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DEVON AREA
INTERNAL REPORT

ENVIRONMENT AGENCY

INVESTIGATION INTO UPSTREAM FAILURES AT PUDDINGTON SEWAGE TREATMENT WORKS.

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(CATCHMENT 05J)

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ENVIRONMENT AGENCY

EA - South West / [illegible]

Investigation into Upstream Failures at Puddington Sewage Treatment Works.

1.0 Introduction

The upstream samples at Puddington Sewage Treatment Works have repeatedly failed to meet their Water Quality Objective (RQO). Appendix 3 shows routine sampling data with failures highlighted. A request to investigate the failures was received from Environment Protection in September 1998.

Puddington sewage treatment works (fig.1) has an unusual set up in that the stream into which the final effluent discharges originates underground in the area of the works. It rises and flows in a network of pipes through the compound and is discharged utilising the same concrete apron as the final effluent, see appendix 1; plate 3.

The stream flows into Binneford Water, which is a tributary of the River Creedy. Binneford Water has a River Ecosystem Use Class of 2 (RE2) (ref. 7.0). See appendix 2 for a table of RE use class standards.

The aim of this investigation is to identify the cause of the upstream failures.

1.1 Project team

Project Manager – Trevor Cronin
Project Leader – Stuart Hunter
Project Officer – Robin Pearson

2.0 Method

An initial site visit was made on 12th October 1998 to map the layout of the works and the upstream sample point. Various manholes and chambers were identified as possible routes for the stream. On 29th October 1998 a second site visit was made, meeting the Environment Protection Officer on site. Drain tracing dye was used to identify the flow of the stream through the works, see figure 2.

The stream was identified as having a number of inputs around the works. A bacteriological survey was planned to try to identify any inputs that were possible sources of contamination to the stream. Twelve sites were sampled, ten within the works and two (final effluent and upstream) outside of the works (fig. 3). The samples were analysed for the microbiological pollution indicators: Faecal Streptococci, Faecal Coliforms and Total Coliforms all measured as number per 100ml. The survey was carried out on 12th November 1998, see Results section 3.2.

2.1 Biological tracer survey

The results of the microbiological survey suggested possible contamination originating in the vicinity of the percolating filter. A second microbiological survey was planned plus a survey using the tracer bacteria Bacillus globigii.

On the 1st February 1999 the second microbiological survey was undertaken, including two extra sites (fig. 3, sites 13 & 14). Also at 11:45 the percolating filter was dosed with 10ml of B.globigii in 1 litre of water. An 'Epic' auto-sampler was used to collect samples from the manhole at sample point 7 (Plates 1 & 2). An 'Epic' sample was taken every 2 hours for 48 hours; the first sample was taken at 13:30.

On 9th March a final site visit was undertaken to make inquiries in the surrounding properties as to their waste water disposal facilities, to try to rule out the possibility of a misconnected septic tank or overflow causing the contamination.

3.0 Results

3.1 Results from dye tracing

Flourescein was used for the dye tracing. Figure 2 shows a layout of the works and the inputs to the upstream as found during the tracing. As can be seen the stream is made up of a number of inputs from different areas of the works. There is the possibility for contamination to enter the stream at a number of different points. The main flow of the stream was established as coming from two pipes. These are shown in figure 3 as a pipe at sample point 8 and a pipe at sample point 3.

A site plan was obtained from South West Water showing drainage channels and effluent pipes throughout the works. Unfortunately the plan had 'Not As Constructed' printed on it so it could only be used as a guideline to the sites layout (Appendix 4).

3.2 Results from Microbiological Surveys

Sites 1 to 12 were sampled on the 12th November 1998. The results are displayed in Table 1. The stream is made up of three main sources within the works:

- Flow from site 11
- Flow from site 8
- Flow from site 3

Approximately 50% of the flow comes from site 3, 45% of the flow from site 8 and the remaining 5% from sites 11 and 9. The results show the main bacterial inputs to the stream. From the results in can be seen the flow between site 11 and site 10 had a low bacteriological count (F.coliforms at site 10: 730 per 100ml). The flow from site 8 (which is in the vicinity of the percolating filter) had high levels of bacterial loading (F.coliforms count of 82727 per 100ml). Site 3, making up the rest of the flow was found to have a low count in comparison (F.coliforms 3200 per 100ml).

Site 6 had the highest Total Coliform count of 160,000, site 7 had the highest Faecal Coliform count of 94545 and site 4 had the highest faecal streptococci count of 7300.

