Thea Foss and Wheeler-Osgood Waterways

2014 Source Control and Water Year 2014 Stormwater Monitoring Report

March 2015

Prepared for
Washington State Department of Ecology and
U.S. Environmental Protection Agency

Prepared by
City of Tacoma

PROJECT OVERVIEW

Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), also referred to as Superfund, contaminated bottom sediments were remediated in the Thea Foss and Wheeler-Osgood Waterways in Tacoma, Washington under the oversight of the Environmental Protection Agency (EPA) at a cost of $105M. Sources of Contaminants of Concern (COCs) continue to exist in the drainage basins and are conveyed to the waterways via stormwater (municipal and private), aerial deposition, marinas, and groundwater discharges. The contaminants identified as having the greatest potential to affect sediment quality following the cleanup action include polycyclic aromatic hydrocarbons (PAHs) and phthalates.

When the waterway sediment remediation projects were completed, the majority of the sediment surface had no, or very low concentrations of contaminants present since the surface was either dredged to clean sediments or covered with new, clean capping materials. It was anticipated that ongoing source contributions to the waterway would cause concentrations of contaminants to increase gradually. Over time, the goal is to have the contaminant concentrations equilibrate at a level below the sediment cleanup standards set by the EPA. The City of Tacoma (City) developed a predictive model so that actual sediment monitoring results can be compared to model predictions to determine areas where additional source controls may be needed to remain in compliance.

Since stormwater is one of the potential sources, the City has been implementing a comprehensive monitoring and source control strategy in the Foss Waterway Watershed since 2001. This includes monitoring of water and sediments in municipal outfalls and using this monitoring information to guide control of contaminant sources in the drainage basins. The intent of this program is to help provide long-term protection of sediment quality in the waterways. The strategy's elements are integrated with the City's National Pollutant Discharge Elimination System (NPDES) requirements; however, many of the elements exceed these requirements.

Over a 13 year period (August 2001-September 2014), stormwater and stormwater sediments have been sampled at the seven major outfalls that discharge into the Thea Foss and Wheeler-Osgood Waterways. This depth of data provides the basis for meaningful statistical evaluation of the trends over the program period. Based on this statistical analysis, the City determined that 46 statistically significant time trends (46 out of 49 tests, or approximately 94% of the tests) were shown in Year 13, with all trends in the direction of decreasing concentrations. This is a larger number of significant reductions than has been observed previously, however, the statistical approach used since 2012 is somewhat modified from that used in previous years. The City is confident that these changes in the statistical approach have improved the City's ability to discern trends.

The time trends were modeled with best-fit regression equations to estimate percent reductions over the 13 year monitoring period for these constituents and outfalls:

- **Total Suspended Solids (TSS)**: Approximately 41-70% reduction in OF230, OF235, OF237A, OF237B and OF245;
- **Lead**: Approximately 46-74% reduction in OF230, OF235, OF237A, OF237B, OF245 and OF254;
- **Zinc**: Approximately 33-59% reduction in all 7 outfalls;

- **Polycyclic Aromatic Hydrocarbons (PAHs):** Approximately 89-98% reduction in phenanthrene, pyrene, and indeno(1,2,3-cd)pyrene in all 7 outfalls; and
- **Bis(2-ethylhexyl)phthalate (DEHP)**: Approximately 69-92% reduction in all 7 outfalls.

As shown by these significant reductions in various constituents of concern, the improvement in stormwater quality since the mid-1990s indicates that source control efforts by the City and others in the Foss Waterway Watershed have been effective in reducing chemical concentrations in stormwater. These efforts have resulted in fewer sites in the watershed with comparatively higher contaminant concentrations relative to other locations. Because the program has been so effective, the concentrations of contaminants of concern in stormwater in the Foss Waterway Watershed are reaching a level where the opportunities for large reductions are more limited. This may lead to few, if any, additional decreasing trends in contaminant concentrations, lower percentages of reduction per year, and potentially even a few minor increasing trends, particularly if looking only at results from more recent years.

The sediments in the waterway are the true barometer, however, of whether additional source controls are needed for compliance with regulatory requirements. Sediment monitoring was performed by the City in 2013, in the portion of the waterway generally north of the SR509 Bridge and in 2014 by the private Utilities group that performed the remediation of the head of the waterway. An evaluation of the 2013 sampling by the City was included in the WY2013 report. An analysis of the Utilities' results in 2014 shows that the data were generally consistent with model predictions and that the risk of significant recontamination is low. In most cases, sediment concentrations have remained relatively stable between their Year 7 and Year 10 monitoring events. Model predictions indicate sediment concentrations begin to level off at approximately Year 7 and are not expected to rise much higher in the future, and generally this is consistent with measured results. Therefore, waterway sediment concentrations appear to have largely equilibrated with modern sources ten years after the completion of the remedial action in the head of the waterway. As a result, the risk of recontamination is not expected to be substantially higher in the future unless there is a change in the nature, strength or distribution of waterway sources.

The City will continue to move forward with ongoing source tracing investigations, treatability studies, and other special investigations for evaluating and identifying cost-effective controls for remaining contaminants in municipal stormwater where such control is determined necessary to protect the waterway. Ongoing control of sources which are outside the City's jurisdiction must also continue to be coordinated by other federal, state, and local authorities.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES – INCLUDED ON ENCLOSED CD ONLY

LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
BEL	Biological Effects Level
BMPs	Best Management Practices
BNSF	Burlington Northern Santa Fe
CDF	Confined Disposal Facility
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CHB	Citizens for a Healthy Bay
City	City of Tacoma
CIPP	Cured-In-Place Pipe
COCs	Contaminants of Concern
CRM	Certified Reference Manual
DEHP	Bis(2-ethylhexyl) phthalate
Ecology	Washington State Department of Ecology
EPA	Environmental Protection Agency
FWDA	Foss Waterway Development Authority
HPAHs	High Molecular Weight PAHs
IDDE	Illicit Discharge Detection and Elimination
ISWGP	Industrial General Stormwater Permit issued by Ecology
LCS	Laboratory Control Sample
LID	Low Impact Development
LPAHs	Low Molecular Weight PAHs
LUST	Leaking Underground Storage Tank
MLLW	Mean Lower Low Water
MS4	Municipal Separated Storm Sewer System
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPDES Phase I Permit	NPDES Phase I Municipal Stormwater Permit dated January 17, 2007
NWDC	Northwest Detention Center
OF	Outfall
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated biphenyls
PIC	Pierce County Code Enforcement Officers Group
PSD	Particulate Size Distribution
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
SSPM	Stormwater Suspended Particulate Matter
SAP	Sampling and Analysis Plan
SQOs	Sediment Quality Objectives

SR	State Route
STRAP	Stormwater Rapid Assessment Program
SWMP	Stormwater Management Program
SWPPP	Stormwater Pollution Prevention Plan
TPCHD	Tacoma Pierce County Health Department
TSS	Total Suspended Solids
UCL	Upper Control Limit
USGS	United States Geological Survey
UST	Underground Storage Tank
Utilities	Group of Private Utilities who performed cleanup in the Head of the Thea Foss Waterway
WASP	Water Quality Analysis Simulation Program
WRDA	Water Resources Development Act
WSDOT	Washington State Department of Transportation

EXECUTIVE SUMMARY

Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), also referred to as Superfund, contaminated bottom sediments were remediated in the Thea Foss and Wheeler-Osgood Waterways in Tacoma, Washington under the oversight of the Environmental Protection Agency (EPA) at a cost of $105M. The waterways are located in a highly urbanized basin with residential, commercial and industrial land uses and transportation corridors. Sources of Contaminants of Concern (COC) continue to exist in the drainage basins and are conveyed to the waterway via stormwater (municipal and private), aerial deposition, marinas, and groundwater discharges. The contaminants identified as having the greatest potential to affect sediment quality following the cleanup action include polycyclic aromatic hydrocarbons (PAHs) and phthalates.

Under a Consent Decree with the EPA dated May 9, 2003, along with prior regulatory agreements, the City of Tacoma (City) implemented a stormwater monitoring and source control strategy for the municipal storm drains entering the Thea Foss and Wheeler-Osgood Waterways to help provide long-term protection of sediment quality in the waterways. The Thea Foss Post-Remediation Source Control Strategy uses a multifaceted approach consisting of aggressive source control efforts, continuation of a comprehensive monitoring program, a computer model to predict impacts, and a decision matrix to identify the need for additional source controls. The strategy's elements are integrated with the City's National Pollutant Discharge Elimination System (NPDES) Phase I requirements, however, many of the elements exceed NPDES requirements.

Under the comprehensive monitoring program, annual baseflow[1], stormwater and stormwater suspended particulate matter (SSPM) monitoring of the stormwater discharges to the Thea Foss Waterway are used to evaluate effectiveness of these source control efforts, and to provide early warning of any new problems which arise in the drainages. The requirements of the monitoring program and the approach to the evaluation of results were outlined in the 2001 Sampling and Analysis Plan (SAP) for the Thea Foss and Wheeler-Osgood Waterways dated September 2001 (Tacoma 2001) and approved by EPA on September 13, 2001. A new Quality Assurance Project Plan for monitoring was completed and approved in 2014, and will go into effect for WY2015 monitoring.

This annual report outlines the City's existing programs and studies which were completed in Water Year 2014 (WY2014), and includes an evaluation of the need for additional source controls. Annual source control evaluations are completed for the seven major outfalls discharging to the waterways; outfalls (OF) 230, 235, 237A, 237B, 243, 245 and 254. The evaluations include a drain-by-drain assessment and incorporate the review of ongoing studies, source control investigations, water quality data, and stormwater suspended particulate matter (SSPM) data for that outfall/basin.

As part of the WY2014 evaluation, this report reviews results from the first 13 years of outfall monitoring conducted under the Foss Monitoring Program and source control actions completed in the Thea Foss drainage basins. Since the group of private Utilities completed additional sediment monitoring in the portion of the waterway generally south of the SR509 Bridge in

---

[1] After 10 years of baseflow monitoring were completed at the end of WY2011, baseflow monitoring was discontinued (approval granted by EPA and Ecology on 2/7/12 and 2/9/12 respectively). Baseflow quantity and quality were determined to be well characterized by the 10 year monitoring record.

WY2014, it also includes an analysis of this data relative to the City's computer model predictions to evaluate trends in sediment concentrations.

Each year, the history and trends emerging over the program are examined and presented in terms of the following questions:

- Is stormwater quality improving over time?
- What efforts have affected change?
- Is Thea Foss sediment quality in compliance with Superfund Sediment Quality Objectives (SQOs)?
- Is Thea Foss sediment quality better or worse than computer model predictions?
- Are additional source controls required?

IS STORMWATER QUALITY IMPROVING OVER TIME?

Over a 13 year period (August 2001-September 2014), stormwater and SSPM have been sampled at the seven major outfalls that discharge into the Thea Foss and Wheeler-Osgood Waterways. In addition, baseflow was sampled at the same seven outfalls for the first 10 years of the program. Over the last 13 years, 1,554 samples have been collected with 322 baseflow and 896 stormwater samples collected at the outfalls, and 80 outfall and 256 upline SSPM samples collected in pipeline sediment traps deployed throughout the watershed. This depth of data provides the basis for meaningful statistical evaluation of the trends over the program period.

Stormwater Time Trend Analysis. Forty-six statistically significant time trends (46 out of 49 tests or approximately 94% of the tests) were shown in Year 13 using simple linear regression. All trends were in the direction of decreasing concentrations. This is a larger number of significant reductions than has been observed previously. In Year 12, 44 trends were detected; in Year 11, 41 trends were detected, in Year 10, 37 significant trends were detected; in Year 9, 26 significant trends were observed; in Year 8, 10 significant trends were observed; and in Year 7, only 4 significant trends were observed. It should be noted that some new statistical approaches were implemented beginning in WY2012 and for this reason, the results since then are not fully comparable to previous year's results. However, these changes have improved the statistical approach to the trend analysis, and the City's ability to discern trends.

The time trends were modeled with best-fit regression equations to estimate percent reductions over the 13 year monitoring period for these constituents and outfalls:

- **Total Suspended Solids (TSS)**: Approximately 41-70% reduction in OF230, OF235, OF237A, OF237B and OF245;
- **Lead**: Approximately 46-74% reduction in OF230, OF235, OF237A, OF237B, OF245 and OF254;
- **Zinc**: Approximately 33-59% reduction in all seven outfalls;
- **Polycyclic Aromatic Hydrocarbons (PAHs):** Approximately 89-98% reduction in phenanthrene, pyrene and indeno(1,2,3-cd)pyrene in all seven outfalls; and
- **Bis(2-ethylhexyl)phthalate (DEHP)**: Approximately 69-92% reduction in all seven outfalls.

WHAT EFFORTS HAVE AFFECTED CHANGE?

The cumulative effect of municipal, state, and federal source control efforts has likely caused the observed improvements in stormwater quality. The City has directed numerous source control efforts in this watershed focused on these COCs. Refer to Sections 2 and 5 for more detail regarding specific efforts.

The City implements aggressive source control activities that comply with or exceed the requirements of the NPDES permit requirements. Many of these activities have been developed specifically to respond to sources of contaminants found during various investigations.

Stormwater Management Program. The NPDES Phase I Municipal Stormwater Permit (NDPES Phase I Permit), effective August 1, 2013 through July 31, 2018, requires a Stormwater Management Program which is divided into 10 components including stormwater outfall sampling, source control, maintenance, inspections, capital projects, and program development and implementation for the municipal separated storm sewer system (MS4). The City integrates these NPDES program elements with the ongoing Thea Foss Program.

The City's stormwater ordinance, through the 2012 Stormwater Management Manual, requires stormwater treatment and control systems on new and redeveloped sites when certain thresholds are met, and provides a mechanism for enforcement of the stormwater management regulations. Through new development and redevelopment, stormwater runoff from industrial and commercial sites throughout the Thea Foss Basin is being converted from untreated to treated runoff (i.e., removal of solids from stormwater runoff).

In 2014, City staff performed numerous field activities within the Foss Waterway Watershed including the following:

- Responded to 230 spills/complaints including conducting investigations;
- Provided technical assistance on source control and best management practices;
- Conducted 175 business inspections;
- Assessed an additional 49,442 feet of pipe under the STRAP program.

All of the business inspections, complaints and spills, and various source control field activities are documented and tracked using a web-based database. The web-based database is an effective tool for retrieving historical information and examining trends.

Special Studies. The City has conducted a number of special studies to better understand the distribution of DEHP and PAHs in the urban environment and how those and other COCs might best be controlled.

Stormwater treatment studies. Stormwater treatment studies have been conducted to evaluate the ability of proprietary and public domain stormwater treatment systems to remove DEHP and PAHs from stormwater runoff. Systems tested to date include StormFilter, AquaFilter, pervious pavements, rain gardens and wet vaults. The City has evaluated each technology's effectiveness, applicability and reasonableness for use within the Foss Waterway Watershed.

Basin-wide sewer line cleaning. Basin-wide sewer line cleaning was conducted in the majority of the area of four drainage basins (OF254 in 2006; OF230 and OF235 in 2007; and OF237B in 2011) and part of a fifth basin (OF237A in 2008). The objective of the sewer line cleaning program is to remove residual sediments in the storm drains and sediment-bound contaminants. Contaminants in sediments present in the system may not solely be from new sources, but may in part be from legacy contamination in the pipe that could be continuing to impact stormwater or baseflow quality through re-suspension and/or dissolution.

A statistical comparison of pre-cleaning versus post-cleaning data ("before" and "after" conditions) shows there are statistically significant reductions in the mean concentrations of all seven Thea Foss index chemicals in OF230, OF235, OF237A, and OF237B and in five of the seven index chemicals in OF254. While this is representative of the results of combined source control efforts, sewer line cleaning appears to have been effective at accelerating removal of PAHs from stormwater, with 63-91% reductions in all five of these drains, including both light and heavy PAH fractions. DEHP also shows a significant reduction of approximately 15-82% in all five drainage basins.

Zinc shows a significant reduction of 13-42% in response to line cleaning in all five of the basins. In 2014, reductions of 10-49% in TSS are statistically significant in four of the five basins (all except OF254), and reductions of 13-50% for lead are statistically significant in four of the five basins (all except OF254). These statistical comparisons will continue to be updated as more post-cleaning data are collected. The statistical power of this test should increase over time, and quite possibly statistical differences that can't be resolved today may be distinguishable in the future.

Enhanced street sweeping program. In January 2007, the City's street sweeping program was enhanced in an attempt to reduce sediment buildup in the storm sewer system. Under the enhanced program, the sweeping frequency was increased, air regenerative sweepers replaced mechanical sweepers, and the City also increased communications with residents, which helped raise awareness of the importance of the street sweeping program.

A statistical comparison of data from before and after implementation of the enhanced sweeping program ("before" and "after" conditions) shows there are statistically significant reductions in the mean concentrations of the three index PAHs and DEHP in all seven outfalls. While this is representative of the results of combined source control efforts, enhanced street sweeping appears to have been effective at accelerating removal of PAHs and DEHP from stormwater, with 56-80% reductions of PAHs in all seven drains, including both light and heavy PAH fractions. DEHP reductions ranged from approximately 16-73% in the seven drains.

Zinc shows significant reductions of 16-38% in response to enhanced sweeping in all seven basins. In six of the seven basins (all but OF243) lead shows significant reductions of 2-46% and TSS shows significant reductions of 33-49% in four of the seven outfalls (OF230, OF235, OF237B and OF245). A statistically significant increase of 5% was shown in OF237A, however, this may be due in part to the updated data set used for statistical analysis that combined the historical OF237A data with the more recent OF237A New data (Tacoma 2013). These statistical comparisons will continue to be updated as more data are collected. The statistical power of this test should increase over time, and quite possibly statistical differences that can't be resolved today may be distinguishable in the future.

Stormwater pipe retrofit projects. In 2010, 13,500 linear feet of existing storm sewer main was structurally rehabilitated in the OF230 drainage basin. In 2013, an additional 13,807 linear feet of existing storm sewer main was structurally rehabilitated in the OF230 drainage basin, along with 5,479 linear feet in the OF235 drainage basin and 5,126 linear feet in the OF237A drainage basin. The rehabilitation projects were accomplished by means of Cured-In-Place Pipe (CIPP) construction technologies using resin impregnated liners which fixed defects (cracks, holes, etc.) in the pipe that could have allowed potentially contaminated groundwater and soil from historic “hot spots” to enter the storm sewer system

A statistical comparison of pre-construction and post-construction monitoring data for the 2010 lining project were reviewed and statistically significant reductions in OF230 were evident for TSS, lead, zinc, PAHs and DEHP (see Table 2-6). CIPP lining, along with other source control activities, resulted in reductions of TSS at 58%, lead at 64%, zinc at 16%, DEHP at 79% and PAHs (phenanthrene, pyrene, and indeno(1,2,3-cd)pyrene) at 87-92%. Since the second lining project was completed in WY2013, there is not enough post-construction monitoring data available at this time to do a pre- and post-construction comparison. This comparison will be performed in future water years once sufficient post-construction data is available.

GIS-based pollutant loading model. The City completed development of a GIS-based pollutant loading model to evaluate other stormwater best management practices (BMPs) that may be effective on a basin-wide scale (i.e., affecting tens, hundreds, or thousands of acres). The BMPs under consideration are street sweeping, low-impact development (LID), and engineered treatment devices such as filtration vaults. The goals of this study are: to evaluate the feasibility and cost-effectiveness of stormwater BMPs implemented on a basin-wide scale; to identify areas of concentrated pollutant runoff where source control efforts are best focused; and to assess the degree to which stormwater BMPs will cause a reduction of pollutant loadings, and thereby improvements in Thea Foss sediment quality. The model was calibrated to the City’s stormwater monitoring record. The City is currently planning to use this model as a tool in evaluating the selection of stormwater BMPs in the future.

Other State Regulations. In July 2012, the Washington State Department of Ecology (Ecology) reissued the final modified Industrial Stormwater General Permit (ISWGP) which includes new requirements. It is anticipated that under Ecology’s ISWGP and the existing Construction Stormwater Permit, contaminants in stormwater will be reduced over time from industrial facilities and construction sites. It is also anticipated that reductions of air pollution will occur through Ecology’s Air Program. As reductions in air pollution are realized, the pollutant loads washed off upland surfaces and entrained in stormwater runoff will decrease.

IS THEA FOSS SEDIMENT QUALITY IN COMPLIANCE WITH SQOS? IS IT BETTER OR WORSE THAN COMPUTER MODEL PREDICTIONS?

When the waterway sediment remediation projects were completed, the majority of the sediment surface had no, or very low concentrations of contaminants present since the surface was either dredged to clean sediments or covered with new, clean capping materials. It was anticipated that ongoing source contributions to the waterway would cause concentrations of contaminants to increase gradually. Over time, the goal is to have the contaminant concentrations equilibrate at a level below the sediment cleanup standards set by the EPA. The City developed a predictive model so that actual sediment monitoring results can be compared to model predictions to determine areas where additional source controls may be needed to remain in compliance.

The sediments in the waterway are the true barometer, however, of whether additional source controls are needed for compliance with regulatory requirements. Sediment monitoring was performed by the City in 2013 in the portion of the waterway generally north of the SR509 Bridge, and in 2014 by the private Utilities group that performed the remediation of the head of the waterway. An evaluation of the 2013 sampling by the City was included in the WY2013 report. An analysis of the Utilities’ results in 2014 shows that the data were generally consistent with model predictions and that the risk of significant recontamination is low. In most cases, sediment concentrations have remained relatively stable between their Year 7 and Year 10 monitoring events. Model predictions indicate sediment concentrations begin to level off at approximately Year 7 and are not expected to rise much higher in the future, and generally this is consistent with measured results. Therefore, waterway sediment concentrations appear to have largely equilibrated with modern sources ten years after the completion of the remedial action in the head of the waterway. As a result, the risk of recontamination is not expected to be substantially higher in the future unless there is a change in the nature, strength or distribution of waterway sources.

ARE ADDITIONAL SOURCE CONTROLS REQUIRED?

While overall trends are decreasing, analytical data indicates that there are some areas where relatively higher concentrations of certain contaminants are present and where additional source control efforts can be implemented. Source control efforts are focused on the COCs for each basin and whether it is found in stormwater or SSPM as follows:

Constituents of Interest in Each Basin

		230	235	237A	237B	243	245	254
TSS	Baseflow							
	Stormwater							✓
Mercury	Baseflow							
	Stormwater							
	SSPM					✓		n/a
Zinc	Baseflow	✓					✓	
	Stormwater							
	SSPM					✓		n/a
Lead	Baseflow		✓			✓		
	Stormwater		✓					
	SSPM					✓		n/a
LPAHs[1]	Baseflow							
	Stormwater							
	SSPM							n/a
HPAHs[2]	Baseflow							
	Stormwater		✓					
	SSPM							n/a
Phthalates	Baseflow		✓					
	Stormwater	✓	✓					
	SSPM							n/a
PCBs	SSPM							n/a

✓ chemical of concern.
[1] As represented by indicator COC phenanthrene
[2] As represented by indicator COCs indeno(1,2,3-cd)pyrene and pyrene
shows statistically significant improvement.
shows potential improvement based on qualitative evaluation.
n/a – not applicable

The City believes further improvements in stormwater quality may be realized in the future with ongoing NPDES Phase I Permit programs and continuing improvements in source control implementation. Sediment trap results are valuable in that they provide an early warning of potential stormwater sources to the waterway sediments that can be investigated and addressed before SQO exceedences requiring action are identified in the waterways. The City is moving forward with ongoing source tracing investigations, treatability studies, and other special investigations to evaluate and identify cost-effective controls for DEHP and PAHs that are consistent with the recommendations of the Sediment Phthalate Work Group.

2015 Source Control Work Plan. A considerable amount of source control work has taken place in the Foss Drainage Basin over the last 13 years. With the significant improvements realized, fewer major source control issues remain. The source control work plan for 2015 identifies specific activities for the watershed and for each basin. Each activity was prioritized in order from highest to lowest with higher priorities given to eliminating/reducing point sources and activities that are based on best professional judgment to provide a measurable benefit in reducing chemical loadings to the waterway. A full list of activities is found in Section 6.0 of this report. Some highlights planned for 2015 are:

- OF230: Continue source tracing investigation and track private property cleanups in area draining to FD3A and FD18 for mercury and PCBs, with PAHs and phthalates analyzed as well.
- OF237B: Review SSPM results for WY2015 to evaluate the effect of removal of the USTs at the EZ Mart site and determine whether additional investigation is needed.
- OF237B: Track PCB removal activities associated with the road construction project in FD34/35.
- OF243: Continue to investigate source of mercury at Burlington Northern Santa Fe (BNSF) and elsewhere in drainage area for FD23.
- OF245: Continue to coordinate work with TPCHD and Ecology at Truck Rail Handling/Quality Transport to identify any potential source(s) of phthalates.
- All: Review WY2015 SSPM data when available to evaluate the effectiveness of treatment systems installed and source control actions taken.

CONCLUSION

Reduction of contaminant loads to the Thea Foss and Wheeler-Osgood Waterways over the years, through the City's implementation of its stormwater source control program, as well as through the control of other sources, has been substantial. The improvement in stormwater quality since the mid-1990s indicates that source control efforts by the City and others in the Foss Waterway Watershed have been effective in reducing chemical concentrations in stormwater. Tests performed show 94% statistically significant time trends, all in the direction of decreasing concentrations. This result is significant and a testament to the City's ongoing comprehensive source control program.

The City believes some minor additional improvements in stormwater quality may be realized in the future with ongoing NPDES Phase I Permit programs and continuing improvements in source control implementation. Source control activities currently being implemented by the City include business inspections, response to spills and illicit discharges, mapping/maintenance/cleaning of the stormwater system, pollutant source tracing, and implementation of the City's Surface Water Management Manual through the stormwater ordinance. The City is moving forward with ongoing source tracing investigations, treatability studies, and other special investigations for evaluating and identifying cost-effective controls for metals, DEHP and PAHs in municipal stormwater. Ongoing control of sources which are outside the City's jurisdiction must also continue to be coordinated by other federal, state, and local authorities.

It should be noted that while considerable improvements to stormwater quality have been made, the largest changes were realized in the earlier years of the program when major sources were identified and eliminated. Because the source control program has been so effective through the years, fewer major sources or maintenance actions are needed and the program is beginning to approach an equilibrium or maintenance mode. In other words, the concentrations of contaminants of concern in the stormwater in the Foss Waterway Watershed are reaching a level where the opportunities for large reductions are more limited. This may over time lead to the appearance of fewer additional decreasing trends in contaminant concentrations, lower percentages of reduction, and potentially even a few minor increasing trends, particularly if looking only at results from more recent years. However, data shows that the City's stormwater source control and monitoring program have been very effective in reducing contaminant levels in stormwater and SSPM and that the risk of recontamination of sediments over biological effects thresholds in the Thea Foss Waterway from stormwater is low.

1.0 INTRODUCTION

1.1 OBJECTIVES

Under a Consent Decree with the EPA dated May 9, 2003, the City completed remediation of marine sediments in the majority of the Thea Foss and Wheeler-Osgood Waterways in Tacoma, Washington in March 2006. Remediation of the southernmost 1,000 feet of the Thea Foss Waterway was completed in 2004 by a group of private utilities under a separate Consent Decree with EPA. The waterways are narrow estuarine water bodies on the southeastern margin of Commencement Bay, with 13 municipal outfalls that discharge stormwater to the waterways as well as numerous private outfalls.

With the completion of the cleanup action in the Thea Foss and Wheeler-Osgood Waterways, it is necessary to continue monitoring source control activities to ensure sediment quality is protected in dredged and capped areas and to ensure that natural recovery is attained in areas where active remediation was not required. Included as part of the Consent Decree Statement of Work, a letter addendum dated November 1, 2001 (identified as Attachment 1 to the Consent Decree), provides a detailed schedule and work plan for the City's stormwater source control efforts for the Thea Foss and Wheeler-Osgood Waterways. This addendum, herein referred to as the Stormwater Work Plan Addendum, includes a description of stormwater monitoring efforts, studies, source control efforts and BMP assessments for municipal stormwater sources. Based upon these various efforts and evaluations, an approach to future stormwater source control decision-making identified as the Thea Foss Post-Remediation Source Control Strategy (herein referred to as the Source Control Strategy), was developed and included in the work plan. The approach and decision-making strategy are shown in Figure 1-1.

This report summarizes the City's existing programs, sampling results and studies completed in 2014, and the City's decision matrix for identifying additional source controls, if and when such controls are needed, to ensure protection of sediment quality in the Thea Foss and Wheeler-Osgood Waterways. This report is specifically concerned with control of municipal stormwater sources. There are other sources which could also potentially affect sediment quality in the waterways, including groundwater seeps, marinas, atmospheric fallout, NPDES-permitted industrial discharges, and other private stormwater discharges. These sources are outside the scope of the City's Source Control Strategy for municipal stormwater, and largely outside the City's jurisdiction.

1.2 BACKGROUND

1.2.1 Remedial Action Description

In 2006, the City completed remediation of marine sediments in the Thea Foss and Wheeler-Osgood Waterways. The remedy for the waterway included a combination of natural recovery, dredging, and capping. The dredged material was disposed of in a nearshore confined disposal facility (CDF) in the nearby St. Paul Waterway.

In general, the remedy included the following elements:

- No action at the mouth of the waterway, an area of clean sediments;
- Natural recovery north of East 11th Street, an area where low-level contamination is expected to recover to below the SQOs within 10 years (2016), and which is currently below required navigational depths;

- Some combination of dredging (complete or partial) followed by capping over any residual contaminated sediment in the area from the East 11th Street Bridge to just north of the State Route (SR) 509 Bridge. Note that the authorized channel depth requirements are maintained in this area; and
- Capping (by others, referred to herein as the Utilities) from just north of the SR509 Bridge to the head of the waterway to maintain a depth of 10 feet Mean Lower Low Water (MLLW). Deauthorization of the federal navigation channel in this area was required, and was approved as part of the Water Resources Development Act (WRDA) Bill of 2007.

Other remedy features included:

- Construction of intertidal habitat as mitigation for construction impacts;
- Dredging to maintain authorized depths in the active navigation channel;
- Capping of about 20 acres of sediments in channel and harbor areas; and
- New slopes and erosion protection on about 10,000 feet of shoreline.

1.2.2 Drainage Basin Description

The Thea Foss and Wheeler-Osgood Waterways are estuarine waterways on the southeastern margin of Commencement Bay. In Commencement Bay and the waterways, average tidal fluctuations vary from 0 feet MLLW to 11 feet MLLW. Extreme tides, which generally occur in June and December, range from approximately –4.0 feet MLLW to 14.5 feet MLLW. The Thea Foss Waterway lies generally north-south along the City's downtown corridor. The Wheeler-Osgood Waterway lies west-east and connects to east side of the Thea Foss Waterway just south of the Murray Morgan (11th Street) Bridge. The Thea Foss and Wheeler-Osgood Waterways are commonly referred to as the Thea Foss or Foss Waterway and are referred to herein as the Foss Waterway. The drainage area tributary to the Foss Waterway is referred to herein as the Foss Waterway Watershed.

The Foss Waterway Watershed is one of nine watersheds in the City (see Figure 1-2). This watershed covers approximately 5,864 acres and is comprised of drainage basins located in the south-central portion of Tacoma. The area borders the North Tacoma Watershed on the north, Lawrence Street on the west, and East F to East K Streets on the east. The area extends as far south as 86th Street and also includes portions of the tideflats on the east side of the Foss Waterway (see Figure 1-2).

The primary municipal outfalls to the Foss Waterway are OF237A and OF237B (the twin 96ers), OF230, OF235, OF243, OF245 and OF254. These seven outfalls cover 5,744 acres (98%) of the watershed. There are also several other smaller outfalls that discharge to the waterway. Primary land uses within the basins draining to each of the major outfall are as follows:

Outfall	Area (Ac)	Land Use
230	557	Commercial and Residential
235	156	Residential and Commercial
237A	2,823	Residential, Commercial and Industrial
237B	1,991	Residential and Commercial
243	59	Industrial and Commercial
245	39	Industrial and Commercial
254	119	Industrial and Commercial

Overall, land use in the watershed is predominately residential, although most of the City's commercial businesses are also located in this watershed (see Figure 1-3). There are some industrial uses, which are concentrated mainly in the eastern tideflat areas and Nalley Valley portions of the watershed.

Several of the outfalls discharging to Foss Waterway are tidally-influenced and portions of the pipe are inundated with marine water twice a day depending on the pipe elevations and the tide height. Continuous or tidal baseflow is also present in some of the outfalls. Baseflow in OF230, OF235, OF237A and OF237B is continuous. In OF237A and OF237B, this baseflow is derived from old creeks and seeps that were piped and/or infiltrating groundwater. In OF230 and OF235, this baseflow consists of groundwater and/or noncontact cooling water. Baseflow in OF243, OF245 and OF254 is seasonal (i.e., higher in the winter and lower in the summer) and is believed to be due to groundwater infiltration due to the high water tables in the tideflat area.

The City has performed a significant amount of sampling and analysis in recent years of the storm drains entering the Foss Waterway. Over the last 13 years, 1,554 samples have been collected: baseflow (322), stormwater (896) and SSPM samples (80 outfall and 256 upline). The purpose of the sampling efforts is to evaluate the quality of stormwater discharges to the Foss Waterway and the effect of those discharges on sediment quality. Early in the program, the results of these efforts were used in an overall evaluation of source loadings to the waterway to predict whether municipal stormwater discharges would be protective of sediment quality following remediation. Prior to beginning remedial action projects, EPA determined that sufficient source control was in place to complete the work. Now the results of stormwater monitoring are used to evaluate the effectiveness of source control efforts, and to provide early warning of any new problems which arise in the drainages. In addition, the results are used to track changes in stormwater quality and to document the improvements that have been realized over time due to source control and other efforts.

1.2.3 Contaminants of Concern

COCs are those contaminants which have been identified through sediment monitoring and model predictions to have the greatest potential to compromise sediment quality in the waterways following remediation. They are, therefore, the primary target for source control activities for the municipal storm drains as well as other potential sources which are largely not in the City’s control. DEHP and various PAHs are the primary COCs for the Foss Waterway and have, therefore, been the primary focus of source control activities to date. In addition, residual concentrations of other legacy COCs for which sources have largely been controlled through regulatory bans or restrictions are continuing to be monitored. These legacy COCs include mercury, PCBs, and pesticides. Source control activities have also been conducted for these COCs.

1.3 THEA FOSS POST-REMEDIATION SOURCE CONTROL STRATEGY

For ongoing evaluation of the municipal stormwater discharges and their relation to future sediment conditions in the waterway, the City has established a source control strategy. This strategy is set forth in Figure 1-1.

The City is continuing to implement a comprehensive stormwater monitoring program and is also conducting several more specialized studies for the Foss Waterway Watershed. The results of these projects will be used to continue to focus source control efforts and to assess the source control program's effectiveness. The various components of the post-remediation source control strategy are described in more detail below.

The City is committed to an ongoing program of stormwater source control to maintain and enhance stormwater quality in the Foss Waterway Watershed. The City will implement all "reasonable and practicable" controls necessary to improve stormwater quality and comply with regulatory standards. "Reasonable and practicable" shall take into consideration maintenance requirements, flood control and cost in comparison to the effectiveness achieved or expected in reducing contaminant loads to the Foss Waterway.

The remainder of this report is as follows:

- Section 2.0 provides a summary of the source control activities performed during 2014 in the Foss Waterway Watershed including an update on special studies.
- Section 3.0 presents the results of the Water Year 2001-2014 stormwater and storm sediment monitoring.
- Section 4.0 presents the results of the Foss Waterway sediment monitoring conducted in 2014 and an evaluation of sediment quality trends.
- Section 5.0 provides an update on the evaluation of program effectiveness for the Thea Foss Source Control Strategy.
- Section 6.0 presents a summary of the conclusions and recommendations.

2.0 SUMMARY OF SOURCE CONTROL ACTIVITIES

This section provides a summary of source control activities including an update on special studies performed in 2014 in the Foss Waterway Watershed. These activities and special studies are further detailed in Appendix A, where relevant, in the specific outfall work plan sections.

The source control activities performed in 2014 are summarized in Sections 2.1 and 2.2 including those associated with the 2014 Work Plan and those associated with the City's NDPES Phase 1 Permit as part of the City's Stormwater Management Program. Section 2.3 presents a summary of the special studies conducted under the Thea Foss Program relevant to source control within the Foss Waterway Watershed.

2.1 MASTER SPREADSHEET (DRAIN, ACTION, DATE, POTENTIAL COCS, STATUS)

A comprehensive listing of source control investigations and other actions for each outfall drainage area is provided in Table 2-1. The activities for each outfall are grouped by the following types of actions:

- Construction – major site construction or development;
- Inspection – major or notable business inspections;
- Onsite Facilities or Public Facilities – onsite facility or public facility constructed;
- Maintenance – key storm system maintenance activities performed;
- Point Sources – point source to storm system identified and/or controlled;
- UST – underground storage tank or leaking underground storage tank (UST/LUST) located, removed or closed in place;
- Cleanup Actions – site cleanup action underway or completed;
- Spill – spill reported and cleaned;
- Fines/Violations – fine or violation issued by a regulatory agency; and
- Education – public education activities.

Each action is defined by drainage basin, date/year of occurrence, potential COCs, status (ongoing, completed, one time) and a short description. Once completed or identified, these activities by themselves may result in a very small impact in the total pollutant load. Over time, however, these very small pollutant load impacts are additive and an overall real reduction in the total pollutant load may be observed. This will be further evaluated in Section 5.0, Thea Foss Program Effectiveness: Water Years 2001 to 2014.

From August 2001 through 2014, approximately 565 actions have occurred within the Foss Waterway Watershed as shown in Table 2-1. The actions specific to particular outfalls are summarized as follows:

Action	Thea Foss	230	235	237A	237B	243	245	254
Construction	80	31	18	19	4	2	--	6
Inspection[1]	111	17	18	26	13	8	10	19
Facilities	61	10	10	16	11	4	4	6
Maintenance	65	15	11	7	5	8	10	9
Point Sources	40	4	3	15	10	--	2	6
UST	58	19	6	17	11	2	3	--
Cleanup Actions	18	2	2	4	--	6	2	2
Spill[1]	21	2	--	7	1	3	5	3
Fines[1]	31	6	2	13	1	--	2	7
Education	5	4	1	--	--	--	--	--
Total	490	110	71	124	56	33	38	58

[1]The number reported includes notable actions only. The total numbers of inspections and spills are provided in Section 2.2.2.

2.1.1 Stormwater Suspended Particulate Matter (SSPM) Monitoring

SSPM monitoring is used in identifying potential problem areas in sub-drainage systems. Multi-year sampling is used to confirm an ongoing problem area or to confirm control/resolution of an ongoing problem. Between WY2002 and WY2014, upstream monitoring was completed in some of the Foss drainage basins. Table 2-2 lists the upstream monitoring locations for each of these years.

The drainage basins and SSPM data are shown graphically in Figures 2-1.1 through 2-1.4 for four of the key COCs (i.e., mercury, total PAHs, total phthalates and total PCBs). These figures show each outfall and upline sediment trap location and the “level” of concentration for that location for that year. The “levels” of concentrations are color-coded as low, medium and high concentration ranges with each additional year stacked on the previous year. These “levels” are set without regulatory basis, but rather at concentrations based on the data collected so as to allow for meaningful comparison between monitoring locations.

Low concentration ranges (green) represent concentrations that are similar to other locations with no need for additional source control efforts at this time. Medium concentration ranges (yellow) represent concentration levels that are slightly above other locations. For locations with medium levels, additional source control may be needed, but are at a lower priority in comparison to other locations with higher levels that are determined to be of greater impact. High concentration ranges (red) represent concentration levels above and beyond other locations in the Foss Waterway Watershed, and the need for additional source control is higher in comparison to other locations.

In WY2014, SSPM data for the most part remained the same. However, a few locations increased and a few decreased in concentration.

- **Mercury**: Consistent with WY2013, no locations were in the large level range in WY2014. Three locations were in the moderate range in WY2014, including FD18B (OF230), FD23 (OF243) and FD22 (OF248) (see Figure 2-1.1). For FD22, this represented an increase when compared to WY2013 results; however, this site has had moderately elevated mercury concentrations two other times during the 13 year monitoring period (WY2002 and WY2010). Review of the data indicates that the concentrations at this location have ranged from 0.138 to 0.21 during the monitoring period, near the 0.20 level that was established to evaluate relative concentrations on Figure 2-1.1. At locations FD18B and FD23, levels were also in the moderate range in WY2013 and source control work in both of these areas is underway at this time. FD3A (OF230) decreased from the moderate to the low range in WY2014.

- **PAHs**: FD13B (OF237A) remained in the low range in WY2014, and the new sediment trap, FD13B New, just upstream from FD13B remained in the medium range (see Figure 2-1.2). Both of these locations are upstream of the media filtration treatment system that was installed upstream of FD13 (237A) in 2010. PAHs at FD31 (OF237B) remained in the medium range of measurements where they have been since WY2012. At this location, SSPM concentrations were in the low range in WY2011, but had been in the high and medium ranges between WY2008 and WY2010. Source control work was recently completed in this area and FD31 will continue to be monitored as new information becomes available to determine whether this source control action was successful in reducing concentrations.
- **Total Phthalates**: FD13B (237A) and FD22 (248) concentrations decreased from moderate to low range in WY2014 (see Figure 2-1.3). FD10C (OF237A) and FD18 (OF230) concentrations remained in the low range of measurements where they have been since WY2012.
- **Total PCBs**: FD3A (OF230) and FD3 New (OF230) concentrations were both at relatively large levels in WY2014 (see Figure 2-1.4). For FD3A, this was the same as it had been in WY2013 while at FD3 New, this represented an increase from low level concentrations in WY2013. FD3 New previously had large levels between WY2004 and WY2007. Source control activities are currently underway for PCBs in this basin. Four locations had moderate level concentrations in WY2014, including FD10C (OF237A), FD16 (OF230), FD18 (OF230) and FD35 (OF237B). Both FD10C and FD16 were also at moderate levels in WY2013. Moderate concentrations at FD18 and FD35 represent a decrease since both of these locations were in the high range in WY2013.

Over the 13 year monitoring period, the number of sites with concentrations at the medium and high levels has decreased. This is a good indicator of the effectiveness of the source control program. However, as indicated above, a few sites remain at medium and high levels or fluctuate to the medium and high levels as compared to the other sites in the Foss Waterway Watershed and are therefore the focus of ongoing and additional source control work.

The data results by basin are discussed in Section 5.0 of this report. The City will continue to conduct SSPM monitoring using sediment traps at the outfalls and at upstream locations in several drainage basins. Future plans and decisions related to upstream monitoring studies are discussed cooperatively with EPA, Ecology and others, as applicable.

2.1.2 Foss Stormwater Work Group

The Stormwater Work Plan Addendum required that the City prepare and submit quarterly Stormwater Source Control Reports. In a letter dated June 10, 2008, EPA and Ecology agreed that quarterly Stormwater Source Control Reports would no longer be required and that one annual submission providing the status of source control activities would be sufficient. This source control status report is submitted annually and is generally appended to the City's NPDES Annual Report which is due March 31 of each year (Appendix A).

A Foss Stormwater Work Group, consisting of representatives from the City, Ecology, EPA, Port of Tacoma, Citizens for a Healthy Bay (CHB), Foss Waterway Development Authority (FWDA) and the Utilities, has met on a periodic basis through the years to discuss the status of source control activities. In years past, this meeting was held at least annually, but a meeting has not been required since it was last held on June 17, 2010. Copies of the Annual Stormwater Monitoring Report including the Annual Work Plan are provided to CHB and the Utilities at the same time that they are provided to EPA and Ecology.

Tacoma submitted the 2013 Stormwater Source Control Report and Water Year 2013 Stormwater Monitoring Report on March 27, 2014. In the 2013 Source Control Report, the City recommended several source control activities referred to herein as the 2014 Work Plan (Tacoma 2014). A summary of the status or outcomes of source control activities identified in the 2014 Work Plan is provided below.

2.1.3 2014 Source Control Work Plan

The majority of the recommended tasks from the 2014 Work Plan were completed or are ongoing at this time. Activities from the 2014 Work Plan and their current status are as follows:

Priority 1 tasks:

- **OF230**: Continue source tracing investigation and track private property cleanups in area draining to FD3A and FD18 for mercury and PCBs, with PAHs and phthalates analyzed as well.

  Status: Results from the PCB portion of the investigation indicate that elevated levels of PCBs are present in the caulking materials from two properties (the Wells Fargo and Sound Physicians properties located in the vicinity of South 12th and South 13th Streets, between Pacific Avenue and Court A in downtown Tacoma). It is likely that these materials are the source of PCB contamination found in the nearby catch basins in the targeted drainage areas. The business owners and the regulatory agencies were notified of the PCB discovery and were provided a copy of the sampling results. The City is continuing to work with the regulatory agencies and the property management companies at the two facilities to address this PCB discovery and is also coordinating efforts to keep contaminants out of the municipal stormwater collection system.

  Results from the mercury investigation and business inspections of the surrounding area indicate that the source of mercury is likely attributed to the presence of contaminated sediments in the sidewalk roof drains draining to a catch basin at the corner of South 12th and Court A in downtown Tacoma. While the specific source of the contamination was not identified during the investigation, the cleaning of the system and subsequent re-sampling of the drainage system will determine whether this was an isolated historic spill event or whether an ongoing source of mercury remains that must be controlled. An inspection performed at the facility on February 14, 2014, confirmed that the sidewalk roof drains had been cleaned. Follow up sampling will be performed in 2015 to determine whether the elevated mercury concentrations return.

  In 2014, individual catch basins in the targeted segment were sampled to identify specific catch basins with elevated levels of PAHs. Fifteen catch basins in this area were targeted, but only ten samples were collected due to a lack of collectable sediment in some of the basins. Results from these ten samples showed a wide range of PAH concentrations. The catch basins with the highest PAH concentrations were those located at the corner of Court A and S 14th St. Based on these results, staff conducted another site investigation to determine whether the adjacent parking lot was draining to these catch basins and found that it was not. With no specific source of this contamination identified, the system will be cleaned in early 2015 and resampled to determine whether the elevated PAH levels were the result of a historic release or an ongoing source of PAH contamination. A report describing the investigations done during 2014 is included in Appendix A

- **OF235**: Begin construction of Hood St. Retrofit.

  Status: Construction of this project was substantially completed in fall 2014 and the water quality facility is now operational.

- **OF237B**: Continue to monitor TPCHD activities at the site of the UST removal at the neighborhood fueling station (EZ Mart) and reinspect the FD31 branch as needed upon completion of their work. Perform a detailed investigation of the area to determine whether other sources are present.

- **Status:** UST removal at the EZ Mart site was completed in August 2014. While continuing to monitor the ongoing TPCHD work, the City also evaluated the area to determine whether there were other possible sources of this contamination. During the initial investigation, it was discovered that the stormwater collection system in this area was cleaned in February 2014, and, therefore, insufficient sediment was present for sampling until September 2014. Five catch basins were sampled at that time, and none showed detectable levels of PAHs. With the cleaning of the drainage system and the removal of the USTs at the EZ Mart site, it will now be possible to determine whether the elevated PAH levels were the result of a historic event or whether an ongoing source is present. The City will continue to review the annual sediment trap monitoring results to determine if further source tracing investigations are necessary. A report describing the investigations done during 2014 is included in Appendix A

- **OF237B**: Track PCB removal activities associated with the road construction project in FD34/35.

- **Status:** No new information is available at this time. The road construction project is scheduled to be performed in two phases, beginning in 2015.

- **OF243**: Continue to investigate source of mercury at BNSF and elsewhere in drainage area for FD23.

  Status: Inspections of the LRI and BNSF facilities were completed in 2014 and no specific source of mercury was identified. Additional inspections will be performed in 2015. A report describing the investigations done during 2014 is included in Appendix A.

- **OF245**: Continue to coordinate work with TPCHD and Ecology at Truck Rail Handling/Quality Transport to identify any potential source(s) of phthalates.

  Status: This is a TPCHD lead site. TPCHD completed a Site Hazard Assessment in 2012 giving the site an overall ranking of 4. The City performed sanitary system mapping and inspections in 2012, and met with the owner in 2013 to discuss source control issues at the site. There continue to be delays on the part of the property owner in fully addressing the environmental concerns at the site. The City is continuing to monitor actions at this site and is currently considering issuance of a compliance schedule and/or an enforcement action at the site. The City will continue to work cooperatively with TPCHD and Ecology to monitor ongoing operations and practices at the site.

Priority 2 tasks:

- **OF237A**: Investigate potential sources of phthalates in the area draining to FD10C.

  Status: Video inspection records for the pipes in the area were reviewed and it was determined that the pipes in the area needed to be cleaned. The pipes were on the schedule for cleaning in early 2015. In WY2013, the phthalate concentrations in the sediment trap decreased from medium concentrations to low concentrations for the first time since monitoring of this sediment trap began and they remained in the low range in WY2014. Elevated phthalate concentrations may have been from an historic source so this will be taken into consideration in development of the WY2015 work plan.

- **OF243/245**: Evaluate the effects of enhanced street sweeping on lead and zinc concentrations in the industrial area.

  Status: The City initiated a pilot program in WY2014 to determine whether an increased frequency of street sweeping in this area would have an effect on elevated lead and zinc in stormwater and baseflow in this area. Starting on October 1, 2013, the City began sweeping the ROW within the OF243 drainage basin at a frequency of once every two weeks rather than the usual frequency of once per month for industrial areas. An evaluation of the effectiveness of this increased sweeping frequency on metals reductions will be performed in future monitoring years as more data becomes available. The pilot project is continuing in WY2015.

Priority 3 tasks are:

- **OF 235:** Investigate sources of lead, PAHs and phthalates in stormwater.

  Status: Based on stormwater monitoring in OF235, this basin was identified in the Foss Work Plan as having ongoing issues with lead in stormwater. In August 2014, staff began an investigation to identify possible sources of the elevated lead concentrations in stormwater. Elevated concentrations of phthalates and PAHs were also observed in historic baseflow discharges (Tacoma 2013). Because of this, the focus of the investigation began with an investigation of baseflow in the OF235 basin. The intent of this work was to identify specific problem areas within the drainage basin for further investigation.

  Due to lack of baseflow present in the study areas during sample collection, staff was unable to target the entire drainage basin. The preceding summer yielded very little precipitation and it is possible that the baseflow was not fully charged during this sampling event. The results of this investigation initiated in 2014 did not identify a specific segment or drainage area in this basin for additional source tracing. Staff will continue the investigation of the drainage basin to determine if additional baseflow is present. If sufficient collectable flow is present staff will re-sample this area during February/March 2015 when baseflow should be flowing at its peak.

- **OF235**: Area draining to FD6A higher than other branches of OF235 in PAH concentrations in stormwater, and stormwater concentrations at the outfall rank highest overall. Evaluate need for additional source control following installation of the Hood St treatment device.

  Status: No new information is available at this time.

Other tasks conducted under the Source Control Program are:

- Continue Foss Stormwater Monitoring Water Year 2014.

  Status: WY2014 stormwater monitoring was completed and WY2015 stormwater monitoring is currently underway.
- Review the WY2014 SSPM data to confirm existing conditions in the basin and to set maintenance schedules for treatment units within the basin (where appropriate).
- **Status:** Completed. An evaluation of these results is included in Sections 3 and 5 and is summarized above.
- Monitor the major construction activities throughout the watershed.
- **Status:** Ongoing. Major construction projects occurring in each basin are discussed in Section 5.0.
- Monitor and conduct inspections at new developments as completed to review appropriate BMPs for each site.
- **Status:** Inspections at new developments were completed, including the inspection/approval of 52 new devices.
- Implement the City's Stormwater Management Manual, 2012 Edition.
- **Status:** The 2012 Stormwater Management Manual is currently being implemented. An updated version was prepared in 2014 and is expected to become effective in mid-2015.
- Continue NPDES business inspections program and document the inspections using the business inspections database. Respond and track all complaints/spills in the complaints database.
- **Status:** Business inspections and spill/complaint response is continuing and activities are tracked in the database.
- Monitor TPCHD and Ecology UST/LUST removal projects along with any other remediation projects in the watershed
- **Status:** Ongoing. A summary of UST/LUST work performed under TPCHD oversight in 2014 is included in Appendix A.

2.2 City of Tacoma Phase I Municipal Stormwater Permit

The 2013-2018 NPDES permit went into effect on August 1, 2013. The permit regulates the discharge of stormwater to surface waters and groundwaters of the state from the City's MS4. The permit is designed to protect and improve the water quality of receiving waters by implementing stormwater management activities. The City's program is described in the Tacoma's Stormwater Management Program (SWMP) which guides the operation of Tacoma's Surface Water Management.

The City's program and its progress in each year are summarized in an annual report. The NPDES Annual Report is used as a tool to assess the City's progress and to determine whether any changes to the SWMP procedures or priorities are needed to fulfill the permit obligations. The SWMP is evaluated annually, and updated when necessary, based on the annual report and program assessment. Table 2-1 identifies program related activities as required under the NPDES Phase 1 Permit as part of the City's SWMP.

2.2.1 City of Tacoma Stormwater Management Program

Tacoma's SWMP is divided into 10 components as outlined in the 2013 NPDES Municipal Stormwater Permit Section S5 (Tacoma 2010). The SWMP components are summarized here:

- **Legal**: The City has the legal authority to control discharges to and from the municipal storm sewers owned by the City, Chapter 12.08 of the Tacoma Municipal Code.
- **Mapping**: The City's stormwater system is updated with new information as it becomes available.
- **Coordination**: Internal and external coordination agreements/mechanisms are established to facilitate cooperation between City departments and surrounding municipalities.
- **Public Involvement and Participation**: Opportunities are provided for in the SWMP.
- **Controlling Runoff from New Development, Redevelopment and Construction Sites**: The City of Tacoma Stormwater Management Manual (SWMM) 2012 Edition (previously the Surface Water Management Manual Tacoma 2008 Edition, 2009 Revision) provides a commonly accepted set of technical standards and guidance on stormwater management measures that control quantity and quality of stormwater produced by new development and redevelopment of property. The minimum requirements in Tacoma Municipal Code Section 12.08 require flow control and water quality treatment of new and redeveloped private and public projects, including right-of-way improvements at sites that meet the thresholds for mitigation in Tacoma. The minimum requirements for all sites, commercial, residential, low and high traffic areas, etc., include treatment to remove at least 80% of the solids on an annual basis. Through implementation of the SWMM, more solids should be removed from the stormwater runoff in the future, thus helping to remove sediment-associated contaminants which may become entrained in municipal stormwater. The City's SWMP should reduce the sediment and associated particulate-bound COCs discharging into the municipal stormwater system and its receiving waters.
- **Structural Stormwater Controls**: A program to prevent or reduce impacts to waters of the state caused by stormwater discharges must be developed and must consist of structural stormwater controls. Projects must be selected and an implementation schedule is required.
- **Source Control**: Inspections of pollutant-generating sources are required for commercial, industrial and multi-family properties including City-owned sites.
- **Illicit Connections**: Continue the ongoing program to detect, remove and prevent illicit connections and discharges, including spill response, for discharges into the City's MS4.
- **Operation and Maintenance**: Maintenance standards and inspection programs are required for public and private stormwater facilities. BMPs are also required for the maintenance and operation of public streets and roads to reduce stormwater impacts.
- **Education and Outreach**: Educational programs need to provide information to elected officials, policymakers, residents, businesses including home-based and mobile businesses, landscapers and property managers, industries, engineers, contractors, land developers, municipal permitting and planning staff, and others. The educational program will be designed to achieve improvements in the understanding of each target audience.

Stormwater Management Goals and Challenges. The City considers itself a leader in responding to water quality issues related to urban runoff. The City's activities have included pioneering efforts in water quality testing to identify pollutants in stormwater runoff as early as 1980. Current efforts include investigating source control and treatment of stormwater pollutants like phthalates. The Tacoma City Council and Tacoma's Surface Water Utility ratepayers have supported substantial rate increases in recognition of the importance of protecting and enhancing the water quality in Commencement Bay and our fresh water lakes, wetlands and streams in the face of increasing stormwater runoff and pollutant loads from urban development, increased traffic and population pressure.

The City's goals established for the original Stormwater Management Program in 1999 under the first NPDES Municipal Stormwater Permit further emphasize the City's commitment to meeting the water quality goals under this permit. The priorities of the City's SWMP include the following:

- Manage stormwater to minimize flooding and erosion;
- Manage stormwater to minimize contact with contaminants;
- Mitigate the impacts of increased runoff due to urbanization;
- Manage runoff from developed properties and those being developed;
- Protect the health, safety and welfare of the public;
- Correct or mitigate existing water quality problems; and
- Restore and maintain the chemical, physical, and biological integrity of the receiving waters in the City for protection of beneficial uses.

Tacoma's SWMP is administered by the Science and Engineering Division, Operations and Maintenance Division, and Environmental Compliance Section of the Environmental Services Department (Tacoma 2010). Staffing and budget are designed to meet the program goals and challenges described above. Our current work includes:

- Inspecting business activities and educating businesses about BMPs to reduce stormwater impacts;
- Collecting and evaluating stormwater and sediment quality monitoring data;
- Implementing a source control and illicit discharge screening program throughout the City's nine watersheds;
- Mapping, maintaining and cleaning the City's stormwater system that includes approximately 500 miles of storm pipe, 10,000 manholes, 19,000 catch basins, 450 outfalls, four pump stations, and over 130 stormwater ponds and other treatment and flow control facilities;
- Managing the City's tree canopy cover and open spaces to maximize stormwater benefits;
- Rehabilitating and replacing aging infrastructure and improving the storm system with capital projects to address identified flow control and water quantity issues;
- Providing public education about the impacts of polluted runoff and practices to reduce those impacts to create behavior change in target audiences ranging from school-age children and homeowners to property managers and builders;

- Coordinating our activities regionally through watershed councils, NPDES permit-holder committees and others;
- Permitting and inspecting new and redevelopment construction projects to help them comply with stormwater requirements including erosion control, maximizing onsite management, use of LID, stormwater treatment, flow control, wetlands protection and ongoing maintenance; and
- Provide staff training to ensure the City activities and operations minimize impacts to stormwater and receiving waters.

The updated SWMP Plan will supplement and enhance the City's existing program activities.

2.2.2 2014 Business Inspections/Spills/Complaints

The City began conducting stormwater business inspections prior to 1984 as part of its delegated responsibility to implement Ecology's NPDES sanitary sewer pretreatment program. Subsequently, the inspection program was intensified in the Foss Waterway Watershed in response to EPA's identification of municipal outfalls as a potential source of contaminants to the Foss Waterway, which had been identified as a problem area within the Commencement Bay Superfund Site. In 2002, under the Consent Decree with the EPA for the Foss Waterway Superfund Cleanup, the City further expanded its comprehensive source control program in the Foss Waterway Watershed. The City's Source Control Program was later expanded City-wide to fulfill the 2007 NPDES permit requirements.

The current program is managed by the Environmental Services Department and includes the following:

- Inspecting multi-family units (including four or more residential units) in addition to businesses and industries. Inspections address both stormwater and sanitary compliance.
- Providing information on BMPs and program literature directly to businesses during site visits (which are available in the City's Stormwater Management Manual).
- Educating the general public and businesses on BMPs and City environmental programs.
- Inspecting and signing off on commercial drainage facilities. This inspection also provides an educational opportunity for Environmental Compliance inspectors to review operation and maintenance requirements with the builder or owner.
- Continuing to implement the City's Illicit Discharge Detection and Elimination (IDDE) Program which includes investigation and termination of illicit connections. The IDDE Program uses the City's database to track the complete process of screening, investigation, referral to responsible agencies (if other than the City), and enforcement.
- Use of a SQL/Access database, the Environmental Services Spills and Complaints Database, to track spills, complaints, business inspections and flooding claims since 2003. Regular updates and refinements have been made to facilitate advanced data management for tracking inspections.
- Investigating potential illicit discharges based on complaints, business inspection reports and stormwater monitoring information and responding to potential and confirmed illicit discharges using the same procedures applied to potential illicit connections.

Out of all the 2014 business inspections/spill and complaints responses (533 business inspections, 747 spill/complaint responses and 746 treatment device inspections), only 11 formal warning letters were sent Citywide. Six of those were in the Foss Waterway Watershed. Four Notice of Violation letters were sent in 2014, all of which were in the Foss Waterway Watershed. Citywide, only 0.74% of all inspections led to formal warnings or enforcement which shows that the City's education-based source control program is very successful and that the business community and City's residents are very supportive and engaged in protecting stormwater quality.

Thus far, since the first NPDES Permit was issued in 2007, Tacoma has canvassed/inspected 100% of the City, inspecting both sanitary and stormwater compliance. The vast majority of the inspections find catch basins that have never been cleaned. Our inspection efforts have resulted in tons of catch basin sediment removal, drainage repair, sewer protection, and customer education.

The City conducts a bi-weekly inspector's meeting for training and coordination with both internal and external staff including periodic guest representatives from the Port of Tacoma, Ecology, TPCHD and other neighboring jurisdictions. In addition, Tacoma participates in the monthly Pierce County Code Enforcement Officers Group (PIC).

Documentation for these activities is available upon request, however, is not presented herein.

2.2.3 Citywide Program Activities

The following is a summary of Citywide activities. Those activities that are specific to the Foss Waterway Watershed are further discussed in Appendix A. Citywide program activities for business inspections and spills and complaints response are discussed in Section 2.2.2.

Several special investigations were completed in 2014 including but not limited to:

- Documented and issued four Notice of Violations;
- Documented and issued eleven formal warning letters (see Appendix A for those issued in the Foss Waterway Watershed);
- Provided technical assistance, education and training to City-owned facilities that are potential pollutant generating sites with specific business practices that may significantly impact surface water and wastewater quality;
- Conducted environmental inspections of City-owned facilities to evaluate site compliance with Tacoma Municipal Code, Stormwater Management Program and NPDES Permit requirements. Inspected fire stations, Fleet Services, parking garages, Street Operations, Solid Waste landfill, Greater Tacoma Convention and Trade Center, Central Wastewater Treatment Plant, North End Treatment Plant, Asphalt Plant, Tacoma Public Utilities (Water, Rail, Power, Pole Yard), Traffic Signal Shop, Dock Street Eductor Facility, Cleveland Way Eductor Decant Facility, and TAGRO Business Operations;
- Inspected and serviced stormwater treatment devices serving City facilities including oil water separators, cartridge filter vaults, Vortechnics, swales, ponds, rain gardens, Filterra systems, catch basins and permeable asphalt;
- Continued retrofitting of fire station wash pads including Fire Stations 9 and 10;
- For the 15 existing Stormwater Pollution Prevention Plans (SWPPPs) for City facilities, the Fire Garage, Solid Waste Landfill, Street Operations Upper Yard, Street Operations

Jefferson Yard, Traffic Signal and Streetlight Shop, Asphalt Plant, Fleet Services, Dock Street Eductor Decant Facility, Cleveland Way Eductor Decant Facility, TAGRO Business Operations, Tacoma Water, Tacoma Rail, Tacoma Power, TPU Pole Yard, and Central Wastewater Treatment Plant, the City:

  - Inspected sites;
  - Reviewed SWPPPs and facility maps and updated as needed; and
  - Provided site specific SWPPP training.

- Coordinated with the Fire Department and the City Laboratory to sample a stormwater oil water separator at Fire Station 8, conducted fish bioassay, cleaned the separator and properly disposed of the sediments;
- Illicit Discharge Detection and Elimination training was performed at City Facilities;
- Provided three presentations to University of Washington Professor McDonald and his freshman science class regarding various aspects of the City Stormwater Program and local stormwater;
- IDDE: Smoked tested 4,971 addresses and located no cross-connections; and
- WSDOT SR16 Nalley Valley and I-5 Project Coordination – Continued to monitor ongoing construction (OF237A).

Other Major Program elements that were ongoing in 2014 include:

- Provided daytime, evening and weekend pager coverage;
- Maintained field and spill supplies;
- Car Wash Kit Program and Drain Marking Program implemented by EnviroChallenger team;
- CHB coordination; and
- Provided ongoing oversight and certification of mobile washers.

Training and coordination activities included:

- Bi-weekly meetings with Source Control Representatives and guests to facilitate training, conduct spill debriefs and discuss employee safety;
- SWPPP presentations to staff from the Central Treatment Plant, Recovery and Transfer Center, Asphalt Plant, and City of Tacoma Heavy Equipment and/or Material Storage facilities;
- Ongoing database training;
- Participated in updating business inspections and BMP databases;
- Thea Foss Superfund Work Plan and activity support/development. Coordinated source control activities and watershed monitoring;
- Training of Source Control Representatives, Construction Inspectors and Project Engineers in CESCL (Certified Erosion & Control Lead), two day program;
- Coordinated with CHB on Commencement Bay Cleanup issues;
- Interacted regularly with CHB – Bay Patrol and spill hotline;

- Participated in a variety of community events; and
- Completed the third year of the Private Treatment and Flow Control Device Annual Inspection program.

All of these activities are expected to benefit the quantity and quality of stormwater discharges to the Foss Waterway. Documentation for each of these activities is available upon request, however, is not presented herein.

2.3 BMP EFFECTIVENESS STUDIES

The primary COCs in waterway sediments are DEHP and PAHs. Since their presence is fairly ubiquitous in urban runoff, many of the City's source control efforts over the years have been aimed at these constituents. Phthalates in particular are widespread in the urban environment. Because of challenges faced by the City and others in addressing phthalate contamination, a Phthalate Work Group comprised of the City, EPA, Ecology, King County/Metro, and Seattle Public Utilities was formed in 2006 to research the sources, pathways and treatment options for phthalates and other ubiquitous compounds in stormwater. The group developed a Summary of Findings and Recommendations document[2] which is currently in the process of being implemented by the regulatory agencies. In addition, the City is continuing to research the sources and treatment options for phthalates and PAHs in stormwater as described further below.

2.3.1 NPDES S8.F BMP Monitoring

Section S8.F of the 2007 and 2012 NPDES Phase I Permits required Tacoma to conduct detailed performance monitoring on two stormwater treatment types that are standard technologies in our manual, bioinfiltration and biofiltration. Bioinfiltration facilities provide enhanced treatment and biofiltration facilities provide basic treatment. The City selected the following BMPs for evaluation monitoring:

- Two bioinfiltration facilities at the Salishan Hope VI Redevelopment (Salishan) – East 46th and R Street Swale and East 44th Street Pond; and
- Two biofiltration facilities – East 32nd Street and Trolley Court.

The Salishan project is a residential redevelopment project consisting of over 1,200 housing units, including both single and multi-family. During redevelopment, the existing stormwater conveyance system was replaced with new infrastructure including a system of biofiltration and bioinfiltration facilities. East 46th and R Street Swale and East 44th Street pond facilities were designed to meet the requirements for basic and enhanced treatment as specified in the Tacoma Surface Water Management Manual (and 2005 Ecology Manual).

The water analytes identified as parameters of concern by Ecology are those that will provide information regarding the effectiveness of basic and enhanced treatment BMPs. These parameters are:

- Conventionals: Hardness, pH, Particulate Size Distribution (PSD), and TSS;

---

[2] Document is available on the Washington State Department of Ecology's website. To view the document copy and paste this link into your web browser: http://www.ecy.wa.gov/programs/tcp/smu/phthalates/Summary%20of%20Findings%20and%20Recommendations%20FINAL%20092807.pdf

- Metals (dissolved & total): Copper and zinc; and
- Nutrients: Orthophosphate and total phosphorus.

In addition, the City added chemicals of concern for the Foss Waterway recontamination evaluation including metals (dissolved and total), lead and mercury, and organic compounds, PAHs and phthalates.

In August 2012, the City submitted a request to Ecology to eliminate the East 32nd Street Swale and Trolley Court Swale sites and replace them with two new wet vault sites. In summer 2012, the City also identified issues with flow measurements at the East 46th and R Street Swale and the East 44th Street Pond. New equipment was selected for the sites and installed prior to the start of WY2013 sampling. The site changes are described in the revised Quality Assurance Project Plan (QAPP) submitted on October 26, 2012, and approved by Ecology on January 8, 2013.

Sampling at the East 46th and R Street Swale and the East 44th Street Pond sites was completed in 2013 and at the two wet vault sites in 2014. A final report dated March 2015 was submitted with the 2014 Annual Report for the NPDES Phase 1 Municipal Stormwater Permit. Treatment effectiveness results will be discussed in the WY2015 Report.

2.3.2 GIS-Based Stormwater Pollutant Loading Model

The City has completed a GIS-based pollutant loading model to evaluate the effectiveness of other stormwater BMPs that may be implemented on a basin-wide scale. This study includes an evaluation of street sweeping, low impact development (LID), and engineered treatment devices (e.g., *StormFilter* vaults by ConTech Construction Products, Inc.; Milesi et al. 2006).

The goal of this study was to develop a model to perform the following:

- Evaluate the feasibility and cost-effectiveness of stormwater BMPs implemented on a basin-wide scale;
- Identify areas of concentrated pollutant runoff where source control efforts are best focused;
- Assess the degree to which stormwater BMPs will cause a reduction of pollutant loadings to the Foss Waterway, and in response, improvements in Foss Waterway sediment quality; and
- Develop recommendations for cost-effective source control investments.

More detailed information about the model was provided in the WY2013 report (Tacoma 2014). With the calibrated model complete, conceptual cost estimates can be developed for implementing the various BMPs on a basin-wide scale, and the net reduction in end-of-pipe pollutant loadings modeled. The cost-effectiveness of the different BMPs (i.e., pounds of pollutant removed per dollar spent) can be evaluated and compared, leading to recommendations for future source control investments if they are found to be required.

2.3.3 Storm Line Cleaning

To fulfill an NPDES permit requirement, the City evaluated the effectiveness of a thorough and systematic maintenance practice for aging pipe systems. Between 2006 and 2008, the City completed basin-wide sewer line cleaning of three entire drainage basins (OF254, OF235, and OF230) and part of a fourth basin (OF237A). In 2010 to 2011, a fifth basin (OF237B) was cleaned. The objective of the sewer line cleaning program was to remove residual sediments in the storm drains, some of which may contain legacy contamination from past years that may continue to contaminate stormwater or baseflow through resuspension and/or dissolution.

Analyses of this effectiveness evaluation were included in past annual reports and results are updated here with the WY2014 data. Results of the analysis are presented in Table 2-4 and a summary of significant reductions observed for each outfall are discussed in Section 5.0. This effectiveness evaluation will continue to be updated as more post-cleaning data become available.

2.3.4 Enhanced Street Sweeping

In January 2007, the City's street sweeping program was transferred from the Streets and Grounds division to the Sewer Transmission Maintenance section for continued implementation. The program was enhanced at that time in an attempt to reduce sediment buildup in the storm sewer system. The schedule was set to sweep all areas of the City twice per year, with more frequent sweeping in the business districts and on major arterials. The 12 primary business districts in the City are swept at night two to three times per week and major arterials are swept on a 3-week rotation. The City also increased communications with residents and business owners, which helped raise awareness of the importance of the street sweeping program.

In 2007, when the work was transferred over, sweeping was done with a combination of mechanical and vacuum sweepers. In 2008, the City started the transition from mechanical sweepers to regenerative air machines. The City currently uses four regenerative air sweepers. GPS is used to track the number of miles swept and the amount of material removed is recorded. Similar to line cleaning, the effectiveness of the program was evaluated and results are presented in Table 2-5. The results are discussed in more detail in Section 5.0. This effectiveness evaluation will continue to be updated as more post-enhanced sweeping data become available.

2.3.5 CIPP Lining

Approximately 41,921 linear feet of existing storm sewer has been rehabilitated in the Foss Waterway Watershed using Cured-In-Place Pipe (CIPP) construction technologies. This approach fixes pipe defects (e.g., cracks, holes) that could have allowed potentially contaminated groundwater and soil from historic "hot spots" to enter the storm sewer system. Specific CIPP lining projects occurred in the following areas:

- OF230
    - 2010 – 13,500 ft
    - 2013 – 13,807 ft
- OF235
    - 2013 – 5,470 ft
- OF237A (DA-1 Line)
    - 2013 – 5,126 ft

Similar to line cleaning and street sweeping, the effectiveness of this approach was evaluated and results are presented in Table 2-6. The results are discussed in more detail in Section 5.0. Again, this effectiveness evaluation will continue to be updated as more post-lining data become available.

3.0 STORMWATER AND STORM SEDIMENT MONITORING RESULTS

One component of the Thea Foss Post-Remediation Source Control Strategy is a stormwater monitoring program. This program is being completed as part of the Stormwater Work Plan Addendum of the Consent Decree and under Ecology Administrative Water Quality Orders (No. DE01WQHQ-3241, Ecology 2001 and No. DE01WQHQ-3241A-01, Ecology 2004). The objectives of the stormwater monitoring program are:

- To measure the effectiveness of stormwater source control actions and whether statistically significant reductions in concentrations of target COCs have been realized. This will be achieved by gathering data to identify spatial and temporal trends in the quality of municipal stormwater;
- To provide an early indication of any new water or sediment quality problems which may be associated with the storm drains; and
- To trace sources of contamination in outfalls using sediment traps.

Over a 13 year period (August 2001–September 2014), stormwater and SSPM were sampled at the seven major outfalls that discharge into the Thea Foss and Wheeler-Osgood Waterways. In addition, baseflow was sampled at the same seven outfalls for the first 10 years of the program[3]. Over the last 13 years, 1,554 samples have been collected with 322 baseflow and 896 stormwater samples collected at the outfalls and 80 outfall and 256 upline SSPM samples collected in pipeline sediment traps deployed throughout the watershed. The whole-water and SSPM concentrations discharged to the waterway are dependent upon a number of factors. Some of these factors include:

- Weather conditions and rainfall amounts and distributions which cannot be controlled by the City;
- Inherent variability of chemical concentrations in stormwater runoff which are addressed using statistically based sampling designs;
- Source activities and land use within the basin; and
- Illicit discharges.

Section 3.1, Sample Representativeness, is a summary of the Data Validation Report which is presented in Appendix B. WY2014 analytical data for stormwater and SSPM are presented in Appendix D.

3.1 SAMPLE REPRESENTATIVENESS

Representativeness evaluates field sampling approximation of actual (true) stormwater and SSPM water quality and quantity of the Foss Waterway Watershed. Representative sampling results are used to identify trends in stormwater quality, provide an early indication of new contaminant sources and trace sources of contamination within the municipal outfalls (SAP goals, Tacoma 2001).

---

[3] After 10 years of baseflow monitoring were completed at the end of WY2011, baseflow monitoring was discontinued (approval granted by EPA and Ecology on 2/7/12 and 2/9/12 respectively). Baseflow quantity and quality were determined to be well characterized by the 10 year monitoring record.

3.1.1 Monitoring Design

Stormwater comprises the majority of freshwater discharge from municipal outfalls and is a direct result of precipitation which produces stormwater runoff and is not a direct result of tidal fluctuations. Baseflow represents the continuous daily discharge from the municipal outfalls that is not a direct result of precipitation and is not a direct result of tidal fluctuations. Sources of baseflow may originate from seeps, creeks, groundwater infiltration, and illicit connections (see Appendix B).

Baseflow monitoring was discontinued after WY2011 because after 10 years of monitoring it was determined that the baseflow component was well characterized. Annual sampling goals for WY2014 include (from each monitoring outfall):[4]

- Eight stormwater samples from OF230, OF235, OF237A and OF237B;
- Three stormwater samples from OF243, OF245 and OF254; and
- One SSPM sample from each outfall, except for OF254. Five of these locations are collected using in-line sediment traps placed to collect SSPM from stormwater only. The other SSPM location, Manhole 390 (OF245), is a sump manhole and the sediment it collects represents a combination of stormwater and baseflow.

