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The State of Jersey Groundwater 2000 and Some Topical Issues

N S Robins, P J Chilton and M J Bird

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N S Robins, P J Chilton and M J Bird

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Contents

List of Tables

EXECUTIVE SUMMARY

Advice was provided by BGS on the Jersey groundwater monitoring and management programme as required. At the start of 2000, groundwater levels were exceptionally low for mid-winter, but the wet summer and very wet autumn replenished the groundwater resource. Some groundwater levels attained highest recorded values by the end of December 2000. Groundwater chemistry continues, for the most part, to remain unchanged. There may be the beginning of a slight decline in nitrate concentrations in some areas, but the continued presence of the metabolite chlorthal and of the pesticides Atrazine and Simazine is still a concern. The case for adopting an organic nitrogen application of only 210 kg N/ha for Jersey, and aiming towards only 170 kg N/ha in due course is advocated. There are significant differences between the UK and Jersey and UK agricultural practice should not be followed without question. Prospects of groundwater abstraction licensing on Jersey promote discussion of suitable license threshold limits. The value of licensing all groundwater users other than domestic, regardless of volume abstracted, is discussed.

1. INTRODUCTION

1.1 Background

Groundwater monitoring was continued throughout the year by staff of the Public Services Department. Groundwater level data have been collected on a monthly basis at selected sites, and groundwater chemistry data twice yearly in spring and autumn. The data collection and analytical work have been carried out by Clare Le Breuilly and Nicola Johnson (PSD). One advisory visit was undertaken by Mike Bird (BGS) to discuss future monitoring strategy and to refine and improve the current list of sample points. In addition a dialogue has been maintained between BGS Wallingford and PSD Bellozanne to assist in the day to day management and protection of the groundwater resource. One member of PSD Bellozanne, Andrew Cousins, visited BGS Wallingford and the Environment Agency to familiarise himself with UK practice. Further visits are to be encouraged.

The impact of the Water Pollution (Jersey) Law 2000, which became active at the beginning of December has yet to be assessed. However, the burden of the new law will inevitably place a strain on the existing monitoring and data assimilation work unless new resources can be found to support this work.

Other activities included the preparation of an overview report on the water resources of Jersey (Robins, 2000). This was printed and made available for distribution during December. However, the St Helier data rescue report (Cheney, 2000) has not yet been finalised and awaits approval from PSD. A number of specific issues have been dealt with during the course of the year. A discussion note was prepared on the vulnerability of Jersey to agricultural pollution – this is reproduced in full in section 3.1. Another topical issue is the prospect of groundwater abstraction licensing and certain practical aspects are reviewed in Section 3.2

This report describes the state of the groundwater resources of Jersey throughout the calendar year 2000 and discusses a number of topical issues. It is not intended as a stand alone report and reference should also be made as necessary to the project report produced in 1998 (Robins and Smedley, 1998) which describes the aquifer system of the island in detail.

1.2 Objectives

The objectives throughout 2000 were:

1. To provide *ad hoc* advice to Public Services Department on data gathering, data collation and storage, and data interpretation with regard to the ongoing groundwater monitoring programme.

2. To provide advice on the management of the groundwater resources of Jersey in general and, from time to time, on other specific issues relating to groundwater, including groundwater protection.

2. CURRENT GROUNDWATER STATUS

2.1 Groundwater Levels

The year was characterised by exceptionally heavy and prolonged rainfall during the autumn. This resulted in the activation of rarely flowing high level springs. The aquifer has low storage and moderate permeability, so that it reacts quite rapidly to prolonged rainfall and intense recharge quickly fills the available storage within the aquifer. Groundwater levels at the end of the year were, therefore, exceptionally high for mid-winter, with spring discharge and streamflow running also at very high volumes. Many borehole water levels had attained their highest recorded levels by the end of the year 2000 (see water level hydrographs in Appendix 1). Two of the monitored boreholes (Redwood and Aviemore in Appendix 1) became temporarily artesian, with the piezometric level above that of the ground surface and contained within the borehole casing proud of the ground level. These levels were in stark contrast to those recorded at the same time in the previous winter.

Reaction of a borehole water level to the intensive rainfall is apparently not dependent on the depth of the water level below ground level. However, between September and December, the reaction of the deeper water in the Orchid Foundation borehole from 20 m to 8 m below ground level is greater than the recovery of any of the shallower water tables monitored in other boreholes. This reflects the inability of shallower groundwater to rise much above ground level without local spring discharge acting as relief. That some boreholes started to upturn in October and some not until November is indicative of the degree of connectivity of each source with recharging water. By way of example, St George's Estate, La Ronce and Trinity School were among the group that tended to react relatively late to the wet autumn.

