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M E M O R A N D U M
November 21, 1979

To: John Glynn

From: Art Johnson and Shirley Prescott

Subject: Lower Nooksack River Water Quality Survey, August 27-28, 1979

Introduction

Past data from Department of Ecology (DOE) routine monitoring stations on the lower Nooksack River at Lynden, Ferndale, and Brennan, and results of an October 27-29, 1975 DOE "high-flow" survey have shown this drainage basin to frequently exceed Class A fecal coliform standards. Non-point agricultural pollution from dairy and livestock farms concentrated in the valley is likely the principal source of fecal contamination. Nutrient concentrations at levels above algal bloom thresholds are an additional water quality problem sometimes identified in the lower river (DOE, 1975).

In response to a request by John Glynn, DOE Northwest Region Office, a water quality survey of the lower Nooksack River and associated tributaries and drainage ditches was conducted on August 27-28, 1979. The primary objective was to evaluate fecal coliform levels during summer low flow. Nutrient and additional water quality data were also collected.

Methods

The sampling network used in the survey is pictured in Figure 1. Stations along the Nooksack River were chosen on the basis of river water time-of-travel intervals of 1/4, 1/2, 1, and 2 hours below tributary and drainage ditch inputs. Travel times were determined in an August 13-14, 1979 reconnaissance survey using surface floats and adjusting the measured travel times by a factor of .85 (Kittrell, 1969). River flow averaged 1690 cfs during the reconnaissance survey and was 1610 cfs on August 27, 1979 when river water samples were collected (USGS gaging data).

Quarter point transects were employed immediately below tributary confluences with the river in recognition of the Nooksack's size and the potential for channeling. Sampling points along tributaries and drainage ditches were distributed as evenly as access and time allowed. All samples were surface grabs.

Water samples taken were packed in ice and shipped to the DOE Tumwater laboratory for fecal coliform and nutrient analysis (NO_3-N, NO_2-N, [NH_3+NH_4]-N, T-PO_4-P). Water temperature, pH, and conductivity were measured in the field. For a few selected tributary and drainage ditch stations, the additional parameters listed below were also sampled for:

1. Dissolved Oxygen (mg/l)
2. Turbidity (NTU)
3. Total Solids (mg/l)
4. Suspended Solids (mg/l)
5. Kjeldahl-nitrogen (mg/l)
6. Total Hardness (as $CaCO_3$, mg/l)
7. Total Alkalinity (as $CaCO_3$, mg/l)
8. Chemical Oxygen Demand (mg/l)

Results and Discussion

Fecal Coliforms

The distribution of fecal coliforms, as determined from the 54 samples taken during the survey, is pictured in Figure 2. The Nooksack River data show a gradual increase in fecal contamination of from 22 to 38 colonies per 100 ml in the vicinity of Everson (river mile 24) to values of between 200 and 280 throughout the lower 15 miles of the river. All samples of river water downstream from station 7 (river mile 17) at Lynden failed to meet Class A standards (100 colonies per 100 ml-median).

With the exception of station 22 on Tenmile Creek and station 29 on Bertrand Creek, all creek and drainage ditch samples exceeded Class A standards and were typically one to two orders of magnitude higher than river water. Sections of Tenmile Creek, Bertrand Creek, Double Ditch, Kamm/Mormon Ditch, and Fountain Lake drainage showed the highest concentrations.

Comparison of coliform data from river water stations above and below these inputs fails to reveal a significant impact on water quality attributable to any one of the above streams for this point in time. The high dilution factor - approximately 400:1 in the case of Fishtrap Creek (USGS gaging data) - coupled with fecal coliform die-off in the river environment, are probably the principal factors operating to rapidly reduce impact.

Comparison of these data with the previously mentioned 1975 DOE "high flow" study (12 samples only), appears to indicate increased fecal contamination in the tributaries of the lower Nooksack relative to data from this low flow survey. The converse appears to be true for river water samples (see Table 1).

Examination of surface water runoff records (USGS, 1976), however, indicates flow for the October 1975 survey to have ranged from only 766 to 1140 cfs at Ferndale (river mile 6) compared to 1610 cfs for this survey. The 1975 data, therefore, is actually representative of low flow conditions (average flow 1961-1970 = 4,118 cfs).

