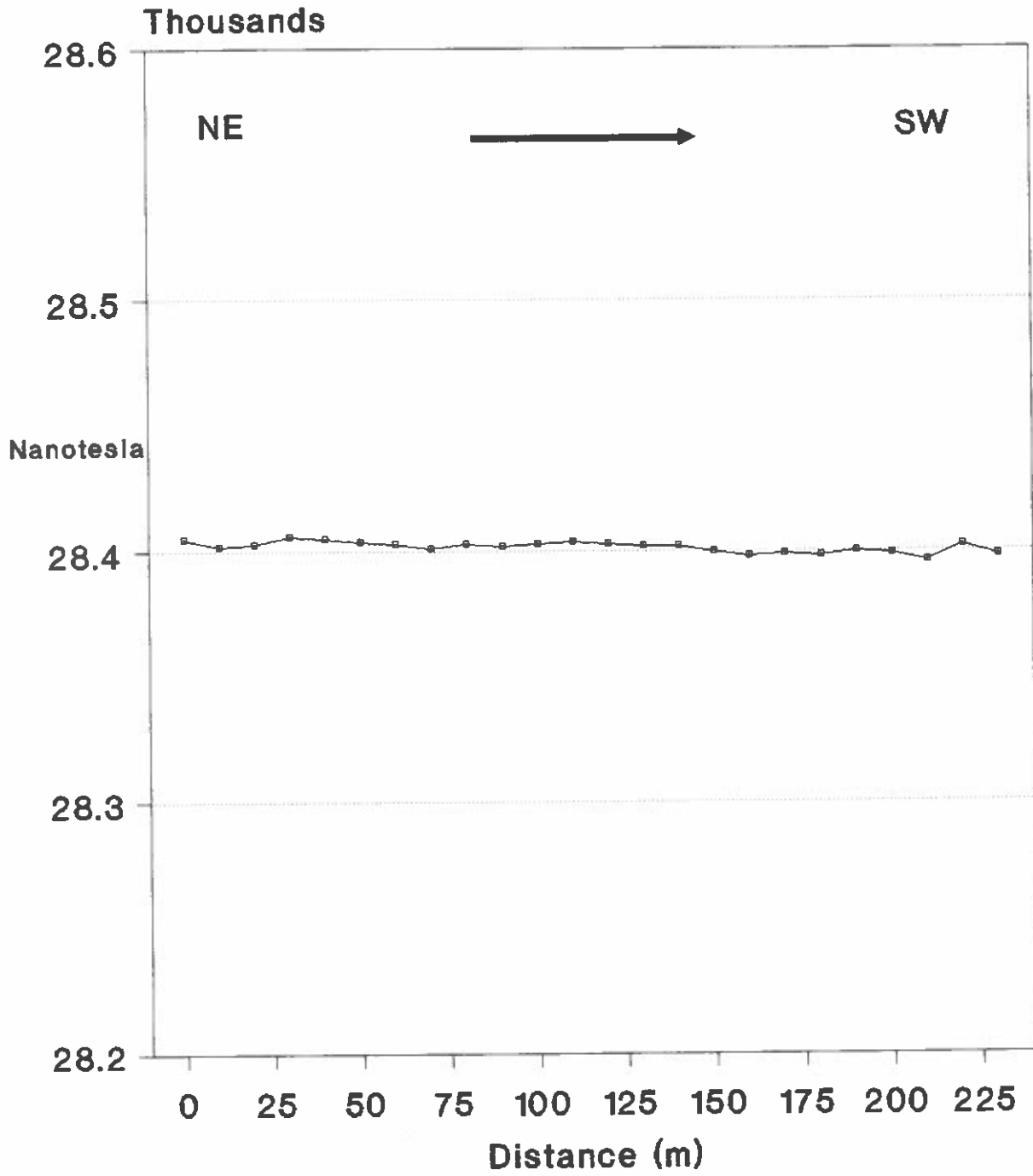
MOTHIBISTAD WASTE SITE
Magnetic traverse T#10



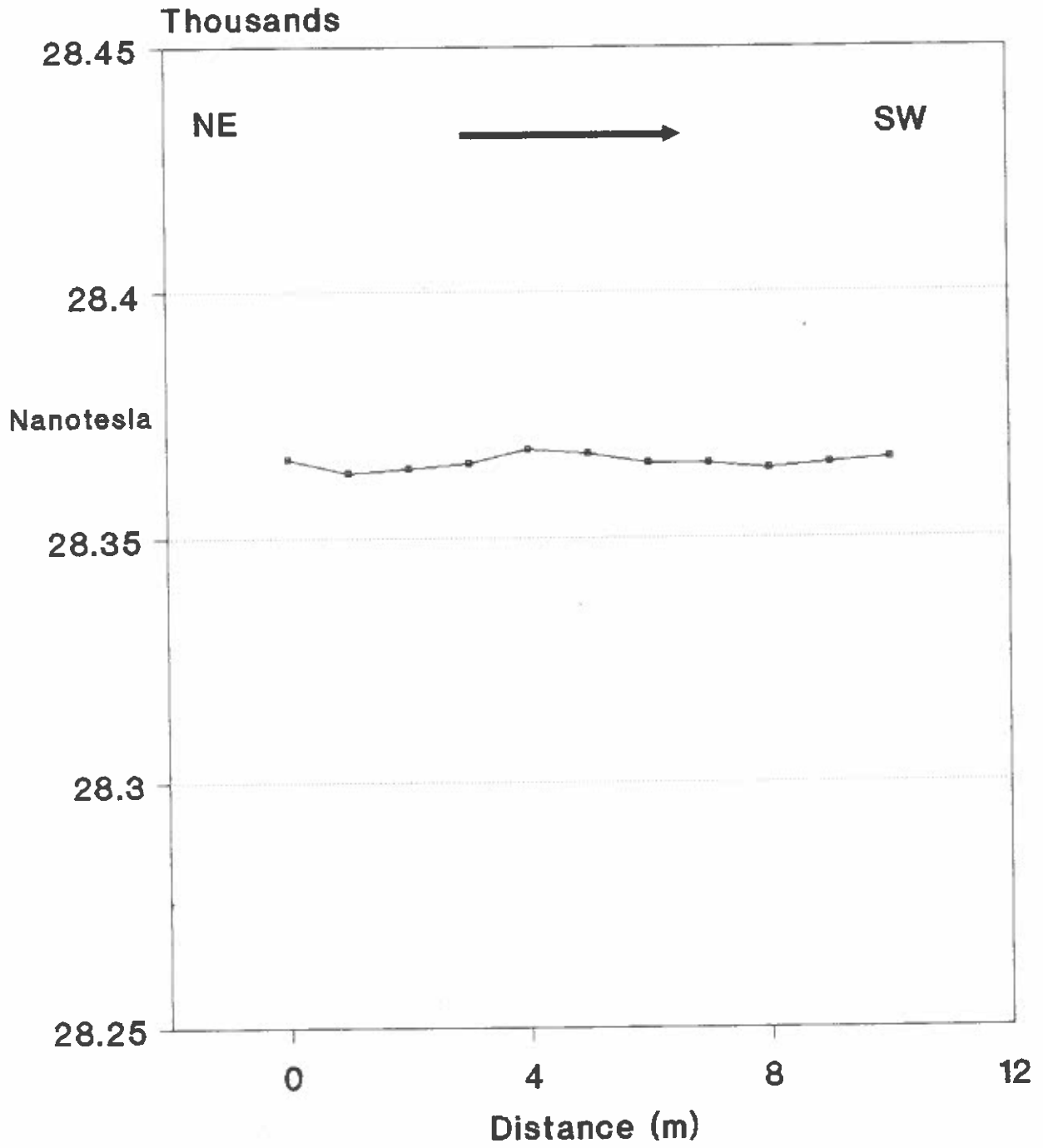
MOTHIBISTAD WASTE SITE
Magnetic traverse T#9



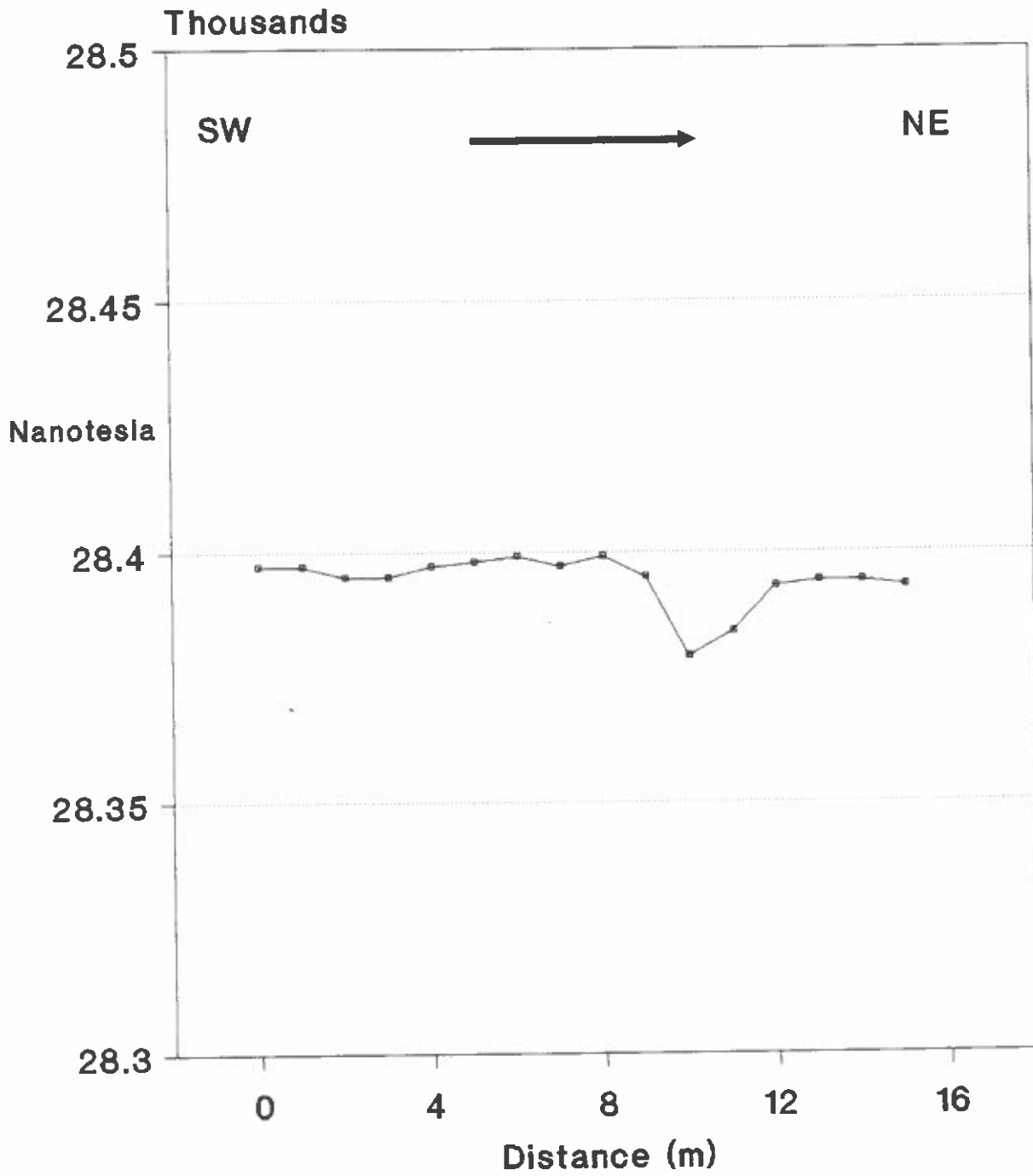
MOTHIBISTAD WASTE SITE
Magnetic traverse T#8



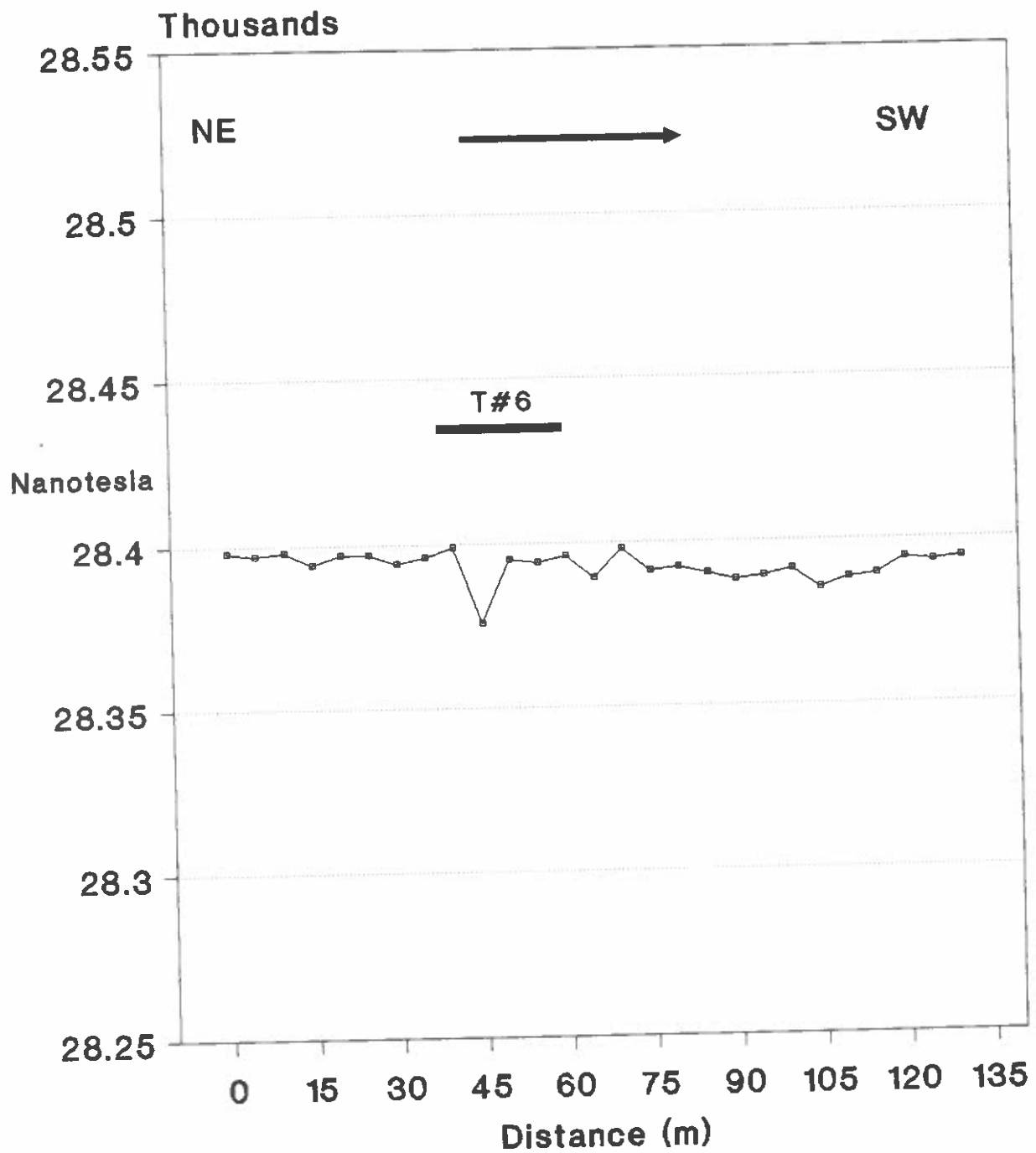
MOTHIBISTAD WASTE SITE
Magnetic traverse T#7



