DEVON AREA
INTERNAL REPORT

ENVIRONMENT AGENCY

INVESTIGATION INTO POTENTIAL STORM SEWAGE DISCHARGE MOVEMENTS DURING SPRING AND NEAP TIDES FROM SHARKHAM POINT STORM OVERFLOW.

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DEV/EP/15/99
(CATCHMENT 06A)

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ENVIRONMENT AGENCY

Investigation into Potential Storm Discharge Movements During Spring and Neap Tides from Sharkham Point Storm Overflow.

1.0 Introduction

Regional Tidal Water Quality (RTWQ) requested Devon Area Investigations undertake two survey's to identify the tidal movement of potential storm sewage discharges from Sharkham point outfall chamber (figure 1) during spring and neap tides.

Sharkham Point is situated on the southern side of Torbay in South Devon (figure 2). The outfall chamber is located on a rocky outcrop at the base of the cliff. The storm overflow consists of a square opening in the side of the chamber with horizontal bar screens approximately 100mm apart. Access is via ladders permanently secured to the cliff face (see figure 3, plates 1 and 2).

1.1 Background

At present the flow through the chamber is one third that expected on completion of the Torbay Marine Scheme. The outfall will also have a diffuser added that could result in some head loss. During the highest astronomical tide the outfall will be at capacity and spillage may occur at the chamber. Additional storm flows to the chamber can also arrive from the new Bolton Street Combined Sewer Overflow (CSO) that discharges to the tunnel sewer. The period of risk to the St. Mary's Bay EC Bathing Water could therefore be extended when both the tidal surge and storm water effects are taken into account. Appendix 4 shows Bathing Water results for St. Mary's Bay for 1997, '98 and '99, appendix 5 shows EC Bathing Water Directive Standards.

The spring tide survey was undertaken on Friday 14th May 1999. The neap tide survey took place on Tuesday 25th May 1999.

1.1 Project Team

Project Manager – Trevor Cronin
Project Leader – Stuart Hunter
Project Officers – Emma-May Harrison, Peter Rose and Robin Pearson

2.0 Method

Robin Pearson (Investigations Officer) and I made an initial site visit on 16th April 1999. During this visit a risk assessment was carried out, this included photographing the site and visually assessing areas of potential risk, a copy of this can be seen in Appendix 3.

RTWQ requested dye releases to take place at HW (high water) –3:45, HW –3:00, HW –2:15 and HW –1:30. These release times were adhered to where possible for each survey. The first releases were made as planned, but on-site conditions and plume movements dictated when subsequent releases took place.

2.1 Spring Tide Survey

The spring tide survey took place on 14th May 1999, high water at Dartmouth was 4.90m at 18:13 BST. The first dye release, three litres of Rhodamine was made at 14:57. The dye was poured from a measuring jug over the rock ledge (to simulate a storm discharge), some dye went on the rocks leading to a revision in procedure for next release.

The second release was at 15:47, this time a length of rope was used to attach the jug to the storm chamber. The jug was thrown into the sea at the base of the rocks below the storm overflow; this method was much more successful and was used for all further releases. The movements of the plume were recorded using photography and hand drawn plume diagrams onto maps.

2.2 Neap Tide Survey

The neap tide survey took place on 25th May 1999; high water at Dartmouth was 3.99m at 15:55 BST. Two litres of fluorescein were released at 12:16. The dye was decanted into a jug that was then thrown into the sea at the base of the rocks below the storm overflow.

A second release of two litres of fluorescein was made at 13:06 using the same method. The movements of the two plumes were recorded using digital photography and hand drawn plume diagrams onto maps.

3.0 Results

3.1 Spring Survey

The spring tide survey took place on the 14th May. High tide in Dartmouth was 4.90m at 18:13 British summer time. The first dye release was made at 14:57. Plates 3 to 7 show the first release. These plates show the dye pooling against the surrounding rocks and remaining in the locality of the release. Figures 4 and 5 show the movements of the dye drawn on to maps. As the dye remained close to the shoreline the two dye patches merged. Plate 9,12,13, 14 and 15 show the easterly portion of release 2 moving out to sea and dissipating. Due to the lack of movement of the plume only two releases were made. Table 1 shows details of tide, wind speed and direction.

Table 1. Showing dye release, wind and tide details for the Spring tide survey.

Time	Dye Releases	State of Tide	Wind Speed .Beaufort Scale	Wind Direction
14:57	3L rhodamine	HW – 3:16		
15:35	-	HW – 2:28	2.5	SW'ly
15:47	3L rhodamine	HW – 2:16		
16:30	-	HW – 1:43	2.5	WSW'ly
16:43	-	HW – 1:30	3.5 gusting to 4	NNW'ly
16:50	-	HW – 1:23	2	Easterly
17:30	-	HW – 0:43	2	Westerly
		High Tide 18:13 (BST) 4.9m @ Dartmouth		

3.2 Neap Survey

The first release of dye was at 12:16, high tide was 3.99 metres at 15:55 British Summer Time at Dartmouth. The plume was seen to move rapidly in a westerly direction (Appendix 1 plates 18, 19 & 20 and figure 6). When the dye was released some foam was formed (visible in plates 18 & 19, on the left of the plume) this was taken in an easterly direction very quickly by the wind, see plate 21.

