EXCELLENCE IN ENVIRONMENTAL CONSULTING SERVICES

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FINAL
BEST MANAGEMENT PRACTICES

AUTOMOTIVE REPAIR AND MAINTENANCE:

CADMIUM AND PAHS

Prepared for:

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EXECUTIVE SUMMARY

This Best Management Practices (BMP) document for the Automotive Repair and Maintenance Sector is one in a series of documents to identify BMPs to eliminate or reduce specific harmful pollutants potentially found in the wastewater of six industrial sectors in Ontario. These documents provide descriptive and hard number estimates of potential reductions from pollution prevention and treatment measures for specific pollutants of concern.

This document identifies BMPs which will assist operators to reduce operating costs, reduce contaminants sent to the sewer, comply with regulations and improve wastewater management. The BMPs have two components: pollution prevention (P2), activities which reduce or eliminate pollutants before they are discharged, and treatment, which uses a combination of physical, chemical and biological means to reduce the strength of the pollutant.

Municipal sewer use by-laws describe what compounds auto repair and maintenance owner/operators can release as wastewater to municipal sanitary sewers. This BMP document is a guide only; each facility is required to identify the most effective pollution prevention and treatment measures for their particular site.

Benefits of implementing BMPs, specifically pollution prevention measures, include but are not limited to, the following:

- Increased cost-effectiveness and lower long-term costs;
- Increased customer satisfaction;
- Social benefits, such as good community relations;
- Reductions in energy, water and materials used; and
- Reduced risk and liability.

Areas of interest

Cadmium and polynuclear aromatic hydrocarbons (PAHs) are found in wastewater effluents of the automotive repair and maintenance sector. It is important that owner/operators do everything practical to reduce the amount of these substances discharged into sewers.

Cadmium is most often found in motor vehicle oils; PAHs are in car exhaust as well as oils. Specific sub-sectors within the automotive repair and maintenance sector addressed by this BMP include Automotive Repair and Maintenance (NAICS 8111); Automotive Body, Paint and Interior Repair and Maintenance (NAICS 811121); and Car Washes (NAICS 811192).[1]

In developing the BMP guidance documents, three final wastewater concentrations were identified as reference criteria for each of PAHs and cadmium ranging from weakest to strongest. To give owner/operators a better sense of how BMPs would help them achieve

[1] North American Industry Classification System (NAICS) used by Statistics Canada.

these wastewater concentrations, a percentage reduction was assigned to each BMP. This percentage reduction came from references from others who have implemented the BMP within the auto repair and maintenance sector or from facilities in other sectors who have implemented similar measures at their facilities.

The final wastewater concentrations (reference criteria) are shown in Table ES.1.

Table ES.1 Reference Criteria for Substances in the Automotive Repair and Maintenance Sector

Substance	Reference Criteria 1 (mg/L)	Reference Criteria 2 (mg/L)	Reference Criteria 3 (mg/L)
Cadmium	0.0006	0.02	1
PAHs	0.00028	0.005	0.005

Table ES.2 shows the types of BMPs that could be considered for implementation:

Table ES.2 Summary of Pollution Prevention (P2) Measures

Substance Addressed	Sub-sector Addressed	BMP Name	Potential Reduction of Substance
Both PAHs & Cadmium	Automotive Repair and Maintenance Automotive Body, Paint, and Interior Repair and Maintenance	Green purchasing practices • requesting less-toxic alternative cleaning products • buying from suppliers who accept materials/ containers back for recycling.	10-40 %
Cadmium	Automotive Repair and Maintenance Automotive Body, Paint, and Interior Repair and Maintenance	Material Substitution • select cadmium-free solder, whenever possible	50-75 %
PAHs	All sub-sectors	Use low aromatic micro emulsions for degreasing	50-75 %
Both PAHs & Cadmium	Automotive Repair and Maintenance Automotive Body, Paint, and Interior Repair and Maintenance	Implement measures to minimize wastewater potential • Use dry vacs and sweeping	10-40 %
Both PAHs & Cadmium	Automotive Repair and Maintenance Automotive Body, Paint, and Interior Repair and Maintenance	Storage and containment • Store oils, solvents and other such materials with proper spill containment.	10-30 %
Both PAHs & Cadmium	Automotive Repair and Maintenance Automotive Body, Paint, and Interior Repair and Maintenance	Storage and disposal practices for used motor oil and used oil filters	10-30 %
Both PAHs & Cadmium	Automotive Repair and Maintenance Automotive Body, Paint, and Interior Repair and Maintenance	Prevent solvent loss • Install drip pans, drain boards, and drying racks to be able to collect solvent for reuse.	10-40 %

Table ES.2 (cont'd) Summary of Pollution Prevention (P2) Measures

Substance Addressed	Sub-sector Addressed	BMP Name	Potential Reduction of Substance
Both PAHs & Cadmium	Automotive Repair and Maintenance Automotive Body, Paint, and Interior Repair and Maintenance	Address spill response and clean-up	10-30 %
Both PAHs & Cadmium	Automotive Repair and Maintenance Automotive Body, Paint, and Interior Repair and Maintenance	Operating practices for service bays • Make effective use of drip pans • Avoid hosing down spills	10-30 %
Both PAHs & Cadmium	Car washes	Place proper signage throughout the facility directing activities to be followed	10-30 %
Both PAHs & Cadmium	Car washes	Chemicals storage • Store chemicals labelled in proper containers	
Cadmium	Automotive Repair and Maintenance Automotive Body, Paint, and Interior Repair and Maintenance	Change the surface preparation and resurfacing operations • Minimize wet sanding practices and use dustless vacuum sanders.	10-30 %
Both PAHs & Cadmium	Automotive Repair and Maintenance Automotive Body, Paint, and Interior Repair and Maintenance	Management and Staff Training	1-30 %
Both PAHs & Cadmium	Car Washes	Management and Staff Training	1-30 %

Achieving final wastewater concentrations

Combinations of P2 measures and treatment processes needed to achieve the three final wastewater concentrations were developed using estimates and engineering judgment. Table ES.3 summarizes key BMPs that provide examples of reduction of contaminants through P2 measures.

Table ES.3 Summary of Effectiveness of BMPs

Substance Addressed	BMP Name	BMP Number
Elimination/ Reduction Effectiveness: 50-75%		
Cadmium	Material Substitution	BMP #1
Cadmium	Green Purchasing Practices	BMP #2
PAHs	Degreasing with low aromatic micro emulsions	BMP# 3
Operating Procedures and Housekeeping Effectiveness: 20% of the remaining substance after substitution		
Cadmium &PAHs	Minimize Wastewater Potential	BMP #4
Cadmium &PAHs	Operating Practices for service bays	BMP #9
Cadmium &PAHs	Chemical storage	BMP #11
Education & Training Effectiveness: 2 % of the remaining substance after substitution		
Cadmium &PAHs	Management and Staff Training	BMP #13, 14

In order to determine which combination of BMPs is required to achieve the final wastewater concentration, a typical incoming concentration was determined (refer to the Tables in Section 5). Cost ranges for capital and operating costs were also estimated. Cost estimates for implementation of pollution prevention measures are based on the number of persons employed at the facility, which was used to estimate percent of operating budget required for implementation. Cost estimates for treatment systems that are needed in conjunction with P2 measure to achieve the reference criteria were based on a range of wastewater flow rates assumed for the sector. Table ES.4 provides a summary of costs for selected P2 BMPs and Table ES.5 provides a summary of costs for selected treatment BMPs.

Table ES.4 Estimated Pollution Prevention Costs (for selected P2 BMPs)

Type of P2 Measure	Pollution Prevention Costs	
	Small Facilities (5 Staff)	**Medium Facilities (25 Staff)**
Pollution Elimination or Reduction	negligible	negligible
Operating/ Housekeeping	$ 10,000 annually	$ 20,000 annually
Education and Training	$ 4,000 annually	$ 8,000 annually
Total Estimate	$ 14,000 annually	$ 28,000 annually

Note:
* Estimated annual costs for each P2 measure are approximations only; facility specific wastewater quality and operating practices must be assessed prior to selection of P2 practices.

Reference Criteria 3 are the least restrictive wastewater concentrations of the three reference criteria and require the least amount of treatment after implementation of P2 measures.

Table ES.5 Estimated Capital and Annual Operation and Maintenance Costs

Reference Criteria	Costs as Function of Flow Range of 1 m^3/h to 10 m^3/h					
	Capital Cost Range			Annual O&M Cost Range		
	0.1m^3/h	5 m^3/h	10 m^3/h	0.1m^3/h	5 m^3/h	10 m^3/h
Criteria 3	$37,000	$170,000	$318,000	$6,000	$20,000	$32,000
Criteria 2	$37,000	$170,000	$318,000	$6,000	$20,000	$32,000
Criteria 1	$359,000	$1,147,000	$1,724,000	$54,000	$138,000	$172,000

Note:

* Estimated annual costs for each process modification are approximations only; facility specific wastewater quality and operating practices must be assessed prior to selection of P2 practices.

Note that estimates are dependent on the incoming concentrations of NPE and cadmium prior to P2 measures and concentrations achieved after P2 measures. Thus, site-specific wastewater testing is necessary at all facilities to determine compliance with regulations and to implement appropriate measures.

For cadmium, it was determined that P2 measures alone could achieve two of the three final wastewater concentrations. For the most difficult concentration to achieve (reference criteria 1), a combination of P2 and the treatment method of deionization is required.

For PAHs, it was determined that for all three final wastewater concentrations, P2 in combination with treatment is required. Treatment would involve using granulated activated carbon (GAC) alone as the basic treatment option to meet Reference Criteria 3 and 2, or GAC followed by an advanced oxidation process (typically a combination of UV and ozone) to meet the lower wastewater concentrations for Reference Criteria 1. Refer to the Tables in Section 5 for details of treatment systems required and estimated cost ranges.

For further details on any of the above information, please consult the main body of this document.

