Analysis of Water Quality Conditions in Pats Branch Watershed, West Virginia: Copper and Fluoride

Prepared by US EPA Region 3

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Acknowledgments

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Basin Name: **Guyandotte River**

Listed Segments:

Name	ID No	Priority Ranking	Use Classification	Size (miles)	Listed Pollutant	Location
Pats Branch	OG-0.5	Low	Aquatic Life, Human Health	1.7	Copper, Fluoride	05070102

Water Quality Standards:

Copper

Total copper shall not exceed 1000 Qg/L for public water supply.

The four-day average concentration of dissolved copper shall not exceed the value determined by the following equation:

$$Cu = e^{(0.8545[\ln(\text{hardness})]-1.465)} \times CF$$

where CF = 0.960

The one-hour average concentration of dissolved copper shall not exceed the value determined by the following equation:

$$Cu = e^{(0.9422[\ln(\text{hardness})]-1.464)} \times CF$$

where CF = 0.960

Fluoride

Total fluoride shall not exceed 1.4 mg/L for public water supply.

1. Problem Understanding

Pats Branch is located in Huntington, West Virginia (Figure 1.1), and its drainage area is represented by the Guyandotte River Watershed (HUC 05070102). It originates at the Dietz Hollow (D.H.) Landfill and flows southwest through a single family home residential area within the City of Huntington. Pats Branch enters a culvert under the Chesapeake and Ohio Rail Road track then within few yards it enters a 6-foot diameter concrete pipe and flows under the INCO Alloys International properties. Pats Branch resurfaces at Huntington's flood wall prior to its confluence with the Guyandotte River.

Pats Branch is listed on the State's 1998 303(d) list due to total copper and total fluoride impairments. Pats Branch has a priority ranking of low. According to West Virginia's schedule, Pats Branch is due for completion October 1, 2000. This is consistent with the consent decree (*Ohio Valley Environmental Coalition, Inc., West Virginia Highlands Conservancy et al.* v. *Browner, et. al*), which sought state and federal aid to improve and maintain West Virginia's water quality standards.

Water quality monitoring data obtained from West Virginia Department of Environmental Protection (DEP), City of Huntington, and INCO Alloys International were used to characterize the type, frequency, and severity of water quality violation. The data were also used to evaluate potential critical condition that represent flow conditions where violations are most likely to occur. It is assumed that if violations do not occur under these conditions, violations will not occur under other flow conditions. This report describes the water quality conditions in Pats Branch.