The tide turned at approximately 12:45. At this time the plume was seen to stop moving to the west and began moving swiftly in an easterly direction, plates 22 and 23 show this.

Plates 25, 26 and 27 show release one moving towards St Mary's Bay. Release 2 was made at 13:06 figure 7 shows a diagrammatic representation of the plumes movements. Plate 28 shows release one in the bottom left of the picture and release 2 is visible moving around the headland. Plate 29 shows release one inside St Mary's Bay, plates 30 and 31 are of release one.

Plates 32 and 33 show release two, that initially followed release one but then the leading portion of the plume broke away and moved out to sea, figure 7. This is most clearly visible in plate 35 taken at 14:32, also see figure 3.

Plates 36 and 37 are of release one but unfortunately the dye is not visible, please refer to figure 6, which is a diagrammatic representation of the dye plume movements visible to the naked eye but too dilute to show up on the photographs. Table 2 shows details of tide, wind speed and direction.

Table 2. Showing dye release, wind and tide details for the Neap tide Survey.

Time	Dye Releases	State of Tide	Wind Speed Beaufort Scale	Wind Direction
12:16	2L fluorescein	HW – 3:39	3.5 - 4	Westerly
13:06	2L fluorescein	HW – 2:49	5.5	Westerly
14:03.	-	HW – 1:52	5 – 5.5	Westerly
		High Tide 15:55 (BST) 3.99m @ Dartmouth		

4.0 Discussion

During both survey's it was evident the chamber had spilled recently, sewage related debris was on the horizontal bars. See figure 3, plate 2.

The movements of dye were very different in each of the surveys. It could be possible that due to the smaller tidal movements throughout the neap survey, the dye was released into a tidal current that occurred at a different stage of the tidal cycle during a spring tide.

As seen during the second dye release of the neap survey, the plume initially followed the direction of the previous plume then turned out to sea. This turn offshore was seen during the spring tide survey too, see plate 12.

4.1 Spring Tide Survey

As shown in plates 3 to 17 at no point did either dye release indicate a potential threat from storm sewage discharges to impact upon water quality at St. Mary's Bay Bathing Beach.

4.2 Neap Tide Survey

The results from the neap tide survey were very different to those of the spring tide survey. It is evident that the dye patch moved into the vicinity of St. Mary's Bay. It was not actually seen to move onto the beach itself, but the possibility of this can not be ruled out as the dye patch dispersed to a degree where it was not possible to see it at that point (as can be seen in plates 36 and 37).

5.0 Conclusions

5.1 Spring Tide Survey

The results from the spring tide survey showed that storm discharges at the same period in the tidal cycle would not move in the direction of St. Mary's Bay beach. But the possibility of dye that is released at a different phase of the cycle moving into St. Mary's Bay cannot be ruled out.

5.2 Neap Tide Survey

The results of the neap tide survey indicate the potential for contaminated water to be taken by tidal currents into the vicinity of St. Mary's Bay beach. A more concentrated plume would have shown more clearly the tidal movements close to the shore. In the presence of an easterly wind this movement of surface water could be exacerbated in the direction of the beach.

5.0 Recommendations

The chamber housing has suffered from pounding by the waves and should be checked for structural integrity.

Action: RTWQ

Figure 1

Map Showing Storm Discharge Location from Outfall Chamber at Sharkham Point.