The relatively high tributary fecal coliform concentrations in October 1975 probably reflect the effect of increased precipitation in that month - 4.41 inches compared to 0.69 inches in August 1979 (Bellingham airport). That maximum coliform concentrations often occur during and following rainfall was shown to be true for unpublished USGS data collected from July through December 1972 on Fishtrap, Bertrand, and Tenmile creeks, Keefe and Wiser Lake outlets, and the Nooksack River at Brennan (CH_2M-Hill, 1974).

Fecal coliforms in the lower Nooksack River are generally at a maximum during July through February and at a minimum during the snow melt in March through June. DOE routine monitoring data show the peaks in coliform concentrations to change from year to year in both magnitude and timing. Their relationship to rainfall, stream flow, and snow melt is not always consistent (CH_2M-Hill, 1974; DOE, 1975 and 1977).

While fecal contamination in the lower Nooksack River appeared minor during this survey, concentrations of up to 8,800 colonies per 100 ml have been recorded in August (Ferndale; August 3, 1977). A DOE routine monitoring sample collected at Ferndale two days after completion of this survey had a fecal coliform count of 500 colonies per 100 ml.

Effluents from three potential urban point sources along this section of the Nooksack - Lynden STP, Kelley Farquhar Co. (food processor, Lynden), and Ferndale STP - were not sampled in this survey. Data from above and below Lynden and Ferndale show no discernable impact to river fecal coliform levels for this sampling period.

Nutrients

The nutrient analysis results are shown in Tables 2 and 3. As with the coliform data, tributary and drainage ditch samples were often highest in compounds of nitrogen and phosphorus.

Nitrate-nitrogen (NO_3-N) was uniformly low in Nooksack River water samples, increasing from 0.02 mg/l at Everson to 0.04 mg/l in the vicinity of Ferndale. Ammonia-nitrogen ($[NH_3+NH_4]$-N) was also low and did not change significantly in the downstream direction. Total phosphate (T-PO_4-P) increased from 0.02 mg/l to between 0.06 and 0.07 mg/l. Nitrate and total phosphate at these concentrations are, for the most part, below the thresholds of 0.30 mg/l (NO_3-N) and 0.05 mg/l (T-PO_4-P) for algal bloom potential suggested by Klein (1965). These results are consistent with the summer-fall nutrient minimums shown in DOE routine monitoring data.

High levels of nitrate occurred in all tributary and drainage ditch samples except station 22 on upper Tenmile Creek and station 27, the only site sampled in the Keefe Lake drainage.

Upper Fountain Lake drainage stations 38 and 39 had concentrations of nitrite-nitrogen (NO_2-N) and ammonia indicative of organic pollution. Station 39's nitrite level, 0.15 mg/l, exceeds the 0.06 mg/l criteria for protection of salmonid fishes (EPA, 1976). This critical level is also approached in Double Ditch just above its confluence with Fishtrap Creek. The un-ionized (NH_3) toxic fraction of ammonia in the Fountain Lake samples would be considerably below levels harmful to freshwater life at pH 6.9.

Total phosphate was low in most samples taken, with the exception of the Fountain Lake and Fishtrap Creek stations mentioned above and upper Tenmile Creek, station 22. These levels ranged from 0.10 mg/l to 0.40 mg/l.

In the seven tributary and drainage ditch samples collected in the October 1975 survey, nitrate levels ranged from 0.80 mg/l to 3.4 mg/l. Nitrite was low in all samples while ammonia and total phosphate were highly variable, ranging from <0.01 mg/l to 0.53 and 0.45 mg/l, respectively.

Other Water Quality Parameters

Water samples from the mouths and upper reaches of Tenmile Creek, Bertrand Creek, Fishtrap Creek, Fountain Lake outlet, and Kamm/Mormon Ditch were also analyzed for dissolved oxygen, chemical oxygen demand, solids, turbidity, alkalinity, and hardness. These data are included in Tables 3 and 4. The only result of note is the low dissolved oxygen at station 22 on upper Tenmile Creek and station 43 on Mormon Ditch.

Summary and Conclusions

Water quality data from this summer low flow survey of the lower Nooksack River can be summarized as follows:

1. Fecal coliform concentrations were low in the Nooksack River between Everson and Lynden.

2. Fecal coliform concentrations exceeded Class A standards in the Nooksack River from Lynden downstream to below Ferndale and in 21 out of 23 sites sampled on major tributaries and drainage ditches flowing into the lower Nooksack.

