Sources of Sediment and Nutrients from the Riparian Corridor

CENTER FOR WATERSHED PROTECTION

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Chesapeake Bay Program
Science. Restoration. Partnership.

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Sediment Reduction and Stream Corridor Restoration Analysis, Evaluation and Implementation Support to the Chesapeake Bay Program Partnership

I. Provide Modeling Support

- Estimate upland and in-stream sediment contributions through a scientific literature review and data analysis.

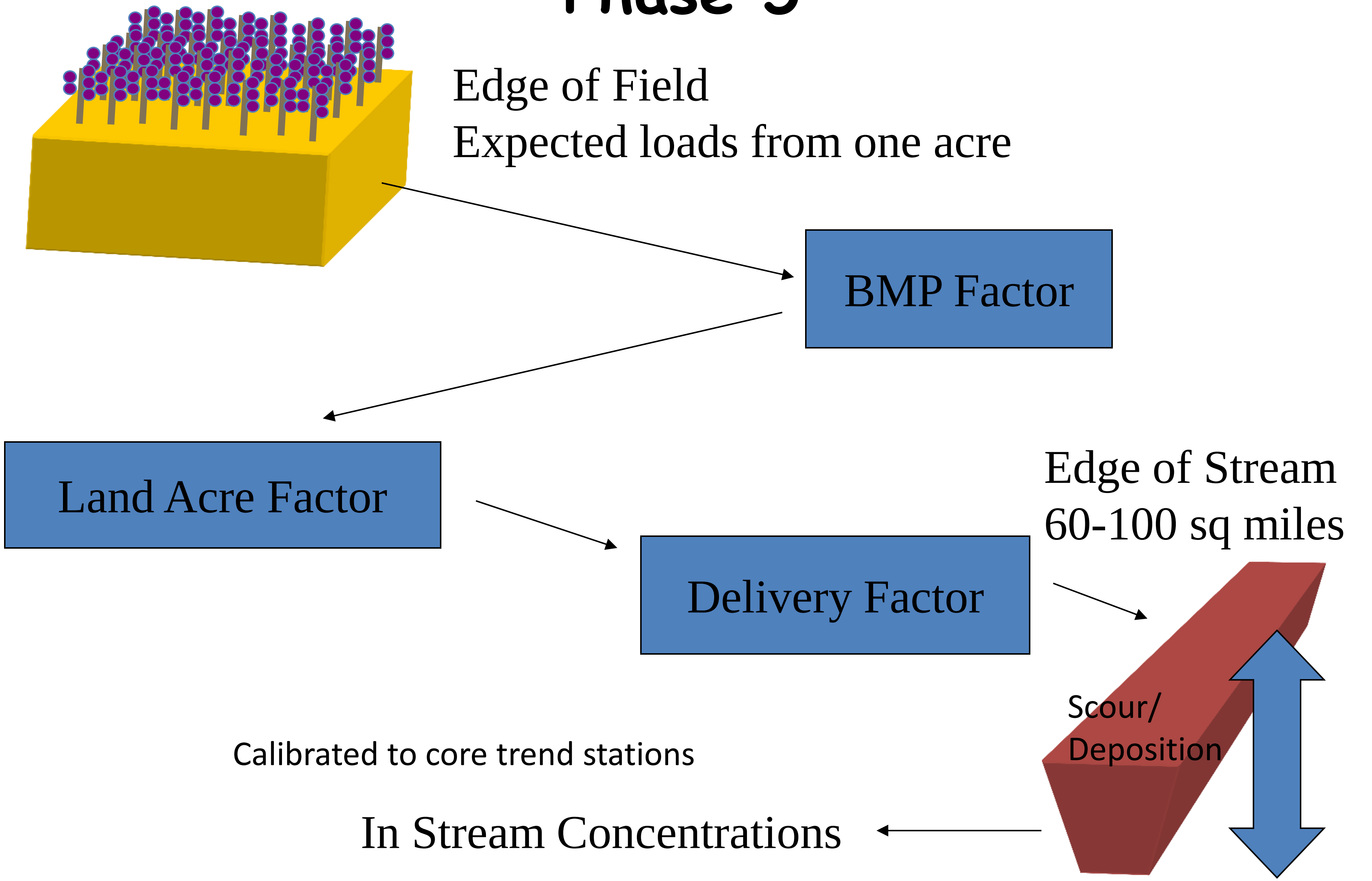
II. Coordinate Partnership Scientific Input

- Urban Stream Restoration Expert Panel
- Shoreline Erosion Control Expert Panel
- Urban Filter Strip/Stream Buffer Upgrade Expert Panel

III. Programmatic Evaluation, Reporting and Verification

- Stream restoration verification principles
- STAC workshop - Designing Sustainable Stream Restoration Projects within the Chesapeake Bay Watershed
- Stream health workgroup