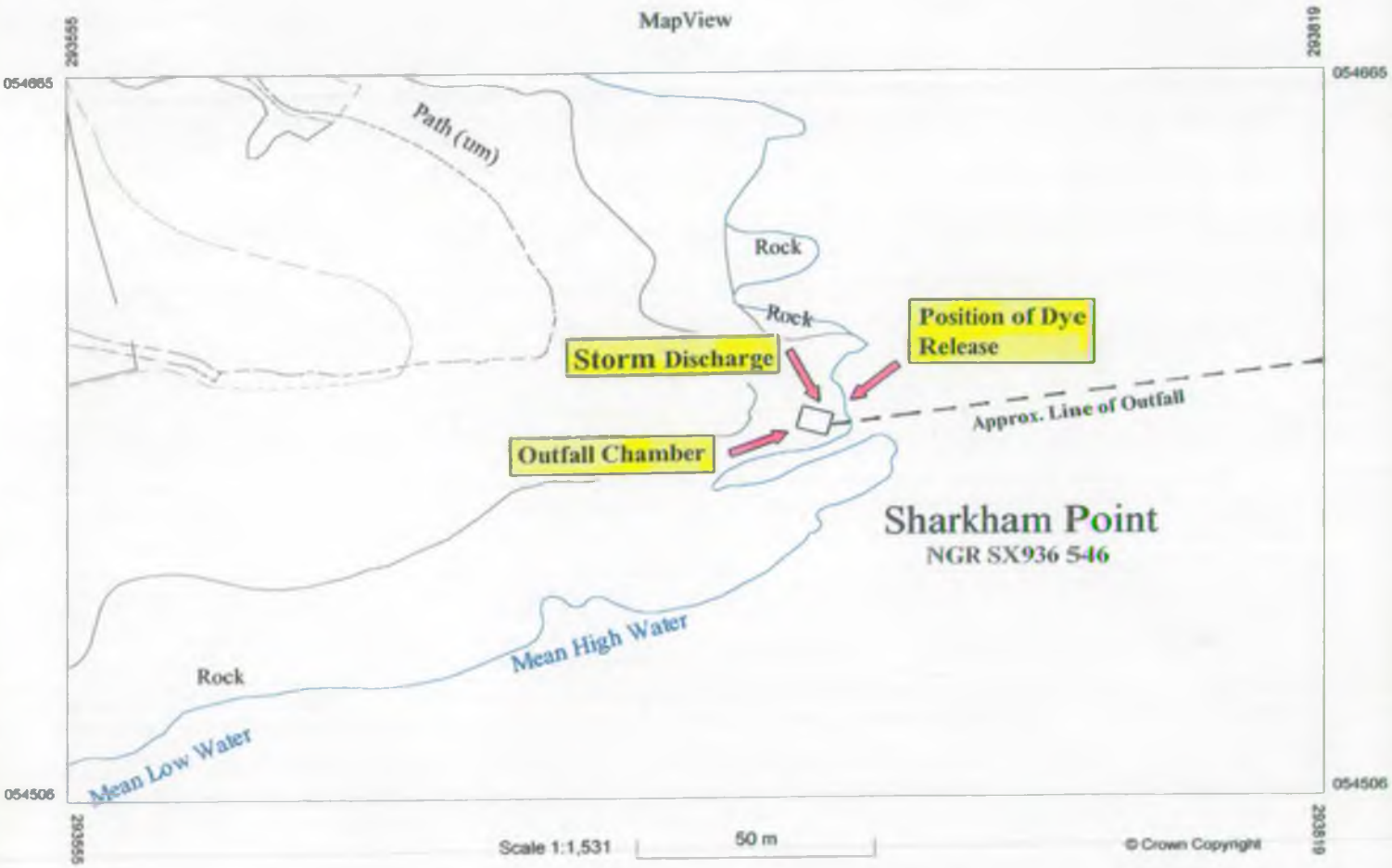

Figure 2

Map showing Sharkham Point in Relation to Torbay

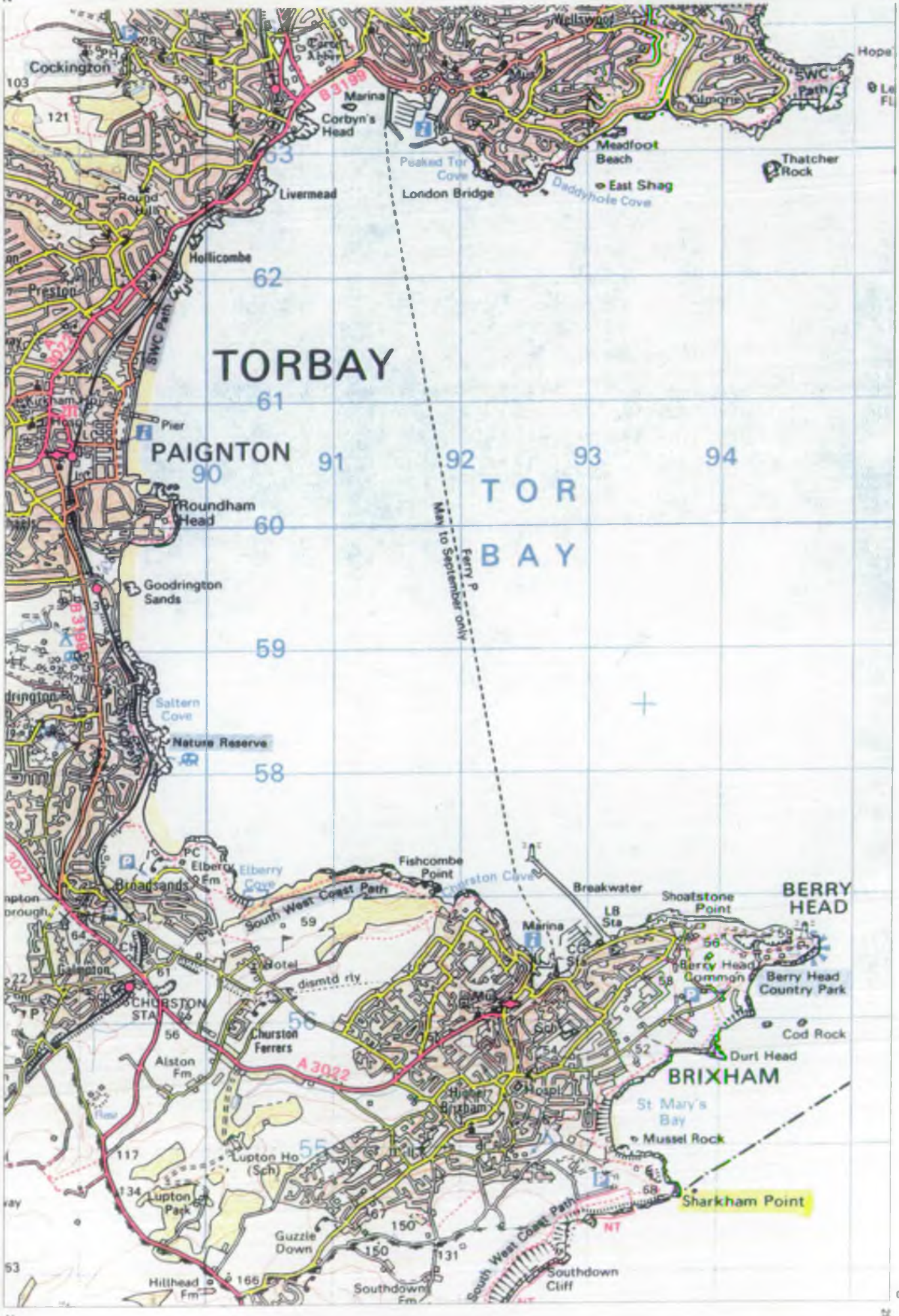

Figure 3

Plate 1

Sharkham Point, looking down on outfall chamber

Plate 2

Storm discharge overflow in outfall chamber

Figure 4 Figures Showing Movements of Dye During Spring Tide Survey

14th May 1999

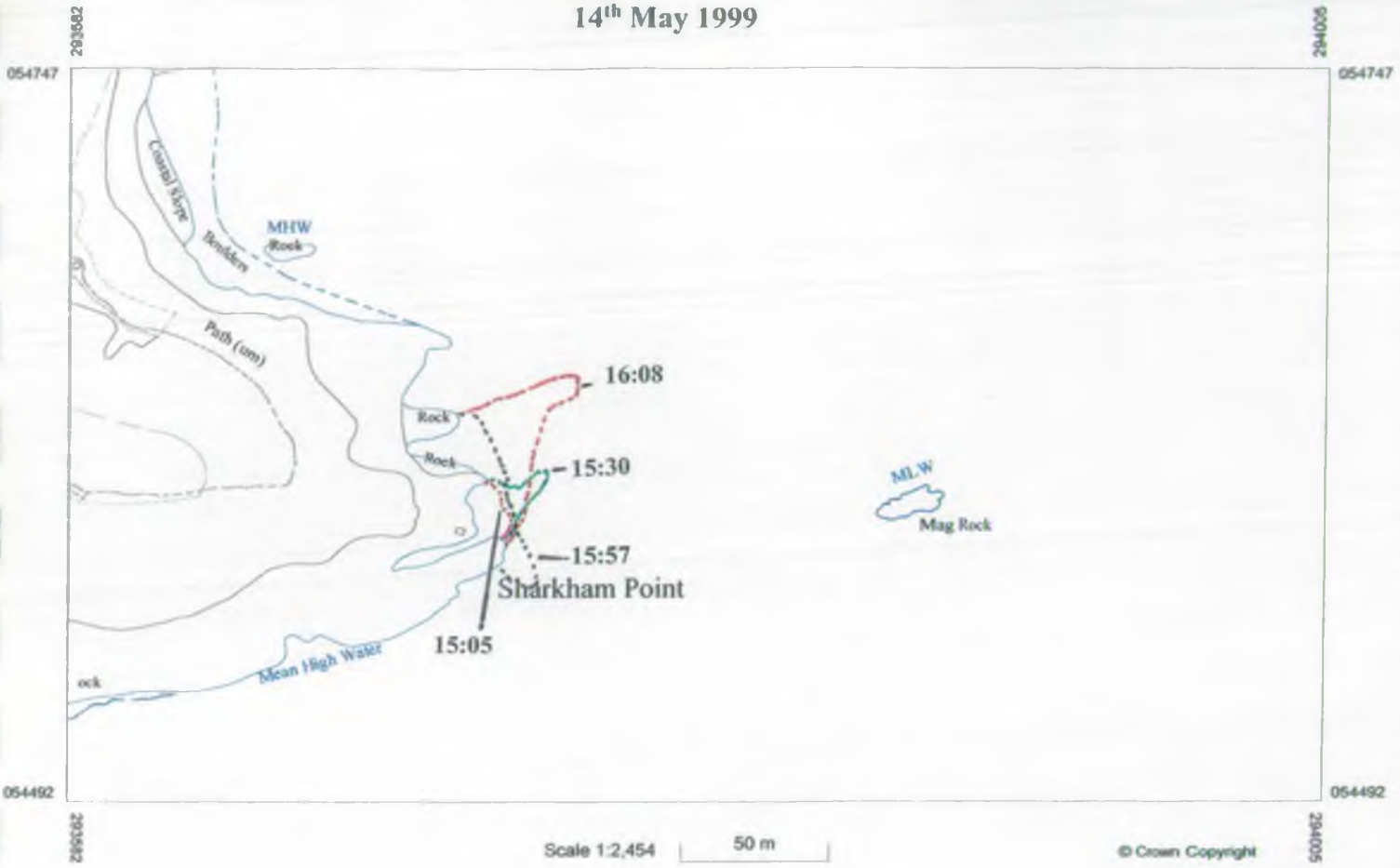

Figure 5

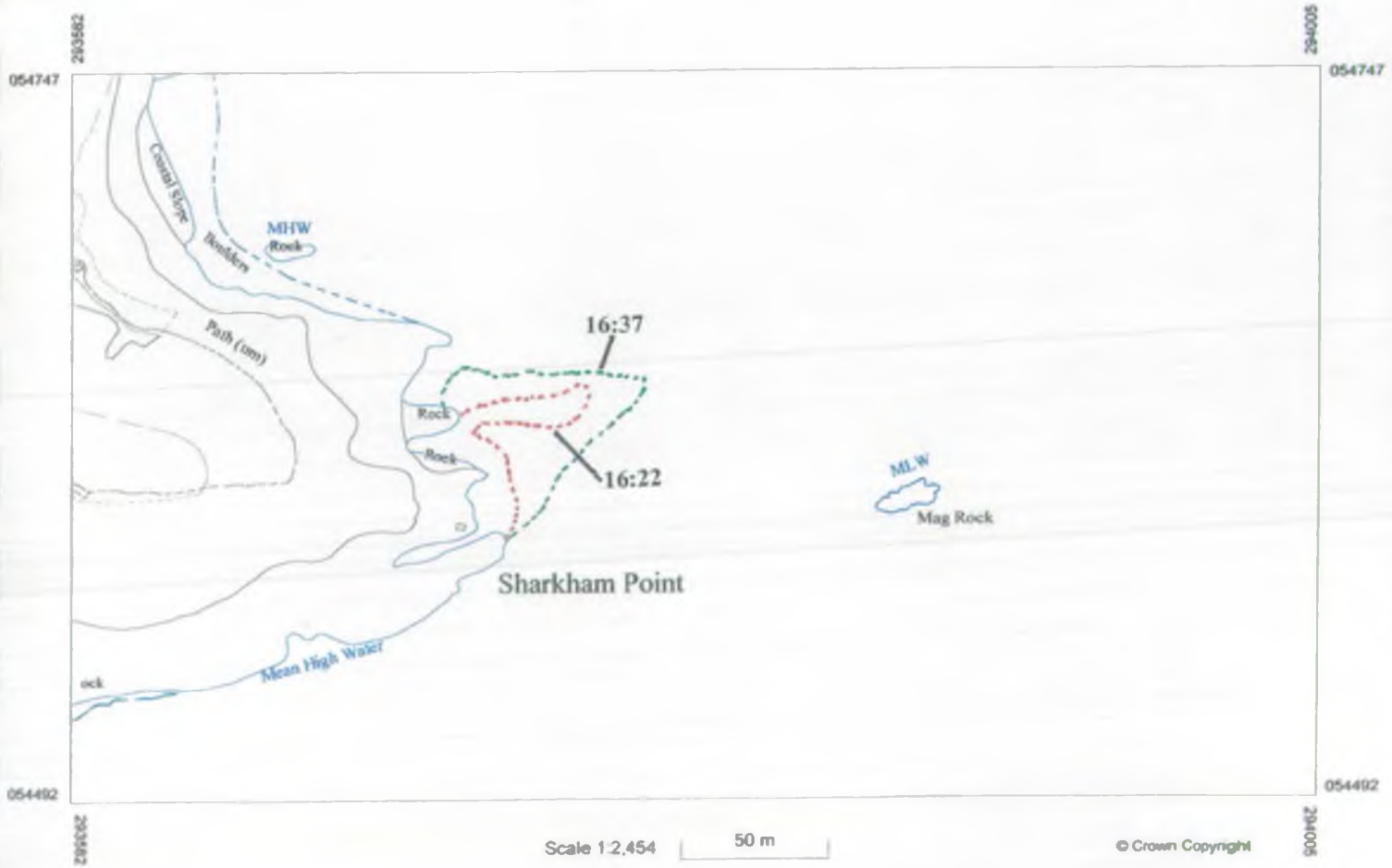

Figure 6

1st Dye Release Sharkham Point
Neap Tide Survey 25th May 1999

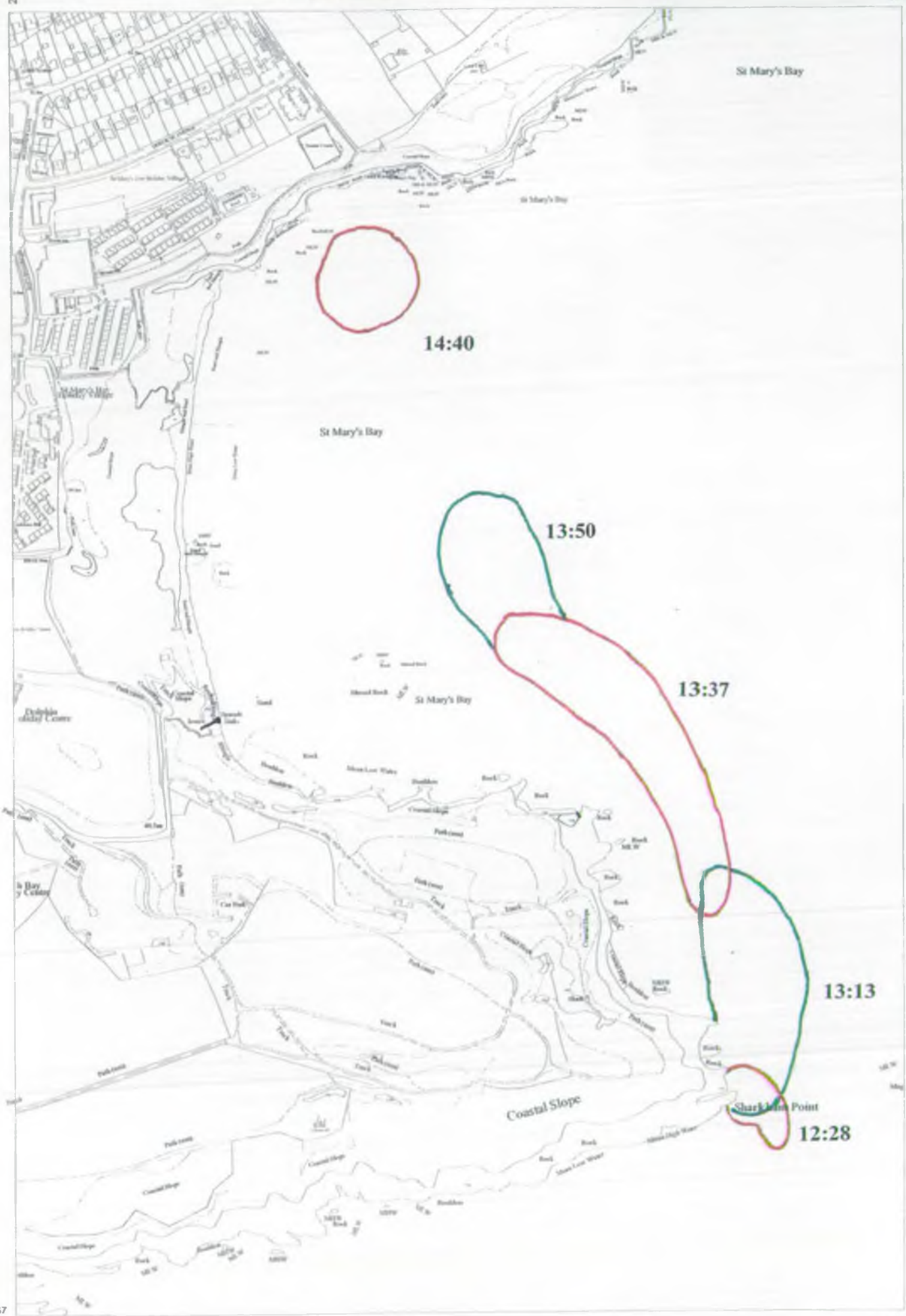

Figure 7

2nd Dye Release Sharkham Point
Neap Tide Survey 25th May 1999

APPENDICES

Appendix 1 Sharkham Point Spring Tide Survey 14th May 1999.

Plate 3. 15:05

Plate 4. 15:30

Plate 5. 15:30

Plate 6. 15:57

Plate 7. 15:57

Plate 8. 15:57

Plate 9. 16:08

Plate 10. 16:08

Plate 11. 16:22

Plate 12. 16:22

Plate 13. 16.22