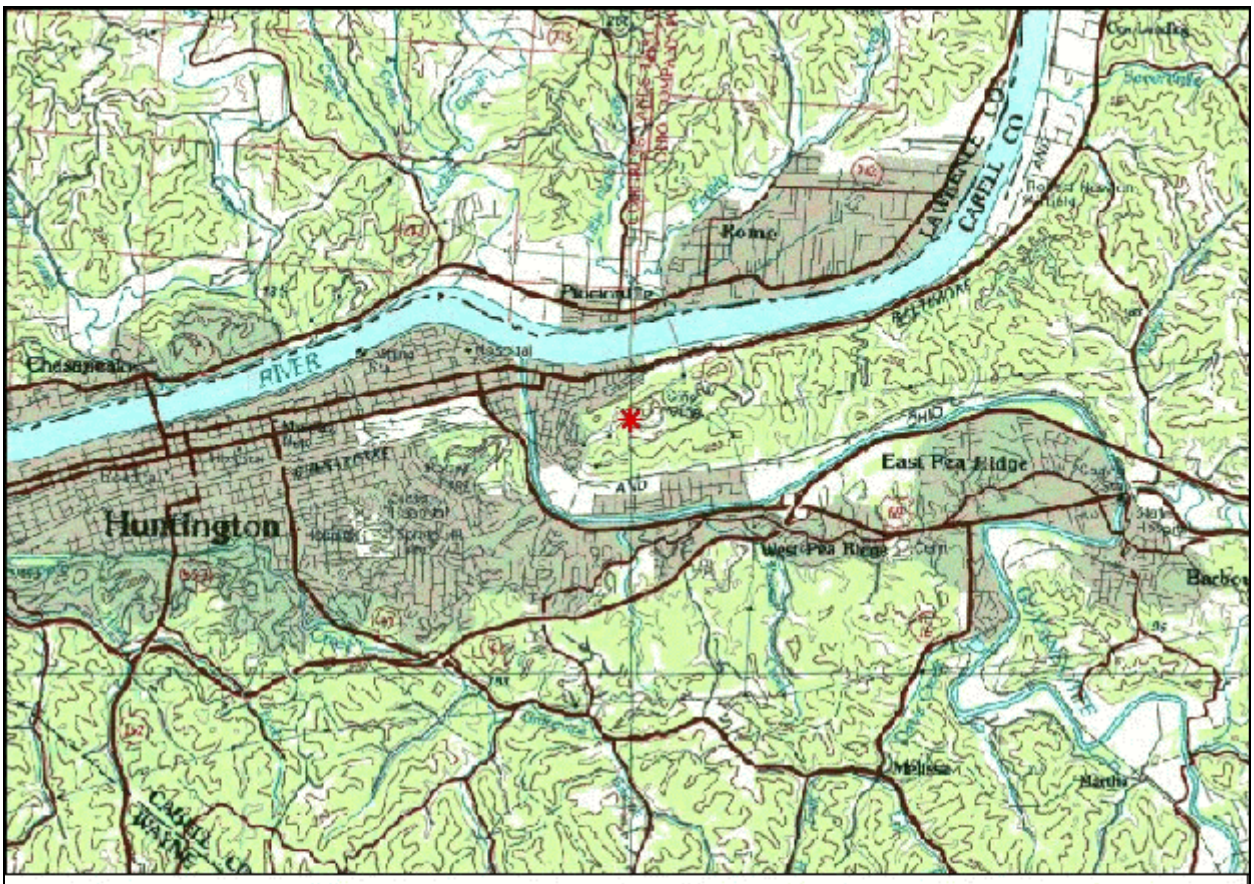

Fig 1.1 Pats Branch Location Map

Data Source: West Virginia DEP

Projection: UTM 1927
Zone 17

2. Applicable Water Quality Standards

The State of West Virginia has given Pats Branch a water use classification of all uses. West Virginia's *Requirements Governing Water Quality Standards* (WVSOS, 1999) defines water quality criteria for surface waters in the form of numeric constituent concentration, levels, or a narrative statement representing a quality of water that supports a designated use or uses. Both total copper and total fluoride are given numeric criteria under the Human Health use designation category A (public water supply, for which criteria have been calculated to protect human health from toxic effects of exposure through drinking water and fish consumption). The dissolved copper standard was expressed as a function of hardness concentration for aquatic life B1, B4 Acute and B2 Acute. Table 2-1 shows the criteria from West Virginia's water quality standards for measurements of total and dissolved copper and fluoride in waters with a use classification of all uses.

Table 2-1. WV Water Quality Standards for All Uses

Pollutant	Use Designation					
	AQUATIC LIFE				HUMAN HEALTH	ALL OTHER USES
	B1, B4		B2		A	
	ACUTE	CHRONIC	ACUTE	CHRONIC		
Copper, Total (µg/L)					1000	
Copper Dissolved The one-hour average concentration of dissolved copper shall not exceed the value determined by the following equation: $Cu = e^{(0.9422[\ln(\text{hardness})]-1.464)} \times CF$ CF = 0.960	X		X			
Fluoride, Total (mg/L)					1.4	

Source: WVSOS,1999.

27 water quality samples were taken from Pats Branch during the period December 1992 to December 1997. Water quality monitoring data taken above and below the INCO tailings storage area shows that the copper standard was violated 36% of the time and the fluoride standard was violated 14% of the time. Based on these water quality impairments Pats Branch was included on the West Virginia 303(d) list.

3. Source Assessment

3.1 Nonpoint Sources

Nonpoint sources are not considered a significant contributor to the instream copper and fluoride loadings in Pats Branch.

3.2 Point Sources

Table 3-1 contains a list of the point source dischargers in the Pats Branch.

Table 3-1. Number of Point Source discharges in the Pats Branch Watershed

Subwatershed	NPDES Permit Number	Facility Type	Number of Pipes
Pats Branch		Dietz H. Landfill	1
Pats Branch		Storm water	1

4. Discussion of Water Quality Data

This section focuses on the analysis of copper and fluoride observations in the main stem of Pats Branch. The primary data used for this section were obtained from WVDEP, the City of Huntington, and INCO. The objectives of the data evaluation were to confirm whether water quality is violated and to characterize the type, frequency, and severity of the water quality standard violations. The data analysis was also used to identify the contribution of potential sources of copper and fluoride. Another objective of the water quality analysis was to evaluate the critical condition, which represents flow conditions where violations are most likely to occur. It is assumed that if violations do not occur under these conditions, violations will not occur under other flow conditions.

4.1 Water Quality Monitoring Data Inventory

Water quality monitoring data for the Pats Branch Watershed were obtained from WVDEP, the City of Huntington, and INCO. The monitoring data types include instream stations, monitoring wells, and the landfill leachate collection system. An inventory of the available water quality data is shown in Table 4-1. An analysis of the water quality data is presented in Section 4.2.

Table 4-1. Inventory of Water Quality Data for Pats Branch

Monitoring Type	Location	Period	Number of Samples	Source
Instream	Downstream Dietz Hollow Landfill	12/97-9/99	8	City of Huntington
	Downstream Dietz Hollow Landfill	9/90-5/00	31	City of Huntington
	Upstream INCO site	12/92-12/97	15	INCO
	Upstream INCO site	11/99-3/00	14	WVDEP
	Downstream INCO site	12/92-12/97	14	INCO
Landfill Leachate	Dietz Hollow Landfill	12/97-9/99	8	City of Huntington
	Dietz Hollow Landfill	5/92-5/00	31	WVDEP

Monitoring Type	Location	Period	Number of Samples	Source
Monitoring Well	Dietz Hollow Landfill	2/91-3/00	117	WVDEP
	INCO	11/91-6/98	108	INCO

4.2 Instream Water Quality Data Analysis

Instream water quality data analysis is presented for the following specific locations:

- Downstream of the D.H. Landfill (Headwaters of Pats Branch)
- Upstream of the INCO site
- Downstream of the INCO site.

4.2.1 Water Quality Conditions Downstream of Landfill: Headwaters of Pats Branch (City of Huntington 1997-1999)

City of Huntington monitoring data from March 1998 to September 1999 show that the instream total copper concentration ranged from 10 Og/L to 270 Og/L. The West Virginia water quality standard for total copper was never exceeded during this monitoring period, as shown in Figure 4.1. For the same monitoring period, instream fluoride concentration ranged from 0.27 mg/L to 1.33 mg/L and the water quality standard for fluoride was never violated, as shown in Figure 4.2.

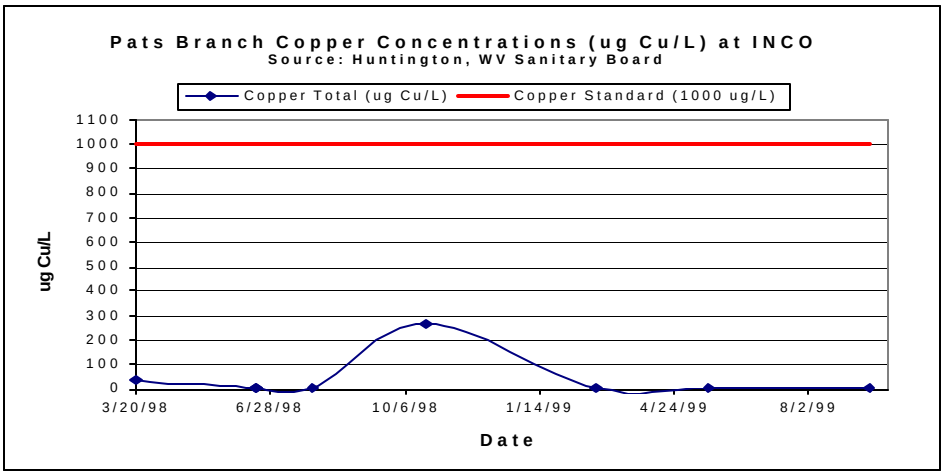

Figure 4.1 Pats Branch water quality conditions downstream of landfill: Copper (City of Huntington)