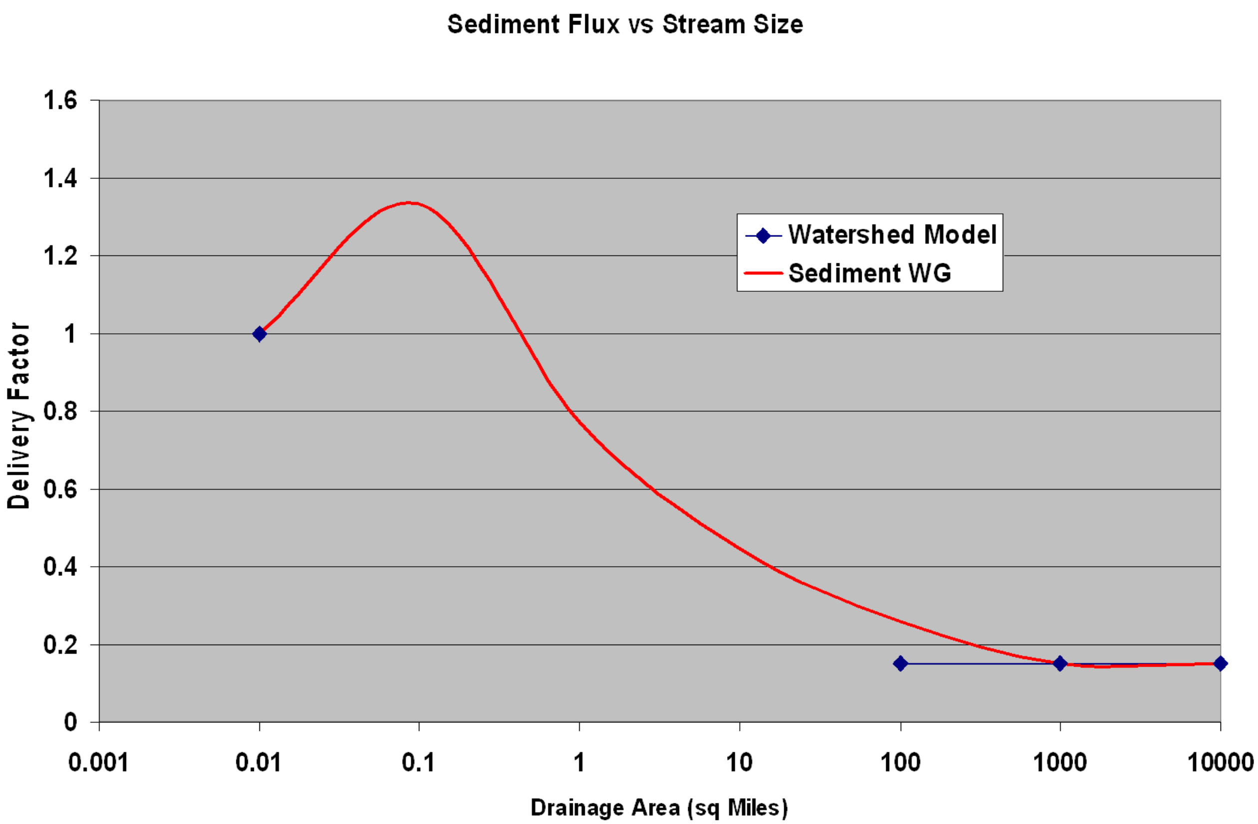
Chesapeake Bay Watershed Model (CBWM) Phase 5



How Sediment and Nutrients are Simulated in the CBWM

Sediment Delivery

The Project Reach versus the CBWM River Basin Segment



Key Issues

- CBWM does not simulate sediment dynamics for basins that average less than 60-100 mi^2. The contribution of channel erosion to sediment or nutrient loadings for 0, 1st, 2nd, and 3rd order streams is not explicitly simulated.

- Updates for Phase 6 of the CBWM will include an approach to model the smaller 0 - 3rd order streams to improve estimates of sediment and nutrient loadings.

- Key Research Need: Quantify the amount of sediment loading attributed to in-stream processes, such as streambank erosion, in comparison to upland sources.

Research on In-Stream Sediment and Nutrient Loadings to Inform Phase 6 of the CBWM

Research Question:

What is the percentage of sediment and nutrients from bank and channel sources of streams and the average rate of erosion? What is the variability in these values and what are the key sources of variation?

