Tasmania
DEPARTMENT of INFRASTRUCTURE, ENERGY and RESOURCES

Mineral Resources Tasmania
Tasmanian Geological Survey
Record 2003/01

A review of groundwater in Tasmania

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Contents

The occurrence of groundwater in Tasmania

In Tasmania groundwater occurs in a number of aquifer types. It is estimated that approximately 85–90% of Tasmania is underlain by fractured rock aquifers (fig. 1), in which water storage and transportation occurs through fractures in the rock mass. The lithological properties of a number of these aquifers are believed to be causing them to operate as dual porosity aquifers, with a degree of storage occurring within pores in the rock mass and water movement occurring along the fractures.

The remainder of the aquifers (underlying some 10–15% of Tasmania) are those in which water storage and flow occurs through the pores within the aquifer material. These intergranular aquifers are typified by Tertiary and Quaternary sedimentary rocks which occur as localised deposits in certain basins (e.g. Longford), or as discrete bodies of very limited extent along the coast.

The hydrogeological setting of the aquifers varies according to their location and variations in geology. In certain areas, the aquifers behave as confined aquifers, in which the water stored is under pressure. In others, generally typical of the Quaternary and some Tertiary aquifers, the water is stored under unconfined conditions.

The exact nature of the hydrogeological conditions in all aquifers in Tasmania is not completely understood, except in certain areas where detailed study work has been carried out, for example in the Longford Basin (Matthews, 1983), Devonport–Port Sorell Basin (Cromer, 1993), Greens Beach (Cromer, 1979), Cygnet (Leaman, 1967) or Scottsdale Basin (Moore, 1990, 1992).

Recent work by Mineral Resources Tasmania has included a hydrogeological study of the Sorell area (Latinovic, 2000*a*, *b*); a study of the groundwater resources of the Northern Midlands and Fingal Valley regions (Taylor, 2000); a study of the hydrogeological setting of areas subject to soil salinity (Dell, 2000); and groundwater catchment mapping of the Great Forester (Latinovic, 2001) and Meander (Latinovic, 2003) catchments.

A 1:500 000 scale *Groundwater Prospectivity Map of Tasmania* was published in 1999. This map has been subsequently updated to incorporate the results of the more recent studies.

The availability of groundwater in Tasmania is influenced by the aquifer properties (particularly lateral and vertical variations in permeability and porosity), hydrogeological conditions, and the proximity to recharge areas, as well as the amount of recharge occurring. The total estimated sustainable availability of groundwater in all of Tasmania's aquifers is between 0.5×10^6 ML/year (ARMCANZ, 1995) and 2.5×10^6 ML/year (Sinclair Knight Merz, 2000).

The prospectivity and yield of Tasmania's aquifers, listed by geological formation, are indicated in Table 1. It should be noted that high prospectivity is not necessarily linked to high yield, and that there are none of the very high yields observed in parts of mainland Australia. This is due not just to the different geological setting but also to the proximity of Tasmanian groundwater to its recharge areas. Confining conditions (where present) are less marked.

Using the criteria defined under the National Land and Water Resources Audit (NLWRA), the figures in Table 1 indicate that, except in a very small number of cases, yield from an extraction borehole alone is not likely to be sufficient to supply centre pivot irrigation systems. It is only slightly more likely that a borehole would provide sufficient yield to act as a sustainable supply to augment a dammed reservoir supply for centre pivot systems.

The yields obtainable from boreholes make them most suitable to supply dairy, stock, domestic or other rural uses. These are generally what most groundwater boreholes in Tasmania are used for at present, except in certain areas (e.g. Wesley Vale, Smithton, Sorell).

There are currently records for over 8000 groundwater boreholes in the MRT groundwater database. These records cover the period from around 1860 until the present (fig. 2).

Reports produced by Mineral Resources Tasmania are available for viewing or downloading on the MRT web site (www.mrt.tas.gov.au). Maps and digital data are available from the Data Management Branch of MRT.

Figure 1

Groundwater prospectivity in Tasmania

[Note: this is a low-resolution image of a 1:500 000 scale map. Printed maps are available from Mineral Resources Tasmania]

