Appendix F
Storm Drain Cleaning Program

Baltimore County Department of
Environmental Protection and Sustainability
Watershed Management and Monitoring Section

Excerpts from Baltimore County MS4 Permit Annual Report (2014) and Draft SOP(2015) .

The Baltimore County DPW stormdrain geodatabase is still being compiled, and will be updated via field investigations, quality control, and compilation from recent storm drain drawings. A copy of this geodatabases accompanies this report. Below are totals from DPW's stormdrain geodatabases as of 12/17/2014.

The Baltimore County storm drain system consists of approximately 1,591 miles of storm drainpipes, channels, and swales, 53,107 inlets, 29,091 manholes, 20,061 in-network structures, and 8,364 outfalls. This is a conservative estimate from DPW's stormdrain geodatabasewhich continues to grow as field investigations, quality control, and compilation of recent storm drain drawings continue.

In order to keep the entire storm drain system clean of trash, debris, and sediment, the Department of Public Works maintains three storm drain cleaning vehicles and employs three crews of two men each on a daily basis to clean the storm drains and pipes. Removing the material from the storm drain system reduces street flooding, a potential safety hazard, reduces the amount of trash and sediment from entering streams, and aids in the detection of illicit connections.

Each time a crew cleans an inlet or pipe the amount of debris removed is recorded on a data sheet that typically contains all cleaning records for that particular location. Completed data sheets are sent to EPS, where the data is entered into a database. The database facilitates reporting for NPDES purposes.

Storm Drain Cleaning Data Analysis

The data entered into the database are analyzed for a number of measures, including the amount of material removed per inlet, the amount of material removed per linear foot of pipe cleaned, total amount of material removed by watershed, and the amount of pollutants removed as a result of the program. Inlet data are reported as the average annual cubic feet of material removed per inlet, and pipe data are reported in cubic feet of material removed per linear foot of pipe.

Program Summary – Storm Drain Cleaning

In twenty years, the storm drain cleaning program has removed ~32,920 cubic yards of material from the Baltimore County storm drain system. At 331 pounds per cubic yard, that amounts to approximately 10.9 million pounds. Without intervention, this material would have eventually entered our waterways.

DRAFT
STANDARD OPERATING PROCEDURE
Tracking, Verification, and Pollutant Load Calculations:
Inlet Cleaning

Important Note: This is provided as a good example of an effective SOP for tracking storm drain cleaning, but the methods and equations may need to be adjusted to reflect the recommendations of this expert panel

Procedural Section

1.0 Definition

In order to keep the entire storm drain system clean of trash, debris, and sediment, the Department of Public Works maintains three storm drain cleaning vehicles and employs three crews of two men each on a daily basis to clean the storm drains and pipes. Removing the material from the storm drain system reduces street flooding, a potential safety hazard, reduces the amount of trash and sediment from entering streams, and aids in the detection of illicit connections.

.

2.0 Tracking

2.1 Initial Inspection

2.1.1 Inspection Method

Each time a crew cleans an inlet or pipe the amount of debris removed is recorded on a data sheet that typically contains all cleaning records for that particular location.

2.1.2 Inspector and Qualifications

Staff from DPW Bureau of Utilities clean inlets and pipes using a VACCON truck.

2.1.3 Documentation

DPW completes a data sheet which is organized by work order.

2.2 Data Entry and QAQC

Data sheets are filled out by DPW and contain the following information for pipe cleaning: Starting address and closest intersection, upstream and downstream manhole number (if available), pipe size, debris type, length of pipe cleared, and applicable notes. For inlet cleaning the following information is recorded: starting address and closest intersection, length, width, and depth of inlet before and cleaning, debris type and odor before and after cleaning. Additional information is also recorded such as weather and arrival time. Completed data sheets are entered into a CASSWORKS database by DPW staff and copies of data sheets are sent to EPS where they are filed. The database facilitates reporting for NPDES purposes.