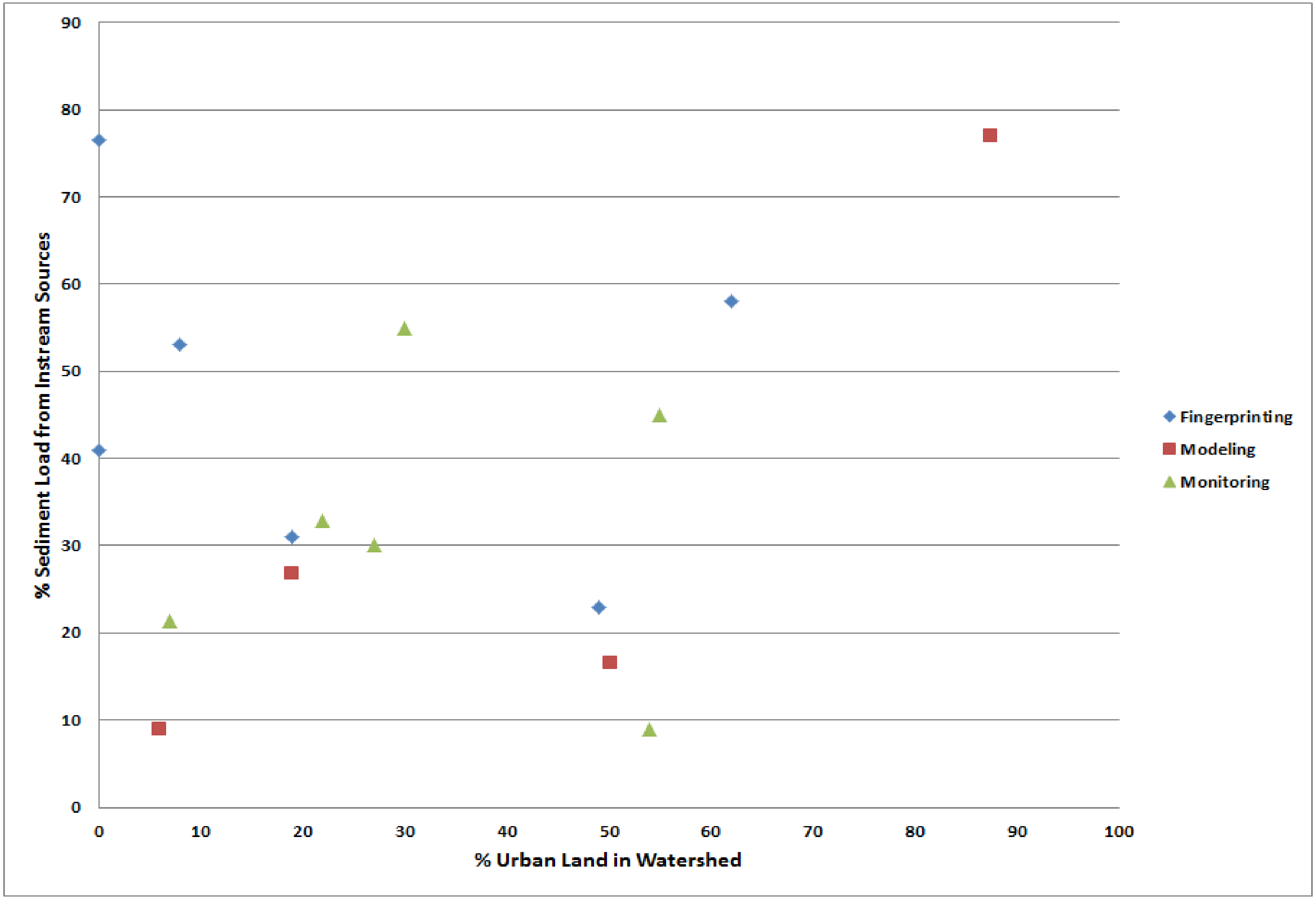
Upland Sources

In-Stream Sources

Stream Sediment Literature Review Database

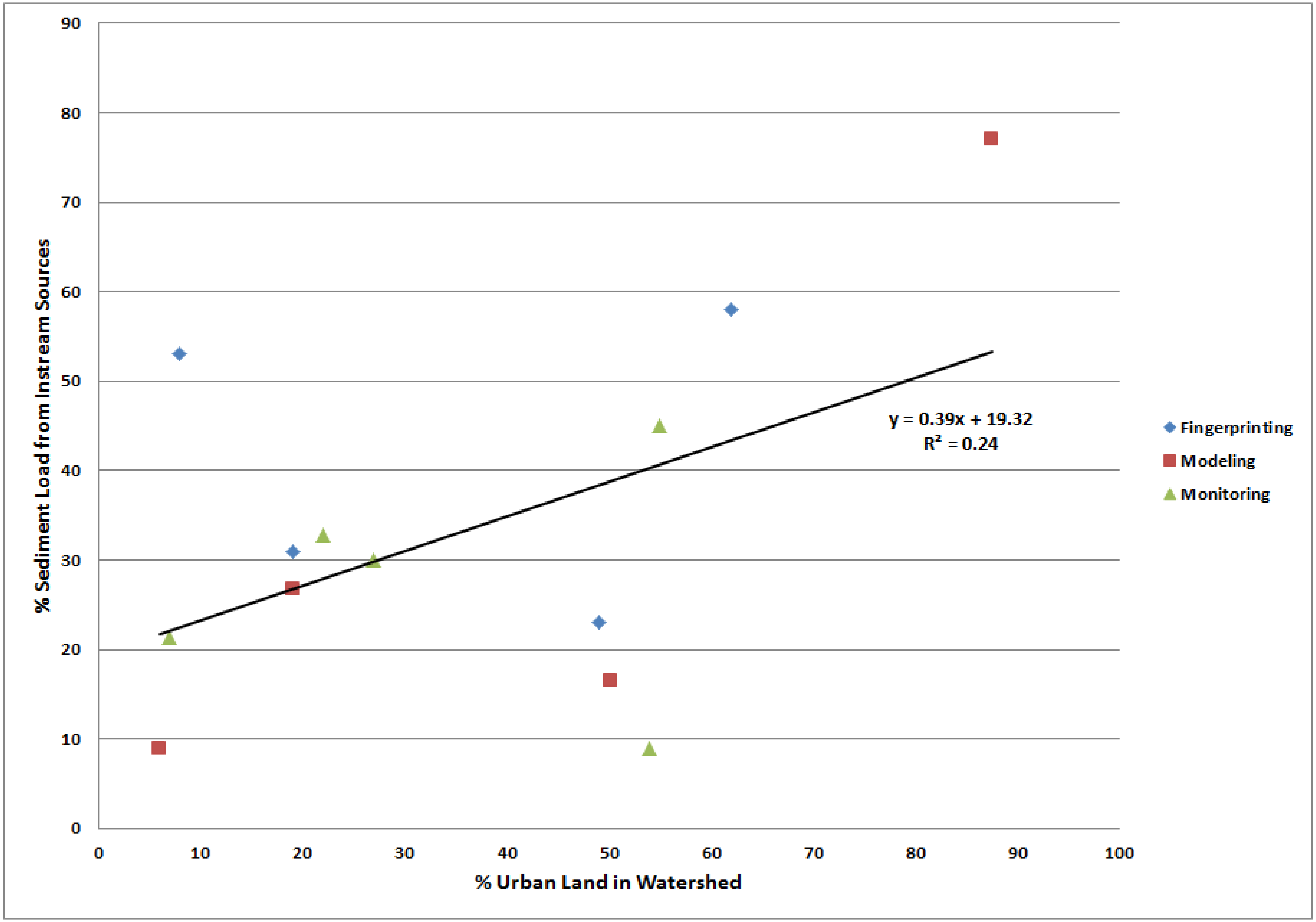
Database Entry Characteristics	
Total Entries	38
Individual Studies	16
Modeling Entries	7
Monitoring Entries	25
Fingerprinting Entries	6
Maryland Entries	14
Pennsylvania Entries	23
Virginia Entries	1
Entries that included the % sediment from in-stream sources	16
Entries that reported the rate of bank erosion	22
Entries that reported total sediment load	17