Stormwater monitoring is conducted at seven of the 13 primary City outfalls to the Foss Waterway. These seven outfalls comprise approximately 5,744 acres, or 98% of the total Foss Waterway Watershed drainage (5,864 acres, see Section 1.2.2). Monitored outfalls include OF230, OF235, OF237A, OF237B, OF243, OF245 and OF254. Primary land uses within the Foss Waterway Watershed include residential, commercial and industrial.

In January 2006, the City began sampling at a new monitoring location (described as 237A New) for OF237A. This new manhole structure was constructed downstream of the original 237A monitoring location during the BNSF realignment project. This location represents the entire drainage with inclusion of the FD2A branch (23rd Street Lateral). Both locations, 237A and 237A New, were sampled between January 2006 and October 2011, in order to build a large enough data set so that the two sampling locations could be compared. Sampling at 237A was discontinued in October 2011 because the sites were deemed equivalent.

Contaminant source tracing is further executed through sampling of SSPM (see Section 2.1.1). One station is located within the stormwater distribution system, near each outfall that represents the entire basin. It was not possible to locate an SSPM station within OF254 because of tidal influence. Additional upstream stations have been established throughout the Foss Waterway Watershed to evaluate and isolate contaminant sources. Up to 34 SSPM stations are sampled annually strictly for source tracing purposes. In WY2014, 17 upline sediment traps were sampled for source tracing purposes in addition to the six outfall sites.

3.1.2 Rainfall Summary for WY2014

For each Water Year, 2002 through 2014, monthly and annual rainfall totals are presented in Table 3-1. The total rainfall for WY2014 was 40.60 inches, which is similar to the recent historic

---

[4] Prior to WY2013, the annual sampling goal was to collect ten samples from each of the seven monitored outfalls. In October 2012, EPA and Ecology approved a reduction in sampling frequency beginning in WY2013.

average of 38.95 inches (Tacoma No. 1 National Oceanic and Atmospheric Administration (NOAA) site). Rainfall during the wet season was close to normal with just 0.37 inches less than average rainfall conditions based on recent history. Conversely, the dry season was wetter than normal with 2.02 inches more rainfall than average conditions based on recent history. The WY2014 weather patterns consisted of a four month dry spell followed by four months of the top ten wettest on record (Sea-Tac Airport) and the wettest February 1 through October 31 (first month of WY2015) on record.

With 13 years of monitoring, the average monthly and annual average rainfall depths for the monitoring period are approaching the historical record and are believed to be representative of the average historical record. Table 3-1 also shows that the average monthly rainfall for each month during the monitoring period is relatively consistent with historic averages, except that rainfall in November and December of 2013 was less than the historical averages by 2.7 and 4.0 inches, respectively, while rainfall in February and March 2014 was greater than the historical averages by 3.2 and 4.6 inches, respectively.

3.1.3 Baseflow

In OF230, OF235, OF237A and OF237B, baseflow is continuous, derived from old creeks that were piped, seeps or groundwater infiltration, and tides have a minimal effect. Baseflow in all of these systems also includes some amount of non-contact cooling water. A summary of baseflow sources to these outfalls is provided in Appendix B.

OF243, OF245 and OF254 do not have any creeks or other sources that provide constant baseflow. These drains do have tidal backflushing year round and during the wet season there is evidence of groundwater infiltration due to the high water table in the tideflat area. The groundwater table is comprised of a bottom layer, which is influenced by tides and an upper fresher water lens. In the wet season, the upper lens is freshened by rain recharge and salinity effects (e.g., conductivity) are less.

As indicated above, baseflow sampling was conducted during the first 10 years of the monitoring program but was discontinued after WY2011 when it was determined that the baseflow had been well characterized.

3.1.4 Stormwater

The intent of stormwater sampling is to identify trends in stormwater quality, to measure the effectiveness of source control actions, and to provide early warning of any new problems that arise in the watershed. Stormwater representativeness is a function of seasonal and individual storm characteristics.

Individual storms, historic averages and seasonal effects. Storm events are variable in nature by runoff volume, flow rate, antecedent rainfall, and season. Each year, this variability is evaluated by comparing the magnitude and intensity of the runoff hydrographs (see Figure 3-2), where samples were collected on the hydrographs, time between storm events, and time of year the samples were collected, to determine whether a representative range of storm types were included in the monitoring program.

Storm sampling during WY2014 was somewhat different from historic storm magnitudes (see Figure 3-3): 65% of 1982-2009 storms deposited approximately 0.15-0.49 inches of rainfall compared to 67% from WY2002-WY2014 and 44% for WY2014. In WY2014, a bias toward larger storms is apparent, with 37.5% of storms sampled having greater than 0.8 inches total depth as compared to 12% of the 1982-2009 storms and 12% of the WY2002-WY2014 storms.

The growing recent monitoring record completed under this program is a closer approximation of the historical record.

Based on the historical record (1982-2009), 84% of annual precipitation occurs during the wet season and 16% during the dry season (see Figure 3-4). Stormwater sampling under the monitoring program is slightly biased toward the dry season, with 25% (WY2002-WY2014) and 31% (WY2014) of sampled storms occurring during the dry season. This is due to the fact that antecedent periods are easier to meet in the dry season as compared to the wet season, which provides more opportunities for sampling.

Individually, the sampled storm volume is proportional to the total storm volume (see Figures 3-5.1 through 3-5.7). As illustrated in the figures, during the early part of the storm sampling program there were a limited number of events at OF230, OF237A and OF237B where the proportion between total storm volume and the volume of the event sampled had a higher differential than the proportion achieved in subsequent years. This was due to event characteristics and building expertise of the City's stormwater monitoring crew.

Numeric goals. Stormwater sampling representativeness criteria is summarized as follows (SAP 2001 and revisions in annual reports):

- Eight samples collected annually at four sites (OF230, OF235, OF237A and OF237B) and three samples collected annually from three sites (OF243, OF245 and OF254);
- Precipitation:
  - Proportional to storm seasonality;
  - During storm flow conditions, defined as:
    1. Total precipitation of at least 0.2 inches and,
    2. Less than 0.02 inches of precipitation in the previous 24 hours (antecedent period).
- Storm, sampling and tidal influence including:
  - Flow composite samples representing 75% of the total storm volume (OF237A[5] and OF237B) or,
  - Conductivity (tidal influence) of ≤ 2,000 µS/cm (≤ 5,000 µS/cm at OF243 and OF254), and
  - A minimum of 10 aliquots composited at all sites.

A dry period of six hours provides delineation between individual storms.

In WY2014, samplers were deployed during 26 different events at the various outfalls, resulting in 109 individual sample deployments (see Appendix B, Table B4-1). Fifty samples were submitted for analysis during WY2014. Only OF235, with seven acceptable storms, did not meet the annual sampling goal of eight storms per year for OF230, OF235, OF237A and OF237B and three storms per year for OF243, OF245 and OF254.

---

[5] OF237A, which is now monitored at the 237A New manhole, has some tidal influence so this criterion does not strictly apply.

All events except three had less than 0.02 inches of precipitation in the previous 24 hours (an antecedent period of 24 hours). While the antecedent period was somewhat less than 24 hours required for these three events, minimal to no runoff occurred, and all sites were at baseflow conditions prior to the start of the rain event. These exceptions are described in detail in Appendix B.

Four events were successfully sampled that had more than a six hour break in rainfall during the event. The January 28, 2014 event lasted 26 hours with 0.83 inches of rain. The first 0.60 inches of rain fell in 8.5 hours followed by a period where the rain was minimal (0.05 inches over 10 hours). Samples were successfully collected from OF237A, but they were validated based on a partial event since the bottles were full before the end of the event, sampling only the first 0.60 inches of runoff. The March 8, 2014 event lasted 58.75 hours with 1.96 inches of rain. Samples were successfully collected from OF230, but they were validated based on a partial event (rather than a six hour break at the end of the event) since the bottles were full before the end of the event. The first 1.12 inches of rain fell in 19.5 hours followed by a period where the rain was intermittent. This sample is believed to be representative of a 1.12 inch at OF230. The June 12 2014 event had a first peak of 0.05 inches with a second peak of 0.18 inches 5.5 hours later. The OF237B sampler sampled the second 0.18 inches and the results are believed to be representative of a 0.18 inch event. The September 24, 2014 event lasted 22.75 hours with 1.48 inches of rain. The storm was twice as large as predicted and therefore the sampler program led to samples being collected only during the first portion of the storm. Samples were accepted for analysis as they were believed to be representative of events for the duration sampled. This is described in detail in Section B.4.3.1.2 in Appendix B.

The percentage of the storm sampled at non-tidally influenced outfalls (OF237B) is another criteria evaluated in Appendix B. For WY2014, two events did not meet these goals. Both were believed to be representative of the rainfall event.

All sites achieved a minimum of 10 aliquots to be composited. For most of the samples, all aliquots are believed to be representative of stormwater and the event sampled. However, several samples did include aliquot(s) that were collected before or after the storm and that weren't representative of the sampling event (not time or flow-based). These deviations, described below, with one exception, are not believed to have impacted the representativeness of the composite sample. These exceptions are described in detail in Appendix B.

Site-specific conductivity criteria were achieved in OF230, OF235, OF237A, OF237B and OF245. Conductivity measurements of the aliquots composited for OF243 (criteria goal of ≤ 5,000 µS/cm) were less than 5,000 µS/cm for one of the four samples. The other samples had a maximum conductivity of 5,960, 6,080, and 7,040 µS/cm (see 2014 Report, Appendix C, Table C-5). Although the samples collected were above the 5,000 µS/cm goal, the samples were believed to be representative of runoff conditions. Conductivity measurements of all but one (max aliquot conductivity of 9,120 µS/cm) sample composited for Conductivity measurements of the aliquots composited for OF254 (criteria goal of ≤ 5,000 µS/cm) were less than 5,000 µS/cm for three of the five samples. The other samples had conductivities of 6,050 and 7,720 µS/cm (see 2014 Report, Appendix C, Table C-7). These samples were believed to be representative of storm runoff conditions.

The eight samples per year requirement for OF230, OF235, OF237A, and OF237B and three samples per year for OF243, OF245, and OF254 were met for all outfalls in WY2014 with the exception of OF235. Even though OF235 had only seven of the eight samples per year, the City believes that the overall sampling program is successful in sampling the precipitation events that met storm criteria and every attempt was made to sample and meet the requirement.

Stormwater Representativeness. Over the course of the City's 13 year monitoring record, a representative range of storm events has been characterized considering the following hydrological variables (see Figure 3-2):

- Total rainfall;
- Runoff hydrograph;
- Intensity;
- Antecedent period; and
- Season.

3.1.5 Stormwater Suspended Particulate Matter Monitoring – Sediment Traps and MH390 Sump

SSPM monitoring is considered successful provided that samples obtained from each monitoring outfall have laboratory results that are verifiable. Sample volumes available at each site vary with weather and insufficient volumes may be available to perform all analyses. In 2014, seven samples from the six outfall[6] locations (FD1, FD2, FD2A, FD3 New, FD6, FD23 and MH390) were submitted to the City laboratory for analysis. Additional upline sediment traps were also placed for source tracing purposes. In all, a total of 23 SSPM samples were collected which includes the outfall and upline locations.

3.1.6 Representativeness of WY2014 Laboratory Analyses

The 2014 laboratory quality assurance/quality control (QA/QC) review included 50 stormwater samples, 23 SSPM samples, certified reference materials (CRM), duplicates, method blanks, spikes, surrogates, laboratory control samples (LCS), and equipment rinsate blanks collected as specified in the Thea Foss and Wheeler-Osgood Waterways Stormwater Monitoring SAP (Tacoma 2001) (September 2001 and subsequent revisions).

Numeric effectiveness criteria were generated from the full review as presented in Appendix B. Reviewed data include classification as:

- Tier I – results that were rejected or could be interpreted as a loss of data, and
- Tier II – results which are classified by the laboratory as estimates, and are within 50% of the laboratory defined rejection range.

This type of analysis is helpful in identifying issues to be addressed when the majority of data quality is acceptable, yet may still be improved. In WY2014, 96% of stormwater and 95% of SSPM data met method quality objectives. Only 0.8% of the data were classified as censored or rejected. Stormwater and SSPM samples are therefore considered representative. This review is discussed in detail in Appendix B.

---

[6] OF254 does not have a sediment trap because of tidal influences.

3.2 MONITORING RESULTS: WY2002-WY2014 (YEARS 1 THROUGH 13)

This section presents a qualitative and quantitative description of spatial and temporal patterns in stormwater, and storm sediment quality in Monitoring Years 1 through 13 which occurred in WY2002 through WY2014. The qualitative analysis is derived from visual inspection of summary tables and box plots appended to this report (see Appendices E through H). The quantitative analysis includes statistical test procedures described in Section 9.3 of the Thea Foss Stormwater SAP (Tacoma 2001) as subsequently revised in the City's annual monitoring reports.

The objective of the statistical evaluation is to test the magnitude and significance of spatial and temporal trends in the monitoring data. Spatial trend analysis includes identification of particular municipal storm drains that may be significantly higher or lower in concentration compared to other storm drains in the Foss Waterway Watershed. Temporal trend analysis includes identification of increases or decreases in stormwater concentrations over time that may be caused by source control actions, construction activities, changes in source strength, land use, or other characteristics of the drainage basins over time.

Temporal trend analysis also includes an evaluation of seasonality, and whether significantly higher stormwater concentrations are observed during certain parts of the year. Conventional wisdom suggests higher concentrations might be expected during dry season conditions because there is more time for contaminants to accumulate on drainage basin surfaces between runoff events. There are two seasons in a water year, as defined in the NPDES Phase I Permit; the wet season runs from October 1 through April 30, and the dry season runs from May 1 through September 30.

3.2.1 Summary Statistics

For each detected chemical at each outfall, the following summary statistics are calculated for both stormwater and baseflow data (see Appendix E):

- Number of samples analyzed;
- Number of samples with detected chemical concentrations;
- Arithmetic mean concentration;
- Median concentration;
- Minimum and maximum concentrations;
- 10^{th} and 90^{th} percentile concentrations;
- 95% upper confidence limit on the arithmetic mean concentration;
- Standard deviation of the arithmetic mean concentration;
- Percent coefficient of variation; and
- Standard error of the arithmetic mean concentration.

Global summary statistics averaged over all municipal outfalls in the Foss Waterway drainage basin and all available monitoring years (WY2002-WY2014: Years 1 through 13) are provided in

Table 3-2 and Table 3-3 for baseflow[7] and stormwater data, respectively. The global summary statistics include:

- Total number of samples;
- Percentage of samples with detected concentrations;
- Minimum and maximum detected concentrations for each outfall;
- Mean and median concentrations for each outfall;
- Global weighted-mean concentrations for the entire Thea Foss basin (weighted by number of samples per outfall); and
- Overall maximum concentration for all outfalls, and sampling date of maximum concentration.

Summary statistics were generated using Microsoft® Office Excel 2010. For non-detected concentrations, 1/2 reporting limit values were used as specified in the Foss SAP (Tacoma 2001.)

3.2.2 Constituents of Interest

Summary charts for stormwater, baseflow, and SSPM were prepared and statistical tests were performed on the following indicator parameters:

- Total Suspended Solids (TSS)
- Metals (total lead and total zinc)
- Polycyclic Aromatic Hydrocarbons (PAHs, including phenanthrene, pyrene and indeno(1,2,3-cd)pyrene)
- Bis(2-ethylhexyl)phthalate (DEHP) [plus butylbenzylphthalate and total phthalates]

These represent the primary COCs for protection of sediment quality in the Thea Foss Waterway.

In addition, several hydrophobic constituents were evaluated statistically in SSPM only, because of their relatively poor solubility in stormwater and tendency to adhere to suspended sediments, including the following:

- Mercury
- Polychlorinated Biphenyls (PCB)
- 4,4’-DDT
- Total Petroleum Hydrocarbons

3.2.3 Statistical Test Methods

The stormwater monitoring data were subjected to the following statistical tests:

---

[7] Baseflow results are presented for WY2002 to WY2011 since baseflow monitoring was discontinued after WY2011.

- Qualitative Assessment of Spatial and Temporal Trends;
- Analysis of Variance (ANOVA) and Post-Hoc Comparison Tests:
  - Parametric ANOVA and Tukey Test (Stormwater Data)
  - Nonparametric ANOVA (Kruskal-Wallis Test) and Dunn Test (Baseflow and SSPM Data)[8]; and
- Time Trend Analysis (Seasonal Kendall and Lognormal Linear Regression).

The ANOVA, Kruskal-Wallis, and Tukey tests were performed using SYSTAT® Version 13.1. The lognormal regressions and nonparametric post-hoc test (Dunn Test) were performed in Microsoft Excel using the equations in Zar (1999). Time trend analysis (Seasonal Kendall test) was performed using the freeware Kendall.exe (a DOS executable program that runs under current versions of the Windows operating system) available from the USGS (http://pubs.usgs.gov/sir/2005/5275/downloads/).

3.3 SPATIAL ANALYSIS

This section presents a qualitative and quantitative spatial analysis of differences in stormwater and SSPM quality between municipal storm drains. It should be noted that there are similarities as well as differences in the spatial patterns of exceedences observed in stormwater and SSPM, as discussed in the following sections and as shown on Tables 3-4 and 3-5.

Qualitative analysis includes inspection of drain-by-drain summary statistics and box plots. Quantitative analysis includes lognormal parametric ANOVA and post-hoc comparison (Tukey Test) for stormwater data, and nonparametric ANOVA (Kruskal-Wallis test) and post-hoc comparison (Dunn Test) for SSPM data. Note that this information is used to guide stormwater source control activities that are discussed further in Section 5.0.

3.3.1 Baseflow Quality

Baseflow sampling was discontinued at the end of Year 10 since baseflow quality was well characterized. Refer to the WY2012 report (Tacoma 2013) for a detailed description of the baseflow characteristics in each of the outfalls.

3.3.2 Stormwater Quality

Qualitative Outfall Comparisons. Inspection of summary tables and box plots of stormwater quality among the various Foss Waterway storm drains suggests the following generalized conclusions (see Table 3-3 and Appendices D, E, F and G):

- **TSS.** Comparatively higher TSS concentrations were observed in OF235 and OF254. OF235 and OF237A had elevated maximum concentrations (441 and 400 mg/L), while OF254 had the highest mean (104.2 mg/L) and median (84.3 mg/L) concentrations, with OF243 and OF235 next highest with mean concentrations of 73.9 mg/L and 72.3 mg/L and median concentrations of 56.3 mg/L and 53.7 mg/L, respectively. OF237A and

[8] Storm sediment has initially tested using a parametric ANOVA and Tukey post-hoc test. The data was re-evaluated in 2012 and it was determined that nonparametric statistical tests were most appropriate. This analysis is described in more detail in Section 3.3.3.

OF230 had the lowest mean (54.0 and 50.0 mg/L) and median (39.5 and 35.5 mg/L) TSS concentrations.

- **Metals.** Comparatively higher mean and median lead concentrations were observed in OF235; while OF243 also showed evidence of elevated lead concentrations, including the highest overall lead concentration (379 µg/L) in September 2009. The highest mean (0.039 µg/L) and maximum (0.87 µg/L) mercury concentrations were observed in OF254 and OF245, respectively. The highest mean (165.3 µg/L) and maximum (1,170 µg/L) zinc concentrations were observed in eastside outfalls OF245 and OF243, respectively.
- **Phthalates.** DEHP is the phthalate compound with most frequent detections (78% detection) and the highest mean and median concentrations. The highest median, mean, and maximum concentrations of DEHP were observed in OF235 (2.7, 5.4, and 97 µg/L, respectively), and the second highest concentrations were observed in OF230 (2.5, 4.1, and 44.1 µg/L, respectively). Unusually elevated DEHP concentrations were also found in OF245 in Year 2 (October 2002 through April 2003) and in Year 7 in OF230 and OF243, but these appear to be isolated occurrences. Certain other phthalates, though less frequently detected, peaked at higher concentrations. In particular, elevated diethylphthalate concentrations were measured in 2002 in OF237A (230 µg/L), OF235 (590 µg/L), OF245 (430 µg/L), and OF254 (120 µg/L). The peak butylbenzylphthalate concentration was measured in OF245 (290 µg/L) in 2003. However, diethylphthalate and butylbenzylphthalate were detected in less than half the samples (31% and 35% detection, respectively). The fact that the peak concentrations of various phthalates occur in different outfalls indicates that the phthalate composition is somewhat variable across the Foss Waterway drainage basins.
- **PAHs.** OF235 contained the highest maximum concentrations of the lighter weight PAH compounds naphthalene, 2-methylnaphthalene, and total Low Molecular Weight PAHs (LPAHs). Comparatively higher mean and median concentrations of a number of other LPAHs and the maximum concentration of anthracene were observed in OF254. The highest maximum concentrations for several other LPAH compounds, including acenaphthene, acenaphthylene, fluorene, and phenanthrene were observed in OF245. Comparatively higher mean, median, and maximum concentrations of High Molecular Weight PAHs (HPAHs) were observed in OF237A and OF254. In general, PAH concentrations over the last six years (Years 8 through 13) were relatively low compared to previous monitoring years.

Parametric ANOVA Results. ANOVA was performed to determine whether or not there are statistically significant differences between outfalls. The ANOVA test helps to determine whether stormwater quality in the Foss Waterway Watershed is relatively uniform across drainages (i.e., all outfalls are drawn from a single statistical population), or whether there is reason to believe that certain drainages are unique (i.e., characterized by unusually high or low concentrations).

Goodness-of-fit tests show that practically all stormwater analytes in all outfalls may be characterized by lognormal or nearly lognormal statistical distributions (Tacoma 2009a, Tacoma 2012). Therefore, lognormal parametric ANOVA tests were conducted. The ANOVA test statistic is the F statistic with 6 (n-1) degrees of freedom (n = 7 outfalls in the monitoring program).

ANOVA and post-hoc comparison tests were performed using: (1) all 13 years of monitoring data, and (2) only the last two years of monitoring data[9]. ANOVA tests using the entire 13 year monitoring record have significantly more power to discriminate between drains due to a much larger sample size. ANOVA tests using only the most recent monitoring data have lower statistical power, but provide information on the most current conditions in the storm drains, to better determine whether the City's source control actions have resulted in recent improvements in stormwater quality and to guide future source control activity prioritization.

Following are the results of the parametric ANOVA test using all 13 years of stormwater monitoring data:

Parameter	F Statistic	Probability	Significant?
TSS	12.790	<0.001	Yes
Total Lead	100.553	<0.001	Yes
Total Zinc	33.051	<0.001	Yes
Phenanthrene	4.536	<0.001	Yes
Pyrene	7.028	<0.001	Yes
Indeno(1,2,3-cd)pyrene	5.432	<0.001	Yes
DEHP	10.909	<0.001	Yes

The parametric ANOVA test results indicate there is greater than or equal to 99.9% probability ($p \leq 0.001$) that one or more outfalls are significantly different from the norm, either higher or lower, for every one of the index constituents. As a result, post-hoc tests were performed to identify which specific outfalls contain unusually high or low stormwater concentrations.

Following are the results of the parametric ANOVA test using only the last two years of monitoring data:

Parameter	F Statistic	Probability	Significant?
TSS	4.572	<0.001	Yes
Total Lead	21.355	<0.001	Yes
Total Zinc	5.349	<0.001	Yes
Phenanthrene	2.843	0.014	Yes
Pyrene	4.417	0.001	Yes
Indeno(1,2,3-cd)pyrene	1.240	0.294	No
DEHP	4.389	0.001	Yes

The ANOVA test results indicate it is possible to differentiate stormwater quality between outfalls in the Foss Waterway Watershed for the index constituents using only the last two years of data.

Parametric Post-Hoc Comparison (Tukey Test). Because the ANOVA test showed statistically significant differences ($p < 0.05$) between stormwater quality in the various municipal

[9] Previous annual reports presented only the last year of monitoring data. However due to the reduction in sampling numbers starting with WY2013, the ANOVA analysis was changed to include the last two years of data. Without this change, very few statistically significant differences would be observed.

drainages, post-hoc tests were performed to determine which specific drains are higher or lower than normal. The Tukey Test is an appropriate post-hoc test for parametric ANOVA. The results of the parametric post-hoc tests are summarized in Table 3-4. On this table, the top portion provides the results for the evaluation of the 13 year data set, while the bottom portion provides the results when looking at only the last two years of data. Since this data set is smaller, there is somewhat less confidence in the results, however it does provide some indication of the current source control status and priorities.

Drainages and constituents exhibiting significant differences in stormwater quality, based on the entire 13 year monitoring record, include the following (see Table 3-4):

- **TSS.** TSS concentrations are moderately lower in OF230 (-4). TSS concentrations are significantly higher in OF254 (+6).
- **Total Lead.** OF237A (-4), OF237B (-4), and OF245 (-4) contain lead concentrations that are moderately below average. OF243 (+4) and OF235 (+6) are moderately to significantly elevated compared to other outfalls.
- **Total Zinc.** Zinc concentrations in OF237B (-6) are significantly lower than all other outfalls. OF235 (+3), OF245 (+4) and OF254 (+4) are moderately elevated in zinc.
- **DEHP.** OF230 (+4) and OF235 (+5) contain moderately to significantly elevated DEHP concentrations relative to other outfalls. DEHP concentrations in the remaining outfalls are relatively low and largely indistinguishable from one another.
- **PAHs.** OF237B has moderately lower concentrations of phenanthrene (-3) and pyrene (-3). OF245 has moderately lower concentrations of pyrene (-3) and indeno(1,2,3-c,d)pyrene (-4). OF254 has moderately higher concentrations of pyrene (+4).

In summary, these results indicate that OF235 and OF254, and to a lesser degree OF230, have the highest number of positive pair comparisons; therefore, source control activities are best focused in these drainages. OF237B and OF245 have the highest number of negative pair comparisons, ranging from neutral to moderately to significantly lower in concentration for all index constituents (except total zinc in OF245) relative to other drains, and therefore exhibit the best overall stormwater quality. OF243 and OF237A have generally good stormwater quality for a majority of constituents relative to other drains, with the exception of OF243 showing evidence of being enriched with lead. With 13 years of monitoring data, very good statistical power has been achieved, and the spatial patterns in Foss stormwater are relatively stable and consistent from one monitoring year to the next.

When looking at only the last two years of monitoring data (see Table 3-4), some differences in the trends are observed. TSS remains moderately elevated in OF254 (+4). Lead remains significantly elevated in OF235 (+6) while it has decreased significantly to nearly neutral conditions in OF243. Overall, the two year results show much more neutral conditions in all of the outfalls.

3.3.3 Baseflow Versus Stormwater Quality

Summary statistics for baseflow[10] and stormwater quality for WY2002-WY2014 are provided in Table 3-2 and Table 3-3, respectively. These tables include weighted mean concentrations

[10] Baseflow results are presented for WY2002 to WY2011 since baseflow monitoring was discontinued after WY2011.

averaged across all seven outfalls in the Foss Waterway Watershed (weighted by sample size for each outfall). The weighted mean concentrations in baseflow and stormwater are summarized below for the Thea Foss index chemicals.

Constituent	Units	Mean Baseflow	Mean Stormwater	Ratio
TSS	mg/L	12	68	18%
Lead	µg/L	5.5	29	19%
Zinc	µg/L	47	123	38%
Phenanthrene	µg/L	0.013	0.087	15%
Pyrene	µg/L	0.026	0.185	14%
Indeno(1,2,3-c,d)pyrene	µg/L	0.006	0.045	13%
DEHP	µg/L	1.1	3.2	34%

Inspection of these summary statistics indicates the following:

- Baseflow concentrations are consistently lower than stormwater concentrations. Average baseflow concentrations range from approximately 1/10 to 1/3 (13-38%) of stormwater concentrations.
- In addition to lower mean concentrations, baseflow samples are typically characterized by less extreme values and less frequent detections.
- Because the TSS content is almost six times higher in stormwater, the increased chemical concentrations that are observed during storm events may be caused in part by suspended sediments entrained in the runoff.

3.3.4 Storm Sediment Quality

SSPM samples were collected in pipeline sediment traps and in the MH390 sump (representing OF245). These samples include suspended particulate matter in transport through the storm drains. OF254 does not have a sediment trap because of tidal influences. SSPM data help to provide information on hydrophobic constituents such as mercury, HPAHs, DDT and PCBs, which have a strong affinity for sediments, but are poorly soluble and often undetected in whole-water samples. In conjunction with baseflow and stormwater data, SSPM data are used to help the City, EPA, and Ecology identify and trace unusually elevated sources of contaminants in the municipal drainages.

Due to the limited dataset available for review (only one sample per year), the assumption was made in previous reports that the SSPM data would follow a lognormal distribution similar to the stormwater data. This assumption was verified in Year 11 (Tacoma 2012) and it was determined that the sediment traps were generally not well described by a lognormal distribution. Therefore, nonparametric statistical tests were used.

ANOVA was performed to identify storm drains with significantly higher or lower sediment concentrations compared to other drains in the Foss Waterway Watershed. A nonparametric ANOVA (Kruskal-Wallis Test) was performed, with 5 (n-1) degrees of freedom (n = 6 outfalls in the sediment trap monitoring program).

Following are the results of the nonparametric ANOVA test using all 13 years of storm sediment data:

Parameter	F Statistic	Probability	Significant?
Total Lead	58.749	<0.001	Yes
Total Zinc	47.420	<0.001	Yes
Total Mercury	45.973	<0.001	Yes
TPH-Heavy Oil	28.021	<0.001	Yes
Phenanthrene	42.306	<0.001	Yes
Pyrene	34.600	<0.001	Yes
Indeno(1,2,3-cd)pyrene	45.710	<0.001	Yes
Total PCBs	9.612	0.087	No
DEHP	23.601	<0.001	Yes
BBP	56.380	<0.001	Yes
Total Phthalates	32.014	<0.001	Yes

The nonparametric ANOVA test results indicate there is a high probability (equal or greater than 99% confidence; $p \leq 0.01$) that storm sediment concentrations in one or more outfalls are significantly different from the norm, either higher or lower, for most analytes. However, differences in DDT and total PCB concentrations between outfalls cannot be discerned in this data set. This is not surprising for DDT, considering the high percentage of undetected DDT concentrations, and the fact that only two DDT isomers were detected in any drains between WY2007 and WY2013 when analysis for DDT was discontinued. Similar to DDT, while a relatively small number of detections of PCBs were observed in WY2014, overall there were so few detections previously from WY2008 to WY2013 that differences cannot be discerned statistically.

Following are the results of the nonparametric ANOVA test using only the last five years of monitoring data:

Parameter	F Statistic	Probability	Significant?
Total Lead	25.470	<0.001	Yes
Total Zinc	23.312	<0.001	Yes
Total Mercury	23.354	<0.001	Yes
TPH-Heavy Oil	14.672	0.012	Yes
DDT[1]	2.259	0.812	No
Phenanthrene	22.420	<0.001	Yes
Pyrene	19.880	0.001	Yes
Indeno(1,2,3-cd)pyrene	21.092	0.001	Yes
Total PCBs	5.580	0.349	No
DEHP	12.504	0.029	Yes
BBP	24.343	<0.001	Yes
Total Phthalates	14.445	0.013	Yes

[1] Note that analysis for DDT was discontinued in WY2013.

The nonparametric ANOVA test results indicate it is possible to differentiate SSPM quality between outfalls in the Foss Waterway Watershed for the same number of index constituents (all except for DDT and Total PCBs) using only the last five years of data.

Pair-comparison tests were performed using the Dunn method, as summarized in Table 3-5. Each outfall is compared to a maximum of five other outfalls in the storm sediment monitoring program (six outfalls total). Outfalls and constituents that exhibit a higher number of significant pair comparisons help to identify drainages that are increasingly unique (either higher or lower concentrations) compared to the other drains in the Foss Waterway Watershed. On Table 3-5, the top portion provides the results for the evaluation of the 13 year data set, while the bottom portion provides the results when looking at only the last five years of data. Since this data set is smaller, there is somewhat less confidence in the results, however, it does provide some indication of the current source control status and priorities.

Following is a summary of observations regarding spatial patterns in SSPM quality based on the 13 year monitoring record. The spatial patterns observed in the SSPM data are sometimes but not always consistent with the patterns observed in stormwater data (compare Table 3-5 and Table 3-4). Discrepancies between these two data sets are included below and may be caused by differential transport of pollutants in dissolved and particulate phases.

- **Metals.** SSPM in OF230 and OF243 are somewhat elevated in lead (+2 and +3, respectively), mercury (+3 and +4, respectively), and zinc (+1 and +3, respectively); OF235 is relatively neutral (+2 to -1); and OF237A, OF237B and OF245 have relatively lower concentrations of the index metals (-1 to -3) except for zinc in OF245 (+1). Some of these patterns are contrary to those observed in stormwater. For example, zinc concentrations in OF235 are elevated in stormwater (+3), but not in SSPM (-1) and zinc concentrations in OF243 are moderately elevated in SSPM (+3) but not in stormwater (-2).
- **Total Petroleum Hydrocarbons (TPH-Oil).** SSPM in OF237B is somewhat lower in TPH-Oil (-2) relative to the other outfalls.
- **DDT.** No significant differences in DDT concentrations were observed among the six outfalls.
- **PAHs.** Storm sediment in OF245 contains somewhat lower concentrations of PAHs (-2 to -3) relative to all other outfalls. OF230 and OF237A are slightly enriched in PAHs (+1 to +2). These patterns are generally consistent with those observed in stormwater except for OF237B where SSPM is neutral (0 to +1) and stormwater somewhat lower than other locations (0 to -3).
- **Total PCBs.** No significant differences in total PCB concentrations were observed among the six outfalls.
- **Phthalates.** DEHP is fairly ubiquitous and consistent in storm sediment throughout the various drainages; only OF237B (-2) shows a slightly lower concentration in DEHP. These patterns are not altogether consistent with those observed in stormwater. For example, DEHP in OF230 and OF235 was moderately to significantly elevated in stormwater (+4 and +5 respectively), but not in storm sediment (+1 and 0, respectively). OF243 and OF245 exhibit notably different phthalate compositions that are dominated by butylbenzylphthalate (+2 and +4, respectively). In particular, OF245 and OF248 have the majority of the highest butylbenzylphthalate concentrations in the monitoring program.

When looking at only the last five years of monitoring data, fewer spatial patterns are observed, but the patterns are generally consistent with the 13 year monitoring record results (Table 3-5). This suggests that there has not been a significant change in spatial distribution over the 13 year monitoring record.

3.4 SEASONAL ANALYSIS

This section presents a qualitative evaluation of seasonality in baseflow and stormwater quality by inspection of seasonal box plots (see Appendix H). As per the City's NPDES Phase I Permit, the wet season is defined as October 1 through April 30, and the dry season is defined as May 1 through September 30.

It might be expected that dry season conditions would generate higher contaminant concentrations in both baseflow and stormwater. This might be caused by more isolated storms and longer antecedent dry periods between storms, resulting in longer periods of contaminant accumulation on the surfaces of the drainage basin. The seasonal effect on runoff quality found through the City's monitoring program is evaluated below.

3.4.1 Seasonal Analysis of Stormwater Quality

Inspection of box plots comparing stormwater quality between the wet and dry seasons suggests the following:

- Evidence of seasonal effects in TSS concentrations is weak in all outfalls.
- Metals (lead and zinc) in stormwater showed occasional evidence of seasonality, i.e., higher median, mean, and/or peak concentrations during dry season months.
- Evidence of seasonal effects was rarely observed in organics data.

3.5 TIME TREND ANALYSIS

This section presents a qualitative and quantitative analysis of time trends in stormwater quality. The objective of time trend analysis is to identify specific drains and constituents that show evidence of significant improvement or degradation in stormwater quality over time. The changes can be a result of source control actions in the drainage basins that help to curtail pollutant concentrations, or alternatively, changes or disturbances in the watersheds that may cause concentrations to increase, for example, temporary construction activities, or increased urban density and traffic.

3.5.1 Stormwater Time Trends

Qualitative Analysis of Time Trends. Inspection of box plots comparing stormwater quality from one monitoring year to the next suggests the following (see Appendix G):

- Time trends are difficult to discern by visual inspection of the year-to-year box plots due to the generally high degree of variability in stormwater data. Time trends are evaluated using more quantitative statistical tests later in this section.
- In spite of the inherent variability of the data, there nevertheless appear to be across-the-board reductions in most PAH compounds and DEHP in most drains over the last five to six years. Having stabilized at low levels for several consecutive years, these trends may be indicative of the effectiveness of the City's source control program.
- WY2010 (Year 9) was problematic for OF243, which was characterized by unusually high concentrations of TSS, lead, and zinc in stormwater. In WY2011 (Year 10), the concentrations of these constituents declined with slight upticks in WY2012 (Year 11).
- Unusually dry (Year 2 and Year 4) and unusually wet (Year 6) monitoring years are summarized in Table 3-1. Monitoring years WY2010 to WY2013) were the, 3rd, 4th, 5th

and 2nd wettest years of the 13 year monitoring record, respectively. Despite this variability, there has been no discernible relationship between these unusual water years and stormwater quality. Reliable correlations between stormwater quality and other hydrologic parameters (i.e., rain depth, rainfall intensity, and antecedent period; see Figure 3-2) are not discernible either.

Regression Analysis. The simple linear regression is performed using the logarithms (base 10) of the stormwater concentrations. This is equivalent to an exponential decay model, which is a typical decay profile for environmental data. No seasonal effects were modeled with the regression given that such effects are not consistently observed, and are especially weak for organic compounds (see Section 3.4.1). The relevant regression statistics are summarized in Table 3-6.

Scatterplots of the time-series data and best-fit lognormal regression models are presented on Figures 3-6.1 (TSS), 3-6.2 (lead), 3-6.3 (zinc), 3-6.4 (phenanthrene), 3-6.5 (pyrene), 3-6.6 (indeno(1,2,3-cd)pyrene), and 3-6.7 (DEHP). These plots show all significant cases of the simple linear regression test.

The regression analysis confirms that reducing trends are statistically significant in 46 of 49 cases at greater than 95% confidence.

The best-fit regression equations are used to estimate percent reductions over the 13 year monitoring period for these constituents and outfalls:

- **TSS.** Approximately 41-70% reduction in OF230, OF235, OF237A, OF237B and OF245;
- **Lead.** Approximately 46-74% reduction in OF230, OF235, OF237A, OF237B, OF245 and OF254;
- **Zinc.** Approximately 33-59% reduction in all seven outfalls;
- **PAHs.** Approximately 89-98% reduction in phenanthrene, pyrene, and indeno(1,2,3-cd)pyrene in all seven outfalls; and
- **DEHP.** Approximately 69-92% reduction in all seven outfalls.

3.6 CONCLUSIONS

The City has been performing outfall monitoring in the Thea Foss Basin for 13 years. Most of the COCs have undergone significant reductions in concentrations and loads compared to past monitoring efforts in the late 1980s through mid-1990s. The cumulative effect of federal, state and municipal source control efforts has likely caused the observed improvements in stormwater quality. The City has directed numerous source control efforts in this watershed, including control of potential TSS, metals, PAH and DEHP sources. In particular, PAH and DEHP concentrations in the last five years appear to be generally below the average concentrations in the majority of outfalls. Having stabilized now for several consecutive monitoring years, the observed concentration reductions are likely an indication of source control effectiveness. The City will continue to evaluate the source(s) of the COCs in the Foss Waterway Watershed. The COCs for each basin and source control priorities are discussed in Section 5.0.

A large number of significant reductions have been observed in the City's 13 year monitoring record. Forty-six time trends were shown in Year 13 to be statistically significant (46 out of 49 tests, or approximately 94% of the tests) using simple linear regression. All trends were in the direction of decreasing concentrations. In Year 12, 44 significant trends were detected; in Year 11, 41 significant trends were detected; in Year 10, 37 significant trends were detected; in Year 9, 26 significant trends were observed; in Year 8, 10 significant trends were observed; and in Year 7, only 4 significant trends were observed. As noted in Section 3.5.1 some new statistical approaches were implemented in WY2012 and for this reason, the last three year's results are not fully comparable to previous year's results. However, these changes have improved the statistical approach to the trend analysis, and the City's ability to discern trends.

With a comprehensive 13 year monitoring record – including substantial sampling of storm events and baseflow events in seven drains every year for at least 13 years[11] – the drainages in the Foss Waterway Watershed have been well characterized. Significant reducing trends have been observed in a majority of cases, including statistically significant reductions in PAHs, TSS, lead, zinc, and DEHP concentrations in all or a majority of the drains, attesting to the effectiveness of the City's source control program.

[11] Baseflow sampling was discontinued at the end of WY2011, so there is a 10 year record for baseflow. Stormwater sampling has continued and currently has 13 years of monitoring data.

4.0 THEA FOSS WATERWAY SEDIMENT MONITORING

The purpose of this section is to evaluate time trends in sediment quality over the first ten years of post-remediation monitoring in the Head of Thea Foss Waterway. Sediment analytical results are compared to the Commencement Bay Sediment Quality Objectives (SQOs) to determine if sediment quality in the waterway is being protected from ongoing sources. In addition, post-remediation sediment data are compared with computer model predictions to assess rates of change in waterway sediment concentrations and to extrapolate trends into the future.

The Utilities are responsible for collecting post-construction sediment quality data in the Head of Thea Foss Waterway. The City is responsible for collecting post-construction sediment quality data in all other areas, including the middle and outer portions of the Thea Foss Waterway and in the Wheeler-Osgood Waterway. During this stormwater monitoring year, the Utilities collected their Year 10 sediment monitoring data in the Head of the Thea Foss Waterway, which is presented and analyzed in this section. In 2013, the City collected their Year 7 sediment monitoring data in other parts of the waterway. Those results were presented in the WY2013 report. No monitoring was required in 2014 under the City's sediment monitoring program and therefore, no new results for the middle and outer portions of the waterway are available to present. Note that the Utilities' and the City's sediment monitoring programs are on different schedules because the remedial actions were completed at different times in different parts of the waterway.

4.1 OVERVIEW OF WASP MODEL OF THEA FOSS WATERWAY

Sediment quality results for Year 10 of the Operation, Maintenance, and Monitoring Plan (OMMP) monitoring event that occurred in the Utilities' portion of the Thea Foss and Wheeler-Osgood Waterways in 2014 are evaluated herein. Sediment analytical results are compared to the SQOs to determine if the waterway is being protected from recontamination, or if additional controls of stormwater or other urban and marine sources may need to be evaluated. In addition, post-remediation sediment data are compared with computer model predictions to assess changes in waterway sediment concentrations over time, and to extrapolate sediment quality trends into the future.

4.1.1 Thea Foss Sediment Quality Model

The Thea Foss sediment quality model was developed using EPA's computer model "WASP" (Water Quality Analysis Simulation Program; Ambrose, Wool, and Martin, 1993). The model predicts future, post-remediation sediment concentrations in consideration of the various sources and mass loadings to the waterway. The Thea Foss model was initially developed during pre-remedial design and a number of model updates and refinements were made in 2006 (Tacoma 2007). The refinements included updating contaminant mass loadings (using more recent stormwater, atmospheric deposition, and NPDES monitoring data), post-remediation waterway conditions (marinas and groundwater discharges), and validating the model with the first two years of post-remediation sediment monitoring data.

4.1.2 Thea Foss Contaminants of Concern

The following COCs were evaluated in the WASP model:

- Phenanthrene
- Pyrene

- Dibenzo(a,h)anthracene
- Bis(2-ethylhexyl)phthalate (DEHP)

Phenanthrene, pyrene and dibenzo(a,h)anthracene were selected as key COCs to represent the range of chemical properties exhibited by PAHs with low, medium, and high molecular weights, respectively.

In addition, the following metals were evaluated in OMMP sediment monitoring data because of their potential association with urban and marine sources:

- Lead
- Zinc

Lead and zinc simulations were not performed in the WASP model; therefore, future sediment quality predictions are not available for these metals. However, model simulation is not necessary because all lead and all but one of the zinc concentrations in Year 10 subtidal sediments were well below the SQOs.

4.1.3 Waterway Segmentation

The WASP model provides spatially averaged sediment concentrations in eight model segments, including six segments in the Thea Foss Waterway (Segments 19 through 24) and two segments in the Wheeler-Osgood Waterway (Segments 25 and 26), as shown on Figure 4-1 and described below.

Segment [1]	Description
Thea Foss Waterway	
19	OF207, 208, 214, 222, 223, Foss Waterway Marina, Comm. Bay Marine
20	OF224 and 225, Foss Harbor Marina, Petrich Marine
21	OF230, Martinac Shipyard
22	OF248 and 249, Delin Docks and Dock Street Marinas
23	OF245, Johnny’s Dock and Foss Landing Marinas
24	OF237A, OF237B, OF235, Utilities’ work area in head of waterway
Wheeler-Osgood Waterway	
25	Lower subtidal basin
26	OF254, Upper tideflat

[1] Segments 19 - 23 and Segments 25 and 26 are in City’s work area and are not included in this report

Results for Year 7 monitoring of the City’s work area in Segments 19-23, 25 and 26 were presented in the WY2013 report. Segment 24 is fully within the Utilities’ work area and is monitored on a different schedule under the Utilities’ OMMP and is analyzed herein.

4.2 HEAD OF THEA FOSS WATERWAY YEAR 10 MONITORING RESULTS

WASP model predictions and post-construction sediment monitoring data in the Head of Thea Foss Waterway are presented on Figure 4-2. The head of the waterway generally contains the highest concentrations of PAHs (including the index constituents phenanthrene, pyrene, and dibenzo[a,h]anthracene) and DEHP, and therefore provides the most sensitive indication of recontamination in the waterway. This is a result of the high sedimentation rates in the head of the waterway coupled with the relatively higher total organic carbon (TOC) content of the sediments at some locations, (average TOC 3.4 percent in Year 10 with a range from 0.99 to 6.47 percent) which tends to sequester organic contaminants such as PAHs and DEHP.

The model prediction begins at Year 0, which represents the clean sediment surface at the close of the sediment remedial action. At the head of the waterway, the concentration at Year 0 was that of the clean import material used to construct the sediment cap. Concentrations are then predicted to rise over time given that there are ambient sources of contaminants in any urban waterfront, including sources such as stormwater, boat traffic, atmospheric deposition and industrial sources. The typical model prediction curve rises more steeply during the early years following sediment remediation, and then begins to level off and approach a steady-state concentration after about a decade. It should be noted that all model predictions are based on an assumption that source loads do not increase beyond present day levels.

The WASP model predicted average PAH concentrations in the head of the waterway would remain below SQOs for at least 10 years. However, it is possible for individual samples to exceed SQOs in localized portions of the waterway as a result of heterogeneities in sediment distribution patterns.

Bioassay testing results in Thea Foss Waterway have shown that the SQO for DEHP (1,300 ug/kg) is overly conservative. DEHP concentrations approximately three times the SQO (approximately 4,000 ug/kg) have been shown to cause no adverse effects on aquatic organisms (Tacoma 1999; TetraTech 2006). Therefore, model predictions and sediment monitoring results for DEHP are compared to the site-specific biological effects level of 4,000 ug/kg because it provides a more reliable toxicity benchmark for this waterway.

Concentrations of DEHP were predicted to rise above the biological effects level several years after the remedial action. That outcome was forecast during pre-remedial design (Tacoma 1999, 2002, 2005b). Knowing that sediments in the Thea Foss Waterway as well as other urban embayments in Puget Sound were being recontaminated by DEHP, EPA, Ecology, Tacoma and others convened the Sediment Phthalate Work Group to investigate this issue further. The Work Group determined that DEHP is ubiquitous in the urban atmosphere and in urban stormwater runoff, and is largely beyond our ability to control cost-effectively using currently available technologies (Tacoma, Ecology, EPA, and others, 2007). Nevertheless, the City continues to move forward with DEHP source control investigations, stormwater treatment pilot studies, and other special studies to better isolate DEHP sources and identify cost-effective source control options for this contaminant.

4.3 EVALUATION OF SEDIMENT QUALITY TIME TRENDS IN YEAR 10

Time series charts of sediment quality monitoring results and WASP model prediction curves for the Head of Thea Foss Waterway are shown on Figure 4-2. Individual sample results (solid diamonds) and the mean concentration of all samples in a given monitoring year (large open squares) are plotted on the figures. Undetected values are plotted at half the value of the analytical reporting limit.

Summary statistics for Year 10 sediment monitoring data and WASP model predictions include:

- Mean observed sediment concentration in Year 10, and corresponding mean SQO exceedance ratio;

- Maximum observed sediment concentration in Year 10, and corresponding maximum SQO exceedance ratio; and
- Model predicted concentration in Year 10, and model prediction bias (positive or negative) relative to the mean observed concentration.

This information is summarized in the following table

Index Chemical [in µg/kg]	SQO	Model Predict Conc.	Model Predict Bias[2]	Mean Observed Conc.	Max Observed Conc.	Mean Exceed Ratio	Max Exceed Ratio
Phenanthrene	1,500	1,100	+ 15%	940[3]	1,800	NE	1.2
Pyrene	3,300	3,200	+ 41%	1,900[3]	3,300	NE	1.0
Dibenzo(a,h)anthracene	230	180	+ 22%	140[3]	250	NE	1.1
DEHP	4,000[1]	5,500	+ 7%	5,100[3]	8,200	1.3	2.1

Notes:
[1] Value listed is site-specific biological effects threshold
[2] Percent difference between model predicted concentration and mean observed concentration
[3] Note that this average includes only those samples within the Utilities' work area that are located in Segment 24 of the model (WC-01, WC-02, WC-03, WC-04, WC-05, WC-06, WC-07, WC-08, WC-09, WC-13 and WC-14).

NE = No Exceedance

In the head of the waterway, the WASP model predictions show excellent agreement with average post-remediation sediment concentrations. Model predictions for phenanthrene, pyrene and dibenzo(a,h)anthracene all appear to have a high bias (tendency to over-predict concentrations) by 15, 41 and 22 percent, respectively. Model predictions for DEHP have minimal bias when compared to actual analytical results, with a slight tendency to bias high.

4.3.1 Polycyclic Aromatic Hydrocarbons

Average Year 10 concentrations of phenanthrene, pyrene and dibenzo(a,h)anthracene are below the SQOs in the Head of the Thea Foss Waterway (Figure 4-2). PAH concentrations in a majority of individual samples are also below SQOs, with a few exceptions. The highest PAH concentrations are consistently observed in one particular sample location (sample WC-02) in a low-energy back-eddy where organic-rich sediments are preferentially accumulating.

An increasing trend in dibenzo(a,h)anthracene concentrations that was observed in the Utilities' Year 7 monitoring was not observed in Year 10.

4.2.2 Bis(2-ethylhexyl)phthalate

The average Year 10 concentration of DEHP of 5,100 µg/kg for samples in Segment 24 is below the model predicted concentration in the Head of the Thea Foss Waterway (Figure 4-2). The highest DEHP concentrations continue to be observed in the same sampling location (sample WC-02) where the highest PAH concentrations are observed.

4.4 CONCLUSION

Sediment analytical results from the Utilities' OMMP Year 10 were compared to SQOs for metals and PAHs, and the BEL for DEHP to determine if the waterway is being protected from recontamination, or if additional controls of stormwater or other urban or marine sources may need to be evaluated. Post-remediation sediment monitoring data were compared to computer model predictions to assess changes in waterway sediment concentrations over time, and to extrapolate sediment quality trends into the future.

The 90% UCL and other key statistics for the sediment monitoring data were generated using the EPA computer program ProUCL version 5.0 (EPA 2013). All data sets were tested and shown to conform to a normal distribution using either Shapiro-Wilk or Lilliefors goodness-of-fit tests, or both. As a result, the Students-t method was used to calculate the 90% UCL, as recommended by ProUCL.

The following conclusions may be drawn from analysis of the Utilities' OMMP Year 10 data:

- No lead exceedences and only one zinc exceedence were observed in the Utilities' monitoring area during Year 10 monitoring. Average concentrations of both lead and zinc for Year 10 throughout the Utilities' work area were very similar to Year 7 concentrations, indicating that the area appears to be equilibrating with current sources at average levels well below the SQO. Therefore, lead and zinc do not appear to pose a significant risk of recontamination in the Utilities' work area.
- There were no mercury exceedences detected during Year 10 monitoring. Average mercury concentrations for Year 10 throughout the Utilities' work area were very similar to Year 7 concentrations, indicating that the area appears to be equilibrating with current sources at average levels well below the SQO. Therefore, mercury does not appear to pose a significant risk of recontamination in the Utilities' work area.
- There were no exceedences of PCBs observed in Year 10 monitoring. Average PCB concentrations for Year 10 throughout the Utilities' work area were very similar to the corresponding Year 7 concentrations, indicating that the area appears to be equilibrating with current sources at average levels well below the SQO. Therefore, Total PCBs do not appear to pose a significant risk of recontamination in the Utilities' work area.
- The average detected concentration of benzyl alcohol within the Head of the Thea Foss Waterway in Year 10 of 148 µg/kg is 2.03 times the SQO.
- Generally, the average detected waterway concentrations of HPAHs and other SVOCs have decreased in Year 10 relative to Year 7. Concentrations of LPAHs increased relative to Year 7, but remain well below the SQO.
- The average Total HPAH concentration was lower in Year 10 (8,720 µg/kg) than the concentrations measured in both Year 7 (9,433 µg/kg) and Year 5 (11,176 µg/kg) (Table 2). Only one location (WC-02) had a Total HPAHs result that exceeded the SQO in Year 10, whereas two locations exceeded the SQO in Year 7 for total HPAHs. Seven individual HPAHs exceeded their SQO at this same location, with a maximum exceedance ratio of 1.48 for fluoranthene. One LPAH, phenanthrene exceeded its SQO at this same location with an exceedance ratio of 1.2. Average results are consistent with model predictions (see Table 4-2). While there is one area with localized exceedances, there does not appear to be a significant risk of widespread PAH recontamination in the head of the waterway.
- The average detected waterway DEHP concentration within the Head of the Thea Foss

Waterway in Year 10 of 4,359 µg/kg is 3.4 times the SQO[12]. This represents a decrease from average concentrations detected during Year 7. It appears that concentrations are stabilizing at average concentrations near the expected Biological Effects Level consistent with model predictions (see Table 4-2).

The reaccumulation of phthalates in the surface sediments at the Head of the Thea Foss Waterway was not unexpected. Due to the ubiquitous nature of this contaminant in the urban environment, it is a common constituent in stormwater. Because of the pervasiveness of phthalates, and as described in previous reports, a multi-jurisdictional Sediment Phthalate Work Group was formed in 2006 to discuss and evaluate phthalates and their effect on sediments. The finalized work product from that group was delivered to the Ecology and other stakeholders in October 2007. Ecology agreed to take the lead on implementing the recommendations contained in the final work product.

The Work Group determined that because of the ubiquitousness of DEHP in modern society and urban atmospheres, it is not amenable to standard stormwater treatment approaches. They also concluded that it is very difficult to treat stormwater to remove fine particulates effectively because stormwater quality and flow are highly variable. No treatment methodologies have been identified to date which would be able to significantly remove these fine particulates. Even if effective control technologies and the space to implement them existed, the Work Group concluded that phthalates would still reaccumulate in sediments (although the rate of accumulation would likely be slower).

The City plans to continue working with EPA and Ecology, to incorporate the recommendations from the Sediment Phthalate Work Group in its decision-making process for future actions throughout the waterway as well as source control efforts in the Thea Foss Watershed.

As indicated above, WASP model predictions indicate sediment concentrations begin to level off at approximately Year 7 and are not expected to rise much higher in the future. For most constituents, sediment concentrations have remained relatively stable or even decreased between the Utilities' Year 7 and Year 10 monitoring events. Therefore, waterway sediment concentrations appear to have largely equilibrated with modern sources ten years after the completion of the remedial action. As a result, the risk of widespread recontamination is not expected to be substantially higher in the future unless there is a change in the nature, strength or distribution of waterway sources. The City will perform its Year 10 OMMP sediment monitoring event in 2016.

[12] Note that this average includes all samples in the Utilities' work area while the data reflected on Table 4-2 are only those samples which are located in Segment 24 of the model (WC-01, WC-02, WC-03, WC-04, WC-05, WC-06, WC-07, WC-08, WC-09, WC-13 and WC-14).

5.0 THEA FOSS PROGRAM EFFECTIVENESS: WATER YEARS 2001 TO 2014

In this section, program effectiveness of the Thea Foss Source Control Strategy is evaluated by linking source control activities, long-term outfall monitoring, post-construction sediment monitoring and WASP modeling (see Figure 1-1).

Long-term outfall monitoring is used to measure the effectiveness of Tacoma's SWMP and on-the-ground source control activities. Monitoring also provides information for setting priorities for future source control activities. Monitoring tools used to achieve this are temporal trend analysis and spatial trend analysis. Temporal trend analysis provides a measure of changes in the characteristics of the drainage basins over time by identifying increases or decreases of contaminant concentrations. These changes can be the result of source control activities, construction activities or other impacts in the basin that alter land use. Spatial trend analysis identifies particular municipal storm drains that may be significantly higher or lower in contaminant concentrations compared to other storm drains in the Foss Waterway Watershed and guides source control prioritization. Table 3-4 summarizes this analysis for stormwater, while Table 3-5 summarizes the analysis for SSPM. On each of these tables, the top portion provides the results for the evaluation of the 13 year data set, while the bottom portion provides the results when looking at only the more recent data. For stormwater the last two years of data are evaluated, while for SSPM the last five years are evaluated since there is only one data point for each year. Since the two or five year data sets are smaller, there is somewhat less confidence in the results, however, it does provide some indication of the current source control status and priorities.

Each subsection includes a presentation of stormwater and SSPM data. SSPM data help to provide information on extremely hydrophobic constituents such as mercury, HPAHs, DDTs and PCBs, which have a strong affinity for sediments, but are poorly soluble and often not detectable in whole-water samples. In conjunction with baseflow and stormwater data, SSPM data are used to help the City, EPA and Ecology identify areas of unusually elevated contaminants in the municipal drainages and to determine the need for focused source control work.

It should be noted that the spatial patterns observed in stormwater are not always consistent with those observed in SSPM. Discrepancies between these data sets may be caused by differential transport of pollutants in dissolved and particulate phases or how the source is introduced into the system (e.g., below ground leak, illicit connection, contact with stormwater).

Post-construction surface sediment data from the waterway is used as another tool to evaluate the effectiveness of existing source controls in the Foss Waterway Watershed, whether additional source controls and BMPs for municipal stormwater discharges or other sources are necessary and appropriate, and if so, where and how they might best be implemented. As discussed in Section 4.0, no lead or mercury and only one zinc exceedence were observed in the sediments during Year 10 monitoring in the head of the waterway. There were also no Total PCB exceedences. A few isolated, low level exceedences of PAHs were observed at some locations in the waterway during the Utilities' Year 10 monitoring. In addition and as expected, DEHP was detected at average levels near the expected biological effects level throughout the head of the waterway. However, when compared to model predictions, data indicates that the sediment chemical concentrations are equilibrating with current sources and it does not appear that widespread recontamination of the waterway sediments is occurring, or that it will occur in the future (see Figure 4-2).

Although the recommendations presented in this section are intended specifically for municipal outfalls and activities within their respective drainage basins, stormwater discharges must also be evaluated in the context of other source loads to the waterway. It is anticipated that chemical loads from other sources will be appropriately monitored and managed under other federal, state, and local regulatory programs.

5.1 OUTFALL 230

Many activities have occurred in the OF230 drainage basin, some of which may have contributed to improvements in the quality of baseflow, stormwater and SSPM. TSS, PAHs and DEHP show a marked improvement along with other contaminants that have source(s) linked to water quality concentrations. Figure 5-1.1 shows the annual average concentration for stormwater, baseflow and SSPM.

This section provides a summary of water/sediment quality results within the OF230 drainage basin and compares the water/sediment data results with the major source control and other activities that have occurred within the basin. A more detailed description of source control activities is provided in Appendix A.

5.1.1 Water and SSPM Quality

Annual and seasonal data for stormwater and SSPM for the COCs and other parameters is used to identify ongoing areas of concern. The following paragraphs summarize the WY2001-WY2014 monitoring results for OF230, where COCs in this outfall are different from other Foss drainage basins, and where subsequent source control activities may be focused.

5.1.1.a TSS and Metals

Stormwater. TSS concentrations in OF230 stormwater were some of the lowest mean and median observed in all the drainages (see Table 3-3 and Figures F-1 and F-11). Stormwater TSS concentrations in OF230 (-4) during the 13 year monitoring period are well below average (see Table 3-4). As shown in Figure 3-6.1 and Table 3-6, TSS has shown a statistically significant improvement in stormwater quality from 2001 to present. The best-fit regression equations result in an estimated 70% reduction in TSS concentrations in OF230 in the 13 year monitoring period.

As shown in Figure G-2a, G-3a, G-12a, and G-13a, lead and zinc concentrations in stormwater have remained fairly consistent over the last 13 years, decreasing somewhat in the last three to four years. Stormwater quality in OF230 for the 13 year data set is slightly elevated in lead (+1) and slightly lower (-1) for zinc as compared to the other outfalls (see Table 3-4). When only the last two years of monitoring data are evaluated, zinc is slightly higher than other outfalls (+1) and lead is slightly lower (-1).

SSPM. Storm sediment in OF230 is slightly to moderately elevated in lead, mercury, and zinc (+2, +3 and +1, respectively) as compared to the other outfalls when looking at the 13 year monitoring record (see Table 3-5 and Figure F-21 through F-23 and F-33 through F-35). When looking at only the last five years of data, SSPM quality in OF230 is generally equivalent to the other basins (0, +1, and 0).

In WY2014, mercury concentrations at FD3A decreased from medium levels to low levels. Mercury at FD18 and FD18B stayed within the same range between WY2013 and WY2014, with low levels at FD18 and medium levels at FD18B. The highest

WY2014 SSPM concentration for mercury in the watershed was found in the OF230 drainage basin at upline sediment trap location FD18B (0.34) (see Figure 2-1.1 and Table D-8).

As shown in Figures 2-1.1 and 5-2.1, mercury concentrations at all of these locations generally decreased somewhat from WY2004 to WY2009 which is believed to be a result of the storm line cleaning project and removal of a point source (see Section 5.1.2 below). Due to increasing or variable contamination levels in recent years (after point source removal and storm line cleaning), a source or sources of mercury are likely still present and is part of an ongoing investigation.

5.1.1.b PAHs

Stormwater. OF230 had similar levels of phenanthrene, pyrene, and indeno(1,2,3-c,d)pyrene in stormwater as compared to other outfalls (+1, -1 and +1) when looking at the 13 year monitoring record (see Table 3-4 and boxplots in Appendix F). When looking at the most recent two year monitoring record, pyrene is slightly better quality (-1) than other outfalls and phenanthrene and indeno(1,2,3-c,d)pyrene are of similar quality (0).

Most PAH concentrations in stormwater appear to have decreased in the last seven years (see Figure 5-1.1 and figures in Appendix G). OF230 stormwater showed weak evidence of seasonality (see boxplots in Appendix H). As shown in Table 3-6 and Figures 3-6.4, 3-6.5, and 3-6.6, PAHs (phenanthrene, pyrene and indeno(1,2,3-cd)pyrene) show a statistically significant improvement in stormwater quality from 2001 to present. The best-fit regression equations result in an estimated 95-98% reduction in PAHs in OF230 in the 13 year monitoring period (see Table 3-6). In particular, there is a consistent decrease from WY2007 (Year 6) to WY2014 (Year 13) (see Figure 5-1.1 and boxplots in Appendix G) that occurred following cleaning of the storm lines (see Section 5.1.2).

SSPM. SSPM quality in OF230 is slightly enriched in indeno(1,2,3-cd)pyrene (+2), phenanthrene (+1) and pyrene (+1) when looking at the 13 year monitoring period (see Table 3-5 and boxplots in Appendix F). When looking at just the last two years, all three indicator PAHs are slightly enriched (+1) relative to other outfalls. As shown in Figure 5-1.1, SSPM PAH concentrations increased slightly between WY2005 to WY2007. Since WY2007, PAH concentrations have remained fairly consistent. The data indicates there is a possible ongoing source(s) of PAHs in Basin 230 that is present in the stormwater sediments, but isn’t seen in stormwater concentrations.

As shown in Figure 5-2.1, FD3B and FD16B PAH concentrations have generally decreased over the last 13 years. There was a slight increase at FD3B in WY2012 and WY2013, however, concentrations decreased again in WY2014. All other OF230 sub-basins appear to have remained relatively consistent over the last 13 years. Overall, PAH concentrations are considered to be relatively low level (see Figure 2-1.2) and are therefore a lower priority for source control.

5.1.1.c Phthalates

Stormwater. The second highest mean, median, and maximum concentrations of DEHP in stormwater were observed in OF230 (4.08, 2.45, and 44.1 µg/L, respectively) (see Table 3-3 and Figures F-8 and F-18). Unusually high peak concentrations of DEHP were observed in Year 7 (WY2008) in OF230, but these appear to be isolated occurrences (see Figures G-8a and G-18a). OF230 contains moderately elevated DEHP concentrations (+4) in stormwater when reviewing the 13 year monitoring record (see Table 3-4). Elevated concentrations of DEHP in OF230 are only slightly evident (+1) when only the last two years of monitoring data is evaluated.

As shown in Table 3-6 and Figure 3-6.7, DEHP shows a statistically significant improvement in stormwater quality from 2001 to present. The best-fit regression equations result in an estimated 84% reduction in DEHP in OF230 in the 13 year period. In particular, there is a consistent decrease in phthalate concentrations from WY2008 to WY2014 (see Figures 5-1.1, G-8a and G-18a) that occurred following cleaning of the storm lines (see Section 5.1.2).

OF230 also showed weak evidence of seasonality in stormwater for DEHP (see boxplots in Appendix H). DEHP shows qualitative evidence of higher dry season concentrations.

SSPM. OF230 SSPM quality is slightly enriched (+1) in DEHP and total phthalates when looking at the entire 13 year monitoring record (see Table 3-5 and Figures F-29 and F-41). Within OF230, some of the highest concentrations of total phthalates were found in FD3A (max of 161,500 µg/kg in WY2004), in FD3B (max of 130,590 µg/kg in WY2005), FD16 (max of 161,860 µg/kg in WY2010), and in FD18 (max of 100,520 µg/kg in WY2004) (see Figures 2-1.3 and 5-2.1). Concentrations have generally been much lower in more recent years, although intermittent medium level concentrations have been noted in FD18 and FD18B. There may be a source or sources of phthalates at these locations within OF230, although concentrations are at relatively low levels. This area is currently the subject of ongoing source control investigation.

5.1.1.d Pesticides

Stormwater. Pesticides are not a COC tested for under the 2001 SAP.

SSPM. The highest concentrations of DDT in SSPM samples were found in OF230 early in the monitoring program (see Figures F-25 and F-37). However, no statistically significant differences in DDT concentrations were observed among outfalls for the 13 year record (see Table 3-5). DDT was found at 220 and 260 µg/kg at FD3A (WY2002 and WY2003, OF 230), and at 140 µg/kg (FD34) and 270 µg/kg (FD35), both in 2005. All of these detections were at least five times greater than the other SSPM samples at these locations (see Appendix D, Tables D-15 and D-16 from WY2012 Report (Tacoma 2013). DDT was not detected anywhere in the Foss drainage basin from WY2007 to WY2014 with the exception of one detection in FD10C in WY2008 at 50 µg/kg and one detection at 14 µg/kg in FD16 in WY2013. Due to the infrequency of detection, the agencies authorized elimination of pesticides from the analyte list in July 2014 and they are no longer analyzed in the SSPM monitoring program

5.1.1.e PCBs

Stormwater. PCBs are not a COC tested for under the 2001 SAP.

SSPM. Some of the highest concentrations in SSPM PCBs have been found in OF230 (see Figures F-31 and F-43 and Figure 2-1.4). FD3A and FD3-New had highest concentrations during W2014 monitoring. WY2014 concentrations at FD3A were lower than they had been in WY2013 while concentrations at FD3-New went from low level to high level between WY2013 and WY2014. Concentrations at FD18 decreased from high levels to moderate levels between WY2013 and WY2014. No statistically significant differences in quality were observed in SSPM between outfall samples when reviewing both the entire 13 year monitoring record and only the last five years of data (see Table 3-5).

As shown on Figure 2-1.4, PCBs concentrations at FD3A, FD3 New, FD18, and FD16 were intermittently at high levels before the 2007 cleaning project and were at low levels immediately following the cleaning (also see Figure 5-2.1 and Section 5.1.2). However, PCBs concentrations at all of these locations have been fluctuating between low, medium, and high levels since pipe cleaning, with high levels detected in some since WY2012. This suggests that there may be an ongoing source of PCBs in OF230, and was the impetus for the source control investigation that is currently underway in this area.

5.1.2 Source Control Program Activities

Mercury Source Tracing Investigation. In 2006, during initial source investigation activities, a source of mercury was found near S. 11th Street and Yakima Avenue in a private parking area by Bates Technical College. Mercury laden sediment was removed from this private catch basin and post cleaning samples confirmed that the mercury source was removed. Also as a result of this investigation, a 75-100 year old deteriorated pipe from 15th to 13th Streets along Court A was abandoned and filled with CDF in the summer of 2007, and the stormwater was redirected to a new pipe on A Street.

Due to the likely presence of a remaining source or sources in this drainage basin, specifically the FD18 and FD3A areas, a source tracing investigation was launched in 2012 and continued through 2013 to further investigate potential sources of mercury in this area. The investigation generally began with analysis of composite samples representing different segments of the drainage area for each of the sediment trap locations. The intent of this work initially was to attempt to isolate specific problem spots within the drainage area. As branches with higher concentrations of contaminants in composite samples were identified, subsequent phases of the investigation were performed to further isolate potential source areas. Individual catch basin and product samples were taken in the branches with higher concentrations. Subsequently, building inspections were completed in the areas with the highest catch basin and product samples.

Results from the mercury investigation and business inspections of the surrounding area indicate that the source of mercury is likely attributed to the presence of contaminated sediments in the sidewalk roof drains draining to a catch basin at the corner of South 12th and Court A in downtown Tacoma. While the specific source of the contamination was not identified during the investigation, the cleaning of the system and subsequent re-sampling of the drainage system will determine whether this was an isolated historic spill event or whether an ongoing source of mercury remains that must be controlled.

Several other areas with lower levels of mercury contamination were also identified through this investigation. These areas were initially assigned lower priority ratings since contaminant levels were lower. The City will continue to investigate these remaining priority areas in 2014 and will also continue to work with the regulatory agencies and businesses to eliminate the sources of PCBs and mercury in the stormwater drainage system.

A copy of the source tracing report is included in Appendix A.

PCBs Source Tracing Investigation. Since the inception of the sediment trap monitoring program, intermittently high levels of PCBs have been identified in some of the OF230 sediment traps (see Figure 2-1.4), but source control investigations were unable to identify a source. Because of the likely presence of a remaining intermittent source, a source tracing investigation was launched in 2012 in conjunction with the mercury source tracing work described above, to further investigate potential sources of PCBs in this drainage basin. In 2013, the investigation indicated that elevated levels of PCBs are present in the caulking materials from two properties (the Wells Fargo and Sound Physicians properties located in the vicinity of South 12th and South 13th Streets, between Pacific Avenue and Court A in downtown Tacoma). It is likely that these materials are the source of PCB contamination found in the nearby catch basins in the targeted drainage areas. The business owners and the regulatory agencies were notified of the PCB discovery and were provided a copy of the sampling results. The City is currently working with the regulatory agencies and the property management companies at the two facilities to address this PCB discovery and is also coordinating efforts to keep contaminants out of the municipal stormwater collection system.

Several other areas with lower levels of PCB were also identified through the initial investigation. These areas were initially assigned lower priority ratings since contaminant levels were lower. The City continued to investigate these remaining priority areas through business inspections in 2014 and will continue to work with the regulatory agencies and businesses to eliminate the sources of PCBs and mercury in the stormwater drainage system.

A copy of the OF230 2013 PCB and Mercury Source Tracing Investigation report was included in the WY2013 report. An addendum to that report is included in Attachment A.2.

Storm System Cleaning. In 2007, the municipal storm system in OF230 was cleaned and video inspected. The objective of this project was to remove residual sediments in the storm drains that may contain legacy contaminants. As discussed in detail in the WY2011 report (Tacoma 2012), storm system cleaning contributed to significant reductions in stormwater concentrations. Sewer line cleaning is an important component of the City's source control program. In combination with other source control activities, it appears to have been effective at removing all seven of the compounds tested. Over time as sediments re-accumulate in the pipes, the systems will need to be cleaned again. The City is currently monitoring the results as shown in Figures 5-1.1 to 5-1.7 to determine the appropriate maintenance schedule for pipe cleaning projects.

Statistically significant reductions were evident for TSS, lead, zinc, PAHs and DEHP (see Table 2-4). Line cleaning, along with other source control activities, resulted in reductions of TSS at 33%, lead at 33%, zinc at 13%, DEHP at 48% and PAHs (phenanthrene, pyrene and indeno(1,2,3-cd)pyrene) at 79-83%.

Enhanced Street Sweeping Program. In January 2007, the City's street sweeping program was enhanced in an attempt to reduce sediment buildup in the storm sewer system. Under the enhanced program, the sweeping frequency was increased, air regenerative sweepers replaced mechanical sweepers, and the City also increased communications with residents, which helped raise awareness of the importance of the street sweeping program.

Statistically significant reductions were evident for TSS, lead, zinc, PAHs and DEHP (see Table 2-5). Street sweeping, along with other source control activities, resulted in reductions of TSS at 36%, lead at 35%, zinc at 16%, DEHP at 47% and PAH (phenanthrene, pyrene, and indeno(1,2,3-cd)pyrene) at 75-80%. PAHs in Figure 5-1.1 show a consistent decrease from

WY2007 to WY2014 that occurred following the start of street sweeping and the cleaning of the storm lines.

Stormwater Pipe Retrofit Projects. In 2010, 13,500 linear feet of existing storm sewer main was structurally rehabilitated in the OF230 drainage basin. In 2013, an additional 13,807 linear feet of existing storm sewer main was structurally rehabilitated in the OF230 drainage basin. The rehabilitation was accomplished by means of Cured-In-Place Pipe (CIPP) construction technologies using resin impregnated liners which fixed defects (cracks, holes, etc.) in the pipe that could have allowed potentially contaminated groundwater and soil from historic “hot spots” to enter the storm sewer system.

The pre-construction and post-construction monitoring data for the 2010 lining[13] were reviewed and statistically significant reductions in OF230 were evident for TSS, lead, zinc, PAHs and DEHP (see Table 2-6). CIPP lining, along with other source control activities, resulted in reductions of TSS at 58%, lead at 64%, zinc at 16%, DEHP at 79% and PAH (phenanthrene, pyrene, and indeno(1,2,3-cd)pyrene) at 87-92%.

General Source Control Activities. In addition to the ongoing investigation and maintenance activities described above, the City has, and is continuing to implement other source control program elements in the OF230 drainage basin which are described in more detail in Appendix A. Several other source control actions have been completed or are currently underway in this basin, including the Sauro’s Cleanerama Site Remediation and the removal of UST/LUSTs at various locations. In addition, the City issued warning letters to three businesses for discharging materials to the storm drainage system or failing to provide adequate BMPs. One of these companies was also issued a Notice of Violation for failure to implement appropriate BMPs.

The Pacific Avenue Streetscape Project which began in late 2012 was completed in early 2014 and provides additional stormwater treatment via rain gardens. Construction of the A St regional treatment system began in June 2014 and was completed in January 2015. This project includes replacement of approximately 1,100 feet of pipe and construction of an underground treatment vault with Baysaver treatment units sized to treat the water quality design storm for the 34-acre tributary area.

5.1.3 Outfall 230 2015 Work Plan

As shown in Table 3-6 and Figures 3-6.1 to 3-6.7, TSS, lead, zinc, PAHs (phenanthrene, pyrene, and indeno(1,2,3-c,d)pyrene) and DEHP all show a statistically significant improvement in OF230 stormwater quality from 2001 to present with an estimated 70% reduction for TSS, 74% for total lead, 33% for total zinc, 95-98% reduction for each of the three index PAHs (phenanthrene, pyrene, and indeno(1,2,3-cd)pyrene), and 84% for DEHP in the 13 year period (see Table 3-6).