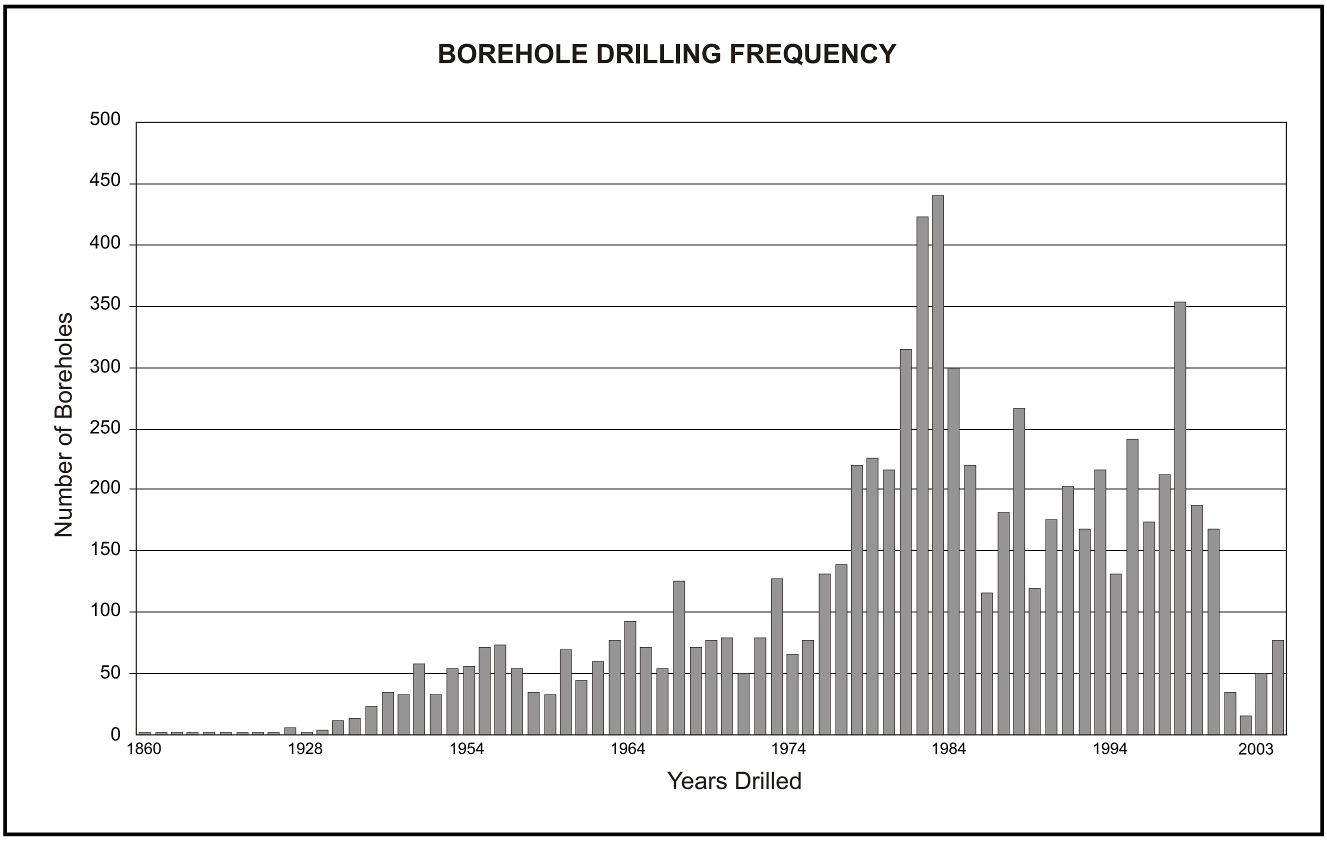
Table 1

Groundwater prospectivity and yields in Tasmania.

Geology	*Aquifer Type*	*Prospectivity*	*Yield Range (L/s)*						
			>0–0.3	0.3–0.8	0.8–1.5	1.5–5	5–10	10–15	>15
Tertiary sedimentary rocks	Intergranular/ dual porosity	Low–high (depends on geology)	24%	30%	10%	30%	5%	1%	-
Tertiary basalt	Fractured	High	18%	32%	20%	18%	8%	2%	2%
Jurassic dolerite	Fractured	Moderate	37%	28%	15%	15%	2%	1%	1%
Triassic sedimentary rocks	Fractured	Moderate–high (depends on geology)	51%	37%	9%	2%	1%	-	-
Permian sedimentary rocks	Fractured/dual porosity	High	23%	38%	13%	20%	5%	1%	1%
Devonian granite	Fractured	Low	33%	35%	26%	6%	-	-	-
Palaeozoic sedimentary rocks (Mathinna Beds)	Fractured	High	8%	48%	19%	20%	4%	-	1%
Cambrian sedimentary and volcanic rocks	Fractured	High	24%	58%	6%	6%	5%	1%	-
Precambrian dolomite with karst features	Fractured	High	20%	46%	10%	18%	3%	3%	-
Other Precambrian sedimentary and metamorphic rocks	Fractured	Moderate	24%	40%	15%	16%	2%	2%	1%

Notes:

1. Prospectivity in this context is the chance of encountering groundwater in a borehole, with a yield greater than 0.05 L/s.
2. Tertiary sedimentary rocks containing thick clay units tend to have low prospectivity; those with thick sand and gravel units tend to have high prospectivity.
3. The Upper Triassic sedimentary formations tend to have moderate prospectivity and Lower Triassic sedimentary formations high prospectivity.
4. Jurassic dolerite in high rainfall areas produces good quality water with yields up to 5 L/s.
5. Values calculated on data to year 2000.



Groundwater Prospectivity

Groundwater prospectivity is largely dependent on the aquifer type and geology and is usually directly related to rainfall. Sometimes local conditions affect the quantity or quality of water available in a rock type that may, in other areas, be more prospective. The following notes relate to the information provided in this section.

- Statistics provided are based on boreholes entered in the MRT groundwater database (BORIS) by February 2003. Boreholes shown on the *Groundwater Prospectivity Map of Tasmania* (fig. 1) are those with known co-ordinates, mainly supplied by drillers and from location in the field.
- Boreholes with yields greater than 0.03 litres/second have been considered as successful bores. Yield-related statistics (average, maximum yield and percent irrigation successful) are based on successful bores. Outputs of bores are those supplied by drillers and are mostly the result of short-term pumping measurements. Some bores have been successful but outputs have not been reported. These bores are included in the total number of bores but have not been used for other statistical calculations. Boreholes reported as dry holes usually have small unreported yields (<0.05 L/s).
- Successful bores with yields greater than 1.5 litres/second are used for irrigation purposes in Tasmania.
- Many spear bores have been installed for investigation and production purposes in coastal sand deposits in Tasmania. These bores have yet to be entered in the groundwater database but salinity ranges for some Quaternary aquifers in southeast Tasmania have been obtained from these borehole records and included into the table (results marked with *).
- Small elevated areas of any hydrogeological unit will usually have lower prospectivity because of limited storage and drainage.

Quaternary

Aeolian sand deposits, consisting of fine to medium-grained sand, marginal to the coast

Prospectivity: High

Vulnerability to pollution: High

These aquifers are contained in surface deposits of limited thickness — up to a maximum of about 10–15 metres but usually less. The groundwater yield depends on the grain size and thickness of the saturated sand, with yields decreasing as the clay content of the sand increases. Groundwater is often extracted from these aquifers using spear bores installed to depths of up to 7 to 8 metres. A single spear in a prospective area may yield 0.5–1.0 L/s or more (sufficient for domestic use, gardens or stock). A nest of 10 to 20 spears using a central pump may yield small irrigation quantities (5–15 L/s).

Quality is often good enough for the water to be used for a wide range of purposes. Major resources occur in sand deposits behind Nine Mile Beach (Swansea) (Cromer, 2003) and at Seven Mile Beach. Significant resources occur at other locations, for example Safety Cove, South Arm peninsula, on Bruny Island and in the Ocean Beach dunes west of Strahan.

Significant extraction from these deposits takes place at Currie on King Island, where the town supply comes from dune sand, and at Stanley where the golf club installed an extraction system to water the course. Other areas, including Woolnorth, Stanley, Arthur River and Peggs Beach, have proved to have potential for useful supplies.