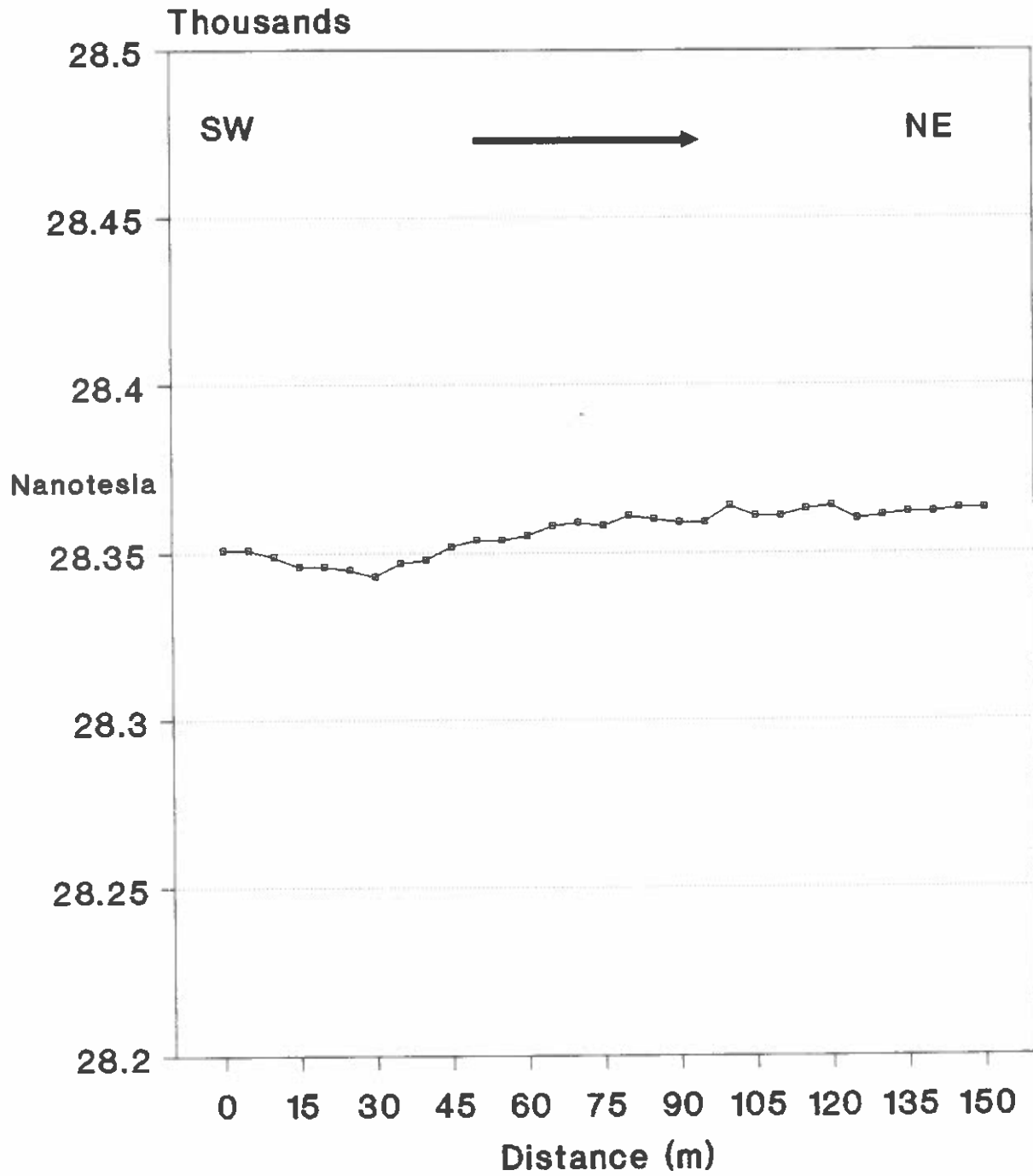
MOTHIBISTAD WASTE SITE
Magnetic traverse T#6



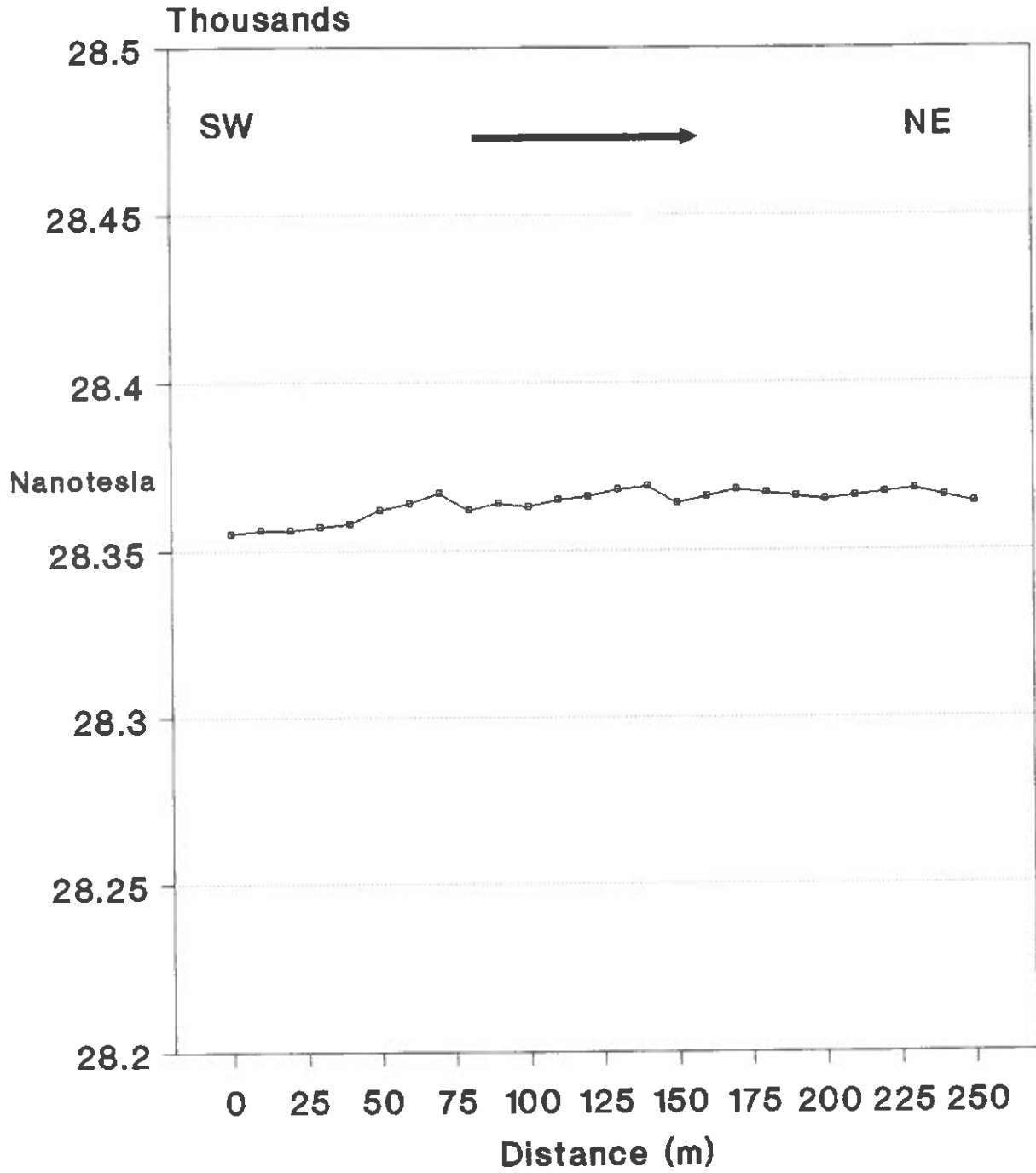
MOTHIBISTAD WASTE SITE
Magnetic traverse T#5



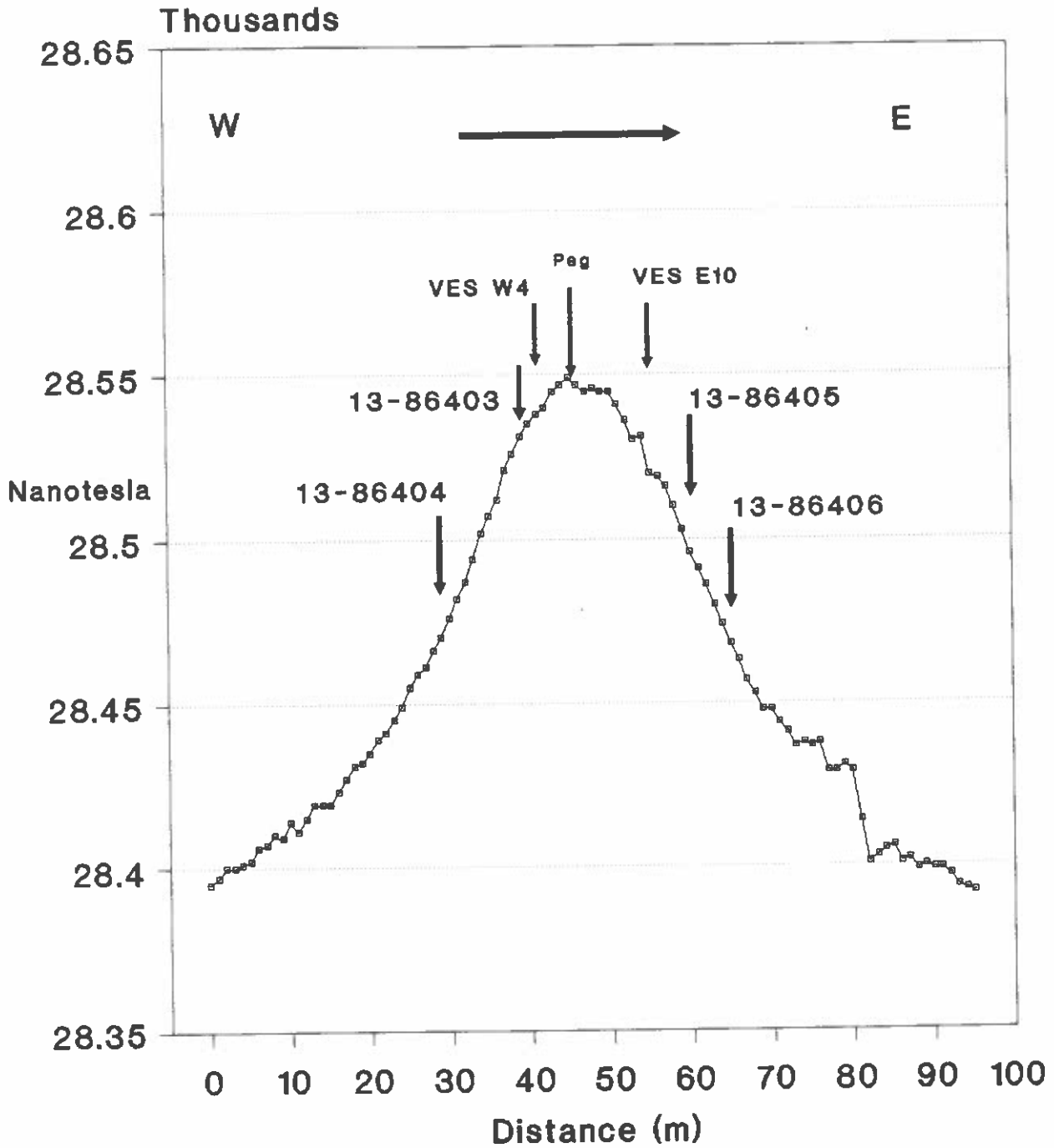
MOTHIBISTAD WASTE SITE
Magnetic traverse T#4



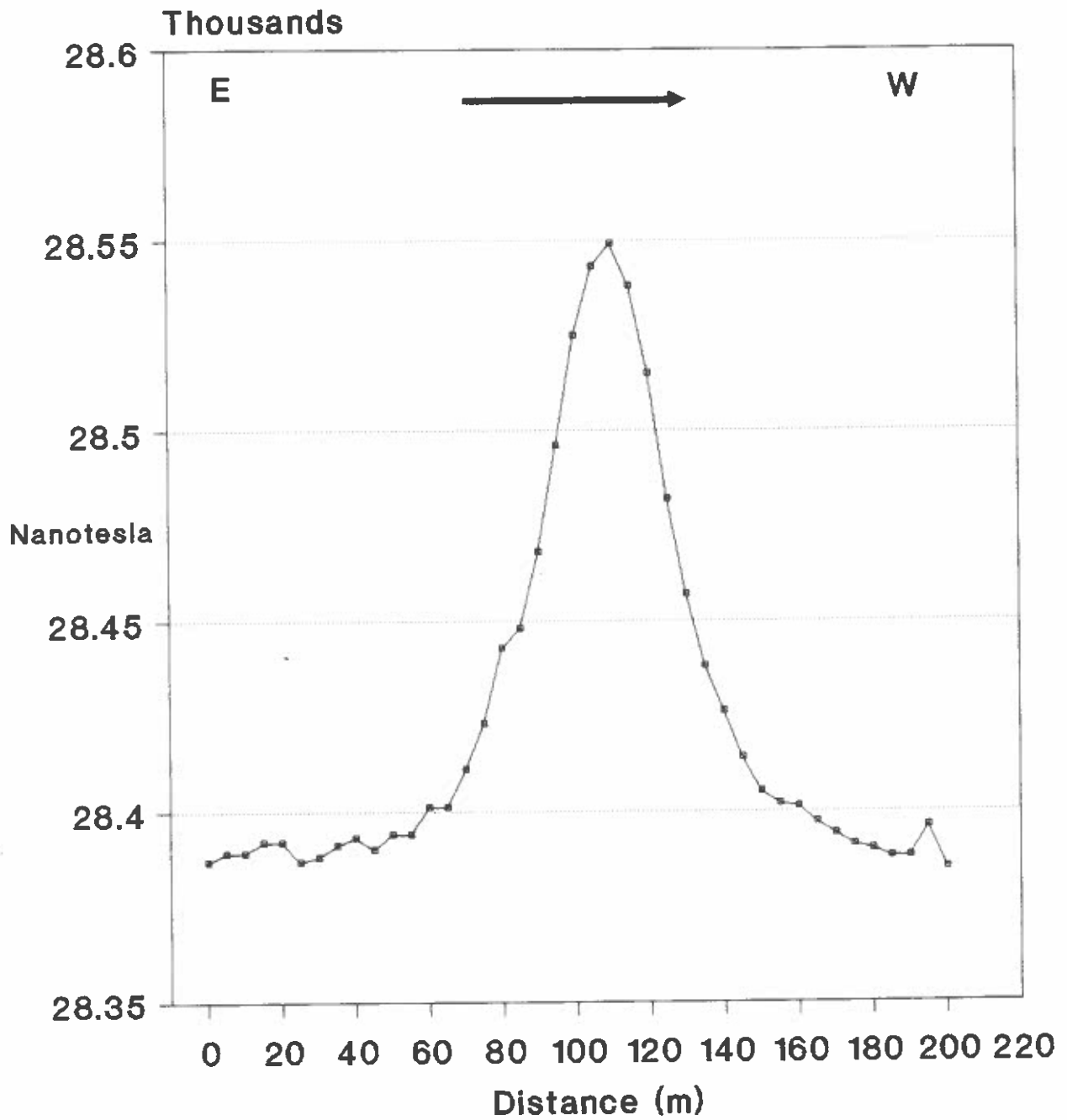
MOTHIBISTAD WASTE SITE
Magnetic traverse T#3



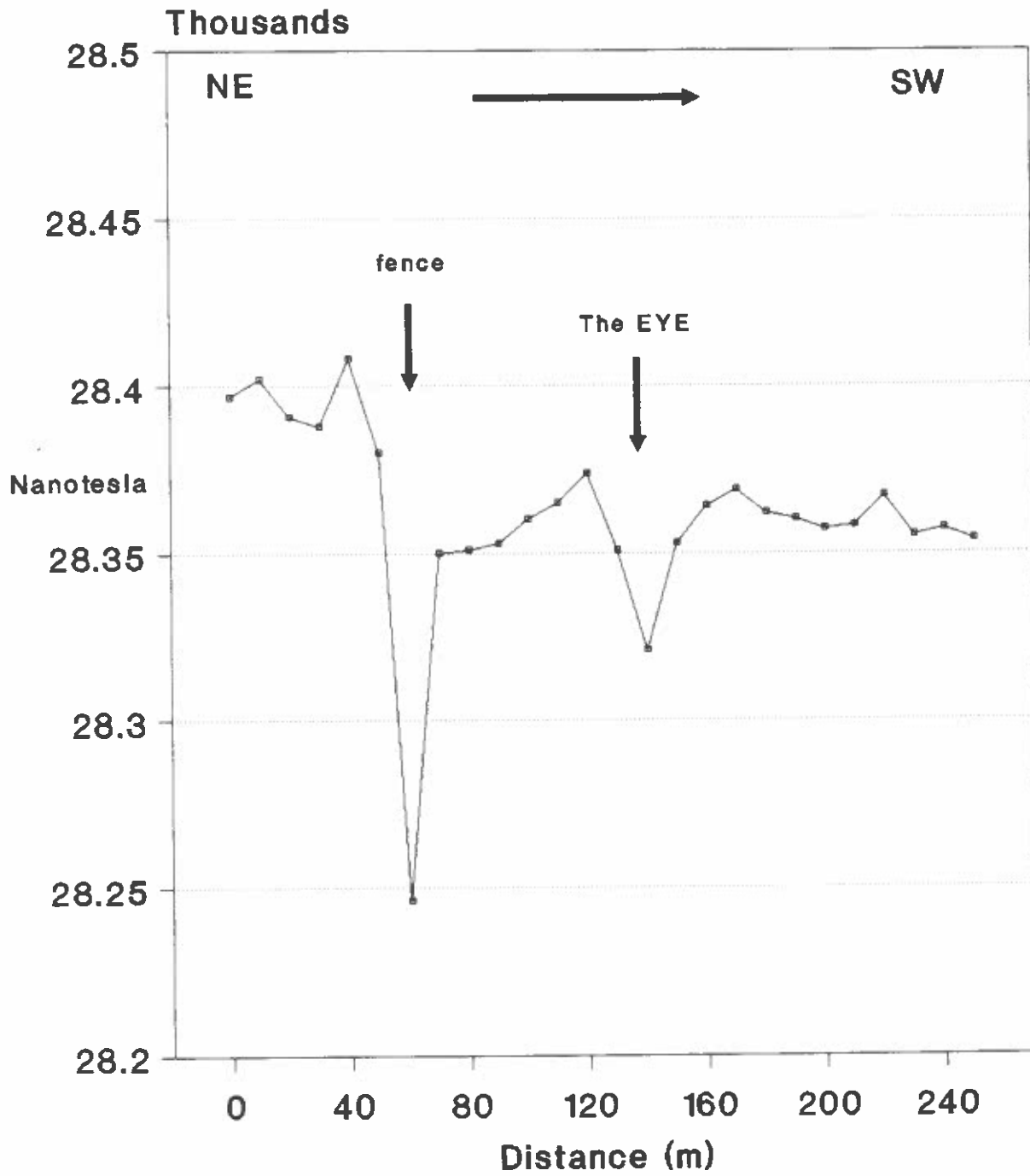
MOTHIBISTAD WASTE SITE
Magnetic traverse T#2



