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WASHINGTON STATE DEPARTMENT OF ECOLOGY
ENVIRONMENTAL INVESTIGATIONS AND LABORATORY
SERVICES PROGRAM

TOXICS INVESTIGATION/GROUND WATER MONITORING SECTION

TECHNICAL MEMORANDUM

January 22, 1990

To: John Bernhardt

Through: Bill Yake BY

From: Denis Erickson DE
Hydrogeologist

Subject: Global Aqua Start Up Ground Water Monitoring Investigation, Rochester, Washington

At Jon Neel's request a ground water monitoring investigation was conducted at the "Big Rock" spring area near the Global Aqua fish hatchery facility to provide information on the cause of the fish kill in the Black and Chehalis Rivers on August 6 and 7, 1989. The springs, based on local landowner reports, were believed to be directly related to discharges at Global Aqua. The investigation, conducted between November 2 and December 20 during facility start up, included water-level monitoring and ground water and surface water sampling. This Technical Memorandum describes the methods, results, and conclusions of this investigation.

METHODS

Monitoring Well Installation

Two monitoring wells, designated MW-1 and MW-2, were installed in the spring area adjacent to the Black River about 1000 feet west of the Global Aqua facility. On November 2, when the wells were installed, the springs were not discharging. The wells were driven to refusal using a 50-pound portable driver. A one-foot bentonite surface seal was placed around each well to prevent conduit flow alongside the casing. Well construction data is listed in Table 1. Both wells were constructed to sample from a depth interval of about three to five feet below the ground surface. MW-1 is completed in sand and gravel with high permeability. MW-2 is completed in gravelly, sandy, silt with low permeability.

Table 1. Well Construction Data

Well ID	Well Diameter (inches)	Total Depth (TOC*, feet)	Screened Interval (GS**, feet)	Casing Mat'l	Screen Mat'l	Stickup (feet)
MW-1	1 1/4	8.3	3.25-5.25	Galvanized Steel	Stainless Steel	2.7
MW-2	1 1/4	8.25	2.85-4.85	Galvanized Steel	Stainless Steel	2.95

* TOC = Measurement relative to top of casing.
** GS = Measurement relative to ground surface.

Water Level Monitoring

Water levels were recorded in both monitoring wells at two hour intervals between November 3 to December 20, 1989, using pressure transducers linked to Unidata data loggers. Pressure transducers had a measurement range of 0 to 1 meter. Verification water levels were obtained for the monitoring wells using an E-tape during six site visits. Based on these measurements, the transducer readings are considered accurate to within 0.1 feet. During the site visits the water level of the Black River was measured at the bridge located at Moon Road about 0.7 miles downstream of the spring area.

Water Quality Sampling

Water quality samples were collected on November 2 and November 20. On November 2 samples were obtained from the Black River near "Big Rock," the two monitoring wells at the springs, a private well located about 2000 feet north of the spring area, and 1000 feet northwest of Global Aqua. The private well is reported to be 30 feet deep, and based on discussions with the well owner, the water level in the well appears to fluctuate in response to activities at Global Aqua. On November 20 Paul Pickett, with Ecology's Southwest Regional Office, assisted by Environmental Investigations obtained water quality grab samples from two springs near "Big Rock" and from the Black River upstream about 20 feet from the springs. The springs reportedly began flowing the morning of November 20.

Sampling Procedures

The monitoring wells were purged and sampled using a peristaltic pump equipped with polyethylene and silastic tubing. Prior to sampling 20 well volumes were purged from MW-1 and 10 well volumes were purged from MW-2. The private well was purged and sampled with the existing jet pump. Specific conductance, pH, and temperature were measured during

purging; stability of these parameters was used to indicate when purging was adequate. Grab samples were obtained from the Black River and the springs. Dissolved oxygen was determined using the azide-modified Winkler titration (APHA, 1985).

One transfer blank was obtained by passing organic free water through a well point identical to the well points used in the monitoring wells. Chain-of-Custody was maintained on all samples.

Analyses

All analyses were done at the Ecology/EPA Manchester Laboratory with the exception of formaldehyde, which was tested at Analytical Resources Incorporated in Seattle. Formaldehyde was tested using two analytical methods: the chromotropic method; and the MBTH method. The chromotropic method has a detection limit of 50 ug/L and the MBTH method has a detection limit of 75 ug/L.