Aquifers are mostly unconfined.

Area	*NW*	*NE*	*SE*
Number of bores[1]	1	5	20
Percent successful (yield >0.03 L/s)	100	100	75
Average yield (L/s)	0.13 (1)[2]	-	0.52 (12)[2]
Maximum yield (L/s)	0.13	-	3.78
Percent irrigation successful (≥1.5 L/s)	0	-	8.3
Salinity range (mg/L)	-	-	210–5000*

1. Many spear bores have been drilled or installed in coastal sand but are not currently entered in the MRT groundwater database.

2. Yield is the average result from the number of samples shown in brackets.

Coastal plain deposits consisting of sand, clayey sand, gravel and shelly deposits underlying areas near the coast; probable marine origin

Prospectivity: Moderate to high

Vulnerability to pollution: Moderate to high

These aquifers are contained in surface deposits of limited thickness, with yields depending on grain size, clay content and saturated thickness. There are few known high-yielding zones in southeast Tasmania but it is often possible to extract small quantities of groundwater using spear bores, for example on the South Arm peninsula. In other areas of Tasmania coarse sand and fine-grained gravel deposits (such as near Lady Barron on Flinders Island) may yield up to 2–3 L/s from a single spear bore. In a number of situations a single spear could yield domestic and stock supplies in the more prospective locations, and a nest of several would be capable of supplying small irrigation quantities.

Yields from a spear can be reduced to 0.1 L/s or less where the aquifer materials have a small clay content. In such cases large volume excavations into the aquifer may be the most effective means of utilising the groundwater if irrigation quantities are required. In many parts of northeast Tasmania these deposits contain varying amounts of clay. Some high yielding bores have been established around the coastline near Devonport and Burnie where some coarser sediments occur.

Water quality is variable and salt content may limit uses in some areas of southeast Tasmania. In the northeast quality is variable but the groundwater can often be used for a wide range of purposes.

In the northwest coastal influences sometimes appear to cause a slight increase in salinity in near-coastal bores compared to bores in areas more remote from the coastline. Extensive areas of these deposits occur near Smithton and on King Island.

Aquifers are unconfined to semi-confined.

Area	*NW*	*NE*	*SE*
Number of bores	54	101	46
Percent successful (yield >0.03 L/s)	51.9	86.1	43.5
Average yield (L/s)	2.19 (24)	0.61 (61)	0.31 (17)
Maximum yield (L/s)	15.2	6.33	0.63
Percent irrigation successful (≥1.5 L/s)	33.3	6.6	-
Salinity range (mg/L)	-	3210	1840–11 200*

Alluvium (clay, sand and gravel with varying clay content), talus and till deposits

Prospectivity: Low to moderate

Vulnerability to pollution: Low to high

These aquifers are contained in surface deposits of limited thickness.

Yields in alluvium are variable and often low because of the relatively high clay content of the sediments. Where the sediments are coarse grained and free of clay, yields can be appreciable, for example at Melrose Road, Tunbridge (where the reported output of a bore is 5.1 L/s), near Pyengana and east of Ringarooma, and near Railton.

Talus often occurs in elevated locations on the side of steep slopes and prospects of appreciable quantities of groundwater in such situations are usually poor.

The prospects of obtaining groundwater from underlying materials in areas where these units are present are often good. Many successful bores penetrate these surface deposits and obtain water from underlying rocks. The underlying rock will often be that which surrounds these deposits at the surface.

Water quality is variable but is usually good in high rainfall areas and in the vicinity of streams.

Aquifers are confined to unconfined.

Area	*NW*	*NE*	*SE*
Number of bores	40	25	34
Percent successful (yield >0.03 L/s)	35.0	96	61.8
Average yield (L/s)	2.06 (14)	1.26 (24)	0.77 (18)
Maximum yield (L/s)	7.6	4.55	5.05
Percent irrigation successful (≥1.5 L/s)	42.9	33.3	5.5
Salinity range (mg/L)	-	2160	210–8290*

Tertiary

Sedimentary rocks: clay, sand and gravel of non-marine origin (lacustrine alluvial deposits); variable thickness up to several hundred metres

Prospectivity: Low to high

Vulnerability to pollution: Low to high

Tertiary sedimentary rocks extend throughout much of the Launceston Tertiary Basin (Longford and Tamar sub-basins) in the north, Scottsdale in the northeast, and in the Coal River Valley region in the southeast, where prospectivity is high and groundwater is stored in fine to medium-grained sand, coarse sand and gravel. The high average yield of successful bores reflects the results achieved in the Campbell Town–Epping Forest and Devonport–Sheffield areas.

Aquifers in the Longford and Tamar regions are usually of fine to medium-grained sand, although occasional thin gravel zones occur. Fine gravel (quartz derived mainly from granite weathering) occurs in zones of varying thickness around Scottsdale and Cleveland, with some coarser quartz gravel occurring on some horizons. High yields of 10–15 L/s have been pumped from these aquifers, with the potential to pump much higher amounts in some cases where thick sand/gravel zones have been drilled. Some of the better aquifers occur in deep leads and old buried river channels. Lower yields are obtained where the clay content of the aquifers increases and where the aquifers are thinner. Yields in the better areas allow a range of uses from domestic and stock to irrigation.

Tertiary sedimentary rocks are exposed at the surface in the Devonport–Sheffield region, but they occur under surface horizons in many areas interbedded with and underlying basalt. Tertiary limestone occurs at the surface or underlying basalt in the Redpa–Woolnorth area.

The Tertiary rocks in the Port Sorell–Thirlstane area are often more clay rich, and the potential for groundwater resources is lower than in the above areas. This particularly applies to areas where the deposits are of limited extent.

Smaller areas of Tertiary sedimentary rocks have provided very mixed results from water boring operations. Areas with particularly low prospectivities include Penna, Cranbrook (where 11 bores failed to obtain useful water in clay sediments to 200 metres depth) and Little Swanport (four bores obtained no useful supplies in clay sediments).