2.2 Inorganic Chemistry

The consistency of the major ion chemistry of Jersey groundwater with time continues despite the characteristically late recharge of the 1999/2000 winter and the contrasting early and prolonged recharge of the autumn and early winter of 2000. However, nitrate-N concentrations may be beginning to show slight moderation. Of the 49 samples taken in May 2000 (Appendix 2), 26 of them (53%) exceeded the EC maximum admissible concentration (mac) for N of 11.3 mg l^{-1}; the mean value for all the May samples was 15.9 mg l^{-1}. Of the 40 samples taken in November 2000 (data not shown), 20 of them (50%) exceeded the mac for N; and the mean value for all the November samples was 13.5 mg l^{-1}. The mean value in November 1999 was 16.6 mg l^{-1}, this slight downward trend is encouraging although it is insufficient evidence as yet to conclude that concentrations are on the decline, and may only reflect dilution of existing nitrate rich groundwater with plentiful recharge.

2.3 Organic Chemistry

The widespread occurrence of the organic metabolite chlorthal remains of concern. It derives from earlier use of the active pesticide Chlorthal Dimethyl which was banned on Jersey in 1998. The metabolite chlorthal may not in itself pose a health risk, but associated chemicals that may be present in small quantities hexachlorobenzene and dioxin) may do so. Atrazine and Simazine continue to occur in many Jersey groundwaters. Although this may reflect the persistence of these products since their use was banned in the 1990s, it raises the suspicion that stocks may still exist on the island in commercial quantities. These pesticides are also present in some garden products which are still available for purchase locally.

2.4 Groundwater Abstraction

Very few groundwater abstraction data were collected due to the paucity of metered sources that remain available for monitoring. This situation is unlikely to change in the absence of suitable enabling legislation.

3. ISSUES

3.1 Groundwater Vulnerability

Groundwater is a major contributor to surface water flow in Jersey, as it is elsewhere. Contaminated groundwater will therefore discharge into streams and lakes and can create contaminated surface waters. Groundwater on Jersey is particularly vulnerable to surface pollutants because:

- Soils on Jersey are thin, loessial or sandy. These equate to the UK Environment Agency vulnerability classification of *Soils of High Leaching Potential*.

- The shallow weathered bedrock aquifer of Jersey is equivalent to the UK Environment Agency aquifer vulnerability classification of *Major Aquifer*. This is because:

    a) the presence of fractures in the aquifer offers rapid by-pass routes for groundwater flow and polluted water ingress to the water table, so elevating the aquifer to this status. In Scotland or Northern Ireland this would equate to a *Highly Permeable* classification.
    b) the designation *Major Aquifer* is deserved because the aquifer is so dominant in providing Jersey's groundwater supplies and baseflow to surface waters.

- There are no weakly permeable cover strata in Jersey equivalent to the glacial and periglacial deposits such as till and clay-with-flints that are common throughout the UK.

- The depth to the water table in Jersey is commonly between 3 and 6 m. This offers little opportunity for attenuating pollutants through physical, chemical or biochemical means as they travel from the land surface to the water table. Although depth to water is not used directly or explicitly as a criterion in the UK Environment Agency vulnerability classification, it is so used in many other approaches to defining vulnerability (eg the US EPA's DRASTIC approach and in the Irish Republic).

- Nitrate profiling studies by Chilton and Bird (1994) indicate downward percolation in the unsaturated zone (above the zone of fracturing) of 1 m in 2 to 3 years. The opportunity for significant attenuation of a pollutant in the unsaturated zone only arises if the degradation half-life of the pollutant is short or it is strongly sorbed. Neither mechanism is likely to affect nitrate, but could help to reduce pesticide impacts.

- The groundwater and surface water available on Jersey are the only viable sources which will sustain demand for potable water on the island.

Under the EC Nitrate Directive, the actual approach and methodology of delineation of Nitrate Vulnerable Zones is left to member states. In Denmark, Germany and the Netherlands, the whole surface area of the country has been declared as vulnerable in consequence of the high value which these nations place on their groundwater resources. Jersey depends on a large number of small, dispersed groundwater sources, rather than (as in much of the UK) a relatively small number of large abstractions. The latter lend themselves much better to the definition of restricted Nitrate Vulnerable Zones around them, compared to the broad distribution of small supplies in Jersey. Further, much of the island contributes runoff and groundwater discharge into the catchments used for public supplies. Thirdly, all of the groundwater can be considered to have equally high value to Jersey. These factors together suggest that Jersey should be considered more equivalent to Denmark, Germany and the Netherlands, in that the whole or almost all of the land surface should be designated as vulnerable to pollution, save for perhaps a 100 to 200 m peripheral sea-drainage zone.

The UK MAFF Code of Good Agricultural Practice for the protection of water has a limit of 250 kg/N/ha for organic nitrogen applications. This and other provisions of the Code are intended to apply broadly to farming areas of the UK, with additional measures envisaged under Nitrate Vulnerable Zones. The recommended nitrogen applications are summarised in Table 1.

TABLE 1 **Nitrogen applications**

	Arable	Grassland
Closed Periods		
Nitrogen Fertiliser	1 Sep – 1 Feb	15 Sep – 1 Feb
Organic Nitrogen	1 Aug – 1 Nov	1 Sep – 1 Nov
Nitrogen limits		
Nitrogen fertiliser	Crop requirements	Crop requirements
Organic Nitrogen (whole farm)	210 kg N/ha/a[1]	250 kg N/ha/a
Organic Nitrogen (field)	250 kg N/ha/a	250 kg N/ha/a

[1]170 kg N/ha/a from December 2002

The "whole farm" approach is intended to allow for applications of up to 250 kg N/ha/a on individual fields to be balanced by lower applications on other fields to bring the farm average for fields receiving organic nitrogen down to 210 and eventually 170 kg N/ha/a, as envisaged in the Directive.

