Figure 1. Location of thermal plume studies in the vicinity of Calvert Cliffs Nuclear Power Plant, August 18-19, 1977.

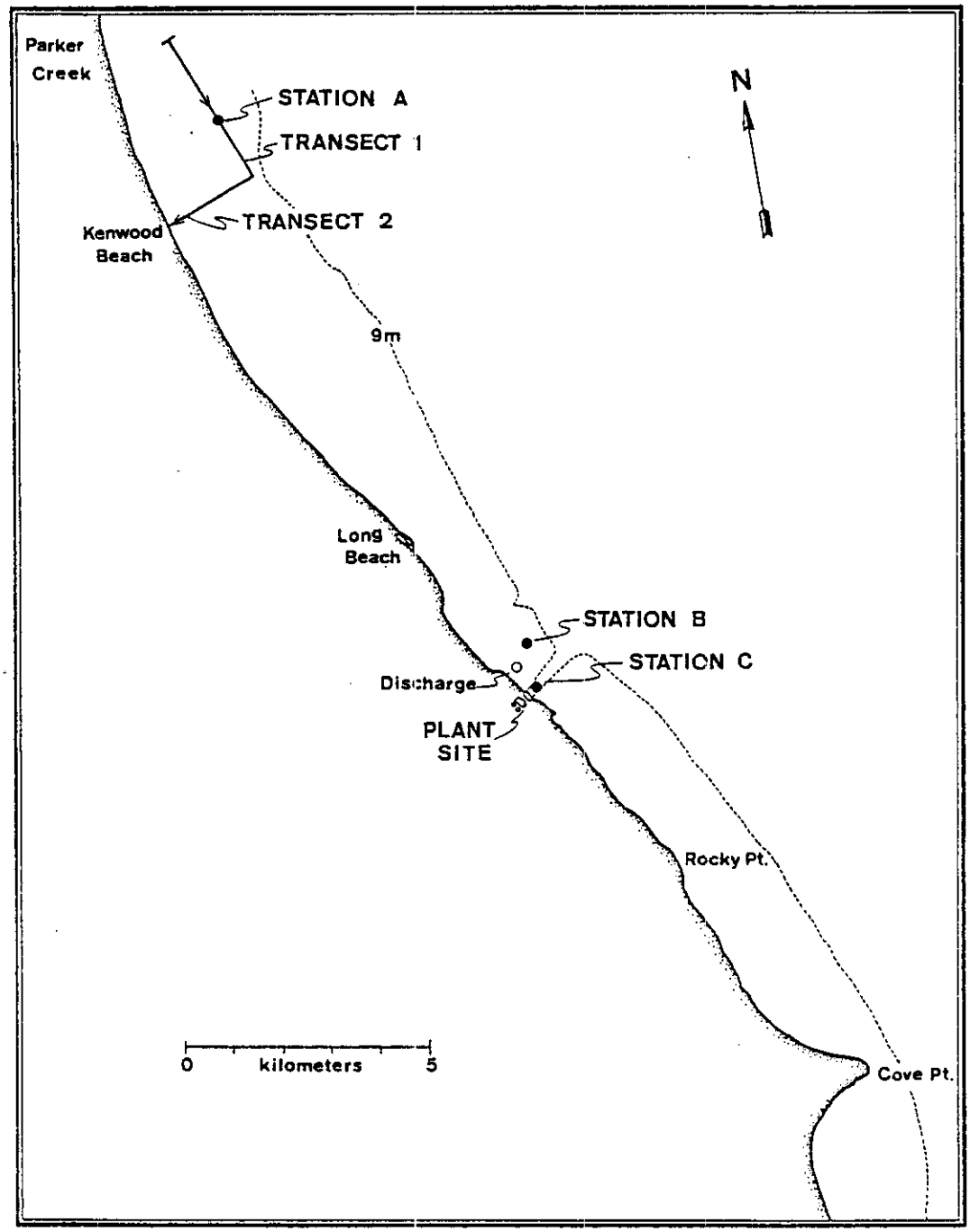

Table 1. Summary of hydrographic, meteorologic and plant operating conditions and estimated areas and radial extents of 2° and 1°C isotherms for thermal plume studies in the vicinity of Calvert Cliffs Nuclear Power Plant, August 1977.

Mapping	1A	1B	1C	1D
Date	8/18	8/18	8/19	8/19
Times	1005-1133	1603-1735	0832-1034	1330-1620
Tidal Phase	Ebb	Flood	SBE	SBF
u (cm/sec)*	-12	21	4	16
v (cm/sec)*	-13	-11	5	- 8
Wind (m/sec)	3.6/NW	1.9/N	2.7/NE	1.3/NE
Air temp (°C)	21.0	23.3	22.2	23.3
Plant load (MWe)	1650	1650	1640	1635
Intake temp (°C)	27.5	27.7	27.2	27.4
Cross-condenser temp. rise (°C)	5.3	5.6	5.6	5.6
Max area enclosed by 2°C isotherm (x 10^4 m^2)	10	>60	8	>30
Max area enclosed by 1°C isotherm (x 10^4 m^2)	>90	>300	>100	>300
Max radial† extent of 2°C isotherm (x 10^3 m)	0.9	>2.3	0.8	1.2
Max radial† extent of 1°C isotherm (x 10^3 m)	>1.7	>2.3	>2.4	>2.2

* Longitudinal component of current velocity, u (positive upestuary), and lateral component, v (positive toward eastern shore), measured at Station 3, 2-m depth, after plume mapping.

† Measured from point of discharge.

Vertical profiles of hydrographic variables in the Chesapeake Bay near Calvert Cliffs, Maryland.

Table 2.

PROFILE: 1A-1 DATE: 8/18/77

STATION: A TIME: 1330

Depth (m)	Temp (C)	Cond. (mmhos/cm)	Salinity (°/oo)	Sigma T	D.O. (ppm)	Velocity ($cmsec^{-1}$/deg)	u (cm/sec)	v (cm/sec)
0	26.9	23.1	13.4	6.6	6.8	24/145	-22	9
2	26.9	23.1	13.4	6.6	6.6	21/165	-21	1
4	26.9	23.2	13.5	6.7	6.0	15/165	-15	1
6	26.9	23.2	13.5	6.7	5.9	15/190	-14	-6
8	26.9	23.2	13.5	6.7	5.5	15/205	-12	-9
10	26.8	23.3	13.5	6.8	2.2	12/150	-11	4

Table 3.

PROFILE: 1A-1 DATE: 8/18/77

STATION: B TIME: 0933

Depth (m)	Temp (C)	Cond. (mmhos/cm)	Salinity (°/oo)	Sigma T	D.O. (ppm)	Velocity ($cmsec^{-1}$/deg)	u (cm/sec)	v (cm/sec)
0	28.5	23.8	13.4	6.1	5.7	21/230	-10	-19
2	28.0	23.8	13.5	6.4	5.7	15/200	-13	- 8
4	27.9	23.6	13.4	6.3	5.9	6/130	- 5	4
6	27.6	23.6	13.5	6.5	5.9	37/115	-22	30
7	27.5	23.6	13.5	6.5	5.8			

Table 4.

PROFILE: 1A-2 DATE: 8/18/77

STATION: B TIME: 1144

Depth (m)	Temp (C)	Cond. (mmhos/cm)	Salinity (°/oo)	Sigma T	D.O. (ppm)	Velocity ($cmsec^{-1}$/deg)	u (cm/sec)	v (cm/sec)
0	27.5	23.7	13.6	6.6	6.5	15/195	-13	- 7
2	27.5	23.7	13.6	6.6	6.3	18/215	-12	-13
4	27.6	23.7	13.6	6.5	6.2	12/180	-12	- 2
6	27.6	23.7	13.6	6.5	6.1	9/180	- 9	- 2
7	27.6	23.7	13.6	6.5	6.0			

Vertical profiles of hydrographic variables in the Chesapeake Bay near Calvert Cliffs, Maryland.

Table 5.

PROFILE: 1A-1 DATE: 8/18/77

STATION: C TIME: 0950

Depth (m)	Temp (C)	Cond. (mmhos/cm)	Salinity (°/oo)	Sigma T	D.O. (ppm)	Velocity ($cmsec^{-1}$/deg)	u (cm/sec)	v (cm/sec)
0	27.0	24.0	13.9	7.0	5.9	6/290	3	-5
2	27.0	23.0	13.3	6.5	5.7	9/310	7	-6
4	27.0	23.0	13.3	6.5	5.5	6/340	6	-1
6	27.0	24.0	13.9	7.0	5.5	6/125	-4	4
8	27.4	23.9	13.8	6.7	5.4	9/155	-9	2
10	27.4	24.1	13.9	6.8	5.4	6/175	-6	-1
12	27.4	24.0	13.8	6.8	5.3	6/175	-6	-1
14	27.4	24.0	13.8	6.8	5.2	6/175	-6	-1

Table 6.

PROFILE: 1A-2 DATE: 8/18/77

STATION: C TIME: 1200

Depth (m)	Temp (C)	Cond. (mmhos/cm)	Salinity (°/oo)	Sigma T	D.O. (ppm)	Velocity ($cmsec^{-1}$/deg)	u (cm/sec)	v (cm/sec)
0	28.0	23.9	13.6	6.4	6.6	12/295	7	-11
2	28.0	23.8	13.5	6.4	6.3	18/270	4	-18
4	28.0	23.8	13.5	6.4	6.2	15/326	14	- 6
6	27.7	23.7	13.5	6.5	6.1	12/329	11	- 4
8	27.5	23.7	13.6	6.6	6.0	6/270	1	- 6
10	27.5	23.8	13.7	6.6	6.0	6/225	- 3	- 5
12	27.4	23.9	13.8	6.7	6.0	6/122	- 4	4
14	27.4	23.9	13.8	6.7	5.9	9/115	- 5	7

Table 7.

MAPPING: 1A
DATE: 081877
TIMES: 1349 TO 1423

*** TRANSECT 1 TEMPERATURE (C) DATA ***

READING NO.	1 M	3 M	5 M	7 M	9 M
1	27.1	27.0	26.8	26.9	*****
2	27.1	27.1	26.8	26.8	*****
3	27.1	27.1	26.8	26.8	*****
4	27.1	27.0	26.8	26.8	*****
5	27.1	27.0	26.8	26.9	*****
6	27.1	27.0	26.8	26.9	*****
7	27.1	27.0	26.8	26.8	*****
8	27.1	27.0	26.8	26.8	*****
9	27.1	27.0	26.8	26.9	*****
10	27.1	27.0	26.8	26.9	*****
11	27.1	27.0	26.8	26.8	*****
12	27.1	27.0	26.8	26.8	*****
13	27.1	27.0	26.8	26.8	*****
14	27.1	27.0	26.8	26.8	*****
15	27.1	27.0	26.8	26.8	*****
16	27.1	27.0	26.8	26.9	*****
17	27.1	27.0	26.8	26.8	*****
18	27.1	27.0	26.8	26.8	*****
19	27.1	27.0	26.8	26.9	*****
20	27.1	27.0	26.8	26.9	*****
21	27.1	27.0	26.8	26.8	*****
22	27.1	27.0	26.8	26.8	*****
23	27.1	27.0	26.8	26.9	*****
24	27.1	27.0	26.8	26.9	*****
25	27.1	27.0	26.8	26.9	*****
26	27.1	27.0	26.8	26.8	*****
27	27.1	27.1	26.8	26.8	*****
28	27.1	27.0	26.8	26.9	*****
29	27.1	27.0	26.8	26.9	*****
30	27.1	27.1	26.8	26.8	*****
31	27.1	27.0	26.8	26.9	*****
32	27.1	27.0	26.8	26.8	*****
33	27.1	27.0	26.8	26.9	*****
34	27.1	27.0	26.8	26.9	*****
35	27.1	27.0	26.8	26.9	*****
36	27.1	27.0	26.8	26.9	*****
37	27.1	27.0	26.8	26.9	*****
38	27.1	27.1	26.8	26.9	*****
39	27.1	27.0	26.8	26.9	*****
40	27.1	27.1	26.8	26.9	*****
41	27.1	27.0	26.8	26.9	*****
42	27.1	27.0	26.8	26.9	*****
43	27.1	27.0	26.8	26.9	*****
44	27.1	27.0	26.8	27.0	*****
45	27.1	27.0	26.8	27.0	*****
46	27.1	27.0	26.8	27.0	*****
47	27.1	27.0	26.8	27.0	*****
48	27.1	27.0	26.8	27.0	*****
49	27.1	27.1	26.8	27.0	*****
50	27.1	27.0	26.8	27.0	*****
51	27.1	27.0	26.8	27.0	*****
52	27.1	27.0	26.8	27.0	*****
53	27.1	27.0	26.8	27.0	*****
54	27.1	27.0	26.8	27.0	*****
55	27.1	27.0	26.8	27.0	*****
56	27.1	27.0	26.8	27.0	*****
57	27.1	27.0	26.8	27.0	*****
58	27.1	27.0	26.8	27.0	*****
59	27.1	27.0	26.9	27.0	*****
60	27.1	27.0	26.8	27.0	*****
61	27.1	27.0	26.9	27.0	*****
62	27.1	27.0	26.9	27.0	*****
63	27.1	27.1	26.9	27.0	*****
64	27.1	27.0	26.9	27.0	*****
65	27.1	27.0	26.9	27.0	*****
66	27.1	27.0	26.9	27.0	*****
67	27.1	27.0	26.9	27.0	*****
68	27.1	27.0	26.9	27.0	*****
69	27.1	27.1	26.9	27.0	*****
70	27.1	27.0	26.9	27.0	*****
71	27.1	27.1	26.9	27.0	*****
72	27.1	27.1	26.9	27.0	*****
73	27.1	27.1	26.9	27.0	*****
74	27.1	27.1	26.9	27.0	*****
75	27.1	27.1	26.9	27.0	*****
76	27.1	27.1	26.9	27.0	*****
77	27.1	27.1	26.9	27.0	*****
78	27.1	27.1	26.9	27.0	*****
79	27.1	27.1	26.9	27.0	*****
80	27.1	27.1	26.9	27.0	*****

Table 8.

MAPPING: 1A
DATE: 081877
TIMES: 1345 TO 1423

*** TRANSECT 2 TEMPERATURE (C) DATA ***

READING NO.	1 M	3 M	5 M	7 M	9 M
1	27.2	27.2	27.0	27.0	*****
2	27.2	27.2	27.0	27.1	*****
3	27.3	27.2	27.0	27.1	*****
4	27.3	27.2	27.0	27.1	*****
5	27.3	*****	*****	27.2	*****
6	27.3	27.3	27.0	27.1	*****
7	27.3	27.3	27.0	27.1	*****
8	27.3	27.3	27.0	27.1	*****
9	27.3	27.3	27.0	27.1	*****
10	27.3	27.3	27.0	27.1	*****
11	27.3	27.3	27.0	27.2	*****
12	27.3	27.3	27.0	27.1	*****
13	27.3	27.3	27.0	27.1	*****
14	27.3	27.3	27.0	27.1	*****
15	27.3	27.3	27.0	27.1	*****
16	27.3	27.3	27.0	27.1	*****
17	27.3	27.3	27.0	27.1	*****
18	27.3	27.3	27.0	27.1	*****
19	27.3	27.3	27.1	27.1	*****
20	27.3	27.3	27.1	27.1	*****
21	27.3	27.3	27.1	27.1	*****
22	27.3	27.3	27.1	27.1	*****
23	27.3	27.3	27.0	27.1	*****
24	27.3	27.3	27.0	27.1	*****
25	27.3	27.3	27.0	27.1	*****
26	27.3	27.3	27.0	27.1	*****
27	27.3	27.3	27.1	27.1	*****
28	27.3	27.3	27.0	27.1	*****
29	27.3	27.3	27.1	27.1	*****
30	27.3	27.3	27.1	27.1	*****
31	27.3	27.3	27.0	27.1	*****
32	27.3	27.3	27.0	27.1	*****
33	27.3	27.3	27.0	27.0	*****
34	27.3	27.3	27.0	27.1	*****
35	27.3	27.3	27.0	27.1	*****
36	27.3	27.3	27.0	27.1	*****
37	27.3	27.3	27.0	27.0	*****
38	27.3	27.3	27.0	27.0	*****
39	27.3	27.3	27.0	27.0	*****
40	27.3	27.3	27.0	27.0	*****
41	27.3	27.3	27.0	27.0	*****
42	27.3	27.3	27.0	27.0	*****
43	27.3	27.3	27.0	27.0	*****
44	27.3	27.3	27.0	27.0	*****
45	27.3	27.3	27.0	27.0	*****
46	27.3	27.3	27.0	27.0	*****
47	27.3	27.3	27.0	27.0	*****
48	27.3	27.0	27.0	*****	*****
49	27.3	27.0	27.0	*****	*****
50	27.3	27.1	27.0	*****	*****
51	27.3	27.1	27.0	*****	*****
52	27.3	27.1	27.1	*****	*****
53	27.3	27.1	27.0	*****	*****
54	27.3	27.1	27.0	*****	*****
55	27.3	27.0	27.0	*****	*****
56	27.3	27.0	27.0	*****	*****
57	27.3	27.0	27.0	*****	*****
58	27.3	27.0	27.0	*****	*****
59	27.3	27.0	27.0	*****	*****
60	27.3	27.0	27.0	*****	*****
61	27.3	27.0	27.0	*****	*****
62	27.3	27.0	27.0	*****	*****
63	27.3	27.0	27.0	*****	*****
64	27.3	27.0	27.0	*****	*****
65	27.3	27.0	27.0	*****	*****
66	27.3	27.0	27.0	*****	*****
67	27.3	27.[illegible]	26.9	*****	*****
68	27.3	27.0	26.9	*****	*****
69	27.3	27.0	26.9	*****	*****
70	27.3	27.0	26.9	*****	*****
71	27.3	27.0	26.9	*****	*****
72	27.3	27.0	26.9	*****	*****
73	27.3	27.0	26.9	*****	*****
74	27.3	27.0	27.0	*****	*****
75	27.3	27.0	27.0	*****	*****
76	27.3	27.[illegible]	*****	*****	*****
77	27.3	27.0	*****	*****	*****
78	27.3	27.0	*****	*****	*****
79	27.3	27.0	*****	*****	*****
80	27.3	27.0	*****	*****	*****
81	27.1	*****	*****	*****	*****
82	27.1	*****	*****	*****	*****
83	27.1	*****	*****	*****	*****

Table 9. Estimated dimensions of excess isotherms for Mapping 1A.