RESULTS

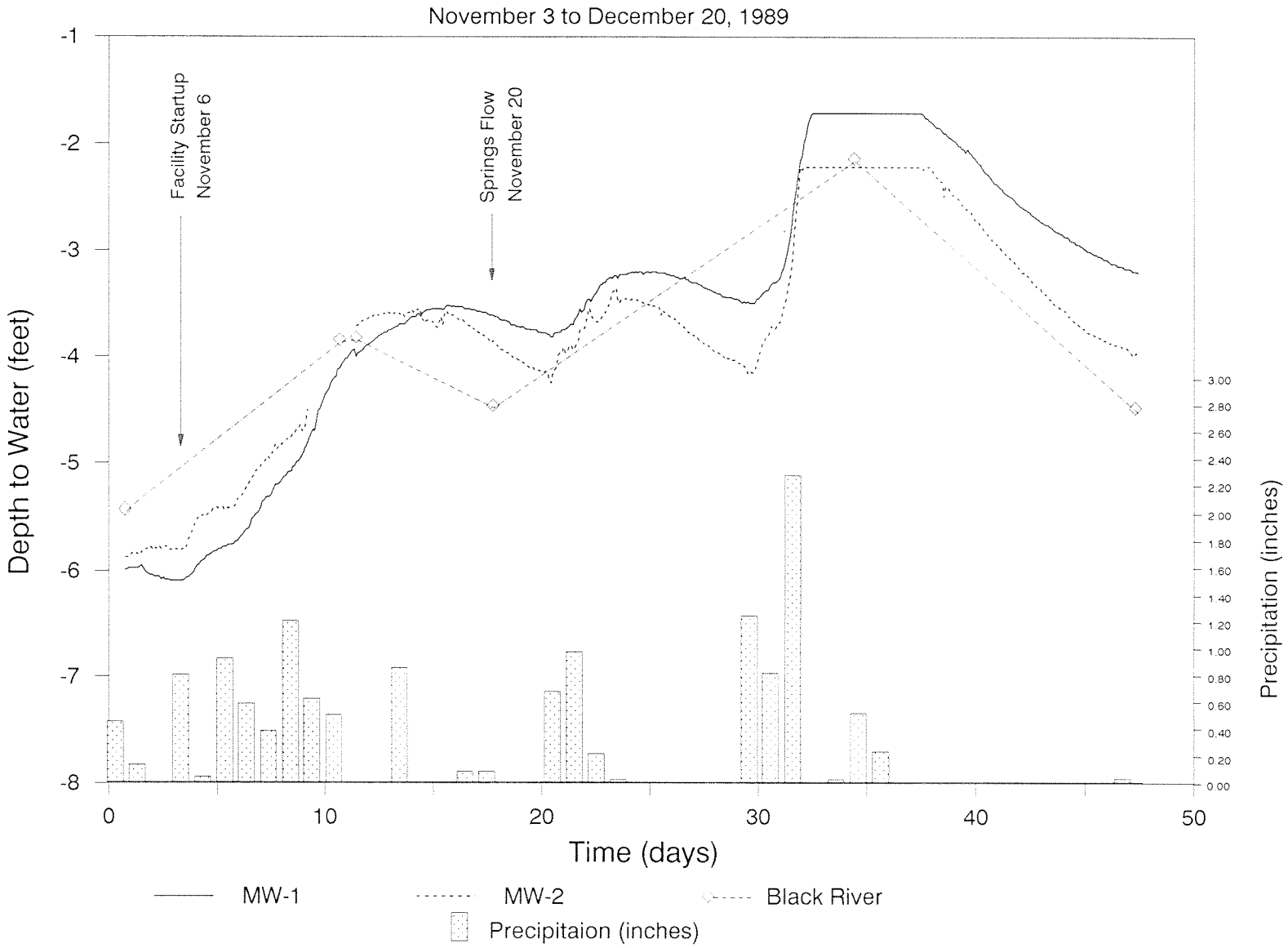
Water Level Monitoring

The hydrographs for MW-1, MW-2, and the Black River for the period November 3 to December 20 are shown on the attached figure. The Black River hydrograph is based on six discrete measurements. Daily precipitation, recorded at the Olympia Airport, is shown along the bottom of the figure. The flat hydrographs for MW-1 and MW-2 between December 5 to December 10 (33 to 37 days after monitoring began) are due to water level heights in the wells exceeding the range of the pressure transducers.

