Publication No. 77-e24
WA-01-0050

STATE OF
WASHINGTON

Dixy Lee Ray
Governor

DEPARTMENT OF ECOLOGY
Olympia, Washington 98504 206/753-2800

M E M O R A N D U M

June 22, 1979

TO: Bruce Johnson, Industrial Section
John Bernhardt, SW Region

FROM: Roger Stanley, Industrial Section

SUBJECT: Bellingham Bay Water Quality Survey

On March 26-28, Darrel Anderson, Bob Bishop and myself conducted a sampling survey in Bellingham Bay in order to document existing water quality conditions. Data accumulated during this survey, along with a study outline, is attached for your review. Current plans call for this information to be complimented by an additional set of data collected during a similar survey in 1980. The results of both surveys will then be written up as a "before and after" type report with noted changes in water quality related, where possible, to the start-up of Georgia Pacific's secondary treatment lagoon.

Notes covering our March 26-28, 1979 visit which may be of interest to you include the following:

1) The visible plume of GP's wasterwater extended for a relatively short distance beyond the end of Bellingham's port dock. Obvious discoloration of surface water was apparent throughout the Whatcom waterway, northwards to near the marina entrance, and for 200-300 yards directly out into the bay proper (SW).

2) Water clarity was determined through the use of standard (all white) 8" marine secchi disk. Readings within the Whatcom waterway were as low as 0.2 feet. Visibility at outer bay sites was typically near 15.0 feet while readings in the northwestern portion of the bay decreased due to the influence of Nooksack river waters.

3) pH values recorded during the survey were determined daily in the field with an Orion Research ionalyzer model 399 A/F. Values noted within the Whatcom waterway were as low 3.4 S.U.. Outer Bellingham Bay pH values were near 7.7 with little varation top to bottom. Windy weather during the survey may have contributed to this stability in that bay waters were well mixed.

4) Dissolved Oxygen concentrations were determined daily in the field via Winkler titration. Concentrations within the Whatcom waterway were noted to be typically less than 5.0 pm and at times non existant (0.0). Outer bay oxygen

content was typically near 8.7 ppm with little variation top to bottom.

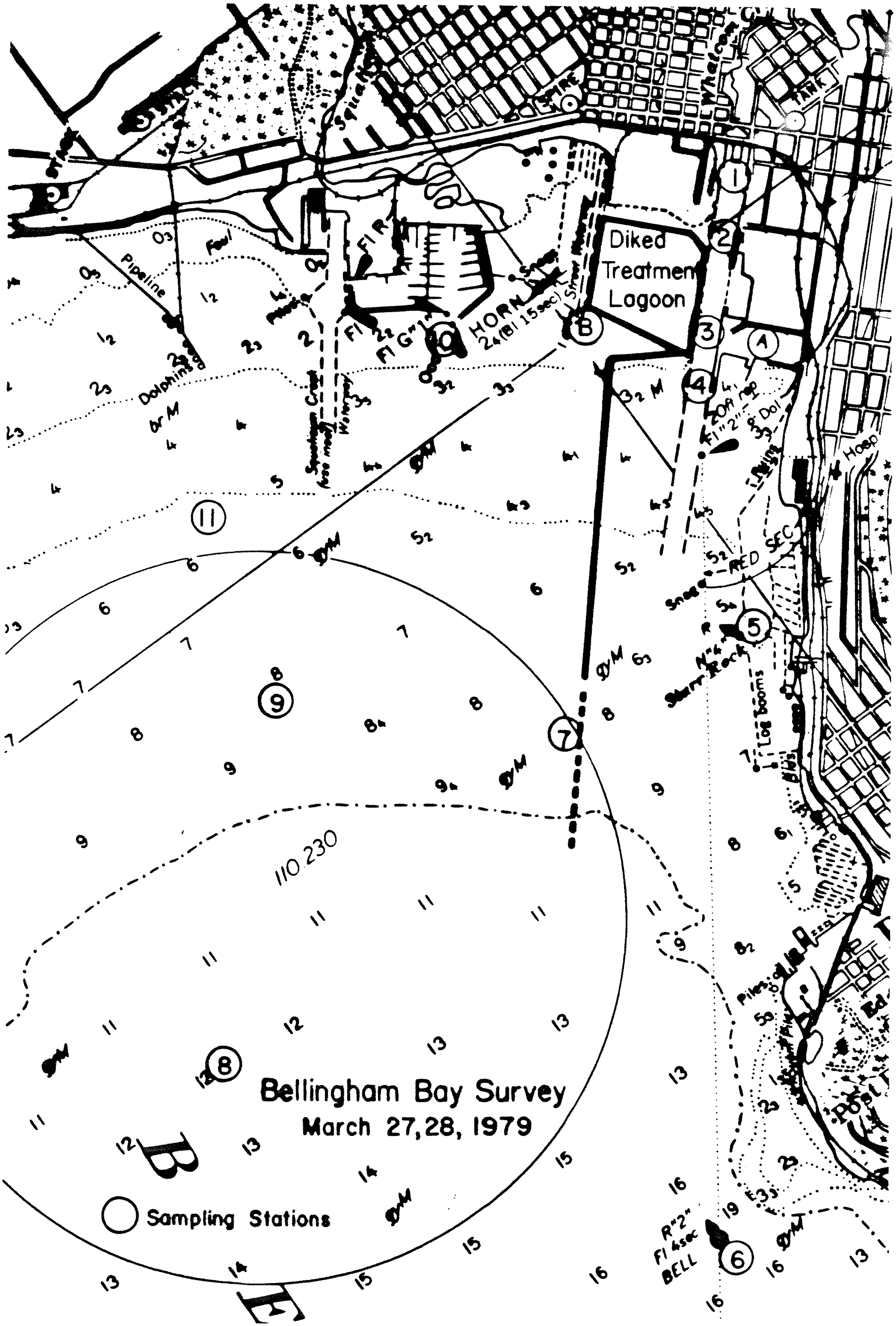
5) Fecal coliform concentrations noted during the survey were low, as had been expected. Counts in Bellingham Bay proper were essentially zero. Counts in the Whatcom waterway were consistantly less than 50 organisms per 100 ml.