Plate 14. 16:37

Plate 15. 16:37

Plate 16. 17:30

Plate 17. 18:35

Sharkham Point Neap Tide Survey 25th May 1999

Plate 18

12:19:24 25/05/99 1st Dye Release, 2 litres of fluorescein @ 12:16

Plate 19

12:19:47 1st Dye Release

Plate 20

12:28 1st Dye Release

Plate 21

12:30 1st Dye Release

Plate 22

12:52 1st Dye Release

Plate 23

13:11:06 1st Dye Release

Plate 24

13:11:23 2nd Dye Release

Plate 25

13:12 1st Dye Release

13:13 1st Dye Release

Plate 26

13:26 1st Dye Release

Plate 27

13:33 1st release bottom left. 2nd release coming around headland

Plate 28

13:34 1st Dye Release

Plate 29

13:59 1st Dye Release

Plate 30

13:59 1st Dye Release

Plate 31

14:02 2nd Dye Release

Plate 32

14:26 2nd Dye Release

Plate 33

14:30 2nd Dye Release

Plate 34

14:32 2nd Dye Rrelease

Plate 35

14:32 1st Dye Release

Plate 36

14:40 1st Dye Release

Plate 37

DEVON AREA INVESTIGATIONS TEAM ACTIVITY RISK ASSESSMENT

Date last modified 22/06/99

SITE: SHARKHAM POINT OUTFALL CHAMBER

CATCHMENT 06A

Date of Assessment 16-04-99

Name of Officer STUART HUNTER

CONSIDERATION	YES	NO	ACTIONS REQUIRED
(A) GENERAL			
1. Do you need to notify site manager/ landowner of Agency presence?	✓		NOTIFY DURING SURVEY - SWW - COASTGUARD
2. Do you need to be accompanied by site staff?		✓	
3. Does task require more than one person?	✓		
4. Are you working outside daylight hours?		✓	
5. Is the site isolated	✓		
5. Do you need to employ Lone Worker procedures?		✓	BECAUSE MORE THAN ONE PERSON SHOULD BE AT SITE AT ANY TIME.
6. Is protective clothing is required?	✓		LIFE JACKET, GLOVES, PROTECTIVE SUIT (FROM DYE STAINING)
7. Will seasonal factors affect site safety?	✓		CALM SEAS NEEDED
8. Are there dangers from the following			
chemicals		✓	
biological hazard	✓		STORM SEWAGE
explosive gases		✓	
inhalation of fumes/dust/asbestos		✓	
moving vehicles		✓	
machinery		✓	
falling objects	✓		BE AWARE YOU ARE NEAR BASE OF CLIFF
9. Are overhead power supplies present?		✓	
10. Is site secure for equipment installation?			N/A
(B) VEHICLE ACCESS			
1. Is there safe vehicle acces to site?	✓		LOW BEAM AT CAR PARK ENTERENCE LARGE K-REG LANDROVER WILL NOT FIT UNDER.
2. Can vehicles be parked/left safely?	✓		YES FREE CAR PARK

(C) FOOT ACCESS

	YES	NO	
1. Is there safe foot access to the site?	✓		
2. Are there fences/ditches etc. to cross?		✓	

(D) BANK SITES

1. Are banks steep or slippery?			N/A
2. Might banks be undercut?			
3. Is water deep/strong currents?			

(E) CLIFF OR SIMILAR SITES

1. Are there dangers from falling?	✓		
2. Is the terrain steep/slippery?	✓		
3. Might the cliff be overhanging?		✓	
4. Are ropes required?	✓		BEST TO TAKE ROPES, USE IF FELT APPROPIATE ON DAY.