Stream Sediment Literature Review Database



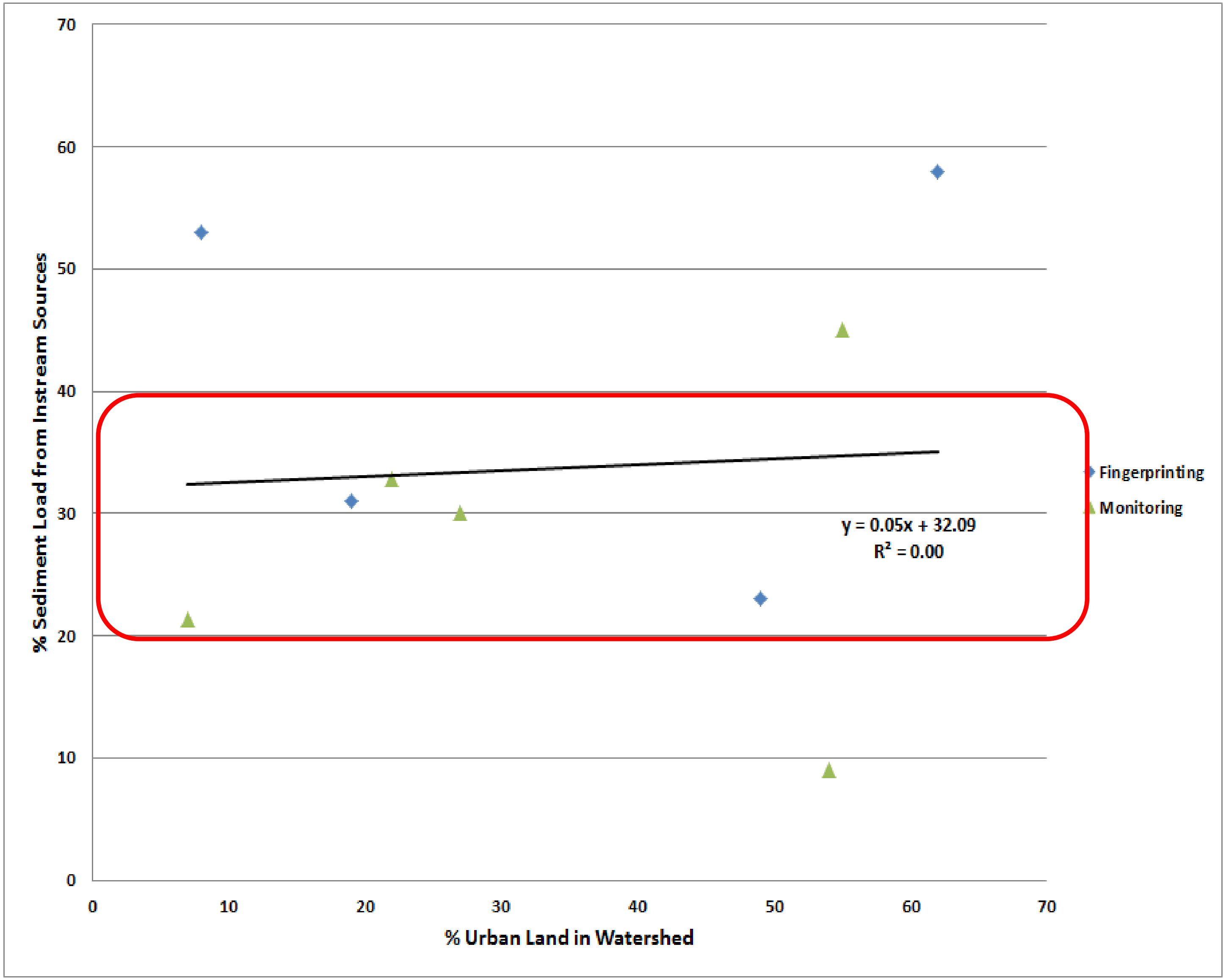
Percentage of sediment load from instream sources compared to the percentage of urban land in the watershed

Stream Sediment Literature Review Database



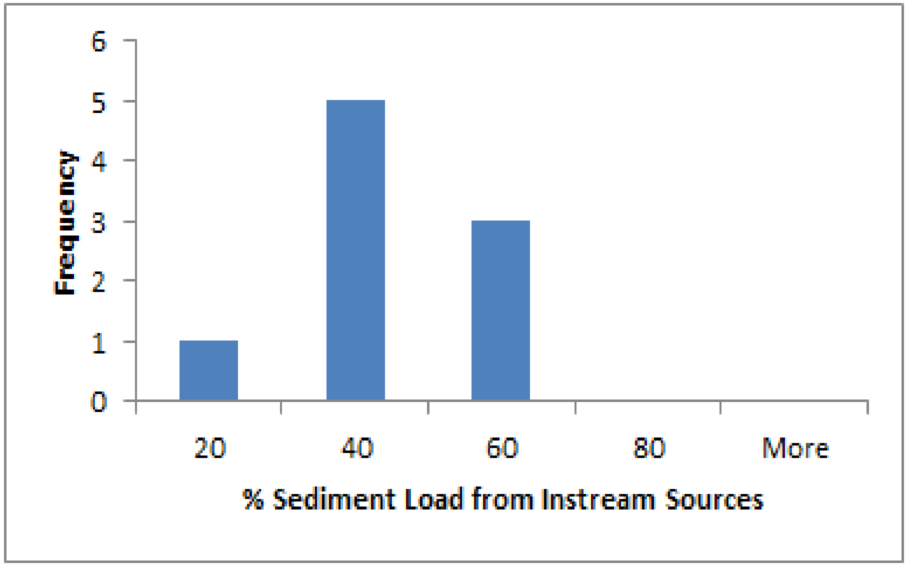
Percentage of sediment load from instream sources compared to the percentage of urban land in the watershed with outliers removed

Stream Sediment Literature Review Database



Percentage of sediment load from instream sources compared to the percentage of urban land in the watershed with outliers and modeling studies removed