As described in detail above, OF230 monitoring results generally show:

- Stormwater – Moderately lower TSS (-4), but moderately higher DEHP (+4) concentrations compared to other outfalls when evaluating the 13 year monitoring record (see Table 3-4).

---

[13] The impact of the 2013 lining project will be reviewed in future years once additional data becomes available.

- SSPM – Outfall results show moderately higher mercury (+3) compared to other sediment trap locations (see Table 3-5) when evaluating the entire 13 year monitoring record. Upline sediment traps show possible areas of concern for mercury, phthalates and PCBs.

Therefore, the following recommendations are included in the 2015 Work Plan for OF230:

- Continue source tracing investigation and track private property cleanups in area draining to FD3A and FD18 for mercury and PCBs, with PAHs and phthalates analyzed as well.
- Evaluate possible sources of PCBs to FD16.

5.2 OUTFALL 235

Many activities have occurred in the OF235 drainage basin during the monitoring period, some of which are contributing to improvements in stormwater and SSPM quality. Statistically significant improvements in all index COCs (TSS, lead, zinc, PAHs and DEHP) have been observed in stormwater in OF235 (Table 3-6). It is, therefore, likely that the City's source control efforts have helped to reduce these constituents in OF235. Figure 5-1.2 shows the annual average concentrations for stormwater, baseflow and SSPM.

This section provides a summary of water/sediment quality results within the OF235 drainage basin and compares the water/sediment data results with the major source control and other activities that have occurred within the basin. A more detailed description of source control activities is provided in Appendix A.

5.2.1 Water and SSPM Quality

Annual and seasonal data for stormwater and SSPM for the COCs and other parameters is used to identify ongoing areas of concern. The following paragraphs summarize the WY2001-WY2014 monitoring results for OF235, where COCs in this outfall are different from other Foss drainage basins, and where subsequent source control activities may be focused.

5.2.1.a TSS and Metals

Stormwater. Comparatively higher TSS concentrations have been observed in stormwater from OF235 with maximum, mean and median TSS concentrations of 441 mg/L, 72.3 mg/L and 53.7 mg/L, respectively (Table 3-3). The highest maximum TSS concentration (441 mg/L) during the monitoring program was observed at OF235 in WY2001 (see Table 3-3 and Figures F-1 and F-11).

TSS in OF235 is slightly above average (+1) compared to other outfalls when looking at the entire 13 year monitoring record in the Foss Watershed (see Table 3-4). As shown in Table 3-6 and Figure 3-6.1, TSS shows a statistically significant improvement in stormwater quality from 2001 to present with an estimated 67% reduction of TSS in 13 years. The trend is gradual over time and does not lend itself to be a direct result of any one action. Figures 5-1.2, G-1a and G-11a also show the gradual downward trend of TSS over the last 13 years.

Comparatively higher mean, median and maximum lead concentrations were observed in OF235 stormwater. OF235 is significantly elevated in lead (+6) and moderately elevated in zinc (+3) when compared to all other outfalls when looking at the 13 year monitoring record (see Table 3-4). When only the last two years of monitoring data is evaluated, lead is still significantly elevated (+6) in OF235, but zinc is only slightly elevated (+1).

Total lead and zinc in OF235 showed occasional evidence of seasonality (i.e., higher median, mean, and/or peak concentrations during dry season months) (see boxplots in Appendix H). This may be caused by more isolated storms and longer antecedent dry periods between storms.

As shown in Table 3-6 and Figure 3-6.2 and 3-6.3, lead and zinc show a statistically significant improvement in stormwater quality from 2001 to present with an estimated 66% and 48% reduction respectively in 13 years. The trend is gradual over time and does not lend itself to be a direct result of any one action. Figure 5-1.2 and the boxplots in Appendix G also show the gradual trends of lead and zinc over the last 13 years. It is, therefore, possible that the City's source control efforts have helped to reduce lead and zinc in OF235. However, the relatively higher stormwater concentrations indicate that there may be a source(s) of lead in OF235 since levels are greater than those found throughout the Foss Waterway Watershed and a source control investigation is currently underway. Lead and zinc are not COCs in the Thea Foss Waterway and therefore this source control investigation is not a high priority.

SSPM. Consistent with stormwater results, total lead in SSPM is slightly elevated in OF235 (+2) during the last 13 years (see Table 3-5). When looking at only the last five years, there is no significant difference in lead concentrations between OF235 and the other outfalls. Results for all other constituents are the same or slightly better than other outfalls. Mercury and zinc were slightly lower (-1) in OF235 when looking at the entire 13 year monitoring period, but there is no significant difference when looking at only the last five years.

5.2.1.b PAHs

Stormwater. OF235 stormwater contained the highest mean and maximum concentrations of the very light end compounds naphthalene and 2-methylnaphthalene and the highest maximum concentration of total LPAHs (see Table 3-3). ANOVA results show that OF235 is slightly above average for PAHs (phenanthrene, pyrene, and indeno(1,2,3-cd)pyrene at +1, +2 and +1) when looking at the entire 13 year monitoring record (see Table 3-4 and boxplots in Appendix F). As shown in Figure 5-1.2 and in the boxplots in Appendix G, LPAH and HPAH concentrations in stormwater have generally decreased from 2007 to present. These decreases are believed to be due in large part to the storm line cleaning project (see Section 5.2.2). When only the last two years of monitoring data are evaluated, there are no significant differences in concentrations of phenanthrene and indeno(1,2,3-c,d)pyrene while pyrene is slightly elevated (+2) compared to other outfalls.

As shown in Table 3-6 and Figures 3-6.4, 3-6.5, and 3-6.6, PAHs (phenanthrene, pyrene and indeno(1,2,3-cd)pyrene) show a statistically significant improvement in stormwater quality from 2001 to present. The best-fit regression equations result in an estimated 95-97% reduction in PAHs in OF235 in the 13 year monitoring period (see Table 3-6).

SSPM. Average PAH concentrations are relatively neutral (-1 to 0) for SSPM at OF235 compared to the other outfalls during both the 13 year monitoring period and the last five years. As shown in Figure 2-1.2, PAH concentrations in storm sediment are considered low level and are similar to other outfall and upland locations. In fact, LPAH and HPAH concentrations in storm sediment have remained fairly consistent over the last 13 years (see Figure 5-1.2).

5.2.1.c Phthalates

Stormwater. The highest mean, median and maximum stormwater concentrations of DEHP were observed in OF235 (5.36, 2.70 and 97 µg/L, respectively). Unusually high peak concentrations of DEHP were observed in WY2003 (Year 2) in OF235, but these appear to be isolated occurrences (October 2002 and December 2002) and are not evident in recent years (see Table 3-3, Figure 5-1.2 and boxplots in Appendices F and G). The cause of the outliers during WY2003 is unknown.

DEHP is usually the phthalate compound with most frequent detections and the highest median concentrations. However, a higher maximum concentration of diethylphthalate was detected in OF235 stormwater (590 µg/L) in 2002. OF235 (+5) contains elevated DEHP concentrations, higher than all other outfalls (see Table 3-4). When only the last two years of monitoring data are evaluated, DEHP concentrations in OF235 are only slightly elevated (+2) compared to all other outfalls.

As shown in Table 3-6 and Figure 3-6.7, DEHP shows a statistically significant improvement in stormwater quality from 2001 to present. The best-fit regression equations result in an estimated 90% reduction in DEHP in OF235 in the 13 year monitoring period. In particular, there is a consistent decrease in phthalate concentrations from the highest concentrations in WY2005 (Year 4) to WY2014 (Year 13) (see Figures 5-1.2, G-8a and G-18a) which is believed to be due to the storm line cleaning project and other source control activities (see Section 5.2.2).

SSPM. Even though DEHP in OF235 was significantly elevated in stormwater (+5), in storm sediment, the average concentration is neutral (0) compared to the other outfalls in the 13 year monitoring period (see Table 3-5 and Figures F-29 and F-41). There are not significant differences of DEHP in any of the outfalls when looking at only the last five years. As shown in Figure 2-1.3, phthalate concentrations are at low levels in OF235 and are similar to other outfall and upland locations. In fact, phthalate concentrations in storm sediment have remained fairly consistent over the last 13 years (see Figure 5-1.2). Discrepancies between the stormwater and storm sediment data sets may be caused by differential transport of pollutants in dissolved and particulate phases. Source control investigations will look at sources that lend themselves to transport in dissolved phases.

5.2.1.d Pesticides

Stormwater. Pesticides are not a COC tested for under the 2001 SAP.

SSPM. No statistically significant differences in quality were observed in SSPM in DDT between outfall samples when reviewing either the entire 13 year monitoring record and only the last five years of data (see Table 3-5).

5.2.1.e PCBs

Stormwater. PCBs are not a COC tested for under the 2001 SAP.

SSPM. No statistically significant differences in quality were observed in SSPM between outfall samples when reviewing either the entire 13 year monitoring record and only the last five years of data (see Table 3-5).

5.2.2 Source Control Program Activities

Storm System Cleaning. In 2007, the municipal storm system in OF235 was cleaned and video inspected. The objective of this project was to remove residual sediments in the storm drains that may contain legacy contaminants. As discussed in detail in the WY2011 report (Tacoma 2012) storm system cleaning contributed to significant reductions in stormwater concentrations. Sewer line cleaning is an important component of the City's source control program. In combination with other source control activities, it appears to have been effective at removing all seven of the compounds tested. Over time as sediments re-accumulate in the pipes, the systems will need to be cleaned again. The City is currently monitoring the results as shown in Figures 5-1.1 to 5-1.7 to determine the appropriate maintenance schedule for pipe cleaning projects.

Statistically significant reductions were evident for TSS, lead, zinc, PAHs and DEHP (see Table 2-4). Line cleaning, along with other source control activities, resulted in reductions of TSS at 48%, lead at 44%, zinc at 33%, DEHP at 72% and PAHs (phenanthrene, pyrene and indeno(1,2,3-cd)pyrene) at 74-77%.

Enhanced Street Sweeping Program. In January 2007, the City's street sweeping program was enhanced in an attempt to reduce sediment buildup in the storm sewer system. Under the enhanced program, the sweeping frequency was increased, air regenerative sweepers replaced mechanical sweepers, and the City also increased communications with residents, which helped raise awareness of the importance of the street sweeping program.

Statistically significant reductions were evident for TSS, lead, zinc, PAHs and DEHP (see Table 2-5). Street sweeping, along with other source control activities, resulted in reductions of TSS at 49%, lead at 46%, zinc at 34%, DEHP at 73% and PAH (phenanthrene, pyrene, and indeno(1,2,3-cd)pyrene) at 69-71%.

2013 Stormwater Pipe Retrofit Project. In 2013, 5,479 linear feet of existing storm sewer main was structurally rehabilitated in the OF235 drainage basin. The rehabilitation was accomplished by means of Cured-In-Place Pipe (CIPP) construction technologies using resin impregnated liners which fixed defects (cracks, holes, etc.) in the pipe that could have allowed potentially contaminated groundwater and soil from historic "hot spots" to enter the storm sewer system. Since the lining was completed in WY2013, there is no post-construction monitoring data available to do a pre- and post-construction comparison. This comparison will be performed in future water years once sufficient post-construction data is available.

General Source Control Activities. In addition to the ongoing maintenance activities described above, the City is continuing to implement other source control program elements in the OF235 drainage basin which are summarized here and described in more detail in Appendix A. In addition, the Hood Street Treatment Retrofit project was completed in September 2014. This modified bioretention facility is now online and provides regional treatment for stormwater runoff discharged from 42 acres of the FS06 drainage basin in Tacoma's downtown area.

5.2.3 Outfall 235 2015 Work Plan

TSS, lead, zinc, DEHP, and PAHs have all shown a statistically significant improvement in stormwater quality from 2001 to present (see Table 3-6 and Figures 3-6.1 to 3-6.7). As shown in Table 3-6, TSS shows an estimated 67% reduction over 13 years, lead at 66%, zinc at 48%, DEHP at 90% and PAHS (both light and heavy PAH fractions) at 95-97% reductions.

As described in detail above, OF235 results generally show:

- Stormwater – Moderately higher zinc (+3) and significantly higher lead (+6) and DEHP (+5) as compared to other outfalls when evaluating the 13 year monitoring record (see Table 3-4). When looking at only the last two years of data, pyrene and DEHP are slightly elevated (both at +2), and lead remains significantly elevated (+6).

- SSPM – Slightly higher lead (+2) compared to other sediment trap locations when evaluating the entire 13 year monitoring record but no discernable differences in SSPM quality at OF235 when looking at only the last five years (see Table 3-5).

Therefore, the following recommendations are included in the 2015 Work Plan for the OF235 drainage basin:

- Continue to investigate sources of lead, PAHs and phthalates in stormwater in the area draining to FD6A and evaluate the effect of the Hood Street treatment device as data become available.
- Continue to monitor the major construction activities in the drainage basin.

5.3 OUTFALL 237A

Many source control efforts have been targeted in the OF237A drainage basin and have resulted in improvements in stormwater and SSPM quality. TSS, Lead, zinc, PAHs and DEHP concentrations have all shown a statistically significant improvement in stormwater quality from 2001 to present with an estimated 41% reduction in TSS concentrations, 46% reduction in lead concentrations, 39% reduction in zinc concentrations, 95-97% reduction in PAHs concentrations, and 80% reduction in DEHP concentrations in the 13 years monitoring period. The statistically significant trends for TSS and lead were new this year. Statistically significant trends for TSS and lead had previously been observed in Year 10, but were not observed in Year 11 (WY2012) or Year 12 (WY2013). This was likely due to the updated data set used for statistical analysis that combined the historical OF237A data with the more recent OF237A New data (Tacoma 2013).

This section provides a summary of water/sediment quality results within the OF237A drainage basin and compares the water/sediment data results with the major source control and other activities that have occurred within the basin. A more detailed description of source control activities is provided in Appendix A.

5.3.1 Water and SSPM Quality

Annual and seasonal data for baseflow, stormwater and SSPM for the COCs and other parameters is used to identify ongoing areas of concern. The following paragraphs summarize the WY2001-WY2014 monitoring results for OF237A, where COCs in this outfall are different from other Foss drainage basins, and where subsequent source control activities may be focused. As described in Section 3.2.4 of the WY2012 report (Tacoma 2013), the OF237A (for data prior to February 26, 2006) and OF237A New data sets (for data after February 26, 2006) were merged in 2012. While the data sets are generally the same, the box plots in Appendix G appear to show a change in the data in between WY2006 (Year 5) and WY2007 (Year 6). This suggests that there are small differences in the two sampling locations.

5.3.1.a TSS and Metals

Stormwater. Stormwater TSS, lead and zinc concentrations at OF237A (-2, -4 and -2, respectively) are slightly to moderately below average in the 13 year monitoring period (see Table 3-4). Concentrations are more neutral when looking at only the last two years of data (-1, -1 and +1, respectively). In stormwater, OF237A had the second lowest mean and median TSS concentrations. As shown in Figure 3-6.3 and Table 3-6, TSS, lead zinc have all shown improvement, with TSS showing a 41% reduction, lead showing a 46% reduction, and zinc showing a 39% reduction in stormwater quality from 2001 to present.

SSPM. OF237A exhibits lower concentrations of lead and mercury in SSPM compared to the smaller drains OF230, OF 235 and OF243, and is lower for zinc in these same outfalls as well as OF245, (see boxplots in Appendix F). ANOVA statistical tests on SSPM showed that OF237A is relatively neutral (-1 to -2) in metals (lead, mercury, and zinc) compared to other outfalls for the 13 year monitoring record (see Table 3-5). When looking at only the last five years of monitoring data, no statistically significant differences were observed for lead or mercury in comparison to other outfalls while zinc was slightly lower in concentration (-1).

5.3.1.b PAHs

Stormwater. OF237A stormwater quality shows some evidence of being somewhat enriched in HPAHs with higher max and mean concentrations of several HPAHs observed (see Table 3-3 and boxplots in Appendix F) compared to other drains although the max concentrations occurred in 2007. PAH concentrations over the last six years (Years 8 through 13) relatively low compared to the previous monitoring years (see boxplots in Appendix G).

ANOVA results showed that OF237A is slightly above average for the HPAHs pyrene (+2) and indeno(1,2,3-c,d)pyrene (+1) relative to other drainages over the 13 year monitoring record (see Table 3-4), while it was neutral for the LPAH phenanthrene (0). When looking at the most recent two year monitoring record, OF237A is neutral to slightly elevated (0) for the HPAHs pyrene (+1) and indeno(1,2,3-c,d)pyrene (0), and is also neutral for the LPAH phenanthrene (0).

As shown in Table 3-6 and Figures 3-6.4, 3-6.5, and 3-6.6, PAHs (phenanthrene, pyrene, and indeno[1,2,3-cd]pyrene) show a statistically significant improvement in stormwater quality from 2001 to present. There is an estimated 95-97% reduction in 13 years. This is likely due to a combination of actions including the point source removals and sewer line cleaning projects. Boxplots in Appendix G also show the gradual decreasing trends of PAHs in stormwater.

SSPM. As shown in Table 3-5, storm sediment in OF237A is slightly enriched in PAHs with phenanthrene, indeno(1,2,3-c,d)pyrene and pyrene all at +1 during the 13 year monitoring period. PAHs in SSPM have remained fairly stable over the last 13 years (see Figure 5-1.3) with the exception of WY2009 which had slightly lower concentrations. Figure 2-1.2 shows that PAH concentrations at FD13B remained elevated at medium levels in WY2011, but dropped to low levels in WY2012 and have remained there since that time. Because the FD13B sediment trap has been submerged since construction of the stormwater treatment vault in this area, a new sediment trap (FD13B New) was placed in a location one manhole upstream from the FD13B trap, and the new trap is not affected by the backwater from the treatment vault. In WY2013, this new trap showed medium levels of PAHs and concentrations remained in that range in WY2014. In WY2014, all other sediment traps in OF237A were at low levels (see Figure 2-1.2).

5.3.1.c Phthalates

Stormwater. As shown in Table 3-6 and Figure 3-6.7, DEHP shows a statistically significant improvement in stormwater quality from 2001 to present. There is an estimated 80% reduction in 13 years (see Table 3-6). The trend is gradual over time and does not lend itself to be a direct result of any one action (see boxplots in Appendix G and Figure 5-1.3).

In comparison to other outfalls, DEHP in OF237A is of slightly better quality (-2 and 0 respectively) over the entire 13 year monitoring record and the last two year data set (see Table 3-4).

SSPM. DEHP concentrations in OF237A are of similar quality (0) as other outfalls when looking at the 13 year monitoring record, and no significant differences were discernable between any outfalls when looking at the last five years of monitoring data (see Table 3-5).

At location FD10C, total phthalate concentrations decreased to low levels in WY2013 after being medium range for the previous ten years (see Figure 2-1.3 and 5-2.3). Concentrations remained in the low range in WY2014. This location will continue to be watched in future years to determine if source control actions are needed. FD13B increased from low to medium levels in WY2013, but returned to low levels in WY2014. All other sediment trap locations had low level concentrations in WY2014.

5.3.1.d Pesticides

Stormwater. Pesticides are not a COC tested for under the 2001 SAP.

SSPM. No statistically significant differences in quality were observed in SSPM in DDT between outfall samples when reviewing both the entire 13 year monitoring record or only the last five years of data (see Table 3-5).

5.3.1.e PCBs

Stormwater. PCBs are not a COC tested for under the 2001 SAP.

SSPM. No statistically significant differences in quality were observed in SSPM between outfall samples when reviewing both the entire 13 year monitoring record or only the last five years of data (see Table 3-5).

In WY2006, PCBs concentrations in the OF237A drainage basin were the highest measured at all locations, ranging from 177 to 390 µg/kg (see Figure 5-2.3). Since WY2006 and after the pipe cleaning in 2007, PCB concentrations in SSPM decreased in concentration. In WY2013, however, PCB concentrations increased to medium levels for FD10 and FD10C (see Figure 2-1.4). In WY2014, concentrations at FD10 were back at low levels while concentrations at FD10C remained at medium levels. This area was recently cleaned and will be watched in future years to determine if there is an active source.

5.3.2 Source Control Program Activities

Point Source Removal. In 2002, Washington State Department of Transportation (WSDOT) removed and sealed the DA-1 Line French drain system that was believed to be a source of PAHs from historical coal tar deposits on the Standard Chemical Site (South 23rd and "A" Streets) (OF237A FD2A branch). In response to this action, PAH concentrations in baseflow decreased in WY2003 and WY2004 (see Figure 5-1.3).

In 2007, Key Bank completed a cleanup of a diesel tank that had leaked into surrounding soils and the storm sewer system from a back-up generator's return fuel line. This is in the sub-basin draining to FD13B. As shown in Figure 5-1.3, PAHs concentrations in baseflow decreased in WY2008 and have remained fairly consistent since (also see boxplots in Appendix G).

Storm System Cleaning. Targeted areas in the northern portion of the OF237A system were cleaned in 2008. The objective of this project was to remove residual sediments in the storm drains that may contain legacy contaminants. As discussed in detail in the WY2011 report (Tacoma 2012), storm system cleaning contributed to significant reductions in stormwater concentrations. Sewer line cleaning is an important component of the City's source control program. In combination with other source control activities, it appears to have been effective at removing all seven of the compounds tested. Over time as sediments re-accumulate in the pipes, the systems will need to be cleaned again. The City is currently monitoring the results as shown in Figures 5-1.1 to 5-1.7 to determine the appropriate maintenance schedule for pipe cleaning projects.

Statistically significant reductions were evident for TSS, lead, zinc, PAHs and DEHP (see Table 2-4). Line cleaning, along with other source control activities, resulted in reductions of TSS at 10%, lead at 13%, zinc at 23%, DEHP at 67% and PAHs (phenanthrene, pyrene and indeno(1,2,3-cd)pyrene) at 85-87%.

Enhanced Street Sweeping Program. In January 2007, the City's street sweeping program was enhanced in an attempt to reduce sediment buildup in the storm sewer system. Under the enhanced program, the sweeping frequency was increased, air regenerative sweepers replaced mechanical sweepers, and the City also increased communications with residents, which helped raise awareness of the importance of the street sweeping program.

Statistically significant reductions were evident for lead, zinc, PAHs and DEHP (see Table 2-5). Street sweeping, along with other source control activities, resulted in reductions of lead at 2%, zinc at 18%, DEHP at 56% and PAH (phenanthrene, pyrene and indeno(1,2,3-cd)pyrene) at 66-71%. A slight increasing trend of 5% was noted for TSS.

Media Filtration System Installation. In 2010, the City installed a media filtration system that treats stormwater from the FD13 sub-basin, approximately 50 acres in size. After one year, FD13, which is immediately downstream of the media filtration system, had minimal sediment and no sample was submitted for analysis. In WY2012, the concentration of PAHs was in the low range. In WY2013, a sample processing error occurred and no results were available for PAHs, phthalates, PCBs, or mercury. WY2014 results at FD13 show levels remaining at low levels.

2013 Stormwater Pipe Retrofit Project. In 2013, 5,126 linear feet of existing storm sewer main was structurally rehabilitated in the OF237A drainage basin. The rehabilitation was accomplished by means of Cured-In-Place Pipe (CIPP) construction technologies using resin impregnated liners which fixed defects (cracks, holes, etc.) in the pipe that could have allowed potentially contaminated groundwater and soil from historic “hot spots” to enter the storm sewer system. Since the lining was completed in WY2013, there is no post-construction monitoring data available to do a pre- and post-construction comparison. This comparison will be performed in future water years once sufficient post-construction data is available.

General Source Control Activities. In addition to the ongoing investigation and maintenance activities described above, the City is continuing to implement other source control program elements in the OF237A drainage basin which are summarized here and described in more detail in Appendix A. Several other source control actions are currently underway in this basin, including UST/LUST removal actions at several sites under TPCHD oversight. In addition, one warning letters and two Notice of Violation letters were issued in 2014 for a discharge of polluting materials to the municipal drainage system (see Appendix A).

5.3.3 Outfall 237A 2015 Work Plan

In Basin 237A, TSS, lead, zinc, PAHs and DEHP concentrations have all shown a statistically significant improvement in stormwater quality from 2001 to present with an estimated 41% reduction in TSS concentration, 46% reduction in lead concentration, 39% reduction of zinc concentration, 80% reduction in DEHP, and 95-97% reductions in PAHs concentrations over the 13 years of monitoring (Table 3-6 and Figures 3-6.3 to 3-6.7). The decrease in these concentrations appears to have resulted not only from removal/control of point sources, but also from the combination of many other activities.

As described in detail above, OF237A results generally show:

- Stormwater – Slightly to moderately lower TSS (-2), lead (-4) and zinc (-2) compared to other outfalls, slightly lower DEHP (-2), and slightly higher pyrene and indeno(1,2,3-cd)pyrene (+2 and +1 respectively) when evaluating the 13 year monitoring record (see Table 3-4). These levels are more neutral when looking at only the last two years of data.
- SSPM – Slightly lower mercury (-2) and butylbenzylphthalate (-2) compared to other sediment trap locations (see Table 3-5) when evaluating the entire 13 year monitoring record.

Therefore, the following recommendations are included in the 2015 Work Plan for OF237A:

- Review the WY2015 SSPM data for FD13 to monitor improvement from the stormwater treatment retrofit along with an evaluation of the information to advise the establishment of a maintenance schedule.
- Continue to monitor the major construction activities including the WSDOT Nalley Valley Viaduct/SR-16 rebuild.
- Evaluate potential sources of PAHs to FD13B-New.

5.4 OUTFALL 237B

OF237B exhibits the best overall baseflow and stormwater quality with some of the lowest median concentrations for the COCs in baseflow, stormwater and stormwater SSPM found during the monitoring program. Figure 5-1.4 shows the annual average concentration for stormwater, baseflow and SSPM. All seven indicator parameters (TSS, metals, PAHs and DEHP) have shown a statistically significant improvement in stormwater concentrations from WY2002 through WY2014.

This section provides a summary of water/sediment quality results within the OF237B drainage basin and compares the water/sediment data results with the major source control and other activities that have occurred within the basin. A more detailed description of source control activities is provided in Appendix A.

5.4.1 Water and SSPM Quality

Annual and seasonal data for stormwater and SSPM for the COCs and other parameters is used to identify ongoing areas of concern. The following paragraphs summarize the WY2001-WY2014 monitoring results for OF237B, where COCs in this outfall are different from other Foss drainage basins, and where subsequent source control activities may be focused.

5.4.1.a TSS and Metals

Stormwater. As shown in Table 3-6 and Figures 3-6.1, 3-6.2 and 3-6.3, TSS, lead and zinc concentrations show a statistically significant improvement in stormwater quality from 2001 to present. The best-fit regression equations result in an estimated 65% reduction in TSS, 71% reduction in lead and 59% reduction in zinc concentrations in OF237B in the 13 year period.

In comparison to other outfalls, TSS (-1) concentrations are slightly better while lead (-4) and zinc (-6) concentrations are moderately to significantly better when looking at the 13 year monitoring record (see Table 3-4). When only the last two years of monitoring data is evaluated, OF237B results are similar with TSS at -1, lead at -3, and zinc at -5), but slightly less pronounced due to the smaller dataset.

SSPM. As shown in Table 3-5, SSPM in OF237B contains moderately lower metals concentrations with both lead and zinc at (-3) and mercury at (-2) (also see boxplots in Appendix F).

Within the OF237B drainage basin, there were no areas with elevated mercury concentrations in the upline sediment traps. Mercury at FD34 decreased from medium to low concentrations in WY2013 and remained there in WY2014 (see Figure 2-1.1).

5.4.1.b PAHs

Stormwater. As shown in Table 3-4, stormwater in OF237B contains somewhat lower concentrations of phenanthrene (-3) and pyrene (-3), and is neutral in indeno(1,2,3-c,d)pyrene (0) when looking at the 13 year monitoring record. When looking only at the last two years of monitoring data, the basin is neutral to slightly better for PAHs (0 to -2) when compared to other outfalls.

PAH concentrations in stormwater have shown a statistically significant improvement from WY2002 through WY2014 with a 94-98% reduction in pyrene, phenanthrene and indeno(1,2,3-c,d)pyrene in 13 years (see Table 3-6).

SSPM. As shown in Table 3-5, SSPM in OF237B is neutral to slightly enriched in PAHs, phenanthrene (0), pyrene (0) and indeno[1,2,3-cd]pyrene (+1) when looking at the 13 year monitoring period. Concentrations are neutral for all when looking at only the last five years.

As shown in Figure 2-1.2, PAHs in SSPM at FD31 have ranged from low to high levels in recent years with medium levels present from WY2012 to WY2014 suggesting an ongoing or new source is present. One point source removal has been completed near this location, a UST at Willard School, and another UST removal at the EZ Mart was completed under TPCHD oversight during WY2014 (see Appendix A).

5.4.1.c Phthalates

Stormwater. As shown in Table 3-6 and Figure 3-6.7, DEHP concentrations show a statistically significant improvement in stormwater quality from 2001 to present. The best-fit regression equations result in an estimated 89% reduction in the 13 year monitoring period.

In comparison to other outfalls, DEHP in OF237B is slightly better in quality over both the entire 13 year monitoring record (-2) and in only the last two years of monitoring data (-2) (see Table 3-4).

SSPM. DEHP (-2), butylbenzylphthalate (-2) and total phthalate (-3) concentrations in SSPM are slightly to moderately lower than observed in other locations (see Table 3-5 and boxplots in Appendix F). No areas of concern were noted in the upline sediment traps.

5.4.1.d Pesticides

Stormwater. Pesticides are not a COC tested for under the 2001 SAP.

SSPM. No statistically significant differences in quality were observed in SSPM in DDT between outfall samples when reviewing both the entire 13 year monitoring record and only the last five years of data (see Table 3-5).

5.4.1.e PCBs

Stormwater. PCBs are not a COC tested for under the 2001 SAP.

SSPM. No statistically significant differences in quality were observed in SSPM between outfall samples when reviewing either the entire 13 year monitoring record or only the last five years of data (see Table 3-5).

In the upline traps FD34 and FD35 there have had intermittent concentrations of concern for total PCBs (see Figure 2-1.4). FD34 concentrations decreased from the high range to the low range in WY2011 and have remained at low levels since that time. In WY2012 concentrations at FD35 increased from the low to high range where they remained in WY2013. In WY2014, FD35 levels decreased to medium range. Due to the high levels seen in WY2012 and Wy2013, a source control investigation was completed in this area, and a source was identified. See below and Appendix A for additional information.

5.4.2 Source Control Program Activities

FD31 PAH Investigation. FD31 has had intermittently higher concentrations of PAHs since the start of sampling, leading to a source control investigation in the area. TPH and PAH concentrations in SSPM decreased at FD31 in WY2011 as a result of the removal of leakage from an UST at Willard Staff School and from a neighborhood fueling station which closed (see Figure 2-1.2). In addition, the City cleaned and video inspected the FD31 branch as part of the PAH source tracing investigation. However, PAH concentrations increased to medium levels again in WY2012 at FD31 and have remained at medium levels through WY2014 sampling (see Figure 2-1.2). In 2011, TPCHD began the process of initiating a Phase I/II assessment of 3402 Pacific Avenue, EZ Food Mart. After several delays, this action was completed near the end of WY2014. Due to the delays taken by the property owner, the City conducted additional investigation in this area in 2014 to ensure that other sources were not present, and none were identified. The City will continue to monitor PAH concentrations in this area now that the UST and associated cleanup has been completed.

PCB and Mercury Source Tracing in FD34 and FD35. PCBs have been found intermittently over time in the sub-basins draining to FD34 and FD35 (see Figure 2-1.4). A source tracing investigation to try to narrow the source of PCBs in this area was initiated in 2012. Substantial additional work was performed in 2013 to further isolate the source of the contamination in this leg of the drainage system. Ultimately it was determined that the source of the contamination was one of the materials used during construction of a roadway in the area in 1975, specifically the sealant used to seal the roadway at the curbline, that likely contained PCBs. The City will be replacing this roadway to remove this source with a project beginning in 2015. SSPM in this area will be monitored in the future as this source is removed to ensure that the concentrations decrease.

A final report on this source control investigation was included in the WY2013 report.

Storm System Cleaning. In 2010-2011, the majority of the OF237B system was cleaned and video inspected. The objective of this project was to remove residual sediments in the storm drains that may contain legacy contaminants. As discussed in detail in the WY2011 report (Tacoma 2012), storm system cleaning contributed to significant reductions in stormwater concentrations. Sewer line cleaning is an important component of the City's source control program. In combination with other source control activities, it appears to have been effective at removing all seven of the compounds tested. Over time as sediments re-accumulate in the pipes, the systems will need to be cleaned again. The City is currently monitoring the results as shown in Figures 5-1.1 to 5-1.7 to determine the appropriate maintenance schedule for pipe cleaning projects.

Statistically significant reductions were evident for TSS, lead, zinc, PAHs and DEHP (see Table 2-4). Line cleaning, along with other source control activities, resulted in reductions of TSS at 49%, lead at 50%, zinc at 42%, DEHP at 82% and PAHs (phenanthrene, pyrene and indeno(1,2,3-cd)pyrene) at 84-91%.

Enhanced Street Sweeping Program. In January 2007, the City's street sweeping program was enhanced in an attempt to reduce sediment buildup in the storm sewer system. Under the enhanced program, the sweeping frequency was increased, air regenerative sweepers replaced mechanical sweepers, and the City also increased communications with residents, which helped raise awareness of the importance of the street sweeping program.

Statistically significant reductions were evident for TSS, lead, zinc, PAHs and DEHP (see Table 2-5). Street sweeping, along with other source control activities, resulted in reductions of TSS at 32%, lead at 39%, zinc at 34%, DEHP at 62% and PAH (phenanthrene, pyrene, and indeno(1,2,3-cd)pyrene) at 64-71%.

General Source Control Activities. In addition to the ongoing investigation and maintenance activities described above, the City is continuing to implement other source control program elements in the OF237B drainage basin which are summarized here and described in more detail in Appendix A. Several other source control actions are currently underway in this basin, including UST/LUST removal actions at two sites under TPCHD oversight.

5.4.3 Outfall 237B 2014 Work Plan

TSS, metals (lead and zinc), PAHs and DEHP concentrations in stormwater have shown a statistically significant improvement from WY2002 through WY2014 (see Figures 3-6.1 to 3-6.7). There has been an estimated 65% reduction in TSS, 71% reduction in lead and 59% reduction in zinc concentrations, and an 89% reduction of DEHP concentrations in the 13 year monitoring period (see Table 3-6). PAHs showed a 94-98% reduction in 13 years for the index PAHs (phenanthrene, pyrene, and indeno(1,2,3-cd)pyrene). This improvement is believed to be the result of the combination of all source control activities within the basin, including business and multi-family inspections, maintenance activities and public education.

OF237B exhibits the best overall baseflow and stormwater quality with some of the lowest median concentrations for the COCs in stormwater (see Figure 5-1.4 and Table 3-4). SSPM quality in OF237B is also generally of better quality than other Foss basins (see Table 3-5).

As described in detail above, OF237B results generally show:

- Stormwater – Slightly lower TSS (-1) and DEHP (-2), moderately lower phenanthrene (-3), pyrene (-3) and lead (-4), and significantly lower zinc (-6) compared to other outfalls when evaluating the 13 year monitoring record (see Table 3-4).
- SSPM – Moderately lower lead, zinc and total phthalates (all at -3) and slightly lower mercury, TPH-Heavy Oil, DEHP and butylbenzylphthalate (all at -2) compared to other sediment trap locations (see Table 3-5) when evaluating the entire 13 year monitoring record.

Therefore, the following recommendations are included in the 2015 Work Plan for the OF237B drainage basin:

- Track PCB removal activities associated with the road construction project in FD34/35.
- Monitor WY2015 SSPM results at FD31 to determine whether UST removal at the neighborhood fueling station (EZ Mart) results in reduction of the PAH concentrations.

5.5 OUTFALL 243

Many activities have occurred in Basin 243 in recent years. Some of these activities have resulted in improvements in stormwater and SSPM quality. Figure 5-1.5 shows the annual average contaminant concentrations for stormwater, baseflow and SSPM. PAHs and DEHP concentrations show a statistically significant improvement in stormwater quality.

This section provides a summary of water/sediment quality results within the OF243 drainage basin and compares the water/sediment data results with the major source control and other activities that have occurred within the basin. A more detailed description of source control activities is provided in Appendix A.

5.5.1 Water and SSPM Quality

Annual and seasonal data for stormwater and SSPM for the COCs and other parameters is used to identify ongoing areas of concern. The following paragraphs summarize the WY2001-WY2014 monitoring results for OF243, where COCs in this outfall are different from other Foss drainage basins, and where subsequent source control activities may be focused.

5.5.1.a TSS and Metals

Stormwater. TSS (0) and zinc (-2) are similar to slightly better in quality as compared to other basins, while total lead is moderately elevated in stormwater at OF243 (+4) compared to all other basins over the 13 year monitoring period (see Table 3-4 and boxplots in Appendix F). These differences are less pronounced when looking at only the last two years at (0), (+1) and (0), respectively. The highest overall lead concentration (379 µg/L in 2009) and zinc concentration (1,170 µg/L in 2004) were detected in OF243 (Table 3-3). These outliers appear to be relatively isolated occurrences (see boxplots in Appendix G).

As shown in Figure 5-1.5, TSS and lead concentrations in stormwater have remained fairly consistent over the last 13 years. No significant trends were detected for TSS or lead over the 13 year monitoring record, while zinc showed a 47% reduction (Table 3-6).

Similar to baseflow, TSS, lead and zinc concentrations in stormwater during dry season conditions appear to be somewhat higher than concentrations during wet season conditions (see boxplots in Appendix H). This may be caused by more isolated storms and longer antecedent dry periods between storms.

SSPM. Storm sediment in OF243 is elevated in lead (+3), mercury (+4) and zinc (+3) when looking at the 13 year monitoring record (see Table 3-5). When only looking at the most recent five year data set, results are similar (lead, mercury and zinc all at +2) but less pronounced due to the smaller data set.

Some of the highest SSPM concentrations of lead, mercury, and zinc were detected consistently at FD23 (see F-21 through F-23 and Figures F-33 through F-35). As shown in Figure 5-1.5, zinc concentrations in SSPM samples have remained fairly consistent over the last 13 years. Lead and zinc are not currently a major concern in the Thea Foss Waterway sediments, but additional source control work may be considered when additional results are available. As described further below and in Appendix A, a street sweeping pilot project is underway in this area to determine whether an increased sweeping frequency will help to reduce metals concentrations in industrial areas. Results will be evaluated as additional data becomes available.

As shown in Figure 2-1.1, medium levels of mercury are present at FD23. This indicates that there may be a source(s) of mercury within the OF243 drainage basin and additional investigation is currently underway.

5.5.1.b PAHs

Stormwater. PAH concentrations in OF243 are neutral to slightly lower (0 to -1) in comparison to other outfalls when looking at the entire 13 year monitoring period (see Table 3-4 and boxplots in Appendix F). When looking at the last two years only, some PAHs become slightly more pronounced, with phenanthrene increasing from (0) to (+1) and pyrene increasing from (-1) to (0), while indeno(1,2,3-c,d)pyrene remained neutral.

As shown in Table 3-6 and Figures 3-6.4, 3-6.5 and 3-6.6, PAHs (phenanthrene, pyrene, and indeno[1,2,3-cd]pyrene) are showing a statistically significant improvement in stormwater quality from 2001 to present. The best-fit regression equations result in an estimated 90-95% reduction in PAHs in OF243 in the 13 year monitoring period. As shown in Figure 5-1.5, PAH concentrations in stormwater were fairly stable from WY2002 until WY2007. From WY2007 to WY2009 the concentrations decreased, and they have remained fairly stable from WY2009 to present with slight increases noted since the minimum concentrations were detected in 2012.

SSPM. In SSPM, LPAHs and HPAHs concentrations at OF243 are not substantially different from other outfalls in either the entire 13 year monitoring period or the last five years (all three indicator COCs at 0) (see Table 3-5 and Figure 2-1.2).

5.5.1.c Phthalates

Stormwater. DEHP appears to be relatively consistent among outfalls (except OF230 and OF235 which are moderately to significantly higher, respectively, as discussed above) (see Table 3-4). Figure 5-1.5 shows total phthalate concentrations in stormwater were fairly stable from WY2002 to WY2008 and then decreased in WY2009. One unusually high peak concentration of DEHP (41 µg/L) was observed in 2008 stormwater in OF243 (see Table 3-3 and boxplots in Appendix G), but this appears to be isolated occurrence. The source is unknown. Concentrations from WY2009 to WY2014 the concentrations have been generally stable, with slight increases noted since the lowest concentrations were detected in WY2011.

As shown in Table 3-6 and Figure 3-6.7, DEHP is showing a statistically significant improvement in stormwater quality from 2001 to present. The best-fit regression equations result in an estimated 91% reduction in the 13 year monitoring period.

SSPM. OF243 is slightly enriched in DEHP, butylbenzylphthalate, and total phthalates (+1 to +2), although DEHP shows no significant differences between outfalls when looking at only the last five years (see Table 3-5). OF243 exhibits notably different phthalate compositions that are dominated by butylbenzylphthalate. Figures F-30 and F-42 show OF243 butylbenzylphthalate average, median and maximum concentrations in SSPM well above all outfalls except OF245.

In Figure 2-1.3, total phthalate concentrations levels at FD23 were medium in WY2002 and WY2003. Since WY2004, total phthalate concentrations levels at FD23 have been low relative to other outfalls.

5.5.1.d Pesticides

Stormwater. Pesticides are not a COC tested for under the 2001 SAP.

SSPM. No statistically significant differences in quality were observed in SSPM in DDT between outfall samples when reviewing either the entire 13 year monitoring record or only the last five years of data (see Table 3-5).

5.5.1.e PCBs

Stormwater. PCBs are not a COC tested for under the 2001 SAP.

SSPM. No statistically significant differences in quality were observed in SSPM between outfall samples when reviewing either the entire 13 year monitoring record or only the last five years of data (see Table 3-5).

As shown in Figure 5-1.5, the WY2009 to WY2013 total PCB concentrations were the lowest concentration measured to date at this location. PCBs were not a required analyte in FD23 in WY2014.

5.5.2 Source Control Program Activities

Redevelopment of the Area. Redevelopment in the OF243 basin has resulted in some improvements in stormwater and SSPM quality. As shown in Table 3-6 and Figure 3-6.7, DEHP concentrations show a statistically significant improvement in stormwater quality with a 91% reduction since 2001. Total phthalate concentrations also show an improvement in stormwater since 2008 (see Figure 5-1.5). As shown in Figure 2-1.3, phthalate concentrations levels at FD23 were at medium levels in 2002 and 2003 but have been at low levels since 2004. These decreases may reflect the redevelopment and improvements at the former Picks Cove Marina site and portions of the American Plating site, along with better BMPs at the new Foss Landing Marina. Development activities do not, however, appear to have improved the concentrations of mercury in SSPM in FD23.

Point Source Removal. In 2002 and again in 2009, the SR509 WSDOT stormwater treatment pond was rebuilt to remove black oil/tar emanating from the old Northern Pacific Rail yard oil pipeline along East D Street and East 19th Street. Removal of this point source is believed to have contributed to reductions in PAHs that have been observed.

Enhanced Street Sweeping Program. In January 2007, the City's street sweeping program was enhanced in an attempt to reduce sediment buildup in the storm sewer system. Under the enhanced program, the sweeping frequency was increased, air regenerative sweepers replaced mechanical sweepers, and the City also increased communications with residents, which helped raise awareness of the importance of the street sweeping program.

Statistically significant reductions were evident for zinc, PAHs and DEHP (see Table 2-5). Street sweeping, along with other source control activities, resulted in reductions of zinc at 38%, DEHP at 45% and PAH (phenanthrene, pyrene, and indeno(1,2,3-cd)pyrene) at 56-70%.

Outfall 243 Mercury Source Tracing. Mercury has been found in the medium to high range of concentrations in all samples analyzed from FD23 since WY2002 (see Figure 2-1.1). Some source tracing work was completed in 2008 and 2009, but no likely point-source of mercury was identified. After working with BNSF in 2009-2010 to gain access to the BNSF yard, the City completed focused business inspections for most of the yard. An updated drainage map was also completed in September 2011. A follow up inspection, including the inspection of onsite ditches and swales, was conducted in 2012. Mercury concentrations in WY2011 through WY2013 remain in the mid-range of concentrations as represented in Figure 2-1.1.

During 2013 and 2014, additional investigations of the right-of-way, the WSDOT pond and the LRI and BNSF sites were completed. While several samples had detectable levels of mercury, the concentrations were at levels that suggested that they are not major contributors to the mercury detected in the sediment trap. A summary of the 2014 investigation is provided in Appendix A. Investigations will continue in 2015.

Acenaphthene in Baseflow. In OF243, acenaphthene was detected in 95% of the baseflow samples and at concentrations higher than those found in stormwater. The mean and median concentrations of acenaphthene in baseflow were 0.030 and 0.028 µg/L and in stormwater were 0.018 and 0.017µg/L . These results indicate that there may be a source(s) of acenaphthene which is diluted by stormwater. The source of these acenaphthene during baseflow conditions is unknown in this basin. Acenapthene does not appear to be a problem in the waterway sediments, so no further action or investigation is planned at this time.

Street Sweeping Pilot Project. Outfalls 243 and 245 have shown somewhat elevated levels of lead and zinc in both stormwater and baseflow relative to other drains. It is theorized that this may be due to the increased amount of trucking in this industrial area. Based on these results, the City initiated a pilot program in WY2014 to determine whether an increased frequency of street sweeping in this area would have an effect on these results. Starting on October 1, 2013, the City began sweeping the ROW within the OF243 and OF245 drainage basins at a frequency of once every two weeks rather than the usual frequency of once per month for industrial areas. The pilot project is continuing in WY2015. Results will be evaluated as sufficient data become available.

General Source Control Activities. In addition to the ongoing investigation and maintenance activities described above, the City is continuing to implement other source control program elements in the OF243 drainage basin which are summarized here and described in more detail in Appendix A.

5.5.3 Outfall 243 2015 Work Plan

PAHs and DEHP concentrations in stormwater have shown a statistically significant improvement from WY2002 through WY2013 (see Figures 3-6.4, 3-6.5, 3-6.6 and 3-6.7). There has been an estimated 91% reduction on concentration for DEHP in 13 years (see Table 3-6). PAHs have shown a 90-95% reduction in 13 years for the index PAHs (phenanthrene, pyrene and indeno(1,2,3-cd)pyrene).

As described in detail above, OF243 results generally show:

- Stormwater – Moderately higher lead (+4) compared to other outfalls when evaluating the 13 year monitoring record (see Table 3-4).
- SSPM – Moderately higher lead (+3), mercury (+4) and zinc (+3) compared to other sediment trap locations (see Table 3-5) when evaluating the entire 13 year monitoring record. These differences are less pronounced, but still present when looking at only the last five years of data (all at +2).

Therefore, the following recommendations are included in the 2015 Work Plan for OF243:

- Continue mercury source tracing investigations in the FD23 drainage area. Continue working with businesses in the BNSF yard to evaluate other potential sources.
- Evaluate effects of street sweeping pilot project on lead and zinc concentrations in the industrial area when sufficient data are available.

5.6 OUTFALL 245

Many source control activities have occurred in the OF245 drainage basin since the beginning of the monitoring program. Some of these activities have resulted in statistically significant improvements in stormwater quality. Figure 5-1.6 shows the annual average contaminant concentrations for stormwater, baseflow and SSPM. Several of the businesses in the area not only discharge stormwater to OF245 but discharge stormwater to the adjacent outfalls, OF248 and OF249.

This section provides a summary of water/sediment quality results within the OF245 drainage basin and compares the water/sediment data results with the major source control and other activities that have occurred within the basin. A more detailed description of source control activities is provided in Appendix A.

5.6.1 Water and SSPM Quality

Annual and seasonal data for stormwater and SSPM for the COCs and other parameters is used to identify ongoing areas of concern. The following paragraphs summarize the WY2001-WY2014 monitoring results for OF245, where COCs in this outfall are different from other Foss drainage basins, and where subsequent source control activities may be focused.

5.6.1.a TSS and Metals

Stormwater. Stormwater TSS concentrations are neutral (0) to slightly better than average (-1) in OF245 when looking at the entire 13 year monitoring record and the most recent two year data set respectively (see Table 3-4).

Lead concentrations are moderately better than average in OF245 when looking at the entire 13 year monitoring record (-4) and the most recent two year data set (-3) (see Table 3-4).

The highest maximum mercury concentration in stormwater was found in in OF245 in WY2008 (see Table 3-3).

The highest stormwater zinc concentrations are found in OF245 with mean and median concentrations of 165.3 and 141 µg/L, respectively (see Table 3-3). Zinc is moderately elevated (+4) in OF245 in the 13 year monitoring record, but the two year record shows that the outfall is only slightly elevated (+1) (see Table 3-4 and Figures F-3 and F-13).

As shown in Table 3-6 and Figures 3-6.1, 3-6.2 and 3-6.3, TSS, lead, and zinc are all showing a statistically significant improvement in stormwater quality from 2001 to present. The best-fit regression equations result in an estimated 67% reduction in TSS, 65% reduction in lead, and a 47% reduction in zinc in the 13 year monitoring period.

In stormwater, zinc boxplots showed occasional evidence of seasonality (i.e., higher median, mean, and/or peak concentrations) during dry season months (see Figures H-3b and H-13b). This may be caused by more isolated storms and longer antecedent dry periods between storms. Increasing source control activities, such as the enhanced sweeping currently being performed, may be effective in reducing this effect.

SSPM. When looking at the entire 13 year monitoring program, zinc is slightly elevated (+1) compared to the other outfalls, while lead (-3) and mercury (-2) are moderately and slightly lower than the other outfalls, respectively (see Table 3-5 and boxplots in

Appendix F). When looking at only the last two years, these differences are still present but less pronounced with zinc neutral (0) and lead and mercury both at (-1).

Within Basins 245/248, mercury has been detected at medium concentrations periodically at FD22 (WY2002, WY2010 and WY2014) (see Figure 2-1.1). All other sediment trap/sump locations have had low levels.

5.6.1.b PAHs

Stormwater. OF245 is neutral (phenanthrene at 0) to moderately lower (pyrene at -3 and indeno(1,2,3-c,d)pyrene at -4) for PAHs in comparison to other outfalls (see Table 3-4 and boxplots in Appendix F) when looking at the entire 13 year monitoring record. When looking at only the last two years of data, the results are neutral (0) for all three indicator PAHs with no significant difference between outfalls noted.

In stormwater, the highest maximum concentrations for several LPAHs including acenaphthene, acenaphthylene, fluorene, and phenanthrene were observed in OF245 (see Table 3-3). These maximum concentrations were all detected in 2004. The high concentrations have not been observed since the Northern Pacific Rail yard oil pipeline area has been remediated (see Section 5.6.2).

As shown in Table 3-6 and Figures 3-6.4, 3-6.5 and 3-6.6, PAHs (phenanthrene, pyrene, and indeno[1,2,3-cd]pyrene) are showing a statistically significant improvement in stormwater quality from 2001 to present. The best-fit regression equations result in an estimated 89-95% reduction in PAHs in the 13 year monitoring period. As shown in Figure 5-1.6, PAH concentrations in stormwater were fairly stable from WY2002 until WY2007. From WY2007 to WY2009 the concentrations decreased when the Northern Pacific Rail Line was remediated and have remained fairly stable from WY2009 to present.

SSPM. OF245 SSPM has moderately to slightly lower concentrations of phenanthrene (-2), pyrene (-2) and indeno(1,2,3-cd)pyrene (-3) relative to all other outfalls (see Table 3-5 and boxplots in Appendix F) when looking at the 13 year monitoring periods. All three indicator PAHs remain slightly lower than other outfalls (-2) when looking at only the last five years of data. All sediment traps/sumps are considered to have low levels of PAHs (see Figure 2-1.2).

5.6.1.c Phthalates

Stormwater. DEHP appears to be relatively consistent among outfalls (except OF230 and OF235 as discussed above), with mean concentrations slightly lower (-1) in OF245 when looking at the entire 13 year monitoring record, and neutral (0) when looking at only the last two years of data (see Table 3-4).

Unusually elevated DEHP concentrations were found in OF245 stormwater in WY2003 (Year 2) (see total phthalates in Figure 5-1.6 and Figures G-8b and G-18b). A possible source of phthalates in this drain is believed to be the former bulk liquid phthalate transloading facility located in the basin. It does not appear to be from residues from the in-place lining of the storm line that was completed in March 2003 (see Section 5.6.2). These sources are believed to be historic since the water quality is improving and most of the peak phthalate concentrations occurred earlier in the monitoring program (2002 through 2005) (see Figure 5-1.6 and boxplots in Appendix G).

OF245 exhibits a notably different phthalate composition that is dominated by butylbenzylphthalate in stormwater and SSPM. Butylbenzylphthalate concentrations in OF245 were among the highest of any reported phthalates in the monitoring program (see Table 3-3, and Table D-15). In stormwater, OF245 butylbenzylphthalate average concentration is 15.6 µg/L as compared to 0.39-1.24 µg/L in the other drains. Elevated peak concentrations of diethylphthalate were also detected in OF245 at 430 µg/L in stormwater.

As shown in Table 3-6 and Figure 3-6.7, DEHP is showing a statistically significant improvement in stormwater quality from 2001 to present. The best-fit regression equations result in an estimated 92% reduction in DEHP in OF245 in the 13 year monitoring period.

SSPM. OF245 is neutral (0) for DEHP, moderately enriched in butylbenzylphthalate (+4), and slightly enriched in total phthalates (+1) when looking at the 13 year monitoring period (see Table 3-5). As with stormwater, SSPM composition is dominated by butylbenzylphthalate. Butylbenzylphthalate remains slightly higher (+1) relative to other outfalls when looking at only the last five years, while Total Phthalates are neutral (0) and there are no significant differences in DEHP between any outfalls. Figures F-30 and F-42 show OF245 butylbenzylphthalate average, median and maximum concentrations in SSPM well above all other outfalls.

Within OF245 and the adjacent OF248, additional sediment traps were located around a suspected source of phthalates, the former MPS site (see Section 5.6.2). At FD21 (OF245) total phthalate concentrations were in the high range in WY2002 and WY2003, decreased to medium range in WY2004, and have been in the low range since that time (see Figure 2-1.3). At FD22 (OF248), total phthalate concentrations have fluctuated primarily between high (WY2003, WY2004, WY2005 and WY2010) and medium concentrations (WY2006 through WY2009, W2011 and WY2013). WY2012 and WY2014 concentrations were in the low range. As discussed in Section 5.6.2, source control work at the former MPS site remains a priority.

5.6.1.d Pesticides

Stormwater. Pesticides were not detected at the reporting limits in whole-water samples and are therefore not a COC.

SSPM. No statistically significant differences in quality were observed in SSPM in DDT between outfall samples when reviewing either the entire 13 year monitoring record or only the last five years of data (see Table 3-5).

5.6.1.e PCBs

Stormwater. PCBs are not a COC tested for under the 2001 SAP.

SSPM. No statistically significant differences in quality were observed in SSPM between outfall samples when reviewing either the entire 13 year monitoring record or only the last five years of data (see Table 3-5).

5.6.2 Source Control Program Activities

MH390/Outfall 245 Black Oil/Tar Releases. Black oil and tar blobs were observed seeping into the storm drains through joints and cracks. Before the extent of the contamination was understood, the City completed three maintenance projects (two line replacements and one relining) to alleviate this issue. After these projects were complete, seeps continued to leak into the storm drain system. Further investigations found contamination along the entire length of the old Northern Pacific Rail yard oil pipeline area along East D Street and East 19th Street. Ecology ordered remediation of the pipeline in 2008 and 2009. During this period, five UST/LUSTs were also removed or filled.

After completion of all of these activities, oil absorbent snares placed in the storm lines remained clean. Use of the oil snares in this basin was discontinued in 2010. These actions contributed to the reductions in PAH concentrations at this location.

Enhanced Street Sweeping Program. In January 2007, the City's street sweeping program was enhanced in an attempt to reduce sediment build-up in the storm sewer system. Under the enhanced program, the sweeping frequency was increased, air regenerative sweepers replaced mechanical sweepers, and the City also increased communications with residents and business owners, which helped raise awareness of the importance of the street sweeping program.

Statistically significant reductions were evident for TSS, lead, zinc, PAHs and DEHP (see Table 2-5). Street sweeping, along with other source control activities, resulted in reductions of TSS at 33%, lead at 26%, zinc at 17%, DEHP at 75% and PAH (phenanthrene, pyrene, and indeno(1,2,3-cd)pyrene) at 64-69%.

Former MPS Site Investigation. Investigation at this site has been ongoing through the years of this program. The site is now operating under the name of Quality Transport, Inc. Quality Transport, Inc. cleaned a majority of their system in 1997 and in 2000 with no effect on the sediment trap phthalate concentrations downstream of their facility (Tacoma 2009b). Average total phthalate concentrations show a peak in WY2003 with a decline in stormwater and baseflow chemistry in WY2004 and WY2005 (see Figure 5-1.6). Baseflow concentrations appear to have remained relatively stable since WY2005; however, stormwater concentrations continued to decrease slightly until WY2010 and have remained relatively stable since that time.

Because of the intermittent medium to high SSPM concentrations at FD22, this site was referred to Ecology and TPCHD for follow-up. Additional follow-up from all involved agencies is needed to fully assess the operations and site conditions at this property to assure that proper controls are in place. A joint inspection was performed by the involved agencies, including the City, and several follow up actions were required. The property owner has requested several time extensions to complete some of the tasks. The City is currently evaluating next steps at this site. An update on the status of site activities is included in Appendix A.

Truck Traffic Effects on Water and SSPM Quality. Truck traffic is believed to be one of the major sources of zinc and TPH in the OF245 drainage basin. As shown in Figure 5-1.6, average COC concentrations in SSPM decreased in WY2005 and increased in WY2006. In particular, average TPH and zinc concentrations were lowest in WY2005, then increased and stabilized between WY2006 and WY2013. In 2005, truck traffic was diminished in the basin with the closure of a warehouse and East D Street during the overpass construction. In 2006, truck traffic resumed when the warehouse and the overpass reopened.

In 2008, Ecology reported that the major sources of zinc contributing to stormwater runoff on industrial sites are:

- Galvanized metals;

- Motor oils/hydraulic fluids exposed on the ground, or absorbed by solid particles such as dust and dirt roads, parking lots, and loading docks, and other surfaces; and
- Tire dust from forklifts, trucks, and other vehicles. Where trucks and truck trailers make tight turns, a considerable amount of zinc is released.

Ecology recommends two methods that can be used to reduce zinc contributions: replacing or coating galvanized metals and sweeping with industrial vacuum sweepers to clean paved areas. It is anticipated that under Ecology's Industrial Stormwater General Permit (ISWGP), zinc concentrations and other chemicals in stormwater will be reduced over time at industrial facilities. The City updated its Stormwater Management Manual to incorporate this change. Additional revisions to the Stormwater Management Manual will be made as new information on sources and control of such pollutants becomes available.

Street Sweeping Pilot Project. Outfalls 243 and 245 have shown somewhat elevated levels of lead and zinc in both stormwater and baseflow relative to other drains. It is theorized that this may be due to the increased amount of trucking in this industrial area. Based on these results, the City initiated a pilot program in WY2014 to determine whether an increased frequency of street sweeping in this area would have an effect on these results. Starting on October 1, 2013, the City began sweeping the ROW within the OF243 and OF245 drainage basins at a frequency of once every two weeks rather than the usual frequency of once per month for industrial areas. The pilot project is continuing in WY2015. Results will be evaluated as sufficient data become available.

Acenaphthene in Baseflow. In OF245, acenaphthene was detected in 86% of the baseflow samples and at concentrations about four times higher than those found in stormwater. It appears that a source is ongoing since acenaphthene was detected at the same levels in the WY2004-WY2011 baseflow events. The source of acenaphthene during baseflow conditions is unknown in this basin. Acenapthene does not appear to be a problem in the waterway sediments, so no further action or investigation will be performed at this time.

General Source Control Activities. In addition to the ongoing investigation and maintenance activities described above, the City is continuing to implement other source control program elements in the OF245 drainage basin which are summarized here and described in more detail in Appendix A.

5.6.3 Outfall 245 2015 Work Plan

TSS, metals (lead and zinc), PAHs and DEHP concentrations in stormwater have shown a statistically significant improvement from WY2002 through WY2014 (see Figures 3-6.1 to 3-6.7). There has been an estimated 67% reduction in TSS, 65% reduction in lead and 47% reduction in zinc concentrations in the 13 year monitoring program. In addition, there has been an estimated 92% reduction in concentration for DEHP, and PAHs showed an 89-95% reduction in 13 years for the index PAHs (phenanthrene, pyrene, and indeno(1,2,3-cd)pyrene (see Table 3-6).

As described in detail above, OF245 results generally show:

- Stormwater – Moderately higher zinc (+4) and moderately lower lead (-4), pyrene (-3), and indeno(1,2,3-c,d)pyrene (-4) compared to other outfalls when evaluating the 13 year monitoring record (see Table 3-4). When looking at only the last two years of data, zinc is only slightly higher (+1) compared to other outfalls.

- SSPM – Moderately higher butylbenzylphthalate (+4) and moderately lower lead (-3), and indeno(1,2,3-c,d)pyrene (-3) compared to other sediment trap locations (see Table 3-5) when evaluating the entire 13 year monitoring record. Other indicator PAHs and mercury are slightly lower (-2) than other outfalls. Butylbenzylphthalate remains slightly higher (+1) compared to other outfalls when looking at only the last five years of data.

Therefore, the following recommendations are included in the 2015 Work Plan for OF245:

- Continue joint inspection and follow-up efforts at Quality Transport for evaluation and control of phthalate sources.
- Evaluate effects of enhanced street sweeping for lead and zinc in the industrial area as additional data becomes available.

5.7 OUTFALL 254

Many source control activities have occurred in the OF254 drainage basin since the beginning of the monitoring program. Some of these activities have resulted in statistically significant improvements in stormwater quality. Figure 5-1.7 shows the annual average contaminant concentrations for stormwater, baseflow and SSPM.

This section provides a summary of water/sediment quality results within the OF254 drainage basin and compares the water/sediment data results with the major source control and other activities that have occurred within the basin. A more detailed description of source control activities is provided in Appendix A.

5.7.1 Water Quality

Annual and seasonal data for stormwater for the COCs and other parameters is used to identify ongoing areas of concern. The following paragraphs summarize the WY2001-WY2014 monitoring results for OF254, where COCs in this outfall are different from other Foss drainage basins, and where subsequent source control activities may be focused. Note that there are not sediment traps in the OF254 drainage basin due to tidal influence.

5.7.1.a TSS and Metals

Stormwater. TSS concentrations in OF254 stormwater are significantly above average when looking at the entire 13 year monitoring record (+6) and moderately higher when only looking at the last two years of data (+4) (see Table 3-4). OF254 has the highest mean (104.2 mg/L) and median (84.3 mg/L) of all the basins (see Table 3-3 and Figures F-1 and F-11. Considerable amounts of unpaved industrial area are present in this drainage basin, likely leading to these elevated concentrations.

The highest average concentrations of mercury were also observed in OF254 stormwater (0.039 µg/L) but it does not appear to be significantly greater than most of the other outfalls (see Table 3-3). The source(s) of mercury in this basin are unknown, however, mercury is not a concern in waterway sediments in this area, so source control for this constituent is not a high priority.

Lead concentrations are slightly elevated (+1) in OF254 when looking at both the entire 13 year monitoring record and the most recent two year data set (see Table 3-4).

Zinc, on the other hand, is moderately elevated (+4) in OF254 when looking at the 13 year monitoring record, but the two year record shows that the outfall is only slightly elevated (+1) (Table 3-4 and Figures F-3 and F-13). Since OF245 is also similarly elevated in zinc, this indicates that there may be a source(s) of zinc present in the industrialized basins. As discussed in Section 5.6.2, truck traffic is a source of zinc but may not be the only source.

As shown in Table 3-6 and Figures 3-6.2 and 3-6.3, lead and zinc are showing statistically significant improvements in stormwater quality from 2001 to present. The best-fit regression equations result in an estimated 47% reductions in lead and 55% reductions in zinc in the13 year monitoring period.

SSPM. No sediment traps are installed in OF254.

5.7.1.b PAHs

Stormwater. OF254 is slightly (phenanthrene and indeno(1,2,3-c,d)pyrene at +1) to moderately elevated (pyrene at +4) for PAHs in comparison to other outfalls (see Table 3-4 and boxplots in Appendix F) when looking at the entire 13 year monitoring record. However, when looking at the two year monitoring record, there are no significant differences from other outfalls with all neutral at (0) compared to other outfalls.

OF254 has had some of the highest concentrations of PAHs in water quality in the Thea Foss Basin (see boxplots in Appendix F), but these concentrations have improved since WY2008 (see boxplots in Appendix G). In the stormwater, comparatively higher concentrations of LPAHs and HPAHs were observed in OF254. The highest mean or maximum concentrations of several LPAHs and HPAHs in stormwater have been reported in OF254 including acenaphthene, acenaphthylene, anthracene, phenanthrene, total LPAHs, chrysene, benzo(a)anthracene, fluoranthene, pyrene, and total HPAHs (see Table 3-3) but the maximum concentrations occurred 2002 and concentrations are much lower in more recent sampling.

As shown in Table 3-6 and Figures 3-6.4, 3-6.5 and 3-6.6, PAHs (phenanthrene, pyrene and indeno(1,2,3-cd)pyrene) show a statistically significant improvement in stormwater quality from 2001 to present. The best-fit regression equations result in an estimated 92-98% reduction in the indicator PAHs in the 13 year monitoring period. In particular, there was a consistent decrease from WY2007 to WY2011 (see Figures 5-1.7) that occurred following cleaning of the storm lines. WY2012 Total HPAH results were slightly higher but the results decreased again in WY2013 and remained there in WY2014. Total LPAH results were slightly higher in WY2014. These differences are likely due to the reduced number of samples from this outfall in the recent years.

SSPM. No sediment traps are installed in OF254.

5.7.1.c Phthalates

Stormwater. DEHP appears to be relatively consistent among outfalls (with the exception of OF230 and OF235 as discussed above), although mean concentrations are somewhat lower (-2) in OF254 when looking at the 13 year monitoring record (see Table 3-4). This outfall is neutral at (0) for DEHP when looking at only the last two years. Figure 5-1.7 shows total phthalate concentrations in stormwater were fairly stable from

WY2002 to WY2009 when they decreased. Concentrations have remained fairly stable since that time.

As shown in Table 3-6 and Figure 3-6.7, DEHP shows a statistically significant improvement in stormwater quality from 2001 to present. The best-fit regression equations result in an estimated 69% reduction in the 13 year monitoring period.

SSPM. No sediment traps are installed in OF254.

5.7.1.d Pesticides

Stormwater. Pesticides are not a COC tested for under the 2001 SAP.

*SSPM***.** No sediment traps are installed in OF254.

5.7.1.e PCBs

Stormwater. PCBs are not a COC tested for under the 2001 SAP.

*SSPM***.** No sediment traps are installed in OF254.

5.7.2 Source Control Program Activities

Storm System Cleaning. In 2006, the municipal storm system in OF254 was cleaned and video inspected. The objective of this project was to remove residual sediments in the storm drains that may contain legacy contaminants. As discussed in detail in the WY2011 report (Tacoma 2012) storm system cleaning contributed to significant reductions in stormwater concentrations. Sewer line cleaning is an important component of the City's source control program. In combination with other source control activities, it appears to have been effective at removing all seven of the compounds tested. Over time as sediments re-accumulate in the pipes, the systems will need to be cleaned again. The City is currently monitoring the results as shown in Figures 5-1.1 to 5-1.7g to determine the appropriate maintenance schedule for pipe cleaning projects.

Statistically significant reductions were evident for zinc, PAHs and DEHP (see Table 2-4). Line cleaning, along with other source control activities, resulted in reductions of zinc at 27%, DEHP at 15% and PAHs (phenanthrene, pyrene and indeno(1,2,3-cd)pyrene) at 63-78%.

Enhanced Street Sweeping Program. In January 2007, the City's street sweeping program was enhanced in an attempt to reduce sediment buildup in the storm sewer system. Under the enhanced program, the sweeping frequency was increased, air regenerative sweepers replaced mechanical sweepers, and the City also increased communications with residents and business owners, which helped raise awareness of the importance of the street sweeping program.

Statistically significant reductions were evident for lead, zinc, PAHs and DEHP (see Table 2-5). Street sweeping, along with other source control activities, resulted in reductions of lead at 9%, zinc at 30%, DEHP at 16% and PAH (phenanthrene, pyrene, and indeno(1,2,3-cd)pyrene) at 65-80%.

Northern Pacific Rail Yard Oil Pipeline and Standard Oil Site Cleanup. Another source of PAHs in the basin may have been associated with the Northern Pacific Rail yard oil pipeline area along East D Street to the old Standard Oil site. In 2009, the Northern Pacific Rail yard oil pipeline area along East D Street and East 19th Street was remediated as directed by Ecology.

In 2010, the final phase of this cleanup within the OF254 basin was completed. Ecology has oversight of the remediation project.

Northwest Detention Center DEHP Investigation. The NWDC (formerly known as INS), a private immigration-related prison, was previously identified as a point source of DEHP (Tacoma 2009b). In 2009, NWDC was remodeled and media filtration stormwater treatment devices were installed. Further sampling and source tracing identified one source of the DEHP to be laundry lint, so the City required that filters be placed in the catch basins, and that the property owner perform regular maintenance of these devices.

During facility inspections in 2013 it was found that the filters continued to be impacted but the stormfilter system appeared to be effective in keeping the material on site. It was also determined that the lint collection system had not been properly installed. This system has now been repaired. A summary of the follow up inspections performed at this site in 2014 is provided in Appendix A. This site will require continued inspection and monitoring to ensure that proper maintenance of the treatment devices is being performed.

General Source Control Activities. In addition to the ongoing investigation and maintenance activities described above, the City is continuing to implement other source control program elements in the OF254 drainage basin which are summarized here and described in more detail in Appendix A. In 2014, one warning letter and one Notice of Violation letter were issued for discharge of sediment or other polluting materials into the municipal drainage system.

5.7.3 Outfall 254 2015 Work Plan.

Lead, zinc, PAHs and DEHP concentrations in stormwater have shown a statistically significant improvement from WY2002 through WY2014 (see Table 3-6 and Figures 3-6.2 to 3-6.7). There has been an estimated 47% reduction for lead and a 55% reduction in zinc concentrations in 13 years. DEHP concentration reductions are estimated at 69% and index PAHs (phenanthrene, pyrene, and indeno(1,2,3-cd)pyrene) showed a 92-98% reduction in the 13 year monitoring period.

As described in detail above, OF254 results generally show:

- Stormwater – Significantly higher TSS (+6) and moderately elevated zinc (+4) and pyrene (+4) compared to other outfalls when evaluating the 13 year monitoring record (see Table 3-4). When evaluating only the last two years of data, zinc TSS remains moderately elevated (+4) compared to other outfalls, while lead and zinc are only slightly elevated (+1). Pyrene is neutral (0) relative to other outfalls during the last two years of monitoring.

Therefore, the following recommendations are included in the 2015 Work Plan for the OF254 drainage basin:

- Continue follow-up inspections at NWDC for proper operation and maintenance of their onsite treatment facilities
- Evaluate potential to expand area of increased street sweeping frequency to this basin.

6.0 RECOMMENDATIONS AND 2015 WORK PLAN

The improvements in stormwater quality since the mid-1990s indicate that source control efforts in the Foss Waterway Watershed have been effective in the reduction of chemical concentrations in stormwater. With the City's comprehensive 13 year monitoring data set, updated statistical analyses have been completed. Forty-six statistically significant time trends (46 out of 49 tests, or approximately 94% of the tests) were observed in Tacoma's stormwater monitoring record. All trends were in the direction of decreasing concentrations. This is a larger number of significant reductions than has ever been observed previously, but the results are not directly comparable due to a change in the statistics approach.

This result is significant and a testament to the City's ongoing comprehensive source control program. Source control activities currently being implemented by the City include business inspections, response to spills and illicit discharges, mapping/maintenance/cleaning of the stormwater system, pollutant source tracing, and implementation of the City's Surface Water Management Manual through our stormwater ordinance. With continued monitoring and source control actions, coupled with implementation of Phase 1 NPDES Permit programs, further improvements in stormwater quality may be realized.

It should be noted however, that while considerable improvements to stormwater quality have been made, the largest changes were realized in the earlier years of the program when major sources were identified and eliminated. Because the source control program has been so effective through the years, fewer major sources or maintenance actions are needed and the program is beginning to approach an equilibrium or maintenance mode. In other words, the concentrations of contaminants of concern in the stormwater in the Foss Waterway Watershed are reaching a level where the opportunities for large reductions are more limited. While this may over time lead to the appearance of fewer decreasing trends in contaminant concentrations if looking only at results from more recent years, the fact remains that the City's stormwater source control and monitoring program have been very effective in reducing contaminant levels in stormwater and SPPM.

Reduction of overall contaminant loads to the Foss Waterway has been achieved through the City's implementation of these stormwater source controls. Control of other sources, many of which are outside the City's jurisdiction and must be coordinated by other federal, state, and local authorities, have also lead to reduction in contaminant loads. Reductions of air and marina pollution are achieved through Ecology's Air Program and through the Marina Source Control Program which was developed specifically for the Foss Waterway. Reductions in air pollution will decrease not only the direct loads from atmospheric fallout to the surface of the waterway, but will also decrease the pollutant loads washed off upland surfaces and entrained in stormwater runoff. The marina improvements implemented by the Foss Waterway Marina, Foss Landing Marina, Johnny's Dock Marina, and Delin Docks, including installation of facility improvements, have undoubtedly translated into reduced source loads for marinas. Finally, upland and in-water remedial actions implemented by Ecology and the Utilities in 2003 and 2004 were directed at controlling tar seeps in the head of the waterway. The effectiveness of these combined actions will continue to be verified through long-term monitoring of stormwater, storm sediment, and marine sediment, and supplemented by source monitoring programs conducted by other parties.

6.1 THEA FOSS WATERWAY SEDIMENT MONITORING PROGRAM

When the waterway sediment remediation projects were completed, the majority of the sediment surface had no, or very low concentrations of contaminants present since the surface was either dredged to clean sediments or covered with new, clean capping materials. It was anticipated that ongoing source contributions to the waterway would cause concentrations of contaminants to increase gradually. Over time, the goal is to have the contaminant concentrations equilibrate at a level below the sediment cleanup standards set by the EPA. The City developed a predictive model so that actual sediment monitoring results can be compared to model predictions to determine areas where additional source controls may be needed to remain in compliance.

The sediments in the waterway are the true barometer, however, of whether additional source controls are needed for compliance with regulatory requirements. Sediment monitoring was performed by the private Utilities group in cooperation with the City in 2014 in the head of the waterway, generally south of the SR509 Bridge. An analysis of the results shows that the data were generally consistent with model predictions and that the risk of large-scale recontamination appears to be low. In many cases, sediment concentrations have remained relatively stable between their Year 7 and Year 10 monitoring events. Model predictions indicate sediment concentrations begin to level off at approximately Year 7 and are not expected to rise much higher in the future. Therefore, waterway sediment concentrations appear to have largely equilibrated with modern sources seven years after the completion of the remedial action. As a result, the risk of recontamination is not expected to be substantially higher in the future unless there is a change in the nature, strength or distribution of waterway sources.

6.2 2015 WORK PLAN

Priorities for 2015 source control work are set in order of highest to lowest as 1, 2, and 3. Higher priorities were given to eliminating/reducing point sources and activities that are based on best professional judgment to provide a measurable benefit in reducing chemical loadings to the waterway for those COCs of most concern in waterway sediments.