(F) CONFINED SPACES

1. Is the risk High, Medium or Lo	H ☐ M ☐ L ☐	N/A

(G) BOAT WORK

1. Are there suitable launch/recovery facilities?			N/A
2. Is there safe boat passage to the site?			N/A
3. Is a weather report required beforehand?	✓		
4. Does state of tide need to be considered?	✓		
5. Is there a risk of grounding?			N/A

(H) MANHOLES

1. Is the area around the manhole safe?			N/A
2. Are bollards/cones required?			
3. Can cover be lifted safely?			
4. Are cover keys/other equipment needed?			

(I) AGGRESSIVE BEHAVIOUR

1. Are people likely to be aggressive?		✓	
2. Are guard dogs/farm dogs/other livestock a risk?		✓	

(J) OTHER

ACCESS VIA LADDERS. EXPOSURE TO SEA AND SUN.

Appendix 4

EC Bathing Water Results for St. Mary's Bay 1997, 1998 & 1999

Environment Agency South West Region

Bathing Water Results for: ST.MARY'S BAY BEACH **Sample Point Code:** 70614997 **Identified Water**
Results are for 1997.1998.1999. **NGR:** SX9320055010 **Devon Area**

Date	Time	Last high tide	Total Coliforms no/100ml		Faecal Coliforms no/100ml		Faecal Streptococci no/100ml	Entero Virus pfu/10l	Salmo-nella code	Salinity g/kg tds	Trans-parency metres	pH units	Colour code	Oil Code	Foam Code	Phenols Code
			Presumptive	Confirmed	Presumptive	Confirmed										
01/05/1997	10:30	13.60	27	27	36	36	9			35.00	< 1		0	0	0	0
09/05/1997	12:40	8.50	18	9	< 10	< 10	< 10			35.20	> 1		0	0	0	0
21/05/1997	12:20	6.15	135	135	72	27	54			35.00	< 1		0	0	0	0
01/06/1997	10:40	15.40	310	248	250	175	36			35.00	< 1		0	0	0	0
11/06/1997	17:15	10.40	117	47	18	18	27			34.60	> 1		0	0	0	0
19/06/1997	10:30	18.20	117	105	99	89	36		1	35.00	< 1	8.05	0	0	0	0
25/06/1997	11:45	10.20	700	560	240	216	290			34.60	0		0	0	0	0
29/06/1997	13:40	14.10	153	153	27	9	63			34.90	< 1		0	0	0	0
03/07/1997	12:25	18.30	54	45	27	27	< 10		0	35.00	< 1	8.15	0	0	0	0
09/07/1997	11:55	9.40	< 10	< 10	< 10	< 10	9			34.90	> 1		0	0	0	0
17/07/1997	16:05	16.50	27	18	18	18	36			35.00	0		0	0	0	0
23/07/1997	12:10	9.35	9	9	9	9	36			35.00	> 1		0	0	0	0
30/07/1997	12:50	16.10	18	18	< 10	< 10	9			35.20	> 1		0	0	0	0
06/08/1997	15:10	8.50	4 500	4 500	660	528	144			34.90	0		0	0	0	0
14/08/1997	12:40	15.10	9	9	< 10	< 10	9			34.50	< 1		0	0	0	0
26/08/1997	10:30	12.50	500	500	460	414	320			34.70	< 1		0	0	0	0
29/08/1997	14:15	16.50	18	18	< 10	< 10	< 10			35.10	0		0	0	0	0
03/09/1997	12:05	7.55	2 400	2 160	530	477	144			35.10	> 1		0	0	0	0
13/09/1997	12:50	16.00	18	18	9	9	36			35.00	< 1		0	0	0	0
24/09/1997	13:10	12.20	3 400	3 400	2 200	1 760	189			34.90	0		0	0	0	0

Bathing Water Results for: ST.MARY'S BAY BEACH **Sample Point Code: 70614997** **Identified Water**