Mapping:	1A	Wind (m/sec):	3.6 NW
Date:	8/18/77	Air Temp (°C):	21.0
Times:	1005-1133	Plant Load (MWe):	1650
Tidal Phase:	EBB	Intake Temp (°C):	27.5
u (cm/sec)*:	-12	Discharge Temp (°C):	32.8
v (cm/sec)*:	-13		

Depth (m)	Estimated ambient temp (°C)	Excess isotherm (°C)	Estimated enclosed area ($x10^4$ m^2)	Estimated maximum radial† extent ($x10^3$ m)
1	27.1	3	2	0.3
		2	10	0.8
		1	>90	>1.6
3	27.0	3	1	0.3
		2	10	0.9
		1	>90	>1.7
5	26.8	3	0.6	0.3
		2	7	0.9
		1	>80	>1.6
7	26.8	1	>50	>1.6

* Longitudinal component of current velocity, u (positive upestuary), and lateral component, v (positive toward eastern shore), measured at Station B, 2-m depth, after plume mapping.

† Measured from point of discharge.

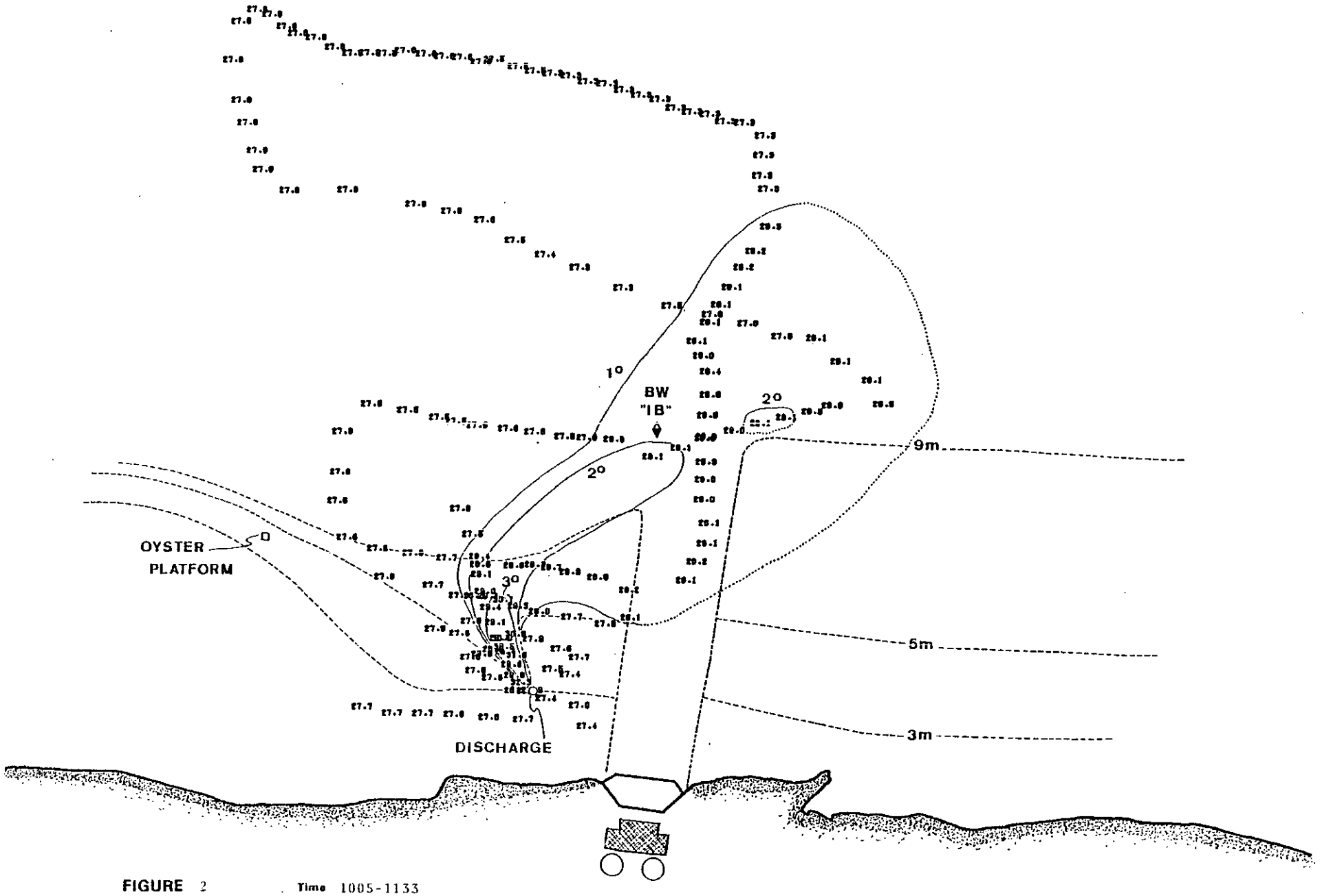

FIGURE 2
Mapping 1A
Depth (m) 1
Date 8/18/77

Time 1005-1133
Tide EBB
Plant Load (MWe) 1650
Ambient Temp. Estimate (°C) 27.1

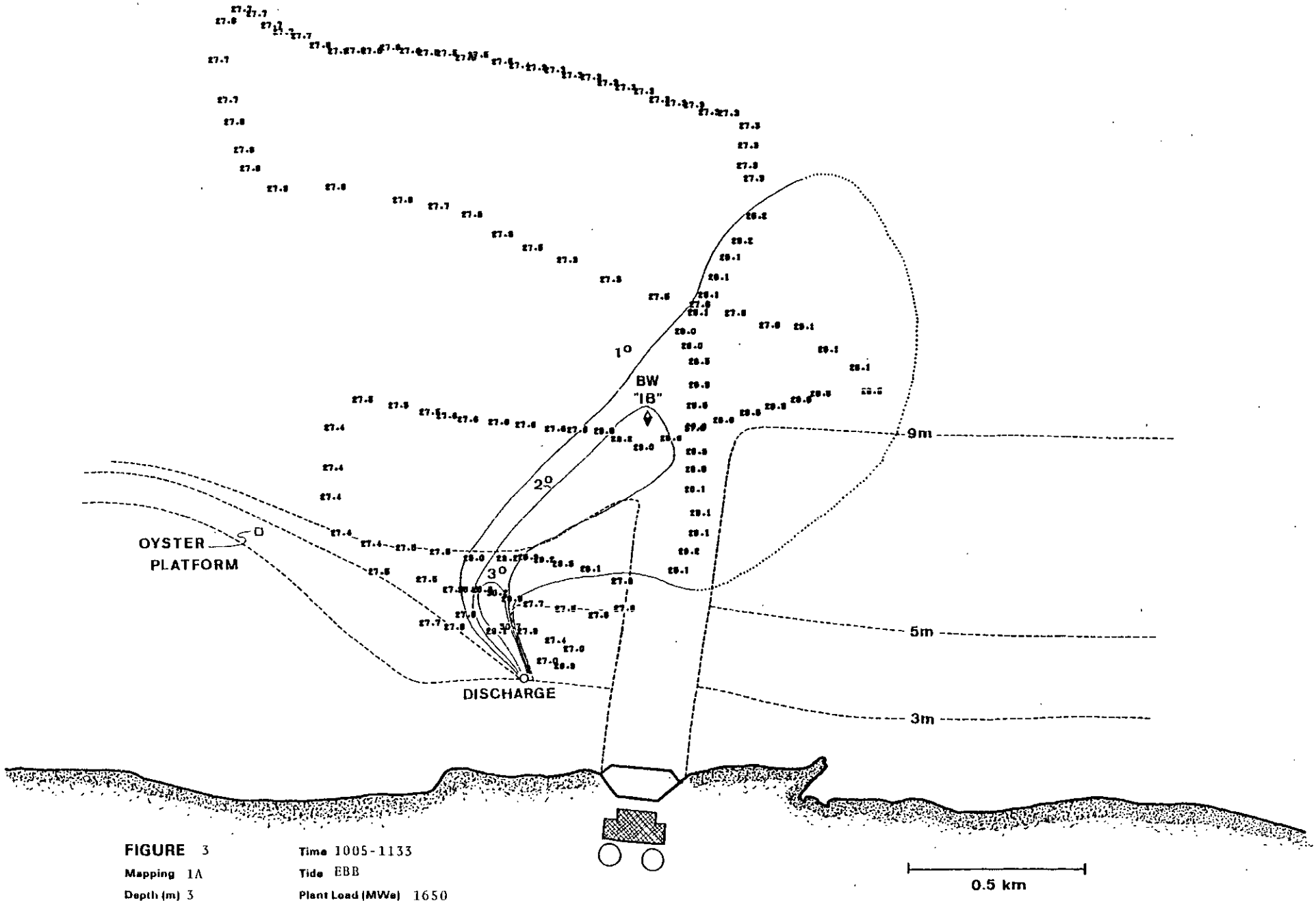

FIGURE 3
Mapping 1A
Depth (m) 3
Date 8/18/77

Time 1005-1133
Tide EBB
Plant Load (MWe) 1650
Ambient Temp. Estimate (°C) 27.0

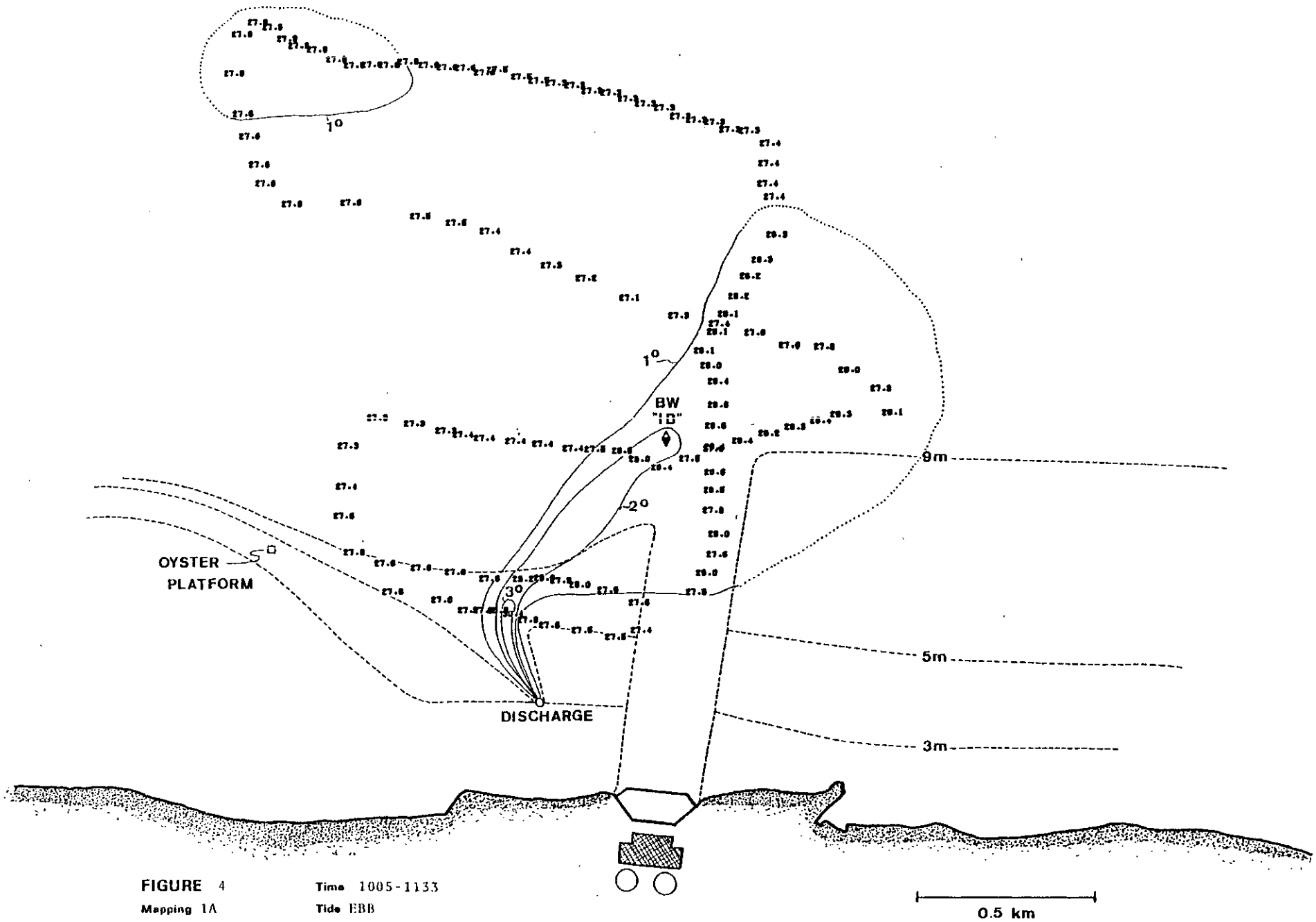

FIGURE 4
Mapping 1A
Depth (m) 5
Date 8/18/77

Time 1005-1133
Tide EBB
Plant Load (MWe) 1650
Ambient Temp. Estimate (°C) 26.8

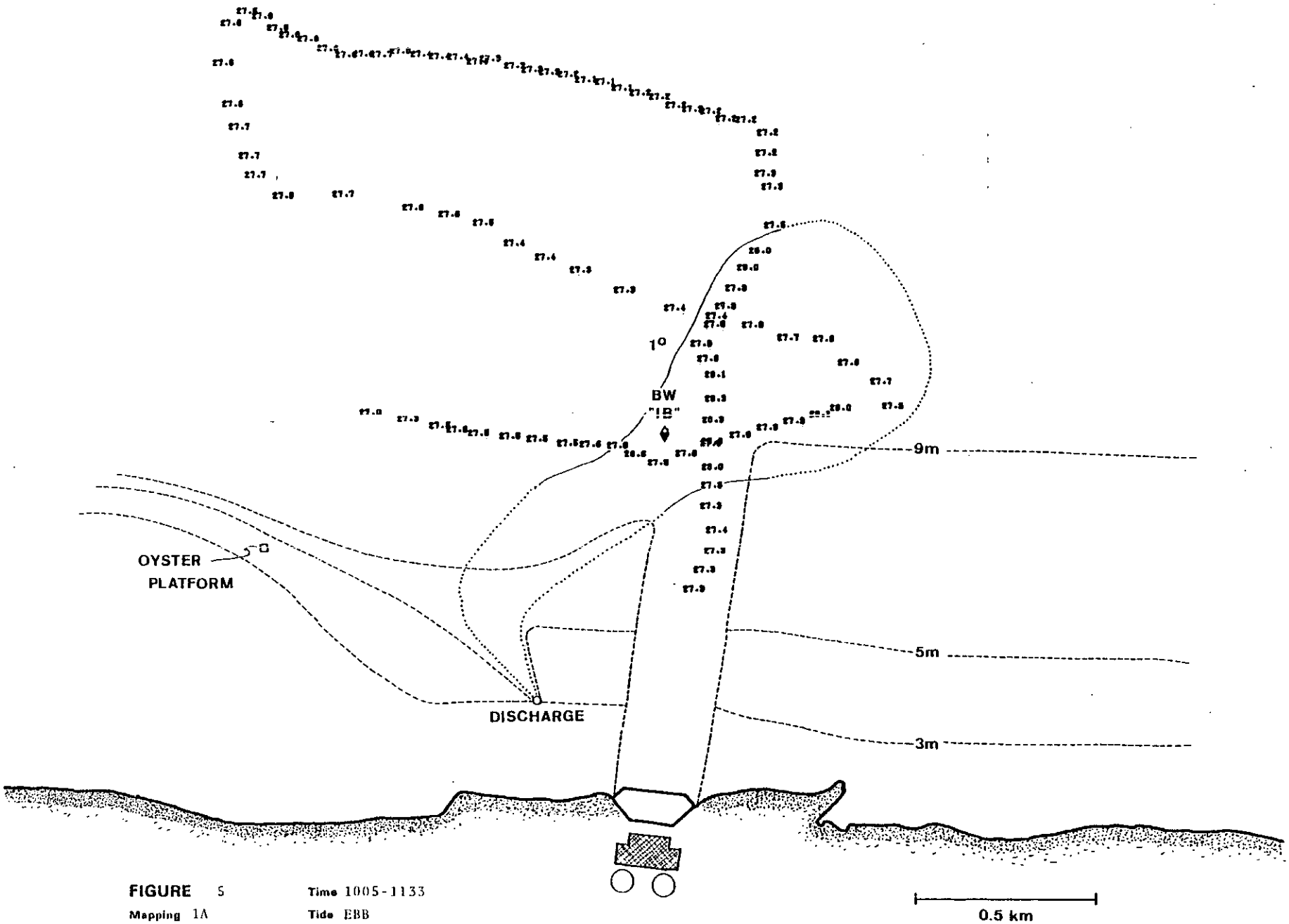

FIGURE 5
Mapping 1A
Depth (m) 7
Date 8/18/77

Time 1005-1133
Tide EBB
Plant Load (MWe) 1650
Ambient Temp. Estimate (°C) 26.8

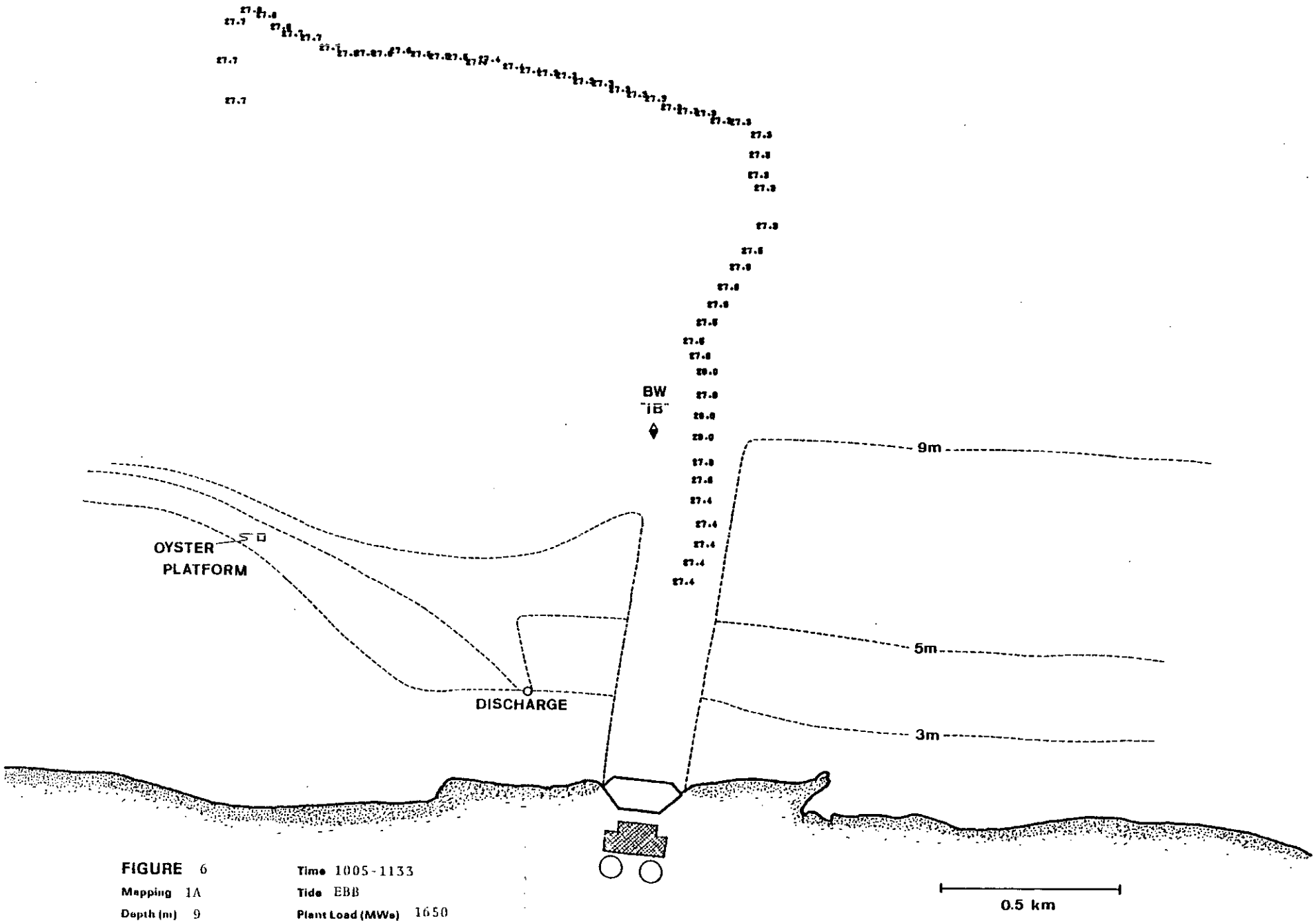

FIGURE 6
Mapping 1A
Depth (m) 9
Date 8/18/77

Time 1005-1133
Tide EBB
Plant Load (MWe) 1650
Ambient Temp. Estimate (°C)

Vertical profiles of hydrographic variables in the Chesapeake Bay near Calvert Cliffs, Maryland.