Priorities will also be based on overall outfall contributions to the waterways. That is, the outfalls with the largest chemical loading contributions to the waterway will generally receive the higher priority. Table 6-1 shows the discharge volume and chemical loadings for each of the municipal outfalls. It should be noted that there are other sources which could also potentially affect sediment quality in the waterways, including groundwater seeps, marinas, atmospheric fallout, NPDES-permitted industrial discharges, and other private stormwater discharges. These sources are outside the scope of the City's Source Control Strategy for municipal stormwater, and largely outside the City's jurisdiction.

For the municipal outfalls, 72% of the freshwater volume discharging to the waterways is from baseflow, mainly from OF237A, OF237B, OF235 and OF230. However, baseflow conveys relatively low concentrations of COCs, typically characterized by reduced maximum values and less frequent detections than in stormwater. The proportion of the contaminant load attributed to baseflow is:

- 16% of the load for phenanthrene;
- 10% of the load for pyrene;
- 16% for dibenz(a,h)anthracene; and

- 28% of the total load for DEHP.

The largest proportion of chemicals discharging into the waterways from municipal outfalls is from stormwater (see Table 6-1). The chemical loading from stormwater is:

- 84% of the total load for phenanthrene;
- 90% of the total load for pyrene;
- 84% for dibenz(a,h)anthracene; and
- 72% of the total load for DEHP.

Priority 1 tasks are ongoing or will generally be initiated in spring 2015, followed by Priority 2 and then Priority 3. Updates, schedules and tasks will be reported in the 2015 Annual Source Control Report.

Priority 1 tasks are:

- OF230: Continue source tracing investigation and track private property cleanups in area draining to FD3A and FD18 for mercury and PCBs, with PAHs and phthalates analyzed as well.
- OF237A: Continue to monitor the major construction activities including the WSDOT Nalley Valley Viaduct/SR-16 rebuild.
- OF237B: Track PCB removal activities associated with the road construction project in FD34/35.
- OF243: Continue mercury source tracing investigations in the FD23 drainage area. Continue working with businesses in the BNSF yard to evaluate other potential sources.
- OF245: Continue joint inspection with TPCHD and Ecology and follow-up efforts at Quality Transport for evaluation and control of phthalate sources.
- OF254: Evaluate potential to expand area of increased street sweeping frequency to this basin.

Priority 2 tasks are:

- OF237A: Review the WY2015 SSPM data for FD13 to monitor improvement from the stormwater treatment retrofit along with an evaluation of the information to advise the establishment of a maintenance schedule. OF237A:
- Evaluate potential sources of PAHs to FD13B-New.
- Evaluate possible sources of PCBs to FD16.
- OF235: Continue to investigate sources of lead, PAHs and phthalates in stormwater. Area draining to FD6A higher than other branches of OF235 in PAH concentrations in stormwater, and stormwater concentrations at the outfall rank highest overall. Evaluate need for additional source control following installation of Hood St treatment device.
- OF237B: Monitor WY2015 SSPM results at FD31 to determine whether UST removal at the neighborhood fueling station (EZ Mart) results in reduction of the PAH concentrations.

Priority 3 tasks are:

- OF243 and OF245: Evaluate effects of street sweeping pilot project on lead and zinc concentrations in the industrial area as sufficient data become available.
- OF254: Continue follow-up inspections at NWDC for proper operation and maintenance of their onsite treatment facilities

In addition, the City will perform a number of tasks as part of the source control program:

- Continue Foss Stormwater Monitoring WY2015.
- Review of the WY2014 SSPM data to confirm existing conditions in the basin and to set maintenance schedules for treatment units within the basin (where appropriate).
- Monitor the major construction activities throughout the watershed.
- Monitor and conduct inspections at new developments as completed to review appropriate BMPs for each site.
- Implement the City's Stormwater Management Manual, 2012/2015 Editions.
- Continue NPDES business inspections program and document the inspections using the business inspections database. Respond and track all complaints/spills in the complaints database.
- Monitor TPCHD and Ecology UST/LUST removal projects along with any other remediation projects in the watershed.

7.0 REFERENCES

Ecology 2001. Administrative Water Quality Order No. DE01WQHQ-3241 against the City of Tacoma, September 17, 2001. Washington State Department of Ecology. September 2001.

Ecology 2004. Administrative Water Quality Order No. DE01WQHQ-3241A-01 against the City of Tacoma, August 11, 2004. Washington State Department of Ecology. August 2004.

Tacoma 2001. Sampling and Analysis Plan for Thea Foss and Wheeler-Osgood Waterways. City of Tacoma. September 2001.

Tacoma 2007. 2006 Stormwater Source Control Report. Thea Foss and Wheeler-Osgood Waterways. City of Tacoma. May 2007.

Tacoma 2009a. Thea Foss and Wheeler-Osgood Waterways Stormwater Monitoring, August 2001-2008 Report. City of Tacoma. March 2009

Tacoma 2009b. 2008 Stormwater Source Control Report. Thea Foss and Wheeler-Osgood Waterways. City of Tacoma. March 2009.

Tacoma 2010. Stormwater Management Program (SWMP). City of Tacoma. March 2010.

Tacoma 2012. 2011 Stormwater Source Control Report and Water Year 2011 Stormwater Monitoring Report. City of Tacoma. March 31, 2012.

Tacoma 2013. 2012 Stormwater Source Control Report and Water Year 2012 Stormwater Monitoring Report. City of Tacoma. March 29, 2013.

Tacoma 2014. 2013 Stormwater Source Control Report and Water Year 2013 Stormwater Monitoring Report. City of Tacoma. March 27, 2013.

TABLES

Table 2-1
Master Spreadsheet for Source Control Actions

Action Number	Action Number by Basin	Sub Basin	Action	Date	Potential COCs	Status	Description
All and NPDES Basin							
1	1		Drought	7/1/2007	Unknown	One Event	One of the driest summers on record
2	2		Drought	5/2009-7/2009	Unknown	One Event	One of the driest summers on record
3	3		Drought	Aug-Sept	Unknown	One Event	One of the longest dry streaks on record
4	4		Earthquake	2/28/2001	Unknown	One Event	6.8 Earthquake
5	5		Flood	11/14/2001	Unknown	One Event	Flooding
6	6		Flood	1/5/2006	Unknown	One Event	Flooding
7	7		Flood	11/6/2007	Unknown	One Event	Flooding
8	8		Flood	12/3/2007	Unknown	One Event	Flooding
9	9		Flood	1/7/2009	Unknown	One Event	Flooding
10	10		Snow	1/1/2007	Unknown	One Event	Record Snow event
11	11		Wet	9/1/2010	Unknown	One Event	3rd all time wettest September
12	12		Wet	9/1/2013	Unknown	One Event	Wettest September on record
13	13		Wet	2/2014 - 10/2014	Unknown	One Event	Wettest February 1 through October 31 on record
14	14		Wet	3/1/2014	Unknown	One Event	Wettest March on record
15	15		Cleanup	2011-2012	All	Ongoing	Broad EIS and South Tacoma's Downtown Subarea plan for Brownsfields and site cleanups
16	16		Edu	7/2/2005	All	Completed	PC Dental Education Outreach
17	17		Edu	7/2/2005	All	Completed	PC Dental Education Outreach
18	18		Const Permit	2002	All	Ongoing	Construction Stormwater Permit
19	19		Ind Permit	2008	All	Ongoing	Industrial General Stormwater Permit
20	20		Const 1	2011-2013	All	Ongoing	Murray Morgan Bridge Rehabilitation
21	21		Const 2	2013	All	Ongoing	Thea Foss Site 9 Bulkhead Replacement Project
22	22		Inspect	2002	All	Completed	106 City Wide Inspections
23	23		Inspect	2003	All	Completed	350 Thea Foss Inspections, 31 City Wide Inspections
24	24		Inspect	2003	All	Completed	263 Thea Foss Inspections, 154 City Wide Inspections
25	25		Inspect	2004	All	Completed	167 Thea Foss Inspections,142 City Wide Inspections
26	26		Inspect	2004	All	Completed	47 Thea Foss Inspections,180 City Wide Inspections
27	27		Inspect	2005	All	Completed	482 Thea Foss Inspections, 1,299 City Wide Inspections
28	28		Inspect	2005	All	Ongoing	City-wide Business inspections
29	29		Inspect	2006	All	Completed	485 Thea Foss Inspections, 1,790 City Wide Inspections
30	30		Inspect	2006	All	Completed	Inspections: 805 Thea Foss Basin , 303 follow ups; 2,209 City Wide, 407 follow ups
31	31		Inspect	2007	All	Completed	City Facilities and Tacoma Public Schools Inspected
32	32		Inspect	2010	All	Completed	City Facilities Inspected: Fire, Maintenance, Parking, Theaters, Solid Waste, Cheney Stadium
33	33		Inspect	2011	All	Completed	City Facilities: Fire Station retrofitting for wash pad/foam test areas
34	34		Inspect	2011	All	Completed	City Facilities Inspections: 45 sanitary and 4 stormwater pump stations and 7 communications facilities
35	35		Inspect	2011	All	Completed	Business Inspections: 452 in Thea Foss and 1,408 City Wide.
36	36		Inspect	2011	All	Completed	BMP Inspections: 119 in Thea Foss and 351 City Wide.
37	37		Inspect	2012	All	Completed	City Facilities inspections and training - Inspected/serviced treatment devices, inspected City facilities including fire stations, parking garages, street operations, equipment and material storage yards, facilities, asphalt plant, etc. and provided technical assistance, education and training.
38	38		Inspect	2012	All	Ongoing	Fire Station Retrofit for wash pad/foam test. One station completed
39	39		Inspect	2012	All	Completed	Conducted 938 device inspections City wide, including 117 new devices signed off or inspected
40	40		Inspect	2012	All	Completed	199 business inspections and follow up visits in the Foss Waterway Watershed and 1045 business inspections and follow up visits City wide
41	41		Inspect	2012	All	Completed	Ten SWPPs were reviewed and updated for City Facilities and 3 new SWPPs are pending for 2013
42	42		Inspect	2013	All	Completed	City Facilities inspections to evaluate site compliance with regulatory requirements. Inspected/serviced treatment devices, inspected City facilities including fire stations, parking garages, street operations, equipment and material storage yards, facilities, asphalt plant, etc.
43	43		Inspect	2013	All	Ongoing	Fire Station Retrofit for wash pad continues
44	44		Inspect	2013	All	Completed	Conducted 556 device inspections on the 605 known stormwater treatment devices City wide, including 45 new devices signed off or inspected
45	45		Inspect	2013	All	Completed	360 business inspections and follow up visits in the Foss Waterway Watershed and 1085 business inspections and follow up visits City wide
46	46		Inspect	2013	All	Completed	Fifteen SWPPs and maps were reviewed and updated for City Facilities; completed site specific SWPP training
47	47		Inspect	2014	All	Completed	City Facilities inspections to evaluate site compliance with regulatory requirements. Inspected/serviced treatment devices, inspected City facilities including fire stations, parking garages, street operations, solid wast landfill, Greater Tacoma Convention Center, treatment plants, asphalt plant, educter facilities, equipment and material storage yards, facilities, etc.
48	48		Inspect	2014	All	Ongoing	Fire Station Retrofit for wash pad continues with pads completed at Station 9 and Station 10

Table 2-1
Master Spreadsheet for Source Control Actions

Action Number	Action Number by Basin	Sub Basin	Action	Date	Potential COCs	Status	Description
49	49		Inspect	2014	All	Completed	Conducted 746 device inspections on the 823 known stormwater treatment devices City wide, including 52 new devices signed off or inspected
50	50		Inspect	2014	All	Completed	175 business inspections and follow up visits in the Foss Waterway Watershed and 533 business inspections and follow up visits City wide
51	51		Inspect	2014	All	Completed	Fifteen SWPPs and maps were reviewed and updated for City Facilities; completed site specific SWPP training
52	52		Manual	2007	All	Completed	Surface Water Manual 2008 ed
53	53		Manual	2/27/2007	All	Completed	Surface Water Manual 2009 revision
54	54		Manual	1/1/2012	All	Ongoing	Surface Water Manual 2012 revision
55	55		Manual	2013	All	Ongoing	Work on the City of Tacoma Stormwater Management Manual - Proposed 2015 edition is underway
56	56		Manual	2014	All	Ongoing	Work on the City of Tacoma Stormwater Management Manual - Proposed 2015 edition is underway and is expected to be effective in mid-2015
57	57		Permit	2/27/2007	All	Complete	City-wide NPDES Phase 1 Permit 2007-2012
58	58		Permit	8/1/2012	All	Ongoing	City-wide NPDES Phase 1 Permit 2012 & 2013-2018
59	59		Permit	2014	All	Ongoing	Implementation of 2013-2018 City-Wide NPDES Phase 1 Permit
60	60		SD Maint	2000-2014	All	Ongoing	Catch Basin and Stormwater Facilities Maintenance Programs
61	61		Spills	2000-2014	All	Ongoing	City-wide Spills/Complaints Response
62	62		Spills	2002	All	Completed	152 spills/complaints
63	63		Spills	2003	All	Completed	197 spills/complaints
64	64		Spills	2004	All	Completed	182 spills/complaints
65	65		Spills	2005	All	Completed	176 spills/complaints
66	66		Spills	2006	All	Completed	219 spills/complaints
67	67		Spills	2007	All	Completed	158 spills/complaints
68	68		Spills	2008	All	Completed	144 spills/complaints
69	69		Spills	2009	All	Completed	147 spills/complaints
70	70		Spills	2010	All	Completed	Spills/complaints: Thea Foss 212; City Wide 977
71	71		Spills	2011	All	Completed	Spills/complaints: Thea Foss Basin 262; City Wide 864
72	72		Spills	2012	All	Completed	322 spills/complaints
73	73		Spills	2013	All	Completed	284 spills/complaints
74	74		Spills	2014	All	Completed	230 spills/complaints
75	75		Sweeping	2010 - 2014	All	Ongoing	Street Sweeping Circuit
OF230 Basin							
76	1		Cleanup 1	2006	Metals, PAH	Completed	Parcel 5 site cleanup Ecology lead
77	2		Cleanup 2	2009-2010	Solvents	Ongoing	Sauro's Cleanerama, 14th & Pacific future cleanup and development
78	3		Const 1	2001	TSS	Completed	Art Museum Construction
79	4		Const 2	11/1/2001	TSS	Completed	Pierce County Jail Construction
80	5		Const 3	2002	TSS	Completed	LINK Construction
81	6		Const 4	2002	TSS	Completed	Museum of Glass and Thea's Landing Construction Dock Street
82	7		Const 5	2003	TSS	Completed	Albers Mill Construction
83	8		Const 6	11/2003-10/2004	TSS	Completed	Courtyard Marriot Construction
84	9		Const 7	2004	TSS	Completed	U of W Tacoma Campus Construction – 2 buildings
85	10		Const 8	2004	TSS	Completed	St. Joseph Hospital Construction
86	11		Const 9	2004	TSS	Completed	Esplanade Construction on Thea Foss Waterway
87	12		Const 10	8/1/2004	TSS	Completed	Marcourt Building 744 Market Street Construction
88	13		Const 11	11/1/2004	TSS	Completed	Convention Center Construction completed
89	14		Const 12	7/2004-2/2005	TSS	Completed	Pacific Ave. was rebuilt for several blocks
90	15		Const 13	10/1/2006	TSS	Completed	708 Market St Construction
91	16		Const 14	10/1/2006	TSS	Completed	1501 Tacoma Ave Condos Construction
92	17		Const 15	11/1/2006	TSS	Completed	Market Street:13th-15th Street Apartments
93	18		Const 16	2007	TSS	Completed	Dock Street Condos Construction
94	19		Const 17	2007	TSS	Completed	St. Helen & 4th-6th Street Construction. Media Filter added
95	20		Const 18	10/1/2007	TSS	Completed	505 Broadway Condos Construction
96	21		Const 19	2008	TSS	Completed	Fawcett Ave & 13th Construction
97	22		Const 20	1/2008-3/2008	TSS	Completed	Dock Street Pump Station Construction
98	23		Const 21	2009	TSS	Completed	S 13th and Pacific Ave Luzon building demo
99	24		Const 22	2009-2010	TSS	Completed	Broadway/St. Helens LID construction

Table 2-1
Master Spreadsheet for Source Control Actions

Action Number	Action Number by Basin	Sub Basin	Action	Date	Potential COCs	Status	Description
100	25		Const 23	2010	TSS	Completed	S 13th and Pacific Ave Luzon building construction
101	26		Const 24	2011	TSS	Ongoing	1142 S Fawcett Ave Condos: Jan-Sept 2011
102	27		Const 25	2011	TSS	Ongoing	2120 South C Street old Heidelberg demo
103	28		Const 26	2012	TSS	Completed	Foss Waterway Seaport Renovation
104	29		Const 27	2012	TSS	Ongoing	Building removal and site redevelopment at old Colonial Fruit Warehouse
105	30		Const 28	2012	TSS	Completed	Construction site washout - South 9th and Broadway
106	31		Const 29	2012-2013	TSS	Ongoing	Pacific Avenue Streetscape Project
107	32		Const 30	2013	TSS	Ongoing	University YMCA - South 17th and Market
108	33		Const 31	2013-2014	TSS	Completed	"A" St Treatment System
109	34		Edu 1	7/2005	All	Completed	"A" St Restaurants Grease education program
110	35		Edu 2	2006	All	Completed	SW/auto care public education program Pie grant study
111	36		Edu 3	3/2007	All	Completed	Cigarette Butt public education program
112	37		Edu 4	7/2/2005	All	Completed	Public Market Flyer and education
113	38		Inspect 1	2006	TSS	Completed	1 BMP inspected
114	39		Inspect 2	10/2006-11/2006	Unknown	Completed	700 E D Street, Process Water Discharge (fish parts)
115	40		Inspect 3	2007	TSS	Completed	2 BMP inspected
116	41		Inspect 4	2007-2011	All	Completed	100% of area inspected
117	42		Inspect 5	2008	TSS	Completed	1 BMP inspected
118	43		Inspect 6	2009	All	Completed	226 concentrated business inspections in the 230 Basin.
119	44		Inspect 7	2010	All	Completed	260 concentrated business inspections in the 230 Basin.
120	45		Inspect 8	2011	All	Completed	62 business inspections in the 230 Basin.
121	46		Inspect 9	10/2009	All	Completed	Multicare Hospital Complex inspected
122	47		Inspect 10	10/2009	All	Completed	PC Jail, buildings and WA National Guard Armory inspected and mapped.
123	48		Inspect 11	2010	All	Completed	St. Joseph Hospital Complex inspected
124	49		Inspect 12	2010	All	Completed	Bates Community College inspected.
125	50		Inspect 13	2010	All	Completed	Republic Parking Facilities inspected.
126	51		Inspect 14	2012	All	Completed	29 business inspections in the OF 230 basin
127	52		Inspect 15	2013	All	Completed	49 business inspections in the OF 230 basin
128	53		Inspect 16	2014	All	Completed	37 business inspections in the OF 230 basin
129	54		Inspect 17	2013-2014	PCB, HG, PAH, DEHP	Ongoing	FD18 and FD3A Source Control Investigation
130	55		Maint 1	12/2000	All	Completed	Pipe cleaned in upper reaches of 230 near St. Joseph Hospital
131	56		Maint 2	2000-2011	All	Ongoing	BIA sweeping and trash collection
132	57	FD3B	Maint 3	2/1/2002	TSS	N/A	FD3B sediment trap filled with gravel
133	58		Maint 4	11/1/2002	TSS	Completed	Hood Street pipe rebuilt after earthquake damage
134	59		Maint 5	2006	All	Completed	Curb marking
135	60	FD3A	Maint 6	1/1/2006	All	Completed	Cleaned/TVed FD3A.
136	61		Maint 7	2007	Unknown	Ongoing	Eroded pipe segments and other pipe drilled through the storm lines.
137	62		Maint 8	3/12-5/14/2007	All	Completed	Cleaned/TVed entire municipal storm drainages.
138	63		Maint 9	3/2007-5/2007	All	Completed	Abandoned and filled pipe on Court A from 15th to 13th Sts. Redirected to new pipe on A St.
139	64		Maint 10	6/2010-11/2010	All	Completed	CIPP Stormwater pipe retrofit - 13,500 feet relined.
140	65		Maint 11	2012	All	Completed	Enhanced street sweeping, general system cleaning and maintenance
141	66		Maint 12	2013	All	Completed	Enhanced street sweeping, general system cleaning and maintenance
142	67		Maint 13	2013	All	Completed	CIPP Stormwater pipe retrofit - 16,274 feet cleaned and inspected, 13,807 feet relined.
143	68		Maint 14	2013	All	Completed	Enhanced street sweeping, general system cleaning and maintenance
144	69		Maint 15	2014	All	Completed	Enhanced street sweeping, general system cleaning and maintenance
145	70		Onsite Fac 1	2003-2004	TSS	Completed	11 media filters,1 bioswales, 3 vortex separators, 2 o/w separators/wet vaults
146	71		Onsite Fac 2	2005	TSS	Completed	2 o/w separators/wet vaults, 1 bioswales
147	72		Onsite Fac 3	2006	TSS	Completed	4 media filter, 2 bioswale
148	73		Onsite Fac 4	2007	TSS	Completed	1 media filter
149	74		Onsite Fac 5	2008	TSS	Completed	8 media filters, 8 bioswale
150	75		Onsite Fac 6	2009	TSS	Completed	2 media filters
151	76		Onsite Fac 7	2011	TSS	Completed	3 media filters
152	77		Onsite Fac 8	2012	TSS	Completed	2 media filters

Table 2-1
Master Spreadsheet for Source Control Actions

Action Number	Action Number by Basin	Sub Basin	Action	Date	Potential COCs	Status	Description
153	78		Onsite Fac 9	2013	TSS	Completed	8 media filters -3 sites , 1 stormwater vault, 1 bioswale
154	79		Onsite Fac 10	2014	TSS	Completed	2 media filters - 1 detention vault and 1 detention pond
155	80		Fine/Violation 1	2012	Soapy water	Completed	Sheer Vision Company - warning letter for discharge of sudsy water
156	81		Fine/Violation 2	2013	Sediment	Completed	Americall Communications and Messaging Systems - Warning letter for catch basins exceeding maintenance threshold
157	82		Fine/Violation 3	2014	Sediment	Completed	Northwest Cascade - warning letter for failure to install proper BMPs at their construction site
158	83		Fine/Violation 4	2014	Sediment	Completed	Northwest Cascade - Notice of Violation for failure to implement BMPs at their construction site
159	84		Fine/Violation 5	2014	Concrete	Completed	Conco - Warning letter for discharge of concrete materials
160	85		Fine/Violation 6	2014	TPH/PAH	Completed	Kevin's Auto Repair - warning letter for discharge of oily sheen due to poor housekeeping
161	86		Point Source 1	2005-2006	Solvent	Low Risk	Found oil/solvent groundwater to CB at South 17th & Court "C". TPCHD/Ecology.
162	87		Point Source 2	1/2006-4/2006	Hg	Completed	Hg removed from CB, S. 11^{th} and Yakima parking area, Bates Technical College. CB and private system cleaned
163	88		Point Source 3	2008	Unknown	Completed	C Ct. restaurants leaking dumpster/compactor re-routed to sanitary.
164	89		Point Source 4	8/1/2010	Unknown	Completed	Russell Investments 900 employees moved to Seattle
165	90		Spill 1	2009	Unknown	Completed	PAM spill response and containment
166	91		Spill 2	3/16/2011	Unknown	Completed	Sanitary sewer collapse. SSO to Outfall 230
167	92		UST 1	2003-2004	Unknown	Ongoing	TPCHD Act program which finds and removes old USTs.
168	93		UST 2	3/1/2007	PAH	Completed	USTs removed Dock Street Project
169	94		UST 3	5/1/2007	PAH	Completed	USTs removed South 17^{th} & Tacoma Ave
170	95		UST 4	8/1/2007	PAH	Completed	2 USTs removed near 15^{th} Street overpass
171	96		UST 5	2008	PAH, TPH	Completed	Plaza Parking Garage expansion, removed 3 USTs and contamination.
172	97		UST 6	3/1/2008	PAH, TPH	Completed	2 USTs removed along Dock Street, BNSF track relocation
173	98		UST 7	2009	PAH, TPH	Completed	UST removed Broadway LID construction.
174	99		UST 8	10/2011-1/2012	PAH, TPH	Completed	1 UST @ 902 S. Market St, Urban Grace/First Baptist Church.
175	100		UST 9	8/1/2012	PAH, TPH	Ongoing	3 UST @ 1701xx Court C
176	101		UST 10	8/1/2012	PAH, TPH	Ongoing	1 UST @ 732 Commerce Street
177	102		UST 11	2013	PAH, TPH	Completed	1 UST @ Tenant spaces at 714 Pacific Ave
178	103		UST 12	2013	PAH, TPH	Completed	1 UST @ Multi-tenant commercial building at 905 Pacific Ave
179	104		UST 13	2013	PAH, TPH	Completed	1 UST @ 1701 Court C
180	105		UST 14	2013	PAH, TPH	Completed	1 UST @ 1015 Pacific Ave
181	106		UST 15	2013	PAH, TPH	Ongoing	1 UST permit issued @ Chase Bank at 1102 Pacific Avenue
182	107		UST 16	2013-2014	PAH, TPH	Completed	1 UST permit issued @ Learning Sprout at 809 Pacific Avenue. Action completed on April 14, 2014
183	108		UST 17	2013	PAH, TPH	Ongoing	1 LUST cleanup initiated at Topping Motors
184	109		UST 18	2013	PAH, TPH	Ongoing	1 LUST Ecology supervised or conducted cleanup planned at Sevencom located at 717-737 Market St
185	110		UST 19	2014	PAH, TPH	Ongoing	1 LUST independent action awaiting cleanup at Main Street Grocery located at 901 Martin Luther King Way
OF235 Basin							
186	1		Cleanup 1	2001	TCE	Ongoing	U of W Tacoma groundwater investigation for Solvents Ecology and TPCHD oversight
187	2		Cleanup 2	2001	PAH	Completed	Standard Chemical Site, Ecology – coal tar.
188	3		Const 1	2001	TSS	Completed	U of W Tacoma Science Building Construction
189	4		Const 2	2002	TSS	Completed	Art Museum Construction
190	5		Const 3	2003	TSS	Completed	LINK Construction
191	6		Const 4	2004	TSS	Completed	Albers Mill Construction
192	7		Const 5	2004	TSS	Completed	U of W Tacoma Campus Construction – 2 buildings
193	8		Const 6	2005	TSS	Completed	St. Joseph Hospital Construction
194	9		Const 7	2006	TSS	Completed	Commerce & 19^{th} Construction
195	10		Const 8	2006	TSS	Completed	6^{th} & Fawcett Construction
196	11		Const 9	2006	TSS	Completed	1717 Market Street Construction
197	12		Const 10	2006	TSS	Completed	UWT Construction
198	13		Const 11	2007	TSS	Completed	Pacific Ave. was rebuilt for several blocks
199	14		Const 12	2007	TSS	Completed	Goodwill Construction
200	15		Const 13	2007-2011	TSS	Completed	UWT Construction - Joy Building
201	16		Const 14	2010	TSS	Completed	UWT Construction - Jet Building
202	17		Const 15	2011	TSS	Ongoing	UWT Construction - 4 Story building and sky bridge to Tioga building
203	18		Const 16	2011	TSS	Ongoing	St. Joseph Hospital Parking Garage Construction

Table 2-1
Master Spreadsheet for Source Control Actions

Action Number	Action Number by Basin	Sub Basin	Action	Date	Potential COCs	Status	Description
204	19		Const 17	8/2011 - 2013	TSS	Completed	Holiday Inn Express Construction 21st & C St
205	20		Const 18	2013-2014	TSS	Ongoing	The Henry - 1933 Dock Street
206	21		Edu	2007	All	Completed	SW/auto care public education program Pie grant study
207	22		Inspect 1	2007-2011	All	Completed	100 % area inspected
208	23		Inspect 2	2007	TSS	Completed	1 BMP inspected
209	24		Inspect 3	2008	TSS	Completed	4 BMP inspected
210	25		Inspect 4	2008	TSS	Completed	3 BMP inspected
211	26		Inspect 5	2008	Metals	Completed	Bronze Works wastewater – pretreatment program
212	27		Inspect 6	2009	All	Completed	51 concentrated business inspections in the 235 Basin.
213	28		Inspect 7	2010	All	Completed	56 concentrated business inspections in the 235 Basin.
214	29		Inspect 8	2011	All	Completed	8 business inspections in the 235 Basin.
215	30		Inspect 9	2009	All	Completed	UWT Campus and SW Trmt Facilities Inspected/cleaning needed
216	31		Inspect 10	2010	All	Completed	Multicare Hospital Complex inspected
217	32		Inspect 11	2010	All	Completed	St. Joseph Hospital Complex inspected
218	33		Inspect 12	2010	All	Completed	WSDOT Pond 21st & Pacific
219	34		Inspect 13	2010	All	Completed	City Shops - paint/carpentry BMPs/inspections completed
220	35		Inspect 14	2010-2011	All	Completed	Esplanade cleaning of sidewalks needed BMPs
221	36		Inspect 15	2012	All	Completed	30 business inspections completed in the OF235 drainage basin
222	37		Inspect 16	2013	All	Completed	61 business inspections completed in the OF235 drainage basin
223	38		Inspect 17	2014	All	Completed	46 business inspections completed in the OF235 drainage basin
224	39		Inspect 18	2014	Lead, PAH, Phthalates	Ongoing	Source control investigation for lead, PAHs and phthalates in stormwater/baseflow
225	40		Maint. 1	2000-2009	Unknown	Completed	Emergency repair of collapsed storm/sanitary sewers at 21st and Jefferson.
226	41		Maint. 2	2002-2008	None	Completed	Mapped Court House and Washington State Museum storm drains.
227	42		Maint. 3	2003-2004	None	Completed	Located missing manhole on SR-705
228	43		Maint. 4	10/1/2005	All	Completed	Curb marking
229	44		Maint. 5	9/1/2006	Unknown	Ongoing	Eroded pipe segments and other pipe drilled through the storm lines.
230	45		Maint. 6	2000-2014	All	Ongoing	BIA sweeping and trash collection
231	46		Maint. 7	8/1/2007	All	Completed	Cleaned/TVed entire municipal storm drainages.
232	47		Maint 8	2012	All	Completed	Enhanced street sweeping, general system cleaning and maintenance
233	48		Maint 9	2013	All	Completed	CIPP Stormwater pipe retrofit - 5,738 feet cleaned and inspected, 5,479 feet relined.
234	49		Maint 10	2013	All	Completed	Enhanced street sweeping, general system cleaning and maintenance
235	50		Maint 11	2014	All	Completed	Enhanced street sweeping, general system cleaning and maintenance
236	51		Onsite Fac 1	12/2002-3/2003	All	Completed	L Street Rain Gardens constructed
237	52		Onsite Fac 2	2003-2004	TSS	Completed	1 media filters
238	53		Onsite Fac 3	2003-2004	TSS	Completed	1 media filter, 1 bioswale
239	54		Onsite Fac 4	2003-2004	TSS	Completed	1 vortex separator
240	55		Onsite Fac 5	2007-2009	TSS	Completed	5 media filters, 1 bioswale
241	56		Onsite Fac 6	2009-2010	TSS	Completed	5 media filters,1 bioswales, 2 vortex separators, 4 o/w seperators/wet vaults
242	57		Onsite Fac 7	2010	TSS	Completed	10 media filters - 4 sites
243	58		Onsite Fac 8	2012	TSS	Completed	3 media filters - 3 sites
244	59		Onsite Fac 9	2013	TSS	Completed	2 media filters - 1 site
245	60		Onsite Fac 10	2014	All	Completed	Hood Street Treatment Retrofit Project
246	61		Fine/Violation 1	2/1/2012	TSS	Ongoing	Holiday Inn Express Construction 21st & C St - Second Warning Letter
247	62		Fine/Violation 2	2013	TSS	Completed	Warning Letter - UW Tacoma for failure to maintain private storm system
248	63		Point Source 1	7/2004-2/2005	All	Completed	City Shop III moved to Basin 237A.
249	64		Point Source 2	5/15- 6/25/2007	BTEX	Completed	Pugnetti Park gasoline (BTEX) in ground, Ecology oversight.
250	65	FD6A	Point Source 3	Jul-07	DEHP	Completed	Dumpster draining to storm at local hospital was removed
251	66		UST 1	10/2002-2006	PAH, TPH	Completed	USTs removed at old Chevron on Pacific Ave
252	67		UST 2	10/2007-12/2007	PAH, TPH	Completed	3 USTs removed at 23rd St & K, L, and M Streets.
253	68		UST 3	2011-2012	PAH, TPH	Ongoing	5 USTs @ 2120 S. C St, Former Heildelberg Brewery.
254	69		UST 4	2/1/2012	PAH, TPH	Completed	1 UST removed at UW Joy Building including removal of contaminated soils
255	70		UST 5	7/5/1905	PAH, TPH	Completed	1 UST @ RMC International at 2112 Jefferson Ave

Table 2-1
Master Spreadsheet for Source Control Actions

Action Number	Action Number by Basin	Sub Basin	Action	Date	Potential COCs	Status	Description
256	71		UST 6	2013	PAH, TPH	Completed	1 UST @ a vacant property at 2112 Jefferson Ave
OF237A Basin							
257	1		Cleanup 1	Dec 02-Mar 03	PAH	Completed	Standard Chemical Site, Ecology – coal tar.
258	2		Cleanup 2	8/1/2003	Pb	Completed	Site soil cleanup for lead, Police headquarters and Fleet Maintenance
259	3		Cleanup 3	2003-2004	TSS	Completed	Construction and Waste removed - Tacoma Rescue Mission.
260	4	FD13/FD13B	Cleanup 4	2007	PAH, TPH	Completed	Key Bank soil/CB cleanup completed.
261	5		Const 1	2004-2005	TSS	Completed	Police headquarters and Fleet Maintenance
262	6		Const 2	7/2004-2/2005	TSS	Completed	Pacific Ave. was rebuilt for several blocks
263	7		Const 3	2005	TSS	Completed	BNRR realignment project: 60' outfall extension, new manhole structures, 23rd Street lateral (FD2A) included.
264	8		Const 4	12/1/2006	TSS	Completed	Sink holes at I5 Yakima/Delin Construction
265	9		Const 5	2007	TSS	Completed	25th & Yakima Ave
266	10		Const 6	2007	TSS	Completed	WSDOT Freeway right-of-way HOV Lanes on SR-16
267	11		Const 7	1/1/2007	TSS	Completed	I5 Yakima/Delin/G St Construction
268	12		Const 8	1/1/2007	TSS	Completed	I5 Yakima/Delin/G St Construction
269	13		Const 9	12/1/2007	TSS	Completed	WSDOT M St. grading/stockpile runoff treated
270	14		Const 10	2008	TSS	Completed	WSDOT Freeway right-of-way HOV Lanes on I-5,
271	15		Const 11	2008-2009	TSS	Completed	Goodwill Construction 27th St & Tacoma Ave
272	16		Const 12	2009-2011	TSS	Ongoing	WSDOT Construction Freeway right-of-way entire SR-16 interchange
273	17		Const 13	2011-2012	TSS	Ongoing	SAD: WSDOT SR-16 interchange; 12,829,299 gals discharged
274	18		Const 14	2010-2012	TSS	Ongoing	Sound Transit, D to M Street Corridor
275	19		Const 15	2011	TSS	Ongoing	SAD: Sound Transit, D to M Street Corridor; 45,236,634 gals discharged
276	20		Const 16	2/1/2011	TSS	Completed	Tacoma Street & Grounds Shop III Building Collapse cleanup
277	21		Const 17	7/4/2005	TSS	Completed	Walmart
278	22		Const 18		TSS	Ongoing	Water Ditch Trail
279	23		Const 19	Jul-05	TSS	Completed	South 25th St Road Improvements
280	24		Fac 1	2006	TSS	Completed	I5 - Yakima and M St Ponds constructed
281	25		Fac 2	2009	TSS	Completed	I5 – 3 MG Pond constructed
282	26	FD13/FD13B	Fac 3	2010	TSS	Completed	StormFilter Retrofit on-line
283	27		Fac 4	2011	TSS	Future	I5 – 22 MG Pond
284	28		Fine 1	6/1/2010	TSS	Completed	Notice of Violation Bill's Towing
285	29		Fine 2	10/13/2011	PAH, TPH	Completed	Notice of Violation Heating oil tank drained onto lawn
286	30		Fine/Violation 3	2012	TSS	Completed	Warning Letter - Sound Transit D to M Streets Track and Signal Project. Untreated water bypassing the treatment facility
287	31		Fine/Violation 4	2012	Unknown	Completed	Notice of Violation - Sound Transit D to M Streets Track and Signal Project. Untreated water bypassing the treatment facility
288	32		Fine/Violation 5	2013	Food waste	Completed	Warning letter - Red Robin - discharge of prohibited materials
289	33		Fine/Violation 6	2013	Wash water	Completed	Warning letter and second warning letter - Mr. Truck Wash - discharge of wash water
290	34		Fine/Violation 7	2013	TSS	Completed	Warning letter - WSDOT - discharge of turbid water
291	35		Fine/Violation 8	2013	Wash water	Completed	Warning letter - First Cousins Detail - discharge of wash water
292	36		Fine/Violation 9	2013	Unknown	Completed	Warning letter - Performance Abatement Services - discharge of process wastewater
293	37		Fine/Violation 10	2013	TSS	Completed	Warning letter - Northwest Landscape Services - discharge of turbid water and oil
294	38		Fine/Violation 11	2014	TSS	Completed	Notice of Violation issued to Rodarte Construction Inc for failure to implement proper BMPs
295	39		Fine/Violation 12	2014	Cornstarch	Completed	Notice of Violation issued to Viral Events for discharge of polluting materials
296	40		Fine/Violation 13	2014	TSS	Completed	Warning letter issued to City's Street Operations Asphalt Plant for failure to follow procedures
297	41		Inspect 1	2002	Unknown	Completed	Operations greatly reduced at Birds Eye (formerly Nalley's Fine Foods).
298	42		Inspect 2	2002	Unknown	Completed	Atlas Foundry zero discharge for stormwater runoff.
299	43		Inspect 3	11/1/2003	TSS	Completed	Cleaning/maintenance of the Coca-Cola Truck Yard SW treatment system.
300	44		Inspect 4	2003-2004	TSS	Completed	CB filters installed at Tacoma Mall
301	45		Inspect 5	2003-2004	All	Completed	Joint inspections with Ecology/TPCHD in the South Tacoma Groundwater Protection District.
302	46	FD10/FD13	Inspect 6	2003-2004	All	Completed	Targeted business inspections
303	47		Inspect 7	2005	All	Completed	Business Inspections - South Tacoma Trunkline.
304	48		Inspect 8	7/1/2005	All	Completed	TNT inspection – Oil Tank and UST found
305	49		Inspect 9	2006	TSS	Completed	6 BMP inspected
306	50		Inspect 10	2007	TSS	Completed	6 BMP inspected

Table 2-1
Master Spreadsheet for Source Control Actions

Action Number	Action Number by Basin	Sub Basin	Action	Date	Potential COCs	Status	Description
307	51		Inspect 11	12/1/2007	All	Completed	TNT inspection – no petroleum leak
308	52		Inspect 12	2009	All	Completed	252 Concentrated business inspections.
309	53		Inspect 13	2011	All	Completed	251 business inspections.
310	54		Inspect 14	2007-2011	All	Completed	Concentrated business inspections - 100% area completed
311	55		Inspect 15	2008	TSS	Completed	7 BMP inspected
312	56		Inspect 16	2008	All	Completed	Business Inspections - South Tacoma Trunkline.
313	57		Inspect 17	2009	All	Completed	Business Inspections with TPCHD in S. Tacoma Channel Groundwater Protection District.
314	58		Inspect 18	2009	Unknown	Completed	Tacoma Dome grease traps connections confirmed
315	59		Inspect 19	2010	Unknown	Completed	261 targetted business inspections
316	60	FD13/FD13B	Inspect 20	2010	PAH	Completed	Concentrated business inspections in subbasin
317	61		Inspect 21	2010	PAH, Metals	Completed	WSDOT Stormwater Ponds inspections
318	62	FD13/FD13B	Inspect 22	3/1/2011	PAH, Metals	Completed	Tacoma News Tribune inspections: cooling tower to sanitary/fuel island
319	63	FD13/FD13B	Inspect 23	2011	Metals	Completed	DSHS inspections: cooling tower from storm to sanitary
320	64		Inspect 24	2012	All	Completed	76 business inspections completed in the OF237A drainage basin
321	65		Inspect 25	2013	All	Completed	97 business inspections completed in the OF237A drainage basin
322	66		Inspect 26	2014	All	Completed	73 business inspections completed in the OF 237A drainage basin
323	67		Maint 1	8/2006-3/2007	Unknown	Completed	3,000' SW pipe upgrade on Center St for trunk line at Cedar and Center Streets, and the Leach Creek Force main.
324	68		Maint 2	2008	TSS	Completed	Large void at intersection of So. 26th and Jefferson repaired.
325	69		Maint 3	4/28-8/8/2008	All	Completed	Targeted areas of Basin 237A were cleaned/TVed, north of Center Street, all sediment trap monitored drainage areas
326	70		Maint 4	2012	All	Completed	Enhanced street sweeping, general system cleaning and maintenance
327	71		Maint 5	2013	All	Completed	Enhanced street sweeping, general system cleaning and maintenance
328	72		Maint 6	2013	All	Completed	CIPP Stormwater pipe retrofit - 5,666 feet cleaned and inspected, 5,126 feet relined.
329	73		Maint 7	2014	All	Completed	Enhanced street sweeping, general system cleaning and maintenance
330	74		Onsite Fac 1	2003-2004	TSS	Completed	7 media filters, 3 bioswales, 9 vortex separators, 6 o/w separators/wet vaults
331	75		Onsite Fac 2	2005	TSS	Completed	5 media filters, 6 bioswales
332	76		Onsite Fac 3	2006	TSS	Completed	15 media filter, 1 bioswale, 1 vortex separators 4 o/w separators/wet vaults
333	77		Onsite Fac 4	2008	TSS	Completed	3 bioswale
334	78		Onsite Fac 5	2009	TSS	Completed	3 media filters, 1 bioswale
335	79		Onsite Fac 6	2009	All	Completed	Classy Chassy Carwash ows for carwash to sanitary
336	80		Onsite Fac 7	2010	TSS	Completed	8 sites with media filters
337	81		Onsite Fac 8	2009-2011	PAH, TPH	Completed	Petro-Card ows to sanitary
338	82		Onsite Fac 9	2011	TSS	Completed	5 sites w/media filters; 4 sites w/ infiltration
339	83		Onsite Fac 10	2012	TSS	Completed	2 media filters, one porous asphalt, three bioswales - 6 sites
340	84		Onsite Fac 11	2013	TSS	Completed	60 media filters - 5 sites, 2 coalescing oil water separators - 2 sites
341	85		Onsite Fac 12	2014	TSS	Completed	7 treatment devices at 6 locations - 2 stormfilter CBs with 1 filter each, 1 SDGSW with 18 stormfilter cartridges, 1 48-inch stormwater MH with 3 filters, 3 stormfilter CBs with 2 filters each (2 at 1 site), and 1 72-inch stormfilter MH with 4 filters
342	86		Point Source 1	3/1/2003	PAH	Completed	WSDOT sealed the DA-1 Line.
343	87		Point Source 2	9/1/2003	PAH, unknown	Completed	Alpine Cold Storage fire, 25th & Holgate.
344	88	FD-2A	Point Source 3	2004	Hg	Completed	Neon sign businesses relocated or shut down.
345	89	FD10	Point Source 4	2004	Hg	Completed	Ccircuit boards manufacturer on Lawrence Street shut down
346	90	FD10c	Point Source 5	2005-2011	PAH, unknown	Completed	Petro Card OWS to sanitary, S. 35th & Lawrence done Jul 2011
347	91		Point Source 6	10/1/2007	Unknown	Completed	Tacoma Mall misconnections removed.
348	92		Point Source 7	10/6/2007	PAH, unknown	Completed	Atlas Foundry major explosion and fire.
349	93		Point Source 8	2008	Unknown	Completed	Top Foods waste compactor to storm removed.
350	94		Point Source 9	2008	Unknown	Completed	City/County EOC, South 25th, a sewer misconnection fixed.
351	95	FD-2	Point Source 10	4/1/2009	Unknown	Completed	Elephant Car Wash misconnected to storm was corrected.
352	96	FD-2	Point Source 11	6/1/2009	Unknown	Completed	Business misconnected to storm was corrected.
353	97	FD-2	Point Source 12	4/22/2010	Unknown	Completed	Verticle World misconnected to storm was corrected.
354	98		Point Source 13	5/1/2009	PAH, unknown	Completed	Vehicle washing at TFD #9, South 18th & Cedar St.
355	99	FD-2A	Point Source 14	8/1/2010	Metals	Completed	Notice of Violation, The Bronze Works.
356	100		Point Source 15	6/1/2011	Unknown	Completed	Bird's Eye (Formerly Nalley's) closed, NPDES discharges ceased.
357	101	FD13/FD13B	Spill 1	1/4/2007	PAH, TPH	Completed	Key Bank diesel generator leak to soil/CB located.

Table 2-1
Master Spreadsheet for Source Control Actions

Action Number	Action Number by Basin	Sub Basin	Action	Date	Potential COCs	Status	Description
358	102		Spill 2	2008	TPH	Completed	Feral Transport trucks leaking on side street (WSP, Ecology and local agencies).
359	103		Spill 3	2009	TPH	Completed	EPA Criminal Dumping at Classy Chassy Carwash site
360	104		Spill 4	5/18/2010	PAH, TPH	Completed	Northbound I5 semi-truck fire - no release
361	105		Spill 5	6/16/2010	PAH, TPH	Completed	Home Biodeisel Fire - sheen on waterway
362	106		Spill 6	4/1/2011	PAH, TPH	Completed	Tacoma Streets & Grounds petroleum spill @ S 37th & G Street
363	107		Spill 7	11/16/2011	PAH, TPH	Completed	75 gal diesel spill from truck accident to WSDOT Pond @ Center St
364	108		UST 1	2004	PAH, TPH	Completed	48th St & Park Ave UST removed
365	109		UST 2	4/1/2004	PAH, TPH	Completed	3919 S Center St UST removed
366	110	FD-2	UST 3	2010-2011	PAH, TPH	Completed	Foremost 2413 Pacific Ave, 3 USTs removed/soil contamination remediated
367	111		UST 4	2012	PAH TPH	Ongoing	2340 S. Holgate - two large out-of-service gasoline fuel tanks identified
368	112		UST 5	2012	PAH TPH	Ongoing	1 UST @ the Elks Club 1965 S. Union St
369	113		UST 6	2012	PAH TPH	Completed	1 UST @ Apartment Complex at 3831 S. Yakima
370	114		UST 7	2012	PAH TPH	Ongoing	2 UST @ Cook's Concrete 1521 S. Grant Ave. LUST - independent action
371	115		UST 8	2013	PAH TPH	Completed	1 UST @ Claude C Purvis site at 3847 South Puget Sound
372	116		UST 9	2013	PAH TPH	Completed	1 UST @ Elks Club at 1965 S Union St
373	117		UST 10	2013	PAH TPH	Completed	1 UST @ On the Water LLC at 2502 South C St
374	118		UST 11	2013	PAH TPH	Ongoing	Permits for 2 UST actions at Foremost South located at 2413 Pacific Avenue
375	119		UST 12	2013	PAH, TPH	Ongoing	LUST cleanup initiated at Vern's Transmission at 3401 South G St
376	120		UST 13	2014	PAH, TPH	Completed	2 USTs at Time Oil at 1501 South Union Ave.
377	121		UST 14	2014	PAH, TPH	Ongoing	UST at US Bank at 2317 Pacific Avenue. Permit issued
378	122		UST 15	2014	PAH, TPH	Ongoing	LUST at Action Business Furniture at 102 South 24th St. Independent action, cleanup initiated
379	123		UST 16	2014	PAH, TPH	Ongoing	LUST at Tri-1 Food at 5602 Yakima Ave. Independent action awaiting cleanup
380	124		UST 17	2014	PAH, TPH	Ongoing	LUST at US Bank at 2317 Pacific Avenue. Awaiting cleanup
OF237B Basin							
381	1		Const 1	2005	None	Completed	60' OFs extended, new manhole structure
382	2		Const 2	2009-2010	TSS	Ongoing	Freeway right-of-way HOV Lanes on I-5,
383	3		Const 3	2010-2012	TSS	Completed	LeMay Museum - Warning letter for TSS in 2010
384	4		Const 4	2012	None	Completed	Tacoma Dome Roof Cleaning
385	5		Fac.	2001	All	Ongoing	Drainage pond- 5708 McKinley Avenue.
386	6		Fine/Violation 1	2013	TSS	Completed	Warning Letter - Northwest Cascade - mud on the roadway at construction site causing turbid water to storm drain
387	7		Inspect 1	2003-2004	All	Completed	Equipment washing stopped at S. 38th & Pacific Ave., A-Berg Equipment Rentals.
388	8		Inspect 2	2006	TSS	Completed	1 BMP inspected
389	9		Inspect 3	2007	TSS	Completed	5 BMP inspected
390	10		Inspect 4	2007-2011	All	Completed	100% of businesses/multi-family inspected.
391	11		Inspect 5	2008	TSS	Completed	9 BMP inspected
392	12		Inspect 6	2009	TSS	Completed	118 inspections
393	13		Inspect 7	2010	TSS	Completed	45 inspections
394	14		Inspect 8	2011	TSS	Completed	51 inspections
395	15		Inspect 9	2012	All	Completed	20 inspections completed in the OF237B drainage basin
396	16		Inspect 10	2013	All	Completed	12 inspections completed in the OF237B drainage basin
397	17		Inspect 11	2014	All	Completed	9 business inspections completed in the OF237B drainage basin
398	18		Inspect 12	2012-2013	PCBs	Completed	PCB source control investigation in area of FD34/FD35
399	19	FD31	Inspect 13	2004-2014	PAHs	Ongoing	PAH source tracing investigation in FD31 basin
400	20	FD31	Maint 1	2005	PAH, TPH	Completed	FD31 branch pipe cleaned/TVed.
401	21		Maint 2	2011	All	Completed	Entire system cleaned/TVed.
402	22		Maint 3	2012	All	Completed	Enhanced street sweeping, general system cleaning and maintenance
403	23		Maint 4	2013	All	Completed	Enhanced street sweeping, general system cleaning and maintenance
404	24		Maint 5	2014	All	Completed	Enhanced street sweeping, general system cleaning and maintenance
405	25		Onsite Fac 1	2003-2004	TSS	Completed	4 media filters,4 bioswales, 2 vortex separators/wet vaults
406	26		Onsite Fac 2	2005	TSS	Completed	6 media filters
407	27		Onsite Fac 3	2006	TSS	Completed	3 media filters, 2 bioswales,1 wetpond/detention pond
408	28		Onsite Fac 4	2008	TSS	Completed	7 media filters

Table 2-1
Master Spreadsheet for Source Control Actions

Action Number	Action Number by Basin	Sub Basin	Action	Date	Potential COCs	Status	Description
409	29		Onsite Fac 5	2009	TSS	Completed	1 media filter
410	30		Onsite Fac 6	2010	TSS	Completed	1 media filter and 4 biofiltration swales
411	31		Onsite Fac 7	2011	TSS	Completed	2 sites w/ media filters
412	32		Onsite Fac 8	2012	TSS	Completed	1 media filter
413	33		Onsite Fac 9	2013	TSS	Completed	7 media filters - 2 sites, 1 coalescing oil water separator, 1 bioswale
414	34		Onsite Fac 10	2014	TSS	Completed	3 treatment devices at 2 locations - OWS, 72 inch stormwater vault with 7 filters, and a bioswale
415	35		Point Source 1	2002	All	Completed	WSDOT Vactor Dump Site (South 38th) closed.
416	36		Point Source 2	2003	All	Completed	WSDOT Vactor Dump Site (South 38th) stormwater routed to pretreatment system then sanitary sewer.
417	37		Point Source 3	3/1/2003	All	Completed	WSDOT Vactor Dump Site (South 38th) permitted
418	38		Point Source 4	10/1/2004	Unknown	Completed	Cross-connection removed- Persian rug cleaning business
419	39	FD31	Point Source 5	2005	PAH, TPH	Completed	1950s UST (heating fuels) at Tacoma Public Schools Willard Staff
420	40	FD31	Point Source 6	2005	PAH, TPH	Completed	Neighborhood fueling station closed
421	41		Point Source 7	2005	Unknown	Ongoing	Old closed demolition landfill, S. 35th and Pacific Ave listed by TPCHD.
422	42		Point Source 8	2006	Unknown	Completed	Tacoma Dome equipment wash pad rerouted to sanitary.
423	43		Point Source 9	2008	Unknown	Completed	Ketebo Apartments, failing side sewer repaired.
424	44		Point Source 10	2008	Unknown	Completed	Lighthouse.cross- connection repaired
425	45		Spill 1	12/4/2010	PAH, TPH	Completed	1,000 gallon release cleanup completed.
426	46		UST 1	2003-2004	PAH, TPH	Completed	Several USTs/LUSTs removed.
427	47	FD31	UST 2	1/1/2006	PAH, TPH	Completed	Inspected 1950s UST (heating fuels) at Tacoma Public Schools Willard Staff
428	48	FD31	UST 3	11/1/2011	PAH, TPH	Completed	UST removed at Tacoma Public Schools Willard Staff
429	49	FD31	UST 4	7/3/2005	PAH, TPH	Ongoing	3402 Pacific Ave, EZ Mart, Phase I/II assesment, Possible UST
430	50		UST 5	2013	PAH, TPH	Completed	1 UST @ Fast Break Grocery at 6329 Pacific Avenue
431	51		UST 6	2013	PAH, TPH	Completed	1 UST @ McDonalds at 7217 Pacific Avenue
432	52		UST 7	2013	PAH, TPH	Ongoing	1 UST Permit issued for JFS #^$! Located at 3740 Pacific Ave
433	53		UST 8	2013	PAH, TPH	Ongoing	1 LUST cleanup initiated at Burns Arco at 716 East 64th St
434	54		UST 9	2013	PAH, TPH	Ongoing	1 LUST cleanups initiated at Larson & Sons at 6332 Pacific Ave
435	55		UST 10	2014	PAH, TPH	Completed	2 USTs at EZ Mart at 3402 Pacific Avenue
436	56		UST 11	2014	PAH, TPH	Ongoing	LUST at John's Tire Service at 5535 McKinley Avenue East. Independent action with cleanup initiated
OF243 Basin							
437	1		Cleanup 1	2002	Hg, DEHP	Completed	Pick's Cove sold & remediated. Now Foss Landing Marina.
438	2		Cleanup 2	5/1/2002	PAH	Completed	SR509 WSDOT Stormwater Ponds cleanup.
439	3		Cleanup 3	6/1/2003	Metals	Completed	American Plating Cleanup, Ecology
440	4		Cleanup 4	8/2008-9/2008	PAH	Completed	N.Pacific Rail yard oil pipeline Phase 1 cleanup D Street, SR509, WSDOT Stormwater Ponds rebuilt.
441	5		Cleanup 5	6/1/2009	PAH	Completed	N.Pacific Rail yard oil pipeline cleanup cleanup D Street & E 19th St.
442	6		Cleanup 6	2012	Metals	Completed	American Plating Cleanup and Site Development
443	7		Const 1	4/2006-6/2008	TSS	Completed	D Street Grade separation construction
444	8		Const 2	2013	TSS	Completed	Sound Transit, D to M Street Cooridor, utilities relocated near Frieghthouse
445	9		Inspect 1	6/4/2007	Unknown	Completed	LRI inspection/BMPs required.
446	10		Inspect 2	2008	Hg	Completed	Source traing using SSPM samples in laterals
447	11		Inspect 3	2009	Hg	Completed	Source traing using SSPM samples in laterals
448	12		Inspect 4	2011	All	Completed	5 business inspections
449	13		Inspect 5	2010	All	Completed	2 business inspections
450	14		Inspect 6	2011	All	Ongoing	BNSF Rail yard inspections - 11 subleases
451	15		Inspect 7	2012	All	Completed	5 business inspections completed in the OF243 drainage basin
452	16		Inspect 8	2013-2014	Mercury	Ongoing	Continued source control investigation for Mercury
453	17		Maint 1	9/1/2001	None	Completed	Tide Flex valve replaced
454	18		Maint 2	1/1/2002	PAH	Completed	WSDOT leg cleaned
455	19		Maint 3	2004	None	Completed	Railroad yards remodeled/stormwater system mapped
456	20		Maint 4	2005	None	Completed	SR509 storm system mapped.
457	21		Maint 5	2012	All	Completed	Enhanced street sweeping, general system cleaning and maintenance
458	22		Maint 6	2013	All	Completed	Enhanced street sweeping, general system cleaning and maintenance
459	23		Maint 7	2014	All	Completed	General system cleaning and maintenance

Table 2-1
Master Spreadsheet for Source Control Actions

Action Number	Action Number by Basin	Sub Basin	Action	Date	Potential COCs	Status	Description
460	24		Maint 8	2014	All	Ongoing	Enhanced street sweeping pilot project to address elevated lead and zinc in stormwater/baseflow
461	25		Onsite Fac 1	2001	TSS	Completed	Media filter
462	26		Onsite Fac 2	2003	TSS	Completed	Bioswale
463	27		Onsite Fac 3	6/1/2008	TSS	Completed	Media filter D Street Grade separation
464	28		Onsite Fac 4	2012	TSS	Completed	2 media filters
465	29		Spill 1	2007	Unknown	Completed	Starch spill on a rail spur cleaned.
466	30		Spill 2	6/4/2007	Unknown	Completed	LRI spill cleaned
467	31		Spill 3	2008	Unknown	Completed	Starch spill on a rail spur, Glacier Transport (now called Tanawax Trucking).
468	32		UST	6/1/2006	PAH, TPH	Completed	UST removed during D Street Grade separation
469	33		UST	8/1/2006	PAH, TPH	Completed	UST removed during D Street Grade separation
OF245 Basin							
470	1	MH390	Cleanup 1	1997	PAH	Completed	N.Pacific Rail yard oil pipeline cleanup cleanup D Street & E 19th St.
471	2	MH390	Cleanup 2	2008-2011	PAH	Completed	N.Pacific Rail yard oil pipeline cleanup D Street.
472	3	MH390	Fine 1	2000	PAH, TPH	Completed	Ecology fined SuperValu for spills
473	4	MH390	Fine 2	2000	PAH, TPH	Completed	Tacoma Fixture's spill, Ecology fine.
474	5	FD21/22	Inspect 1	2005	Phthalates	Completed	MPS Joint inspections and sampling with Ecology.
475	6	MH390	Inspect 2	2007	All	Closed	SQG hazardous Waste Facility closed.
476	7	MH390	Inspect 3	2008	All	Ongoing	Phoenix new waste treatment & transporter permitted. Trans-loading of hazardous waste shipments occur in the near by BNSF rail yard.
477	8	MH390	Inspect 4	2008	Unknown	Completed	LRI inspection/BMPs required.
478	9	MH390	Inspect 5	2010	All	Completed	7 business inspections
479	10	MH390	Inspect 6	2011	All	Completed	7 business inspections
480	11		Inspect 7	2012	All	Completed	4 business inspections in the OF245 drainage basin
481	12		Inspect 8	2013	All	Completed	4 business inspections in the OF245 drainage basin
482	13		Inspect 9	2013-2014	Phthalates	Ongoing	Continued joint work with TPCHD and Ecology at Truck Rail Handling site
483	14		Inspect 10	2014	All	Completed	3 business inspections in the OF245 drainage basin
484	15	MH390	Maint 1	10/1/2001	PAH	Completed	604' pipe slip-lined
485	16	MH390	Maint 2	9/1/2002	PAH	Completed	300' stormwater line & laterals replaced on E. 19th St.
486	17	MH390	Maint 3	3/1/2003	PAH	Completed	24' outfall pipe replaced with HPDE.
487	18	FD21/22	Maint 4	2/1/2004	All	Completed	Cleaned city lines from Quality Transport (MPS).
488	19	FD21/22	Maint 5	2008	All	Completed	Cleaned Quality Transport (MPS) pipes.
489	20	FD21/22	Maint 6	2009	All	Completed	Cleaned Quality Transport (MPS) pipes.
490	21		Maint 7	2012	All	Completed	Enhanced street sweeping, general system cleaning and maintenance
491	22		Maint 8	2013	All	Completed	Enhanced street sweeping, general system cleaning and maintenance
492	23		Maint 9	2014	All	Completed	General system cleaning and maintenance
493	24		Maint 10	2014	All	Ongoing	Enhanced street sweeping pilot project to address elevated lead and zinc in stormwater/baseflow
494	25	MH390	Onsite Fac. 1	5/1/2004	TSS	Completed	Media filter installed (basic treatment)
495	26	MH390	Onsite Fac. 2	8/1/2004	PAH, TPH	Completed	SuperValu 5 oil/water separators onsite.
496	27	MH390	Onsite Fac. 3	2010	PAH, TPH	Completed	SuperValu 3 oil/water separators onsite.
497	28		Onsite Fac 4	2013	TSS	Completed	1 media filter
498	29	MH390	Point Source 1	9/1/2004	PAH	Completed	TVed petroleum/tar blobs in pipe E. 19th St.
499	30	MH390	Point Source 2	7/1/2005	PAH	Completed	TVed petroleum/tar blobs in pipe E. 19th St., see cleanup 2008
500	31	MH390	Spill 1	12/1/2006	Unknown	Completed	Starch spill on a rail spur cleaned.
501	32	MH390	Spill 2	6/4/2007	TPH	Completed	Matrix Trucking petroleum spill
502	33	MH390	Spill 3	6/4/2007	Unknown	Completed	LRI spill cleaned
503	34	MH390	Spill 4	9/1/2007	PAH, TPH	Completed	4 petroleum spills SuperValu's OF249
504	35	MH390	Spill 5	12/2/2010	PAH, TPH	Completed	Diesel Truck Fire, contained
505	36	MH390	UST 1	10/1/2007	PAH	Completed	3 USTs removed at Nichols Trucking
506	37	MH390	UST 2	2007-2008	PAH	Completed	Diesel UST removed at Tacoma Fixtures
507	38	MH390	UST 3	7/1/2009	PAH	Completed	Diesel UST removed at Tacoma Fixtures
OF254 Basin							
508	1		Cleanup 1	12/1/2006	Metals, PAHs, PCBs	Completed	Site cleanup. Port of Tacoma ownership
509	2		Cleanup 2	2010	PAH	Completed	N.Pacific Rail yard oil pipeline cleanup D Street.

Table 2-1
Master Spreadsheet for Source Control Actions

Action Number	Action Number by Basin	Sub Basin	Action	Date	Potential COCs	Status	Description
510	3		Const 1	2003	TSS	Completed	INS Detention Facility Construction
511	4		Const 2	2003-2004	TSS	Completed	Panattoni site construction
512	5		Const 3	1/2006-12/2006	TSS	Completed	Portside Warehouse Facility
513	6		Const 4	2007	TSS	Completed	INS Detention Facility Expansion Construction
514	7		Const 5	10/2008-2009	TSS	Completed	Ecology fined First Student Facility, permit required/turbid discharge; 2008 now is Durham.
515	8		Const 6	6/17/2011	TSS	Completed	TPU Hydrant Repair discharges muddy water
516	9		Fine 1	2007	All	Completed	Feed Commodities inspection/BMPs
517	10		Fine/Violation 2	2012	Diesel	Ongoing	First Student - Second Warning Letter
518	11		Fine/Violation 3	2012	Diesel	Ongoing	First Student - Notice of Violation
519	12		Fine/Violation 4	2013	Soapy Water	Completed	Warning letter - Oh So Clean Mobile Wash - discharge of soapy water
520	13		Fine/Violation 5	2013	TSS	Completed	Warning letter - HEMR Industrial Contractors - discharge of turbid material
521	14		Fine/Violation 6	2014	TSS	Completed	Notice of Violation issued to First Student for failure to implement BMPs
522	15		Fine/Violation 7	2014	TSS	Completed	Warning letter issued to Harris Transportation Services for failure to implement BMPs
523	16		Inspect 1	2002	All	Completed	Ecology business inspections
524	17		Inspect 2	2003	All	Completed	Drive-by observations and complaint investigations
525	18		Inspect 3	2003	All	Completed	16 industries were inspected
526	19		Inspect 4	2003-2004		Completed	Storm sediment sampling/TV inspection of storm pipe
527	20		Inspect 5	12/1/2005	All	Completed	7 BMP inspections
528	21		Inspect 6	2006	All	Completed	Basin 254 Public Outreach Meeting
529	22		Inspect 7	5/1/2006	All	Completed	Initial business inspections of all facilities
530	23		Inspect 8	6/1/2006	All	Completed	Collected pipe sediment data from businesses
531	24		Inspect 9	8/1/2006	TSS, PAH, TPH	Completed	First Student Facility inspected by Ecology.
532	25		Inspect 10	11/1/2006	All	Completed	5 BMP inspections
533	26		Inspect 11	2007	All	Completed	5 BMP inspections
534	27		Inspect 12	2008	All	Completed	Focused inspections: TriPak, Urban Logistics, NW Detention Center, Portside Complex, First Student, Pacific Machine, Johnson Postman, Urban Accessories
535	28		Inspect 13	2008	All	Completed	Jan 26-28, March 23-25, Apr 27-28, Jun 12-14, 2006 cleaned/TV inspected entire municipal storm drainages
536	29		Inspect 14	2010	All	Completed	20 business inspections
537	30		Inspect 15	2011	All	Completed	9 business inspections
538	31		Inspect 16	2012	All	Completed	9 business inspections in the OF254 drainage basin
539	32		Inspect 17	2013	All	Completed	2 business inspections in the OF254 drainage basin
540	33		Inspect 18	2013	Phthalates	Completed	Completion of source control investigation at NWDC
541	34		Inspect 19	2014	All	Completed	1 business inspection in the OF254 drainage basin
542	35		Maint 1	2006	TSS	Completed	First Student Facility media filter
543	36		Maint 2	4/1/2006	Unknown	Completed	Update GIS map of public/private systems
544	37		Maint 3	6/1/2006	All	Ongoing	Regular street vacuum sweeping of the area
545	38		Maint 4	2007	All	Ongoing	Increased street sweeping frequency.
546	39		Maint 5	2/1/2008	TSS	Completed	1-wet/detention pond, 1-bioswale, 1-vortex sep
547	40		Maint 6	2010	TSS	Completed	Nichols Trucking Yard 2 update tide gate valve
548	41		Maint 7	2012	All	Completed	Enhanced street sweeping, general system cleaning and maintenance
549	42		Maint 8	2013	All	Completed	Enhanced street sweeping, general system cleaning and maintenance
550	43		Maint 9	2014	All	Completed	Enhanced street sweeping, general system cleaning and maintenance
551	44		Onsite Fac. 1	2005	TSS	Completed	1-media filter, 1-bioswale, 2-detention/wet vault, 2-wet pond
552	45		Onsite Fac. 2	2006	TSS	Completed	2-wet pond
553	46		Onsite Fac. 3	2007-2010	TSS	Completed	2 Contech Stormfilter vaults connected, NW Detention Center/INS Detention Facility
554	47		Onsite Fac. 4	2009	TSS	Completed	First Student Facility turbid discharge
555	48		Onsite Fac. 5	2010	TSS	Ongoing	First Student Facility turbid discharge
556	49		Onsite Fac 6	2012	TSS	Completed	Above ground settling tank
557	50		Point Source 1	2003-2006	TPH, PAHs	Completed	Petroleum discharge removed. BMPs required.
558	51		Point Source 2	12/15/2005	Hg	complete	Reinhold Petroleum Hg @ 4.75 mg/kg in CB
559	52		Point Source 3	8/1/2006	DEHP	Ongoing	NW Detention Center DEHP@ 610,000 ug/kg in stormwater pond inlet.
560	53		Point Source 4	8/1/2006	DEHP	Ongoing	NW Detention Center DEHP@ 790,000 ug/kg
561	54		Point Source 5	2008-2011	DEHP	Completed	NW Detention Center onsite DEHP@ 270,000-880,000 ug/kg; after media filter offsite DEHP was low. Source was laundry lint from dryer vent.
562	55		Point Source 6	2009	Unknown	Completed	LRI spill. BMPs required.

Table 2-1
Master Spreadsheet for Source Control Actions

Action Number	Action Number by Basin	Sub Basin	Action	Date	Potential COCs	Status	Description
563	56		Spill 1	6/4/2007	PAH, TPH	Completed	Urban Logistics oil spill to SW pond
564	57		Spill 2	12/12/2008	PAH, TPH	Completed	CB on street by Codel Inc diesel spill.
565	58		Spill 3	6/2010-2011	PAH, TPH	Completed	4 spills in 12 months at First Student - LOOK AT DATA!!! June 2010-2011

Table 2-2
Sediment Trap Monitoring Locations for 2002-2014

		WY2002	WY2003	WY2004	WY2005	WY2006	WY2007	WY2008	WY2009	WY2010	WY2011	WY2012	WY2013	WY2014
	Dates Deployed	8/31/01 3/25-26/02	8/27-29/02 4/28/03	8/27/03 4/8/04	8/24-26/04 4/05	8/26-30/05 4/06/06	8/21-23/06 3/1*:4/20/07	8/21-24/07 4/3-4/08	8/28/2008 5/4-8/09	8/27/2009 8/23-24/10	8/23-24/10 8/25-26/11	8/24-25/11 8/14-23/12	8/13-23/12 8/30/13	7/10-8/23/13 8/25-27/14
OF237A	FD2	X	X	X	X	X 9/26/05	X	X	X	X	X	X	X	X
	FD2A	X	Pulled 3/10/03	Site gone	X	X 1/9/06	X	X	X	X	X	X	X	X
	FD5	X	X	X	X	X	X	X	X	X	X	X	X	
	FD10		X	X	X	X	X	X	X	X	X	X	X	X
	FD10B		X	X	X	X	X	X	X	X	X	X	X	X
	FD10C		X	X	X	X	X	X	X	X	X	X	X	X
	FD13		X	X	X	X	X	X	X	X	X	X	X	X
	FD13B		X	X	X	X	X	X	X	X	X	X	X	X
	FD13B NEW												X	X
OF237B	FD1	X	X	X	X	X 9/26/05	X	X	X	X	X	X	X	X
	FD30		X		X			X	X					
	FD31		X		X			X	X	X	X	X	X	X
	FD32		X		X			X	X					
	FD33		X		X			X	X					
	FD34		X		X			X	X	X	X	X	X	X
	FD35		X		X			X	X	X	X	X	X	X
	FD36		X		X			X	X					
	FD37		X		X			X	X					
	FD38		X		X			X	X					
OF230	FD3NEW	X	X	X	X	X	X *	X	X	X	X	X	X	X
	FD3	X	X	X	X	X	X *	X	X	X	X	X	X	
	FD3A	X	X	X	X	X	X *	X	X	X	X	X	X	X
	FD3B	X	Pulled	X	X	X	X *	X	X	X	X	X	X	X
	FD16		Lost	X	X	X	X *	X	X	X	X	X	X	X
	FD16B		X	X	X	X	X *	X	X	X	X	X	X	
	FD18		X	X	X	X	X *	X	X	X	X	X	X	X
	FD18B		X	X	X	X	X *	X	X	X	X 1/24/11	X	X	X
OF235	FD6	X	X	X	X	X	X *	X	X	X	X	X	X	X
	FD6-A					X 10/7/05	X *	X	X	X	X	X	X	
	FD6-B					X 10/6/05	X *	X	X	X	X	X	X	
OF243	FD23	X	X	X	X	X	X	X	X	X	X	X	X	X
OF245	MH390	X	X	X	X	X	X	X	X	X	X	X	X	X
	FD21	X	X	X	X	X	X	X	X	X	X	X	X	X
OF248	FD22	X	X	X	X	X	X	X	X	X	X	X	X	X

In 2006, FD2, FD2A and FD1 weren't installed until construction was complete on the outfall extensions for Outfalls 237A and 237B. In 2011, FD18B wasn't installed until pipe relining construction was complete in Basin 230.