In most cases success rates are moderate to high where these materials have been drilled. As they are usually unconsolidated, care needs to be taken by drillers to stabilise these aquifers with a screen or slotted casing with an appropriate slot size and gravel pack. The development of reliably operating bores in these sedimentary rocks, particularly where the aquifers are fine to medium-grained sand, requires specialist drilling skills (especially in the Longford–Westbury area). Small irrigation supplies have been obtained from a large proportion of the bores where yields have been reported.

Water quality is mainly good in north and northeast Tasmania and the water is usually suitable for all purposes. Water quality in the southeast is more variable and often reaches salinity levels that seriously limit the use of groundwater. Quality is usually poor in the Tamar Valley and in shallow, perched water table aquifers in low rainfall areas. A very saline zone occurs in limestone at Woolnorth.

Aquifers are often confined.

Area	*NW*	*NE*	*SE*
Number of bores	122	452	138
Percent successful (yield >0.03 L/s)	70.5	70.4	52.9
Average yield (L/s)	2.43 (80)	1.96 (282)	1.56 (60)
Maximum yield (L/s)	30.3	15.17	15.17
Percent irrigation successful (≥1.5 L/s)	41	38.3	43.3
Salinity range (mg/L)	65–1000	28–2160	535–5800

Triassic and Permian sedimentary rocks

Triassic quartzose and lithic sandstone, mudstone, minor coal; terrestrial origin

Permian mudstone, siltstone and sandstone (often pebbly), minor limestone, conglomerate; mainly marine origin, minor zones of terrestrial origin

Prospectivity: High

Vulnerability to pollution: High (unless low permeability layer overlies part of the aquifer)

Triassic and Permian rocks in Tasmania are mainly regarded as fractured rock aquifers, although there is likely to be some intergranular storage and flow in the coarser-grained units (sandstone, conglomerate). In most cases, transmission of water to bores is probably through joints, bedding planes and fractures.

These rocks are the most commonly drilled in the southeast and are very prospective. Yields range up to irrigation quantities (up to 25 L/s). The water is used for domestic, garden, stock and irrigation purposes.

The success rate for bores drilled in these rocks in the northwest is particularly high, with a high proportion of high yielding bores (outputs up to almost 20 L/s). Lower-lying areas are usually more favourable for siting bores than elevated areas, such as the slopes of the Great Western Tiers.

Water quality in the southeast is variable and salinity restricts use at many locations. Near-surface small yielding zones often have poorer quality groundwater than deeper, higher yielding zones. High sulphate groundwater occurs in Permian rocks at some locations, for example just north of Tunnack. Triassic rocks at Dodges Ferry are particularly prospective. Elevated and/or steeply sloping areas are likely to be less prospective than lower-lying locations in most cases.

Water quality in northwest Tasmania is almost always very good and a wide range of uses are possible. Aquifers are usually confined to semi-confined. Of particular interest is a zone around Spreyton, where artesian water can be obtained from the base of the Permian (gravel/tillite) at about 120-150 metres.

In elevated locations, such as on the slopes of the Central Plateau, prospectivity is likely to be much lower than in lower-lying locations.

In general aquifers are mainly unconfined to locally confined.

Area	*NW*	*NE*	*SE*
Number of bores	207	279	1787
Percent successful (yield >0.03 L/s)	88.9	83.9	78
Average yield (L/s)	2.35 (175)	2.88 (231)	1.23 (1316)
Maximum yield (L/s)	18.95	25.33	25.3
Percent irrigation successful (≥1.5 L/s)	41.1	33.3	19.1
Salinity range (mg/L)	82–1100	97–6800	116–13 790

Palaeozoic and Neoproterozoic rocks

Ordovician to Devonian turbidite sequence of sandstone and mudstone (Mathinna Beds); Ordovician limestone; Cambrian volcanic and sedimentary rocks; Precambrian dolomite, limestone, siltstone, slate, sandstone, quartzite and conglomerate; Neoproterozoic sedimentary rocks

Prospectivity: High

Vulnerability to pollution: High (unless low permeability layer overlies part of the aquifer)

The success rate of bores in this group of rocks is high, even though there is a wide range of rock types and ages. Yields range from domestic, garden and stock supplies to irrigation outputs (up to 25 L/s). Five bores drilled into limestone in areas south of Deloraine all had yields of greater than 10 L/s.

The Mathinna Beds, occurring throughout much of northeast Tasmania, are one of the more prospective units for groundwater in Tasmania, although thick mudstone beds in the Mathinna Beds are often less prospective.

The Ordovician, Cambrian and Neoproterozoic rocks occur throughout western Tasmania, with isolated occurrences in other parts of Tasmania.

The Ordovician rocks are the least prospective in the northwest region, although yields are high where water has been obtained, with a high proportion of bores giving amounts of >1.5 L/s or small irrigation quantities. Cavitied dolomite in the Smithton–Togari–Redpa area has produced many high-yielding bores.

Precambrian rocks have a lower proportion of bores yielding small irrigation quantities. Yields are up to 25 L/s and the water is used for domestic, garden, stock and irrigation purposes. Rocks outside the agricultural areas (such as the promising Precambrian rocks of the Dazzler Range west of Beaconsfield) are largely untested and little information is available.

Quality is generally very good and a wide range of uses is often possible. Near-coastal areas may have groundwater with slightly higher salinity levels. The Mathinna Beds around Bridport and some other near-coastal regions contain some saline water.

Aquifers are often confined locally.

Area/rock type	*No. of bores*	*Percent successful (>0.03 L/s)*	*Average yield (L/s)*	*Maximum yield (L/s)*	*Percent irrigation successful (≥1.5 L/s)*	*Salinity range (mg/L)*
NW Ordovician sedimentary rocks	21	61.9	4.18 (13)	25.27	53.9	61–820
NW Ordovician limestone	63	57.1	3.92 (30)	12.67	60.0	100–176
NW Cambrian and Neoproterozoic sedimentary rocks	357	85.4	1.85 (272)	25.33	28.7	85–1830
NW dolomite	222	85.1	7.56 (184)	25.27	54.3	250–3700
NW Precambrian mudstone, slate, quartzite	423	83.9	1.48 (335)	17.05	22.4	105–972
Total NW	**1086**	**82.7**	**2.75** (834)	**25.33**	**33.3**	**61–3700**
NE Ordovician to Devonian turbidite sequence including Mathinna Beds	300	88.0	1.48 (239)	30.40	21.8	
NE Ordovician, Cambrian and Precambrian limestone, siltstone, slate, sandstone, quartzite, conglomerate	44	65.9	5.04 (28)	25.30	67.9	64–3330
Total NE	**344**	**85.2**	**2.20** (267)	**30.40**	**26.6**	**64–3330**
SE Ordovician to Devonian turbidite sequence including Mathinna Beds	6	16.7	3.78 (1)	3.78	100	

Tertiary basalt

Prospectivity: High

Vulnerability to pollution: High

The prospectivity for groundwater in basalt is high at most locations, but there are some exceptions. Where known, these areas have been placed in a lower prospectivity group (with Jurassic dolerite).