Table 10.

PROFILE: 1B-1 DATE: 8/18/77

STATION: A TIME: 1855

Depth (m)	Temp (C)	Cond. (mmhos/cm)	Salinity (°/oo)	Sigma T	D.O. (ppm)	Velocity ($cmsec^{-1}$/deg)	u (cm/sec)	v (cm/sec)
0	27.1	23.3	13.5	6.6	7.6	34/315	29	-19
2	27.1	23.2	13.4	6.6	7.6	34/320	30	-16
4	27.1	23.5	13.6	6.7	6.1	37/330	35	-11
6	27.1	23.7	13.7	6.8	5.5	34/350	34	1
8	27.1	23.7	13.7	6.8	4.1	21/8	20	7
10	26.8	23.9	13.9	7.0	3.5	12/345	12	- 1

Table 11.

PROFILE: 1B-1 DATE: 8/18/77

STATION: B TIME: 1528

Depth (m)	Temp (C)	Cond. (mmhos/cm)	Salinity (°/oo)	Sigma T	D.O. (ppm)	Velocity ($cmsec^{-1}$/deg)	u (cm/sec)	v (cm/sec)
0	28.3	23.8	13.4	6.2	6.9	21/325	19	- 8
2	28.0	23.7	13.5	6.3	6.5	24/320	21	-11
4	27.9	23.7	13.5	6.4	5.9	27/315	23	-15
6	27.6	23.8	13.7	6.6	5.8	24/315	20	-13
7	27.6	23.9	13.7	6.6	5.7	24/315	20	-13

Table 12.

PROFILE: 1B-2 DATE: 8/18/77

STATION: B TIME: 1740

Depth (m)	Temp (C)	Cond. (mmhos/cm)	Salinity (°/oo)	Sigma T	D.O. (ppm)	Velocity ($cmsec^{-1}$/deg)	u (cm/sec)	v (cm/sec)
0	28.0	23.8	13.5	6.4	6.8	21/315	18	-11
2	28.1	23.7	13.4	6.3	6.6	24/320	21	-11
4	28.1	23.8	13.5	6.3	6.6	24/315	20	-13
6	28.1	23.8	13.5	6.3	6.6	24/315	20	-13
7	28.1	23.8	13.5	6.3	6.5	21/315	18	-11

Vertical profiles of hydrographic variables in the Chesapeake Bay near Calvert Cliffs, Maryland.

Table 13.

PROFILE: 1B-1 DATE: 8/18/77

STATION: C TIME: 1541

Depth (m)	Temp (C)	Cond. (mmhos/cm)	Salinity (°/oo)	Sigma T	D.O. (ppm)	Velocity ($cmsec^{-1}$/deg)	u (cm/sec)	v (cm/sec)
0	28.1	23.9	13.5	6.4	7.0	9/275	3	- 9
2	28.1	23.9	13.5	6.4	6.6	9/275	3	- 9
4	28.1	23.9	13.5	6.4	6.4	12/270	2	-12
6	28.1	23.9	13.5	6.4	6.3	15/265	2	-15
8	28.0	23.9	13.6	6.4	6.2	18/260	1	-18
10	28.0	24.0	13.6	6.5	6.3	12/260	0	-12
12	28.0	23.9	13.6	6.4	6.1	12/250	- 2	-12
14	27.8	23.9	13.6	6.5	5.9	3/260	0	- 3

Table 14.

PROFILE: 1B-2 DATE: 8/18/77

STATION: C TIME: 1811

Depth (m)	Temp (C)	Cond. (mmhos/cm)	Salinity (°/oo)	Sigma T	D.O. (ppm)	Velocity ($cmsec^{-1}$/deg)	u (cm/sec)	v (cm/sec)
0	27.6	24.0	13.8	6.7	5.8	3/170	- 3	0
2	27.9	23.9	13.6	6.5	5.9	9/180	- 9	- 2
4	27.9	23.8	13.5	6.4	5.7	9/195	- 8	- 4
6	27.8	23.9	13.6	6.5	5.4	9/175	- 9	- 1
8	27.8	23.8	13.6	6.5	5.4	9/185	- 9	- 3
10	27.8	23.9	13.6	6.5	5.2	12/205	-10	- 7
12	27.8	23.8	13.6	6.5	5.2	9/215	- 6	- 7
14	27.8	23.8	13.6	6.5	5.2	6/205	- 5	- 4

Table 13.

MAPPING: 18
DATE: 081877
TIMES: 1900 TO 1955

*** TRANSECT 1 TEMPERATURE (C) DATA ***

READING NO.	1 M	3 M	5 M	7 M	9 M
1	27.1	27.1	27.0	27.1	*****
2	27.1	27.1	27.0	27.0	*****
3	27.1	27.1	27.0	27.0	*****
4	27.1	27.1	27.0	27.0	*****
5	27.1	27.1	27.0	27.0	*****
6	27.1	27.1	27.0	27.0	*****
7	27.1	27.1	27.0	27.0	*****
8	27.1	27.1	27.0	27.0	*****
9	27.1	27.1	27.0	27.0	*****
10	27.1	27.1	27.0	27.0	*****
11	27.1	27.1	27.0	27.0	*****
12	27.1	27.1	27.0	27.0	*****
13	27.1	27.1	27.0	27.0	*****
14	27.1	27.1	27.0	26.9	*****
15	27.1	27.1	27.0	27.0	*****
16	27.1	27.1	27.0	27.0	*****
17	27.1	27.1	27.0	27.0	*****
18	27.1	27.1	27.0	27.0	*****
19	27.1	27.2	27.0	27.0	*****
20	27.1	27.2	27.0	27.0	*****
21	27.1	27.2	27.0	27.1	*****
22	27.1	27.2	27.0	26.9	*****
23	27.2	27.2	27.0	27.0	*****
24	27.2	27.2	27.0	27.0	*****
25	27.1	27.2	27.0	27.0	*****
26	27.2	27.2	27.0	27.0	*****
27	27.2	27.2	27.0	27.0	*****
28	27.2	27.2	27.0	27.0	*****
29	27.2	27.2	27.0	27.0	*****
30	27.2	27.2	27.0	26.9	*****
31	27.2	27.2	27.0	27.0	*****
32	27.2	27.2	27.0	26.9	*****
33	27.2	27.3	27.0	26.9	*****
34	27.2	27.2	27.0	26.9	*****
35	27.2	27.3	27.0	26.9	*****
36	27.2	27.2	27.0	26.9	*****
37	27.2	27.2	27.0	26.9	*****
38	27.2	27.2	27.0	26.9	*****
39	27.2	27.3	27.0	26.9	*****
40	27.2	27.3	27.0	26.9	*****
41	27.2	27.2	27.0	26.9	*****
42	27.2	27.2	27.0	26.9	*****
43	27.2	27.2	27.0	27.0	*****
44	27.2	27.2	27.0	26.9	*****
45	27.2	27.2	27.0	27.0	*****
46	27.2	27.2	27.0	26.9	*****
47	27.2	27.3	27.0	27.0	*****
48	27.2	27.3	27.0	26.9	*****
49	27.2	27.2	27.0	26.9	*****
50	27.2	27.2	27.0	26.9	*****
51	27.2	27.3	27.0	26.9	*****
52	27.3	27.3	27.0	26.9	*****
53	27.3	27.3	27.0	26.9	*****
54	27.3	27.3	27.0	27.0	*****
55	27.3	27.3	27.0	26.9	*****
56	27.3	27.3	27.0	26.9	*****
57	27.3	27.3	27.0	26.9	*****
58	27.3	27.3	27.0	26.9	*****
59	27.3	27.3	27.0	26.9	*****
60	27.3	27.3	27.0	26.9	*****
61	27.3	27.3	27.0	26.9	*****
62	27.3	27.3	27.0	26.9	*****
63	27.3	27.3	27.0	27.0	*****
64	27.3	27.3	27.0	26.9	*****
65	27.3	27.3	27.0	27.0	*****
66	27.3	27.3	27.0	26.9	*****
67	27.3	27.3	27.0	26.9	*****
68	27.3	27.3	27.0	26.9	*****
69	27.3	27.3	27.0	26.9	*****
70	27.3	27.3	27.0	26.9	*****
71	27.3	27.3	27.0	27.0	*****
72	27.3	27.3	27.0	26.9	*****
73	27.3	27.3	27.0	27.0	*****
74	27.3	27.3	27.0	26.9	*****
75	27.3	27.3	27.0	26.9	*****
76	27.3	27.3	27.0	26.9	*****
77	27.3	27.3	27.0	26.9	*****
78	27.3	27.3	27.0	26.9	*****
79	27.3	27.3	27.0	26.9	*****
80	27.3	27.3	27.0	26.9	*****

Table 16.

MAPPING: 1B
DATE: 081877
TIMES: 1900 TO 1955

*** TRANSECT 2 TEMPERATURE (C) DATA ***

READING NO.	1 M	3 M	5 M	7 M	9 M
1	27.2	27.2	27.0	26.9	*****
2	27.2	27.2	27.0	26.9	*****
3	27.2	27.2	27.0	26.9	*****
4	27.2	27.2	27.0	26.9	*****
5	27.2	27.2	27.0	26.9	*****
6	27.2	27.2	27.0	26.9	*****
7	27.2	27.2	27.0	26.9	*****
8	27.2	27.2	27.0	26.9	*****
9	27.2	27.2	27.0	26.9	*****
10	27.2	27.2	26.9	27.0	*****
11	27.2	27.2	27.0	27.0	*****
12	27.1	27.2	27.0	26.9	*****
13	27.2	27.2	27.0	26.9	*****
14	27.1	27.2	27.0	27.0	*****
15	27.2	27.2	27.0	27.0	*****
16	27.2	27.2	27.0	27.0	*****
17	27.2	27.2	27.0	27.0	*****
18	27.1	27.2	27.0	26.9	*****
19	27.2	27.2	27.0	26.9	*****
20	27.2	27.2	27.0	26.9	*****
21	27.1	27.2	27.0	27.0	*****
22	27.1	27.2	27.0	27.0	*****
23	27.2	27.2	27.0	26.9	*****
24	27.1	27.2	27.0	26.9	*****
25	27.1	27.0	27.0	*****	*****
26	27.2	27.0	27.1	*****	*****
27	27.2	27.0	27.0	*****	*****
28	27.2	27.0	27.0	*****	*****
29	27.1	27.0	27.0	*****	*****
30	27.1	27.0	27.0	*****	*****
31	27.2	27.0	27.0	*****	*****
32	27.1	27.0	27.0	*****	*****
33	27.2	27.0	27.0	*****	*****
34	27.2	27.0	27.0	*****	*****
35	27.2	27.0	27.0	*****	*****
36	27.1	27.0	27.0	*****	*****
37	27.1	27.0	27.0	*****	*****
38	27.1	27.0	27.1	*****	*****
39	27.1	27.0	27.1	*****	*****
40	27.1	27.0	27.1	*****	*****
41	27.1	27.0	27.1	*****	*****
42	27.1	27.0	27.1	*****	*****
43	27.1	27.0	27.1	*****	*****
44	27.1	27.0	27.1	*****	*****
45	27.1	27.0	27.1	*****	*****
46	27.2	27.0	27.1	*****	*****
47	27.2	27.0	27.1	*****	*****
48	27.1	27.0	27.1	*****	*****
49	27.1	27.0	27.1	*****	*****
50	27.1	27.0	27.1	*****	*****
51	27.1	27.1	*****	*****	*****
52	27.1	27.1	*****	*****	*****
53	27.1	27.1	*****	*****	*****
54	27.1	27.1	*****	*****	*****
55	27.1	27.1	*****	*****	*****
56	27.1	27.1	*****	*****	*****
57	27.1	27.1	*****	*****	*****
58	27.2	27.1	*****	*****	*****
59	27.2	27.1	*****	*****	*****
60	27.2	27.1	*****	*****	*****
61	27.2	27.1	*****	*****	*****
62	27.2	*****	*****	*****	*****
63	27.0	*****	*****	*****	*****
64	27.1	*****	*****	*****	*****
65	27.1	*****	*****	*****	*****
66	27.1	*****	*****	*****	*****
67	27.1	*****	*****	*****	*****
68	27.0	*****	*****	*****	*****
69	27.0	*****	*****	*****	*****
70	27.0	*****	*****	*****	*****
71	27.0	*****	*****	*****	*****
72	26.9	*****	*****	*****	*****
73	26.9	*****	*****	*****	*****
74	26.9	*****	*****	*****	*****
75	26.9	*****	*****	*****	*****

Table 17. Estimated dimensions of excess isotherms for Mapping 1B.

Mapping:	1B	Wind (m/sec):	1.9 N
Date:	8/18/77	Air Temp (°C):	23.3
Times:	1603-1735	Plant Load (MWe):	1650
Tidal Phase:	FLOOD	Intake Temp (°C):	27.7
u (cm/sec)*:	21	Discharge Temp (°C):	33.3
v (cm/sec)*:	-11		

Depth (m)	Estimated ambient temp (°C)	Excess isotherm (°C)	Estimated enclosed area ($x10^4$ m^2)	Estimated maximum radial† extent ($x10^3$ m)
1	27.1	3	4	0.6
		2	>60	>2.3
		1	>300	>2.3
3	27.0	2	>10	>1.0
		1	>90	>2.2
5	27.0	2	>7	>0.9
		1	>90	>1.9
7	26.9			

* Longitudinal component of current velocity, u (positive upestuary), and lateral component, v (positive toward eastern shore), measured at Station B, 2-m depth, after plume mapping.

† Measured from point of discharge.