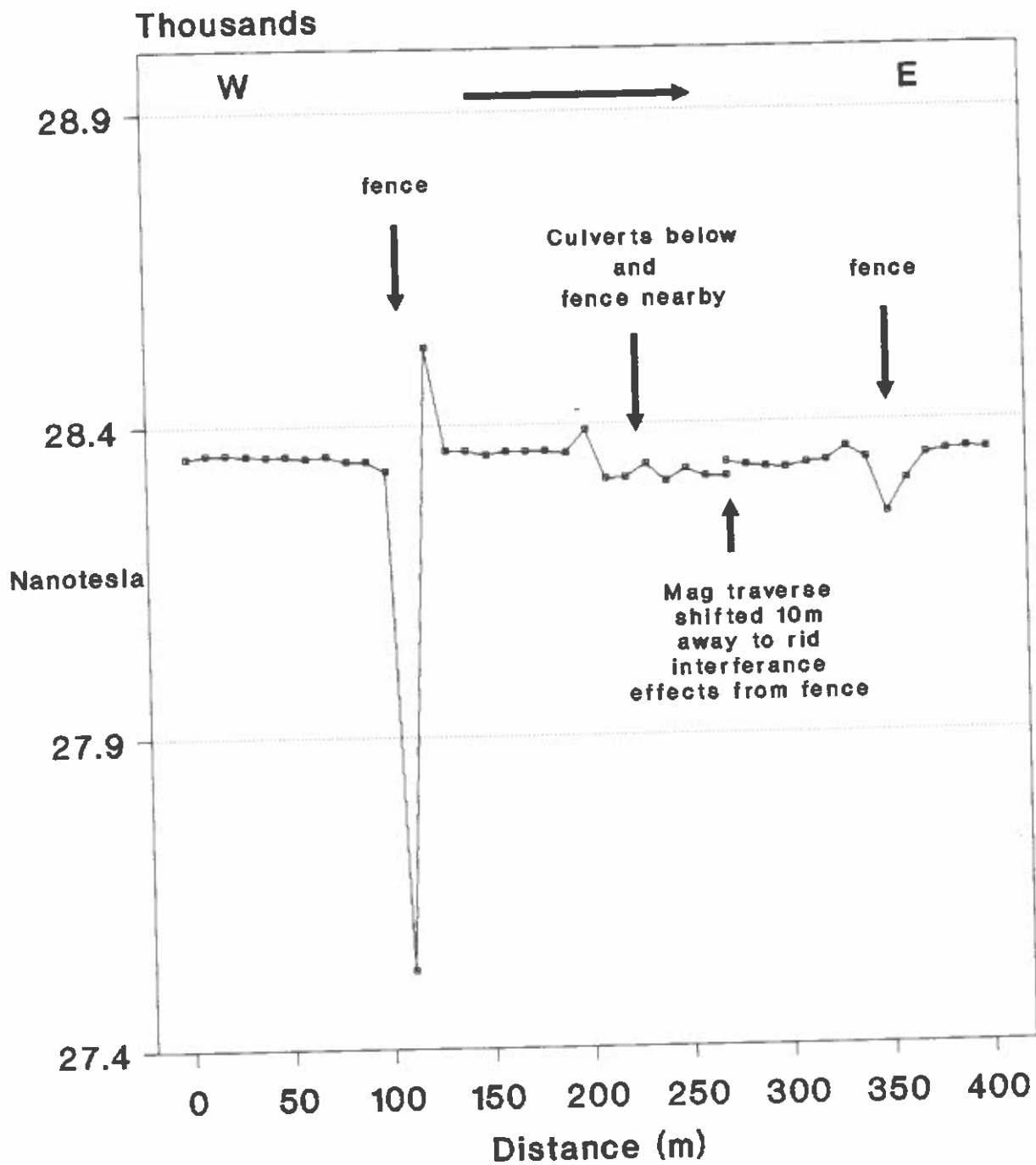
MOTHIBISTAD WASTE SITE
Magnetic traverse T#1
Mothibistad compartment dyke



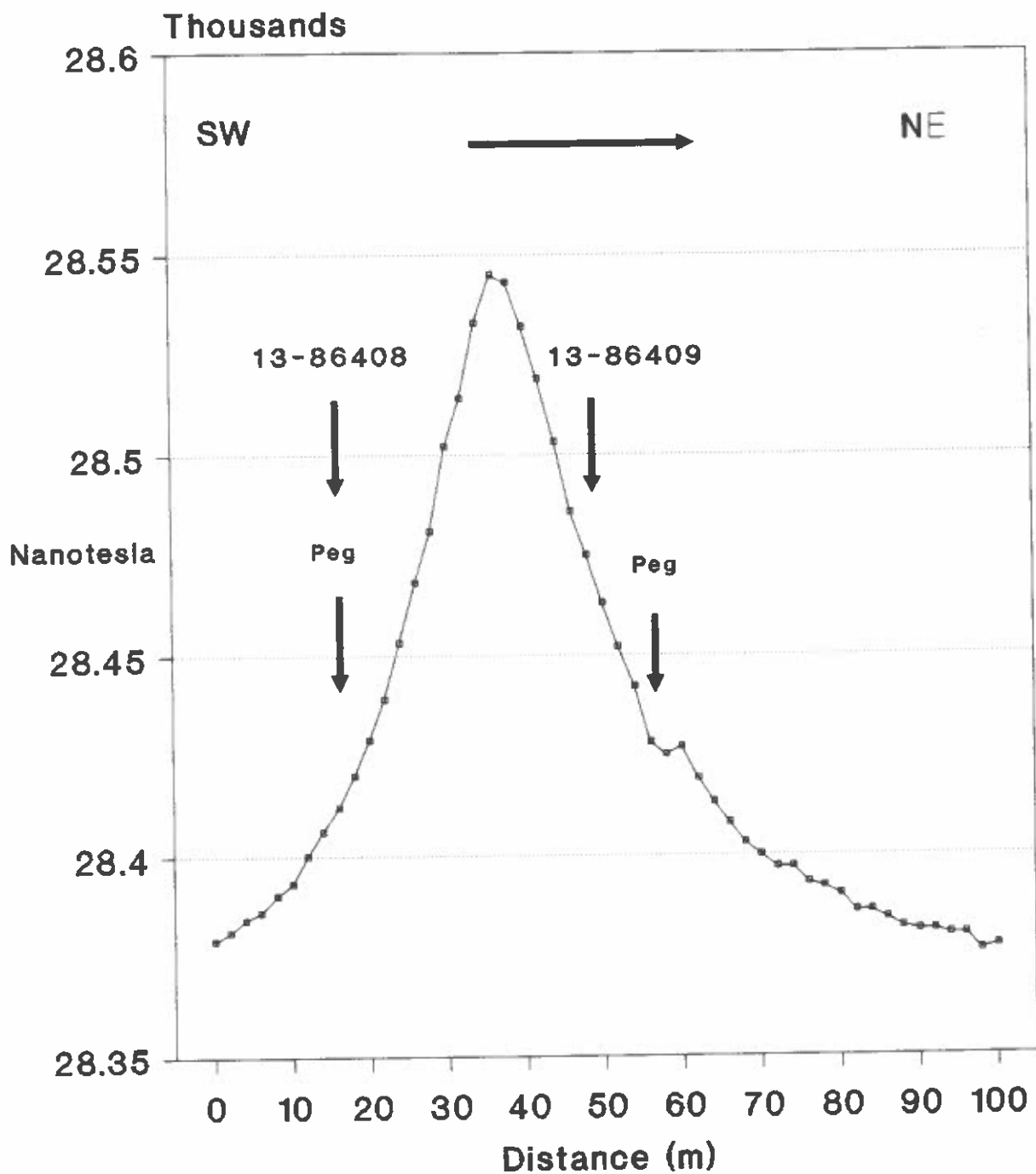
MOTHIBISTAD WASTE SITE
Magnetic traverse T#J



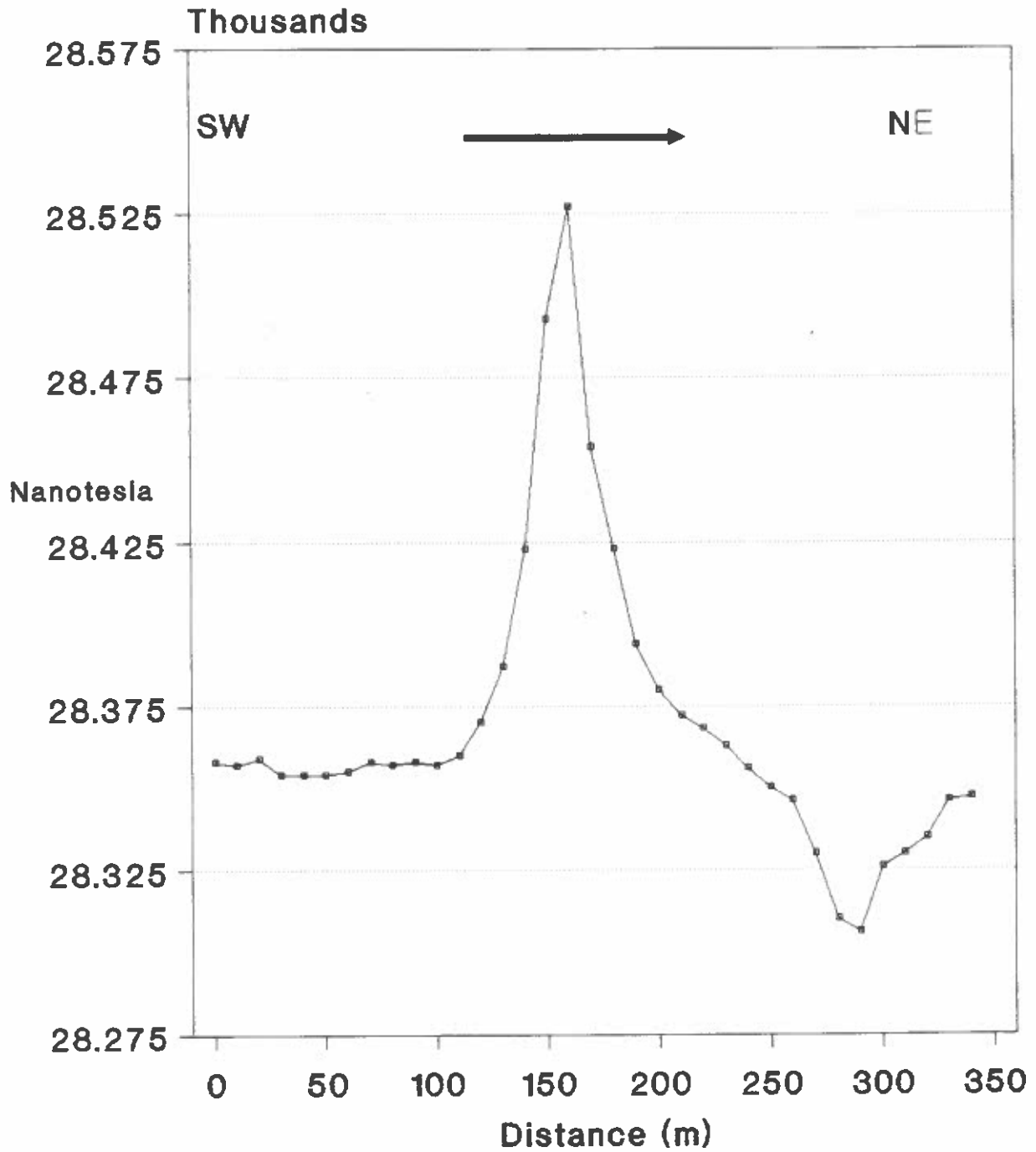
MOTHIBISTAD WASTE SITE Magnetic traverse T#1



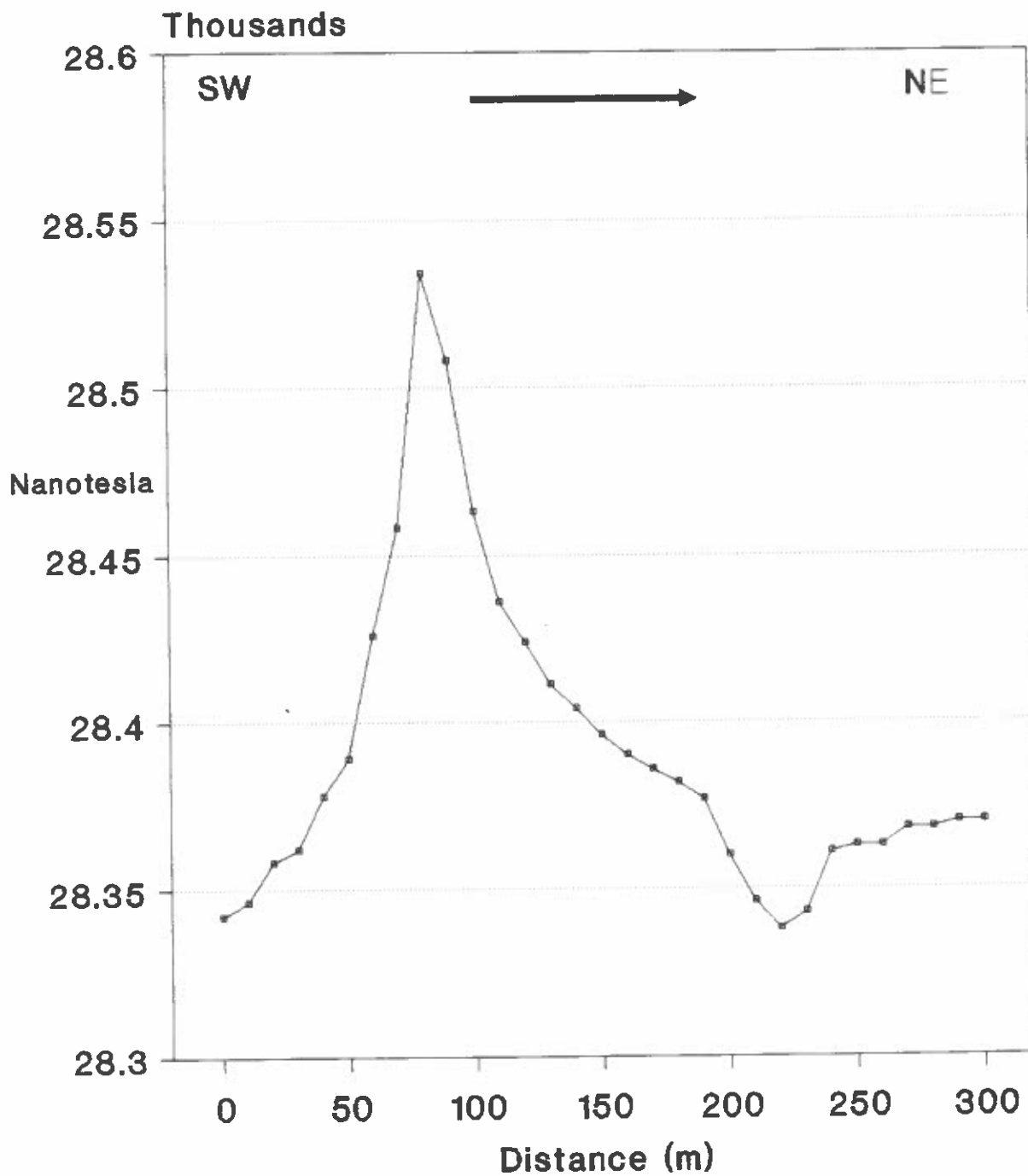
MOTHIBISTAD WASTE SITE
Magnetic traverse T#H