Storage per unit volume of rock can be greater for basalt than other fractured rock aquifers if the rock is vesicular. As a result of this, and the often intense fracturing, basalt tends to have a greater proportion of higher-yielding bores than other fractured rock aquifers. Small to moderate irrigation quantities are often obtained (up to about 38 L/s) and stock, domestic and garden use is common. Small areas of basalt, or areas where basalt occurs on hill tops, may have low potential as a result of the limited storage in these topographic positions.

Basalt has a widespread occurrence throughout the northwest and there are more bores installed in basalt than in the other rock units in this region. The basalt-derived soil is the dominant soil type on which the more intensive farm production activities take place in Tasmania.

Water yields in northwest Tasmania can be high (up to 25 L/s reported) and the proportion of bores with small irrigation yields is also high. Many of the irrigation bores in the Devonport–Port Sorell area are in basalt. Some localised areas of basalt are less prospective, for example the Moriarty Basalt at Northdown (where the basalt has been weathered to a clay). By contrast the Central Marrawah basalt often has greater storage capacity than other fractured rock aquifers as a result of more extensive and closely-spaced jointing and the presence of widespread vesicularity (gas holes).

The quality of groundwater in basalt is generally very good and a wide range of uses are usually possible. Salinity may increase in lower rainfall areas and near the coastline, and use becomes more restricted. The quality in southeast Tasmania is variable, and moderate to high levels of salinity restrict water use. Where groundwater of poorer quality has been mixed with fresh surface water it has been successfully used for irrigation.

The Campbell Town and Pawleena Road (near Sorell) areas are particularly prospective. Excessive use in these areas could result in restrictions on use being applied because both are low rainfall (and hence low recharge) areas.

Aquifers may be unconfined to locally confined.

Area	*NW*	*NE*	*SE*
Number of bores	1700	557	181
Percent successful (yield >0.03 L/s)	87.2	84.7	81.8
Average yield (L/s)	1.90 (1417)	3.25 (437)	3.25 (140)
Maximum yield (L/s)	25.27	37.83	25.25
Percent irrigation successful (≥1.5 L/s)	32.7	50.3	40.7
Salinity range (mg/L)	80–950	45–2760	560–8390

Jurassic dolerite and lower prospectivity basalt

Prospectivity: Moderate

Vulnerability to pollution: Moderate

Jurassic dolerite is usually less fractured than Tertiary basalt and has a lower prospectivity at most locations.

The proportion of successful bores is lower than in the Permian/Triassic and Tertiary basalt units but the average output of those bores that are successful is relatively high.

Yields of up to about 20 L/s (irrigation quantities) have been obtained and domestic/stock/garden quantities are commonly obtained in successful bores.

Jurassic dolerite is of limited extent in the northwest region and only a few bores have been attempted. The success rate is moderate, as at most other locations in Tasmania. Average output is moderate to low and only one bore has been recorded with small irrigation quantities. Dolerite often has less fracturing than other fractured rock aquifers and fractures can be less open, causing lower permeability and storage capacity.

Quality is variable but is seldom saline enough in the northeast to limit uses markedly. In the northwest quality is likely to be good at most locations. In the southeast quality is variable and salinity is often at levels that restrict use.

Tertiary basalt areas of lower prospectivity include the area north of Scottsdale, where the rock is deeply weathered to clay, and south of Ringarooma where it appears to lack sufficient fracturing or the fractures are very tight. Tertiary basaltic rocks along the River Tamar are often coarse grained, similar to Jurassic dolerite.

The Triassic basalt near St Marys is untested.

Aquifers are usually unconfined to semi-confined.

Area	*NW*	*NE*	*SE*
Number of bores	16	146	480
Percent successful (yield >0.03 L/s)	56.3	56.2	63.1
Average yield (L/s)	1.12 (9)	0.73 (67)	1.24 (293)
Maximum yield (L/s)	1.52	8.85	18.95
Percent irrigation successful (≥1.5 L/s)	1.11	11.9	19.8
Salinity range (mg/L)	187	85–1470	70–11 200

Devonian granitic rocks and Cambrian serpentinite

Prospectivity: Low to moderate

Vulnerability to pollution: Low to moderate

The granitic rocks are often sparsely jointed and generally have a lower prospectivity than other rock types. Closely spaced fracturing will locally raise prospectivity. Some granitic rocks in the Scottsdale Batholith (adamellite and granitic, Trewalla and Kamona types) may have a higher than average prospectivity.

Although some 50% of bores in granite in northeast Tasmania have produced some water, there are a number of bores where considerable depths of granite have been drilled under Tertiary sedimentary rocks where no water was produced. These bores have been assigned as failed Tertiary sedimentary rock bores.

Yields are usually in the ranged suited to stock and domestic uses, although higher yields are occasionally obtained.

Quality is variable but is sometimes a little saline for many uses.

Devonian granite occurs in areas adjacent to or outside agricultural areas and only a few bores have been recorded.

Precambrian granite on King Island has been drilled at several locations.

Bore success rates in granites of both ages are relatively poor, probably because of the sparse nature of the jointing.

Peridotite and serpentinite outside the agricultural areas are untested and little is known of their potential. Cambrian serpentinite occurring near Beaconsfield is also untested.

The aquifers range from unconfined to confined.