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1. OVERVIEW OF THIS DOCUMENT

1.1 Objective and Audience

This document identifies best management practices (BMPs) to eliminate or reduce cadmium and polynuclear aromatic hydrocarbons (PAHs) in wastewater effluents of the automotive repair and maintenance sector. The benefits of undertaking the best management practices are also described. This BMP document is a guide only; site-specific analysis of each facility is required to identify the most effective pollution prevention and treatment measures.

This document is one in a series of documents to identify BMPs to eliminate or reduce specific harmful pollutants potentially found in wastewater effluents of six key industrial sectors in Ontario. Appendix A identifies the other industrial sectors and substances for which similar BMP documents have been developed.

The two primary audiences for this document are:

- **Municipal representatives** interested in assisting industrial facilities with sewer discharges to eliminate or reduce harmful pollutants.
- **Industrial facility representatives** interested in implementing BMPs to eliminate or reduce harmful pollutants, specifically:
  - Automotive repair operations that involve work or service for vehicles including: collision repair shops, mechanical repair shops, service stations, engine washing activities, oil change operations, auto detailing, vehicle dealerships, vehicle maintenance facilities, vehicle recycling operations, radiator repair shops, and/or towing businesses.
  - Facilities that have vehicle service bays and an oil/water separator that discharges effluent to a municipal sanitary sewer system.
  - Vehicle wash facilities including commercial car and/or truck and/or heavy equipment wash facilities, plus any other washing of vehicle exteriors, i.e. tunnel washes, rollover washes, and wand washes.

Appendix B identifies assessment form templates for use by municipal representatives and self-assessment templates for use by representatives of this sector.

Specific sub-sectors within the automotive repair and maintenance sector addressed within this document include:

- Automotive Repair and Maintenance (NAICS[2] 8111);

[2] North American Industry Classification System (NAICS) used by Statistics Canada. The NAICS is an industry classification system developed by the statistical agencies of Canada, Mexico and the

- Automotive Body, Paint and Interior Repair and Maintenance (NAICS 811121); and
- Car Washes (NAICS 811192).

Definitions for these sub-sectors are provided in Appendix C.

The harmful pollutants addressed in this series of BMP documents have been identified at both the federal and provincial government levels, as part of on-going initiatives to limit the effect of wastewater discharges on receiving waters. Appendix D provides a list of agreements and programs, as well as substances identified by the Ontario MOE to be of particular concern under these or other initiatives.

1.2 Benefits of Implementing Pollution Prevention

In addition to reductions in pollutants released to water, air, and soil, implementation of pollution prevention best management practices and high quality environmental performance has numerous benefits, including:

- Increased cost-effectiveness and lower long-term costs through implementation of pollution prevention measures in a planned, holistic manner;
- Increased customer satisfaction through meeting expectations for goods and services to be produced in an environmentally responsible manner;
- Social benefits, such as good community relations and potential endorsement of facility efforts and activities;
- Reductions in energy, water, and materials used, with associated operating cost savings;
- Compliance with federal and municipal regulations;
- Reduced risk and liability resulting from regulatory non-compliance, spills, and environmental emergencies;
- Increased innovation through process and materials improvements and supply chain communication;
- Better return on investment for shareholders;
- Health and safety benefits through reduced worker exposure; and

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United States. Created against the background of the North American Free Trade Agreement, it is designed to provide common definitions of the industrial structure of the three countries and a common statistical framework to facilitate the analysis of the three economies. http://www.statcan.ca/english/Subjects/Standard/naics/2002/naics02-intro.htm (accessed December 20, 2005)

- Higher public approval ratings and improved corporate reputation.

A study of the relationship between environmental performance and financial performance,[3] using the Standard & Poor's 500 Index (S&P 500), compared the financial performance of "low polluter" portfolios to industry-matched "high polluter" portfolios. The study found that the "low polluter" portfolio performed as well as - and often better than - the "high polluter" group. Investors who chose the environmental leaders in an industry-balanced portfolio were found to do as well (or better) than those choosing the environmental laggards in each industry. According to the study, a portfolio that tracked the S&P 500 and included only the environmental leaders in each industry category would be expected to meet or exceed the market returns of the S&P 500. The study concluded that greener firms are performing as well as, or better than, their more polluting counterparts.

Literature references on pollution prevention do not generally quantify benefits and cost savings resulting from implementation of P2 measures. Individual case studies, however, often do identify cost savings and benefits. Refer to Appendix E, Case Study Examples Demonstrating Benefits of P2 Measures for case studies of facilities that have documented the benefits of implementing P2 measures while, at the same time, reducing releases of hazardous substances.

1.3 Methodology

This BMP document was developed by a consultant team with the advice of a Steering Committee of provincial and municipal representatives. A detailed review of literature was conducted by the consultant team to identify available information on specific substance–sector combinations. Sector specialists and other representatives identified through the literature review were contacted for additional information and to obtain recent data, where available. Engineering estimates and consultant team expertise also supported the analysis and development of the BMP documents.

A number of estimating procedures or assumptions were made to support the development of options and costs for both the pollution prevention and the treatment measures. These estimating procedures were developed through available data and consultant team expertise. Refer to Section 3 and 4 for brief outlines of the estimating procedures made for pollution prevention and treatment effectiveness and costs.

1.4 How to Use This Document

In addition to this introductory section, this BMP document consists of the following sections:

[3] Environmental and Financial Performance: Are They Related? M. A. Cohen, S. A. Fenn, S. Konar, Vanderbilt University, Nashville, TN, 1997 (URL http://sitemason.vanderbilt.edu/files/d/dLwFkQ/Environmental%20and%20Financial%20Performance.pdf, accessed January 2006)

- **Section 2, Background**, provides information on the use of substances of interest in the sector, reference criteria targets used to analyze and develop the BMPs and reporting requirements for the substances.

- **Section 3, Pollution Prevention**, identifies pollution prevention (P2) options, including operating, housekeeping, training and education opportunities and suggestions. Identifies specific combinations of P2 practices, including estimates of implementation costs.

- **Section 4, Treatment**, identifies the specific combinations of treatment (assuming the combinations of P2 measures identified in Section 3 are implemented) to achieve the three reference criteria levels, including underlying assumptions for the reduction analyses.

- **Section 5, Options for Reduction of Substance concentrations in Effluents,** summary tables of the P2 and treatment measures identified in Sections 3 and 4.

- **Section 6, References**, identifies key reference documents used in the development of this BMP document.

- **Section 7, Glossary**, defines terminology and acronyms used in the document.

- **Appendices** provide information on other documents in this series, templates for assessment of facilities, sector definitions, a list of harmful substances of particular interest, and case studies.

Once having read this document, practitioners are encouraged to:

- Assess the concentration of identified substances in the effluent of their facility versus the three reference criteria analyzed (Section 2.2).

- Identify potential sources of these substances in their effluent and assess pollution prevention and treatment options, as well as broader management practices (Sections 3 and 4).

- Review the estimating procedures and assumptions stated in Sections 3 and 4 and information presented in the Tables of Section 5 for an indication of measures that could potentially be implemented to meet the target reference criteria.

- Refer to municipal sewer use by-laws or other requirements applicable to the facility with respect to control requirements for the substances.

- Refer to the companion template documents that provide guidance on assessment (for municipal representatives) and self-assessment (for industrial representatives) of facilities.

2. BACKGROUND

2.1 Use of the Substances of Interest in This Sector

For the purposes of assessing the effectiveness of pollution prevention measures and treatment technologies, representative raw wastewater concentrations of the substances addressed in this document have been estimated as summarized in Table 2.1. The raw wastewater concentrations in Table 2.1 were determined from an extensive review of available data for the automotive repair and maintenance sector. In the data reviewed, concentrations of pollutants in wastewaters for this sector varied greatly. Each facility should assess its wastewater components, as the compounds listed in Table 2.1 may be found at higher, lower or negligible concentrations, depending on operating conditions and existing pollution prevention and treatment practices.

Table 2.1 Wastewater Concentrations in the Automotive Repair and Maintenance Sector

Substance	Representative Concentration in Wastewater (prior to pollution prevention or treatment) (mg/L)
Cadmium	0.026
PAHs	1

This BMP document addresses specifically the compounds listed in Table 2.1. Other compounds that may be present in the wastewater should be identified as they may be reduced by practices identified herein or by other practices.

2.1.1 Cadmium

Cadmium and its compounds have been declared toxic substances under Section 64 of the *Canadian Environmental Protection Act, 1999* (CEPA 1999), and added to the List of Toxic Substances in Schedule 1 of CEPA 1999.

In the automotive repair and maintenance sector, cadmium is mainly found in motor oil. A study found that virgin motor oil had negligible levels of cadmium (<4 µg/L-oil), which suggests that cadmium accumulates in motor oil during use. Improper disposal practices of used motor oil, such as dumping in the sanitary sewer or storm drain system or simply pouring used oil on the ground, can result in cadmium making its way into sanitary and combined sewers. Cadmium in municipal sewers has also been traced to car wash enterprises.[4] Accumulated sediments in car wash wastewater may have contaminants that reach concentrations where the sludge

[4] Ontario Ministry of the Environment, Potential Industrial, Commercial & Institutional Sources of Harmful Pollutants to Municipal Sewage Treatment Plants via Sanitary Sewer

is considered a regulated waste. In addition, the wastewater may include metals, elevated levels of oil and grease, and unacceptable levels of acidity or alkalinity.[5]

In two studies, 75% of wash water from brake washing tested positive as hazardous wastes because of their lead and cadmium concentrations.[6] Cadmium is found in engine parts and vehicle surfaces. In engines, there is inevitably some exposure of the oil to products of internal combustion, and rubbing of metal engine parts inevitably produces some microscopic metallic particles from the wearing of the surfaces. On vehicle surfaces, cadmium is an integral part of the steel and painted material. Cadmium is soluble and binds in oily waste. If exposed to water, the oily waste containing cadmium will emulsify in the water.

