

Effects of Precipitate on Aquatic Biota

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Dissolved earth metals, especially iron and manganese, draining into surface waters and forming precipitates is common near landfills and other soil disturbances. In addition to anthropogenic impacts, precipitates can also originate from natural sources. Without an effective collection and treatment system, leachate from landfills can reach groundwater and create conditions conducive to dissolving of earth metals. Often, groundwater reaches surface waters, forming precipitates and causing environmental and human health issues.

Metal toxicity is not necessarily the primary cause for the declining condition of the macroinvertebrate community in areas affected by precipitates. Wellnitz et al. (1994) hypothesize that other reasons include:

-smothering
-behavioral avoidance
-inability to use iron bacteria as food

With these points in mind we will attempt to determine at what point the physical impacts of precipitates cause impairment of the aquatic biota.

Methods: Precipitates were collected using frosted microslides and granite blocks of the same size. Both were attached to bricks and left in precipitate areas for 28-30 days then rinsed into 250 mls of deionized water to find mg/m2. This is an experimental method. Macroinvertebrate and fish samples were collected along with water chemistry and habitat observations above and below several leachate sources.

Fish communities were less responsive to precipitates and for the purposes of this poster, results and discussion regarding them will be omitted.

Sites:

Rodman Brook, in Morristown, is located near the Lamoille Landfill which was active until 1992. Groundwater monitoring has occurred since 1979 and shows a general increase in contamination at the monitoring wells most down gradient and closest to the brook. Precipitates have also been noted.

Inn Brook, in Stowe, is the only site examined here not in proximity to a landfill. The brook re-emerges from beneath a long parking lot culvert and deposits an iron precipitate.

Barney Brook, in Bennington, drains both an EPA superfund landfill site and a construction and demolition landfill. Recent creation of a wetland (2000) between the primary sampling site and the landfills may mask potential impacts. Existence of this wetland was unknown to us until our most recent sampling. Battery manufacturing waste, an unknown amount of lead sludge, and a 47,780 drum equivalent (~2.6 million gallons) of hazardous waste were disposed of in unlined lagoons (EPA Superfund Site Progress File – 5 Year Review). The site underwent remedial action in 2000 with the wetland possibly a part of the project. Barney Brook appears affected by a manganese precipitate.

Smith Brook, in Randolph, is near an open dump site that was used until the early 70s. A shallow ravine draining towards the brook was filled with waste and was later found unsuitable as a sanitary landfill by the state.

Table 1. Macroinvertebrate metrics for all sites sampled in 2006.

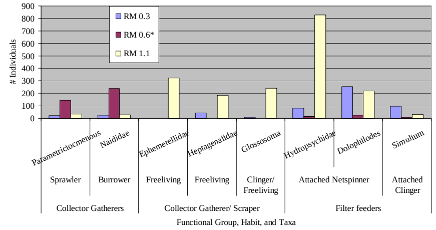
Location	River Mile	Density	Richness	EPT	BI	Oligochaeta %	EPT/ EPT&Chiro	PMA Order	PPCS-Funct. Group	Community Assessment
Rodman Brook	0.3	**1550**	**41.5**	**20.0**	3.46	1.7	0.59	70	0.39	**G-Fair**
	0.6	**1248**	**39.5**	**15.0**	**4.50**	27.5	0.35	44	0.38	**Poor**
	1.1	4556	**71.0**	37.0	3.08	0.6	0.75	77	0.51	**VGood**
Inn Brook	0.6	**240**	33.0	12.0	3.27	32.5	0.57	55	0.60	**Poor**
	0.7	412	36.0	13.0	3.09	1.7	0.65	57	0.54	**Fair**
Barney Brook	0.3	1924	31.0	**14.0**	4.12	0.0	0.96	87	0.35	**G-Fair**
	1.5	**162**	**11.0**	**5.0**	**4.64**	0.0	0.92	**45**	**0.17**	**Poor**
	2.2	640	41.0	21.0	2.39	0.3	0.91	84	0.68	**Exc**
	2.7	790	41.0	22.0	1.36	0.3	0.84	73	0.64	**Exc**
Smith Brook	0.2	**433**	45.0	22.0	3.54	15.0	0.57	65	0.56	**Fair**
	0.3	2860	46.0	21.0	4.16	1.3	0.80	66	0.54	**Good**
Small High Gradient ALS Class B Standard		**>300**	**>27.0**	**>16.0**	**<4.50**	**<12.0**	**>0.45**	**>45**	**>0.40**	

Colored sites are precipitate impacted sites

Bold Denotes significant change in metric

Red Denotes metric failed standard

Figure 1. Some notable taxa from **Rodman Brook** in 2006 appearing most affected by the leachate and precipitate. RM 0.6 and 1.1 represent an average of 2 samplings and RM 0.3 represents 1 sampling. *Precipitate impact begins



- Taxa increasing in areas of iron precipitate either thrive with lack of competition/predation or are able to consume iron bacteria
- Mayflies possibly most sensitive to suffocation/toxicity
  - *E. subvaria* affected by iron at as low as 320 ug/l (Warnick and Bell 1969)
- Net spinners collection disrupted by precipitate

