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M E M O R A N D U M

May 20, 1976

To: Rhys Sterling

From: Roger Stanley and Dale Tucker

Subject: Onion Creek Survey, April 4-10, 1976

Introduction

This memorandum documents the results of an April 4-10, 1976 receiving water survey conducted by the Department of Ecology's Water Investigation Section on the Onion Creek drainage near Colville, Washington. Onion Creek is a small perennial stream which originates in the hills approximately 15 miles north of Colville. The stream flows from its headwaters northward through sparsely populated forested lands for approximately another 15 miles before emptying into the Columbia River just south of the town of Northport. With the exception of scattered residences and minor agricultural activities the Callahan Mining Corporation's lead and zinc mine appears to be the only human activity exerting significant impact on water quality within the drainage. This study was the result of a recent request by DOE's Eastern Regional Office and was prompted through an increase in public concern as to the possible effects of nearby mining activities on local stream quality.

Methods and Materials

The Onion Creek survey consisted of two basic segments; sample collection and a livebox survey.

Sample collection was performed on a regular basis during the study at a total of 14 sites. These stations were positioned at strategic locations along the middle fork of Onion Creek (and significant tributaries to it in the mine area), on the stream's west fork, and on the mainstem of the creek below the confluence of the 2 forks (see station location map and descriptions). The following tabulation lists the study parameters utilized during this survey and their method of analysis.

A.) Stream temperature: Measured in the field with a precision centigrade mercury thermometer

B.) Dissolved oxygen: Samples collected in the field and analyzed via the Azide modification of the Winkler method.

C.) Hydrogen Ion Concentration (pH): Measured in the field with an Analytical Measurements portable pH meter, Model 107.

D.) Conductivity: Measured in the field with a Beckman, Solu-Bridge conductivity meter, Model RB-3

E.) Turbidity: Collected samples returned to the Department of Ecology laboratory and analyzed on a Hach 2100 A Nephelometer

F.) Total Suspended Solids: Collected samples returned to the DOE laboratory for analysis via Standard Methods for the Examination of Water and Wastewater, 13th Edition

G.) Heavy Metals and Minerals: Collected samples returned to the DOE laboratory for analysis on a Perkin-Elmer, Atomic Absorption Spectrophotometer, Model 360

H.) Nutrients: Samples collected and preserved in the field and returned to the DOE laboratory for analysis on a Technicon, Auto-Analyzer II.

Livebox studies were conducted using eastern Brook trout (Salvelinus fontinalis) from the Washington State Department of Game's Colville

hatchery as the test organisms. These fish ranged between 4 and 7 centimeters in length. Following their collection on the morning of April 5 the fish were immediately transported to the study area in a large aerated plastic pail. The fish were backpacked upstream from the mine to Station 1 (see station descriptions). Immediately upon reaching Station 1, backpacks were placed in Onion Creek to provide temperature equilibration between backpack water temperature and stream water temperature. Fish were then placed in two circular fiberglass liveboxes (D 12" x L 18") and acclimated to the waters of Onion Creek for 24 hours.

The following day (April 6) all but 10 of these fish were moved downstream and placed in liveboxes (10 fish per box) at Stations 3, 5, 7, 8, 9 and 10. Placement of these liveboxes was conducted such that the test fish were not stressed by the velocity of the stream. Liveboxes at these lower sites were 8" in diameter by 12" in length. Water temperatures between carrying container and the stream were allowed to equilibrate at each of the above stations such that the test fish experienced no more than a .2°C immediate change when transferred. Excess fish were released. The test fish were then visited daily for the next three days and their condition observed. All fish were selected for similar length and health. Fish which appeared atypical in any way were not utilized.