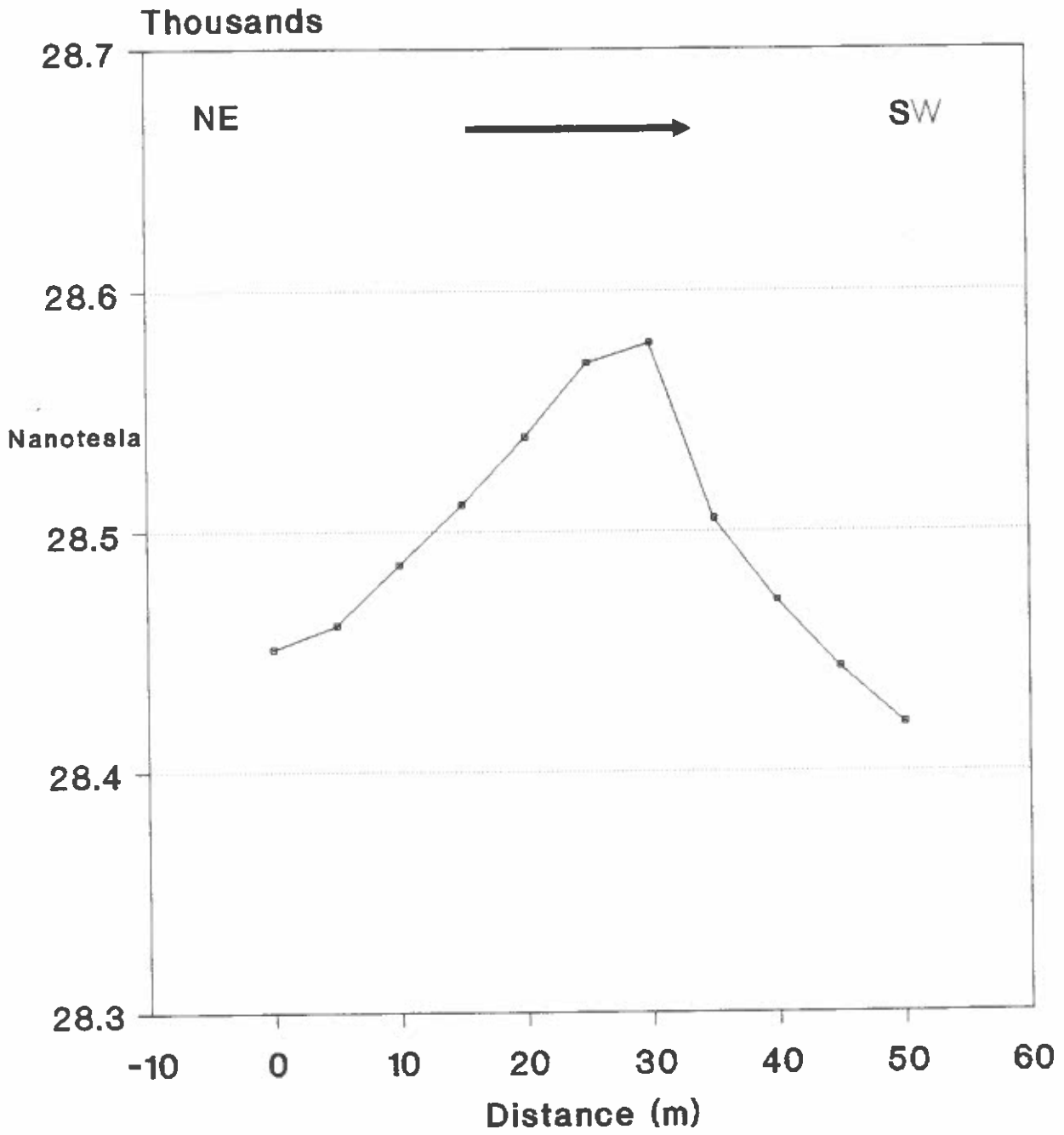
MOTHIBISTAD WASTE SITE
Magnetic traverse T#G



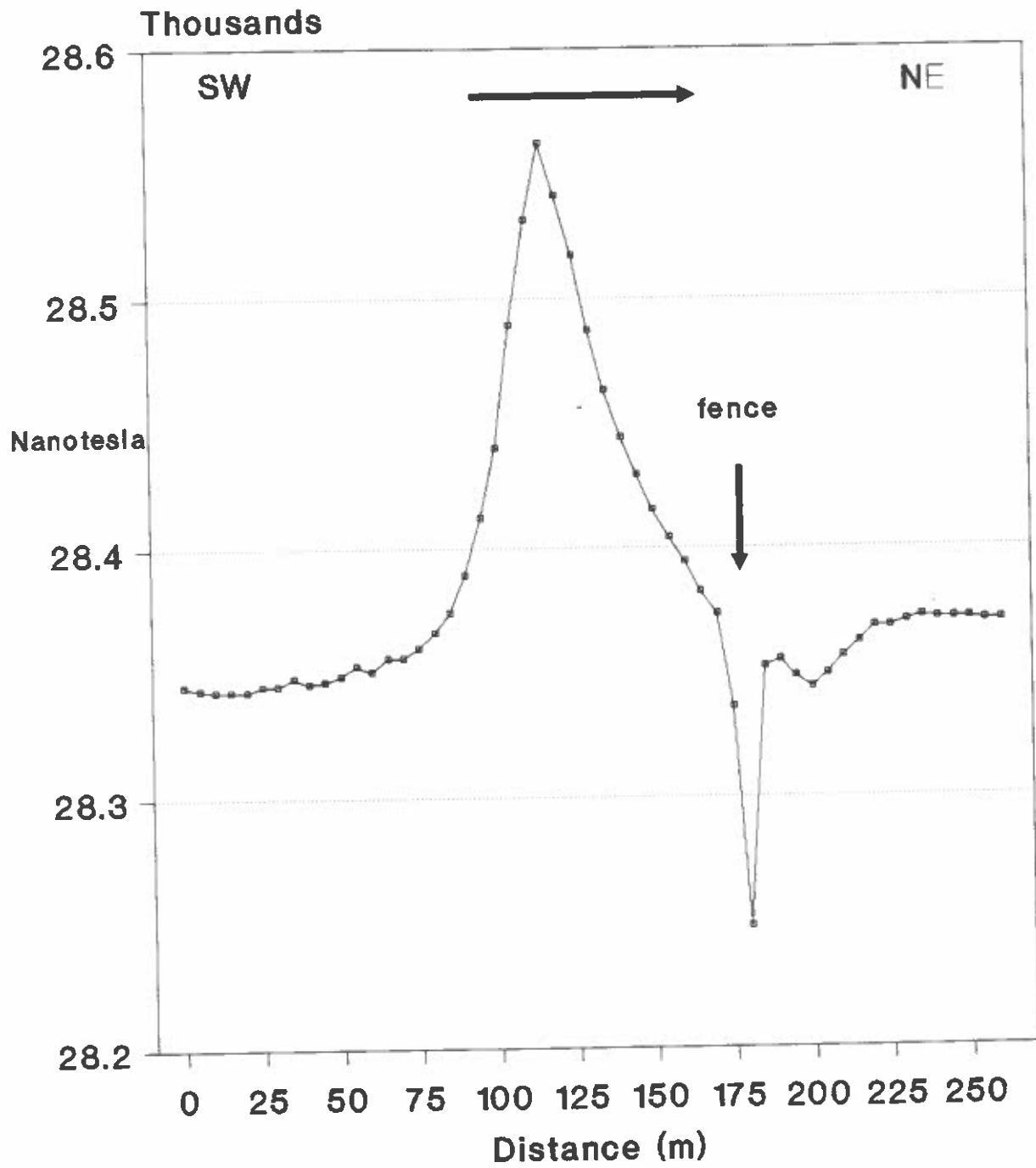
MOTHIBISTAD WASTE SITE
Magnetic traverse T#F



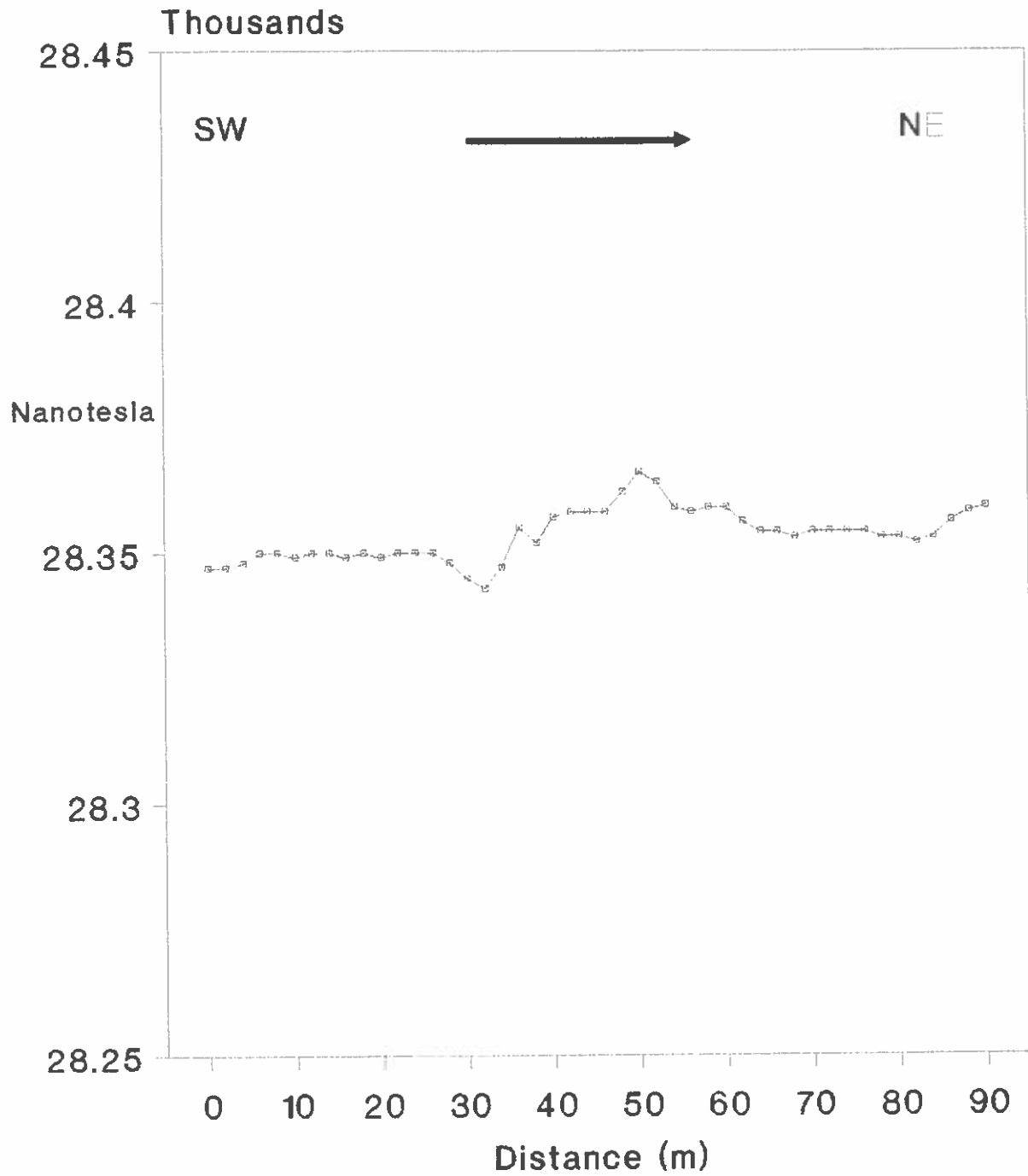
MOTHIBISTAD WASTE SITE
Magnetic traverse T#E
(30m NW of T#D)



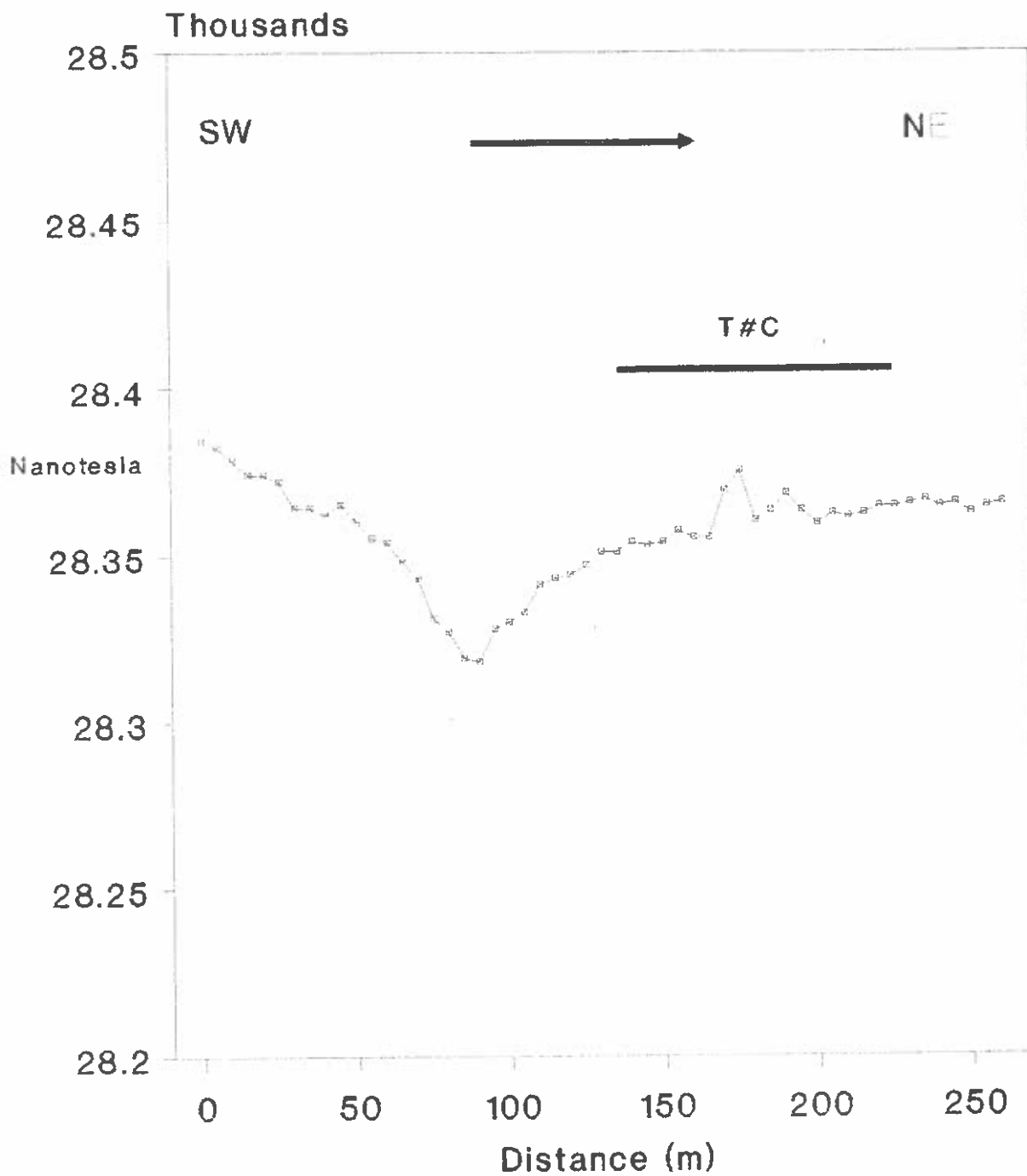
MOTHIBISTAD WASTE SITE
Magnetic traverse T#D