6) Bottom sampling of accumulated sediments within the Whatcom waterway was accomplished through the use of a clamshell dredge. No life forms were observed in collected samples except those obtained at Station A. Sediments at this site contained a few small bloodworm-like invertebrates. Analysis of sediment samples for Total Mercury (on a dry weight basis) revealed concentrations which were fairly low. Levels in the waterway proper were typically less than 5 ppb. Concentrations off the old chlor-alkai outfall averaged 32 ppb.

The attached data is currently being keypunched for computer storage and further analysis on Water Programs' Wang System.

RS:lf

cc: Darrel Anderson, SW Region
Bob Bishop, Industrial Section


Diked
Treatment
Lagoon
HORN
24(B) 15sec
RED SEC
Log Booms
Pipeline
Dolphins
Starr Rock
Piles
110 230
R"2"
Fl 4sec
BELL
Bellingham Bay Survey
March 27,28, 1979
Sampling Stations

Bellingham Bay Receiving Water Survey
March 26-28, 1979

Summary Sheet: _____

SWL as PBI - mg/l

Station No.	Depth	TIDE STAGE				Mean Concentration
		March 27		March 28		
		Low	High	Low	High	
1	S	250	300	1400	650	650
2	S	830	430	2300	3000	1640
3	S	630	930	2050	2100	1428
	M	41	27	72	72	53
4	S	-	270	360	790	473
	M	9	9	36	63	29
5	S	9	18	14	14	14
	M	-	<5	14	9	<9
6	S	5	5	14	<5	<7
	M	<5	5	32	<5	<12
	B	<5	5	5	5	<5
7	S	5	<5	5	5	<5
	M	5	<5	36	9	<14
	B	5	5	9	5	6
8	S	5	9	41	9	16
	M	-	<5	36	<5	<15
9	S	<5	<5	9	<5	<6
	M	5	5	9	<5	<6
10	S	5	5	5	>5	<5
11	S	<5	5	18	5	<8

Miscellaneous Data:	3/27	3/28
I. Georgia Pacific wastewaters		
1. #3	4000	4800
2. #5	5600	4200
3. Clarifier	1300	4700
4. Chlorine plant	-	-
II.. Bellingham STP final effluent	<5	110
III. Whatcom Creek at old STP	5	14
IV. Nooksack River below Ferndale	9	<5
V. Bellingham Bay off NW corner of GP lagoon (B)	9	59
VI. Whatcom Waterway (lagoon off chlorine plant) (A)	210	2200