Results and Discussion

Turbidity and Suspended Solids

Turbidity levels throughout the study period were very low at Station 1 above the mine influence. Waters at this site remained

exceptionally clear, cold and springlike during the study even though snow melt and runoff was substantial. Turbidity values at this upper station did not exceed 10 JTU (Table 2). Downstream from Station 1 turbidities increased sharply as the middle fork of Onion Creek received the effluent stream arising between the north and south pits in the vicinity of the mine shaft. During the time of the survey this turbid discharge arose from substantial snow melt and consequent runoff within the drainage area described above. Turbidity levels of this effluent stream were consistently well above 1000 JTU (Station 2, Table 2). Concentrations on the middle fork of Onion Creek just below Station 2 were observed as high as 2750 JTU (Station 3).

Below the above noted problem area turbidities slowly decreased at each successive sampling station until those noted at Station 10 were nearly normal. Turbidities noted at significant tributaries to the mainstem and middle fork of Onion Creek (including the west fork) were typically quite low (less than 20 JTU) with the one exception of those recorded at Station 3B (see station descriptions). This small stream had its origin at the old tailings pile, and during the study was draining roughly 60% of the pile's surface area. Turbidities within this small stream were observed as high as 5250 JTU. Visual observation of this flow clearly revealed these high levels to be almost wholly the result of suspended, fine Dolomite limestone (the mine waste material constituting the tailings pile). This small stream apparently flows for only a short time during periods of peak

snowmelt and runoff. Flows observed during the survey varied from almost nonexistent to near .2 cfs (estimated) depending on local weather conditions.

Suspended solids analyses conducted at selected sites along Onion Creek on April 8 (peak melt conditions) revealed concentrations which also indicate significant impact of mining activities on the waters of Onion Creek (see Table 2). Solids concentrations jumped sharply at the middle fork's reception of the effluent stream between the north and south pits and then received another significant load from the small stream draining the old tailings pile. These solids dropped out to some extent whenever a decrease in turbulance occurred and consequently the stream bottom in these areas was typified by thick deposits of silt. These deposits (and suspended materials) played an important role in the outcome of livebox studies as documented within another section of this report. Cursory examination of benthic larval insects within the heavily affected areas of Onion Creek's middle fork (Station #5) indicated that their populations are probably not being seriously affected. This fact seems to indicate that the waters of Onion Creek (especially the middle fork) are seriously reduced in quality for a relatively short period of time.

Metals Analyses

Concentrations of heavy metals noted during the survey correlated well with observed turbidities and suspended solids (Table 3). Total zinc, lead and copper concentrations remained quite low

throughout the study at Stations 1 (above the mine) and 8 (on the west fork). Substantial input of these metals (excepting copper which remained low) was noted on the middle fork of Onion Creek as soon as it received its first significant runoff from the mine area (the effluent at Station 2). Concentrations of zinc just below this point (at Station 3) were observed as high as 10 mg/l whereas lead approached 1 mg/l. A second significant "slug of these metals entered the middle fork of Onion Creek at Station 3B from the old tailings pile. Other tributaries to the creek in the vicinity of the mine did not appear to be contributing significantly to heavy metals contamination. Concentrations below the mine area tapered off downstream, with those recorded at Station 10 being only slightly above normal.

Initial observation of recorded metals concentrations could easily lead one to the absolute belief that toxic conditions existed within the waters of the middle fork of Onion Creek in and below the mine area. However, drawing conclusions as to the actual toxicity in the creek is complicated by a number of factors such that no clear implications can be drawn. Among these factors are the following:

a.) Analytical results are in terms of total metals concentrations. Samples for metals analyses were not collected to reveal the state of the metal (dissolved or combined). Results consequently deal only with the total amount present. The high amount of suspended solids present, however, would lead a person to believe that a high percentage of the metals observed may be in a combined rather than a dissolved state. Most metals are typically highly toxic only in their readily available dissolved forms. This is especially true of zinc. Lead may, however, be toxic in some of its combined forms.

b.) The relative hardness or softness of water plays an important role in determining the actual toxicity due to heavy metals. Analyses for calcium and magnesium at selected sites along

Onion Creek revealed its waters to be of a moderately hard nature (see Table 5). Concentrations of calcium near or greater than 50 mg/l would have the effect of lowering and possibly even eliminating any toxicity due to metals contamination.

c.) The presence of copper can enhance or have a synergistic effect on the toxicity of zinc. Copper concentrations recorded throughout the study area were typically quite low (Table 3) however, concentrations within and slightly below the mine area were seen to be high enough (between .05 and .10 mg/l) to increase any toxic effects due to levels of dissolved zinc.

d.) The relative toxicity of zinc or lead varies greatly depending on the type of animal exposed. Mammals appear to be able to withstand concentrations of zinc many times greater than those which are highly toxic to fish and other aquatic organisms.

