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1.0 SUMMARY

Between August 6 & 7, 1989, a fish kill occurred in the Black River and on August 10th & 11th in the Chehalis River in southwest Washington State. Evidence indicates a toxic agent(s) entered the Black River in the vicinity of river mile 9.2 on about August 6, 1989 and moved downstream entering the Chehalis River near Oakville on about August 11, 1989, resulting in a substantial fish kill. In addition, in the Black River, in the vicinity of the fish kill and downstream of it, plant nutrients such as ammonia, nitrites, nitrates and phosphates were measured in elevated amounts. Increased amounts of these nutrients can cause increased algae and rooted plant growth which can at high concentrations, in turn, reduce the amount of oxygen available for fish and other aquatic organisms.

Based on the apparent conditions of carcasses and indications of residents and witnesses, a discharge likely occurred around August 6. The Department of Ecology was notified and responded to the fish kill on August 8. There are a variety of industrial and commercial enterprises in this vicinity of the Black River where the fish kill occurred. Virtually all possible pollutant sources were investigated. This report discloses all the significant findings regarding water chemistry and upland activities surrounding the fish kill event.

Although the ambient water quality in the Black and Chehalis River was not ideal for salmon, trout, and whitefish in early August 1989, this fish kill event was not caused by ambient river conditions. However, on and after the afternoon of August 8 (the date of the first fish kill report and investigation), investigators were not able to find physical evidence of pollutants being actively discharged into the Black River.

2.0 BACKGROUND

The Black River starts at Black Lake near Olympia and flows southwest to the Chehalis River which empties into the Pacific Ocean. The Black River has a shallow gradient (about 5 feet/mile). It slowly meanders through marshes and swamps over much of its course. The water is discolored black by organic material from which its name is derived.

According to Washington Department of Fisheries, Washington Department of Wildlife, and Chehalis Indian Nation fisheries biologists, the Black River supports significant populations of coho salmon, cutthroat trout, bass, sunfish, and forage fish (suckers, dace, shiners, sculpins, etc.). Salmon and trout spawning is primarily in tributary creeks such as Waddell Creek (r.m. 17.3). Those anadromous fish rear in the tributaries and the river and migrate to sea. The bass, sunfish, and forage fish are resident fishes and spawn and rear throughout the watershed. The river contains unique and valuable habitat for those species.

The river and shoreline from about r.m. 15.5 to r.m. 10 is a slough surrounded by swamp. This area has been designated as a conservation zone and habitat management area by State and County governments (Figure 1). The area is a unique habitat characterized by large pond lilies and osprey nests along the shoreline which takes on the appearance of a southeastern United States swamp.

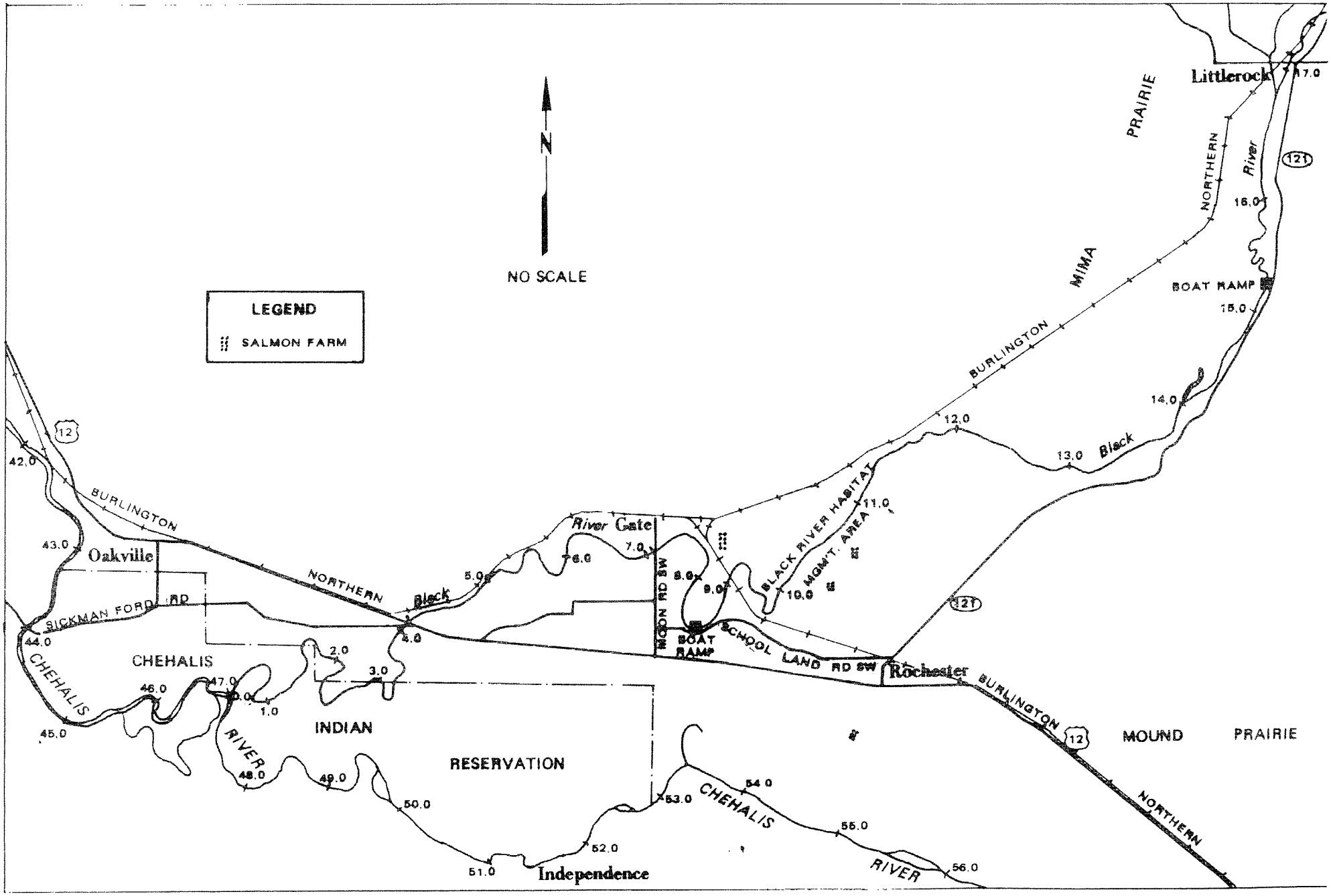

Figure 1. LANDMARKS ASSOCIATED WITH THE BLACK RIVER FISH KILL, AUGUST 6–7, 1989.

Four aquaculture facilities discharge into the Black River below r.m. 10.5, near Rochester: Swecker, Carlson, Steelhammer, and Global Aqua (Figure 2). Steelhammer discharges to the river through Rochester Slough at r.m. 9.6 (a tributary flood channel). Swecker and Carlson discharge to the river through channels in a swamp at r.m. 10.5 and r.m. 10.3 respectively. Global Aqua discharges to the river through springs from r.m. 9.3 to r.m. 7.8. In this reach, the channel becomes weed choked and navigation is impossible in some areas.

Other commercial enterprises include the Black River Ranch (Dairy) (r.m. 13), Weyerhaeuser Tree farm (r.m. 14), Drew's Blueberry farm (r.m. 7.2), and Emerald Turf farm (r.m. 7.0). While these operations do not have direct discharges to the river, they may exert some influence on the river through nonpoint discharge and/or groundwater.

Water quality data are almost nonexistent for the Black River. The Chehalis Indian Nation (the CIN) has collected water temperature data at the School Land Road boat launch (r.m. 8.5) in July and August from 1985 to 1989 (the data are presented in Attachment 2). Temperature ranges from 15 degrees Celsius to 18.5 degrees Celsius. The average temperature for August was 15.5 degrees Celsius (59.9 degrees Fahrenheit). According to WDF those temperatures in the Black River were ideal for salmon and trout and the Black River does not have a history of fish kills.

The Chehalis River from the City of Chehalis to the Satsop River (tidal influence point) is also a shallow stream gradient similar to the Black River and supports similar fish species.

Unlike the Black River, the Chehalis River in this reach has a history of fish kills associated with high temperatures and low dissolved oxygen (D.O.). Those kills in the Chehalis River are annual events and severity of kill is flow and weather dependent.