Given the argument outlined above for considering the whole of Jersey as vulnerable, then a case can be made for adopting the figure of 210 kg N/ha, aiming towards 170 kg N/ha. Three additional factors can be cited to support this lower figure:

- The work by Chilton and Bird (1994) found average unsaturated zone nitrate concentrations (i.e. water moving from soil to water table) ranging broadly from 10 to 30 mg NO_3-N/l, compared to a drinking water standard of 11.3 mg NO_3-N/l. These were derived from a number of fields with nitrogen applications in the range 95 to 272 kg N/ha. Application rates of 200-250 kg N/ha are likely to produce nitrate concentrations in recharge which exceed the drinking water standard.

- Estimated percentage leaching losses based on these concentrations were in the range 5 to 12 % of the applied nitrogen. While these are not excessive, and probably low compared to equivalent cultivation in the UK, the significantly lower volume of recharge in Jersey (60-100 mm/a compared to 150-300 mm/a in arable UK) provides less dilution and the consequent higher nitrate concentrations. In this very important sense, Jersey cannot be directly compared to the UK.

- The most important crop in Jersey, potatoes, is known to be an inefficient user of nitrogen and high leaching losses are commonly observed. As this crop is much more dominant in overall farming than in the UK, again direct comparisons are potentially problematic.

For both the hydrogeological and agricultural reasons outlined above, the Jersey situation is different to that of mainland UK, and should be recognised in developing target application rates for an agricultural code for the Island.

3.2 Groundwater Abstraction Licensing

The analysis of the water cycle for Jersey remains incomplete without measurement of source abstraction volumes. This could be done under suitable enabling legislation by issuing abstraction licenses to certain categories of groundwater user who would then be required to meter the discharge and return abstraction volumes to the licensing office. In return, the licensing office would provide some recourse to derogation from new sources through discretionary licensing and periodic review of existing licenses. To this end the licensing office may be found to be at fault if it wantonly licensed competing sources or local polluting activities either of which could be shown to derogate the license holders source. This is an essential part of the licensing objective which provides the license holder with a stake in the license as well as providing the license issuing office with essential data. There are, however, a number of issues that need to be considered before drafting the enabling legislation. These are:

- Who pays for the water meter and the cost of reading it?
- Who pays to determine the likelihood of a new source or activity derogating an existing licensed source? This could amount to an off-island consultancy visit with some primary data collection and interpretation by a suitably experienced hydrogeologist. At today's prices this would amount to £1000s rather than £100s. Alternatively a new technical post of hydrogeologist will be required.
- What license thresholds are appropriate for Jersey? Which user categories need to be licensed, and which categories can be license exempt?
- What is the license holder going to do with the data collected?
- What level of protection is the license issuing office going to provide to the licensee?

The 'who pays?' issue is political and has a political solution. An industrial user may be willing to safeguard his source through a hydrogeological survey costing a few thousand pounds, but a domestic supply for a new property situated away from an existing water main would not wish to spend more than a few hundred pounds in this way. Any law that forced such expenditure would drive consumers away from groundwater, ultimately providing additional stress on the public water supply system.

License thresholds depend on two factors. These are the coverage required and the need to collect data. However, the 'protection afforded to the source' aspect of the license should be remembered so that small and perhaps ephemeral sources are excluded. Groundwater use figures estimated from meter information collected between 1989 and 1991 are shown in Table 2.

These data suggest that a license threshold of 20 $m^3\ d^{-1}$ as used in the UK, would probably involve the issue of about 30 licenses. A threshold of 10 $m^3\ d^{-1}$ would perhaps increase the number of licenses required to about 150. A threshold of 2 $m^3\ d^{-1}$ would gather most non-domestic users and involve about 500 license applications. A threshold of only 1 $m^3\ d^{-1}$ begins to draw in domestic users with more than one property, domestic users with large capacity swimming pools and keen gardeners. These may amount to an additional few hundred applications.

TABLE 2 **Estimated groundwater use in the period 1989 to 1991**

Water use	Sample population	Mean consumption (m^3 d^{-1})	Estimated number of sources	Annual abstraction (Mm^3)
Agriculture	24	7.7	500	1.4
Domestic	6	0.6	4000	0.9
Leisure	9	42.4	50	0.8
Hotels and hospitals	20	4.5	60	0.1
Industry	10	10.9	20	0.1
Total (including uncategorised)	76		5000	3.6

.
There are a number of practical problems with setting threshold abstractions, not least that users, particularly domestic users, do not know what they are taking. Some agricultural users may mistakenly claim seasonal use that brings down their daily abstraction rate to at or below the threshold.