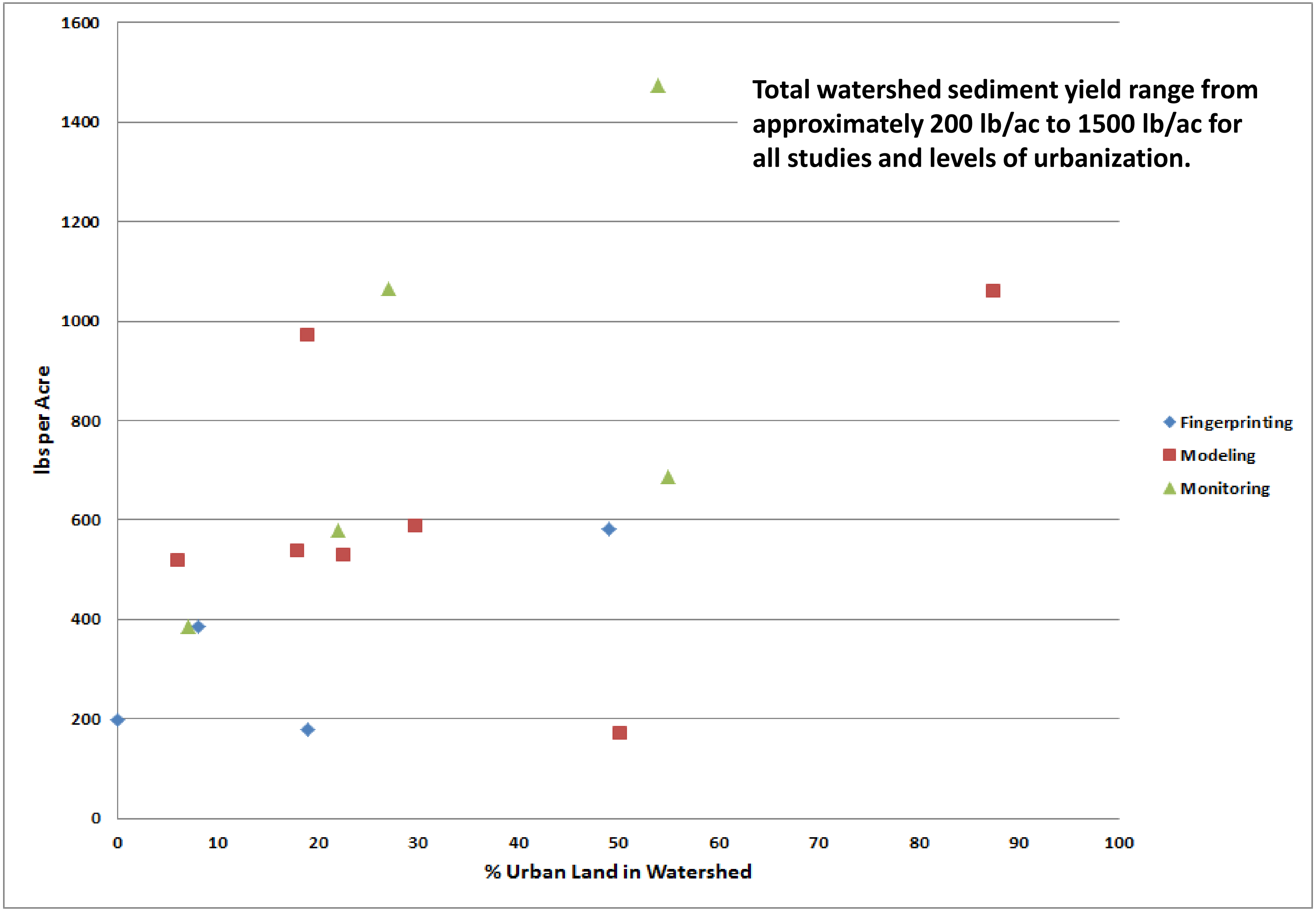
Stream Sediment Literature Review Database



Histogram of the percentage of sediment load from instream two outliers and modeling studies removed.

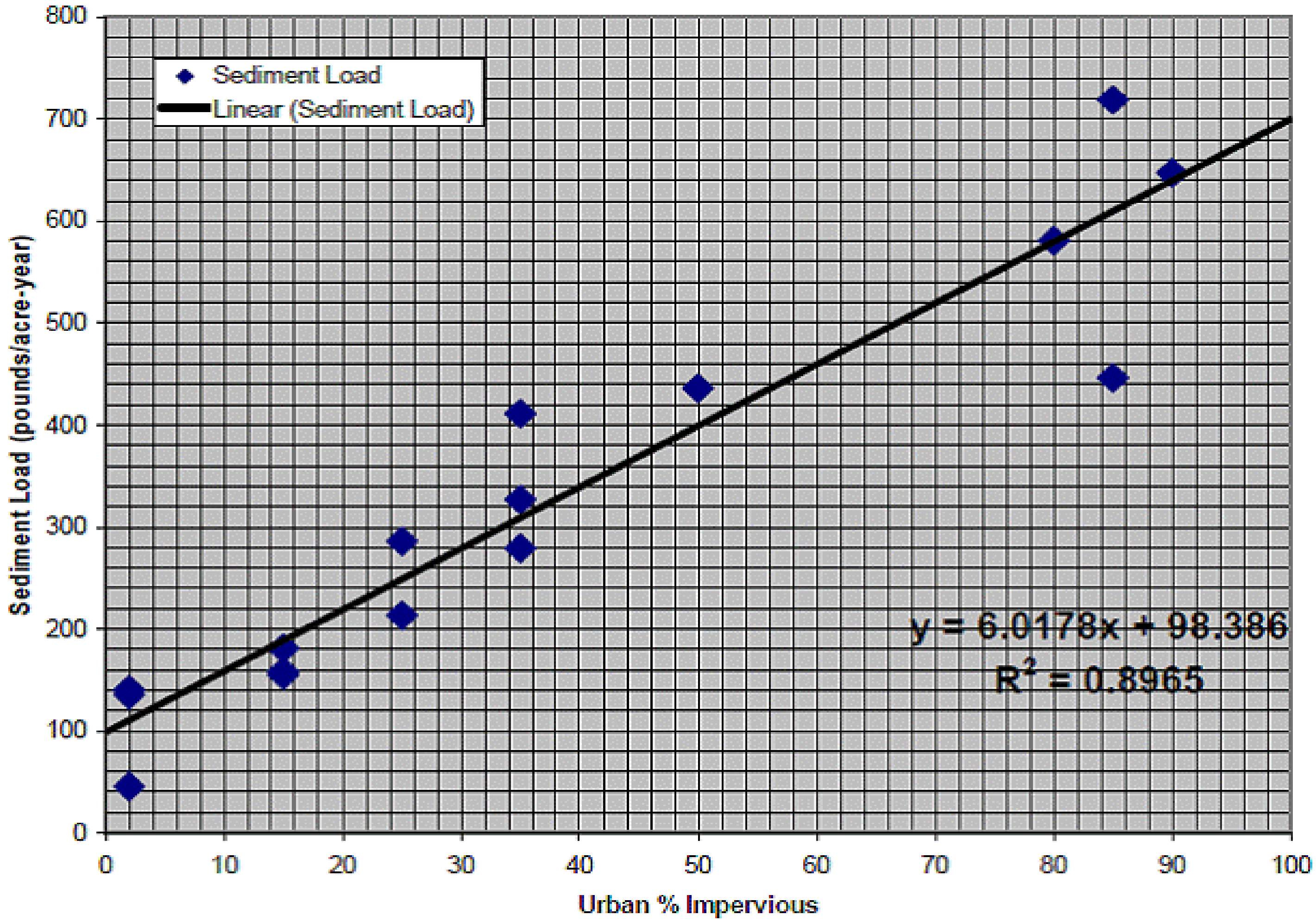
Most of the percentage of sediment load from instream sources is within the 20-40% range