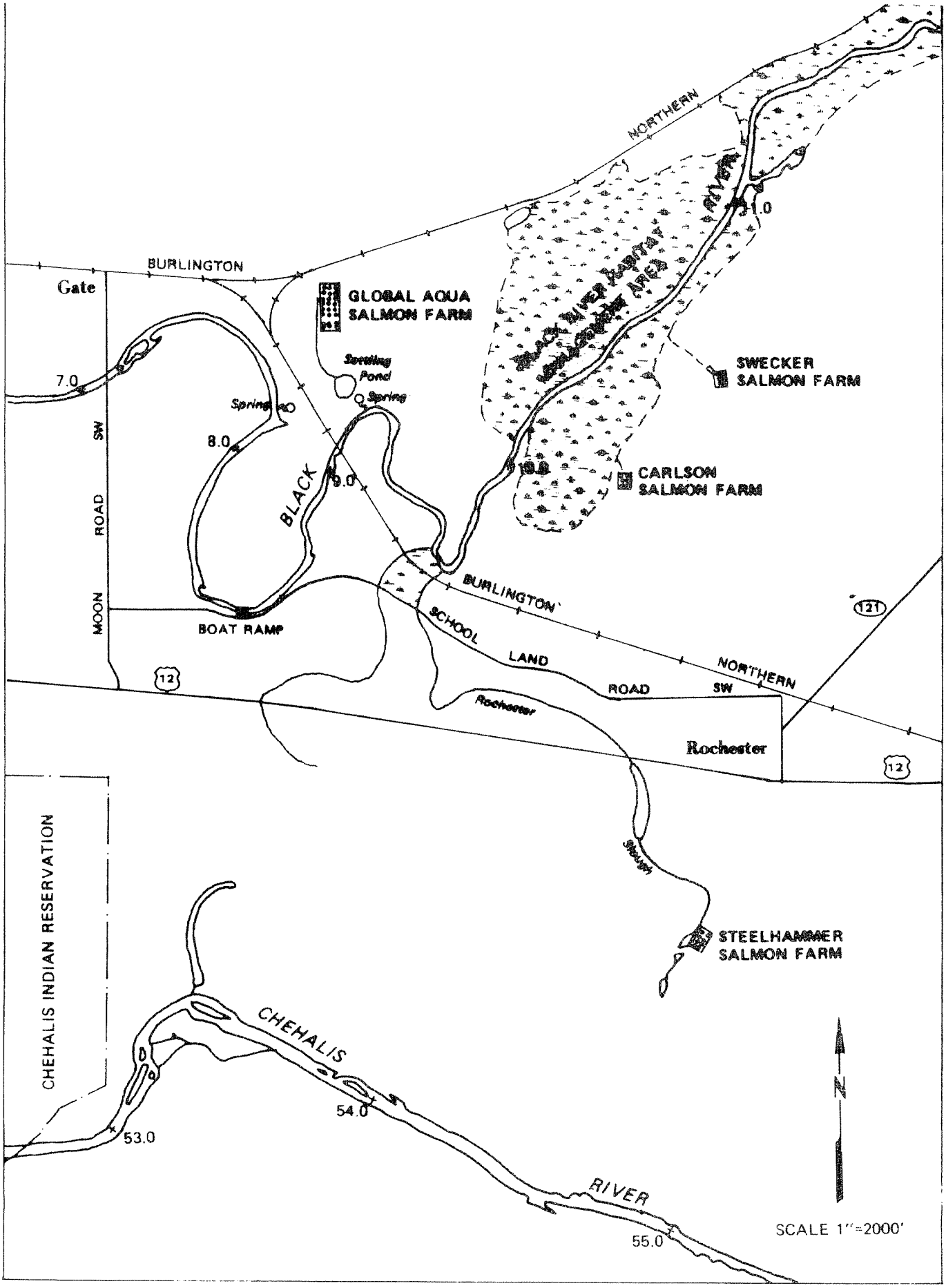

Figure 2. LANDMARKS ASSOCIATED WITH THE BLACK RIVER FISH KILL, SALMON FARMS, AUGUST 6–7, 1989.

3.0 INVESTIGATIONS/INSPECTIONS/SURVEYS DESCRIPTIONS

During the course of this incident, several investigations were conducted by Washington Department of Ecology (Ecology), Washington Department of Fisheries (WDF), and the Chehalis Indian Nation (CIN). This section describes those investigations/-inspections. Section 4.0 will describe the results/findings of those investigations. The subsections of Section 3.0 correspond numerically to related subsections in Section 4.0. Section 3.0 describes investigation methods, and Section 4.0 provides the related findings.

3.1 Ecology Complaint Investigations - Ecology received several leads concerning the fish kill. Reports typically involved suspected dumping or illegal discharges into the river. Each lead was followed up with an investigation. Ecology personnel conducted numerous investigations and interviews. Their purpose was to determine who or what was responsible for the fish kill. Investigators looked for abnormal operating procedures, discharges, chemical usage, and made other relevant observations.

3.2 WDF Stream Fish Carcass Surveys - WDF conducted stream surveys on August 8 & 9, 1989, noting carcasses and general stream conditions. Their objective was to determine the severity and the starting point of the fish kill. They waded and drifted the river noting carcasses, fish activity, and made other relevant observations.

3.3 Chehalis Indian Nation (CIN) Field Surveys - The CIN conducted daily field surveys starting on August 10, 1989 and ending on August 20, 1989 on the Black and Chehalis Rivers noting fish activity, carcasses, and making other relevant observations. Their purpose was to determine the number of salmon and trout mortalities in the Black River and Chehalis River.

3.4 Ecology Shoreline and Stream Fish Carcass Surveys - Ecology conducted stream surveys on August 11 and 13, 1989, noting carcasses and general stream conditions. Their objective was to determine where the fish kill started and find a responsible party. They walked the shoreline and drifted the river noting carcasses, fish activity, and other relevant observations.

3.5 Ecology Aquaculture Facility Inspections - Ecology conducted inspections at aquaculture facilities from August 11-21, 1989. Aquaculture facilities along the Black river discharge directly to the river. Water and sediment samples were collected at the locations described in Table 1.

Table 1. Washington Department of Ecology Aquaculture Facility Inspection Sample Locations. Ecology. Black River Fish Kill, August 6-7, 1989.

Date	Facility	Matrix	Location
8/17	Steelhammer	W	Rochester Slough at School Land Road.
8/18	Steelhammer	S	Discharge channel south of Tanglewood Trailer Park.
8/18	Steelhammer	W	Rochester Slough at School Land Road.
8/18	Carlson	W	Source well at Carlson Salmon Farm.
8/18	Carlson	W	Effluent channel
8/18	Swecker	W	Drainage channel near duck blind access road.
8/18	Swecker	S	Drainage channel below last rearing pond.
8/18	Swecker	W	Black River at Swecker duck blind.
8/10	Global Aqua	S	Settling Pond.
8/11	Global Aqua	W	Source Well.
8/11	Global Aqua	W	Standing water in raceway discharge.
8/11	Global Aqua	W	Standing water in settling pond.
8/11	Global Aqua	S	Settling Pond.
8/16	Global Aqua	W	Standing water in discharge channel.

NOTE: Matrix S = sediment
Matrix W = water

Water samples were analyzed by the Ecology Manchester Laboratory for the following parameters: pH, conductivity, alkalinity, hardness, chemical oxygen demand (COD), total organic carbon (TOC), total ammonia as nitrogen (NH3-N), nitrite-nitrate (NO2+NO3-N), ortho-phosphate (O-PO4-P), total phosphate (T-PO4-P), and total chloride (T-Cl).

Selected water and sediment samples were analyzed for the following elements antimony (Sb), arsenic (As), beryllium (Be), cadmium (Cd), copper (Cu), lead (Pb), nickel (Ni), selenium (Se), silver (Ag), thallium (Tl), zinc (Zn); and the following classes of organic chemicals, acid/base-neutral organics, volatile organics (VOA), pesticides/PCB, organo-phosphate pesticides, and herbicides. A complete list of the latter is in Attachment 3. Standard methods were used to analyze samples.

In addition to sample collection, investigators looked for abnormal operating procedures, discharges, chemical usage, and made other relevant observations.

3.6 Ecology Black River Ambient Water Quality Surveys - Black River water quality investigations were conducted by Ecology from August 16-18, 1989. The purpose of those investigations was to collect ambient water quality data upstream and downstream of the fish kill and determine if the kill was caused by natural conditions or other factors. Water and sediment samples were collected at Little Rock (r.m. 17.2), the boat ramp on highway 121 (r.m. 15.3), near Mima (r.m. 13.0), Black River habitat management area (r.m. 11.0), near Carlson fish farm (r.m. 9.8), Global Aqua (r.m. 9.3), the railroad bridge (r.m. 9.2), Big Rock (r.m. 7.8), Moon Road SW bridge, Gate (r.m. 7.1).

Water samples were analyzed for the same parameters as in section 3.5. Dissolved oxygen (D.O.), temperature, pH, conductivity, and barometric pressure were collected in the field.

Selected water and sediment samples were analyzed for the same metals and pesticides mentioned in section 3.5.

In addition to sample collection, investigators noted carcasses, aquatic vegetation, and made other relevant observations.

3.7 Ecology Chehalis River Ambient Water Quality Survey - A Chehalis River receiving water survey was conducted by Ecology on August 15, 1989. The purpose of the survey was to gather ambient water quality data and determine whether a toxic plume was moving down the Chehalis River. Water and sediment samples were collected at Montesano (r.m. 14.0), Keys Road (r.m. 21.0), Porter (r.m. 33.0), and Sickman Ford Bridge (r.m. 44.0).