Statistics accepted in the UK and found to hold also in Jersey are that the average domestic household uses between 0.6 and 0.7 m^3 d^{-1} of water. Assuming that these values will be skewed upwards by swimming pool owners and gardeners, a reasonable estimate of total consumption could be derived by questionnaire such as the Census. There seems little to be gained, therefore, by invoking license requirements within the domestic sector.

Few groundwater users know what their current abstraction rate is. Application of a license threshold will only, therefore, lead to confusion. It would appear more practical to require licenses for all purposes other than domestic, no matter what the daily or annual abstraction rate is likely to be. It is anticipated that a total number of only about 600 licenses would be issued in this way. This is a manageable number which will provide Government with the data it requires to assess the water balance when combined with the current statistical understanding of the domestic water consumption.

There is also the problem of protection afforded the licensee. Initial licenses may be issued as ‘right’ for a set period, say three years. At the end of that period a new application would be required to extend the license for a further period, and applications would also be received for new sources. On a rolling basis this suggest an annual license issue of about 200. Assessing each one on a rational technical basis, using the ‘will not derogate existing license holders’ as the bottom line, then a full time programme of assessment and data handling is envisaged for a qualified hydrogeologist over the initial first year period following the expiry of licenses of right. However, the complex, sometimes unpredictable nature of the Jersey bedrock aquifer would, for the most part exclude digital modelling of source capture zones and the hydrogeologist would rely heavily on intuitive derivation of source capture areas. Thereafter, the new post, if it were retained, could be used to support groundwater protection activities and other water management issues.

It is likely that source test pumping would be required to determine prospects of derogation in some areas. It would also be beneficial to prepare a register of domestic sources in order to ensure that these are also protected from derogation by new sources.

3.3 Other Issues

The Water Pollution (Jersey) Law is now in force. This is a great step forward for Jersey towards the proper and rational management of its water resource. However, pollution of the St Ouen's Bay public supply wellfield and a number of private sources remains an outstanding concern with little progress having been made with regard to corrective or remedial (including do nothing) options.

Monitoring of groundwater levels and groundwater quality along with data handling and archiving continue on a satisfactory basis. Import of daily rainfall data from the Airport has been recommended to investigate the influence of recharge events. The collection of groundwater abstraction data may only recommence given suitable legislation and costs involved in reviving working meters.

At the end of the calendar year 2000, the state of the groundwater resource was good. The aquifer was full to the point that many ephemeral high ground springs were discharging to surface. Water chemistry data indicate no deterioration in quality over the year, although the occurrence and distribution of nitrate and some pesticide or metabolite compounds remains of concern. There is, however, a tenuous indication that nitrate values may be declining.