Stream Sediment Literature Review Database



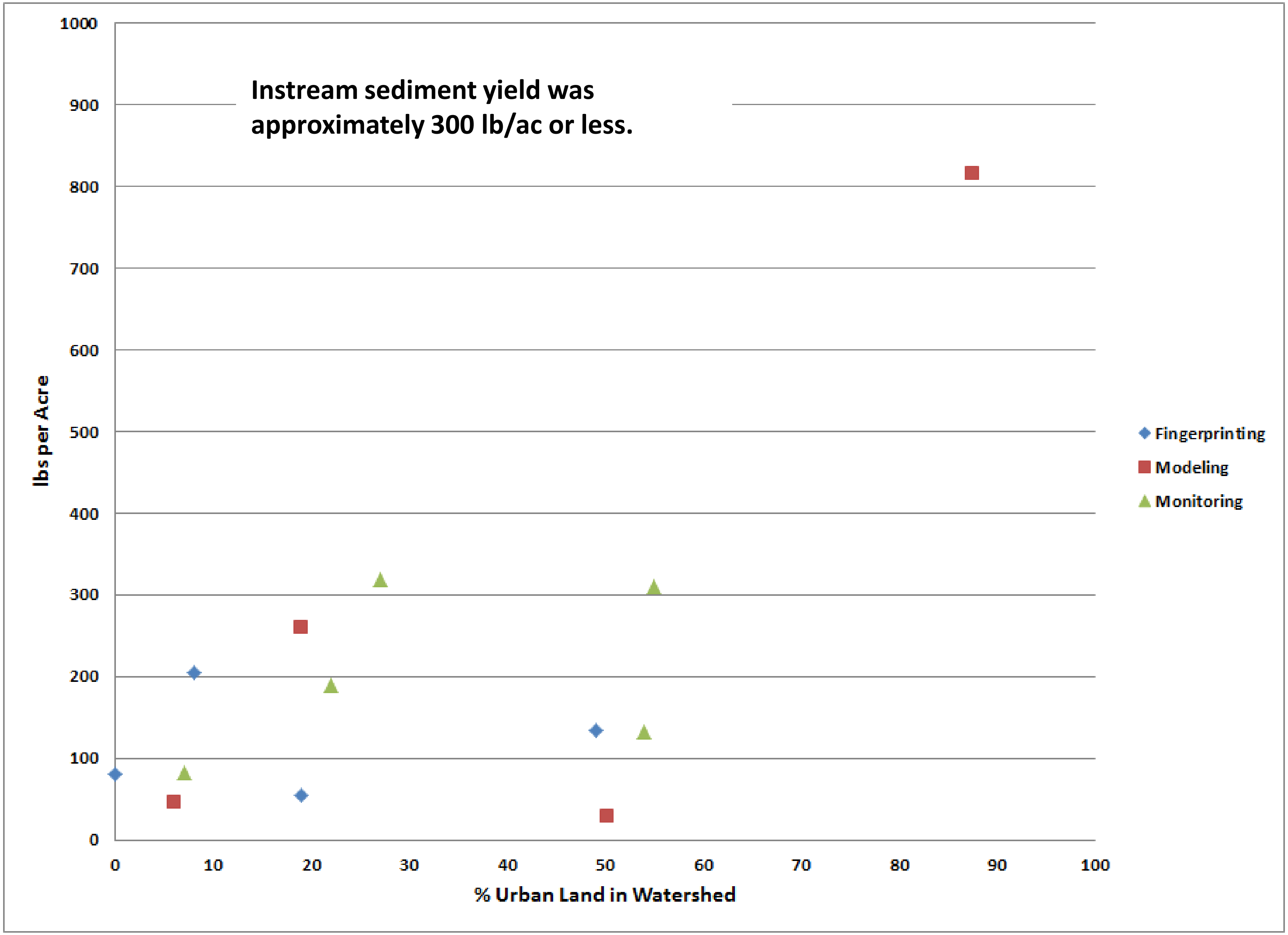
Total sediment yield compared to the percentage of urban land in the watershed .

Stream Sediment Literature Review Database



Relationship between Edge-of-Stream Urban Sediment Loads and Impervious Cover developed from data from Langland and Cronin (2003)

Stream Sediment Literature Review Database



Sediment yield from instream sources compared to the percentage of urban land in the watershed.

Monitoring Data Analysis

Modeled hourly flow data provided by CBP Modeling Team from 1984 to 2005.

Primary dataset = MD MS4 Monitoring Data

Three primary land use categories = residential, commercial, and industrial

Monitoring Data Analysis

MS4 and modeled flow data used to estimate baseflow and stormflow pollutant loads.

A mass balance approach was used to estimate in-stream sediment contributions.

$$\boldsymbol{InStream_{Bed/Bank} = Total_{Watershed} - Outfall}$$

Assumptions were applied given limited data available:

- Sediment concentrations were averaged for each land use, MS4 and location (outfall or watershed) and this average was used for the entire period of flow data.
- Surface runoff (stormflow), baseflow, and interflow serve as surrogates for unmeasured flow associated with monitored sediment concentrations.
- Outfall flow sampling locations were assumed to have no baseflow or interflow.
- Watershed sampling locations were assumed to have baseflow, interflow and stormflow.

