Tasmania

MINERAL RESOURCES TASMANIA

Tasmanian Geological Survey

Record 1999/03

A study of the Sand Resources of Southern Tasmania

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for Mineral Resources Tasmania

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— January 1999 —

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SUMMARY

1. Large amounts of sand have been deposited by natural processes in southern Tasmania. This survey has outlined, within the areas investigated in this report, inferred *in situ* resources of 78 million cubic metres of sand, only part of which, for a variety of reasons, will be available for extraction.

2. Current (1998) sand production in southern Tasmania is running at a depressed level of 96 274 cubic metres, the first time since 1987 that the figure has been less than 100 000 cubic metres. Taking the annual average production over the last seven years as 129 791 cubic metres, it is predicted that the total consumption over the twelve year period (1998 to 2010) will be 1.6 million cubic metres.

3. The resources estimate for sharp sand is five million cubic metres as dry pit operations on established leases, representing 69 or 93 years supply at the average or current (depressed) extraction rates respectively.

4. If future lease conditions allow wet pit sand dredging, additional sand resources of at least 1.8 million cubic metres could be considered for use in concrete and other sharp sand applications.

5. Additional sand resources of 9.8 million cubic metres have been identified outside current leases, much of them probably suitable as sharp sand and extractable as dry pit operations but dependant on testing by industry, owners' permission and planning approval.

6. A further nine million cubic metres of dune sand is known to occur in the Seven Mile Beach area and is considered to be suitable for addition to concrete. This is the largest, single, on-shore sand resource in the Hobart region but is within the Seven Mile Beach Protected Area. Under the current Clarence Municipal Planning Scheme the area is zoned as active recreation in which extractive industries are prohibited.

7. The on-lease resource estimates for clayey sand, from which fat sand is derived for mortar, is 6.5 million cubic metres. This represents between 114 to 155 years supply at the average or current extraction levels respectively. Much of this may not be available for industry as the figure is dominated by one lease within which the owner is committed to farm improvement. However, future supplies are considered to be adequate as resources on open ground are estimated to approach 4.7 million cubic metres.

8. While sand prices remain low, there is commercial pressure for concrete manufacturers to access low-cost dune sand sources. Competition and future access to supplies of dune sand (including Seven Mile Beach) will encourage a trend of low sand prices.

9. In the event of price rises in the future, it may become attractive for producers to accept increased treatment costs and develop the other sources of sand and gravel in southern Tasmania or to import these commodities from elsewhere in Tasmania or beyond.

10. There is an important role for government to lead and educate the community in ensuring appropriate access by industry to the diverse range of sand resources within Tasmania for future generations.

INTRODUCTION

Objectives

The objective of this study, funded and supervised through Mineral Resources Tasmania, was to provide more accurate estimates of sand resources in the Hobart region on both current leases and in open (non leased) areas with potential to contain substantial sand deposits.

In recent years, there has been concern in both government and business circles that sand supplies on current leases are approaching exhaustion, particularly for sharp sand which is used as fine aggregate in concrete manufacture. Such a situation could lead to shortages of this basic commodity and possible price rises, which may result in increased building and construction costs.

Previous reports by Threader (1974) and more recently by Sloane and Weldon (1993) and Matthews and Donaldson (1994) have given estimates of known sand resources in southern Tasmania compared with predicted future consumption trends. All have drawn attention to the lack of reliable information, particularly subsurface data, on which to base more accurate assessments of *in situ* sand resources and have recommended exploration programs to overcome this disadvantage.

Scope of the Survey

The extent of this survey was to collect and compile information on sand resources both within current leases and outside on open ground with potential to contain substantial sand deposits, regardless of land tenure, classification, zoning or ownership.

The investigation allowed for compilation of existing information contained in MRT reports, files and registers, field examination and mapping of sand deposits, subsurface investigations by drilling and test pitting, and sample testing (screening).

An essential component of the study was to review the current and historical production of sand, to make predictions of the future consumption and gauge the likely impact of these patterns on the availability of sand in the Hobart region, particularly on the rate of depletion of the reserves in the existing leases.

Confidentiality

An important phase of the study was the investigation of the current leases, ranging from inspection, mapping and hand sampling to drill or excavator testing and access to a variety of resource plans, including previous exploration surveying of deposits, made available by the lease holders.

All lessees, without exception, were willing participants in the study. **Access to leases was negotiated on the basis that all information gained would be confidential to government and not made available to the industry in detail**. Copies of all technical information, such as drill hole logs, test pit logs, and sample screen results collected during the investigation of any individual lease were made available to that lease holder only. When the survey was carried out off lease on a private property, results were returned to that owner.

Production figures held by MRT for individual leases and used in this report are based on quarterly returns by lease holders and are regarded as commercially sensitive and confidential and not for public release. Sand resource figures and life of pits estimated for individual leases as part of this study should be regarded in the same light and not revealed to the public or industry, except as generalised bulk figures.

Conventions

Sand volumes estimated in this report, whether on or off lease, are expressed as mineral resources rather than reserves after the *Australasian Code for Reporting of Identified Mineral Resources and Ore Reserves* (1996). The resource category is based on geological data only and covers *in situ* resources of sand which may eventually proceed to the status of extractable reserves after the application of a number of factors such as technical, financial, legal, environmental, social and political.

Most of the sand deposits where volumes are quoted are in the *Inferred Resource* category, with those tested by drilling or pitting being more certain *Indicated Resources*. Elevation to the confirmed *Measured Resource* category would require closer-spaced testing, accurate surveying of data points, measurement of specific gravity on samples and pilot testing of sand for suitable uses. Sand volume estimates are rounded to the second significant figure.

In identifying the extent of a potentially viable sand deposit, a one metre average thickness was adopted as the minimum workable value following the practice of the British Geological Survey (Crimes *et al*., 1994).

Tonnage or specific gravity factors (*in situ*) were assumed to be 1.6 for dry sand, 1.95 for wet sand and 1.8 for dry gravel (Berkman and Ryall, 1976).

Sand samples were sieved according to specification AS1141-1974 with sieve apertures of 4.75 mm, 2.36 mm, 1.18 mm, 0.60 mm, 0.30 mm, 0.15 mm and 0.075 mm. Because the majority of samples were expected to be in the fine-grained size range, the 2.36 mm sieve was omitted in favour of a 0.212 mm sieve. Only in several gravel samples was the position reversed. The grain sizes of the samples within the deposit descriptions are compared by their modal average (ma), i.e. the interval with the greatest weight percent of the sample, so that ma + 0.212 mm, means that this occurs in the interval minus 0.30 mm to plus 0.212 mm.

Structure of Report

The main part of the report contains a review of sand occurrence, use and production (current and historical), predicted future requirements, and sand resource figures both on lease and on open ground. It also describes the methods used in the study, the location and exploration testing of the sand deposits, and the possible future sources of sand in the southern Tasmania region.

Brief descriptions of the more important deposits are contained in Appendices 1 and 2 together with maps showing the drill holes and test sites completed during the investigation.

Several additional folders held by Mineral Resources Tasmania, but not included with this report, contain:

- field maps, notes and sample localities of the deposits visited;
- geological logs and sample numbers of the test drill holes and pits;
- screen (grading) test results on over 400 sand samples; and
- a photographic record of selected sand operations, disused pits and exploration activities conducted in this investigation.

All sand samples are lodged with Mineral Resources Tasmania.

Acknowledgments

The writer is grateful to Mineral Resources Tasmania and its Director, Dr Tony Brown, for help and support received in the course of this study and for access to a wide range of Departmental records.

The study was planned and supervised by Mr W. L. Matthews, Chief Geologist Engineering Geology and Groundwater, at Mineral Resources Tasmania. He also arranged and supervised the auger drilling (carried out by Shane Heawood) and some of the excavator testing used in the evaluation of sand and gravel deposits at Flexmore Park, Carlton Plains, Brown Mountain Road, Buckland and Huonville.

Wojciech Grun assisted with advice and information on the resource aspects, lease conditions and management plans of the sand mining operations.

Miladin Latinovic designed the data base and computer printouts for the sand sizing information and made sand records available from water bore logs. Mike Jacobson carried out the sieving program on over 400 sand samples.

Ken Bird and the Data Management Group allowed free use of lease and topographic maps and photocopying services and provided the GIS-derived plans. Dennis Burgess and staff of the Registry provided production figures for the sand leases.

Anthony Hollick, Matt Tilyard, Jo-Anne Bowerman and Amanda Ploughman drafted the plans of the sand deposit testing. Kylie Lau searched and retrieved sand publications from the MRT Library and beyond. The final report was edited, formatted and produced by Michael Dix.

Finally the author thanks the lease holders, the land owners, the drilling contractor (KMR Drilling Pty Ltd) and the numerous excavator operators, without whose help the study would have been much less comprehensive.

Sand Occurrence and Use

The background to sand occurrence and usage in the Hobart region has been reviewed by Matthews and Donaldson (1994) and is only summarised here.

Current sand production is derived from the following deposit types, each with its own set of characteristics.

1. Quaternary age dune or windblown sheet deposits, mainly located in coastal areas (55%); e.g. Hope Beach, South Arm.
2. Tertiary–Quaternary age marine, estuarine or lacustrine deposits situated in near-shore areas (13%); e.g. Flexmore Park, Penna.
3. Quaternary age alluvial deposits occurring as terraces in old river valleys (14%); e.g. Clarke's, Huonville.
4. Residual deposits on sandstone, mainly of Triassic age (18%); e.g. Stanton's, Penna, but some may be Permian.

Figure 1 shows the location of the current sand leases and historic production sites in the Hobart region and their dependence on the distribution of the Quaternary and Triassic sediments. Figure 2 shows the sand mining leases within 20 km of Hobart.

The potential uses of sand include fine aggregate in concrete (sharp), mortar sand (fat), bedding sand, joint filling sand, foundry or moulding sand, high quality glass sand, and top dressing or garden sand.

Current (1998) usage in southern Tasmania (Table 1) amounts to 154 038 tonnes (96 274 m^3). Of this, 86 390 t (56%) is used for concrete sand, 45 837 t (30%) is used for general sand, while 21 811 t (14%) is used for building or mortar sand. No glass sand is currently being produced since the ACI operation on a lease at Sandford ended in recent years, associated with the closure of the Derwent Park glass factory.

The four most important producers for 1998 were Males at South Arm, Stanton at Penna, Clarke at Huonville and Calvert at South Arm. The Sandford–South Arm Peninsula is still the most important area for sand production, with 63% of the total production of the Hobart region.

The most important leases for concrete or sharp sand are Males' and Calvert's at South Arm and Clarke's at Huonville. Stanton's lease at Penna is the main supplier of fat sand.

Most sharp sand for concrete or hot mix road surface comes from the South Arm area (69 678 t) where dune sand is extracted from Type 1 deposits. The sand is clean with few fines (less than 1% less than 0.075 mm), is homogeneous and needs only to be dry screened before trucking to the concrete plant. The main disadvantage with this sand is its fine-grained, well sorted nature, which means that to fall within the ASA concrete classification it must be mixed with crusher dust at a 45% sand:55% dust blend. At Males' lease, an older dune sand is washed to provide a coarser sand for concrete.

A smaller amount of concrete sand is produced from a Type 3 deposit at Huonville, where washing of coarser sand and gravel produces the only sand in southern Tasmania to fall within ASA concrete specifications without adding crusher dust (apart from Males' coarse sand). The material is screened and washed through a classifier which can produce a well graded sand to meet any required specification. The resulting concrete is structurally stronger and with a better finish.

Clayey sand (47 828 t) suitable for mortar sand and other uses is found in Type 2 and Type 4 deposits in the Penna, Sandford and New Norfolk areas. These sands have either been transported and deposited into their position (e.g. Flexmore Park and Calvert A) or occur by weathering *in situ* over sandstone bedrock (e.g. Stanton and Ashbolt). Clayey sand can be dry blended (Flexmore Park) with other sand or washed (Lazenby) to improve its utility.

Untreated clayey sand (referred to by the industry as 'inland sand') is not used for concrete because the fines or clay component causes excess use of cement and uptake of water after curing, with cracking and deterioration of the concrete. In some cases, there is also a problem with salinity.

Clayey sands generally leach and dry out under weathering, forming an *in situ* upper layer of sharp sand which may be transported by wind into adjacent areas.

Sand Production

Figures for annual production of sand in the Hobart region from 1960 to 1993 were published by Matthews and Donaldson (1994) based on quarterly returns to Mineral Resources Tasmania. More recent figures to 1998 have been compiled (Table 1) and are graphed (fig. 3). Since 1981 the annual production figures relate to financial rather than calendar years.

In the period 1963–1974, sand production fluctuated in the range 40 000–70 000 m^3. Following a record low in 1975 (20 000 m^3) caused by the collapse of the Tasman Bridge, production more than doubled and since then (1976–1998) has varied mostly in the range 80 000–150–000 m^3.

In the last three years, extracted volumes of sand have progressively decreased from nearly 150 000 m^3 in 1995 to 96 274 m^3 in 1998, the first time since 1987 that the figure has been less than 100 000 m^3. This obviously equates with the downturn in the building and construction industry and may well be reinforced by a net population drift from Tasmania.