Table 2-3
STRAP Assessment for the Thea Foss Basin

Basin	Basin Total (ft)	Assessment (ft)			Total Assessed (ft)	Capacity (ft)		Maintenance Needed (ft)	Percentage			Total Percentage
		Green	Yellow	Red		No Issue	Issues		Green	Yellow	Red	
FS_01	42,632	14,353	16,110	8,907	39,370		2,109	2,501	33.70%	37.80%	20.90%	92.30%
FS_02	47,933	27,246	6,977	845	35,068		2,431	8,900	56.80%	14.60%	1.80%	73.20%
FS_03	45,384	24,542	6,018	2,524	33,084		1,305	4,201	54.10%	13.30%	5.60%	72.90%
FS_04	33,227	9,119	8,618	5,695	23,432			3,561	27.40%	25.90%	17.10%	70.50%
FS_05	91,620	56,244	10,098	9,117	75,459	234	2,616	223	61.40%	11.00%	10.00%	82.40%
FS_06	22,586	12,918	1,395	2,334	16,647		1,452	197	57.20%	6.20%	10.30%	73.70%
FS_07	25,789	14,565	4,835	2,347	21,747			1,587	56.50%	18.70%	9.10%	84.30%
FS_08	35,835	18,902	7,079	636	26,617			7,256	52.70%	19.80%	1.80%	74.30%
FS_09	56,053	4,181	12,898	4,251	21,330			9,755	7.50%	23.00%	7.60%	38.10%
FS_10	61,926	16,421	10,615	2,919	29,955			9,907	26.50%	17.10%	4.70%	48.40%
FS_11	101,883	41,167	5,238	3,404	49,809		1,982	9,569	40.40%	5.10%	3.30%	48.90%
FS_12	16,684	5,957	4,633		10,590			710	35.70%	27.80%		63.50%
FS_13	9,106	3,940			3,940				43.30%			43.30%
FS_14	6,324	1,348	154	783	2,285				21.30%	2.40%	12.40%	36.10%
FS_15	4,128	753			753			158	18.20%			18.20%
Total ->	**601,110**	**251,656**	**94,668**	**43,762**	**390,086**	**234**	**11,895**	**58,525**	**39.51%**	**0.17131**	**0.08717**	**61.34%**
Whole City Total		1,179,700	432,741	124,166	1,736,607	1,796	25,441	293,516	46.00%	16.90%	4.80%	67.70%

Table 2-4
Stormwater Summary Statistics, Before and After Line Cleaning

	TSS (mg/l)		Lead (ug/l)		Zinc (ug/l)		Phenanthrene (ug/l)		Pyrene (ug/l)		Indenopyrene (ug/l)		Bis(2EH)phthalate (ug/l)	
	Pre-Cleaning	Post-Cleaning	Pre-Cleaning	Post-Cleaning	Pre-Cleaning	Post-Cleaning	Pre-Cleaning	Post-Cleaning	Pre-Cleaning	Post-Cleaning	Pre-Cleaning	Post-Cleaning	Pre-Cleaning	Post-Cleaning
OF230*														
Count	49	62	50	66	50	66	50	66	50	66	50	66	49	66
Minimum	13.9	4.8	7.8	4.0	53.6	35.2	0.011	0.005	0.035	0.005	0.005	0.002	0.50	0.20
Median	49.5	26.9	22.6	10.2	120.0	93.5	0.143	0.020	0.307	0.022	0.102	0.006	4.90	1.28
Arithmetic Mean	61.3	41.1	28.9	19.3	136.7	118.3	0.181	0.037	0.368	0.061	0.110	0.022	5.59	2.90
Maximum	232.0	304.0	125.0	229.0	721.0	670.0	0.653	0.235	1.200	0.467	0.346	0.161	24.90	44.10
Standard Deviation	43.3	48.6	20.0	29.2	98.3	95.6	0.150	0.048	0.276	0.097	0.083	0.039	4.24	5.65
Standard Error	6.2	6.2	2.8	3.6	13.9	11.8	0.021	0.006	0.039	0.012	0.012	0.005	0.61	0.70
t-statistic	3.957		4.770		1.812		10.388		11.505		9.507		5.561	
p-value	<0.001		<0.001		0.036		<0.001		<0.001		<0.001		<0.001	
Significant? (p < 0.05)	**Yes**		**Yes**		**Yes**		**Yes**		**Yes**		**Yes**		**Yes**	
Percent Reduction in Mean	**33%**		**33%**		**13%**		**79%**		**83%**		**80%**		**48%**	
OF235*														
Count	54	77	54	82	54	82	54	82	54	82	54	82	53	82
Minimum	10.4	7.8	23.2	9.5	37.3	36.6	0.009	0.002	0.034	0.002	0.005	0.002	0.50	0.32
Median	78.0	40.8	80.0	48.8	137.5	94.2	0.138	0.023	0.328	0.037	0.073	0.007	6.10	1.49
Arithmetic Mean	101.0	52.2	95.8	53.5	165.1	111.0	0.170	0.045	0.339	0.088	0.080	0.018	9.55	2.65
Maximum	441.0	176.0	368.0	204.0	475.0	406.0	0.479	0.689	1.010	0.854	0.280	0.145	97.00	16.70
Standard Deviation	77.8	35.3	57.0	28.6	95.3	55.8	0.108	0.083	0.215	0.126	0.055	0.029	13.46	2.84
Standard Error	10.6	4.0	7.8	3.2	13.0	6.2	0.015	0.009	0.029	0.014	0.008	0.003	1.85	0.31
t-statistic	5.066		6.951		4.389		10.325		10.652		10.796		8.786	
p-value	<0.001		<0.001		<0.001		<0.001		<0.001		<0.001		<0.001	
Significant? (p < 0.05)	**Yes**		**Yes**		**Yes**		**Yes**		**Yes**		**Yes**		**Yes**	
Percent Reduction in Mean	**48%**		**44%**		**33%**		**74%**		**74%**		**77%**		**72%**	
OF237A*														
Count	60	59	60	59	60	59	60	58	60	58	60	58	59	58
Minimum	3.5	7.4	1.7	2.4	41.8	36.9	0.005	0.002	0.035	0.005	0.005	0.002	0.50	0.20
Median	49.0	35.0	12.7	8.4	105.5	69.7	0.125	0.015	0.326	0.025	0.096	0.006	3.30	0.87
Arithmetic Mean	56.5	50.9	15.0	13.1	117.1	90.8	0.162	0.025	0.423	0.054	0.126	0.017	3.41	1.12
Maximum	281.0	400.0	43.2	67.8	361.0	338.0	0.893	0.309	2.930	0.770	0.680	0.269	13.70	5.48
Standard Deviation	41.0	60.2	8.4	12.6	52.7	55.4	0.159	0.042	0.446	0.106	0.130	0.040	2.50	1.06
Standard Error	5.3	7.8	1.1	1.6	6.8	7.2	0.021	0.005	0.058	0.014	0.017	0.005	0.32	0.14
t-statistic	2.103		2.594		4.760		13.799		16.509		14.791		9.526	
p-value	0.019		0.005		<0.001		<0.001		<0.001		<0.001		<0.001	
Significant? (p < 0.05)	**Yes**		**Yes**		**Yes**		**Yes**		**Yes**		**Yes**		**Yes**	
Percent Reduction in Mean	**10%**		**13%**		**23%**		**85%**		**87%**		**87%**		**67%**	
OF237B*														
Count	92	31	92	34	92	35	92	35	92	35	92	35	91	35
Minimum	3.6	7.8	1.5	1.9	15.0	22.1	0.002	0.004	0.010	0.005	0.003	0.002	0.35	0.14
Median	53.3	26.0	11.9	6.3	63.5	39.8	0.052	0.010	0.127	0.013	0.039	0.003	2.50	0.52
Arithmetic Mean	68.6	34.7	15.4	7.7	81.9	47.1	0.080	0.013	0.180	0.017	0.054	0.005	3.10	0.57
Maximum	278.0	97.6	64.2	23.8	243.0	136.0	0.838	0.053	1.493	0.068	0.546	0.034	12.00	1.84
Standard Deviation	51.2	23.8	11.6	5.5	50.0	24.0	0.104	0.010	0.210	0.013	0.071	0.007	2.61	0.36
Standard Error	5.3	4.3	1.2	1.0	5.2	4.0	0.011	0.002	0.022	0.002	0.007	0.001	0.27	0.06

Table 2-4
Stormwater Summary Statistics, Before and After Line Cleaning

	TSS (mg/l)		Lead (ug/l)		Zinc (ug/l)		Phenanthrene (ug/l)		Pyrene (ug/l)		Indenopyrene (ug/l)		Bis(2EH)phthalate (ug/l)	
	Pre-Cleaning	Post-Cleaning	Pre-Cleaning	Post-Cleaning	Pre-Cleaning	Post-Cleaning	Pre-Cleaning	Post-Cleaning	Pre-Cleaning	Post-Cleaning	Pre-Cleaning	Post-Cleaning	Pre-Cleaning	Post-Cleaning
t-statistic	3.916		4.644		4.664		7.555		10.044		9.266		9.717	
p-value	<0.001		<0.001		<0.001		<0.001		<0.001		<0.001		<0.001	
Significant? (p < 0.05)	**Yes**		**Yes**		**Yes**		**Yes**		**Yes**		**Yes**		**Yes**	
Percent Reduction in Mean	**49%**		**50%**		**42%**		**84%**		**91%**		**90%**		**82%**	
OF254*														
Count	37	57	37	59	37	59	37	59	37	59	37	59	37	59
Minimum	5.2	14.3	4.2	3.1	73.7	43.1	0.018	0.002	0.086	0.002	0.012	0.002	0.50	0.14
Median	77.0	85.1	16.7	13.4	157.0	121.0	0.133	0.039	0.402	0.061	0.060	0.012	2.20	1.10
Arithmetic Mean	83.4	115.4	20.4	19.0	181.9	133.6	0.159	0.058	0.572	0.124	0.071	0.021	2.61	2.22
Maximum	240.0	354.0	49.5	68.0	427.0	334.0	0.657	0.283	4.120	0.773	0.239	0.110	6.60	10.20
Standard Deviation	48.2	80.9	10.7	15.0	83.1	70.8	0.116	0.058	0.654	0.168	0.042	0.026	1.73	2.41
Standard Error	7.9	10.7	1.8	2.0	13.7	9.2	0.019	0.008	0.108	0.022	0.007	0.003	0.28	0.31
t-statistic	-1.834		1.612		3.458		6.815		8.840		8.425		2.420	
p-value	0.965		0.055		<0.001		<0.001		<0.001		<0.001		0.009	
Significant? (p < 0.05)	No		No		**Yes**		**Yes**		**Yes**		**Yes**		**Yes**	
Percent Reduction in Mean	--		--		**27%**		**63%**		**78%**		**71%**		**15%**	

Notes:
**Following are the dates of the City's sewer-line cleaning activities:*
OF230: March 12 through May 14, 2007.
OF235: May 15 through June 25, 2007
OF237A: April 28 through August 8, 2008 (only the northern half of this drainage basin was cleaned)
OF237B: November 7, 2010 to February 24, 2011
OF254: January 26 through June 14, 2006
**Any monitoring events within the window of cleaning activities were excluded from the analysis.*
OF237A location includes data from OF237A New sampling location for all data collected after to 2/26/06.

Table 2-5
Stormwater Summary Statistics, Before and After Street Sweeping

	TSS (mg/l)		Lead (ug/l)		Zinc (ug/l)		Phenanthrene (ug/l)		Pyrene (ug/l)		Indenopyrene (ug/l)		Bis(2EH)phthalate (ug/l)	
	Pre-Sweeping	Post-Sweeping	Pre-Sweeping	Post-Sweeping	Pre-Sweeping	Post-Sweeping	Pre-Sweeping	Post-Sweeping	Pre-Sweeping	Post-Sweeping	Pre-Sweeping	Post-Sweeping	Pre-Sweeping	Post-Sweeping
Outfall 230*														
Count	41	64	41	69	41	69	41	69	41	69	41	69	40	69
Minimum	13.9	4.8	7.8	4.0	53.6	35.2	0.011	0.005	0.035	0.005	0.005	0.002	0.50	0.20
Median	49.5	27.1	24.4	11.7	122.0	92.0	0.157	0.021	0.316	0.022	0.102	0.007	4.55	1.29
Arithmetic Mean	64.9	41.4	30.4	19.7	141.1	118.2	0.192	0.043	0.383	0.075	0.112	0.028	5.65	3.02
Maximum	232.0	304.0	125.0	229.0	721.0	670.0	0.653	0.235	1.200	0.553	0.346	0.228	24.90	44.10
Standard Deviation	45.6	47.9	21.4	28.7	106.0	93.9	0.161	0.055	0.296	0.119	0.089	0.048	4.66	5.56
Standard Error	7.1	6.0	3.3	3.5	16.6	11.3	0.025	0.007	0.046	0.014	0.014	0.006	0.74	0.67
t-statistic	3.936		4.475		1.839		8.928		9.492		7.654		4.561	
p-value	<0.001		<0.001		0.034		<0.001		<0.001		<0.001		<0.001	
Significant? (p < 0.05)	**Yes**		**Yes**		**Yes**		**Yes**		**Yes**		**Yes**		**Yes**	
Percent Reduction in Mean	**36%**		**35%**		**16%**		**78%**		**80%**		**75%**		**47%**	
Outfall 235*														
Count	44	80	44	85	44	85	44	85	44	85	44	85	43	85
Minimum	10.4	7.8	23.2	9.5	37.3	36.6	0.009	0.002	0.034	0.002	0.005	0.002	0.50	0.32
Median	81.8	41.9	81.5	49.0	135.0	96.9	0.147	0.023	0.355	0.037	0.078	0.007	6.20	1.51
Arithmetic Mean	107.6	54.4	99.5	54.0	169.5	112.3	0.178	0.055	0.359	0.106	0.083	0.024	10.09	2.72
Maximum	441.0	176.0	368.0	204.0	475.0	406.0	0.479	0.776	1.010	1.164	0.280	0.338	97.00	16.70
Standard Deviation	82.6	37.3	61.1	28.5	102.7	55.8	0.115	0.115	0.224	0.177	0.058	0.047	14.76	2.84
Standard Error	12.5	4.2	9.2	3.1	15.5	6.0	0.017	0.012	0.034	0.019	0.009	0.005	2.25	0.31
t-statistic	4.882		6.652		4.063		8.740		9.145		9.033		7.972	
p-value	<0.001		<0.001		<0.001		<0.001		<0.001		<0.001		<0.001	
Significant? (p < 0.05)	**Yes**		**Yes**		**Yes**		**Yes**		**Yes**		**Yes**		**Yes**	
Percent Reduction in Mean	**49%**		**46%**		**34%**		**69%**		**70%**		**71%**		**73%**	
Outfall 237A*														
Count	44	71	44	71	44	71	44	70	44	70	44	70	43	70
Minimum	13.1	3.5	5.0	1.7	41.8	36.9	0.005	0.002	0.041	0.005	0.005	0.002	0.50	0.20
Median	51.7	35.6	13.4	8.9	105.5	75.9	0.126	0.017	0.341	0.029	0.100	0.006	2.60	0.96
Arithmetic Mean	53.1	55.6	14.5	14.2	118.6	96.7	0.163	0.048	0.405	0.129	0.118	0.040	3.37	1.49
Maximum	120.0	400.0	31.5	67.8	361.0	338.0	0.893	0.828	1.770	2.930	0.669	0.680	13.70	7.90
Standard Deviation	23.4	63.9	6.8	13.1	55.7	55.6	0.146	0.112	0.324	0.375	0.115	0.099	2.70	1.55
Standard Error	3.5	7.6	1.0	1.6	8.4	6.6	0.022	0.013	0.049	0.045	0.017	0.012	0.41	0.19
t-statistic	1.728		2.207		3.182		8.644		9.532		8.126		5.180	
p-value	0.043		0.014		0.001		<0.001		<0.001		<0.001		<0.001	
Significant? (p < 0.05)	**Yes**		**Yes**		**Yes**		**Yes**		**Yes**		**Yes**		**Yes**	
Percent Reduction in Mean	**-5%**		**2%**		**18%**		**71%**		**68%**		**66%**		**56%**	
Outfall 237B*														
Count	45	77	45	80	45	81	45	81	45	81	45	81	44	81
Minimum	7.5	3.6	3.8	1.5	31.3	15.0	0.005	0.002	0.028	0.002	0.005	0.002	0.50	0.14
Median	60.3	37.1	14.3	7.8	70.5	48.0	0.091	0.014	0.242	0.021	0.061	0.004	3.00	0.75
Arithmetic Mean	76.4	52.2	18.0	10.9	93.3	61.6	0.102	0.036	0.238	0.069	0.066	0.024	3.87	1.48
Maximum	278.0	211.0	64.2	54.8	232.0	243.0	0.423	0.838	0.972	1.493	0.277	0.546	12.00	8.70
Standard Deviation	55.1	44.9	12.5	9.5	54.0	40.5	0.071	0.097	0.174	0.179	0.051	0.066	3.02	1.69
Standard Error	8.2	5.1	1.9	1.1	8.0	4.5	0.011	0.011	0.026	0.020	0.008	0.007	0.46	0.19
t-statistic	3.235		4.251		4.272		8.908		9.684		8.058		6.793	
p-value	0.001		<0.001		<0.001		<0.001		<0.001		<0.001		<0.001	

Table 2-5
Stormwater Summary Statistics, Before and After Street Sweeping

	TSS (mg/l)		Lead (ug/l)		Zinc (ug/l)		Phenanthrene (ug/l)		Pyrene (ug/l)		Indenopyrene (ug/l)		Bis(2EH)phthalate (ug/l)	
	Pre-Sweeping	Post-Sweeping	Pre-Sweeping	Post-Sweeping	Pre-Sweeping	Post-Sweeping	Pre-Sweeping	Post-Sweeping	Pre-Sweeping	Post-Sweeping	Pre-Sweeping	Post-Sweeping	Pre-Sweeping	Post-Sweeping
Significant? (p < 0.05)	**Yes**		**Yes**		**Yes**		**Yes**		**Yes**		**Yes**		**Yes**	
Percent Reduction in Mean	**32%**		**39%**		**34%**		**65%**		**71%**		**64%**		**62%**	
Outfall 243*														
Count	32	41	32	42	32	42	32	42	32	42	32	42	31	42
Minimum	10.7	4.4	9.7	1.4	51.1	19.6	0.023	0.005	0.033	0.012	0.005	0.002	0.50	0.20
Median	58.4	49.0	27.1	23.5	99.9	67.7	0.098	0.020	0.163	0.037	0.033	0.005	3.10	0.55
Arithmetic Mean	69.4	78.0	46.5	49.4	147.2	92.0	0.100	0.030	0.180	0.066	0.041	0.018	3.33	1.82
Maximum	220.0	300.0	353.0	379.0	1170.0	392.0	0.221	0.116	0.620	0.452	0.121	0.113	8.40	41.00
Standard Deviation	50.2	71.4	61.5	67.5	193.8	73.4	0.055	0.027	0.124	0.093	0.029	0.029	2.11	6.26
Standard Error	8.9	11.2	10.9	10.4	34.3	11.3	0.010	0.004	0.022	0.014	0.005	0.005	0.38	0.97
t-statistic	0.271		0.397		2.598		7.787		6.429		5.833		6.728	
p-value	0.394		0.346		0.006		<0.001		<0.001		<0.001		<0.001	
Significant? (p < 0.05)	No		No		**Yes**		**Yes**		**Yes**		**Yes**		**Yes**	
Percent Reduction in Mean	--		--		**38%**		**70%**		**63%**		**56%**		**45%**	
Outfall 245*														
Count	41	62	41	66	41	65	41	65	41	65	41	65	31	42
Minimum	17.6	6.2	2.7	1.7	54.8	27.7	0.019	0.002	0.026	0.002	0.005	0.002	0.50	0.20
Median	72.4	49.6	12.2	8.7	146.0	123.0	0.083	0.024	0.123	0.025	0.025	0.004	3.10	0.55
Arithmetic Mean	83.8	56.2	14.8	11.0	186.9	154.5	0.136	0.042	0.162	0.053	0.026	0.009	3.33	1.82
Maximum	243.0	186.0	38.8	60.0	585.0	498.0	1.650	0.477	1.310	0.295	0.057	0.051	8.40	41.00
Standard Deviation	52.9	38.5	8.5	9.9	122.8	105.6	0.256	0.063	0.200	0.068	0.014	0.012	2.11	6.26
Standard Error	8.3	4.9	1.3	1.2	19.2	13.1	0.040	0.008	0.031	0.008	0.002	0.002	0.38	0.97
t-statistic	3.125		3.078		2.119		6.893		7.324		7.778		8.349	
p-value	0.001		0.001		0.018		<0.001		<0.001		<0.001		<0.001	
Significant? (p < 0.05)	**Yes**		**Yes**		**Yes**		**Yes**		**Yes**		**Yes**		**Yes**	
Percent Reduction in Mean	**33%**		**26%**		**17%**		**69%**		**67%**		**64%**		**75%**	
Outfall 254*														
Count	35	55	35	57	35	57	35	57	35	57	35	57	35	57
Minimum	5.2	14.3	8.6	3.1	73.7	43.1	0.018	0.002	0.086	0.002	0.012	0.002	0.50	0.14
Median	78.8	85.1	17.3	13.4	179.0	109.0	0.133	0.038	0.402	0.054	0.060	0.012	2.20	1.08
Arithmetic Mean	86.0	115.2	21.0	19.1	186.6	130.5	0.161	0.056	0.584	0.119	0.073	0.020	2.62	2.19
Maximum	240.0	354.0	49.5	68.0	427.0	334.0	0.657	0.283	4.120	0.773	0.239	0.110	6.60	10.20
Standard Deviation	48.0	82.0	10.6	15.2	83.0	69.5	0.118	0.058	0.670	0.169	0.042	0.025	1.78	2.45
Standard Error	8.1	11.1	1.8	2.0	14.0	9.2	0.020	0.008	0.113	0.022	0.007	0.003	0.30	0.32
t-statistic	-1.458		1.916		3.918		6.915		8.949		8.645		2.439	
p-value	0.926		0.029		<0.001		<0.001		<0.001		<0.001		0.008	
Significant? (p < 0.05)	No		**Yes**		**Yes**		**Yes**		**Yes**		**Yes**		**Yes**	
Percent Reduction in Mean	--		**9%**		**30%**		**65%**		**80%**		**73%**		**16%**	

Notes:

**Street sweeping program started in January 2006 and was in full swing by January 2007. Any monitoring events within the startup window (1/1/06 to 1/1/07) were excluded from the analysis.*

237A location includes data from 237A New sampling location for all data collected after to 2/26/06.

Table 2-6
Stormwater Summary Statistics, Before and After CIPP Lining

	TSS (mg/l)		Lead (ug/l)		Zinc (ug/l)		Phenanthrene (ug/l)		Pyrene (ug/l)		Indenopyrene (ug/l)		Bis(2EH)phthalate (ug/l)	
	Pre-Sweeping	Post-Sweeping	Pre-Sweeping	Post-Sweeping	Pre-Sweeping	Post-Sweeping	Pre-Sweeping	Post-Sweeping	Pre-Sweeping	Post-Sweeping	Pre-Sweeping	Post-Sweeping	Pre-Sweeping	Post-Sweeping
Outfall 230*														
Count	80	29	82	32	82	32	82	32	82	32	82	32	81	32
Minimum	9.7	4.8	5.7	4.0	53.6	35.2	0.010	0.005	0.013	0.005	0.003	0.002	0.45	0.20
Median	43.1	22.4	21.6	7.9	122.0	71.2	0.098	0.016	0.226	0.017	0.064	0.004	4.50	1.05
Arithmetic Mean	56.4	23.9	28.7	10.3	132.9	111.3	0.137	0.018	0.273	0.023	0.085	0.009	5.38	1.15
Maximum	232.0	62.2	229.0	35.4	721.0	670.0	0.653	0.055	1.200	0.109	0.346	0.042	44.10	3.26
Standard Deviation	43.2	15.1	28.8	7.2	82.4	128.9	0.136	0.011	0.262	0.024	0.081	0.011	5.80	0.77
Standard Error	4.8	2.8	3.2	1.3	9.1	22.8	0.015	0.002	0.029	0.004	0.009	0.002	0.64	0.14
t-statistic	5.397		6.977		3.302		8.942		9.731		7.380		7.758	
p-value	<0.001		<0.001		0.001		<0.001		<0.001		<0.001		<0.001	
Significant? (p < 0.05)	**Yes**		**Yes**		**Yes**		**Yes**		**Yes**		**Yes**		**Yes**	
Percent Reduction in Mean	**58%**		**64%**		**16%**		**87%**		**92%**		**89%**		**79%**	

Notes:
**CIPP lining is OF230 occurred between June 2010 and November 2010. Any monitoring events within the lining window (6/10 to 11/10) were excluded from the analysis.*
*** CIPP lining also occurred near the end of WY2013. The effect of this will be evaluated in future monitoring years.*

Table 3-1
Total Rain Depth (Inches) during Past and Present Monitoring Years

		WY2002	WY2003	WY2004	WY2005	WY2006	WY2007	WY2008	WY2009	WY2010	WY2011	WY2012	WY2013	WY2014	WY2002 -WY2014 Average	Historical Monthly	
																Mean NCDC 1971-2000	Mean NCDC 1981 - 2010
WET	October	3.32	0.41	8.88	3.61	3.00	1.28	3.64	2.36	4.18	4.64	3.39	5.97	1.57	3.56	3.39	3.70
	November	10.13	2.96	6.15	2.81	6.25	15.81	2.64	7.61	7.74	5.37	5.98	7.12	3.40	6.46	6.10	6.68
	December	6.82	6.58	4.65	4.03	6.28	8.05	8.36	4.03	2.67	6.83	6.44	8.33	1.91	5.77	5.89	5.52
	January	6.68	8.5	6.79	4.71	11.93	6.92	4.63	7.15	7.40	5.17	7.02	3.31	4.29	6.50	5.38	5.93
	February	3.56	1.71	2.55	0.79	2.59	4.09	2.84	1.61	3.95	3.54	3.19	1.58	7.68	3.05	4.44	3.86
	March	4.16	5.08	2.18	3.14	1.91	6.09	4.16	4.68	4.91	6.57	7.11	2.50	8.81	4.72	4.18	4.06
	April	3.64	3.3	0.91	4.74	2.46	1.34	1.76	3.31	2.90	5.13	3.74	4.52	4.22	3.23	2.87	3.00
DRY	May	1.14	0.55	2.56	3.34	1.56	1.31	1.01	3.03	4.15	3.77	2.33	2.86	3.23	2.37	2.01	2.11
	June	1.36	0.36	0.64	1.26	2.25	1.44	1.26	0.33	3.05	1.40	2.54	1.85	0.94	1.44	1.58	1.57
	July	0.42	0.13	0.00	1.16	0.11	1.30	0.26	0.00	0.78	0.74	0.87	0.01	0.57	0.49	0.86	0.68
	August	0.06	0.29	2.75	0.04	0.00	0.90	2.32	1.04	0.24	0.27	0.00	1.05	1.72	0.82	0.83	0.82
	September	0.36	0.69	3.26	0.92	0.74	2.22	0.39	2.82	3.93	0.96	0.02	8.29	2.26	2.07	1.42	1.29
Wet Season		38.31	28.54	32.11	23.83	34.42	43.58	28.03	30.75	33.75	37.25	36.87	33.33	31.88	33.28	32.25	32.75
Dry Season		3.34	2.02	9.21	6.72	4.66	7.17	5.24	7.22	12.15	7.14	5.76	14.06	8.72	7.19	6.70	6.47
Total		41.65	30.56	41.32	30.55	39.08	50.75	33.27	37.97	45.90	44.39	42.63	47.39	40.60	40.47	38.95	39.22

Key:

	Months	*Seasons/Years*
	> 2" above historical monthly average	*> 8" above historical seasonal/yearly average*
	> 1" above historical monthly average	*> 4" above historical seasonal/yearly average*
	≤ 1" above/below historical monthly average	*≤ 4" above/below historical seasonal/yearly average*
	> 1" below historical monthly average	*> 4" below historical seasonal/yearly average*
	> 2" below historical monthly average	*> 8" below historical seasonal/yearly average*

Table 3-2
Summary Statistics for Baseflow

	Overall Data						OF230				OF235				OF237A				OF237B				OF243				OF245				OF254			
	Overall Detections	% Detections	Arithmetic Mean	Weighted Mean	Max	Date of Max	Min	Max	Arithmetic Mean	Median	Min	Max	Arithmetic Mean	Median	Min	Max	Arithmetic Mean	Median	Min	Max	Arithmetic Mean	Median	Min	Max	Arithmetic Mean	Median	Min	Max	Arithmetic Mean	Median	Min	Max	Arithmetic Mean	Median
Conventionals																																		
Hardness (mg/L as CaCO3)	281/281	100		N/A	N/A	N/A	27.9	249	144	142	123	199	155	149	85.4	134	105	105	61	129	111	113	463	2,310	1418	1,345	136	2,880	874	808	386	4,410	2799	3,030
pH (pH units)	296/296	100		N/A	N/A	N/A	6.8	9.0	7.7	7.7	7.1	8.0	7.7	7.7	6.8	7.8	7.4	7.4	5.9	8.0	7.2	7.3	6.6	7.8	7.1	7.1	7.1	8.0	7.4	7.4	6.7	7.6	7.1	7.2
TSS (mg/L)	273/295	93	12.29	12.2	319	3/12/09	0.26	319	15.8	5.90	0.31	258	25.4	6.85	0.26	16.3	3.08	2.1	0.26	16.9	2.54	1.3	1.5	42.7	13.6	10.7	0.3	78.9	9.6	6.40	1.8	140	16.1	7.7
Metals in ug/L																																		
Lead	209/289	72	5.52	5.53	112	8/7/06	0.97	29.8	5.56	4.0	1.64	112	14.29	6.5	0.06	6.11	1.21	0.70	0.07	6.6	0.99	0.60	0.385	43.9	7.56	3.99	0.13	18.2	3.30	1.65	0.24	39.0	5.75	2.9
Mercury	18/293	6	0.03	0.03	0.38	7/26/04	0.025	0.250	0.036	0.025	0.025	0.38	0.041	0.025	0.025	0.196	0.031	0.025	0.025	0.025	0.025	0.025	0.025	0.075	0.029	0.025	0.025	0.125	0.029	0.025	0.025	0.055	0.026	0.025
Zinc	283/286	99	46.55	47.5	1,950	8/28/07	19.3	108	46.6	34.0	6.6	355	41.9	17.20	1.65	27.0	9.5	9.3	1.05	14.2	4.43	3.7	5.3	73.6	21.60	15.4	11.8	1,950	174.1	52.3	7.24	95.2	27.7	23.6
Dissolved Lead	169/288	59	2.88	2.86	47.2	8/28/07	0.140	5.5	1.52	1.25	0.210	6.0	1.56	1.10	0.051	4.5	0.81	0.60	0.016	4.0	0.83	0.65	0.013	35.6	5.38	2.13	0.007	18.9	2.80	0.80	0.013	47.2	7.26	2.10
Dissolved Mercury	9/289	3	0.028	0.03	0.193	7/27/04	0.025	0.059	0.031	0.025	0.025	0.025	0.025	0.025	0.025	0.135	0.031	0.025	0.025	0.025	0.025	0.025	0.025	0.193	0.030	0.025	0.025	0.125	0.029	0.025	0.025	0.114	0.028	0.025
Dissolved Zinc	274/286	96	25.3	25.9	1,220	8/28/07	6.42	95.0	29.15	24.4	3.80	29.9	10.78	9.24	2.30	12.6	7.7	7.4	0.60	14.3	4.6	3.7	0.130	45.8	12.3	8.9	0.600	1,220	91.4	20.9	0.325	54.7	21.3	16.3
PAHs in ug/L																																		
2-Methylnaphthalene	55/297	19	0.015	0.015	2.100	2/12/02	0.002	0.122	0.013	0.005	0.002	0.023	0.006	0.005	0.002	2.100	0.063	0.005	0.002	0.019	0.005	0.005	0.002	0.006	0.004	0.005	0.002	0.018	0.005	0.005	0.002	0.022	0.006	0.005
Acenaphthene	124/297	42	0.014	0.014	0.103	11/21/02	0.002	0.013	0.005	0.005	0.002	0.032	0.011	0.012	0.002	0.031	0.005	0.005	0.002	0.005	0.004	0.005	0.005	0.069	0.030	0.028	0.002	0.103	0.031	0.026	0.002	0.096	0.012	0.005
Acenaphthylene	7/297	2	0.004	0.004	0.019	7/17/08	0.002	0.005	0.004	0.005	0.002	0.005	0.004	0.005	0.002	0.016	0.004	0.005	0.002	0.005	0.004	0.005	0.002	0.005	0.004	0.005	0.002	0.008	0.004	0.005	0.002	0.019	0.005	0.005
Anthracene	36/297	12	0.006	0.006	0.077	7/17/05	0.002	0.012	0.004	0.005	0.002	0.031	0.006	0.005	0.002	0.005	0.004	0.005	0.002	0.005	0.004	0.005	0.002	0.022	0.007	0.005	0.002	0.014	0.006	0.005	0.002	0.077	0.008	0.005
Fluorene	56/291	19	0.006	0.006	0.086	2/12/02	0.002	0.012	0.005	0.005	0.002	0.060	0.009	0.005	0.002	0.086	0.007	0.005	0.002	0.005	0.004	0.005	0.002	0.013	0.005	0.005	0.002	0.017	0.006	0.005	0.002	0.060	0.008	0.005
Naphthalene	139/297	47	0.023	0.023	3.000	2/12/02	0.005	0.228	0.026	0.014	0.003	0.054	0.011	0.009	0.002	3.000	0.088	0.010	0.002	0.025	0.007	0.005	0.001	0.017	0.007	0.006	0.003	0.057	0.011	0.009	0.002	0.034	0.008	0.005
Phenanthrene	134/297	45	0.013	0.013	0.684	7/17/05	0.002	0.060	0.012	0.011	0.002	0.115	0.014	0.005	0.002	0.149	0.011	0.005	0.002	0.008	0.004	0.005	0.002	0.057	0.011	0.005	0.002	0.028	0.011	0.008	0.002	0.684	0.028	0.005
Total LPAHs[1,2]	496/1776	28	0.066	0.011	3.276	N/A	0.016	0.270	0.056	0.043	0.013	0.206	0.056	0.045	0.010	3.276	0.119	0.031	0.011	0.050	0.028	0.030	0.025	0.151	0.065	0.061	0.013	0.181	0.068	0.064	0.010	0.898	0.068	0.030
Benzo(a)anthracene	72/297	24	0.012	0.012	1.110	1/13/09	0.001	0.066	0.007	0.005	0.001	0.114	0.013	0.005	0.001	0.022	0.006	0.005	0.001	0.045	0.005	0.005	0.001	0.055	0.008	0.005	0.001	0.021	0.006	0.005	0.001	1.110	0.043	0.005
Benzo(a)pyrene	42/297	14	0.007	0.007	0.142	1/24/06	0.002	0.057	0.006	0.005	0.002	0.142	0.013	0.005	0.002	0.020	0.006	0.005	0.002	0.041	0.005	0.005	0.002	0.042	0.007	0.005	0.002	0.048	0.006	0.005	0.002	0.131	0.010	0.005
Benzo(g,h,i)perylene	52/297	18	0.007	0.007	0.166	8/7/06	0.002	0.023	0.007	0.005	0.002	0.166	0.012	0.005	0.002	0.022	0.006	0.005	0.002	0.044	0.006	0.005	0.002	0.046	0.008	0.005	0.002	0.033	0.006	0.005	0.002	0.055	0.008	0.005
Benzo(b,k)fluoranthenes	115/297	39	0.015	0.015	0.376	7/17/05	0.002	0.113	0.013	0.007	0.002	0.344	0.026	0.006	0.002	0.047	0.011	0.005	0.002	0.107	0.008	0.005	0.002	0.105	0.013	0.005	0.002	0.062	0.009	0.005	0.002	0.376	0.027	0.013
Chrysene	76/297	26	0.011	0.011	0.362	3/12/09	0.002	0.087	0.010	0.005	0.002	0.199	0.018	0.005	0.002	0.026	0.006	0.005	0.002	0.060	0.005	0.005	0.002	0.098	0.011	0.005	0.002	0.063	0.008	0.005	0.002	0.362	0.020	0.005
Dibenz(a,h)anthracene	14/297	5	0.005	0.005	0.028	8/7/06	0.002	0.011	0.005	0.005	0.002	0.028	0.005	0.005	0.002	0.010	0.005	0.005	0.002	0.011	0.005	0.005	0.002	0.012	0.005	0.005	0.002	0.013	0.005	0.005	0.002	0.017	0.005	0.005
Fluoranthene	177/297	60	0.021	0.021	1.140	3/12/09	0.003	0.133	0.017	0.011	0.003	0.295	0.029	0.012	0.002	0.046	0.010	0.005	0.003	0.088	0.007	0.005	0.003	0.133	0.022	0.015	0.003	0.046	0.013	0.011	0.003	1.140	0.051	0.013
Indeno(1,2,3-c,d)pyrene	32/297	11	0.006	0.006	0.115	8/7/06	0.002	0.019	0.005	0.005	0.002	0.115	0.009	0.005	0.002	0.018	0.005	0.005	0.002	0.039	0.005	0.005	0.002	0.034	0.006	0.005	0.002	0.018	0.005	0.005	0.002	0.053	0.007	0.005
Pyrene	234/297	79	0.026	0.026	0.879	7/17/05	0.004	0.173	0.021	0.015	0.003	0.253	0.034	0.018	0.002	0.056	0.013	0.005	0.002	0.078	0.007	0.005	0.005	0.116	0.030	0.021	0.004	0.081	0.024	0.023	0.002	0.879	0.051	0.022
Total HPAHs[1]	814/2673	30	0.112	0.012	3.287	N/A	0.025	0.671	0.091	0.060	0.025	1.639	0.162	0.068	0.022	0.249	0.067	0.045	0.022	0.513	0.052	0.045	0.031	0.606	0.109	0.072	0.029	0.368	0.081	0.073	0.024	3.287	0.222	0.078
Total PAHs[1]	1310/4449	29	0.178	0.012	4.185	N/A	0.041	0.840	0.147	0.121	0.038	1.845	0.217	0.116	0.034	3.464	0.186	0.087	0.033	0.543	0.081	0.075	0.055	0.757	0.174	0.133	0.042	0.436	0.149	0.141	0.034	4.185	0.290	0.116
Phthalates in ug/L																																		
Bis(2-ethylhexyl)phthalate	85/290	29	1.07	1.06	33.0	3/23/10	0.26	33.00	2.00	0.50	0.20	21.30	1.84	0.72	0.20	1.60	0.56	0.50	0.20	0.80	0.50	0.50	0.20	16.00	1.03	0.50	0.20	3.30	0.72	0.50	0.08	10.00	0.82	0.50
Butylbenzylphthalate	29/297	10	0.56	0.56	16.0	7/28/04	0.09	0.70	0.39	0.50	0.09	1.60	0.44	0.50	0.09	0.50	0.37	0.50	0.05	0.50	0.36	0.50	0.09	1.80	0.43	0.50	0.09	16.00	1.49	0.50	0.09	1.40	0.41	0.50
Diethylphthalate	65/297	22	0.92	0.92	32.0	2/5/03	0.07	8.40	0.69	0.50	0.04	15.00	0.91	0.50	0.04	32.00	1.99	0.50	0.04	17.00	0.99	0.50	0.05	10.00	0.71	0.50	0.04	4.40	0.65	0.50	0.04	3.80	0.48	0.50
Dimethylphthalate	2/297	1	0.36	0.36	0.5	N/A	0.02	0.50	0.36	0.50	0.02	0.50	0.36	0.50	0.02	0.50	0.35	0.50	0.02	0.50	0.35	0.50	0.02	0.50	0.38	0.50	0.02	0.50	0.35	0.50	0.02	0.50	0.36	0.50
Di-n-butylphthalate	59/297	20	0.43	0.43	4.3	3/23/10	0.10	0.50	0.40	0.50	0.05	0.50	0.40	0.50	0.05	0.50	0.41	0.50	0.05	0.50	0.39	0.50	0.05	4.30	0.55	0.50	0.15	1.30	0.46	0.50	0.05	0.50	0.40	0.50
Di-n-octyl phthalate	5/297	2	0.38	0.38	3.9	7/26/04	0.04	2.00	0.40	0.50	0.04	3.90	0.44	0.50	0.04	0.50	0.35	0.50	0.04	0.50	0.35	0.50	0.04	0.50	0.37	0.50	0.04	0.50	0.36	0.50	0.04	0.50	0.36	0.50
Total Phthalates[3]	245/1782	14			33.4	N/A	0.23	33.40	4.44	0.94	0.12	22.90	4.06	1.60	0.20	32.00	4.60	1.00	0.20	32.10	5.28	1.21	0.10	22.87	3.14	1.10	0.21	18.70	3.91	1.30	0.22	13.80	2.21	1.27

Notes:
1 = PAH summations based on 1/2 detection limit for nondetects.
2 = Calculation of Total LPAHs does not include 2-Methylnaphthalene.
3 = Phthalate summations exclude nondetect values.
OF237Anew isn't included in the count of samples.

Highest average or highest median concentration detected in Years 1-10 monitoring.
Highest maximum concentration detected in Years 1-10 monitoring.
Results in italics indicate nondetected values.

Table 3-3
Summary Statistics for Stormwater

	Overall Data: Overall Detections	Overall Data: % Detections	Overall Data: Arithmetic Mean[4]	Overall Data: Weighted Mean[5]	Overall Data: Max	Overall Data: Date of Max
Conventionals						
Hardness (mg/L as CaCO3)	801/801	100	N/A	N/A	N/A	N/A
pH (pH units)	801/801	100	N/A	N/A	N/A	N/A
TSS (mg/L)	780/780	100	69.0	67.8	441	10/10/01
Metals in ug/L						
Lead	793/800	99	28.6	28.7	379	9/5/09
Mercury	191/801	24	0.033	0.033	0.870	5/20/08
Zinc	800/800	100	124.0	122.9	1,170	8/6/04
Dissolved Lead	508/800	64	2.35	2.35	145	8/6/04
Dissolved Mercury	56/800	7	0.025	0.024	0.552	7/23/14
Dissolved Zinc	796/798	100	52.0	51.8	910	8/6/04
PAHs in ug/L						
LPAHs in ug/L						
2-Methylnaphthalene	573/799	72	0.025	0.026	4.130	3/16/02
Acenaphthene	372/799	47	0.014	0.013	0.855	8/6/04
Acenaphthylene	226/799	28	0.008	0.007	0.095	8/6/04
Anthracene	409/799	51	0.019	0.018	0.389	2/21/02
Fluorene	512/799	64	0.018	0.017	0.928	8/6/04
Naphthalene	623/796	78	0.032	0.033	4.430	3/16/02
Phenanthrene	764/799	96	0.086	0.087	1.650	8/6/04
Total LPAHs[1,2]	2906/4791	61	0.168	0.004	4.930	N/A
HPAHs in ug/L						
Benzo(a)anthracene	602/799	75	0.055	0.055	0.915	2/21/02
Benzo(a)pyrene	534/799	67	0.055	0.056	0.865	2/18/07
Benzo(g,h,i)perylene	656/799	82	0.061	0.062	0.794	9/4/07
Benzo(b,k)fluoranthenes	643/799	80	0.154	0.156	2.430	9/4/07
Chrysene	699/799	87	0.116	0.116	1.906	2/21/02
Dibenz(a,h)anthracene	342/799	43	0.013	0.013	0.177	9/4/07
Fluoranthene	786/799	98	0.188	0.189	3.964	2/21/02
Indeno(1,2,3-c,d)pyrene	579/799	72	0.044	0.045	0.680	9/4/07
Pyrene	782/799	98	0.184	0.185	4.120	2/21/02
Total HPAHs[1]	5623/7191	78	0.866	0.000	13.558	N/A
Total PAHs[1]	8529/11982	71	1.035	0.000	14.681	N/A
Phenols in ug/L						
4-Methylphenol	221/257	86	0.047	0.048	0.568	1/21/03
Phthalates in ug/L						
Bis(2-ethylhexyl)phthalate	621/792	78	3.14	3.22	97	10/3/02
Butylbenzylphthalate	280/799	35	2.84	2.83	290	2/15/03
Diethylphthalate	245/799	31	2.35	2.48	590	12/10/02
Dimethylphthalate	78/793	10	0.34	0.34	4.70	9/29/05
Di-n-butylphthalate	256/799	32	0.43	0.43	4.80	6/12/04
Di-n-octyl phthalate	152/789	19	0.42	0.43	4.50	8/6/04
Total Phthalates[3]	1632/4771	34	7.97	0.64	596.4	N/A

	OF230 Min	OF230 Max	OF230 Arithmetic Mean	OF230 Median	OF235 Min	OF235 Max	OF235 Arithmetic Mean	OF235 Median	OF237A New Min	OF237A New Max	OF237A New Arithmetic Mean	OF237A New Median
Conventionals												
Hardness (mg/L as CaCO3)	9.1	179	20.7	17.9	15.1	61.3	31.8	30.6	14.5	68.8	30.1	28.5
pH (pH units)	5.0	10.6	6.8	6.8	5.4	8.6	6.9	7.0	5.3	7.9	6.7	6.7
TSS (mg/L)	4.8	304	50.0	35.5	7.8	441	72.3	53.7	3.5	400	54.0	39.5
Metals in ug/L												
Lead	4.0	229	23.6	18.2	9.5	368	70.1	59.8	1.7	68	14.2	10.8
Mercury	0.002	0.130	0.033	0.025	0.002	0.190	0.037	0.025	0.002	0.100	0.025	0.025
Zinc	35.2	721	126.3	111.5	36.6	475	132.2	113.0	36.9	361	104.5	91.9
Dissolved Lead	0.20	9.05	1.17	0.75	0.18	28.0	7.12	5.30	0.12	3.46	0.71	0.55
Dissolved Mercury	0.001	0.100	0.023	0.025	0.001	0.100	0.023	0.025	0.001	0.100	0.023	0.025
Dissolved Zinc	11.5	543	66.5	51.5	13.0	262	47.6	40.3	21.3	282	53.6	43.8
PAHs in ug/L												
LPAHs in ug/L												
2-Methylnaphthalene	0.002	0.330	0.028	0.015	0.001	4.130	0.048	0.013	0.001	0.104	0.016	0.010
Acenaphthene	0.002	0.080	0.008	0.005	0.002	0.086	0.011	0.005	0.002	0.532	0.012	0.005
Acenaphthylene	0.002	0.060	0.006	0.005	0.001	0.060	0.007	0.005	0.001	0.061	0.005	0.005
Anthracene	0.002	0.122	0.013	0.005	0.002	0.138	0.016	0.006	0.002	0.105	0.012	0.005
Fluorene	0.002	0.246	0.015	0.007	0.001	0.083	0.015	0.010	0.001	0.110	0.012	0.006
Naphthalene	0.003	0.362	0.033	0.023	0.002	4.430	0.059	0.018	0.002	0.150	0.025	0.019
Phenanthrene	0.005	0.653	0.100	0.046	0.002	0.776	0.100	0.053	0.002	0.893	0.094	0.042
Total LPAHs[1,2]	0.008	0.923	0.167	0.092	0.009	4.930	0.200	0.087	0.003	1.087	0.151	0.081
HPAHs in ug/L												
Benzo(a)anthracene	0.001	0.439	0.063	0.021	0.001	0.555	0.059	0.020	0.001	0.902	0.072	0.021
Benzo(a)pyrene	0.002	0.563	0.073	0.019	0.001	0.498	0.060	0.019	0.001	0.865	0.074	0.019
Benzo(g,h,i)perylene	0.002	0.457	0.081	0.027	0.002	0.410	0.067	0.026	0.002	0.794	0.090	0.031
Benzo(b,k)fluoranthenes	0.002	1.396	0.205	0.052	0.002	1.199	0.150	0.054	0.005	2.430	0.239	0.064
Chrysene	0.002	0.860	0.139	0.039	0.002	0.678	0.116	0.041	0.002	1.490	0.159	0.050
Dibenz(a,h)anthracene	0.002	0.088	0.018	0.010	0.002	0.154	0.014	0.005	0.002	0.177	0.019	0.005
Fluoranthene	0.003	1.687	0.217	0.076	0.003	1.550	0.200	0.078	0.008	2.640	0.259	0.103
Indeno(1,2,3-c,d)pyrene	0.002	0.346	0.062	0.019	0.002	0.338	0.045	0.017	0.002	0.680	0.072	0.021
Pyrene	0.005	1.200	0.197	0.065	0.002	1.164	0.195	0.080	0.005	2.930	0.240	0.100
Total HPAHs[1]	0.025	6.680	1.050	0.311	0.027	6.497	0.901	0.348	0.029	12.263	1.220	0.405
Total PAHs[1]	0.037	7.494	1.217	0.428	0.045	7.552	1.114	0.481	0.033	13.295	1.372	0.506
Phenols in ug/L												
4-Methylphenol	0.005	0.280	0.068	0.025	0.005	0.568	0.072	0.040	0.005	0.149	0.031	0.022
Phthalates in ug/L												
Bis(2-ethylhexyl)phthalate	0.204	44.1	4.08	2.45	0.321	97.0	5.36	2.70	0.204	13.70	2.26	1.27
Butylbenzylphthalate	0.085	8.40	0.62	0.50	0.085	6.60	1.01	0.50	0.085	2.92	0.47	0.50
Diethylphthalate	0.077	9.30	0.60	0.50	0.077	590	4.88	0.50	0.085	230.00	3.00	0.50
Dimethylphthalate	0.016	4.70	0.40	0.50	0.016	2.40	0.32	0.20	0.016	0.50	0.30	0.50
Di-n-butylphthalate	0.050	1.60	0.45	0.50	0.050	1.60	0.41	0.50	0.095	4.80	0.46	0.50
Di-n-octyl phthalate	0.042	3.20	0.55	0.50	0.042	3.20	0.50	0.50	0.042	2.50	0.37	0.50
Total Phthalates[3]	0.00	44.1	5.19	3.09	0.000	596.4	11.1	4.300	0.00	230	5.23	1.76

	OF237B Min	OF237B Max	OF237B Arithmetic Mean	OF237B Median	OF243 Min	OF243 Max	OF243 Arithmetic Mean	OF243 Median	OF245 Min	OF245 Max	OF245 Arithmetic Mean	OF245 Median	OF254 Min	OF254 Max	OF254 Arithmetic Mean	OF254 Median
Conventionals																
Hardness (mg/L as CaCO3)	20.7	1,220.0	55.1	45.7	59.3	3,150	498.6	389.0	14.0	285	59.4	47.3	49.5	1,720	479.3	416
pH (pH units)	5.7	7.8	6.8	6.9	6.1	7.5	7.0	7.0	5.6	7.6	6.8	6.8	6.2	8.1	7.1	7.1
TSS (mg/L)	3.6	278	60.6	45.0	4.4	300	73.9	56.3	6.2	243	67.6	53.1	5.2	354	104.2	84.3
Metals in ug/L																
Lead	1.5	64	13.3	9.3	1.4	379	46.6	25.4	1.7	60	12.6	10.3	3.1	68	19.7	15.8
Mercury	0.001	0.216	0.029	0.025	0.005	0.188	0.036	0.025	0.002	0.870	0.034	0.025	0.005	0.307	0.039	0.025
Zinc	15.0	243	72.4	59.1	19.6	1,170	114.6	84.2	27.7	585	165.3	141.0	43.1	427	152.4	134.0
Dissolved Lead	0.14	11.40	0.70	0.47	0.01	145.0	4.48	1.20	0.04	6.27	0.74	0.55	0.01	12.20	1.51	0.65
Dissolved Mercury	0.001	0.100	0.023	0.025	0.001	0.552	0.030	0.025	0.000	0.108	0.025	0.025	0.001	0.211	0.027	0.025
Dissolved Zinc	6.3	161	27.5	21.8	8.4	910	44.3	29.6	18.3	335	70.7	52.1	5.1	239	54.1	41.7
PAHs in ug/L																
LPAHs in ug/L																
2-Methylnaphthalene	0.002	0.250	0.014	0.008	0.002	0.136	0.014	0.008	0.001	1.143	0.035	0.011	0.001	0.435	0.022	0.014
Acenaphthene	0.002	0.063	0.006	0.005	0.002	0.045	0.018	0.017	0.002	0.855	0.020	0.009	0.002	0.352	0.022	0.011
Acenaphthylene	0.002	0.064	0.005	0.005	0.002	0.064	0.009	0.005	0.001	0.095	0.010	0.005	0.001	0.070	0.011	0.005
Anthracene	0.002	0.097	0.009	0.005	0.002	0.079	0.023	0.019	0.002	0.289	0.014	0.005	0.002	0.389	0.044	0.017
Fluorene	0.002	0.078	0.009	0.005	0.002	0.098	0.016	0.011	0.001	0.928	0.031	0.012	0.001	0.159	0.027	0.016
Naphthalene	0.003	0.130	0.017	0.013	0.003	0.135	0.023	0.016	0.002	0.795	0.041	0.020	0.002	0.126	0.025	0.021
Phenanthrene	0.002	0.838	0.060	0.027	0.005	0.221	0.062	0.037	0.002	1.650	0.082	0.047	0.002	0.657	0.103	0.071
Total LPAHs[1,2]	0.006	1.134	0.096	0.060	0.030	0.473	0.145	0.109	0.007	4.612	0.190	0.101	0.016	1.244	0.227	0.148
HPAHs in ug/L																
Benzo(a)anthracene	0.001	0.685	0.041	0.013	0.001	0.335	0.040	0.020	0.001	0.247	0.025	0.013	0.001	0.915	0.088	0.046
Benzo(a)pyrene	0.002	0.690	0.047	0.015	0.002	0.182	0.038	0.017	0.001	0.133	0.023	0.011	0.002	0.428	0.070	0.040
Benzo(g,h,i)perylene	0.002	0.614	0.056	0.026	0.002	0.189	0.042	0.025	0.002	0.112	0.030	0.018	0.002	0.253	0.059	0.048
Benzo(b,k)fluoranthenes	0.002	1.763	0.131	0.048	0.005	0.554	0.104	0.048	0.002	0.414	0.060	0.030	0.005	1.662	0.191	0.110
Chrysene	0.002	0.965	0.087	0.031	0.002	0.516	0.080	0.040	0.002	0.420	0.057	0.025	0.002	1.906	0.175	0.097
Dibenz(a,h)anthracene	0.002	0.143	0.011	0.005	0.002	0.044	0.009	0.005	0.002	0.027	0.006	0.005	0.002	0.071	0.014	0.008
Fluoranthene	0.003	1.835	0.132	0.050	0.013	0.444	0.116	0.065	0.002	1.720	0.087	0.043	0.003	3.964	0.307	0.141
Indeno(1,2,3-c,d)pyrene	0.002	0.546	0.040	0.016	0.002	0.137	0.029	0.016	0.002	0.058	0.017	0.011	0.002	0.239	0.041	0.027
Pyrene	0.002	1.493	0.131	0.049	0.012	0.620	0.120	0.066	0.002	1.310	0.104	0.058	0.002	4.120	0.304	0.152
Total HPAHs[1]	0.019	8.734	0.675	0.242	0.031	2.880	0.569	0.315	0.011	4.393	0.400	0.207	0.027	13.558	1.244	0.697
Total PAHs[1]	0.028	9.868	0.771	0.287	0.065	3.353	0.714	0.413	0.020	9.005	0.590	0.340	0.047	14.681	1.471	0.804
Phenols in ug/L																
4-Methylphenol	0.005	0.160	0.027	0.021	0.005	0.481	0.054	0.029	0.005	0.320	0.045	0.030	0.005	0.252	0.034	0.023
Phthalates in ug/L																
Bis(2-ethylhexyl)phthalate	0.144	12.00	2.35	1.43	0.204	41.00	2.47	1.31	0.204	31.0	3.02	1.70	0.144	10.20	2.41	1.76
Butylbenzylphthalate	0.085	2.80	0.39	0.50	0.085	9.20	1.24	0.50	0.085	290	15.57	0.50	0.085	6.10	0.55	0.50
Diethylphthalate	0.050	52.00	1.33	0.48	0.070	7.60	0.54	0.50	0.077	430	4.21	0.50	0.070	120	1.88	0.50
Dimethylphthalate	0.016	0.55	0.30	0.20	0.016	1.00	0.33	0.50	0.016	1.10	0.33	0.50	0.016	3.20	0.42	0.50
Di-n-butylphthalate	0.095	1.00	0.39	0.50	0.050	1.27	0.41	0.50	0.148	1.60	0.46	0.50	0.100	1.30	0.44	0.50
Di-n-octyl phthalate	0.042	2.30	0.37	0.40	0.042	1.00	0.34	0.50	0.042	4.10	0.37	0.50	0.042	4.50	0.46	0.50
Total Phthalates[3]	0.00	66.2	3.59	1.78	0.000	41.0	3.71	2.10	0.000	593.1	22.49	2.90	0.000	123.2	4.48	2.17

Notes:
1 = PAH summations based on 1/2 detection limit for nondetects.
2 = Calculation of Total LPAHs does not include 2-Methylnaphthalene.
3 = Phthalate summations exclude nondetect values.
4 = Overall data arithmetic mean is average of individual outfall means.

Highest average or highest median concentration detected in Years 1-13 monitoring. (light yellow shading)
Highest maximum concentration detected in Years 1-13 monitoring. (darker yellow shading)

Table 3-4
Spatial Analysis of Stormwater Quality (ANOVA Results)

A. Parametric Outfall Pair Comparisons, Years 1-13							
Analyte	**OF230**	**OF235**	**OF237A**	**OF237B**	**OF243**	**OF245**	**OF254**
TSS	-4	1	-2	-1	0	0	6
Total Lead	1	6	-4	-4	4	-4	1
Total Zinc	-1	3	-2	-6	-2	4	4
DEHP	4	5	-2	-2	-2	-1	-2
Phenanthrene	1	1	0	-3	0	0	1
Pyrene	-1	2	2	-3	-1	-3	4
Indeno(1,2,3-c,d)pyrene	1	1	1	0	0	-4	1

B. Parametric Outfall Pair Comparisons, Year 12-13							
Analyte	**OF230**	**OF235**	**OF237A**	**OF237B**	**OF243**	**OF245**	**OF254**
TSS	-2	1	-1	-1	0	-1	4
Total Lead	-1	6	-1	-3	1	-3	1
Total Zinc	1	1	1	-5	0	1	1
DEHP	1	2	0	-2	-1	0	0
Phenanthrene	0	0	0	-1	1	0	0
Pyrene	-1	2	1	-2	0	0	0
Indeno(1,2,3-c,d)pyrene	0	0	0	0	0	0	0

Key:

- *Well Below Average (-6 to -3)*
- *Below Average (-2 to -1)*
- *Neutral (0)*
- *Above Average (1 to 2)*
- *Well Above Average (3 to 6)*

Table 3-5
Spatial Analysis of Storm Sediment Quality (ANOVA Results)

A. Nonparametric Outfall Pair Comparisons, Years 1-13						
Analyte	**OF230**	**OF235**	**OF237A**	**OF237B**	**OF243**	**OF245**
Lead	2	2	-1	-3	3	-3
Mercury	3	-1	-2	-2	4	-2
Zinc	1	-1	-1	-3	3	1
TPH-OIL	1	0	0	-2	1	0
DDT	No significant differences					
Phenanthrene	1	0	1	0	0	-2
Indeno(1,2,3-cd)pyrene	2	-1	1	1	0	-3
Pyrene	1	0	1	0	0	-2
Total PCBs	No significant differences					
DEHP	1	0	0	-2	1	0
Butylbenzylphthalate	-1	-1	-2	-2	2	4
Total Phthalates	1	0	0	-3	1	1

B. Nonparametric Outfall Pair Comparisons, Years 9-13						
Analyte	**OF230**	**OF235**	**OF237A**	**OF237B**	**OF243**	**OF245**
Lead	0	0	0	-1	2	-1
Mercury	1	0	0	-2	2	-1
Zinc	0	0	-1	-1	2	0
TPH-OIL	0	0	0	-1	1	0
DDT	No significant differences					
Phenanthrene	1	0	1	0	0	-2
Indeno(1,2,3-cd)pyrene	1	0	1	0	0	-2
Pyrene	1	0	1	0	0	-2
Total PCBs	No significant differences					
DEHP	No significant differences					
Butylbenzylphthalate	0	0	0	-2	1	1
Total Phthalates	0	0	0	-1	1	0

Key:

Well Below Average (-6 to -3)
Below Average (-2 to -1)
Neutral (0)
Above Average (1 to 2)
Well Above Average (3 to 6)

Table 3-6
Regression Statistics of Stormwater Time Trends

Analyte	Outfall Number	Sample Count	S_x	S_y^2	slope	y-intercept	R^2	t - statistic	Significance Level	Year 1 Concentration (log)	Year 13 Concentration (log)	Year 1 Concentration	Year 13 Concentration	Est % Reduction in 13 years
Total Suspended Solids	OF230	113	1407	0.121	-0.00011	5.84	0.192	-5.14	>99.9%	1.83	1.32	68.0	20.7	70%
	OF235	132	1349	0.103	-0.00010	5.76	0.183	-5.40	>99.9%	2.01	1.53	101.9	33.5	67%
	OF237A*	120	1411	0.098	-0.00005	3.53	0.048	-2.44	98.4%	1.74	1.51	55.0	32.4	41%
	OF237B	127	1368	0.121	-0.00010	5.42	0.140	-4.52	>99.9%	1.90	1.45	79.4	28.0	65%
	OF245	112	1311	0.101	-0.00010	5.72	0.175	-4.83	>99.9%	1.97	1.49	94.1	31.0	67%
Lead	OF230	118	1401	0.111	-0.00012	6.15	0.275	-6.63	>99.9%	1.56	0.96	35.9	9.2	74%
	OF235	137	1343	0.058	-0.00010	5.73	0.313	-7.84	>99.9%	2.04	1.57	110.3	37.0	66%
	OF237A*	120	1411	0.085	-0.00006	3.30	0.076	-3.11	99.8%	1.20	0.93	15.9	8.5	46%
	OF237B	130	1380	0.116	-0.00011	5.43	0.206	-5.77	>99.9%	1.29	0.76	19.4	5.7	71%
	OF245	116	1312	0.096	-0.00010	4.78	0.167	-4.78	>99.9%	1.23	0.77	17.0	5.9	65%
	OF254	100	1263	0.095	-0.00006	3.49	0.057	-2.43	98.3%	1.34	1.06	21.6	11.4	47%
Zinc	OF230	118	1401	0.051	-0.00004	3.47	0.050	-2.48	98.5%	2.13	1.95	133.6	89.8	33%
	OF235	137	1343	0.049	-0.00006	4.42	0.131	-4.51	>99.9%	2.22	1.94	166.2	86.7	48%
	OF237A*	120	1411	0.040	-0.00005	3.78	0.104	-3.70	>99.9%	2.09	1.87	122.7	74.3	39%
	OF237B	131	1381	0.064	-0.00008	4.98	0.194	-5.58	>99.9%	2.00	1.61	99.0	40.9	59%
	OF243	79	1324	0.077	-0.00006	4.24	0.078	-2.55	98.7%	2.09	1.81	121.9	64.3	47%
	OF245	115	1308	0.066	-0.00006	4.43	0.088	-3.30	99.9%	2.28	2.01	191.8	101.4	47%
	OF254	100	1263	0.048	-0.00007	4.97	0.174	-4.54	>99.9%	2.30	1.96	201.6	91.4	55%
Phenanthrene	OF230	118	1401	0.276	-0.00028	9.58	0.548	-11.78	>99.9%	-0.59	-1.90	0.3	0.0	95%
	OF235	137	1343	0.316	-0.00028	9.80	0.455	-10.56	>99.9%	-0.57	-1.90	0.3	0.0	95%
	OF237A*	119	1413	0.370	-0.00028	9.77	0.455	-9.62	>99.9%	-0.65	-1.99	0.2	0.0	95%
	OF237B	131	1381	0.278	-0.00026	8.76	0.471	-10.65	>99.9%	-0.84	-2.08	0.1	0.0	94%
	OF243	79	1324	0.177	-0.00021	6.78	0.429	-7.61	>99.9%	-0.90	-1.88	0.1	0.0	90%
	OF245	115	1312	0.199	-0.00020	6.64	0.357	-7.92	>99.9%	-0.85	-1.82	0.1	0.0	89%
	OF254	100	1263	0.203	-0.00023	7.87	0.424	-8.42	>99.9%	-0.63	-1.73	0.2	0.0	92%
Pyrene	OF230	118	1401	0.404	-0.00035	12.75	0.598	-13.12	>99.9%	-0.20	-1.86	0.6	0.0	98%
	OF235	137	1343	0.288	-0.00028	10.23	0.505	-11.73	>99.9%	-0.25	-1.60	0.6	0.0	96%
	OF237A*	119	1413	0.376	-0.00033	12.05	0.582	-12.75	>99.9%	-0.16	-1.73	0.7	0.0	97%
	OF237B	131	1381	0.368	-0.00034	12.19	0.598	-13.87	>99.9%	-0.36	-1.97	0.4	0.0	98%
	OF243	79	1324	0.207	-0.00023	7.81	0.440	-7.78	>99.9%	-0.60	-1.68	0.3	0.0	92%
	OF245	115	1312	0.262	-0.00026	8.88	0.436	-9.35	>99.9%	-0.63	-1.86	0.2	0.0	94%
	OF254	100	1263	0.372	-0.00038	13.90	0.605	-12.24	>99.9%	0.05	-1.74	1.1	0.0	98%
Indeno(1,2,3-c,d)pyrene	OF230	118	1401	0.500	-0.00034	11.70	0.460	-9.82	>99.9%	-0.78	-2.38	0.2	0.0	98%
	OF235	137	1343	0.397	-0.00031	10.59	0.452	-10.41	>99.9%	-0.89	-2.37	0.1	0.0	97%
	OF237A*	119	1413	0.515	-0.00033	11.43	0.435	-9.37	>99.9%	-0.77	-2.34	0.2	0.0	97%
	OF237B	131	1381	0.428	-0.00032	11.00	0.486	-10.84	>99.9%	-0.96	-2.50	0.1	0.0	97%
	OF243	79	1324	0.309	-0.00027	8.63	0.410	-7.24	>99.9%	-1.20	-2.46	0.1	0.0	95%
	OF245	115	1312	0.253	-0.00027	8.64	0.512	-10.75	>99.9%	-1.35	-2.64	0.0	0.0	95%
	OF254	100	1263	0.334	-0.00033	11.26	0.536	-10.44	>99.9%	-0.86	-2.43	0.1	0.0	97%
Bis(2-ethylhexyl)phthalate	OF230	117	1397	0.209	-0.00017	6.92	0.265	-6.33	>99.9%	0.82	0.03	6.5	1.1	84%
	OF235	136	1339	0.208	-0.00021	8.64	0.373	-8.86	>99.9%	1.03	0.05	10.6	1.1	90%
	OF237A *	118	1410	0.178	-0.00015	6.01	0.259	-6.19	>99.9%	0.55	-0.15	3.6	0.7	80%
	OF237B	130	1377	0.214	-0.00020	8.02	0.369	-8.43	>99.9%	0.68	-0.26	4.8	0.5	89%
	OF243	78	1320	0.233	-0.00022	8.73	0.371	-6.60	>99.9%	0.63	-0.41	4.3	0.4	91%
	OF245	113	1312	0.212	-0.00023	9.35	0.443	-9.33	>99.9%	0.80	-0.30	6.3	0.5	92%
	OF254	100	1263	0.175	-0.00011	4.44	0.110	-3.41	>99.9%	0.47	-0.04	2.9	0.9	69%

237A - Includes data from 237A New site for all samples collected after 2/26/06.*

Shaded cells indicate newly significant trend detected in Water Year 2014

Table 6-1
Percent of Annual Loading Rates by Outfall

Stormwater Outfalls		Phenanthrene			Pyrene			Dibenz(ah)anthracene			Bis(2-ethylhexyl)phthalate			Volume, ac-ft/yr	% of Total Volume
		Contaminant Load in Kg/Year	% of Total SW Load	% of Total Load	Contaminant Load in Kg/Year	% of Total SW Load	% of Total Load	Contaminant Load in Kg/Year	% of Total SW Load	% of Total Load	Contaminant Load in Kg/Year	% of Total SW Load	% of Total Load		
OF237A	SW	0.155	36.4%	7.1%	0.389	41.3%	10.7%	0.042	41.1%	15.4%	3.70	22.7%	15.5%	789	10.5%
	BF	0.043	10.1%	2.0%	0.045	4.8%	1.2%	0.009	8.8%	3.3%	1.75	10.7%	7.3%	2,027	27.1%
OF237B	SW	0.088	20.7%	4.0%	0.208	22.1%	5.7%	0.015	14.7%	5.5%	3.70	22.7%	15.5%	731	9.8%
	BF	0.019	4.5%	0.9%	0.038	4.0%	1.0%	0.003	2.9%	1.1%	1.92	11.8%	8.0%	3,113	41.6%
OF230	SW	0.055	12.9%	2.5%	0.111	11.8%	3.1%	0.016	15.6%	5.9%	1.75	10.7%	7.3%	244	3.3%
	BF	0.002	0.4%	0.1%	0.003	0.3%	0.1%	0.001	1.0%	0.4%	0.26	1.6%	1.1%	87	1.2%
OF235	SW	0.027	6.3%	1.2%	0.055	5.8%	1.5%	0.005	4.9%	1.8%	1.59	9.8%	6.7%	126	1.7%
	BF	0.005	1.2%	0.2%	0.011	1.2%	0.3%	0.003	2.9%	1.1%	0.64	3.9%	2.7%	166	2.2%
OF245		0.006	1.4%	0.3%	0.007	0.7%	0.2%	0.001	0.7%	0.3%	0.22	1.4%	0.9%	33	0.4%
OF243		0.006	1.4%	0.3%	0.010	1.1%	0.3%	0.002	2.0%	0.7%	0.19	1.2%	0.8%	45	0.6%
OF254		0.010	2.3%	0.5%	0.035	3.7%	1.0%	0.003	2.9%	1.1%	0.18	1.1%	0.8%	50	0.7%
All Other SW Outfalls		0.010	2.4%	0.5%	0.029	3.1%	0.8%	0.003	2.5%	1.0%	0.38	2.3%	1.6%	72	1.0%
BF Total		**0.07**	**16.2%**	**3.1%**	**0.10**	**10.3%**	**2.7%**	**0.016**	**15.6%**	**5.9%**	**4.57**	**28.1%**	**19.2%**	**5,393**	**72.1%**
SW Total		**0.36**	**84%**	**16.3%**	**0.84**	**90%**	**23.3%**	**0.086**	**84%**	**31.6%**	**11.71**	**72%**	**49.1%**	**2,090**	**27.9%**
Total Outfall Loadings		**0.43**		**19.4%**	**0.94**		**26.0%**	**0.102**		**37.4%**	**16.28**		**68.2%**	**7,483**	
Total Loadings		**2.19**		**100.0%**	**3.62**		**100.0%**	**0.273**		**100.0%**	**23.86**		**100.0%**		

Loadings as developed for the 2006 WASP Model Update.
SW - Stormwater
BF- Baseflow

FIGURES

Figure 1-1
Thea Foss Post-Remediation Source Control Strategy

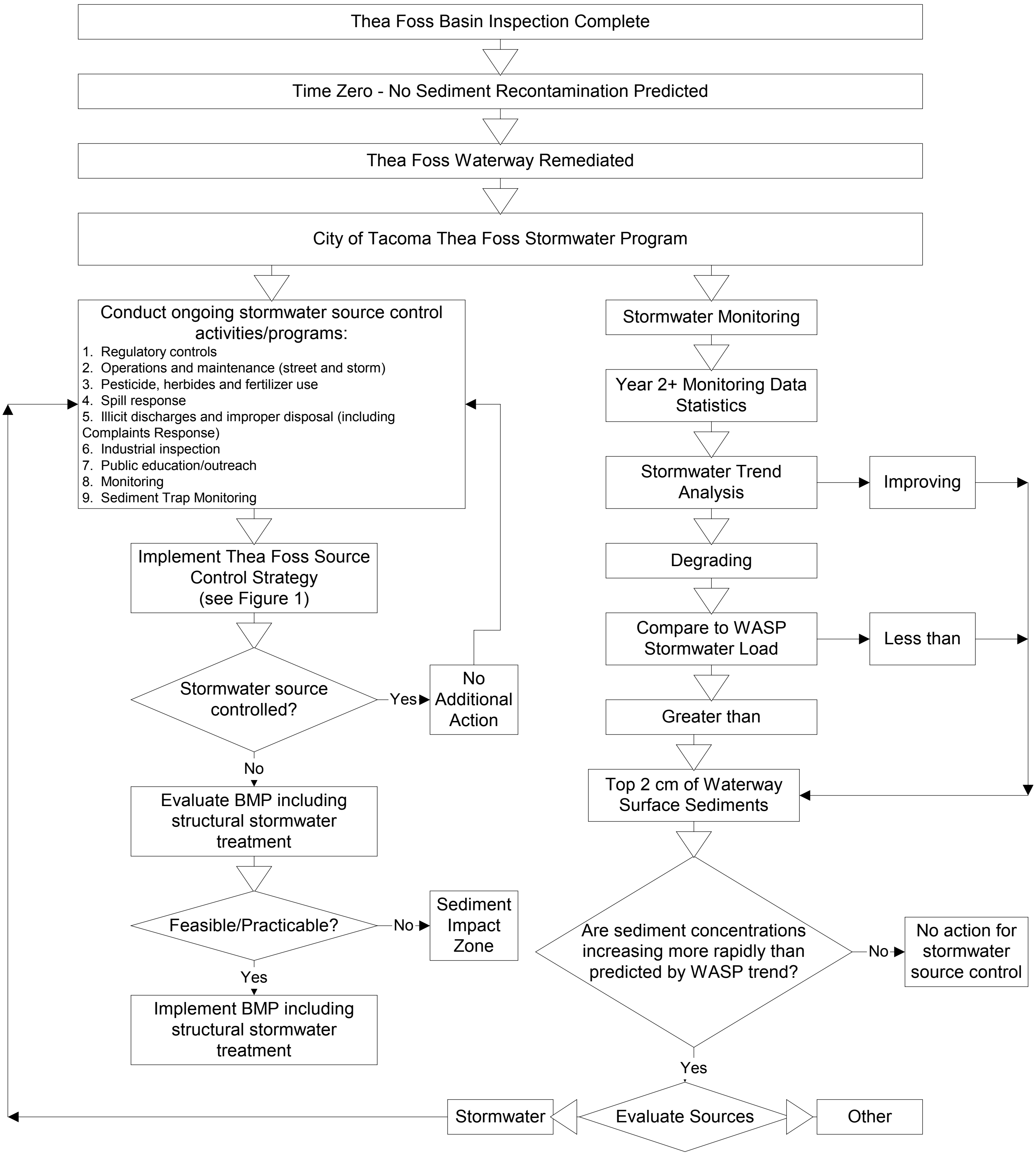
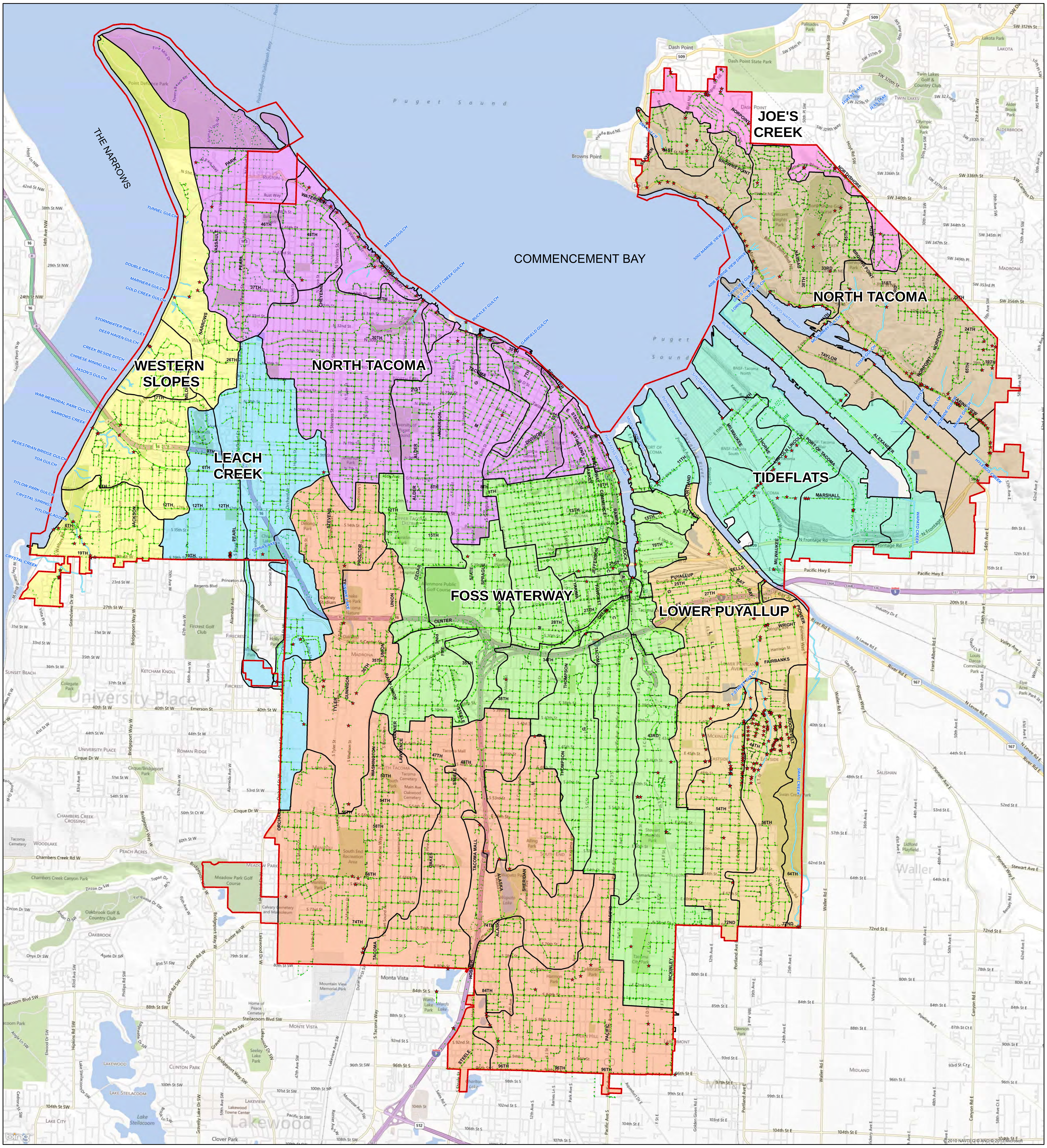


Figure 1-1 Source Control Strategy

Figure 1-2
City of Tacoma Watersheds



0 0.375 0.75 1.5 2.25 Miles

N

WATERSHEDS

- WESTERN SLOPES
- TIDEFLATS
- NORTH TACOMA
- NE TACOMA
- LOWER PUYALLUP
- LEACH CREEK
- JOE'S CREEK
- FOSS WATERWAY
- FLETT CREEK
- TACOMA CITY LIMITS
- OUTFALLS
- SUB-BASINS