*Area**	*NW*	*NE*	*SE*
Number of bores	31	60	4
Percent successful (yield >0.03 L/s)	37.8	51.7	100
Average yield (L/s)	0.50 (11)	0.61 (21)	0.60 (4)
Maximum yield (L/s)	1.01	1.88	1.01
Percent irrigation successful (≥1.5 L/s)	0	9.5	0
Salinity range (mg/L)	770	240–1950	-

* Northwest — Devonian and Precambrian granite
Northeast — Devonian granite, Cambrian serpentinite
Southeast — Devonian granite

Groundwater Quality

Groundwater quality varies according to aquifer type, hydrogeological setting and location within Tasmania. The quality of groundwater is influenced by the quality of the recharge water and the degree of interaction between water and the aquifer material, as well as the composition of the aquifer material (e.g. Dell, 2000; Cromer, 1993; Leaman, 1971). There is a very general relationship with rainfall; the southeastern parts of Tasmania, where rainfall is less, generally have poorer quality groundwater than areas of higher rainfall in the west, north and northeast.

A recent study to examine the hydrogeological setting of some saline-affected areas of Tasmania (Dell, 2000) indicated that the proximity of aquifers to recharge areas and the rate of flow within aquifers are major influences on water quality. Groundwater that has a longer residence time will tend to interact chemically with the aquifer material to a greater degree, with consequent affects on water quality. The nature of the aquifer material and hydrogeological regime present will also influence the degree of this interaction.

Water quality is usually expressed as total dissolved solids (TDS) (frequently referred to as salinity in Tasmania). In low rainfall areas aquifers formed in Tertiary sedimentary rocks, Jurassic dolerite and in the upper sequences of the Triassic sedimentary rocks generally produce groundwater of a significantly poorer quality than other aquifer types. This difference is likely to be related to the mechanism of water storage and transport, as well as the mineralogy of the materials in these aquifers.

In certain parts of Tasmania, the mineralogy of the aquifer material or that of other geological materials surrounding the aquifer (including recent overburden) has had a marked effect on the pH of the groundwater in the aquifer. Groundwater derived from the Mathinna Beds and Devonian granites in northeast Tasmania (including Flinders Island) has a very low pH at some locations. Similarly, in the Mella area in the northwest, acid sulphate soils in Quaternary swamp deposits, which are in direct hydraulic connection with the underlying carbonate aquifer, have caused the groundwater to have a low pH, with values as low as 1.

Tasmanian Groundwater Flow Systems

A groundwater flow system is a landscape entity that includes all aspects of a single groundwater flow path. It is a fundamental unit that needs to be considered when management options for dryland salinity control are being selected. Groundwater flow systems characterise similar landscapes in which similar groundwater processes contribute to similar salinity issues, and where similar salinity management options apply.

Groundwater Flow Systems can be defined by a series of attributes that describe how they will respond to different recharge regimes, and that describe how they will express any imbalance in their water budget. These attributes include information about the hydraulic properties of the aquifer, as well as information on their landscape expression.

Attributes such as the hydrogeology and the slope can be used to spatially define the various flow systems using available catchment information. Other attributes can be used to describe the likely success or otherwise of management options.

Thirteen broad groundwater flow systems have been identified in Tasmania for dryland salinity management purposes and have been described by Latinovic *et al.* (2003).

The thirteen systems are:

1. Local flow systems in Quaternary sedimentary rocks (talus and till);
2. Local to intermediate flow systems in Quaternary sedimentary rocks (aeolian, coastal plains and alluvium);
3. Local to intermediate flow systems in undifferentiated Quaternary to Tertiary sedimentary rocks;
4. Local flow systems in high-relief Jurassic dolerite;
5. Local flow systems in high-relief Permian and Triassic sedimentary rocks;
6. Local flow systems in granites;
7. Local flow systems in high-relief folded and fractured Proterozoic and Palaeozoic rocks;
8. Intermediate flow systems in Tertiary sedimentary rocks;
9. Intermediate to local flow systems in Tertiary basalt;
10. Intermediate to local flow systems in low-relief Jurassic dolerite;
11. Intermediate flow systems in low-relief Permian and Triassic sedimentary rocks;
12. Intermediate flow systems in low-relief folded and fractured Proterozoic and Palaeozoic rocks;
13. Regional and local flow systems in Tertiary sedimentary rocks.

Risks to the Groundwater Resource

Risks to groundwater use can be summarised as:

- unsustainable use; and
- point source and diffuse pollution.

Unsustainable use

The National Land and Water Resources Audit (Sinclair Knight Merz, 2000) provided a quantified estimate of sustainable yield for various areas of Tasmania. It also projected a linear increase in the number of groundwater extraction points, with extraction rates assumed to remain the same as at present. These estimates indicated that in only two of the areas identified by the audit (Sorell and Wesley Vale) was the resource likely to be overdeveloped within the next seventy years (Table 2). It should be recognised that this assumed no change in land-use patterns, and was based on very approximate estimates of sustainable yield. The NLWRA highlighted the need for more accurate determination of sustainable yield through investigation.

Assessments of whether the current use of groundwater is sustainable are severely limited by the available data. There is currently no licensing system for groundwater extraction boreholes, and no requirement for major irrigation or other extraction proposals to carry out investigation and analysis of aquifer properties to relevant national or international standards (e.g. AS2368 for pumping tests) before commencement of such projects. Only limited investigation work has been carried out to date. There has been a legislative requirement for some years for individuals and organisations installing extraction boreholes to supply details of borehole location and construction to the Tasmanian Government, but there is currently no licensing system for drillers. This leaves Tasmania as the only Australian State where drillers are not required to be licensed.

Collection of monitoring information is a most important aspect of understanding risks to the groundwater resource. Monitoring of a limited number of boreholes across Tasmania is undertaken by Mineral Resources Tasmania. In certain areas, particularly around Devonport, these data show that over time, the static water level in boreholes is gradually falling. This indication of unsustainable depletion of the resource is presumed to be caused by an increase in the construction of extraction boreholes combined with land use change. More monitoring stations would be desirable.

Analysis of long-term records in some areas indicates that groundwater extraction is having an effect on groundwater levels. In some cases boreholes have been sunk on adjacent properties into the same aquifer, without consideration of interference effects and the long-term viability of the boreholes. Boreholes have also been drilled by property owners close to some of MRT's monitoring boreholes, and the extraction of water influences the monitoring results.

