

EA South West Box 11



ENVIRONMENT
AGENCY

ENVIRONMENT PROTECTION DEPARTMENT
CORNWALL AREA

FINAL DRAFT REPORT

PORTHLUNEY (CAERHAYS) BATHING
WATER FAILURES

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COR/2000/1

Author: Rob Hocking
Environment Protection
Investigations Officer

Geoff Boyd
Area Manager



PORHLUNEY (CAERHAYS) BATHING WATER FAILURES

1. INTRODUCTION

1.1 Background

The Porthluney (Caerhays) EC Designated Bathing Water (81814942) on the south coast of Cornwall is sampled in accordance with the EC Bathing Water Directive (76/160/EEC). From 1990 to date individual samples have exceeded the imperative standards of the Directive on ten occasions, causing overall failures three times, in 1991, 1998 and 1999 (this does not include Enterovirus or Salmonella data). The archived data shows that the bathing water at Porthluney is strongly influenced by the stream input on the eastern side of the beach. Samples taken from the stream show occasional elevated concentrations of faecal and total coliforms, usually coinciding with previous or current rainfall events. Seven out of the ten exceeding samples were collected in the month of September. The catchment surrounding the Caerhays Stream is used mainly by the agricultural industry for dairy and arable farming. There are no major sewage inputs to the catchment.

1.2 Objective

To identify the main bacterial inputs to the Caerhays Stream which cause EC Bathing Water Directive non-compliance at Porthluney Beach.

1.3 Water Quality Standards

The EC Bathing Water Directive imperative standards for total and faecal coliforms are 10,000 and 2,000 per 100ml respectively. Twenty samples are usually collected from an EC designated bathing beach, more than one exceeding sample causes a failure to comply with the EC Bathing Water Directive for that particular year. The official bathing season is from the beginning of May to the end of September.

2. METHODS

- 2.1 Review the archived bathing water and stream water quality data since 1990.
- 2.2 Conduct a catchment visit with Chris Hitchings (Central Team Environment Protection Officer) to identify known and potential sources of bacterial contamination.
- 2.3 Compile a program of additional monitoring of the Caerhays Stream coinciding with the routine statutory bathing water sampling (usually weekly).
- 2.4 Conduct water quality surveys during and after periods of wet weather to identify sources of bacterial contamination to the Caerhays Stream.
- 2.5 Release a small quantity of fluorescein dye from the Caerhays Stream to demonstrate the transport of freshwater across the bathing water monitoring point.
- 2.6 Collect sediment samples from sites throughout the Caerhays Stream catchment to obtain bacteria in sediment data.



3. RESULTS

The following table lists the location of the data collected and figures showing the catchment and sample sites.

Data	Table	Figure
Caerhays Stream and Tributaries Monitoring (1999)	1 & 2	-
Caerhays Stream and Tributaries Sediment Data (1999)	3	-
Wet Weather Survey Data (1/11/99)	4	-
Wet Weather Survey Data (10/12/99)	5	-
Wet Weather Survey Data (17/12/99)	6	-
Catchment map showing survey sites	-	1
Dye Survey Photographs	-	2 - 7
1999 Rainfall Data for Heligan Gardens	Appendix 1	-

4. DISCUSSION

4.1 Archived Data

A study of the archived routine monitoring data clearly shows the cause of bathing water exceedences at Porthluney Beach to be freshwater influence from the Caerhays Stream. The degree of influence is determined by a number of factors including tidal state, wind direction, sample depth and the flow from the Caerhays Stream. A summary of the exceeding samples is shown in the table below.

Porthluney Beach (81914942)

List of Samples Exceeding Imperative Values for Total and Faecal Coliforms

Date	Time (BST)	High Tide (BST)	Total Coliforms (No./100ml)	Faecal Coliforms (No./100ml)	Faecal Streps (No./100ml)	Salinity (g/kg)	% Freshwater	Wind Direction	Rainfall (mm) Past 24 hrs	Rainfall (mm) Today
09-Aug-91	11:25	5:20	22700.0	1600.0	446.0	No Result	No Result	SW	0.0	0.0
29-Sep-91	12:50	5:05	14300.0	6400.0	1000.0	20.5	42.1	N	4.6	0.0
01-Jul-92	12:11	6:39	42000.0	3400.0	80.0	No Result	No Result	NW	1.4	0.0
16-Jul-93	10:30	3:14	6400.0	4000.0	1100.0	26.0	26.6	SW	17.6	0.0
07-Sep-95	13:50	4:45	3000.0	2070.0	5000.0	31.5	11.0	S	15.0	12.3
04-Sep-98	12:00	4:25	11200.0	4506.0	1060.0	21.3	39.8	S	2.9	14.6
08-Sep-98	13:15	7:21	2800.0	2500.0	340.0	32.1	9.3	SW	8.4	6.1
26-Sep-98	13:05	8:50	9000.0	6480.0	2400.0	32.4	8.5	E	13.2	7.9
10-Sep-99	10:35	6:24	6600.0	7600.0	1430.0	11.9	66.4	SE	0.0	0.0
16-Sep-99	12:05	9:40	> 20000.0	> 20000.0	12800.0	26.5	35.1	SE	28.5	5.8

