ANALYSIS OF STREAM WATER ALONG
US 131 RELOCATION IN KENT AND
MONTCALM COUNTIES, A PROGRESS REPORT

MICHIGAN
HIGHWAY RESEARCH LABORATORY SECTION

MICHIGAN DEPARTMENT OF STATE HIGHWAYS

ANALYSIS OF STREAM WATER ALONG US 131 RELOCATION IN KENT AND MONTCALM COUNTIES, A PROGRESS REPORT

W. L. Frederick
M. H. Janson

Research Laboratory Section
Testing and Research Division
Research Project 71 G-179
Research Report No. R-795
Environmental Report EV-11

Lansing, November 1971

This progress report was prepared to summarize the status of the laboratory testing, and briefly review the water quality analyses of Handy Creek, Tamarack Creek, Duke Creek, Cedar Creek, and Little Cedar Creek in the Kent and Montcalm County relocation area for US 131. The results of five weekly samplings over a six-week period are reported. Literature has been reviewed on water quality analysis and recommendations for further work have been prepared.

In initiating this investigation it was understood that the Environmental Liaison Unit wanted to monitor the effects of highway construction on the natural waters in the relocation area. As usual, lack of time did not permit a preliminary study of the water quality analysis field and, therefore, monitoring parameters were arbitrarily chosen. These parameters, as shown below, were considered sufficient to cover most criteria for water quality comparisons and it was expected that further knowledge of water quality standards would permit deletion of some parameters.

Parameters used for water quality criteria

color	nitrate	dissolved oxygen
odor	chloride	dissolved solids
phosphate	sulfate	suspended matter
pH	calcium	acidity
heavy metals	iron	alkalinity
sodium		temperature

A number of sampling sites upstream and downstream from the construction area were recommended by others and a weekly sampling cycle was arbitrarily established. These actions constituted the initial chemical investigation program.

Sample Sites and Sampling

Identification of the streams chosen for monitoring are shown in Table 1, and Figure 1 charts the 19 sample sites. Stream samplings were made on August, 4, 11, 18, and 25, and again on September 9, 1971.