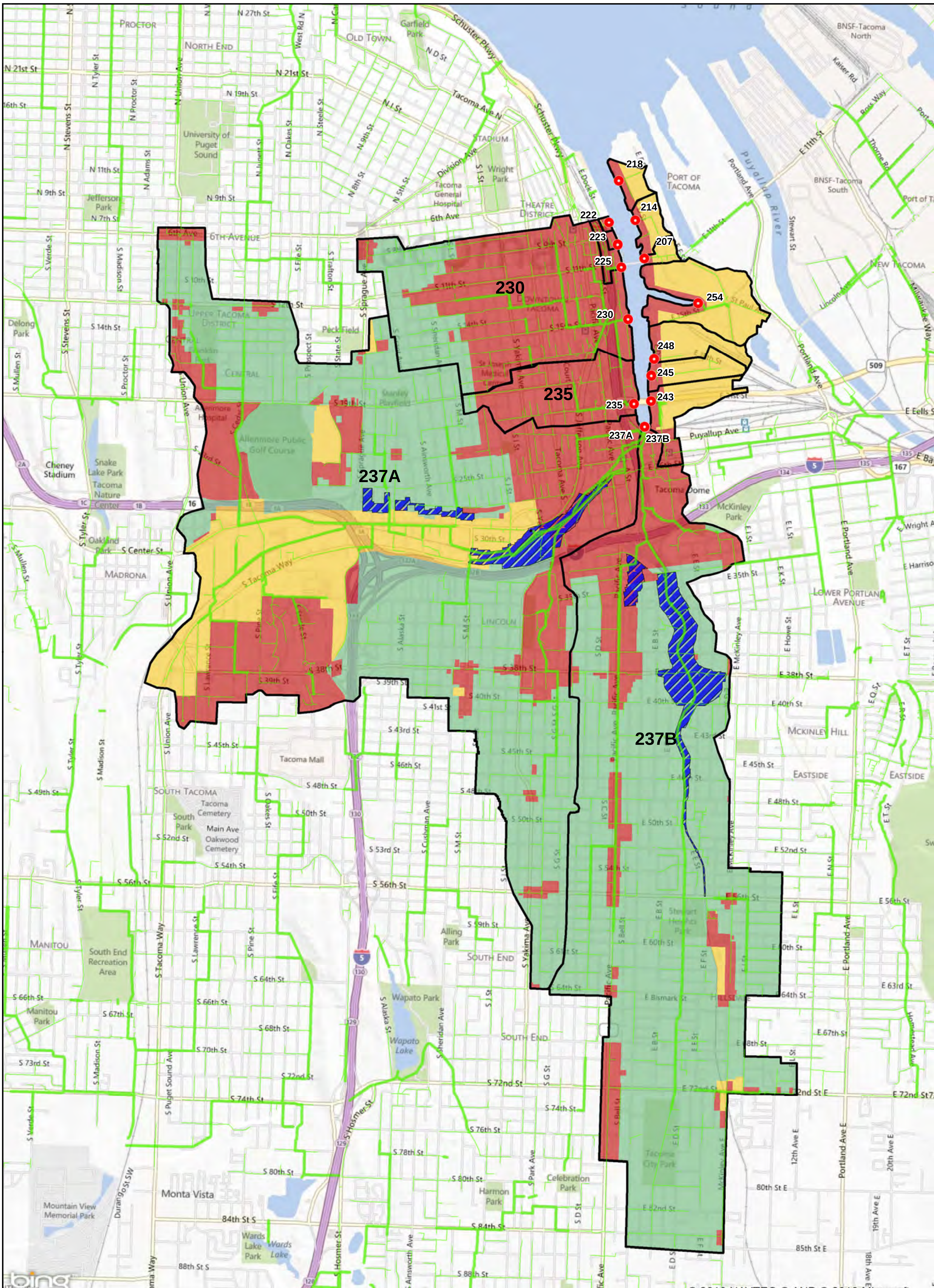
Created in ArcGIS 9 using ArcMap

Source: Environmental Services Division,
Public Works Department City of Tacoma
Date: June 2009

Tacoma

GPS DATAREQUEST\NEWSUB-BASINS - VAN PELT

Figure 1-3
Thea Foss Basins Land Use and Outfall Locations



Legend

- STORM LINES
- TRUNKLINES 24" AND LARGER
- OUTFALLS

Map Date: February 22, 2013
Source: Environmental Services Division, Public Works Department City of Tacoma

Center for Urban Waters
326 East D Street, Tacoma WA 98421
(253) 591-5588

N

0 1,000 2,000 4,000 Feet

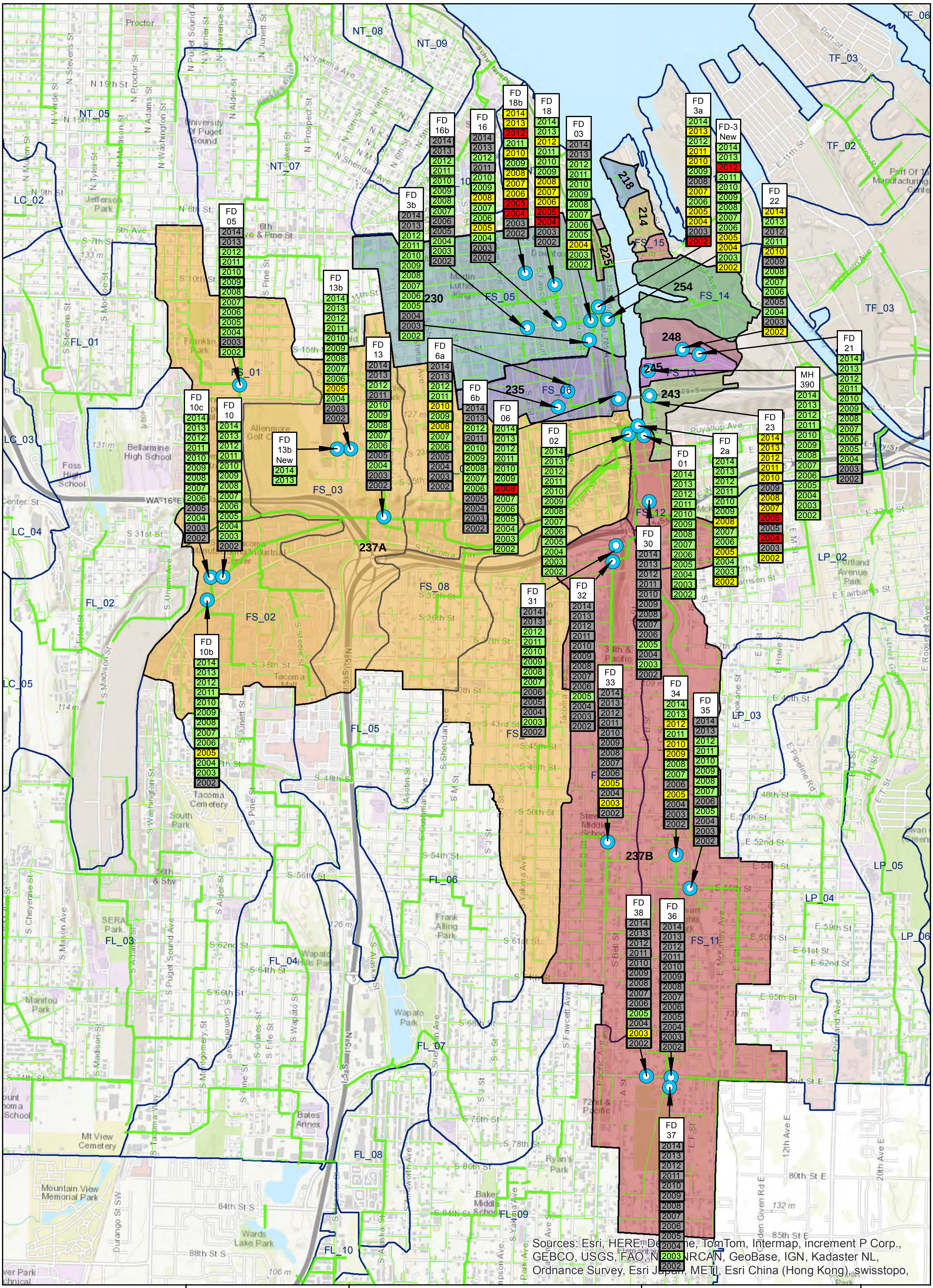
Land Use

- OPEN SPACE
- INDUSTRIAL
- COMMERCIAL
- RESIDENTIAL

Tacoma

Datarequest/MHenley/Thea Foss Monitoring Program Figure 2-1c - Van Pelt

Figure 2-1.1
Sediment Trap Results - Mercury



Legend

- SAMPLE SITE LOCATIONS
- STORM LINES
- TRUNKLINES 24" AND LARGER
- STORMWATER SUB-BASINS

Map Date: February 18, 2015
Source: Science and Engineering Division, Environmental Services Department City of Tacoma

Environmental Services/ Science & Engineering
326 East D Street, Tacoma WA 98421
(253) 591-5588

N

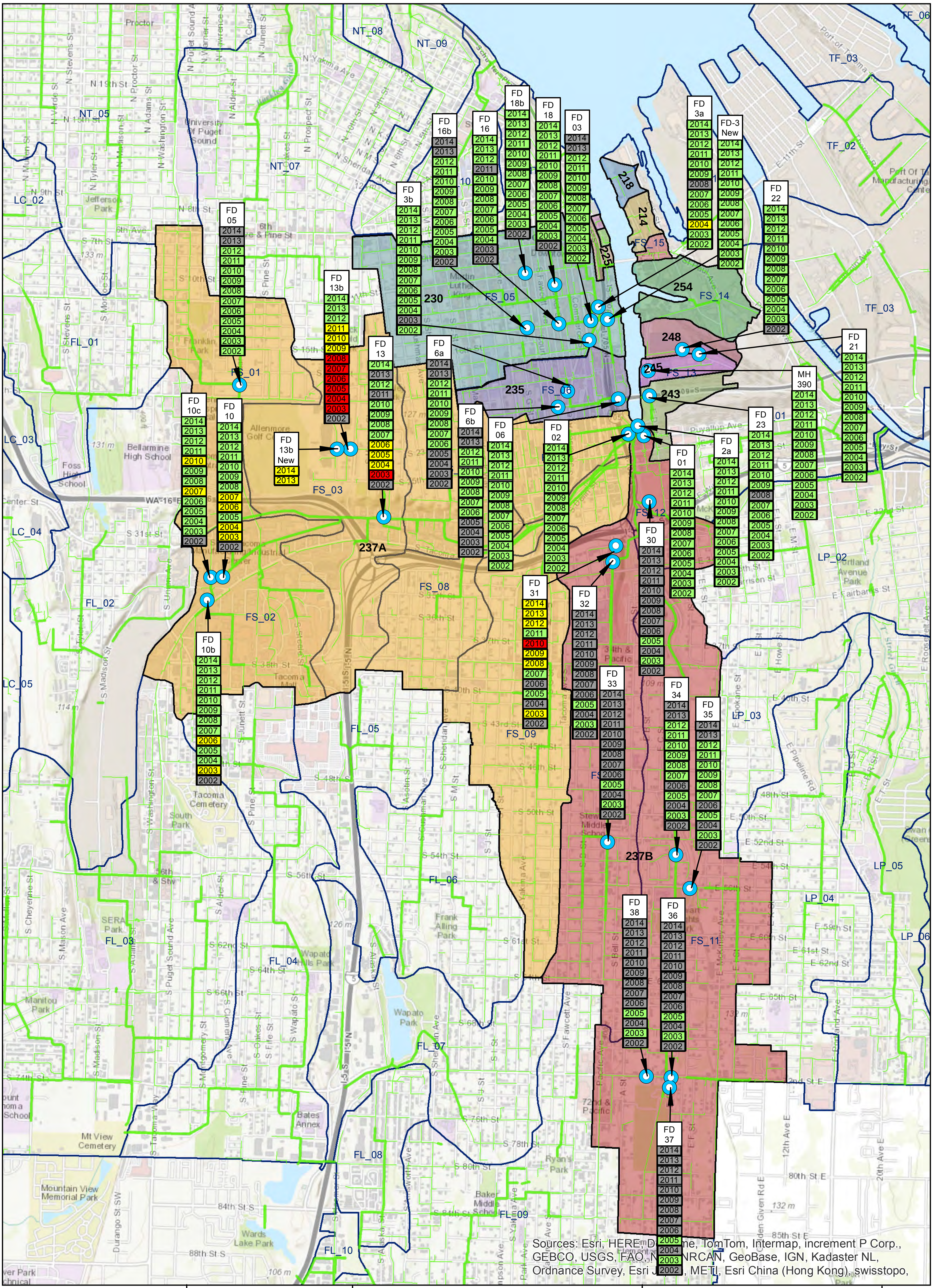
0 1,000 2,000 4,000 Feet

Symbol Level Key

- NO ANALYSIS
- SMALL LEVELS - <.20 mg/Kg
- MEDIUM LEVELS - .20 - .70 mg/Kg
- LARGE LEVELS - >.70 mg/Kg

Datarequest/MHenley/NPDES_2015/Thea Foss Monitoring Program Figure 2-1b - Van Pelt

Figure 2-1.2
Sediment Trap Results - PAHs



Legend

- SAMPLE SITE LOCATIONS
- STORM LINES
- TRUNKLINES 24" AND LARGER
- STORMWATER SUB-BASINS

Map Date: February 18, 2015
Source: Science and Engineering Division, Environmental Services Department City of Tacoma

Environmental Services/ Science & Engineering
326 East D Street, Tacoma WA 98421
(253) 591-5588

N

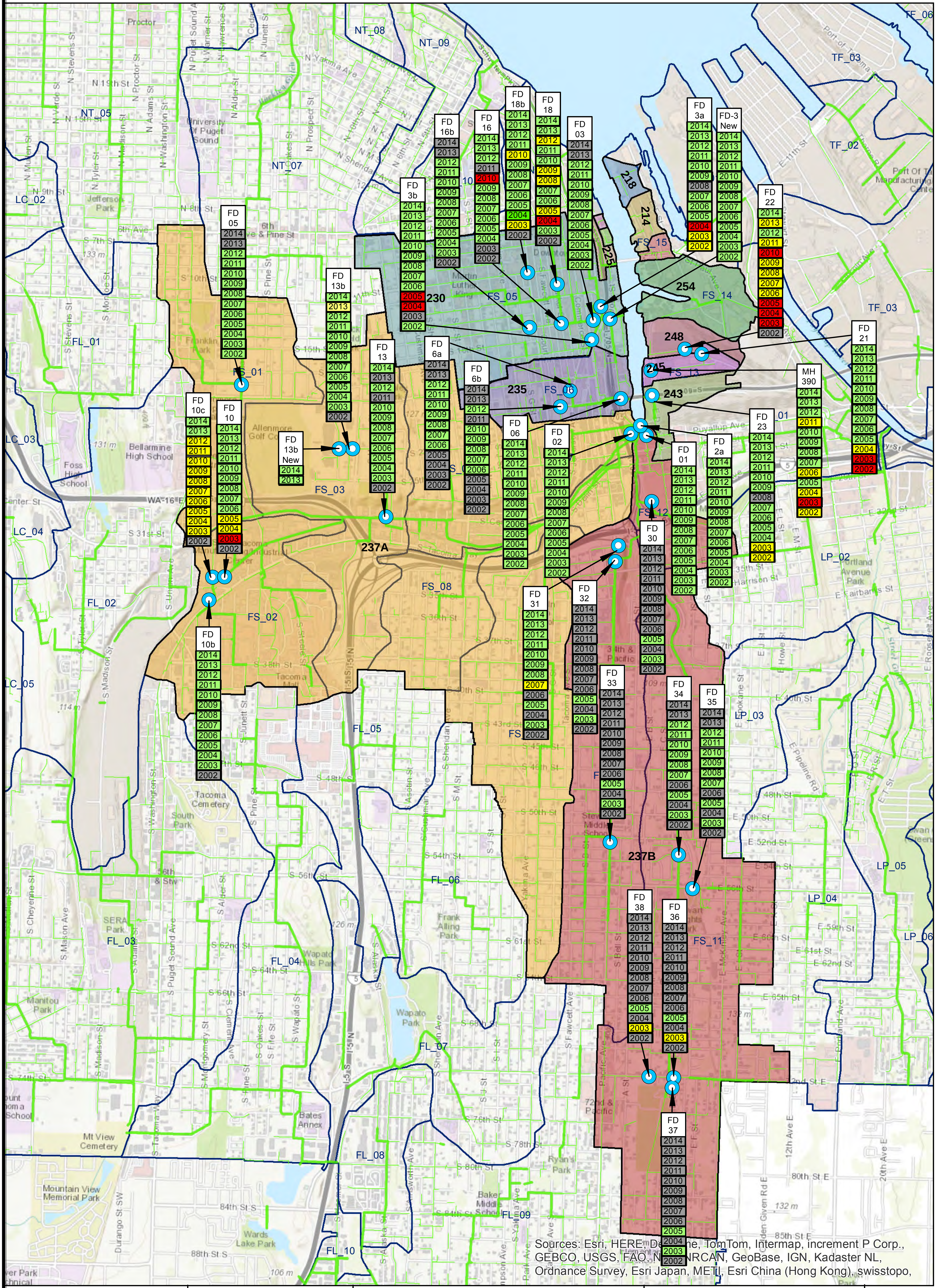
0 1,000 2,000 4,000 Feet

Symbol Level Key

- NO ANALYSIS
- SMALL LEVELS - < 164,000 ug/Kg
- MEDIUM LEVELS - 164,000 - 300,000 ug/Kg
- LARGE LEVELS - > 300,000 ug/Kg

Datarequest/MHenley/NPDES_2015/Thea Foss Monitoring Program Figure 2-1b - Van Pelt

Figure 2-1.3
Sediment Trap Results - Phthalates



Legend

- SAMPLE SITE LOCATIONS
- STORM LINES
- TRUNKLINES 24" AND LARGER
- STORMWATER SUB-BASINS

Map Date: February 05, 2014
Source: Science and Engineering Division, Environmental Services Department City of Tacoma

Environmental Services/ Science & Engineering
326 East D Street, Tacoma WA 98421
(253) 591-5588

N

0 1,000 2,000 4,000 Feet

Symbol Level Key

- NO ANALYSIS
- SMALL LEVELS - < 50,000 ug/Kg
- MEDIUM LEVELS - 50,000 - 100,000 ug/Kg
- LARGE LEVELS - > 100,000 ug/Kg

Tacoma

Datarequest/MHenley/NPDES_2015/Thea Foss Monitoring Program Figure 2-1b - Van Pelt

Figure 2-1.4
Sediment Trap Results - PCBs

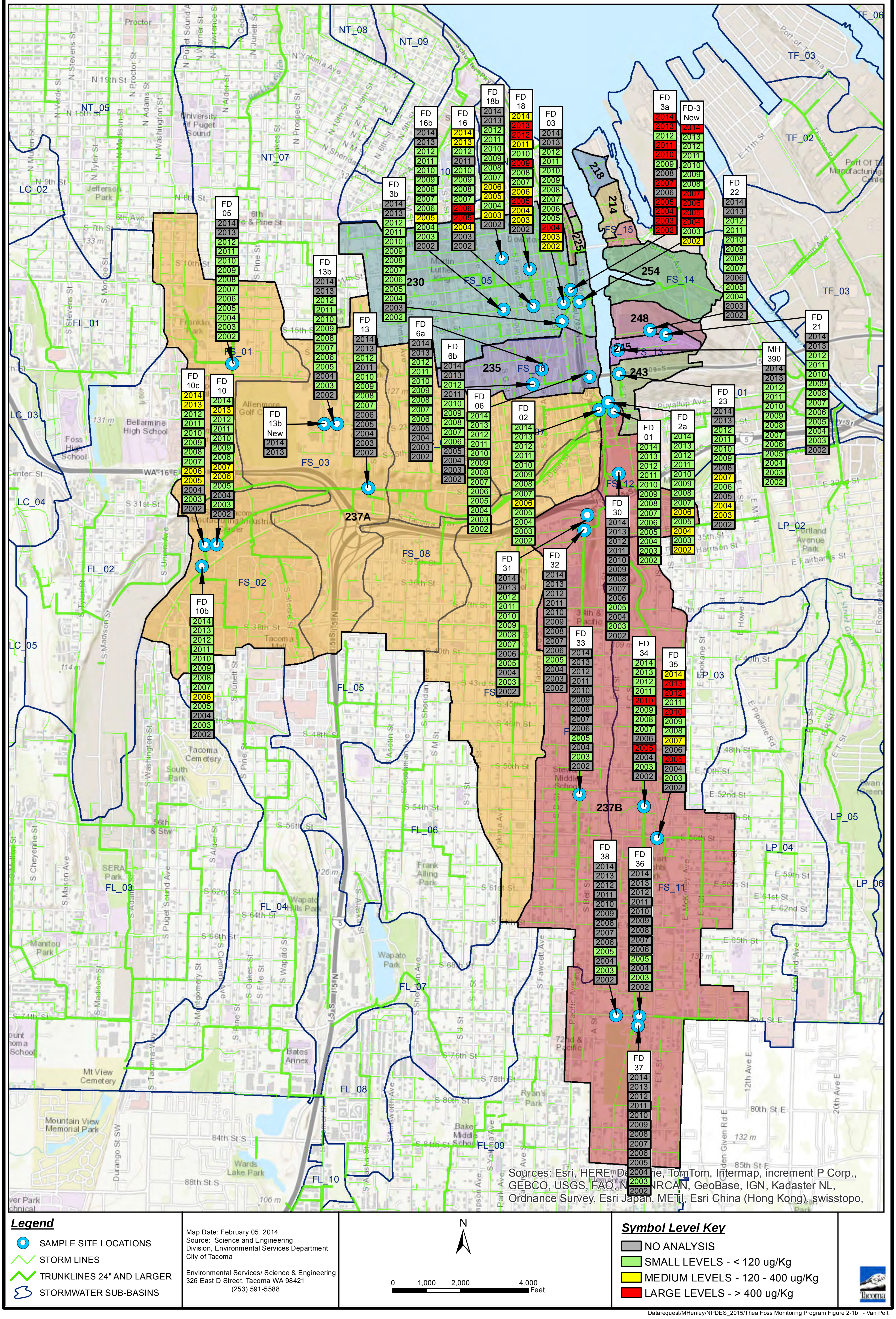
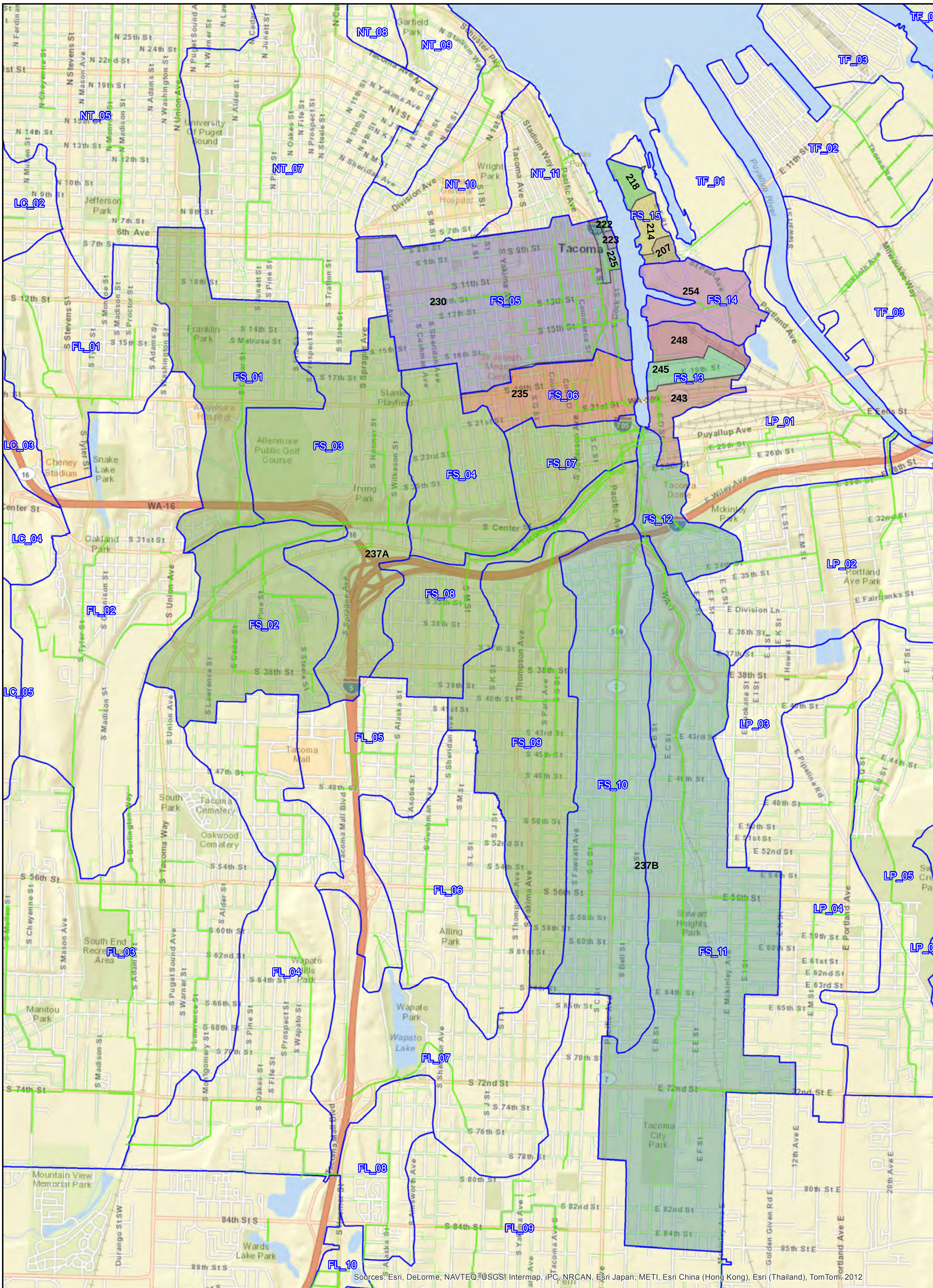


Figure 2-2
Stormwater Sub-Basins In the Thea Foss Basin



Legend

STORM LINES

TRUNKLINES 24" AND LARGER

Map Date: February 22, 2013
Source: Environmental Services Division, Public Works Department City of Tacoma

Center for Urban Waters
326 East D Street, Tacoma WA 98421
(253) 591-5588

N

0 1,000 2,000 4,000 Feet

STORM SUB-BASINS

Datarequest/MHenley/Thea Foss Monitoring Program Figure 2-1c - Van Pelt

Figure 2-3.1
OF230 Storm Line Cleaning Comparison [Log Scale]

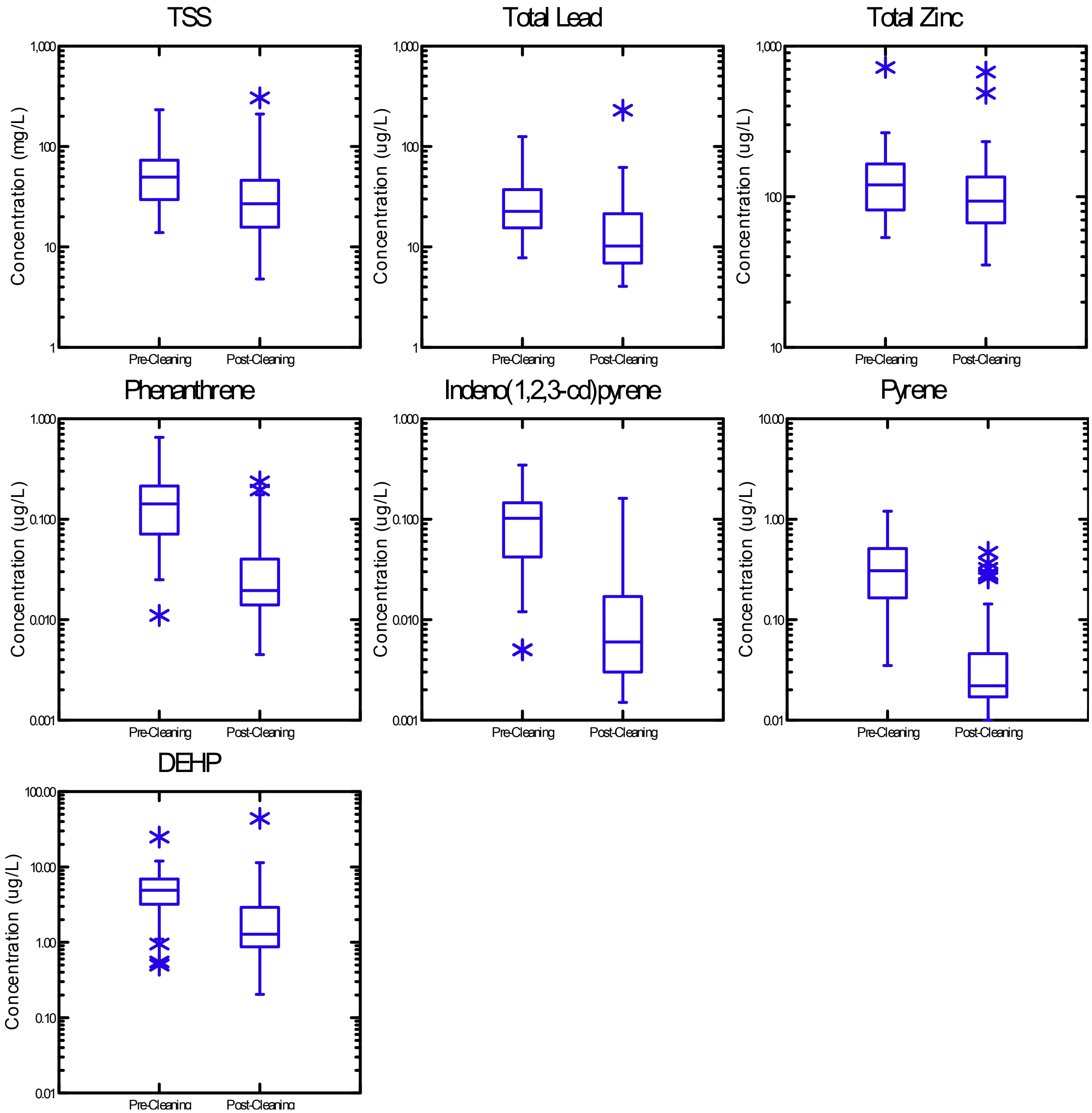


Figure 2-3.2
OF235 Storm Line Cleaning Comparison [Log Scale]

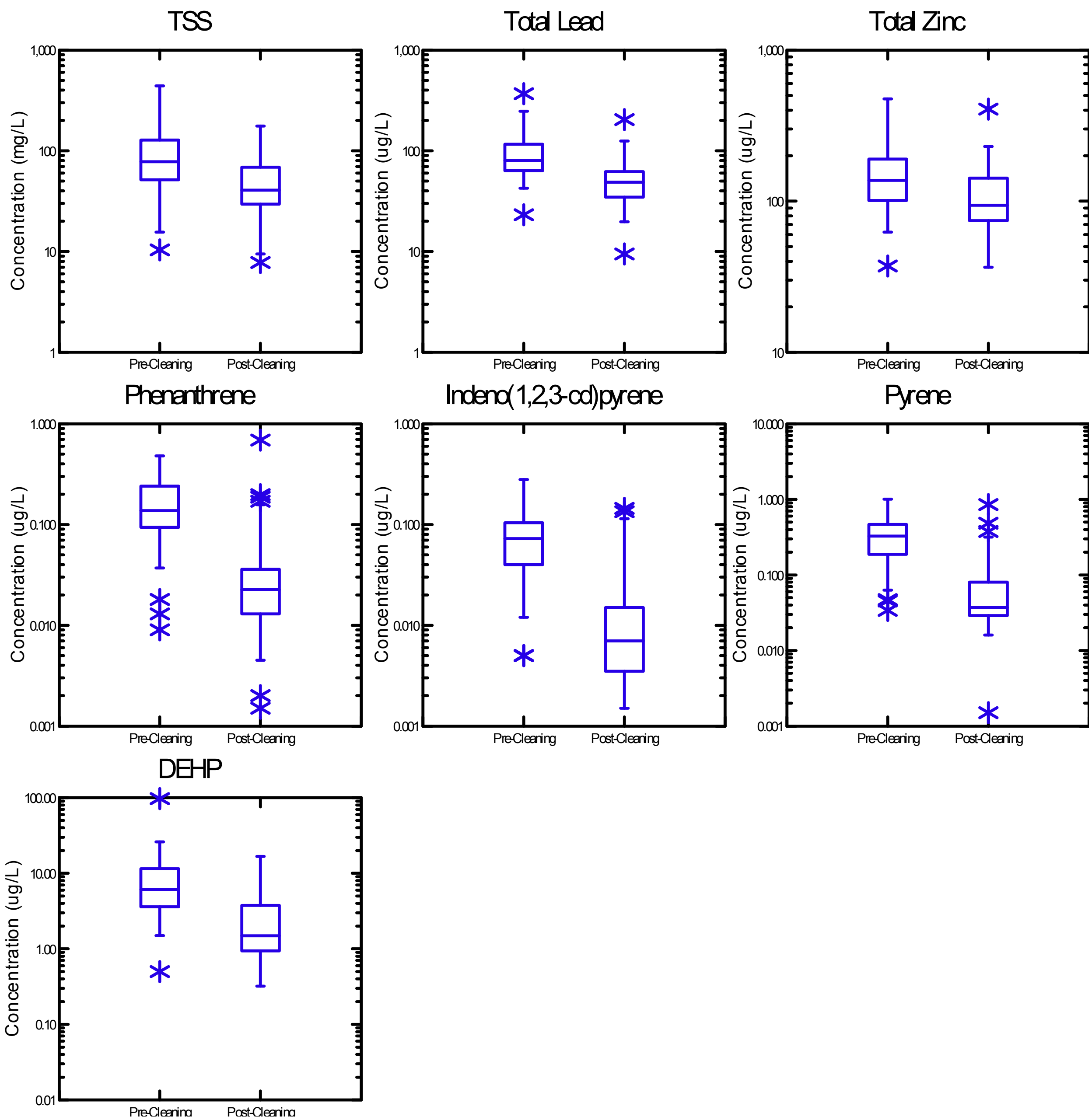


Figure 2-3.3
OF237A Storm Line Cleaning Comparison [Log Scale]

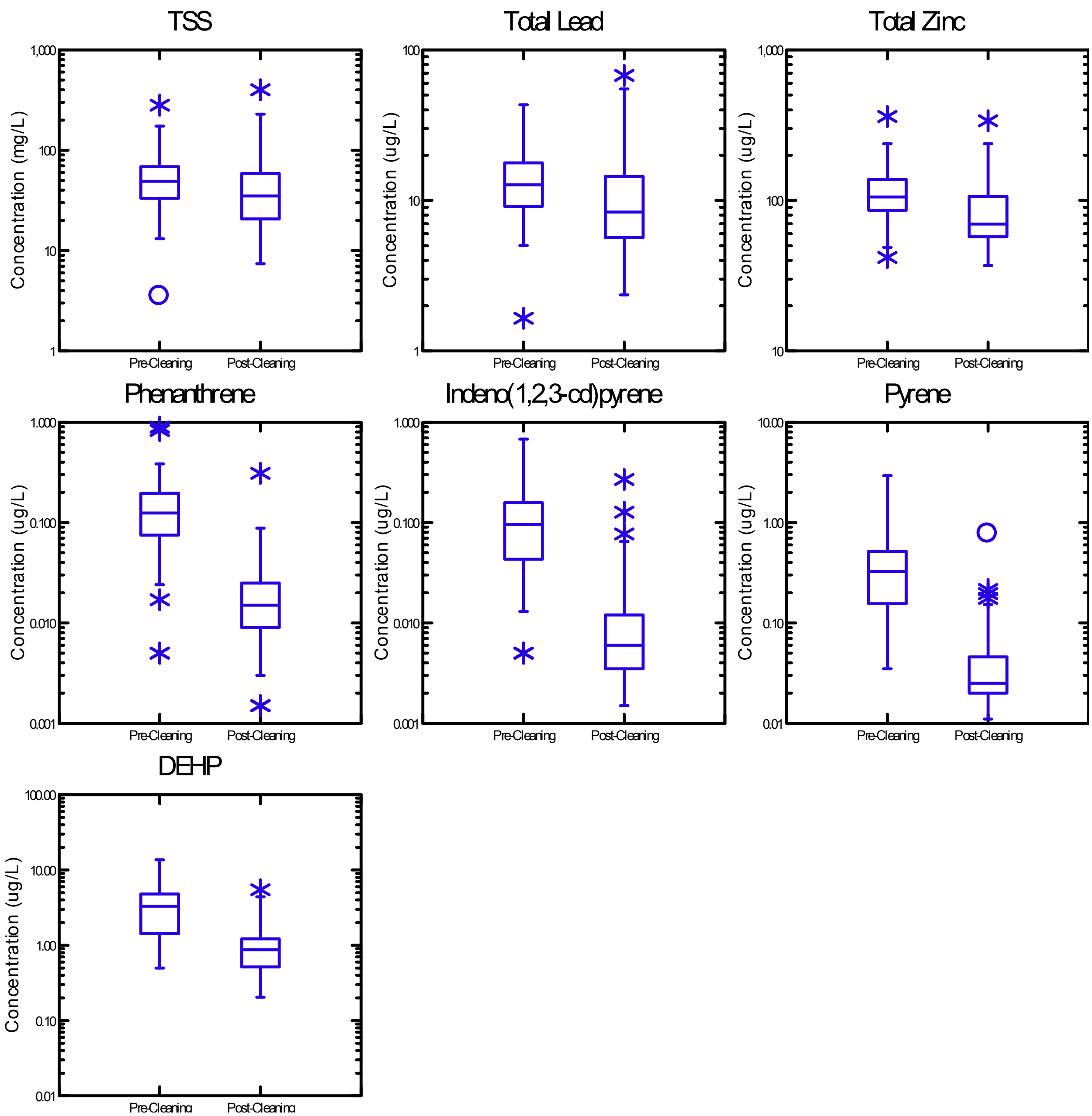


Figure 2-3.4
OF237B Storm Line Cleaning Comparison [Log Scale]

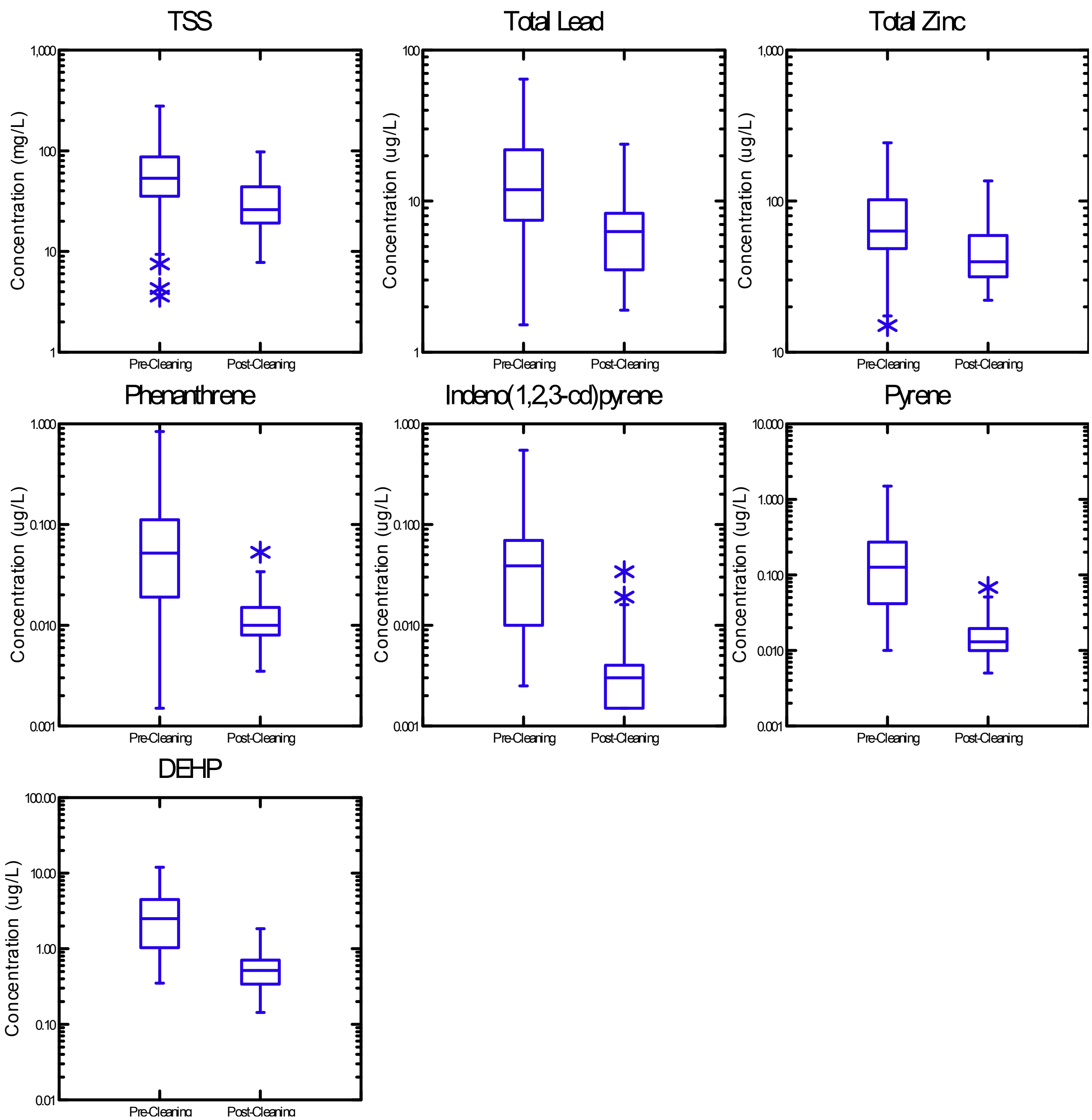


Figure 2-3.5
OF254 Storm Line Cleaning Comparison [Log Scale]

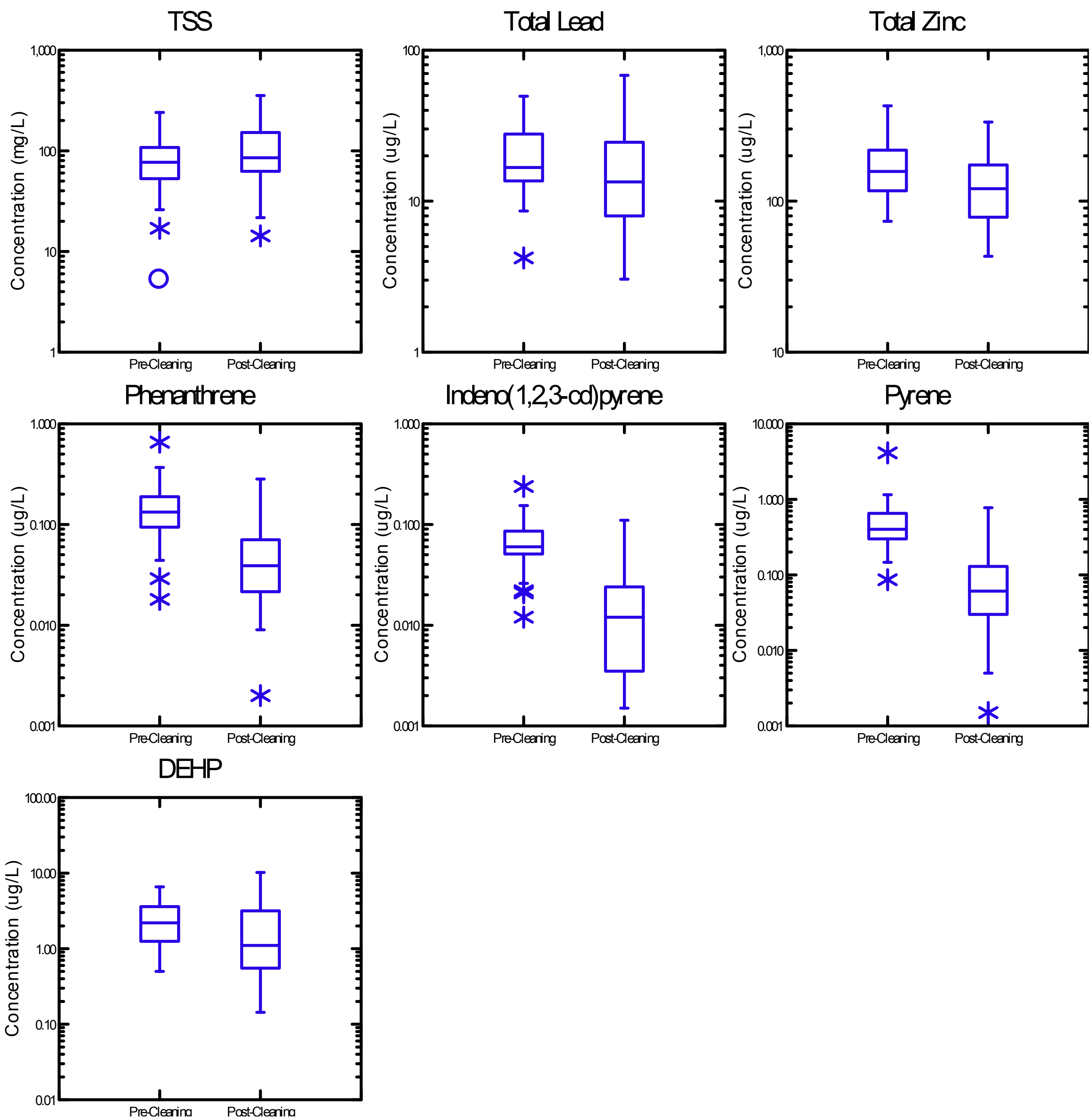


Figure 3-1
Daily Rainfall - Monthly Averages WY2002-2014

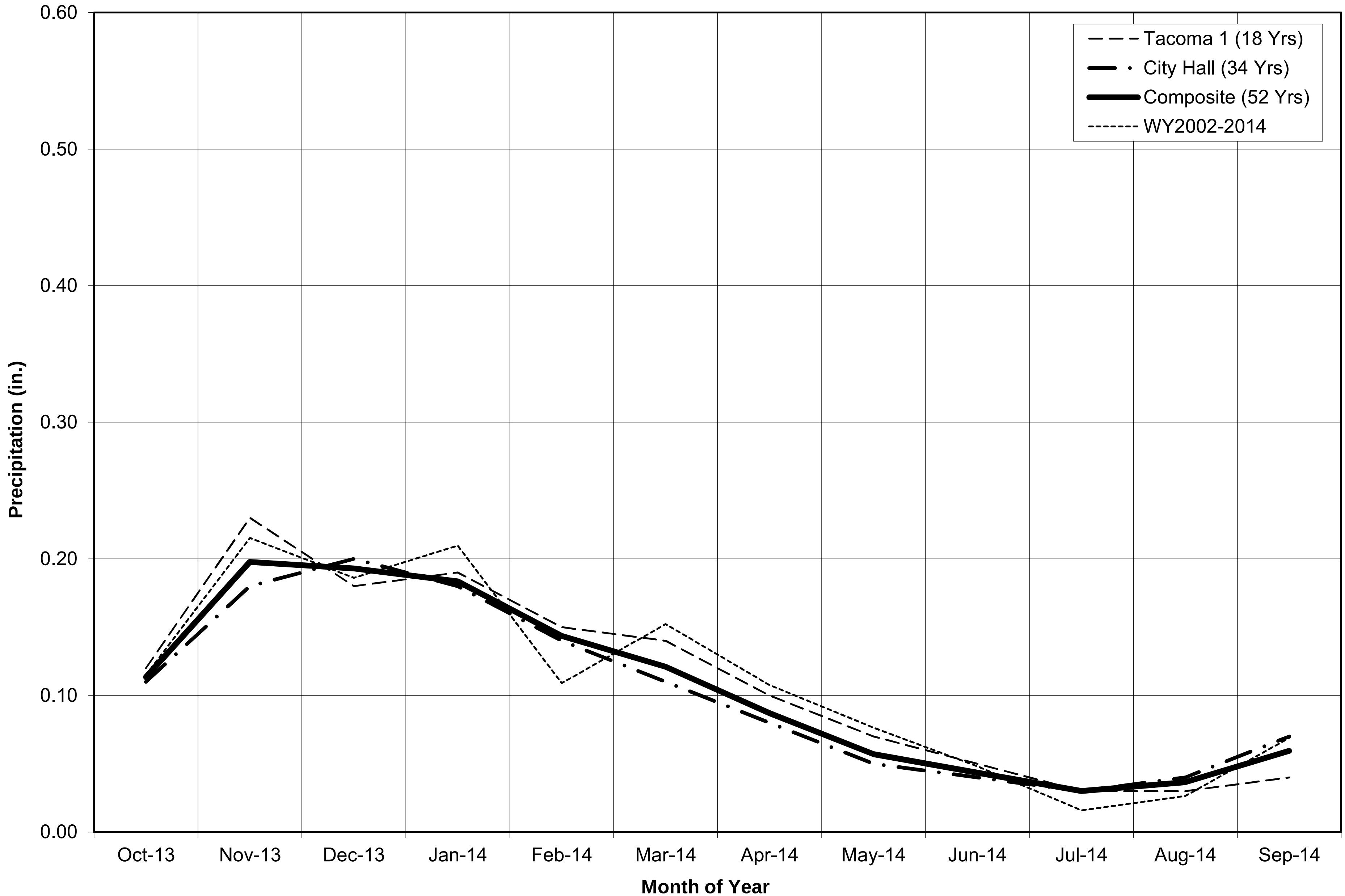
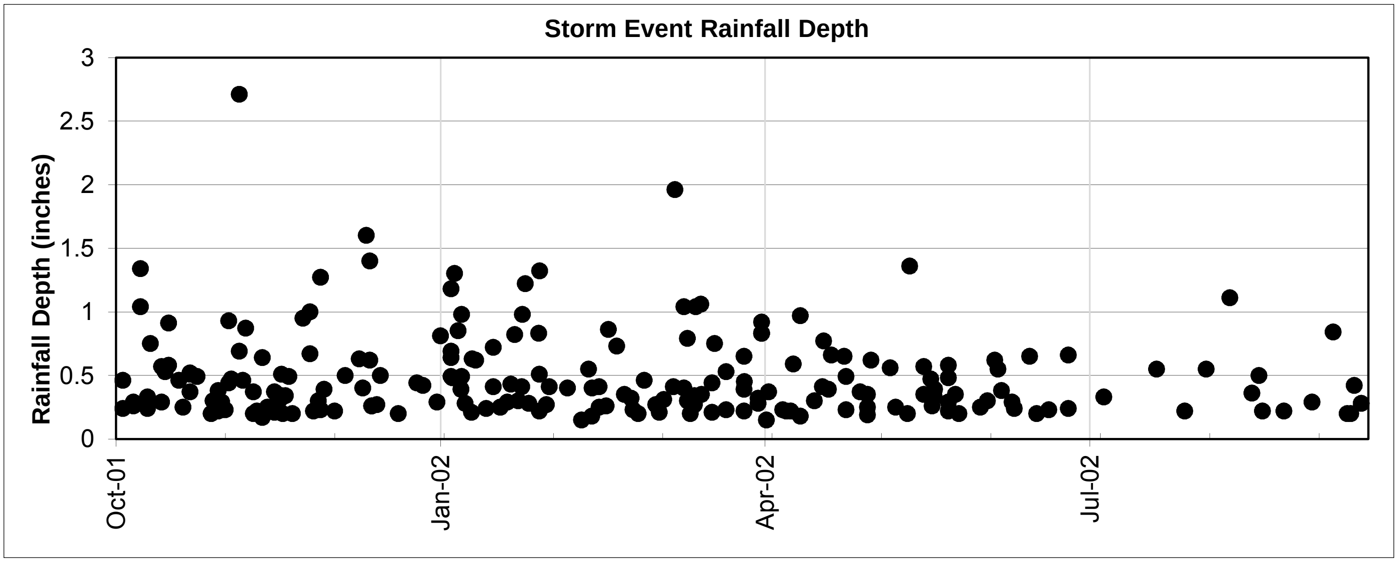
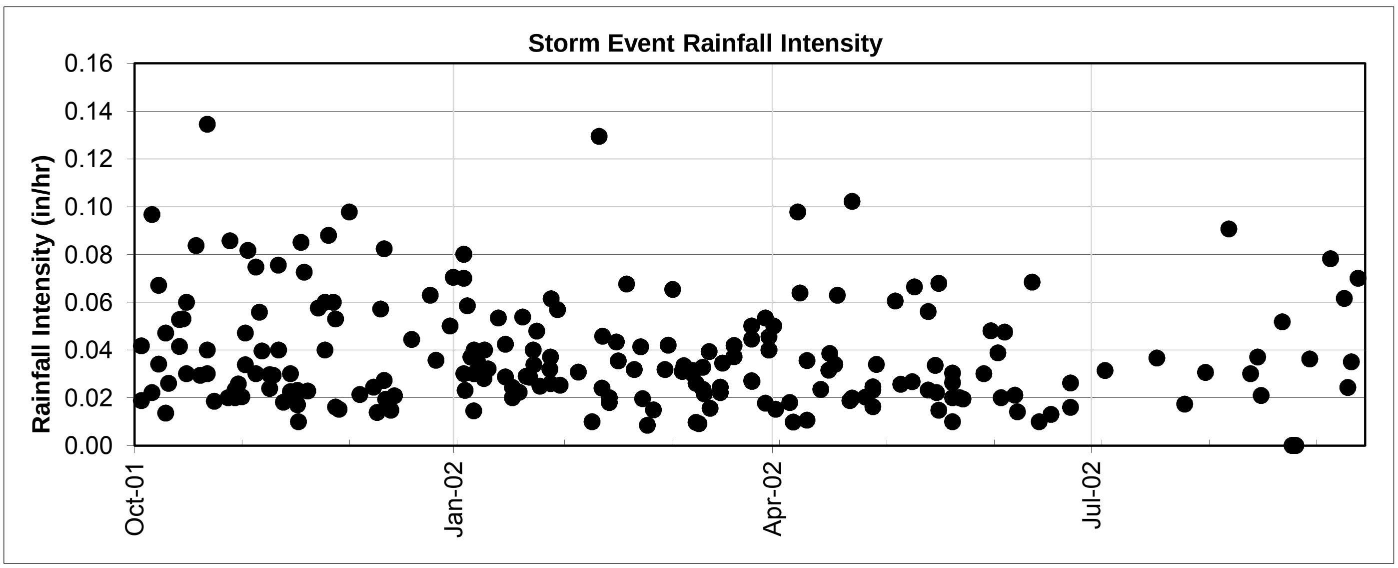


Figure 3-1 Daily Rainfall_Monthly Averages.xls

Figure 3-2

Storm Event Hydrologic Parameters, October 2001 - September 2014





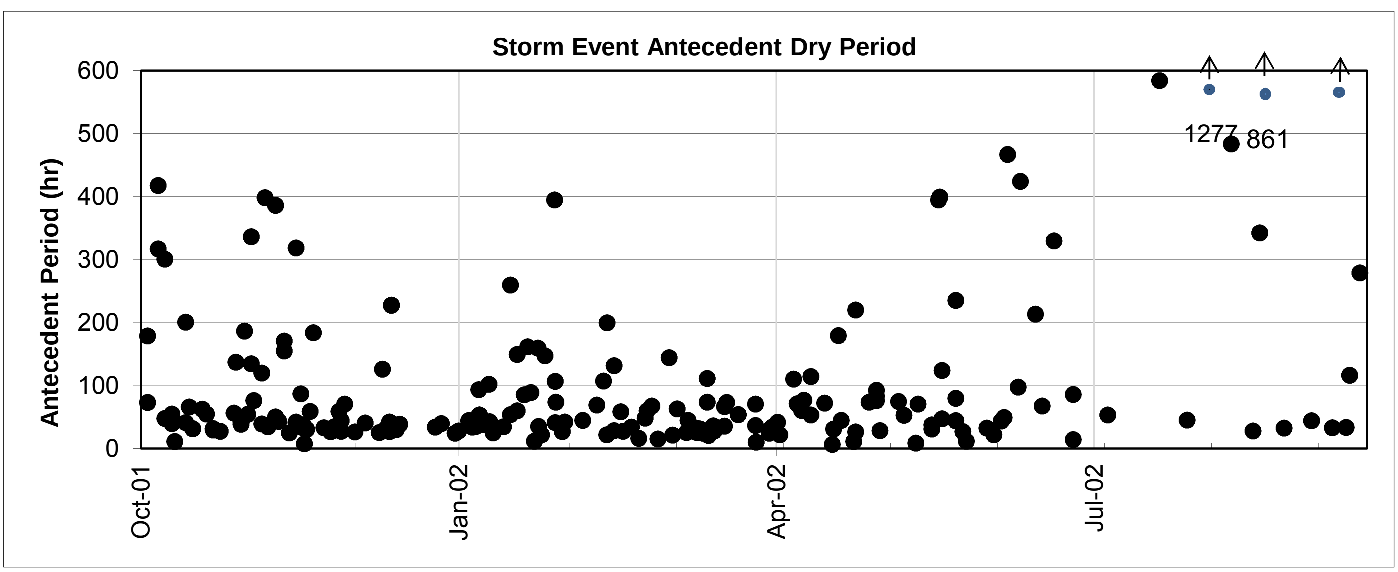
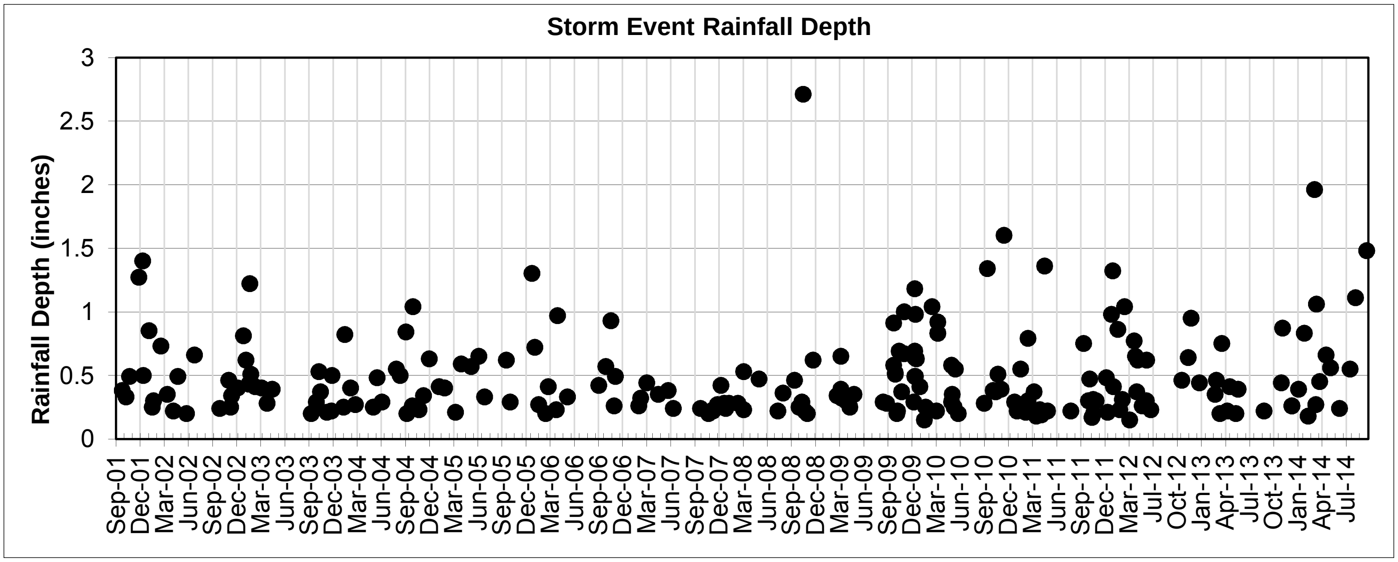
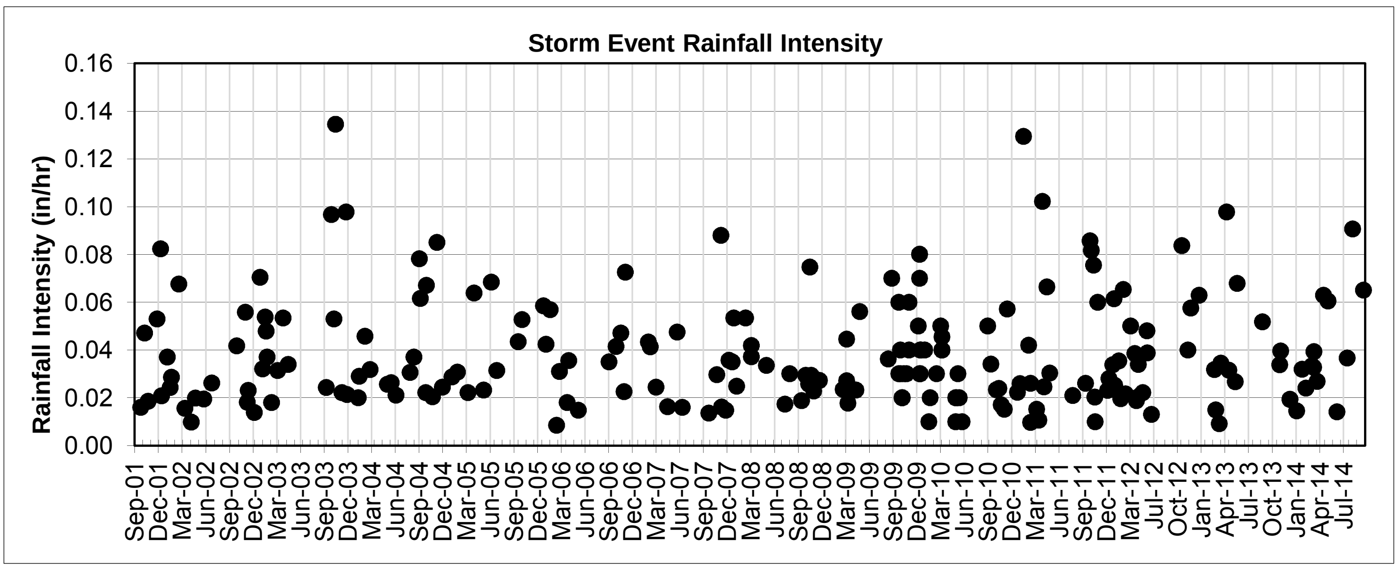


Figure 3-2

Storm Event Hydrologic Parameters, October 2001 - September 2014





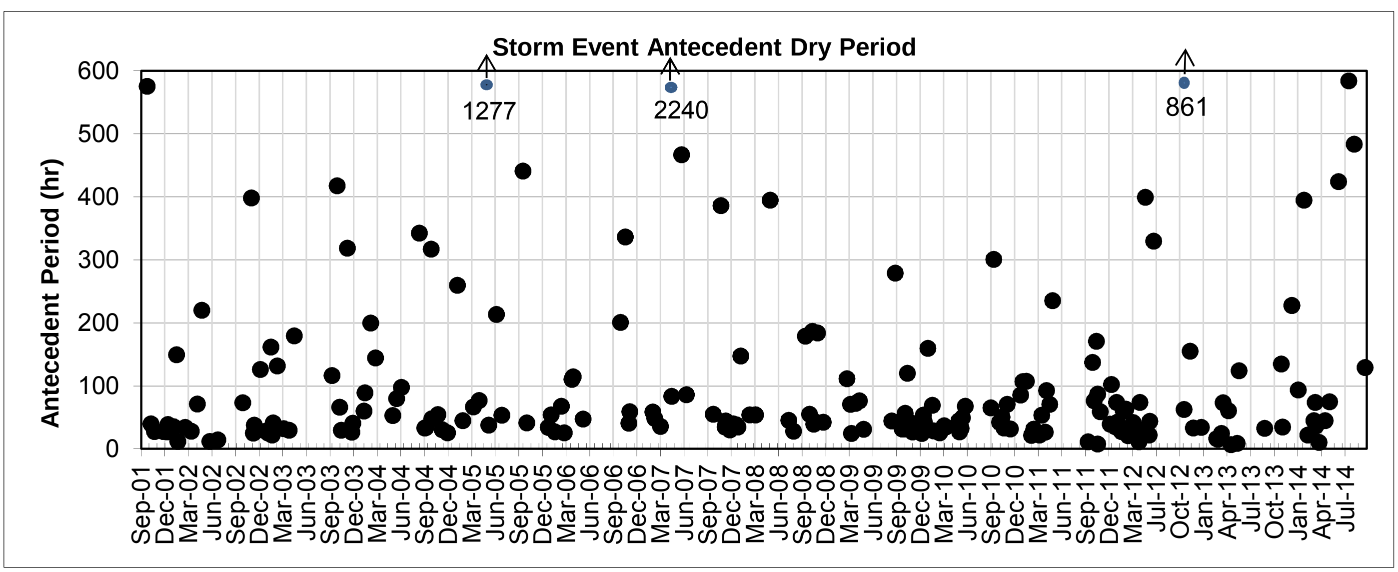


Figure 3-3
Representativess of Sampled Storm Sizes

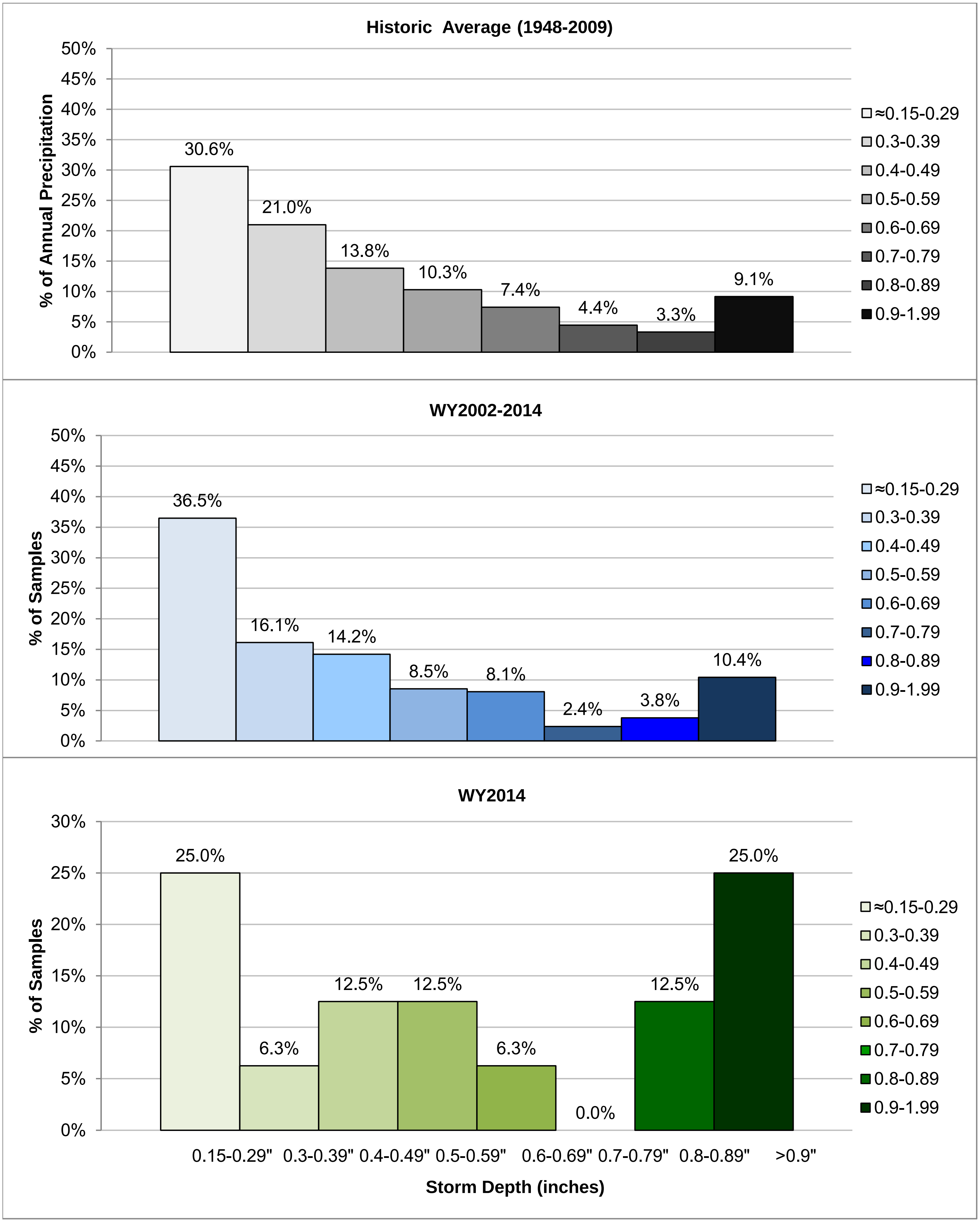
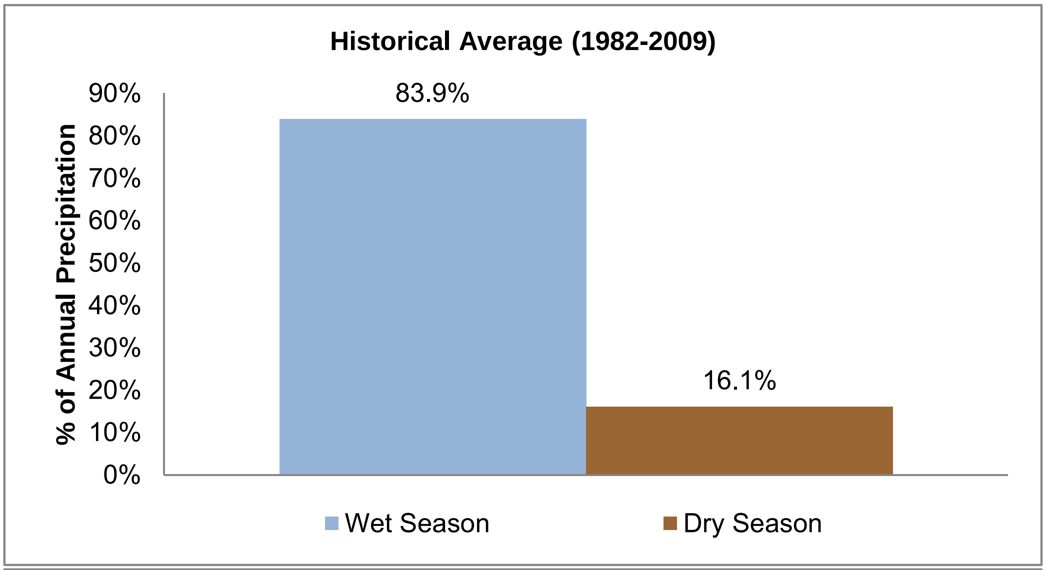
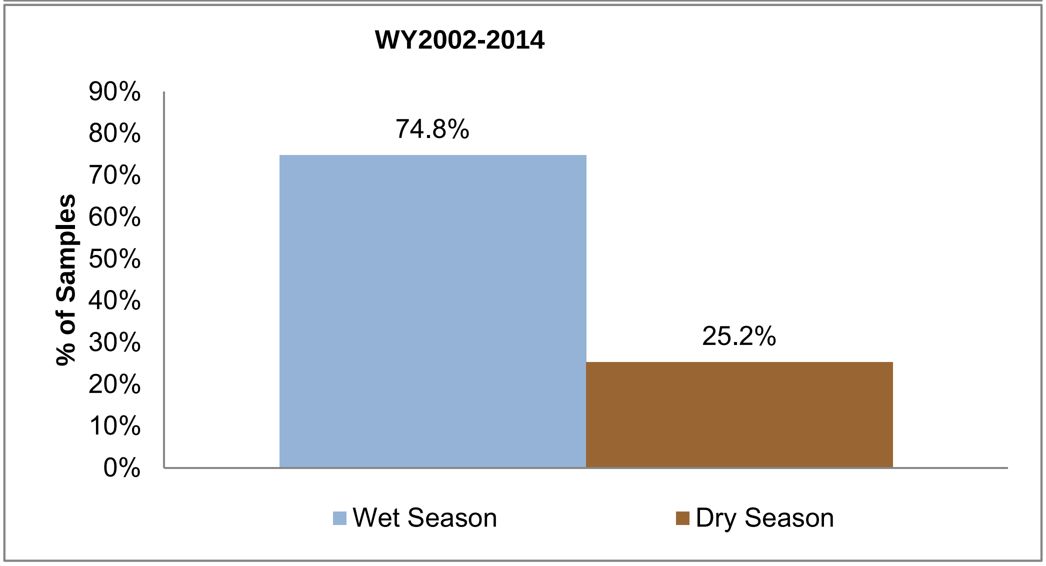
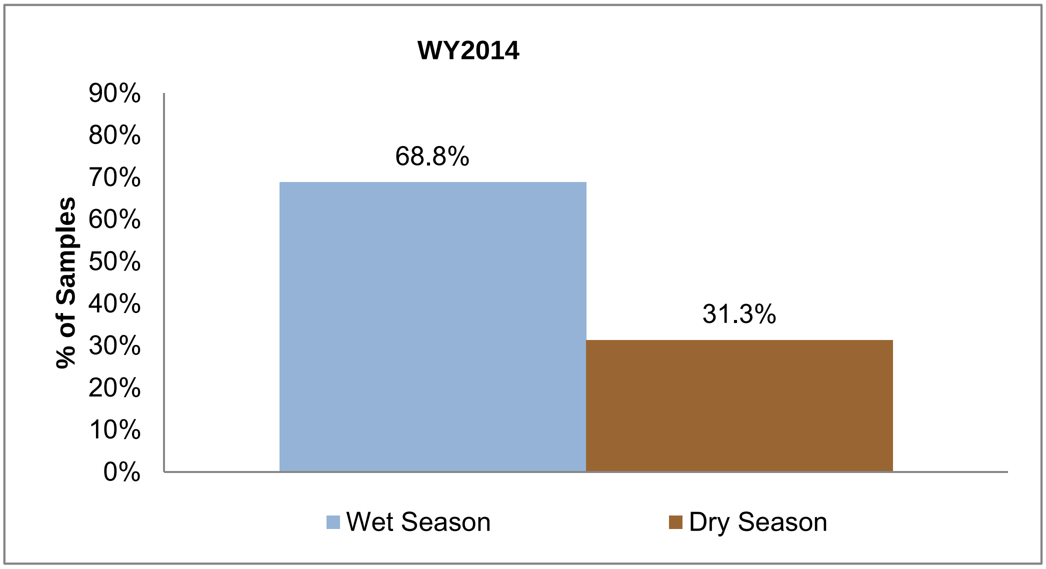


Figure 3-4
Representativeness of Seasonal Sampling Distribution

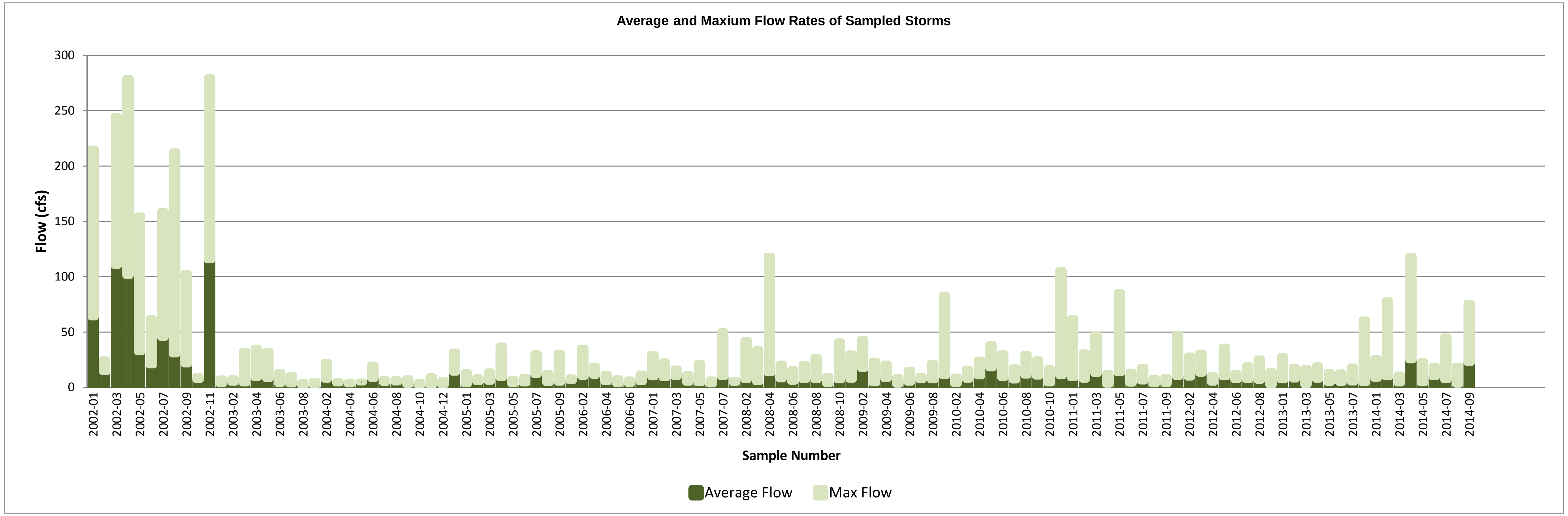






WY2014 Figure B4-3 Seasonal Representativeness.xls

Figure 3-5.1
Sampled Storm Flows and Volumes - OF230



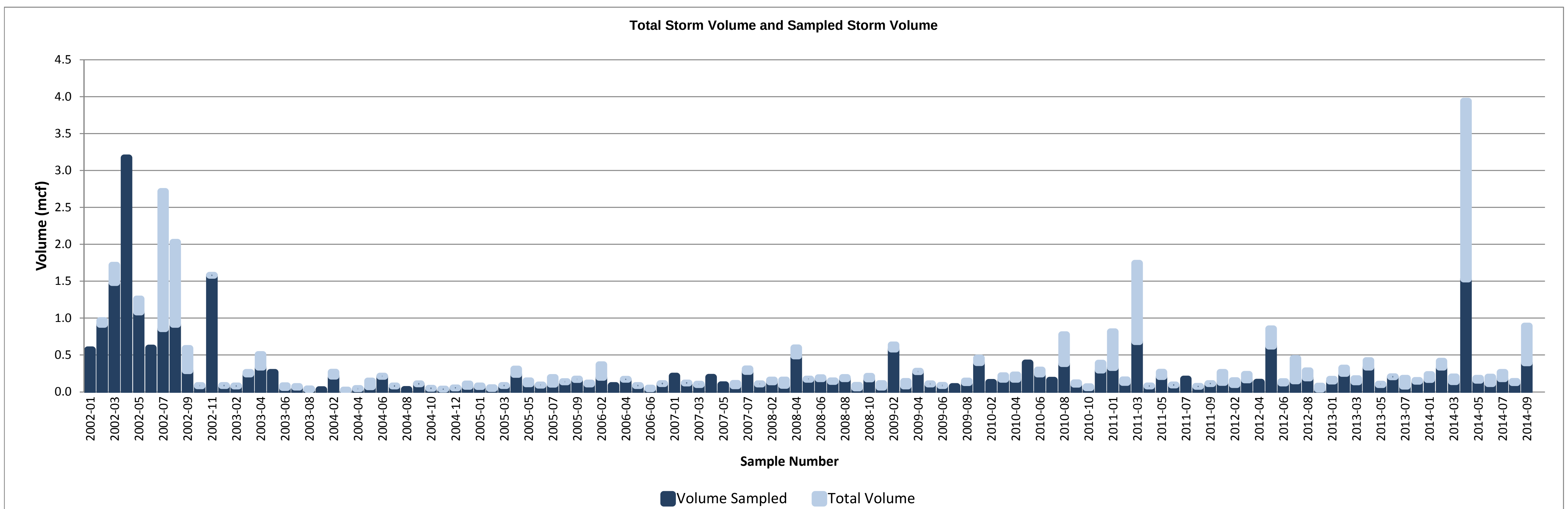
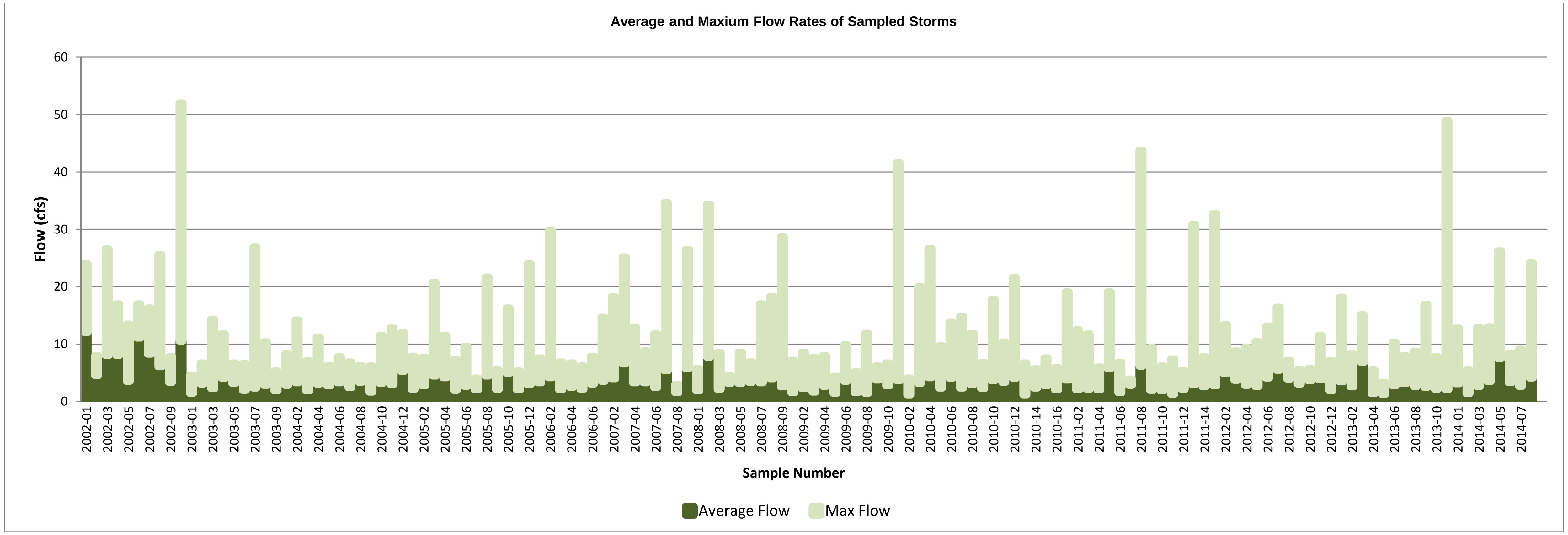


Figure 3-5.1 - Flow Data 230.xls

Figure 3-5.2
Sampled Storm Flows and Volumes - OF235



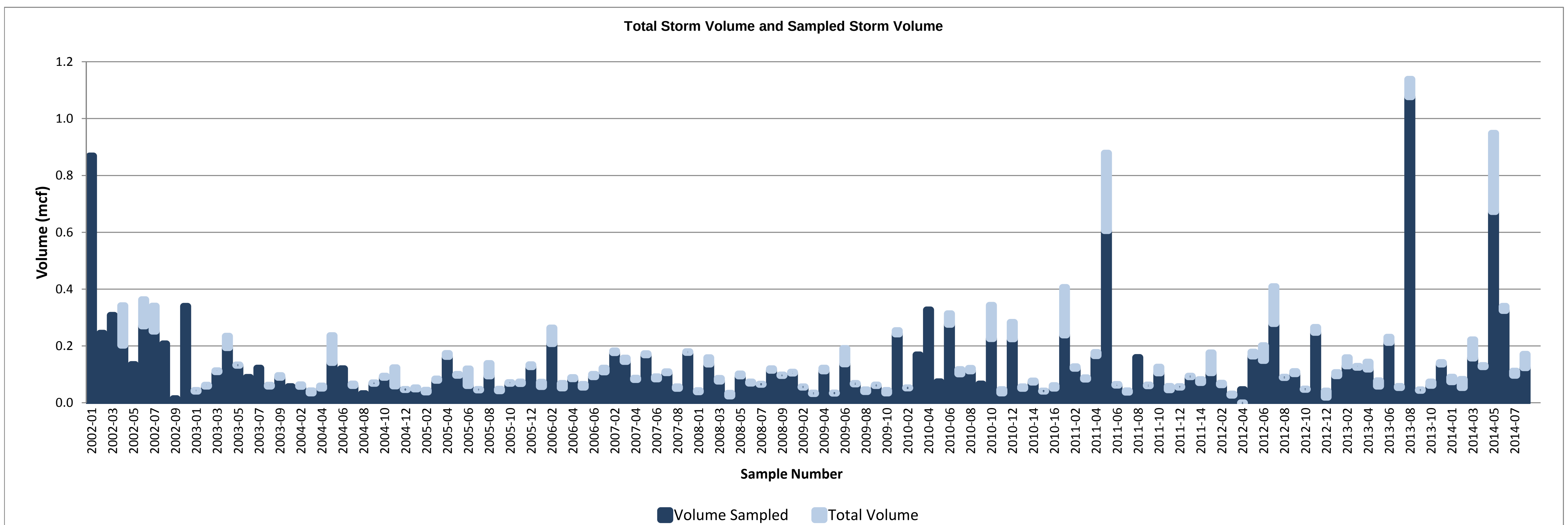
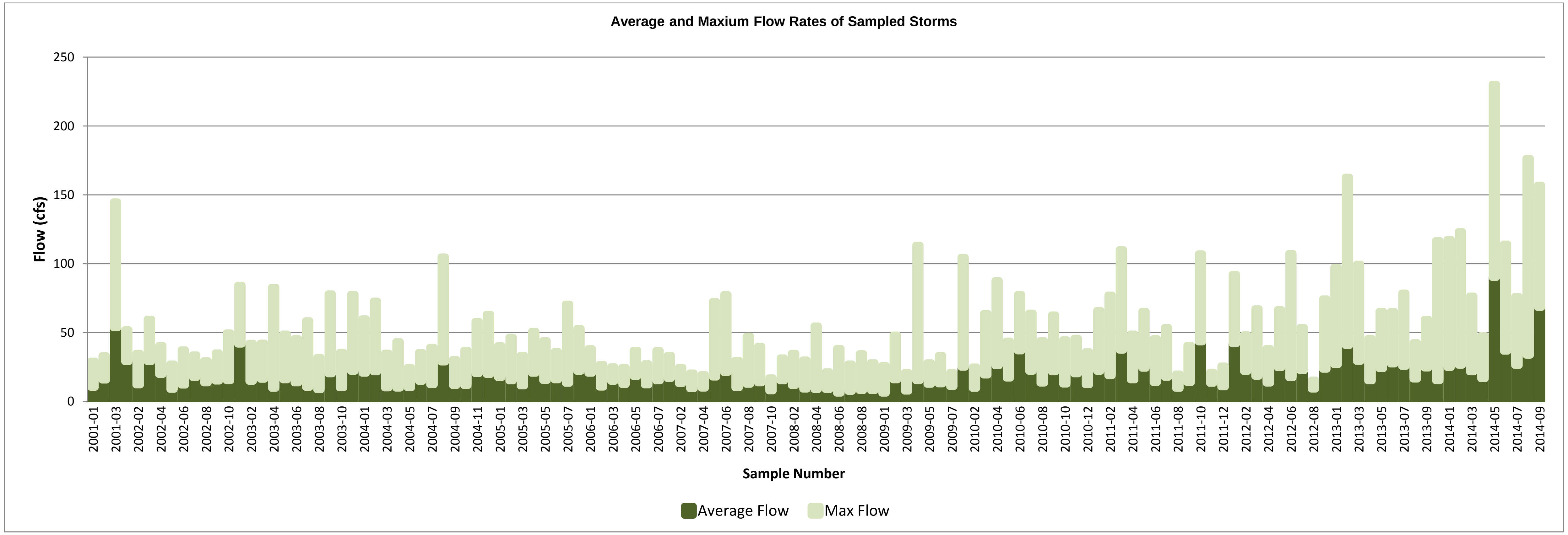


Figure 3-5.3
Sampled Storm Flows and Volumes - OF237A



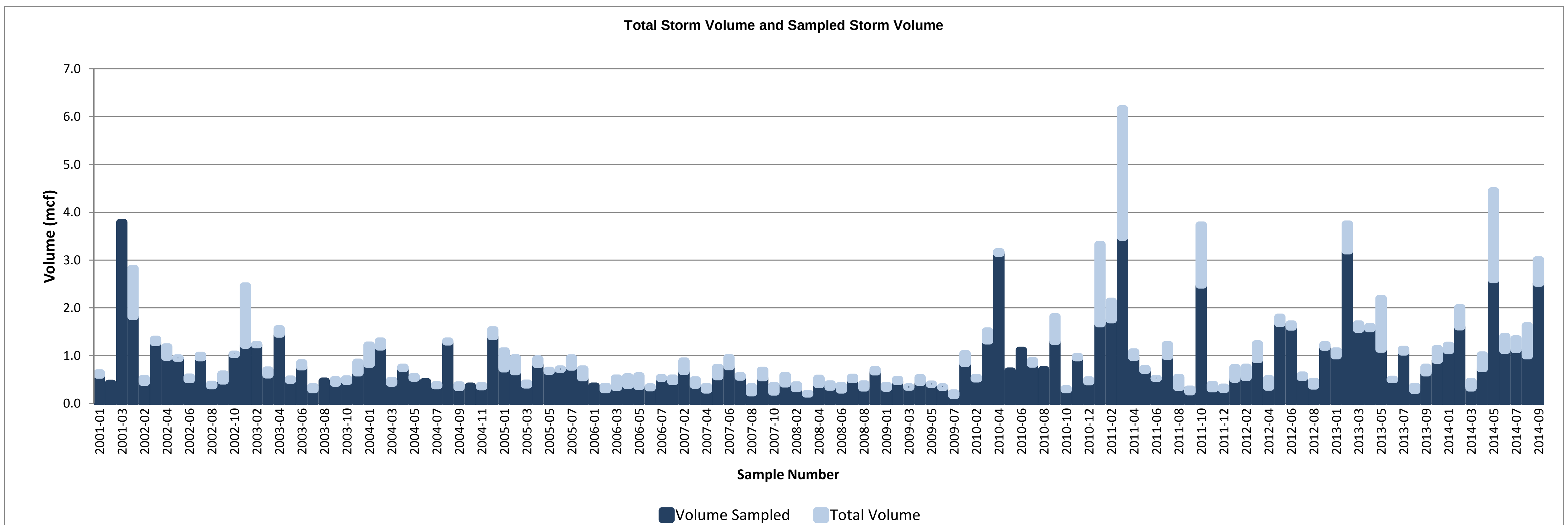
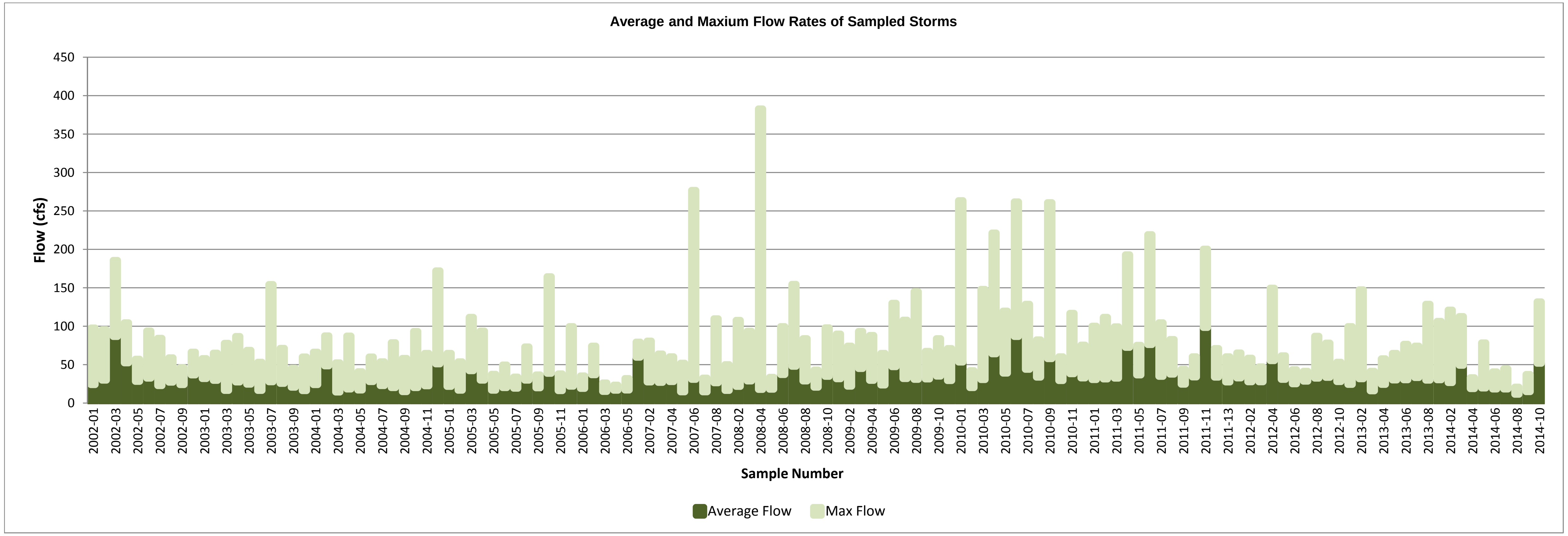


Figure 3-5.3 - Flow Data 237A.xls

Note: Data is from the old sampling site 237A through end of WY2011. Data from WY2012 onward is from 237A New site.

Figure 3-5.4
Sampled Storm Flows and Volumes - OF237B



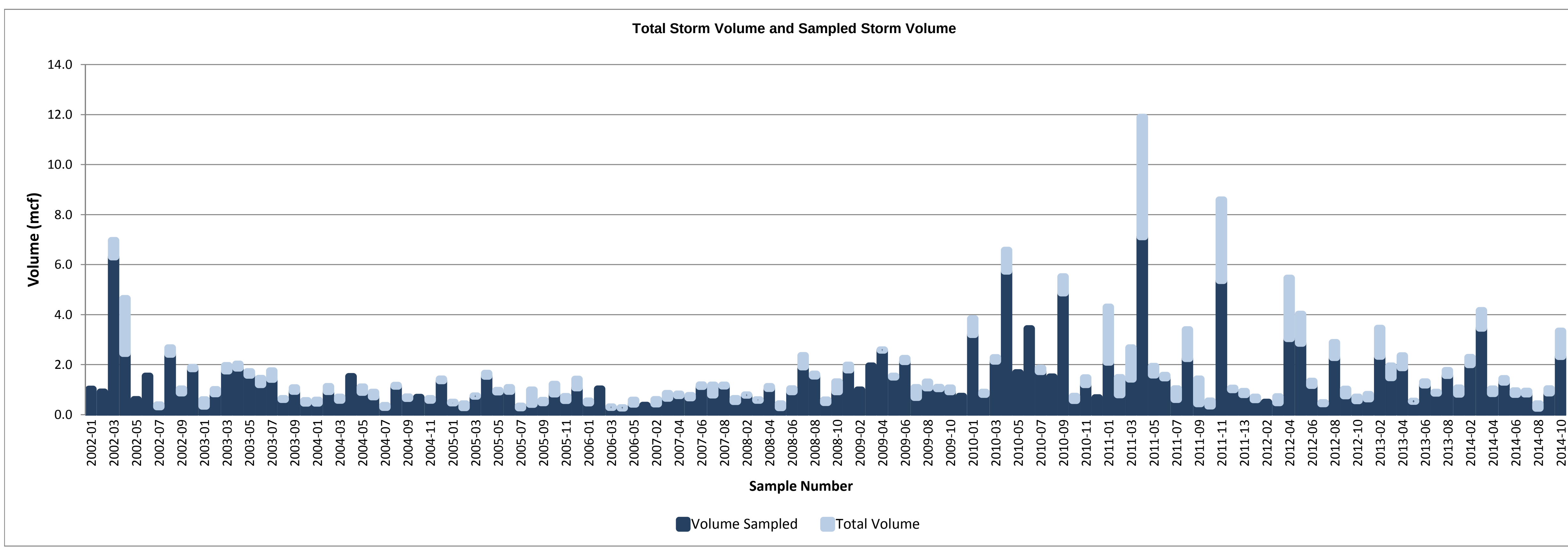
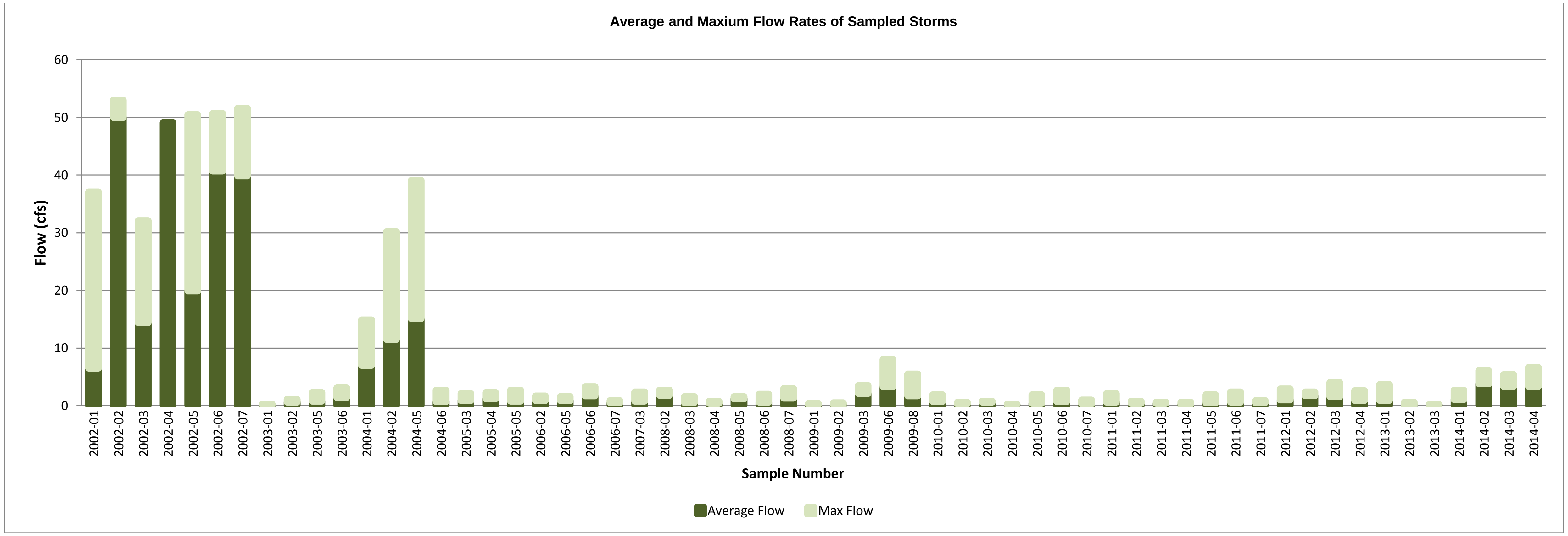


Figure 3-5.5
Sampled Storm Flows and Volumes - OF243



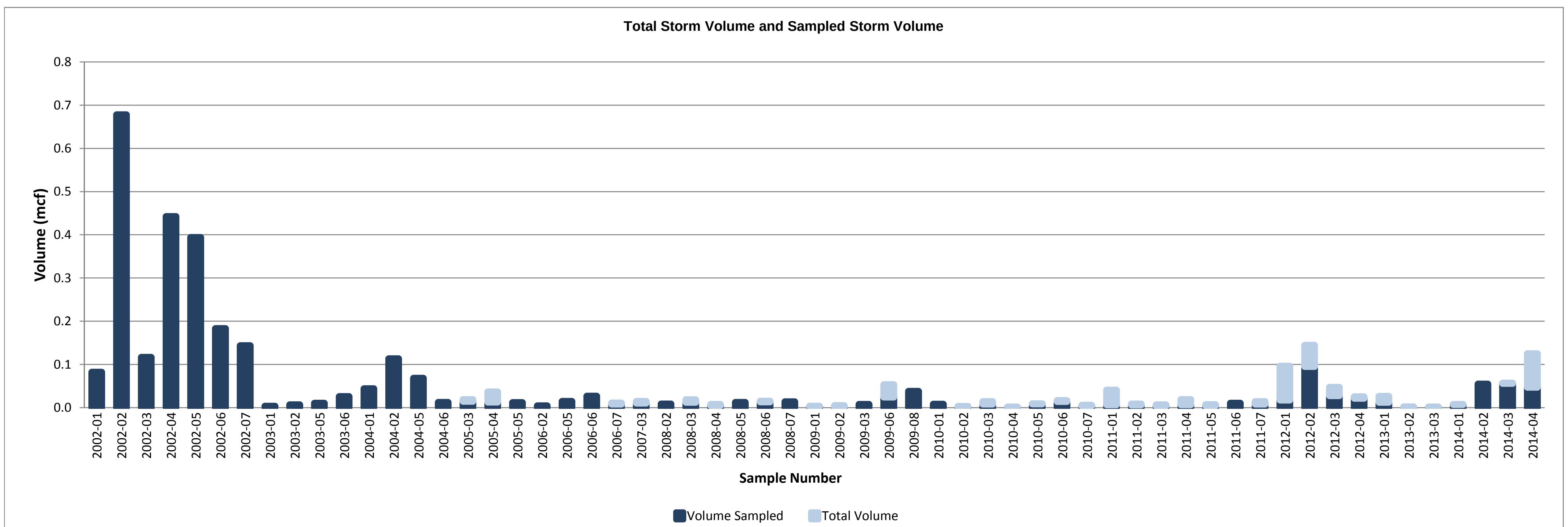
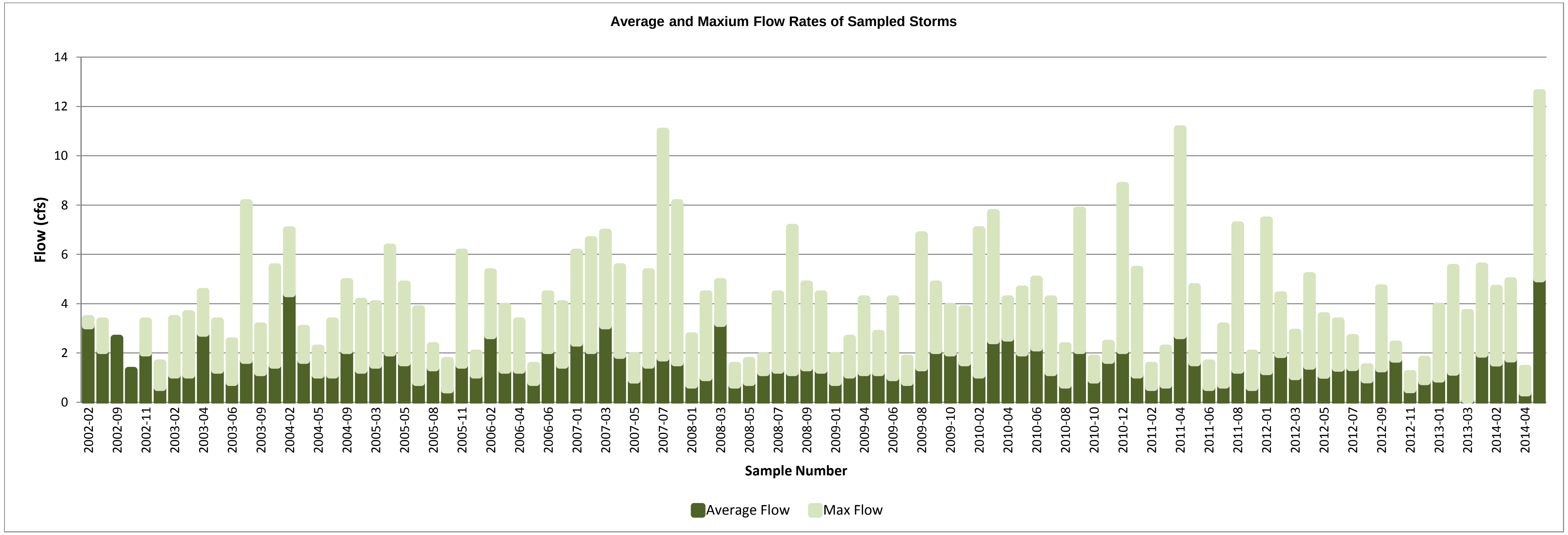


Figure 3-5.5 - Flow Data 243.xls

Figure 3-5.6
Sampled Storm Flows and Volumes - OF245



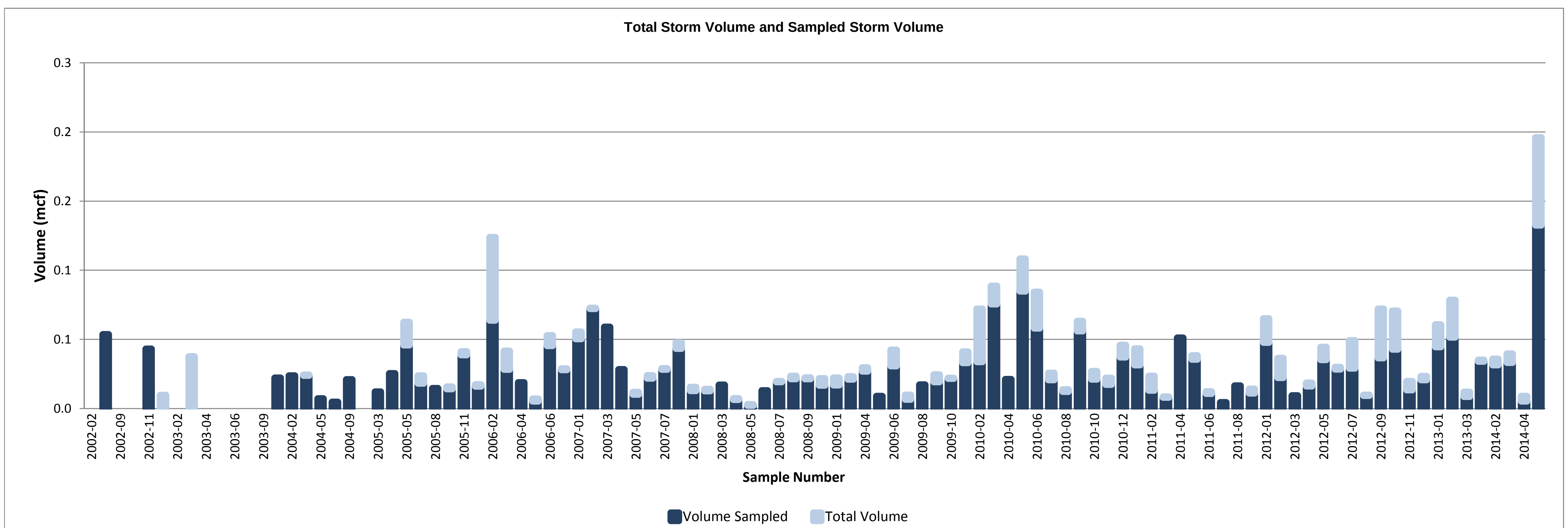
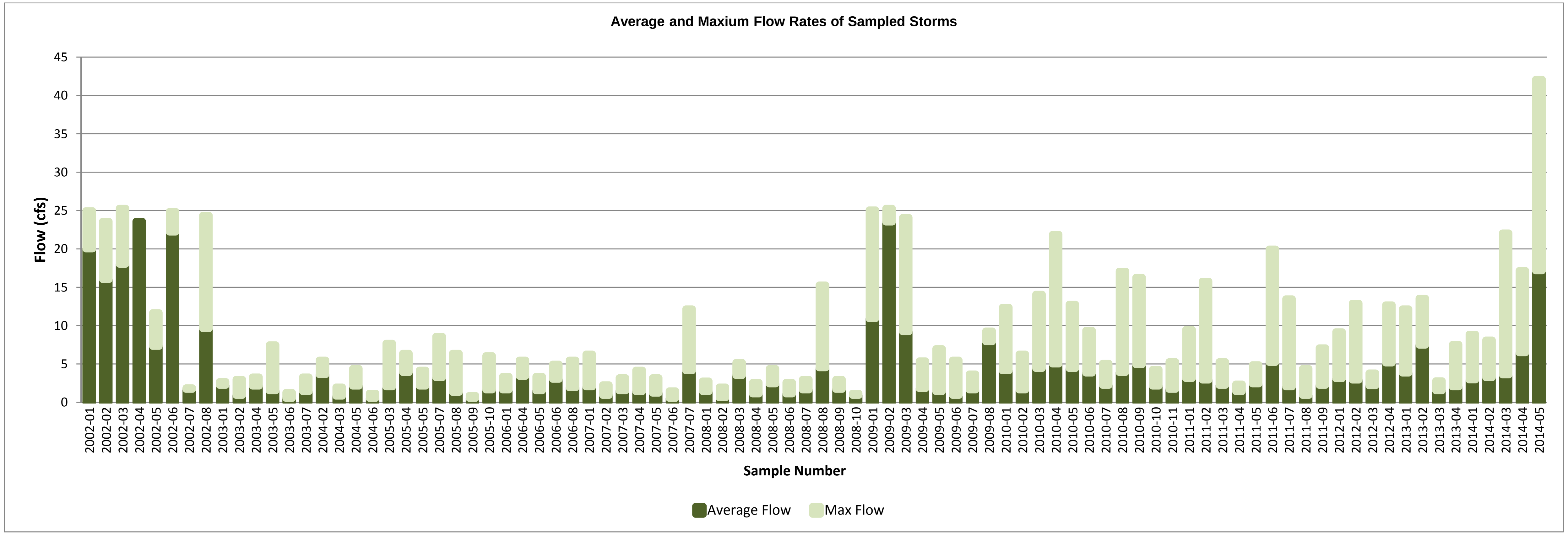


Figure 3-5.7
Sampled Storm Flows and Volumes - OF254



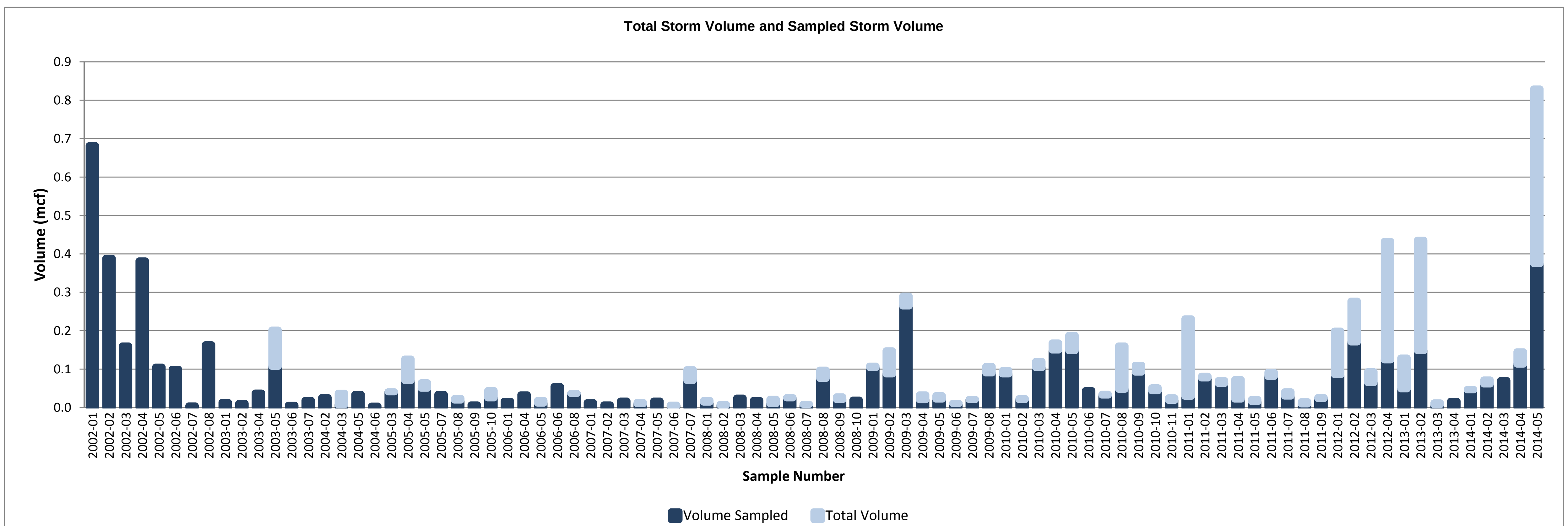


Figure 3-5.7 - Flow Data 254.xls

Figure 3-6.1
Linear Regression Analysis of Stormwater Time Trends
Time Series for Total Suspended Solids (TSS)
September 2001 - September 2014

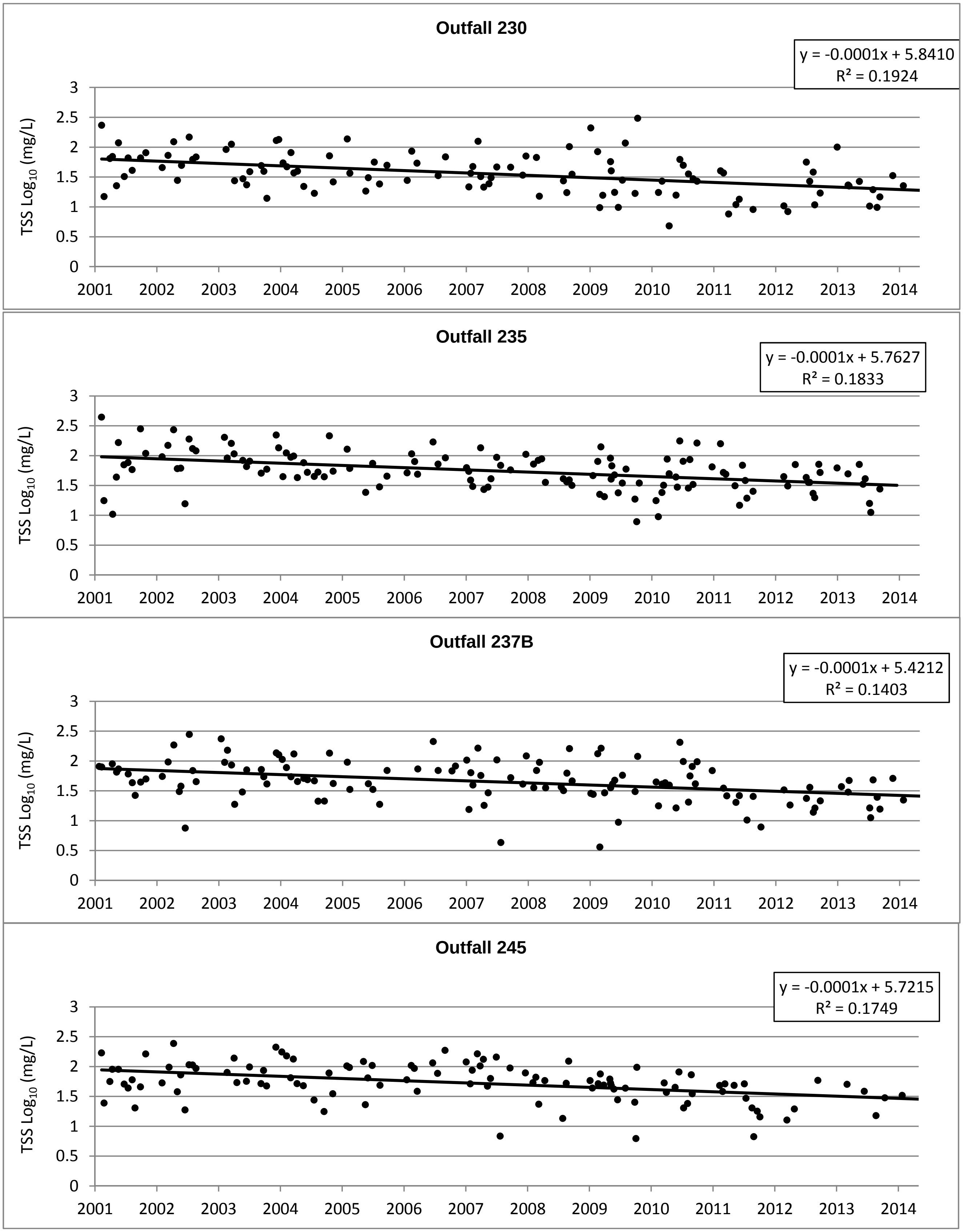
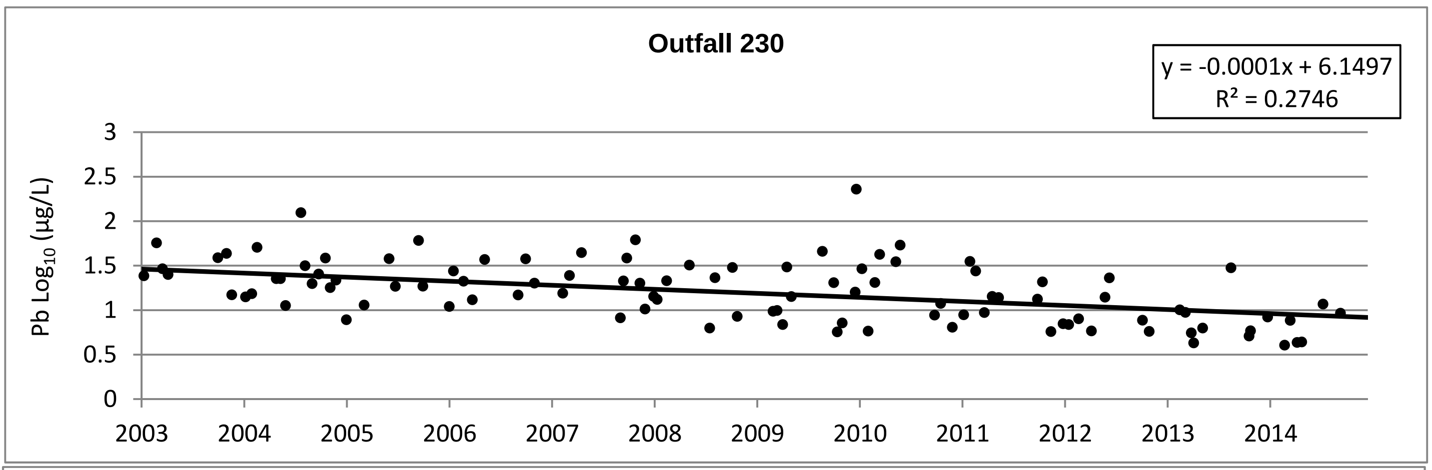
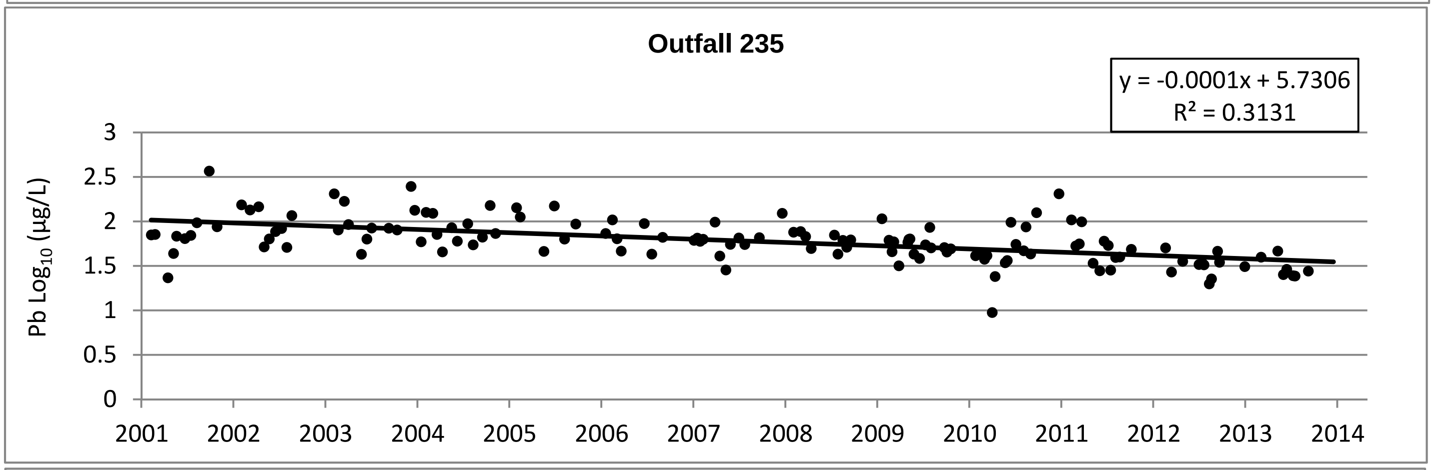
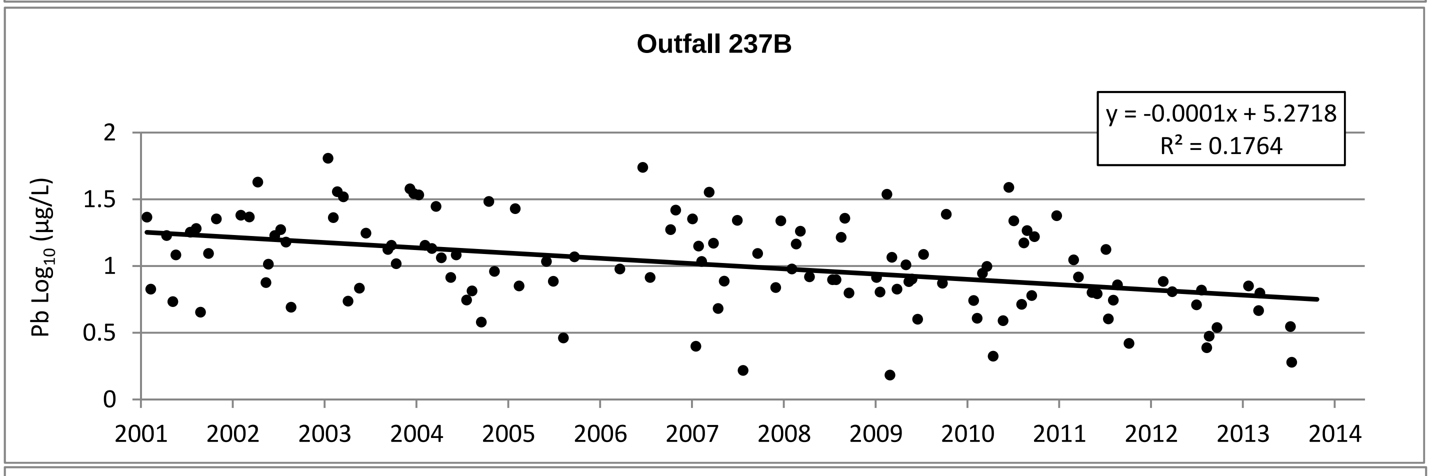
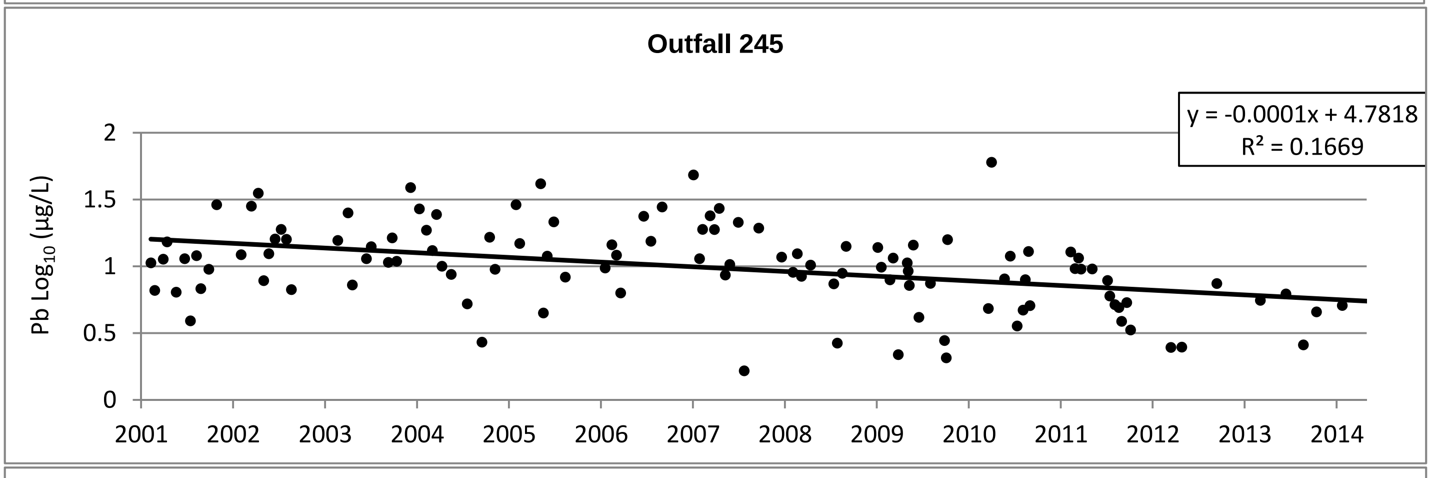


Figure 3-6.2
Linear Regression Analysis of Stormwater Time Trends
Time Series for Total Lead
September 2001 - September 2014









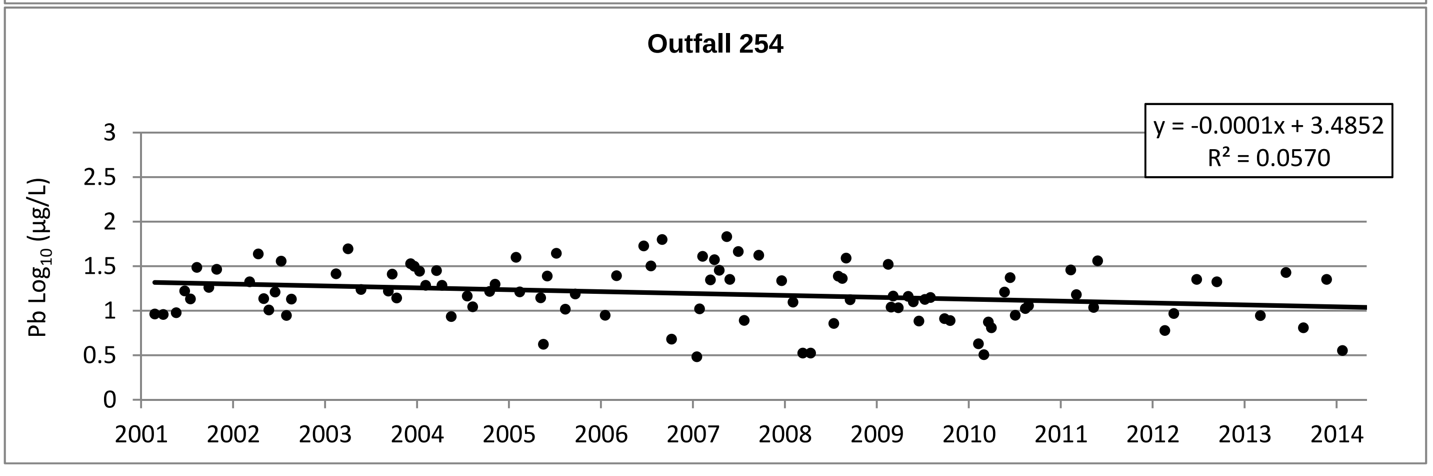


Figure 3-6.3
Linear Regression Analysis of Stormwater Time Trends
Time Series for Total Zinc
September 2001 - September 2014

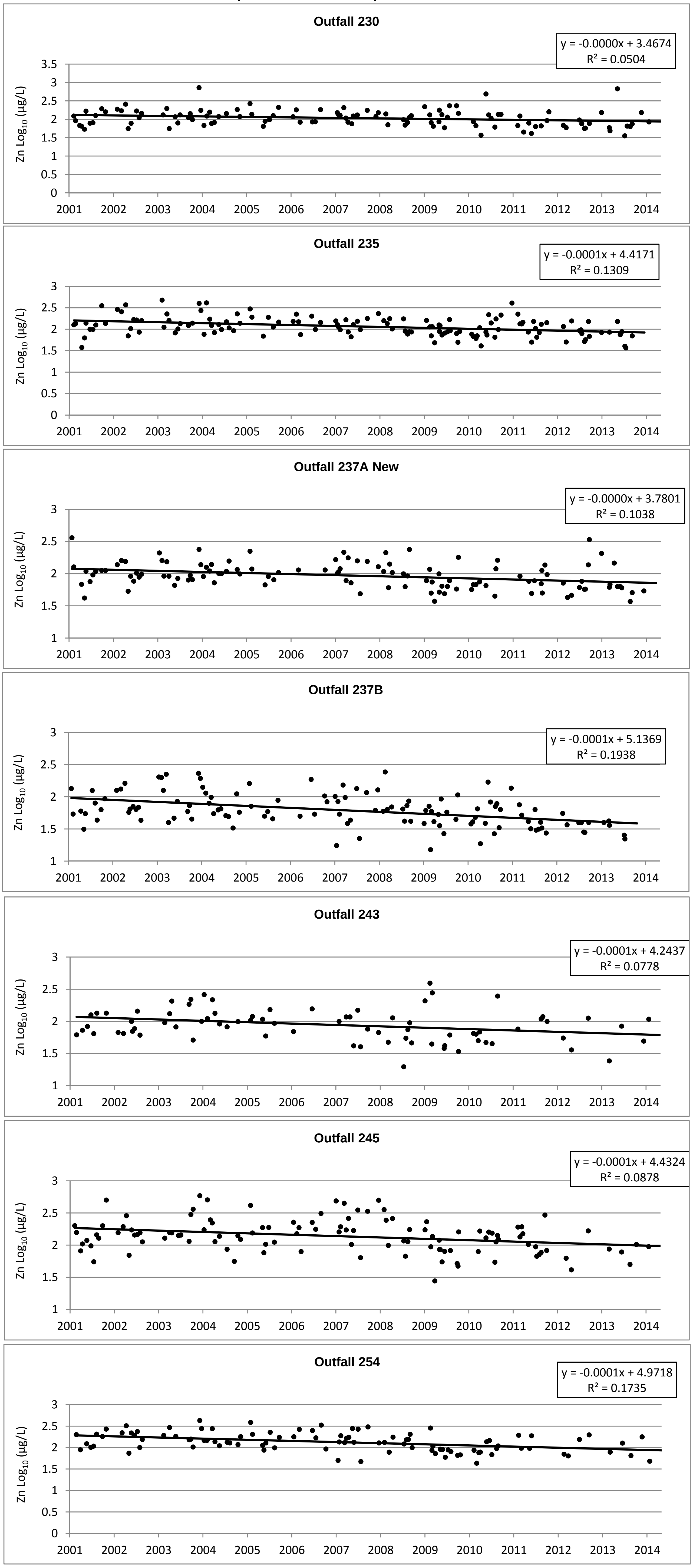
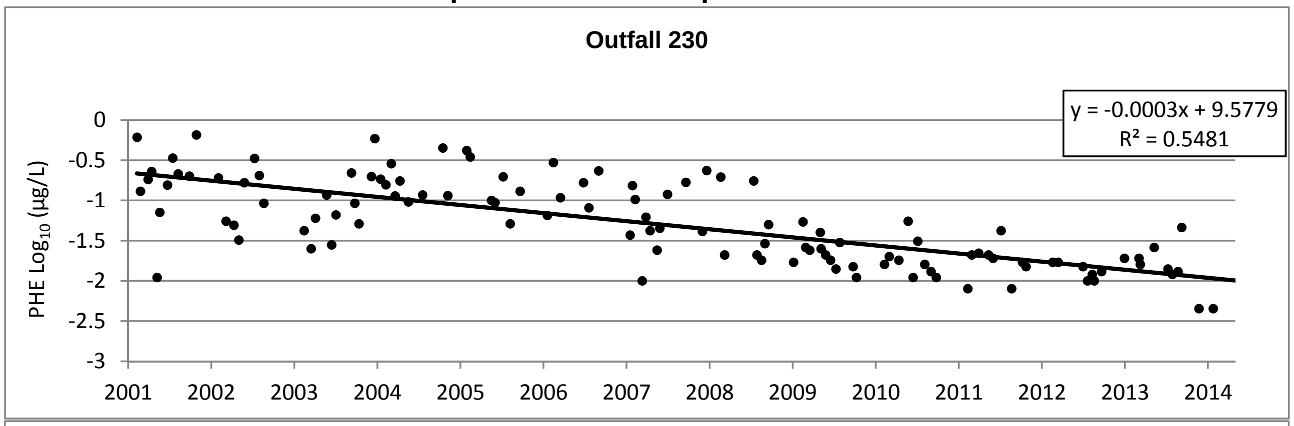
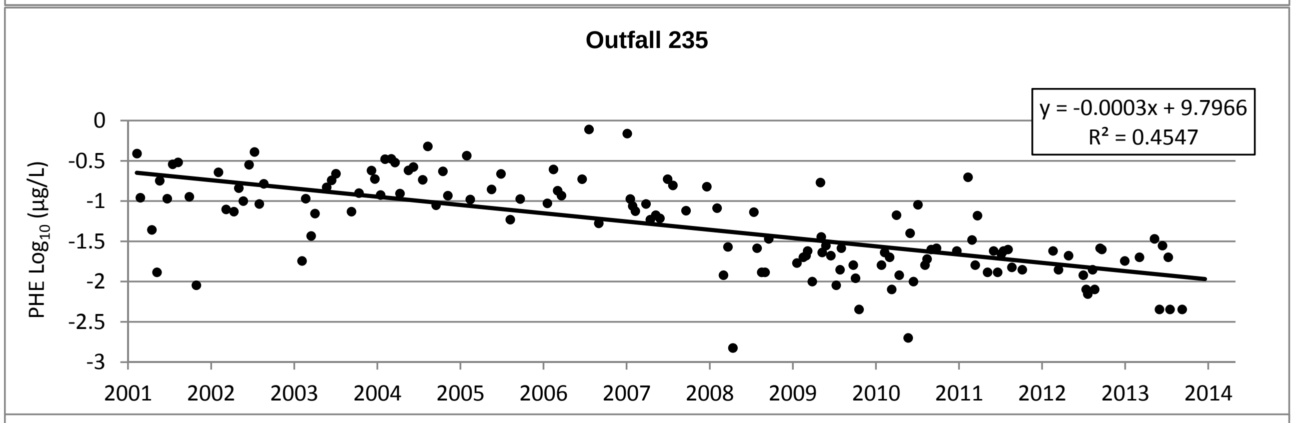
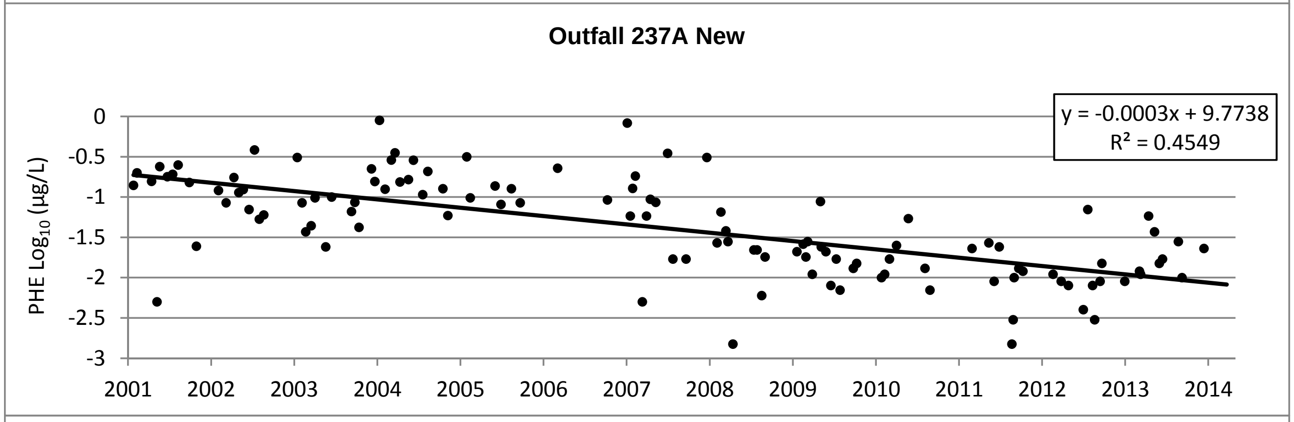


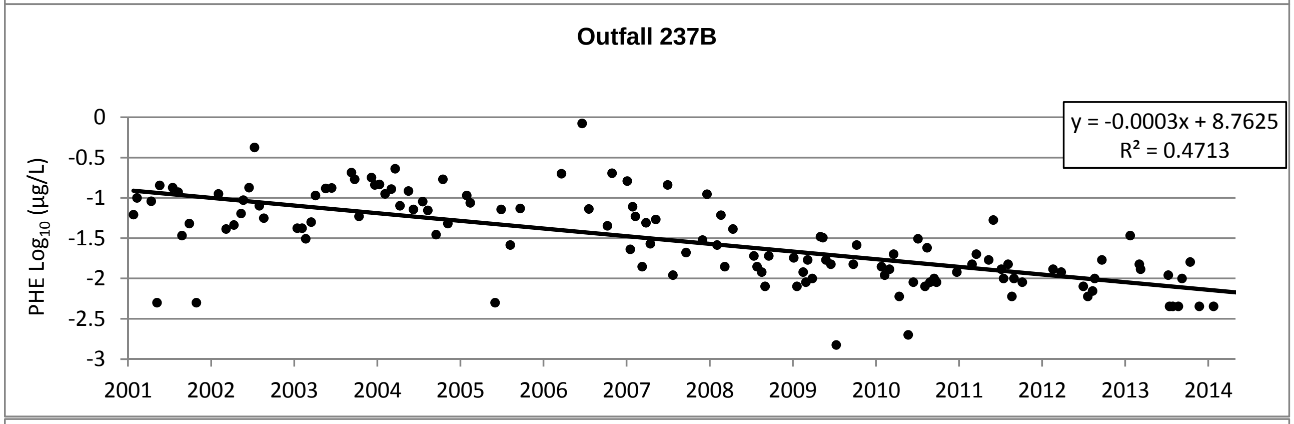
Fig_3-6a_to_3-6n_Linear_Regression_Plots_2014.xlsx

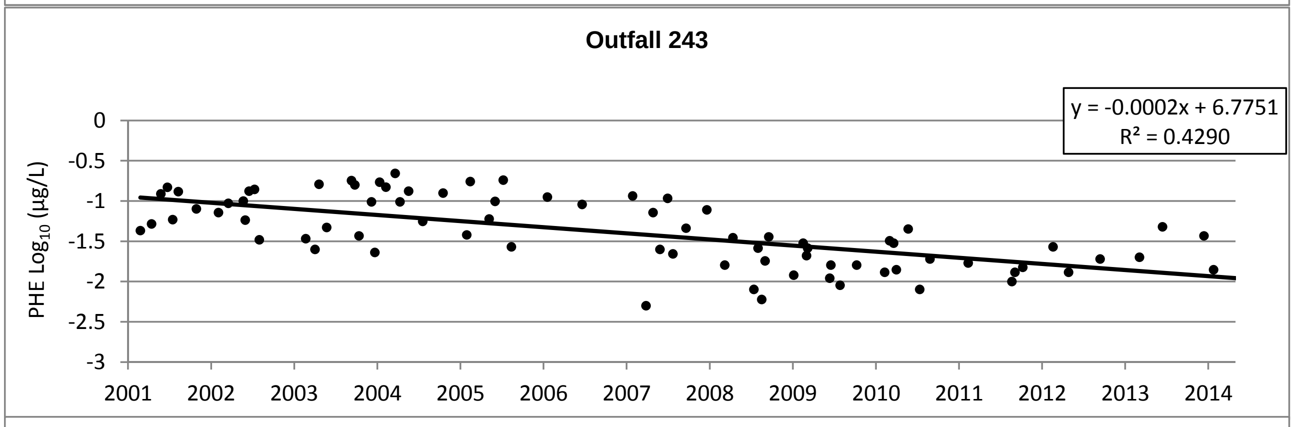
Figure 3-6.4
Linear Regression Analysis of Stormwater Time Trends
Time Series for Phenanthrene
September 2001 - September 2014

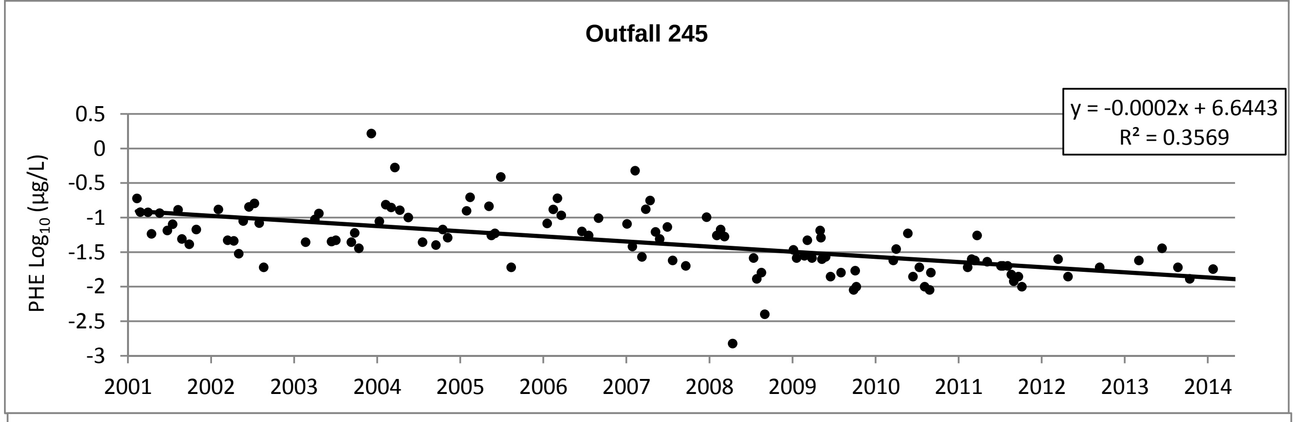












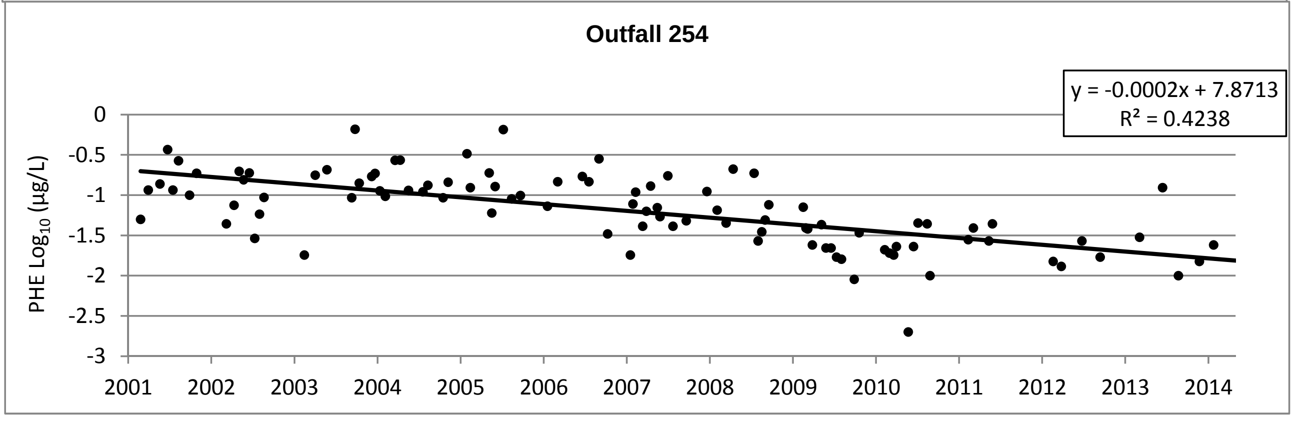


Figure 3-6.5
Linear Regression Analysis of Stormwater Time Trends
Time Series for Pyrene
September 2001 - September 2014

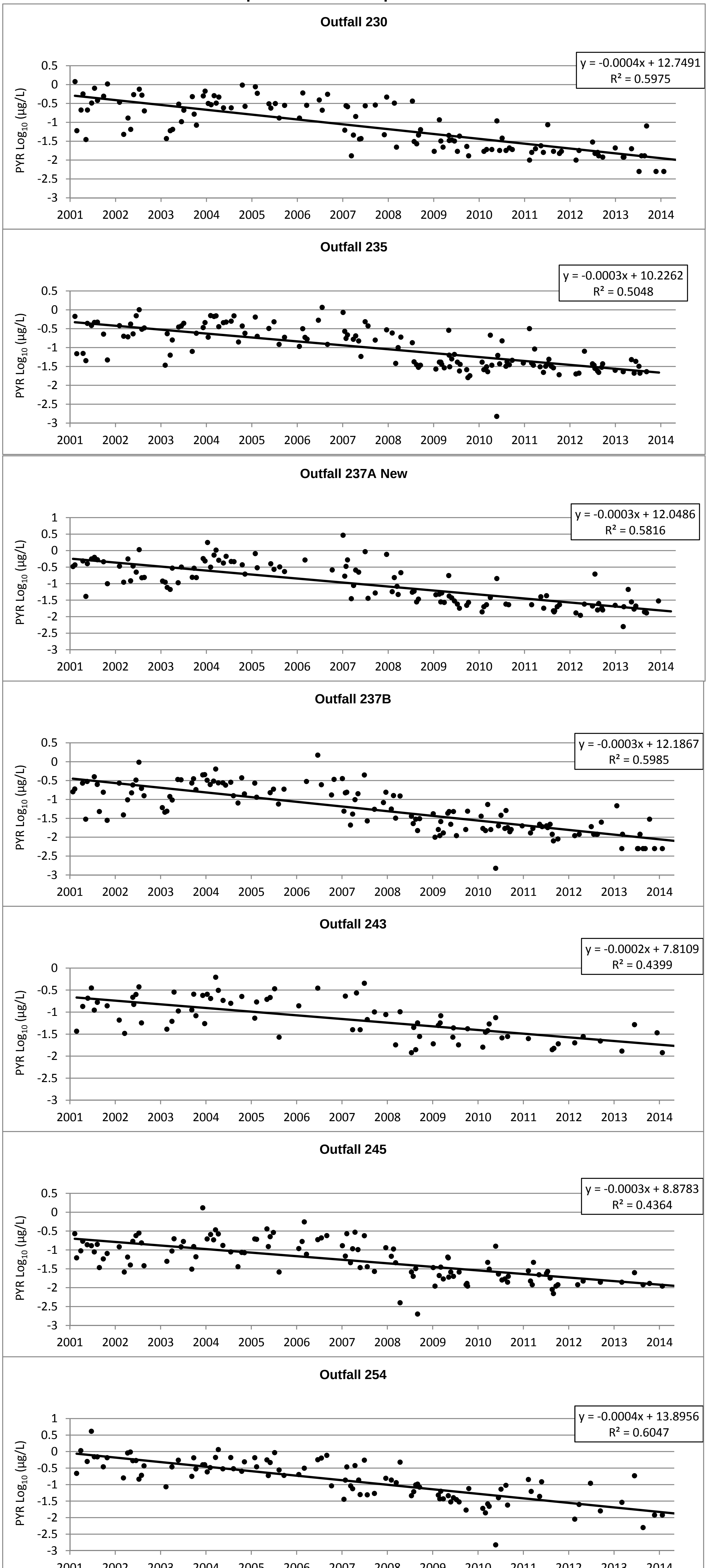


Fig_3-6a_to_3-6n_Linear_Regression_Plots_2014.xlsx

Figure 3-6.6
Linear Regression Analysis of Stormwater Time Trends
Time Series for Indeno(1,2,3-c,d)pyrene
September 2001 - September 2014

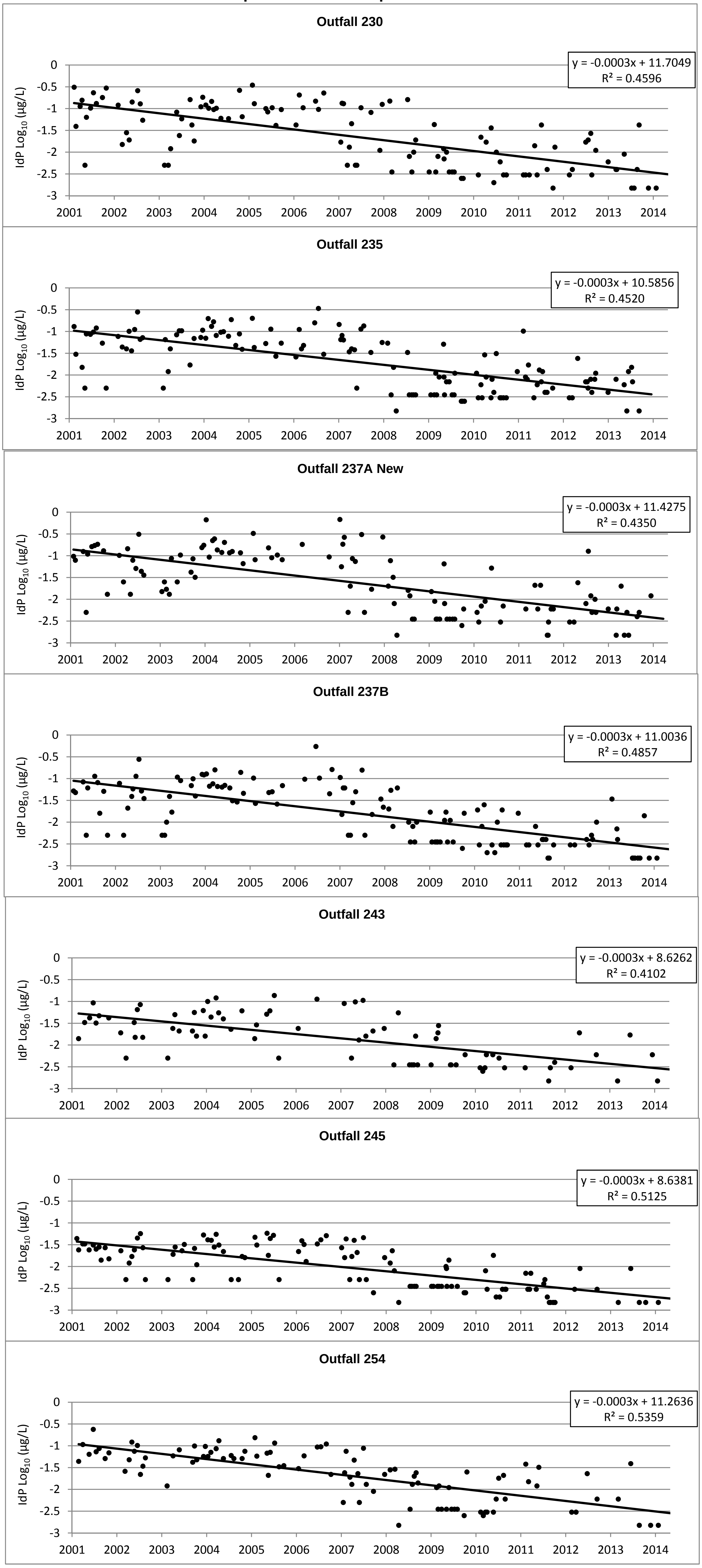
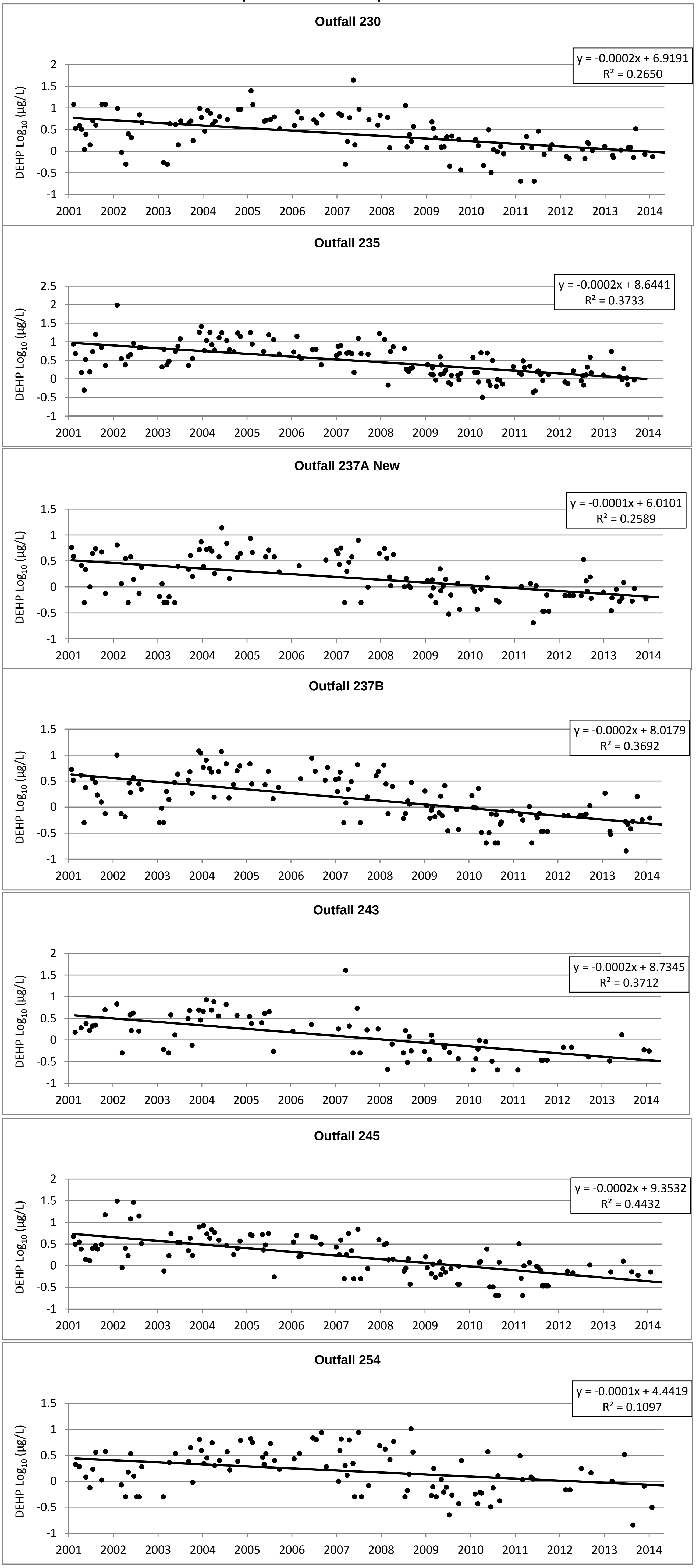