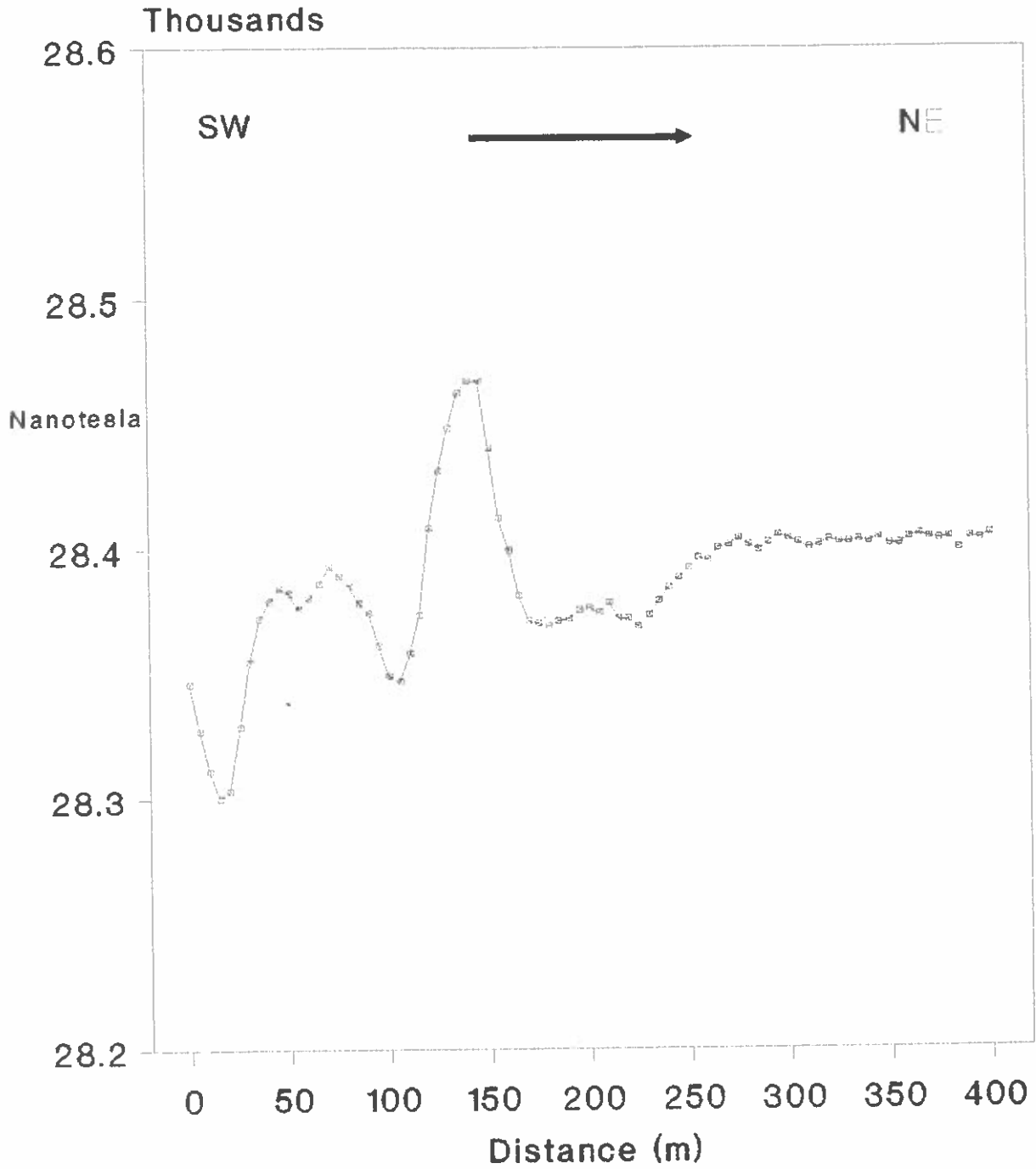
MOTHIBISTAD WASTE SITE
Magnetic traverse T#C



MOTHIBISTAD WASTE SITE
Magnetic traverse T#B



MOTHIBISTAD WASTE SITE
Magnetic traverse T#A



APPENDIX - D
PERCUSSION DRILLING LOGS

PROJECT: MOTHIBISTAD WASTE SITE
 BOREHOLE NO: 13-86403
 MACHINE TYPE: Percussion rig & 17 bar compressor
 DRILLED BY: Aqua Alpha
 DRILLING STARTED: 12/2/93
 DRILLING COMPLETED: 12/2/93
 LOGGED BY: H.J.S.

KEY
 ▼ Standing Water
 ▽ Water Seepage
 ⇕ Air Loss
 □ Casing
 ■ Test and Position

Casing and drill diam.	Penetration (mins/metre)	Chip size Range (mm.)	Additional Data	Geological column	Depth (m)	DESCRIPTION
	1'00"	Clay - 30			1	(0 - ±1,00 m.) Reddish brown, <u>SILTY SAND</u> with scattered gravels; roots; <u>transported soils of mixed origins.</u>
	1'14"	Clay - 60			2	(+1,00 - ±4,00 m.) Pale yellow-brown, <u>CLAYEY fine SAND</u> with numerous calcareous gravels, cobbles and boulders; <u>hardpan calcrete.</u>
	0'50"			3		
	0'58"			4		
	1'13"	Clay - 15			5	(+4,00 - ±18,00 m.) Olive green, slightly micaceous <u>SILTY CLAY</u> ; <u>residual dolerite.</u>
	1'14"			6		
	1'00"			7		
165	1'13"			8		
	1'00"			9		
	2'06"			10		
	1'44"			11		
	2'16"			12		
216	1'52"			13		
	1'60"			14		
	1'80"			15		
	2'31"			16		
	1'44"			17		
	1'47"			18		
	1'33"			19	(±18,00 - ±26,00 m.) Pale green, highly weathered, probably highly fractured, <u>soft - hard rock</u> ; <u>dolerite.</u>	

PROJECT: MOTHIBISTAD WASTE SITE
 BOREHOLE NO: 13-86403 (continued)
 MACHINE TYPE:
 DRILLED BY:
 DRILLING STARTED:
 DRILLING COMPLETED:
 LOGGED BY:

KEY
 ▼ Standing Water
 ▽ Water Seepage
 ⇕ Air Loss
 □ Casing
 ■ Test and Position

Casing and drill diam.	Penetration (mins/metre)	Chip size Range (mm.)	Additional Data	Geological column	Depth (m)	DESCRIPTION
216	7'34"	Clay - 25	▽	+	21	(+18,00 - +26,00 m.) Pale green, highly weathered, probably highly fractured <u>soft - hard rock</u> ; <u>dolerite</u> .
	3'26'			+	22	
	3'27'			+	23	
	3'09'			+	24	
	3'15'			+	25	
	3'07'			+	26	
165	2'36'	◀25		+	27	(+26,00 - +40,00 m.) Dark green, fine grained, very hard rock; <u>dolerite</u> .
	2'48'			+	28	
	2'46'			+	29	
	2'38'			+	30	
	-			+	31	
	5'16'			+	32	
	5'03'			+	33	
	3'58'			+	34	
	5'02'			+	35	
	-			+	36	
	3'54'			+	37	
	3'28'			+	38	
3'30'	+	39				

NOTES:

- Borehole drilled to a final depth of 40,0 m.
- Final blowing yield 0,1 l/s.
- Water level 6,95 m.b.g.l. on the 16/02/93 (-3½ hours after drilling).

PROJECT: MOTHIBISTAD WASTE SITE
 BOREHOLE NO: 13-86404
 MACHINE TYPE: Percussion rig and 17 bar compressor
 DRILLED BY: Aqua Alpha
 DRILLING STARTED: 12/2/93
 DRILLING COMPLETED: 13/2/93
 LOGGED BY: H.J.S.

KEY
 ▼ Standing Water
 ▽ Water Seepage
 ↑↓ Air Loss
 □ Casing
 ■ Test and Position

Casing and drill diam.	Penetration (mins/metre)	Chip size Range(mm.)	Additional Data	Geological Column	Depth(m)	DESCRIPTION
203		< 2		0-1.0	1	(0 - ±1,0 m.) Reddish brown, SILTY SAND with scattered gravels; <u>transported soils of mixed origin.</u>
		0,5-50		1.0-3.0	2	(±1,0 - ±3,0 m.) Abundant nodular calcretions cemented in a yellow-brown CLAYEY SAND matrix; <u>hardpan calcrete.</u>
	3'20"	0,5-30		3.0-5.0	3	(±3,0 - ±5,0 m.) Bluish grey speckled white, fine grained, <u>hard rock</u> ; <u>dolomite.</u>
	5'39"			4		
	2'10"	Clay - 40		5.0-8.0	6	(±5,0 - ±8,0 m.) Bluish grey speckled white, fine grained, <u>hard rock</u> ; dolomite with calcrete veins.
	2'34"			7		
	3'30"			8		
	4'05"			9		
	3'40"	< 0,5 - 20,0		8.0-54.0	10	(±8,0 - ±54 m.) Bluish grey speckled white, unweathered, fine grained, <u>hard rock</u> ; <u>dolomite.</u>
	3'20"			11		
	2'47"			12		
	3'09"			13		
	3'22"			14		
	3'26"			15		
	2'56"			16		
	2'45"			17		
	2'35"		18	(±16,0 - ±20,0 m.) Contains black carbonaceous shale lenses.		

PROJECT: MOTHIBISTAD WASTE SITE
 BOREHOLE NO: 13-86404 (continued)
 MACHINE TYPE:
 DRILLED BY:
 DRILLING STARTED:
 DRILLING COMPLETED:
 LOGGED BY:

- KEY
- ▼ Standing Water
 - ▽ Water Seepage
 - ↕ Air Loss
 - Casing
 - Test and Position

Casing and drill diam.	Penetration (mins/metre)	Chip size Range (mm.)	Additional Data	Geological column	Depth (m)	DESCRIPTION
165	2'31"	0,5 - 20,0			21	<p>(⁺18,0 - ⁺54,0 m.) Bluish grey speckled white, unweathered, fine grained, <u>hard rock</u>; <u>dolomite</u>.</p>
	3'50"				22	
	3'06"				23	
	2'48"				24	
	2'45"				25	
	3'16"				26	
	2'24"				27	
	2'07"				28	
	1'46"				29	
	2'45"				30	
	2'32"				31	
	2'30"				32	
	2'15"				33	
	2'52"				34	
	3'01"				35	
	3'04"				36	
	3'02"				37	
	3'29"				38	
3'21"	39					

PROJECT: MOTHIBISTAD WASTE SITE
 BOREHOLE NO: 13-86404 (continued)
 MACHINE TYPE:
 DRILLED BY:
 DRILLING STARTED:
 DRILLING COMPLETED:
 LOGGED BY:

KEY
 ▼ Standing Water
 ▽ Water Seepage
 ⇕ Air Loss
 □ Casing
 ■ Test and Position

Casing and drill diam.	Penetration (mins/metre)	Chip size Range (mm.)	Additional Data	Geological column	Depth (m)	DESCRIPTION
165	3'15"	< 0,5 - 20,0			41	(+18,0 - -54,0 m.) Bluish grey speckled white, unweathered, fine grained, <u>hard rock</u> ; <u>dolomite</u> .
	3'05"				42	
	2'38"				43	
	3'08"				44	
	3'05"				45	
	3'20"				46	
	3'20"				47	
	3'01"				48	
	2'45"				49	
	3'30"				50	
	2'57"				51	
	3'30"				52	
	3'05"				53	
	3'19"				54	
					55	
					56	
					57	
					58	

NOTE:
 1. Borehole drilled to a final depth of 54,0 m.

PROJECT: MOTHIBISTAD WASTE SITE
 BOREHOLE NO: 13-86405
 MACHINE TYPE: Percussion rig and 17 bar compressor
 DRILLED BY: Aqua Alpha
 DRILLING STARTED: 13/2/93
 DRILLING COMPLETED: 13/2/93
 LOGGED BY: H.J.S.

KEY

- ▼ Standing Water
- ▽ Water Seepage
- ↕ Air Loss
- U Casing
- Test and Position

Casing and drill diam.	Penetration (mins/metre)	Chip size Range(mm.)	Additional Data	Geological column	Depth(m)	DESCRIPTION
216	0'43"	< 0,5-20	damp	1	1	(0,0 - ⁺ 2,0 m.) Reddish brown, SILTY SAND; <u>transported soils of mixed origins.</u> Below ⁺ 1,0 m. contains calcareous concretions.
	0'45"			2		
	1'09"	< 0,5 - 25,0		3	3	(⁺ 2,0 - ⁺ 9,0 m.) Buff; <u>hardpan calcrete.</u>
	1'48"			4		
	1'18"			5		
	1'35"			6		
	1'10"			7		
	1'16"			8		
	0'56"			Clay - 10,0		
	1'39"	10				
	1'06"	11				
	1'29"	Clay - 25,0		12	12	(⁺ 13,0 - ⁺ 24,0 m.) Pale green, highly weathered, fine grained, highly fractured (stained yellow-brown), <u>very soft rock</u> ; <u>dolerite.</u>
	1'19"			13		
	1'25"			14		
	0'58"			15		
	1'30"			16		
	1'28"	17		17	17	
		18		18	18	

PROJECT: MOTHIBISTAD WASTE SITE
 BOREHOLE NO: 13-86405 (continued)
 MACHINE TYPE:
 DRILLED BY:
 DRILLING STARTED:
 DRILLING COMPLETED:
 LOGGED BY:

KEY
 ▼ Standing Water
 ▽ Water Seepage
 ⇕ Air Loss
 □ Casing
 ■ Test and Position

Casing and drill diam.	Penetration (mins/metre)	Chip size Range (mm.)	Additional Data	Geological column	Depth (m)	DESCRIPTION
216	1'24"	Clay - 25		+	21	(+13,0 - +24,0 m.) Pale green, highly weathered, fine grained, highly fractured (stained yellow-brown), <u>very soft rock</u> ; <u>dolerite</u> .
	-			+	22	
	1'07"			+	23	
	1'16"			+	24	
	1'46"	< 20		+	25	(+24,0 - +31,0 m.) Dark green speckled white, highly weathered, <u>soft rock</u> ; <u>dolerite</u> .
	1'41"			+	26	
	1'38"			+	27	
	1'30"			+	28	
	2'24"			+	29	
	5'30"			+	30	
8'30"	damp	+	31	Below +29,0 m becomes <u>hard rock</u> .		
					32	
					33	
					34	
					35	
					36	
					37	
					38	

NOTE:
 1. Borehole drilled to a final depth of 31,0 m.

PROJECT: MOTHIBISTAD WASTE SITE
 BOREHOLE NO: 13-86406
 MACHINE TYPE: Percussion rig and 17 bar compressor
 DRILLED BY: Aqua Alpha
 DRILLING STARTED: 13/2/93
 DRILLING COMPLETED: 13/2/93
 LOGGED BY: H.J.S.

- KEY
- ▼ Standing Water
 - ▽ Water Seepage
 - ↕ Air Loss
 - Casing
 - Test and Position

Casing and drill diam.	Penetration (mins/metre)	Chip size Range (mm.)	Additional Data	Geological Column	Depth (m)	DESCRIPTION
	-	Clay - 10			1	(0,0 - ⁺ 1,0 m.) Reddish brown, <u>SILTY SAND</u> with scattered fine gravels; <u>transported soil of mixed origin.</u>
	0'40"	Clay - 30	▼		2	(1,0 - ⁺ 3,0 m.) Yellow-brown, <u>hardpan calcrete</u> with chert gravels.
	1'02"			3		
	2'23"			4		
	1'49"			5		
	2'13"	< 0,5 - 15	▼		6	(3,0 - ⁺ 6,0 m.) - Abundant calcareous cemented dolomite <u>GRAVELS</u> , <u>COBBLES</u> and <u>BOULDERS</u> ; <u>hardpan calcrete.</u>
	3'08"			7		
	2'10"			8		
	2'07"			9		
	2'30"			10		
	2'03"			11		
	2'31"	< 0,5 - 10	▼		12	(6,0 - ⁺ 12,0 m.) Bluish grey speckled white, un-weathered, fine grained, <u>hard rock</u> ; <u>dolomite</u> with runnels of grey <u>SILTY</u> fine SAND and calcareous nodules.
	2'51"			13		
	3'30"			14		
	3'15"			15		
	2'08"	< 0,5 - 10	▼		16	(12,0 - ⁺ 35,0 m.) Bluish grey speckled white, un-weathered, fine grained, <u>hard rock</u> ; dolomite.
	2'27"			17		
	2'08"			18		
	2'30"				19	(18,0 - ⁺ 19,0 m. ⁺ 6,0 - ⁺ 12,0 m.) Contains runnels as per

165

203

165

PROJECT: MOTHIBISTAD WASTE SITE
 BOREHOLE NO: 13-86406 (continued)
 MACHINE TYPE:
 DRILLED BY:
 DRILLING STARTED:
 DRILLING COMPLETED:
 LOGGED BY:

KEY
 ▼ Standing Water
 ▽ Water Seepage
 ⇕ Air Loss
 □ Casing
 ■ Test and Position

Casing and drill diam.	Penetration (mins/metre)	Chip size Range (mm.)	Additional Data	Geological column	Depth (m)	DESCRIPTION
165	2'38"	< 0,5 - 10	(1,0 1/s)		21	(±12,0 - ±35,0 m.) Bluish grey speckled white, unweathered, fine grained, <u>hard rock</u> ; <u>dolomite</u> .
	2'01"				22	
	2'10"				23	
	2'01"				24	
	2'22"				25	
	2'45"				26	
	2'43"				27	
	2'41"				28	
	4'08"				29	
	3'21"				30	
	3'42"				31	
	3'11"				32	
	5'35"				33	
	3'05"				34	
	3'30"				35	
					36	
					37	
					38	

NOTES:

- Borehole drilled to a final depth of 35,0 m.
- Water rest level at 4,50 m.b.g.l. on the 15/02/93.
 Water rest level at 4,37 m.b.g.l. on the 16/02/93.