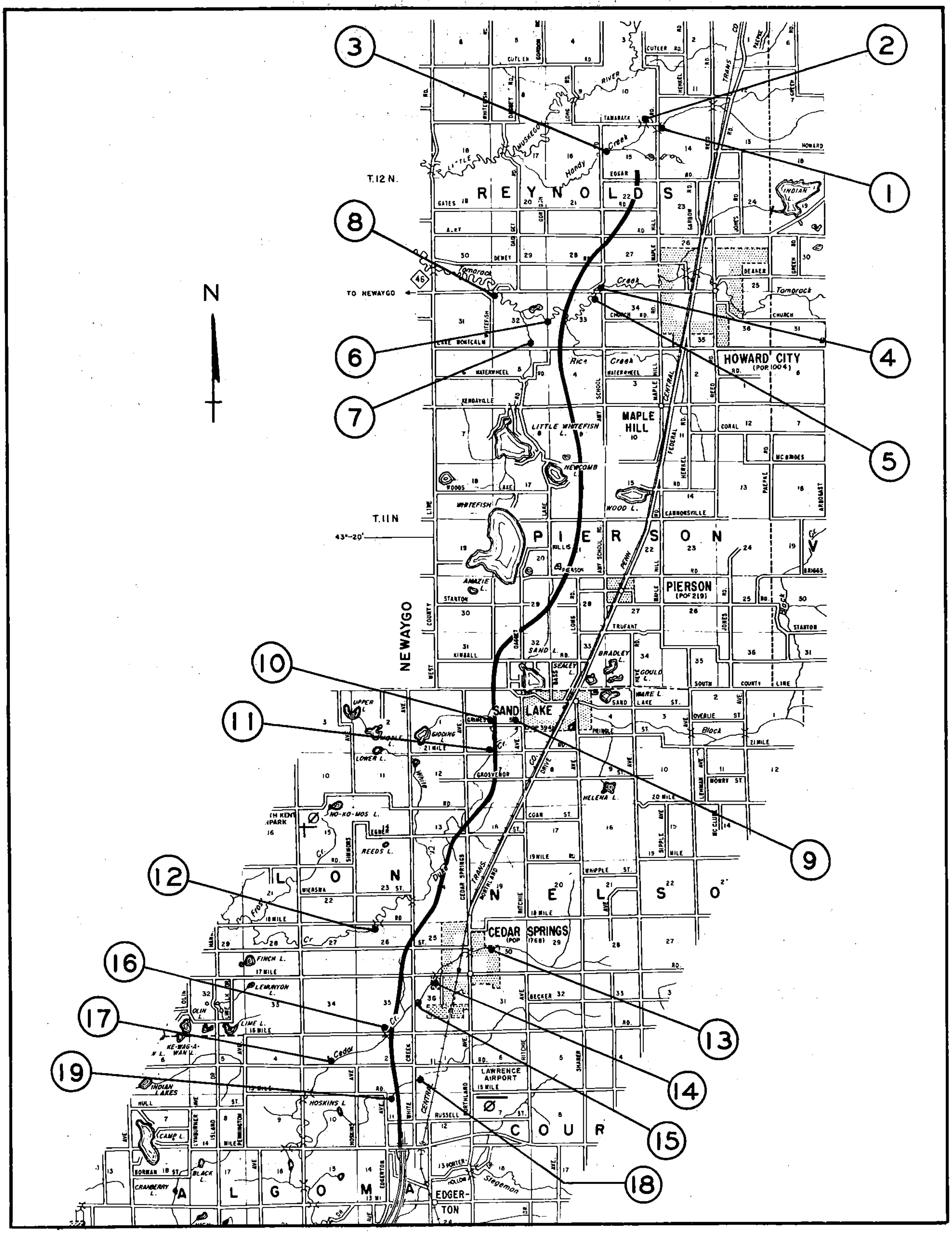

Figure 1. Present water sampling sites for study area along realignment of US 131

TABLE 1
STREAM SAMPLE SITES

Site Number	Location
1, 2, 3	Handy Creek
4, 5, 6, and 8	Tamarack Creek
7	feeder to Tamarack Creek
9, 10, 11, and 12	Duke Creek
13, 14, 15, 16, and 17	Cedar Creek
18 and 19	Little Cedar Creek

Testing Procedures and Analytical Results

The samples were analyzed in accordance with "Standard Methods for Examination of Water and Waste Water," prepared by American Public Health Association.

The results are shown in Tables 2 through 6 which follow.

TABLE 2
COLOR, ODOR, pH, PHOSPHATE AND HEAVY METALS

Parameter	Test Results
Color	All samples were clear and nearly colorless, except the sample from site 14 on August 11 which was turbid
Odor	None of the samples had unusual odors. Presence of sulfides was ruled out.
pH	All samples had a slightly alkaline pH. Measurements were made in the stream with a pH meter.
Phosphate	none detected - but sensitivity of the method may be increased to detect a concentration less than 0.1 ppm in the future.
Heavy metals	None of the samples showed detectable heavy metals.

TABLE 3
NITRATE, CHLORIDE AND SULFATE RESULTS

Sample[1] Site	Nitrate, ppm as N					Chloride, ppm as Cl					Sulfate, ppm as SO_4				
	8-4-71	8-11-71	8-18-71	8-25-71	9-9-71	8-4-71	8-11-71	8-18-71	8-25-71	9-9-71	8-4-71	8-11-71	8-18-71	8-25-71	9-9-71
1	0.8	0.6	0.7	0.6	0.7	132	143	83	142	194	Data not available	Data not available	8.2	12.8	29.4
2	1.0	0.6	0.7	0.6	0.7	134	128	79	135	196			8.4	11.0	27.8
*															
3	0.6	0.4	0.2	0.4	0.4	96	85	64	98	156			1.6	3.1	30.9
4	1.2	0.8	1.0	1.1	1.1	49	36	41	42	52			21.9	21.7	30.6
5	1.4	0.8	0.9	1.0	0.9	49	36	41	41	51			21.6	23.7	25.6
*															
6	1.8	0.7	0.8	0.9	1.0	39	30	32	33	43			25.3	23.0	26.2
7	0.4	0.5	<0.1	0.1	<0.1	11	8	8	8	8			7.7	4.9	3.1
8	1.1	0.7	0.8	0.9	0.6	45	37	40	37	41			23.9	23.5	26.0
9	1.8	1.3	1.2	1.3	0.9	9	8	6	6	8			17.7	20.6	5.9
*															
10	1.2	0.5	1.0	0.4	0.5	9	11	6	6	9			16.6	3.9	24.5
11	2.2	0.9	1.5	1.4	1.3	9	6	5	5	7			12.8	16.5	17.8
12	1.8	0.6	1.2	1.6	0.9	11	7	7	7	8			15.8	1.3	18.2
13	0.5	0.5	<0.1	0.7	0.4	7	4	4	5	4			42.6	50.0	60.0
14	0.6	0.5	<0.1	0.5	0.4	23	21	29	13	14			36.7	44.2	51.8
15	0.5	0.5	<0.1	0.5	0.4	30	21	21	16	21			34.1	43.7	54.8
*															
16	1.3	1.0	0.6	0.9	0.7	34	24	30	22	22			45.9	42.8	53.5
17	3.5	2.5	1.8	1.6	1.2	26	22	23	22	20			36.4	35.2	49.0
18	0.6	0.7	<0.1	0.4	0.4	12	11	8	8	11			16.3	15.8	23.0
*															
19	0.6	0.5	<0.1	0.3	0.3	7	6	5	5	5			17.6	17.4	20.9

* Indicates proposed highway crossing of stream flow.

1 Sample site numbers increase in downstream direction.

TABLE 4
CALCIUM, IRON AND SODIUM RESULTS

Sample[1] Site	Calcium, ppm					Iron, ppm					Sodium, ppm				
	8-4-71	8-11-71	8-18-71	8-25-71	9-9-71	8-4-71	8-11-71	8-18-71	8-25-71	9-9-71	8-4-71	8-11-71	8-18-71	8-25-71	9-9-71
1	67	68	51	71	93	0.14	0.26	0.04	0.14	0.16	35	40	22	37	52
2	67	66	50	67	95	0.18	0.26	0.10	0.16	0.12	36	35	22	37	53
*															
3	62	55	55	58	87	0.16	0.24	0.10	0.13	0.12	25	25	18	28	41
4	64	33	56	63	76	0.30	0.36	0.06	0.18	0.20	18	14	16	16	18
5	65	59	63	61	74	0.20	0.36	0.06	0.14	0.20	18	14	16	16	18
*															
6	70	67	61	62	76	0.14	0.22	0.06	0.09	0.16	14	12	13	13	15
7	36	47	38	37	40	0.14	0.16	0.25	0.12	0.10	4	4	4	4	4
8	69	87	60	58	62	0.14	0.24	0.10	0.17	0.16	19	16	18	17	16
9	61	56	53	52	52	0.38	0.80	0.24	0.37	0.74	3	3	3	3	3
*															
10	52	43	45	43	55	0.20	0.30	0.17	0.21	0.15	3	4	4	3	4
11	49	44	41	40	47	0.20	0.38	0.11	0.17	0.12	3	3	3	3	4
12	55	57	50	48	57	0.14	0.30	0.08	0.10	0.12	4	3	4	4	4
13	54	63	56	64	70	0.22	0.28	0.16	0.13	0.11	3	3	3	3	3
14	64	66	64	64	75	0.34	0.72	0.32	0.22	0.25	9	8	9	6	6
15	68	68	69	61	74	0.28	0.44	0.24	0.22	0.20	12	9	13	8	9
*															
16	71	65	70	64	73	0.42	0.66	0.20	0.24	0.20	20	15	18	14	12
17	69	68	68	67	71	0.20	0.20	0.11	0.16	0.16	17	12	14	12	10
18	57	52	52	53	59	0.18	0.10	0.26	0.69	0.12	4	4	3	4	5
*															
19	60	41	56	58	58	0.24	0.20	0.79	0.22	0.20	9	2	2	2	2

* Indicates proposed highway crossing of stream flow.
1 Sample site numbers increase in downstream direction.

TABLE 5

DISSOLVED OXYGEN, DISSOLVED SOLIDS AND SUSPENDED MATTER RESULTS

Sample[1] Site	Dissolved Oxygen ppm				Dissolved Solids ppm					Suspended Matter ppm				
	8-4-71	8-11-71	8-18-71	8-25-71	8-4-71	8-11-71	8-18-71	8-25-71	9-9-71	8-4-71	8-11-71	8-18-71	8-25-71	9-9-71
1	9.5	8.8	9.6	9.0	Data not available	456	338	478	645	Data not available	17	14	0	0
2	9.5	9.1	9.6	9.2		451	380	439	622		7	12	0	0
*														
3	9.3	8.8	9.5	8.9		342	337	382	573		12	10	0	0
4	10.8	9.2	9.8	9.3		292	339	302	411		20	11	5	2
5	11.1	9.4	9.9	9.4		303	340	326	403		21	17	0	3
*														
6	9.7	9.4	9.5	9.2		291	321	298	394		15	15	0	0
7	8.8	8.4	8.5	9.4		171	201	170	203		12	12	0	0
8	10.5	9.1	9.8	9.4		302	324	304	352		16	13	0	0
9	7.0	5.2	6.6	5.2		243	258	239	270		24	29	5	6
*														
10	6.5	5.7	6.6	5.8		224	242	201	290		13	16	0	0
11	8.9	8.0	9.1	8.1		198	217	210	260		18	22	0	0
12	9.5	8.6	9.8	8.7		202	240	214	271		20	12	0	0
13	10.3	9.0	11.3	9.9		282	288	272	340		20	9	0	0
14	9.8	8.1	9.9	9.6		299	321	289	349		62[2]	16	0	0
15	10.5	9.5	10.7	9.9		308	361	288	368		23	12	0	0
*														
16	9.5	8.9	9.9	9.0		328	361	298	360		25	19	0	0
17	10.6	9.8	10.4	9.4		313	334	305	370		8	11	0	0
18	14.0	10.5	6.5	4.2		250	256	236	285		23	56[3]	62	18
*														
19	8.1	7.2	8.1	8.5		239	268	236	273		18	12	0	0

* Indicates proposed highway crossing of stream flow.
[1] Sample site numbers increase in downstream direction.
[2] Turbid
[3] Aquatic life

TABLE 6
TEMPERATURE AND SAMPLING DATA

Sample[1] Site	Water Temperature, F					Time of Sampling (E.S.T.)				
	8-4-71	8-11-71	8-18-71	8-25-71	9-9-71	8-4-71	8-11-71	8-18-71	8-25-71	9-9-71
1	57	60	56	61	63	9:55	9:55	9:10	10:20	11:00
2	58	61	56	61	63	10:00	10:00	9:20	10:30	11:13
*										
3	58.5	62	56	61	64	10:04	10:10	9:30	10:40	11:22
4	62	64	62	65	66	11:23	11:00	10:05	11:10	11:35
5	62	64	62	65	66	11:32	11:05	---	11:18	11:45
*										
6	62	64	61	65	65	11:55	12:05	10:55	12:07	12:00
7	65	68	65	68	73	12:08	11:55	10:45	11:55	12:15
8	62	64	61	63	67	12:25	11:35	10:35	11:40	12:25
9	65	66	69	66	68	1:50	1:50	11:30	1:50	1:30
*										
10	65	68	64	68	66	1:56	1:56	11:38	2:00	1:33
11	65	66	60	68	66	2:04	---	11:45	2:15	1:37
12	66	66	64	68	68	2:55	2:35	12:17	2:40	2:00
13	68	68	68	70	67	2:23	2:43	12:25	2:55	1:45
14	68	68	66	71	67	3:08	2:49	12:35	3:05	1:55
15	69	70	66	72	---	3:18	2:54	12:43	3:11	2:05
*										
16	66	67	64	70	66	3:30	3:13	1:20	4:00	2:20
17	68	68	67	68	68	3:43	3:25	1:30	4:10	2:28
18	75	74	80	72	68	4:08	---	1:45	4:30	2:40
*										
19	68	65	68	70	74	3:55	3:32	1:36	4:20	2:35

* Indicates proposed highway crossing of stream flow.
[1] Sample site numbers increase in downstream direction.

Summary of Results

The data serve as an indicator of the present water quality in the streams so that a basis for comparison is available, should changes in water quality occur as construction proceeds. The streams are apparently unpolluted or possibly lightly polluted in some cases.

There are relatively higher levels of chloride at sites 1, 2, and 3 (Handy Creek), sites 4, 5, 6, and 8 (Tamarack Creek) and sites 14, 15, 16, and 17 (Cedar Creek) than on the remaining streams. There are relatively higher levels of sodium at sites 1, 2, 3 (Handy Creek); sites 4, 5, 6, 8 (Tamarack Creek); and at sites 15, 16, and 17 (Cedar Creek) than on the remaining streams. The coincidence of elevated sodium and chloride levels indicates that sodium chloride (salt) is entering these three streams in some fashion. Sulfate levels are relatively higher on Cedar Creek; sites 13, 14, 15, 16, and 17 than on the other streams. Turbidity, resulting from construction activity associated with a roadway extension by city or county personnel was found on only one occasion, August 11, 1971, at site 14 on Cedar Creek.

The results were also examined to determine the variability of test values or extremes in values obtained for the selected parameters. This was done because water quality parameters or indices can be selected on the basis of applicable standards, on the basis of establishing a base-line water quality, or on the basis of determining trends that will indicate water quality degradation. The latter two bases for selection are the most relevant to this investigation. The data showed that suspended matter and iron varied considerably on samples from most of the sites. Sodium, chloride, sulfate, and dissolved solids content also varied considerably but only at a few sites. Nitrate, calcium, and dissolved oxygen content with a few exceptions remained constant. Color, odor, phosphate content, and heavy metals were unchanged for all samples. It appeared, then, that measurements of suspended matter and iron may be relatively important and that sodium, chloride, sulfate, and dissolved solids content should be considered further. It was learned, however, that some of these variations may be normal changes in stream condition caused by factors such as rainfall. In view of this, additional information was considered necessary before recommendations for continued water analysis could be prepared.

Additional Information on Water Quality Parameters

In a report on the Federal Water Quality Office (1) it was noted that a relatively large number of parameters were chosen to determine whether industrial wastes end up in open waters or in ground reservoirs. The list reported is as follows with the parameters considered in this study indicated by askerisks.

Physical Parameters

flow	color*
temperature*	specific conductance
pH*	

Chemical Parameters

total solids*	sulfate*	chromium
total volatile solids	sulfide	copper
total suspended solids*	phenols	iron*
total dissolved solids*	ammonia	cadmium
acidity*	nitrate*	lead
alkalinity*	nitrite	manganese
5-day biological oxygen demand	organic nitrogen	zinc
COD	total nitrogen	fluoride
oil and grease	ortho-phosphorous*	arsenic
chloride*	total phosphorous	mercury

In another report by William T. Sayers, on "Water Quality Surveillance: the Federal-State Network" (2) it was learned that of those water stations participating in the surveillance program, the following were always analyzed.

dissolved oxygen	settleable solids
pH	turbidity and/or color
coliform	taste - odor
temperature	toxic substances
floating solids (oil & grease)	

Sayers' report goes on to show that test stations analyze for the following additional indices more than 20 percent of the time.

radioactivity	chromium (hexavalent)	copper
U.S. Public Health Service Drinking Water Stds.	fluoride	nitrate
total dissolved solids	lead	phenols
arsenic	selenium	phosphate
barium	silver	sulfate
cadmium	suspended solids	cyanide
	chloride	

In order to better understand the relationship of the various indices to pollution the sources and effects of some of the indices were investigated.

Iron

Iron may be dissolved from soils and rocks and it is often a part of industrial waste. A concentration of 0.3 ppm iron in water affects taste, color and odor of the water, but low concentrations pose no threat to plant or animal life. Hydroxides of iron are sparingly soluble in water of neutral pH, so appreciable concentrations of iron would not be expected in stream water.

Sodium

Soils, rocks, and runoff from roadways and urban structures account for the presence of sodium. Sodium has no direct toxic effect on stream life.

Calcium

Calcium comes from soils and rocks, and may be present in runoff from roadways. It is essential for aquatic life processes and high concentrations are not harmful.

Dissolved Solids

These solids are contributed by any natural or artificial substance that may be soluble in water. Measurement of these solids provides a non-specific method for following pollution levels.

Suspended Matter

These solids are contributed by any natural or artificial substance that may be mechanically carried along in the water. This measurement monitors sediment which a stream may be carrying.

Chloride

The presence of chlorides is due to soil, rocks, highway runoff, industrial wastes, and sewage effluents. About 200 ppm causes a salty taste, but concentrations up to several thousand ppm can be tolerated by plant and animal life.

Phosphates

Phosphates usually come from the soil, agricultural drainage, and municipal or industrial waste. The presence of phosphates provides a plant nutrient source which may cause excessive plant growth and algae blooms.

Nitrate

Nitrates are present because of agricultural drainage and from municipal or industrial waste. Increasing concentrations lead to choking a stream with excessive plant growth and a lowered dissolved oxygen content. In drinking water, concentrations above 20 ppm have reportedly caused methemoglobinemia in infants or "blue babies."

Sulfate

Sulfate comes from soils and rocks, and may be present in industrial waste. It has no direct toxic effect on aquatic life.

Dissolved Oxygen

Oxygen is contributed by photosynthesis in aquatic plants during daylight and by aeration of stream water. It is needed to support both plant and animal aquatic life. Approximately 5 ppm is needed for fish propagation.

Color and Turbidity

Color changes are associated with composition changes, and turbidity is a readily detected measure of suspended sediment. Water temperature changes can be affected due to the light absorbtion associated with a color change.

pH

Stream water must have a near neutral condition, in the pH range from 6.5 to 8.5, for aquatic life to thrive.

Temperature

Fish and other aquatic life require moderate temperatures to live and propagate. Also, unpolluted water will normally be near saturation with oxygen for its temperature. Thus, a low oxygen level relative to oxygen saturation at a particular temperature indicates an oxygen consuming pollutant may be present.

After examining the above information on water quality parameters it was concluded that the investigation should continue on the basis of analyzing the following parameters:

- dissolved solids
- suspended matter
- nitrate / organic N
- chloride
- temperature
- phosphate
- dissolved oxygen
- color/ turbidity
- pH

A test for coliform bacteria (indicates sewage) should be added to the above and since construction is involved, tests for herbicide and pesticide residues might be added. These tests are beyond the capabilities of this laboratory but the Departments of Agriculture and Public Health do have the facilities and experience.

Measurement of these parameters will best serve as indicators of pollution, with a possible subsequent environmental effect, because the chemical tolerances related to survival of the plant and animal forms in the construction area have not been determined. The actual environmental impact, if any, will have to be evaluated by observations of plant and animal life.

Recommendations for Future Sampling and Testing

Literature on water quality analysis indicates that sampling frequency should be based on variations shown by the various water quality parameters and the activities in the sample area.

1. Routine monthly samplings should be analyzed for the above parameters during the construction season.

2. Additional samplings should be made as soon as activities occur which may affect water quality at a sample site and one week following the occurrence. Analysis may be limited to a few of the parameters, depending on the activity near the sample site.

3. The number of sampling sites should be reduced to those listed below. Locations of the sites are shown on a map in Figure 2. A suffix letter denotes a new sample site near a previous site with the same number.

Site Number	Location
2	Handy Creek
5, 5a, 6, 6a	Tamarack Creek
10a, 11, 12a	Duke Creek
15a, 15b, 16	Cedar Creek
18a, 19	Little Cedar Creek

A single site was chosen on Handy Creek because no construction activity is expected in that area during the course of the present project. Thus, no variation in stream condition is expected upstream and downstream from the proposed crossing.

Sites 5a, 6a, and 15b were chosen in order to sample the streams closer to the right-of-way crossing. They will be reached from the right-of-way after the land is cleared. Until then sampling will continue at sites 5, 6, and 15a.

Site 5a will improve the sampling procedure by including the input from Rice Creek in the control sample for Tamarack Creek. Rice Creek presently enters Tamarack Creek downstream from the control sample point.

A change from site 10 to 10a is recommended to sample further downstream and include possible effects of Grimes St. in the control sample for Duke Creek.

A change from site 12 to 12a is recommended to exclude possible effects of White Creek Rd. and 18 Mile Road from the downstream samples on Duke Creek.

The change from original site 15 to 15a was made to move downstream and include the effluent from a drainage ditch that may carry treated sewage in the control sample for Cedar Creek.

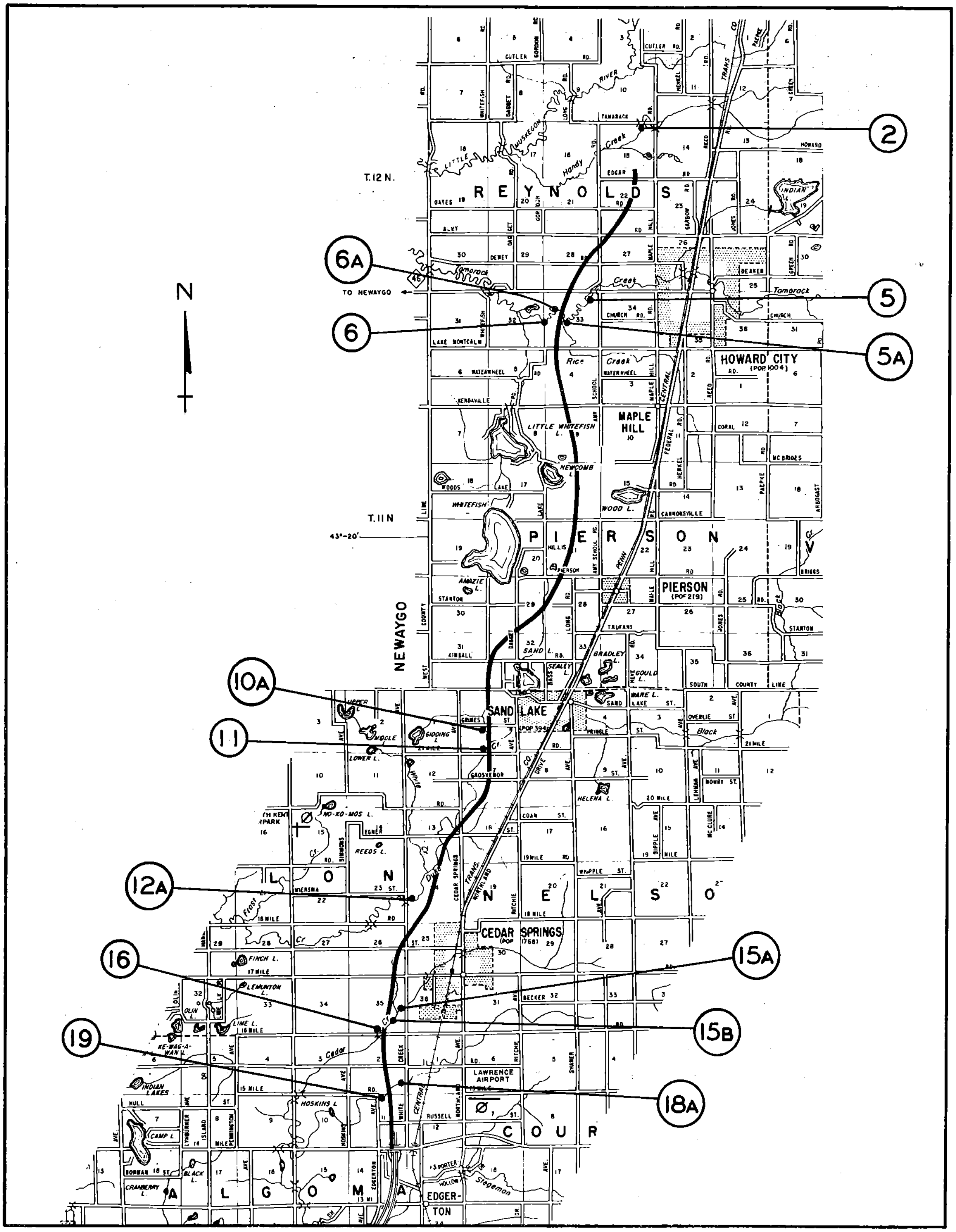

Figure 2. Proposed future sampling sites for study area along realignment of US 131

A change from site 18 to 18a is recommended to include possible effects of White Creek Rd. in the control sample for Little Cedar Creek.

4. Rainfall data, stream flow data, construction activities and activities by others which may affect the sample sites should be reported routinely, with sufficient frequency to permit meaningful samplings at the affected sites.

5. Bottom samplings or stream gaging should be carried out to provide possible correlation with chemical results obtained.

6. It is further recommended that the results of sampling and analysis of the plant and animal life in the stream areas by DNR be made available while the project is going on.

REFERENCES

1. Environmental Science & Technology, Vol. 5, No. 1, pp. 20-21, 1971.

2. Environmental Science & Technology, Vol. 5, No. 2, pp. 114-119, 1971.