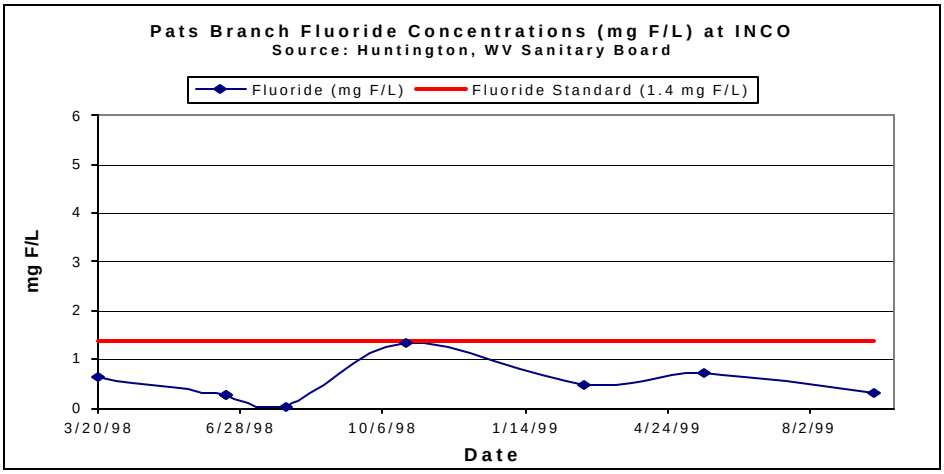

Figure 4.2. Pats Branch water quality conditions downstream of landfill: Fluoride (City of Huntington)

4.2.2Water Quality Conditions Downstream of Landfill: Headwaters of Pats Branch: (City of Huntington 1990-2000)

The available data from the city of Huntington (March 1994 to May 2000) show that the instream fluoride concentration ranged from 0.27 mg/L to 1.93 mg/L. The West Virginia water quality standard for fluoride was exceeded only once during this monitoring period, as shown in Figure 4 From December 1990 to December 1999, the available instream copper concentration ranged from 10 Og/L to 270 Og/L and the water quality standard for copper was violated 4 times, as shown in Figure 4.4. The copper violations occurred prior to landfill closure and capping in 1995.

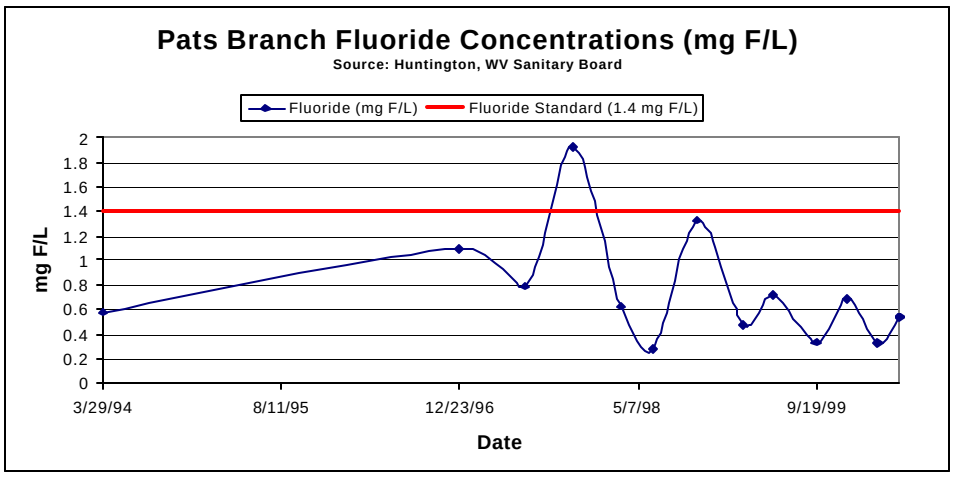

Figure 4.3 Pats Branch water quality condition downstream of landfill: Fluoride (City of Huntington)

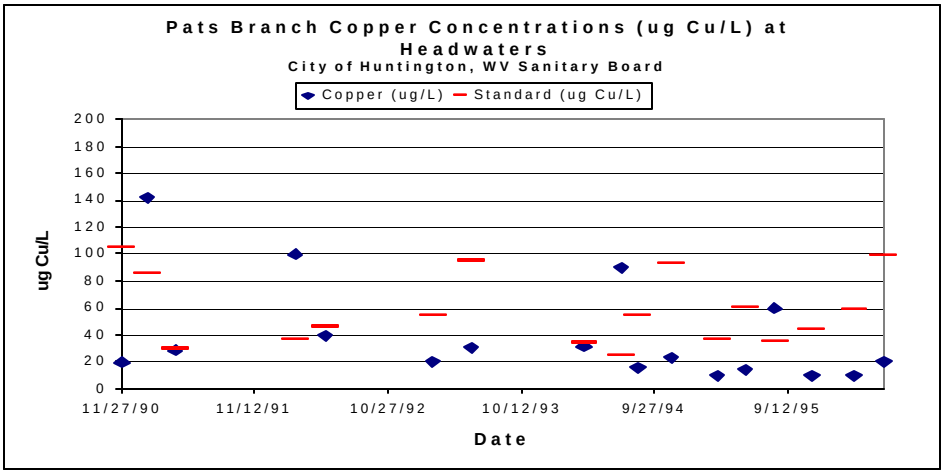

Figure 4.4. Pats Branch water quality conditions downstream of landfill: Copper (City of Huntington)

4.2.3 Water Quality Conditions at INCO Plant: Upstream of INCO Plant (INCO 1992-1997)

Monitoring water quality data for copper and fluoride upstream of the INCO plant were provided by INCO and are presented in Figures 4.5 and 4.6. Upstream of the INCO plant, the water quality data for the monitoring period December 1992 to September 1997 indicate that instream copper concentration violated the water quality standard 4 times. For the same monitoring period, the instream fluoride concentration was violated six times.