MINERAL RESOURCES TASMANIA

DISTRIBUTION OF TRIASSIC AND QUATERNARY SEDIMENTS HOBART AND ENVIRONS

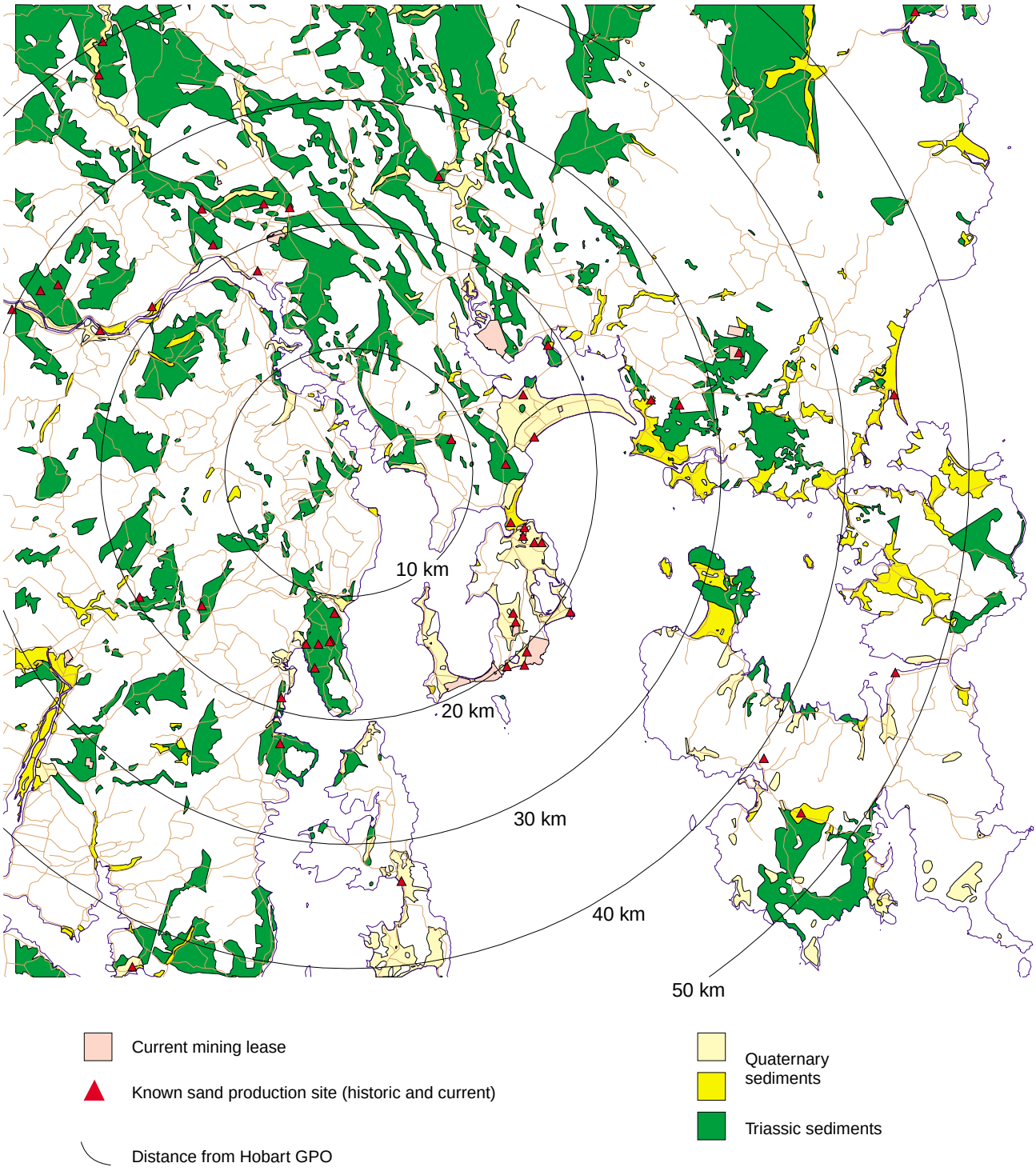

Figure 1

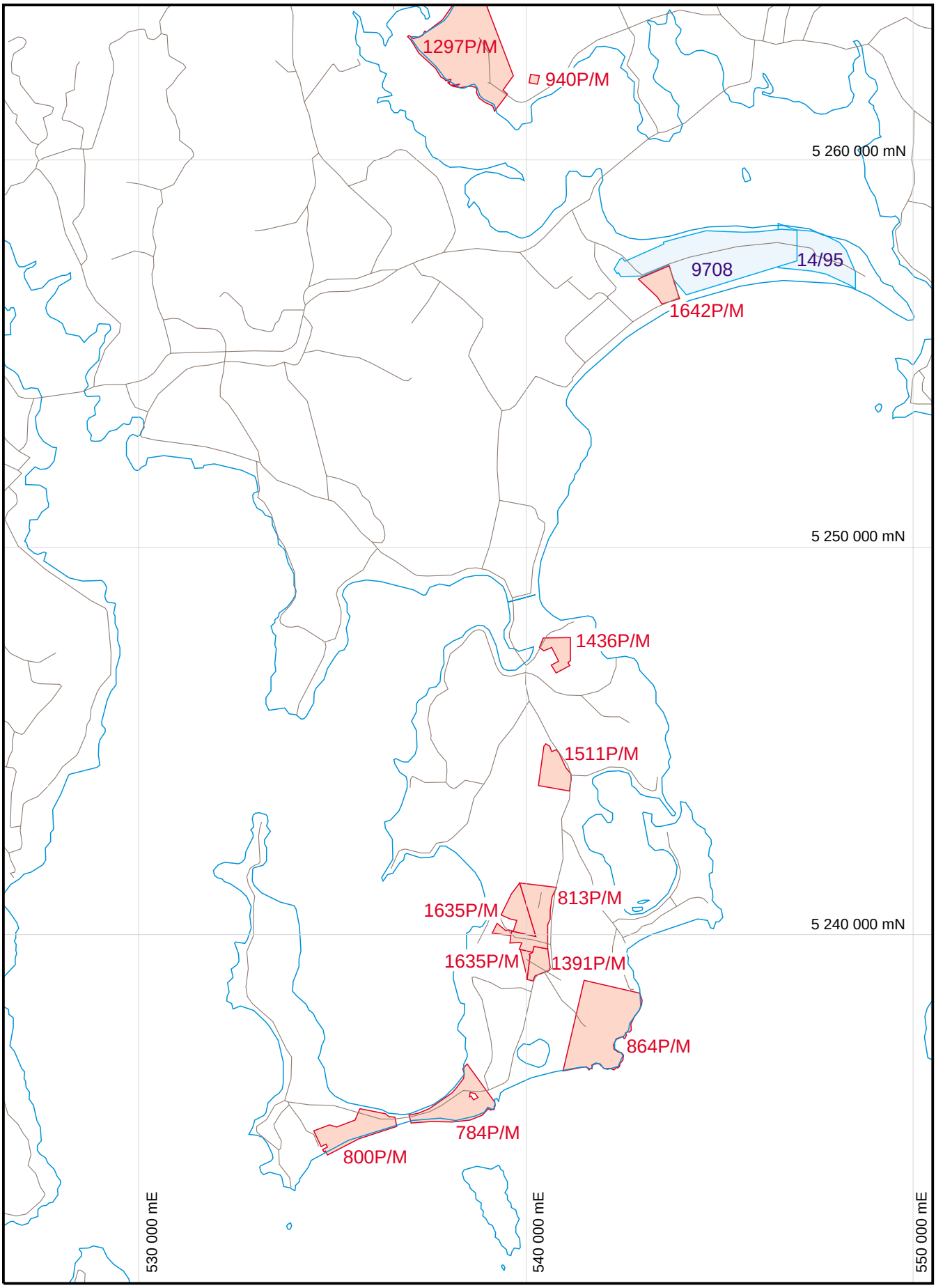

Figure 2

Sand mining leases and tenements within twenty kilometres of Hobart

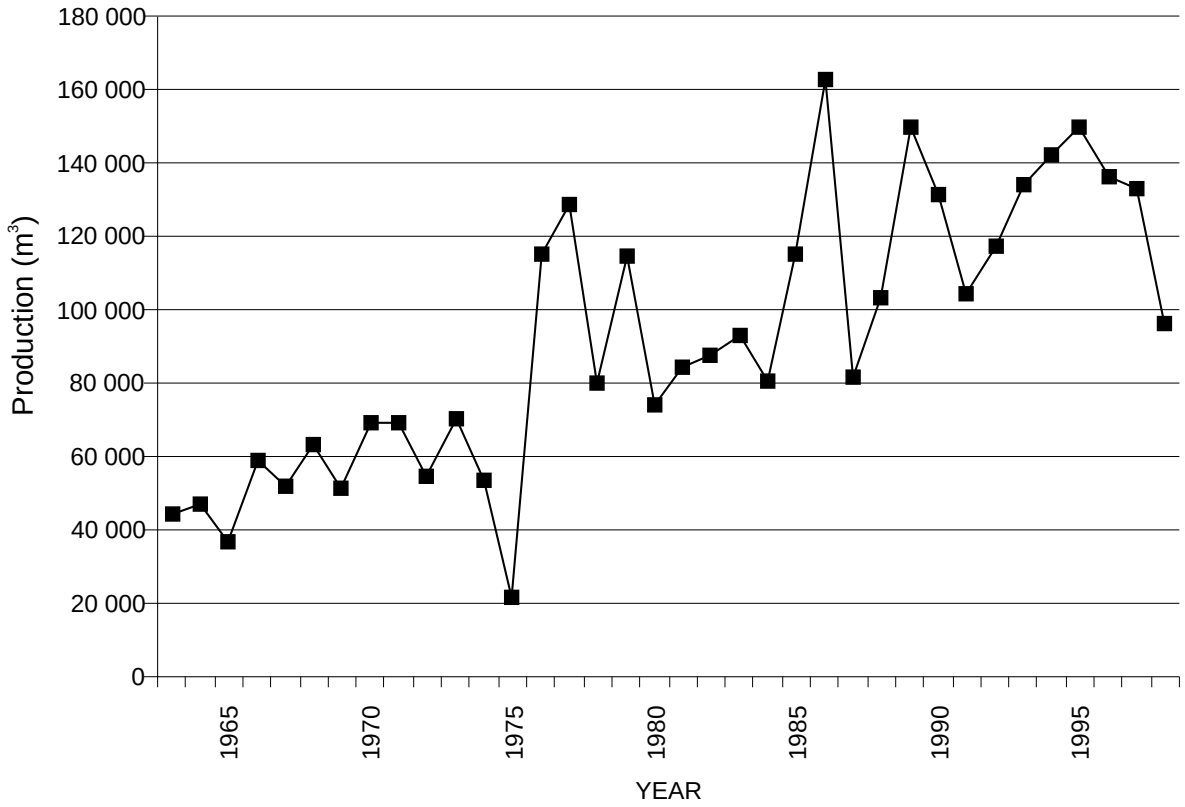

Figure 3

Sand production in the Hobart area, 1963 to 1998

Attempts by Threader (1974) and Sloane and Weldon (1993) to predict future sand consumption based on the recognition of historical growth trends have proved to be too optimistic. In this study, it has been assumed that a steady-state model is just as valid and that the seven year average will be acceptable for the foreseeable future.

Adding the production figures for the years 1992 to 1998 (Table 1) gives a total of 908 536 m^3 of sand with an annual average of 129 791 m^3 over the seven year period.

On this basis, the required total sand production for southern Tasmania in the 12 year period 1998–2010 will be about 1.6 million cubic metres.

Table 1

Sand production in southern Tasmania, 1963 to 1998

Year	*Sand produced (m^3)*	*Year*	*Sand produced (m^3)*
1963	44 230	1981	84 456
1964	46 819	1982	87 716
1965	36 967	1983	93 056
1966	58 820	1984	80 718
1967	51 824	1985	115 335
1968	63 191	1986	162 793
1969	51 318	1987	81 462
1970	69 410	1988	103 263
1971	69 377	1989	149 513
1972	54 816	1990	131 428
1973	70 287	1991	104 481
1974	53 320	1992	117 561
1975	21 762	1993	133 986
1976	115 355	1994	142 106
1977	128 404	1995	149 549
1978	80 065	1996	136 052
1979	114 837	1997	133 008
1980	73 805	1998	96 274

Methods of Investigation

The initial step in this investigation was to visit and review the existing sand leases and other areas considered of potential in the Matthews and Donaldson (1994) report, in company with MRT geologists. The districts visited were South Arm, Sandford, Penna, Seven Mile Beach, New Norfolk, Huonville, Carlton, Copping, Murdunna, Bangor, and Sloping Main. Towards the end of the survey, outlying districts were included such as Buckland and (briefly) Maydena.

The districts of best potential, and therefore most worthy of a resource assessment, were investigated as follows.

South Arm

This area supplies 63% of the sand used in southern Tasmania. Calvert's Lease (800 P/M) was drilled with six hollow auger holes totalling 70 metres, while Males' Lease (784 P/M) was drilled with six holes totalling 76 metres. An additional 12 metre hole was drilled on Linardi's property at the western end of South Arm Neck on former lease 810 P/M, now open ground.

Penna

Flexmore Park is a large lease (1297 P/M) on the Morey property. Production is relatively small and comes mainly from farm improvement work. The area was mapped and tested by ten excavator pits totalling 37.1 metres.

Cape Contrariety

This area lies east of Calverts Lagoon on Watson's Lease (864 P/M). This area was drilled with six solid auger holes totalling 91.5 metres.

Huonville

Coarse, well-graded siliceous sand and gravel occurs in terraces of the Huon River. These are currently being worked in Clarke's Pit (631 P/M) on the outskirts of Huonville. At Pitt's property, 2 km west of Huonville, ten test pits totalling 40.1 m were completed by excavator. Seven test pits, totalling 23.7 m, were excavated near Harrisons Road at Cradoc.

Carlton

There is a substantial area of non-leased ground near the Council tip site where water bores and old sand pits revealed thick sand deposits. The deposit was mapped and sampled. The northern part was already subdivided and was not investigated further. The southern part, on one property, was tested with 25 excavator pits totalling 56.7 m and seven auger holes totalling 40 metres.

Copping

Sand occurs on ridges near Bedding Hill on the Downie property, near the planned regional tip site on non leased ground. Thirteen test pits were excavated totalling 20.7 metres.

Buckland

Small amounts of sand have been extracted from this district in the past, the deposits being based on large areas of Triassic sandstone which can be expected to yield significant resources at present disadvantaged by the transport costs to Hobart. The Sand River area, north of Buckland, was investigated by seventeen excavator pits totalling 58.8 metres. An additional area on Turvey's property, some 3 km east of Buckland, was investigated by eleven pits totalling 18.95 metres.

Seven Mile Beach

This area contains the largest undeveloped on-shore deposit of sand in the Hobart area and has been the focus of building industry interest over recent years. The sand resources are considered sufficiently defined by exploration and groundwater drilling. It is a Protected Area under the *Crown Lands Act* with extractive industries being prohibited under the 1986 City of Clarence Planning Scheme.

Pitt Water

Previous drilling to determine groundwater resources (Cromer, 1980) revealed substantial shallow and continuous sand deposits on the Milford property, adjacent to the Tasman Highway.

Murdunna

Geological maps show extensive sand deposits on open ground. Thick sand (7 m) was also recorded in a water bore (hole 44) near Duck Creek Road.

Because of time constraints, Murdunna and the outlying districts of Maydena and the Tasman Peninsula were not investigated further.

A second method employed in the study was to extract sand deposit information from the MRT construction materials register (CONMAT) and highlight deposits with moderate to large resources. Of these deposits (32), 78% (25) have been visited and assessed (and most sampled). The seven deposits not assessed were:

- One deposit had been taken over by the Margate tip site at Baretta;
- A deposit at Mt Rumney was not found, possibly because of subdivision;

- Mays at Sandford was worked out and the lease had expired;
- Two deposits at Maydena and one at Nubeena were considered to be outside the priority area because of distance from Hobart;
- A deposit on the Clarendon property near Gretna was reported at the end of the study and was only inspected briefly.

During field work, some of the smaller deposits on the register were also visited as convenient, so that about 55% (or 67 out of 121) of all known sand deposits in southern Tasmania have been assessed.

This phase of the investigation resulted in the recognition of further potential at the Brown Mountain Road sand deposit near Campania, where a program of 24 test pits and four auger holes was carried out to extend the resources. Two new deposits of small to medium tonnages were found in the Elderslie area at Tanina and Royden North.

In the course of the investigation, seventeen additional deposits were identified as worthy of entry into CONMAT. These represent both deposits that were recognised in the course of the study, or that were known about or were even operating but had not been entered into CONMAT.

Table 2

Sand resources in southern Tasmania

		Dry pit (m^3)	*Wet pit to -3 m (m^3)*	*Wet pit -3 m to clay (m^3)*
Sharp sand — on lease		5 040 000	1 780 000	2 490 000
Fat sand — on lease		6 450 000		
Other sand — on lease		2 420 000		
Sharp sand — open ground				
Carlton Plains	dry pit	1 900 000		
Carlton North	dry pit	940 000		
Watson	dry pit dunal	1 300 000		
Watson adjacent	dry pit dunal	850 000		
Brown Mountain Road	dry pit	610 000		
Linardi	dry pit dunal	130 000		
	wet pit to -3 m RL		120 000	
	wet pit -3 m RL to clay at -8 m RL			160 000
Buckland	dry pit	1 100 000		
Huonville	washed sand/gravel	1 000 000		
Pitt Water	dry pit	2 000 000		
Total		**9 830 000**	**120 000**	**160 000**
Fat sand — open ground				
Stanton	dry pit	160 000		
Carlton Plains	dry pit	940 000		
Brown Mountain Road	dry pit	210 000		
Buckland	dry pit	3 400 000		
Total		**4 710 000**		
Other sand — open ground				
CONMAT	dry pit	520 000		
Total		**520 000**		
Seven Mile Beach Protected Area	dry pit	9 000 000		
	wet pit to -3 m RL		9 000 000	
	wet pit -3 m to clay			27 000 000
Total		**9 000 000**	**9 000 000**	**2 7000 000**

RESULTS OF THE SURVEY

Sand resource figures have been estimated for all significant deposits investigated in the southern Tasmanian region (Table 2). The figures are subtotalled into resources on leases and those on open ground, and into sharp, fat and other sand categories. **All resource figures for individual leases are confidential**. Seven Mile Beach, because of its size and the fact that it is government-controlled, has been kept separate in the summary.

All figures refer to *in situ* resources of quartz sand in the indicated resource category except where otherwise mentioned. Where possible, the resources are expressed in three columns as dry pit to +1 m RL, wet pit from +1 m to -3 m RL, and wet pit from -3 m RL to total depth of deposit.

Also included in the Table 2 under the 'other sand' category are estimates of the total sand resources (both on open and leased land, the latter including Pine Hill at Maydena which is held under Exploration Licence) in the CONMAT deposits actually visited but not drilled or test pitted. These figures are in the *inferred resource* category and are conservative, as 45% of all sand deposits in CONMAT were not visited.

Interpretation

The main features of the resource figures are as follows.

- The quantity of sand inferred in this report amounts to 78 million cubic metres (Table 3). For a variety of reasons, including social, political, commercial and technical, only a fraction of this sand will be available for extraction.

- The total amount of sand in southern Tasmania has the potential to be many times the above figure as the following resources remain unquantified; the sand spits and dunes adjacent to coastal areas (other than the South Arm–Cape Contrariety area and Seven Mile Beach), the offshore marine and estuarine sand in bays and rivers, and the outlying districts more remote from Hobart such as Nubeena, Maydena and Lune River.

- Sharp sand on current leases (Calvert, Males, Watson, Clarke and Flexmore Park) reaches five million cubic metres capable of extraction by dry pit operations. This represents 93 years supply or 69 years supply at the current or average production rates respectively (Table 4). If wet pit operations were sanctioned to a modest -3 m RL by dredging, an additional 1.8 million cubic metres of sand would be available at South Arm and Cape Contrariety. Watson's lease in the latter area remains the largest undeveloped sharp sand resource (combined off and on lease resources) in the Sandford Peninsula. A further resource below -3 m RL would probably be partly or wholly unavailable.

- Additional, possible sharp sand resources totalling 9.8 million cubic metres occur outside current leases including Milford at Pitt Water (2 million), Carlton Plains (1.9 million), Watson's (1.3 million), Sand River at Buckland (1.1 million) and Huonville (1 million). Many of these resources may prove to be suitable for addition to fine aggregate in concrete, with suitable treatment in some cases, but development will depend on owner's permission, government approval and testing by industry.

- Seven Mile Beach is the largest on-shore sand deposit in southern Tasmania. It is known to contain nine million cubic metres of dune sand resources, nearly double those in current leases, and probably extractable as a dry pit operation. While marginally finer grained than South Arm sand, it is probably acceptable for addition to concrete aggregate and is the subject of exploration and retention licences from industry for that purpose. The area is government-controlled, being Crown Land with Protected Area status, and mining is currently prohibited under the City of Clarence Planning Scheme. Additional resources of sand occur under the above dune resource, with nine million cubic metres from 0 to -3 m RL and 27 million cubic metres thereafter to clay base.

- The on-lease resource estimates for clayey sand, from which mortar sand is derived, is 6.5 million cubic metres. This represents 155 years supply or 114 years supply at the current or average extraction levels respectively (Table 4). This figure is dominated by the Flexmore Park resource, most of which may not be available to industry as the owner is committed to farm improvement rather than purely extraction. There are indications of substantial resources of 4.7 million cubic metres of clayey sand on open ground (Table 2) in the Buckland (3.4 million cubic metres) and the Carlton Plains (94 000 m^3) districts.

- The 'other sands' (including general or mixed sands) category has 2.4 million cubic metres of on-lease deposits (Table 4) and 500 000 m^3 of deposits on open ground. The CONMAT figures for open (as above) and on-lease (390 000 m^3) ground refers to those deposits on the Register which were visited but not tested, and the resources would be in the inferred category. As 45% of the CONMAT deposits were not visited (although mainly those in the small category), the resource figures are somewhat conservative.

Table 3

Summary of sand resources in southern Tasmania (rounded figures)

Summary (rounded figures)	*Dry pit (m^3)*	*Wet pit -3 m (m^3)*	*Wet pit -3 m to clay (m^3)*
Sharp sand — on lease	5 000 000	1 800 000	2 500 000
Sharp sand — open ground	9 800 000	120 000	160 000
Sharp sand — Seven Mile Beach Protected Area	9 000 000	9 000 000	27 000 000
Fat sand — on lease	6 500 000		
Fat sand — open ground	4 700 000		
Other sand including CONMAT — on lease	2 400 000		
Other sand including CONMAT on open ground	500 000		
Total	**37.9 M**	**10.92 M**	**29.66 M**
Total Resources	**78 M**		

Table 4

Estimated on-lease sand resources in southern Tasmania

	Resources (m^3)	*Annual production (m^3) — current*	*Annual production (m^3) — 7 year rate*	*Life — years at current rate*	*Life — years at average rate*
Sharp sand	5 000 000	54 000	73 000	92.6	68.5
Fat sand	6 500 000	42 000	57 000	154.8	114.0
Total		**96 000**	**130 000**		

In this table, general sand is included in the fat sand category

FUTURE SAND RESOURCES

The current leases have the capacity to produce sand, suitable for addition to concrete, at the current or average production rates for between 69 to 93 years. If wet pit operations are allowed in the marine sand under the dunal dry pits in the South Arm–Cape Contrariety area, this may extend the lives of the current sand pits up to the same duration again.

The possible future sources of sand for southern Tasmania are reviewed in turn.

Dune Sand

Dunal, dry pit sand will continue to be sought by the major premix concrete operators because of the relatively cheap mining and processing methods, and because they can guarantee their customers a uniform product of acceptable specifications. For these reasons, some operators seem unwilling to use the coarser, washed sand from Males' lease.

Dunal and underlying marine sand beach structures, as well as sheet sand, are widespread in the coastal areas of southern Tasmania (fig. 1). These areas include:

- Seven Mile Beach;
- Dodges Ferry–Carlton;
- Murdunna;
- Marion Bay;
- Rheban Beach at Orford;
- North Bay and Lagoon Bay, Bangor, Forestier Peninsula;
- Roaring Beach at Nubeena;
- Sloping Main on the Tasman Peninsula;
- The Neck Beach and Cloudy Bay on Bruny Island; and
- Big Lagoon Beach, Southport Lagoon.

These are big structures with substantial sand deposits of reasonably predictable size and quality (although the Roaring Beach dune system appears to have a sandstone core which could limit the *in situ* volumes of sand).

Because these coastal areas are scenically beautiful and environmentally sensitive, they are mostly protected by formal reserves if Crown land, or by council planning schemes which do not allow extractive industries if the areas have been subdivided.

Only areas of private property such as Carlton Plains, Murdunna and Bangor Station would be open for consideration by industry by negotiation with the owners, but would then subject to planning approval by government agencies. Sheet sand deposits, such as those occurring at Carlton Plains (defined in this report) or Murdunna, may provide sand in the future. In the absence of subsurface data, the Bangor property showed no obvious promise on the extensive flat areas behind the coastal sand dunes.

Seven Mile Beach is the most obvious example of sterilisation by a council planning scheme in which sand extraction is prohibited. Because of the size and quality of the resource, and its close proximity to Hobart, Seven Mile Beach was seen as the next source of dune sand when the South Arm area is exhausted. The area is currently held under two exploration titles by companies wishing to secure long term supplies of sand with the knowledge of the long lead times necessary to obtain development permission. Lobbying continues to change the planning scheme to allow sand mining in this protected area, which is basically a sand spit with a pine forest, including the use of innovative projects which combine extraction of sand with resort development or plantation management.

Residual Sand

'Inland' sand deposits occurring as residual mantles on Triassic sandstone ridges can be expected to contribute to future sand resources in Southern Tasmania. Large exposed areas of sandstone occur to the north of Buckland and lie in an arc to the north of Hobart as far west as Maydena. Many such sand deposits will be in the small tonnage category, with a few in the medium tonnage category, for example Brown Mountain Road. There will be occasional large deposits, for example in the Sand River area at Buckland.