The linkage between surface water and groundwater is not understood in many areas, although evidence exists to suggest that groundwater extraction may be influencing river flows in a number of areas, including (for example) two recognised by the NLWRA, around Don and Wesley Vale.

Groundwater pollution

Some aquifers in Tasmania are vulnerable to pollution. Potential pollution sources are relatively diverse, but examples currently include landfills (especially if poorly sited, engineered or managed), storage sites of petroleum-based fuels and oils, septic tanks, certain manufacturing and processing industries, animal waste burial sites, and arable farmland which is treated with excessive amounts of fertiliser or pesticide. Waste water reuse schemes are a potential pollution source in the future, if inappropriately sited, monitored or managed.

The most vulnerable aquifers are those in direct hydraulic connection with surface pollution sources, and especially those which exist under unconfined hydrogeological conditions. Such aquifers frequently contain good quality water, which is in many cases used for domestic supply. Examples of such possible pollution potential exist at Currie on King Island and at Scottsdale.

The connection between surface water and groundwater, as well as between individual aquifers, has the potential to introduce natural contaminants into groundwater systems. An example of this process exists in the Mella area, where surface water contaminated by acid sulphate soil has been drawn into the underlying carbonate aquifer through sinkholes and by borehole extraction.

Poor borehole design, construction and maintenance can also result in aquifer pollution, as they may provide a preferred pathway for polluted near-surface groundwater or surface water to enter aquifers. This is especially the case for stock supply boreholes and monitoring boreholes that surround landfills or industrial operations.

The impacts of waste disposal on groundwater quality

The results of a study into the impacts of waste disposal on groundwater quality were released in 2003. Ten sites around Tasmania were investigated in detail. The reports issued detail the history of each site, management practices, hydrology, geology, investigation methods (including drilling), surface and groundwater chemistry, conceptual

Table 2

Estimated and projected yields of groundwater (Sinclair Knight Merz, 2000)

Groundwater Management Unit	*Estimated sustainable yield (ML/year)*	*Current extraction (ML/year)*	*Current no. of boreholes*	*Average no. of new boreholes per year*	*Yield 2020 (ML/year)*	*Yield 2050 (ML/year)*
Smithton	60 000	832	264	6	1 277	1 857
Burnie	135 000	2 155	438	12	3 571	5 418
Spreyton	2 500	183	33	1	366	605
Wesley Vale	4 825	2 649	177	6	4 825	7 663
Longford	25 661	1 116	119	3	1 829	2 759
Sorell	449	302	22	1	485	723
Llanherne	3 039	29	2	1	219	468
St Marys	458	81	1	1	174	296
Scottsdale	9 630	56	7	1	106	170
Tomahawk	38 138	5	1	19	2 190	5 040
Ringarooma	1 017	60	1	1	129	219
Legerwood	1 017	29	2	1	59	99
Winnaleah	763	35	3	1	75	128
Flinders Island	38 322	80	13	1	182	316
West — urban area	1 315 046	1 906	80	2	3 060	4 564
South Central — urban area	728 383	10 236	150	3	14 678	20 472
North East — urban area	175 191	498	17	1	799	1 193

hydrogeological models, principal conclusions and recommendations for further work.

The findings of these detailed studies are summarised below.

Smithton (Blue Ribbon) abattoir (Ezzy, 2002e)

Poor weather conditions prevented access for the drilling of an appropriate number of boreholes to assess groundwater quality in the area of the Smithton Blue Ribbon abattoir disposal sites. Only limited data were collected at the site and extensive work is still required to assess surface and groundwater quality and related environmental implications.

Chapel Street and Jackson Street waste depots, Glenorchy (Ezzy, 2002i, j)

The landfill footprints of the Chapel Street and Jackson Street waste depots are located on Permian sedimentary rocks and Jurassic dolerite, which contain heterogenous fractured bedrock aquifers. Groundwater at the toe of the Chapel Street landfill footprint is elevated in chloride, ammonia, manganese and total petroleum hydrocarbon fraction C_{10}–C_{14}. Migration rate will be related to the fracture widths within the aquifers. No evidence of major groundwater contamination was identified around the Jackson Street landfill. Geophysical surveys have identified the extent of the Chapel Street waste depot and an area of partial clay capping. The saturation level of fill material within the Chapel Street landfill has on-going risk management implications, relating to stability and the local urban environment.

McRobies Gully waste depot, Hobart (Ezzy, 2002m)

The McRobies Gully waste depot is a landfill located in a valley close to the suburb of South Hobart. Data were collected for the site, including the testing of 14 groundwater bores within or adjacent to the landfill. It was found that water within the landfill contained some contaminants at levels significantly greater than bedrock water, but generally at the lower end of the range considered typical of operating landfills. Analysis of chemical signatures and water levels indicated limited hydraulic connection between fill and bedrock waters and generally only minor effects on groundwater quality.

A localised impact of high nitrate concentrations was observed in groundwater adjacent to the western gully of the landfill. Surface water inflows to the fill appear critical in the management of the site. Slope stability of the fill material and the associated level of risk were identified as issues requiring further investigation.

Port Latta waste depot (Ezzy, 2002f)

The Port Latta waste depot is a disposal site for general and hazardous waste materials. The local groundwater table slopes away from the site north towards Bass Strait. The regolith profile and related engineering grades of the clay material affects recharge to the fractured bedrock aquifer. Groundwater quality in the area of the leachate ponds is degraded. On-going monitoring and changes in the engineering design (i.e. filling sequence, surface water controls and leachate pond infrastructure) are high priorities at the site.

Port Sorell waste depot (Ezzy, 2002b)

The Port Sorell waste depot was a disposal site for general and industrial waste. The waste depot was converted to a waste transfer station in 1995. The local groundwater table slopes towards the southeast. The waste fill has an hydraulic connection with the surface water drainage system. Clay-rich sediments appear to be perching and/or storing water. Groundwater and surface water quality are degraded around the site. Surface water management, capping of both landfills, appropriate disposal of sediments contaminated by hydrocarbons, leachate management infrastructure, and protection of the public from contaminated surface and groundwater are high priorities at the site.