The extent to which each of the above factors is influencing toxicity within Onion Creek is at the present time unknown. Accurate determination of the roles played by each of these influences would necessitate an in-depth study far beyond the scope of this study.

However, the presence of an apparently healthy and diverse insect population at sampling Station 5 below the mine indicates that concentrations of zinc within the waters of the middle fork of Onion Creek are most likely not causing any toxicity problems. For further information regarding the toxicity of waters due to excessive concentrations of zinc and lead, the reader is referred to: Water Quality Criteria, second edition by McKee and Wolf, published by the Resources Agency of California, State Water Quality Control Board, Sacramento, California, 1963.

Water Temperatures and Dissolved Oxygen

Field analyses for these two parameters revealed no abnormalities (Table 4). Observed values were consistently of high quality throughout the study area.

Conductivity and Hydrogen Ion Concentration (pH)

Field analyses for these two parameters revealed no abnormalities (Table 5). The influence of mine runoff was however observable at Station 3 as the middle fork of Onion Creek received substantial input of dissolved solids from the effluent stream at Station 2. Conductivities consequently rose accordingly.

Nutrient Concentrations

Nutrient analyses conducted on samples collected during the survey revealed concentrations which by-in-large can be considered normal for a stream such as Onion Creek during the peak runoff period (see Table 6). Impact from the mine area was evident only at Station 3 as the stream received the effluent originating between the north and south pit areas (Station 2). This discharge contained relatively high nutrient levels and consequently nitrogen and phosphorous concentrations rose substantially at Station 3. These concentrations were not however high enough to indicate their involvement in any observed toxicities noted below the mine proper. In light of the short-lived nature of the above effluent stream (active only during the spring runoff period) it is felt that the observed increases in nutrient concentrations present a minimal problem to the lower reaches of Onion Creek.

Livebox Studies

Results of the livebox studies performed along the Onion Creek drainage between April 5 and 9 indicate adverse conditions for

salmonid fishes to exist below the mine area (Table 1). All test fish above the mine at Station 1 remained healthy and vigorous throughout the survey. Observation of recorded mortalities in conjunction with acquired water quality data within and below the mine area does not, however, paint a clear picture as to cause of death. Fish remained healthy at Station 3 indicating that turbidity alone did not account for mortalities recorded downstream. These mortalities appear to have been caused in some way by the small stream entering the middle fork of Onion Creek between study Stations 3 and 5 from the old tailings pile (Station 3B). All fish at Station 5 were killed after 48 hours exposure. Gill surfaces of these fish were noted to be heavily clogged with silt, and a thick silt deposit had built up within the livebox. Mortalities at Station 7 were somewhat less, with 5 fish dead after 48 hours and 2 more dead after 72 hours exposure. Mortalities at study site 9 were again progressively less with the only loss being that of 3 fish at the end of 48 hours exposure.

Livebox results recorded at Stations 8 and 10 have the effect of complicating data interpretation to some degree in that mortalities at these two sites did not appear to be directly correlated to existing water quality levels. The loss of 4 fish after 24 hours exposure at Station 8 was apparently due to stressing either at initial transfer of the fish to the waters of the west fork or to stresses encountered due to stream velocity. It is the author's belief that this latter possibility is the most likely of the two.

Checking the livebox at this site after 24 hours revealed that it had shifted position to the point where the test fish were being subjected to substantial current. No further mortalities were recorded at this site following replacement of the livebox to quieter waters. Deaths at Station 10 appeared to be the result of natural scouring of the streambed in this area. Heavy pea-sized gravel deposits were noted to have built up within the livebox at this site.