3.0 Pollutant Load Calculations

3.1 Data Retrieval and Processing

A summary table is prepared from the storm drain cleaning data sheets showing the debris collected (cubic yards and tons); TN, TP, TSS (pounds) removed; and equivalent impervious urban acres by watershed.

3.1.1 Export data for appropriate time period from CASSWORKS into an Excel file.

3.1.2 Transfer raw data from CASSWORKS in excel file to CASSWORKS import template available on S drive: file:///S:\EPS\WMM\Data\Chemical\Storm%20Drain%20Cleaning%20(Vaccon)\CASSWORKS\Template_ImportFromCASSWORKS.xlsx. Follow directions on the Description tab in order to get the data into the template.

3.1.3 Perform quality control on the import Excel file. Paper data sheets are compared to the information in Excel. Any missing inlet or pipe cleanings are entered by EPS in Excel. Dimensions are reviewed and are converted to inches if they are in a different unit.

3.1.4 Transfer the data from the import Excel file to this spreadsheet: file:///S:\EPS\WMM\Data\Chemical\Storm%20Drain%20Cleaning%20(Vaccon)\Vaccon_Data.xlsm which contains the formulas and macros to get the volumes.

For inlet cleaning, all dimensions are entered in inches. There are 36^3 cubic inches per cubic yard, or 2.14335×10^{-5} cubic yards per cubic inch. Formula 3.1 is used to calculate the volume of material removed in cubic yards:

$$V_{inlet\ debris} = L_i \times W_i \times \left(D_{i,post} - D_{i,pre}\right) \times 2.14335 \times 10^{-5} \quad (3.1)$$

where $V_{inlet\ debris}$ = volume of debris removed from inlet in cubic yards,
L_i = length of inlet in inches,
W_i = width of inlet in inches,
$D_{i,post}$ = depth of inlet, in inches, after cleaning completed,
$D_{i,pre}$ = depth of inlet, in inches, before cleaning begins, and
2.14335×10^{-5} = cubic yards per cubic inch

3.1.5 Geocode the addresses and overlay the watersheds.

3.1.6 Transfer data to excel and use a pivot table to show the number of inlets cleaned and volume of debris removed per watershed.

3.1.7 Trash debris is not eligible for nutrient and sediment reductions. Using the volume of debris removed, estimate the weight of sediment and organic material, and the weight of trash, removed from inlets. A study of debris removed from inlets (Law, DiBlasi and Ghosh 2008) informs this

estimation. Debris was weighed without drying, so we conservatively assume that all weights from this study are wet weight. The study found that the bulk density of the debris is 331 wet pounds per cubic yard (0.166 wet tons/cubic yard). The study also found that trash accounted for 8.9% of the weight of debris from inlets, while sediment and organic material made up 91.1% of the weight of debris. Formulae 3.2 and 3.3 are used respectively to estimate the weight of sediment and organic material, and the weight of trash:

$$W_{S+OM} = V_{inlet\ debris} \times D_b \times P_{S+OM}$$
$$W_{S+OM} = V_{inlet\ debris} \times 0.166 \times 0.911$$

where W_{S+OM} = wet weight of sediment and organic matter in tons, 3.2
$V_{inlet\ debris}$ = volume of debris removed from inlet in cubic yards,
D_b = bulk density of inlet debris in tons per cubic yard, and
P_{S+OM} = proportion sediment & $organic\ matter, by\ weight$

$$W_{trash} = V_{inlet\ debris} \times D_b \times P_{trash}$$
$$W_{trash} = V_{inlet\ debris} \times 0.166 \times 0.089$$

where W_{trash} = wet weight of trash in tons, 3.3
$V_{inlet\ debris}$ = volume of debris removed from inlet in cubic yards,
D_b = bulk density of inlet debris in tons per cubic yard, and
P_{trash} = proportion trash, by weight