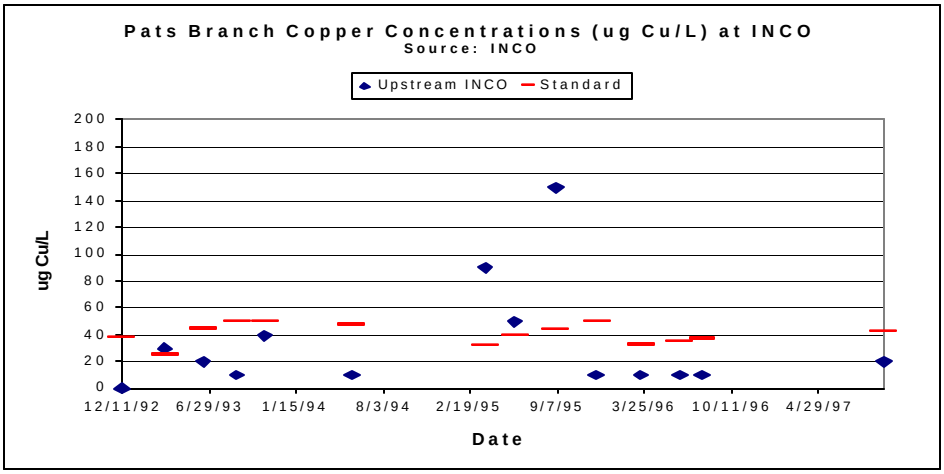

Figure 4.5 Pats Branch water quality conditions upstream of INCO site: Copper (INCO)

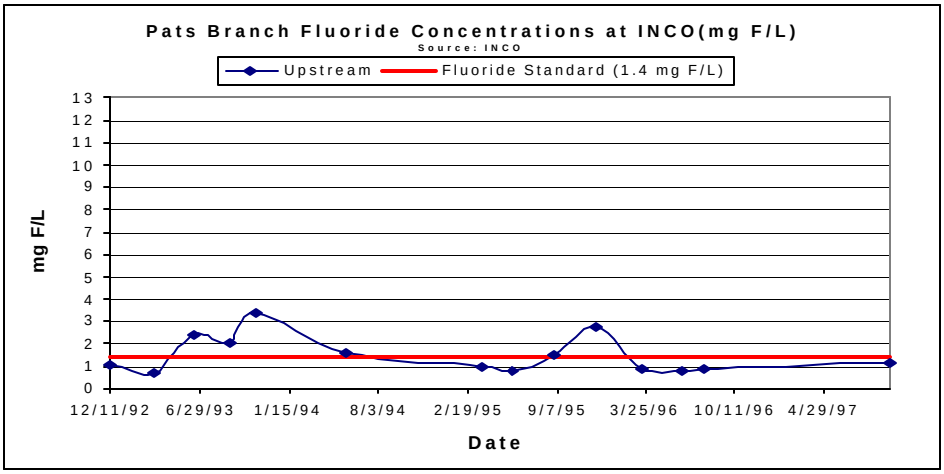

Figure 4.6 Pats Branch water quality conditions upstream of INCO site: Fluoride (INCO)

4.2.4 Water Quality Conditions at INCO Plant: Downstream of INCO Plant (INCO 1992-1997)

Pats Branch flows through a 6-ft-diameter pipe about 25 ft below INCO property. The only contribution to Pats Branch is through a permitted storm water outfall located on the INCO site. Monitoring water quality data for copper and fluoride downstream of the INCO plant were provided by INCO and are presented in Figures 4.7 and 4.8. The instream water quality data for copper show four violations of the West Virginia water quality standard. However, the fluoride instream concentration exceeded the water quality standard eleven times for the same monitoring period, December 1992 to September 1996.

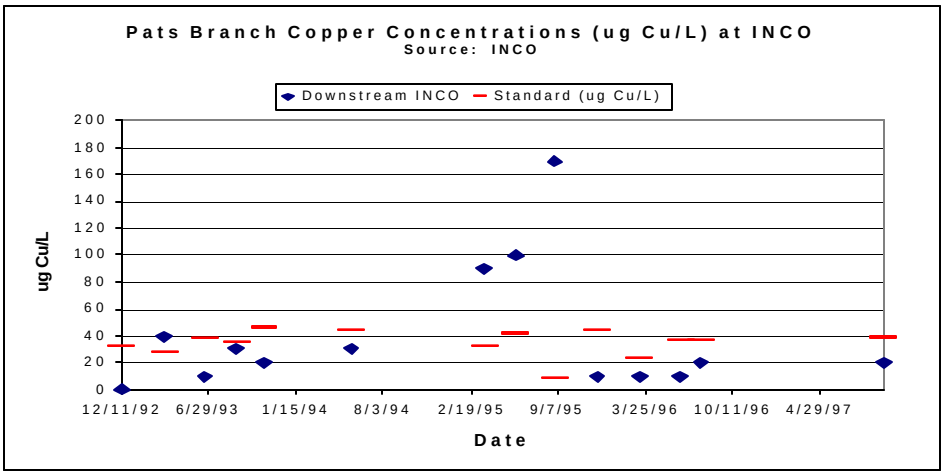

Figure 4.7 Pats Branch water quality conditions downstream of INCO of site: Copper (INCO)