Monitoring Data Analysis

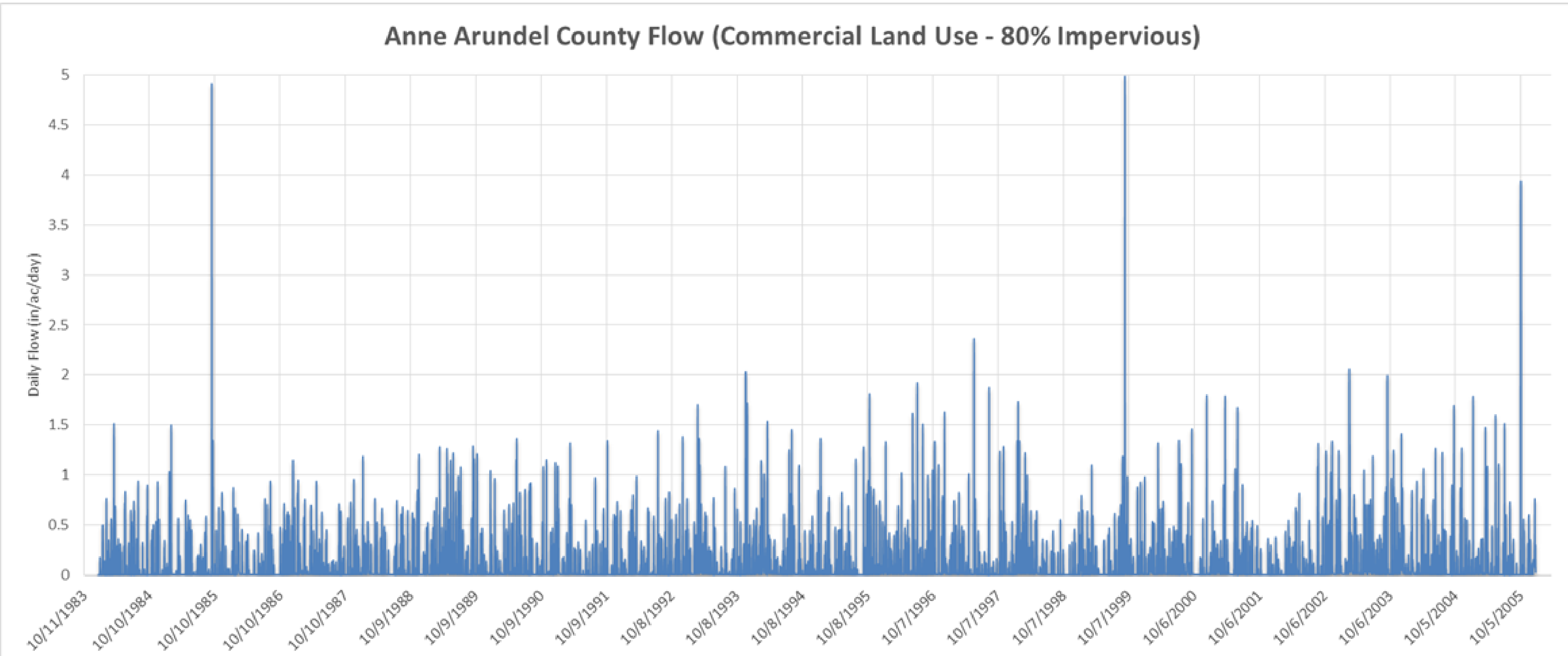
MDE EMC Storm Event Database

Table 3. Average event mean concentration (EMC) data (mg/L) during storm events for MS4s in Maryland. Data are representative of outfall and watershed sampling locations. The sample size (n) is indicated in parentheses.

	Residential		Commercial		Industrial	
County	Outfall	Watershed	Outfall	Watershed	Outfall	Watershed
Anne Arundel	nd	nd	96.3 (132)	72.2 (129)	nd	nd
Baltimore City	88 (131)	112.3 (153)	nd	nd	nd	nd
Baltimore	42 (79)	66.9 (98)	39.6 (18)	96.9 (18)	nd	nd
Carroll	nd	nd	nd	nd	90.4 (53)	123 (51)
Charles	59.6 (156)	34.3 (149)	nd	nd	nd	nd
Frederick	23.5 (95)	180.2 (118)	nd	nd	nd	nd
Harford	37 (90)	51 (94)	nd	nd	nd	nd
Howard	33.3 (74)	162.7 (59)	nd	nd	nd	nd
Montgomery	64.5 (88)	170.6 (87)	nd	nd	78.4 (40)	100.7 (48)
Prince George's	166.5 (115)	340.2 (172)	285.6 (23)	591.8 (17)	126.3 (28)	646.6 (24)