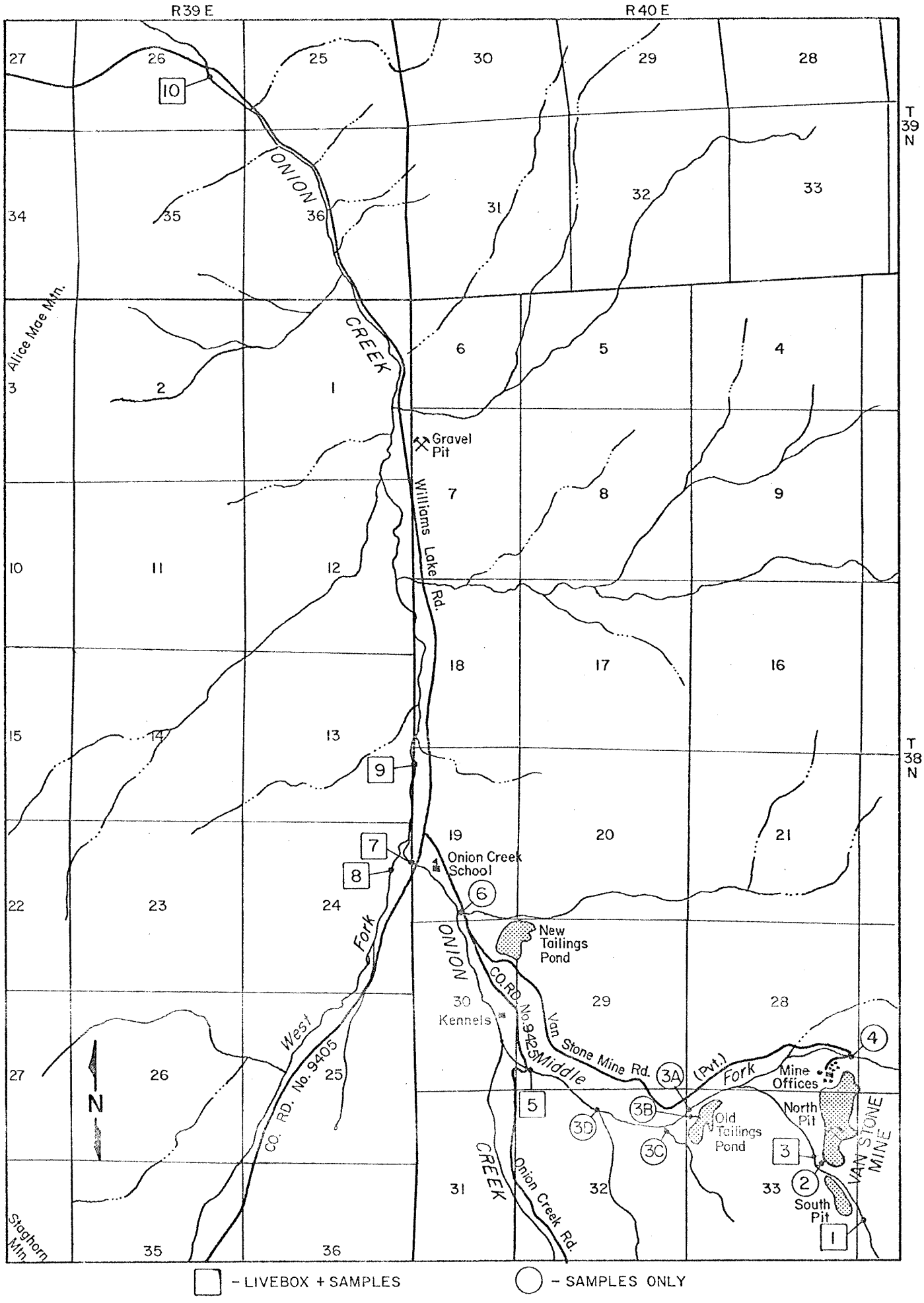
Summary and Conclusions

Study results clearly reveal a serious lowering of water quality levels along the middle fork and mainstem of Onion Creek in the vicinity of the Callahan Mining Corporation's lead and zinc mine. Turbidity, suspended solids and heavy metals concentrations within Onion Creek were seen to increase sharply on reception of mine discharges. High turbidities observed on Onion Creek within and below the mine area had the effect of seriously reducing the aesthetic quality of the stream in question. Suspended solids were seen to drop out in less turbulent areas of the creek and consequently a substantial portion of the stream bottom was characterized by thick deposits of fine silt. Zinc and lead concentrations were high in the vicinity of mine discharges and could under the right conditions, contribute to adverse conditions for biological organisms. Livebox studies resulted in an almost 100% mortality to test fish within the waters of the middle fork of Onion Creek downstream of the old tailings pile. Mortalities below the confluence of the west and middle forks were considerably less. Test fish above the mine influence remained healthy throughout the survey.

It is the authors' belief that, at least during high flow periods, the Callahan Mining Corporation wastes are seriously impacting Onion Creek water quality with a curtailment of beneficial uses. Remedial action by the Corporation should be taken.

APPENDIX I

Station Locations and Descriptions



ONION CREEK SURVEY - APRIL 4-10, 1976

Station Descriptions

Station 1 - The most upstream station - located approximately 200 yards above the south pit on the Middle Fork of Onion Creek at the old domestic water supply dam.

Station 2 - Located on the effluent stream in the gully between the north and south pits just prior to its confluence with the Middle Fork of Onion Creek. This site is approximately 1/3 mile below Station 1.