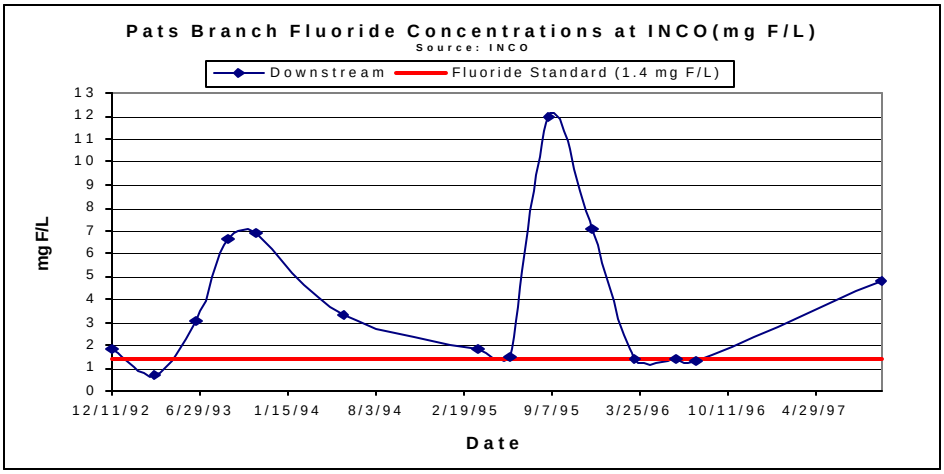

Figure 4.8 Pats Branch water quality conditions downstream of INCO of site: Fluoride (INCO)

Comparison of the upstream and the downstream water quality conditions, shown in Table 4-2, indicates the following:

- On only two occasions the downstream concentration of copper and on only one occasion the fluoride concentrations were less than the upstream concentration, indicating that dilution from runoff or seepage may be taking place in the concert pipe below the INCO site.

- The ratios of the downstream-to-upstream concentrations of copper and fluoride indicate that copper concentration is less likely to increase while the fluoride concentration is more likely to increase.

- The range of copper concentration increase was from 0% to 300%; for fluoride the range of concentration increase was from 27% to 700%. This may indicate that INCO's on-site tailing storage area is contributing to the fluoride concentration in Pats Branch.

- Recent downstream-to-upstream ratios (post landfill closure) indicate that the copper concentration increase is not significant and fluoride concentration increase was substantially reduced.

Table 4-2. Comparison of Copper and Fluoride Concentrations Upstream and Downstream of INCO Site

	Copper		Fluoride	
Date	Ratio of Downstream to Upstream concentration	% Increase	Ratio of Downstream to Upstream concentration	% Increase
12/11/92	4.00	300.0%	1.68	68.2%
3/17/93	1.33	33.3%	0.97	-2.7%
6/18/93	0.50	-50.0%	1.27	27.2%
9/2/93	3.00	200.0%	3.24	224.4%
11/3/93	0.50	-50.0%	2.02	102.3%
5/20/94	3.00	200.0%	2.05	104.9%
3/23/95	1.00	0.0%	1.80	80.0%

Date	Copper		Fluoride	
	Ratio of Downstream to Upstream concentration	% Increase	Ratio of Downstream to Upstream concentration	% Increase
6/2/95	2.00	100.0%	1.95	94.8%
9/1/95	1.13	13.3%	8.00	700.0%
12/6/95	1.00	0.0%	2.54	153.6%
3/14/96	1.00	0.0%	1.65	64.8%
6/12/96	1.00	0.0%	1.67	66.7%
8/1/96	2.00	100.0%	1.46	46.1%
9/23/97	1.00	0.0%	4.00	300.0%

4.2.5 Critical Flow Conditions

Using flow and water quality data provided by INCO, the critical conditions for copper and fluoride were determined. Figures 4.9 through 4.12 show the variation of instream copper and fluoride concentration with flow monitored at locations upstream and downstream of the INCO plant. Based on these figures, it can be concluded that

- At both sampling sites, low-flow conditions appear to be the critical condition for water quality standard violation for fluoride.

- Due to the type of copper standards used, no critical flow condition can be defined for copper violations.

Location: INCO, Upstream
Pollutant: F
Data from: 12/11/1992 to 9/23/1997 (14 Observations)
Number of Violations: 6

Flow Range	# Obs	Flow (cfs)			Concentration (ug/L)			# Viol
Percentile	*Count*	*Mean*	*Min*	*Max*	*Mean*	*Min*	*Max*	*Count*
0-10	2	24.0	7.8	40.2	2.0	1.5	2.1	2
10-20	1	48.0	48.0	48.0	2.8	2.8	2.8	1
20-30	1	60.0	60.0	60.0	1.2	1.2	1.2	0
30-40	2	148.2	96.0	200.4	1.8	1.0	3.4	1
40-50	1	210.0	210.0	210.0	0.9	0.9	0.9	0
50-60	1	480.0	480.0	480.0	1.6	1.6	1.6	1
60-70	2	582.0	564.0	600.0	1.7	0.8	2.4	1
70-80	1	642.0	642.0	642.0	0.9	0.9	0.9	0
80-90	1	1200.0	1200.0	1200.0	1.1	1.1	1.1	0
90-100	2	7017.0	2004.0	12030.0	0.7	0.7	0.8	0

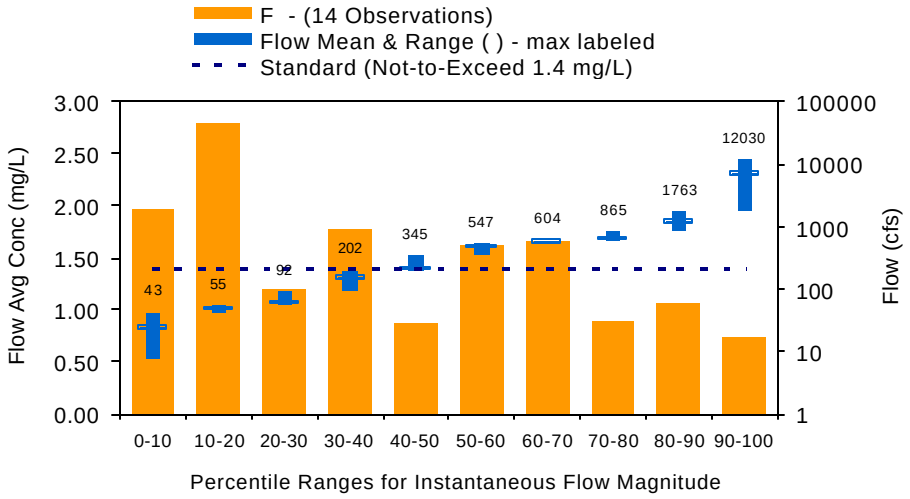

Figure 4.9 Critical conditions for fluoride violations upstream of INCO site

Location: INCO, Downstream
Pollutant: F
Data from: 12/11/1992 to 9/23/1997 (14 Observations)
Number of Violations: 11