The results from the survey on 1st February show that all sites flowing into the stream had lower bacterial loading than in the previous survey (see table 2). Site 9 had the highest Total Coliform count of 727, site 5 had the highest Faecal Coliform count of 210 and site 5 had the highest faecal streptococci count of 63. There was no flow between sites 10 and 11.

3.3 Results from Biological Tracer Survey

The background levels of B.globigii sampled at 11:25 prior to dosing were <10 per 100ml. The highest B.globigii count found during the survey was 18 per 100ml, found at 19.35 on 02/02/99, see Table 3 for full results. All other samples were found to have counts of less than 10. Unfortunately the auto-sampler did not sample properly for the first 25 hours. The sampler was reset on 2nd February to sample for every 2 hours for 24 hours. Manual samples were also taken.

4.0 Discussion

The microbiological survey results indicated that the stream was receiving the highest concentrations of bacterial loading from sites 6 to 9. Upon inspection of the site plan obtained from SWWL, it is not apparent where these pipes originate. In fact the pipe connecting sites 8 and 9 to site 7 is not shown at all.

Also the construction of the upstream sample point makes it almost impossible to guarantee an upstream sample is taken without some level of contamination from the final effluent discharge, if it is operating (see plate 3).

Initial suspicions were that there might have been a leak from the percolating filter into the stream at site 9. A biological tracing exercise was undertaken in an attempt to prove this theory. Although no significant B.globigii counts were detected, due to the malfunction of the Epic it is impossible to state categorically that no such contamination is taking place.

When rainfall data is compared with routine sample results (Fig. 4) it can be seen there is no apparent correlation between heavy rainfall or low rainfall with upstream failures at Puddington STW. See appendix 3 for full rainfall and sample result data.

The chamber containing sites 5, 6 and 10 is located near the perimeter fence of the works, adjacent to a paddock and a chicken coup. A number of broken eggs were present in this chamber. The eggs must have been deliberately thrown into it (see plate 4, appendix 1). Although this is not believed to be the cause of the failure, it is obviously bad practice and has a potential to influence the results of samples taken of the stream.

5.0 Conclusions

5.1 Microbiological Surveys

The microbiological surveys suggest that the portion of the stream which originates/flows in the vicinity of the filter could lead to possible contamination.

5.2 Contamination from within the works

Due to the dynamics of the site the opportunity for contamination to enter the stream in the works is very high. Pipes that carry the stream run around and underneath the works. Any leakage from the works has the potential to infiltrate the pipe work, or contaminate the water at source.

5.3 Upstream Sample Point

The present location of the upstream sample point makes it almost impossible to take a confident sample when the final effluent is discharging.

6.0 Recommendations

The construction of the final effluent discharge and upstream sample point makes it impossible to take an upstream sample without a high possibility of contamination from the final effluent. Upstream and down stream sampling is not a statutory obligation and could be discontinued; however this would lead to difficulties in determining whether the sewage treatment works is having an impact on the stream. If however upstream and down stream sampling is to continue, work must be undertaken at the point of discharge, to separate the effluent from the stream, and allow uncontaminated stream samples to be collected.

ACTION: Environment Protection Officer.

An attempt should be made to stop the practice of throwing waste eggs into the chamber.

ACTION: Environment Protection Officer.

Discussions to take place with SWWL regarding probable contaminated leakage to the watercourse adjacent to the percolating filter.

ACTION: Environment Protection Officer.

7.0 References

Environment Agency, 1996. *Catchment Management Plan, River Exe Action Plan August 1996.*

Table 1. Showing microbiological sample results on 12th November 1998

Sample Point	Faecal Streptococci No. per 100ml	Faecal Coliforms No. per 100ml	Total Coliforms No. per 100ml
Site 1 (U/S)	5300	34000	61000
Site 2	5000	40000	68000
Site 3	1117	3200	12000
Site 4	7300	71000	140000
Site 5	5000	76000	150000
Site 6	6000	91818	160000
Site 7	3700	94545	89091
Site 8	4000	82727	120000
Site 9	2400	52000	67000
Site 10	370	730	4200
Site 11	570	1273	4900
Site 12 (FE)	65000	100000	460000

Table 2. Showing microbiological sample results on 1st February 1999

Sample Point	Faecal Streptococci No. per 100ml	Faecal Coliforms No. per 100ml	Total Coliforms No. per 100ml
Site 1 (U/S)	27	108	330
Site 2	-	-	-
Site 3	36	36	410
Site 4	9	18	45
Site 5	63	210	560
Site 6	-	-	-
Site 7	9	9	99
Site 8	9	9	135
Site 9	9	36	727
Site 10	No flow		
Site 11	No flow		
Site 12 (FE)	63000	150000	270000
Site 13	630000	3300000	11000000
Site 14	24000	41000	130000

Table 3. Showing B.globigii results from dosing on 1st February 99.