Station 3 - Located on the Middle Fork of Onion Creek approximately 150 feet below the entry of the effluent stream (Station 2).

Station 4 - Located on a small tributary to the Middle Fork of Onion Creek - at the yellow steel gate entrance to the Van Stone mine properties.

Station 3A -Located on the Middle Fork of Onion Creek 1 mile below Station 3, and immediately upstream from the Creek's reception of the small tributary draining the old tailings pile.

Station 3B -Located on the small tributary draining the old tailings pile just prior to its confluence with the Middle Fork of Onion Creek.

Station 3C -Located on a small tributary to the Middle Fork of Onion Creek, slightly less than 1/4 mile below Station 3B.

Station 3D -Located on a small tributary to the Middle Fork of Onion Creek at the cabin 1/2 mile below Station 3C.

Station 5 - Located on the Middle Fork of Onion Creek at its intersection with the Lotze Creek Road 1/2 mile below Station 3D.

Station 6 - Located on a small tributary to the Middle Fork of Onion Creek at the Van Stone Mine Road just below the new tailings pile and 1 mile below Station 5.

Station 7 - Located on the Middle Fork of Onion Creek at its intersection with the main Onion Creek Road slightly less than 1/2 mile below Station G.

Station 8 - Located on the West Fork of Onion Creek approximately 350 yards above its confluence with the East Fork.

Station 9 - Located on Onion Creek approximately 1 mile below the confluence of its east and west forks.

Station 10 -Located on Onion Creek 100' above its intersection with the main Onion Creek Road approximately 4 miles below Station 9.

APPENDIX II

Data Tables

Table 1: Livebox Mortalities, Onion Creek Survey, April 4-10, 1976

	April 7	April 8	April 9
Station 1	0/10	0/10	0/10
Station 3	0/10	0/10	0/10
Station 5	2/10	8/8	N
Station 7	0/10	5/10	2/5
Station 8	4/10	0/6	0/6
Station 9	0/10	3/10	0/7
Station 10	0/10	9/10	1/1

Table 2: Observed Turbidities and Total Suspended Solids, Onion Creek Survey (April 4-10, 1976)