Cleaning wastes can be hazardous due to the nature of the solvent or from the contaminants in the soils washed from the vehicle parts. Besides oil and grease removed from the part, heavy metal contamination from cadmium, lead, or other metals may cause solvent streams to become hazardous wastes when their useful life is over.[7]

Surface preparation and resurfacing operations conducted on vehicles are typical of activities undertaken at automotive repair facilities. Research has shown that sanding dust contains toxic metals, such as lead, arsenic, cadmium, and chromium.[8] Table 2.2 illustrates where cadmium can be found in the automotive repair and maintenance sector.

Table 2.2 Cadmium in the Automotive Repair and Maintenance Sector

Sub-sector	Where cadmium may be found in the Automotive Repair and Maintenance Sector
Automotive Repair and Maintenance (NAICS 8111)	Improper disposal practices of motor oil, oil filters; Brake washing (waste aqueous solutions); and Parts cleaning (cleaning wastes).
Automotive Body, Paint and Interior Repair and Maintenance (NAICS 811121)	Surface preparation and resurfacing operations; and Parts cleaning (cleaning wastes).
Car Washes (NAICS 811192)	Oily material washed from vehicles.

It is assumed in this BMP that undertaking the practices for managing oil wastes will result in reducing cadmium levels in the wastewater discharge.

[5] Canadian Petroleum Products Institute - http://www.cppi.ca/tech/BMPwash.pdf
[6] U.S. EPA, Region 9 - http://www.epa.gov/region09/cross_pr/p2/autofleet/profit.pdf
[7] Pollution Prevention Institute, Kansas State University - http://www.sbeap.org/ppi/publications/ppi_automanual.pdf
[8] Rhode Island Department of Environmental Management - http://www.dem.ri.gov/programs/benviron/assist/abdycert/workbook.pdf

2.1.2 Polynuclear Aromatic Hydrocarbons (PAHs)

Polynuclear aromatic hydrocarbons (PAHs) are largely produced through the combustion or pyrolysis of organic matter, such as oil, wood, tobacco, coal, petroleum, or garbage. PAHs can combine with dust particles in the air and can be carried into water and soil. Because of its presence in diesel engine exhaust, it will be assumed that 7H-dibenzo(c,g)carbazole can also be found in the effluents from car washes. Benzo(j)fluoranthene is found in gasoline, crude oil, coal tar, wood preservative sludge, and exhaust condensate of gasoline engines. It may also be present in car wash effluent. Dinitropyrenes are emitted as gaseous or absorbed into particulate matter during the process of incomplete combustion of organic compounds, such as fossil fuels. They are specifically known to survive the diesel combustion process within a diesel engine and can be released as particulate in the exhaust. They may also be found in car wash effluents. Perylene is found in crude oil, gasoline, the exhaust condensate of gasoline engine, lubricating motor oils, coal tar, and bitumen. It may also be found in car wash effluents.[9]

PAHs have been declared toxic substances under Section 64 of the *Canadian Environmental Protection Act, 1999* (CEPA 1999), and added to the List of Toxic Substances in Schedule 1 of CEPA 1999.

The sources of PAHs, which may discharge directly into aquatic environment, include accidental spillage and/or leakage of PAH-containing fluids (e.g., waste oils, gasoline, etc.), and industrial and domestic wastewaters. Non-stationary sources of PAHs usually refer to automobiles or other vehicles, which use petroleum products as a fuel. Temperatures within an internal combustion engine are often sufficient enough to convert a fraction of the fuel or oil into PAHs via pyrolysis. These compounds are then emitted to the atmosphere through exhaust fumes, whereupon they sorb onto particulates. Most PAHs are then degraded by sunlight or are deposited onto street surfaces. Precipitation then washes these PAHs into stormwater drainage systems eventually flushing them into the aquatic environment.[10]

In one study, effluent wastewaters from a large number of automatic vehicle washing facilities in Göteborg were analysed for conventional parameters (COD[11], oil content) and for individual organic pollutants. Dirt/dust particles and traffic grime contributed to a large extent to the origin of PAHs in the effluent wastewater. [12]

Table 2.3 illustrates where PAHs can be found in the automotive repair and maintenance sector.

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[9] Ontario Ministry of the Environment, Potential Industrial, Commercial & Institutional Sources of Harmful Pollutants to Municipal Sewage Treatment Plants via Sanitary Sewer

[10] British Columbia Ministry of Environment, Lands and Parks, http://wlapwww.gov.bc.ca/wat/wq/BCguidelines/pahs/pahs-03.htm

[11] Chemical oxygen demand

[12] Article by Nicklas Paxéus, Vehicle Washing as a Source of Organic Pollutants in Municipal Wastewater (copyright)

Table 2.3 PAHs in the Automotive Repair and Maintenance Sector

Sub-Sector	Where PAHs may be found in the Automotive Repair and Maintenance Sector
Automotive Repair and Maintenance (NAICS 8111)	Improper disposal practices of motor oil, oil filters; Brake washing (waste aqueous solutions); Parts cleaning (cleaning wastes); and Spillage and/or leaking of PAH-containing fluids.
Automotive Body, Paint and Interior Repair and Maintenance (NAICS 811121)	Parts cleaning (cleaning wastes).
Car Washes (NAICS 811192)	Oily material washed from vehicles.

PAHs are one of the pollutants referenced in the Canadian Petroleum Products Institute (CPPI) Automotive Repair Operations BMP and the practices listed in this BMP will assist operators in minimizing the effects of their operations on the quantity and quality of wastewater and contaminants discharged to sewers. It is assumed in this BMP, that undertaking the practices for managing oil wastes will result in reducing PAHs levels in the wastewater discharge.

2.2 Reference Criteria for Concentrations of Substances of Interest in Discharges to Sewers

This sub-section identifies the reference criteria for substances of concern. In developing the BMP guidance documents, three reference criteria were considered with respect to final effluent concentrations for harmful substances. In Table 2.4, Reference Criteria 1 are the most stringent; that is, Reference Criteria 1 are the lowest reference criteria, whereas Reference Criteria 3 are the least stringent reference criteria. Due to the methodology applied to develop the reference criteria, as elaborated below, two of the three reference criteria are the same in several instances.

Table 2.4 Reference Criteria for Substances in the Automotive Repair and Maintenance Sector

Substance	Designation	Reference Criteria 1 (mg/L)	Reference Criteria 2 (mg/L)	Reference Criteria 3 (mg/L)
Cadmium	COA* Tier II	0.0006	0.02	1
PAHs	COA Group for Elimination	0.00028	0.005	0.005

Notes:
* COA: Canada-Ontario Agreement respecting the Great Lakes Basin Ecosystem

The *Canadian Environmental Protection Act, 1999* (CEPA) is the cornerstone of the Government of Canada's environmental legislation aimed at preventing pollution and protecting the environment and human health. CEPA recognizes the contribution of pollution prevention and the management and control of toxic substances and

hazardous waste to reducing threats to Canada's ecosystems and biological diversity. CEPA acknowledges the need to virtually eliminate the most persistent toxic substances that remain in the environment for extended periods of time before breaking down, and bioaccumulative toxic substances that accumulate within living organisms.

From a regulatory perspective, pollution prevention planning becomes one of the tools Environment Canada risk managers can use to address Schedule 1 CEPA toxic substances. Facilities that use Schedule 1 CEPA toxic substances should be aware of the impact that CEPA may have on them.

Reference Criteria 1

Substances identified in the Canada-Ontario Agreement respecting the Great Lakes Basin Ecosystem (COA) are either Tier I substances, subject to virtual elimination, or Tier II substances, targeted for reduction. Column 2 of Table 2.4 identifies substances subject to the COA. For substances identified in the COA, Reference Criteria 1 are the more stringent of the Recommended Method Detection Limit (RMDL) or the Provincial Water Quality Objective (PWQO).

For other substances not subject to COA, Reference Criteria 1 are the more stringent of 20 times the PWQO or 20 times the RMDL.

Reference Criteria 2

Reference Criteria 2 were established by the minimum values identified in municipal sewer use by-laws in Ontario for the identified substances. In cases where the sewer use by-law limit was the same as the PWQO or RMDL, Reference Criteria 2 are the same as Reference Criteria 1.

Reference Criteria 3

Reference Criteria 3 were established by the median values identified in municipal sewer use by-laws in Ontario for the identified substances. In cases where only one by-law identified a limit for the substance, or where the same limit was identified in all by-laws, Reference Criteria 3 are the same as Reference Criteria 2.

2.3 Select Regulatory Requirements for the Substances Addressed

Toxic and hazardous substances may be subject to several regulations at the federal, provincial, and municipal levels, in addition to international agreements and protocols. It is incumbent on owners and operators of industrial facilities to be knowledgeable of all management and reporting requirements for specific substances used in, produced by, transported to and from, or otherwise used at, or released from, their facilities and operations.

The following section is intended as a guide only regarding specific regulations. Proponents are advised to consult these regulations directly to ensure they have all information they require. Requirements discussed in this section include municipal

sewer use by-laws, the National Pollutant Release Inventory (NPRI) and the federal Environmental Emergency requirements.

Municipal Sewer Use By-laws

The majority of municipalities in the province of Ontario have municipal sewer use by-laws. A wide range of materials, chemicals, and conditions for discharge are identified in the sewer use by-laws with corresponding objectives that may include the following:[13]

- Protection of the environment;
- Protection of municipal staff and infrastructure;
- Efficient use of the system;
- Prevention of stormwater and 'clear' water from entering the system;
- Protection of sludge or biosolids quality; and
- Protection of public health and safety and protection of public property.

Some municipal sewer use by-laws include an option for entering into over-strength agreements with industrial dischargers, although these agreements are typically limited to substances intended for treatment by the community wastewater treatment facility and do not include the toxic substances addressed in this document. Some municipal sewer use by-laws also require pollution prevention planning and reporting by industrial facilities. Proponents are encouraged to access the municipal sewer use by-law pertaining to the community sewer system into which they discharge to ensure they are in compliance with all discharge and reporting requirements of the by-law.