Surface water samples were analyzed for the same parameters as in section 3.5. Dissolved oxygen (D.O.), temperature, pH, conductivity, and barometric pressure were collected in the field.

Selected water and sediment samples were analyzed for the same metals and pesticides mentioned in section 3.5.

In addition to sample collection, investigators noted carcasses, aquatic vegetation, and made other relevant observations.

Ecology also collected surface D.O. samples at the Sickman Ford bridge. Their purpose was to determine if oxygen was being depleted in the Chehalis River during night time hours.

4.0 RESULTS

Data indicate the Black River was highly nutrient enriched (eutrophic) and ambient water quality conditions in the Black River prior to the kill were approaching stressful levels for mountain whitefish, salmon, and trout. These fish species are temperature and dissolved oxygen (D.O.) sensitive. These fish require temperatures below 20°c and D.O. levels above 8.0 ppm to maintain healthy populations. Daytime temperatures were approaching 20°c and night time D.O.'s were below 8.0 ppm indicating stressful conditions, but not acute conditions.

The data indicate a few fish were dying possibly of stress related diseases in the Black and Chehalis Rivers prior to the August 6-7, 1989 kill. According to WDF and CIN fisheries biologists, all but a few were surviving under the existing, somewhat stressful conditions.

4.1 Ecology Complaint Inspections

At 1400 on August 8, 1989, a complainant reported to Ecology Southwest Regional Office (SWRO), that his children had been swimming in the Black River at Big Rock (r.m. 7.8) on the previous day, August 7, and they had complained of irritated eyes and skin, and they had seen a few dead fish (Attachment 1). The report was passed on to SWRO spill response unit. At about 1445, the complainant was contacted to confirm the report.

Ecology responded to the scene at 1500, August 8, 1989. They inspected the Black River shoreline at the School Land Road boat launch (r.m. 8.5), Drew's blueberry farm (r.m. 7.2), Big Rock (r.m. 7.8), and from the Moon Road SW bridge (r.m. 7.1) (Figure 1). They did not see any stressed fish or fish carcasses along the shoreline. Their search was restricted to the shoreline because of the heavy aquatic weed growth. They were unable to search the open channels through the weed growth. Two children at the School Land Road boat launch told the Ecology inspectors, they had seen "a couple of dead fish a few days back". The Ecology inspectors returned to the SWRO at about 1700.

That evening and the following day (August 9) WDF employees using waders and a boat were able to conduct a closer search. They searched the clear channel (through the weeds) and found fish carcasses from r.m. 9.2 to 7.1. (see section 4.2).

On August 9, 1989, Ecology interviewed the owners of Drew's Blueberry Farm (Drew's) which is near the Moon Road SW bridge. According to Drew's, nothing had been sprayed on the fields for

about one month as they were harvesting blueberries. Water and sediments were tested for herbicides and pesticides and none were found.

Additional complaints were investigated by Ecology, SWRO. Those investigations are summarized in Table 2.

Ecology also interviewed eleven people that had been swimming in the river during the kill. The information is summarized in Table 3.

These swimmers indicated the river was cloudy which is unusual for the Black River. According to the swimmers, the Black River water is normally black and clear, not cloudy. These data indicate something abnormal was in the Black River between r.m. 8.5 and r.m. 7.0 on August 7 and 8, 1989. Ammonia (NH_3-N) found in the ambient water samples could have caused the irritation, provided the levels were higher.

Table 2. Washington Department of Ecology Complaint Report Follow-up Investigation Summary. Black River Fish Kill August 6-7, 1989.

Date	River Mile	Complaint Report	Findings
8/17	7.2	A site near Gate had been used to produce pesticides & had been used as a dump.	The underground pesticide storage tanks had been removed. No discharge found.
8/16	9.5	A company in Rochester was dumping solvent into storm drain.	The site has no drain leaving the site. No evidence of a spill.
8/16	?	A tree farm was spraying pesticides near Gate.	Information not adequate to find spray site.
8/18	14.0	A possible clandestine drug manufacturing operation was dumping waste into the river.	Referred to Sheriff. Sheriff was not aware of a lab operation in the area.
8/18	13.0	A Dairy was discharging manure into river.	Dairy was not discharging to the river.
8/18	14.0	A forklift punctured a pesticide container at a tree nursery near Gate.	No spill found, but containers of Pydrin, Dacolil 2787 and Benomyl on site.
8/23	14.0	A green truck near Dodd Road was seen dumping blue containers on 8/7/89.	No evidence of dumping found.
8/18	52.0 of the Chehalis River	Someone was dumping copper sulfate into Chehalis R. near Independence.	Found 36 barrels full of copper sulfate on site. No evidence of dumping found.

Table 3. Black River Swimmer Interview Summary. Black River Fish Kill, August 6-7, 1989.

Swimmer	Date-Time	Location	Description
#1	8/7-1300	Turf Farm Pump (r.m. 7.0)	Irritated eyes for 24 hours.
#2	8/7-1300	Turf Farm Pump (r.m. 7.0)	Irritated eyes for 24 hours. Upset stomach for for 36 hrs.
#3	8/7-1300	Below Moon Rd. (r.m. 7.0)	Irritated eyes for 18 hrs. Rash and sores on stomach.
#4	8/7-1300	Below Moon Rd.	Irritated eyes.
#5	8/7-1500	Big Rock (r.m. 7.8)	Irritated eyes.
#6	8/7-1500	Big Rock (r.m. 7.8)	Irritated eyes. River salty to taste.
#7	8/7-1500	Big Rock (r.m. 7.8)	Eyes okay, but wore goggles.
#8	8/8-1200	Below Moon Rd. (r.m. 7.0)	Irritated eyes for 24 hrs.
#9	8/8-1200	Below Moon Rd. (r.m. 7.0)	No Problems, but swim was brief.
#10	8/8-1600	Above School Land Rd. boat launch (r.m. 8.5)	Irritated eyes for 18 hrs. Eyes were light sensitive.
#11	8/8-1600	Above School Land Rd. boat launch (r.m. 8.5)	Irritated eyes for 18 hrs. Eyes were light sensitive

4.2 WDF Stream Fish Carcass Surveys August 8-9, 1989

WDF Stream Survey August 8, 1989 - At 1800 on August 8, 1989, a local resident reported several dead fish near his property (r.m. 6.5) to WDF. WDF responded and arrived on scene at about 1900. WDF waded a 200 yard reach of the river near r.m. 6.5. WDF observed hundreds of trout, coho salmon fry, juvenile lamprey, sculpin,and crayfish carcasses in channels and weed beds. The experienced investigators estimated the fish had been dead for 24 to 48 hours, fixing the fish kill date on August 6 or 7, 1989. They collected a subsample of trout, coho, and sculpin carcasses (Attachment 3).

WDF Stream Survey August 9, 1989 - On August 9, 1989, WDF conducted a carcass survey. WDF drifted the Black River from r.m. 10.3 to r.m. 7.2 , Moon Road SW bridge. Their report says, in part, "At 10 a.m. WDF launched a canoe at r.m. 9.8 and paddled upstream to r.m. 10.3. At the launch point and upstream no dead fish were found, only live fish. They proceeded downstream and encountered the first dead fish just below the train trestle (r.m. 9.2). From this point down to r.m. 8.0 they found a few dead fish. The number of dead fish greatly increased below r.m. 8.0 and continued to increase through r.m. 7.2 where they pulled out (Table 5). Mortalities included the following species: coho salmon fry, trout fry (age 0+), cutthroat trout (up to 12"), sculpins, large scale suckers, lampreys, crayfish and freshwater clams. The only live fish observed below r.m. 8.0 were cyprinid fry (approximately 3/4 inches in length)" (see attachment 3). Cyprinids are resistant to many pollutants. These data suggest the fish kill started near r.m. 9.2.

WDF collected surface water samples at r.m. 9.7, 9.2, 8.0, and 7.5. The respective nutrient levels (NO_2+NO_3-N) were 1.08, 2.01, 1.17, and 1.30 ppm respectively. Those levels were significantly higher than levels found in the subsequent August 16-18 samples (.01 ppm to .70 ppm) although the data are somewhat compromised by sample preservation and holding time problems. They do indicate an unusually enriched condition probably existed in the river on August 9, 1989.

4.3 Chehalis Indian Nation (CIN) Stream Surveys - On August 10, 1989, CIN fishery technicians, drifted the Black River from the School Land Road boat launch (r.m. 8.5) to the Highway 12 bridge boat launch (r.m. 4.1). From r.m. 8.5 to r.m. 7.1 (Moon Road SW bridge), they found the following carcasses: 3 coho salmon fingerlings (avg. 3 in.) and 1 squawfish (16 in.). From r.m. 7.1 to r.m. 4.1, they found the following carcasses: 4 native sea-run cutthroat (12 -14 in), 1 sucker (18 in.) and 1 red-sided shiner. They noted the water was murky and aquatic plants were very thick throughout the river.