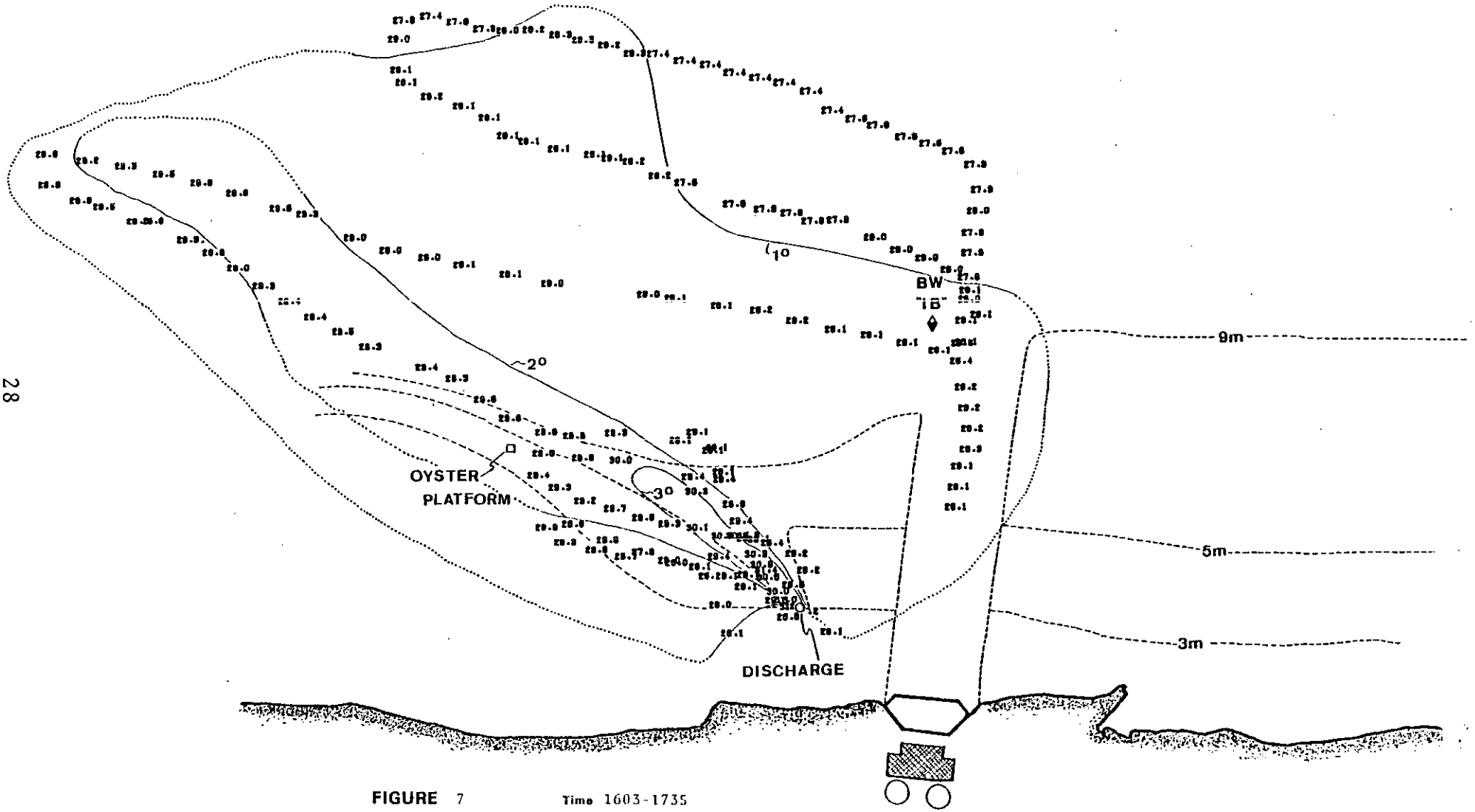

FIGURE 7
Mapping 1B
Depth (m) 1
Date 8/18/77

Time 1603-1735
Tide FLOOD
Plant Load (MWe) 1650
Ambient Temp. Estimate (°C) 27.1

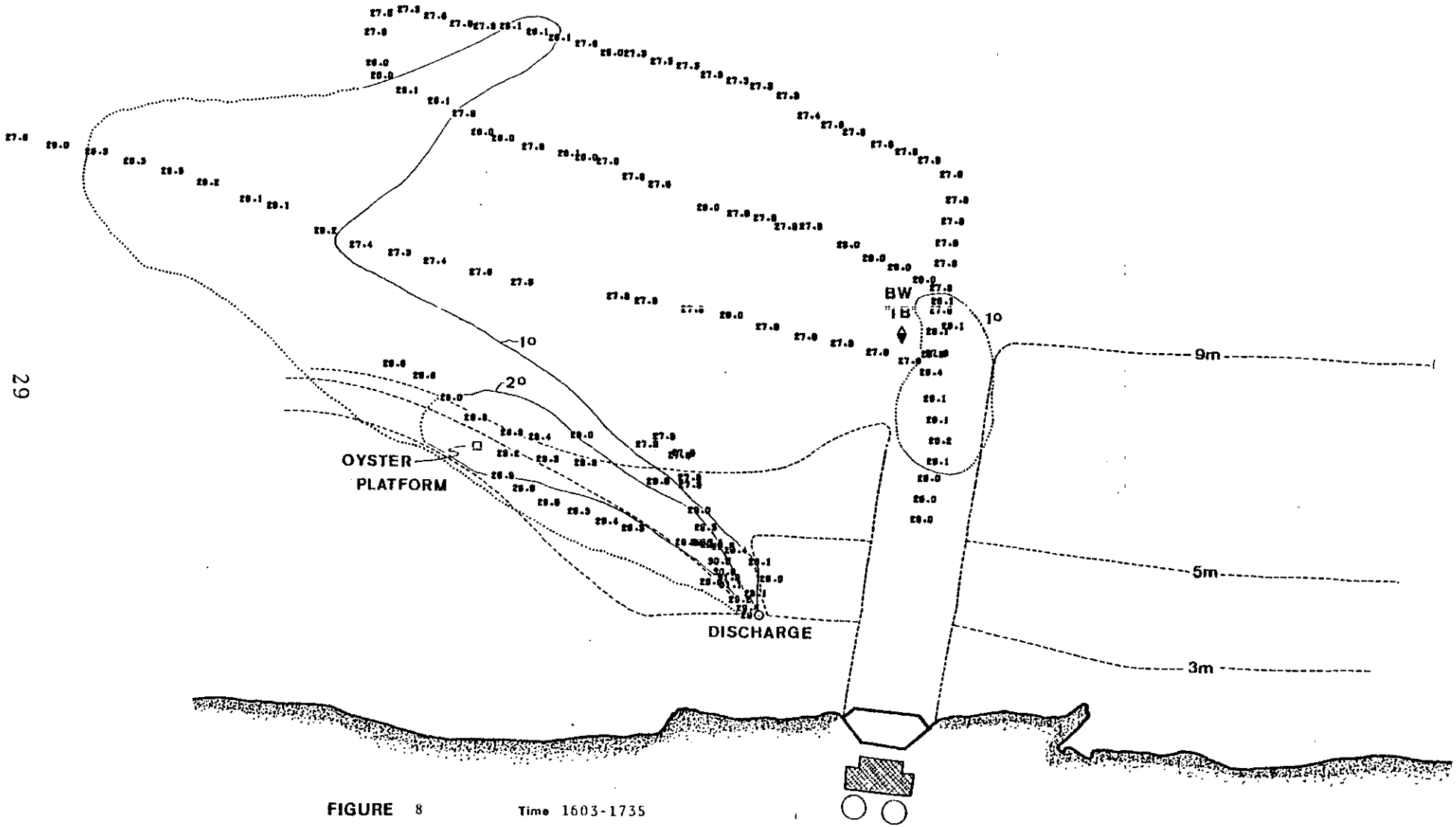

FIGURE 8
Mapping 1B
Depth (m) 3
Date 8/18/77

Time 1603-1735
Tide FLOOD
Plant Load (MWe) 1650
Ambient Temp. Estimate (°C) 27.0

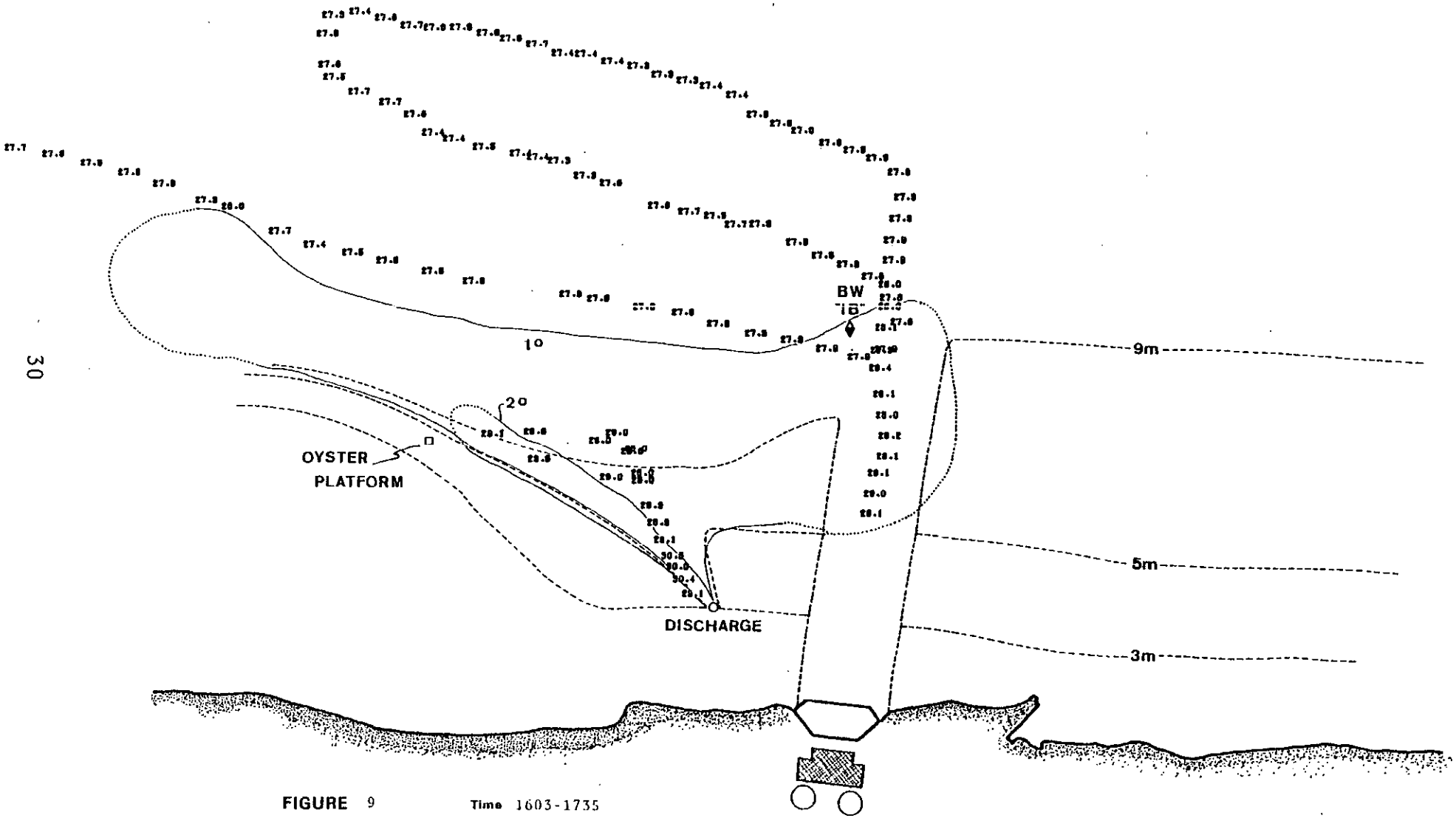

FIGURE 9
Mapping 1B
Depth (m) 5
Date 8/18/77

Time 1603-1735
Tide FLOOD
Plant Load (MWe) 1650
Ambient Temp. Estimate (°C) 27.0

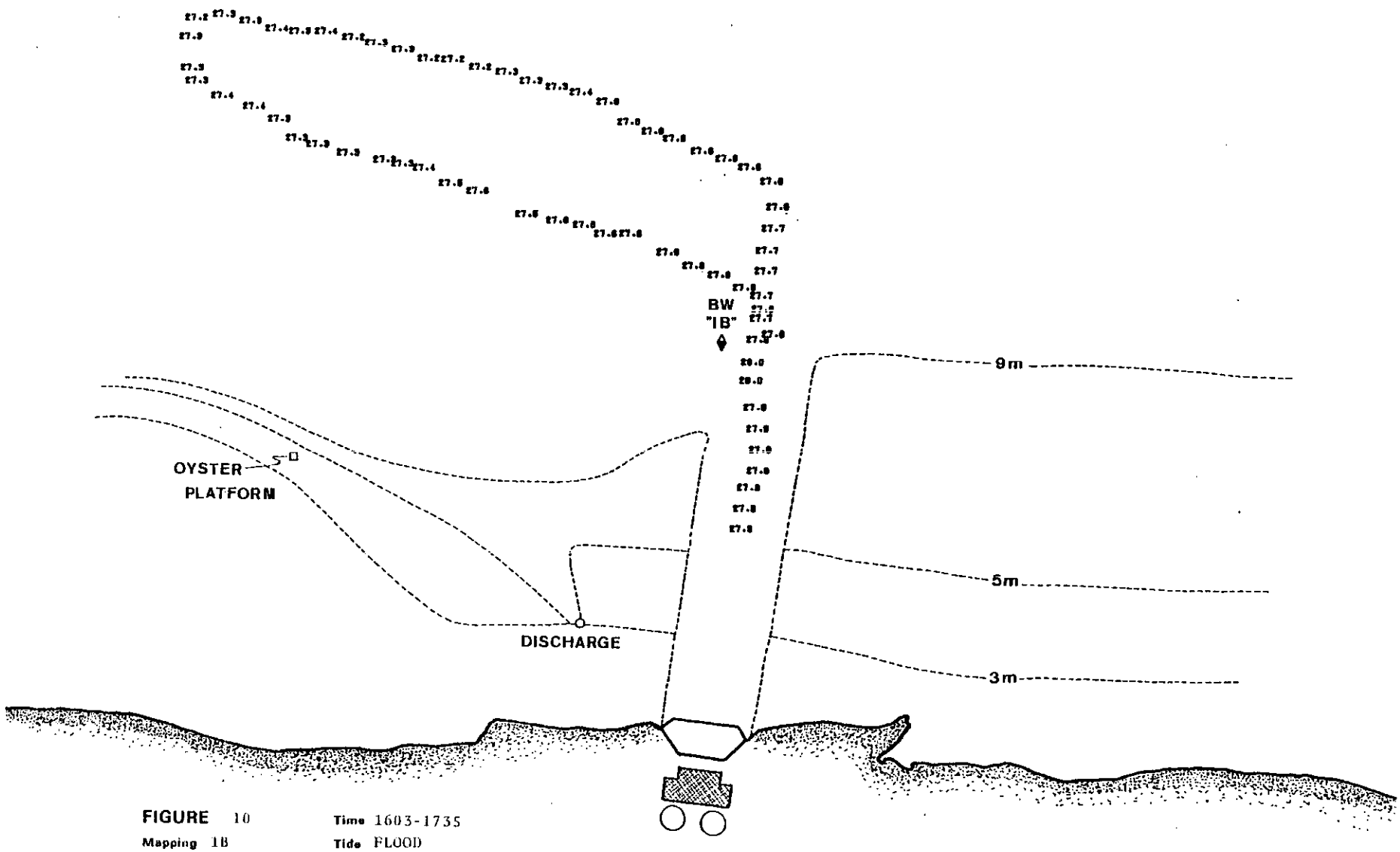

FIGURE 10
Mapping 1B
Depth (m) 7
Date 8/18/77

Time 1603-1735
Tide FLOOD
Plant Load (MWe) 1650
Ambient Temp. Estimate (°C) 26.9

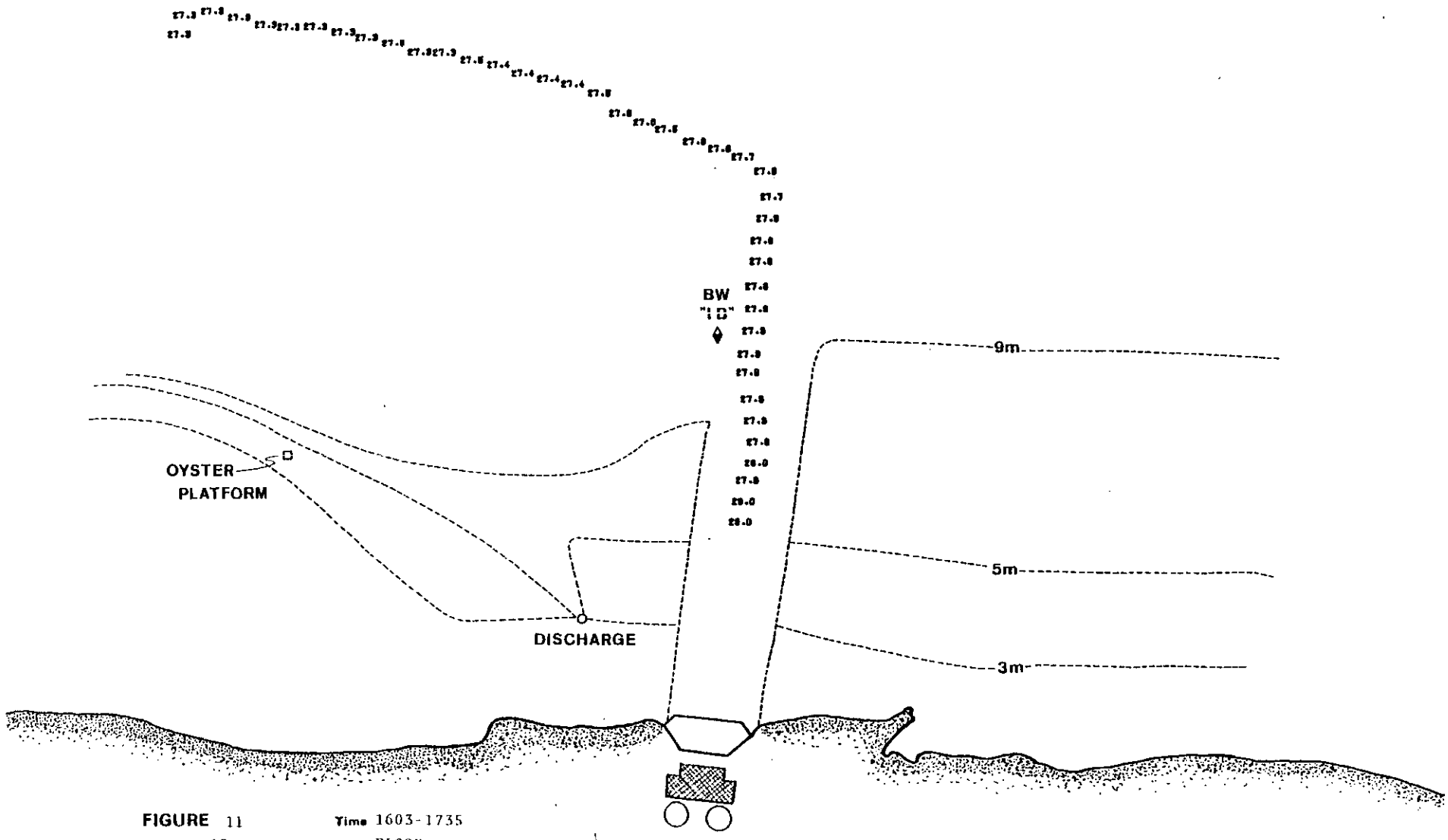

FIGURE 11
Mapping 1B
Depth (m) 9
Date 8/18/77

Time 1603-1735
Tide FLOOD
Plant Load (MWe) 1650
Ambient Temp. Estimate (°C)

Vertical profiles of hydrographic variables in the Chesapeake Bay near Calvert Cliffs, Maryland.

Table 18.

PROFILE: 1C-1 DATE: 8/19/77

STATION: A TIME: 1144

Depth (m)	Temp (C)	Cond. (mmhos/cm)	Salinity (°/oo)	Sigma T	D.O. (ppm)	Velocity ($cmsec^{-1}$/deg)	u (cm/sec)	v (cm/sec)
0	27.0	23.9	13.9	6.9	6.6	15/150	-14	5
2	26.9	23.7	13.8	6.9	5.8	18/145	-17	7
4	26.7	23.8	13.9	7.1	5.4	18/150	-17	6
6	26.7	23.8	13.9	7.1	5.4	18/145	-17	7
8	26.7	23.8	13.9	7.1	5.2	18/150	-17	6
10	26.7	23.8	13.9	7.1	5.1	15/140	-13	7

Table 19.

PROFILE: 1C-1 DATE: 8/19/77

STATION: B TIME: 0812

Depth (m)	Temp (C)	Cond. (mmhos/cm)	Salinity (°/oo)	Sigma T	D.O. (ppm)	Velocity ($cmsec^{-1}$/deg)	u (cm/sec)	v (cm/sec)
0	29.0	24.1	13.4	6.0	5.6	49/320	43	-23
2	28.9	24.1	13.4	6.0	5.6	49/345	49	- 3
4	28.6	24.2	13.6	6.2	5.6	43/340	43	- 6
6	28.2	24.0	13.6	6.4	5.7	27/20	23	14
7	28.3	24.0	13.6	6.3	5.7	27/35	20	21

Table 20.