Results are for 1997.1998.1999. **NGR: SX9320055010** **Devon Area**

Date	Time	Last high tide	Total Coliforms no/100ml		Faecal Coliforms no/100ml		Faecal Streptococci no/100ml	Entero Virus pfu/10l	Salmo-nella code	Salinity g/kg tds	Trans-parency metres	pH units	Colour code	Oil Code	Foam Code	Phenols Code
			Presumptive	Confirmed	Presumptive	Confirmed										
05/05/1998	13:20	14.30	45	27	36	36	< 10			34.90	> 1		0	0	0	0
12/05/1998	10:40	7.35	63	45	27	27	< 10		0	34.60	> 1	8.10	0	0	0	0
21/05/1998	17:25	14.40	54	36	18	18	72			34.80	> 1		0	0	0	0
31/05/1998	12:20	9.30	320	288	27	27	< 10			35.10	< 1		0	0	0	0
09/06/1998	12:40	18.50	480	336	27	18	18			35.30	< 1		0	0	0	0
16/06/1998	12:20	10.50	< 10	< 10	< 10	< 10	< 10			35.00	< 1		0	0	0	0
25/06/1998	11:10	8.00	54	45	27	27	< 10			35.20	0		0	0	0	0
02/07/1998	12:25	12.40	108	108	36	36	< 10			35.10	0		0	0	0	0
07/07/1998	10:30	5.25	90	72	72	45	54			34.70	> 1		0	0	0	0
20/07/1998	12:15	16.30	27	27	< 10	< 10	< 10		0	35.10	< 1	8.10	0	0	0	0
27/07/1998	10:30	21.40	45	27	9	9	< 10			35.20	> 1		0	0	0	0
05/08/1998	13:15	17.20	36	18	9	9	< 10			35.30	> 1		0	0	0	0
12/08/1998	16:45	10.10	54	36	18	9	9			35.10	> 1		0	0	0	0
17/08/1998	13:00	14.40	90	63	45	45	< 10			35.20	< 1		0	0	0	0
21/08/1998	13:00	19.00	490	490	300	270	81			35.20	< 1		0	0	0	0
28/08/1998	12:15	10.30	9		9					35.20	0		0	0	0	0
06/09/1998	11:50	6.55	220	220	207	145	135			35.20	< 1		0	0	0	0
08/09/1998	10:30	8.25	480	480	162	130	540			35.10	0		0	0	0	0
15/09/1998	10:35	14.40	135	122	81		18			35.20	< 1		0	0	0	0
17/09/1998	13:15	17.00	45	36	< 10	< 10	27			35.20			0	0	0	0
20/09/1998	10:30	7.02	290	232	210	147	72			35.20			0	0	0	0
22/09/1998	12:00	8.40	250	250	99	99	9			35.20	< 1		1	0	0	0

Bathing Water Results for: ST.MARY'S BAY BEACH **Sample Point Code:** 70614997 **Identified Water**
Results are for 1999 **NGR:** SX9320055010 **Devon Area**

Date	Time	Last high tide	Total Coliforms no/100ml		Faecal Coliforms no/100ml		Faecal Streptococci no/100ml	Entero Virus pfu/10l	Salmo-nella code	Salinity g/kg tds	Trans-parency metres	pH units	Colour code	Oil Code	Foam Code	Phenols Code
			Presumptive	Confirmed	Presumptive	Confirmed										
05/05/1999	13:00	9.50	36	27	18	< 10	< 10			34.40	> 1		1			
12/05/1999	10:40	16.20	< 10	< 10	< 10	< 10	< 10			35.00	> 1		0			
17/05/1999	11:15	8.20	63	45	54	54	18			35.10	0		0			
21/05/1999	12:45	11.40	< 10	< 10	< 10	< 10	< 10			35.00	> 1		0			
28/05/1999	12:30	18.10	< 10	< 10	< 10	< 10	< 10			35.00	> 1		0			
07/06/1999	14:10	11.10	< 10	< 10	< 10	< 10	< 10		0	35.00	< 1	8.10	0			
16/06/1999	11:00	8.59	< 10	< 10	< 10	< 10	> 10			34.80	> 1		0			
23/06/1999	13:30	14.50	54	54	< 10	< 10	< 10			35.10	> 1		0			
02/07/1999	12:15	9.10	36	18	< 10	< 10	< 10			35.10	< 1		0			
09/07/1999	12:40	15.20	18	18	< 10	< 10	< 10			34.90	> 1		0			
18/07/1999	10:50	1055.00	171	154	63	54	162			35.20	< 1		0			
27/07/1999	12:45	18.50	250	175	180	180	72			35.20	< 1		1			
03/08/1999	13:20	10.50	< 10	< 10	18	18	18			35.10	> 1		0			
12/08/1999	10:10	8.02	162	113	63	54	240			34.90	< 1		0			
19/08/1999	17:12	11.60	81	72	81	81	54			35.10	< 1		0			
28/08/1999	09:00	8.09	117	94	144	144	126			35.00	> 1		0			
09/09/1999	13:15	7.02	< 10	< 10	< 10	< 10	< 10			35.10	< 1		0			
14/09/1999	10:00	9.40	18	18	18	< 10	< 10			35.20	> 1		0			
18/09/1999	13:35	12.10	550	550	510	510	108			35.10	< 1		0			
21/09/1999	10:30	16.00	220	176	36	27	54			34.90	< 1		0			

EC BATHING WATERS DIRECTIVE

Compliance is generally assessed against the imperative (I) standards for the principal bacteriological parameters total and faecal coliforms. These standards are:

Total coliforms: Max 10,000 per 100ml
Faecal coliforms: Max 2,000 per 100 ml

Bathing waters are allowed a five per cent failure rate in any one year. This means that 19 samples in 20 have to meet the imperative standards for compliance to be achieved.

The principal guidelines (G) standards, which have to be achieved in 80 percent of samples (i.e. 16/20 samples are:

Total coliforms: Max 500 per 100ml
Faecal coliforms: Max 100 per 100ml
Faecal streps.: Max 100 per 100ml (achieved in 90% of samples)