Date	Time of Sample	Number of Glob. Per 100 ml	Type of Sample
01-02-1999	11:25	Background Levels <10	Manual
01-02-1999	12:30	<10	Manual
01-02-1999	12:45	<10	Manual
01-02-1999	13:30	<10	Manual
	NO SAMPLES	**DUE TO MALFUNCTION OF**	**EPIC**
02-02-1999	12:35	<10	Epic
02-02-1999	13:35	<10	Epic
02-02-1999	15:35	9	Epic
02-02-1999	17:35	9	Epic
02-02-1999	19:35	18	Epic
02-02-1999	21:35	<10	Epic
02-02-1999	23:35	<10	Epic
03-02-1999	01:35	<10	Epic
03-02-1999	03:35	<10	Epic
03-02-1999	05:35	<10	Epic
03-02-1999	07:35	9	Epic
03-02-1999	09:35	<10	Epic
03-02-1999	11:35	<10	Epic
03-02-1999	13:35	<10	Manual

Figure 1

A Map Showing Puddington and Puddington Sewage Treatment Works

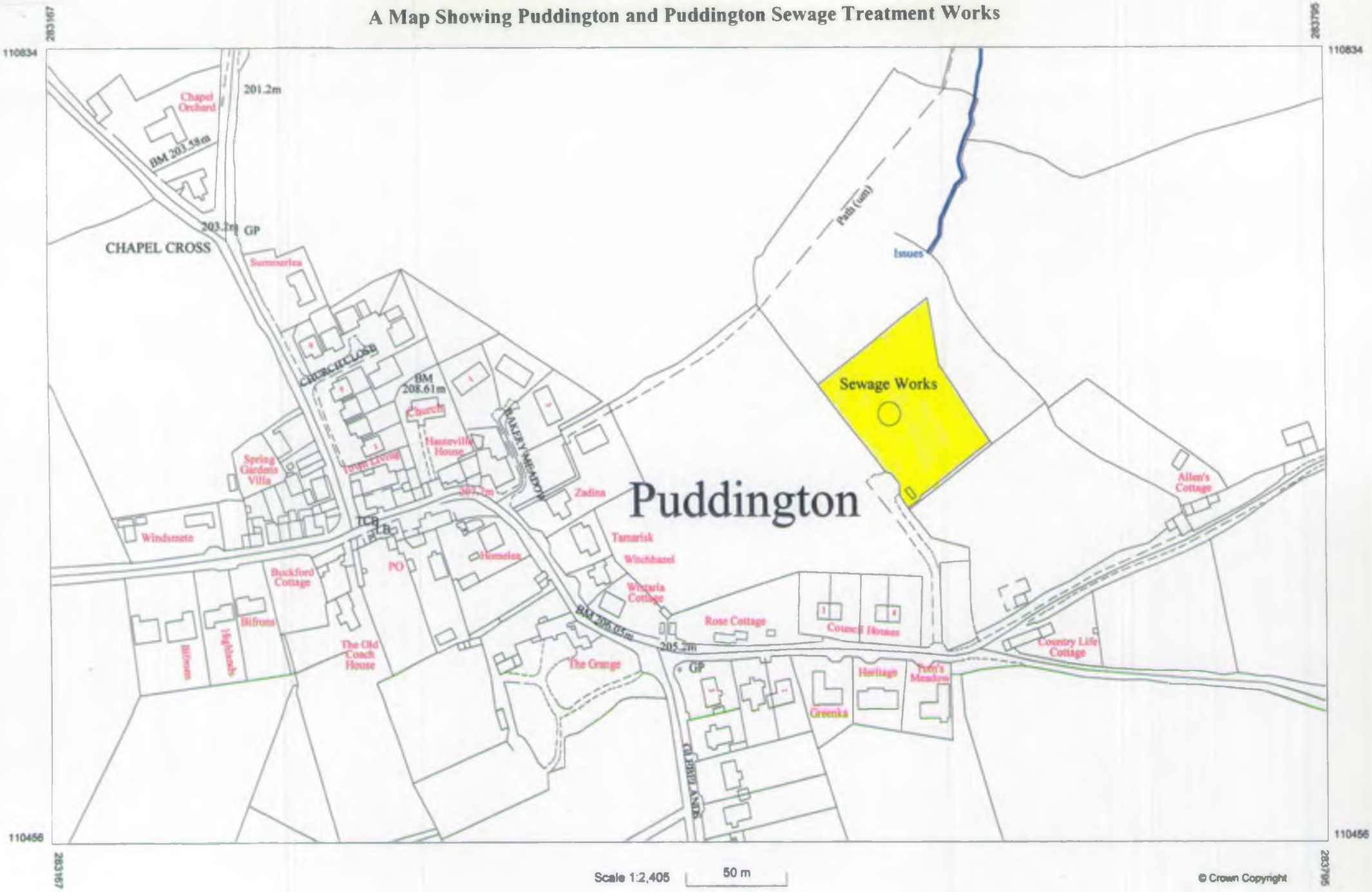


Figure 2

Figure showing dye tracing results Puddington STW.