PROFILE: 1C-2 DATE: 8/19/77

STATION: B TIME: 1041

Depth (m)	Temp (C)	Cond. (mmhos/cm)	Salinity (°/oo)	Sigma T	D.O. (ppm)	Velocity ($cmsec^{-1}$/deg)	u (cm/sec)	v (cm/sec)
0	28.3	24.1	13.6	6.4	6.7	9/30	7	6
2	28.2	24.1	13.6	6.4	6.3	6/40	4	5
4	28.1	23.9	13.5	6.4	6.3	6/145	- 6	2
6	27.5	23.8	13.7	6.6	6.2	18/150	-17	6
7	27.1	23.9	13.8	6.9	6.0	18/140	-16	8

Vertical profiles of hydrographic variables in the Chesapeake Bay near Calvert Cliffs, Maryland.

Table 21.

PROFILE: 1C-1 DATE: 8/19/77

STATION: C TIME: 0819

Depth (m)	Temp (C)	Cond. (mmhos/cm)	Salinity (°/oo)	Sigma T	D.O. (ppm)	Velocity ($cmsec^{-1}$/deg)	u (cm/sec)	v (cm/sec)
0	27.0	24.2	14.1	7.1	6.0	6/210	- 4	- 4
2	27.1	24.1	14.0	7.0	5.9	9/165	- 9	0
4	27.2	24.0	13.9	6.9	5.8	3/230	- 1	- 3
6	27.2	24.1	13.9	6.9	5.7	9/245	- 2	- 9
8	27.1	24.1	14.0	7.0	5.6	9/245	- 2	- 9
10	27.0	24.0	13.9	7.0	5.6	0	0	0
12	26.9	24.8	14.5	7.4	4.0	12/250	- 2	-12
14	26.4	28.7	17.2	9.6	0.3	9/240	- 3	- 9

Table 22.

PROFILE: 1C-2 DATE: 8/19/77

STATION: C TIME: 1052

Depth (m)	Temp (C)	Cond. (mmhos/cm)	Salinity (°/oo)	Sigma T	D.O. (ppm)	Velocity ($cmsec^{-1}$/deg)	u (cm/sec)	v (cm/sec)
0	27.6	24.1	13.8	6.7	6.1	3/105	- 1	3
2	27.7	24.1	13.8	6.7	6.0	9/100	- 3	8
4	27.6	24.0	13.8	6.7	6.1	12/240	- 4	-11
6	27.5	24.0	13.8	6.7	6.1	12/255	- 1	-12
8	27.4	24.0	13.8	6.8	5.9	12/245	- 3	-12
10	27.3	24.3	14.0	7.0	5.4	6/270	1	- 6
12	26.7	27.4	16.2	8.8	1.8	6/220	- 4	- 5
14	26.2	28.4	17.0	9.5	0.7	9/135	- 8	5

Table 23.

MAPPING: 1C
DATE: 081977
TIMES: 1200 TO 1230

*** TRANSECT 1 TEMPERATURE (C) DATA ***

READING NO.	1 M	3 M	5 M	7 M	9 M
1	27.3	27.1	26.5	26.0	*****
2	27.3	27.0	26.7	26.7	*****
3	27.3	27.0	26.6	26.7	*****
4	27.3	27.0	26.5	26.7	*****
5	27.3	27.0	26.5	26.7	*****
6	27.3	27.0	26.5	26.7	*****
7	27.3	27.0	26.5	26.7	*****
8	27.3	27.1	26.5	26.0	*****
9	27.3	27.1	26.6	26.7	*****
10	27.3	27.1	26.5	26.7	*****
11	27.3	27.1	26.5	26.7	*****
12	27.3	27.1	26.5	26.7	*****
13	27.3	27.1	26.5	26.7	*****
14	27.3	27.0	26.5	26.7	*****
15	27.3	26.9	26.6	26.7	*****
16	27.3	26.9	26.5	26.7	*****
17	27.3	26.9	26.5	26.5	*****
18	27.3	26.9	26.5	26.5	*****
19	27.3	26.6	26.5	26.5	*****
20	27.3	26.9	26.5	26.6	*****
21	27.3	26.9	26.5	26.6	*****
22	27.3	26.9	26.5	26.5	*****
23	27.3	26.9	26.5	26.6	*****
24	27.3	26.9	26.5	26.5	*****
25	27.3	26.9	26.5	26.7	*****
26	27.3	26.9	26.5	26.7	*****
27	27.3	26.5	26.5	25.7	*****
28	27.3	26.5	26.6	26.7	*****
29	27.3	26.5	26.5	26.7	*****
30	27.3	26.6	26.5	26.7	*****
31	27.3	26.6	26.5	26.7	*****
32	27.3	26.6	26.5	26.5	*****
33	27.3	26.5	26.5	26.7	*****
34	27.3	26.5	26.6	26.7	*****
35	27.3	26.6	26.6	26.7	*****
36	27.3	26.6	26.5	26.7	*****
37	27.3	26.6	26.5	26.7	*****
38	27.3	26.6	26.5	26.6	*****
39	27.3	26.6	26.6	26.5	*****
40	27.3	26.5	26.6	26.7	*****
41	27.3	26.6	26.5	26.7	*****
42	27.3	26.6	26.5	26.7	*****
43	27.3	26.6	26.6	26.7	*****
44	27.3	26.6	26.5	26.7	*****
45	27.3	26.6	26.6	26.7	*****
46	27.3	26.9	26.5	26.7	*****
47	27.3	26.9	26.5	26.7	*****
48	27.3	26.5	26.6	26.5	*****
49	27.3	26.9	26.5	26.7	*****
50	27.3	26.9	26.5	26.7	*****
51	27.3	26.9	26.6	26.6	*****
52	27.3	27.0	26.6	26.7	*****
53	27.3	27.0	26.6	26.7	*****
54	27.3	27.1	26.5	26.7	*****
55	27.3	27.1	26.6	26.6	*****
56	27.3	27.1	26.6	26.7	*****
57	27.3	27.0	26.6	26.7	*****
58	27.2	27.0	26.7	26.5	*****
59	27.3	27.0	26.7	26.7	*****
60	27.3	27.0	26.7	26.5	*****
61	27.3	27.0	26.7	26.5	*****
62	27.3	27.0	26.6	26.7	*****
63	27.3	26.9	26.5	26.6	*****
64	27.3	26.9	26.7	26.7	*****
65	27.3	26.9	26.5	26.7	*****
66	27.3	26.9	26.7	27.1	*****
67	27.3	26.9	26.7	26.7	*****
68	27.3	26.9	26.7	26.7	*****
69	27.3	26.9	26.7	26.7	*****
70	27.3	26.9	26.5	26.7	*****
71	27.3	26.9	26.6	26.7	*****
72	27.3	26.9	26.5	26.7	*****
73	27.3	26.9	26.5	26.7	*****
74	27.3	26.9	26.5	26.7	*****
75	27.3	26.9	26.6	26.7	*****

Table 24.

MAPPING: 1C
DATE: 061977
TIMES: 1200 TO 1230

*** TRANSECT 2 TEMPERATURE (C) DATA ***

READING NO.	1 M	3 M	5 M	7 M	9 M
1	27.3	26.8	26.6	26.7	*****
2	27.3	26.8	26.6	26.7	*****
3	27.3	26.8	26.6	26.7	*****
4	27.3	26.9	26.6	26.7	*****
5	27.3	26.8	26.6	26.7	*****
6	27.3	26.9	26.6	26.7	*****
7	27.3	26.9	26.6	26.7	*****
8	27.3	26.9	26.6	26.7	*****
9	27.3	26.9	26.6	26.7	*****
10	27.3	26.8	26.6	26.7	*****
11	27.3	26.9	26.6	26.7	*****
12	27.3	26.8	26.6	26.7	*****
13	27.3	26.8	26.6	26.7	*****
14	27.2	26.8	26.6	26.7	*****
15	27.3	26.8	26.6	26.7	*****
16	27.2	26.8	26.6	26.7	*****
17	27.2	26.8	26.6	26.7	*****
18	27.2	26.8	26.6	26.7	*****
19	27.2	26.8	26.6	26.7	*****
20	27.2	26.8	26.6	26.7	*****
21	27.3	26.8	26.6	26.7	*****
22	27.3	26.8	26.6	26.7	*****
23	27.2	26.9	26.6	26.7	*****
24	27.2	26.9	26.6	26.7	*****
25	27.2	26.8	26.6	26.7	*****
26	27.2	26.8	26.6	26.7	*****
27	27.2	26.8	26.6	26.7	*****
28	27.3	26.8	26.6	26.7	*****
29	27.3	26.8	26.6	26.7	*****
30	27.3	26.9	26.6	26.7	*****
31	27.3	26.9	26.6	26.7	*****
32	27.3	26.9	26.6	26.7	*****
33	27.3	26.9	26.6	26.7	*****
34	27.3	26.9	26.6	26.7	*****
35	27.3	26.9	26.6	26.7	*****
36	27.3	26.9	26.6	26.7	*****
37	27.3	26.9	26.6	26.6	*****
38	27.3	26.9	26.6	26.6	*****
39	27.3	26.9	26.6	26.6	*****
40	27.3	27.1	26.6	26.7	*****
41	27.3	27.3	26.7	26.6	*****
42	27.3	27.3	26.6	26.6	*****
43	27.2	27.1	26.6	26.6	*****
44	27.3	26.4	26.7	26.6	*****
45	27.3	26.7	26.7	26.6	*****
46	27.3	27.3	26.7	26.6	*****
47	27.3	*****	26.6	26.6	*****
48	27.2	27.3	26.7	26.6	*****
49	27.3	26.6	26.6	*****	*****
50	27.2	26.6	26.6	*****	*****
51	27.3	26.6	26.6	*****	*****
52	27.3	26.6	26.7	*****	*****
53	27.2	26.6	26.7	*****	*****
54	27.2	26.6	26.7	*****	*****
55	27.2	26.6	26.7	*****	*****
56	27.2	26.6	26.7	*****	*****
57	27.2	26.6	26.7	*****	*****
58	27.3	26.7	26.7	*****	*****
59	27.3	26.7	26.7	*****	*****
60	27.2	26.7	26.6	*****	*****
61	27.2	26.7	26.7	*****	*****
62	27.1	26.6	26.6	*****	*****
63	27.1	26.6	26.6	*****	*****
64	27.2	26.6	26.7	*****	*****
65	27.1	26.6	26.6	*****	*****
66	27.2	26.6	26.6	*****	*****
67	27.3	26.6	26.6	*****	*****
68	27.2	26.6	26.6	*****	*****
69	27.3	26.6	26.6	*****	*****
70	27.3	26.6	26.6	*****	*****
71	27.3	26.6	*****	*****	*****
72	27.3	26.6	*****	*****	*****
73	27.3	26.6	*****	*****	*****
74	27.3	26.6	*****	*****	*****
75	27.3	26.6	*****	*****	*****
76	27.3	26.4	*****	*****	*****
77	27.4	26.4	*****	*****	*****
78	27.4	26.4	*****	*****	*****
79	27.4	26.6	*****	*****	*****
80	27.3	*****	*****	*****	*****
81	27.3	*****	*****	*****	*****
82	27.3	*****	*****	*****	*****
83	27.3	*****	*****	*****	*****

Table 25. Estimated dimensions of excess isotherms for Mapping 1C.

Mapping:	1C	Wind (m/sec):	2.7 NE
Date:	8/19/77	Air Temp (°C):	22.2
Times:	0832-1034	Plant Load (MWe):	1640
Tidal Phase:	SBE	Intake Temp (°C):	27.2
u (cm/sec)*:	4	Discharge Temp (°C):	32.8
v (cm/sec)*:	5		

Depth (m)	Estimated ambient temp (°C)	Excess isotherm (°C)	Estimated enclosed area ($x10^4$ m^2)	Estimated maximum radial† extent ($x10^3$ m)
1	27.3	2	8	0.8
		1	>80	1.9
3	26.9	2	8	0.8
		1	>100	>2.4
5	26.6	1	40	1.2
7	26.7			

* Longitudinal component of current velocity, u (positive upestuary), and lateral component, v (positive toward eastern shore), measured at Station B, 2-m depth, after plume mapping.

† Measured from point of discharge.

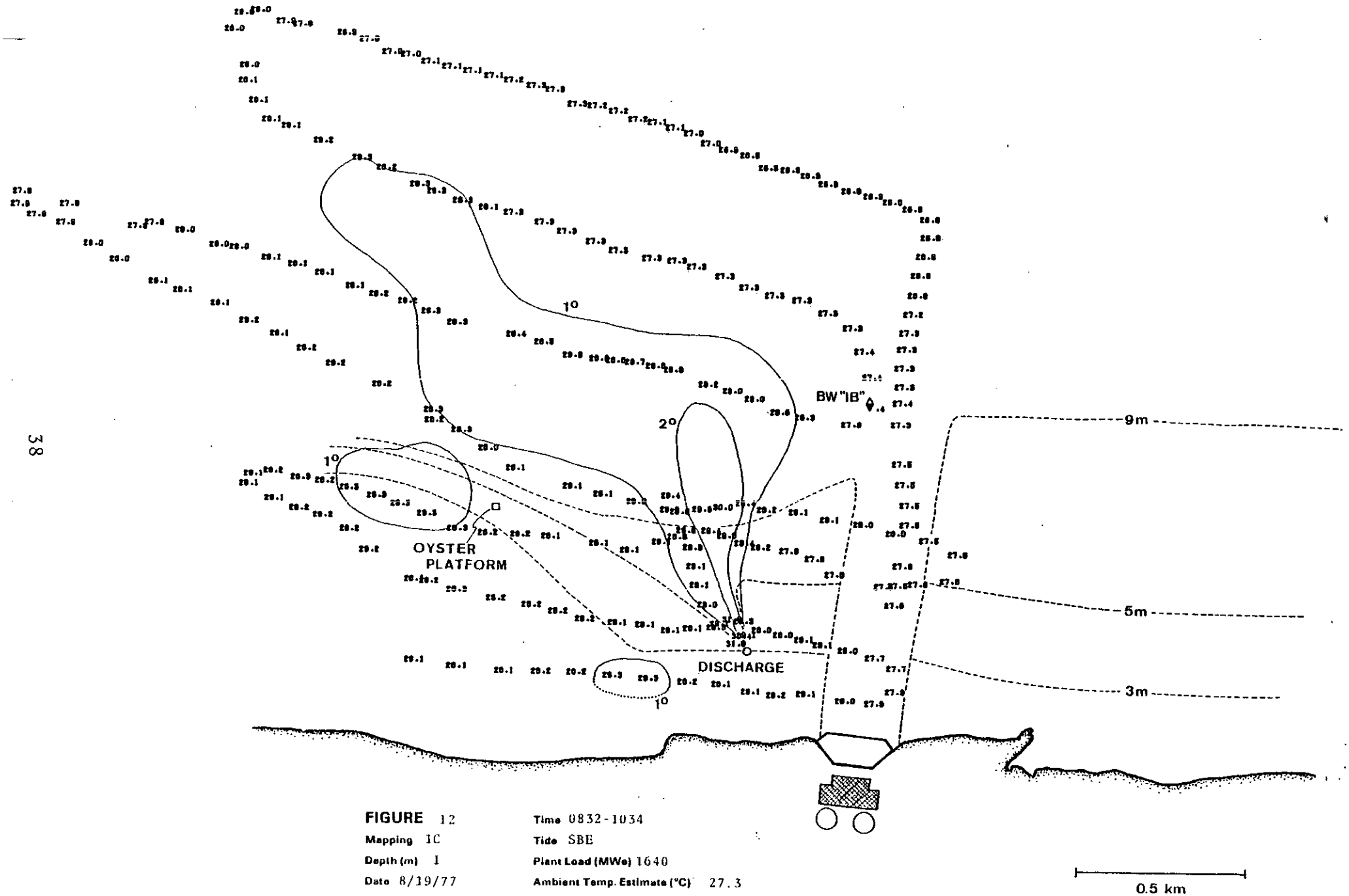

FIGURE 12
Mapping 1C
Depth (m) 1
Date 8/19/77

Time 0832-1034
Tide SBE
Plant Load (MWe) 1640
Ambient Temp. Estimate (°C) 27.3

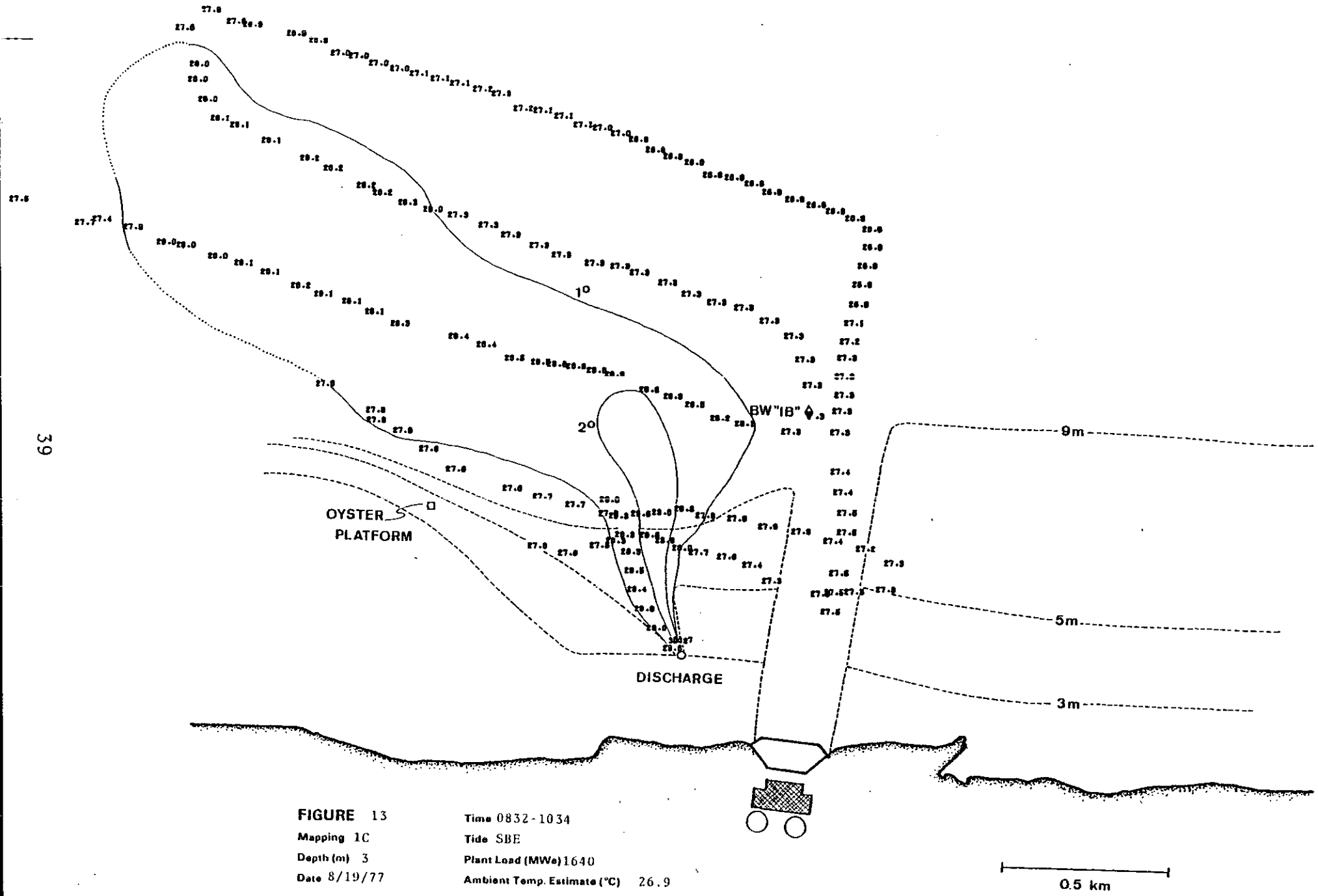

FIGURE 13
Mapping 1C
Depth (m) 3
Date 8/19/77

Time 0832-1034
Tide SBE
Plant Load (MWe) 1640
Ambient Temp. Estimate (°C) 26.9

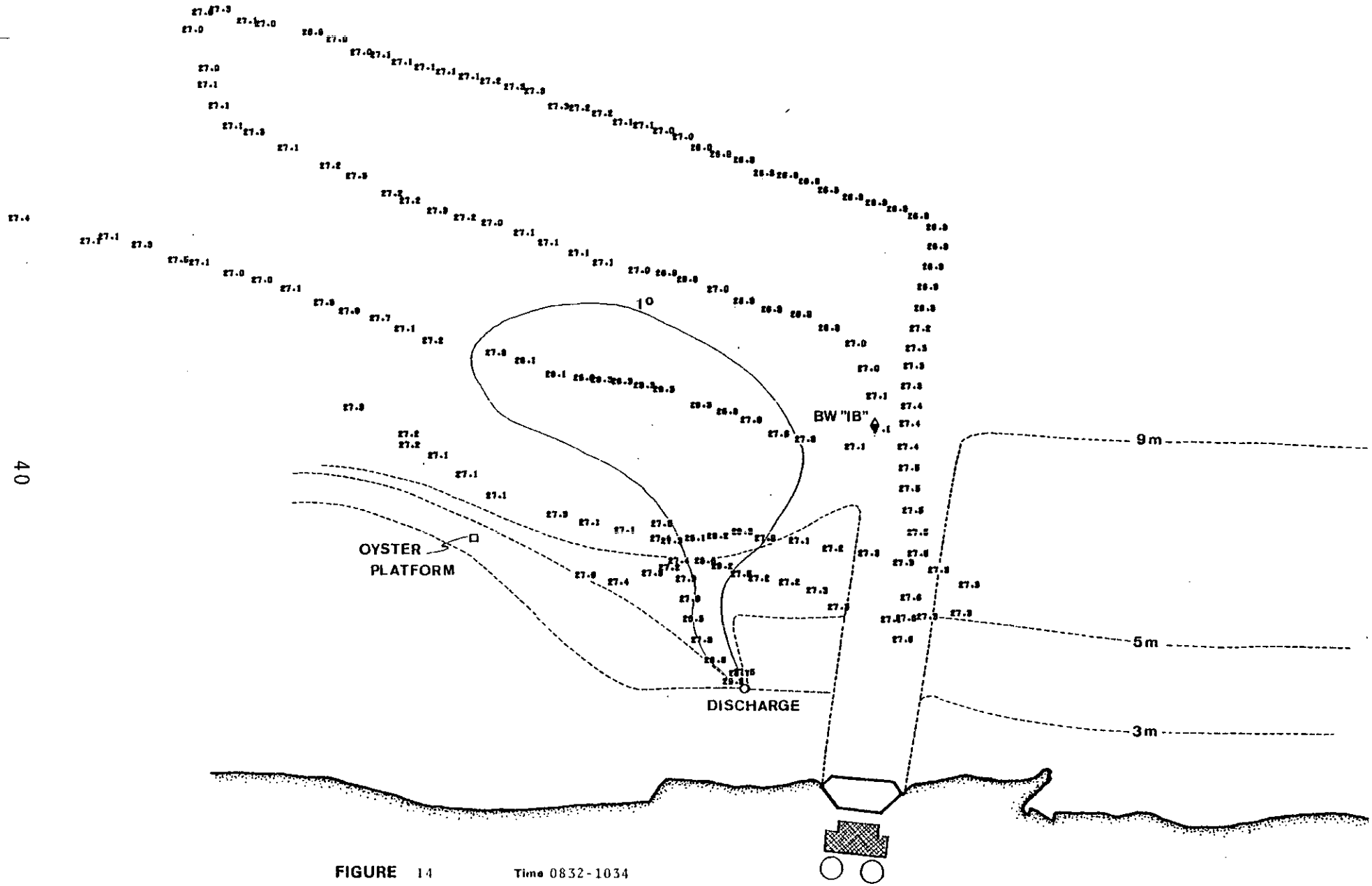

FIGURE 14
Mapping 1C
Depth (m) 5
Date 8/19/77

Time 0832-1034
Tide SBE
Plant Load (MWe) 1640
Ambient Temp. Estimate (°C) 26.6

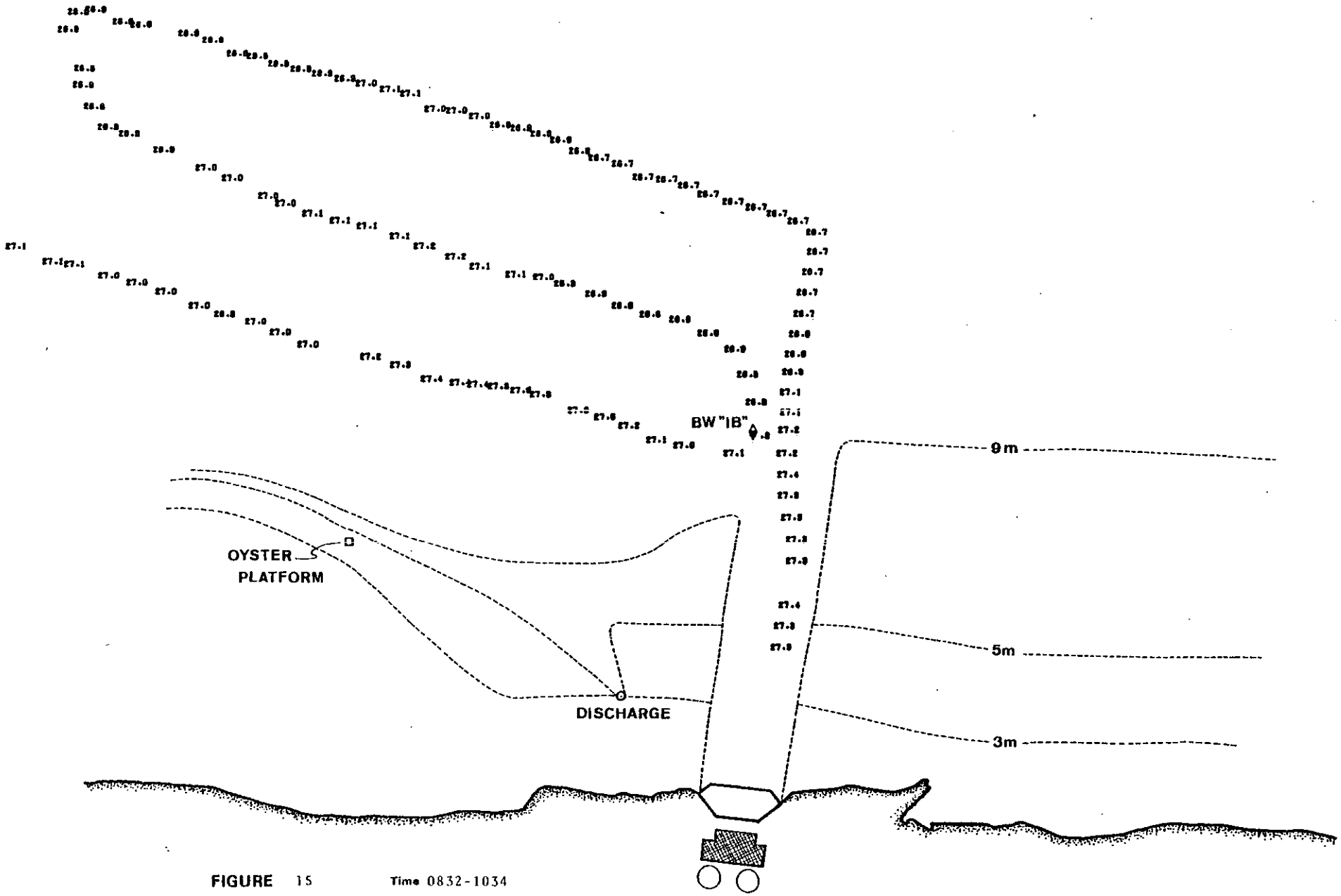

FIGURE 15
Mapping 1C
Depth (m) 7
Date 8/19/77

Time 0832-1034
Tide SBE
Plant Load (MWe) 1640
Ambient Temp. Estimate (°C) 26.7

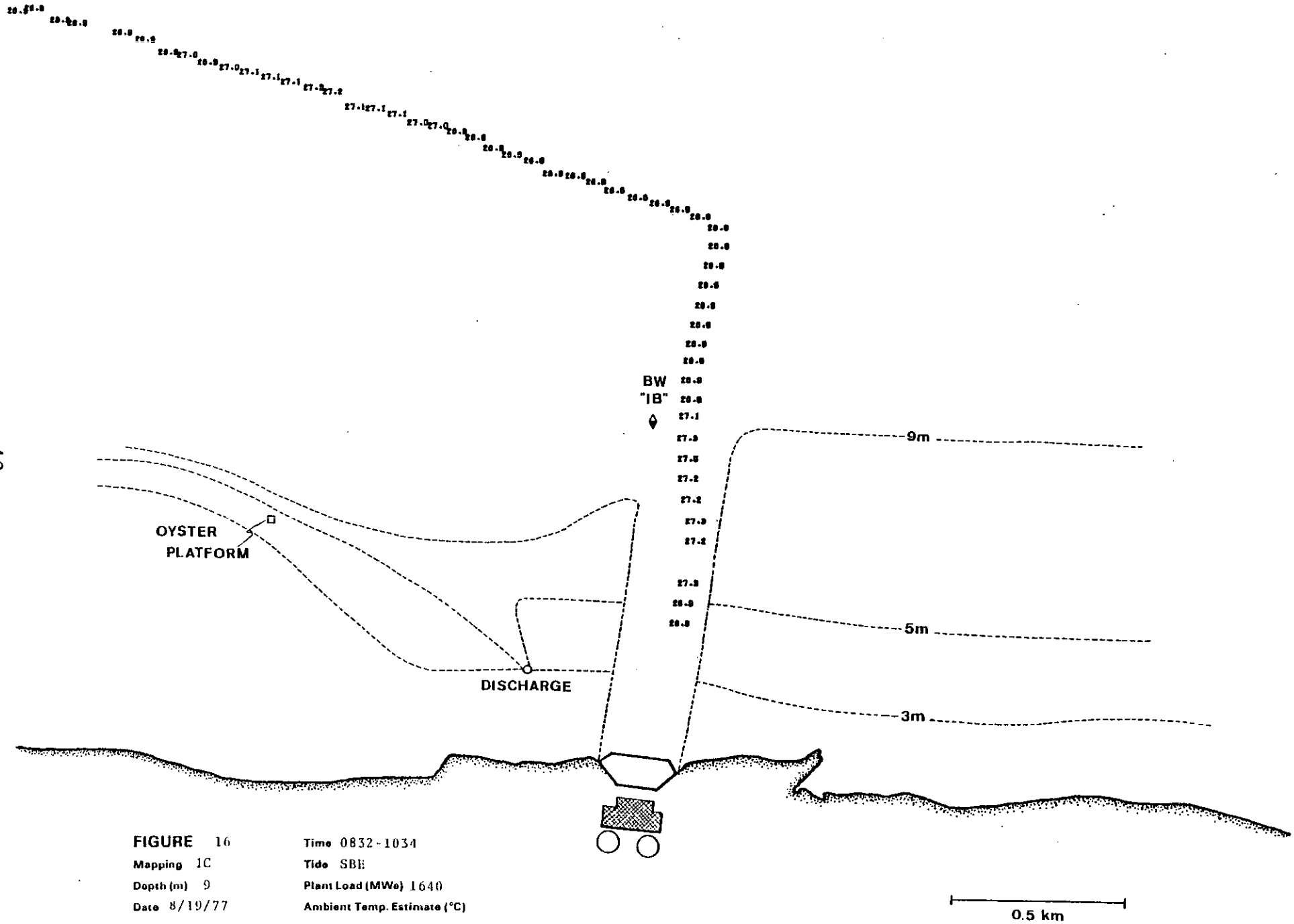

FIGURE 16
Mapping 1C
Depth (m) 9
Date 8/19/77

Time 0832-1034
Tide SBE
Plant Load (MWe) 1640
Ambient Temp. Estimate (°C)

Vertical profiles of hydrographic variables in the Chesapeake Bay near Calvert Cliffs, Maryland.

Table 26.

PROFILE: 1D-1 DATE: 8/19/77

STATION: A TIME: 1735

Depth (m)	Temp (C)	Cond. (mmhos/cm)	Salinity (°/oo)	Sigma T	D.O. (ppm)	Velocity ($cmsec^{-1}$/deg)	u (cm/sec)	v (cm/sec)
0	28.1	23.4	13.2	6.1	8.7	12/300	8	- 9
2	27.0	23.0	13.3	6.5	6.3	21/315	18	-11
4	26.7	23.0	13.4	6.7	5.4	21/320	19	-10
6	26.7	23.2	13.5	6.8	5.4	21/340	21	- 3
8	26.7	23.3	13.6	6.8	5.5	18/10	17	7
10	26.7	23.3	13.6	6.8	5.5	18/0	18	4

Table 27.

PROFILE: 1D-1 DATE: 8/19/77

STATION: B TIME: 1317

Depth (m)	Temp (C)	Cond. (mmhos/cm)	Salinity (°/oo)	Sigma T	D.O. (ppm)	Velocity ($cmsec^{-1}$/deg)	u (cm/sec)	v (cm/sec)
0	28.6	23.8	13.3	6.1	6.2	9/295	5	- 7
2	28.6	23.7	13.3	6.0	6.1	12/330	11	- 4
4	28.4	23.1	13.0	5.9	6.1	12/210	- 9	- 8
6	27.7				5.6	15/170	-15	- 1
7	27.3	23.9	13.8	6.8	5.6	12/150	-11	4

Table 28.

PROFILE: 1D-2 DATE: 8/19/77

STATION: B TIME: 1627

Depth (m)	Temp (C)	Cond. (mmhos/cm)	Salinity (°/oo)	Sigma T	D.O. (ppm)	Velocity ($cmsec^{-1}$/deg)	u (cm/sec)	v (cm/sec)
0	28.5	23.6	13.2	6.0	7.1	12/310	9	- 7
2	27.8	23.3	13.3	6.3	6.4	18/320	16	- 8
4	27.3	23.4	13.5	6.6	5.9	21/320	19	-10
6	27.2	23.5	13.6	6.7	5.6	18/320	16	- 8
7	27.2				5.5	15/320	13	- 7

Vertical profiles of hydrographic variables in the Chesapeake Bay near Calvert Cliffs, Maryland.

Table 29.

PROFILE: 1D-1 DATE: 8/19/77

STATION: C TIME: 1329

Depth (m)	Temp (C)	Cond. (mmhos/cm)	Salinity (°/oo)	Sigma T	D.O. (ppm)	Velocity ($cmsec^{-1}$/deg)	u (cm/sec)	v (cm/sec)
0	27.9	23.5	13.4	6.3	6.6	6/120	- 4	4
2	28.3	23.7	13.4	6.2	6.6	6/145	- 6	2
4	28.3	23.7	13.4	6.2	6.6	6/215	- 4	- 4
6	28.1	23.7	13.4	6.3	6.4	9/290	5	- 8
8	27.8	23.6	13.4	6.4	5.2	12/285	5	-11
10	27.4	23.9	13.8	6.7	5.5	12/225	- 7	-10
12	26.9	25.9	15.2	7.9	2.2	9/215	- 6	- 7
14	26.5	27.7	16.5	9.0	0.93	6/180	- 6	- 1

Table 30.

PROFILE: 1D-2 DATE: 8/19/77

STATION: C TIME: 1647

Depth (m)	Temp (C)	Cond. (mmhos/cm)	Salinity (°/oo)	Sigma T	D.O. (ppm)	Velocity ($cmsec^{-1}$/deg)	u (cm/sec)	v (cm/sec)
0	28.7	23.2	12.9	5.7	7.5	3/195	- 3	- 1
2	28.6	23.4	13.1	5.9	7.0	3/10	3	1
4	28.4	23.4	13.2	6.0	6.8	3/85	0	3
6	28.2	23.4	13.2	6.1	6.4	9/225	- 5	- 8
8	27.9	23.5	13.4	6.3	6.0	12/245	- 3	-12
10	27.7	23.5	13.4	6.4	5.6	12/225	- 7	-10
12	27.3	24.0	13.8	6.8	5.0	0	0	0
14	26.9	27.5	16.2	8.7	0.7	3/145	- 3	1

Table 31.