Date	Mainstem of Onion Creek			Supplementary Tributaries		
	Station #	Turb(JTU)	TSS(mg/l)	Station #	Turb(JTU)	TSS(mg/l)
April 6	1	10		2	1125	
	3	435		4	10	
	5	260		6	19	
	7	95		8	11	
	9	37				
	10	22				
April 7	1	2		2	6750	
	3	2750		4	14	
	5	740		6	21	
	7	210		8	15	
	9	66				
	10	26				
April 8	1	5	10	2	4625	
	3	1600	3660	4	18	
	3A	1350	4870	3B	5250	25,870
	5	1100	4820	3C	3	5
	7	795		3D	42	
	9	370		6	24	
	10	38		8	11	
April 9	1	4		2	(none taken)	
	3	315		4	6	
	3A	310		3B	200	
	5	195		6	15	
	7	92		8	14	
	9	46				
	10	44				

Table 3: Observed Heavy Metals Concentrations, Onion Creek Survey (April 4-10, 1976) *

Date	Mainstem of Onion Creek				Supplementary Tributaries			
	Station #	Zn	Pb	Cu	Station #	Zn	Pb	Cu
April 6	1	<.02	<.05	<.02	2	4.4	.5	<.05
	3	1.1	<.05	<.05	4	.04	<.05	<.02
	5	1.0	.10	<.05	6	.08	<.05	<.02
	7	.40	.05	<.02	8	<.02	<.05	<.02
	9	.14	<.05	<.05				
	10	.04	<.05	<.02				
April 7	1	<.02	<.05	<.02	2	13.	1.1	.10
	3	10.0	1.1	.05	4	.02	<.05	<.02
	5	6.3	.70	.10	6	.06	<.05	<.02
	7	1.3	.10	.05	8	<.02	<.05	<.02
	9	.31	<.05	<.05				
	10	.03	<.05	<.02				
April 8	1	<.02	<.05	<.02	2	20.0	1.6	.10
	3	4.3	.40	<.05	4	.04	<.05	<.02
	3A	2.8	.50	<.05	3B	41.0	5.7	.70
	5	4.3	.60	.05	3C	<.02	<.05	<.02
	7	2.0	.30	.05	3D	<.02	<.05	<.02
	9	1.8	.20	<.05	6	.05	<.05	<.02
	10	.06	<.05	<.02	8	<.02	<.05	<.02
April 9	1	<.02	<.05	<.02	2	(None taken)		
	3	1.2	.10	<.02	4	<.02	<.05	<.02
	3A	.68	<.05	<.02	3B	1.9	.10	<.05
	5	.38	.05	<.02	6	<.02	<.05	<.02
	7	.21	<.05	<.02	8	<.02	<.05	<.02
	9	.10	<.05	<.02				
	10	.10	<.05	<.02				

* All values in mg/l for total metal concentrations

Table 4: Observed Water Temperatures, Dissolved Oxygen Content and Percent Saturation, Onion Creek Survey (April 4-10, 1976)

Date	Mainstem of Onion Creek				Supplementary Tributaries			
	Station #	Temp(°C)	D.O.(mg/l)	% Sat.	Station #	Temp(°C)	D.O.(mg/l)	% Sat.
Apr. 6	1	1.7	12.1	85.5	2	2.8	--	--
	3	3.2	11.9	87.7	4	.8	12.2	84.0
	5	2.2	12.5	89.7	6	2.9	12.2	89.0
	7	3.5	12.2	90.3	8	3.4	11.9	87.9
	9	4.0	11.9	89.6				
	10	4.5	12.1	92.2				
Apr. 7	1	1.9	11.9	84.7	2	6.1	12.2	96.5
	3	3.1	12.6	92.6	4	1.0	12.2	84.7
	5	4.5	12.1	92.3	6	4.2	11.7	88.4
	7	6.4	11.4	90.9	8	6.6	11.1	88.9
	9	6.2	11.0	87.4				
	10	7.2	11.2	91.1				
Apr. 8	1	2.0			2	6.4		
	3	2.8			4	.3		
	3A	1.3			3B	5.4		
	5	6.2			6	6.4		
	7	6.2			8	6.7		
	9	6.8						
	10	7.9						
Apr. 9	1	2.0			2	--		
	3	2.2			4	.4		
	3A	2.0			3B	2.8		
	5	2.5			6	2.8		
	7	3.4			8	4.9		
	9	4.5						
	10	5.4						

Table 5: Observed Conductivities, Hydrogen Ion Concentrations (pH) and Calcium and Magnesium Levels, Onion Creek Survey (April 4-10,1976)

Date	Mainstem of Onion Creek					Supplementary Tributaries				
	Sta. #	Cond(um)	pH(SU)	Ca(mg/l)	Mg(mg/l)	Sta. #	Cond(um)	pH(SU)	Ca(mg/l)	Mg(mg/l)
Apr. 6	1	187	7.0			2	540	7.1		
	3	354	7.2			4	235	6.8		
	5	368	7.6			6	300	7.4		
	7	330	7.6			8	420	7.8		
	9	378	7.6							
	10	450	8.0							
Apr. 7	1	202	6.8			2	450	7.3		
	3	320	7.2			4	218	7.0		
	5	328	7.4			6	287	7.6		
	7	308	7.7			8	432	8.0		
	9	361	7.8							
	10	438	8.0							
Apr. 8	1	199	7.3			2	440	7.4		
	3	300	7.5	33	17	4	180	6.9		
	3A	352	7.6	50	17	3B	260	7.5	380	54
	5	315	7.6	78	17	3C	445	8.0		
	7	293	7.7			3D	210	7.6		
	9	338	7.8			6	255	7.5		
	10	418	8.0	44	14	8	420	7.9	45	15
Apr. 9	1	202	7.1			2	--	--		
	3	347	7.1			4	198	6.7		
	3A	400	7.3			3B	565	7.1		
	5	365	7.6			6	245	7.2		
	7	278	7.8			8	425	7.8		
	9	325	7.7							
	10	394	8.0							

Table 6: Observed Nutrient Concentrations, Onion Creek Survey (April 4-10, 1976) (mg/l)

Date		Station #	NH_3-N	NO_2-N	NO_3-N	TPO_4-P	OPO_4-P
April 6	Mainstem	1	.01	0.0	0.0	.05	.01
		3	.27	0.0	1.05	.13	.02
		5	.04	0.0	.36	.08	.03
		7	.02	0.0	.32	.07	.02
		9	.16	.05	.27	.06	.06
		10	.03	0.0	.23	.08	.08
	Supplementary Tributaries	2	.36	.02	3.9	.10	.03
		4	.05	0.0	.11	.08	.04
		6	.04	0.0	.34	.07	.09
		8	.07	0.0	.18	.07	.07
April 7		1	.02	0.0	0.0	.08	.02
		3	.12	.01	.77	1.1	.62
		7	.03	0.0	.24	.04	.04
		9	.01	0.0	.20	.03	.06*
		8	.03	0.0	.15	.05	.09*

* = Questionable laboratory result

Miscellaneous Data

I. Weather and Melt Conditions During Onion Creek Survey

Sunday, April 4	Sunny and warm, substantial melt
Monday, April 5	Sunny and warm, substantial melt
Tuesday, April 6	Cooler and mostly overcast with occasional light showers, melt and resultant stream-flows down
Wednesday, April 7	Sunny and warm, substantial melt
Thursday, April 8	Sunny and warmer, peak melt
Friday, April 9	Cooler w/broken clouds, melt down

II.) Estimated flows varied widely with melt conditions but in general ranged from .2 cfs at Station 1 to 3.0 cfs at Station 7 to 5.0 cfs at Station 10.

III.) Benthic insect analyses, Stations 1 and 5, April 9, 1976 (Samples collected via net downstream of a 1 minute disturbance of approximately 8 square feet of stream bottom).

	Ephemeroptra	Diptera	Tricoptera	Plecoptera	Coleoptra	Total
Station 1	2	3	3	2	2	12
Station 5	12	14	12	7	2	47