The figure shows that a complex hydraulic relationship exists between ground water and Black River, and that both are very responsive to precipitation events. The water levels in the monitoring wells rose in excess of four feet in response to precipitation events between November 3 and December 10. During this interval, 13.59 inches of precipitation were recorded at the Olympia Airport. The water levels declined from December 10 to December 20 when there was little precipitation.

Although the relative elevations of the measuring points were not surveyed for this investigation, the relative elevations of the water levels in MW-1 and MW-2 and the Black River levels were determined during the November 2 sampling using a surveyor's level. On November 2 the water level in the Black River was 0.50 feet and 0.44 feet higher than the water levels in monitoring wells MW-1 and MW-2, respectively. On the figure, the Black River hydrograph has been translated so that the water level on November 3 was about 0.5 feet above the monitoring well water levels. Therefore, the hydrographs may be used in a

Black River Water-Level Monitoring



qualitative sense to indicate whether ground water is flowing into the Black River (the hydrographs of the monitoring wells are above the Black River hydrograph) or whether seepage is occurring from the Black River (the hydrograph of the Black River is above the hydrographs for the monitoring wells). The general pattern that emerges from the figure is that when the water levels are rising, the Black River loses water to the ground water and when the water levels are dropping, the ground water flows into the Black River.

Global Aqua restarted operations on November 6 at a fairly low discharge rate of about 500 gallons per minute (gpm). The discharge rate remained constant through the monitoring period (Paul Pickett, 1989). The facility is permitted to discharge up to 7000 gpm. Unfortunately, precipitation events coincided with start up of the facility. Water level responses in the monitoring wells, due to river stage changes and natural recharge to the aquifer, have masked any responses that may have occurred due to discharge from the facility. Also, a portion of the discharge channel to the surface impoundment was lined prior to start up, which may have altered further the effects of the effluent discharge on ground water at the springs.

Water Quality

The water quality results of both sampling events are shown in Table 2.

Qualifications of the data are discussed as follows. A COD concentration of 4 mg/L was reported for the transfer blank. Therefore, all concentrations less than 20 mg/L COD have a "B" qualifier and are considered unreliable. The specific conductance reported by the laboratory for sample 47-7539 was 167 umhos/cm and the field result was 80 umhos/cm. The cause for this difference is unknown. Based on previous sample results, the field specific conductance measurement seems more appropriate. Field and laboratory specific conductance measurements agreed favorably for all other samples. The MBTH method did not detect formaldehyde in any of the samples; however, the matrix spike recovery was low (66.7 percent). A memorandum from Janet Hyre that desribes the quality assurance of the formaldehyde results is attached to this report.

The November 2 sample results for the monitoring wells and the Black River are similar for most parameters. This is consistent with the finding that Black River was recharging ground water. Formaldehyde was detected in all samples using the chromotropic method with concentrations ranging from 0.055 to 0.089 mg/L. The highest concentration was present in the sample from the Black River. The MBTH method did not detect formaldehyde in any of the samples.

Table 2. Global Aqua Startup Ground Water Monitoring Investigation- Water Quality Data