The table above clearly demonstrates a significant correlation between rainfall events and exceeding samples. In only two out of the ten exceeding samples was there no rainfall either on the day or previous day of sampling (daily rainfall is recorded from 09:00 - 09:00). It should also be noted that the second dry weather exceeding sample, taken on 10/09/99 had a salinity of 11.9g/kg. This represents over 66% freshwater and clearly demonstrates the significance of the freshwater influence at Porthluney Beach.

4.2 1999 Caerhays Stream Monitoring

At the beginning of the 1999 bathing season five sites in the Caerhays Stream catchment (three from the main stream and two tributaries with known water quality problems) were sampled coincident with the statutory bathing water samples. A study of the initial results showed that coliform concentrations in the Caerhays stream were low during periods of dry weather and therefore further sampling was only to be conducted after or during wet weather events. The first sampling run was conducted during a period of light rainfall. The two tributaries (sites 9 and 15) both contained high coliform concentrations (total coliforms up to 200,000/100ml). (See tables 1 & 2).

4.3 Sediment Data

One high total coliform result was found at site 15 but there were not sufficient sediment samples to draw any significant conclusions (see table 3).

4.4 Wet Weather Surveys

During this investigation three small surveys were conducted at times of wet weather. It was hoped for at least one larger scale survey to be conducted but this was not possible for varying reasons ranging from the unpredictable weather to sampling and lab staff shortages. During each survey seventeen sites were visited both on the Caerhays Stream and the main tributaries prior to their confluence (see figure 1). The three surveys conducted did however highlight catchment wide bacterial contamination.

01/11/99 Survey

The rainfall recorded at Heligan Gardens (approximately 5km from Porthluney Beach) on 1/11/99 was 5.7mm. This is not considered a significant rainfall event but it was sufficient to cause runoff from the land and discoloration in the tributaries and the main Caerhays Stream. High concentrations of both total and faecal coliforms were found throughout the catchment. Three tributaries (sites 3, 9 & 14) contained significant concentrations of total and faecal coliforms (total coliforms up to 550,000/100ml) See Table 4. At both sites 3 and 9 the sampler noted the smell of farm waste. The sample taken from the bathing water monitoring point at Porthluney exceeded the mandatory faecal coliform standard of 2000/100ml with a presumptive count of 2700/100ml.

These data are representative of September concentrations when a wet weather event causes increased rivers flows following a dry period. October 1999 was a relatively dry month with 28.0mm being recorded at the Heligan Gardens rain gauge (see Appendix 1).

10 & 17/12/99

The surveys on 10 & 12/12/99 were conducted immediately following a period of light rain. Both were time limited due to the availability of laboratory staff. The surveys followed an extended period of consistent rainfall at the end of November and early December. The recorded concentrations were therefore significantly lower than those measured during the wet weather event following a dry period (see Tables 5 & 6). The bacterial matter from the surrounding catchment had been washed into the Caerhays Stream by the earlier rainfall.

4.5 Dye Release

At 14:00 on 18/01/00 (HW -0.5) one litre of fluorescein dye was released into the Caerhays Stream 20 yards upstream of the Porthluney Beach. The beach is situated in a cove approximately 300 metres wide with the Caerhays Stream entering the beach at the eastern end. The dye movement showed that the prevailing tidal currents cause some of the freshwater to be advected from east to west across the beach (see Figures 2 - 7).

5. CONCLUSIONS

5.1 The results from this investigation indicate that the occasionally poor bacterial water quality in the Caerhays Stream is likely to be caused by diffuse agricultural runoff throughout the catchment. Some areas of more significant contamination were identified.

During periods of dry weather coliform concentrations in the Caerhays Stream are relatively low and should not cause non-compliance at the bathing water monitoring point.

5.2 Porthluney bathing beach exceedences are caused by the freshwater influence from the Caerhays Stream. The degree of influence is determined mainly by sample depth, tidal state and stream flow.

6. RECOMMENDATIONS

6.1 Compile and maintain a program of farm visits to encourage agricultural practices that will help improve the water quality in the Caerhays Stream catchment by reducing run-off during wet weather events.

Action: Environment Protection Team Leader (Central)

6.2 Recommend that the Caerhays Stream catchment to be included in the Influence of Land Use on Bathing Water Quality R & D project. The project will study the effect of an agricultural, riverine catchment on an EC designated bathing water. The project would be undertaken in the 2000-bathing season.