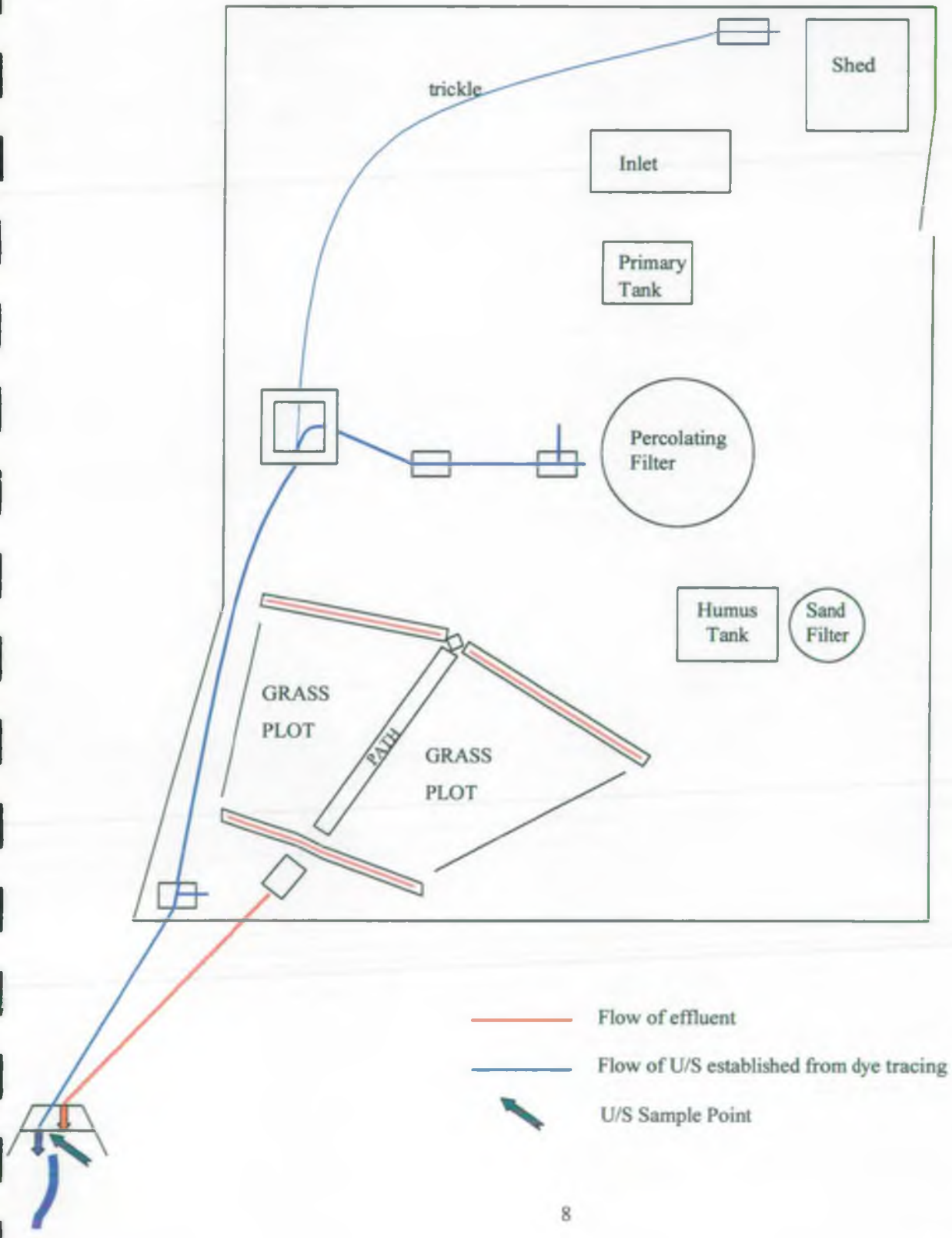


Figure 3

Figure showing Microbiological Survey Sample Points for 12th November 1998 & 1st February 1999 at Puddington STW.