Bellingham Bay Receiving Water Survey
March 26-28, 1979

Summary Sheet: _____

SECCHI VISIBILITY - feet

Station No.	TIDE STAGE				Mean Visibility
	March 27		March 28		
	Low	High	Low	High	
1	2.0	0.7	1.0	1.5	1.3
2	3.5	0.7	1.2	0.5	1.5
3	2.0	1.0	1.5	0.2	1.2
4	6.0	1.5	7.0	3.0	4.4
5	16.0	5.0	11.0	14.0	11.5
6	17.0	10.0	18.0	20.0	16.3
7	11.0	10.0	12.0	16.0	12.3
8	16.0	15.0	17.0	17.0	16.3
9	13.0	14.0	16.0	17.0	15.0
10	4.0	10.5	4.0	4.0	5.6
11	6.0	10.0	4.0	3.5	5.9

Bellingham Bay Receiving Water Survey
March 26-28, 1979

Summary Sheet: _____

COLOR, c.u.

Station No.	Depth	TIDE STAGE				Mean Concentration
		March 27		March 28		
		Low	High	Low	High	
1	S	180	440	540	350	378
2	S	250	1070	430	1000	688
3	S	300	260	300	300	290
	M	8	4	8	21	10
4	S	-	150	88	240	159
	M	4	4	8	13	7
5	S	4	29	8	8	12
	M	-	4	4	13	7
6	S	<4	4	4	8	<5
	M	4	4	4	13	6
	B	4	<4	4	4	<4
7	S	4	4	8	<4	<5
	M	4	4	8	4	5
	B	4	<4	8	4	<5
8	S	8	<4	4	4	<5
	M	4	<4	8	4	<5
9	S	8	4	8	8	7
	M	4	4	8	4	5
10	S	4	8	8	8	7
11	S	4	4	8	8	6

Bellingham Bay Receiving Water Survey Summary Sheet: _____
March 26-28, 1979

HYDROGEN ION CONCENTRATION - pH, s.u.

Station No.	Depth	TIDE STAGE			
		March 27		March 28	
		Low	High	Low	High
1	S	6.6	6.2	3.6	6.1
2	S	6.4	5.6	3.7	3.4
3	S	6.6	6.8	4.3	4.5
	M	7.7	7.6	7.5	7.6
A	S	-	6.6	5.4	-
4	S	-	6.6	7.1	6.4
	M	7.7	7.5	7.6	7.7
B	S	7.6	7.4	7.5	7.6
5	S	7.7	7.4	7.7	7.8
	M	-	7.5	7.8	7.7
6	S	7.6	7.5	7.8	7.8
	M	7.7	7.6	7.7	7.9
	B	7.6	7.5	7.8	7.8
7	S	7.7	7.5	7.8	7.7
	M	7.7	7.5	7.6	7.7
	B	7.6	7.5	7.8	7.8
8	S	7.6	7.5	7.8	7.9
	M	7.5	7.4	7.8	7.8
9	S	7.7	7.3	7.8	7.8
	M	7.5	7.4	7.7	7.8
10	S	7.7	7.5	7.8	7.8
11	S	7.7	7.5	7.8	7.8

Miscellaneous Data:

Georgia Pacific Corporation		
C - Outfall #3	3.2	3.1
D - Outfall #5	2.1	3.3
E - Clarifier	6.3	6.2
E' - Chlor-alkali	9.3	9.8
Bellingham STP final effluent		
F	7.2	7.1
Nooksack River below Ferndale at Slater Road		
G	6.8	7.6
Whatcom Creek near mouth at old STP		
H	7.2	7.1