Action: Environment Protection Investigations Team Leader

6.3 Include total coliform analysis in the Caerhays Stream samples (81811103) which are taken coinciding with the routine bathing water samples. This was dropped in 1998 and a misunderstanding between the Agency and the Public Health Laboratory which analyses Cornwall Area's bathing water samples meant that the reinstatement was delayed at the beginning of the 1999 bathing beach season.

Action: Environment Protection Monitoring Team Leader

6.4 Install a sub daily logging rain gauge within the Caerhays Stream catchment to gain accurate rainfall data. This data would also be of valuable use to the R & D project if approved.

Action: Environment Protection Investigations Team Leader

6.5 Install a flow logger at site 13 (u/s of tidal influence). Should future exceedences occur, flow data would be valuable when establishing the cause of the exceedences.

Action: Water Resources Team Leader

TABLE 1

Caerhays Stream at Polmassick Bridge (81811160)

Site 8

Date	Time	Total Coliforms (no./ 100ml)	Faecal Coliforms (no./ 100ml)	Faecal Streps (no./ 100ml)	Rainfall (mm) Past 24 hrs	Rainfall (mm) Today's
08/05/99	11:45	7100.0	2800.0	450.0	1.7	5.8
14/05/99	10:55	7200.0	2000.0	620.0	0.0	0.0
26/05/99	15:15	4500.0	3500.0	260.0	0.0	0.0
01/06/99	10:30	3800.0	2500.0	350.0	0.0	18.0
07/06/99	9:30	1850.0	1110.0	280.0	11.0	1.8
13/06/99	8:05	820.0	800.0	210.0	0.0	0.0
17/06/99	11:05	1530.0	1490.0	200.0	0.0	0.0
05/07/99	9:55	5200.0	2500.0	280.0	0.3	0.0
12/07/99	11:10	1170.0	1030.0	370.0	0.0	0.0
16/09/99	11:30	105000.0	96000.0	51000.0	28.5	5.8

Caerhays Stream at Tubbs Mill (81811127)

Site 10

Date	Time	Total Coliforms (no./ 100ml)	Faecal Coliforms (no./ 100ml)	Faecal Streps (no./ 100ml)	Rainfall (mm) Past 24 hrs	Rainfall (mm) Today's
08/05/99	12:00	9000.0	2500.0	390.0	1.7	5.8
14/05/99	11:15	3200.0	2200.0	320.0	0.0	0.0
26/05/99	15:30	2400.0	1760.0	90.0	0.0	0.0
01/06/99	10:45	2200.0	2200.0	150.0	0.0	18.0
07/06/99	9:45	1270.0	750.0	260.0	11.0	1.8
13/06/99	8:20	1330.0	1250.0	140.0	0.0	0.0
17/06/99	11:18	1660.0	1580.0	170.0	0.0	0.0
05/07/99	10:10	3400.0	1170.0	270.0	0.3	0.0
12/07/99	11:25	5100.0	4600.0	470.0	0.0	0.0
16/09/99	11:50	112000.0	89000.0	66000.0	28.5	5.8

Caerhays Stream at 2nd Footbridge (81811111)

Date	Time	Total Coliforms (no./ 100ml)	Faecal Coliforms (no./ 100ml)	Faecal Streps (no./ 100ml)	Rainfall (mm) Past 24 hrs	Rainfall (mm) Today's
08/05/99	12:15	55000.0	3100.0	460.0	1.7	5.8
14/05/99	11:40	2600.0	800.0	50.0	0.0	0.0
26/05/99	15:50	630.0	520.0	680.0	0.0	0.0
01/06/99	11:25	1800.0	2100.0	170.0	0.0	18.0
07/06/99	10:40	3100.0	1590.0	440.0	11.0	1.8
13/06/99	10:45	1470.0	1090.0	90.0	0.0	0.0
17/06/99	11:40	3300.0	1550.0	110.0	0.0	0.0
05/07/99	10:35	1240.0	950.0	200.0	0.3	0.0
12/07/99	12:10	2500.0	2300.0	270.0	0.0	0.0

Caerhays Stream prior to Beach (81811103)