Scottsdale waste depot (Ezzy, 2002c)

The Scottsdale waste depot is an 'open-gate' disposal site for general waste streams (including herbicide, pesticide and weedicide containers). The landfill footprint is located on the Jetsonville aquifer, a groundwater resource of State significance. Some groundwater and surface waters are degraded around the site. Surface water management, capping of the landfill, leachate management infrastructure, and protection of the public from contaminated surface and groundwater are all high priorities at the site.

Bridport sewage lagoons (Ezzy, 2002a)

Groundwater was investigated in the area of the Bridport sewage lagoons to determine if the lagoons were affecting groundwater quality. The depth to the water table and groundwater quality data indicate that there is an hydraulic connection between the lagoons and the groundwater system. Groundwater quality down gradient is degraded compared to that up gradient of the lagoons. Further work is required to quantify the extent and nature of groundwater degradation.

Smithton sewage lagoons (Ezzy, 2002d)

Groundwater was investigated in the area of the Smithton sewage lagoons to determine if the lagoons were affecting groundwater quality. Significant nitrogen-based groundwater contamination was identified in excess of guideline limits. Natural attenuation processes appear to be occurring beneath adjacent farmland.

Stieglitz sewage lagoons (Ezzy, 2002h)

Groundwater was investigated in the area of the Stieglitz sewage lagoons to determine if the lagoons were affecting groundwater quality. The lagoons are situated close to perched shallow water tables. Further investigations are required to refine the hydrogeological model of the site and preferred pathways of flow from groundwater mounding beneath the lagoons.

Stanley sewage lagoons (Ezzy, 2002g)

Groundwater was investigated in the area of the Stanley sewage lagoons to determine if the lagoons were affecting groundwater quality. Nitrite and nitrate were detected at low concentrations in close proximity to the lagoons. The lagoons are located close to a landfill, which has the potential to affect groundwater quality in the area of the lagoons.

Mitigation of risks to groundwater

Tasmania has suffered from the lack of licensing of groundwater extraction points. Groundwater has not been considered to be a resource which has to be managed sustainably, and this has apparently resulted in a public perception that groundwater resources are infinite. A strategic planned approach to the investigation of groundwater resources has not been developed, and requisite studies to reach such a goal have not been undertaken. Implementation of the Council of Australian Governments (COAG) recommendations for groundwater reform is now being undertaken.

The main methods of risk mitigation are likely to be:

- regulation by licensing of boreholes;
- catchment mapping;
- further detailed investigation;
- expansion of the monitoring network;
- development of the borehole database;
- licensing of drillers;
- use of appropriate expertise; and
- education.

The *Water Management Act 1999* provides for the licensing of extraction boreholes and for the development of integrated water management planning, but does not include any requirement for investigation of groundwater regimes and aquifers on a local or regional scale. Without appropriate in situ and laboratory testing, further understanding of Tasmania's groundwater will be difficult to achieve.

Catchment maps of resources are currently being prepared by MRT for the Department of Primary Industries, Water and the Environment to carry out initial resource assessments, but these maps will be based on historical data, collected over a period of fifty years, which may not always portray an accurate reflection of current conditions.

Mineral Resources Tasmania is the custodian of a groundwater database which is managed by two hydrogeologists. MRT also carries out regular monitoring of a number of boreholes throughout Tasmania. The borehole water level monitoring network consists of over thirty boreholes located at sites representative of local hydrogeological conditions across Tasmania. While this allows some degree of tracking of groundwater resource development, it requires expansion in the longer term, and this need is recognised in the National Land and Water Resources Audit.

The priority for Tasmania is to ensure that future development of its groundwater resources progresses in a planned and sustainable manner, which also prevents environmental harm.

Licensing of Drillers

In other Australian States water drillers must be licensed before they are able to undertake water boring operations. The licensing body is made up of representatives from State government departments and private industry, and always includes highly experienced former drillers. Licenses are issued when the driller has demonstrated technical competence by means of theoretical and practical examinations. The examiners make regular on-site inspections to determine the standard of work being performed. Fees are charged for the examinations and issue of the license. Licenses are issued for a set period of time. Licenses are not currently transferable between State jurisdictions, although they may be in the future. There is currently no legislative requirement for drillers to be licenced in Tasmania.

Conclusions

To accurately determine the risks to Tasmania's groundwater resources and ensure sustainable future development, a statewide approach is required. This should incorporate:

- strategic regional and long-term groundwater investigation work;
- study of surface and groundwater interaction;
- expansion of long-term monitoring;
- ensure maintenance and upgrading of the borehole data base to include data not currently held by MRT and to enable end users access via the Internet; and
- adoption of a driller licensing system.

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[9 July 2004]

APPENDIX 1

Characterisation attributes: definitions of the relative ratings applied to groundwater flow systems within fact sheets

Attributes	*Rating*	*Meaning/value*
Scale (of groundwater processes)	Local	Groundwater flows over distances less than five kilometres within the confines of sub-catchments
	Intermediate	Groundwater flow over distances of 5 to 30 kilometres and may occur across sub-catchment boundaries
	Regional	Groundwater flow occurs over distances exceeding 50 kilometres at the scale of river basins
Aquifer Transmissivity (ability to transmit groundwater through the aquifer)	Low	Less than 2 m^2/day
	Moderate	2 m^2/day to 100 m^2/day
	High	Greater than 100 m^2/day
Groundwater Salinity	Low	Less than 1.5 dS/m (3 dS/m in NLWA)
	Moderate	Ranging from 1.5–3 dS/m (3–15 dS/m in NLWA)
	High	Greater than 3 dS/m (15 dS/m in NLWA)
Catchment Size	Small	Less than 10 km^2
	Moderate	Ranging from 10 km^2 to 500 km^2
	Large	Greater than 500 km^2
Annual Rainfall	Low	Less than 400 mm
	Moderate	Ranging from 400 mm to 800 mm
	High	Greater than 800 mm
Salinity Rating	S1	Loss of production
	S2	Saline land covered with salt tolerant volunteer species
	S3	Barren saline soils, typically eroded with exposed sub-soils
Equilibrium response time (to land management)	Slow (Low NLWA)	Salinity benefits accrue over timeframes that exceed 50 years
	Moderate	Salinity benefits accrue over timeframes ranging from 30 to 50 years
	Fast (High NLWA)	Salinity benefits accrue over timeframes less than 30 years