						Transfer			
	Sta. ID ---->	MW-1	MW-2	DW-25	Black Riv	Blank	Black Riv	Spring 1	Spring 2
	Sample No.-->	44-8015	44-8017	44-8018	44-8016	44-8019	47-7539	47-7540	47-7541
	Sample Date->	11/02/89	11/02/89	11/02/89	11/02/89	11/02/89	11/20/89	11/20/89	11/20/89
Field Parameters	Units								
pH	Std Units	6.8	7.2	6.6	7.2	NT	6.7	6.5	6.6
Specific Conductance	umhos/cm	106	118	100	110	NT	80	190	190
Temperature	C	10.0	10.2	10.0	9.3	NT	9.7	11.6	11.6
Dissolved Oxygen	mg/L	3.7	4.1	9.7	5.9	NT	7.3	8.8	10.2
% Saturation		33	37	86	52	NT	65	82	94
Analytes									
Specific Conductance	umhos/cm	124	117	96	106	8.6	167(?)	212	209
Total Dissolved Solids	mg/L	87	160(?)	85	82	11	NT	NT	NT
Total Suspended Solids	mg/L	19	70	5	1	NT	1	22	4
Ammonia-N	mg/L	0.01	0.05	0.01u	0.02	0.01u	0.08	0.01	0.01u
Nitrate/Nitrite-N	mg/L	0.98	0.22	1.85	1.03	0.03	0.67	2.75	2.80
Total Phosphorus	mg/L	0.10	0.09	0.02	0.12	0.01u	0.18	0.10	0.08
Total Organic Carbon	mg/L	6.4	7.9	4.9	9.2	0.9	14.6	6.3	5.7
Chemical Oxygen Demand	mg/L	11.8B	12.1B	6.7B	17.7B	4.1	35.6	12.3B	8.0B
Biochem. Oxygen Demand	mg/L	4u	4u	4u	4u		3u	3u	3u
Chloride	mg/L	5.8	5.4	7.3	6.0	0.1	5.9	28.3	29.1
Sulfate	mg/L	2.9	2.6	3.3	3.0	NT	NT	NT	NT
Formaldehyde									
Chromotropic Method	mg/L	0.055	0.079	0.079	0.089	0.050u	NR	NR	NR
MBTH Method	mg/L	0.075u	0.075u	0.075u	0.075u	0.075u	0.07	0.04u	0.04u

B = Analyte found in the blank and the sample, indicated transfer blank contamination.
NT = Not tested.
NR = Not reported.
u = Analyte was tested for but not detected.
(?) = result is uncertain, see text for explanation.

Additional observations on the November 2 water quality results are discussed as follows:

1. Chloride (7.3 mg/L) and NO_3/NO_2-N (1.85 mg/L) concentrations appear to be elevated in the private well. The well owner reported that the water level in the well fluctuates in response to discharge activities at Global Aqua. Samples obtained from the discharge channel and the settling pond in August showed elevated chloride concentrations of 519 and 80 mg/L (Ecology, 1989). Nitrate is associated with fish rearing and hatchery effluent (Kendra, 1989). However, another potential source of elevated choride and nitrate is septic tank effluent. Without knowing the ground water flow pattern and the location of nearby septic systems, it is not possible to positively identify the source.

2. The NO_2/NO_3-N concentration for MW-2 is lower than the other three sampling points; the cause is unknown.

3. Total dissolved solids (TDS) and total suspended solids in MW-2 are elevated probably as a function of the silty material in which the well is screened. However, the TDS of 160 mg/L seems disproportionately high considering the specific conductance was only 117 umhos/cm.

4. Dissolved oxygen was elevated at the private well (DW-25), probably due to aeration of the sample by the jet pump.

The water quality of both springs on November 20 was nearly identical. Specific conductance, chloride, nitrate, and temperature were elevated relative to the Black River. Association of chloride and nitrate with Global Aqua and fish rearing effluent is discussed above. Elevated specific conductance (a function of total dissolved solids) is associated with Global Aqua effluent. Samples obtained from the disharge channel and the settling pond at the Global Aqua facility in August showed specific conductance at 5500 and 435 umhos/cm. Elevated temperature is associated with discharges from hatchery and fish rearing facilities (Kendra, 1989). In the absence of any other nearby sources for these parameters and considering the reports that the discharge at the springs occur when Global Aqua is operating, it seems likely that Global Aqua is the probable source. Without knowing the hydraulic properties of the aquifer transmitting the contaminants, it is not possible to estimate travel times. Therefore, it is not known if the degradation is due to past or present discharges. Formaldehyde (MBTH method) was not detected in either of the spring samples but was detected in the Black River sample at a concentration of 0.07 mg/L. None of the observed concentrations exceeded the Maximum Contaminant Levels for public drinking water systems. Ammonia-N, chemical oxygen demand (COD), total organic carbon (TOC), and total phosphorous were higher in the Black River than the springs.

CONCLUSIONS

1. The water quality results of this investigation do not provide any additional information regarding the cause of the Black River fish kill in August 1989. Formaldehyde, a potential pollutant of concern, was observed at essentially the same low concentration at all sample locations on November 2 and was not observed in the spring samples on November 20. The elevated specific conductance, chloride, temperature and nitrate data at the springs suggest that ground water degradation is occurring as a result of discharges from the facility. It is not known whether the affects are due to present or past discharges. None of the observed concentrations exceeds Maximum Contaminant Levels for public drinking water systems.