Flow Range	# Obs	Flow (cfs)			Concentration (ug/L)			# Viol
Percentile	*Count*	*Mean*	*Min*	*Max*	*Mean*	*Min*	*Max*	*Count*
0-10	2	24.0	7.8	40.2	7.5	6.7	12.0	2
10-20	1	48.0	48.0	48.0	7.1	7.1	7.1	1
20-30	1	60.0	60.0	60.0	4.8	4.8	4.8	1
30-40	2	148.2	96.0	200.4	3.5	1.8	6.9	2
40-50	1	210.0	210.0	210.0	1.5	1.5	1.5	1
50-60	1	480.0	480.0	480.0	3.3	3.3	3.3	1
60-70	2	582.0	564.0	600.0	2.3	1.4	3.1	1
70-80	1	642.0	642.0	642.0	1.3	1.3	1.3	0
80-90	1	1200.0	1200.0	1200.0	1.8	1.8	1.8	1
90-100	2	7017.0	2004.0	12030.0	0.8	0.7	1.5	1

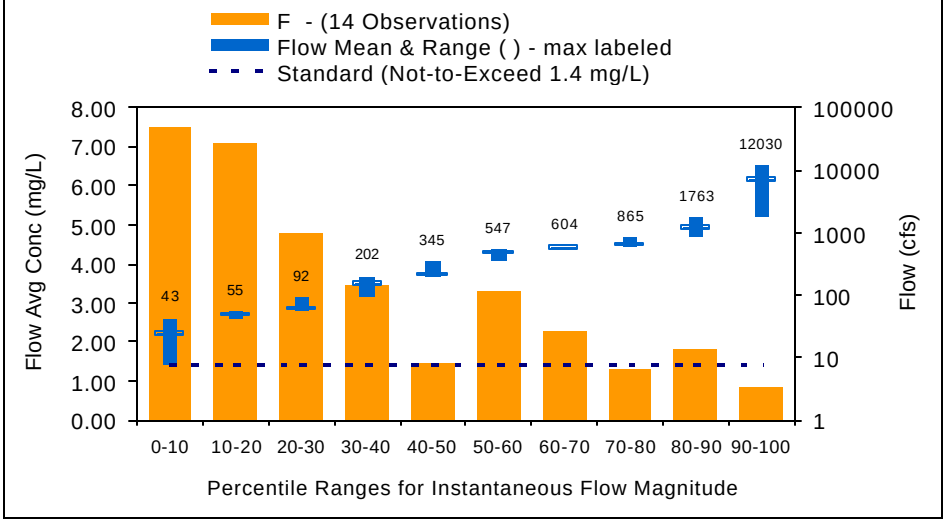

Figure 4.10 Critical conditions of fluoride violations downstream of INCO site

Location: INCO, Upstream
Pollutant: Cu
Data from: 12/11/1992 to 9/23/1997 (14 Observations)

Flow Range	# Obs	Flow (cfs)			Concentration (ug/L)			# Viol
Percentile	*Count*	*Mean*	*Min*	*Max*	*Mean*	*Min*	*Max*	*Count*
0-10	2	24.0	7.8	40.2	32.8	10.0	150.0	0
10-20	1	48.0	48.0	48.0	10.0	10.0	10.0	0
20-30	1	60.0	60.0	60.0	20.0	20.0	20.0	0
30-40	2	148.2	96.0	200.4	73.8	40.0	90.0	0
40-50	1	210.0	210.0	210.0	10.0	10.0	10.0	0
50-60	1	480.0	480.0	480.0	10.0	10.0	10.0	0
60-70	2	582.0	564.0	600.0	15.2	10.0	20.0	0
70-80	1	642.0	642.0	642.0	10.0	10.0	10.0	0
80-90	1	1200.0	1200.0	1200.0	0.0	0.0	0.0	0
90-100	2	7017.0	2004.0	12030.0	32.9	30.0	50.0	0

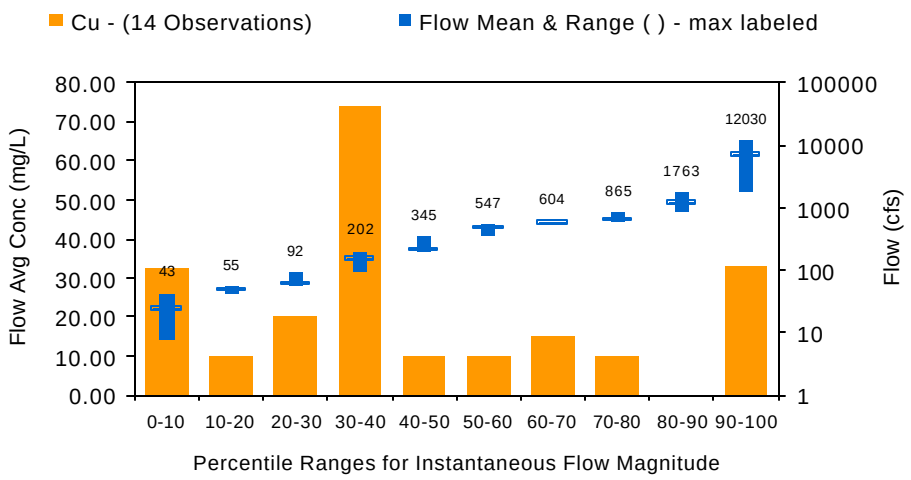

Figure 4-11. Critical conditions of copper observations upstream of INCO site

Location: INCO, Downstream
Pollutant: Cu
Data from: 12/11/1992 to 9/23/1997 (14 Observations)