3. Although fecal coliforms levels in these tributaries and drainage ditches were one to two orders of magnitude higher than river water, dilution and die-off rapidly reduced their impact on the river.

4. Nutrient levels in the lower Nooksack River were relatively low.

5. Nitrate-nitrogen was high in all tributaries and drainage ditches sampled. Ammonia-nitrogen and nitrite-nitrogen were high in parts of the Fountain Lake and Fishtrap Creek drainages. Total phosphate concentrations were high in these same areas as well as in the upper section of Tenmile Creek.

Considering the intensive agricultural land use in the Nooksack River Basin, river water quality appeared good for the period of this survey. Moderate degradation from fecal contamination was evident in the lower river. Tributary and drainage ditch water quality was significantly degraded with respect to fecal coliforms and nutrients, especially nitrates. It must be remembered that results obtained from short-term studies in a large and dynamic system such as the Nooksack basin represent conditions existing at a fixed point in time only. Changes in rainfall, livestock concentrations, and sampling station placement would probably have significantly changed the above results with respect to distribution and magnitude of fecal coliforms and nutrients, especially in tributaries and drainage ditches. In light of the year-to-year variability in water quality here, hydrology and land use should be closely related to water quality data collected in future studies.

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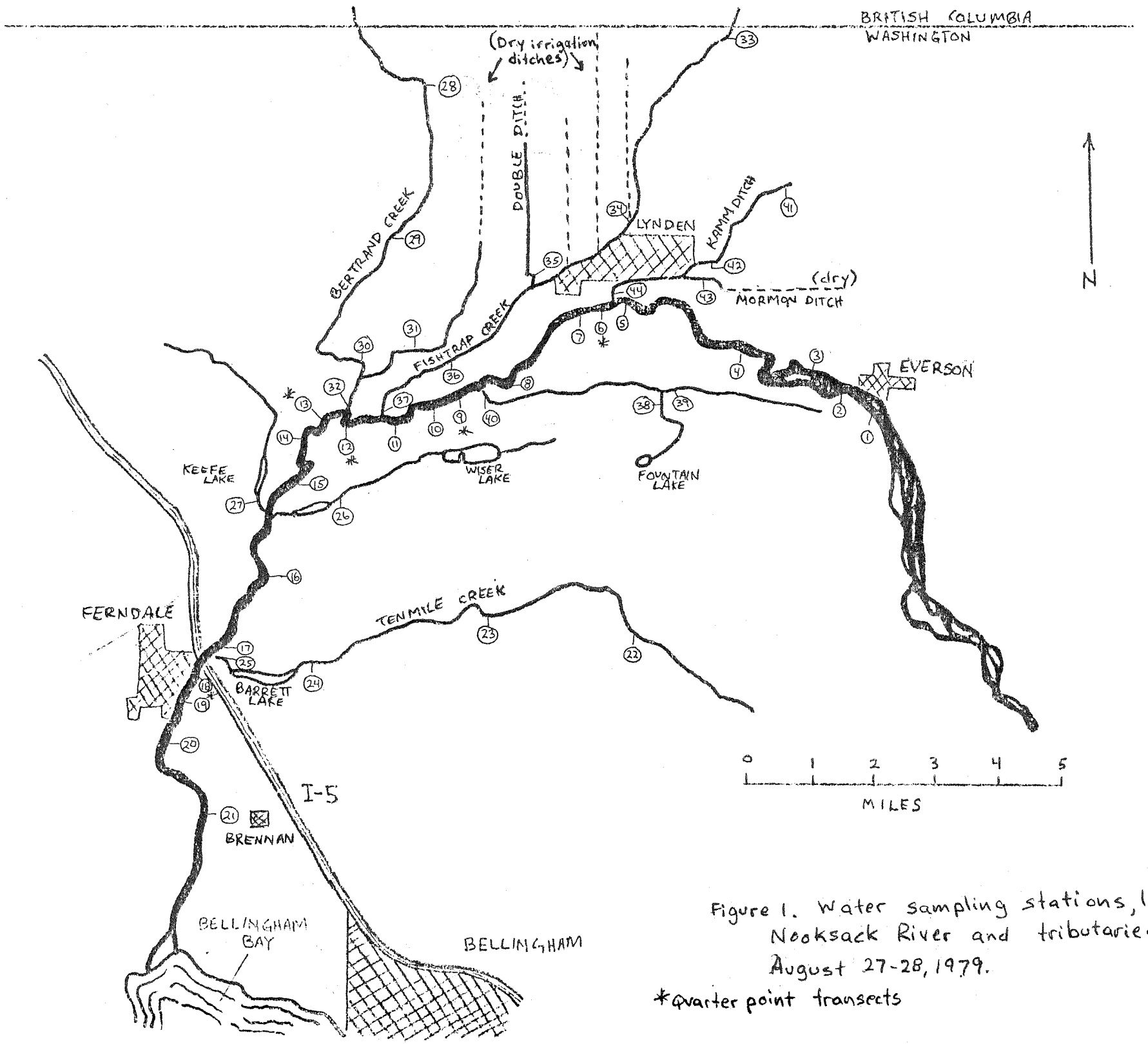