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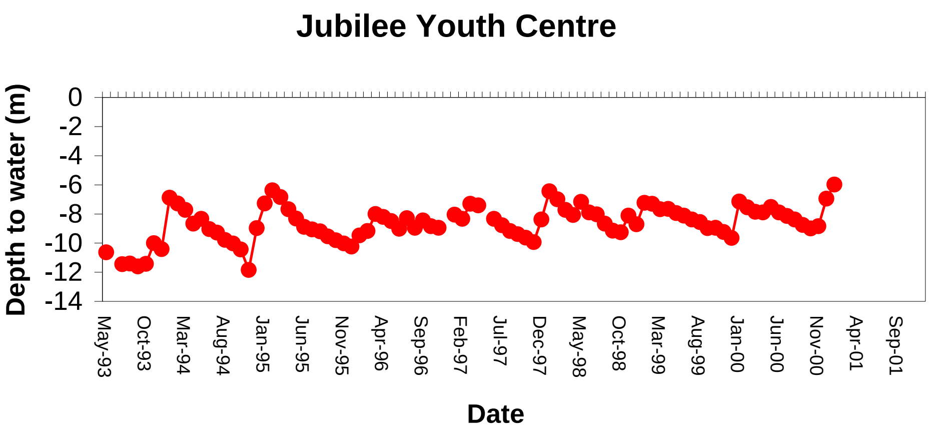
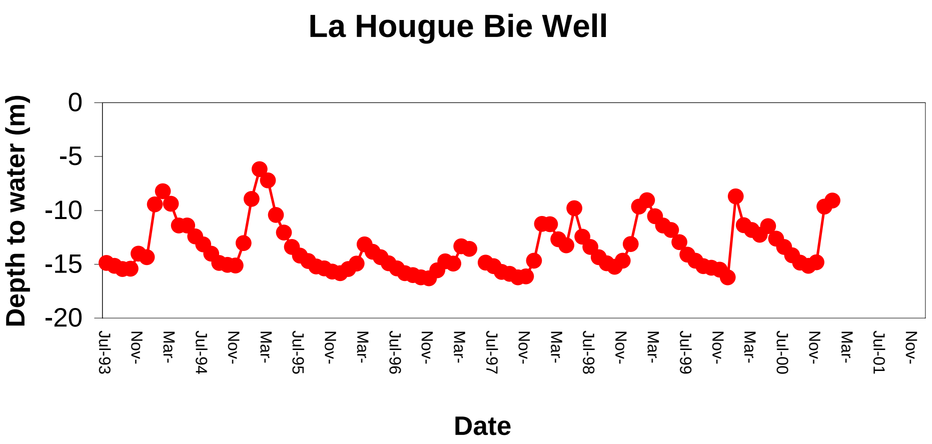
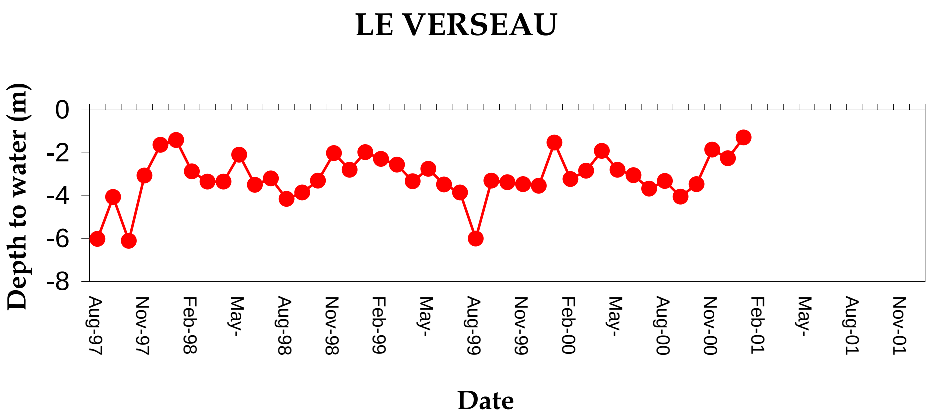
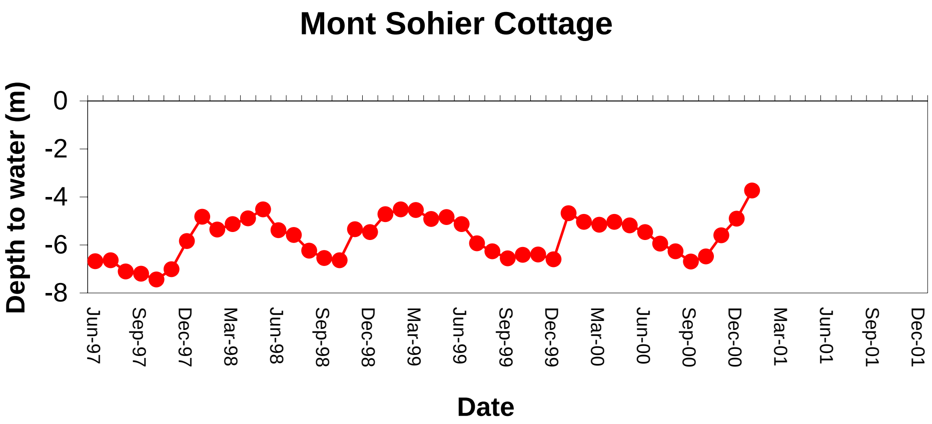
APPENDIX 1 SELECED BOREHOLE HYDROGRAPHS





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-2
-4
-6
-8
Jun-97
Sep-97
Dec-97
Mar-98
Jun-98
Sep-98
Dec-98
Mar-99
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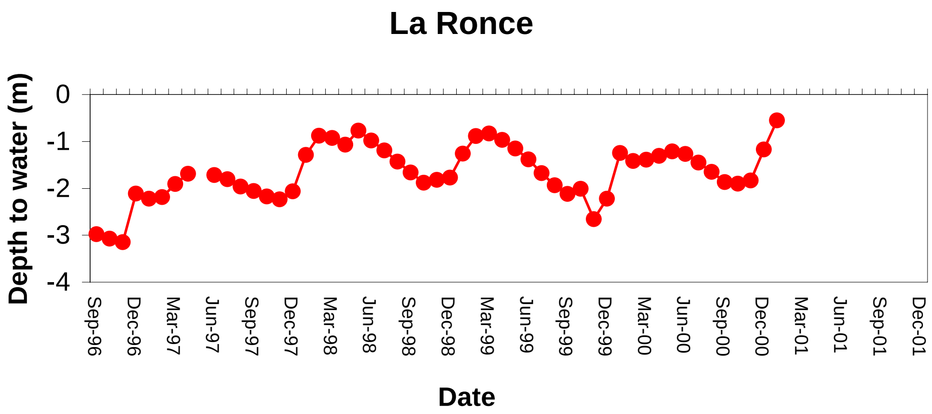
Sep-01
Dec-01
Date