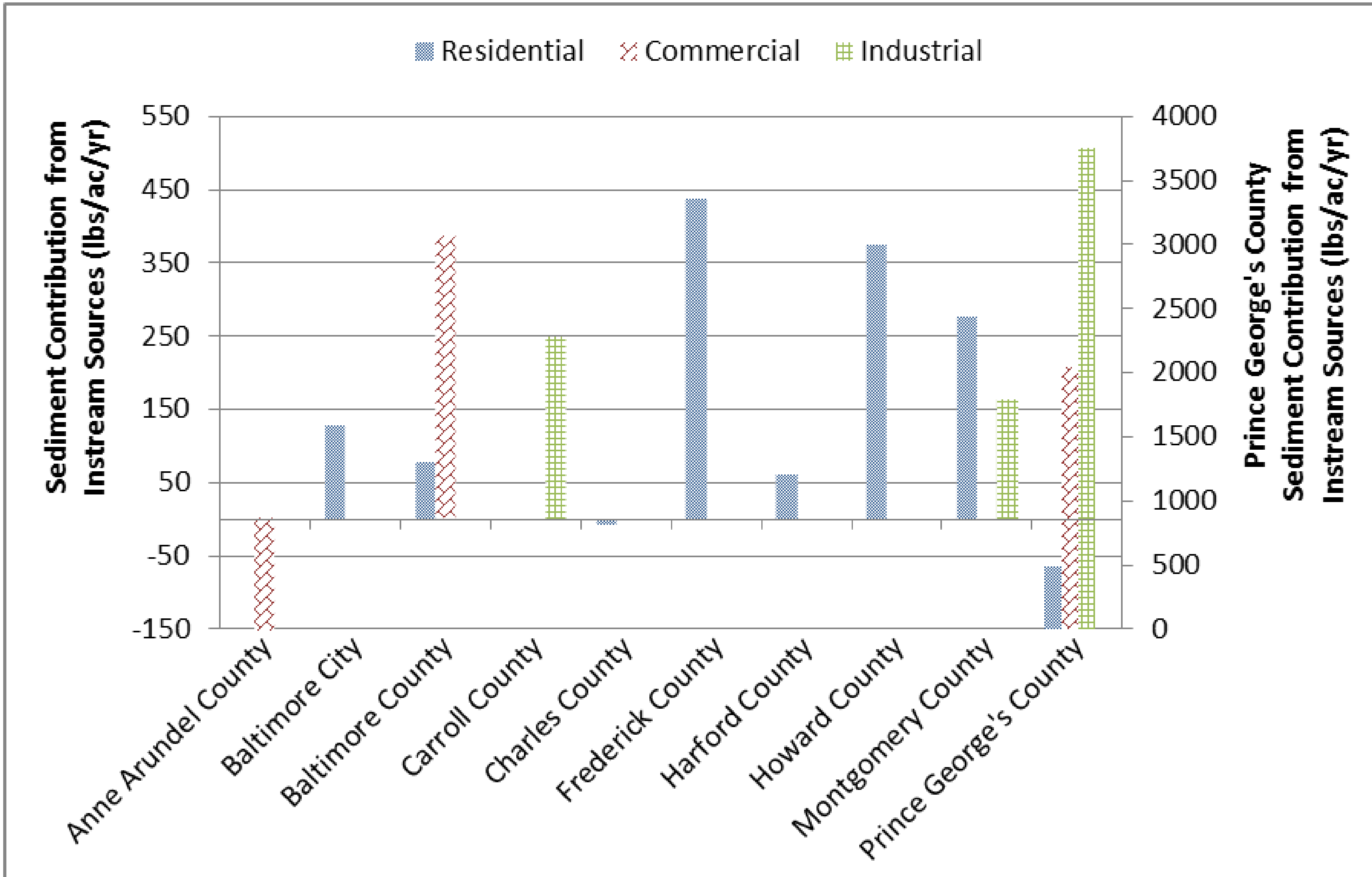
Monitoring Data Analysis

Modeled Hourly Flow Data from CBP



Monitoring Data Analysis

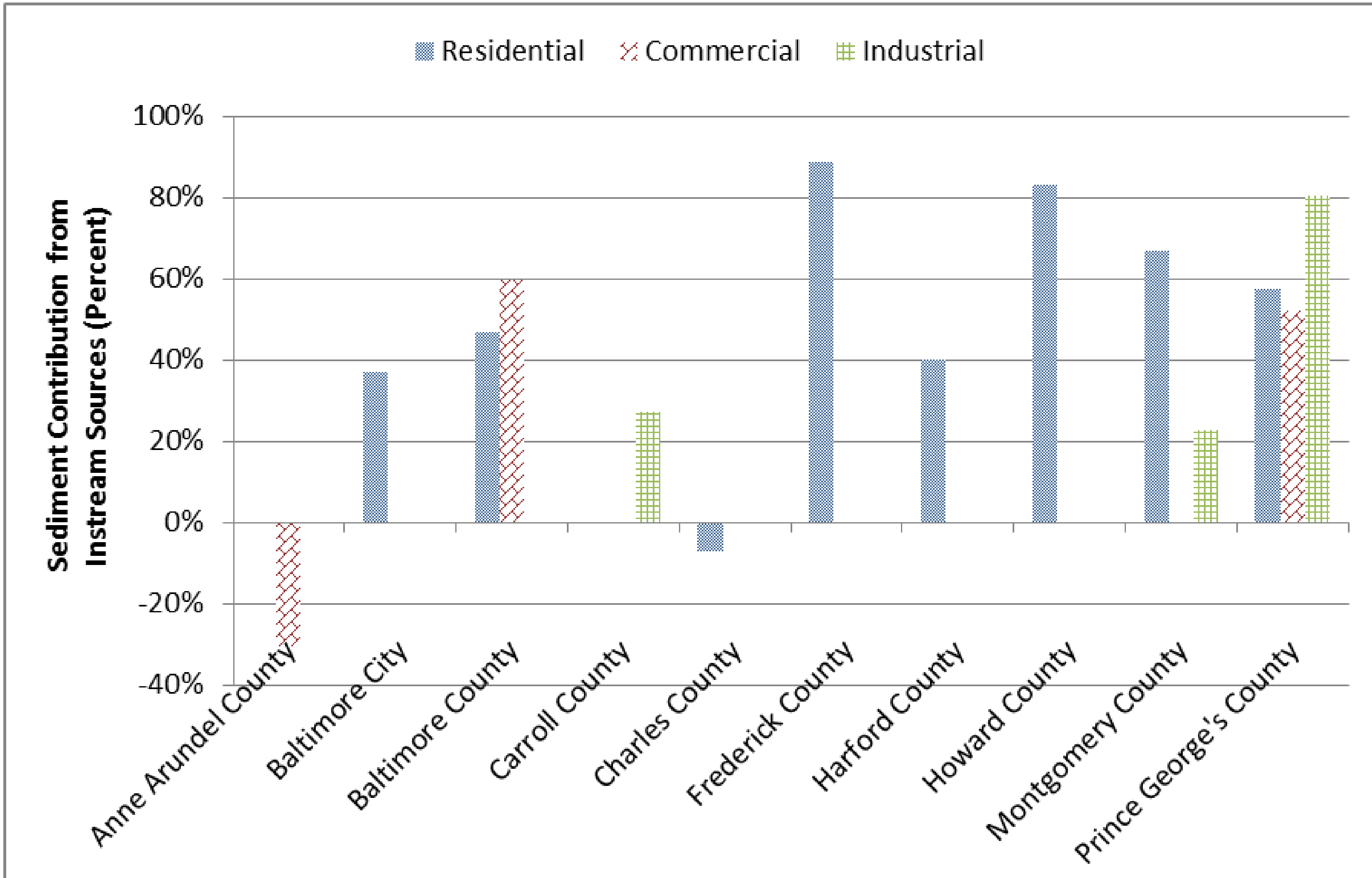
Stream Loadings for Land Uses Reported to MDE from MS4 Communities



Estimates are based on reported event mean concentrations (EMCs) and modeled flow.

Monitoring Data Analysis

Stream Contributions (%)



Values represent average stream contribution based on imperviousness estimated by combining Event Mean Concentrations provided by MDE and CBPO modeled flow.

Summary

Total Watershed Sediment Yield	Literature Review	200 – 1,500 lbs/ac/yr
	Monitoring Data Analysis	100 – 900 lbs/ac/yr (to 4,600 lbs/ac/yr with PGC)
Sediment Yield from In-Stream Sources	Literature Review	<300 lbs/ac/yr
	Monitoring Data Analysis	<450 lbs/ac/yr (<3,800 lbs/ac/yr with PGC)
% Contribution from In-Stream Sources	Literature Review	20 – 60%
	Monitoring Data Analysis	23 – 89% for source (average 55%) -7 – -30% for sink (average -19%)

Recommendations and Next Steps

1. Analysis of stream bank erosion rates.
2. Determine the sources of TP and TN loading.
3. Similar analysis of stream sediment in agricultural watersheds.
4. Improved characterization of headwater streams to identify landscape characteristics affecting the source-sink function.