Flow Range	# Obs	Flow (cfs)			Concentration (ug/L)			# Viol
Percentile	*Count*	*Mean*	*Min*	*Max*	*Mean*	*Min*	*Max*	*Count*
0-10	2	24.0	7.8	40.2	52.8	30.0	170.0	0
10-20	1	48.0	48.0	48.0	10.0	10.0	10.0	0
20-30	1	60.0	60.0	60.0	20.0	20.0	20.0	0
30-40	2	148.2	96.0	200.4	67.3	20.0	90.0	0
40-50	1	210.0	210.0	210.0	10.0	10.0	10.0	0
50-60	1	480.0	480.0	480.0	30.0	30.0	30.0	0
60-70	2	582.0	564.0	600.0	10.0	10.0	10.0	0
70-80	1	642.0	642.0	642.0	20.0	20.0	20.0	0
80-90	1	1200.0	1200.0	1200.0	0.0	0.0	0.0	0
90-100	2	7017.0	2004.0	12030.0	48.6	40.0	100.0	0

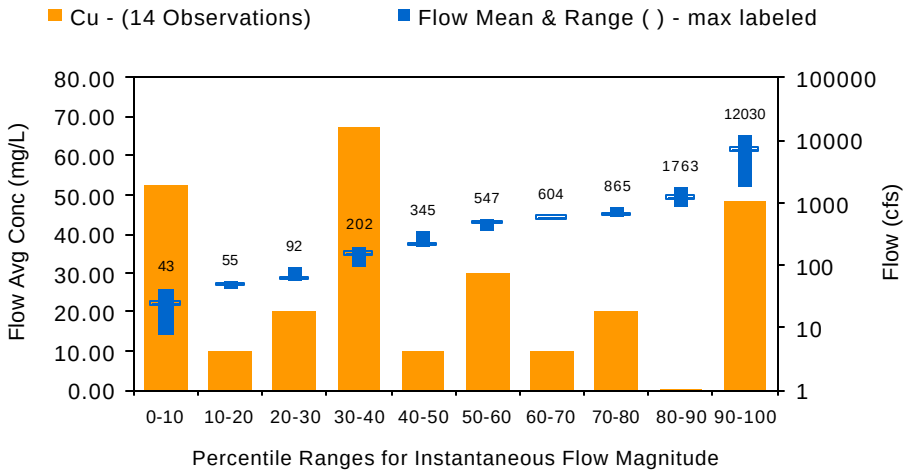

Figure 4-12. Critical conditions of copper observations downstream of INCO site

4.2.6 Monitoring Wells Water Quality Data

Monitoring well data were provided by the City of Huntington and INCO. Figure 4.13 is a map showing the locations of the monitoring wells. Water quality data from monitoring wells were analyzed to characterize potential pollutant migration trends and to investigate whether groundwater is a potential source of contamination.

The maximum and the minimum observed copper and fluoride concentrations were determined and are presented in Table 4-3. The table shows that the maximum observed copper concentration in the wells surrounding the landfill ranged from 37 Og/L to 50 Og/L. The maximum fluoride concentration ranged from 0.36 mg/L to 7.14 mg/L. For the wells monitored by INCO, the maximum range of copper concentration ranged from 30 Og/L to 260 Og/L and the maximum fluoride concentration ranged from 0.22 mg/L to 7.35 mg/L. It appears that wells with high copper concentrations are located down gradient from the landfill with a potential plume migrating toward Pats Branch. Continued monitoring and assessment of the wells to assess amplitude of this seepage to surface water that may result from the migration of this plume.

Table 4-3. Summary of Monitoring well data

Source	Well No.	Monitoring Period	No. of samples		Copper Og/L		Fluoride mg/L	
			Cu	Fl	Min	Max	Min	Max
City of Huntington	MW-1	3/94 - 3/00	19	9	10	50	0.11	0.36
	MW-2	3/94 - 3/00	18	8	10	50	0.10	1.21
	MW-3	2/93	4	1	10	60	4.00	4.00
	MW-4	2/93 - 3/00	23	10	10	37	0.15	0.56
	MW-5	2/93 - 3/00	23	9	10	50	2.70	7.14
INCO	MW-1	11/91-8/92	4	4	30	40	0.18	0.22
	MW-1A	3/93-6/98	19	19	10	140	0.08	2.05
	MW-2	11/91-8/92	4	4	30	260	0.86	1.95
	MW-2A	12/92-6/98	23	23	10	230	0.07	1.40
	MW-3	11/91-8/92	4	4	60	130	0.26	0.37
	MW-3A	3/93-6/98	17	17	10	60	0.07	0.29
	MW-4	11/91-8/92	4	4	30	30	6.50	7.35
	MW-4A	12/92-6/98	23	23	10	110	0.29	2.05

Insert Figure 4.13 (Map showing locations of monitoring wells

5. Frequency of Water Quality Standard Exceedance and Violation Analysis

Table 5-1 is a summary of the frequency of exceedance of copper and fluoride water quality standards. The table shows that:

- Instream total copper concentrations do not violate the water quality standard downstream of the landfill for the monitoring period from March 1998 to September 1999.
- Based on the City of Huntington water quality data, downstream of the landfill copper concentration violated the water quality standard 4 times (24%) during the November 1990 through May 2000 monitoring period.
- The instream copper concentration in the segment of Pats Branch downstream of the landfill and upstream of the INCO site shows no violation of the water quality standard for the monitoring period from November 1999 to March 2000.
- Upstream of the INCO site the water quality standard for copper was violated 4 times (27%) for the monitoring period from December 1992 to December 1998.
- Downstream of the INCO site, the water quality standard of copper was violated 4 times (29%) for the monitoring period from December 1992 to September 1999.
- Based on the City of Huntington water quality data, downstream of the D.H. Landfill, the fluoride standard was violated one time (5%) for the monitoring period from November 1990 to May 2000.
- At the monitoring station located between the landfill and the INCO site, the WVDEP data indicate that fluoride does not violate the water quality standard.
- The water quality data indicate the fluoride standard was violated upstream of the INCO site 40% of the time and downstream of the INCO site 79% of the time.