La Ronce
Depth to water (m)
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-2
-3
-4
Sep-96
Dec-96
Mar-97
Jun-97
Sep-97
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Jun-98
Sep-98
Dec-98
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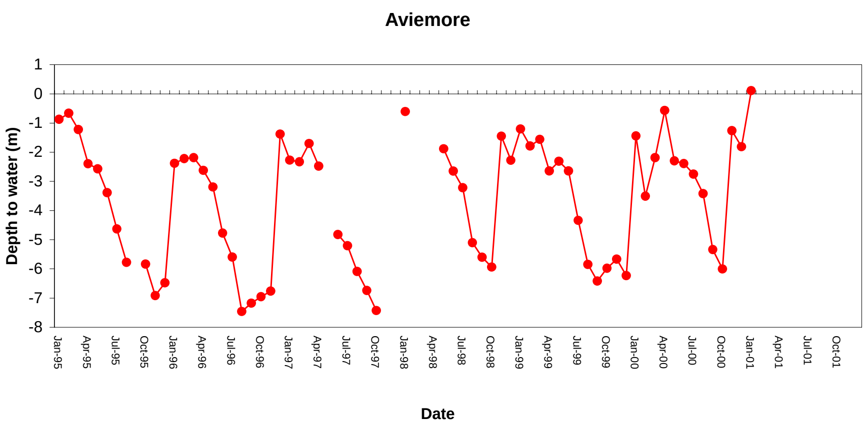
Date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0
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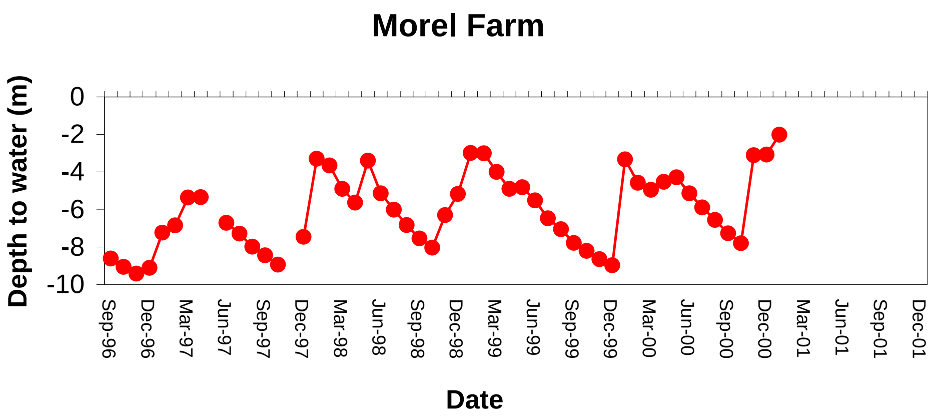
-2
-3
-4
-5
-6
-7
-8
Date


Morel Farm
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-4
-6
-8
-10
Sep-96
Dec-96
Mar-97
Jun-97
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Dec-97
Mar-98
Jun-98
Sep-98
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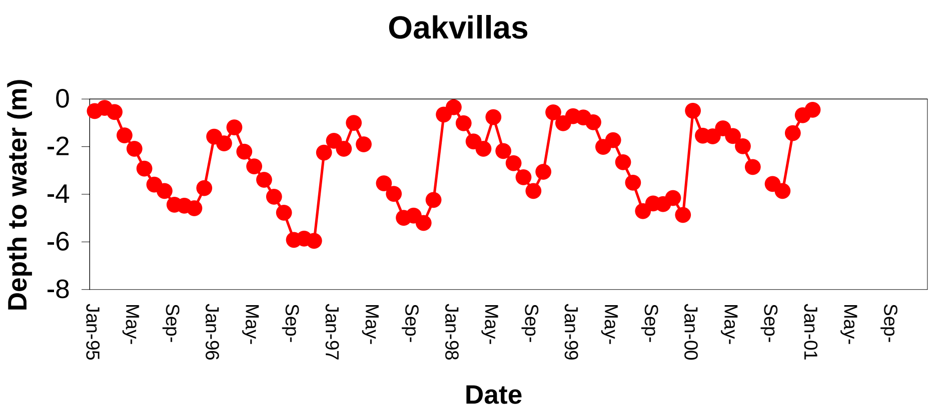
Oakvillas
Depth to water (m)
0
-2
-4
-6
-8
Jan-95
May-
Sep-
Jan-96
May-
Sep-
Jan-97
May-
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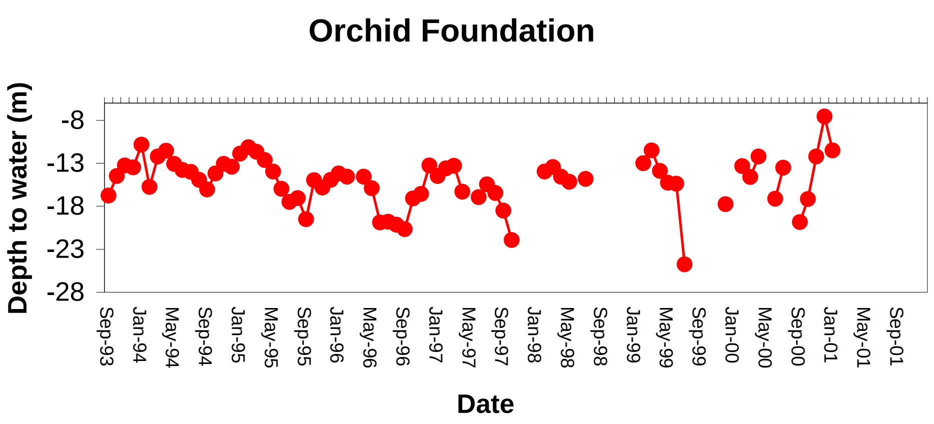
May-
Sep-
Date


Orchid Foundation
Depth to water (m)
-8
-13
-18
-23
-28
Sep-93
Jan-94
May-94
Sep-94
Jan-95
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Sep-95
Jan-96
May-96
Sep-96
Jan-97
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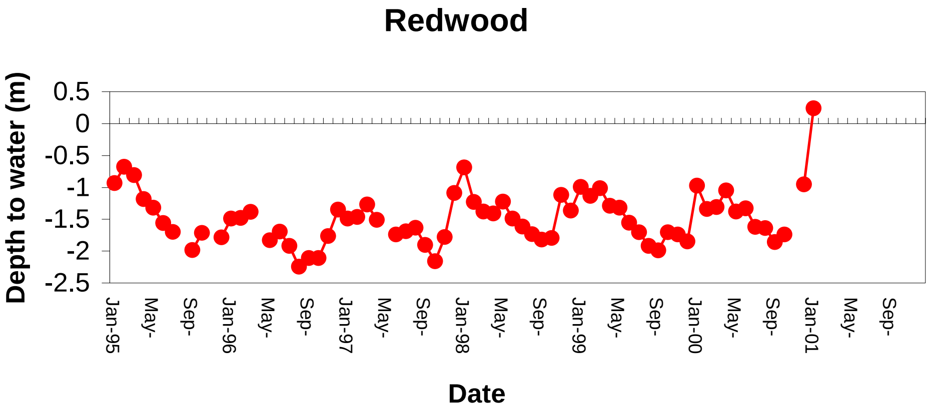
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-1
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-2
-2.5
Jan-95
May-
Sep-
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May-
Sep-
Jan-97
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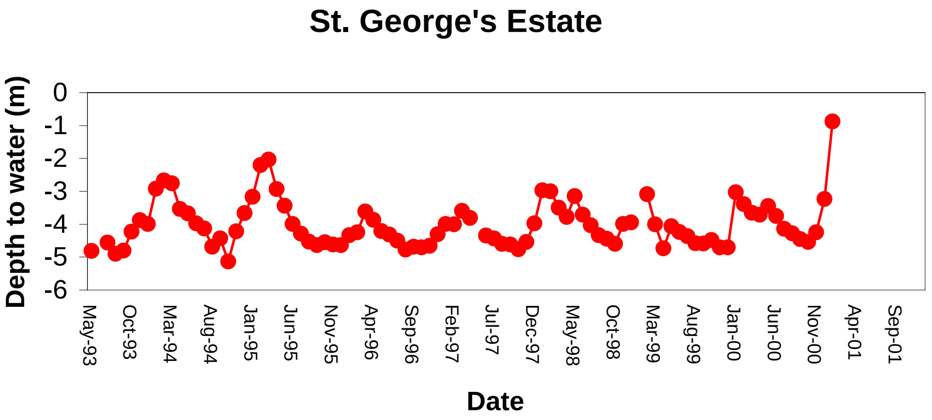
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May-93
Oct-93
Mar-94
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Apr-96
Sep-96
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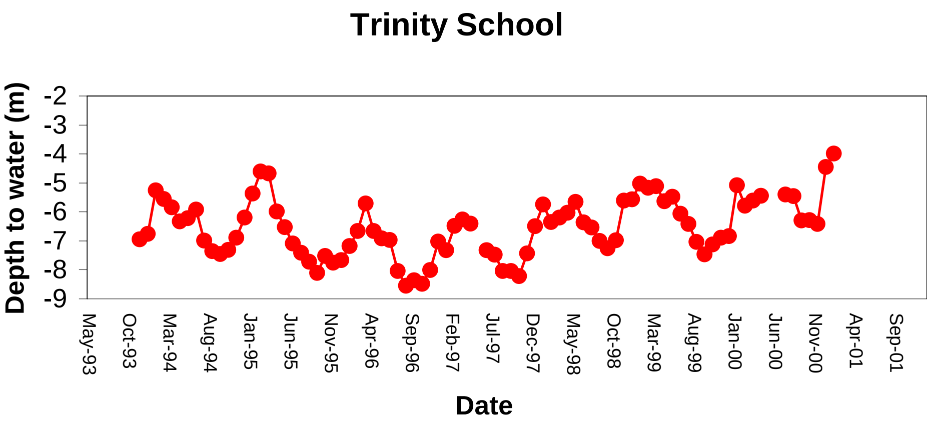
Trinity School
Depth to water (m)
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Mar-94
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Jun-95
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Feb-97
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Oct-98
Mar-99
Aug-99
Jan-00
Jun-00
Nov-00
Apr-01
Sep-01
Date

APPENDIX 2 ANALYTICAL CHEMISTRY DATA FOR MAY 2000

LOCATION	SITE	DATE	HCO_3 (mg/l)	Cl mg/l	NO_3 mg/l	SO_4 mg/l	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Mn µg/l	Fe µg/l
A5 St Ouen's Bay	J04	5/17/00	174	52	1.3	17	62	5	31	1.6	20	10
Applebarn	J49	5/18/00	60	69	16.6	103	43	11	69	2.3	40	<10
Atlantic Hotel	J09	5/15/00	48	83	10.8	71	32	13	59	6.5	30	20
Aviemore	J123	5/24/00	18	45	12.4	62	28	13	30	8.1	<10	20
Bellozanne B/H	J165	5/17/00	163	116	16.0	114	85	22	78	2.4	60	<10
Besco Laundry	J23	5/15/00	181	100	2.4	157	97	25	66	4.6	80	50
Bon Air Stables	J44	5/26/00	89	30	8.2	49	30	9	26	31.7	110	<10
Broughton Farm	J121	5/16/00	99	71	1.5	79	45	13	51	3.1	130	<10
Chaise Au Diable	J91	5/17/00	156	62	1.8	79	68	11	41	4.4	330	280
Chateau Le Chaire	J109	5/25/00	46	62	13.7	62	33	16	44	4.9	<10	<10
Coronation Park	J45c	5/18/00	154	154	0.1	126	48	23	113	8.7	230	500
First Tower Park	J36	5/22/00	166	105	4.7	165	85	25	69	2.6	200	30
Geranium Farm	J16	5/15/00	24	133	37.5	95	67	18	74	25.4	90	40
Greystones	J01	5/25/00	26	109	50.0	81	59	27	60	25.9	60	<10
Greywings	J47	5/25/00	22	95	20.7	139	24	19	99	6.8	<10	<10
Grouville Spring	J100	5/22/00	102	87	24.6	158	85	27	70	1.8	<10	<10
Highfield hotel	J60	5/26/00	9	78	17.8	81	25	19	49	12.3	40	<10
Homefields Farm	J107	5/19/00	87	151	49.8	199	114	44	88	7.4	<10	<10
Hougue Bie Nursery	J81	5/19/00	4	64	20.1	77	36	18	36	2.4	10	<10
L'Auberge du Nord	J48	5/23/00	32	46	9.7	64	26	12	24	7.7	<10	10
La Cachette	J118	5/25/00	132	83	4.6	54	57	14	46	1.2	50	<10
La Hauteur	J115	5/16/00	70	140	10.5	114	84	19	51	10.2	990	280
La Maison du Puits	J129	5/16/00	79	133	19.0	73	84	15	48	20.8	10	10
La Mare Vineyard	J67	5/23/00	48	84	10.3	68	31	13	59	6.6	20	<10
La Moye Golf Club (4)	J128a	5/18/00	266	62	5.7	38	92	9	40	2.8	20	<10

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La Moye Golf Club (5)	J128b	5/18/00	178	38	5.0	29	63	6	32	1.1	<10	<10
La Villaise	J112	5/16/00	60	128	30.2	97	93	15	48	33.8	<10	<10
Les Bourgeons	J25	5/24/00	81	79	9.0	117	66	19	40	3.9	50	<10
Les Mauves	J02	5/25/00	31	82	20.7	87	53	15	44	15.6	30	30
Manor Farm	J79	5/24/00	10	50	23.1	67	31	16	32	17.0	30	20
Meadow Springs	J76	5/19/00	41	52	25.6	68	52	13	40	1.7	40	<10
Northlynn Farm	J119	5/23/00	18	43	12.5	62	19	12	30	21.8	10	<10
Oakbank	J80	5/24/00	1	70	29.1	56	39	19	38	8.0	150	<10
Parade Park	J37	5/22/00	292	53	<0.5	93	84	14	71	1.7	270	1820
Priory Inn	J20	5/23/00	17	75	19.9	78	33	18	51	5.8	40	<10
Shredding Site	J124	5/18/00	50	61	1.0	72	22	11	46	2.0	30	<10
Quennevais Campsite	J19	5/15/00	65	66	9.8	73	41	11	57	1.7	40	<10
Ronez Quarry	J58	5/23/00	77	48	1.7	52	19	13	34	1.6	10	40
St Helier Nursery	J30	5/22/00	27	45	14.6	75	31	7	53	2.0	60	<10
St Peter Nursery	J15	5/15/00	60	60	4.6	183	48	22	57	2.3	60	<10
States Farm B/H b (3)	J65B	5/26/00	19	39	7.2	59	13	9	28	27.0	50	20
States Farm Well	J66	5/26/00	62	59	36.5	85	62	25	30	14.5	40	240
Stonewall Farm	J31	5/25/00	131	77	19	62	79	11	51	3.4	140	<10
Surville Cemetery	J125	5/22/00	39	55	16.5	61	29	21	31	4.4	30	<10
Tesson Mill	J84	5/17/00	133	98	15.3	103	75	19	60	2.6	<10	<10
Val Bachelier Farm	J127	5/16/00	20	129	43.8	107	67	26	66	30.0	20	20
Val de la Mare	J05	5/17/00	71	107	4.0	37	31	12	63	2.1	30	30
Val de la Mare Farm	J13	5/25/00	54	124	25.9	113	64	21	74	12.1	30.0	<10
Westways(b)	J117b	5/25/00	57	105	32.1	100	61	23	63	18.5	<10	20