Site 16

Date	Time	Total Coliforms (no./ 100ml)	Faecal Coliforms (no./ 100ml)	Faecal Streps (no./ 100ml)	Rainfall (mm) Past 24 hrs	Rainfall (mm) Today's
03/05/99	11:30	No Result	580.0	100.0	0.0	0.0
08/05/99	11:40	No Result	11100.0	1040.0	1.7	5.8
14/05/99	11:05	No Result	970.0	150.0	0.0	0.0
26/05/99	17:20	No Result	510.0	100.0	0.0	0.0
01/06/99	10:14	No Result	2700.0	200.0	0.0	18.0
07/06/99	14:05	No Result	6100.0	0.0	11.0	1.8
13/06/99	10:45	No Result	1030.0	130.0	0.0	0.0
17/06/99	11:35	No Result	1440.0	210.0	0.0	0.0
23/06/99	10:33	No Result	2000.0	180.0	0.0	0.0
05/07/99	12:15	No Result	3000.0	420.0	0.3	0.0
12/07/99	14:35	5100.0	2100.0	240.0	0.0	0.0
17/07/99	11:27	2600.0	1150.0	240.0	0.0	0.0
23/07/99	10:30	3200.0	950.0	210.0	0.0	0.0
28/07/99	12:55	7800.0	2200.0	650.0	0.0	0.0
04/08/99	10:45	4000.0	3000.0	No Result	0.0	31.1
12/08/99	12:40	4600.0	3300.0	460.0	1.5	0.0
21/08/99	10:35	8400.0	2800.0	2200.0	0.0	0.0
29/08/99	12:00	20000.0	5600.0	340.0	0.0	0.0
10/09/99	10:40	10800.0	6800.0	2600.0	0.0	0.0
16/09/99	12:10	20000.0	20000.0	20000.0	28.5	5.8

TABLE 2

**Lanuah Trib
Site 9**

Date	Time	Total Coliforms (no./ 100ml)	Faecal Coliforms (no./ 100ml)	Faecal Streps (no./ 100ml)	Rainfall (mm) Past 24 hrs	Rainfall (mm) Today's
08/05/99	11:50	200000.0	195000.0	10600.0	1.7	5.8
14/05/99	11:00	8600.0	2200.0	430.0	0.0	0.0
26/05/99	15:17	3800.0	1150.0	160.0	0.0	0.0
01/06/99	10:35	3100.0	1230.0	70.0	0.0	18.0
07/06/99	7:35	2100.0	1000.0	230.0	11.0	1.8
13/06/99	8:00	1800.0	830.0	230.0	0.0	0.0
17/06/99	11:07	3200.0	2200.0	190.0	0.0	0.0
05/07/99	10:57	10800.0	1660.0	280.0	0.3	0.0
16/09/99	11:35	132000.0	118000.0	29000.0	28.5	5.8

**Tregavarras Trib
Site 15**

Date	Time	Total Coliforms (no./ 100ml)	Faecal Coliforms (no./ 100ml)	Faecal Streps (no./ 100ml)	Rainfall (mm) Past 24 hrs	Rainfall (mm) Today's
08/05/99	12:10	87000.0	66000.0	10300.0	1.7	5.8
14/05/99	11:35	10800.0	8300.0	180.0	0.0	0.0
26/05/99	16:00	3500.0	2300.0	350.0	0.0	0.0
01/06/99	11:30	5000.0	4200.0	160.0	0.0	18.0
07/06/99	10:45	2000.0	1150.0	470.0	11.0	1.8
13/06/99	8:45	3400.0	2000.0	80.0	0.0	0.0
17/06/99	11:35	3800.0	2500.0	200.0	0.0	0.0
05/07/99	10:37	33000.0	26000.0	6300.0	0.3	0.0
12/07/99	12:05	12300.0	11100.0	5800.0	0.0	0.0

TABLE 3

Caerhays Stream and Tributaries Sediment Results

Site No.	Description	Total Coliforms (No./100ml)	Faecal Coliforms (No./100ml)	Faecal Strep. (No./100ml)
1	D/s of Hewaswater	No sample taken		
2	Lower Sticker D/s CSO	2500.0	250.0	73.0
3	Carwinnick Trib.	8200.0	1600.0	6500.0
4	D/s of Paramoor Wood	330.0	42.0	230.0
5	Carlooze Bridge	1700.0	270.0	280.0
6	Bridge D/s of Tregain	280.0	155.0	173.0
7	Trib D/s of St Ewe STW (81811349)	10000.0	900.0	38.0
8	Caerhays Stream at Polmassick Bridge (81811160)	9600.0	530.0	91.0
9	Lanuah Trib. D/s of Polmassick Bridge	3800.0	800.0	300.0
10	Caerhays Stream at Tubbs Mills Bridge (8181112)	1500.0	210.0	200.0
11	Trevennen Trib.	1200.0	173.0	2600.0
12	Trib. East of Trevennen Trib.	1700.0	450.0	1600.0
13	Caerhays Stream at the Estate Weir	5700.0	1100.0	290.0
14	Rescassa Trib.	10000.0	1600.0	550.0
15	Tregavarras Trib	100000.0	700.0	270.0
16	Caerhays Stream prior to the beach (81811103)	3100.0	280.0	87.0