PROJECT: MOTHIBISTAD WASTE SITE
 BOREHOLE NO: 13-86407
 MACHINE TYPE: Percussion rig and 17 bar compressor
 DRILLED BY: Aqua Alpha
 DRILLING STARTED: 16/02/93
 DRILLING COMPLETED: 16/02/93
 LOGGED BY: H.J.S.

KEY
 ▼ Standing Water
 ▽ Water Seepage
 ↑↓ Air Loss
 U Casing
 ■ Test and Position



Casing and drill diam.	Penetration (mins/metre)	Chip size Range (mm.)	Additional Data	Geological column	Depth (m)	DESCRIPTION
165 mm	2'55"	2 Clay - 15	(0,1 1/s) 	1	(0,0 - ±0,5 m.)	Reddish brown, <u>SILTY SAND</u> ; <u>trans-ported soils of mixed origins.</u>
	4'24"			2	(±0,5 - ±2,5 m.)	Bluish grey, unweathered, fine grained, <u>hard rock</u> ; <u>dolomite pinnacles/boulders.</u>
	4'56"			3	(±2,5 - ±4,0 m.)	Yellow-brown, <u>hardpan</u> ; <u>calcrete</u> with dolomite boulders.
	2'21"	< 0,5 - 10		4		
	3'17"			5	(±4,0 - ±7,0 m.)	Bluish grey, moderately weathered, fine grained, <u>soft - hard rock</u> ; <u>dolomite.</u>
	3'23"			6		
	3'51"			7		
				8		
					9	
					10	
					11	
					12	
					13	
					14	
					15	
					16	
					17	
					18	

NOTE:

1. Borehole drilled to a final depth of 7,0 m.

PROJECT: MOTHIBISTAD WASTE SITE
 BOREHOLE NO: 13-86408 (continued)
 MACHINE TYPE:
 DRILLED BY:
 DRILLING STARTED:
 DRILLING COMPLETED:
 LOGGED BY:

KEY
 ▼ Standing Water
 ▽ Water Seepage
 ⇕ Air Loss
 □ Casing
 ■ Test and Position

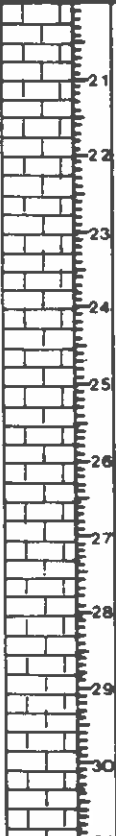
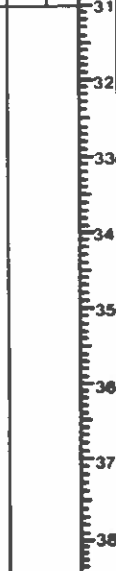
Casing and drill diam.	Penetration (mins/metre)	Chip size Range (mm.)	Additional Data	Geological column	Depth (m)	DESCRIPTION
165	3' 47"	Clay - 70,0			21	(+16,00 - +25,00 m.) Bluish grey speckled white, unweathered, fine grained, highly fractured <u>hard rock</u> ; <u>dolomite</u> with numerous stringers of completely weathered dolerite (yellow-brown, CLAY-SILT).
	2' 25"				22	
	9' 22"				23	
	7' 30"				24	
	2' 40"				25	
	4' 55"	< 0,5 - 10,0			26	(+25,00 - +31,00 m.) Bluish grey speckled white, unweathered, fine grained, <u>hard rock</u> ; <u>dolomite</u> .
	5' 27"				27	
	5' 43"				28	
	-				29	
	5' 40"				30	
4' 40"	31			32		
	33					
	34					
	35					
	36					
	37					
	38					
	39					

NOTES:

- Borehole drilled to a final depth of 31,0 m.
- Final blowing yield > 10,0 l/s.
- Water level 6,34 m.b.g.l. on the 24/02/93 (11 hours after drilling).

PROJECT: MOTHIBISTAD WASTE SITE
 BOREHOLE NO: 13-86409 (continued)
 MACHINE TYPE:
 DRILLED BY:
 DRILLING STARTED:
 DRILLING COMPLETED:
 LOGGED BY:

KEY
 ▼ Standing Water
 ▽ Water Seepage
 ⇕ Air Loss
 □ Casing
 ■ Test and Position

Casing and drill diam.	Penetration (mins/metre)	Chip size Range (mm.)	Additional Data	Geological column	Depth (m)	DESCRIPTION
165	3'30"	< 0,5 - 10,0			21	(+9,00 - +31,00 m.) Bluish grey speckled white, unweathered, fine grained, <u>hard rock</u> ; <u>dolomite</u> .
	3'38"				22	
	3'50"				23	
	3'46"				24	
	3'56"				25	
	2'15"				26	
	3'24"				27	
	3'06"				28	
	4'27"				29	
	3'07"				30	
	3'55"				31	
					32	
					33	
					34	
					35	
					36	
					37	
					38	

- NOTES:
- Borehole drilled to a final depth of 31,0 m.
 - Water level at 3,80 m.b.g.l. on the 25/02/93 (+15 hours after drilling).
 - Final blowing yield +1,0 l/s.

APPENDIX - E
BOREHOLE CENSUS DATA SHEETS

BOREHOLE CENSUS DATA SHEET**PROJECT :** MOTHAIBESTAD WASTE SITEBorehole file no: 13-80278 Present marking/no: 13-80278GENERAL DATADate of census : 22/02/93 Recorded by : H.S.S.Locality : Mothaibestad Elevation : _____Topography : perimeter Accessibility: goodGEOLOGY AND HYDROGEOLOGYGeology : dolomiteMain aquifer : residual dolomite (partially filled void)Water level : (1) 13.47 m on 17/12/1991 ; (2) 13.2 m on 02/01/1992 ; (3) 14.2 m on 22/02/1993INFORMATION ON BOREHOLEType : perimeter Date of construction : 16/12/91Reported depth : 26.0 m Casing : yes (00 - 0.0 m)Borehole diameter : 165 mmReported yield : < 0.1 l/sPUMPING EQUIPMENT AND HEADWORKSPump type : none Type of engine : N/APump discharge : _____ l/s. Finish/protection : steel plateAuxiliary facilities : noneUSE AND PERFORMANCEUse : monitoringEst. population served : N/A Est. livestock served : N/AAdequacy : N/A Performance : N/AEstimated average abstraction : N/A m³/day.WATER QUALITYQuality : ? Taste : ?Odour : ? Colour : ?

Bacteriological sample : Y(N)

2 litre sample : Y(N)

BOREHOLE CENSUS DATA SHEET**PROJECT :** MOTHILISTAD WASTE SITEBorehole file no: 13-86275 Present marking/no : 13-86275**GENERAL DATA**Date of census : 22/02/93 Recorded by : H.J.S.Locality : Mothilistad extension Elevation : _____Topography : plateau Accessibility : good**GEOLOGY AND HYDROGEOLOGY**Geology : calc. mts.Main aquifer : sheet residualWater level : (1) 3.06 m on 17/12/1993; (2) 2.70 m on 07/01/1992; (3) 3.37 m on 22/02/1993**INFORMATION ON BOREHOLE**Type : percussion Date of construction : 15/12/91Reported depth : 16.0m Casing : yes (0.0 - 16.0m)Borehole diameter : 165 mmReported yield : < 0.1 l/s**PUMPING EQUIPMENT AND HEADWORKS**Pump type : none Type of engine : N/APump discharge : N/A l/s. Finish/protection : steel plateAuxiliary facilities : none**USE AND PERFORMANCE**Use : monitoringEst. population served : N/A Est. livestock served : N/AAdequacy : N/A Performance : N/AEstimated average abstraction : N/A m³/day.**WATER QUALITY**Quality : ? Taste : ?Odour : ? Colour : ?Bacteriological sample : Y(N) 2 litre sample : Y(N)

BOREHOLE CENSUS DATA SHEET

PROJECT : MOTHIBISTAD WASTE SITE

Borehole file no: 13-86276 Present marking/no : 13-86276

GENERAL DATA

Date of census : 23/02/93 Recorded by : H.J.S.

Locality : Methibistad extension Elevation : _____

Topography : pediment Accessibility: good

GEOLOGY AND HYDROGEOLOGY

Geology : dolomite

Main aquifer : residual dolomite

Water level : (1) 3.36 m on 17/12/1991 ; (2) 3.10 m on 07/01/1992 ; (3) 4.17 m on 22/02/1993

INFORMATION ON BOREHOLE

Type : percussion Date of construction : 16/12/91

Reported depth : 16.0 m Casing : yes (20-6.0m)

Borehole diameter : 105 mm

Reported yield : < 0.1 l/s.

PUMPING EQUIPMENT AND HEADWORKS

Pump type : none Type of engine : N/A

Pump discharge : N/A l/s. Finish/protection : N/A

Auxiliary facilities : N/A

USE AND PERFORMANCE

Use : monitoring

Est. population served : N/A Est. livestock served : N/A

Adequacy : N/A Performance : N/A

Estimated average abstraction : N/A m³/day.

WATER QUALITY

Quality : ? Taste : ?

Odour : ? Colour : ?

Bacteriological sample : Y(N) 2 litre sample : Y(N)

BOREHOLE CENSUS DATA SHEET

PROJECT : MOTHIBISTAD WASTE SITE

Borehole file no: _____ Present marking/no : _____

GENERAL DATA

Date of census : 22/02/92 Recorded by : H. J. S.

Locality : Mapoteng Elevation : _____

Topography : hill slope Accessibility: difficult

GEOLOGY AND HYDROGEOLOGY

Geology : slate

Main aquifer : _____

Water level : (1) 5.67 m on 22/02/1993; (2) _____ m on _____ / /19 ; (3) _____ m on _____ / /19 ;

INFORMATION ON BOREHOLE

Type : percussion Date of construction : ?

Reported depth : ? Casing : probably

Borehole diameter : ?

Reported yield : ?

PUMPING EQUIPMENT AND HEADWORKS

Pump type : hand pump Type of engine : n/a

Pump discharge : ± 0.1 l/s. Finish/protection : concrete block

Auxiliary facilities : pipe

USE AND PERFORMANCE

Use : church congregation

Est. population served : ± 40 Est. livestock served : none

Adequacy : ? Performance : ?

Estimated average abstraction : _____ ? _____ m³/day.

WATER QUALITY

Quality : good Taste : good

Odour : none Colour : clear

Bacteriological sample : Y/N: _____ 2 litre sample (Y/N): _____

BOREHOLE CENSUS DATA SHEETPROJECT : MOTHSIBIGIAD WASTE SITEBorehole file no: 13-86010 Present marking/no : 13-86010GENERAL DATADate of census : 22/2/93 Recorded by : H.J.S.Locality : Mapateng reservoir Elevation : _____Topography : hill crest Accessibility: locatedGEOLOGY AND HYDROGEOLOGYGeology : oleomitic

Main aquifer : _____

Water level : (1) _____ m on / /19 ; (2) _____ m on / /19 ; (3) _____ m on / /19 ;

INFORMATION ON BOREHOLEType : perimeter Date of construction : _____Reported depth : 107 m Casing : _____Borehole diameter : 165 mmReported yield : 1.5 l/s for 24 hoursPUMPING EQUIPMENT AND HEADWORKSPump type : none at present Type of engine : N/APump discharge : N/A l/s. Finish/protection : _____Auxiliary facilities : pump shedUSE AND PERFORMANCEUse : not equipped at presentEst. population served : N/A Est. livestock served : N/AAdequacy : N/A Performance : _____Estimated average abstraction : 130 (available) m³/day.WATER QUALITYQuality : good Taste : ?Odour : none Colour : ?

Bacteriological sample : Y(N)

2 litre sample : Y(N)

BOREHOLE CENSUS DATA SHEETPROJECT : MOTHEBIYAD WASTE SITE

Borehole file no: _____ Present marking/no : _____

GENERAL DATADate of census : 22/02/93 Recorded by : H. J. S.Locality : Malaputeny Elevation : _____Topography : pediment Accessibility: difficultGEOLOGY AND HYDROGEOLOGYGeology : claystone

Main aquifer : _____

Water level : (1) _____ m on / / 19 ; (2) _____ m on / / 19 ; (3) _____ m on / / 19 ;

INFORMATION ON BOREHOLEType : percussion Date of construction : 09/04/89Reported depth : ± 20.0 m Casing : probablyBorehole diameter : ± 165 mm

Reported yield : _____

PUMPING EQUIPMENT AND HEADWORKSPump type : hand pump Type of engine : N/APump discharge : ± 0.1 l/s l/s. Finish/protection : concrete blockAuxiliary facilities : pipeUSE AND PERFORMANCEUse : house hold (private)Est. population served : 10 Est. livestock served : noneAdequacy : suffices Performance : goodEstimated average abstraction : probably ± 0.5 m³/day.WATER QUALITYQuality : good Taste : goodOdour : none Colour : clear

Bacteriological sample : Y(N) 2 litre sample : Y(N)

BOREHOLE CENSUS DATA SHEETPROJECT : MOTHIBISIAD WASTE SITE

Borehole file no: _____ Present marking/no : _____

GENERAL DATADate of census : 22/02/93 Recorded by : H.J.S.Locality : Mapoteng P/S Elevation : _____Topography : pediment Accessibility: goodGEOLOGY AND HYDROGEOLOGYGeology : calomite

Main aquifer : _____

Water level : (1) 3.2 m on 1/1981; (2) 4.74 m on 22/02/1993; (3) _____ m on 1/19;INFORMATION ON BOREHOLEType : percussion Date of construction : 01/08/81Reported depth : 90 m Casing : probablyBorehole diameter : 114.5 mmReported yield : 450 l/sPUMPING EQUIPMENT AND HEADWORKSPump type : hand pump Type of engine : N/APump discharge : ± 0.1 l/s. Finish/protection : concrete blockAuxiliary facilities : noneUSE AND PERFORMANCEUse : potable water sourceEst. population served : ± 300 Est. livestock served : noneAdequacy : sufficient Performance : fairEstimated average abstraction : < 0.5 m³/day.WATER QUALITYQuality : good Taste : goodOdour : none Colour : clearBacteriological sample : Y/N2 litre sample : Y/N

BOREHOLE CENSUS DATA SHEET

PROJECT : MLATHIBISTAD WASTE SITE

Borehole file no: - Present marking/no: -

GENERAL DATA

Date of census : 22/02/93 Recorded by : H.J.S.

Locality : mlapateny Elevation :

Topography : pediment Accessibility: poor

GEOLOGY AND HYDROGEOLOGY

Geology : dolomite

Main aquifer :

Water level : (1) ? m on / /19 ; (2) m on / /19 ; (3) m on / /19 ;

INFORMATION ON BOREHOLE

Type : percussion Date of construction : ?

Reported depth : ? Casing :

Borehole diameter : ± 165 mm

Reported yield : ?

PUMPING EQUIPMENT AND HEADWORKS

Pump type : hand pump Type of engine : N/A

Pump discharge : ± 0.1 l/s. Finish/protection : concrete block

Auxiliary facilities : pipe

USE AND PERFORMANCE

Use : private

Est. population served : ± 6 Est. livestock served : none

Adequacy : ? Performance : ?

Estimated average abstraction : ? m³/day.

WATER QUALITY

Quality : ? Taste : ?

Odour : ? Colour : ?