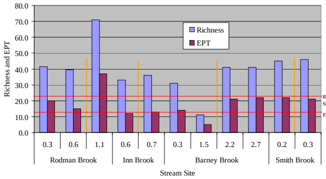
Table 2. Results for precipitate collection at Rodman and Inn Brook. Replicates were averaged for Rodman Brook. **Bold** indicates values of note. *No standards exist for this collection method. PQL = Practical Quantifiable Limit

		Rodman Brook			Inn Brook		Blank	
		0.3	**0.6**	**1.1**	**0.6**	**0.7**	**Slide**	**Granite**
Antimony	mg/m^2	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Arsenic	mg/m^2	1.34	2.18	0.07	0.21	0.2	0.1	<PQL
Beryllium	mg/m^2	0.15	0.22	0.17	<PQL	<PQL	<PQL	0.15
Cadmium	mg/m^2	0.35	0.32	<PQL	<PQL	<PQL	<PQL	<PQL
Chromium	mg/m^2	12.23	6.43	2.85	0.59	2.2	<PQL	<PQL
Copper	mg/m^2	2.40	3.13	1.58	<PQL	<PQL	<PQL	4.95
Iron	mg/m^2	**3326.9**	**5491.0**	**1861.8**	**1783.0**	**498.7**	<PQL	**1051.7**
Lead	mg/m^2	18.93	26.42	16.80	<PQL	<PQL	<PQL	11.41
Manganese	mg/m^2	**275.8**	**436.7**	**373.4**	63.4	29.1	<PQL	**205.4**
Mercury	mg/m^2	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Nickel	mg/m^2	7.21	4.40	2.07	0.57	1.6	<PQL	0.65
Selenium	mg/m^2	0.08	0.12	0.10	0.02	0.02	<PQL	0.05
Silver	mg/m^2	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Thallium	mg/m^2	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Zinc	mg/m^2	19.96	24.29	15.05	2.39	2.0	0.2	15.50

- Some leaching from granite into Rodman samples
- High background levels in the Rodman watershed and some contamination may account for elevated results
- Mobilization of metals due to reducing conditions created by landfill
  - •Reducing (anaerobic) conditions created by decomposition organic-rich waste
- Lamoille Landfill (Rodman Brook) groundwater chemistry shows increasing As, Fe, Mn, and Cl at the most downgradient wells since capping in 1979 (VT SWD)
- Other impacts to Inn Brook besides precipitates

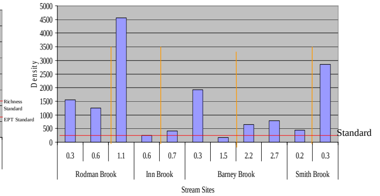
* Orange line indicates beginning of precipitate for **Figures 2-5**

Figure 2. Macroinvertebrate richness and EPT richness for 2006



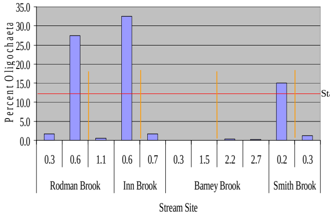
- Richness and EPT typically decline within the disturbed area
- Barney Brook deteriorates over time

Figure 3. Macroinvertebrate community densities for 2006



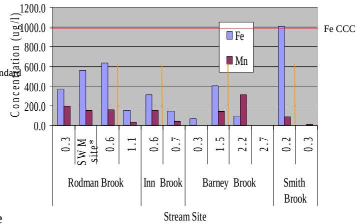
- For most streams density is affected in precipitate impacted areas
- Barney Brook densities decrease since first sampling in 2003
- Densities at lower Rodman sites are largely made up of oligochaeta and chironomidae

Figure 4. Percent of the macroinvertebrate community made up of tolerant oligochaeta (mostly Naididae) for 2006



- % oligochaeta increases in areas of iron precipitate
- We hypothesize that Naidid worms are one of the few taxa that successfully feed on iron-associated bacteria
- Barney Brook is largely affected by a manganese precipitate and conditions are less favorable for oligochaeta

Figure 5. Dissolved Fe and Mn concentrations. Only Rodman 0.6, 1.1, and Barney 1.5 represent >1 sample. * Solid Waste Monitoring (SWM) includes average October samples since 1987



- Only Smith Brook exceeds the chronic criteria for iron (single sample)
- Toxic effects on some taxa below 1000 ug/l (Warnick and Bell 1969)
- Landfill conditions mobilize metals present in the soils

Conclusions:

- ➢ Obvious impacts to the macroinvertebrate community, especially in regards to richness, EPT richness, density, and % tolerant taxa (oligochaeta)
- ➢ Barney Brook probably affected by the recent creation of a wetland and the resulting mobilization of metals
- ➢ Landfill leachates appear to be the primary source of iron and manganese and resulting precipitates
- ➢ Combination of physical impacts/metal toxicity affecting sensitive taxa
- ➢ Precipitate collection method should be refined and more data collected before attempting to make a more definitive statement as to the level of impairment vs. amount of precipitate

Further Study

1. Analysis of precipitates as solids
2. Continued precipitate collection using slides and at intervals downstream from source and correlate this with return/loss of macroinvertebrate diversity
3. Taxa tolerance to precipitate physical impacts/toxicity
4. More rigorous chemical sampling effort throughout summer and fall

References

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Warnick, S.L. & H.L. Bell, 1969. The acute toxicity of some heavy metals to different species of aquatic insects. *J. Wat. Pollut*. Cont. Fed. 41: 280-284.

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