Canada's National Pollutant Release Inventory (NPRI)

The NPRI has several reporting thresholds, including number of employee hours, quantities and concentrations of reportable substances manufactured, processed or otherwise used, with requirements pertaining to specific cases where substances are produced as by-products. Practitioners are encouraged to reference the NPRI website[14] directly for the most recent reporting requirements, including reportable substances and reporting thresholds, as these may change over time. There are over 330 substances and substance groups reportable under NPRI; Table 2.5 identifies the substances of interest for this BMP document.

[13] Review of Existing Municipal Wastewater Effluent (MWWE) Regulatory Structures in Canada, Marbek Resource Consultants for the Canadian Council of Ministers of the Environment (CCME), 2005

[14] NPRI website: http://www.ec.gc.ca/pdb/npri/npri_home_e.cfm

Table 2.5 NPRI Reporting Requirements (2003) for Substances in the Automotive Repair and Maintenance Sector

Substance	NPRI Reportable Substances	NPRI Part Designation	Reporting Threshold
Cadmium	Cadmium and its compounds	Part 1B	5 kg
PAH's	Specific cogeners	2 congeners in Part 1A; 17 congeners in Part 2	10 tonnes for 2 Part 1A cogeners; 50 kg total for Part 2 congeners

The NPRI has various reporting criteria. The first of which, employee criteria, has a threshold of 20,000 hours. Given that many facilities in the automotive repair and maintenance sector have fewer than 12 full time employees it is unlikely that this criterion would be met. If the employee criterion was met then a determination of the mass and concentration levels would occur. To be reportable, the mass and concentration levels for cadmium used at the facility must exceed 5 kilograms and 0.1%, respectively. Because the PAHs from the automotive repair and maintenance sector are only used and not manufactured, they are not reportable to NPRI.

Federal Environmental Emergency (EE) Regulation

Environmental Emergency (EE) Regulations under Part 8 of the CEPA 1999, promote prevention and planning for preparedness, response and recovery. Neither of the two substances discussed in this document are identified in the federal emergency regulation at this time. Practitioners are encouraged to reference the regulatory requirements at Environment Canada's website.[15]

MOE Spills Action Centre

When a spill occurs, it is the responsibility of the owner and the person who had control of the pollutant at the time it was spilled to clean up and dispose of the pollutants and ameliorate any adverse effects in a timely manner. It is the Ministry's role to ensure that those responsible take preventative measures and use proper clean up, disposal, and amelioration practices. Under the Environmental Protection Act, the Ministry can order those responsible for the spill to clean up the site.

The MOE should be contacted (Spill Action Centre 1-800-268-6060) if the spill is discharged to a storm water system and into the natural environment, migrates off-site, or where the spill occurs off-site. In such a situation, the MOE, the municipality and the controller, and/or owner of the pollutant, if different, are to be notified.

[15] Environment Canada EE Regulatory Requirements website: http://www.ec.gc.ca/ee-ue/default.asp?lang=En&n=8A6C8F31-1

3. POLLUTION PREVENTION

Pollution prevention (P2) is defined as "the use of processes, practices, materials, products, substances or energy that avoid or minimize the creation of pollutants and waste, and reduce the overall risk to the environment or human health."[16] P2 practices therefore include elimination of hazardous substances through materials substitutions (Section 3.2); reduction of hazardous substances through process or equipment modifications (Section 3.2); operating procedures and housekeeping practices (Section 3.3); and education and training of staff, suppliers, customers and the public (Section 3.4). P2 measures can be undertaken concurrently. The most effective actions are those that eliminate hazardous substances, through substitution, for example.

Treatment (Section 4) is not a pollution prevention activity. For many substances, treatment moves pollutants from one media to another (e.g., removal of a metal from the water effluent to a solids residue) and does not avoid or minimize the creation of the pollutant or waste.

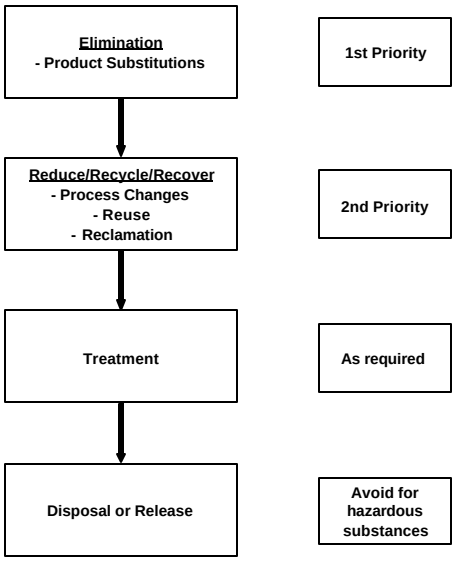
Pollution prevention and treatment BMPs must be assessed and implemented based on specific site and process conditions and characteristics; however, some overall observations can be made about effective ways to proceed with assessment and implementation of BMPs. Specific options for the automotive repair and maintenance sector for P2 are outlined in the sub-sections following.

The best way to improve environmental management issues is to use a systematic approach. One key first step is to develop an environmental policy and strategy that is formally supported through senior management's commitment to the strategy. An Environmental Management System (EMS) is a tool that organizations in a variety of sectors have implemented to systematically identify, prioritize, and take action to address the environmental impacts of their operations and services. In addition, an EMS can establish the record-keeping and reporting required to ensure facility management has the necessary information for continuous improvements. It is recommended that all facilities consider developing, adopting, and implementing an EMS. One example of such a system is the ISO 14001 standard. Pollution prevention, product stewardship, and social responsibility are important aspects of a comprehensive, integrated environmental approach. Employee engagement and training, communication throughout the supply chain, and customer education may be appropriate elements for a successful, integrated approach to long-term sustainability.

[16] Definition from: "*Guidelines for the Implementation of the Pollution Prevention Planning Provisions of Part 4 of the Canadian Environmental Protection Act, 1999 (CEPA 1999)*," National Office of Pollution Prevention, Environment Canada, 2001

The following sequence of steps presents a hierarchy of techniques for undertaking pollution prevention and waste minimization.

Figure 3.1 Environmental Management Options Hierarchy



- Eliminate generation of waste streams through process development and design;
- Reduce waste streams at source through process-integrated changes to raw materials, equipment, and operating procedures;
- Recycle waste streams by direct re-use or reclamation and re-use;
- Recover any resource value from waste streams; and
- Treat and dispose of waste streams using end-of-pipe techniques.

The sequence of general techniques to prevent and minimize release of water pollutants includes the following steps:

- Identify all wastewater streams and characterize their quality, quantity, and variability;
- Minimize quantity of water used in the process;
- Minimize contamination of process water and washwater contamination with hazardous raw materials, product, or wastes;
- Maximize wastewater re-use; and
- Maximize the recovery and retention of substances from streams unfit for re-use.

3.1 Overview of P2 Measures for PAHs and Cadmium in the Automotive Repair and Maintenance Sector

This sub-section provides an overview of the P2 measures discussed in the following three sub-sections: 3.2 Pollution Elimination or Reduction; 3.3 Operating Procedures and Housekeeping; and 3.4 Education and Training.

Table 3.1 Overview of P2 Measures for Cadmium and PAHs in the Automotive Repair and Maintenance Sector

P2 Type	Substance Addressed	Sub-sector Addressed	BMP Name	BMP Number
Elimination/ Reduction	Both PAHs & Cadmium	Automotive Repair and Maintenance Automotive Body, Paint, and Interior Repair and Maintenance	Green purchasing practices	BMP #1
	Cadmium	Automotive Repair and Maintenance Automotive Body, Paint, and Interior Repair and Maintenance	Material Substitution	BMP #2
	PAHs	All sub-sectors	Degreasing with low aromatic micro emulsions	BMP #3
Operating Procedures and Housekeeping	Both PAHs & Cadmium	Automotive Repair and Maintenance Automotive Body, Paint, and Interior Repair and Maintenance	Implement measures to minimize wastewater potential	BMP #4
	Both PAHs & Cadmium	Automotive Repair and Maintenance Automotive Body, Paint, and Interior Repair and Maintenance	Storage and containment	BMP #5
	Both PAHs & Cadmium	Automotive Repair and Maintenance Automotive Body, Paint, and Interior Repair and Maintenance	Storage and disposal practices for used motor oil and used oil filters	BMP #6
	Both PAHs & Cadmium	Automotive Repair and Maintenance Automotive Body, Paint, and Interior Repair and Maintenance	Prevent solvent loss	BMP #7

Table 3.1 (cont'd) Overview of P2 Measures for Cadmium and PAHs in the Automotive Repair and Maintenance Sector

P2 Type	Substance Addressed	Sub-sector Addressed	BMP Name	BMP Number
	Both PAHs & Cadmium	Automotive Repair and Maintenance Automotive Body, Paint, and Interior Repair and Maintenance	Address spill response and clean-up	BMP #8
	Both PAHs & Cadmium	Automotive Repair and Maintenance Automotive Body, Paint, and Interior Repair and Maintenance	Operating practices for service bays	BMP #9
	Both PAHs & Cadmium	Car washes	Place proper signage throughout the facility directing activities to be followed	BMP #10
	Both PAHs & Cadmium	Car washes	Chemicals storage	BMP #11
	Cadmium	Automotive Repair and Maintenance Automotive Body, Paint, and Interior Repair and Maintenance	Change the surface preparation and resurfacing operations	BMP #12
Education and Training	Both PAHs & Cadmium	Automotive Repair and Maintenance Automotive Body, Paint, and Interior Repair and Maintenance	Management and Staff Training	BMP #13
	Both PAHs & Cadmium	Car Washes	Management and Staff Training	BMP #14

3.2 Pollution Elimination or Reduction

P2 opportunities to eliminate or reduce hazardous substances include material substitutions and process alterations. Changes in operating costs will depend on the cost differential of the substitute in comparison with the hazardous material. Where

the cost of the substitute is higher, operating costs will increase; however, where the cost of the substitute is lower, operating costs will decrease. Some capital investment in equipment modifications or replacements to accommodate any differences in properties of the substitute substances may also be required. Alterations to processes to reduce use of hazardous substances may entail changes in operating budget, including possible reductions in costs due to more efficient operations. Capital investment for equipment modification or replacement may also be required.