Bellingham Bay Receiving Water Survey
March 26-28, 1979

Summary Sheet: _____

DISSOLVED OXYGEN - mg/l

Station No.	Depth	TIDE STAGE				Mean Concentration
		March 27		March 28		
		Low	High	Low	High	
1	S	3.7	4.8	2.2	4.2	3.7
2	S	4.5	4.6	2.2	0.0	2.8
3	S	5.0	4.9	3.1	0.0	3.2
	M	8.4	8.2	7.7	7.9	8.1
4	S	7.4	7.3	6.9	6.9	7.1
	M	8.4	8.2	7.5	8.2	8.1
5	S	8.7	8.4	8.4	8.9	8.6
	M	-	8.2	8.4	8.7	8.4
6	S	8.6	8.6	9.1	9.2	8.9
	M	8.3	8.6	8.8	9.1	8.7
	B	8.5	8.6	8.7	8.6	8.6
7	S	8.6	8.6	8.5	9.1	8.7
	M	8.6	8.6	7.9	8.8	8.5
	B	8.5	8.6	8.5	8.6	8.6
8	S	8.7	8.8	8.8	9.0	8.8
	M	8.7	8.8	8.7	8.8	8.7
9	S	8.6	8.4	8.6	9.2	8.7
	M	8.4	8.6	8.6	9.0	8.7
10	S	8.0	8.5	10.1	9.5	9.0
11	S	8.3	8.2	10.5	10.0	9.2

Miscellaneous Data:

	3/27	3/28
Nooksack River below Ferndale at Slater Road	11.8	11.6
Whatcom Creek near mouth at old STP	11.5	12.1
Whatcom Waterway Lagoon off GP chlorine plant		0.0

Bellingham Bay Receiving Water Survey
March 26-28, 1979

Summary Sheet: _____

TURBIDITY, NTU

Station No.	Depth	TIDE STAGE				Mean Value
		March 27		March 28		
		Low	High	Low	High	
1	S	8	4	12	2	7
2	S	8	8	18	11	11
3	S	9	6	13	11	10
	M	1	3	1	1	1
4	S	-	4	1	4	3
	M	3	2	2	1	2
5	S	2	2	1	1	1
	M	-	2	1	1	1
6	S	2	2	1	1	1
	M	2	3	1	1	2
	B	2	2	1	1	1
7	S	1	5	1	1	2
	M	1	5	1	1	2
	B	1	3	1	1	1
8	S	1	4	1	1	2
	M	1	2	1	1	1
9	S	1	2	1	1	1
	M	4	3	1	1	2
10	S	3	3	5	2	3
11	S	4	4	4	5	4

Nooksack River below Ferndale at Slater Road 3/27 - 7, 3/28 - 3.
Whatcom Creek near mouth at old STP 3/27 - 2, 3/28 - 1.

Bellingham Bay Receiving Water Survey
March 26-28, 1979

Summary Sheet: _____

SPECIFIC CONDUCTIVITY, umhos (1000's)

Station No.	Depth	TIDE STAGE				Mean Conductivity
		March 27		March 28		
		Low	High	Low	High	
1	S	41.2	36.4	18.7	12.5	27.2
2	S	40.8	37.6	23.4	18.0	30.0
3	S	41.4	42.1	28.2	28.7	35.1
	M	45.9	47.5	46.6	45.8	46.5
4	S	-	45.8	43.9	39.2	43.0
	M	46.2	47.8	46.3	45.9	46.6
5	S	46.4	47.0	45.9	46.3	46.4
	M	-	47.1	46.6	46.7	46.8
6	S	47.2	47.6	46.5	47.0	47.1
	M	47.2	48.2	46.7	47.4	47.4
	B	47.8	47.7	45.3	46.8	46.9
7	S	48.1	47.3	45.8	46.2	46.9
	M	49.0	47.1	45.5	46.7	47.1
	B	48.2	47.2	45.7	47.2	47.1
8	S	46.6	47.0	45.4	47.1	46.5
	M	46.7	47.1	45.8	48.0	46.9
9	S	46.4	47.0	45.6	46.7	46.4
	M	46.8	47.0	45.3	47.5	46.7
10	S	46.6	47.1	30.9	34.8	39.9
11	S	47.1	48.2	27.6	33.8	39.2