MAPPING: 10
DATE: 081977
TIMES: 1748 TO 1815

*** TRANSECT 1 TEMPERATURE (C) DATA ***

READING NO.	1 M	3 M	5 M	7 M	9 M
1	*****	*****	*****	*****	*****
2	*****	26.9	26.6	26.5	*****
3	26.3	27.0	*****	26.7	*****
4	26.3	27.0	26.5	26.7	*****
5	26.3	27.0	26.5	26.7	*****
6	26.3	27.0	26.5	26.7	*****
7	26.3	27.1	26.5	26.7	*****
8	26.3	26.9	26.5	26.5	*****
9	26.2	27.0	26.5	26.6	*****
10	26.2	27.0	26.5	26.7	*****
11	26.3	27.0	26.5	26.6	*****
12	26.3	27.0	26.5	26.6	*****
13	26.3	26.9	26.4	26.6	*****
14	26.3	26.9	26.4	26.6	*****
15	26.2	26.9	26.4	26.7	*****
16	26.2	26.9	26.4	26.7	*****
17	26.3	26.9	26.4	26.7	*****
18	26.3	26.9	26.4	26.7	*****
19	*****	26.9	26.4	26.7	*****
20	*****	26.8	26.5	26.7	*****
21	26.3	26.9	26.4	26.7	*****
22	26.3	27.0	26.4	26.7	*****
23	26.2	26.8	26.5	26.7	*****
24	26.2	26.8	*****	26.7	*****
25	26.2	26.6	26.5	26.7	*****
26	26.2	26.9	26.5	26.7	*****
27	26.3	26.9	26.5	26.7	*****
28	26.3	26.8	26.5	26.7	*****
29	26.3	26.6	26.5	26.7	*****
30	26.3	26.6	26.5	26.6	*****
31	26.3	26.6	26.5	26.7	*****
32	26.3	26.8	26.5	26.6	*****
33	26.3	26.6	26.5	26.7	*****
34	26.3	26.8	26.6	26.6	*****
35	26.3	26.9	26.5	26.6	*****
36	26.3	26.9	26.6	26.6	*****
37	26.2	27.0	26.6	26.7	*****
38	*****	26.9	26.6	26.7	*****
39	26.2	26.9	*****	26.7	*****
40	26.2	27.0	26.6	26.7	*****
41	26.2	27.0	26.6	26.7	*****
42	26.2	27.1	26.6	26.6	*****
43	26.3	27.5	*****	26.6	*****
44	26.3	27.1	*****	26.6	*****
45	26.3	27.1	26.6	26.6	*****
46	26.2	27.0	*****	26.6	*****
47	26.3	27.0	26.6	26.7	*****
48	26.3	27.0	26.6	26.7	*****
49	26.3	27.0	26.5	26.6	*****
50	26.3	27.0	26.5	26.6	*****
51	26.2	27.0	26.6	26.6	*****
52	26.2	27.1	26.6	26.6	*****
53	26.3	27.1	26.5	26.6	*****
54	26.3	27.1	26.6	26.6	*****
55	26.3	27.0	26.6	26.6	*****
56	26.3	26.9	26.5	26.6	*****
57	26.3	26.9	26.5	26.6	*****
58	26.3	26.9	26.5	26.6	*****
59	26.3	26.9	26.5	26.6	*****
60	26.3	26.8	26.5	26.6	*****
61	26.3	26.8	26.6	26.6	*****
62	26.3	26.9	26.5	26.6	*****
63	26.3	26.9	26.6	26.6	*****
64	26.3	26.9	26.6	26.6	*****
65	26.4	26.9	26.5	26.6	*****
66	26.4	26.9	*****	26.6	*****
67	26.4	26.9	*****	26.6	*****
68	26.4	26.9	26.6	26.6	*****
69	26.4	26.9	26.5	26.6	*****
70	26.4	26.9	26.5	26.6	*****
71	26.4	26.9	26.6	26.6	*****
72	26.4	26.9	26.6	26.6	*****
73	26.4	26.9	26.5	26.7	*****
74	26.4	26.9	26.5	26.6	*****
75	26.4	26.9	26.6	26.6	*****
76	26.4	26.9	26.5	26.6	*****
77	26.3	27.5	26.6	*****	*****
78	26.3	27.4	26.6	26.6	*****

Table 32.

MAPPING: 10
DATE: 081977
TIMES: 1746 TO 1815

*** TRANSECT 2 TEMPERATURE (C) DATA ***

READING NO.	1 M	3 M	5 M	7 M	9 M
1	28.4	27.0	26.6	26.6	*****
2	28.4	27.0	26.6	26.6	*****
3	28.4	27.1	26.6	26.6	*****
4	28.4	27.1	26.6	26.6	*****
5	28.4	27.1	26.6	26.6	*****
6	28.4	27.1	26.6	26.6	*****
7	28.3	27.3	26.6	26.6	*****
8	28.4	27.3	26.6	26.6	*****
9	28.4	27.3	26.6	26.6	*****
10	28.4	*****	26.6	26.6	*****
11	28.4	27.3	26.6	26.6	*****
12	28.4	27.3	26.6	26.6	*****
13	28.3	27.3	26.6	26.6	*****
14	28.4	26.6	26.2	26.7	*****
15	28.3	27.0	26.7	*****	*****
16	28.3	27.1	26.7	*****	*****
17	28.3	27.0	26.7	*****	*****
18	28.3	26.9	26.6	*****	*****
19	28.3	26.9	26.7	*****	*****
20	28.3	26.9	26.7	*****	*****
21	28.3	26.9	26.7	*****	*****
22	28.3	26.9	26.7	*****	*****
23	28.3	26.9	26.7	*****	*****
24	28.3	26.9	26.7	*****	*****
25	28.3	26.9	26.7	*****	*****
26	28.3	26.9	26.7	*****	*****
27	28.3	26.9	26.7	*****	*****
28	28.2	26.9	26.7	*****	*****
29	28.2	26.9	26.7	*****	*****
30	28.2	26.9	26.7	*****	*****
31	28.1	27.0	26.7	*****	*****
32	28.1	27.0	26.7	*****	*****
33	28.1	27.0	26.7	*****	*****
34	28.1	27.3	26.8	*****	*****
35	28.1	27.4	26.8	*****	*****
36	28.1	27.3	26.8	*****	*****
37	*****	27.4	26.8	*****	*****
38	28.1	27.4	26.8	*****	*****
39	28.1	27.3	26.8	*****	*****
40	28.1	27.3	26.8	*****	*****
41	28.1	27.3	26.7	*****	*****
42	28.1	27.3	26.7	*****	*****
43	28.1	27.3	26.7	*****	*****
44	28.1	27.3	26.7	*****	*****
45	28.1	27.2	26.7	*****	*****
46	28.1	27.3	26.7	*****	*****
47	28.1	27.3	26.7	*****	*****
48	28.1	27.4	26.5	*****	*****
49	28.1	27.2	26.7	*****	*****
50	28.2	27.1	26.7	*****	*****
51	28.1	26.9	26.6	*****	*****
52	28.1	27.0	26.7	*****	*****
53	28.1	26.9	26.7	*****	*****
54	28.1	27.1	26.7	*****	*****
55	28.0	26.8	*****	*****	*****
56	28.0	26.8	*****	*****	*****
57	28.0	*****	*****	*****	*****
58	28.0	*****	*****	*****	*****
59	28.0	*****	*****	*****	*****
60	28.0	*****	*****	*****	*****
61	28.0	*****	*****	*****	*****
62	28.0	*****	*****	*****	*****
63	28.0	*****	*****	*****	*****
64	27.9	*****	*****	*****	*****
65	27.9	*****	*****	*****	*****
66	27.9	*****	*****	*****	*****
67	27.8	*****	*****	*****	*****
68	27.8	*****	*****	*****	*****
69	28.0	*****	*****	*****	*****
70	27.9	*****	*****	*****	*****
71	27.9	*****	*****	*****	*****

Table 33. Estimated dimensions of excess isotherms for Mapping 1D.

Mapping:	1D	Wind (m/sec):	1.8 NE
Date:	8/19/77	Air Temp (°C):	23.3
Times:	1350-1620	Plant Load (MWe):	1635
Tidal Phase:	SBF	Intake Temp (°C):	27.4
u (cm/sec)*:	16	Discharge Temp (°C):	33.0
v (cm/sec)*:	-8		

Depth (m)	Estimated ambient temp (°C)	Excess isotherm (°C)	Estimated enclosed area ($x10^4$ m^2)	Estimated maximum radial† extent ($x10^3$ m)
1	27.8	2	2	0.4
		1	>300	>2.2
3	26.9	2	>20	1.2
		1	>300	>2.1
5	26.5	2	>30	0.8
		1	>200	>2.2
7	26.6	1	>50	1.4

* Longitudinal component of current velocity, u (positive upestuary), and lateral component, v (positive toward eastern shore), measured at Station B, 2-m depth, after plume mapping.

† Measured from point of discharge.