At 1045, on August 10, 1989, CIN technicians noted live fish at the Howanut bridge (r.m. 1.1), but the water was starting to get murky indicating conditions were changing. CIN also visited the Moon Road SW bridge and observed several stressed lamprey larvae and numerous fish carcasses. A detailed accounting is included in Attachment 6.

On August 11, 1989, CIN fisheries technicians drifted the Chehalis River from the Sickman Ford bridge (r.m. 44.0) to the Oakville boat launch (r.m. 42.2). They found 31 adult Chinook carcasses and 16 stressed adult Chinook. The mortalities were concentrated near the Sickman Ford bridge.

From August 11 to August 21, 1989, CIN collected 240 adult carcasses. The gill tissue from two fish were analyzed for copper and zinc. Those analyses revealed no significant difference between adult Chinook salmon upstream (control) and Chinook carcasses within the kill area (test). The results are shown in Table 4.

Table 4. Adult Chinook salmon gill tissue copper and zinc analysis results. Values are wet weight. Black River Fish Kill, August 6-7, 1989.

Fish	Location	Cu (ug/Kg)	Zn (ug/Kg)
Control	Chehalis R. near Independence (r.m. 50.0)	0.7	33.3
Test	Chehalis R. near Sickman Ford Bridge (r.m. 44)	0.7	27.2

4.4 Ecology Shoreline and Stream Fish Carcass Surveys - On August 11, 1989, Ecology surveyed the shoreline of the Black River, in the vicinity of the kill. It was suspected the carcasses were not visible from the shore. Needing a view from bank to bank including midstream sections, Ecology drifted the Black River on Sunday, August 13, 1989 from the Highway 121 boat launch to the School Land Road boat launch searching the river from shore to shore. The observations are summarized in Table 5. The purpose of the trip was to determine the kill starting point.

Following an intensive mid channel search from a drift boat, Ecology found no fish carcasses above r.m. 9.2, but found carcasses from r.m. 9.2 to 8.5 (see Table 5). Those carcasses were found along the clear channel between the heavy shoreline weed growth. They did not find any carcasses along the shoreline

explaining why previous shoreline searches had not yielded carcasses. Further, Ecology's findings corroborate WDF's boat survey of August 9, 1989. It is possible that scavengers had eaten many of the dead fish by the time Ecology investigators completed this survey.

4.5 Ecology Aquaculture Facility Inspections - Ecology inspected Swecker Salmon Farm (August 18 and 21), Carlson Salmon Farm (August 9 and 18), Steelhammer Salmon Farm (August 17, 18 and 21), and Global Aqua (August 9, 11, 16 and 18). Detailed inspection reports are included in Attachment 4. Ecology's inspections revealed all farms except Global were operating normally.

Table 5. Washington Departments of Ecology and Fisheries Black River Shoreline and River Surveys on August 8-11, 1989. Black River Fish Kill, August 6-7, 1989.

Type	Location	Date	Observation
B	Little Rock bridge - ECY (r.m. 17.2)		8/13 No dead fish or plants.
S	Highway 121 Boat launch near Little Rock - ECY (r.m. 15.3)		8/11 Water clear, small fish dimpling water surface. Live fish & aquatic insects present. No carcasses.
S	Highway 121 Canoe Rental Shop - ECY (r.m. 14.2)		8/11 Same as above.
B	Highway 121 Canoe Rental Shop - ECY (r.m. 14.2)		8/13 No dead fish or plants.
B	Swecker aqua- culture facility ECY (r.m. 10.5)	8/13	No dead fish or plants.
B	r.m. 10.3 - WDF		8/9 No dead fish.
B	r.m. 9.8 - WDF	8/9	No dead fish.
S	Across from Good- rich Farm - ECY (r.m. 9.5)		8/11 No carcasses. No fish seen live aquatic insects along shoreline.
S	Goodrich Farm - ECY (r.m. 9.5)		8/11 Area choked with aquatic plants. Live small fish and aquatic insects present along shoreline.
S	Drainage ditch along upstream boundary of Global Aqua - ECY (r.m. 9.4)	8/11	No carcasses nor live fish or aquatic insects found.

Table 5 - Continued

Type	Location	Date	Observation
S	Near Global Aqua well - ECY (r.m. 9.3)		8/11 No carcasses nor live fish or aquatic insects found along the shoreline.
B	Global Aqua aquaculture facility upstream end - ECY (r.m. 9.3)		8/13 No dead fish or plants.
S	Railroad bridge - ECY (r.m. 9.2)		8/11 Area choked with aquatic plants. No fish present. Live aquatic insects seen along shoreline.
B	Railroad bridge - ECY (r.m. 9.2)		8/13 One sculpin carcass 200 ft. upstream of bridge.
B	Below RR bridge - WDF (r.m. 9.1)		8/11 Dead fish.
S	School Land Rd. boat launch - ECY (r.m. 8.5)		8/11 Area choked with aquatic plants. No fish present. Two earthworm carcasses.
B	School Land Rd. boat launch - ECY (r.m. 8.5)		8/13 One sculpin carcass.
B	r.m. 8.0 - WDF 8/9 r.m. 7.2.		Dead fish density same as
S	Big Rock - ECY (r.m. 7.8)	8/11	Five live sculpin observed. No fish carcasses along shoreline.
B	r.m. 7.2 - WDF 8/9		Dead fish density increased significantly.
S	Moon Road SW bridge - ECY (r.m. 7.1)	8/11	Area choked with aquatic plants. No fish present.
W	r.m. 6.5 - WDF 8/8		Numerous dead trout, sculpins, lamprey and mussels.

NOTE:
S = Shoreline Survey
B = Boat Survey
W = Wader Survey
ECY = Wash. Department of Ecology
WDF = Wash. Department of Fisheries

Several factors suggested Global Aqua warranted a further look. These factors include the farm's proximity to fish carcasses, the fact that the hatchery had been shutdown at the time of the fish kill (an abnormal situation), and the observation that the last of the cleanup water moving through the facility had percolated into the ground through its drainage channel and settling pond prior to seeping into the Black River.

On August 9, 1989, Ecology returned to the fish kill site and visited Global Aqua (Global). The facility had recently ceased fish rearing operations and was shutdown. According to Global, the facility had been shutdown because of disease problems (Frunculosis). The hatchery is permitted to use up to 12 million gallons of well water daily. According to Global, the water had been shut off on August 2 and the entire system allowed to drain through a series of rearing and holding ponds eventually discharging through a drainage channel and into a 5 acre settling pond.

According to Global, the tanks were cleaned and flushed as follows. The water was shutoff on August 3, 1989. Fish remaining in the rearing tanks were allowed to suffocate. The fish suffocation would have reduced oxygen in the tank water to a low level because the fish would have respired the oxygen. After a time, this anoxic water plus the residual fish sludge and feces were flushed into the drainage channel. Those sludges and feces typically have very high NH3-N, total organic carbon, and chemical oxygen demand levels.

Water from the drainage channel and settling pond percolates rapidly into the ground. Under normal operating conditions the channel and pond percolate several million gallons per day into the ground and do not have an overland discharge to the river. It is accepted that Global's discharge enters the river through springs located at r.m. 9.3 and 7.8. Ecology conducted an inspection tour with Global and found the settling pond empty and no evidence of an overland discharge to the river.

Aerial photographs taken on August 6, 1989 revealed the Global settling pond was one-half full indicating the springs along the riverbank from r.m. 9.3 to 7.8 which are fed by Global's drainage channel and settling pond water was probably discharging during the August 6 to 7 kill. See "springs" in Figure 2.

According to a local resident, flows from the springs near r.m. 7.8 dropped significantly on August 4, 1989 and flows declined until they stopped on August 7, 1989. The timing of those observations correlate with the water shutoff at Global (Table 6) and the aerial photo data, and also corroborate the groundwater link between Global and the Black River.

During Ecology's inspections, Global perscnnel stated Global's shutdown started on July 27, 1989 and was completed by August 9, 1989. Again, the shutdown of several million gallons per day of well water flowing through the facility meant that as these flows diminished, the final effluent to the drainage channel and settling pond would be concentrating during the warm sunny days. Table 6 summarizes the shutdown operation.

Ecology also noted opened and used drums and bags of "Paracide - F", sodium thiosulfate, "Pentahydrate", formaldehyde, and chlorine on site.

Global records indicate chlorine had been used on three occasions from July 1 to August 4, 1989 to disinfect tools and the resulting chlorinated water had been neutralized with sodium thiosulfate (a substance which can deplete oxygen) prior to discharging the water into the settling pond. Ecology tested the settling pond and the Black River at r.m. 7.2 on August 9 for residual chlorine on the off chance that a residual remained and found no residual chlorine. The chances of finding a chlorine residual 24 hours after a discharge are unlikely.