2. The potential affects of facility start up on ground water levels were likely masked by the rising water levels in ground water and the Black River due to precipitation events that occurred simultaneously with the start up. Other factors that may have mitigated affects of the discharge on ground water levels are:

   a) The discharge rate was low during the monitoring period. The facility was operating at about 500 gpm but is permitted to discharge at 7000 gpm.

   b) A portion of the discharge channel to the settling pond has been lined since August 1989. If additional water level monitoring is desired, it should be conducted when the facility is changing discharge rates and when precipitation events are less likely to occur.

3. With the existing data, the source of the elevated nitrate and chloride concentrations at the private well cannot be identified.

4. If additional monitoring is desired, the hydrogeology and the ground water flow patterns around the facility should be characterized. Such a characterization would define the geometry and hydraulic properties (hydraulic conductivities, storage coefficients, porosities, and hydraulic gradients) of the hydrogeologic units that underlie the site. Of particular concern is the extent, continuity, and hydraulic properties of the gravelly sandy SILT unit observed at the MW-2 location.

REFERENCES

APHA et al (American Public Health Association, American Water Works Association, and Water Pollution Control Federation), 1985. Standard Methods for the Examination of Water and Wastewater, 16th edition. Washington, D.C., 1268 pages.

Kendra, Will, 1989. Quality and Fate of Fish Hatchery Effluents During the Summer Low Flow Season. Washington State Department of Ecology Report 89-17, 59 pages.

Pickett, Paul, 1989. Personal Communication December 1989.

Washington Department of Ecology, 1989. Black River Fish Kill Report. October 1989. Report 89-54, 35 pages.

DE:krc
Attachment
cc: Steve Hunter
Jon Neel
Bill Backous
Paul Pickett

WASHINGTON STATE DEPARTMENT OF ECOLOGY
ENVIRONMENTAL INVESTIGATIONS AND LABORATORY SERVICES
MANCHESTER LABORATORY

M E M O R A N D U M

TO: Denis Erickson

FROM: Janet Hyre

SUBJECT: Formaldehyde Results for Black River Samples

DATE: November 21, 1989

The formaldehyde samples from the Black River project were analyzed by two different methods by ARI. We requested (and pay for) the MBTH method only, which is the one used for previous Black River sample sets. ARI is now offering the chromotropic method as well, which offers a lower detection limit.

I am sending the results by both methods. The standard curves for both methods are linear. Duplicate analyses were done on sample 448019, for which all results are lower than the limits of detection. Matrix spike recovery data is quite low for the MBTH method, but good for the chromotropic method. Check standard values varied by greater than 10% for the MBTH method, but were accurate and reproducible for the chromotropic method.

The MBTH results may be slightly lower than the actual concentration levels judging by the low value of the MBTH matrix spike. All of this makes the results by the chromotropic method very credible.

I hope that this explanation is helpful. Please feel free to call if we can be of further assistance.

JH:mb

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Final Report
Laboratory Analysis of Formaldehyde

Project No: Black River
QC Report No: 3966 - WDOE
VTSR: 11/03/89

Matrix: Waters

Data Release Authorized: _____
Report Prepared 11/14/89 - MAC:B

Sample Data:

Lab ID	Client Sample Number	MBTH mg/L	Chromotropic mg/L
3966 A	44-8015	< 0.075	0.055
3966 B	44-8016	< 0.075	0.089
3966 C	44-8017	< 0.075	0.079
3966 D	44-8018	< 0.075	0.079
3966 E	44-8019	< 0.075	< 0.050

		mg/L	mg/L
Method Blank Analysis:	Method Blank 1	< 0.075	< 0.050
	Method Blank 2	< 0.075	< 0.050
	Method Detection Limit (MDL):	0.075	0.050

		mg/L	mg/L
Check Standard:	*(Calculated Amount)*	0.546	1.23
	(Calculated Amount)	0.473	1.25
	Standard Value	0.480	1.20

		mg/L	mg/L
Duplicate Analysis:	44-8019	< 0.075	< 0.050
	44-8019-DUP	< 0.075	< 0.050
	RPD	-	-

		mg/L	mg/L
Spike Analysis:	44-8017	<0.075	0.079
	44-8017-MS	0.08	0.211
	Spike Amount:	0.120	0.120
	%Rec	66.7%	110%

Comments: