Darrin Fresh Water Institute
AT LAKE GEORGE

ANALYSIS OF SEDIMENTARY METALS ASSOCIATED WITH STORMWATER RUNOFF IN THE LAKE GEORGE BASIN

prepared for

The Lake George Association
Lake George, New York

Prepared by

Lawrence W. Eichler
Research Scientist
&
Erik Posner
Research Associate

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DFWI Technical Report 97-4

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Executive Summary

Stormwater runoff and the nutrients and pollutants that it carries is recognized as a major component of non-point source pollution. Runoff of stormwater from urban areas is a major pathway for chemicals from land into receiving waters, where it limits and impairs beneficial uses. Elevated levels of nitrogen, carbon, phosphorus, suspended sediments, metals and fecal bacteria, all of which are generally associated with particulate materials, are observed in urban runoff. One of the most obvious impacts of stormwater runoff is the sediment transported to the lake. This sediment forms deltas at the outlets of numerous streams within the basin. These deltas have been growing at a substantial rate over the last 20 years.

Sediments can be removed from the lake by dredging once they have been deposited. One of the limitations of dredging as a management technique for sedimentation is the disturbance and possible release of toxic materials currently deposited in the lake bottom sediments. Without information on sediment characteristics and possible contaminants, no permits can be obtained for in-lake sediment removal.

In the current investigation, sediment samples were collected to evaluate the concentrations of several metals in the sediments of stream deltas in urbanized areas and compare the results from these sites to other areas of the lake bottom. For this purpose, four delta areas were chosen. Two control sites were also selected. Control sites were selected to provide comparable sediment types, water depth, and wave action to stream deltas and to be remote from any marina locations.

The geochemistry of bottom sediment was related to the proximity of the stream outfalls to the sampling points. Coarse-grained sediments (sand and gravel) were typically found near the stream mouth in shallow waters. Finer grained, organic rich materials were generally located in deeper waters more remote from the tributary inlet. The geochemical data provided in this report can be used to develop estimates for dredging, including type of equipment, dewatering needs, and disposal costs.

The areas most likely to be the subject of dredging operations, shallow waters at the mouths of streams, were generally coarse-grained materials low in heavy metal concentrations. The only exception was the copper concentrations at Finkle Brook delta. Copper levels in the shallow sediments of Finkle Brook delta fall into the *moderate contamination* category which may result in permit restrictions for dredging operations in this area. Additional investigations are warranted prior to consideration of sediment removal via dredging. Deeper water dredging projects, in water depths greater than two meters, in the Sheriffs Dock and West Brook areas will also encounter moderate and high contamination levels of lead. These sites will require more intensive investigations prior to any dredging operations.

Background

Stormwater runoff and the nutrients and pollutants that it carries is recognized as a major component of non-point source pollution. Runoff of stormwater from urban areas is a major pathway for chemicals from land into receiving waters, where it limits and impairs beneficial uses. Historical and ongoing research programs conducted by the Darrin Fresh Water Institute and the NYS Department of Environmental Conservation have evaluated the chemical and physical characteristics of runoff waters from urbanized watersheds within the Lake George basin. Elevated levels of nitrogen, carbon, phosphorus, suspended sediments, metals and fecal bacteria, all of which are generally associated with particulate materials, are observed in urban runoff. One of the most obvious impacts of stormwater runoff is the sediment transported to the lake. This sediment forms deltas at the outlets of numerous streams within the basin. These deltas have been growing at a substantial rate over the last 20 years.

Sedimentation accelerates eutrophication or "lake aging" through reduced water depth, disturbs habitats for vegetation and wildlife and is a source of nutrients and contaminants associated with particulate materials. The large delta areas created by runoff borne sediments also pose a hazard to navigation. The principle sources of water borne sediments are erosion of disturbed soils and highway friction materials. Tons of sand are placed on area highways every winter. If not captured and reclaimed, all of this material ultimately reaches the lake. Contaminants from highway runoff result from deicing salts, corrosion products from vehicles, petroleum byproducts, and degradation of highway and bridge components.

Two primary means exist for capture and reclamation of water borne sediments and the contaminants they carry. Detention basins installed in water courses upstream from the lake can capture and retain sediments prior to entry into the lake. Sediments can also be removed from the lake by dredging once they have been deposited. It is generally necessary to employ both techniques since sedimentation problems are rarely dealt with until an obvious in-lake problem exists. Once upstream sources for sediments are managed, and a number of these type projects are currently underway in the Lake George basin, in-lake management projects can be attempted. One of the limitations of dredging as a management technique is the disturbance and possible release of toxic materials currently deposited in the lake bottom sediments. Without information on sediment characteristics and possible contaminants, no permits can be obtained for in-lake sediment removal. The following report represents an effort to develop information necessary to effectively design sediment removal programs.

Methods

Sediment samples were collected to evaluate the concentrations of several metals in the sediments of stream deltas in urbanized areas and compare the results from these sites to other areas of the lake bottom. For this purpose, four delta areas were chosen. Two control sites were also selected. Control sites were selected to provide comparable sediment types, water depth, and wave action to stream deltas and to be remote from any marina locations. Sediment type, particularly the extent of organic material present may largely control: 1) the degree of metal absorption or adsorption, 2) the extent of chelation or binding of certain metals, 3) the type of benthic (bottom dwelling) organisms present and thus their feeding preferences, and 4) the background levels of metals present. Twelve core samples were collected at each of the six sites selected. Cores were collected in triplicate at differing water depths for statistical purposes. Four different water depths (1, 2, 3, and 5 meters) were selected for each site to provide information on dispersion of pollutants from the point of origin (stream mouth).

All samples were collected between September 15 and October 23, 1996. Cores were collected in polystyrene core tubes (Cadillac Plastics, Albany, NY) 10 cm in diameter. All cores were collected by SCUBA divers to assure relatively undisturbed cores. Two of the three cores from each depth were further sectioned into upper, median and lower soil horizons. These sections were used to define the extent of metal contamination on a time line relative to depth in the sediments. A total of 144 samples were produced in this way. The third core was retained intact for photographic purposes and to provide material for additional analysis. Photographs of the cores are available upon request.

The sectioned core materials were dried to constant weight (103^{o}C) and then ashed (550^{o}C) to determine total carbon content via loss on ignition. The dried samples were digested prior to analysis for common toxic metals. All sediment samples were digested for total metals analysis (APHA, 1995). Each sample was analyzed for Lead, Chromium, Zinc, Magnesium, Manganese and Copper, via atomic absorption spectroscopy at the Darrin Fresh Water Institute laboratories in Troy, New York. Sediments were also assayed for grain size (US Standard Sieve) and organic content (loss on ignition). Sediments were characterized as to metal content and results reviewed in light of federal guidelines for hazardous substances. Sediment characterization will also form the basis for future permit applications for in-lake sediment removal projects

Sample Locations

Sample sites were distributed between both the north and south basins of Lake George, with one control site in each basin. Control sites were selected to be remote from tributaries and other known contaminant sources. Each of the stream deltas has been proposed for in-lake dredging to improve navigation, reduce nutrient loading and manage nuisance aquatic vegetation.

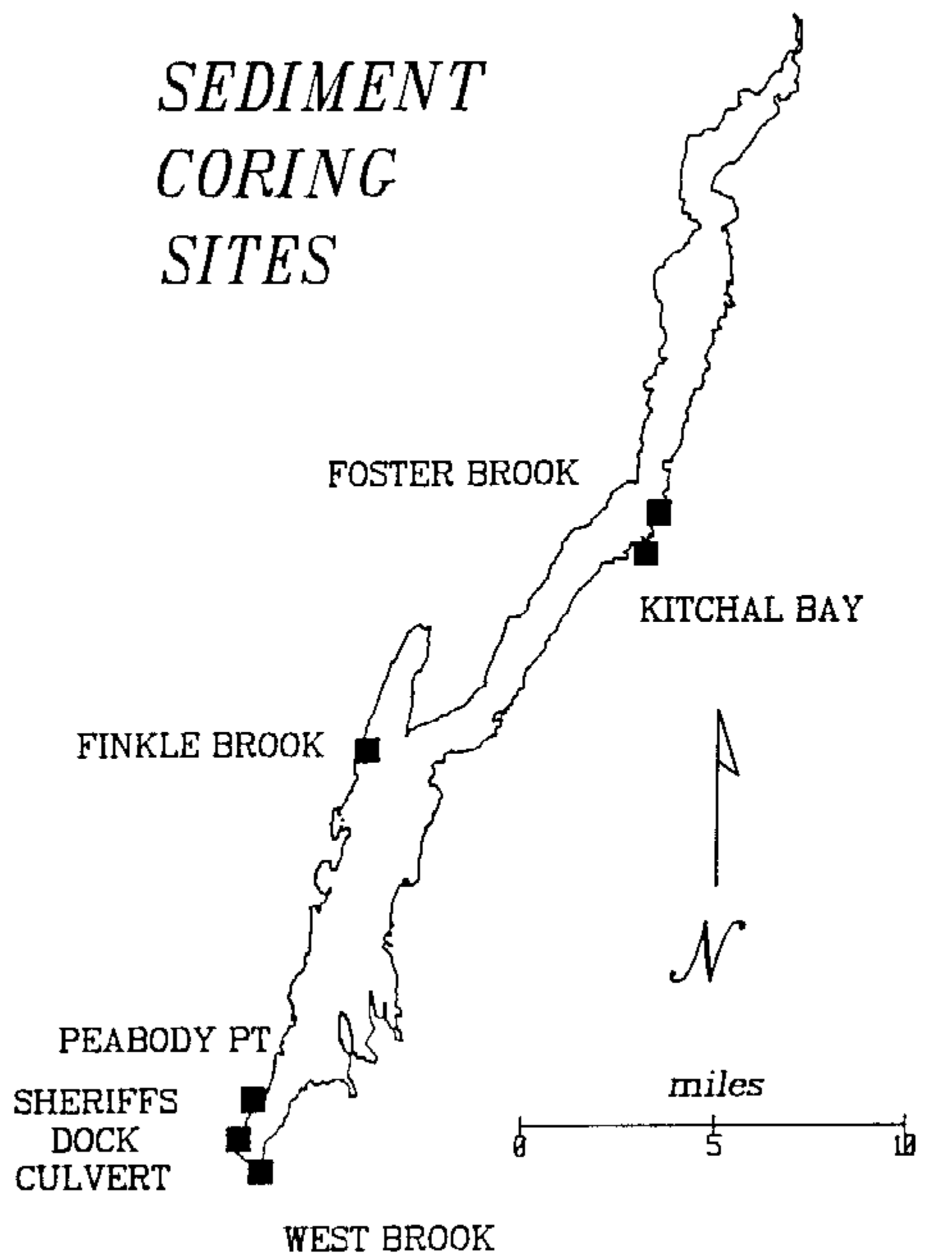
South Basin	***North Basin***
Sheriffs Dock Culvert	
Finkle Brook	Foster Brook
West Brook	Kitchal Bay (control)
Peabody Estate (control)	

Sheriffs Dock Culvert

The Sheriffs Dock Culvert (Prospect Mountain Brook) watershed is the subject of an ongoing stormwater runoff study conducted by the NYS DEC (Hyatt et al., 1995).

Located in the village of Lake George, this brook has a drainage area of 463 acres with a mean slope of 21.4%. The watershed is 65% forested with the majority of the remaining area listed as urban. Soils are primarily groups B and C, consisting of sand, loam and scattered rock outcrops. The Sheriffs Dock Culvert system drains the southern end of the village of Lake George. Aquatic plant growth in this area is dense from 2 to 5 meters depth.

Figure 1. Sample site locations within the Lake George basin.



Finkle Brook

The Finkle Brook watershed is the subject of an ongoing stormwater runoff study conducted by the NYS DEC (Hyatt et al., 1995). This brook is in the Town of Bolton and has a drainage area of 2707 acres with a mean slope of 5.1%. The watershed is 76% forested with the majority of the remaining area listed as urban (24%). Soils are primarily groups A and B, consisting of sand and loam interspersed with cobblestones and boulders. Aquatic plant growth in this area is dense from 2 to 5 meters depth.

West Brook

West Brook watershed, located in the Town of Lake George, is the subject of an ongoing stormwater runoff study conducted by the NYS DEC (Hyatt et al., 1995). This brook has a drainage area of 5444 acres with a mean slope of 19.6%. The watershed is 81% forested with the majority of the remaining area listed as urban (19%). Soils are primarily groups A and B, consisting of sand and loam interspersed with cobblestones and boulders. Aquatic plant growth in this area is dense from 2 to 5 meters depth.

Foster Brook

Foster Brook is located in the Town of Dresden. This brook drains an intensively developed subdivision (Eichlerville) and is criss-crossed with water and sewer lines for the subdivision. Developed lands are restricted to the last 200 meters of the stream course. The remainder of the watershed is densely forested with steep slopes. Bacterial contamination has been a chronic problem in this area. Aquatic plant growth in this area is dense from 2 to 5 meters depth.

Kitchal Bay

Kitchal Bay is a small bay in the Town of Dresden on the northeastern shore of Lake George. Residential development is concentrated on the lakeshore with forested lands comprising the remainder of the drainage to this bay. This site was chosen as the control site for the north basin. Several road drains (culverts) drain into the bay, but all are at least 100 meters from the sampling area. Bottom slope in the bay is gradual and aquatic vegetation is low growing and sparse.

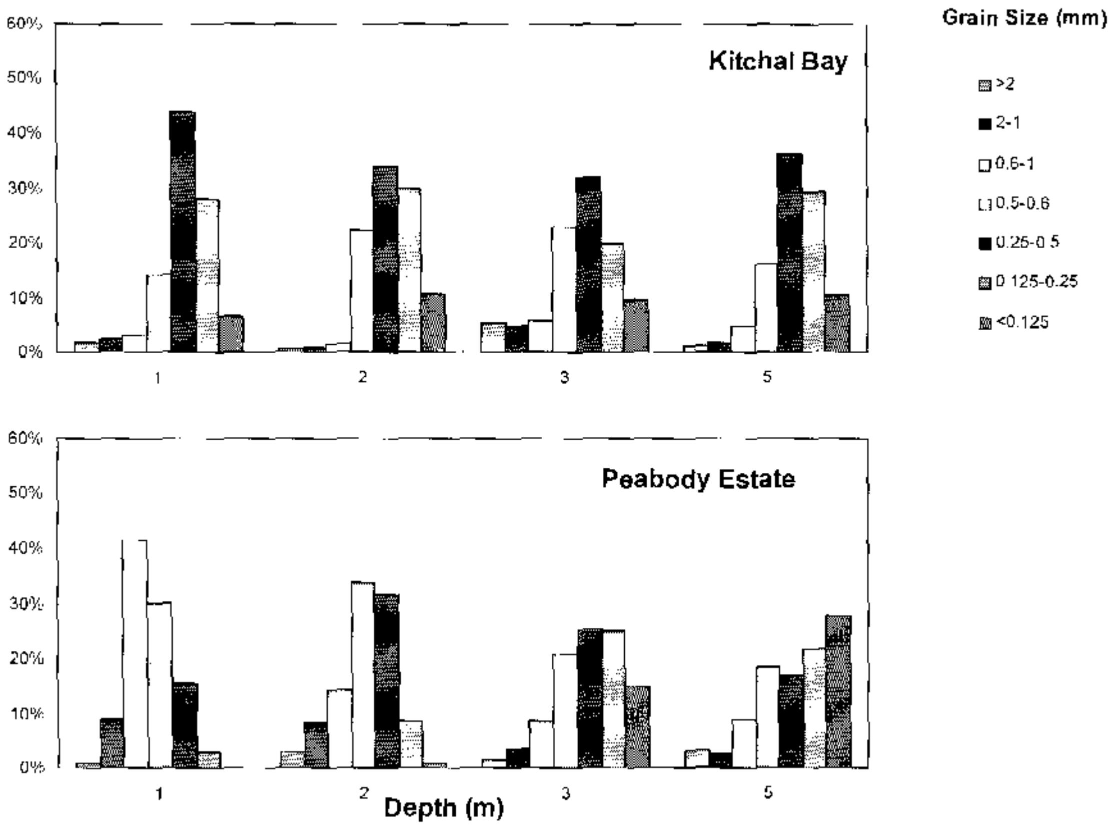
Peabody Estate

The Peabody Estate sample site is located in the Town of Lake George on the southwest shore of the lake. Density of residential development is low to moderate on the lakeshore. This site was chosen as the control site for the south basin. Several road drains (culverts) drain into the lake in this region, but all are at least 100 meters from the sampling area. Bottom slope in the area is moderate and aquatic vegetation is low growing and sparse.

Geochemistry

Grain size analysis (Figure 2) indicates that the 1 and 2 meter depth cores were commonly coarse grained materials (sand and gravel), given their location within the wave washed zone. Deposition of coarser materials near the point of entry of runoff waters is characteristic, with finer materials deposited farther away from the mouth of the tributary. Samples from 3 and 5 meters depth were typically silts and clays, with fine-grained sands also present. Core depth was variable based on the nature of the sediments present, with depth ranging from 15 to 30 cm.

Figure 2. Grain size distribution of sediments at the control sites.



At the control sites (Figure 2), Kitchal Bay produced relatively uniform grain size distributions with depth. Sediments were predominately fine sands (0.125 to 0.5 mm). This site represents a sheltered embayment, with limited wave activity. At the Peabody Estate, grain size distributions were more typical of runoff sites, with coarse sands and gravels in the wave washed zone (1 meters water depth). Finer grained sediments became more prevalent as depth increased. This is an exposed shoreline, subject to extensive wave action. The cores from the greatest water depth (5 meters) were dominated by silts and clays with grain sizes less then 0.125 mm. Organic fractions (Figure 5) at all depths were relatively low (<5% by weight) with the exception of the cores from 5 meters depth at the Peabody Estate which reached 8% of total weight (Figure 5).

Grain size distributions at the sites located at the southern terminus of the Lake George basin, West Brook and Sheriffs Dock Culvert, were typical of delta formations (Figure 3).

Figure 3. Grain size distribution of sediments at the Sheriffs Dock and West Brook.

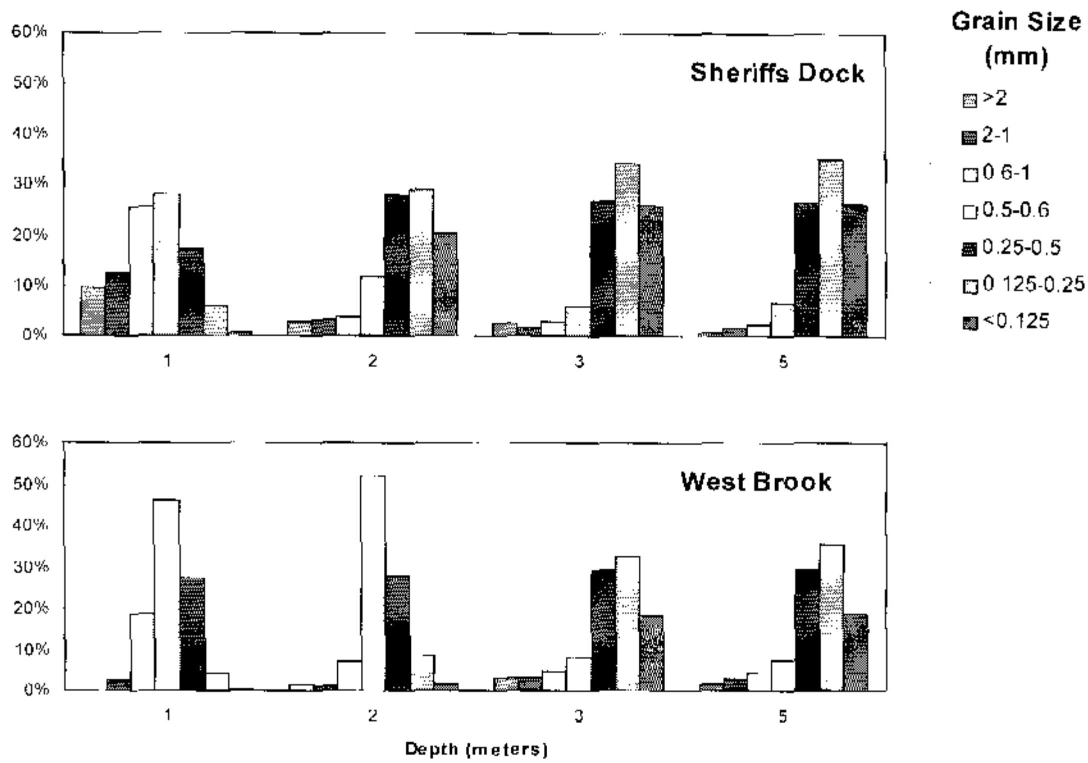
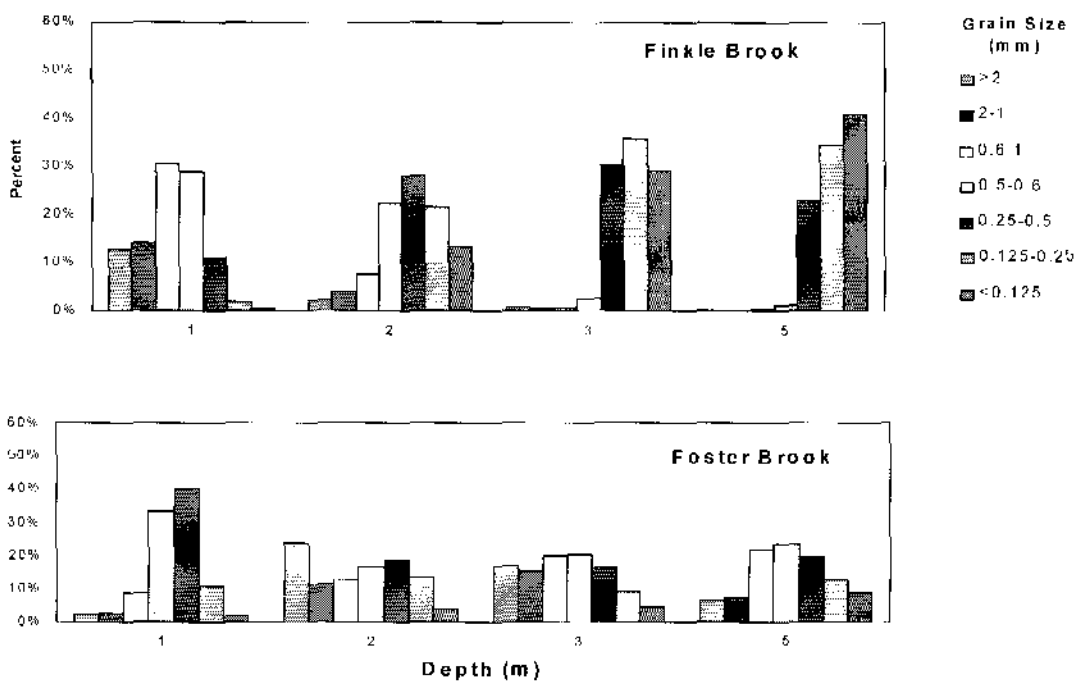


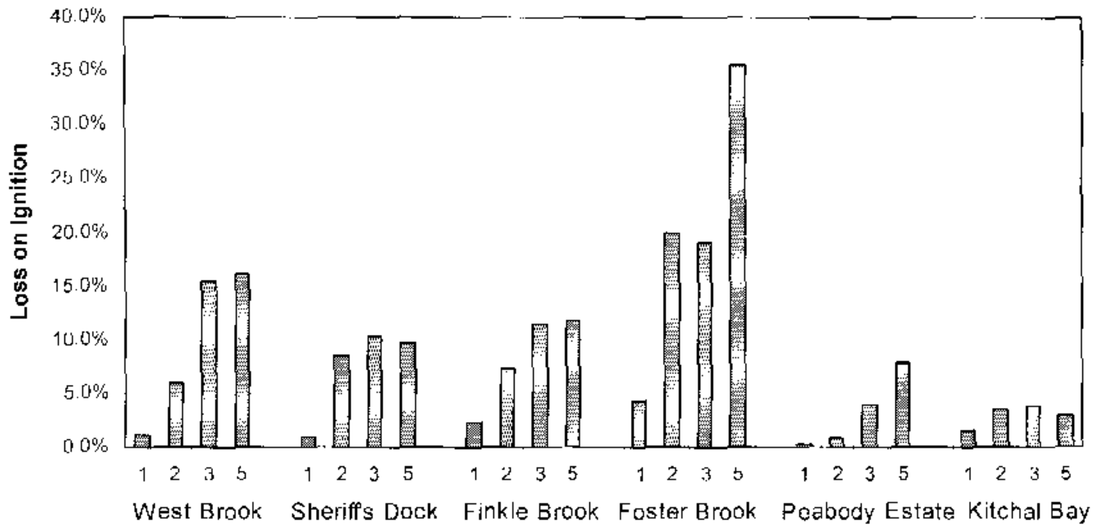
Figure 4. Grain size distribution of sediments at Finkle Brook and Foster Brook.



Coarse-grained materials were found in 1 meter water depth. Finer grained sands, silts and clays were dominant in deeper waters father from the mouth of the stream. The percent organic fractions also increased with water depth (Figure 5).

Finkle Brook produced the greatest range of sediment types of any of the sites tested. Very coarse-grained materials (Figure 4) occurred in shallow waters at the mouth of the brook. Intermediate levels of coarse and fine-grained materials were found at 2 meters water depth. Beyond a depth of 2 meters, sediments were dominated by very fine sands, silts and clays. Foster Brook was dominated by detrital particles (leaves, twigs, etc.) in deeper waters which show up as coarser grained materials.

Figure 5. Percent total carbon (loss on ignition) by site and depth for all samples.



Sediment Toxicity

Because many metals occur naturally, anthropogenic enrichment can be defined only in relation to background or natural concentrations. For the purposes of our evaluation, control sites remote from stream deltas can be used to characterize background levels of heavy metals. A comparison of average metal concentrations for all sediment samples from each site with published guidelines for metal toxicity (Table 1) indicates that the lowest effect levels were rarely reached for any of the metals analyzed. Effects levels are based on the toxicity of metals to aquatic organisms. New York State (NYS DEC, 1994) provides guidance levels for metal concentrations in dredge spoils. Lowest effects levels require restrictions on dredging and dredge spoils disposal. Severe effects levels require stringent handling of dredge spoils as hazardous wastes. One site (Finkle Brook) exceeded copper lowest effect limits. All sites, with the exception of Kitchal Bay, the north basin control site, exceeded lowest effect limits for lead, however none of the sample results approached the severe effect level.

Heavy metals tend to associate with fine-grained particles (Mayer et al., 1995). Given the settling velocity of these fine-grained particles, they typically settle further from the point of introduction than coarser grained materials. Thus, greater heavy metal concentrations

Table 1. Concentrations of selected metals in sediments from each sample site, with guidelines for levels toxic to aquatic organisms (Persaud et al., 1993) and levels requiring additional permitting requirements for disposal (NYS DEC, 1994).

					Control Sites			
	Sheriffs Dock (N=24)	West Brook (N=24)	Finkle Brook (N=24)	Foster Brook (N=24)	Peabody Estate (N=24)	Kitchal Bay (N=24)	MOEE Guidelines (DEC Guidelines) LEL[1]	SEL[2]
Analyte	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	Mg/kg	mg/kg	mg/kg
Chromium								
Mean	8.91	8.88	10.52	7.38	6.65	10.44	26	110
Std.Dev.	3.87	5.66	4.51	3.55	2.90	7.73		
Copper								
Mean	13.39	8.29	28.62	14.00	6.92	6.11	16	110
Std.Dev.	6.41	5.99	21.21	14.18	3.72	4.47	(16-110)	(>110)
Lead								
Mean	95.03	39.54	43.32	34.62	34.60	18.99	31	250
Std.Dev.	73.09	40.40	32.58	22.84	37.38	20.40	(30-100)	(>100)
Zinc								
Mean	113.58	74.34	88.63	83.04	57.94	35.48	120	820
Std.Dev.	77.15	53.05	54.71	55.86	50.22	29.83		
Manganese								
Mean	63.16	103.11	155.94	143.46	98.06	51.51	460	1100
Std.Dev.	27.78	54.45	118.69	99.73	62.89	24.83		
Magnesium								
Mean	4020.42	1736.88	2233.11	2410.58	1780.53	1169.17		
Std.Dev.	4958.10	539.5	2149.51	1355.24	591.81	574.13		

[1]LEL = lowest effect level

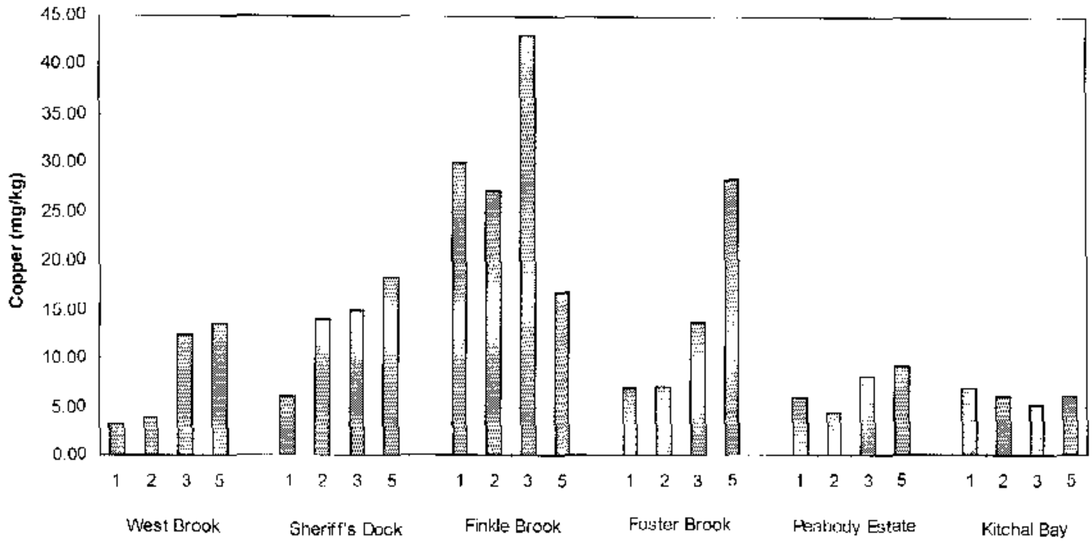
[2]SEL = severe effect level

N = number of cases

were generally associated with cores from 3 and 5 meters depth. With the exception of Finkle Brook, this is apparent for copper (Figure 6). At the Finkle Brook site, copper concentrations exceeded the lowest effects level at all depths, with the samples from 3 meters showing the greatest concentrations.

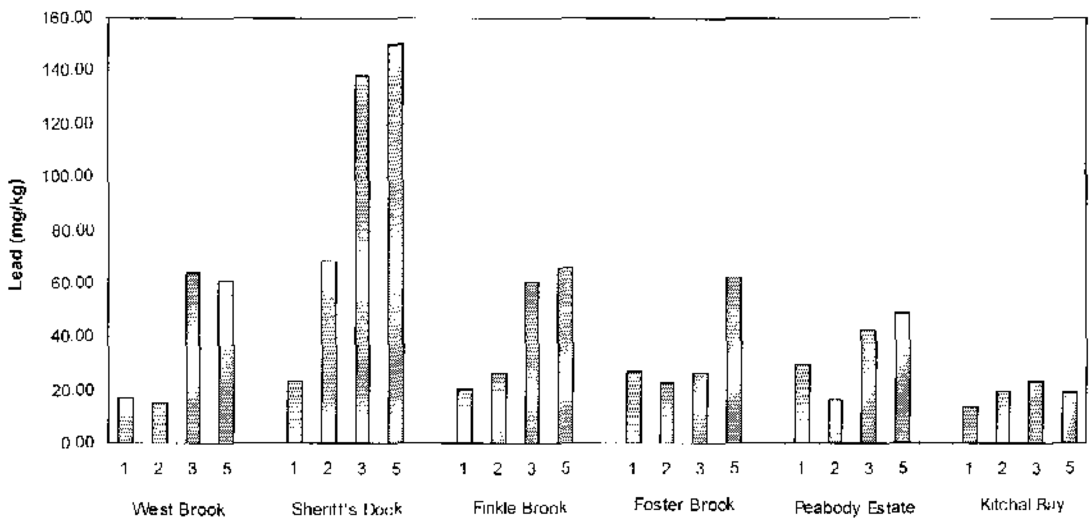
Edgecomb Pond, the headwaters for Finkle Brook, is the reservoir for the Town of Bolton. This reservoir is frequently treated with copper sulfate for algae control. The presence of elevated levels of copper compounds in the sediments of the Finkle Brook delta may be attributable to this source.

Figure 6. Copper concentrations by site and water depth for all locations.



Lead concentrations typically only exceeded lower effects levels in sediments from areas deeper than 2 meters water depth (Figure 7). These sediments were typically fine-grained silts and clays with high percentages of carbon. This phenomena is often reported in the literature. Sources for lead include fuel additives (Tetraethyl lead), coatings (lead based marine and house paints) and automotive corrosion products. Greatest concentrations of lead were observed at the Sheriffs Dock and West Brook sites. Analysis of runoff waters for these sites (Sutherland et al., 1983) reported the presence of lead associated with particulate materials.

Figure 7. Lead concentrations by site and water depth for all locations.



Conclusions

Stormwater runoff and the nutrients and pollutants that it carries is recognized as a major component of non-point source pollution. Stormwater runoff from urban areas is a major pathway of chemicals from land into receiving waters, where it limits and impairs beneficial uses. One of the most visible use impairments in the Lake George basin is the rapid growth of stream deltas which alter habitats, interfere with navigation, and serve as a source of nutrients and contaminants to the lake.

Sediments can be removed from the lake by dredging once they have been deposited. One of the limitations of dredging as a management technique for sedimentation is the disturbance and possible release of toxic materials currently deposited in the lake bottom sediments. Without information on sediment characteristics and possible contaminants, no permits can be obtained for in-lake sediment removal.

In the current investigation, the geochemistry of bottom sediment was related to the proximity of the stream outfalls to the sampling points. Coarse-grained sediments (sand and gravel) were typically found near the stream mouth in shallow waters. Finer grained, organic rich materials were generally located in deeper waters more remote from the tributary inlet. The geochemical data provided in this report can be used to develop estimates for dredging, including type of equipment, dewatering needs, and disposal costs.

Alluvial deposits at the sites evaluated were generally low in heavy metals, with concentrations well below the lowest effect levels for aquatic organisms. Certain exceptions were observed. Sediments from the delta of Finkle Brook, in the Town of Bolton, produced copper concentrations which exceeded lowest effect levels but did not approach severe effect levels. Certain heavy metal concentrations appear to correlate with depth at runoff sites, including lead, copper, and zinc. This however may be related to a correlation with sediment organic content and grain size rather than simply depth of water. A Multiple Analysis of Variance (MANOVA) design was used to review differences in metals concentrations between control and experimental sites, depth of the water column, and depth within the sediment cores (Appendix III). These correlations were not statistically significant when comparing control and experimental sites.

The areas most likely to be the subject of dredging operations, shallow waters at the mouths of streams, were generally coarse-grained materials low in heavy metal concentrations. The only exception was the copper concentrations at Finkle Brook delta. Copper levels in the shallow sediments of Finkle Brook delta fall into the *moderate contamination* category (NYS DEC, 1994) which may result in permit restrictions for dredging operations in this area. Additional investigations are warranted prior to consideration of sediment removal via dredging. Deeper water dredging projects, in water depths greater than two meters, in the Sheriffs Dock and West Brook areas also encounter moderate and high contamination levels of lead. These sites will require more intensive investigations prior to any dredging operations.

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APPENDIX I. Sediment Grain Size Data

Legend

Site Codes:	BB - Finkle Brook FB - Foster Brook KB - Kitchal Bay PE - Peabody Estate SD - Sheriffs Dock WB - West Brook
Depth Codes:	1 meter water depth 2 meter water depth 3 meter water depth 5 meter water depth
Replicate Code:	1 - First sample 2 - Second sample
Sediment Horizon Code:	T - Top segment of sediment core M - Middle segment of core B - Bottom segment of core

Lake George Sediment Study - Stream Deltas

All results are in grams dry weight

Sample ID	Grain size in mm						
	>2	2-1	0.6-1	0.5-0.6	0.25-0.5	0.125-0.25	<0.125
BB-1-2-B	4.5840	6.0250	9.5796	9.3596	6.4650	0.4550	0.1589
BB-1-2-M	8.3796	7.7055	11.6930	5.9010	1.0020	0.1038	0.0336
BB-1-2-T	8.4001	6.3919	12.6599	8.2513	2.3016	0.2683	0.0806
BB-1-3-B	3.6476	4.9010	6.0636	8.1937	4.6012	1.0997	0.3322
BB-1-3-M	0.7730	2.3322	11.4026	13.2919	2.9915	0.7432	0.2032
BB-1-3-T	1.2481	2.1487	11.4315	13.3422	5.0355	1.0042	0.3133
BB-2-2-B	0.4602	0.2630	1.5918	6.9783	2.5891	0.2874	0.0310
BB-2-2-M	0.2280	0.1916	0.3867	3.5366	4.1535	2.0311	0.5744
BB-2-2-T	0.1845	0.2221	0.8650	0.9993	8.5304	5.0825	7.0805
BB-2-3-B	0.2547	1.2301	1.3402	1.0110	3.1377	1.8717	1.0288
BB-2-3-M	0.3682	0.4194	0.7786	1.2767	2.4480	1.3676	0.4801
BB-2-3-T	0.0277	0.0800	0.1355	0.9983	0.5825	3.8800	2.1805
BB-3-2-B		0.0120	0.0163	0.0924	1.1605	1.5978	1.3474
BB-3-2-M			0.0143	0.0852	3.9456	2.9454	2.2557
BB-3-2-T	0.0041	0.0128	0.0391	0.0930	3.1287	3.3033	2.3362
BB-3-3-B	0.0420	0.0203	0.0216	0.2201	1.7676	1.9216	2.2381
BB-3-3-M	0.1456	0.0970	0.0892	0.2406	0.9432	1.3120	1.1049
BB-3-3-T		0.0010	0.0476	0.2382	3.5773	6.0615	3.9439
BB-5-2-B		0.0083	0.0093	0.0193	0.7363	1.3620	1.8080
BB-5-2-M		0.0072	0.0165	0.0172	0.2836	1.0604	2.1908
BB-5-2-T			0.0288	0.0546	1.2035	2.7247	2.6513
BB-5-3-B	0.0232	0.0512	0.1258	0.5439	13.4805	8.1416	2.6081
BB-5-3-M	0.0212	0.0030	0.0084	0.0225	0.4697	1.3131	2.2628
BB-5-3-T			0.0140	0.0730	0.8103	1.0943	0.9840
FB-1-2-B	0.2474	0.1284	0.4187	1.9313	4.8384	1.4099	0.1892
FB-1-2-M	0.1941	0.1153	0.2357	2.1481	4.2314	1.7389	0.3515
FB-1-2-T	0.0808	0.0784	0.2206	1.3880	4.0306	1.4774	0.3165
FB-1-3-B	0.3636	0.4904	1.3543	4.6755	2.5859	0.2856	0.0308
FB-1-3-M	0.2330	0.3897	1.5521	4.4846	3.0741	0.3814	0.0467
FB-1-3-T	0.2208	0.2542	1.2388	3.9054	2.6522	0.3715	0.0508
FB-2-2-B	0.3258	0.4010	1.0957	1.1876	1.3376	1.4630	0.3510
FB-2-2-M	0.3618	0.4058	0.4613	0.6364	1.9650	1.7509	0.3609
FB-2-2-T	0.7491	0.2467	0.1397	0.0940	0.0823	0.0633	0.0243
FB-2-3-B	5.0392	1.8506	3.3945	7.9109	5.6893	1.9850	0.3990
FB-2-3-M	2.6942	1.4755	2.5633	4.2226	3.6555	1.5665	0.6144
FB-2-3-T	2.0344	1.0484	0.5886	0.3411	0.4407	0.3151	0.1580
FB-3-2-B	1.2962	1.6295	3.7428	5.5625	3.6243	1.2320	0.5810
FB-3-2-M	0.9055	0.7127	0.8685	0.9466	1.1442	0.7621	0.3430
FB-3-2-T	0.8873	0.7759	0.4719	0.2918	0.3836	0.2898	0.1591
FB-3-3-B	5.8429	6.3302	7.8889	7.2032	3.4203	0.4302	0.1536
FB-3-3-M	7.8512	5.3370	7.7308	5.9740	2.4023	0.8569	0.3063
FB-3-3-T	0.4327	0.4894	1.0923	1.4077	1.7066	1.3777	0.7512
FB-5-2-B	0.7160	0.9551	1.4034	0.7860	1.1256	0.6763	0.3747
FB-5-2-M	0.1056	0.2196	0.9644	1.1454	1.1203	0.8190	0.3713
FB-5-2-T	0.0171	0.1131	0.3653	0.3910	0.5857	0.3748	0.2838
FB-5-3-B	0.7952	0.4884	1.6615	3.5307	1.3118	0.4050	0.2036
FB-5-3-M	0.7173	0.4324	1.2684	0.7920	0.6073	0.4452	0.3791
FB-5-3-T	0.0047	0.0954	0.7620	0.8236	0.5954	0.4760	0.4965

Lake George Sediment Study - Stream Deltas

All results are in grams dry weight

Sample ID	Grain size in mm						
	>2	2-1	0.6-1	0.5-0.6	0.25-0.5	0.125-0.25	<0.125
KB-1-2-B	0.3610	0.4273	0.4811	3.4904	6.1672	3.0730	0.7565
KB-1-2-M	0.3031	0.6144	0.9668	3.6680	4.7182	2.4587	0.5500
KB-1-2-T	0.1756	0.1918	0.2071	0.5998	2.6489	2.0705	0.8302
KB-1-3-B	0.0422	0.0894	0.1229	1.4033	8.6583	7.2919	1.6438
KB-1-3-M	0.0460	0.1403	0.0657	0.9037	5.8289	4.4305	0.9583
KB-1-3-T	0.3787	0.3428	0.3108	1.4624	6.8116	3.1006	0.2185
KB-2-2-B	0.1030	0.0793	0.3337	14.7065	17.6905	3.2225	0.3951
KB-2-2-M	0.2847	0.1633	0.5128	17.8649	12.1338	2.7147	0.7757
KB-2-2-T		0.0151	0.0280	1.0296	3.4229	3.2770	1.4786
KB-2-3-B	0.3702	0.4560	0.7093	2.7647	4.0731	5.3706	1.1345
KB-2-3-M	0.0063	0.0380	0.0889	0.5302	1.8800	2.2945	0.8499
KB-2-3-T	0.0107	0.0346	0.0230	0.1388	0.9865	2.1544	0.9654
KB-3-2-B	1.1117	0.2968	1.3231	6.5240	8.9723	4.7603	1.8878
KB-3-2-M	0.1109	0.1551	0.5345	3.7979	10.1175	5.3867	2.6631
KB-3-2-T	0.0002	0.0978	0.2277	2.3295	7.5790	5.7229	2.4863
KB-3-3-B	1.5987	1.9661	1.4147	10.8365	4.6472	2.0393	0.5433
KB-3-3-M	4.1400	3.2214	3.5044	4.9000	4.0566	2.4919	1.1745
KB-3-3-T	0.2271	0.3290	0.3764	1.3159	3.1110	2.4978	1.5939
KB-5-2-B	0.8920	1.2248	1.6337	4.6245	13.2271	6.0174	2.2635
KB-5-2-M	0.3004	0.3211	1.1359	3.7916	10.0189	6.6177	2.2130
KB-5-2-T	0.0100	0.0253	0.1400	1.4734	3.5000	3.9005	1.3613
KB-5-3-B	0.3045	0.4478	1.6358	3.2051	4.3156	2.4143	0.9624
KB-5-3-M	0.1427	0.1752	0.7582	3.6380	6.8568	7.7804	2.9105
KB-5-3-T		0.0251	0.1376	0.8411	2.5640	2.8415	0.9961
PE-1-2-B	0.0188	0.8907	2.7929	0.7046	0.0413	0.0102	
PE-1-2-M	0.1442	1.0339	6.4709	1.2086	0.0193	0.0112	
PE-1-2-T	0.0301	0.3458	4.7648	1.8496	0.0666	0.0232	0.0138
PE-1-3-B	0.1070	0.6862	1.8848	4.2469	3.3609	0.8127	0.0343
PE-1-3-M	0.0917	0.2616	0.9030	3.3585	2.9038	0.4700	
PE-1-3-T	0.1115	0.7418	1.7053	4.4419	2.5116	0.3593	0.0148
PE-2-2-B	0.0587	0.2896	0.4770	2.0850	3.5185	0.9309	0.0976
PE-2-2-M	0.5295	1.7355	2.4054	2.8076	0.9810	0.2126	0.0326
PE-2-2-T	0.5683	1.4520	2.2366	2.9822	0.9306	0.2098	0.0289
PE-2-3-B	0.0923	0.2474	0.8369	3.2752	3.2352	0.7030	0.0414
PE-2-3-M	0.1678	0.1305	0.4994	2.3250	3.7795	1.2833	0.0890
PE-2-3-T	0.0674	0.2643	0.5787	2.6211	2.4239	0.6648	0.0772
PE-3-2-B		0.0570	0.1457	0.3364	1.8394	1.7586	0.9068
PE-3-2-M		0.0185	0.0494	0.1782	0.3714	1.5789	0.9308
PE-3-2-T	0.0407	0.0155	0.0424	0.1273	0.3708	1.0286	0.9699
PE-3-3-B	0.1941	0.3227	1.1407	2.8300	2.4527	0.8249	0.0863
PE-3-3-M	0.2481	0.7233	1.4603	2.9675	2.1448	0.6453	0.1310
PE-3-3-T	0.1143	0.4593	1.0964	2.8139	2.5296	0.5023	0.0661
PE-5-2-B	0.6309	0.4546	1.0505	1.5156	0.8532	1.2208	1.1589
PE-5-2-M		0.1367	0.5561	1.1059	0.7285	0.2818	0.6372
PE-5-2-T	0.0019		0.0578	0.2514	0.2478	0.7168	0.6441
PE-5-3-B	0.4436	0.2280	0.6433	1.3722	1.3183	1.0065	1.2516
PE-5-3-M	0.0925	0.0767	0.1926	0.4588	0.5530	0.7303	1.0101
PE-5-3-T			0.0686	0.1965	0.4422	0.6949	1.1205

Lake George Sediment Study - Stream Deltas

All results are in grams dry weight

Sample ID	Grain size in mm						
	>2	2-1	0.6-1	0.5-0.6	0.25-0.5	0.125-0.25	<0.125
SD-1-2-B	0.0466	0.0905	0.2443	1.8682	2.4400	0.4855	0.0278
SD-1-2-M	0.7175	0.9149	2.8168	1.9030	0.4777	0.0826	0.0140
SD-1-2-T	2.5171	1.8099	1.4106	0.7860	0.2865	0.1662	0.0319
SD-1-3-B	0.3666	1.3305	3.0606	2.2791	0.7435	1.0820	0.0121
SD-1-3-M	0.0920	0.6058	2.2120	2.6098	1.2690	0.2548	0.0386
SD-1-3-T	0.2836	0.6077	1.2740	1.8920	1.1683	0.4102	0.1548
SD-2-2-B	0.0907	0.0877	0.1036	0.1382	0.6997	1.5993	1.2050
SD-2-2-M	0.0793	0.1296	0.1386	0.4357	1.9669	1.1950	0.4630
SD-2-2-T	0.2413	0.1813	0.2187	0.5190	1.0250	0.7938	0.2000
SD-2-3-B	0.2613	0.2999	0.4036	1.0211	1.6987	1.1693	0.6561
SD-2-3-M	0.0137	0.0159	0.0169	0.0826	0.2077	0.3553	0.4033
SD-2-3-T	0.0077	0.0733	0.0609	0.5410	0.8908	1.0447	0.9693
SD-3-2-B	0.0068	0.0269	0.0338	0.1664	0.9785	0.9295	0.6500
SD-3-2-M	0.0293	0.0340	0.0440	0.0919	0.4921	0.7405	0.5611
SD-3-2-T	0.0111	0.0310	0.0357	0.1833	0.7993	0.7450	0.4238
SD-3-3-B	0.2183	0.0797	0.1147	0.1160	0.6290	0.9665	0.5974
SD-3-3-M	0.0937	0.0364	0.1023	0.1012	0.4252	0.5452	0.3576
SD-3-3-T		0.0060	0.0293	0.1970	0.4903	1.0130	1.2167
SD-5-2-B		0.0213	0.0310	0.1742	0.9410	1.0970	1.3122
SD-5-2-M	0.0488	0.0673	0.0510	0.2207	1.6340	1.7246	0.8797
SD-5-2-T	0.0293	0.0256	0.0427	0.1927	1.5280	2.4300	1.4660
SD-5-3-B	0.0009	0.0516	0.1600	0.4557	0.7125	0.8320	0.6030
SD-5-3-M	0.0035	0.0140	0.0185	0.0550	0.3888	1.1568	1.1218
SD-5-3-T	0.0585	0.1132	0.1202	0.2105	0.7650	0.7144	0.3506
WB-1-2-B	0.0354	0.5544	2.4419	2.0010	0.5759	0.1444	0.0540
WB-1-2-M		0.0712	0.2435	1.5796	2.0575	0.4511	0.0207
WB-1-2-T		0.0153	0.2521	2.8896	1.6300	0.1590	0.0125
WB-1-3-B		0.0237	0.3842	3.4736	2.6272	0.4261	0.0390
WB-1-3-M	0.0298	0.4253	3.7881	3.5590	0.4591	0.0181	0.0092
WB-1-3-T	0.0000	0.0059	0.4531	3.2913	1.8069	0.1470	0.0168
WB-2-2-B	0.0394	0.0204	0.3517	3.0497	0.8390	0.3044	0.0589
WB-2-2-M	0.0281	0.0295	0.2246	1.7680	0.8138	0.2230	0.0331
WB-2-2-T	0.1510	0.0710	0.1068	0.1926	0.7572	0.5558	0.1232
WB-2-3-B	0.0051	0.0054	0.2827	2.7354	1.0763	0.1225	0.0160
WB-2-3-M		0.0075	0.4474	3.3155	1.3114	0.0753	0.0072
WB-2-3-T	0.0221	0.0472	0.3785	3.1068	2.0471	0.3932	0.0332
WB-3-2-B	0.0704	0.0940	0.0965	0.1954	0.6412	0.4243	0.1316
WB-3-2-M	0.0813	0.0621	0.0805	0.1022	0.3264	0.3656	0.0993
WB-3-2-T	0.0119	0.0181	0.0673	0.4526	1.8518	1.3905	0.4650
WB-3-3-B		0.0103	0.0219	0.0363	0.0983	0.4381	0.6426
WB-3-3-M	0.0426	0.0808	0.1715	0.2282	0.9130	1.0615	0.4589
WB-3-3-T	0.0656	0.0396	0.0650	0.0852	0.2770	0.3505	0.1692
WB-5-2-B	0.0399	0.0520	0.3096	0.2190	0.5540	0.6190	0.4488
WB-5-2-M	0.0602	0.0919	0.0655	0.2857	1.2495	0.8670	0.2452
WB-5-2-T	0.0155	0.0455	0.0697	0.1381	0.5706	0.6074	0.2901
WB-5-3-B	0.0115	0.0164	0.0145	0.0396	0.1974	0.5259	0.4206
WB-5-3-M	0.0315	0.0774	0.0315	0.1150	0.7654	0.9133	0.3539
WB-5-3-T	0.0492	0.0446	0.0342	0.1338	0.4116	0.6255	0.2825

APPENDIX II. Sediment Chemistry Data

Sample Code	Chromium mg/kg	Copper mg/kg	Lead mg/kg	Zinc mg/kg	Manganese mg/kg	Magnesium mg/kg	%organic matter
BB-1-2-B	7.5	42.5	60.9	37.0	95.4	2102.7	0.8%
BB-1-2-M	6.3	15.0	12.5	40.5	133.0	11647.7	0.8%
BB-1-2-T	4.3	7.0	12.5	35.0	105.9	3132.5	0.7%
BB-1-3-B	6.3	47.5	20.0	67.5	104.5	1835.0	9.6%
BB-1-3-M	5.7	31.9	9.0	40.4	72.4	1472.2	1.4%
BB-1-3-T	4.8	36.9	6.5	31.4	60.8	1435.0	1.1%
BB-2-2-B	4.1	11.0	2.0	11.0	26.5	560.0	1.2%
BB-2-2-M	6.5	25.0	13.0	40.4	64.4	1173.1	5.6%
BB-2-2-T	9.1	10.5	28.4	81.7	99.6	1474.3	6.0%
BB-2-3-B	8.7	29.5	37.5	69.5	110.5	1475.0	14.1%
BB-2-3-M	8.6	8.5	33.4	60.9	92.9	1502.7	7.6%
BB-2-3-T	11.4	61.8	45.4	102.7	152.5	2068.8	9.5%
BB-3-2-B	13.2	67.4	67.4	116.9	150.3	2122.5	9.8%
BB-3-2-M	13.3	76.8	64.4	118.8	180.6	2100.8	13.0%
BB-3-2-T	13.2	66.9	60.9	115.3	250.0	2020.8	11.1%
BB-3-3-B	11.2	12.0	31.5	79.5	100.0	1439.7	9.8%
BB-3-3-M	15.5	16.5	81.0	134.0	155.5	1810.0	12.9%
BB-3-3-T	11.8	19.0	57.9	138.7	259.5	2066.1	11.9%
BB-5-2-B	14.6	12.0	32.5	81.9	123.4	1553.1	6.9%
BB-5-2-M	13.0	18.5	88.4	162.9	241.3	1988.6	13.2%
BB-5-2-T	20.5	25.4	102.7	209.5	606.9	4637.9	17.8%
BB-5-3-B	12.0	7.5	11.5	43.9	100.7	1126.8	5.6%
BB-5-3-M	10.9	12.9	37.8	93.1	139.4	1587.7	9.3%
BB-5-3-T	19.8	24.9	122.7	214.9	316.7	1261.7	17.4%
FB-1-2-B	10.9	5.5	23.5	62.0	105.4	2853.3	4.2%
FB-1-2-M	10.6	10.0	34.5	82.5	192.4	2583.4	9.8%
FB-1-2-T	11.8	11.0	44.0	87.0	176.5	2685.0	7.5%
FB-1-3-B	5.6	4.5	17.5	42.9	92.9	3001.4	1.4%
FB-1-3-M	8.9	5.0	23.4	47.8	72.6	2189.1	1.3%
FB-1-3-T	10.5	5.5	21.0	50.0	83.5	1974.0	1.5%
FB-2-2-B	11.5	3.5	13.0	34.0	62.0	1359.2	2.6%
FB-2-2-M	9.1	7.5	23.5	68.5	97.4	1693.8	12.8%
FB-2-2-T	6.7	9.0	26.0	68.9	141.3	2106.8	64.1%
FB-2-3-B	7.7	3.5	11.5	27.9	54.9	1865.9	2.2%
FB-2-3-M	4.8	3.5	18.0	27.0	37.5	824.3	6.4%
FB-2-3-T	12.2	15.5	44.0	124.5	269.5	2765.0	31.7%
FB-3-2-B	4.6	3.0	17.0	27.9	40.9	888.4	5.5%
FB-3-2-M	11.2	23.5	51.5	133.5	146.0	2045.0	53.0%
FB-3-2-T	11.0	21.9	47.8	139.4	313.2	2744.0	45.3%
FB-3-3-B	6.4	22.0	7.5	19.0	63.4	2056.3	1.2%
FB-3-3-M	8.4	3.5	10.5	23.0	55.0	1560.0	1.6%
FB-3-3-T	9.2	8.5	23.5	61.0	95.0	2250.0	8.4%
FB-5-2-B	5.5	21.4	78.6	179.7	258.3	2717.5	42.0%
FB-5-2-M	2.2	66.9	65.9	127.8	196.6	3074.5	32.1%
FB-5-2-T	2.4	21.5	57.0	174.5	370.5	2910.0	43.0%
FB-5-3-B	2.2	4.0	17.0	31.9	35.4	713.3	6.3%
FB-5-3-M	2.0	26.0	76.5	172.5	189.0	3200.0	48.6%
FB-5-3-T	1.8	30.0	78.4	179.9	293.8	7793.8	41.1%
KB-1-2-B	4.7	9.0	8.5	16.0	38.9	1013.6	1.0%

Sample Code	Chromium mg/kg	Copper mg/kg	Lead mg/kg	Zinc mg/kg	Manganese mg/kg	Magnesium mg/kg	%organic matter
KB-1-2-M	4.8	3.0	5.5	26.4	36.4	967.5	0.7%
KB-1-2-T	6.4	5.0	9.0	40.5	62.0	1334.6	1.1%
KB-1-3-B	9.1	19.5	11.5	21.5	75.8	1801.2	1.3%
KB-1-3-M	8.3	3.0	35.4	8.5	40.9	1103.0	4.5%
KB-1-3-T	5.1	2.0	10.5	21.9	42.9	1106.9	0.9%
KB-2-2-B	4.1	2.5	4.0	12.0	33.9	907.9	0.7%
KB-2-2-M	5.6	2.0	7.5	1.5	32.4	767.7	1.0%
KB-2-2-T	13.6	10.0	44.0	47.0	73.5	1540.0	7.3%
KB-2-3-B	25.9	3.5	1.5	16.0	34.0	719.2	0.7%
KB-2-3-M	10.1	4.5	10.5	33.9	54.8	1310.5	2.5%
KB-2-3-T	19.8	14.5	50.4	115.9	102.4	2067.7	8.3%
KB-3-2-B	4.7	4.5	4.5	17.9	28.9	782.7	2.0%
KB-3-2-M	13.9	5.0	16.9	34.4	41.4	1041.7	2.9%
KB-3-2-T	8.4	5.0	16.5	33.0	46.4	1038.6	2.9%
KB-3-3-B	2.5	1.5	2.5	8.0	22.5	449.1	2.1%
KB-3-3-M	4.6	2.5	16.4	22.4	29.4	567.8	3.7%
KB-3-3-T	21.8	13.0	84.8	111.8	103.3	1741.9	9.5%
KB-5-2-B	13.7	9.5	10.5	29.5	98.4	3045.4	2.2%
KB-5-2-M	8.8	6.0	7.0	19.0	50.0	1340.0	1.7%
KB-5-2-T	12.1	5.5	17.5	32.4	32.4	663.7	3.5%
KB-5-3-B	3.9	3.5	4.5	71.9	37.0	634.3	2.3%
KB-5-3-M	5.7	4.5	23.5	36.5	34.0	759.2	2.3%
KB-5-3-T	32.8	8.0	52.8	73.8	84.7	1355.7	6.2%
PE-1-2-B	3.9	4.0	9.0	22.5	58.9	1791.4	0.1%
PE-1-2-M	6.0	4.0	10.5	24.0	60.4	1621.9	0.3%
PE-1-2-T	3.4	3.0	11.0	22.9	68.3	1818.8	0.3%
PE-1-3-B	12.2	4.5	10.0	19.9	57.8	1230.2	0.1%
PE-1-3-M	10.4	16.0	125.3	178.7	145.3	1971.6	1.2%
PE-1-3-T	4.3	4.0	12.5	24.5	49.4	1487.5	0.5%
PE-2-2-B	4.2	4.5	19.0	24.4	42.4	1955.7	0.8%
PE-2-2-M	4.1	3.5	14.0	25.5	51.0	1758.4	0.4%
PE-2-2-T	2.4	3.5	15.9	26.4	63.7	1414.3	1.4%
PE-2-3-B	8.0	6.0	16.4	24.9	142.4	2584.1	0.2%
PE-2-3-M	3.8	5.0	15.5	21.0	78.0	1349.9	0.1%
PE-2-3-T	3.3	4.0	20.5	53.4	104.3	1322.2	1.8%
PE-3-2-B	7.5	9.5	78.0	102.5	126.0	1810.0	6.1%
PE-3-2-M	6.5	10.0	68.5	96.4	110.9	1554.1	7.4%
PE-3-2-T	11.2	13.0	81.5	106.0	329.5	3235.0	7.9%
PE-3-3-B	7.2	6.0	11.5	35.9	100.8	2231.7	0.7%
PE-3-3-M	5.8	5.0	6.0	24.0	51.9	1278.5	0.5%
PE-3-3-T	7.2	5.5	11.5	36.9	140.5	2799.1	1.6%
PE-5-2-B	9.5	10.5	7.5	41.9	144.3	2966.1	1.9%
PE-5-2-M	9.5	7.0	41.5	63.0	67.5	1089.7	4.7%
PE-5-2-T	9.0	12.5	105.3	172.6	173.6	1631.6	11.7%
PE-5-3-B	6.6	8.0	26.9	53.8	40.9	1091.8	3.8%
PE-5-3-M	10.6	12.9	107.4	156.2	83.6	1467.2	10.7%
PE-5-3-T	2.9	4.5	5.5	33.3	62.1	1271.9	14.1%
SD-1-2-B	4.0	6.5	14.0	61.9	58.4	3042.7	0.9%
SD-1-2-M	3.5	5.5	15.5	38.0	59.0	6597.4	1.0%
SD-1-2-T	6.0	5.5	31.5	43.5	80.0	26250.0	2.1%

Sample Code	Chromium mg/kg	Copper mg/kg	Lead mg/kg	Zinc mg/kg	Manganese mg/kg	Magnesium mg/kg	%organic matter
SD-1-3-B	8.5	6.5	26.9	46.4	68.8	3440.7	0.0%
SD-1-3-M	2.0	7.0	32.0	71.4	165.8	7590.1	1.9%
SD-1-3-T	3.0	6.0	21.5	39.0	62.0	3597.1	0.3%
SD-2-2-B	9.5	16.5	94.7	132.6	42.4	1989.0	8.8%
SD-2-2-M	6.0	9.5	49.0	93.4	39.0	1239.0	5.7%
SD-2-2-T	10.0	15.0	41.4	123.2	67.9	3642.4	11.5%
SD-2-3-B	6.5	11.0	118.0	93.0	39.5	1724.8	2.9%
SD-2-3-M	17.0	19.5	105.4	0.0	71.4	3794.7	14.1%
SD-2-3-T	11.5	13.5	92.4	384.9	69.9	2496.0	8.1%
SD-3-2-B	7.5	11.5	175.3	106.1	50.8	3387.1	6.3%
SD-3-2-M	6.5	11.0	108.1	98.7	37.4	2940.3	2.8%
SD-3-2-T	9.0	10.5	51.9	85.4	51.9	3546.1	5.5%
SD-3-3-B	13.5	17.5	111.9	179.4	111.9	3548.2	23.8%
SD-3-3-M	11.6	21.3	185.7	154.7	45.8	2050.0	15.3%
SD-3-3-T	10.0	18.0	195.5	179.6	49.9	1750.6	7.9%
SD-5-2-B	9.5	11.5	108.9	89.4	47.5	2847.4	5.4%
SD-5-2-M	11.5	13.5	97.0	119.0	48.0	2029.2	9.9%
SD-5-2-T	15.5	13.5	76.8	106.3	59.9	2235.3	6.3%
SD-5-3-B	7.5	17.5	267.3	189.8	42.0	1378.8	8.6%
SD-5-3-M	12.5	32.0	214.5	190.0	63.5	2125.0	9.4%
SD-5-3-T	12.0	22.0	135.9	100.4	83.4	3248.1	18.0%
WB-1-2-B	1.3	4.0	21.0	33.5	78.5	1824.6	1.1%
WB-1-2-M	5.3	4.5	25.0	34.5	82.9	2746.4	1.4%
WB-1-2-T	3.8	3.0	lt 1	22.0	72.0	1001.1	0.9%
WB-1-3-B	10.4	3.0	11.0	27.9	50.4	1596.6	1.0%
WB-1-3-M	3.1	4.5	10.0	31.0	64.9	1773.4	1.2%
WB-1-3-T	4.1	3.0	37.4	25.9	45.4	1162.4	1.1%
WB-2-2-B	25.9	3.5	20.0	34.9	40.4	1009.4	2.6%
WB-2-2-M	15.6	4.0	13.0	38.9	52.4	1478.1	4.5%
WB-2-2-T	4.4	7.0	22.5	59.0	120.5	1137.2	25.4%
WB-2-3-B	6.1	2.5	12.9	23.9	40.3	1011.1	1.3%
WB-2-3-M	3.6	3.0	13.0	26.0	47.4	1318.2	0.9%
WB-2-3-T	2.9	3.5	12.0	29.0	45.5	1250.0	1.5%
WB-3-2-B	5.9	9.1	31.1	82.9	81.6	1411.6	15.0%
WB-3-2-M	9.0	11.8	36.2	104.3	124.5	1815.0	15.7%
WB-3-2-T	7.9	16.0	39.9	112.7	134.1	2592.7	14.4%
WB-3-3-B	14.7	16.1	121.3	218.4	167.7	2602.4	14.2%
WB-3-3-M	11.6	8.5	100.4	95.4	76.4	1513.3	13.5%
WB-3-3-T	15.8	13.4	56.4	132.5	217.5	1888.3	20.2%
WB-5-2-B	6.5	26.0	135.3	159.8	138.8	1897.2	19.1%
WB-5-2-M	11.4	10.0	37.9	87.3	123.2	2010.4	16.2%
WB-5-2-T	9.2	13.5	lt 1	107.5	204.0	2700.0	17.5%
WB-5-3-B	15.4	12.7	131.0	131.0	124.3	2005.7	16.0%
WB-5-3-M	10.9	10.5	37.4	97.8	163.1	1915.4	12.7%
WB-5-3-T	8.2	9.0	26.5	90.1	178.8	2023.2	15.2%

APPENDIX III. Statistical Summaries

The SAS System

General Linear Models Procedure
Class Level Information

Class	Levels	Values
LOCATION	2	control/stream .
REP	4	1 2 3 4 = site @ streams
DEPTH	4	1 2 3 5
HORIZON	3	B M T

Number of observations in data set = 144

Dependent Variable: CR

Source	DF	Sum of Squares	F Value	Pr > F
Model –	27	1439.41544237	2.51	0.0004
Error	116	2459.97804879		
Corrected Total	143	3899.39349116		

R-Square	C.V.	CR Mean
0.369138	52.36357	8.79442361

Source	DF	Type III SS	F Value	Pr > F
HORIZON	2	60.15561336	1.42	0.2463
LOCATION*REP	4	291.69188473	3.44	0.0108
LOCATION*REP*DEPTH	12	713.20897527	2.80	0.0021
LOCATION*HORIZON	2	39.31028419	0.93	0.3987

Tests of Hypotheses using the Type III MS for LOCATION*REP as an error term

Source	DF	Type III SS	F Value	Pr > F
LOCATION	1	4.42332939	0.06	0.8176

Tests of Hypotheses using the Type III MS for LOCATION*REP*DEPTH as an error term

Source	DF	Type III SS	F Value	Pr > F
DEPTH	3	280.60897180	1.57	0.2470

Tests of Hypotheses using the Type III MS for LOCATION*REP*DEPTH as an error term

Source	DF	Type III SS	F Value	Pr > F
LOCATION*DEPTH	3	34.47409319	0.19	0.8989

Dependent Variable: CU

Source	DF	Sum of Squares	F Value	Pr > F
Model	27	13678.3829550	4.79	0.0001
Error	116	12280.6943208		
Corrected Total	143	25959.0772758		

R-Square	C.V.	CU Mean
0.526921	79.82715	12.8893750

Source	DF	Type III SS	F Value	Pr > F
HORIZON	2	39.30876877	0.19	0.8308
LOCATION*REP	4	5514.65198105	13.02	0.0001
LOCATION*REP*DEPTH	12	3451.80966999	2.72	0.0029
LOCATION*HORIZON	2	36.07552652	0.17	0.8436

Tests of Hypotheses using the Type III MS for LOCATION*REP as an error term

Source	DF	Type III SS	F Value	Pr > F
LOCATION	1	2921.93812378	2.12	0.2192

Tests of Hypotheses using the Type III MS for LOCATION*REP*DEPTH as an error term

Source	DF	Type III SS	F Value	Pr > F
DEPTH	3	875.52386817	1.01	0.4203

Tests of Hypotheses using the Type III MS for LOCATION*REP*DEPTH as an error term

Source	DF	Type III SS	F Value	Pr > F
LOCATION*DEPTH	3	418.92650079	0.49	0.6987

The SAS System

General Linear Models Procedure
Class Level Information

Class	Levels	Values
LOCATION	2	control stream
REP	4	1 2 3 4
DEPTH	4	1 2 3 5
HORIZON	3	B M T

Number of observations in data set = 144

Dependent Variable: MG

Source	DF	Sum of Squares	F Value	Pr > F
Model	27	333363179.543	2.68	0.0001
Error	116	533535144.739		
Corrected Total	143	866898324.282		

R-Square	C.V.	MG Mean
0.384547	96.38286	2225.11631

Source	DF	Type III SS	F Value	Pr > F
HORIZON	2	10390578.342	1.13	0.3267
LOCATION*REP	4	74878503.739	4.07	0.0040
LOCATION*REP*DEPTH	12	116980715.083	2.12	0.0206
LOCATION*HORIZON	2	9070779.950	0.99	0.3761

Tests of Hypotheses using the Type III MS for LOCATION*REP as an error term

Source	DF	Type III SS	F Value	Pr > F
LOCATION	1	40528523.0202	2.17	0.2151

Tests of Hypotheses using the Type III MS for LOCATION*REP*DEPTH as an error term

Source	DF	Type III SS	F Value	Pr > F
DEPTH	3	29383440.6122	1.00	0.4243

Tests of Hypotheses using the Type III MS for LOCATION*REP*DEPTH as an error term

Source	DF	Type III SS	F Value	Pr > F
LOCATION*DEPTH	3	25536598.0156	0.87	0.4820

The SAS System

General Linear Models Procedure
Class Level Information

Class	Levels	Values
LOCATION	2	control stream
REP	4	1 2 3 4
DEPTH	4	1 2 3 5
HORIZON	3	B M T

Number of observations in data set = 144

Dependent Variable: MN

Source	DF	Sum of Squares	F Value	Pr > F
Model	27	546143.908903	5.90	0.0001
Error	116	397432.115212		
Corrected Total	143	943576.024116		

R-Square	C.V.	MN Mean
0.578802	57.08306	102.540451

Source	DF	Type III SS	F Value	Pr > F
HORIZON	2	69542.212356	10.15	0.0001
LOCATION*REP	4	153368.734734	11.19	0.0001
LOCATION*REP*DEPTH	12	91492.191136	2.23	0.0146
LOCATION*HORIZON	2	12059.552296	1.76	0.1766

Tests of Hypotheses using the Type III MS for LOCATION*REP as an error term

Source	DF	Type III SS	F Value	Pr > F
LOCATION	1	55465.1201668	1.45	0.2954

Tests of Hypotheses using the Type III MS for LOCATION*REP*DEPTH as an error term

Source	DF	Type III SS	F Value	Pr > F
DEPTH	3	70911.0852047	3.10	0.0673

Tests of Hypotheses using the Type III MS for LOCATION*REP*DEPTH as an error term

Source	DF	Type III SS	F Value	Pr > F
LOCATION*DEPTH	3	34692.8623159	1.52	0.2605

The SAS System

General Linear Models Procedure
Class Level Information

Class	Levels	Values
LOCATION	2	control stream
REP	4	1 2 3 4
DEPTH	4	1 2 3 5
HORIZON	3	B M T

Number of observations in data set = 144

Dependent Variable: PB

Source	DF	Sum of Squares	F Value	Pr > F
Model	27	184209.607090	5.80	0.0001
Error	116	136528.909002		
Corrected Total	143	320738.516092		

R-Square	C.V.	PB Mean
0.574330	77.35615	44.3494722

Source	DF	Type III SS	F Value	Pr > F
HORIZON	2	1033.7820322	0.44	0.6456
LOCATION*REP	4	60016.9773586	12.75	0.0001
LOCATION*REP*DEPTH	12	29154.0526943	2.06	0.0246
LOCATION*HORIZON	2	4972.9485589	2.11	0.1256

Tests of Hypotheses using the Type III MS for LOCATION*REP as an error term

Source	DF	Type III SS	F Value	Pr > F
LOCATION	1	22192.7502942	1.48	0.2908

Tests of Hypotheses using the Type III MS for LOCATION*REP*DEPTH as an error term

Source	DF	Type III SS	F Value	Pr > F
DEPTH	3	40261.7084617	5.52	0.0129

Tests of Hypotheses using the Type III MS for LOCATION*REP*DEPTH as an error term

Source	DF	Type III SS	F Value	Pr > F
LOCATION*DEPTH	3	12356.0090936	1.70	0.2209

The SAS System
General Linear Models Procedure
Class Level Information

Class	Levels	Values
LOCATION	2	control stream
REP	4	1 2 3 4
DEPTH	4	1 2 3 5
HORIZON	3	B M T

Number of observations in data set = 144

Dependent Variable: ZN

Source	DF	Sum of Squares	F Value	Pr > F
Model	27	264186.499503	4.68	0.0001
Error	116	242711.907448		
Corrected Total	143	506898.406951		

	R-Square	C.V.	ZN Mean
	0.521182	60.58390	75.5021528

Source	DF	Type III SS	F Value	Pr > F
HORIZON	2	16560.8678778	3.96	0.0217
LOCATION*REP	4	26497.3534776	3.17	0.0165
LOCATION*REP*DEPTH	12	43170.5906524	1.72	0.0712
LOCATION*HORIZON	2	1148.9528535	0.27	0.7604

Tests of Hypotheses using the Type III MS for LOCATION*REP as an error term

Source	DF	Type III SS	F Value	Pr > F
LOCATION	1	59684.8082921	9.01	0.0399

Tests of Hypotheses using the Type III MS for LOCATION*REP*DEPTH as an error term

Source	DF	Type III SS	F Value	Pr > F
DEPTH	3	75975.8625479	7.04	0.0055

Tests of Hypotheses using the Type III MS for LOCATION*REP*DEPTH as an error term

Source	DF	Type III SS	F Value	Pr > F
LOCATION*DEPTH	3	15120.7743672	1.40	0.2904

APPENDIX IV. Budget Justification

LGA Sediments - Budget Justification

Field Operations (Sample Collection)

Personnel (15 person/days)		$2,532.32
Equipment Rental	boat usage	$525.00
	scuba usage - 10 days @ $45/day	$450.00
Supplies	fuel	$124.57
	disposables	$11.50
	Field Total	$3,643.39

Sample Processing

Personnel (10 person days)		$877.80
Supplies	disposables	$145.30
	Sample Processing Total	$1,023.10

Laboratory Analysis

Grain Size Analysis	144 samples @ $12.50 ea.	$1,800.00
Total Carbon via Loss on Ignition	144 samples @ $12.50 ea.	$1,800.00
Sample Digestions	144 samples @ $5.00 ea.	$720.00
Total Chromium via FAAS	144 samples @ $7.00 ea.	$1,008.00
Total Copper via FAAS	144 samples @ $7.00 ea.	$1,008.00
Total Lead via FAAS	144 samples @ $7.00 ea.	$1,008.00
Total Magnesium via FAAS	144 samples @ $7.00 ea.	$1,008.00
Total Manganese via FAAS	144 samples @ $7.00 ea.	$1,008.00
Total Zinc via FAAS	144 samples @ $7.00 ea.	$1,008.00
Total Lead via Furnace AAS	144 samples @ $30.00 ea.	$4,320.00
	(-) bulk discounts 15%	-$2,203.20
	Laboratory Analysis Total	$12,484.80

Report Preparation

Personnel (20 person/days)		$3,298.40
Supplies		$246.48
	Total Report Preparation	$3,544.88

TOTAL DIRECT EXPENDITURES	$20,696.17
INDIRECT EXPENSES	$5,132.65
TOTAL EXPENSES	$25,828.82