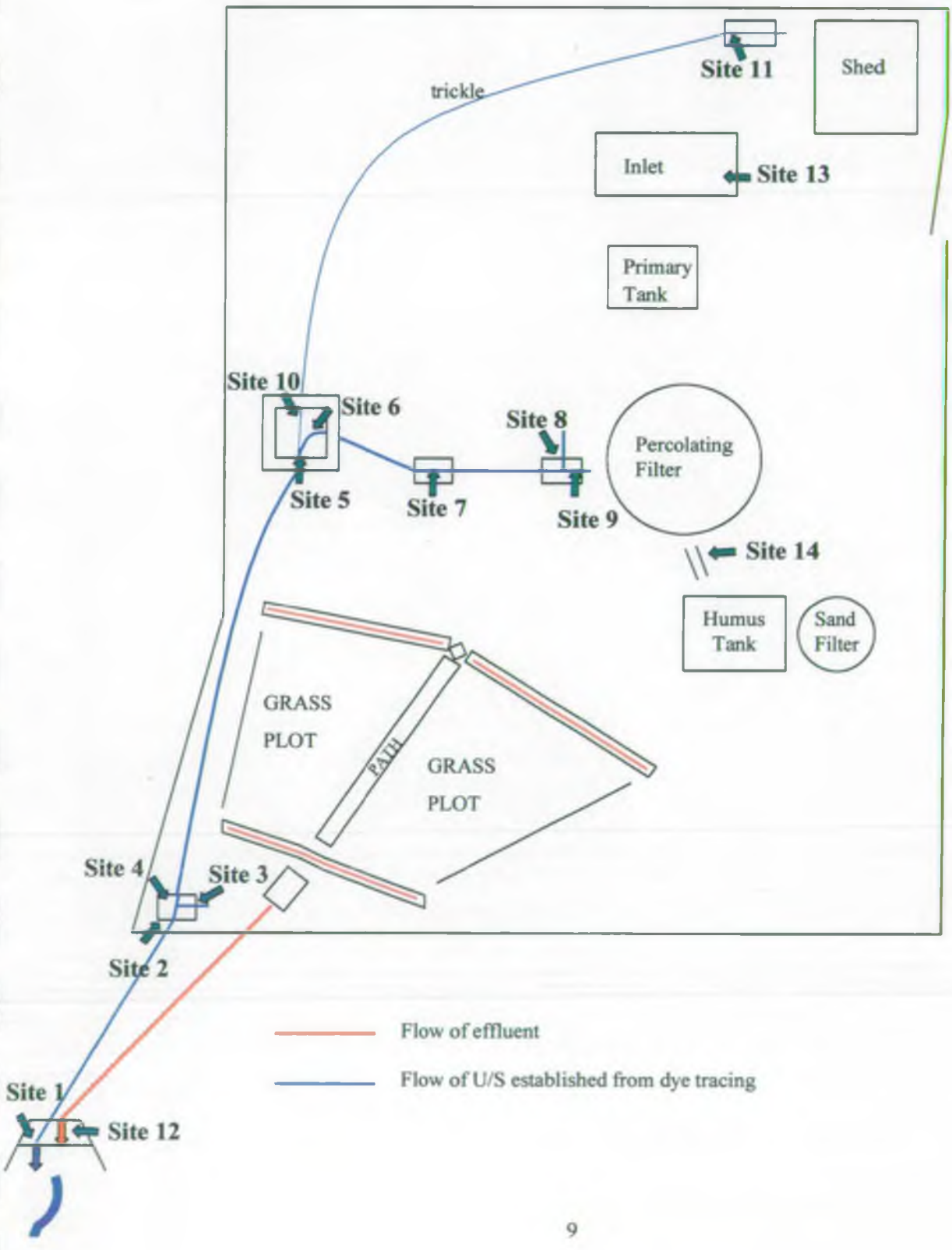
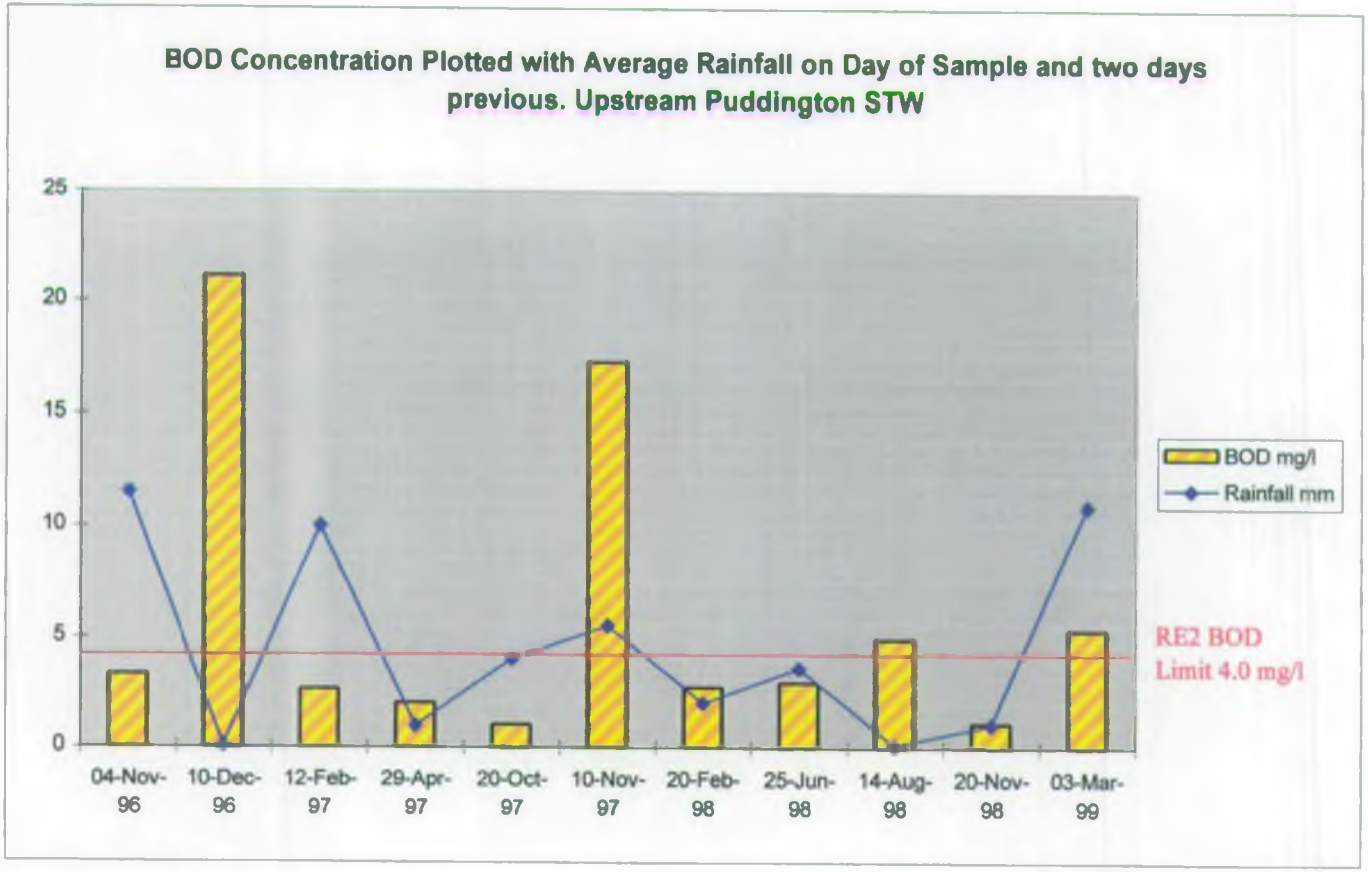


Figure 4


BOD Concentration Plotted with Average Rainfall on Day of Sample and two days previous. Upstream Puddington STW
25
20
15
10
5
0
04-Nov-96
10-Dec-96
12-Feb-97
29-Apr-97
20-Oct-97
10-Nov-97
20-Feb-98
25-Jun-98
14-Aug-98
20-Nov-98
03-Mar-99
BOD mg/l
Rainfall mm
RE2 BOD Limit 4.0 mg/l

APPENDICES

Appendix 1

Plate 1

Epic auto-sampler next to manhole at site 7.