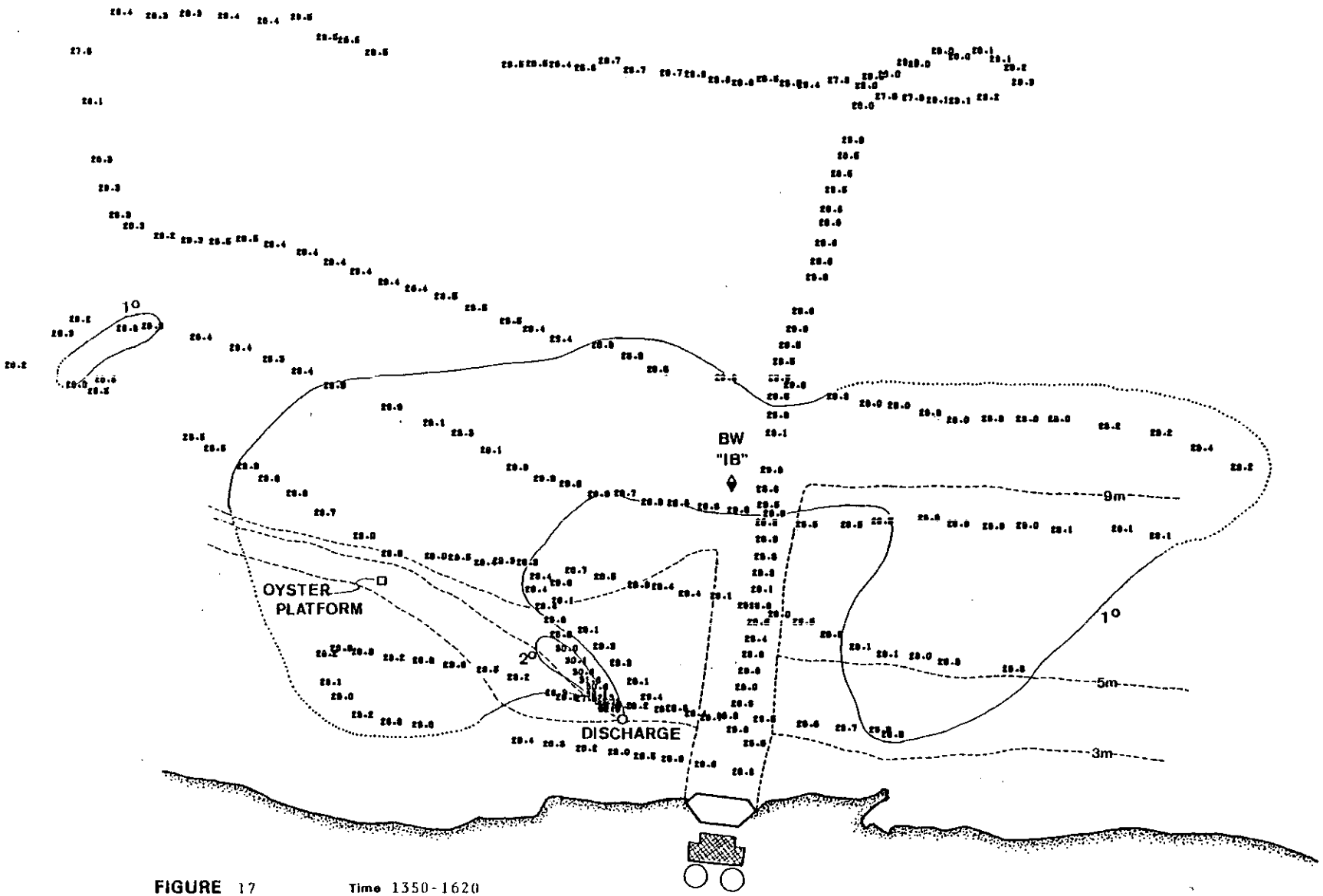

FIGURE 17
Mapping 1D
Depth (m) 1
Date 8/19/77

Time 1350-1620
Tide SBF
Plant Load (MWe) 1635
Ambient Temp. Estimate (°C) 27.8

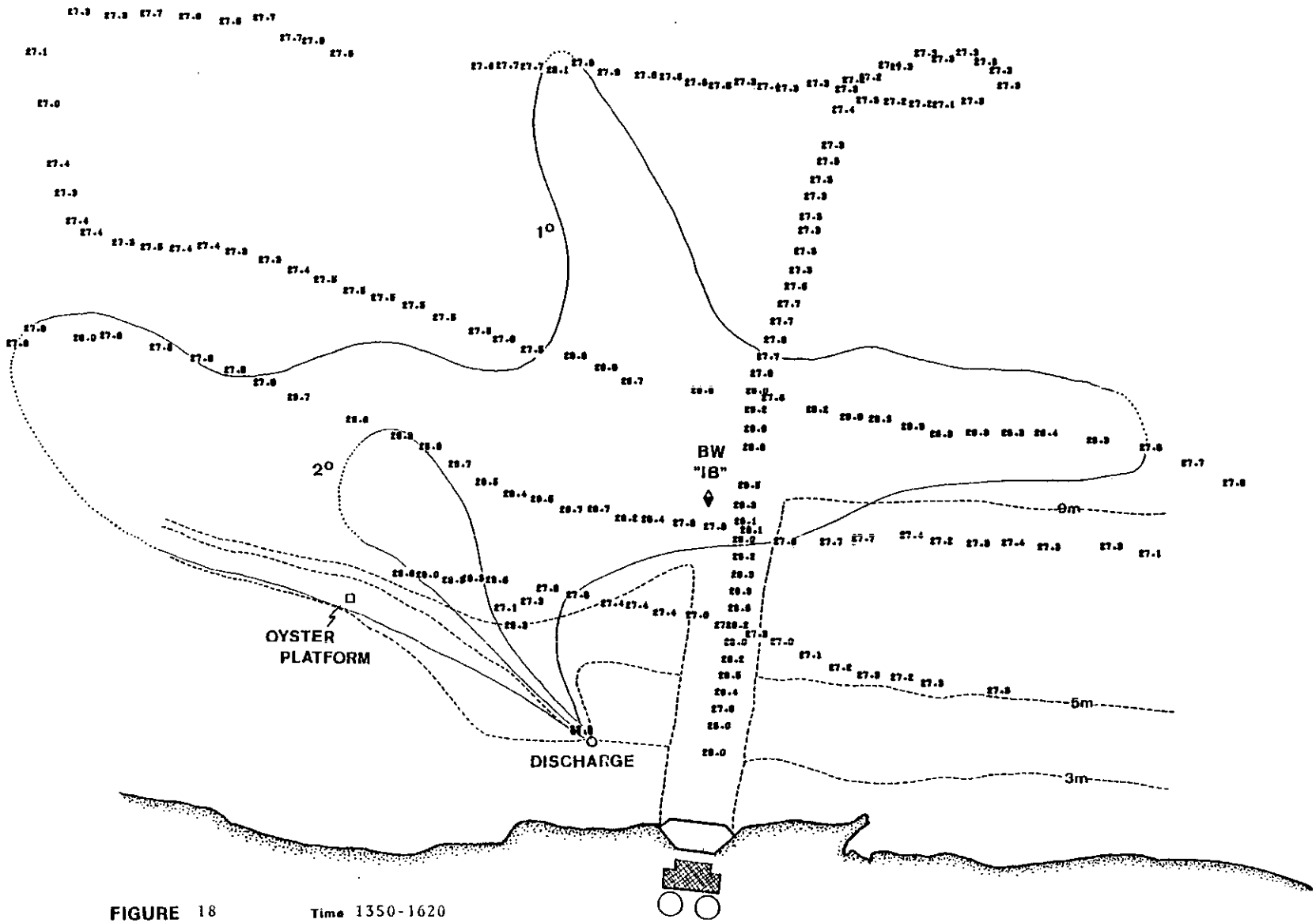

FIGURE 18
Mapping 1D
Depth (m) 3
Date 8/19/77

Time 1350-1620
Tide SBF
Plant Load (MWe) 1635
Ambient Temp. Estimate (°C) 26.9

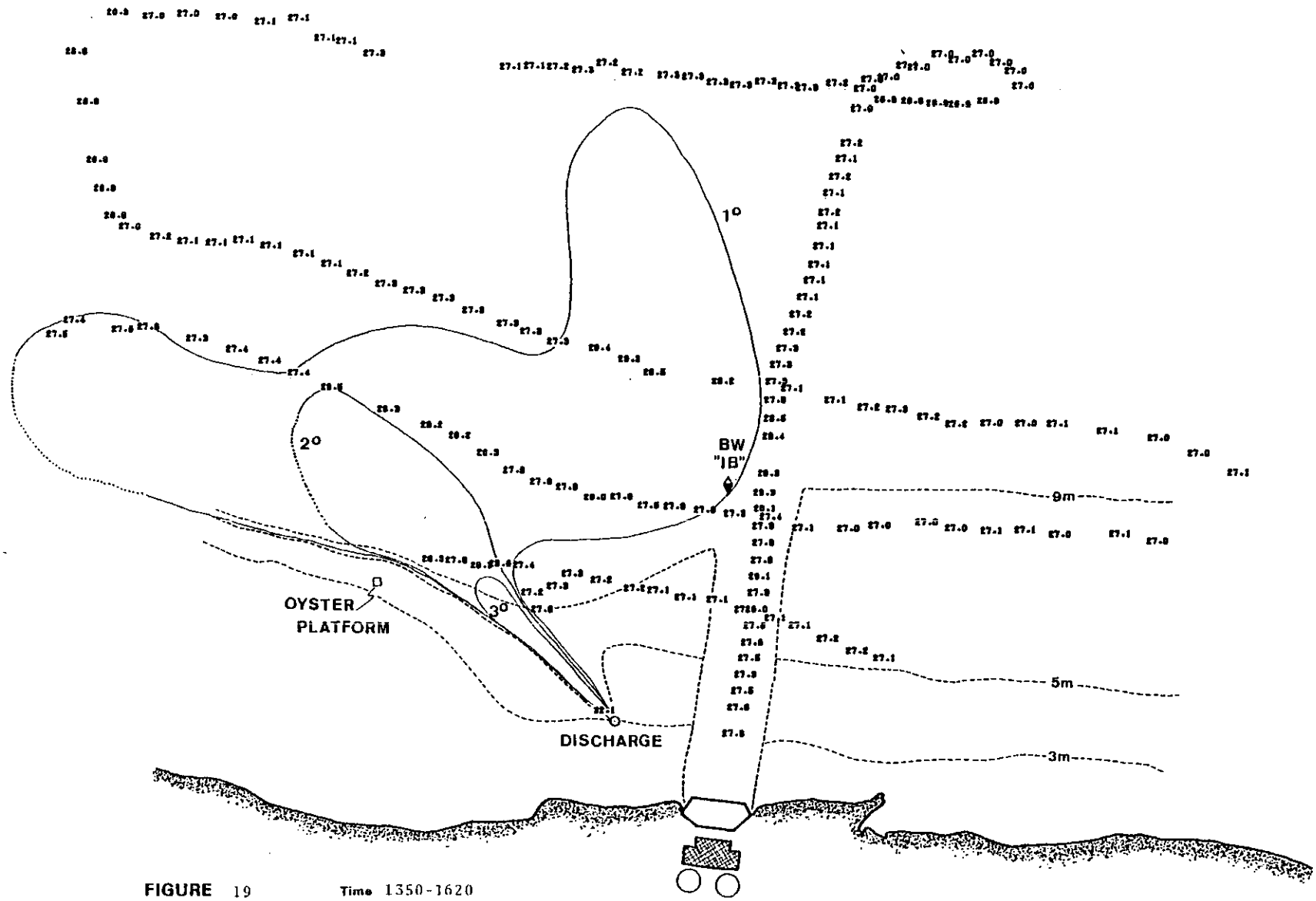

FIGURE 19
Mapping 1D
Depth (m) 5
Date 8/19/77

Time 1350-1620
Tide SBF
Plant Load (MWe) 1635
Ambient Temp. Estimate (°C) 26.5

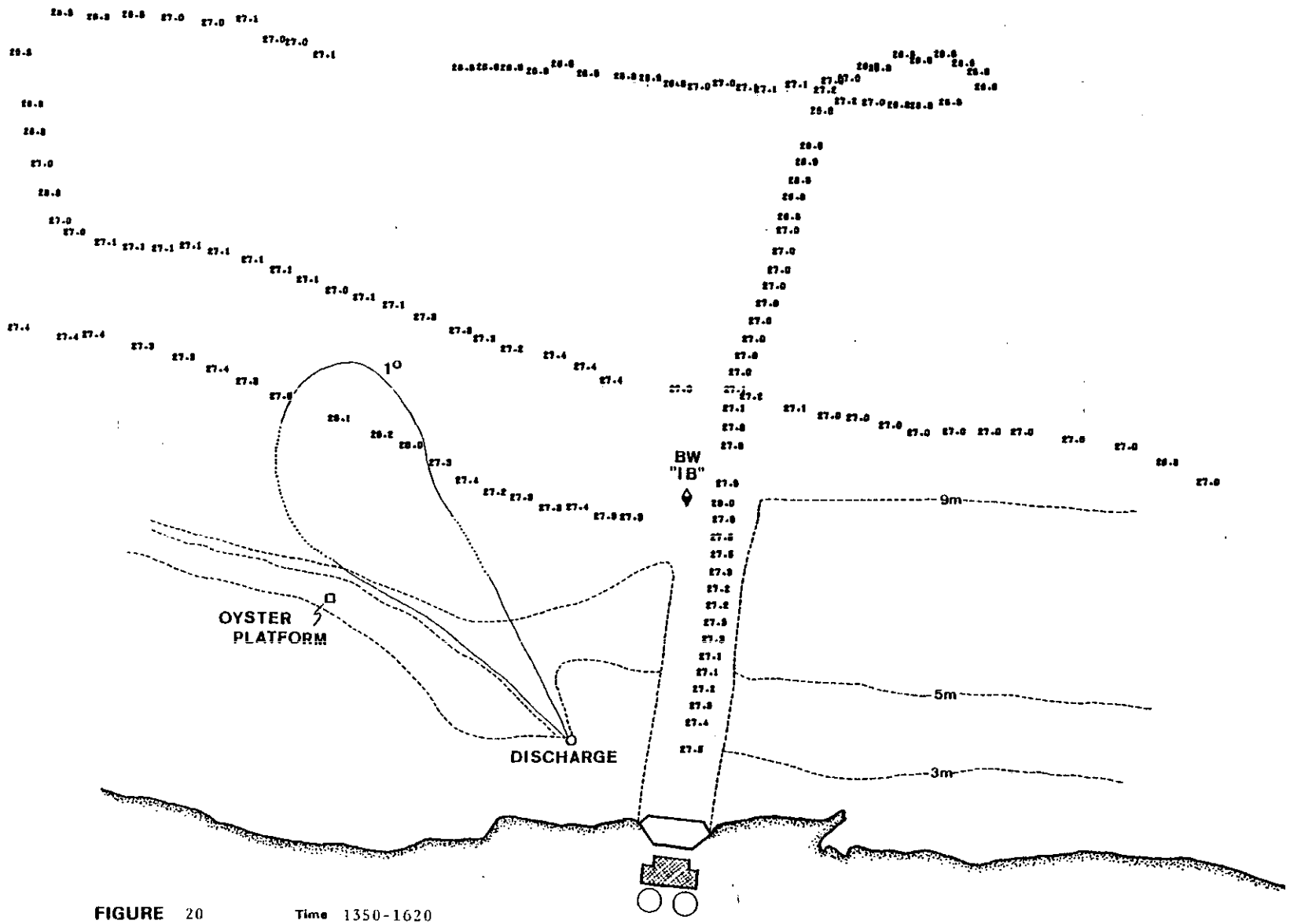

FIGURE 20

Mapping 1D

Depth (m) 7

Date 8/19/77

Time 1350-1620

Tide · SBF

Plant Load (MWe) 1635

Ambient Temp. Estimate (°C) 26.6

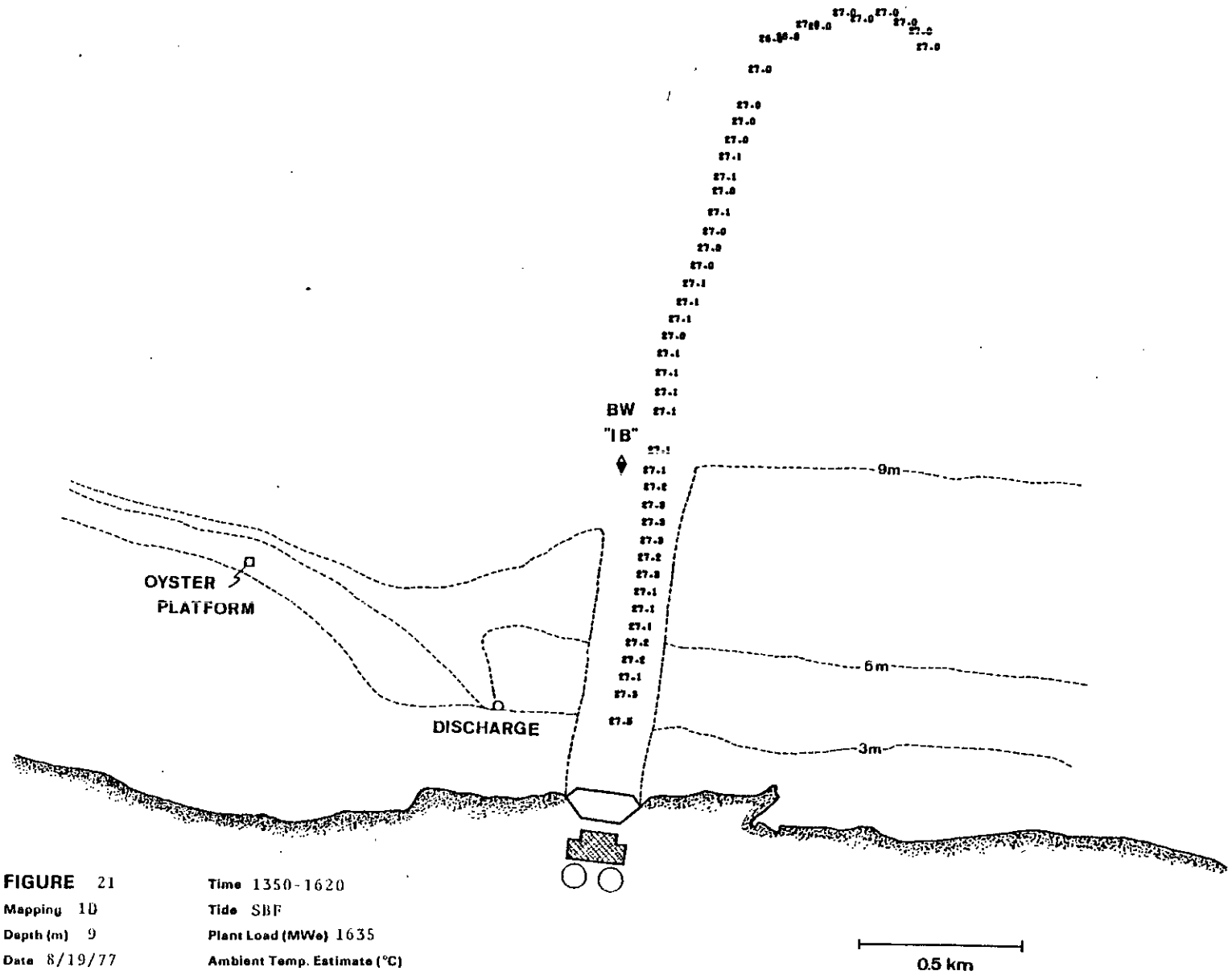

FIGURE 21
Mapping 1D
Depth (m) 9
Date 8/19/77

Time 1350-1620
Tide SBF
Plant Load (MWe) 1635
Ambient Temp. Estimate (°C)

APPENDIX B

Thermal Plume Studies in the vicinity of Calvert Cliffs Nuclear Power Plant November 1977

Scott Zeger

No. 78-13

Academy of Natural Sciences of Philadelphia

Division of Limnology and Ecology

19th and the Parkway Philadelphia, Pa. 19103

February 15, 1978

TABLE OF CONTENTS

	Page
INTRODUCTION	1
Objective of Study	1
Plant Description	1
METHODS AND EQUIPMENT	1
Plume Mapping	1
Ambient Temperature Measurements	2
Vertical Profiling	3
Data Reduction	3
RESULTS	4
Survey 2A	4
Survey 2B	5
Survey 2C	6
Survey 2D	6
DISCUSSION	7
Summary of Results	7
Uncertainty in Plume Dimensions	8
ACKNOWLEDGMENTS	11

LIST OF TABLES

Table 1. Summary of hydrographic, meteorologic and plant operating conditions and estimated plume dimensions	13
Tables 2-6. Vertical profiles of hydrographic variables, Survey 2A	14
Tables 7-8. Temperature data along Transects 1 and 2, Survey 2A	16
Table 9. Estimated plume dimensions, Mapping 2A	18
Tables 10-14. Vertical profiles of hydrographic variables Survey 2B	24
Tables 15-16. Temperature data along Transects 1 and 2, Survey 2B	26

LIST OF TABLES (Continued)

Page

Table 17. Estimated plume dimensions, Mapping 2B..... 28

Tables 18-22. Vertical profiles of hydrographic variables, Survey 2C..... 34

Tables 23-24. Temperature data along Transects 1 and 2, Survey 2C..... 36

Table 25. Estimated plume dimensions, Mapping 2C..... 38

Tables 26-30. Vertical profiles of hydrographic variables, Survey 2D..... 43

Tables 31-32. Temperature data along Transects 1 and 2, Survey 2D..... 45

Table 33. Estimated plume dimensions, Mapping 2D..... 47

LIST OF FIGURES

Figure 1. Location of thermal plume studies..... 12

Figures 2-6. Mapping 2A results..... 19

Figures 7-11. Mapping 2B results..... 29

Figures 12-15. Mapping 2C results..... 39

Figures 16-19. Mapping 2D results..... 48

Introduction

Objective of Study

In November 1977, at the request of the Maryland Power Plant Siting Program, the Academy of Natural Sciences of Philadelphia conducted the second in a series of three hydrothermal studies on the Chesapeake Bay in the vicinity of the Calvert Cliffs Nuclear Power Plant. This study was designed to determine the distribution of temperature in the vicinity of the power plant, to estimate ambient water temperature there and to estimate the configuration and extent of the Calvert Cliffs Nuclear Power Plant thermal plume.

Plant Description

The Calvert Cliffs Nuclear Power Plant is located on the western shore of the Chesapeake Bay approximately 15 km north of its confluence with the Patuxent River. The plant has two nuclear units which typically generate between 1600 and 1800 MWe at full operation. It has a once-through cooling system which draws Chesapeake Bay water at a rate of 5500 cfs from below a curtain wall at the plant intake. The curtain wall forms an enclosed embayment and extends to a depth of 9 m. A 15-m deep intake channel extends from the curtain wall perpendicular to the shore line for a distance of approximately 1300 m. At full plant capacity the cooling water is heated between 5 and 6°C. It is discharged at a velocity of 3 m/sec from four rectangular pipes which terminate 500 m northeast of the plant intake.

Methods and Equipment

Four plume surveys, 2A, 2B, 2C and 2D were conducted between November 1 and 3, 1977. Surveys 2B and 2C were scheduled to coincide with the times of predicted maximum flood and ebb tidal velocities; 2A and 2D, to coincide with predicted slack tides. Each survey included mapping of the thermal plume, collecting temperature data along a longitudinal transect and a lateral transect near Kenwood Beach to estimate ambient water temperature, and vertical profiling of hydrographic variables.

Plume Mapping

Five YSI 15606 thermistors were used to measure temperature. Two thermistors were attached to the boat, approximately 0.5 and 1.0 m below the surface. Three thermistors were bound to a stress cable stabilized by a 2-ft ENDECO

V-fin and towed at 3, 5 and 7 m. An ENDECO depth probe was used to monitor the depth of the deepest thermistor. The desired towing angle was maintained by regulating boat velocity.

Analog signals from the five thermistors were converted into 0 to 100 mv signals proportional to temperatures from 0 to 50°C by a YSI signal conditioner. The conditioned signal was digitized and stored on magnetic cassette by a NERA Model 4 data logger. A record of the five thermistor readings was written to cassette tape by a manually operated switch on the NERA data logger. Temperature data acquired by this system are accurate to within 0.2°C. The thermistors were calibrated before and after the study against an ASTM standard thermometer which was checked against the NBS standard thermometer used by BG&E for calibrating plant thermistors.

During mapping, boat velocity ranged between 5 and 10 km/h. A temperature meter built into the YSI signal conditioner continuously displayed the temperature reading for any given thermistor. The observed temperature data were used in determining boat course. Each mapping lasted approximately 2 h during which temperature data were collected at 200 to 300 locations.

Two theodolites, stationed on shore, were used to determine boat position. The theodolites measure horizontal angles from a chosen zero to the nearest 10 sec. During a mapping, the theodolites were zeroed on one another. Each time a temperature record was written to cassette tape, the theodolite operators were signaled by two-way radio. Each operator immediately recorded the horizontal angle formed by the zero siting and the boat siting. These angles and theodolite location information were sufficient to determine the boat position accurate to within 5 m throughout the plume mapping area.

Ambient Temperature Measurements

To estimate ambient water temperature, temperature data were collected along Transects 1 and 2 shown in Figure 1. Temperatures were measured immediately before Mappings 2A, 2B and 2C, and immediately after Mapping 2D, using the methods described for plume mappings. Temperature data at up to five depths were recorded on cassette tape once every 10 sec while the boat maintained a constant velocity along each transect. Approximately 80 locations were sampled on each transect.

Vertical Profiling

Vertical profiles of temperature, conductivity, dissolved oxygen and current velocity were made by sampling at 2-m depth intervals at three stations, A, B and C (Figure 1). Profiling was conducted at Stations B and C before and after each mapping and at Station A at the time Transect 1 and 2 data were collected. Temperature, conductivity and dissolved oxygen were measured with a Hydrolab Environmental Monitor. A Marsh-McBirney Model 727 current meter was used to measure current velocity. Salinity (°/oo) and density expressed as $\sigma_T = (\rho - 1.00) \times 10^3$ * were calculated from observed temperature and conductivity data. Current velocities were resolved into a longitudinal component, u, along the tidal direction of 160-340° true (positive upestuary) and a lateral component, v, perpendicular to the tidal direction (positive toward the eastern shore).

Data Reduction

Temperature data stored on cassette tape during the surveys were listed on a low-speed computer terminal. These data and the manually recorded theodolite data were then stored on computer cards. All temperature data collected at a given depth during a plume mapping were mapped on a Calcomp electromagnetic plotter. Each temperature value at a given depth was plotted at the map location corresponding to the boat's position when that measurement was taken.

Ambient temperature for each depth was estimated from the data collected at that depth along Transects 1 and 2 near Kenwood Beach. At the time the study was designed, Kenwood Beach was thought to be upestuary beyond the area of plant influence. Ambient temperature was to be estimated by the mean temperature over both transects. A recent dye-release study, however, has indicated that Kenwood Beach may receive some plant heat (William Richkus, Martin Marietta Laboratories, personal communication). When trends in the transect data suggested a plant effect, ambient temperature was estimated by the mean of a subset of observations which appeared to be unaffected by the plant. The procedure for each survey is described in the Results section of this report.

Excess temperature isotherms were drawn by hand at 1°C intervals on each map. Contour locations between observed values were determined by linear interpolation. Isotherms were drawn to include as many non-isolated data points with temperatures greater than or equal to the designated excess

---

* ρ = density of water in g/ml as calculated from salinity and temperature.

value as possible. In some cases, it was necessary to enclose a few points with smaller excess temperatures in order to form a contiguous plume. In this way, however, plume dimensions tend to be conservatively overestimated.

When the observed data were insufficient to properly close an excess isotherm, it was closed by a broken line at the limit of data. The isotherm dimensions based upon these contours are preceded by > in tables and represent estimated lower limits to true plume dimensions.

Results

Survey 2A

Survey 2A was conducted on November 1, 1977 between 1322 and 1724 hours. Slack before flood tide was predicted to occur at 1433 hours. During the survey, air temperature and wind velocity, measured by BG&E (Rick Lassahn, personal communication) at Calvert Cliffs, averaged 15.0°C and 2.6 m/sec from the north respectively. Mean plant load during Mapping 2A was 1746 MWe; mean cross-condenser temperature rise was 5.5°C. Plant operating, hydrographic and meteorologic conditions for each plume mapping are summarized in Table 1.

Vertical profiles of hydrographic variables measured at Stations A, B and C (Fig. 1), collected before and after Mapping 2A, are presented in Tables 2 through 6. Salinities ranged between 10.4 and 21.3 °/₀₀. Stratification was high at all stations. The greatest top-to-bottom difference, over 11 °/₀₀, occurred in the nearfield at Station C, where bottom water is drawn under the curtain wall into the plant. The density of water heated 5.5°C from 15°C will increase if salinity is increased more than 1.5 °/₀₀. Thus, the plant effluent was negatively buoyant during Survey 2A. Dissolved oxygen values ranged between 10.2 and 6.2 ppm and decreased with increasing depth at all stations. At 14°C and with 10 °/₀₀ salinity, saturation level for dissolved oxygen is 9.7 ppm. In general, dissolved oxygen levels were close to saturation. The longitudinal component of current velocity was downstream at Stations A and C before Mapping 2A and upstream at Station C after the mapping, indicating a change in tidal current direction. Current velocities at Station B were probably influenced by the discharge jet.

Plume Mapping 2A was conducted between 1444 and 1703 hours. Vertical profiles of temperature were measured at 280 locations in the plant vicinity during the mapping. The observed temperature values are displayed by depth in Figures