3.2.1 Reduction Measures Common to All Substances of Interest

Sub-Sector specific Measures: General Automotive Repair and Maintenance and Automotive Body, Paint, and Interior Repair and Maintenance.

BMP #1: Green purchasing practices. Influence suppliers by requesting and purchasing less-toxic alternative cleaning products and buying from suppliers who accept materials and containers back for recycling.

3.2.2 Reduction Measures for Cadmium

Sub-Sector specific Measures: General Automotive Repair and Maintenance and Automotive Body, Paint, and Interior Repair and Maintenance.

BMP #2: Material substitution. Choose environmentally friendly products, such as cadmium-free solder, whenever possible.

3.2.3 Reduction Measures for PAHs

BMP #3: Use low aromatic micro emulsions for degreasing. Bi- and polycyclic aromatic compounds, i.e., naphthalenes, biphenyl, and several PAHs, occur both in petroleum solvents used for degreasing (minor constituents) and in the oily dirt on the vehicles. When low aromatic micro emulsions are used, the contribution from the washing and cleaning chemicals to the discharge of bi- and polyaromatic compounds becomes negligible and the discharged quantity of naphthalene is decreased.[17] The removal potential ranges from 50-60 % depending on the degree of implementation

3.3 Operating Procedures and Housekeeping

Operating procedures and housekeeping BMPs are P2 measures that can be implemented concurrently with elimination/reduction BMPs and education/training BMPs. Some operating costs may be incurred to initiate improved operating and housekeeping practices, for example to establish an inventory control system. Once implemented however, these costs can be expected to be offset by optimized performance, reduced losses of time and materials, reduced liability, better-informed staff and management and, potentially, improved customer satisfaction. Reliable record-keeping systems are needed to realize the full benefits of operating

[17] Article by Nicklas Paxéus, Vehicle Washing as a Source of Organic Pollutants in Municipal Wastewater (copyright)

procedures and housekeeping BMPs. Minimal capital investment to implement operating and housekeeping best management practices can be expected.

3.3.1 Operating Procedures and Housekeeping Practices Common to All Substances of Interest

Sub-Sector specific Measures: General Automotive Repair and Maintenance and Automotive Body, Paint, and Interior Repair and Maintenance.

BMP #4: Implement measures to minimize wastewater contamination potential including:

- Use non-wet cleaning methods, such as sweeping and vacuuming, when cleaning the shop, since these materials can contain regulated pollutants. Do not wash these materials into floor drains or the sewer system.
- Pre-clean equipment by wiping excess materials off prior to washing.
- Cover parking, storage, and fuelling areas to keep rain from contacting cars, equipment, service areas, and waste materials. Route roof downspouts to grassed areas or, if necessary, directly to storm drains.
- Use concrete paving instead of asphalt in areas where autos leak, such as fuelling islands, outdoor workspaces, and heavily used parking areas. Asphalt absorbs contaminants and can be dissolved by some fluids.

BMP #5: Storage and Containment:

- Operators should ensure that the following materials are stored using spill containment:
  - Used acid-filled batteries;
  - Spent solvents, used antifreeze, used oils, used oil filters, used brake fluid, used transmission fluid, and other hazardous waste materials;
  - Aboveground fuel storage tanks; and
  - Solvents, antifreeze, oil, or other hazardous materials stored at floor level in containers over 50 litres and not contained in permanent engineered containers that are protected from vehicle contact.

Any material captured in the containment area should be collected, drummed, labelled and sent off-site for disposal/recycling in accordance with provincial regulations regarding liquid industrial and hazardous waste. Any draining or pumping of accumulated stormwater out of the secondary containment area to the sediment pits and oil/water separators should be supervised at all times. It should be assessed for potential contamination.

BMP #6: Storage and disposal practices for used motor oil and used oil filters. Properly dispose of waste oil and oil filters. In Ontario, oil filters having more than 3% oil makes them liquid industrial and hazardous wastes. Automotive waste oils include crankcase oils, gear and metalworking oils, and transmission and hydraulic fluid.

Storage of Used Oil

- All used oil should be stored in a sealed tank used exclusively for that purpose.
- The tank should be tightly capped to minimize water seepage.
- Used oil should be collected and disposed of by a provincially licensed contractor.

Storage of Used Oil Filters

- Using a tool designed for puncturing, puncture and drain all filters for a minimum 24 hours before storing in a properly labelled container.
- Have filters collected by a provincially licensed contractor.

Disposal / handling practices of waste aqueous solutions, best available techniques (BATs) to include:

- Brake Fluid
  - Collect and store brake fluid in a separate, marked, closed container and dispose of it with assistance from a government licensed waste disposal company.
- Engine Cleaning/Shampooing
  - Collect wastewater for reuse, recycling, or for treatment and disposal as engine cleaning products can contain cadmium, PAHs, and other toxic compounds to remove oil and dirt. Ensure the wash area does not drain to sanitary or storm sewers.

BMP #7: Prevent solvent loss. Prevent solvents and cleaners from spilling and dripping onto the shop floor. Install drip pans, drain boards, and drying racks in a way that directs drips back into the fluid holding tank.

BMP #8: Address spill response and clean-up. The following practices should be adhered to:

- All fuel spills should be immediately cleaned up with rags or sorbents and properly managed.

- Rags used for spill clean-up should be stored in closed containers awaiting collection and/or cleaning.
- Sorbents used for spill clean-up should be stored in closed containers awaiting disposal by a government-licensed contractor.
- All service bay spills, other than water, should be immediately cleaned-up with rags or sorbents.
- Consideration should be given to installation of commercially available inserts for floor drains that allow water to pass but absorb oil. These inserts will also seal up and close the drain in the event of a catastrophic oil spill.

Spill Response

- Automotive repair operations should have an up-to-date and tested spill response plan.
  - The spill response plan should be posted in an easily visible location and clean-up equipment and supplies should be kept in stock at all times.
  - The operator should respond immediately to clean-up spills.
  - After spill clean-up, the oil/water separator should be inspected and cleaned, if necessary, before resuming wastewater discharge from the operation.
  - Consideration should be given to purchasing re-usable spill sorbents (absorbent material). Reusable pads are highly absorbent and can be used several times before disposal. The pads can be passed through a wringer to remove a large amount of the spilled product, allowing the pads to be reused and the spilled material to be recycled.
  - Two containers should be designated: one for partially saturated rags to be re-used and one for saturated rags to be disposed. All rags, floor sweeps, absorbent pads and towels used to wipe, absorb, or clean up spills should be covered with the substance before being disposed. Wring out saturated rags (recycling the collected material if possible) before disposal. Used rags may be considered a special waste; they should not be thrown into the garbage. It is not recommended that used rags be laundered. However, if laundering is done, use a professional laundry facility that will handle the used rags in a safe and environmentally responsible manner.

BMP #9: Operating practices for Service Bays:

- Do not drain shop wastes into a stormwater drain, into a septic tank, onto the ground, or into surface water.

- Place drip pans underneath vehicles and equipment when performing maintenance such as parts removal, unscrewing filters, and unclipping hoses. Do not leave drip pans or other open containers lying around.
- Place dirty parts in drip pans instead of on the floor.
- Instead of hosing down spills with water contain the spill and collect in containers for disposal according to applicable provincial regulations.

Sub-Sector specific Measures: Car Washes.

BMP #10: Place proper signage throughout the facility directing activities to be followed. This includes:

- At wand washes, there shall be signs that state that the wash area is for washing vehicle exteriors only and that other maintenance or cleaning activities, such as oil changes and engine cleaning, are prohibited. (Engine cleaning is prohibited in vehicle wash bay areas because solvents will remove oil and dirt from the engines that could enter the sewer.)
- If engines and engine parts are washed on the premises, the wastewater produced should be collected in a separate holding tank and disposed of appropriately, as the water may be considered liquid industrial and hazardous waste. Every effort should be made to prevent such wastewater from being discharged to the oil/water separator or to storm drains.
- At wand washes, post signs indicating that no outside cleaning agents are allowed (as they may cause unknown chemical reactions and interfere with the sediment pits and oil/water separators).
- Instead of pouring wastes into drains, into surface water, or onto the ground, collect the material in drums and dispose according to applicable regulations.
- Instead of hosing down spills with water, contain the spill and collect it in containers for disposal according to applicable provincial regulations.

BMPs #11: Chemicals Storage

- Store materials, such as detergents, other cleaning agents, and machinery lubrication oils and greases, in proper containers and identify with an appropriate Material Safety Data Sheet (MSDS) compliant label. Up-to-date MSDS should be available for each product and employees should be knowledgeable of their content and how to access them at any time.
- Store flammable and combustible materials in fireproof cabinets or drums.
- Maintain an appropriate distance between different chemicals to prevent cross contamination and chemical reactions.

3.3.2 Operating Procedures and Housekeeping Practices Common for Cadmium

Sub-Sector specific Measures: General Automotive Repair and Maintenance and Automotive Body, Paint, and Interior Repair and Maintenance

BMP #12: Surface preparation and resurfacing operations. Minimize wet sanding practices and use dustless vacuum sanders. Using a disc sander in combination with a dust collection unit should significantly reduce sanding dust generated during resurfacing operations.

3.4 Education and Training

Education and training are P2 measures that can be implemented concurrently with elimination/reduction BMPs and operating/housekeeping BMPs. Investments in education and training for management and staff can return significant benefits, including improved staff motivation, an improved health and safety record, reduced material losses, improved productivity and, potentially, improved customer satisfaction. Communication and education of the supply chain, including material and equipment suppliers, can result in improved working relationships, as well as environmental benefits resulting from reduced pollution release.

It is important to keep education and training current and to ensure a management system is in place to maintain the relevance of education and training delivered. As mentioned above, a comprehensive management approach is important for effective reduction of releases of hazardous substances, including reductions through education and training.

Some operating costs may be incurred to initiate education and training practices, for example, time required to discuss improved materials specifications with suppliers. Once implemented, however, these costs can be expected to be offset by the benefits of education and training. Capital investment is not typically required for implementation of education and training practices.

BMP #13: Management and Staff Training for General Automotive Repair and Maintenance and Automotive Body, Paint and Interior Repair and Maintenance.

- Ensure employees are trained whenever new equipment is installed or new procedures are implemented. They should be familiar with the hazards associated with the material they are using and be aware of potential sources of contamination.
- Make sure employees are familiar with and understand the purpose of a spill response plan and are properly trained to carry it out.
- Maintain awareness of best available techniques (BAT), as many companies now consider environmental issues when designing and manufacturing their products.

- Ensure employees are familiar with the location and purpose of Material Safety Data Sheets (MSDS).

BMP #14: Management and Staff Training for Car Washes.

- Ensure every employee is fully trained before beginning his or her first employment shift and whenever new equipment is installed or new procedures implemented. They should be familiar with the hazards that accompany the material they are using and be aware of potential sources of contamination. MSDS should be available for all detergents, solvents and other materials used at the facility.

- Ensure employees are familiar with the site's layout and catch basin locations. Ensure they employ good housekeeping practices and understand proper reporting procedures.

- Ensure all employees are aware of the spill response plan and are properly trained to carry it out.

- Document all employees' training and retain the records for a minimum of two years after the employee ceases employment; e.g., date and location of training, subject(s) covered, test results if applicable, trainer's name, etc.

3.5 P2 Options and Costs

The rationale for selection of BMPs and associated cost estimates is outlined in this section. In general, information on the effectiveness and cost of P2 measures is not well documented in literature. Therefore, a number of estimating procedures were made with respect to the effectiveness and costs of implementing BMPs to eliminate or reduce the substances of concern. In the absence of specific information, rules of thumb were developed for each type of P2 measure, as summarized below.

Data in literature with respect to substance removal effectiveness of P2 measures is very sparse. Where data is provided, there is wide variability in results. Further, costs and cost savings information are not provided with sufficient context to be useful for this analysis. In the absence of directly relevant data, several rules of thumb were developed for P2 effectiveness and cost estimations were based on available literature information. Case study information from a range of literature sources for the six sectors of interest was researched to identify P2 effectiveness experience for any substance. These case study results were grouped by type of P2 measure and the data was assessed to derive a reasonable range of substance removal effectiveness. The following Table provides a summary of the rules of thumb for P2 effectiveness.

Table 3.2 Rules of Thumb for P2 Effectiveness

Type of P2 Measure	Percent Reductions in Releases			
	Material Substitution	**Process Modification**	**Operating/ Housekeeping**	**Education and Training**
Sub-Section title in BMP Document	Pollution Elimination or Reduction	Pollution Elimination or Reduction	Operating Procedures and Housekeeping	Education and Training
Rule of Thumb to Apply (in absence of specific information)	50% to 75%	10% to 40%	10% to 30%	1% to 30%

In the absence of directly relevant data for P2 costs, it was assumed that P2 costs primarily impact operating budgets, except in the case of process modifications where capital investments were also assumed to be required. Extrapolations of operating costs were derived from Statistics Canada data on annual average earnings by company size for manufacturing and service sector groups.

Table 3.3 Rules of Thumb for P2 Costs

P2 Rules of Thumb	Range of Costs			
Type of P2 Measure	**Material Substitution**	**Process Modification**	**Operating/ Housekeeping**	**Education and Training**
Rule of Thumb to Apply (in absence of specific information)	Materials budget implications of –2% to 4%; negligible for typical materials	¼ person year to 5 person year per modification, plus capital investment (annualized $5,000 per year for manufacturing sectors; $1,000 per year for service)	½% to 5% increase in operating budget staff time (off-set over time as a result of reduced liability, materials losses, etc.)	¼% to 2% increase in staff time (based on 240 workdays per year).

3.5.1 P2 Removal Effectiveness

For the Auto Repair & Maintenance Sector it is assumed that the most effective Elimination/Reduction P2 measure would be implemented for each substance of concern. In addition, it was assumed that all applicable measures in the Operating Procedures and Housekeeping group of BMPs and all applicable measures in the Education and Training group of BMPs would also be implemented.

The most effective Elimination/Reduction P2 measures for PAHs and cadmium are as follows:

- Cadmium- BMP #2- Material Substitution, Green Purchasing Practices-BMP #1.
- PAHs – BMP #3-Degreasing with low aromatic micro emulsions.

Effectiveness of materials substitution for cadmium is estimated to be 50-75%, based on rules of thumb developed for application where no specific industry data was available. For purposes of delivering a single number for cadmium reduction, 75% was used. Effectiveness for materials reduction for PAHs is estimated to be 55%, based on referenced data.

Applicable Operating Procedures and Housekeeping BMPs are:

- Minimize Wastewater Potential- BMP #4.
- Operating Practices for service bays-BMP #9.
- Chemical storage - BMP #11.

The effectiveness of Operating Procedures and Housekeeping is estimated to be 20% removal of the remaining contaminants after materials substitution (i.e., the mid-range of assumed effectiveness of this group of BMPs). In the case of cadmium, Operating Procedures and Housekeeping are estimated to remove 20% of the remaining 25% of contaminants, for an additional 5% net reduction in cadmium prior to treatment. Therefore, with the combination of Substance Substitution and Operating Procedures and Housekeeping, a cumulative removal of 80% of cadmium in the wastewater effluent from automotive repair and maintenance is estimated.

For PAHs, Operating Procedures and Housekeeping are estimated to remove 20% of the remaining 45% of the remaining concentration, for an additional 9% net reduction in PAHs concentration in the wastewater effluent from automotive repair and maintenance facilities, prior to treatment. Therefore, with the combination of Substance Substitution and Operating Procedures and Housekeeping, a cumulative removal of 64% of PAHs in the wastewater effluent from motor vehicle parts manufacturing facilities is estimated.

Applicable Education and Training BMPs for cadmium and PAHs are:

- Management and Staff Training for General Automotive Repair and Maintenance and Automotive Body, Paint and Interior Repair and Maintenance-BMP #13.
- Management and Staff Training- BMP #13 and #14.

The effectiveness of Education and Training practices in removing cadmium is estimated to be 2% removal of the remaining contaminants after materials substitution. This effectiveness rate is relatively low due to the fact that staff within the automotive repair sector are already familiar with the types of practices. Education and Training is an integral component of a comprehensive pollution prevention program and is needed to ensure the success of the other recommended BMPs. The combination of Substance Substitution, Operating Procedures and Housekeeping, and Education/Training in the wastewater effluent from automotive repair and maintenance facilities is estimated to result in a cumulative removal of 80% of cadmium.

For PAHs, Education and Training practices are vital to the reduction of this contaminant. These practices are estimated to remove 20% of the remaining 36% present in wastewater effluent, for an additional 7% removal. Therefore, the combination of Process Modification, Operating Procedures and Housekeeping, and Education/Training in the wastewater effluent from motor vehicle parts manufacturing facilities is estimated to result in a cumulative removal of 71% of PAHs.

In summary and as indicated in Tables 5.1 and 5.2 (Section 5), P2 practices are assumed to result in reductions of 80% of cadmium prior to treatment and 71% of PAHs prior to treatment. Table 3.4 presents a summary of estimated ranges of effectiveness of P2 practices.

Table 3.4 Summary of Effectiveness of BMPs

Substance Addressed	BMP Name	BMP Number
Elimination/ Reduction Effectiveness: 50-75%		
Cadmium	Material Substitution	BMP #1
Cadmium	Green Purchasing Practices	BMP #2
PAHs	Degreasing with low aromatic micro emulsions	BMP #3
Operating Procedures and Housekeeping Effectiveness: 20% of the remaining substance after substitution		
Cadmium &PAHs	Minimize Wastewater Potential	BMP #4
Cadmium &PAHs	Operating Practices for service bays	BMP #9
Cadmium &PAHs	Chemical storage	BMP #11
Education & Training Effectiveness: 2 % of the remaining substance after substitution		
Cadmium &PAHs	Management and Staff Training	BMP #13, 14

3.5.2 P2 Costs

Costs for elimination/reduction measures are assumed to be negligible for material substitution for all sizes of facility as the benefits will exceed the costs. Products produced will not be adversely affected by implementation of BMPs. Various positive indirect benefits, such as reduced hazardous materials handling costs and reduced health and safety costs.

Costs associated with implementation of Operating Procedures and Housekeeping BMPs are assumed to be proportional to staff complement and to cost between 1/2% and 5% of the staff budget. The upper end of this range would be applicable to facilities without well-established operating procedures and record-keeping practices. The cost estimates adopt the mid-range of the estimated percent of staff budget.

Costs associated with implementation of Education and Training BMPs are assumed to be proportional to staff complement and to cost between ¼% and 2% of the staff

budget. The upper end of this range would be applicable to facilities without well-established training programs. The cost estimates adopt the mid-range of the rule of thumb range.

Estimated costs for implementation of the P2 BMPs are summarized in Table 3.5. Clearly, these estimates constitute a first-cut high-level estimate in the absence of facility-specific data and circumstances.

Table 3.5 Estimated Pollution Prevention Costs (for selected P2 BMPs)

Type of P2 Measure	Pollution Prevention Costs	
	Small Facilities (5 Staff)	**Medium Facilities (25 Staff)**
Pollution Elimination or Reduction	negligible	Negligible
Operating/ Housekeeping	$ 10,000 annually	$ 20,000 annually
Education and Training	$ 4,000 annually	$ 8,000 annually
Total Estimate	$ 14,000 annually	$ 28,000 annually

Note:
* Estimated annual costs for each P2 measure are approximations only; facility specific wastewater quality and operating practices must be assessed prior to selection of P2 practices.