Plate 2

Showing view of sample tube in manhole.

Plate 3

Showing concrete apron where final effluent and stream discharge

Plate 4

Chamber which stream flows through into which eggs have been thrown.

Appendix 2

Standards For The Five River Ecosystem Use Classes

Use Class	DO % sat 10%ile	BOD (ATU) mg/l 90%ile	Total Ammonia mgN/l 95%ile	Un-ionised Ammonia mgN/l 95%ile	pH 5%ile & 95%ile	Hardness mg/l Ca CO_3	Disolved Copper ug/l 95%ile	Total Zinc ug/l 95%ile	Class Description
1	80	2.5	0.25	0.021	6.0-9.0	≤ 10	2	30	Water of very good quality suitable for all fish species
						>10 and ≤ 50	22	200	
						>50 and ≤ 100	40	300	
						>100	112	500	
2	70	4.0	0.6	0.021	6.0-9.0	≤ 10	2	30	Water of good quality suitable for all fish species
						>10 and ≤ 50	22	200	
						>50 and ≤ 100	40	300	
						>100	112	500	
3	60	6.0	1.3	0.021	6.0-9.0	≤ 10	2	300	Water of fair quality suitable for high class coarse fish populations
						>10 and ≤ 50	22	700	
						>50 and ≤ 100	40	1000	
						>100	112	2000	
4	50	8.0	2.5	-	6.0-9.0	≤ 10	2	300	Water of fair quality suitable for coarse fish populations
						>10 and ≤ 50	22	700	
						>50 and ≤ 100	40	1000	
						>100	112	2000	
5	20	15.0	9.0	-	-	-	-	-	Water of poor quality which is likely to limit coarse fish populations

Appendix 3

Table Showing Rainfall Data and Routine Sample Results U/S Puddington STW

Sample Dates (bold)	**Rainfall mm** Gauge ref. 391497	**Puddington** U/S Faliures (in grey)		Average rainfall on day of sample plus 2 days previous (mm)
		Ammonia	BOD	
		RE2 Limit 0.6	RE2 Limit 4.0	
01-Nov-96	0.8			
02-Nov-96	10.2			
03-Nov-96	20.9			
04-Nov-96	3.5	0.73mg/l	3.3	11.5
07-Dec-96	0.0			
08-Dec-96	0.2			
09-Dec-96	0.0			
10-Dec-96	0.1	2.8mg/l	21.1mg/l	0.1
09-Feb-97	5.8			
10-Feb-97	2.5			
11-Feb-97	21.2			
12-Feb-97	6.4	0.46	2.6	10.0
26-Apr-97	5.8			
27-Apr-97	2.6			
28-Apr-97	0.2			
29-Apr-97	0.1	0.06	2	1.0
17-Oct-97	0.4			
18-Oct-97	0.0			
19-Oct-97	9.0			
20-Oct-97	3.1	0.066	<1	4.0
07-Nov-97	21.8			
08-Nov-97	3.5			
09-Nov-97	7.8			
10-Nov-97	5.4	1.97mg/l	17.3mg/l	5.6
17-Feb-98	0.0			
18-Feb-98	0.0			
19-Feb-98	0.7			
20-Feb-98	5.4	2.6mg/l	2.7	2.0
22-Jun-98	0.8			
23-Jun-98	0.0			
24-Jun-98	10.8			
25-Jun-98	0.0	0.747mg/l	2.9	3.6
11-Aug-98	0.0			
12-Aug-98	0.0			
13-Aug-98	0.0			
14-Aug-98	0.4	4.2mg/l	4.9mg/l	0.1
17-Nov-98	0.2			
18-Nov-98	0.0			
19-Nov-98	2.4			
20-Nov-98	0.8	0.51	1.1	1.1
28-Feb-99	11.3			
01-Mar-99	5.2			
02-Mar-99	10.8			
03-Mar-99	16.8	0.315	5.3	10.9

Appendix 4

Site Plan of Puddington Sewage Treatment Works