Table 6. Summary of Events Relating to Global Aqua operation shutdown July-August, 1989. Black River Fish Kill August 6-7, 1989.

Date	Sequence of Events
7/27	Shut off pump on one of two wells reducing flow to about 3 million gallons/day (Global).
8/3	Shut off remaining fresh water well pump. Removed remaining fish from site (Global).
8/4	Flow from springs into Black River near r.m. 7.8 reduced by one half (Local Long-Time Resident).
8/6	Aerial photos show water in settling pond, about 1/2 full (Ecology).
8/7	Swimmers from r.m. 8.0 - 7.0 experience eye and skin irritation, and see murky water conditions, fish carcasses.
8/7	Flow from springs into Black River near r.m. 7.8 has ceased (Local Resident).
8/9	Settling pond dry (Ecology).

NOTE: Comments from local residents confirm Ecology's understanding that the springs are hydraulically connected to Global Aqua's drainage channel and settling pond. Springs only flow when Global Aqua is operating.

Global records indicate formaldehyde (a toxic substance and a carcinogen) was used on six occasions from June 20 to July 13, 1989 to treat eggs for disease problems and was not used in August. Residual formaldehyde was found in sediment samples taken in the channel between the rearing tanks and settling pond on August 10, 1989 at 0.10 ppm and 12.74 ppm, respectively, indicating the formaldehyde had not completely degraded 27 days after the last reported use.

Water samples collected at r.m. 7.8 and 7.1 were analyzed for formaldehyde on August 9 in the off chance that formaldehyde could be found and none was found. Like chlorine, the chances of finding formaldehyde 24 hours after a discharge to a flowing stream are unlikely.

On August 16, 1989, Ecology collected a water sample from the drainage channel between Global's fish rearing tanks and their settling pond. Ten days after the fish kill and thirteen days after the water was shut off, this water had an extremely high ammonia concentration (703 ppm). This channel water was not only very high in ammonia, but also very high in organic matter (total organic carbon value, 2190 ppm; chemical oxygen demand, 11,000 ppm). The toxicity of total ammonia as nitrogen (NH3-N) is dependent on pH and temperature. Total NH3-N would have been acutely toxic at 12 ppm in the Black River using a pH of 7.5 and temperature of 19 degrees Celsius (66.2 F^{o}) which were the averages measured during the Black River ambient water quality survey (Table 7). Total NH3-N would have been toxic at 3.7 ppm in the Chehalis River using a pH of 8.2 and a temperature of 19.5 degrees Celsius (67.1 F^{o}) which were the averages found during the Chehalis River ambient water quality survey (Section 4.7).

Table 7. Washington Department of Ecology Black River Ambient Water Quality Survey Temperature and Dissolved Oxygen Data, August 17-18, 1989. Black River Fish Kill August 6-7, 1989.

R.M.	Date-Time	Depth (m)	Temp. (°C)	D.O. (ppm)	% Sat.	Barom. (in. Hg)	Cond. (uMHOS/cm)
17.2	8/17-1630	0.0	19.2	7.3			125
	8/18-0545	0.0	18.4	6.7	70.3	30.12	116
	8/18-0755	0.0	17.9	6.5	67.5	30.12	93
15.3	8/18-0820	0.0	14.7	6.3	61.2	30.18	99
13.0	8/18-1020	0.0	18.8	11.1	117.1	30.20	100
		5.0	10.7	2.6	23.1	30.20	100
11.0	8/18-1125	0.0	17.8	11.8	122.2	30.20	89
	-1125	5.0	15.6	6.0	59.3	30.20	100
9.8	8/17-1340	0.0	18.8	8.0			110
	-1330	B		<1.1			118
9.3	8/17-1425	0.0	18.1	8.9			115
	-1415	B		3.9			119
	8/18-0522	0.0	18.1	9.4	98.1	30.12	100
	-1210	0.0	19.5	11.2	120.2	30.20	100
	-1210	2.5	18.4	9.4	98.4	30.20	100
7.7	8/17-1530	0.0	19.2	8.8			125
7.1	8/18-0505	0.0	17.4	6.7	68.9	30.20	100
	-1305	0.0	19.8	9.5	102.8	30.03	113
4.0	8/18-0453	0.0	17.8	8.6	89.2	30.20	100

NOTE: B = Bottom
Cond. = Conductivity
Barom. = Barometric Pressure

Water of the quality found in the drainage channel would, if discharged into the Black River in sufficient quantity, result in both ammonia toxicity and anoxia in the river. Minimum dilution ratios of roughly 60:1 for NH3-N plus 1,000:1 for chemical oxygen demand, would be required to prevent severe impacts to the river. An additional dilution ratio of roughly 500:1 would be required to prevent severe impacts downstream frcm the nitrogenous oxygen demand of the total NH3-N as it oxidized to NO3 (nitrate). The quantity of water, and therefore the concentration of pollutants, discharged to the Black River through the channel and settling pond during the Global shut down and cleaning operation is unknown.

4.6 Ecology Black River Ambient Water Quality Surveys - The results of the Black River ambient water quality surveys are presented in this section.

Temperatures - Surface water temperatures within the Black River study area ranged from 14.7 degrees Celsius (58.5 F^{o}) to 19.8 degrees Celsius (67.6 F^{o}) (Table 7).

Dissolved Oxygen (D.O.) - Surface D.O. levels within the Black River study area varied with location, ranging from 6.3 ppm to 11.8 ppm (Table 7).

At r.m. 13, 9.8, and 9.3, D.O.'s near the bottom of the river (5m) were very low (2.5, <1.1, and 3.9 ppm respectively). D.O. at these concentrations is inadequate to support healthy fish populations. The water temperature and D.O. data indicate the water column was stratified, with a low D.O. layer near the bottom typical of eutrophic lakes.

Ecology collected D.O. samples in the Black and Chehalis River just before daylight (4:53 a.m. to 5:45 a.m.) to determine if the respiration and decay of aquatic plants and algae were depleting the oxygen and causing fish kills. The data indicate surface D.O.'s were not depleted significantly and were adequate to support fish (Table 7). Trout and salmon are supported by oxygen levels above 5 ppm. Thus it was concluded, natural D.O. depletion did not cause the fish kill.

Nutrients - Based on nutrient data collected during the Black River surveys (see Table 8), and despite a spike at r.m. 15.3, total nutrient concentrations (nitrite, nitrate, ammonia and phosphates) increase an average of about three-fold below r.m. 10 (Figure 4).

Total phosphate concentrations above r.m. 10 average 0.06 ppm (range 0.05 to 0.08 ppm); while concentrations downstream from r.m. 10 average 0.13 ppm (range 0.08 to 0.19 ppm) (Figure 5).

Similarly NO2+NO3-N concentrations increase dramatically: a mean of 0.18 ppm above r.m. 10 increasing to 0.51 ppm downstream of r.m. 10 (Figure 3). NH3-N (ammonia) concentrations increase significantly at r.m. 9.3 (Figure 6).

This three-fold increase in nutrient concentrations (Table 8) (Figure 3-5) correlates with a clear increase in density of rooted aquatic plants and algae. Ecology Environmental Investigation/Laboratory Services summarized the aquatic plants in this reach of the Black River (Attachment 5).

Table 8. Washington Department of Ecology Black River Ambient Water Quality Survey Temperature and Nutrient Data, August 17-18, 1989. Black River Fish Kill August 6-7, 1989.

					Nutrients			
R.M.	Date-Time	Depth m	Temp (°C)	pH	NO2+ NO3-N ppm	NH3-N ppm	O-PO4-P ppm	T-PO4-P ppm
17.2	8/18-0755	0.0	17.9	7.3	0.01	0.02	0.02	0.06
15.3	8/18-0820	0.0	14.7	7.1	0.41	0.03	0.02	0.06
13.0	8/18-1020	0.0	18.8	7.5	0.02	0.01	0.01	0.05
11.0	8/18-1125	0.0	17.8	7.4	0.29	0.01	0.02	0.08
	Averages		17.3	7.2	0.18	0.02	0.02	0.06
9.9	8/17-1340	0.0	18.8	8.0	0.51	0.01		0.11
9.3	8/17-1425	0.0	18.1	7.3	0.70	0.09		0.11
	8/18-1210	0.0	19.5	7.4	0.52	0.04	0.04	0.19
7.8	8/17-1530	0.0	19.2	7.3	0.70	0.05		0.08
7.1	8/18-1305	0.0	19.8	7.6	0.64	0.02	0.02	0.15
	Averages		19.1	7.5	0.51	0.04	0.03	0.13