3.2 TN Calculations

Nitrogen reductions per ton of sediment and organic matter removed via catch basin cleaning and storm drain vacuuming are provided in the document Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated (MDE 2014). Reductions per ton of wet weight material are provided in Table 7 of that report, and are 3.5 pounds total nitrogen per wet ton (MDE 2014, 19). Reductions per ton of dry weight material are shown on page 46, and are 0.0025 pounds nitrogen per dry pound (5 pounds per dry ton) (MDE 2014, 46). Weight of wet material can be converted to dry weight by multiplying by 70% (MDE 2014, 46). Equation 3.4 is used to estimate nitrogen reductions from the wet weight of sediment and organic matter removed from inlets and storm drains.

$$TN = W_{S+OM} \times 3.5\ \text{lbs/ton}$$

where TN = total nitrogen removed in pounds,
W_{S+OM} = wet weight of sediment and organic matter in tons, and
3.5 lbs/ton = total nitrogen removal rate in pounds per wet ton 3.4

3.3 TP Calculations

Phosphorus reductions per ton of sediment and organic matter removed via catch basin cleaning and storm drain vacuuming are provided in the document Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated (MDE 2014). Reductions per ton of wet weight material are provided in Table 7 of that report, and are 1.4 pounds total phosphorus per wet ton (MDE 2014, 19). Reductions per ton of dry weight material are shown on page 46, and are 0.001 pounds phosphorus per dry pound (2 pounds per dry ton) (MDE 2014, 46). Weight of wet material can be converted to dry weight by multiplying by 70% (MDE 2014, 46). Equation 3.5 is used to estimate phosphorus reductions from the wet weight of sediment and organic matter removed from inlets and storm drains.

$$TP = W_{S+OM} \times 1.4 \text{ lbs/ton}$$

where TP = total phosphorus removed in pounds,
W_{S+OM} = wet weight of sediment and organic matter in tons, and
1.4 lbs/ton = total phosphorus removal rate in pounds per wet ton

3.5

3.4 TSS Calculations

Sediment reductions per ton of sediment and organic matter removed via catch basin cleaning and storm drain vacuuming are provided in the document Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated (MDE 2014). Reductions per ton of wet weight material are provided in Table 7 of that report, and are 420 pounds total suspended sediment per wet ton (MDE 2014, 19). Reductions per ton of dry weight material are shown on page 46, and are 30% of the dry weight (600 pounds per dry ton) (MDE 2014, 46). Weight of wet material can be converted to dry weight by multiplying by 70% (MDE 2014, 46). Equation 3.6 is used to estimate phosphorus reductions from the wet weight of sediment and organic matter removed from inlets and storm drains.

$$TSS = W_{S+OM} \times 420 \text{ lbs/ton}$$

where TSS = total suspended sediment removed in pounds,
W_{S+OM} = wet weight of sediment and organic matter in tons, and
420 lbs/ton = total suspended sediment removal rate in lbs per wet ton

3.6

Law, Neely L., Katie DiBlasi, and Upal Ghosh. 2008. *Deriving Reliable Pollutant Removal Rates for Municipal Street Sweeping and Storm Drain Cleanout Programs in the Chesapeake Bay Basin.* Research Report, Ellicott City, MD: Center for Watershed Protection. http://www.cwp.org/online-watershed-library/doc_download/577-deriving-reliable-pollutant-removal-rates-for-municipal-street-sweeping-and-storm-drain-cleanout-programs-in-the-chesapeake-bay-basin.

MDE. 2014. *Accounting for Stomwater Wasteload Allocations and Impervious Acres Treated: Guidance for National Pollutant Discharge Elimination System Stormwater Permits.* Baltimore, MD: MDE.

http://www.mde.state.md.us/programs/Water/StormwaterManagementProgram/Documents/NPDES%20MS4%20Guidance%20August%2018%202014.pdf.

Urban Stormwater Workgroup. 2011. *Technical Memo on street sweeping and BMP era recommendation of expert panel.* Annapolis, MD: Chesapeake Bay Program. http://chesapeakestormwater.net/wp-content/uploads/downloads/2012/06/CBP-Expert-Panel-Memo-on-Street-Sweeping.pdf.