These residual sand deposits will tend to occur in the southeast aspects of ridges and in valleys where they are protected from westerly wind erosion and the desiccating effects of the northern sun. The clayey sand will be useful for mortar and other (including joint filling) sand and deposits may even have leached caps of sharp sand suitable for concrete. Being remote from Hobart and requiring transport, they will be vulnerable to low prices, and washing for concrete use will not usually be an option for the same reason. Being small, the deposits will have disproportionately large development and rehabilitation costs out of balance with expected returns.

Permian sandstones are also a target in this category, particularly the coarse correlates of the Risdon Sandstone. Such deposits are being investigated at Balfes Hill near Cradoc and have been exploited in the past at Lady Bay Road at Southport, where material from quartz pebble lag pavements was hand shovelled, trucked, barged up to Hobart, mixed with gravel from Randalls Bay and used in concrete in the former floating bridge spanning the River Derwent.

Quaternary Sand and Gravel

These alluvial deposits are found in the Huon Valley (and to a lesser extent in the Derwent Valley) where they are exploited in Clarke's Pit on the outskirts of Huonville. Apart from Males' coarse sand, this pit produces the only concrete sand which conforms to ASA specifications.

The alluvial sand deposits occur on both sides of the Huon River from Judbury to Cradoc (and have been investigated in several areas in this study) and as far downstream as Poverty Point and Randalls Bay. They are an important sand resource in southern Tasmania which, in the absence of any unroofed granites, lacks any substantial source of coarse sand which is so common in the north of Tasmania. The deposits are poorly exposed, potentially lying under the large areas of river flats and terraces of the Huon and its tributary rivers like the Russell and Little Denison.

The terraces on both sides of the Huon River between the Arve and Weld River junctions have some promise; the area covering the northern terraces is currently held by RNB Trading under Exploration Licence 19/96.

Gravel is well exposed near the confluence of the Picton and Huon rivers at Tahune, where a disused quarry (300 × 100 m wide) has faces containing 4–5 m thick, poorly bedded, siliceous gravel with boulders to 300 mm in a gritty matrix. At Blakes Opening, further to the west and in the World Heritage Area, a 10 m high terrace reveals some Quaternary sediments including coarse gravel and overlying finer sand, all overlying Precambrian dolomite. The gravel contains quartzite, quartz and agate pebbles derived from catchments to the west, probably by fluvioglacial processes.

Semi-consolidated siliceous gravel occurs further downstream adjacent to the Huon River estuary. A subdivision at Poverty Point appears to have sterilised the remaining gravel beds at that location but at Randalls Bay there are sufficient areas still unsettled and available to allow for testing of the residual resources. The gravel deposits range from two to six metres in thickness and are composed of equal parts of sand and gravel. The pebbles are mainly composed of quartz and quartzite, with lesser dolerite, mudstone, banded agate and Tertiary silcrete (Farmer, 1979). The gravel occurs at heights of up to 30 metres above present river level, suggesting deposition during the higher interglacial sea levels of the Pleistocene age.

Such terrace deposits form an important potential source of coarse sand and gravel in southern Tasmania and are rather under-explored and under-exploited by the sand extraction industry. The disadvantages of this type of deposit, compared with dune sand, are the higher processing costs, higher capital costs for plant, and 30% of the deposits have to be disposed of as slimes or oversize, with a corresponding greater environmental impact. A substantial rise in the price of sand could make these attractive exploration targets, with the additional possibility of crushing the oversize.

The possibility of resources of sand and gravel being found on the longitudinal islands downstream from Huonville, and underwater in the river bed and estuary of the Huon River, has been speculated on in the past but the concept suffers from the lack of hard exploration data. Sand was extracted from the river bed at Franklin and was used in the extensive reclaimed areas on the foreshore of the township. Geophysical (seismic refraction) surveys (Leaman, 1978) were carried out in the search for offshore gravel at Randalls Bay with encouraging initial results but recommended follow-up drilling never eventuated. Gravel has recently been reported in the bed of the River Derwent at Bridgewater during foundation drilling for a possible causeway upgrade. The presence of such estuarine gravel resources remains unproved but probable.

Offshore Sand

Sand and mud occur on the offshore shelf around Tasmania above -30 metres, overlying carbonate sediments (Colhoun, 1989). The main source of sand on the coastal shelf and beaches is from rivers, with the erosion of adjacent headlands considered to be negligible in comparison. The sand resources present in the marine, estuarine and beach environments in southern Tasmania have been introduced by the Derwent, Coal and Huon rivers since the Tertiary. On an island scale, they have been sheltered in the re-entrant of Storm Bay from the dominant southwesterly swells responsible for the overall movement of beach material from the southwest to the northeast of Tasmania (Davies, 1965).

Locally, bays and estuaries can be shown to contain extensive areas of sand (e.g. Frederick Henry Bay, Norfolk Bay, Ralphs Bay, Pitt Water, D'Entrecasteaux Channel, Storm Bay and Marion Bay). In the absence of any offshore exploration providing geophysical or drilling information, sand thicknesses and quality are largely unknown but resources are liable to be very large.

In recent years, RNB Trading attempted to explore the tidal flats in the southern part of Ralphs Bay, adjacent to the South Arm sand pits, but was refused an exploration licence because of environmental concerns. Limited hand sampling to 0.5 metres with a bait pump on the tidal flats of the same bay adjacent to the Lauderdale Canal revealed that the sand is fine (am 0.30–0.150 mm) to medium grained (am 0.39–0.30 mm) and is shell rich. The sand would probably serve as fine aggregate in concrete if washed to remove salt and screened to remove the coarser shell.

Extraction of such deposits would be by dredging and would have to clear environmental hurdles and avoid conflict with other activities, such as aquaculture and recreational use of waterways. While the recent trend in Australia is to phase out dredging activities (e.g. in

Sydney Harbour, the Hawkesbury River and now reportedly in the Brisbane River), the United Kingdom still recovers 13% of its aggregate from offshore operations, the USA 2–3% and Japan 19% (Collis and Fox, 1985), while extensive landfill projects in Hong Kong depend on dredged offshore sand defined by high resolution seismic geophysics.

Manufactured Sand

A growing trend has been reported in industry in areas close to Mainland capital cities, where sand pits are being exhausted or phased out because of subdivision and environmental pressures, to rely on the crushing and screening of natural rock to produce desired gradings of fine aggregate.

Importation of Sand

The freighting of sand to the Hobart region from the north of the State would be an option if shortages developed in the south. The abundance of granite bedrock in northeast Tasmania has resulted in very large resources of medium to coarse sand suitable for concrete being present in the region. More sand derived from granite would be available further east, including the gravel in the alluvial tinfields. Production from the Scottsdale leases is used in road surfacing after mixing with blue chips. Trial amounts have been trucked to the south for use in nursery and garden centres, concrete blocks and foundry sand.

Grading of Sand

Screening analysis has been carried on the over 400 sand samples collected in the course of this study to show the range of particle sizes present in each sample. A wide distribution of sizes gives a well-graded sand, while a narrow distribution gives a poorly-graded or well-sorted sand.

The Australian Standard 1141-1974 specification for fine aggregate in concrete gives a recommended grading envelope to be achieved by sand producers. Most sand added to concrete in southern Tasmania falls outside this envelope by being fine grained and well sorted. This is the case with the bulk of the dunal and associated marine sands, such as at South Arm, Cape Contrariety and Seven Mile Beach, which have been derived from Triassic sandstone and which require mixing with crusher dust to conform with specifications. Sheet sand also falls outside specification. At Carlton Plains the typical sand tends to be even finer than dune sand.

This is illustrated in Figure 4 where the grain size analyses for a number of typical sand samples have been plotted and compared with the specification envelope or limits for fine aggregate. Those falling outside the lower limit are samples 647 (Carlton Plains sand), 802 (Calvert's dune sand), 806 (Males' dune sand), 812 (Lazenby's stockpile washed sand), and 815 (Watson's dune sand).

In several cases, coarser sand and gravel conforming to AS 1141-1974 occurs. Samples 808 and 821 are respectively siliceous gravel and stockpile sand (washed) from Clarke's pit, and represent the Huonville River terrace deposits. Samples 804 and 626 are from Males' Lease at South Arm and are respectively examples of sand from an older, coarser sand dune and its washed equivalent from the stockpile. Sample 629 is from a gravel lag deposit based on the Permian Risdon Sandstone at Southport. The deposit is now mostly worked out but was added to concrete used to build the former floating bridge at Hobart.

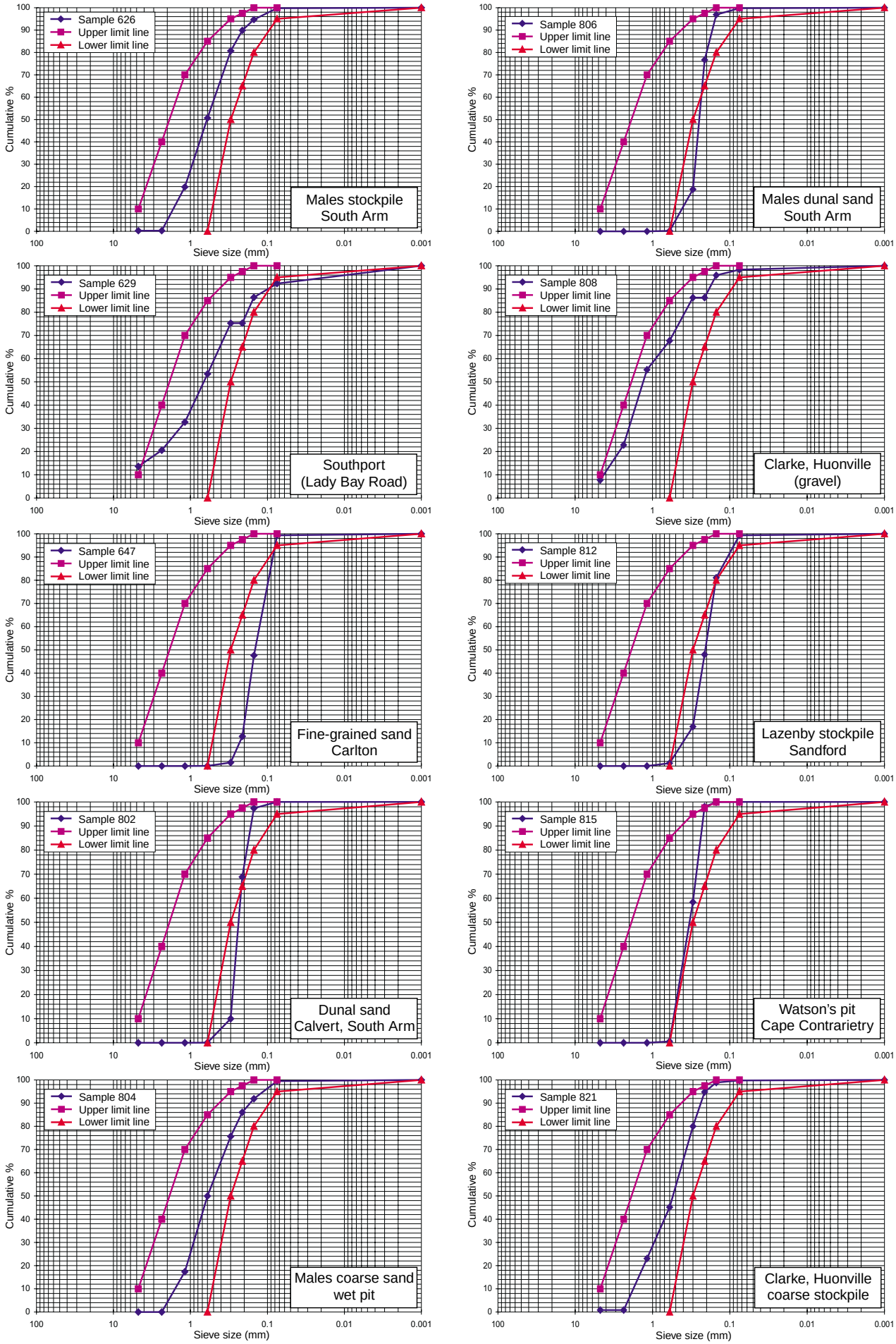

Figure 4. *Size gradings of selected sand samples*

CONCLUSIONS

1. Geological processes have caused large amounts of sand to be deposited in southern Tasmania. The quantity of sand inferred in this survey totals 78 million cubic metres. For a variety of reasons, including social, political, commercial and technical, only part of this sand is expected to be available for extraction.

2. Current (1998) sand production from leases in the south of Tasmania, using official figures, is 96 274 cubic metres. This is the first time since 1987 that the figure has dropped below 100 000 tonnes. Previous predictions of future sand requirements based on historical figures have proven to be too optimistic, with actual consumption being below interpreted growth trends. In this report, the annual average production of 129 791 cubic metres over the last seven years is considered to be probable for the foreseeable future, making the predicted requirements for sand in the Hobart region to be a total of 1.6 million cubic metres in the 1998–2010 period.

3. The resource estimate for sharp sand, the fine aggregate in concrete, on established leases in southern Tasmania is 5.0 million cubic metres. On the assumption that all of these *in situ* resources can be extracted with dry pit operations, this represents 93 years supply at the current depressed rate of extraction (54 000 m^3/ annum) or 69 years supply at the seven year average rate (73 000 m^3/ annum).

4. If future lease conditions allow wet pit sand dredging to a modest -3 m RL, then an additional 1.8 million cubic metres may be considered for use in concrete and other sharp sand applications. Deeper sand resources have been identified amounting to a further 2.5 million cubic metres but require dredging to a depth of -9 or -10 m RL, which may not be acceptable for a variety of environmental and technical reasons.

5. Additional sand resources have been identified outside current leases and amount to 9.8 million cubic metres (excluding Seven Mile Beach) extractable as dry pit operations. Many of these resources are considered to be suitable as sharp sand but development will be dependant on acceptance by industry, owner's permission and planning approval by government agencies. The largest of these is at Carlton, where 1.9 million cubic metres of sand is present on one property title which is not yet subject to subdivision.

6. The Seven Mile Beach area is already considered to be a dune sand resource for fine aggregate but is in a government-controlled Protected Area in which extraction is currently prohibited. The dry pit resources are considerable, amounting to 9 million cubic metres which is nearly equal to the total dry pit resources mentioned above in open ground and nearly double those in current leases.

7. The resource estimates for clayey sand on leases from which fat sand is derived for building applications, such as mortar, is 6.5 million cubic metres. This represents 155 years supply at the current extraction level (42 000 m^3/annum) or 114 years supply at the seven year average level (57 000 m^3/annum). Fat sand resources on open ground comprise 4.7 million cubic metres, most of which has been identified at Buckland and Carlton.

8. Dune sand production could continue from the South Arm leases for many years yet. Additional resources of washed sand may then be sourced by dredging in the former wet pits.

9. There is considerable commercial pressure for operators of the larger concrete manufacturers to remain with dune sand as it is clean, cheap to mine and process, uniformly narrowly graded and of predictable behaviour in concrete. Wet pit operations will introduce increased costs and possible changes in size specifications which may influence concrete properties and may not be readily accepted by users. This encourages operators to position themselves early to ensure continuing supplies of dune sand, as has happened with Seven Mile Beach where transport costs to Hobart will presumably be lower than from South Arm. At Cape Contrariety, Watson's Lease is the largest undeveloped dune sand resource on the Sandford Peninsula and is expected to be accessed by larger producers in the future.

10. Future possible sources of sand, other than dune sand, for light aggregate, such as residual, 'inland' sand, terraced sand and gravel, offshore marine and estuarine sand and manufactured sand are available in southern Tasmania. Importation of sand is also possible from elsewhere in Tasmania and beyond. However, unless there is a marked increase in the price of sand, there is little incentive for producers to diversify their sources of supply in the face of additional development, operational and transport costs.

11. Considering the past alienation of potential sand reserves by subdivision, land use planning decisions and the declaration of reserves, there is an important role for all tiers of government to lead and educate the community in ensuring appropriate access by industry to the diverse range of sand resources within Tasmania for future generations.

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[21 April 1999]

APPENDIX 1
Brief description of sand deposits

Calvert, Lease 800P/M, South Arm

This lease occupies the western half of the South Arm Neck, a sandy structure or tombolo stretching from Cape Direction east to Goat Bluff and connecting two ranges of block-faulted Permian sediments with Jurassic dolerite intrusions. The structure is composed of marine sands overlain by a series of east-west trending aeolian dunes developed on Hope Beach on the Storm Bay side of the tombolo.

The current mining operation is operated by Boral Resources (Tasmania) Ltd who are extracting sand in a dry pit operation for concrete production. The sand is blended with crushed basalt from Boral's Bridgewater quarry. The extraction and rehabilitation is controlled by a management plan (Nieuwhof, 1993) in which the entire operation is described in detail. The sand is dry screened to remove the coarser shells, vegetation roots and carbonate pipes, and is stockpiled and trucked from the site.

Current mining on a six metre face is proceeding east towards the South Arm State Recreation Area, which covers the narrowest part of the South Arm Neck. The operation is extracting sand from a dune system up to 12 metres high, leaving a border of younger frontal dunes 100 metres wide to low water mark on Hope Beach as a protective reserve. The dunes being mined are composed of bedded, yellow to tan, fine-grained quartz sand with minor shell grit and black heavy minerals. Carbonate pipes or chimneys around roots are well developed locally, indicating the calcium content of the sand. Sizing analyses (samples 683, 684 and 802, 803) show that the sand is well sorted and fine grained, with the modal average being 0.3–0.212 mm (ma +0.212 mm) or 0.212–0.15 mm (ma +0.15 mm). Fines, less than 0.075 mm, are less than 0.15%.

Towards the base of the pit at about +1 m RL, the sand becomes more shell rich and was used in the past for glassware.

Drilling

A drilling campaign was carried out to reveal the full extent of the marine sand under the level of the pit, which is nominally +1 m RL. Six holes (totalling 70 m) were drilled at a spacing of 200–300 m along the length of the deposit, the first four being in the pit floor and the western two being on the northern flank of the dunes because of access problems on top of the dunes (fig. 5). A seventh hole (14 m deep) was drilled near a disused pit on the adjacent Linardi property, the site of a previous mining lease (810P/M). Drilling contractors KMR Drilling used hollow augers, mostly below the water table, and the sand was bailed out and sampled in one metre intervals (samples 701–775).

The holes were drilled through a succession of marine sands to a heavy green, blue or grey clay base. A series of fine-grained tan sands, from 5 to 7 m thick, with up to 20% shelly fragments (to 30 mm across) overlies 3 to 6 m of fine-grained, green to grey sands which become clay rich within a metre or two of the heavy clay bottom. Very fine-grained sand (in one case silt; Hole 6) intervals are present in places in both series but more particularly in the lower series, which is mostly free of shells except in the most western hole (Hole 7) adjacent to Fort Hill, where thin (2 m) lower green sand contains 1% of snail spiral shells to 2 mm.

Grain size analysis shows that the upper shelly sand has modal averages in the range ma +0.212 mm or less likely ma +0.15 mm. Many of the shell-rich sands are bimodal, with up to 20% of the sample (shell) reporting in the +1.18 mm or less likely in the +4.75 mm sieve. The lower green to grey sand is more variable in average grain, with most reporting in the fine (ma +0.212 mm, ma +0.15 mm) to very fine-grained (ma +0.075 mm) size intervals. The coarsest material is medium-grained (ma +0.3 mm) green sand, with quartz and rock grains to 2 mm, over two metres in Hole 5. The last fine-grained sand interval overlying the clay base in holes 5 and 6 contains about 5% coarse material, with black pebbles to 100 mm and quartz grains to 2 mm. Occasional pebbles to 100 mm are also found in the upper sand, particularly in Hole 4, and are composed of shelly limestone, dolerite, siliceous Permian sediments and once, a quartzo-feldspathic variant. Traces of black heavy minerals occur in both sand series.