Fig_3-6a_to_3-6n_Linear_Regression_Plots_2014.xlsx

Figure 3-6.7
Linear Regression Analysis of Stormwater Time Trends
Time Series for Bis(2-ethylhexyl)phthalate (DEHP)
September 2001 - September 2014



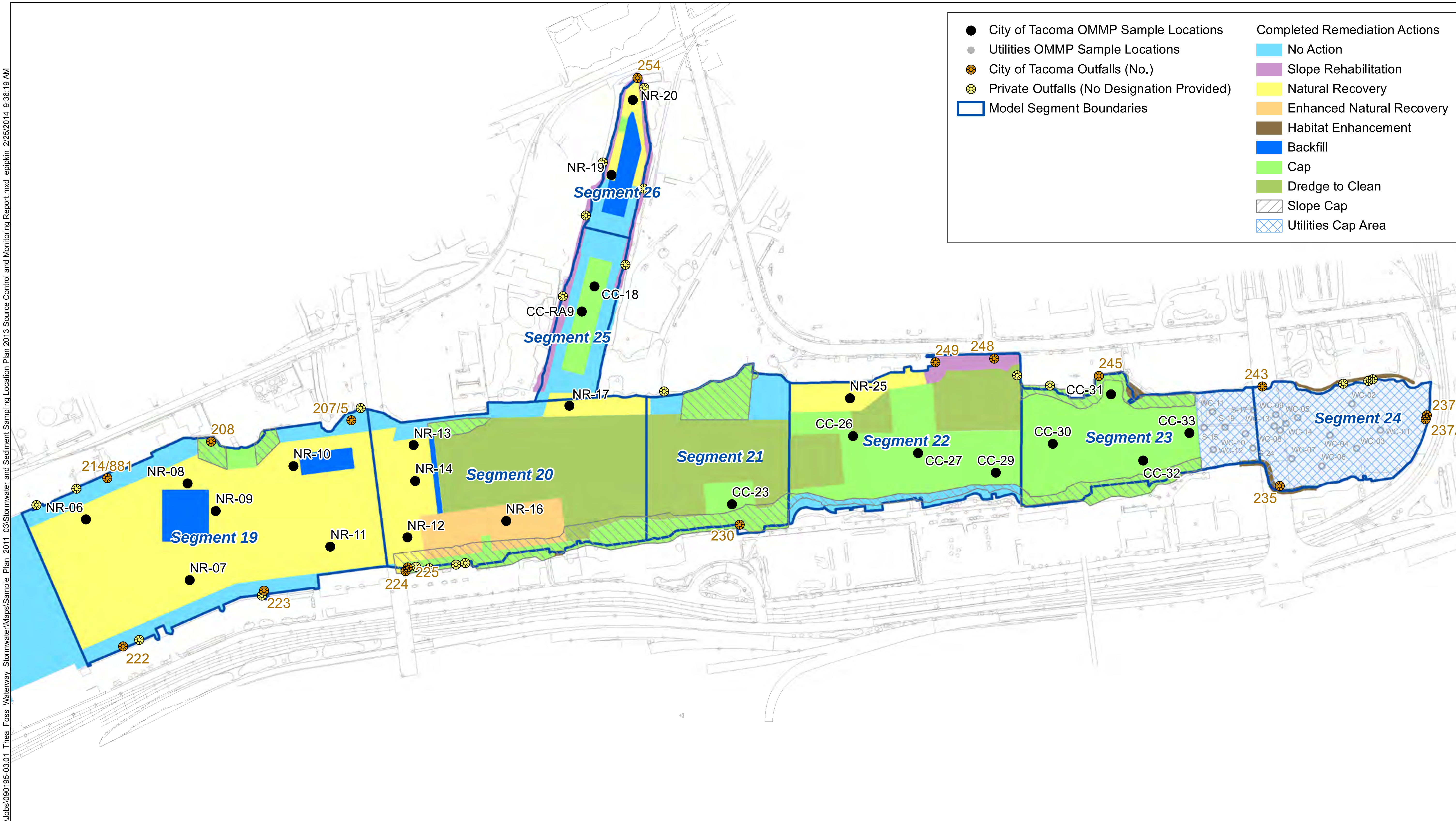
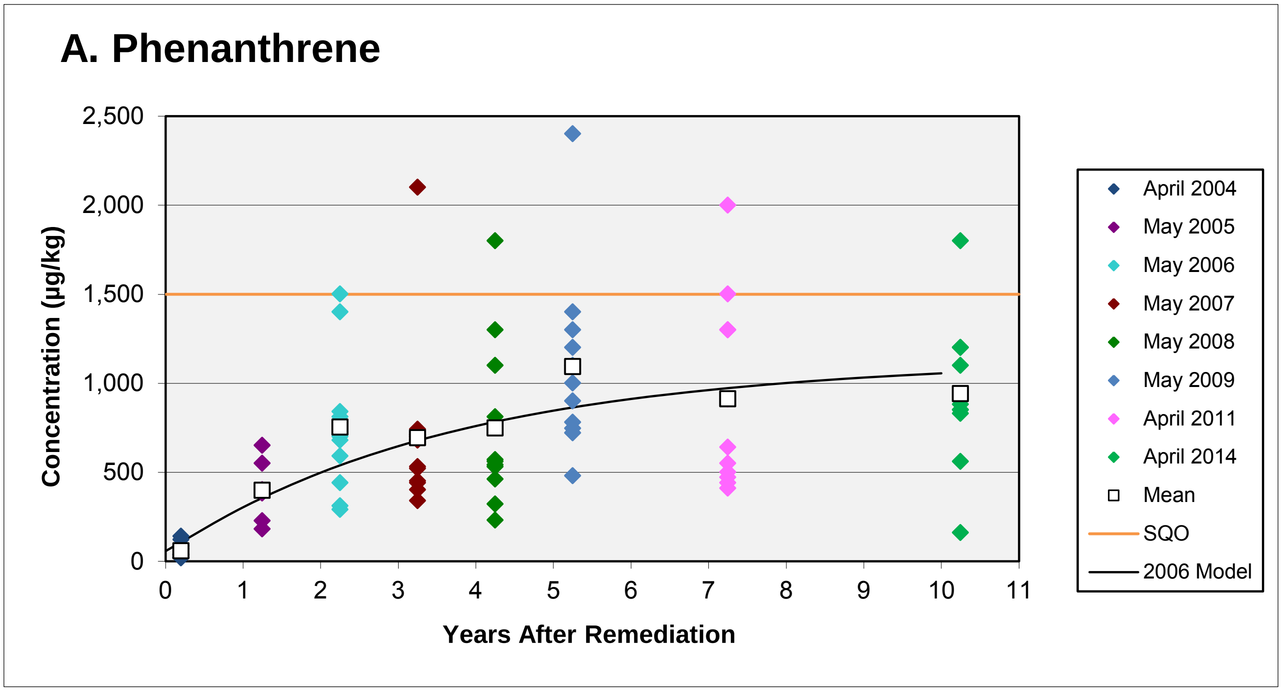


Figure 4-1
Sediment Sampling Location Plan
2013 Source Control and Stormwater Monitoring Report

Q:\Jobs\090195-03.01_Thea_Foss_Waterway_Stormwater\Maps\Sample_Plan_2011_03\Stormwater and Sediment Sampling Location Plan 2013 Source Control and Monitoring Report.mxd epipkin 2/25/2014 9:36:19 AM

Figure 4-2
Post-Construction Sediment Quality Trends
Thea Foss Waterway



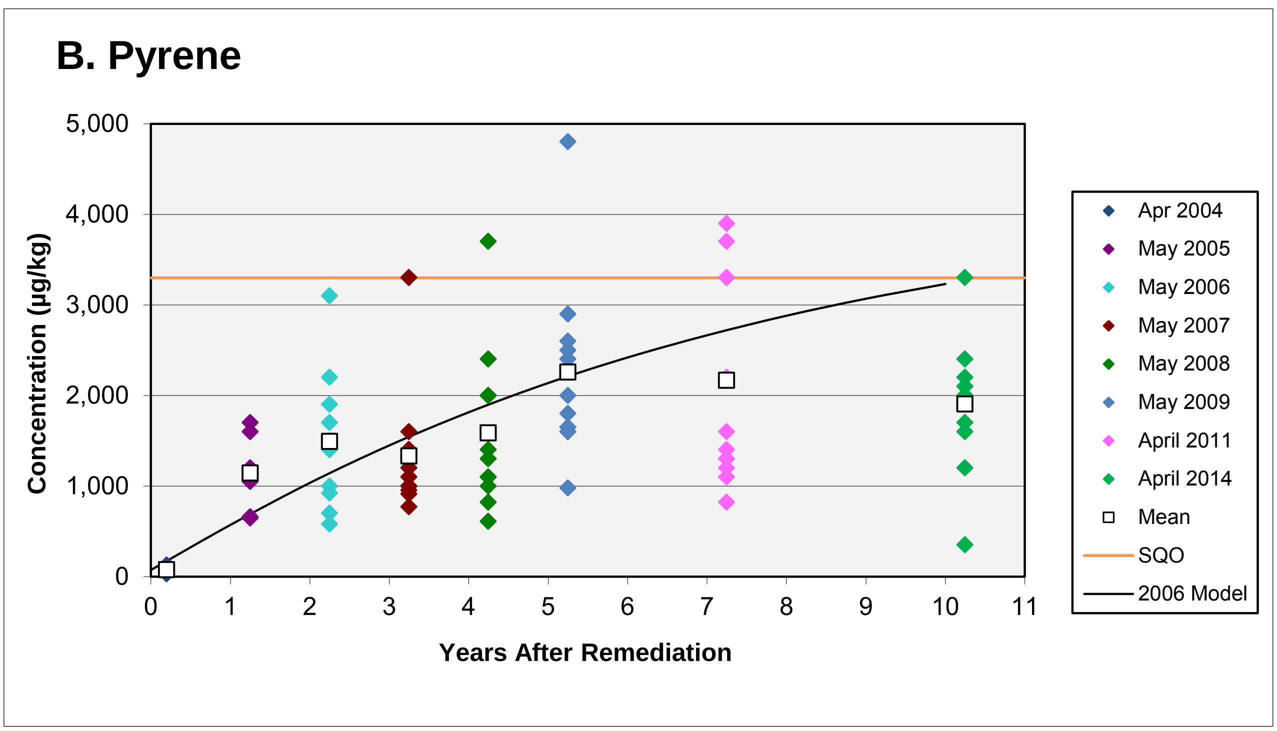
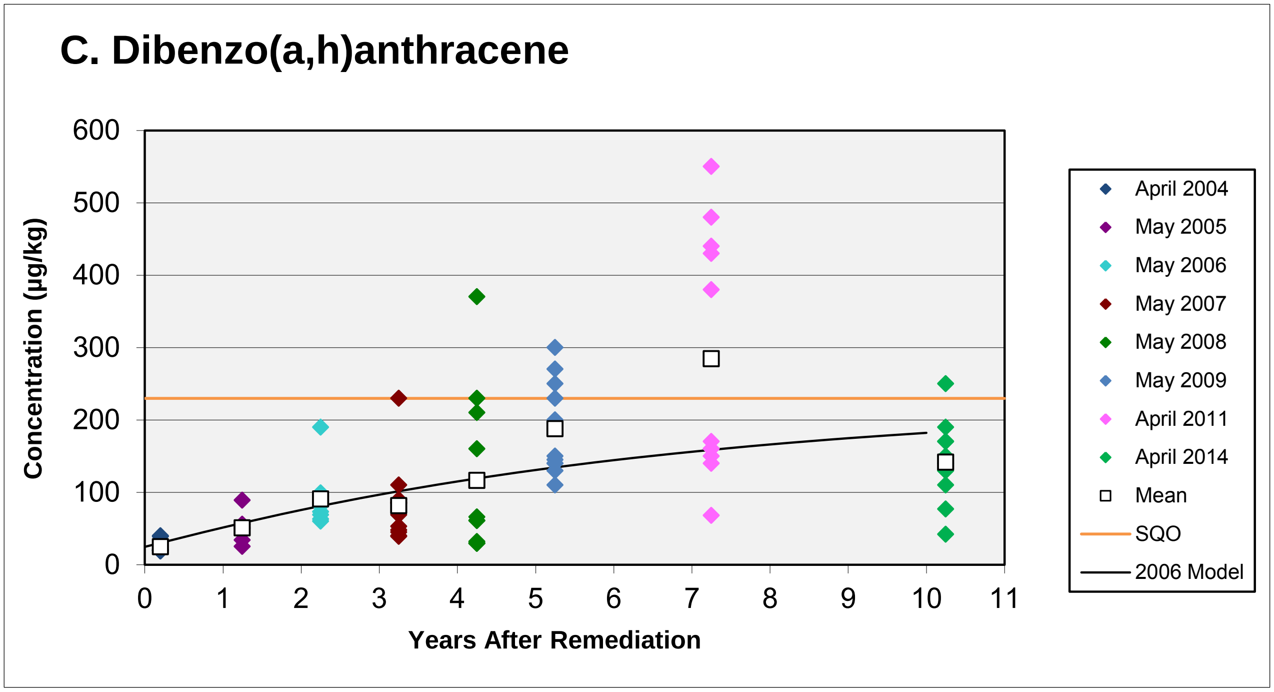
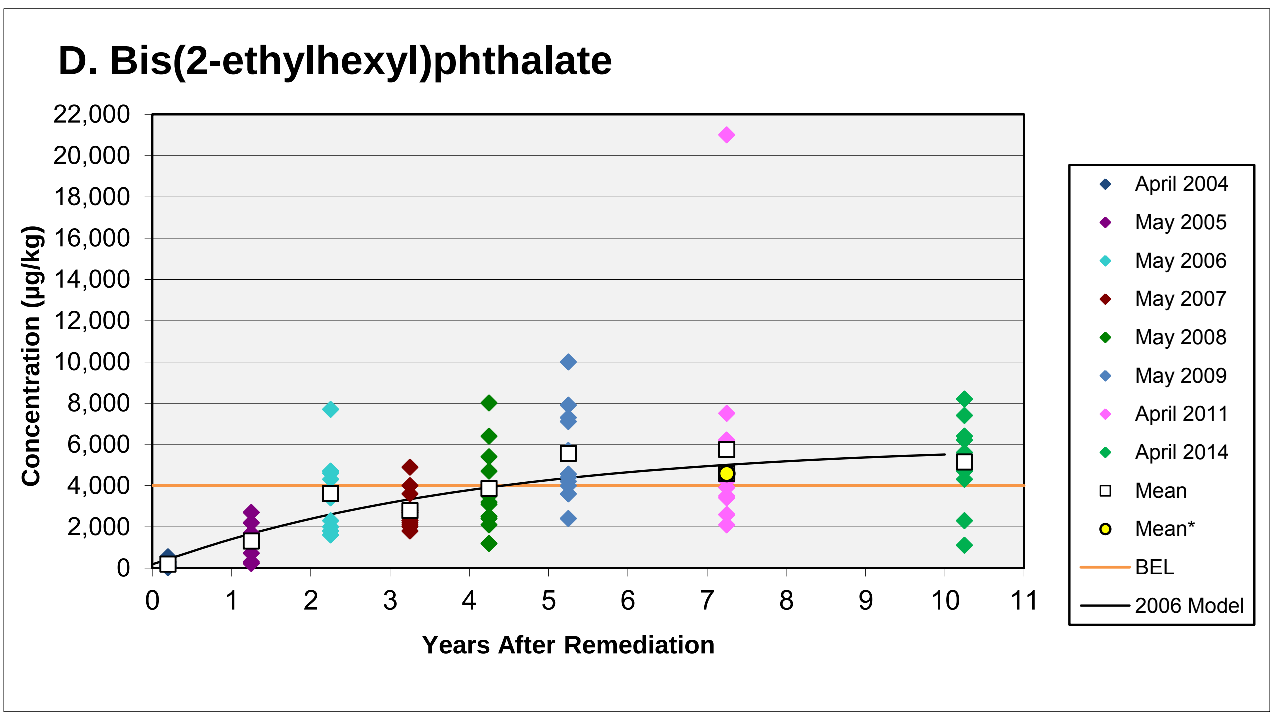


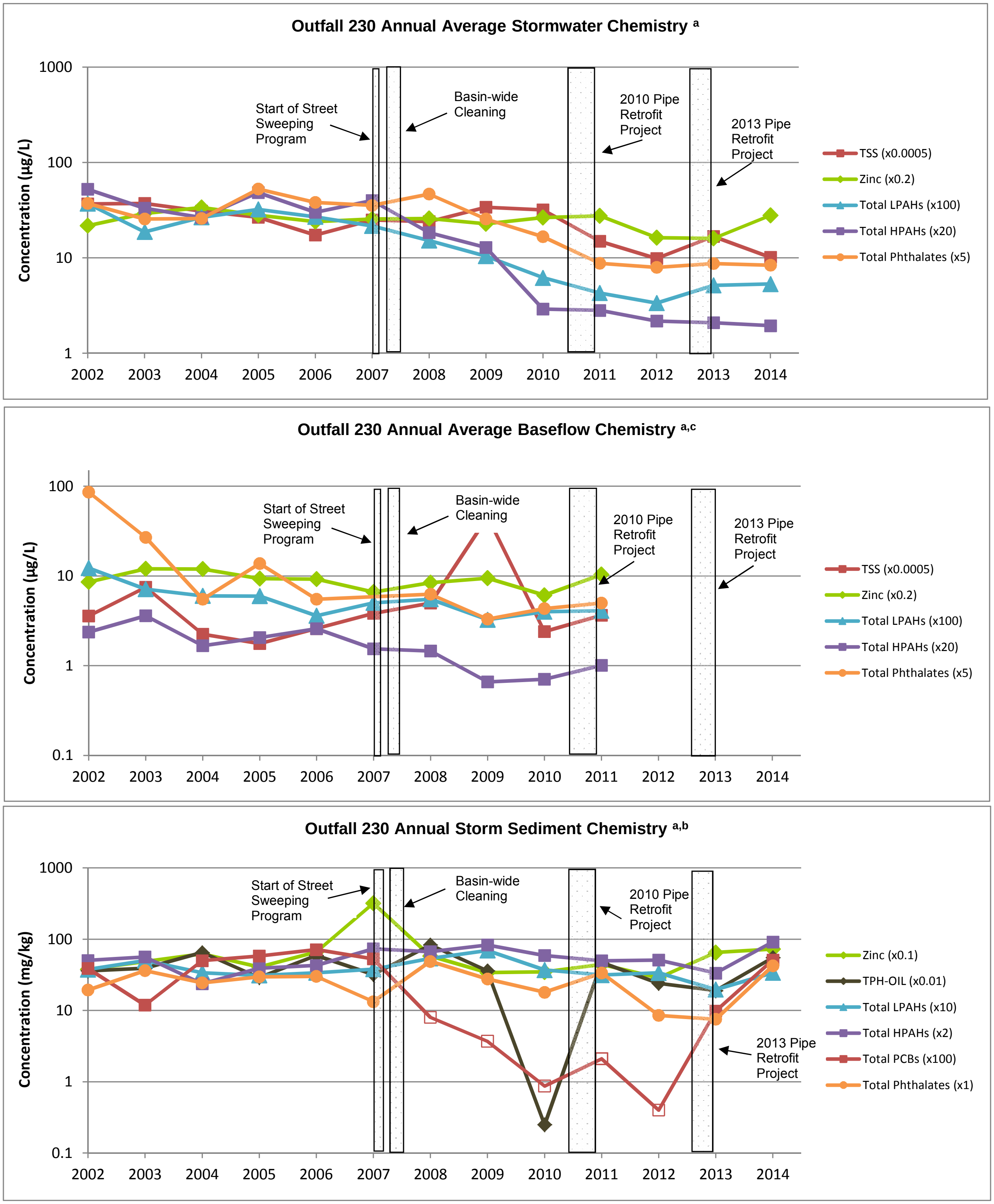
Figure 4-2
Post-Construction Sediment Quality Trends
Thea Foss Waterway





Note: Data on these figures includes only those samples withing the Utilities' work area that are located in Segment 24 of the model (WC-01, WC-02, WC-03, WC-04, WC-05, WC-06, WC-07, WC-08, WC-09, WC-13 and WC-14).
* Mean calculated using result from 2-cm sample from location WC-05

Figure 5-1.1
Analysis of Monitoring Trends in Stormwater, Baseflow, and Storm Sediment
OF230



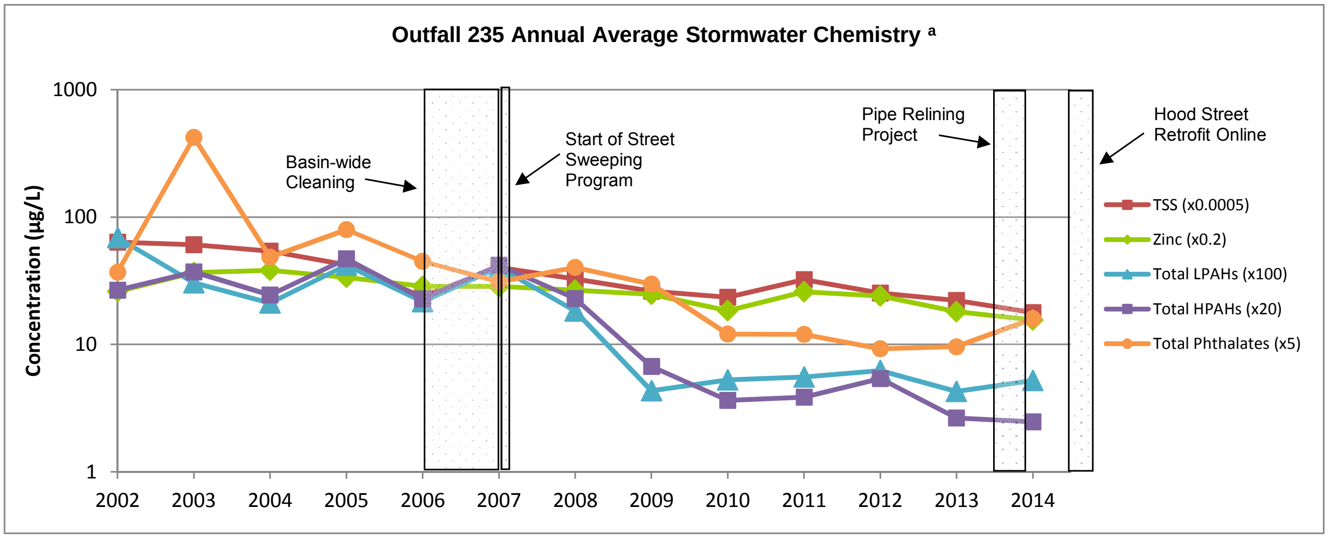
Notes:

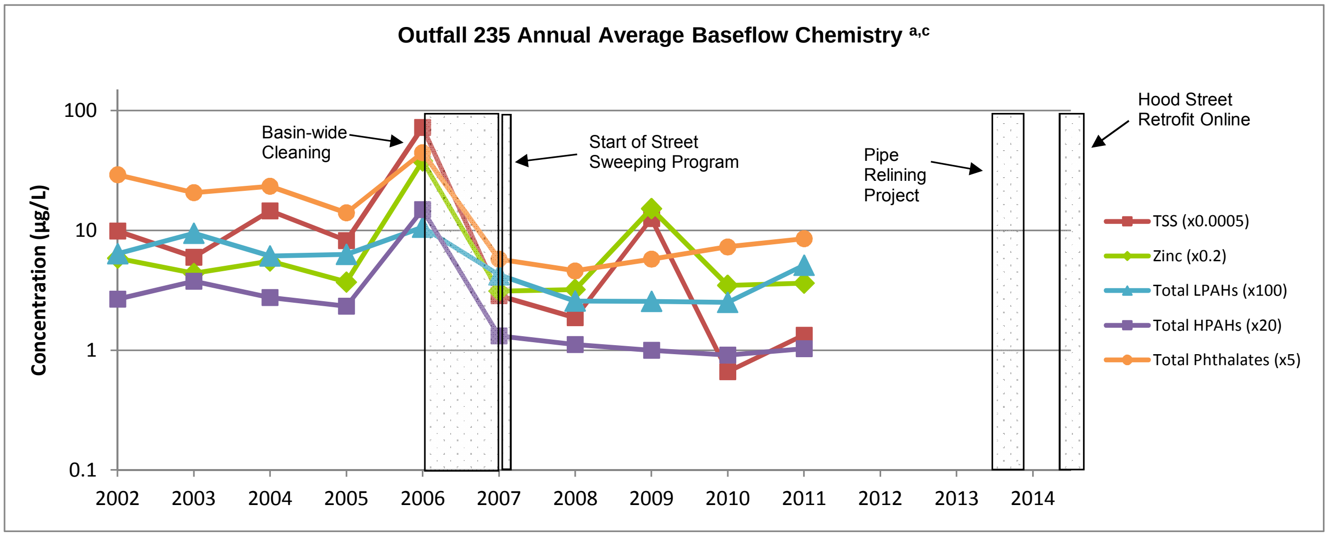
[a] Results shown are a product of chemistry data and an analyte-specific multiplier in order to display results on a common scale

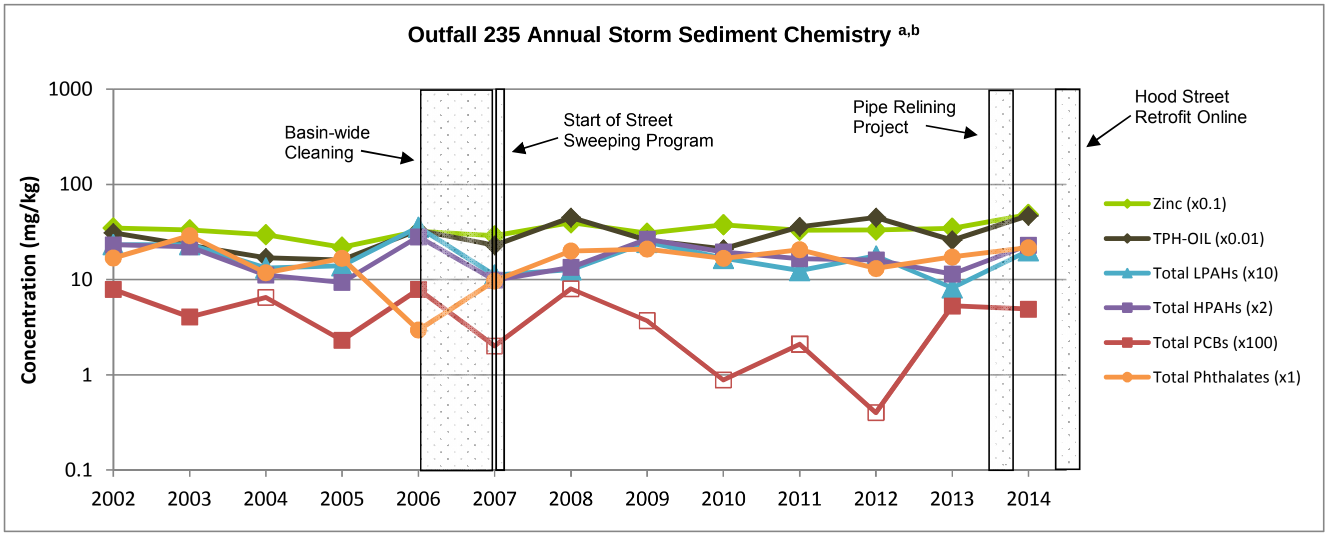
[b] Open symbols denote censored data; highest detection limit posted as value

[c] Baseflow sampling was discontinued after WY2011.

Figure 5-1.2
Analysis of Monitoring Trends in Stormwater, Baseflow, and Storm Sediment
OF235







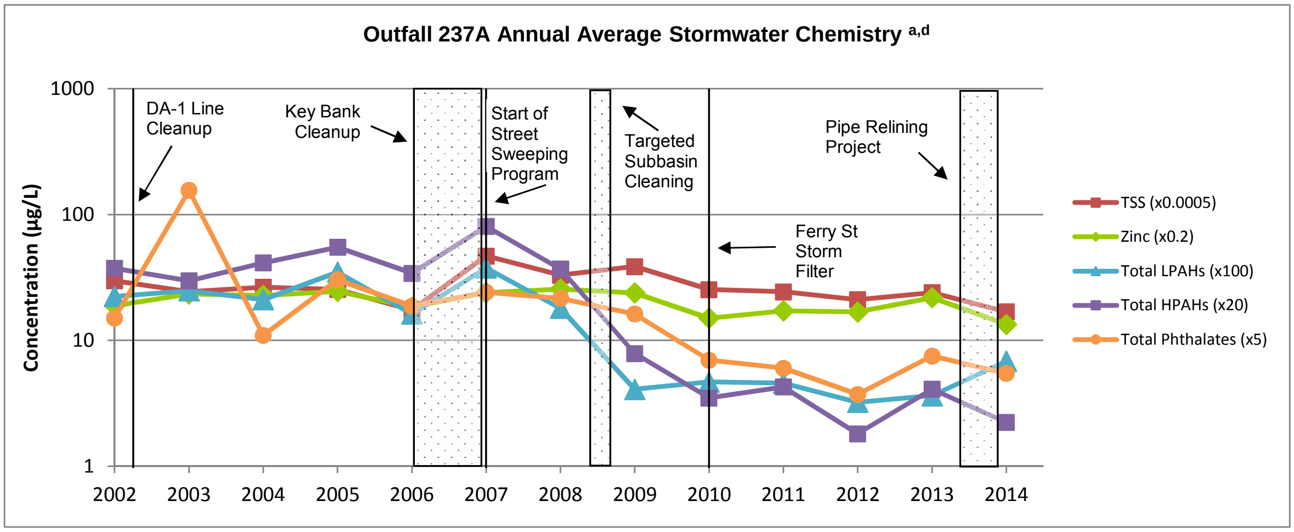
Notes:

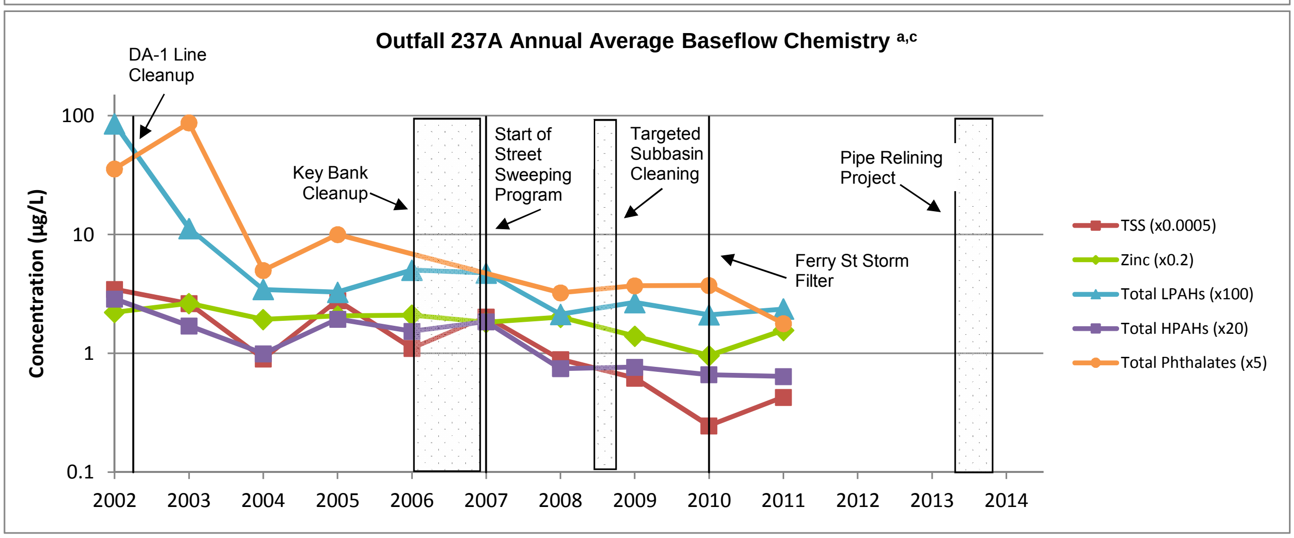
[a] Results shown are a product of chemistry data and an analyte-specific multiplier in order to display results on a common scale

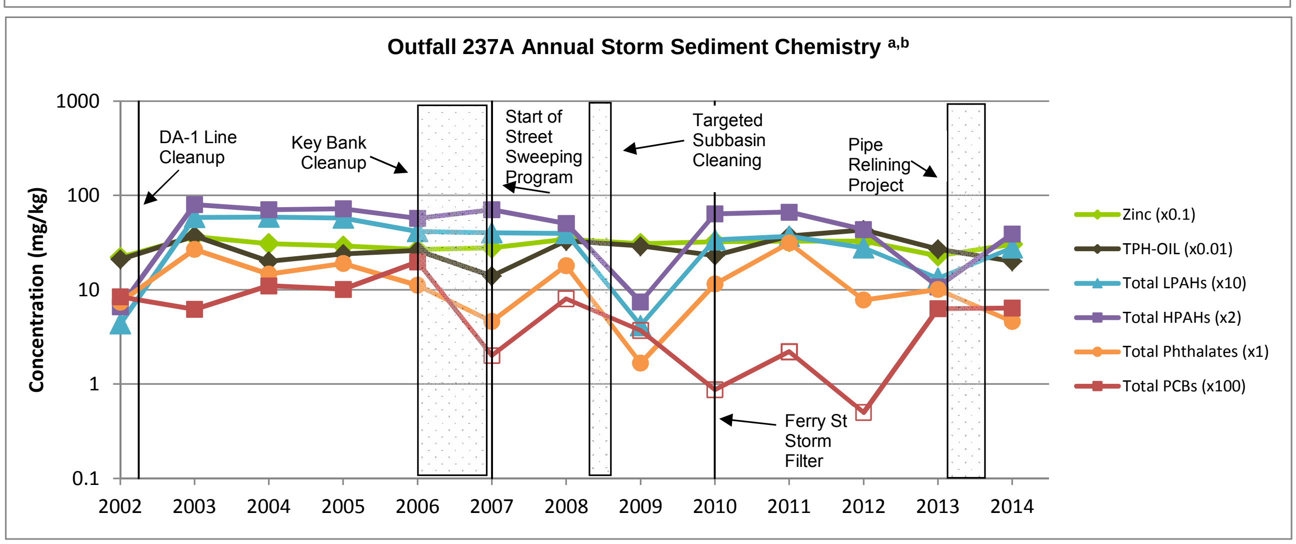
[b] Open symbols denote censored data; highest detection limit posted as value

[c] Baseflow sampling was discontinued after WY2011.

Figure 5-1.3
Analysis of Monitoring Trends in Stormwater, Baseflow, and Storm Sediment
OF237A







Notes:

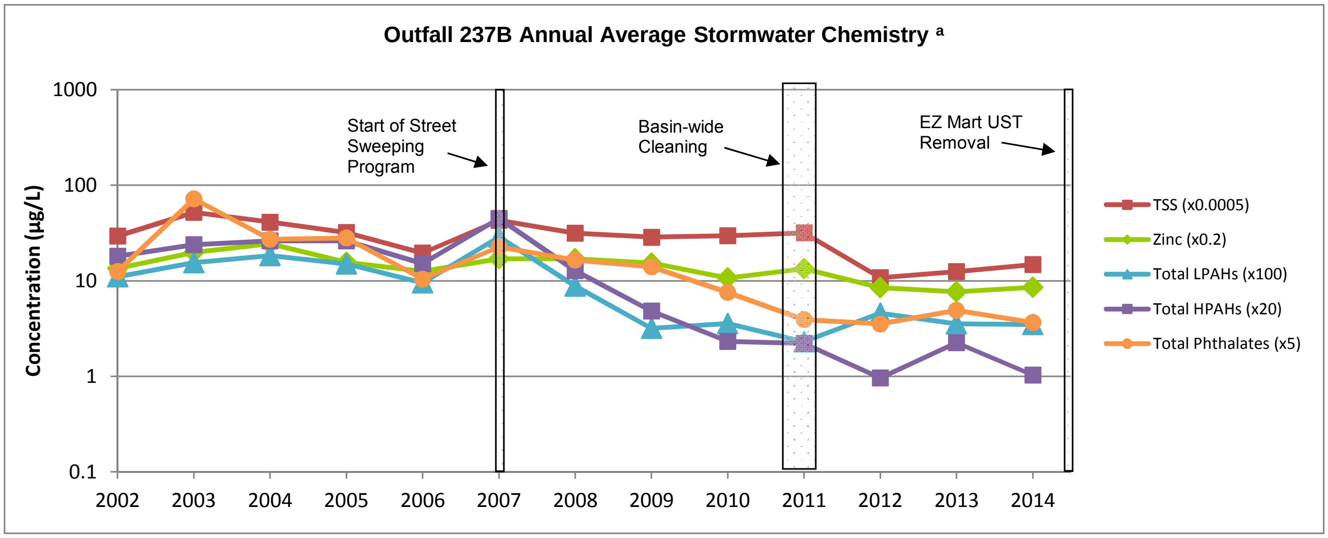
[a] Results shown are a product of chemistry data and an analyte-specific multiplier in order to display results on a common scale

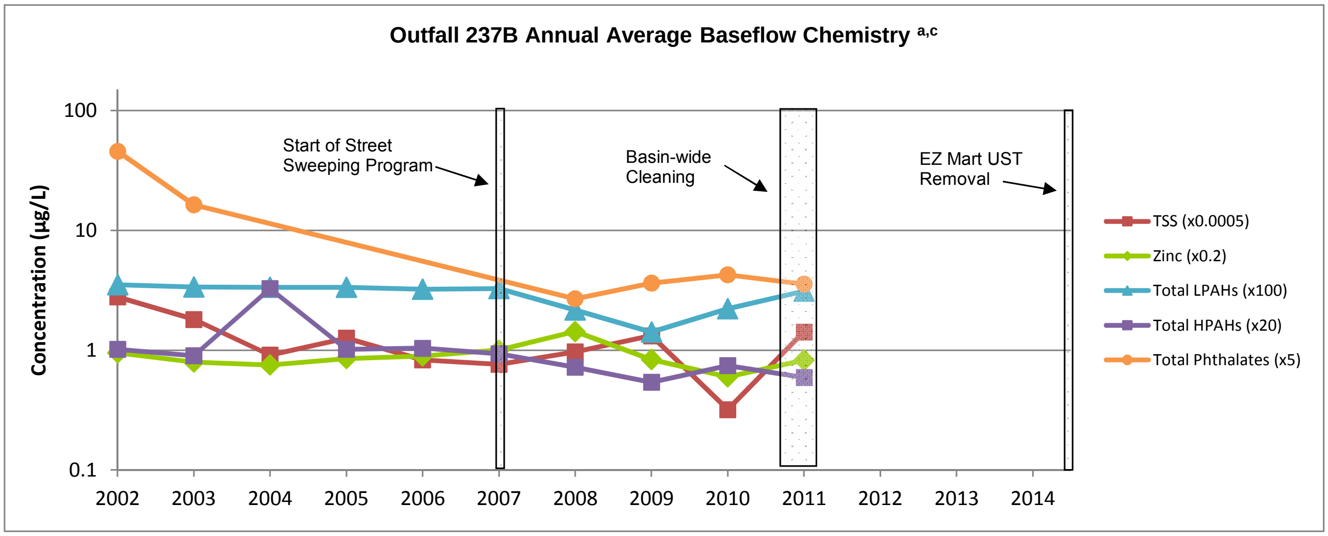
[b] Open symbols denote censored data; highest detection limit posted as value

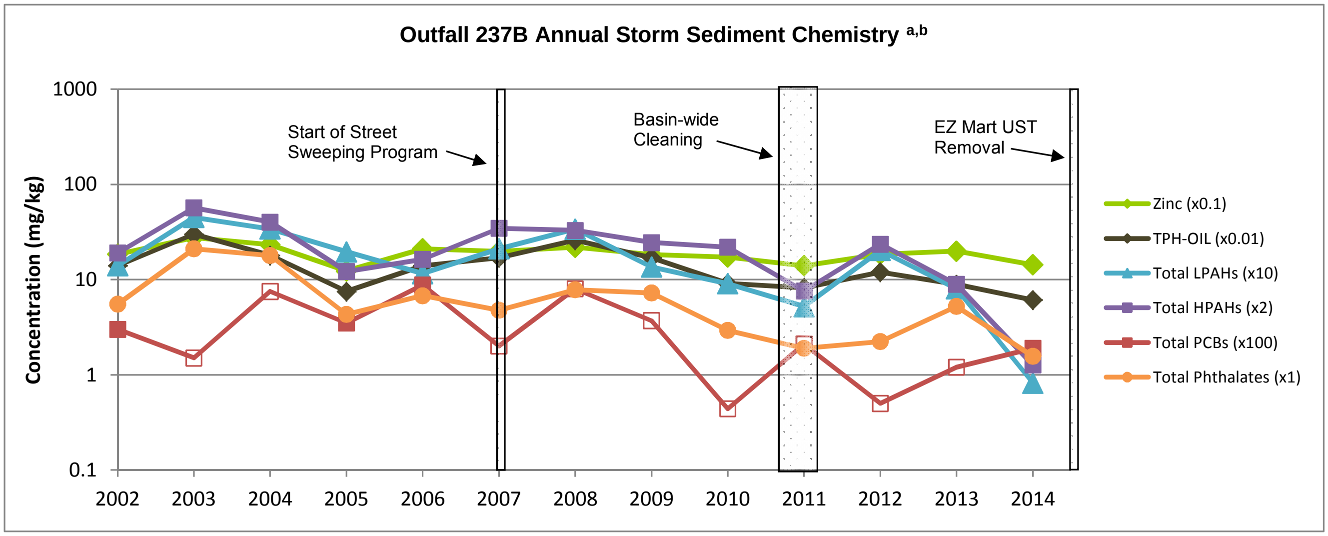
[c] Baseflow sampling was discontinued after WY2011.

[d] 237A data Includes data from the old 237A site for events prior collected prior to 2/26/06. Events after 2/26/06 were from the 237A New site.

Figure 5-1.4
Analysis of Monitoring Trends in Stormwater, Baseflow, and Storm Sediment
OF237B







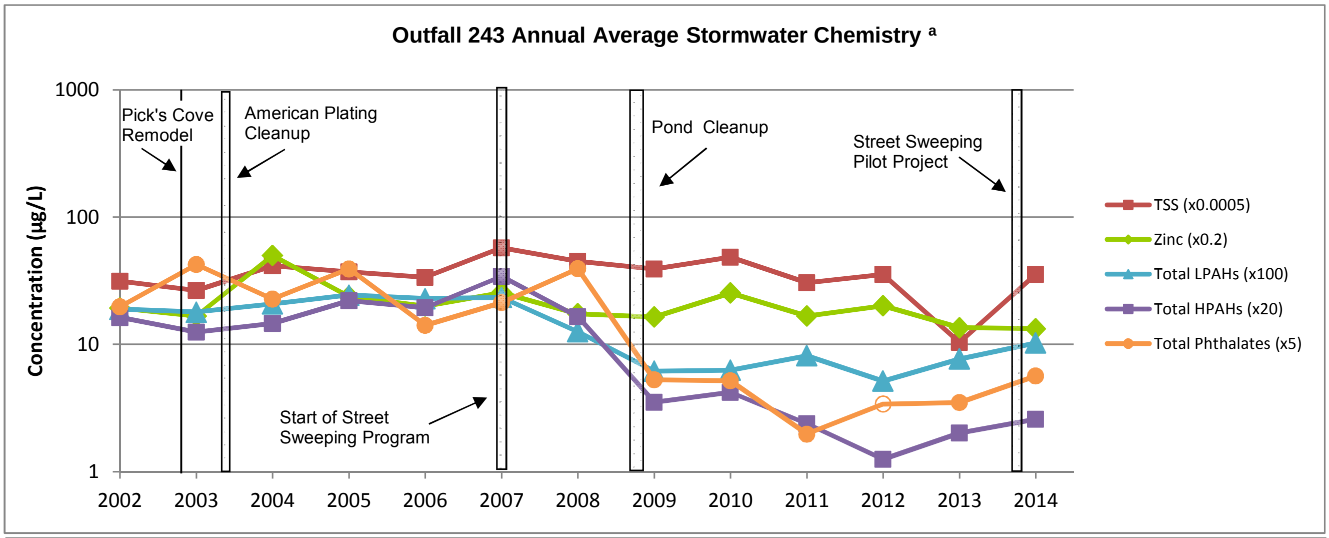
Notes:

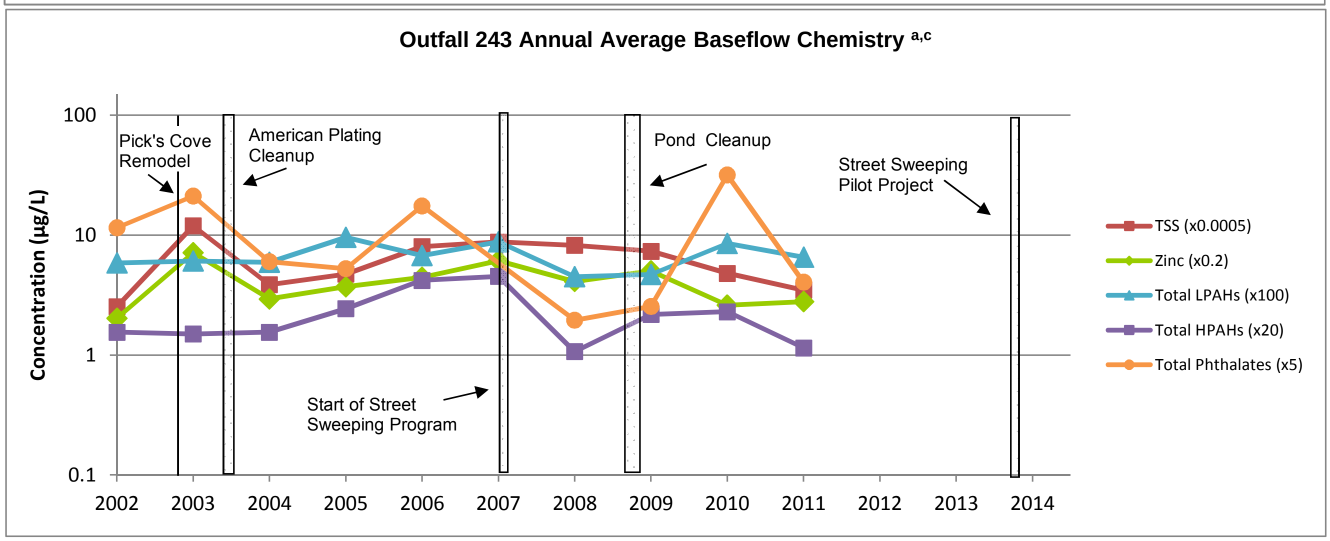
[a] Results shown are a product of chemistry data and an analyte-specific multiplier in order to display results on a common scale

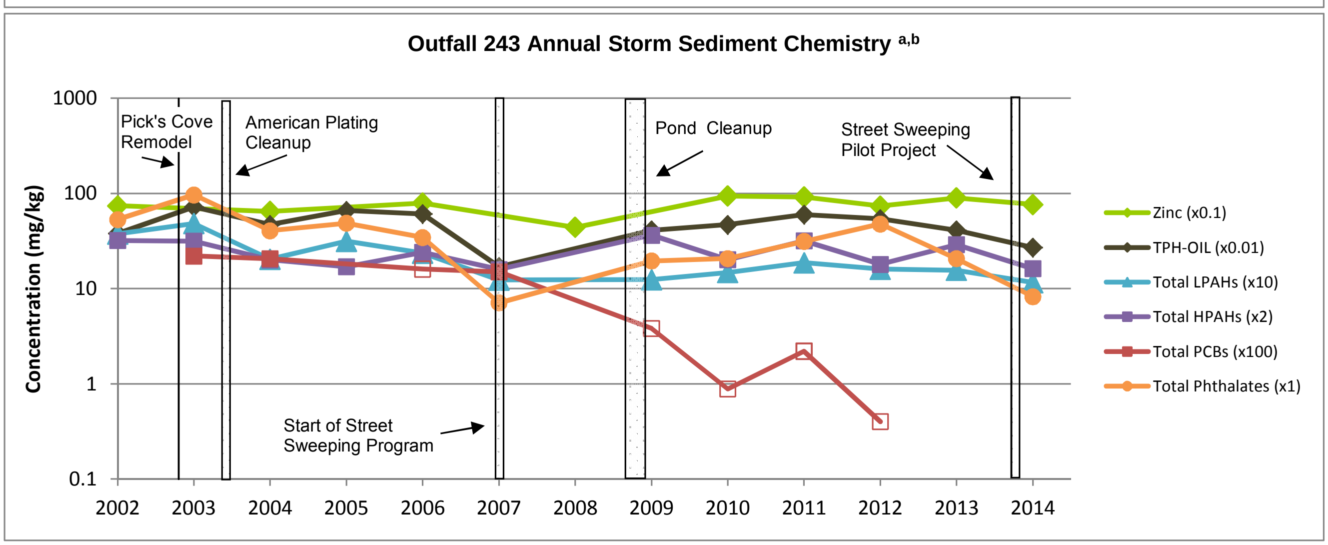
[b] Open symbols denote censored data; highest detection limit posted as value

[c] Baseflow sampling was discontinued after WY2011.

Figure 5-1.5
Analysis of Monitoring Trends in Stormwater, Baseflow, and Storm Sediment
OF243







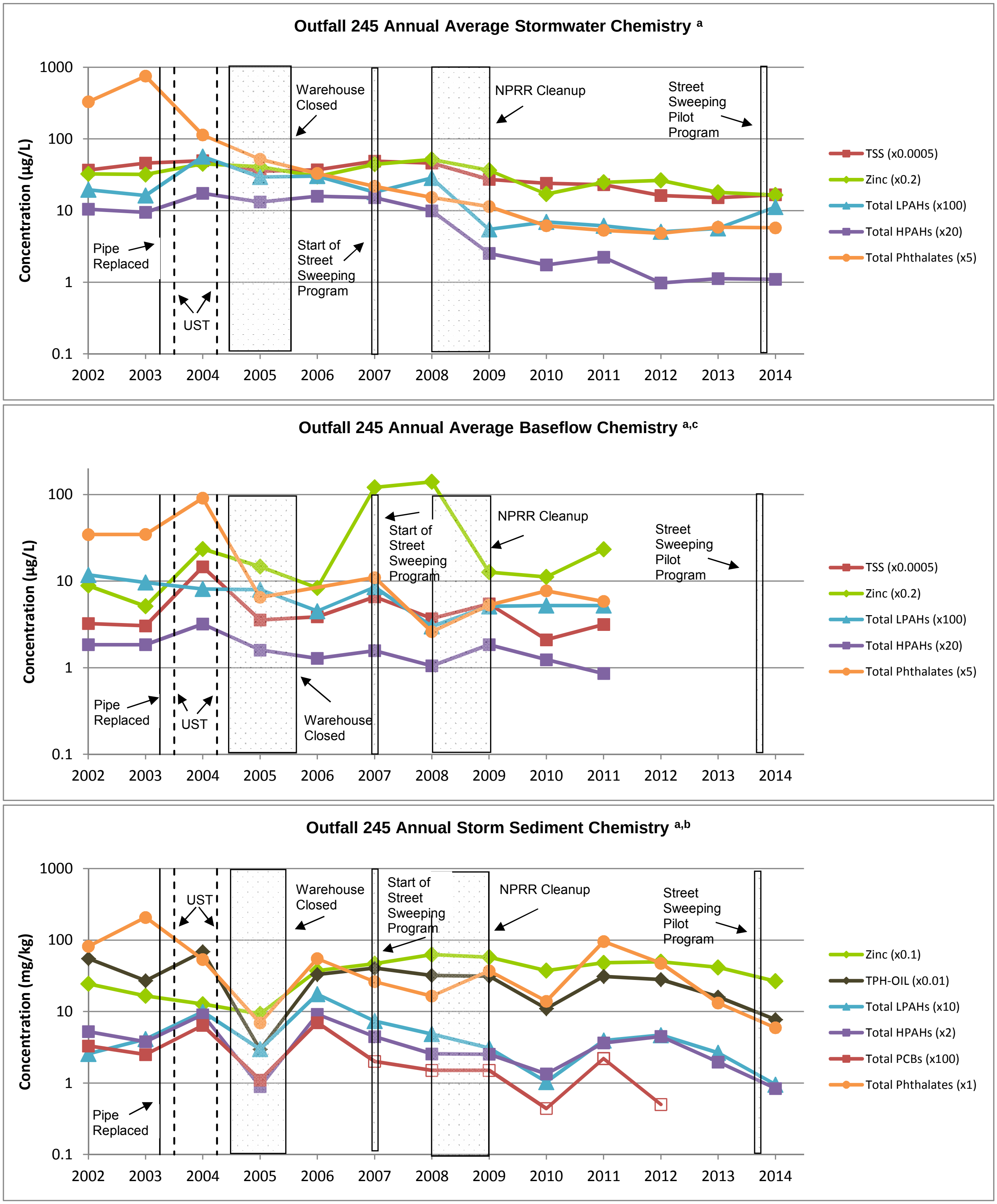
Notes:

[a] Results shown are a product of chemistry data and an analyte-specific multiplier in order to display results on a common scale

[b] Open symbols denote censored data; highest detection limit posted as value

[c] Baseflow sampling was discontinued after WY2011.

Figure 5-1.6
Analysis of Monitoring Trends in Stormwater, Baseflow, and Storm Sediment
OF245



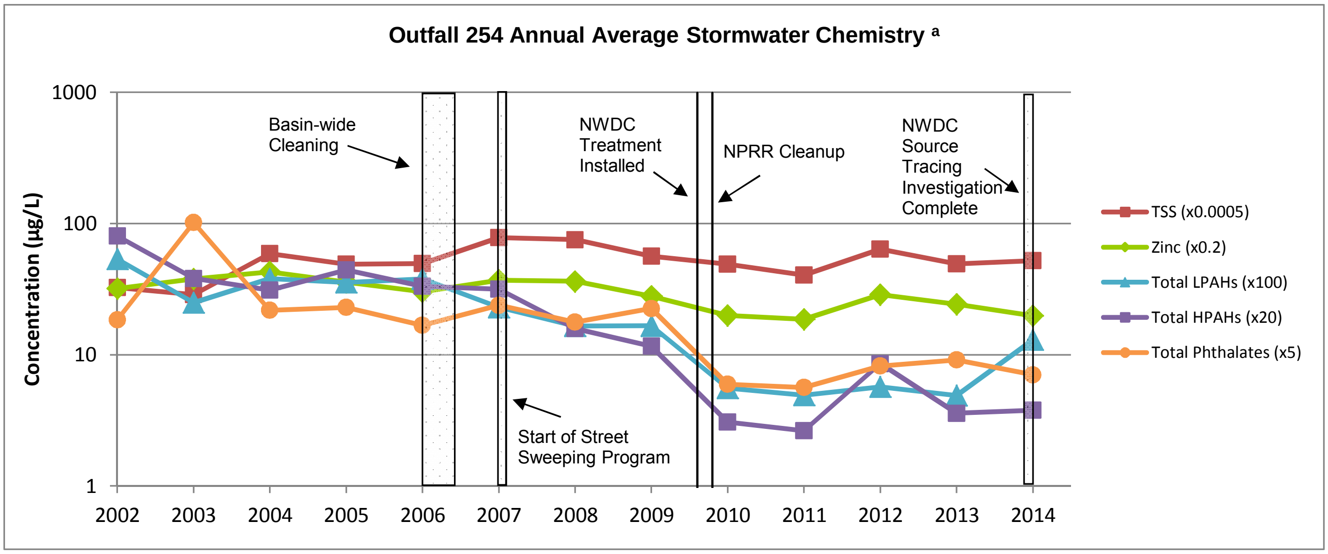
Notes:

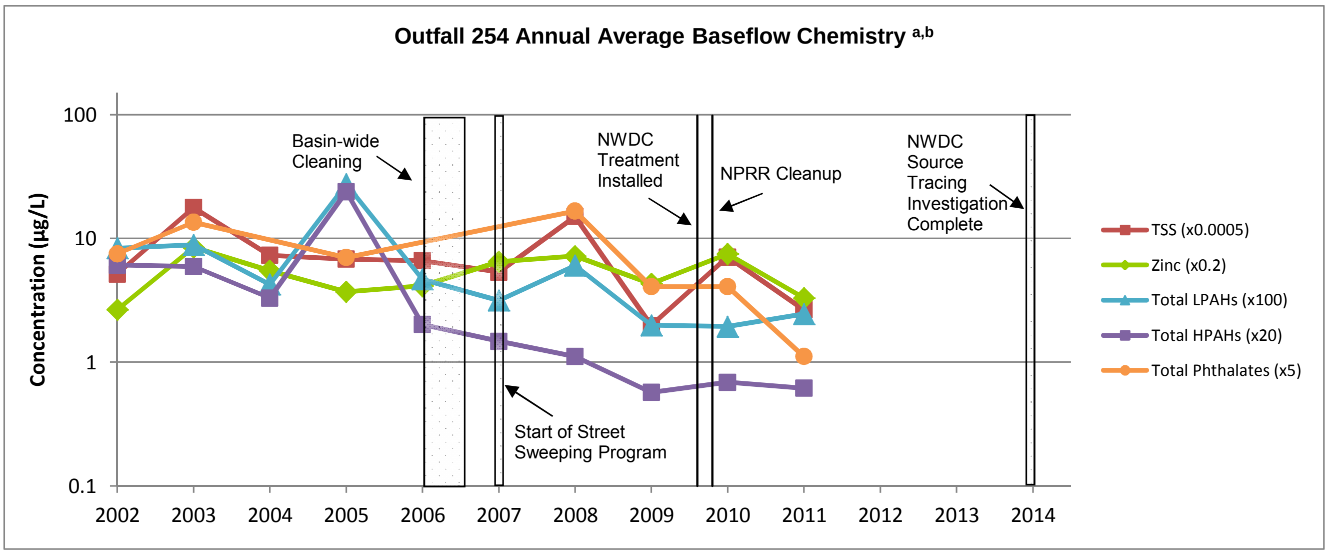
[a] Results shown are a product of chemistry data and an analyte-specific multiplier in order to display results on a common scale

[b] Open symbols denote censored data; highest detection limit posted as value

[c] Baseflow sampling was discontinued after WY2011.

Figure 5-1.7
Analysis of Monitoring Trends in Stormwater and Baseflow, and Storm Sediment
OF254





Notes:
[a] Results shown are a product of chemistry data and an analyte-specific multiplier in order to display results on a common scale
[b] Baseflow sampling was discontinued after WY2011.

Figure 5-2.1
Analysis of Monitoring Trends in Storm Sediment in OF230

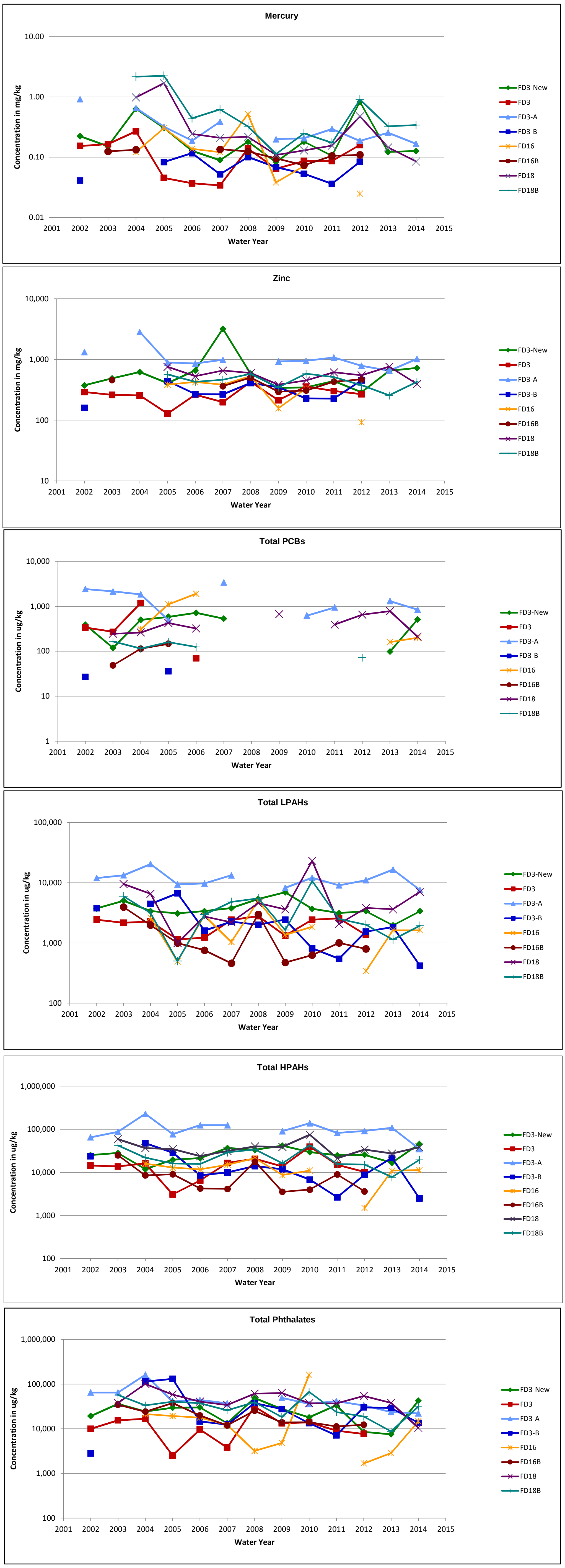


Figure 5-2.2
Analysis of Monitoring Trends in Storm Sediment in OF235

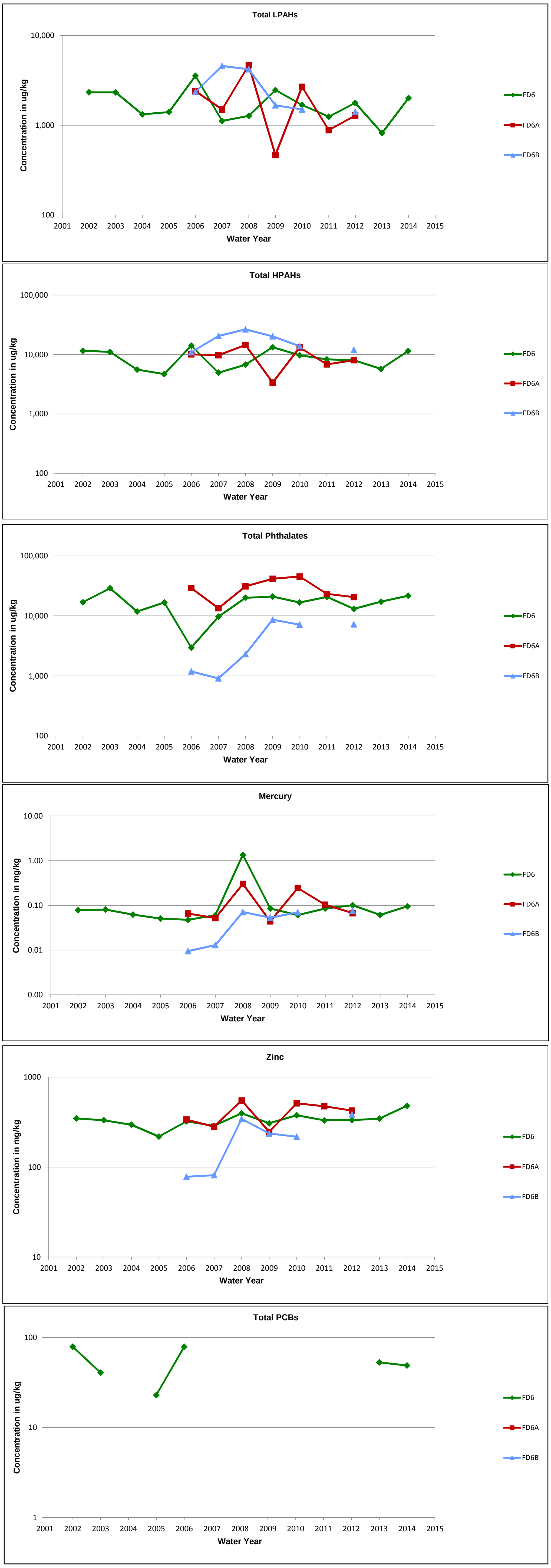


Figure 5-2.3
Analysis of Monitoring Trends in Storm Sediment in OF237A

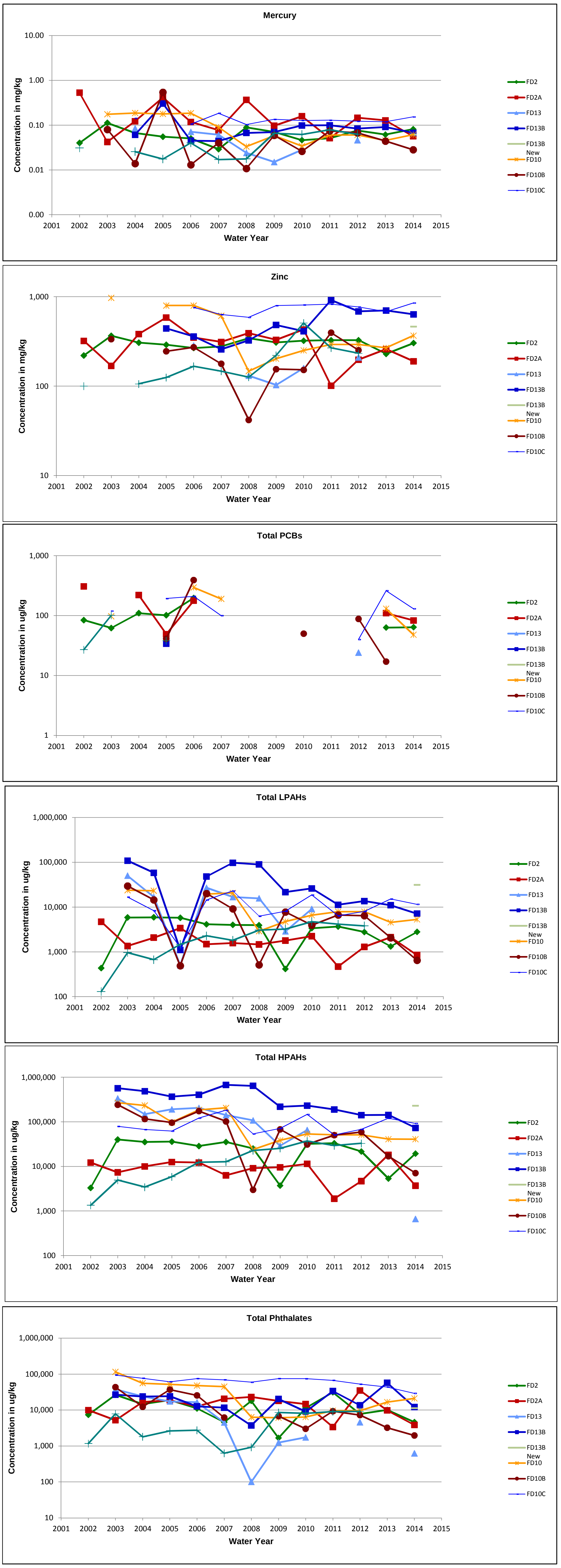


Figure 5-2.4
Analysis of Monitoring Trends in Storm Sediment in OF237B

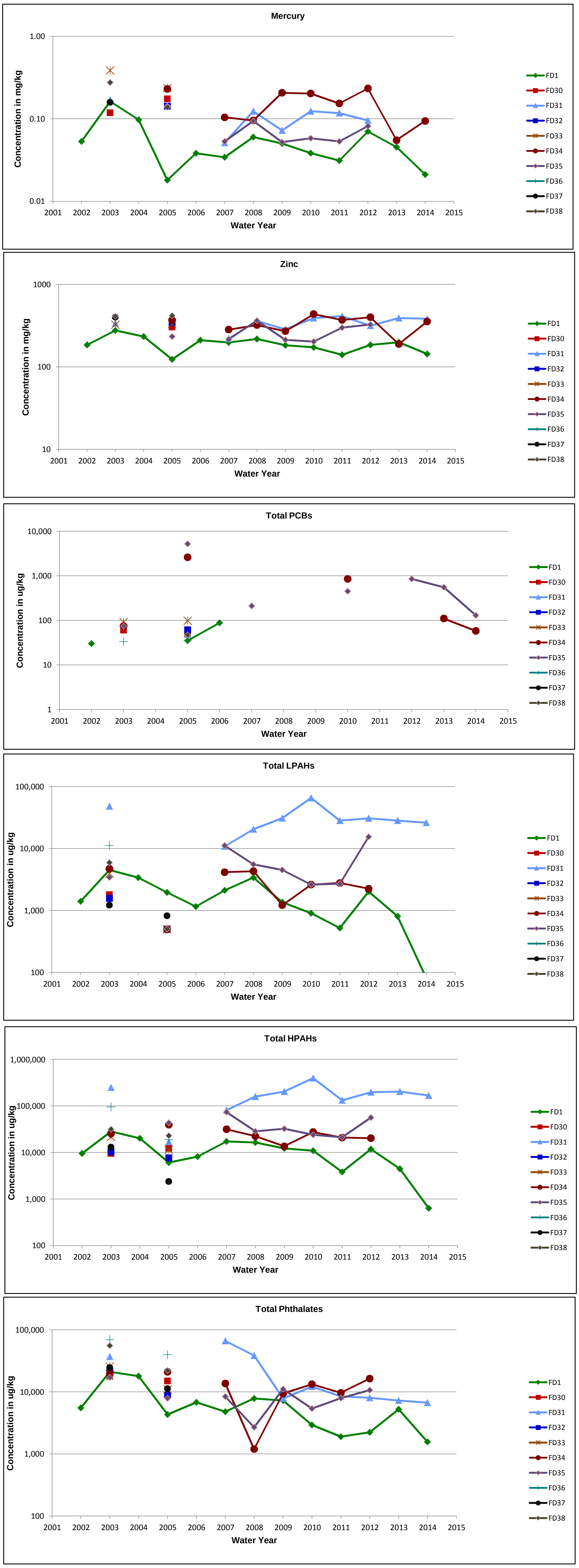


Figure 5-2.4 237b SedT Trend Charts_LOG.xls

Figure 5-2.5
Analysis of Monitoring Trends in Storm Sediment in OF243

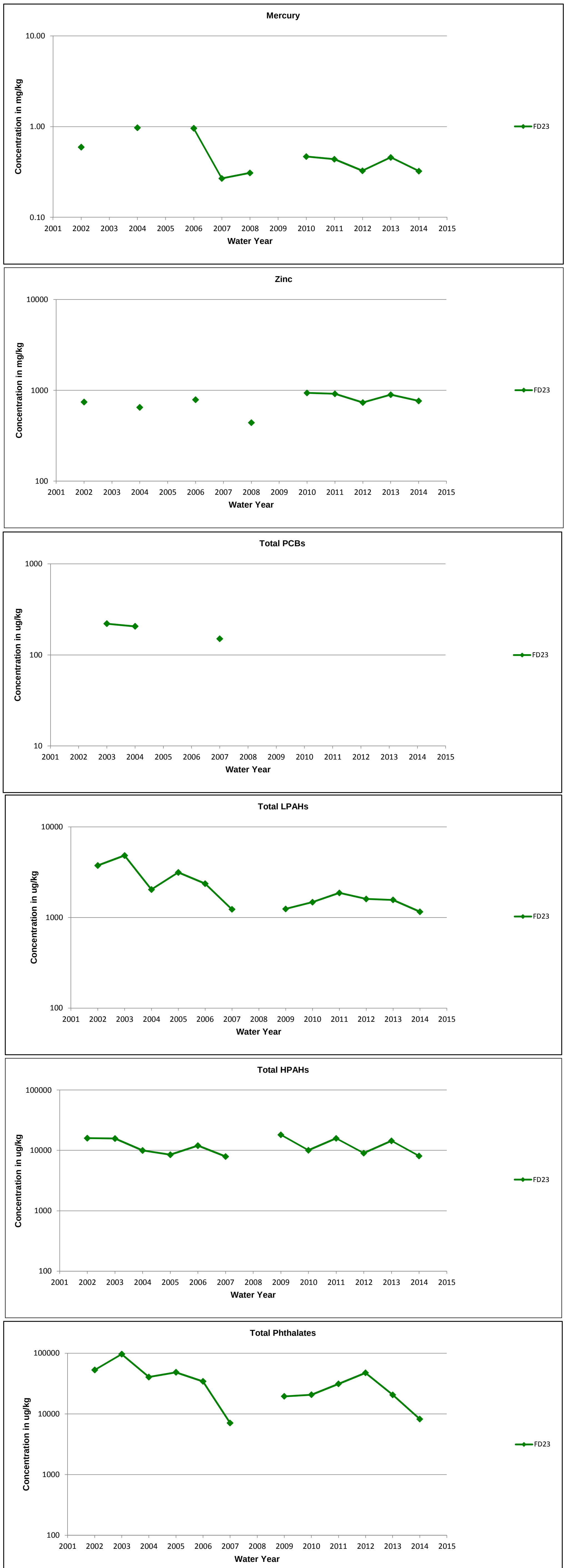


Figure 5-2.6
Analysis of Monitoring Trends in Storm Sediment in OF245