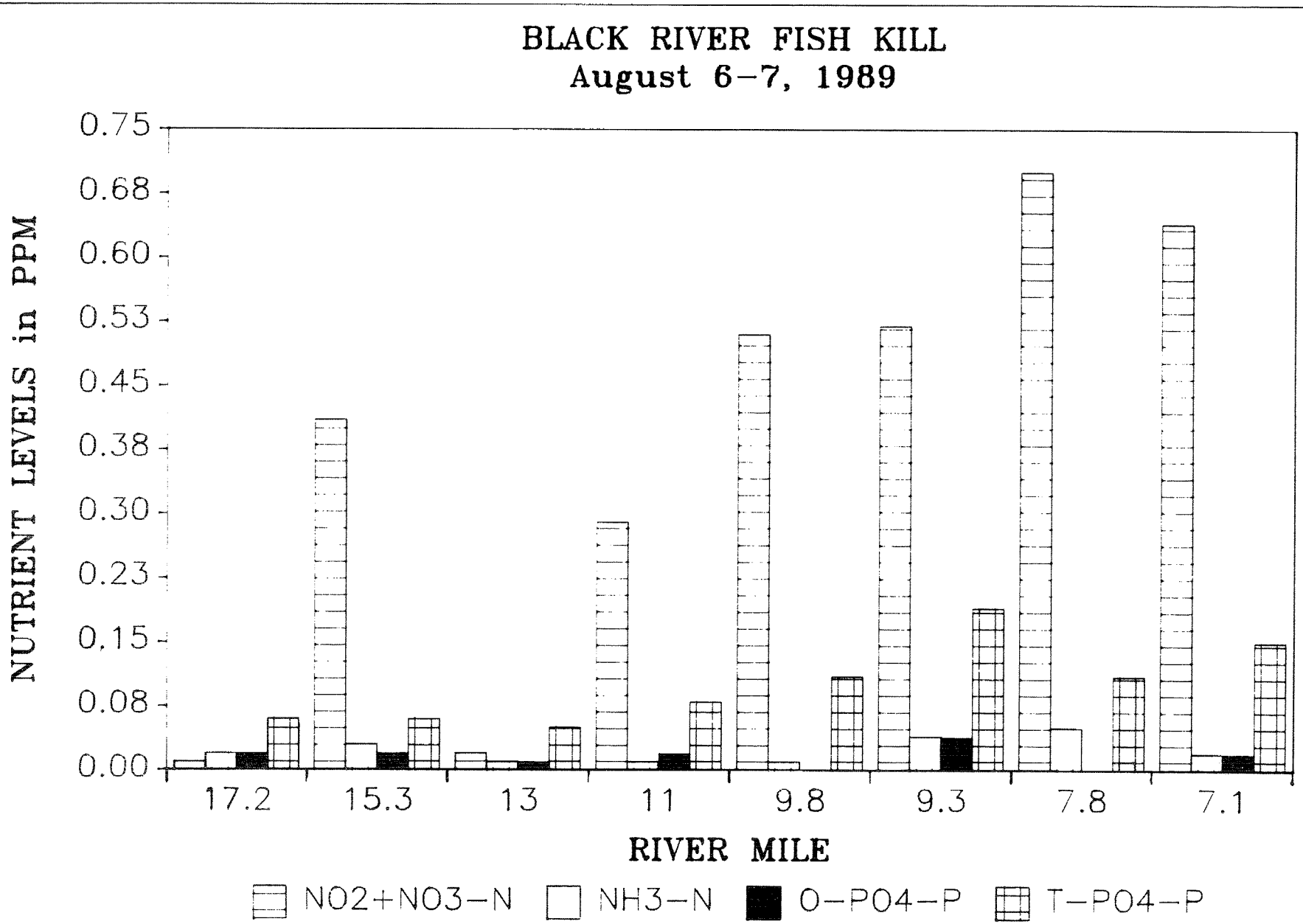

Figure 3. Black River Surface Water Nutrient Data
Black River Fish Kill, August 6-7, 1989

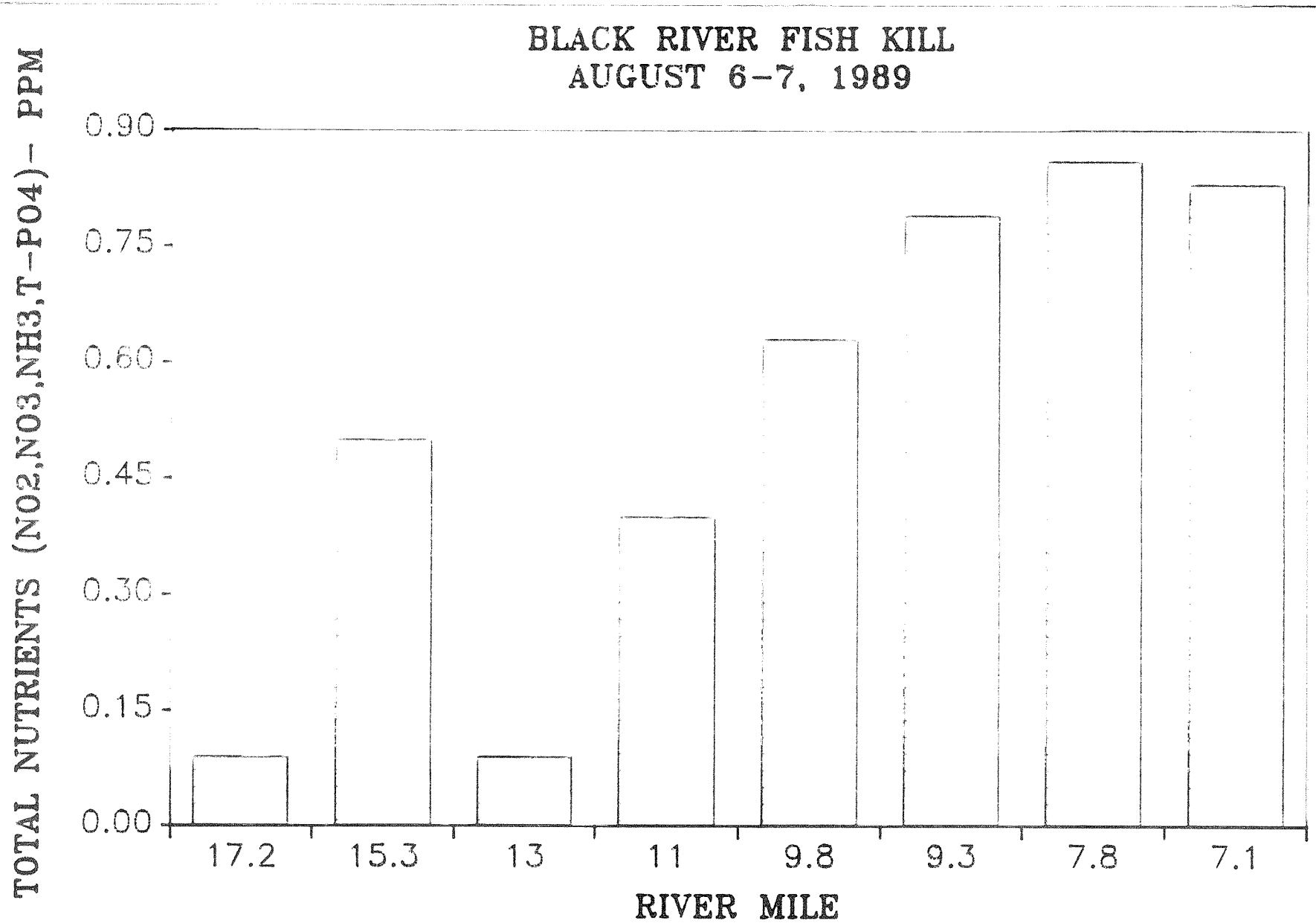

Figure 4. Black River Surface Water Total Nutrient Data. Black River Fish Kill, August 6-7, 1989