TABLE 4

Wet Weather Survey Data (01/11/99)

Site No.	Description	Time (GMT)	BOD (mg/l)	NH4 (mg/l)	Solids (mg/l)	Total Coliforms (No./100ml)	Faecal Coliforms (No./100ml)	Faecal Streps (No./100ml)	Salinity (g/kg)	Comments
1	D/s of Hewaswater	11:50	<4.00	<0.50	6.2	42000.0	34000.0	76000.0		
2	Lower Sticker D/s CSO	11:30	<4.00	<0.50	47.0	31000.0	11000.0	10000.0		
3	Carwinnick Trib.	12:02	10.80	<0.50	161.0	240000.0	80000.0	42000.0		Faint smell of farm waste
4	D/s of Paramoor Wood	11:40	<4.00	<0.50	42.0	23000.0	20000.0	17700.0		
5	Carlooze Bridge	12:10	4.51	<0.50	155.0	18700.0	10700.0	23000.0		
6	Bridge D/s of Tregain	12:21	<4.00	<0.50	182.0	31000.0	13100.0	8400.0		
7	Trib D/s of St Ewe STW (81811349)	12:20	<4.00	<0.50	43.0	29000.0	31000.0	11200.0		
8	Caerhays Stream at Polmassick Bridge (81811160)	12:55	6.63	0.56	124.0	42000.0	23000.0	96000.0		
9	Lanuah Trib. D/s of Polmassick Bridge	12:30	13.40	<0.50	62.0	550000.0	240000.0	1490000.0		Water smells of farm waste
10	Caerhays Stream at Tubbs Mills Bridge (81811127)	12:50	<4.00	<0.50	116.0	31000.0	6900.0	7800.0		
11	Trevennen Trib.	12:45	9.47	<0.50	35.0	91000.0	58000.0	58000.0		
12	Trib. East of Trevennen Trib.	12:40	<4.00	<0.50	32.0	3800.0	3300.0	3200.0		
13	Caerhays Stream at the Estate Weir	13:05	2.70	<0.50	29.6	11300.0	7900.0	8500.0		
14	Rescassa Trib.	13:10	23.20	0.58	42.6	480000.0	90000.0	21000.0		
15	Tregavarras Trib	13:22	<4.00	<0.50	18.0	16000.0	25000.0	23000.0		
16	Caerhays Stream prior to the beach (81811103)	13:35	3.60	<0.50	19.0	24000.0	17400.0	20000.0	<1.0	
17	Porthluney Beach (81814942)	13:38				4000.0	2700.0	2900.0	29.7	

TABLE 5

Wet Weather Survey Data (10/12/99)

Site No.	Description	Date	Time (GMT)	BOD (mg/l)	NH4 (mg/l)	Solids (mg/l)	Total Coliform (No./100ml)	Faecal Coliform (No./100ml)	Faecal Streps (No./100ml)	Salinity (g/kg)	Comments
1	D/s of Hewaswater	10/12/99	15:37	<3.00	<0.50	24.5	8550.0	6200.0	4500.0		
2	Lower Sticker D/s CSO	10/12/99	15:25	1.6	<0.50	33.0	10200.0	6900.0	2090.0		
3	Carwinnick Trib.	10/12/99	16:29	3.2	<0.50	47.7	6700.0	4600.0	2800.0		
4	D/s of Paramoor Wood	10/12/99	16:03	1.0	<0.50	<6.0	1850.0	1650.0	2300.0		
5	Carlooze Bridge	10/12/99	16:21	1.1	<0.50	9.7	909.0	836.0	560.0		
6	Bridge D/s of Tregain	10/12/99	16:15	1.1	<0.50	<6.0	3900.0	2700.0	1820.0		
7	Trib D/s of St Ewe STW (81811349)	10/12/99	16:57	1.4	<0.50	21.7	25000.0	11400.0	1450.0		
8	Caerhays Stream at Polmassick Bridge (8181116)	10/12/99	16:47	1.1	<0.50	6.9	1240.0	1110.0	510.0		
9	Lanuah Trib. D/s of Polmassick Bridge	10/12/99	16:49	2.6	<0.50	46.5	56000.0	33000.0	10700.0		
10	Caerhays Stream at Tubbs Mills Bridge (8181111)	10/12/99	16:00	1.0	<0.50	8.1	2700.0	864.0	360.0		
11	Trevennen Trib.	10/12/99	15:56	1.7	<0.50	44.0	2500.0	1450.0	400.0		
12	Trib. East of Trevennen Trib.	10/12/99	15:50	1.2	<0.50	25.3	936.0	891.0	164.0		
13	Caerhays Stream at the Estate Weir	10/12/99	16:10	1.1	<0.50	6.9	1950.0	2100.0	550.0		
14	Rescassa Trib.	10/12/99	16:12	<3.0	<0.50	16.1	1050.0	918.0	530.0		
15	Tregavarras Trib	10/12/99	16:24	<1.0	<0.50	87.7	3800.0	2400.0	1550.0		
16	Caerhays Stream prior to the beach (81811103)	10/12/99	16:40	1.4	<0.50	9.7	2300.0	1110.0	530.0	<1.0	
17	Porthluney Beach (81814942)	10/12/99	16:36	No Result	<0.50	No Result	109.0	73.0	55.0	32.9	Guideline Depth
18	Porthluney Beach (81814942)	10/12/99	16:38	No Result	<0.50	No Result	320.0	330.0	91.0	30.5	