Figure 1. Water sampling stations, lower Nooksack River and tributaries, August 27-28, 1979.

*quarter point transects

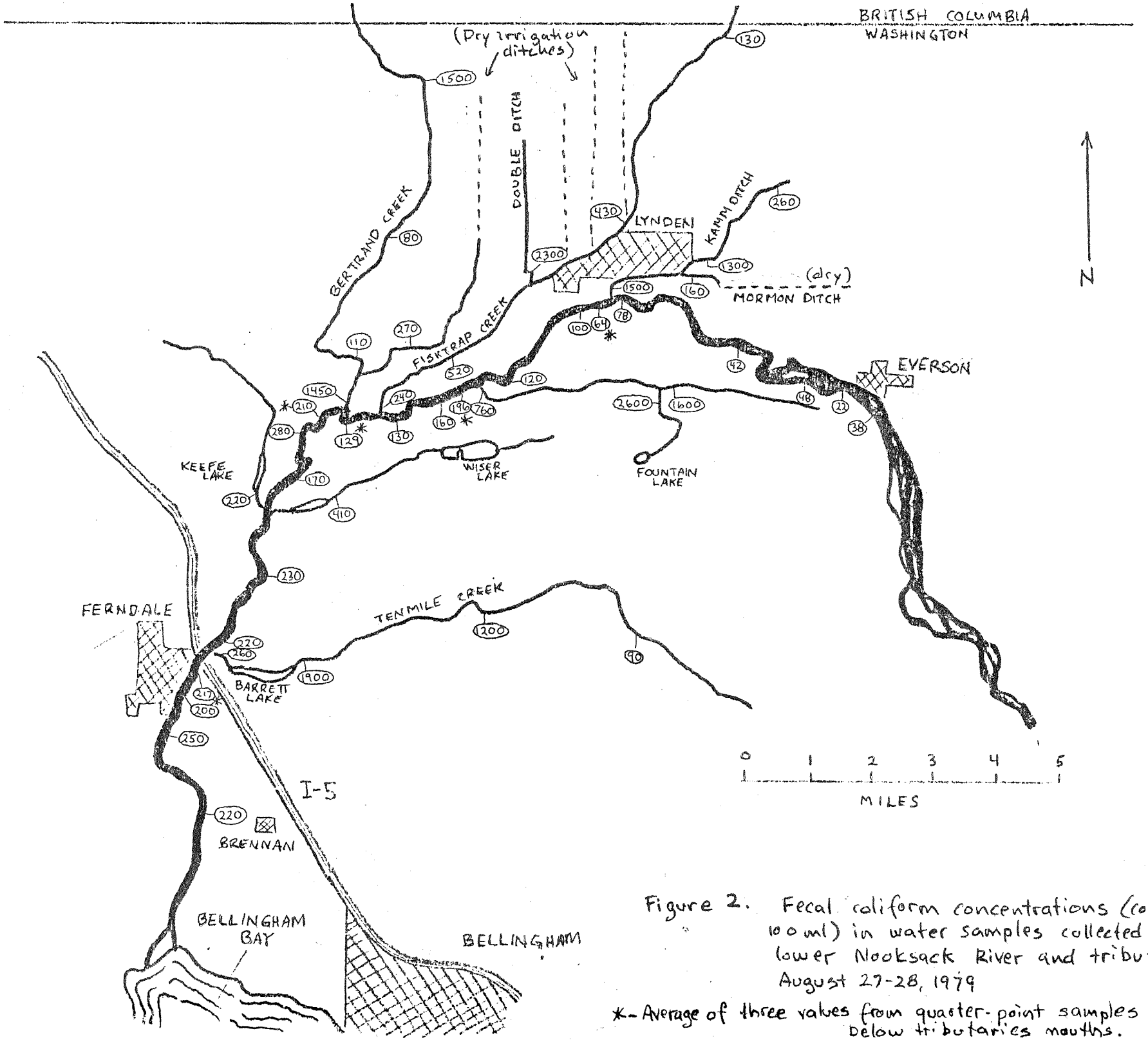

Figure 2. Fecal coliform concentrations (colonies per 100 ml) in water samples collected from the lower Nooksack River and tributaries, August 27-28, 1979

*- Average of three values from quarter-point samples below tributaries mouths.

Table 1. Fecal coliform concentrations, lower Nooksack Drainage basin, August 27-28, 1979 and October 27-30, 1975.

Station Number (1979)	Description	Fecal Coliforms (col/100 ml) 8/27-28/79	10/27-30/75
43	Mormon Ditch at Norwood Rd.	160	3,000
42	Kamm Ditch at Norwood Road	1,300	13,300
33	Fishtrap Crk. @ U.S.-Canada Border	130	700
36	Fishtrap Creek	520	1,300
30	Bertrand Creek at Willeys Road	110	730
38	Fountain Lake Outlet	2,600	940
25	Tenmile Creek below Barret Lake	260	70
4	Nooksack River above Lynden	42	6
7	Nooksack River below Lynden	100	52
18	Nooksack River at Ferndale	217	120
20	Nooksack River below Ferndale	250	110

Table 2. Water quality data, lower Nooksack River, August 27, 1979

Station Number	Description	Approx. River Mile	Temp. (°C)	pH	Conduc-tance (µmhos/cm)	Fecal Coliforms (Col/100 ml)	Nitrate NO_3-N (mg/l)	Nitrite NO_2-N (mg/l)	Ammonia (NH_3+NH_4)-N (mg/l)	Total Phosphate $T\text{-}PO_4$-P (mg/l)
1	Nooksack R. above Everson	24	12.6	6.9	--	38	.02	<.01	.02	.02
2	Nooksack R. below Everson	23	13.0	---	78	22	.02	<.01	.03	.02
3	Nooksack R. below Everson	22.5	13.1	---	--	48	.02	<.01	.05	.02
4	Nooksack R. below Everson	21.5	13.4	6.9	--	42	.02	<.01	.01	.02
5	Nooksack R. below Everson	18.5	13.6	6.9	--	78	.02	<.01	.02	.03
6	Nooksack R. at Lynden*	17.5	13.5	---	--	64	.03	<.01	.01	.02
7	Nooksack R. at Lynden	17	13.8	---	76	100	.03	<.01	.07	.03
8	Nooksack R. below Lynden	16	14.2	7.0	--	120	.02	<.01	.02	.03
9	Nooksack R. below Fountain Lake*	15	14.4	---	--	196	.02	<.01	.03	.03
10	Nooksack R. below Fountain Lake*	14.5	14.5	6.9	79	160	.02	<.01	.02	.03
11	Nooksack R. below Fountain Lake*	13.5	14.6	---	--	130	.02	<.01	.02	.02
12	Nooksack R. below Fishtrap Creek*	12.5	15.1	---	--	129	.02	<.01	.02	.03
13	Nooksack R. below Bertrand Creek*	12	15.0	---	--	210	.03	<.01	.02	.02
14	Nooksack R. below Bertrand Creek	11.5	15.2	---	--	280	.03	<.01	.02	.04
15	Nooksack R. below Bertrand Creek	11	15.2	7.0	90	170	.03	<.01	.04	.02
16	Nooksack R. below Bertrand Creek	8.5	15.3	---	--	230	.03	<.01	.05	.04
17	Nooksack R. abv Tenmile Crk.	7	15.3	---	--	220	.03	<.01	.03	.06
18	Nooksack R. blw Tenmile Crk*	6.5	15.4	7.0	90	217	.04	<.01	.02	.06
19	Nooksack R. at Ferndale	6	15.4	7.0	90	200	.04	<.01	.03	.07
20	Nooksack R. below Ferndale	5	15.8	---	--	250	.04	<.01	.03	.07
21	Nooksack R. below Ferndale	3.5	16.2	7.0	90	220	.04	<.01	.04	.06

*Coliform and nutrient data for these stations represents average of 3 samples from quarter-point transects. All other data based on single samples from center of river.
-- = Not measured

Table 3. Water quality data, tributaries to lower Nooksack River, August 27-28, 1979.

Station No.	Description	Temp. (°C)	pH	Conductance (µmhos/cm)	Fecal Coliforms (Col/100 ml)	Nitrate NO_3-N (mg/l)	Nitrite NO_2-N (mg/l)	Ammonia (NH_3+NH_4)-N (mg/l)	Kjeldahl Nitrogen (mg/l)	Total Phos. T-PO_4-P (mg/l)	D.O. (mg/l)	COD (mg/l)	Total Solids (mg/l)	Total Sus. Solids (mg/l)	Turb. (NTU)	Total Hardness as $CaCO_3$ (mg/l)[3]	Total Alkalinity as $CaCO_3$ (mg/l)[3]
Tenmile Creek																	
22	At Hemmi Road	15.2	7.1	340	90	<.01	<.01	.05	.20	.15	N.D.	15	220	4	2	110	130
23	At Old Guide Road	14.6	7.0	330	1,200*	.28	<.01	.06	--	.03	--	--	--	--	--	--	--
24	At Wiser Lake Road	15.1	7.3	350	1,900*	.53	<.01	.04	--	.04	--	--	--	--	--	--	--
25	Mouth	18.6	7.3	550	260	.36	<.01	.04	.09	.04	8.8	29	390	4	3	160	61
Wiser Lake Outlet																	
26	At Wiser Road	16.1	7.0	375	410	.49	<.01	.04	--	.01	--	--	--	--	--	--	--
Keefe Lake Outlet																	
27	At Grandview Road	18.2	6.4	325	220	<.01	<.01	.07	--	.05	--	--	--	--	--	--	--
Bertrand Creek																	
28	At H Street Road	18.3	7.5	180	1,500	.37	.01	.07	.50	.07	8.8	18	130	8	4	60	63
29	At Blaine-Sumas Highway	14.8	6.9	240	80	1.0	.01	.05	--	.01	--	--	--	--	--	--	--
30	At Willeys Road	16.2	7.2	240	110	1.1	<.01	.03	--	.02	--	--	--	--	--	--	--
31	Tributary to Bertrand Creek	15.5	7.1	285	270	2.2	.01	.04	--	.02	--	--	--	--	--	--	--
32	Mouth	15.8	7.0	240	1,450*	1.2	<.01	.03	<.01	.02	9.3	7	200	5	3	80	44
Fishtrap Creek																	
33	At U.S.-Canada Border	15.9	7.1	178	130	2.2	.02	.04	.26	.02	6.1	37	140	2	1	84	55
34	At Bender Road	16.4	7.5	210	430	1.1	.01	.06	--	.06	--	--	--	--	--	--	--
35	Double Ditch @ Blaine-Sumas Hwy.	15.7	7.9	148	2,300*	.74	.06	.07	--	.10	--	--	--	--	--	--	--
36	At Guide-Meridian Road	17.3	8.0	187	520	.84	<.01	.06	--	.09	--	--	--	--	--	--	--
37	Mouth	17.2	7.5	181	240	.63	<.01	.03	.03	.05	7.5	15	150	6	4	76	52
Fountain Lake Outlet																	
38	At Wiser Lake Road	14.4	6.9	225	2,600*	.55	.03	.18	--	.04	--	--	--	--	--	--	--
39	Tributary at Thiel Road	13.8	6.9	330	1,600*	.23	.15	3.1	--	.40	--	--	--	--	--	--	--
40	Mouth	17.5	6.9	313	760	1.2	.03	.08	.14	.02	6.8	18	240	5	4	110	42
Kamm/Mormon Ditch																	
41	Kamm Ditch @ Blaine-Sumas Hwy.	14.8	7.2	180	260	1.3	.01	.03	.19	.03	7.3	18	140	6	2	76	53
42	Kamm Ditch @ Norwood Road	12.1	7.0	172	1,300*	2.9	.02	.03	--	.04	7.6	--	--	--	--	--	--
43	Mormon Ditch @ Norwood Road	15.6	6.8	230	160	.42	<.01	.07	.28	.02	1.6	16	160	1	1	80	45
44	Kamm/Mormon Ditch Mouth	15.2	7.1	190	1,500*	1.7	.02	.02	.25	.02	8.7	7	160	5	4	80	50

N.D. = None Detected
* = Estimated
-- = Not measured

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