Bellingham STP, final effluent 3/27 - 1.28, 3/28 - 0.52

Bellingham Bay Receiving Water Survey
March 26-28, 1979

Summary Sheet: _____

SALINITY, ppt*

Station No.	Depth	TIDE STAGE				Mean Salinity
		March 27		March 28		
		Low	High	Low	High	
1	S	29.7	26.1	12.8	8.1	19.2
2	S	29.4	27.0	16.3	12.3	21.3
3	S	29.8	30.3	19.9	20.3	25.1
	M	33.2	34.4	33.7	33.1	33.6
4	S	-	33.1	31.7	28.2	31.0
	M	33.4	34.6	33.5	33.2	33.7
5	S	33.6	34.0	33.2	33.5	33.6
	M	-	34.1	33.7	33.8	33.9
6	S	34.2	34.5	33.6	34.0	34.1
	M	34.2	34.9	33.8	34.3	34.3
	B	34.6	34.5	32.7	33.9	33.9
7	S	34.8	34.2	33.1	33.4	33.9
	M	35.5	34.1	32.9	33.8	34.1
	B	34.9	34.2	33.0	34.2	34.1
8	S	33.7	34.0	32.8	34.1	33.6
	M	33.8	34.1	33.1	34.8	33.9
9	S	33.6	34.0	33.0	33.8	33.6
	M	33.9	34.0	32.7	34.4	33.8
10	S	33.7	34.1	21.9	24.9	28.7
11	S	34.1	34.9	19.5	24.1	28.2

*Salinity calculated via conductivity data due to malfunction of field instrument.

Bellingham Bay Receiving Water Survey
March 26-28, 1979

Summary Sheet: _____

NUTRIENTS, mg/l

Station No.	Depth	March 27 Low Tide					March 27 High Tide				
		NH_3-N	NO_2-N	NO_3-N	O-PO_4	T-PO_4	NH_3-N	NO_2-N	NO_3-N	O-PO_4	T-PO_4
1	S	<0.01	<0.01	0.22	0.02	0.08	0.01	<0.01	0.33	0.04	0.04
2	S	0.04	<0.01	0.32	0.06	0.17	0.06	<0.01	0.36	0.10	0.10
3	S	0.13	<0.01	0.34	0.05	0.12	0.06	<0.01	0.37	0.06	0.10
	M	<0.01	<0.01	0.39	0.05	0.06	0.07	<0.01	0.40	0.05	0.06
4	S	-	-	-	-	-	0.04	<0.01	0.39	0.05	0.07
	M	<0.01	<0.01	0.39	0.05	0.08	<0.01	<0.01	0.41	0.05	0.08
5	S	<0.01	<0.01	0.39	0.05	0.17	<0.01	<0.01	0.41	0.05	0.06
	M	-	-	-	-	-	0.01	<0.01	0.41	<0.01	0.07
6	S	<0.01	<0.01	0.38	0.05	0.08	0.01	<0.01	0.39	0.04	0.10
	M	0.01	<0.01	0.38	0.06	0.06	0.01	<0.01	0.40	0.05	0.10
	B	0.02	<0.01	0.38	0.02	0.08	0.03	<0.01	0.40	0.05	0.08
7	S	0.01	<0.01	0.40	0.05	0.08	0.01	<0.01	0.42	0.05	0.09
	M	<0.01	<0.01	0.39	0.04	0.08	0.01	<0.01	0.41	0.05	0.08
	B	0.01	<0.01	0.40	<0.01	0.06	0.01	<0.01	0.40	0.04	0.12
8	S	0.01	<0.01	0.40	0.04	0.07	0.01	<0.01	0.40	0.04	0.07
	M	0.01	<0.01	0.41	0.04	0.09	0.01	<0.01	0.41	0.05	0.05
9	S	0.02	<0.01	0.40	0.04	0.06	0.02	<0.01	0.42	0.01	0.06
	M	<0.01	<0.01	0.41	0.04	0.07	<0.01	<0.01	0.42	0.04	0.09
10	S	0.01	<0.01	0.40	0.05	0.06	<0.01	<0.01	0.41	0.05	0.10
11	S	0.03	<0.01	0.41	0.05	0.06	<0.01	<0.01	0.41	0.05	0.12
Miscellaneous Data:											
Georgia Pacific Wastewaters											
Site C, Discharge #3							0.02	Interf.	Interf.	-	-
Site D, Discharge #5							0.16	<0.01	0.25	-	0.10
Site E, Clarifier discharge							0.03	0.01	0.11	0.35	1.70
Site E', Chlor-alkali discharge							0.02	<0.01	0.34	<0.01	0.04
Bellingham STP, final effluent							14.0	<0.01	<0.10	3.0	6.3
Whatcom Creek at old STP							0.02	<0.01	0.70	0.01	0.03
Nooksack River below Ferndale							0.02	<0.01	0.36	0.02	0.03