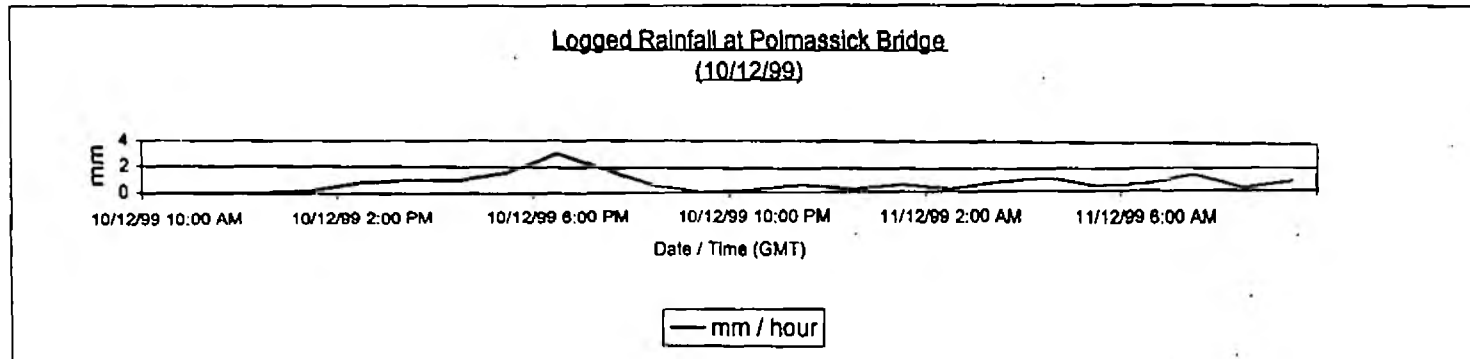


TABLE 6

Wet Weather Survey Data (17/12/99)