4. TREATMENT

Treatment is not a P2 measure and it is not as effective as P2 in preventing the release of hazardous substances since it occurs after the hazardous substance has been used or created and subsequently becomes part of the facility's wastewater. With some treatment, the hazardous substance may be simply transferred from the water to the air or the sludge. Operating and capital costs of treatment can be significant. As a result, treatment should only be considered after P2 measures have been implemented and after all efforts have been taken to reduce or eliminate the substances first through P2 practices.

4.1 Treatment Measures

Treatment measures and BMPs must be assessed and implemented based on specific site and process conditions and characteristics. The following subsections present treatment processes to be considered where P2 alone does not meet the reference criteria.

The reference criteria outlined in Section 2.2 are provided for the purpose of assessing the potential for application of select treatment technologies for the select substances identified in this BMP document.

The following subsections provide a brief overview of typical treatment systems for the removal of cadmium and PAH for this sector. The processes described were based on estimated wastewater constituents for the automotive repair and maintenance sector. The treatment review was based on representative wastewater data available for this sector.[18] Other treatment processes may be more applicable at facilities that have a wastewater stream significantly different from that used in this assessment.

4.1.1 Treatment Measures for PAHs

Three types of treatment processes are potentially applicable to meet the reference criteria for PAHs outlined in Section 2.2. The treatment processes provided are presented in sequential order of treatment requirements, with the process required to achieve the lowest concentration presented last. These treatment processes can be used alone or in combination, depending on specific wastewater properties.

- **Air stripping**: Some PAH compounds are volatile and can be volatilized in an air stripper. After volatilization the PAHs in the air would be passed through an air phase granular activated carbon (GAC) adsorption unit to capture the PAHs.
- **GAC or powdered activated carbon (PAC):** The GAC process involves pumping wastewater through a fixed-bed column containing GAC granules. The GAC adsorbs pollutants from the wastewater. A two-stage system (i.e.,

[18] Refer to Section 2.1.

two GAC columns operated in series) may be required to reduce the concentration to below the concentration required to meet the reference criteria. The spent GAC is regenerated off-site. The type of pollutants adsorbed and the extent of adsorption are a function of the source material for the GAC and the preparation procedure for the GAC granules. Typically, a sand filter or mixed media filter is required to remove suspended solids as a pre-treatment stage for a GAC filter. As an alternative to GAC, PAC can be mixed with wastewater in a contact tank. PAC cannot be regenerated and is disposed of as a waste with the biological treatment sludge.

- **Advanced Oxidation (AOT)**: The AOT process uses ultraviolet (UV) light in conjunction with an oxidant such as ozone or hydrogen peroxide. This combination achieves a significantly greater treatment performance that using the oxidant alone. UV light is used to split the oxidant molecule, producing very reactive hydroxyl radicals. These hydroxyl radicals react quickly with organic pollutants in the water, breaking them down into carbon dioxide and water. The treatment process will break down any organic contaminant; therefore, to treat the organic contaminants of concern, the removal of other organics may be required before this process is used.

4.1.2 Treatment Measures for Cadmium

Three types of treatment processes are potentially applicable to meet the reference criteria for cadmium outlined in Section 2.2. The treatment processes provided are presented in sequential order of treatment requirements, with the process required to achieve the lowest concentration presented last. These treatment processes can be used alone or in combination, depending on specific wastewater properties.

- **Chemical precipitation:** Cadmium can be precipitated as insoluble cadmium hydroxide by pH adjustment. The precipitated metal is removed from the wastewater stream by settlement. Filtration using a sand filter or mixed media filter may be used after settlement to further reduce the concentration. It is assumed that chemical precipitation and settlement is in place for facilities with raw wastewater cadmium concentrations in excess of the sewer use by-law limit. Therefore, this treatment stage was not included in the cost assessment for cadmium removed.

- **Granular activated carbon (GAC):** GAC is not a conventional treatment option for cadmium as the removal efficiency is relatively low (around 30%). However, if a GAC process is used to remove organic pollutants, such as PAHs, there will also be some reduction in the cadmium concentration. The GAC process involves pumping wastewater through a fixed-bed column containing GAC granules. The GAC adsorbs pollutants from the wastewater. The spent GAC is regenerated off-site. The type of pollutants adsorbed and the extent of adsorption are a function of the source material for the GAC and the preparation procedure for the GAC granules. Typically, a sand filter or

mixed media filter is required to remove suspended solids as a pre-treatment stage for a GAC filter.

- **Reverse osmosis (RO) or Deionization (DI)**: RO or DI processes can be used as a polishing stage to further reduce the concentration of cadmium. Filtration using a sand or mixed media filter followed by microfiltration is typically used as a pre-treatment stage. The RO process separates water from dissolved materials in solution by filtering through a semipermeable membrane under pressure. The basic components of an RO system are the membrane, a membrane support structure, a containing vessel, and a high-pressure pump. The permeability of the membrane used, level of wastewater pre-treatment and membrane cleaning are the key criteria for the performance of this process. RO results in a waste stream, or reject, that must be disposed of. For the DI process, specific ions are displaced from an insoluble exchange material (or resin) by different ions in solution. The spent resin is regenerated and reused. The waste stream from regeneration must be disposed of. The type of resin, level of wastewater pre-treatment and frequency of regeneration are the key criteria for effectiveness of treatment for DI.

4.2 Treatment Options and Costs

Treatability information is provided for the individual pollutants specified in Tables 5.1 and 5.2 as a guide (Section 5). Based on the estimated wastewater concentrations of each pollutant identified after P2 measures that are provided in the tables, an assumption that all pollutants identified will be reduced, and an assumption that the wastewater biochemical oxygen demand (BOD_5) is less than 100 mg/L, the overall treatment system in terms of sequential process steps for each target reference criteria is as follows:

- Reference Criteria 1: sand/mixed media filtration, GAC, microfiltration, DI, and AOT.
- Reference Criteria 2 and 3: sand/mixed media filtration and GAC.

The GAC and AOT treatment processes are required for the removal of PAHs. DI is required to remove cadmium from the wastewater stream, and some cadmium removal will be provided by GAC.

The proposed treatment strategies identified above serve as preliminary guidelines for the level of treatment likely to be required. Different treatment options may be required, depending on the wastewater constituents and strength. For example, RO may be a more suitable process than DI for cadmium removal at some facilities.

Site and facility specific information is needed to determine what treatment trains and components are required to achieve the reference criteria. A typical total treatment process for automotive repair maintenance sector wastewater after P2 measures will provide treatment for all pollutants identified in the wastewater. A comprehensive analysis of the wastewater stream is required and bench-scale and/or

pilot testing of treatment may be needed to verify the optimum treatment system for a specific facility.

Capital and annual operational and maintenance (O&M) costs were developed for full treatment for the three reference criteria using a wastewater flow range of 0.1 m^3/h to 10 m^3/h (the expected flow range for this industry sector). It is estimated that this flow range is representative of the majority of industries within this sector. In particular instances, such as very large multi-bay car washes, flows may be higher. For these instances, extrapolations of the costing information provided in the following pages may be needed to develop the cost estimates. Regression equations provided on the costing figures can be used to determine the cost estimates at the higher flows. The estimated costs are presented in Table 4.1.

Reference Criteria 3 are the least restrictive wastewater concentrations and require the least amount of treatment after P2 measures. In this instance (and also for Reference Criteria 2) the basic treatment option would require granulated activated carbon (and pre-filtration) to achieve the required reduction in PAHs.

The costs provided in Table 4.1 are conceptual level only, normally considered to be accurate to a range of –35% to + 50%.

Table 4.1 Estimated Capital and Annual Operation and Maintenance Costs

Reference Criteria	Costs as Function of Flow Range of 1 m^3/h to 10 m^3/h*					
	Capital Cost Range			Annual O&M Cost Range		
	0.1m^3/h	5 m^3/h	10 m^3/h	0.1m^3/h	5 m^3/h	10 m^3/h
Criteria 3	$37,000	$170,000	$318,000	$6,000	$20,000	$32,000
Criteria 2	$37,000	$170,000	$318,000	$6,000	$20,000	$32,000
Criteria 1	$359,000	$1,147,000	$1,724,000	$54,000	$138,000	$172,000

Note:
* Refer to Figures 4.1 to 4.3 for capital and O&M costing curves to estimate full treatment costs for a specific flow rate. Costs exclude chemical precipitation (metals removal), which is assumed to be installed. If required, the following estimated capital costs should be added: 0.1 m^3/hr = $27,000; 5 m^3/hr = $151,000; 10 m^3/hr = $215,000.

The capital costs presented in Table 4.1 do not include chemical precipitation for metals pre-treatment and removal, as it is assumed that this would be a treatment process already installed and operating. Should a particular plant or facility not have a chemical precipitation system installed, then the capital costs should be increased accordingly, as shown in Table 4.1. Costing includes engineering, equipment, piping and instrumentation, electrical and controls, installation, and construction costs.

The annual O&M costs were determined as a percentage of capital costs, assuming 15 percent for the 0.1 m^3/h flow condition, 12 percent for the intermediate 5 m^3/h

flow condition and 10 percent for the 10 m^3/h flow condition. Annual O&M costs include a consideration of the following:

- Increased power and energy costs to operate the additional treatment processes;
- Chemical costs for treatment chemicals, where required;
- Additional labour costs for operation;
- Sampling and monitoring costs for the specific substances requiring treatment; and
- Disposal costs for residues and waste streams generated from treatment.

Figures 4.1 to 4.3 show capital and annual O&M costing curves for the estimated full treatment cost range presented in Table 4.1 for each set of reference criteria.