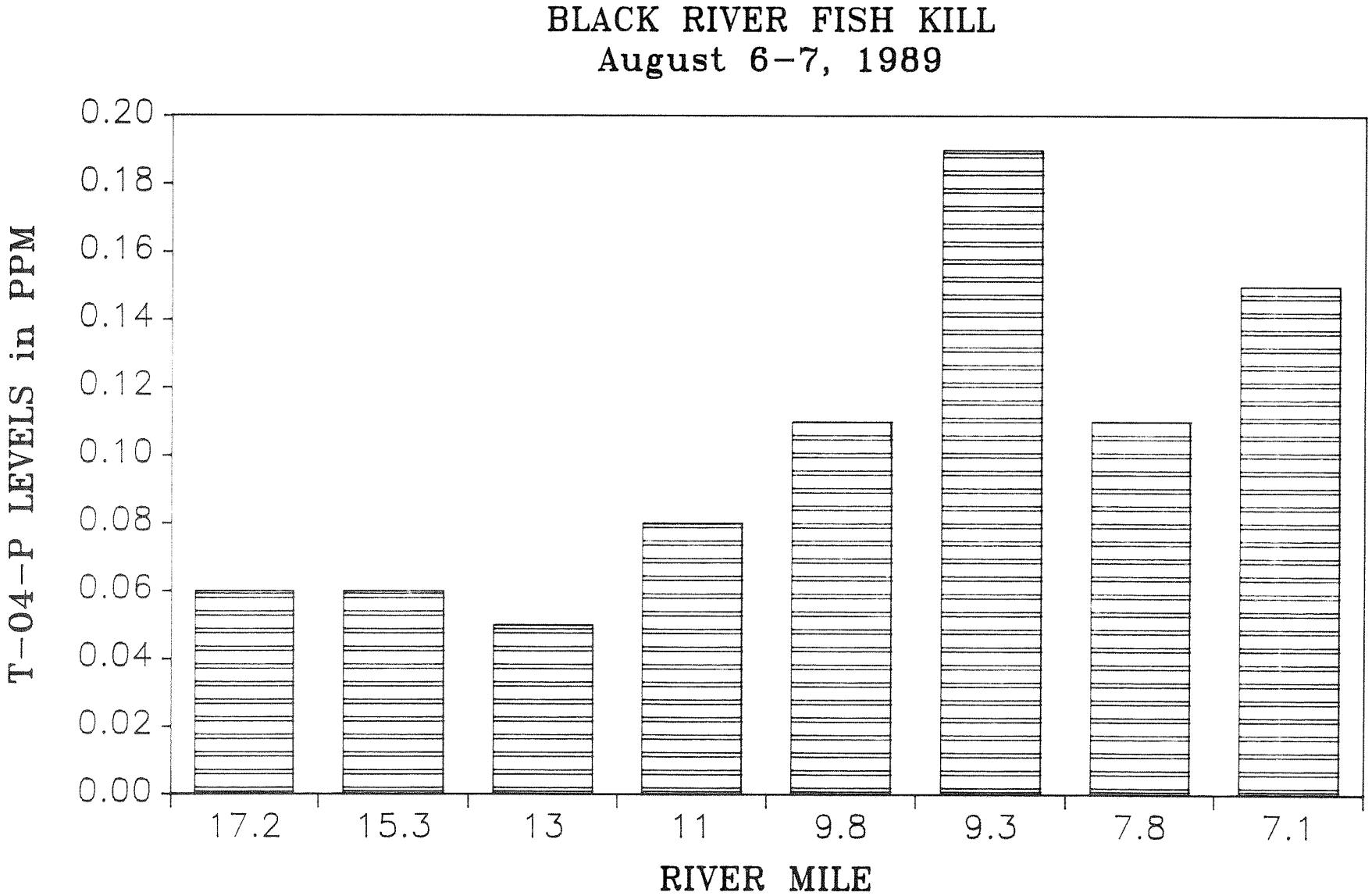

Figure 5. Black River Surface Water
Total Posphate Data
Black River Fish Kill, August 6-7, 1989

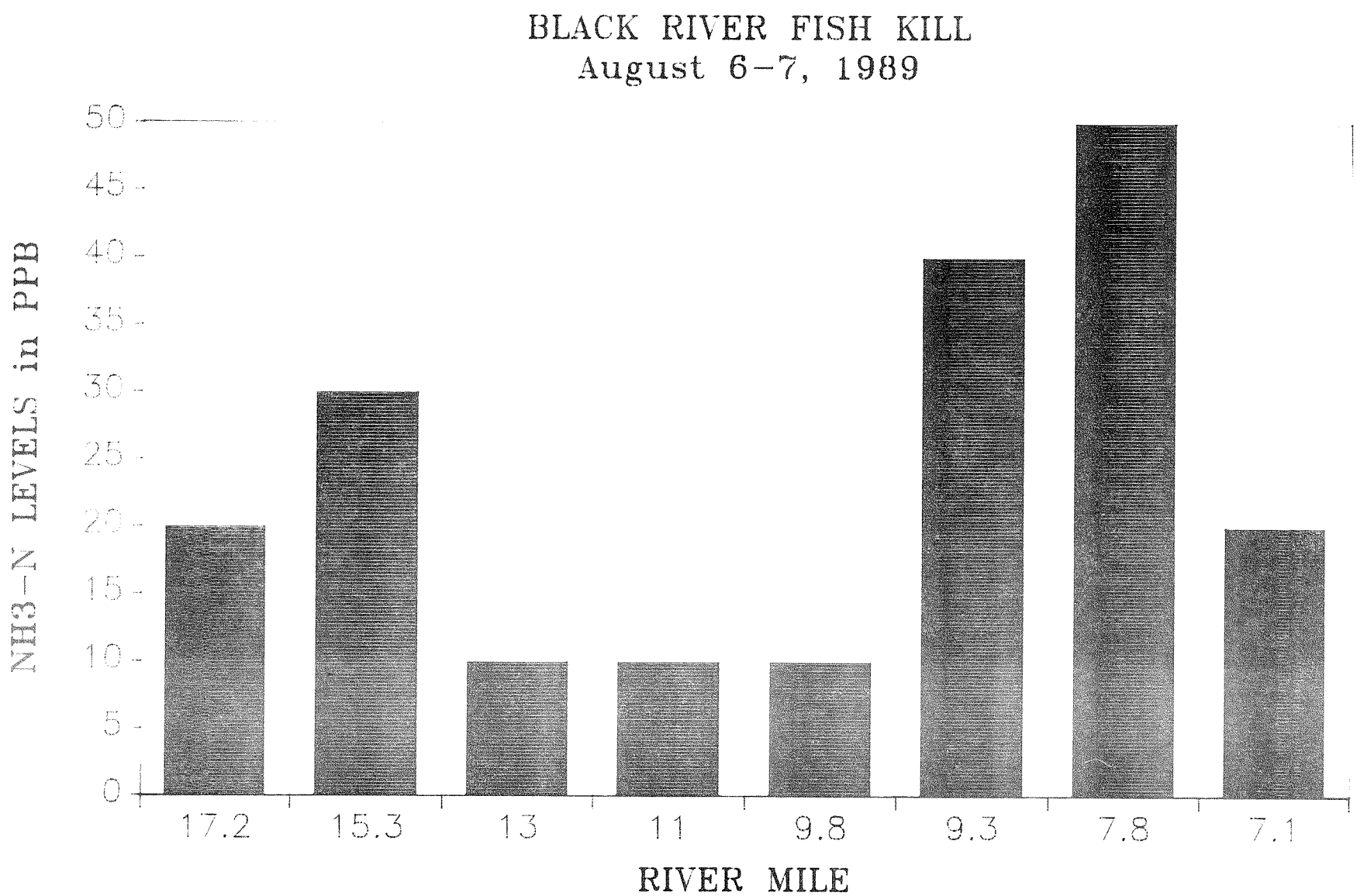

Figure 6. Black River Surface Water Ammonia Data
Black River Fish Kill, August 6-7, 1989

The increase in nutrient concentrations and aquatic plant density below r.m. 10 is a problem which aggravates conditions in the river. High productivity typically leads to dramatic swings in oxygen concentrations. This is particularly troublesome in a stream like the Black River which has a very low velocity and thus little capacity for physical reaeration.

The combination of low river velocity, high nutrient concentrations, high productivity, and stratified pools is one which can put the lower Black River at risk to conditions which induce anoxia (Table 8).

It should be noted that while these nutrients, ammonia in low concentrations is quite a good plant nutrient, contribute to the degradation of water quality, they do not normally cause acute, widespread mortality as seen in this fish kill. Conversely, ammonia in adequate concentration, can be lethal.

Pesticides and Other Observations - No pesticides or herbicides were found in the Black River sediment samples and metals were below toxic levels.

One mountain whitefish carcass was found on August 18, 1989 near r.m. 13.0. Judging from the state of decomposition, the carcass was less than 48 hours old. This carcass indicates a limited summer kill was occurring which is normal.

On that same day, several freshwater clam carcasses were noted at r.m. 9.5 and r.m. 7.1. The carcasses at r.m. 9.5 were floating on the surface and were in an advanced state of decay. The clam carcasses were analyzed for metals and pesticide residuals. The analysis did not find significant metal concentrations or pesticides.

The data indicate ambient water quality in the Black River was adequate to support fish.

4.7 Ecology Chehalis River Ambient Water Quality Survey - On August 15, 1989, Ecology's Chehalis River study revealed surface D.O.'s of 10.2, 12.8, 11.7, and 11.6 ppm at river miles 14, 21, 33, and 44 respectively. The average surface water pH and temperature were 8.2 and 19.5 C^{o}, respectively. These conditions were adequate to support fish and other aquatic life.

Ecology also noted one decomposing adult Chinook carcass near the Satsop River (r.m. 21.1) and several fresher Chinook carcasses upstream of Davis Creek (r.m. 42.5).

Analysis of the Chehalis River water and sediment samples did not find significant metal concentrations or pesticides.

Ecology's sample revealed a surface D.O. of 9.9 ppm at r.m. 44.0 (Sickman Ford bridge, Oakville). These data indicate surface D.O. in the Chehalis River was adequate during night time hours to support fish.

The data indicate ambient water quality in the Chehalis River was adequate to support fish and that the kill occurred in the reach of the Chehalis above Davis Creek.