Table 5-1. Instream Water Quality analysis for Pats Branch

Sample Location		Copper			Fluoride			
	Period	# Obs.	# Viol.	%	# Obs.	# Viol.	%	Source
Headwaters, Pats Branch, downstream landfill	3/98-9/99	8	0	0	0	0	0	Huntington, WV Sanitary Board
Headwaters, Pats Branch, downstream landfill	11/90-5/00	17	4	24	21	1	5	Huntington, WV Sanitary Board
Pats Branch, between headwaters and INCO	11/99-3/00	14	0	0	12	0	0	WVDEP
Pats Branch, Upstream INCO	12/92-12/98	14	4	27	15	6	40	INCO
Pats Branch, Downstream INCO	12/92-9/97	13	4	29	14	11	79	INCO

Violations of the copper standard downstream of the landfill occurred on the following dates: February 1991, February 1992, July 1994, and August 1995. This clearly indicates that all of the copper violations occurred prior to the landfill closure and capping in 1995.

To elucidate the impact of the Dietz Hollow Landfill closure on the water quality conditions, the water quality conditions were re-evaluated after closure and capping . Table 5-2 is a summary of the analysis. It indicates that from 1995 to the present, the fluoride violations upstream of the INCO site were reduced from 40% to 22%, and downstream of INCO site, the violations were reduced from 79% to 75%. This indicates that landfill closure had a significant impact on reducing the water quality standard violation upstream of the INCO site but had no significant effect of the frequency of violation downstream of the INCO site. The only violation of the fluoride standard downstream of the landfill occurred in 3/97. However, the water quality monitoring data upstream of INCO indicated that the majority of the fluoride violations occurred prior to 1995.

Table 5-2. Water Quality for Pats Branch Watershed

Sample Location	Period	Copper			Fluoride			Source
		# Obs.	# Viol.	%	# Obs.	# Viol.	%	
Headwaters, Pats Branch, downstream landfill	3/98-9/99	8	N/A[1]	N/A	8	0	0	Huntington, WV Sanitary Board
Headwaters, Pats Branch downstream landfill	12/96-5/00	3	0	0	13	1	8	Huntington, WV Sanitary Board
Pats Branch, between headwaters and INCO	11/99-3/00	12	0	0	12	0	0	WVDEP
Pats Branch, Upstream INCO	3/95-12/98	5	0	0	9	2	22	INCO
Pats Branch, Downstream INCO	3/95 -9/97	5	0	0	8	6	75	INCO

1 - Hardness data not available; not applicable to the standard

6. Summary and Conclusions

Based on the available instream water quality data, monitoring well data, and analysis of frequency and violations severity of water quality standard, the following conclusions can be drawn regarding copper and fluoride conditions in Pats Branch.

Copper:

- Copper water quality standard violations were confirmed (Table 5-1, Figures 4-5 and

4-7).

- The critical conditions for copper violations could not be identified (Figures 4-11 and Figure 4-12).
- Copper water quality standard violations were observed down stream of the landfill, upstream and downstream of INCO site. However all of these violation occurred prior to 1995 (Table 5-2).
- After landfill closure (1996 to present), Pats Branch instream water quality data showed no violation of copper standard at any of the stations monitored by WVDEP, INCO, and City of Huntington (Table 5-2).
- The landfill closure and capping provided a significant improvement of water quality, by eliminating copper water quality violations in Pats Branch. All copper data collected post landfill closure were below water quality standards.

Fluoride:

- Fluoride water quality standard violations were confirmed (Table 5-1, Figure 4-6 and Figure 4-8).
- The critical conditions for fluoride violations were identified as low flow conditions (Figures 4-9, and 4-10).
- After landfill closure (1996 to present), Pats Branch instream water quality data indicated a decline in the frequency of fluoride standard violations, only one fluoride violation was observed. This violation occurred in March 1996, following landfill closure, which could be attributed to residual or unusual disturbance of fill materials (Table 5-2).
- During the period 1997 to 2000, there were no observed fluoride violations in the segment of Pats Branch extending downstream of the landfill to the INCO site. This based on INCO, WVDEP, and the City of Huntington monitoring data (Table 5-2).
- The landfill closure and capping had a significant impact, by reducing the frequency of fluoride violation upstream of the INCO site. The frequency of violations was reduced by 50% (Table 5-1 and 5-2).
- Downstream of the INCO site, the increase in the instream concentration indicates that INCO's tailing storage area may be contributing to the fluoride loading in Pats Branch.

7. Recommendations

Based on review of the available data and information and the above findings and conclusions, the following recommendations can be made:

1. It appears that Pats Branch is no longer impaired due to high copper concentrations. The landfill closure and capping played a major role in reducing the instream copper concentrations below standard levels. Therefore 303(d) de-listing of Pats Branch for copper is recommended.

2. The instream fluoride concentration in the upper segment of Pats Branch, extending between the landfill and INCO site, were also effected by the landfill closure and capping. No violations of the fluoride water quality standard were observed since 1997. Therefore it can be

considered that the Dietz Hollow landfill is no longer contributing to the fluoride loading in Pats Branch.

3. For the segment of Pats Branch that is directly beneath INCO property, it appears that the tailing storage area is contributing to the fluoride loadings in Pats branch. Fluoride loadings can be entering Pats Branch either through direct runoff (NPDES permitted pipe) or seepage through breaks or cracks in the concrete pipe. Therefore it is recommended that monitoring the water quality conditions upstream and down stream of the site be continued, evaluating the integrity of the concrete pipe, and eliminating any seepage or over flow from the tailing storage area.

4. Monitoring Recommendations:
    1. Continue monitoring for permit compliance especially at discharge locations including INCO Plant and Dietz Hollow landfill
    2. Continue instream water quality monitoring at existing locations including downstream of the landfill, two location upstream of INCO site and downstream of INCO site.
    3. Recommended frequency of instream water quality monitoring is monthly during the first year and quarterly thereafter, unless violations were observed.

References

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