Bacteriological sample : Y(N) 2 litre sample : Y(N)

BOREHOLE CENSUS DATA SHEETPROJECT : MOTHIKISTAD WASTE SITEBorehole file no: — Present marking/no : —GENERAL DATADate of census : 22/02/93 Recorded by : H.S.S.Locality : Mapoteng Elevation : —Topography : pediment Accessibility: poorGEOLOGY AND HYDROGEOLOGYGeology : dolomiteMain aquifer : —Water level : (1) ? m on — / /19 ; (2) — m on — / /19 ; (3) — m on — / /19 ;INFORMATION ON BOREHOLEType : percussion Date of construction : ?Reported depth : ? Casing : probablyBorehole diameter : ± 165 mmReported yield : ?PUMPING EQUIPMENT AND HEADWORKSPump type : hand pump Type of engine : N/APump discharge : ± 0,1 l/s. Finish/protection : concrete blockAuxiliary facilities : pipeUSE AND PERFORMANCEUse : privateEst. population served : ± 8 Est. livestock served : noneAdequacy : ? Performance : ?Estimated average abstraction : ? m³/day.WATER QUALITYQuality : ? Taste : ?Odour : ? Colour : ?Bacteriological sample : Y(N)2 litre sample : Y(N)

BOREHOLE CENSUS DATA SHEETPROJECT : MOTHIBISTAD WASTE SITEBorehole file no : _____ Present marking/no : T10634dGENERAL DATADate of census : 22/02/93 Recorded by : H. J. S.Locality : North of Mothibistad Elevation : _____Topography : pediment Accessibility : roadGEOLOGY AND HYDROGEOLOGYGeology : dolomiteMain aquifer : dolomiteWater level : (1) 8.38 m on 22/02/1993; (2) _____ m on _____ / _____ / 19 ; (3) _____ m on _____ / _____ / 19 ;INFORMATION ON BOREHOLEType : percussion Date of construction : N/AReported depth : ? Casing : probablyBorehole diameter : ± 125 mmReported yield : ?PUMPING EQUIPMENT AND HEADWORKSPump type : windmill Type of engine : N/APump discharge : ± 0.1 l/s. Finish/protection : concrete blockAuxiliary facilities : reservoirUSE AND PERFORMANCEUse : livestockEst. population served : ? Est. livestock served : ?Adequacy : suffice Performance : fairEstimated average abstraction : ? m³/day.WATER QUALITYQuality : good Taste : goodOdour : none Colour : clearBacteriological sample : (Y/N);2 litre sample : (Y/N);

BOREHOLE CENSUS DATA SHEET

PROJECT : MOTHIBISTAD WASTE SITE

Borehole file no: Present marking/no :

GENERAL DATA

Date of census : 23/02/93 Recorded by : H.J.S.

Locality : Mapoteng Spring Elevation :

Topography : pediment Accessibility: good

GEOLOGY AND HYDROGEOLOGY

Geology : dolomite

Main aquifer : contact between dolomite & dolerite dyke

Water level : (1) 0.0 m on 23/2/1993; (2) m on / /19 ; (3) m on / /19 ;

INFORMATION ON BOREHOLE

Type : Spring Date of construction : N/A

Reported depth : Casing :

Borehole diameter :

Reported yield : + 20 l/s

PUMPING EQUIPMENT AND HEADWORKS

Pump type : Type of engine :

Pump discharge : l/s. Finish/protection :

Auxiliary facilities :

USE AND PERFORMANCE

Use : local populace & livestock

Est. population served : > 100 Est. livestock served : > 100

Adequacy : suffice Performance : good

Estimated average abstraction : ± 2000 m³/day.

WATER QUALITY

Quality : good Taste : good

Odour : none Colour : clear

Bacteriological sample : (Y/N); 2 litre sample (Y/N)

BOREHOLE CENSUS DATA SHEET

PROJECT : MOTHEBISIAD WASTE SITE

Borehole file no: 13-86403 Present marking/no : 13-86403 ✓

GENERAL DATA

Date of census : 22/02/93 Recorded by : H.S.S

Locality : near prop waste site Elevation : _____

Topography : pediment Accessibility: good

GEOLOGY AND HYDROGEOLOGY

Geology : claystone

Main aquifer : _____

Water level : (1) 6.45 m on 16/02/1993; (2) _____ m on / /19 ; (3) _____ m on / /19 ;

INFORMATION ON BOREHOLE

Type : percussion Date of construction : 12/02/93

Reported depth : 40.0 m Casing : yes (0.0 - 26.0m)

Borehole diameter : 165 mm

Reported yield : 0.1 l/s

PUMPING EQUIPMENT AND HEADWORKS

Pump type : none Type of engine : N/A

Pump discharge : N/A l/s. Finish/protection : concrete block

Auxiliary facilities : sanitary seal

USE AND PERFORMANCE

Use : monitoring

Est. population served : N/A Est. livestock served : N/A

Adequacy : N/A Performance : N/A

Estimated average abstraction : 0 m³/day.

WATER QUALITY

Quality : ? Taste : ?

Odour : ? Colour : ?

Bacteriological sample : Y(N)

2 litre sample : Y(N)

BOREHOLE CENSUS DATA SHEETPROJECT : MUTHIBISTAD WASTE SITEBorehole file no: 13-86406 Present marking/no : 13-86406 VGENERAL DATADate of census : 22/02/93 Recorded by : H.S.S.Locality : near prop. waste site Elevation : _____Topography : pediment Accessibility: good.GEOLOGY AND HYDROGEOLOGYGeology : dolomiteMain aquifer : fractures in the dolomite.Water level : (1) 4.37 m on 16/02/1993; (2) _____ m on 1/19 ; (3) _____ m on 1/19 ;INFORMATION ON BOREHOLEType : percussion Date of construction : 13/02/93Reported depth : 35.0m Casing : yes (0.0 - 15.0m)Borehole diameter : 165 mmReported yield : 1.0 l/sPUMPING EQUIPMENT AND HEADWORKSPump type : none Type of engine : N/APump discharge : N/A l/s. Finish/protection : concrete blockAuxiliary facilities : sanitary sealUSE AND PERFORMANCEUse : monitoringEst. population served : N/A Est. livestock served : N/AAdequacy : N/A Performance : N/AEstimated average abstraction : 0 m³/day.WATER QUALITYQuality : good Taste : goodOdour : none Colour : noneBacteriological sample : Y/N2 litre sample Y/N

BOREHOLE CENSUS DATA SHEET**PROJECT :** NOTHIBISTAD WASTE SITEBorehole file no: 13-86408 Present marking/no: 13-86408 ✓**GENERAL DATA**Date of census : 23/02/93 Recorded by : H.J.SLocality : near prop wash site Elevation : _____Topography : pediment Accessibility: good**GEOLOGY AND HYDROGEOLOGY**Geology : dolomiteMain aquifer : dolomite / dolomite contactWater level : (1) 6.34 m on 24/02/1993; (2) _____ m on 1/19 ; (3) _____ m on 1/19 ;**INFORMATION ON BOREHOLE**Type : percussion Date of construction : 24/02/93Reported depth : 31.0 m Casing : yes (0.0 - 11.0 m)Borehole diameter : 165 mmReported yield : > 10,0 l/s**PUMPING EQUIPMENT AND HEADWORKS**Pump type : none Type of engine : N/APump discharge : N/A l/s. Finish/protection : concrete blockAuxiliary facilities : sanitary seal**USE AND PERFORMANCE**Use : monitoringEst. population served : N/A Est. livestock served : N/AAdequacy : N/A Performance : N/AEstimated average abstraction : 0 m³/day.**WATER QUALITY**Quality : good Taste : goodOdour : none Colour : clearBacteriological sample : YN; 2 litre sample : YN

BOREHOLE CENSUS DATA SHEETPROJECT : MOHIBISTAD WASTE SITEBorehole file no: 13-86409 Present marking/no : 13-86409 ✓GENERAL DATADate of census : 25/02/93 Recorded by : H.J.S.Locality : new prop. waste site Elevation : _____Topography : pediment Accessibility: good.GEOLOGY AND HYDROGEOLOGYGeology : dolomiteMain aquifer : fractured dolomiteWater level : (1) 3.80 m on 25/02/1993; (2) _____ m on 1/19 ; (3) _____ m on 1/19 ;INFORMATION ON BOREHOLEType : percussion Date of construction : 24/Reported depth : 31.0 Casing : yes (9.0-13.0m)Borehole diameter : 165 mmReported yield : 1.0 l/s.PUMPING EQUIPMENT AND HEADWORKSPump type : none Type of engine : N/APump discharge : N/A l/s. Finish/protection : concrete blockAuxiliary facilities : sanitary sealUSE AND PERFORMANCEUse : monitoringEst. population served : N/A Est. livestock served : N/AAdequacy : N/A Performance : N/AEstimated average abstraction : _____ 0 m³/day.WATER QUALITYQuality : good Taste : goodOdour : none Colour : clearBacteriological sample : Y(N)2 litre sample : Y(N)

APPENDIX - F
TEST PUMPING RESULTS

STEP DRAWDOWN TEST

* Pumping data
+ Recovery data

MOTHIBISTAD

WASTE SITE

23.02.1993

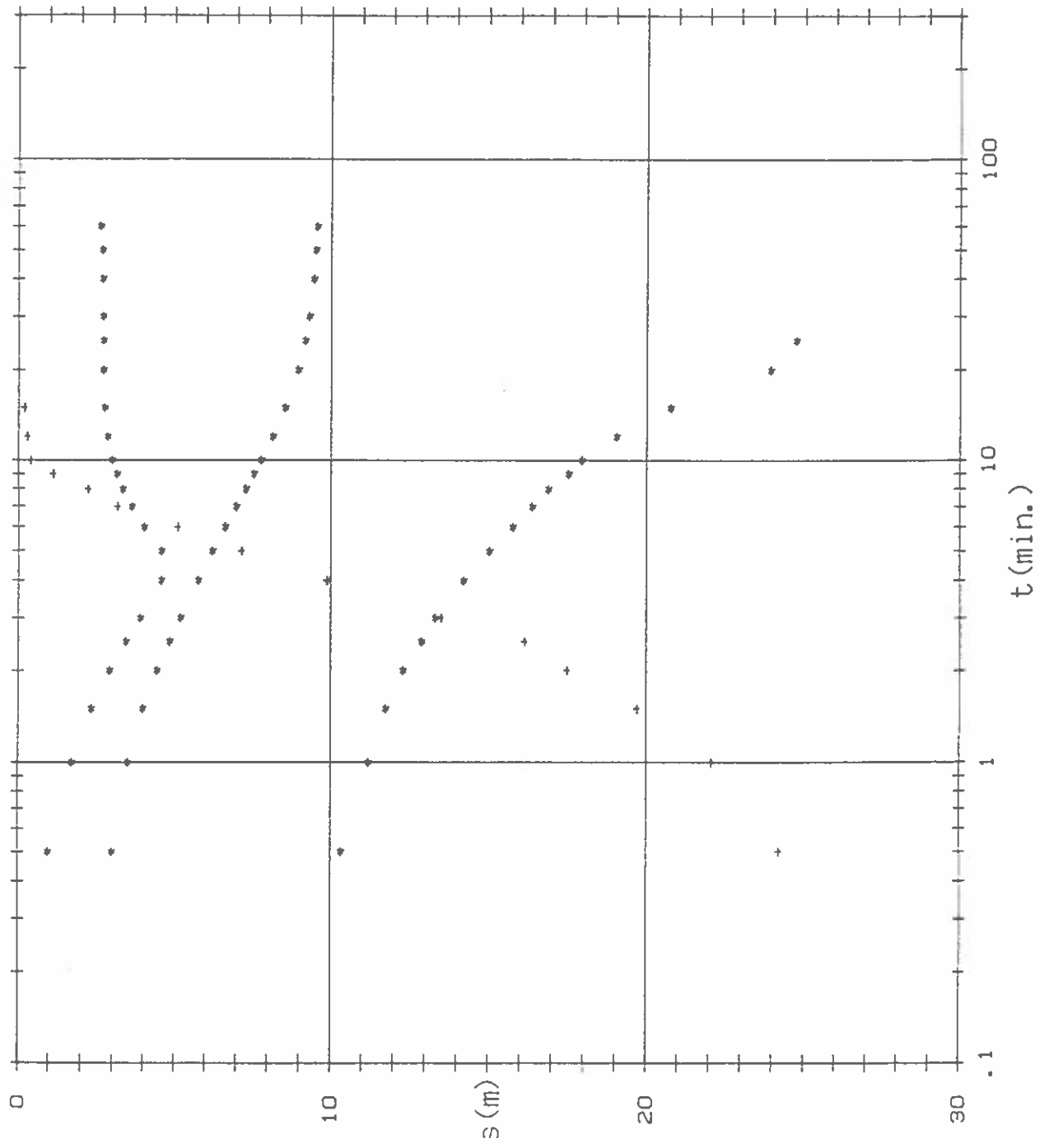
B.H. No. 13-86406

$Q_1 = .52 \text{ l/s}$

$Q_2 = .98 \text{ l/s}$

$Q_3 = 1.49 \text{ l/s}$

S.W.L. = 4.91 m



CONSTANT DISCHARGE TEST

+ Drawdown data.
* Recovery data.

MOTHIBISTAD

WASTE SITE

23.02.1993

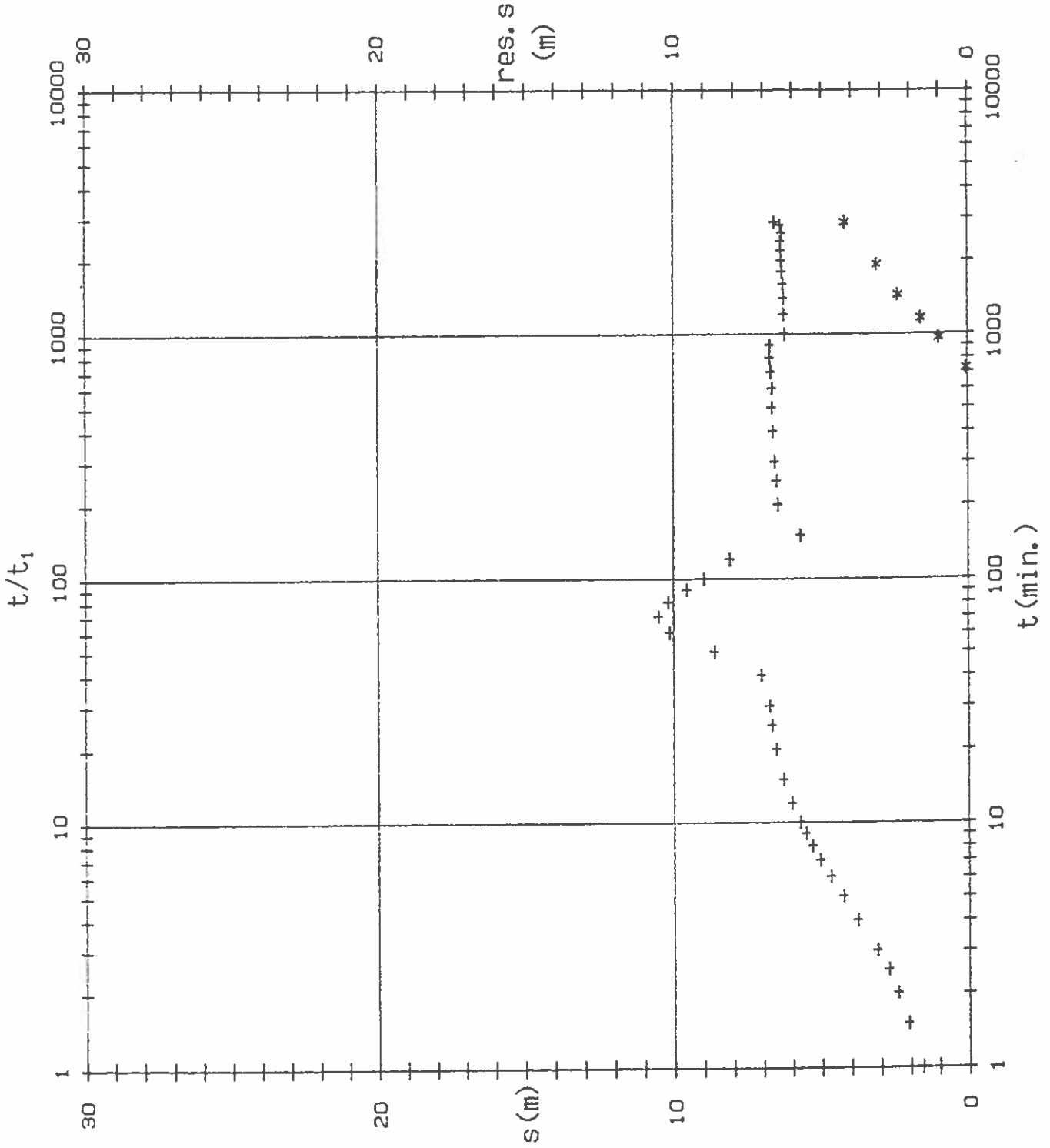
Pumped Borehole
13-86406

Readings on Borehole
13-86406

$Q = .85 \text{ l/s}$

S.W.L. = 4.91 m

$T = 2 \text{ m}^2/\text{d}$



CONSTANT DISCHARGE TEST

+ Drawdown data.

* Recovery data.

MOTHIBISTAD

WASTE SITE

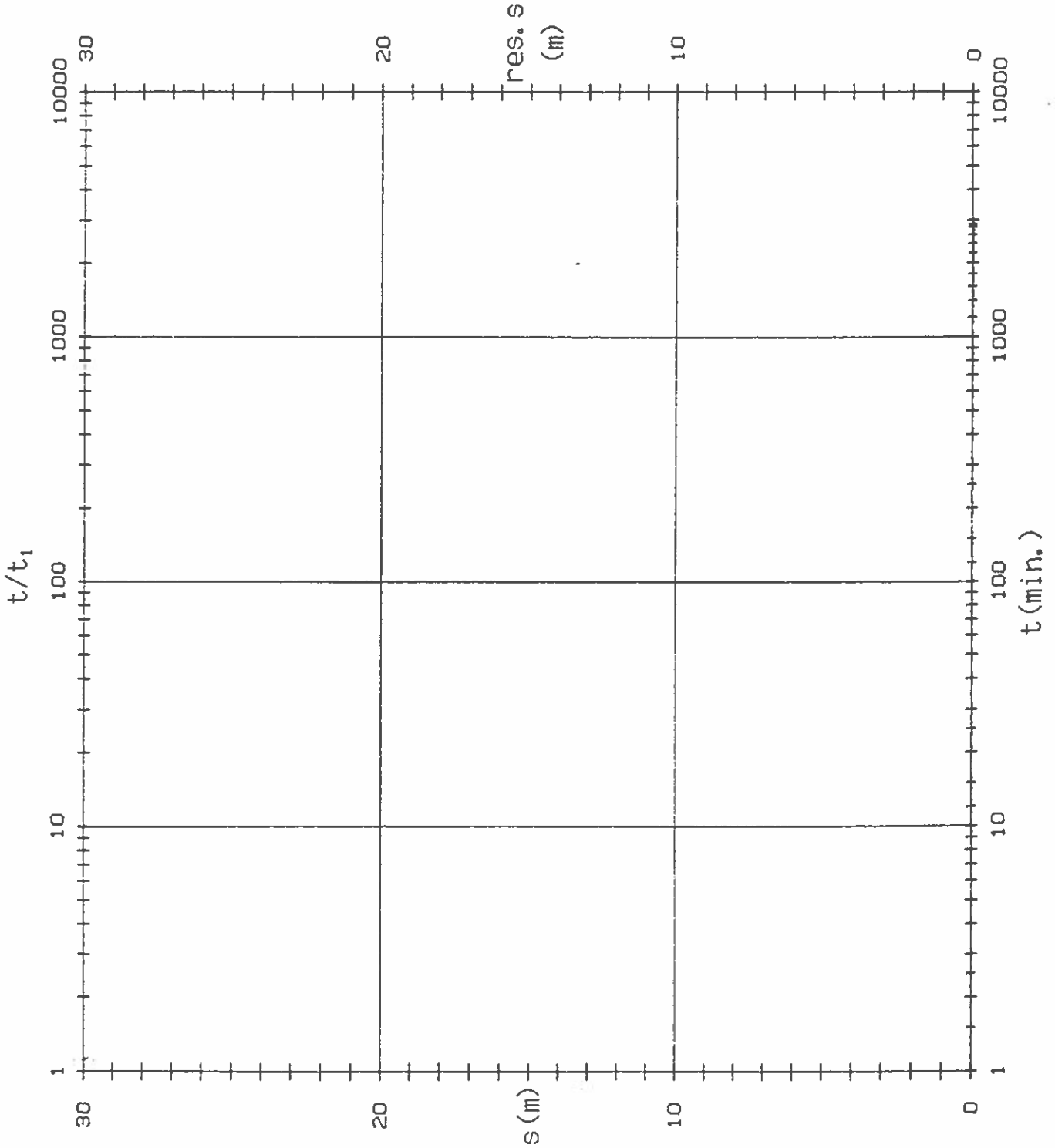
23.02.1993

Pumped Borehole
13-86406

Readings on Borehole
13-86403

$Q = .85 \text{ l/s}$

S.W.L. = 6.92 m



STEP DRAWDOWN TEST

- * Pumping data
- + Recovery data

MOTHIBISTAD

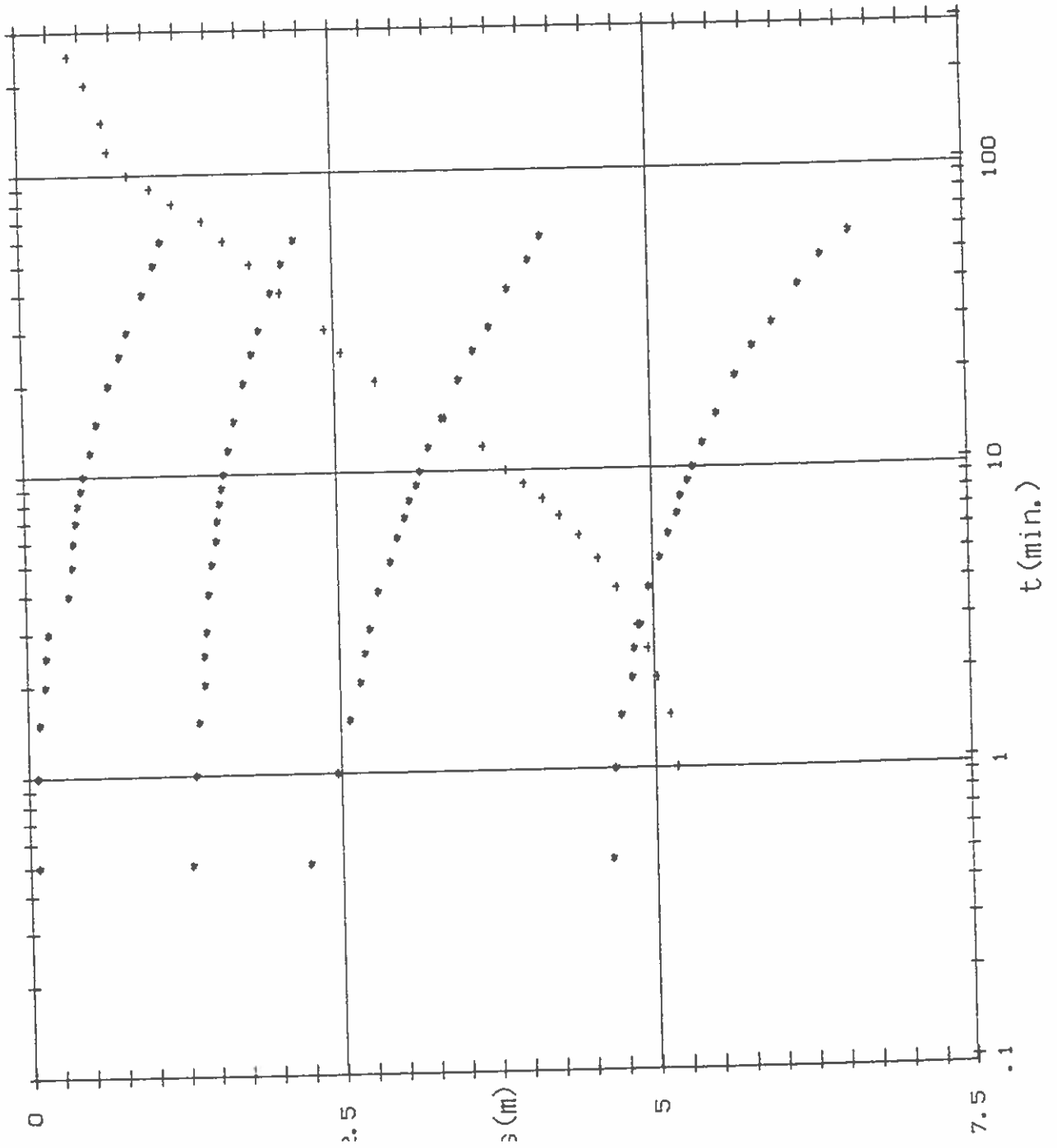
WASTE SITE

25.02.1993

B. H. No. 13-86408

- $Q_1 = 5.48 \text{ l/s}$
- $Q_2 = 9.4 \text{ l/s}$
- $Q_3 = 14.63 \text{ l/s}$
- $Q_4 = 22.26 \text{ l/s}$

S. W. L. = 6.3 m



CONSTANT DISCHARGE TEST

+ Drawdown data.
* Recovery data.

MOTHIBISTAD

WASTE SITE

26.02.1993

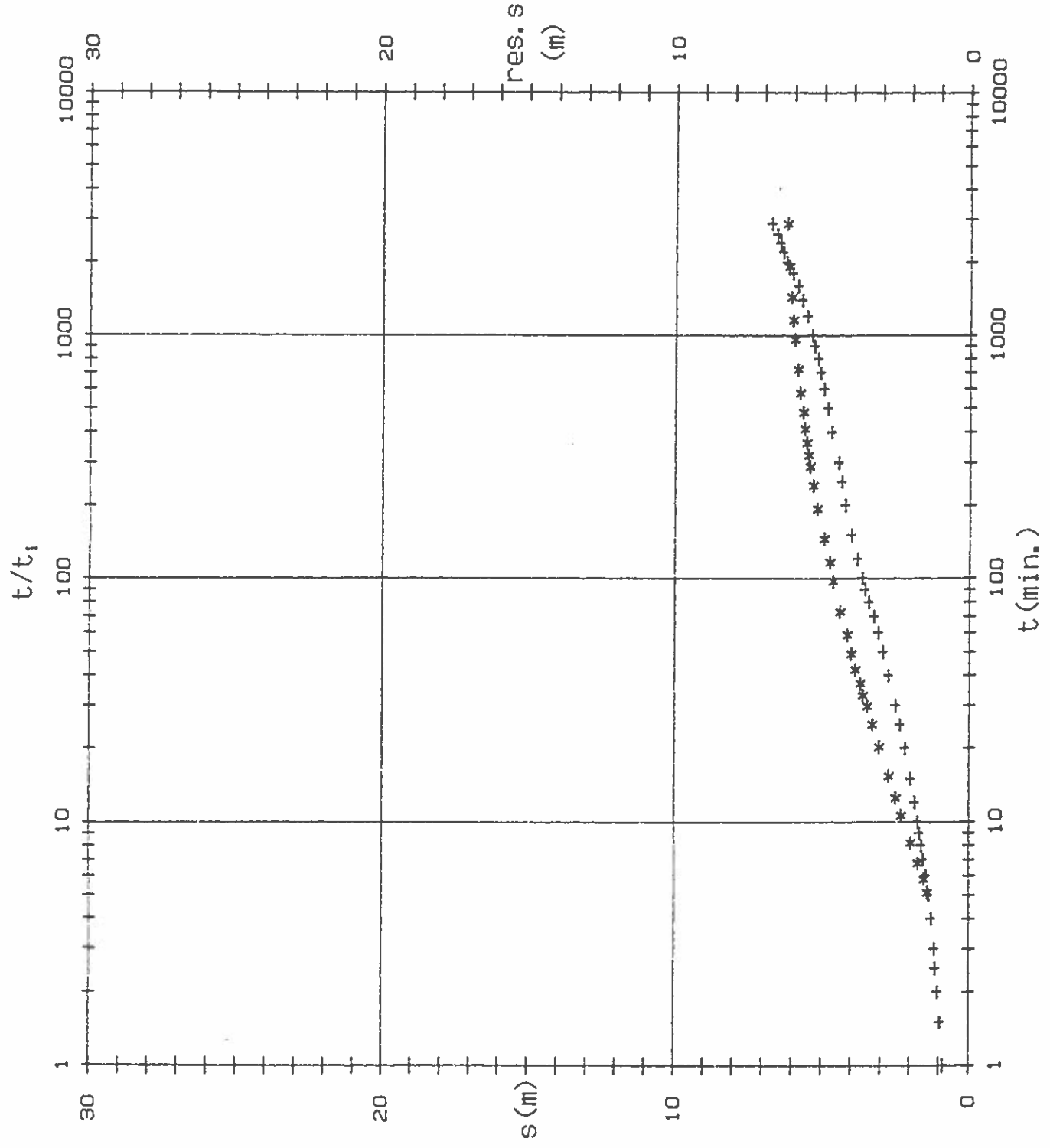
Pumped Borehole
13-86408

Readings on Borehole
13-86408

Q = 12.97 l/s

S.W.L. = 6.3 m

T = 375 m²/d



CONSTANT DISCHARGE TEST

+ Drawdown data.
* Recovery data.

MOTHIBISTAD

WASTE SITE

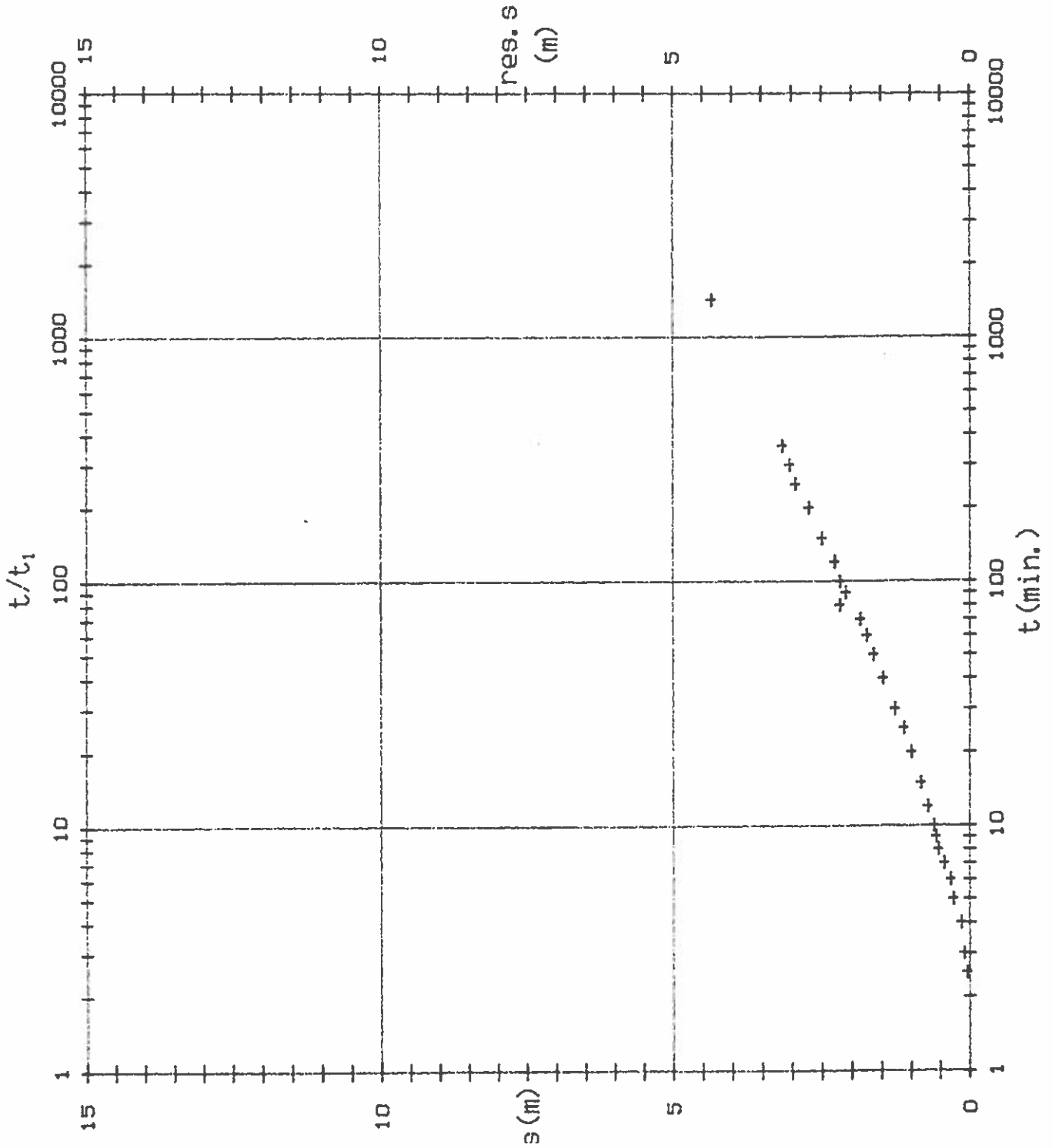
26.02.1993

Pumped Borehole
13-86408

Readings on Borehole
13-86406

$Q = 12.97 \text{ l/s}$

S.W.L. = 4.17 m



CONSTANT DISCHARGE TEST

+ Drawdown data.
* Recovery data.

MOTHIBISTAD

WASTE SITE

26.02.1993

Pumped Borehole
13-86408

Readings on Borehole
13-86409

$Q = 12.97 \text{ l/s}$

S.W.L. = 4.43 m