5.0 FISH MORTALITY ESTIMATE

The fish mortality estimate and resource loss is discussed in this section.

5.1 Black River Fish Mortality Estimate

For the purposes of this report, it was assumed that 100% of the fish in the Black River from r.m. 9.2 to the mouth were killed.

WDF collected 16 fish: 3 coho salmon fingerlings, 3 resident cutthroat trout, and 10 forage fish (sculpins, dace, shiners, suckers, and lamprey) carcasses in about 200 yards. The reach was choked with aquatic vegetation hiding the majority of the carcasses making an accurate carcass count impossible.

WDF estimated about 100,000 coho fingerlings died as a result of the kill. Their estimate is based on WDF coho smolt trapping data collected over the last four years and applying fingerling survival rates to smolt production (Attachment 7).

For the purposes of this report, it was assumed by WDW that the density of cutthroat trout was about one per 7.1 square meters. The surface area of the affected reach was 118,422 m^2 (9.2 mi. x 1,609 m/mi. x 8m).

Applying the cutthroat density to the surface area provided a cutthroat mortality estimate (118,422 m^2 x .14 fish/m^2) of 16,579 or roughly 17,000.

Again, for the purposes of this report is was assumed the forage fish density was one fish per square meter resulting in a forage fish mortality estimate of approximately 118,422.

5.2 Chehalis River Fish Mortality Estimate

The CIN counted 240 adult Chinook salmon carcasses and 1 adult steelhead trout carcass in the Chehalis River downstream from the Black River. Because of predation and fish size it was assumed by CIN 75% of the Chinook and 33% of the steelhead were collected resulting in a mortality estimate of 320 (240/.75) and 3 (1/.33) respectively (Table 9).

For the purposes of this report is was estimated that 320 mountain whitefish also died as a result of this incident.

Table 9. Chehalis River Fish Mortality Estimate. Black River Fish Kill, August 6-7, 1989.

Species	No. Fish Collected	Percent Collected	Mort. Est.
Chinook	240	75	320
Steelhead	1	33	3
Whitefish	Est.	NA	320

6.0 CONCLUSIONS

Based on the facts available, the Department of Ecology has concluded:

- Although the ambient water quality in the Black and Chehalis River was not ideal for salmon, trout, and whitefish in early August 1989, this fish kill event was not caused by ambient river conditions.

- The fish kill was caused by a pollutant(s) discharged to the river resulting in an acute mortality.

- The fish kill in the Black River probably occurred on August 6, 1989 and began in the vicinity of river mile 9.2.

- Subsequent to the kill, the Black River contained elevated levels of ammonia, nitrites, nitrates, and phosphorous. Lethal levels of an acutely toxic substance in either river could not be found due to the very rapid (usually within less than 24 hours) dilution, dissipation and evaporation of the pollutant(s).

- On and after the afternoon of August 8 (the date of the first fish kill report and investigation), investigators were not able to find physical evidence of pollutants being actively discharged into the Black River.

- Results of the Black River fish kill investigation indicate discharge permits in this area warrant upgrading (see Section 7.0 Corrective Actions).

7.0 CORRECTIVE ACTION

The investigation of the August fish kill revealed that chronic water quality problems associated with elevated levels of nutrients exist in the lower Black River. This situation presents a stressful environment for fish and other aquatic organisms especially during late summer and reduces the recreational/boating value of the river. However, limited information exists regarding flows and overall water quality of the entire Black River.

As a result of the extensive investigation Ecology has identified several corrective actions that will provide better water quality information and better control of potential sources of pollution. The following actions are currently underway or will be carried out as indicated:

1. Ecology and the Chehalis Tribe will conduct a short-term cooperative ambient water quality monitoring study. Water samples will be collected monthly by tribal members from October 1989 through June 1990 at two monitoring stations along the Black River. The samples will be sent to Ecology for analysis. Ecology will train tribal members in appropriate sample collection techniques and assist in selecting the two water monitoring stations.

2. Ecology will immediately increase inspections of point and nonpoint sources of water pollution in the greater Chehalis River watershed to identify the source and type of pollutants entering the water. Facilities identified as requiring wastewater discharge permits will be brought into the permit program. Facilities having wastewater discharge permits will be reviewed for compliance with current technological and water quality standards. If needed, these facilities will be required to upgrade their operations to ensure water quality in the Black and Chehalis rivers is protected.

3. Because wastewater from the Global Aqua fish-rearing operation is not monitored due to its ground discharge, the facility will immediately undergo a review and wastewater permit upgrade. Global Aqua is currently working cooperatively with Ecology to implement interim control measures prior to permanent facility modifications.

   In a related action, Ecology has been working with the aquaculture industry to develop a policy regarding water quality requirements for fish production facilities. The purpose of the fin-fish discharge permit policy is to provide a consistent and predictable permitting process that ensures

environmental protection. All fish-rearing facilities on the Black River will be subject to any additional requirements that result from the new policy.

4. Upon completion of the short-term Black River water quality monitoring study, Ecology will assess the need for an intensive water quality study in the Black River. Pending an evaluation of priorities, the study would likely be conducted from mid-summer to early winter, 1990.

5. To provide a better understanding of water quality trends, Ecology will evaluate establishing an ambient water quality monitoring station on the Black River.

WASHINGTON STATE DEPARTMENT OF ECOLOGY

News Release

FOR IMMEDIATE RELEASE
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FISH KILL REPORT RELEASED

OLYMPIA--The August fish kill in the Black and Chehalis rivers was caused by pollution not natural environmental conditions, according to a report released today by the Department of Ecology.

"Although water quality in the Black and Chehalis rivers was not ideal for salmon, trout and whitefish in early August, this fish kill was not caused by the ambient river conditions," said Ecology Director Chris Gregoire. "However, on and after the afternoon of August 8, the day the fish kill was reported to Ecology, our investigators were not able to find physical evidence of pollutants actively entering the Black River."

Gregoire said the investigation is continuing and Ecology is taking action to tighten pollution requirements for fish farms and other wastewater dischargers located on the Black River.

"We are not closing the book on this case, nor are we saying that enforcement actions won't be taken at a later date. The report we are issuing today summarizes the results of the investigation to date and actions we feel are necessary to prevent future problems."

Gregoire said Ecology, the departments of Fisheries and Wildlife, and the Chehalis Tribe conducted one of the most exhaustive investigations ever of a fish kill in Washington.

Gregoire said it appears that something toxic entered the Black River about August 6 nine miles upstream from the confluence of the Black and Chehalis rivers. Ecology was notified and responded to the incident on August 8.

"Although our spill responders were on the scene shortly after being notified on August 8, they failed to take water samples that day," Gregoire said. "However, water samples collected by Fisheries and private citizens were analyzed by Ecology."

Gregoire said the agency should have also notified the Chehalis Tribe of the fish kill. "This was a unique event because a second fish kill occurred downstream several days after the initial kill. From now on, we will put out a widespread warning during all fish kill incidents."

Gregoire said Ecology learned a lot from the incident and the experience will be used to improve response should there be future fish kills of this kind.

During the investigation, Ecology inspected four fish-farms, several dairies, a blueberry farm, a turf farm and several businesses that handle chemicals. Several tips about possible illegal dumping of chemicals into the river were also investigated.

"Numerous samples of water, sediments and fish were collected by Ecology and analyzed for literally hundreds of pollutants," Gregoire said.

Eleven people who reported stinging eyes while swimming in the river on August 7 and 8 were also interviewed.

According to the report, all fish in a nine-mile stretch of the Black River were assumed to be killed.

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Fisheries estimates show that 320 adult chinook salmon, 100,000 coho salmon fingerlings, 16,500 cutthroat trout, 118,000 forage fish (sculpins, dace, shiners, suckers and lampreys), 320 mountain whitefish, and 3 adult steelhead trout were killed.

The report concluded that facilities along the river need to have their wastewater discharge permits upgraded.

The Global Aqua facility is receiving special attention because it is the largest fish-rearing facility on the Black River and is located where the fish kill began.

The report also identified several corrective actions that are needed. Among the actions underway or being considered are:

o a short-term cooperative water quality monitoring study by Ecology and the Chehalis Tribe;

o an immediate increase in inspections of water pollution sources in the greater Chehalis River watershed to get a better idea of what pollutants are getting into the water and to ensure that facilities have the required permits;

o an assessment of whether an intensive Ecology water quality study is needed in the Black River; and

o an assessment of whether an ambient water quality monitoring station on the Black River should be established by Ecology.

Ecology has also been working for the past year on a new general permit for fish-rearing facilities. Ecology is drafting the permit with the help of governmental agencies, environmental organizations, the aquaculture industry and the public.

--over--

Gregoire said the incident highlighted the need for investigators to receive notification of fish kills and spills as soon as possible.

"It is essential that people call Ecology immediately when they see a spill occur or if they observe an unusual number of dead fish."