Linardi Deposit

The extreme western end of the South Arm Neck is occupied by Linardi's property and is the site of a previous mining lease (810P/M, G. B. Calvert). Former mining activities have left a disused sand pit with an eight metre high face in dune sand running from Calvert's Lease.

Some residual sand resources are apparent and have been investigated by Hole 7 (fig. 5), which drilled four metres of overlying fine-grained tan dune sand (no coarse shell) before encountering eight metres of fine-grained tan sand with up to 20% shell to 30 mm then two metres of very fine-grained green sand, the last 0.5 m of which is brown to black sandy clay at -8.5 m RL.

Residual resources of fine-grained dune sand to +1 m RL are estimated from Calvert's EMP surveyed plans as 130 000 cubic metres workable as a dry pit. Possible wet pit fine-grained sand dredgeable from +1 m to -3 m RL are assessed to be 120 000 cubic metres with an additional volume of 160 000 cubic metres to clay base being of problematical significance.

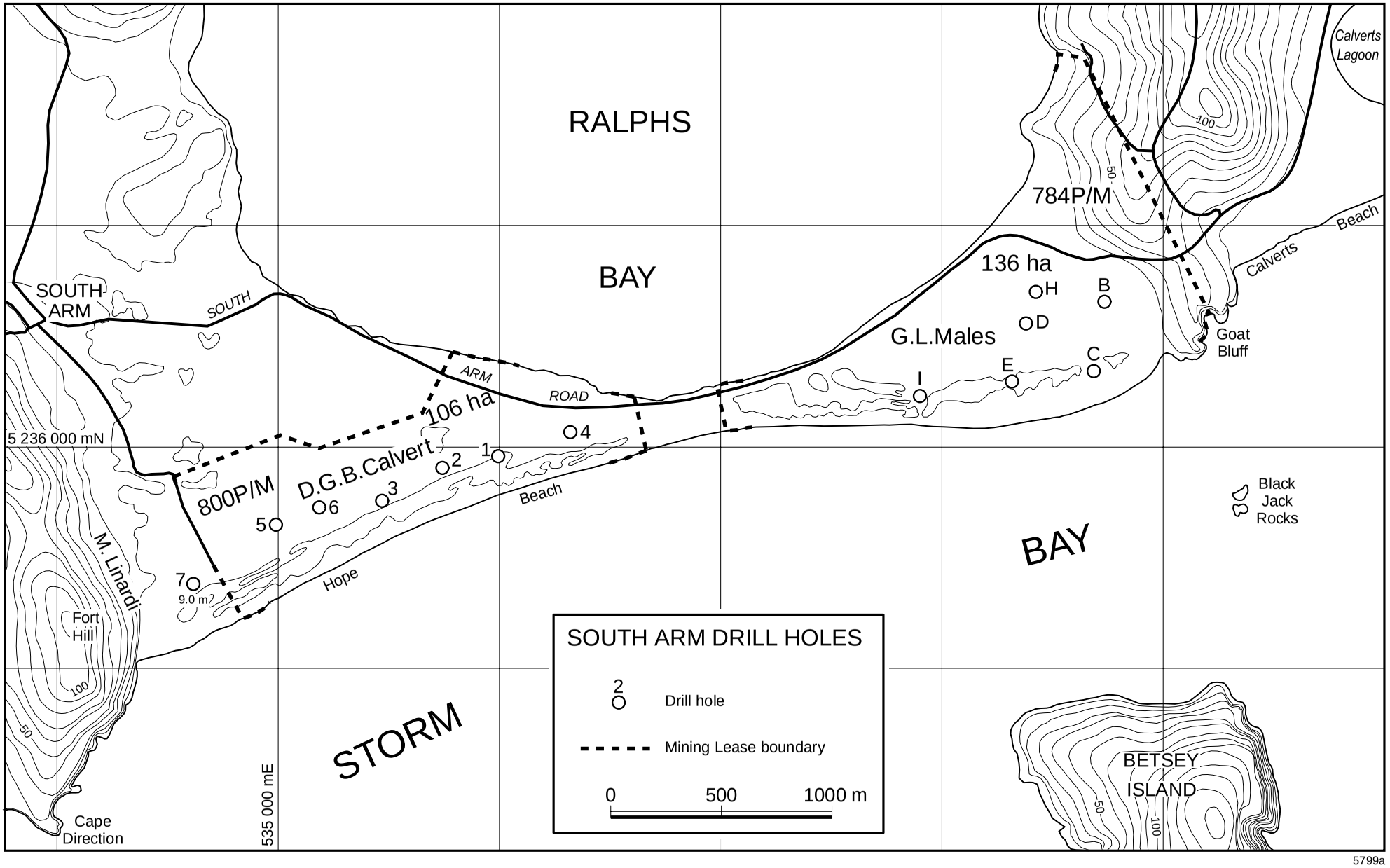

Figure 5. *Sand drill holes at South Arm*

Males, Lease 784P/M, South Arm

Males' Lease covers the eastern half of the isthmus of the South Arm Neck. Sand mining commenced on this area in 1935 as a non-mechanised operation in which the sand was dug and loaded by hand. Now fully mechanised, the operation is conducted on two fronts which still continue despite the present subdued demand for sand. Details of the operation are included in the Environmental Management Plan (Steane and Associates, 1993).

As with Calvert's Lease, the sand mining is based on aeolian dune systems overlying marine sand. At this lease, up to three parallel dune systems run east-west and increase in age to the north.

The oldest, northern dune is being extracted and washed by Males Pty Ltd on the eastern part of the lease and has been traditionally valued by industry because of its coarser grain size compared with standard dune sand. This older, shell-free sand is brown and iron stained and partially cemented into hard pan layers. Several humus rich layers in the sand profile are previous soil horizons. The sand is pushed into ponds, in previously mined sand pits, and then pumped by a pontoon-mounted gravel pump to an adjacent washing plant. They then pass through a rotating screen and into a cyclone where the slimes are separated and returned to a tailings pond, from where the water is recycled. The washed sand is used for the manufacture of concrete blocks and pipes and surface renders.

Sizing of the brown sands to the east and west of the wet pit shows that they are coarse (098, 804; ma +0.6 mm) or medium grained (097, 805; ma +0.3 mm). Fines are less than 1.7%. A good section through this dune is preserved in the west of the pit where a five metre high face shows two metres of parallel and cross-bedded, coarse-grained red-brown sand (804) above three metres of parallel-bedded, medium-grained yellow sand (805). The brown dune is overlain to the south by the younger yellow dune as seen in the wall (801; ma +0.3 mm) of the disused pit and in a trench (627, ma +0.6 mm) near Hole E.

To the west, a larger dry-pit operation, conducted by RNB Trading under an arrangement with the lease holders, produces sand from the second oldest dune. The pit is proceeding west on an eight metre high face from which well-bedded, yellow to pale tan sand is being mined. Black, heavy mineral layers are prominent in places. The sand above the pit floor at +1 m RL has no coarse shell and is screened to remove roots and lime concretions before stockpiling. The sand is used in pre-mixed concrete and hot mix bitumen. The main customer is Pioneer, which adds dolerite crusher dust from its Flagstaff Gully quarry to this sand to produce the desired gradings for concrete.

Sizing of the yellow sands shows that they are fine grained (099, 806, 807; ma +0.212 mm; 100; ma +0.15 mm), well sorted and with fines less than 0.1%. The older dune sand is coarser and also has better grading.

The youngest dune system is protected under the EMP by a 100 metre buffer zone against Hope Beach.

Drilling

A drilling program was carried out to determine the sand potential under the wet and dry pit floors. Six holes were drilled totalling 76 metres, three (B, D and H) in the wet pit area and three (C, E and I) along the length of the dry pit (fig. 5). The spacing of the holes ranged from 150 to 400 metres. The hollow auger/bailer technique of KMR Drilling was used with the sampling on one metre intervals (samples 001–066).

All three holes in the flat wet pit area behind the sand dunes went through two metres of processed slimes and then penetrated mostly grey fine-grained sand before terminating in green sandy clay or heavy green clay (Hole B). In the first two metres under the slimes, in the range -1 to -3 m RL, tan to brown sand has a coarse to medium grain size with quartz grains and some lithic fragments (black, red and pink) to 1–2 mm (samples 001, 002, 013, 014, 027, 028). Fine-grained grey sand then persists to the sandy clay bottom, with some quartz grains and lithic fragments to 1 mm making the sand appear coarser than it proves to be in the sizing analyses. Despite this, some of the grey sand in Hole D, closer to the brown sand dunes, recorded medium grain sizes in the analyses (am +0.3 mm). The coloured lithic grains, which are present in lesser amounts throughout the sand column, may have a different source from the quartz and could have been introduced from the local Permian range to the east.

Watson, Lease 864P/M, Cape Contrariety

This is a large lease covering the York Grove farm property of Kevin Watson, enabling him as owner and lessee to extract sand and dolerite gravel. The lease covers a range of hills composed of dolerite and Permian sediments running down in a westerly direction to a flat area behind the dune fields of Calverts Beach, the sand structure which extends from Goat Bluff in the west to Cape Contrariety in the east. The lease covers a substantial and mostly undeveloped sand resource behind the eastern quarter of Calverts Beach. To the west, the largest part of the dune fields between the beach and Calverts Lagoon are contained within the South Arm State Recreation Area and are now not available for extraction despite a previous mining history.

Two samples of sand from the existing pit (815, 845) gave sizing analyses in or near the medium-grained range (am +0.3 mm, +0.212 mm), a bit more coarse than typical dry pit dune sand from the South Arm area.

A drilling program tested the area behind the frontal dune which reaches 15 metres in height within the lease

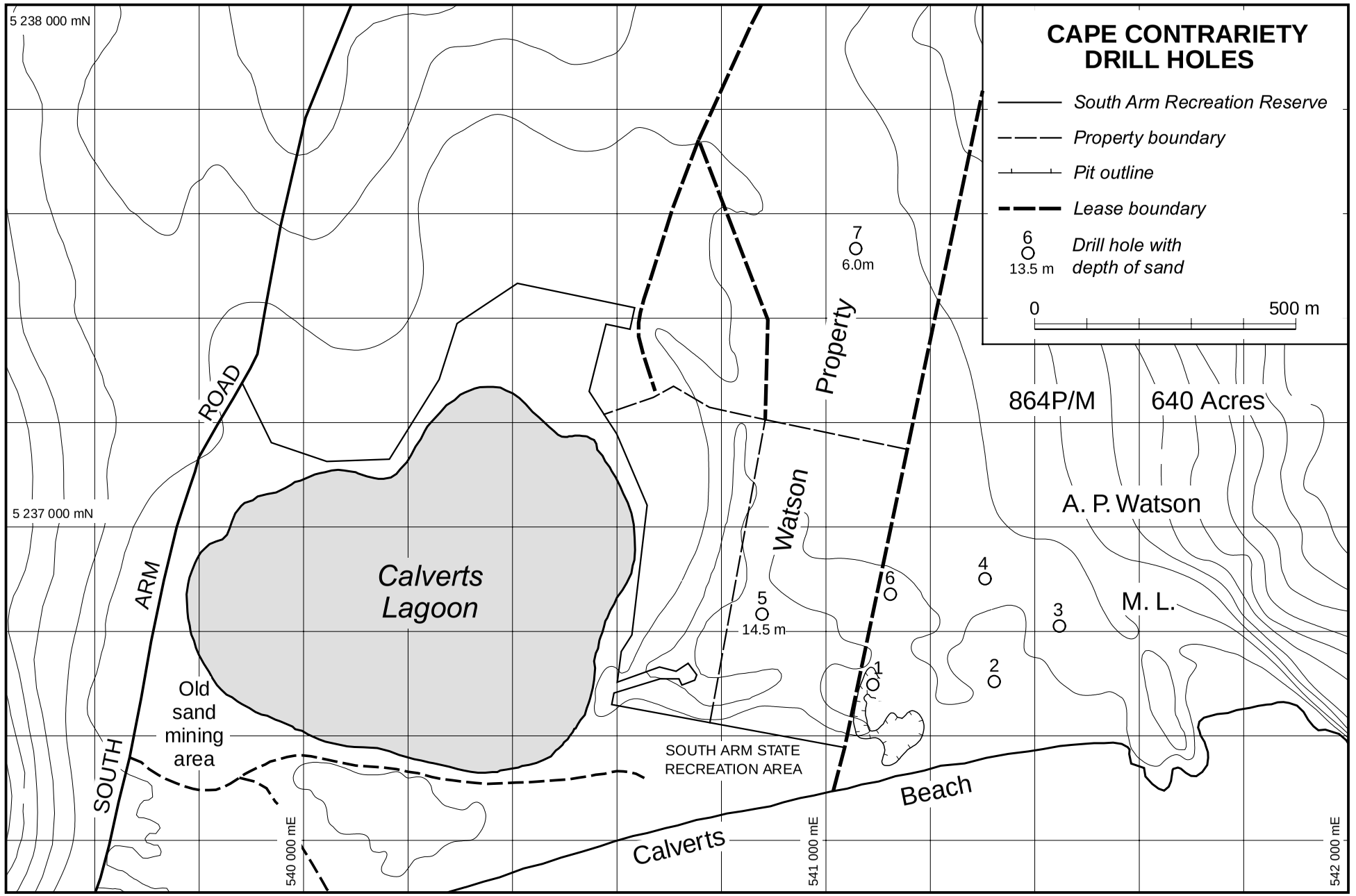

Figure 6. *Sand drill holes at Cape Contrariety*

and rises to a 30 metres high L-shaped dune crest outside the lease to the west overlooking Calverts Lagoon.

A farm dam outside the lease on the flat plain on the western side has revealed deposits of clayey sand which the owner has pursued to a depth of at least five metres by auger.

Drilling

The drilling program was carried out using solid augers, as the sections drilled were mainly above the water table. The augers were drawn every two metres and sand samples were taken from the spirals (samples 827–872). Six holes were completed in the dune sand and one to the north in a clayey sand area near a large farm dam. Depth drilled totalled 91.5 metres (fig. 6).

The dune and marine sands are mostly in the fine-grained range (am +0.212 mm) but occasional samples screen in the medium-grained range (am +0.3 mm, e.g. 827, 829 and 835).

Hole 5, sited off-lease to the west on a +15 m platform behind the highest dune crest, remained entirely in dune sand to the end of hole at RL +1.5 metres.

Hole 7, in the clayey sand prospect to the north, intersected six metres of grey to green clayey sand above five metres of brown sandy clay sitting on ?Permian bedrock. The six metres of clayey sand of unknown areal extent may be suitable for mortar, possibly with blending. The deposit may run to a dam 150 metres downslope in a clayey sand to clay succession.

Lazenby, Lease P/M1635, ACI, P/M813, Sandford

A number of small sand pits are found to the west of the South Arm Road between Calverts Lagoon and Sandford. The operations are run by Michael Lazenby as a consolidation of former leases P/M1454 and P/M1455 and P/M813, now transferred from ACI which used to wash sand for the now defunct glass industry in Hobart.

The sand deposits occur between the 30 and 50 metre contours on the eastern (lee) aspect of the ridges and overlie Permian sedimentary bedrock. They probably originated by being blown up from the beds of Ralphs Bay and the River Derwent when they were exposed to winds during glacial episodes in the Pleistocene.

The sand is generally fine grained (811, 812, 824 and 825) with am +0.150 mm and fines less than 1.6%. One sample (826), on the border with Atkinson's lease, was very fine grained with am +0.075 mm and fines to 4.7%.

The sand is sold for bedding sand, mortar, children's sand pits and garden centre sand. When used for glass tableware, high quality silica sand could be produced by removing heavy minerals such as chromite and spinel (picotite) by putting the material through a washing plant equipped with spirals. The plant is still on site but underutilised.

P Calvert, Lease 1436P/M, Sandford

Named the Richardsons Road Sand Pit, this sand deposit has been worked from the early 1950's. Now owned by Paul Calvert, the current operation is governed by an Environmental Management Plan produced by Environmental and Technical Services Pty Ltd in 1995.

Production is geared to provide cover materials and clay seal for the adjacent Lauderdale tip site and as such is considered to have an operating life to about year 2001 when the tip is due to be closed and rehabilitated. The lease has been a significant producer in recent years.

The geology of the area is made up of beds and lenses of unconsolidated sand, clayey sand and clay of Holocene age, possibly deposited in a coastal, estuarine or swamp environment. The succession is known to be 4-5 metres thick in the sides of the pit and nearly seven metres thick in adjacent auger holes drilled by MRT for groundwater studies. Patches of windblown sand less than one metre thick overlie the clay-rich sand.

This deposit was not investigated for future resources in this study as its life appears limited to that of the tip site. The sand is of clayey or fat sand character and an adjacent subdivision has put constraints on the longer term operation of the lease.

Clarke Sand Pty Ltd, Lease 631P/M, Huonville

This deposit was worked on a small scale for over 30 years by D. S. Clarke. Recognising its potential for producing coarser grades of sand, Hazell Brothers acquired the lease, tested the sand and gravel using excavator pits, and set up an expanded operation involving washing. The operation was controlled by an EMP (1993) submitted by Clarke Sand Pty Ltd.

The deposit is located within the town boundary of Huonville on Glen Road on an old alluvial terrace of the Huon River at its confluence with Mountain River. The quartz sand and siliceous gravel have their source in the Precambrian rocks of southwest Tasmania, from where they have been transported by the tributaries and headwaters of the Huon River.

The sand and gravel are dug out by a 28 tonne excavator from six metre high vertical faces in a quarry with a high water table, which requires a sump to keep conditions dry for working and trucking to the adjacent washing plant. An Eagle classifier was acquired by chance from the Hydro-Electric Corporation and is the key to treating the gravel deposit, which contains 20–25% fines and clay layers and 10% of +5 mm pebbles to 30 mm. The resulting slimes are stored in tailings dams with excess water being recycled to the washing plant, and the oversize is stockpiled for future use. Up to five separate size fractions of sand can be produced by the classifier or

blends of varying grades depending on the required properties of the resulting concrete. Dolerite chips and cement are blended in at the HBMI Longley quarry to produce the final concrete mix. The operators claim they are the only supplier in southern Tasmania of sand in readymix concrete which is within Australian Standard specifications. The major product is concrete sand with some sand used for top dressing turf and for plant propagation.

Geology

In the active northern pit, two metres of coarse-grained sand occurs above four metres of very coarse sand and gravel which contains layers 1–2 metres thick alternating with thinner clay beds. The whole section rests on a dark grey, heavy clay floor. In this pit, the sand gets thicker towards the east with the gravel thickening to the west.

A good section through the deposit is visible in a seven metre high face on the northeast boundary of the lease behind the washing plant and the stockpiles. The lower five metres of material is yellow to buff coloured, fine to medium-grained, poorly-sorted sand with a clayey matrix. The sand is poorly bedded in irregular horizontal layers with some indications of cross bedding. Overlying this is an irregular one metre thick bed of clast to matrix-supported gravel with well rounded pebbles up to 100 mm of variable quartzites. This section is completed by a one metre layer of dolerite boulders up to 500 mm across and then a thin soil horizon.

Two samples were selected for sizing, one being a coarse-grained sand or gravel and the other a pink sand. The gravel (808) had an ma of +1.18 mm and was well graded, while the sand (809) was well sorted with an ma of +0.15 mm. A sample (821) of grey sand from the coarse washed sand stockpile had an ma of +0.3 mm and a good grading with no fines and is close to the operator's quoted concrete specifications (e.g. 4.75 – 0.64% retained; 2.36 – 10.99%; 1.18 – 28.83%; 600 – 50.55%; 425 – 71.19%; 300– 89.09%; 150 – 99.28%; and 075 – 100%).

Carlton Sand Deposit

The Dodges Ferry–Carlton area was highlighted in the Matthews and Donaldson (1994) report as being of potential for the future production of sand in the Hobart region. Geological Survey mapping indicated broad expanses of Quaternary windblown sand, numerous waterbores in adjacent properties revealed that up to a seven metre depth of sand was possible, and exposed sand faces of up to five metres at the Carlton tip site and in several disused sand pits completed the picture.

The sand area was outlined, mapped and sampled and found to extend for three kilometres in a north–south direction. The widest part (1 km) with most potential is in the south near the tip site, with the additional advantage of being contained on one property owned by Southbridge whose proprietor is orchardist Peter Shield of Huonville. This part of the deposit is informally called the Carlton Plains sand deposit. The other part of the deposit, informally named the Carlton North sand deposit, runs to the north in a narrow tongue, traversing several small holdings with houses. Sparse outcrops, water bores and dams would indicate that this deposit is shallower.

The deposit was further assessed with an excavator program of 25 test pits (totalling 56.7 m) on 200 metre centres concentrated on the Southbridge property. Following that, seven auger holes (totalling 40 metres) were drilled to the south of Josephs Road on some of the sites where the excavator reached its limit of three metres while still in sand (fig. 7).

The sub-surface testing showed that a layer of variably coloured sand (white, pink grey, tan, light brown and dark brown) overlies grey, brown or green clayey sand. The top sand layer ranges in thickness from 0.7 to 5.2 metres, with the bottom clayey sand being from 0.4 to 5.3 metres thick. Three auger holes remained in clayey sand after seven metres (holes 2, 4 and 13) in an area adjacent to the tip site (southeast corner). Elsewhere the auger holes or test pits end in bedrock, either sandstone in the west or, after a brown or grey clay zone, basalt in the east. The dark brown colour of the sand of the upper zone is caused by iron staining which can give rise to cemented hard pan layers when exposed, as in the old sand pit north of Josephs Road. The clayey sand tends to have clay layers with depth.

A series of samples (630–682) taken from the test pits have been screened. This showed that the upper sand is fine to very fine grained (am +075 mm commonly, am +150 mm less frequently) and is finer than the aeolian dune sand from South Arm. The fines content (less than 0.075 mm) of this sand is commonly less than 5% but can be as high as 17.8%. Sand approaching medium grain (am +0.212 mm) is found in the old sand mentioned above (pit 23) and in the bottom of pit 12. The clayey sand generally does not disaggregate but two samples (634, 648) which did respond gave very fine grains.

The deposit is part of a windblown sheet of sand extending from Dodges Ferry through Carlton to Primrose Sands. Such sheets are common in the coastal areas of this region and are thought to have been deflated from the beds of the bays, estuaries and rivers during the Pleistocene glacial times when sea level was much lower. There are suggestions of low ridges in the southwest of the deposit which may be dunes coinciding with the thickest part of the deposit and the high accumulation of sand behind the tip may be caused by deposition in an eddy behind a sandstone ridge. The northern part of the deposit may have had local contribution of sand from the same pronounced sandstone ridge.

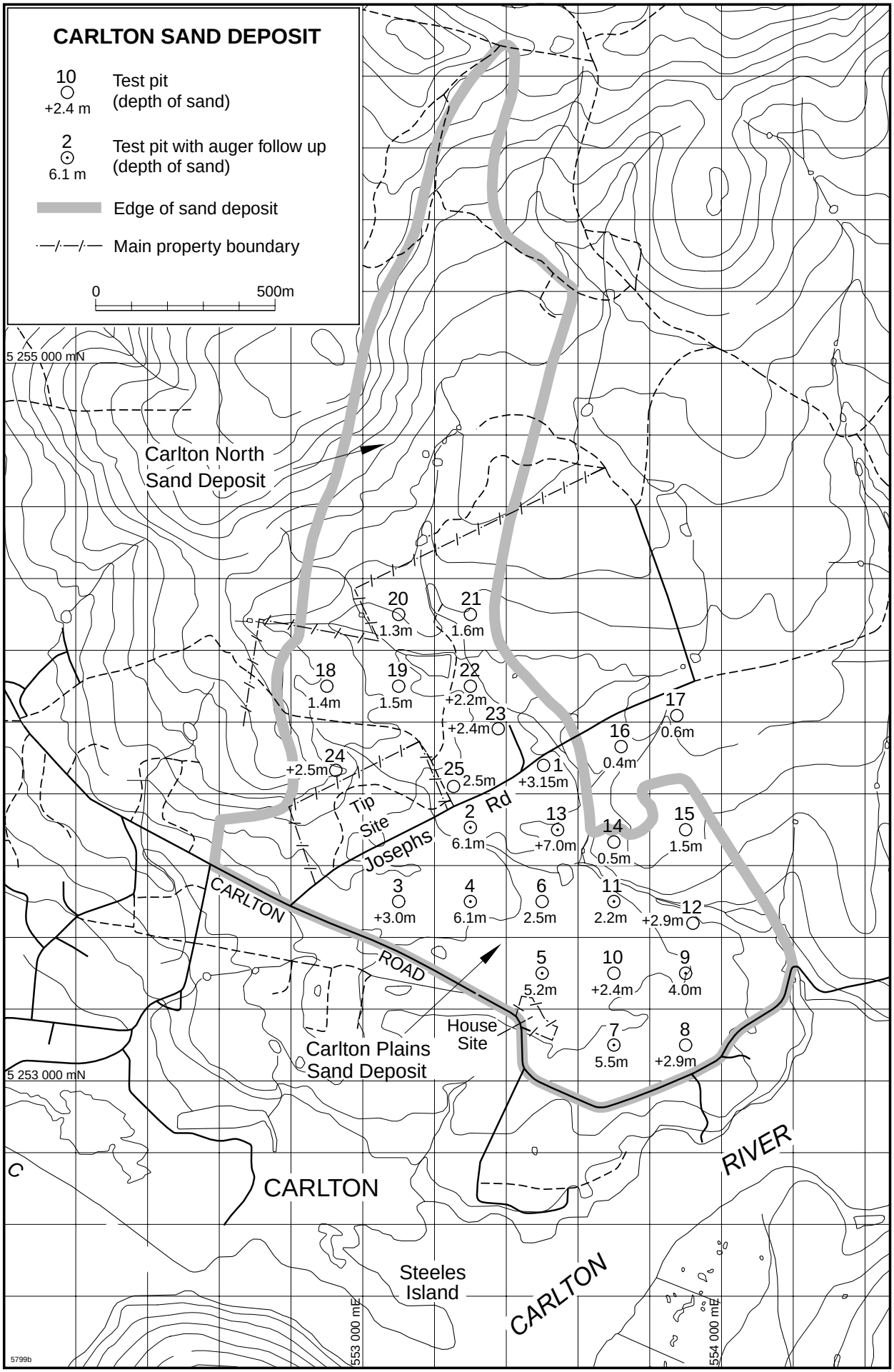

Figure 7. *Test pitting and auger drilling of Carlton sand deposit.*

Resources

Resource numbers were estimated on each four hectare block using the sand intersections in its central test pit. Blocks 14, 16 and 17 were omitted as their sand was less than one metre thick. The total *in situ* resource of upper sand in the deposit is 1.9 million cubic metres (rounded) for the Carlton Plains deposit (based on the subsurface testing) with an additional figure of 940 000 cubic metres for the clayey sand. The Carlton North deposit is estimated to have 940 000 cubic metres of sand based on thicknesses in road cuts, dams and water bores.

These figures indicate that the Carlton Plains Deposit may be a significant resource of sand for southern Tasmania. Although they are mostly finer grained than dunal sand and the fines content may be higher than the desired 5% in places, the sand may serve as fine aggregate for concrete by washing or blending. Patches of coarser grained sand may be present as indicated. The underlying clayey sand may be suitable for fat sand or washed to produce sharp sand.

Conversion of these resources to reserves of sand will depend on the future development permission by the owner and the regulatory authorities, and acceptance and testing by industry for potential uses. As the land is probably held for its residential rather than its agricultural potential, no subdivision should be allowed without consideration of its value as a future sand source for southern Tasmania.

Brown Mountain Road Sand Deposit

A sand deposit near Campania, located from the CONMAT database, was the site of a former mining lease. The deposit is marked by a disused sand pit some 200 metres long and 100 metres wide situated on the southeastern aspect of a sandstone ridge. A number of small scrapes suggested its extent along strike to the north and south, while a gentle slope covered in bracken fern towards White Kangaroo Rivulet indicated potential in that direction. Three properties partition the deposit: *Ticehurst* to the west, *Roslyn* to the north and east and *Stratford* to the east and south. During the work another sand lens was located to the south of the sandstone ridge on the *Stratford* property.

Four auger holes (totalling 10.1 m) were drilled on the *Roslyn* property and 24 test pits (fig. 8), totalling 49.7 metres, were dug by an excavator, on an average spacing of 100 metres.

Sand depths in the larger northern deposit (20 pits, 4 auger holes) ranged from 0.8 to 3.5 metres, with fine grained pale tan or grey sand overlying grey clayey sand or clay. A brown sand layer of up to 0.7 metres can separate the two layers mentioned and can contain a trace to a substantial hardpan development. Sometimes the upper sand layer is mottled in shades of red, brown and grey. On occasions, sandstone blocks to100 mm are found in the clayey sand or the hardpan layer. The upper sand layer passes into either clayey sand or clay or can remain open at depth.

The southern deposit (4 pits) has up to 2.5 metres of sand open at depth, except for one hole where it becomes clayey sand. Fine-grained tan sand overlies light to dark brown sand. An old sand pit, now filled in, on the edge of the deposit was reported to have provided bedding sand for the Brighton to Campania water pipeline and contained 4-6 metres depth of sand. The sand was also tested some years ago for possible use by Cambridge Sand.

The majority of the sand has a modal average grain size of +0.212 mm putting it in the fine grained to medium grained size range. Fines range from 0.4–7.1% making the sand suitable for fine aggregate in concrete. Threader (1977) reported that sand from the northern deposit was tested by the Public Works Department and found to be suitable for adding to surface coarse materials for roads and low strength concrete. The clayey sand should be suitable for mortar.

The sand occurs as a residual blanket lying on the eastern and southern slopes of a ridge and is derived from weathered Triassic sandstone.

Resources

The sand resources were estimated by averaging the thickness in the pits and drill holes over the area of the deposits contained in each property, with the two deposits treated separately.

The deposit contains 610 000 cubic metres of sand and 210 000 cubic metres of clayey sand (rounded figures), making a total sand figure of 820 000 cubic metres (indicated).

As the deposit is on open ground, a mining lease would be necessary for extraction along with other agency permissions. The fact that three property owners would have to agree to the terms of a development may be seen as a disadvantage in exploiting this sand deposit.

Bedding Hill, Copping

Sand was reported by MRT geologists on the slopes of the sandstone ridge running east from Bedding Hill on the *Downie* property, adjacent to the planned regional tip site. Inspection revealed a small (20 m across), newly opened sand pit with a 1.3 metre high face of clean, white fine to medium-grained sand (sample 621, am +0.212 mm, fines 0.3%) near the crest of the ridge. The owner suggested that the sand had been tested by the Dunalley Cement Company and found to be suitable for their use (presumably concrete). There were surface indications of sand on the steep southern and gently sloping northern flanks of the ridge and it was decided to test the area with a small excavator program.

Thirteen pits, totalling 20.7 metres, were dug on the ridge slopes.

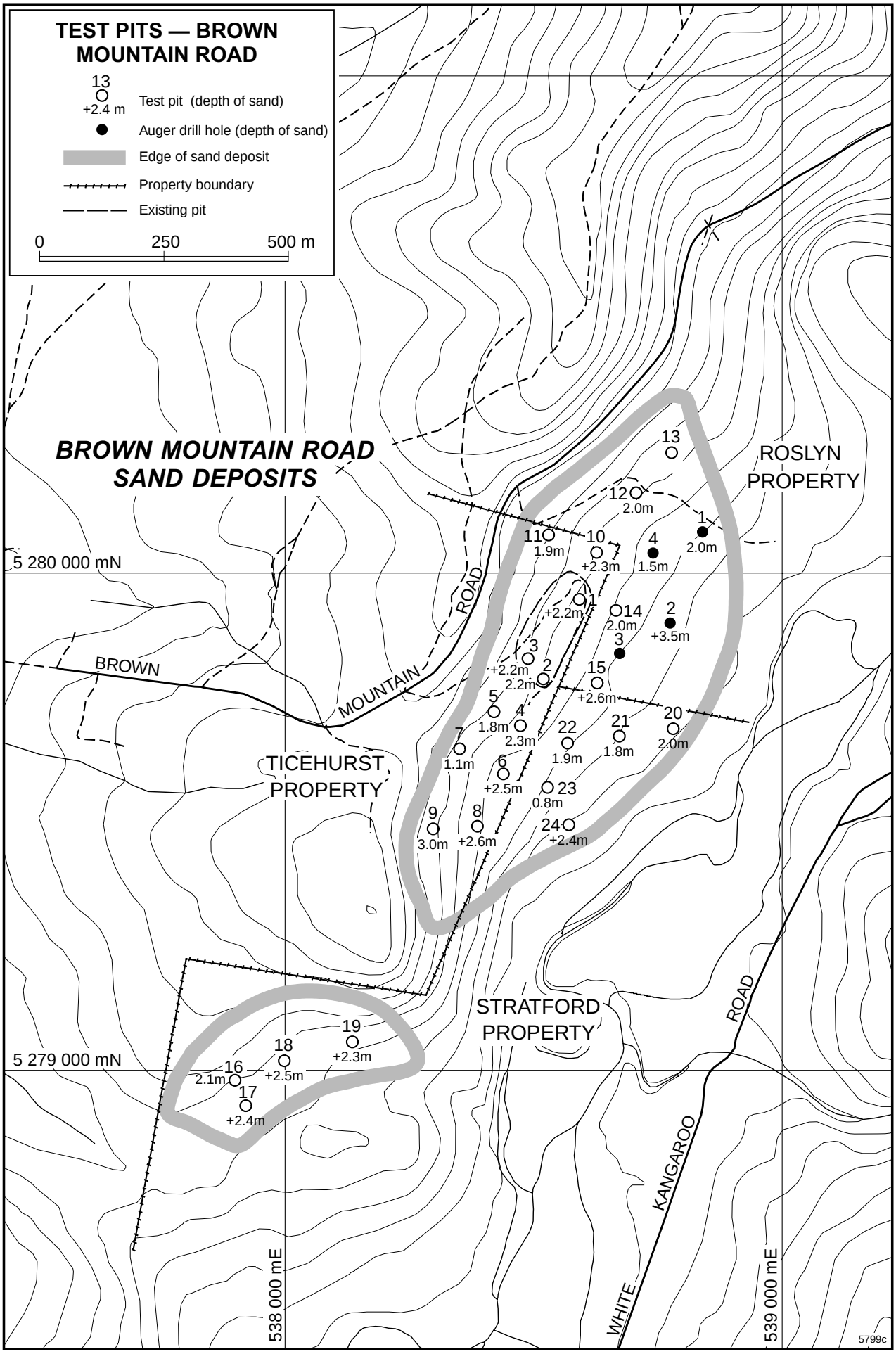

Figure 8. *Test pitting and auger drilling, Brown Mountain Road sand deposits.*

The best sections of sand were found in and close to the existing sand pit. Beneath the pit floor is 1.3 metres of fine-grained grey sand above green to brown sandy clay (0.8 m) with sandstone blocks. The original depth of sand was then 2.6 metres, which compares with 2.3 m+ in pit 13 which was located 20 metres to the northeast. Pits 2 and 3, dug 100 metres apart on a bench below the steep sandstone outcrops to the south, gave between one and 1.3 metres of whitish grey sand (including sandy soil) above up to 1.2 metres of clayey sand to clay with sandstone blocks to 300 mm.

On the northern slopes pits 4–12, excavated in two traverses, recorded from 0.2–1.2 metres (including root zones) of fine-grained sand of various shades of grey and brown with traces of hardpan overlying up to one metre of clayey sand, sandy clay or heavy clay above sandstone bedrock.

Resources

The light veneer of sand on this ridge is a small residual deposit on the Triassic sandstone bedrock. Characteristically, the blanket thickens on the protected southeast aspect of the ridge where the sand pit has been started. The northern slopes, where the sand is mostly less than one metre thick, are not considered worth regarding as a deposit. On the south and southeast side, the resources are estimated to be some 30 000 cubic metres of fine-grained sharp sand suitable for concrete (am +0.212 mm, fines less than 5.5%).

Flexmore Park, Lease 1297P/M, Penna

This large 400 hectare lease covers the Morey farm property, where sand mining has been largely tied to farm improvement. The farm is based on an eight metre high terrace of Tertiary sediments overlooking the Pitt Water estuary, with a range of hills to the east composed of Triassic sandstone and Jurassic dolerite. Over 50% of the sand is used for mortar, another 25% is sharp sand and the remainder is used for top dressing loam. Blending of sharp and fat sand during screening produces mortar sand and bedding sand for laying under concrete slabs or pipes. Farm improvements consist of excavation for large dams in fat sand, removal of sharp sand drifts from paddocks and the spreading of clay-rich fat sand to increase water retention for crops and pasture.

Mapping information collected from the well-exposed cliff section and from the dams and sand pit, combined with details supplied by the owner from deep post holes and trenching for a water reticulation system, has built up a picture of sand distribution over the lease.

The farm area is underlain by 6 to 7 metres of Tertiary clayey sand and clay overlain by 1–2 metres of assorted sand. The overlying sand in the larger northern area is a combination of residual brown or hardpan layers or yellow windblown drifts collecting around the lee of isolated hills or in low NNW-trending ridges. The aeolian component increases to the south where it is expressed as 1–2 metres of sharp, white to light brown sand in the sand pit overlying clayey sand or as a low one metre high coastal platform of white fine-grained sand just above water level in the lee of the bluffs.

In the current sand pit, a section was measured as follows: 2.1 m of white to light brown fine-grained sand, underlain by 0.8 m dark brown hardpan layer then 2.5 m clayey sand, then 1.6 m sandy clay or clay base. A 0.2 metre sandy soil layer on top contained numerous marine shells, a common feature of the area, resulting from ancient occupation of the area by aboriginals.

Measurements in several localities along the coastal section showed the following section: 0.6–1.6 m pink sand (aeolian), 0.7–2.2 m massive, hard, red sand (may be a leached hardpan layer), 3.7–4.7 m clayey sand underlain by 0.6–1.1 m sandy clay or clay base.

The clayey sand is poorly bedded and yellow brown in colour, while the clay-rich beds are dark grey. They contain at least two upward-fining cycles from sand to clay.

To the north, the sand shows some cross-bedding with truncated tops and some thin sandy units lens out over 20–30 metres. A calcareous siltstone replaces the clay at the base of the section.

In the extreme north, on Billys Island, a much reduced section (from the base up) comprises 0.2 m of pebbly limestone, a 1.2 m thick massive gravel bed (matrix supported, clasts to150 mm of dolerite and quartzite), then 2.2 m of poorly bedded sand, a 0.3 m thick massive red sand bed and finally 0.5 m of shelly dark soil.

The extent and thickness of the clayey sand at Flexmore Park appears to be unusual for Tertiary sediments in southern Tasmania, where the dominant lithology is clay. This sand has been deposited in the fault trough of the Coal River Valley, probably in an estuary (Leaman, 1971). The sand was mainly derived from erosion of Triassic sandstone and transported seawards by the ancestral Coal River and perhaps added to by local creeks from the extensive sandstone ridges of Mt Lord to the east.

Subsequently, during the lower sea levels of Quaternary glacial times, the overlying sharp sand was blown up from the exposed Coal River bed by northwesterly winds to accumulate in the lee of ridges, valleys and bluffs, for example in the southern part of the current lease. As the clayey sand was leached and dried out, this produced sharp sand which blew downwind and added to the southern deposits, a process which is continuing today.

Stanton, Lease 940P/M, Penna

This sand deposit was originally part of Flexmore Park but was bought by the present owner, Ross Stanton of Cambridge Sand, some 14 years ago. The present five hectare lease sits on a steep southeast-facing slope

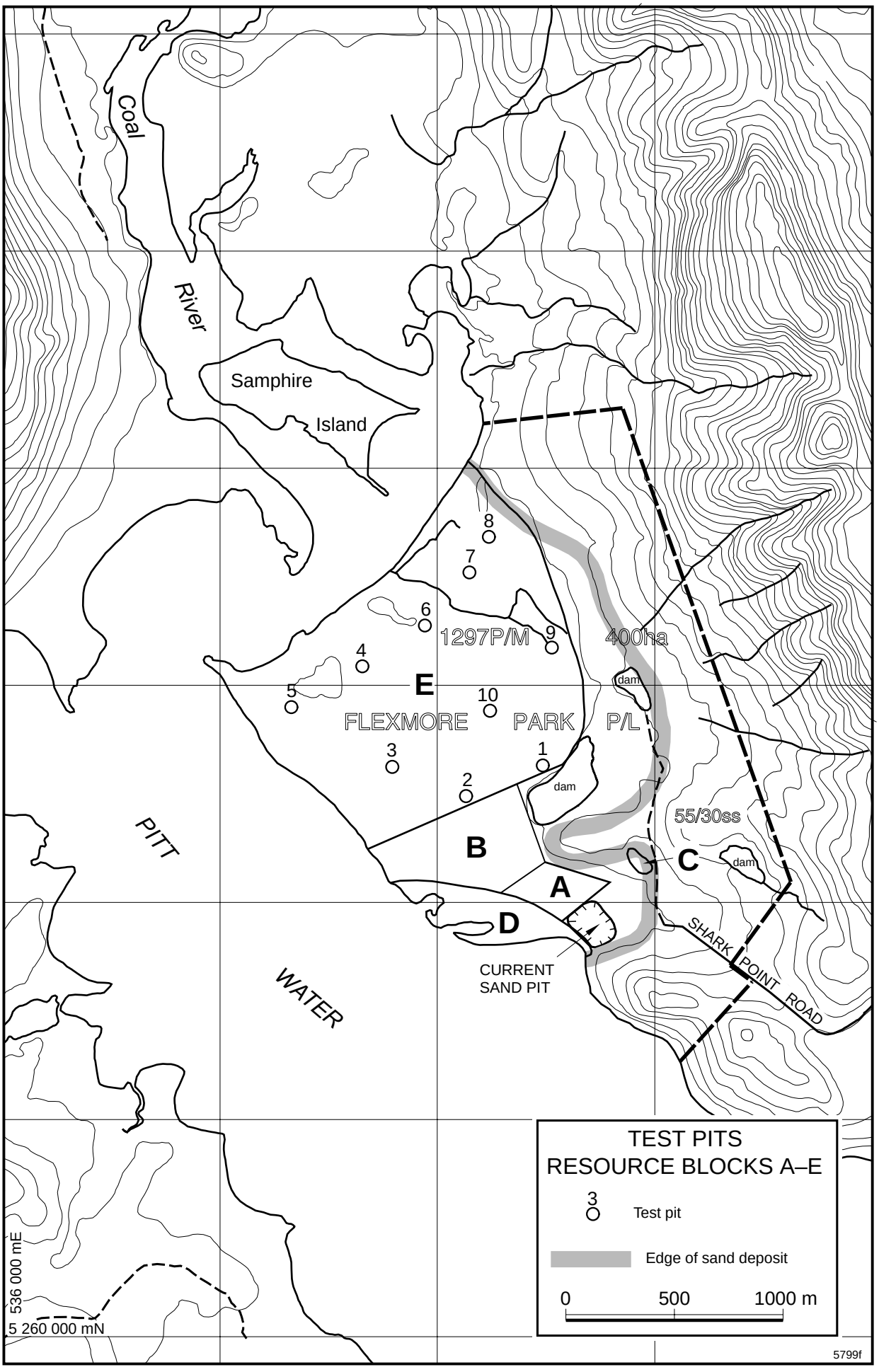

Figure 9. *Test pits and resource blocks, Flexmore Park.*

overlooking Pitt Water, at an elevation of between 60 and 120 metres. This is a residual sand deposit occupying a valley with a Triassic sandstone ridge to the northwest and dolerite to the southeast.

Because of the steep slope, the extraction pit is benched, with sand faces up to 8–10 metres high. Some three to four metres of bedded, transported (aeolian) tan sand (sample 818; am +0.15 mm, fines 1.03%) overlies light brown fine-grained fat sand (sample 817; am +0.15 mm, fines 0.96%) in places. An oxidised underlying sandstone outcrop is visible on at least one bench. There is some sand upslope but this is not being developed to avoid visible scars towards the skyline. About half of the deposit lies off lease downslope where it may be available in the future on a new or extended mining lease.

No washing is allowed on the lease and the sand is removed to Cambridge where it is sold as bedding sand, blended with loam or mixed with sharp sand for use in mortar.

Seven Mile Beach

This deposit is a sand spit some eight kilometres long which separates the enclosed waters of Pitt Water from Frederick Henry Bay, with a connecting outflow channel at the eastern end.

The deposit is a composite sand structure made up of Quaternary beach sand with overlying windblown dunes, mostly stabilised by vegetation.

The average topographic elevation of the dunes is about five metres above sea level, with up to 18 metres of beach and other sand below sea level lying on a Tertiary? estuarine clay. Dune heights reach up to 10–12 metres at the eastern end of the spit.

In detail, yellow-buff aeolian quartz sand covers yellow-grey, shelly marine sand with slightly clayey estuarine quartz sand coming in at depth (Cromer and Sloane, 1976).

This deposit is the largest onshore sand resource in the Hobart region (Matthews and Donaldson, 1994). It has been investigated over the years for its construction sand, heavy mineral sand and groundwater resources, much of this involving subsurface drilling. An early estimate by Threader (1974),over an area of five square kilometres, gave a resource of 45 million cubic metres to a depth of nine metres, allowing for a 90 metre wide foreshore reserve. As a dry pit operation, about nine million cubic metres would be available above the water table.

The land containing the deposit is Crown Land and a Protected Area, with special conditions applying to exploration and mining. Yet, under the City of Clarence Planning Scheme (1986), extractive industry is a prohibited use. Despite this, the construction industry has continued to explore the deposit because of its attractive potential so close to Hobart and with the hope that planning schemes can be changed. Currently, the western area is held as EL20/89 by Sanbar Pty Ltd and the smaller eastern part as EL14/95 by Boral Ltd. RNB Trading, an associated company of Sanbar, has a mining lease application (1642P/M) pending over 61 hectares at the western end of the Seven Mile beach area.

APPENDIX 2
Excavator testing of areas

W. L. Matthews

HUONVILLE AREA

Siliceous gravel associated with the Huon River is a potential source of sand/gravel for concrete manufacture and other purposes. Currently there is a pit of considerable size being operated by HBMI just to the north of Huonville township. Operations of varying size have been conducted at other locations, e.g. Cradoc and Randalls Bay to the south of Cygnet. At Cradoc and Randalls Bay the gravel is partly at least located on elevated terraces, while the pit at Huonville is not much above present river level although it is not developed in the most recent floodplain deposits. A layer of dolerite boulders overlies the siliceous sand and gravel in the worked pit. It is also known that siliceous gravel deposits occur in the upper reaches of the Huon catchment.

The siliceous gravel and sand are probably largely derived directly from the weathering, erosion, and transport by the river, of siliceous rocks of Precambrian age over which the river passes west of Blakes Opening. Some of the siliceous material may be recycled from the weathering of Permian sediments which contain dropstones of pre-Permian age and from the tillite unit that occurs at the base of the Permian sequence.

Fairly extensive flat areas occur around the Huon River within reasonable transport distance of Hobart. The general location of areas with potential to have siliceous gravel of similar origin to other worked deposits around the river are shown Figure 10. These extend six kilometres west of Judbury and to Cradoc, about ten kilometres south of Huonville. A considerable part of the areas outlined is unlikely to be available for the extraction of sand and gravel because of housing developments, golf courses, etc. Part of Egg Island in the Huon estuary is a conservation area. However, there are significant flat areas around the river where development is limited and there may be some potential to set up extraction operations if suitable resources are identified. Other areas at more distant locations than shown on the map will have potential to have similar deposits.

Test pits were dug in two areas around the Huon River to test the potential of the zones outlined on Figures 11 and 12. These were located about two kilometres along the Glen Huon Road from Huonville, where a large area is currently operated as a dairy farm, and at Cradoc, which consisted of parts of several properties and included swamp land, bush land and areas developed for fruit growing and grazing.

Huonville area (D. Pitt's property)

Ten test pits were dug in the approximate positions shown on Figure 11. Eight out of the ten pits encountered siliceous gravel, with one pit (number 5) encountering clayey sand and sand with a few pebbles. The depth of the gravel/sand has not been ascertained and would require drilling to obtain information on its vertical extent. However, taking the area where the test pits were dug, and excluding pit 8, an average depth of 1.6 metres for each hole is suggested for the other pits. Over an area of about 0.65 square kilometres this gives indicated resources of a little over one million cubic metres of material for the area tested. This must be regarded as a very approximate estimate considering the relative sparseness of the test pits. However, with the depth of the base of the gravel unknown, the area must be regarded as having significant quantities of the siliceous gravel/sand.

The gravel has a wide size range with rounded boulders up to 300 millimetres across and with a considerable proportion of the material above sixteen millimetres. This may limit its use unless crushing was a consideration. Rounded fresh dolerite occurred in a few of the test pits but was most common in pit 1.

Similar material is expected to underlie the land to the west. The golf course and smaller properties have been subdivided here which makes the chance of extraction very small. A trebling of the indicated resources is quite feasible if the nearby land is considered.

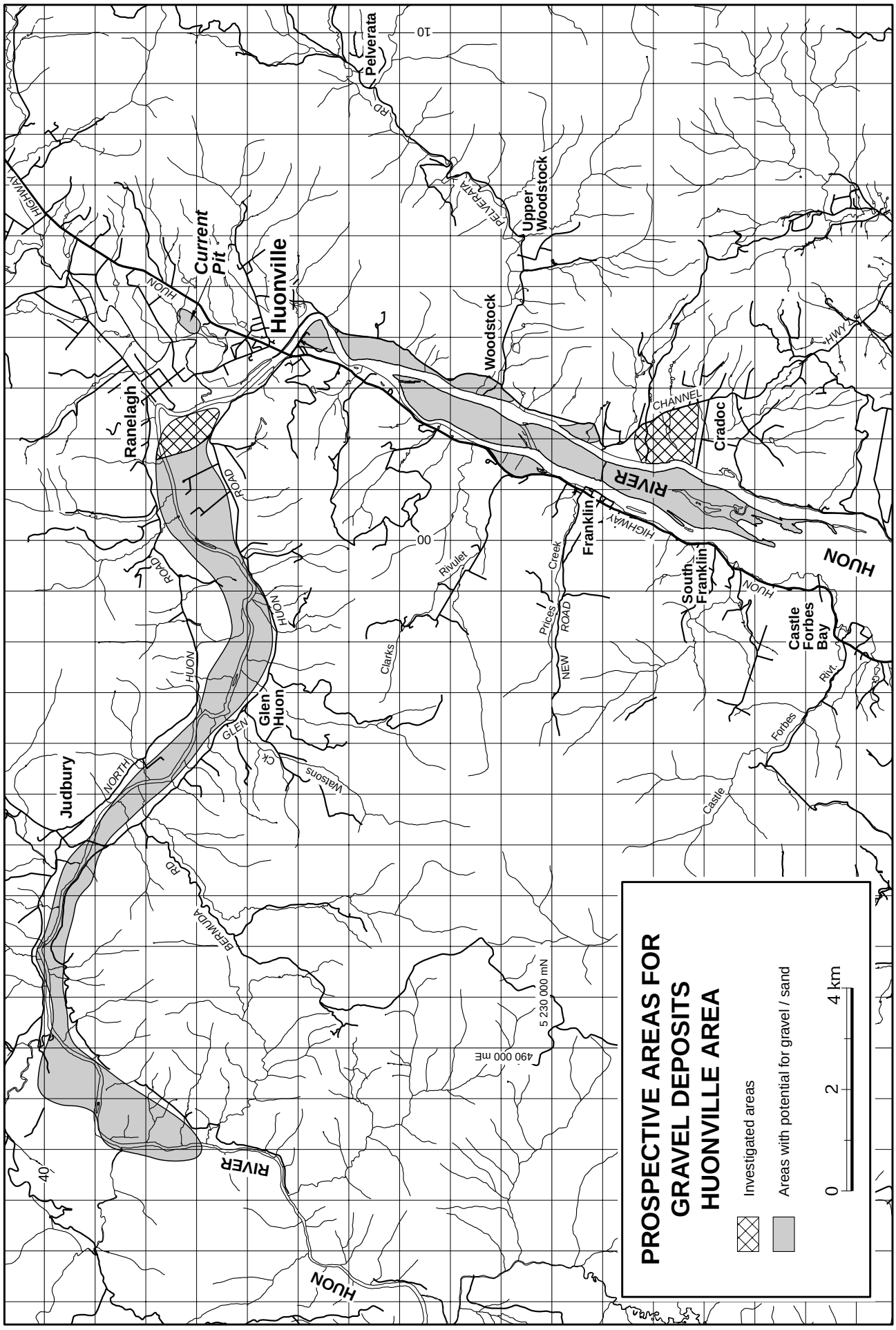
PROSPECTIVE AREAS FOR GRAVEL DEPOSITS HUONVILLE AREA
Investigated areas
Areas with potential for gravel / sand
0
2
4 km
Huonville
Current Pit
Ranelagh
Judbury
Glen Huon
Woodstock
Upper Woodstock
Franklin
South Franklin
Cradoc
Castle Forbes Bay
Port Huon
Pelverata
RIVER HUON
CHANNEL
HIGHWAY
ROAD
NORTH
GLEN HUON
Clarks
Rivulet
Prices Creek
NEW ROAD
BERMUDA
Watsons
Forbes
Castle
490 000 mE
5 230 000 mN

Figure 10

Logs of test pits, Huonville

Pit 1

0.0–0.2	Grey sandy silty soil, roots
0.2–1.0	Brown clay
1.0–2.3	Brown clay, sandy clay
2.3–4.4	Sandy gravel, rounded boulders up to 100 mm across, towards base 300 mm, mainly quartzite some dolerite.

Water entering hole at about 3 metres 660 µS/cm.

Pit 2

0.0–0.3	Grey brown sandy silty soil, roots
0.3–0.8	Brown and grey sandy silty clay
0.8–1.5	Clayey gravel
1.5–4.1	Sandy gravel, rounded fragments, some clay becoming, less with depth, boulders up to 300 mm across, mainly quartzite a few dolerite boulders but less than previous hole

No water entered pit.

Pit 3

0.0–0.2	Grey brown sandy silty soil, roots
0.2–2.3	Brownish grey and brown sandy silty clay
2.3–3.9	Clayey gravel, rounded less clay with depth boulders up to 300 mm (10–15% >100 mm)

A little water entered hole at base.

Pit 4

0.0–0.5	Dark brown silty soil, roots
0.5–1.4	Brown clay, sandy clay
1.4–2.0	Grey sandy clay
2.0–3.6	Sandy gravel, rounded

Water entering lower levels -800 µS/cm. This gravel is finer than in previous three pits, occasional fragments up to 200 mm.

Pit 5

0.0–0.8	Brown silty sandy soil, roots
0.8–3.5	Mid brown changing to light brown clayey silt, sandy clay towards the base
3.5–4.4	Clayey sand passing into sand with a low clay content, occasional pebbles, collapsing at 3.5 metres

Water in base of hole.

Pit 6

0.0–0.4	Dark grey brown sandy silty soil
0.4–2.8	Light brown clayey sand and sandy clay
2.8–4.1	Brownish and greyish clayey sand, wet and collapsing
4.4–4.1	Sandy gravel, boulders up to 150 mm

Unable to collect sample of gravel due to collapse. Water in base of hole -500 µS/cm.

Pit 7

0.0–0.35	Dark grey brown sandy silty soil
0.35–1.8	Grey and brown clay and sandy clay
1.8–4.0	Sandy gravel, finer grained than in holes to the west

Water entering hole -3500 µS/cm.

Pit 8

0.0–0.5	Brown silty clay soil
0.5–1.4	Brown and grey plastic clay
1.4–2.3	Wood waste including a log of wood
2.3–4.2	Green and bluish sandy clay

Water entering hole through wood waste -250 µS/cm.

Pit 9

0.0–0.3	Mid grey brown silty soil, roots
0.3–2.0	Light brown sand grey clayey sand
2.0–3.5	Sandy gravel with boulders up to 250 mm, few if any dolerite boulders.

Water seeping slowly into base of hole -850 µS/cm.

Pit 10

0.0–0.3	Light grey brown silty soil
0.3–1.0	Brown and grey clayey sand
1.0–2.2	Grey sand, clayey sand
2.2–3.6	Sandy gravel, a little clay, some dolerite boulders. Quartzite boulders up to 300 mm across

A little water seepage.

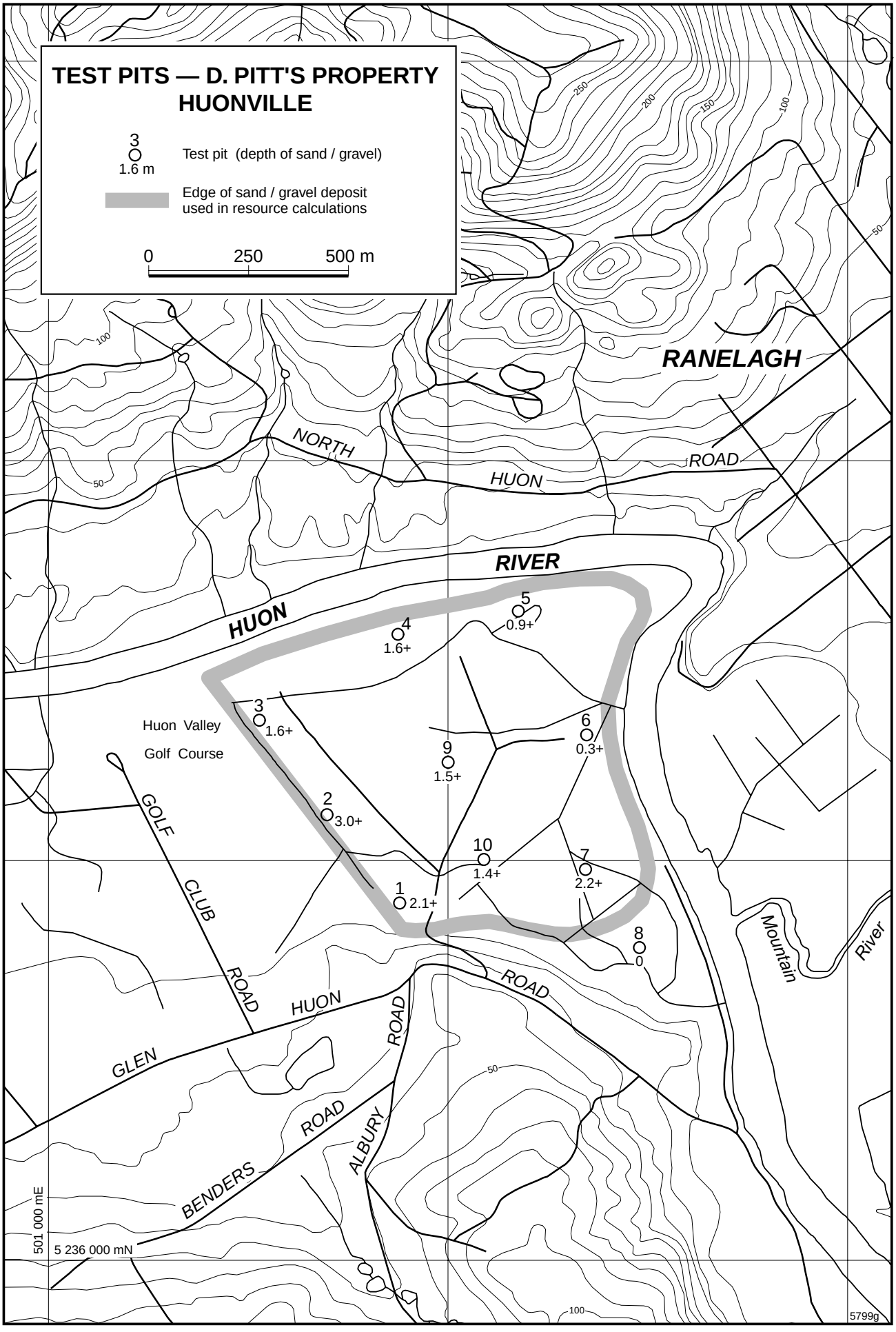
TEST PITS — D. PITT'S PROPERTY
HUONVILLE
3
1.6 m
Test pit (depth of sand / gravel)
Edge of sand / gravel deposit
used in resource calculations
0
250
500 m
RANELAGH
NORTH
HUON
ROAD
RIVER
HUON
Huon Valley
Golf Course
GOLF
CLUB
ROAD
HUON
ROAD
ROAD
GLEN
ROAD
ALBURY
BENDERS
Mountain
River
1 2.1+
2 3.0+
3 1.6+
4 1.6+
5 0.9+
6 0.3+
7 2.2+
8 0
9 1.5+
10 1.4+
501 000 mE
5 236 000 mN
5799g

Figure 11

Cradoc

Seven test pits were dug in this area (fig. 12). No significant resources that would require no treatment were located, although isolated pockets of useable material have been utilised in the past and similar zones probably remain unused at some locations.

Pits 1 and 2 along Harrisons Road encountered brown sandy clay and clayey sand to the depth dug (about three metres in each case). Towards the base the material in each pit contained bivalve shells about 25 millimetres and less across. Test pit 3 struck some sand, clayey sand and a thin layer of sandy gravel (siliceous) before going into bedrock (Permian). Pits 4, 5 and 6 passed through gravelly clay and clayey gravel for most of their depth and as with pit 3 were located on the lower undulating land adjacent to the river. They contained a considerable proportion of coarse fragments (rounded quartzite boulders up to 30 mm across). Pit 7 was in an elevated position near where a small gravel pit had been developed. Gravelly material extended to about 1.7 metres with clayey sand at lower levels.

Because of the doubt about the useable nature of the material in the area, no indicated resources have been calculated. Washing, grading and/or crushing could yield considerable amounts of material but with more easily and cheaply produced material available, it is unlikely to be developed in the short to medium term. Small pockets of reasonably clean siliceous sand and gravel may be developed by small producers.

Logs of test pits, Cradoc

Pit 1 (Harrisons Road- near western end)

0.0–0.3	Dark brown grey sandy clay soil, roots
0.3–2.8	Brownish grey sandy clay, clayey sand, some sand-rich zones. Bivalve shells in material from about 2 metres, common at base

Pit 2 (Harrisons Road)

0.0–0.3	Dark grey sandy soil, roots
0.3–2.0	Grey and brown sandy clay, clay, some sand-rich areas
2.0–3.0	Brown sandy clay with shells

Pit 3

0.0–0.5	Dark brownish grey sandy soil
0.5–1.1	Light brown sand, fairly loose
1.1–1.5	Dark grey clayey sand
1.5–1.7	Gravelly sandy layer
1.7–2.5	Light blue clay, sandy clay
2.5–2.6	Weathered mudstone bedrock on one side of pit

Water seeping in through upper section (sandy zones) 400 µS/cm.

Pit 4

0.0–0.8	White gravelly sand, large quartzite boulders
0.8–4.2	Brown and grey clayey gravel mainly large quartzite boulders. More boulders in section from 0.8–2.5 metres

Water seeping in from about three metres –5000 µS/cm.

Pit 5

0.0–0.3	Dark grey brown sandy and gravelly soil
0.3–1.0	Brown sandy gravel, variable depth
1.0–2.5	Brown gravelly clay coarse rounded quartzite fragments up to 300 mm, many greater than 100 mm in diameter
2.5–4.2	Grey gravelly clay, with large boulders. Bedrock on the east side of pit

Pit 6

0.0–0.2	Grey sandy gravelly soil
0.2–0.8	Grey gravelly sand, sandy gravel, quartzite pebbles up to 70–80 mm
0.8–2.8	Brown clayey gravel mainly larger boulders
0.8–3.6	Grey blue clayey gravel, larger boulders up to 200 mm across predominate

Slow seepage near base.

Pit 7 (began a little below natural surface)

0.0–0.4	White consolidated quartzite gravel in a fine-grained matrix
0.4–0.7	Clayey sandy gravel
1.7–1.9	Dark brown-black organic-rich sand
1.9–2.7	Light brown clayey sand
2.7–3.3	Light grey to brown sandy clay

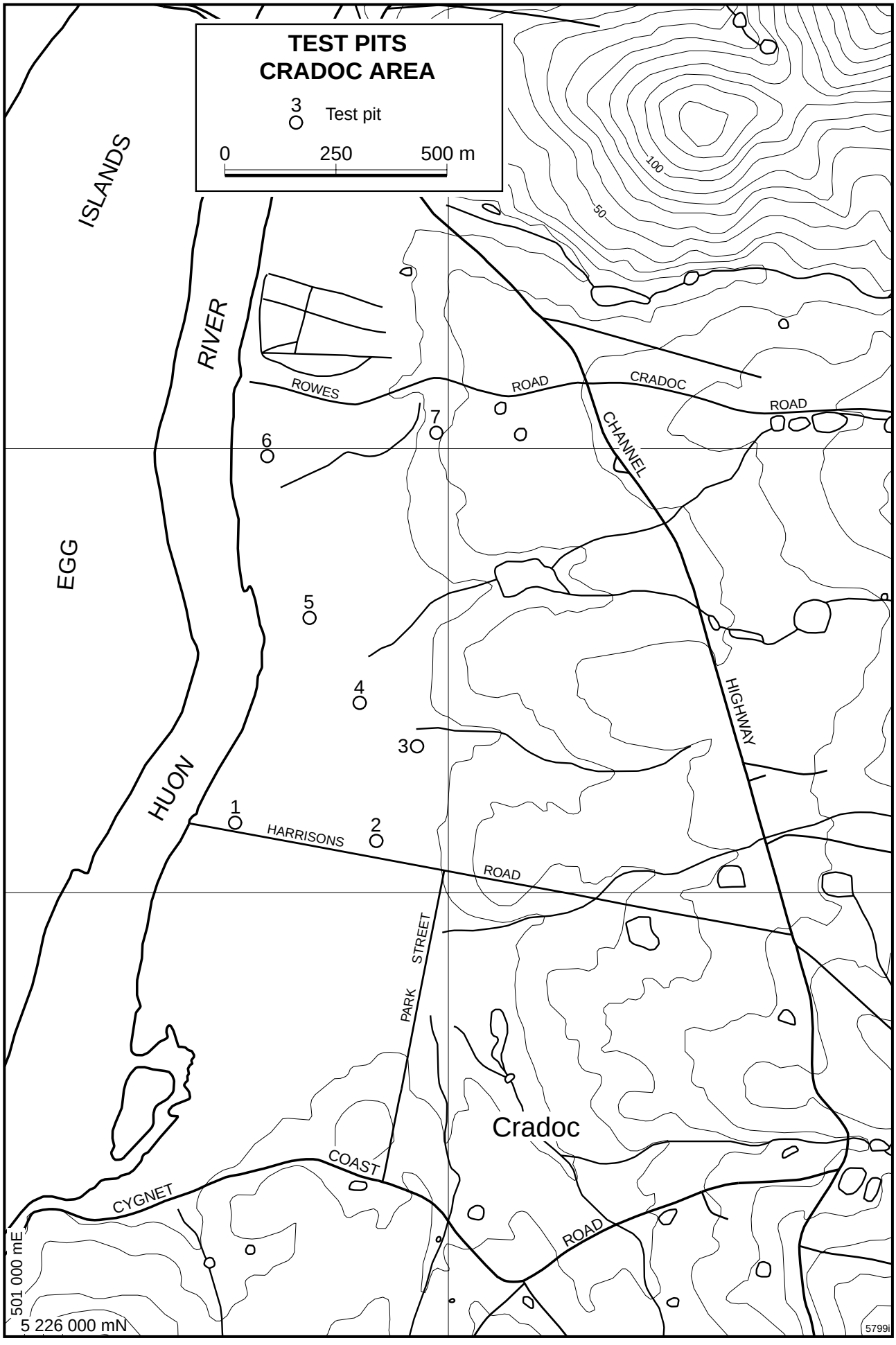
TEST PITS
CRADOC AREA
3 Test pit
0 250 500 m
ISLANDS
RIVER
EGG
HUON
ROWES
ROAD
CRADOC
ROAD
CHANNEL
HIGHWAY
HARRISONS
ROAD
PARK STREET
Cradoc
COAST
CYGNET
ROAD
100
50
1
2
3
4
5
6
7
501 000 mE
5 226 000 mN
5799i

Figure 12

PITT WATER AREA SAND RESOURCES

Drilling to determine shallow groundwater resources on the property *Milford* and surrounding areas (Cromer, 1980) resulted in a report with attached logs showing the lithology for various locations. Many of these holes encountered sand at the surface overlying a sequence of clayey sand, sand, clay and sandy clay beds. Sand at the surface or near the surface could be readily extracted.

The drilling (fig. 13) shows a section adjacent to the Tasman Highway as having the most significant and continuous near-surface sand. Sand occurs in the other parts tested but is less continuous. Of particular note is nine metres of sand in a hole on Pitt Water Road near the southern boundary of Milford Farm and just outside the Seven Mile Beach Protected Area. Sand beds also occur at deeper levels under clayey sand and clay layers but have not been considered for the indication of resource calculations below.

The boreholes in the area outlined (800 000 square metres) have an average of about 2.6 metres of surface sand which is about two million cubic metres of near-surface sand as an indicated resource. More resources are present at deeper levels and outside the selected area to the south.

The description of the sand suggests that it is mainly very fine to fine grained with small pockets of coarser sand.

The area is outside the protected area of Seven Mile Beach and as a result has potential for use as a sand source.

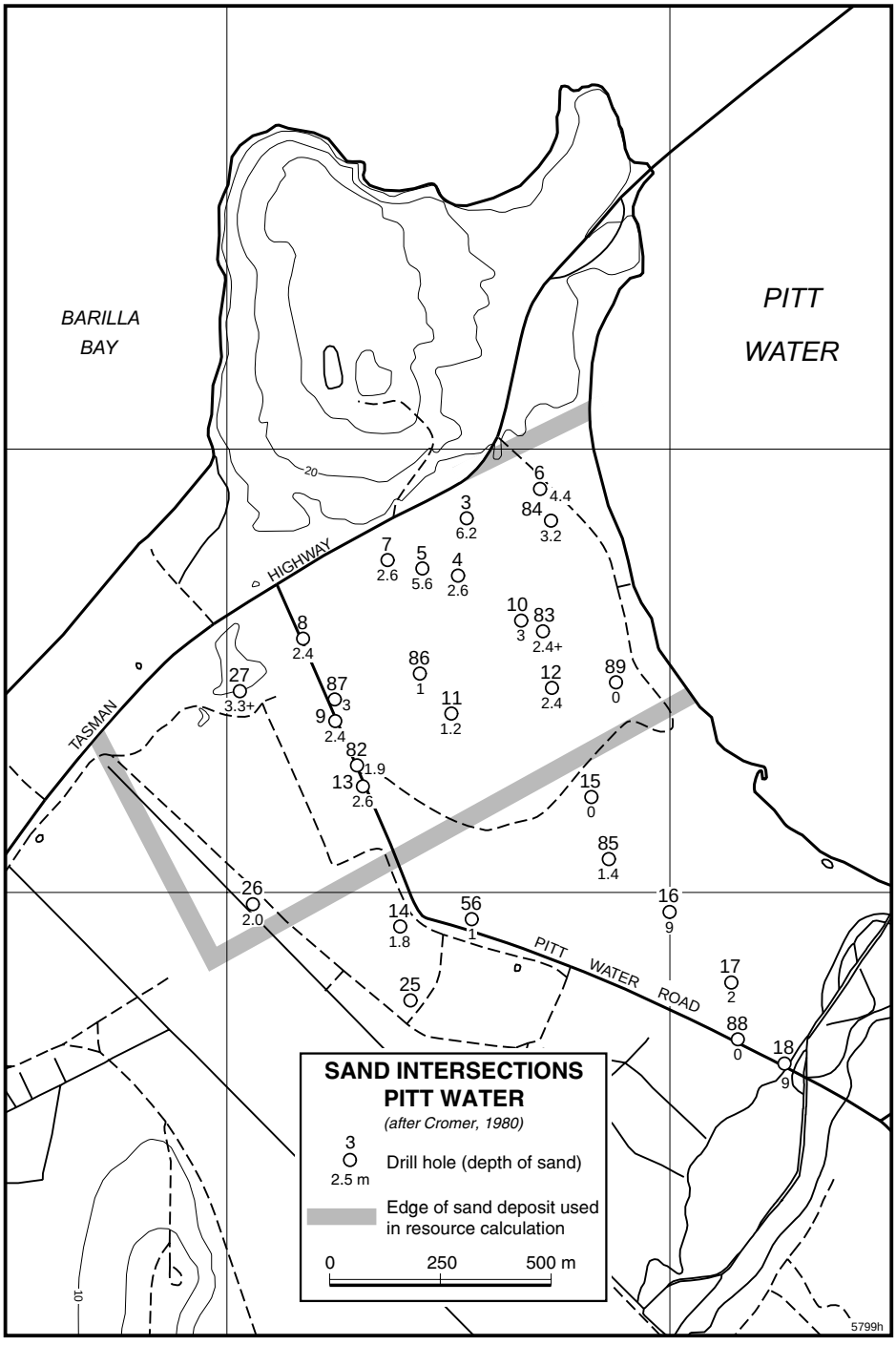

Figure 13

BUCKLAND AREA

A large area of Triassic age rocks occur at Buckland (fig. 14) and there is little doubt that significant deposits of sand are associated with these rocks. Quartz sandstone appears to be a dominant lithological unit throughout the area and sand will accumulate as a result of weathering, transport and redeposition by wind and water.

Small amounts of sand have been extracted from a few areas. Two other areas (fig. 15, 16) were investigated with test pitting to obtain indications of resources. Sand has not been extracted from either of these areas to date. Figure 14 shows the location of these areas together with two areas where it is known sand has been extracted previously. Other areas of extraction occur north of the area covered by the plan.

Sand River (north of Buckland)

In this area Sand River has cut down through previously deposited sand and clayey sand sediments. Seventeen test pits were dug on two properties. Additional sand resources are likely to be present in areas adjacent to that investigated, particularly downstream and to the west.

The test pits in the investigated area had relatively clay-free sand near the surface, but contained varying amounts of clay with depth. Pits 4, 6 and 7 had sand with relatively small amounts of clay over their total depths of 4.3–5.0 metres.

Test pits were dug over an area of about 1.4 square kilometres. An average depth of about two metres of sand and clayey sand was obtained in each pit (excluding pit 5, which was dug near outcropping sandstone on a small hill and pit 11 on the margin of the valley). Resources of about four million cubic metres of sand and clayey sand are indicated for the area investigated, of which about 25–30% is likely to be largely clay free. Further investigations in the general area are likely to increase the indicated resources significantly. Greater depths of sand are likely in the vicinity of pits 4, 6 and 7, and perhaps near some of the other pits.

Samples collected from the pits show a somewhat variable average grain size. The largest sand fraction obtained was +0.075–0.150 mm for many of the near-surface clay free zones. Significant proportions of samples taken from lower levels in the pits were coarser, in the range of +0.212 and +0.300–0.600 millimetres.

Logs of test pits

Pit 1

0.0–0.2	Dark grey sandy soil, roots
0.2–0.8	Loose quartz sand
0.8–2.5	Light brown and grey mottled clayey sand, sandy clay
2.5–3.0	Very light brown fine sand
3.0–3.8	Brown and grey mottled clayey sand, sandy clay

Samples: 0.2–0.8 m, 0.8–2.5 m, 2.5–3 m, 3–3.6 m

Pit 2

0.0–0.2	Dark grey sandy soil, roots
0.2–0.9	Grey sand, loose
0.9–3.2	Brown and grey clayey sand
3.2–4.0	Light coloured (almost white) gravel and sand (boulders of sandstone, rounded, up to 100 mm across)

Pit 3

0.0–0.2	Sandy soil, roots
0.2–0.6	Brown sand
0.6–3.7	Brown and grey mottled clayey sand and sandy clay, thin layer of sand stone boulders at 1.6 metres

Sample: 1.5–3.5 m

Pit 4

0.0–0.2	Mid grey sandy soil, roots
0.2–1.2	Grey and brown sand
1.2–1.4	Brown clayey sand
1.4–4.8	Brown sand, loose, some clay
4.8–5.0	Grey sand, some clay

Samples: 1–4.5 m, 5 m

Pit 5

0.0–0.3	Dark grey sandy soil, roots
0.3–0.6	Grey sand
0.6–1.2	Brown sandy clay

Samples: 0.3–0.6 m

Pit 6

0.0–0.2	Dark grey sandy soil, roots
0.2–0.8	Light brown sand, loose
0.8–3.0	Brown sand, a little clay
3.0–4.3	Light brown and grey sand, slightly consolidated

Sample: 0.5–4 m, 4.3 m

Pit 7

0.0–0.2	Dark grey sandy soil, roots
0.2–0.8	Brown sand, loose, some roots
0.8–1.5	Brown clayey sand, blocky fracture
1.5–4.6	Brown sand, a little clay, clayey sand layer about 3.8–4.1

Sample: 0.5–4 m, 4.6 m
Water came in at base of hole -200 µS/cm.

Pit 8

0.0–0.2	Grey sandy soil, roots
0.2–1.0	Light brown sand, loose
1.0–2.8	Brown and grey clayey sand, more sand in section 1–2 metres, then more clayey
2.8–3.0	Grey and brown sandy clay, clay
3.0–4.3	Brown and grey sandy clay, clay layer at 3.9 m

Samples: 0.2–1 m, 1–2.8 m

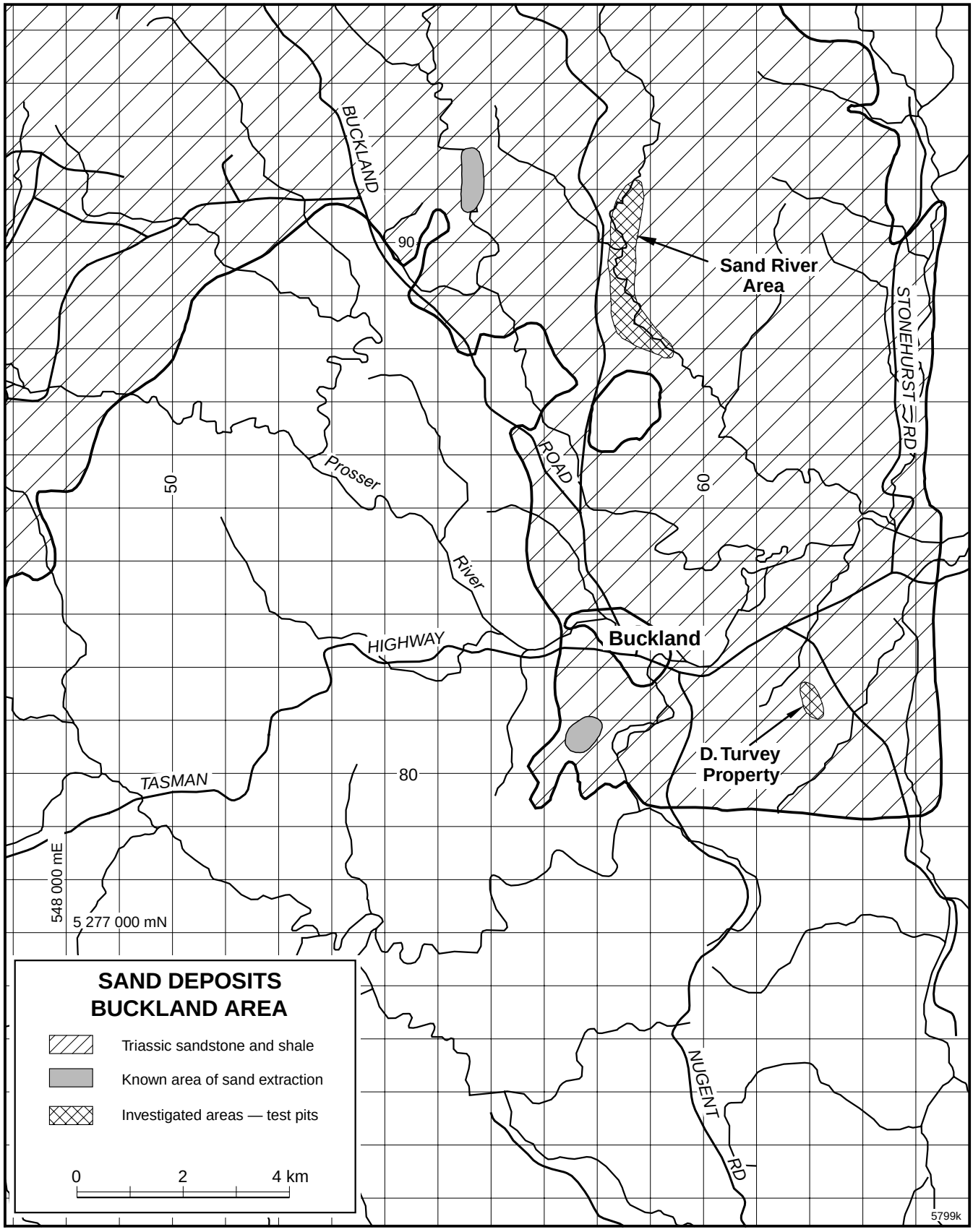
BUCKLAND
90
Sand River
Area
STONEHURST RD
ROAD
Prosser
River
50
60
HIGHWAY
Buckland
D. Turvey
Property
TASMAN
80
548 000 mE
5 277 000 mN
SAND DEPOSITS
BUCKLAND AREA
Triassic sandstone and shale
Known area of sand extraction
Investigated areas — test pits
0
2
4 km
NUGENT RD
5799k

Figure 14

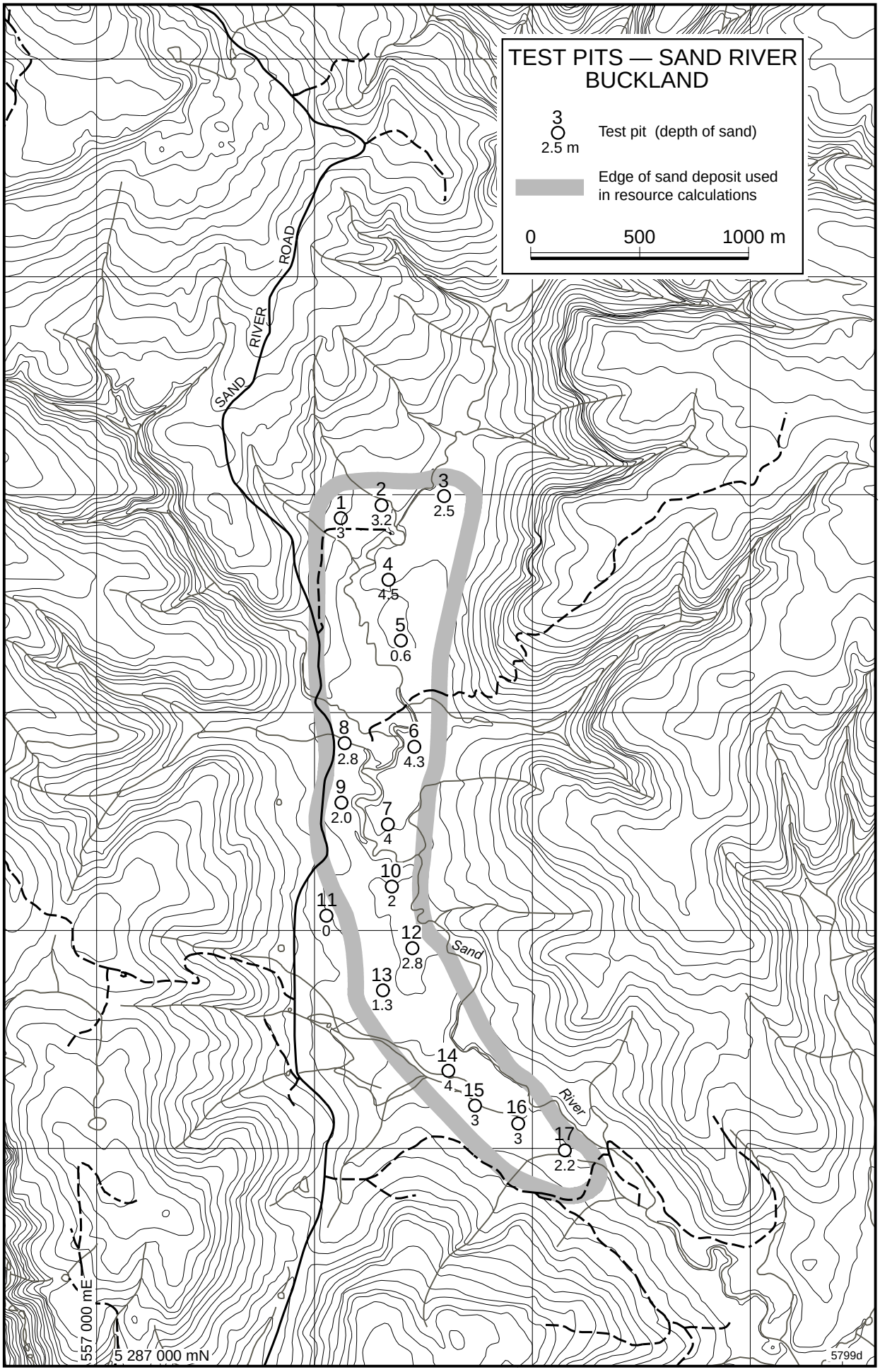
TEST PITS — SAND RIVER
BUCKLAND
3
2.5 m
Test pit (depth of sand)
Edge of sand deposit used in resource calculations
0
500
1000 m
SAND RIVER ROAD
Sand River
1
3
2
3.2
3
2.5
4
4.5
5
0.6
6
4.3
7
4
8
2.8
9
2.0
10
2
11
0
12
2.8
13
1.3
14
4
15
3
16
3
17
2.2
557 000 mE
5 287 000 mN
5799d

Figure 15

Pit 9

0.0–0.25	Dark grey sandy soil
0.25–1.2	Light brown sand, loose
1.2–1.7	Clayey sand, sandy clay
1.7–2.4	Grey and brown clayey sand

Samples: 0.2–1 m, 1.7–2.3 m

Pit 10

0.0–0.2	Dark grey soil, roots
0.2–1.0	Light brown and grey sandy clay, clayey sand
1.0–2.5	Brown and grey sandy clay, clayey sand
2.5–3.1	Brown and grey sand
3.1–	Rock (Triassic sandstone ?)

Samples: 0.2–1 m, 2.5–3.1 m

Pit 11

Soil, then clay to 0.5 metres.

Pit 12

0.0–0.3	Brownish grey silty soil , roots
0.3–0.6	Brown plastic clay
0.6–1.8	Light brown loose sand
1.8–2.4	Bluish clay
2.4–4.0	Brown and grey clayey sand

Samples: 0.6–1.8 m, 2.4–4 m

Pit 13

0.0–0.2	Dark grey sandy soil, roots
0.2–0.6	Grey sand, loose
0.6–0.8	Dark brown organic rich sand
0.8–1.9	Grey and brown mottled clay
1.9–2.5	Grey and brown clayey sand, becoming more clay rich with depth

Samples: 0.2–0.6 m, 0.8–1.9 m

Pit 14

0.0–0.2	Grey sandy soil, roots
0.2–1.2	Brown sand, loose
1.2–1.4	Dark brownish grey clay
1.4–3.3	Light brown and grey sand, a little clay
3.3–4.3	Clayey sand

Samples: 0.2–1.2 m, 2–4 m

Pit 15

0.0–0.1	Grey sandy soil, roots
0.1–0.8	Brown sand, loose
0.8–1.1	Brown sand
1.1–1.4	Clay and sandy clay
1.4–1.6	Grey sand, loose
1.6–3.2	Brown and grey clayey sand
3.2–3.7	Clayey sand, clay content increased

Samples: 0.1–1.1 m, 1.6–3.2 m

Pit 16

0.0–0.2	Dark grey sandy soil, roots
0.2–1.2	Loose brown sand
1.2–2.5	Brown and grey clay, clayey sand
2.5–4.3	Clayey sand

Samples: 0.2–1.2 m, 2.5–4 m

Pit 17

0.0–0.2	Dark grey sandy soil
0.2–1.2	Brown sand, loose
1.2–1.8	Clay and sandy clay
1.8–2.8	Clayey sand
2.8–3.1	Sandy clay

Samples: 0.2–1.2 m, 1.2–2.8 m

Derek Turvey's property (east of Buckland)

This property, some three kilometres east of Buckland (fig. 16), has east-facing slopes on which sand has accumulated. The area where test pits were dug is relatively small, being about 0.35 square kilometres. Depth of sand was variable, with the thickest zones being located on the southeast side of east-trending ridges.

Taking an average depth of sand over the whole are of about 1.5 metres, indicated resources are about 500 000 cubic metres of sand of which about 25–30% is largely clay-free near-surface sand. If only the zones where the thicker sand accumulations are considered (in pits 5, 6, 7, 10 and 11), where an average depth of about 2.25 metres of sand occurs, some 330 000 cubic metres of sand and clayey sand are indicated. Further resources could be established in areas around the zone tested.

Sand size is variable with the +0.212–0.300 mm fraction often being the largest. Near-surface clay-free sand sometimes has the largest fraction in the +0.075–0.150 mm range.

Logs of test pits

Pit 1

0.0–0.2	Brown sandy soil, roots
0.2–0.6	Brown sand, minor clay
0.6–0.8	Clayey sand
0.8–	Hard band (possibly bedrock–Triassic)

Pit 2

0.0–0.2	Grey sandy soil, roots
0.2–0.5	Light grey brown sand
0.5–0.9	Brown cemented sand — organic and/or iron rich
0.9–1.3	Brown and grey clayey sand
1.3–1.5	Brown sandy clay

Pit 3

0.0–0.3	Dark grey sandy soil
0.3–0.9	Light grey brown sand
0.9–1.2	Brown to dark brown cemented sand (organic cement ?) variable thickness
1.2–1.4	Brown clayey sand
1.4–1.6	Light brown sandy clay

Pit 4

0.0–0.3	Dark grey sandy soil, roots
0.3–0.9	Light grey changing to dark grey, loose sand
0.9–1.1	Dark brown organic rich cemented sand
1.1–1.5	Brown and grey clayey sand
1.5–1.9	Brown sandy clay

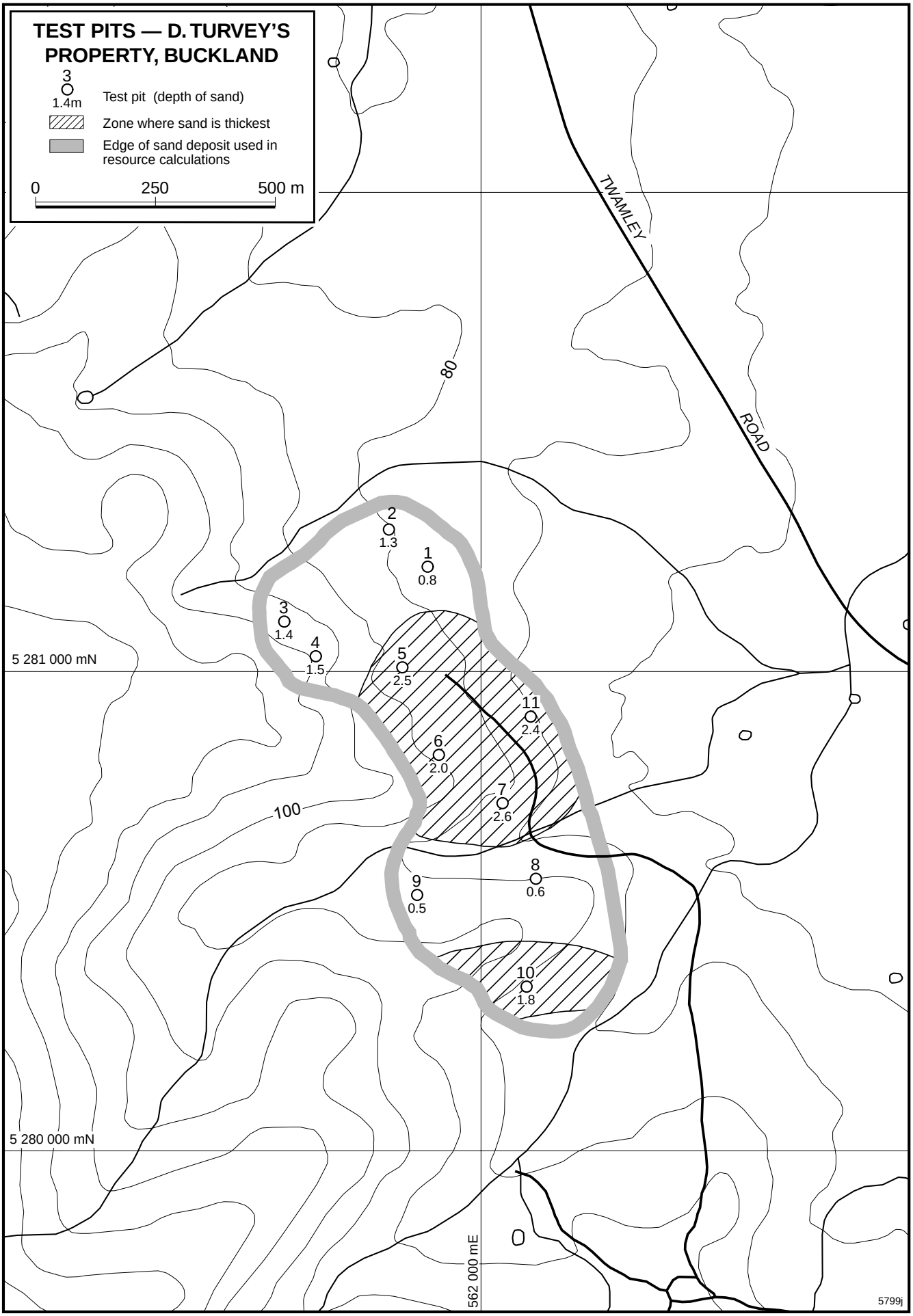
TEST PITS — D. TURVEY'S PROPERTY, BUCKLAND
3
1.4m
Test pit (depth of sand)
Zone where sand is thickest
Edge of sand deposit used in resource calculations
0
250
500 m
TWAMLEY ROAD
80
100
2
1.3
1
0.8
3
1.4
4
1.5
5
2.5
11
2.4
6
2.0
7
2.6
8
0.6
9
0.5
10
1.8
5 281 000 mN
5 280 000 mN
562 000 mE
5799j

Figure 16

Pit 5

0.0–0.3	Dark grey sandy soil, roots
0.3–1.3	Brown sand, loose
1.3–1.7	Brown cemented sand, friable
1.7–2.3	White sand, loose
2.3–2.5	Light brown and grey clayey sand

Pit 6

0.0–0.3	Grey sandy soil, roots
0.3–1.3	Light brownish grey sand, loose
1.3–2.0	Darker brownish grey sand, variably cemented, some roots
2.0–2.2	Grey brown sandy clay

Small surface at 2.1 metres.

Pit 7

0.0–0.4	Brown sandy soil, roots
0.4–2.6	Light brown sand, loose, localised harder zones at two metres

Pit 8

0.0–0.2	Brown sandy soil, roots
0.2–0.6	Brown sand, loose
0.6–0.75	Brown sandy clay

Pit 9

0.0–0.2	Brown sandy soil, roots
0.2–0.5	Loose brown sand
0.5–0.7	Grey and brown sandy clay
0.7+	Hard, sandstone fragments (Triassic bedrock?)

Pit 10

0.0–0.3	Light grey sandy soil, roots
0.3–1.0	Brown sand, loose
1.0–1.8	Brown sand, variably cemented
1.8–2.0	Blue grey clay, sandy clay

Pit 11

0.0–0.3	Grey sandy soil, roots
0.3–1.2	Light grey brown sand, loose
1.2–1.5	Dark brown grey sand, variably cemented
1.5–2.4	Light grey and brownish sand, a little clay in some zones

Seepage coming at 1.8 metres.

BROWN MOUNTAIN ROAD

Four auger holes were drilled in part of the area near Brown Mountain Road, adjacent to an area where test pits were dug in and around a previously operated pit.

Three of the pits (2, 3 and 4) encountered 0.7–1 metre of loose sharp sand at the surface, while two (2 and 3) had sand with only a minor clay content to 1.5 metres. Clayey sand occurs at deeper levels. An average of some 2.3 metres depth of sand and clayey sand was indicated from the auger holes. The area of some 80 000 square metres would therefore have some 180 000 cubic metres of sand and clayey sand.

Augered holes with Triefus drill rig

Hole 1

0–1	Brown clayey sand
1–2	Brownish grey clayey sand, sandy clay becoming hard to drill

Hole 2

0.0–1.0	White to light grey sand, loose, changing to brown coloured at end
1.0–1.5	Dark brown sand with a little clay for 0.2 m, followed by 0.3 m of lighter brown sand
1.5–3.5	Brown and grey clayey sand

Hole 3

0.0–0.2	Dark grey sandy soil
0.2–0.8	Light grey sand, loose
0.8–1.5	Brown sand, minor clay
1.5–2.5	Brown clayey sand

Hole 4 (about 50 m north of some sandstone boulders)

0.0–0.2	Dark grey sandy soil
0.2–0.7	Grey and brown sand, loose
0.7–1.5	Brown clayey sand
1.5–2.1	Brown sandy clay, clayey sand.

FLEXMORE PARK, PENNA

The part of the property where test pits were dug is underlain by Tertiary age sediments, with Pitt Water forming one boundary to the area with rising land underlain by Triassic sandstone and shale on the inland side. The area underlain by Tertiary sediments is relatively flat with some undulations, particularly in the northern part.

Sand deposits are being worked just west of the homestead. The property owner did not want disturbance by test pitting in a zone to the north of the workings. There are obviously significant resources in this area with appreciable volumes of sharp sand present as well.

Ten test pits were dug on the northern part of the property and these were selected in positions low on the landscape. As a result, the pits intersected mainly clayey sand with probably less than average depths for the whole area, of sharp sand. Sharp sand has often accumulated in thicker layers on the southern and eastern side of some of the higher zones.