Bellingham Bay Receiving Water Survey Summary Sheet: _____
March 26-28, 1979

WATER TEMPERATURE, °C

Station No.	Depth	TIDE STAGE			
		March 27		March 28	
		Low	High	Low	High
1	S	8.3	7.8	6.8	10.0
2	S	8.4	7.8	* -	12.8
3	S	9.8	8.6	-	10.5
	M	7.1	6.8	-	8.9
4	S	9.3	7.7	-	9.5
	M	7.5	6.8	-	7.4
5	S	7.2	7.1	-	7.8
	M	-	6.8	-	7.8
6	S	7.0	6.8	-	7.8
	M	7.0	6.9	-	7.2
	B	6.9	6.8	-	7.5
7	S	7.2	6.9	-	7.5
	M	7.0	7.1	-	7.2
	B	6.6	6.8	-	7.5
8	S	7.1	7.0	-	7.8
	M	7.1	6.8	-	7.5
9	S	6.9	6.8	-	7.5
	M	7.0	6.9	-	7.5
10	S	-	7.6	-	7.5
11	S	7.1	7.1	-	7.5

* Instrument malfunction.

Bellingham Bay Receiving Water Survey
March 26-28, 1979

Summary Sheet: _____

BACTERIAL CONCENTRATIONS

Station No.	Fecal Coliform Count (100 ml)	KES Group (%)	Klebsiella Pneumoniae (%)
1	28 est	0	
2	13 est	20	100
3	20 est	0	
4	16	0	
5	3	0	
6	<1	-	
7	<1	-	
8	<4	-	
9	<1	-	
10	1	0	
11	1	0	

Miscellaneous Bacterial Data:

	Fecal coli	% KES	%K. pneumon.
Georgia Pacific wastewaters:			
Site C, discharge #3	<10		
Site D, discharge #5	<10		
Site E, clarifier	140 est	40	67*
Site E', chlor-alkali	<1		
Bellingham STP, final effluent	140 est	0	
Nooksack River below Ferndale	12 est	0	
Whatcom Creek near mouth at old STP	230	0	

*The remaining 33 percent was identified as klebsiella species. See memorandum from Janet Woodward to Roger Stanley dated May 2, 1979.

STATE OF WASHINGTON
Dixy Lee Ray
Governor

DEPARTMENT OF ECOLOGY
7272 Cleanwater Lane, Olympia, Washington 98504 206/753-2353

MEMORANDUM
May 2, 1979

To: Roger Stanley

From: Janet Woodward

Subject: Klebsiella Results from Bellingham Bay Study
Collected March 27, 1979

Eighteen samples collected March 27, 1979 from Bellingham Bay were analyzed for fecal coliform. The results are on the lab summary sheet. The blue colonies from the fecal coliform test were further analyzed for the presence of the KES group. The colonies which were esculin positive i.e., the KES group (Klebsiella, Enterobacter, Serratia), were streaked onto holding media (Nutrient agar) and left at room temperature until April 16 (while I was on annual leave). Then the isolates were identified through biochemical reactions. The following tests were performed: motility; indole; ornithine decarboxylase; citrate; TSI (including H_2S production); and oxidase.

Results

Only two samples yielded esculin positive fecal coliform colonies:

Station	Lab No.	Percent of Fecal Coliform Count due to KES group	Identification of KES Positive Colonies
E-GP eff.	956	40%	67% K. pneumoniae 33% Klebsiella species
Bellingham Bay 2/1/H/S	985	20%	K. pneumoniae

Discussion

As we expected, the fecal coliform counts were fairly low. K. pneumoniae was present in only one receiving water station and in one effluent sample, and in very low numbers. In the receiving water sample, the Klebsiella count would be 2.6 per 100 ml (fecal coliform count: 13 est per 100 ml). In the effluent sample, the Klebsiella pneumonaie count is 38/100 ml and the Klebsiella species count is 18/100 ml.

JW:cp

Bellingham Bay Receiving Water Survey
March 26-28, 1979

Summary Sheet: _____

FLOW DATA

Nooksack River at Ferndale	3/26/79	2900 cfs
Whatcom Creek at Whatcom Falls Park	3/26/79	4.5 cfs
Georgia Pacific Corporation	3/27/79	3/28/79
Outfall #3	3.2 mgd	3.2 mgd
Outfall #5	15.5 mgd	15.5 mgd
Clarifier discharge	12.6 mgd	12.6 mgd
Chlor-alkali	0.57 mgd	0.57 mgd

Bellingham STP final effluent, 3/27/79 - 4.43 mgd