Site No.	Description	Date	Time (GMT)	BOD (mg/l)	NH4 (mg/l)	Solids (mg/l)	Total Coliform (No./100ml)	Faecal Coliform (No./100ml)	Faecal Streps (No./100ml)	Salinity (g/kg)	Comments
1	D/s of Hewaswater	17/12/99	09:01	1.3	<0.50	No Result	2500.0	1660.0	2400.0		
1		17/12/99	12:15	3.1	<0.50	89.5	3700.0	3800.0	2800.0		
2	Lower Sticker D/s CSO	17/12/99	08:41	1.0	<0.50	No Result	3700.0	3500.0	460.0		
2		17/12/99	11:41	<1.0	<0.50	11.2	800.0	780.0	770.0		
3	Carwinnick Trib.	17/12/99	09:15	2.0	0.78	No Result	1340.0	1350.0	560.0		
3		17/12/99	12:25	2.2	<0.50	52.8	1240.0	1030.0	520.0		
4	D/s of Paramoor Wood	17/12/99	08:51	1.0	<0.50	No Result	2000.0	2100.0	800.0		
4		17/12/99	11:45	1.2	<0.50	6.8	1220.0	1060.0	700.0		
5	Carlooze Bridge	17/12/99	09:21	1.2	<0.50	28.8	620.0	660.0	320.0		
5		17/12/99	12:27	1.2	0.60	56.0	845.0	836.0	400.0		
6	Bridge D/s of Tregain	17/12/99	09:35	2.0	<0.50	28.0	4400.0	4600.0	964.0		
6		17/12/99	12:31	1.7	<0.50	6.4	2800.0	2400.0	1580.0		
7	Trib D/s of St Ewe STW (81811349)	17/12/99	09:39	<1.0	<0.50	20.4	3700.0	3200.0	440.0		
7		17/12/99	12:37	1.1	<0.50	34.4	5700.0	5600.0	400.0		
8	Caerhays Stream at Polmassick Bridge (8181116)	17/12/99	09:41	2.0	<0.50	43.6	6400.0	4200.0	470.0		
8		17/12/99	12:43	1.6	<0.50	25.2	2100.0	1440.0	320.0		
9	Lanuah Trib. D/s of Polmassick Bridge	17/12/99	09:45	1.4	<0.50	26.0	5400.0	4000.0	640.0		
9		17/12/99	12:43	2.3	<0.50	56.0	9450.0	7200.0	4700.0		
10	Caerhays Stream at Tubbs Mills Bridge (818111)	17/12/99	09:02	1.4	<0.50	44.0	7900.0	2700.0	350.0		River Fairly Discoloured
10		17/12/99	11:42	1.7	<0.50	38.4	2300.0	2100.0	400.0		
11	Trevennen Trib.	17/12/99	09:00	1.1	<0.50	28.4	1520.0	1480.0	210.0		
11		17/12/99	11:38	1.1	<0.50	27.6	260.0	230.0	200.0		
12	Trib. East of Trevennen Trib.	17/12/99	08:56	1.1	<0.50	57.2	600.0	520.0	270.0		
12		17/12/99	11:34	<1.0	<0.50	38.0	380.0	310.0	100.0		
13	Caerhays Stream at the Estate Weir	17/12/99	09:26	1.4	<0.50	02/12/99	5500.0	2300.0	310.0		
13		17/12/99	11:52	1.4	<0.50	47.2	2300.0	2600.0	680.0		
14	Rescassa Trib.	17/12/99	09:24	2.1	<0.50	41.6	16600.0	14800.0	2800.0		Fairly high flow
14		17/12/99	11:54	3.1	<0.50	38.0	16100.0	10450.0	800.0		
15	Tregavarras Trib	17/12/99	09:44	1.2	<0.50	10.8	33000.0	26000.0	360.0		
15		17/12/99	12:12	1.0	<0.50	14.4	3900.0	2900.0	520.0		
16	Caerhays Stream prior to the beach (8181103)	17/12/99	10:00	1.3	<0.50	39.6	5200.0	4000.0	430.0	0.5	
16		17/12/99	12:20	1.5	<0.50	44.4	3800.0	2100.0	640.0	0.5	
17	Porthuney Beach (81814942)	17/12/99	09:58				2200.0	1740.0	250.0	16.4	Shallow Depth
17		17/12/99	12:24				1260.0	800.0	109.0	26.3	Shallow Depth
18		17/12/99	09:56				827.0	740.0	220.0	26.1	Guideline Depth
18		17/12/99	12:22				360.0	340.0	100.0	30.2	Guideline Depth

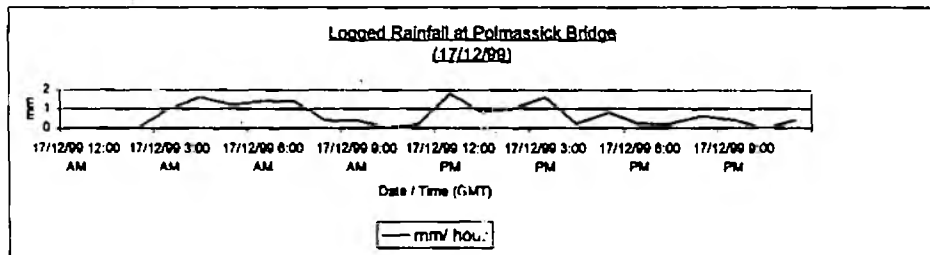


Figure 1
Caerhays Stream Catchment Sample Sites

- 1 D/s of Hewaswater
- 2 Lower Sticker D/s CSO
- 3 Carwinnick Trib.
- 4 D/s of Paratrooper Wood
- 5 Carboze Bridge
- 6 Bridge D/s of Tregain
- 7 Trib D/s of St Ewe STW (81811349)
- 8 Caerhays Stream at Polmassick Bridge (81811160)
- 9 Lanush Trib. D/s of Polmassick Bridge
- 10 Caerhays Stream at Tubbs Mills Bridge (81811127)
- 11 Trevennen Trib.
- 12 Trib. East of Trevennen Trib.
- 13 Caerhays Stream at the Estate Weir
- 14 Rescassa Trib.
- 15 Tregavarras Trib
- 16 Caerhays Stream prior to the beach (81811103)
- 17 Porthluney Beach (81814942)





Figure2.JPG



Figure3.JPG



Figure4.JPG



Figure5.JPG



Figure6.JPG



Figure7.JPG

Environment Agency Cornwall Area

GAUGE REFERENCE : 377657
M.O. REFERENCE : 377657
GAUGE TYPE : Storage
RAIN DAY START : 09:00 GMT

STATION NAME : HELIGAN GARDEN
LOCATION : HELIGAN, ST AUSTELL
GRID REF : SX 001 463
ALTITUDE : 70.0 m

Annual Summary : 1999

Record Type : Archive file
Quality Level: Mixed Quality

Daily Rainfall totals recorded in mm

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1	16.5	-	2.3	2.3	-	25.7	0.2	-	-	7.2 Q	5.7 Q	1.1 Q	1
2	9.9	-	10.9	2.3	-	14.6	0.5	-	-	5.8 Q	1.0 Q	0.3 Q	2
3	8.2	-	9.5	0.2	-	6.1	-	-	-	1.6 Q	0.9 Q	2.8 Q	3
4	4.4	-	8.5	4.9	-	11.7	0.4	22.1 Q	-	-	20.7 Q	0.4 Q	4
5	-	-	4.2	3.0	0.9	5.4	-	22.3 Q	-	-	9.0 Q	0.1 Q	5
6	1.1	1.2	3.8	5.9	1.0	11.3	-	4.5 Q	0.6 Q	-	0.3 Q	2.0 Q	6
7	8.8	5.9	0.1	0.2	1.8	2.1	-	31.4 Q	0.3 Q	0.1 Q	1.9 Q	2.7 Q	7
8	2.0	11.4	0.2	0.2	5.8	3.8	-	9.8 Q	2.1 Q	-	0.1 Q	6.6 Q	8
9	-	1.2	T	1.2	7.2	-	-	5.5 Q	-	1.2 Q	-	7.1 Q	9
10	-	1.4	-	0.6	1.4	-	-	-	-	0.2 Q	-	16.7 Q	10
11	2.9	-	-	10.3	0.5	-	-	5.9 Q	1.3 Q	-	-	18.7 Q	11
12	2.9	4.2 e	-	0.3	-	-	-	-	1.3 Q	-	-	7.3 Q	12
13	2.8	0.1	-	5.1	1.9	-	-	3.7 Q	-	-	-	9.2 Q	13
14	0.8	2.3	0.1	10.2	0.1	-	-	0.2 Q	-	0.2 Q	-	1.0 Q	14
15	27.5	-	-	0.3	-	-	0.2	0.4 Q	29.6 Q	0.1 Q	1.9 Q	0.3 Q	15
16	3.9	-	-	-	-	-	T	4.1 Q	7.4 Q	0.1 Q	2.1 Q	6.5 Q	16
17	0.2	1.6	-	2.1	2.8	-	-	15.4 Q	10.1 Q	-	11.0 Q	31.6 Q	17
18	11.2	10.4	-	0.2	0.1	2.0	1.9	6.3 Q	5.9 Q	-	-	36.7 Q	18
19	28.3	9.1	-	21.5	-	0.5	3.2	-	0.1 Q	-	-	-	19
20	0.2	0.4	1.1	9.4	-	-	0.5	-	15.2 Q	-	0.1 Q	22.2 Q	20
21	-	4.3	0.4	1.9	0.5	-	0.2	0.5 Q	0.6 Q	5.5 Q	0.6 Q	0.1 Q	21
22	-	0.2	-	15.1	T	0.8	T	1.0 Q	1.6 Q	1.1 Q	1.4 Q	14.8 Q	22
23	3.8	8.3	-	-	T	T	-	22.1 Q	1.1 Q	2.6 Q	1.4 Q	25.6 Q	23
24	2.4	0.1	6.0	22.5	T	-	-	25.4 Q	6.8 Q	0.4 Q	5.0 Q	21.9 Q	24
25	0.3	0.5	0.5	16.2	-	-	-	2.9 Q	2.5 Q	-	1.1 Q	12.7 Q	25
26	4.6	6.0	-	0.5	-	5.7	-	0.1 Q	9.6 Q	-	8.9 Q	6.2 Q	26
27	0.2	-	-	-	15.9	0.4	-	-	5.0 Q	-	0.2 Q	8.7 Q	27
28	0.6	17.1	5.2	-	0.5	15.1	-	-	5.5 Q	-	15.2 Q	1.0 Q	28
29	0.2	-	4.7	-	23.2	0.1	-	-	2.6 Q	1.9 Q	0.2 Q	0.4 Q	29
30	0.9	-	11.2	-	T	5.6	-	-	1.4 Q	-	1.0 Q	7.2 Q	30
31	-	-	0.2	-	-	-	-	-	-	-	-	1.4 Q	31
Totals:	144.6	85.7 e	68.9	136.4	63.6	110.9	7.1	183.6 Q	110.6 Q	28.0 Q	89.7 Q	273.3 Q	
Day:	28.3	17.1	11.2	22.5	23.2	25.7	3.2	31.4 Q	29.6 Q	7.2 Q	20.7 Q	36.7 Q	

Annual Total : 1302.4 mm e

Quality Original Records : E=Edited S=Snow ?=Suspect M=Incomplete T=Trace A=Acc
Quality M.O. Quality cont : e=Edited s=Snow !=Suspect m=Incomplete t=Trace A=Acc
Quality Code : Q = Original Record