Figure 4.1 Automotive Repair and Maintenance Sector Capital and O&M Costs for Reference Criteria 1

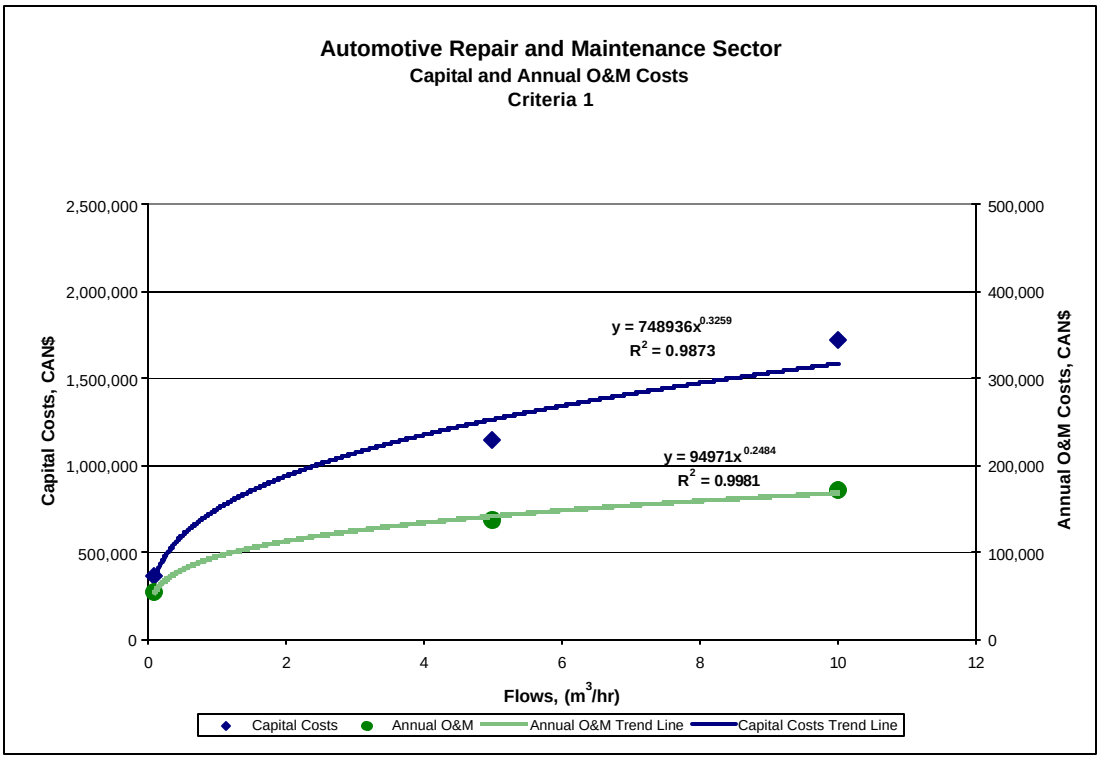


Figure 4.2 Automotive Repair and Maintenance Sector Capital and O&M Costs for Reference Criteria 2

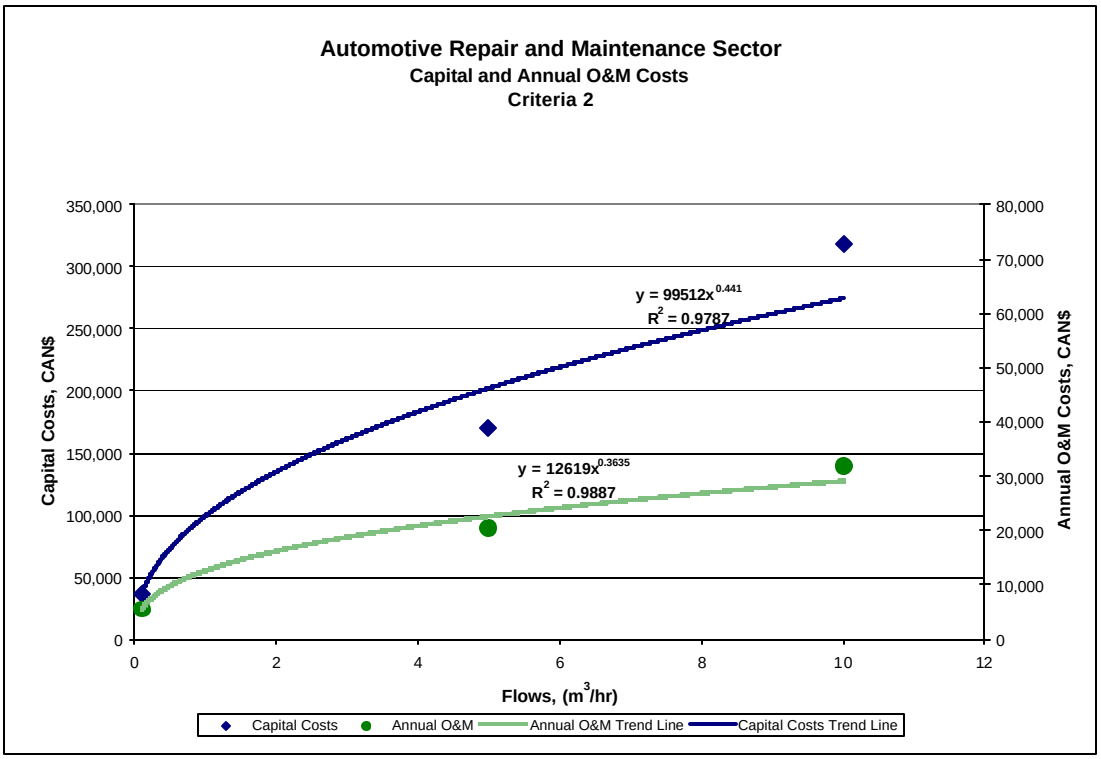
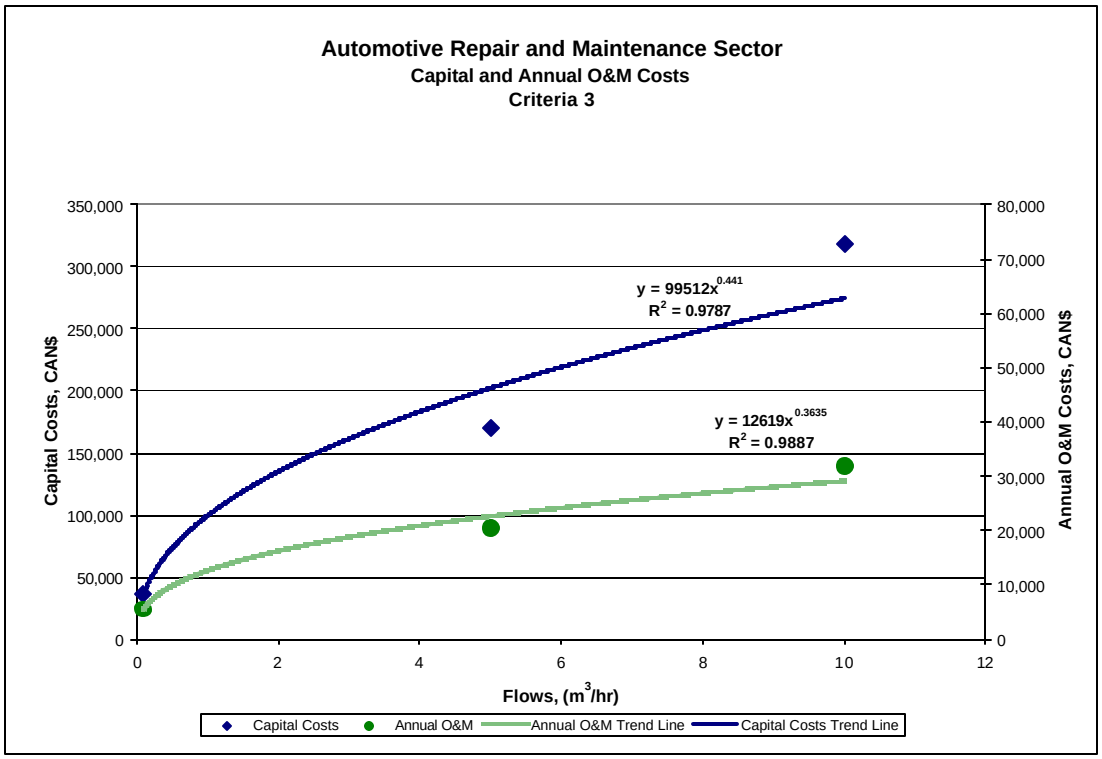


Figure 4.3 Automotive Repair and Maintenance Sector Capital and O&M Costs for Reference Criteria 3



5. OPTIONS FOR REDUCTION OF SUBSTANCE CONCENTRATIONS IN EFFLUENTS

The following tables outline the combination of P2 measures and treatment evaluated for substance removal effectiveness. These measures were chosen on the basis of ability to achieve the reference criteria, costs, and feasibility for implementation.

Based on the estimating procedures used to determine initial concentrations and percent removal resulting from implementation of P2 measures, some reference criteria may be met with P2 alone (i.e., no additional treatment required):

- Reference Criteria 1: No substances.
- Reference Criteria 2: Cadmium.
- Reference Criteria 3: Cadmium.

Site and facility specific analysis of the wastewater stream is required to determine which pollutants can be reduced to the reference criteria by implementation of P2 measures.

Information provided in the tables is based on estimates used for the concentration of each substance in wastewater before and after P2 measures. Treatability information is also based on estimated removal rates for treatment processes. A detailed analysis of the waste streams and the wastewater would be required for each facility to determine the optimum treatment system should this be required after P2 implementation.

Table 5.1 Summary: Cadmium

Table 5.2 Summary: PAHs

6. KEY REFERENCES

The following documents were key in preparing this BMP:

1. Canadian Petroleum Products Institute, *Best Management Practices: Automotive Repair Operations that Discharge to a Sanitary Sewer System*, March 2004. Available at URL: http://www.cppi.ca/tech/BMPrepair.pdf

2. Canadian Petroleum Products Institute, *Best Management Practices: Vehicle Wash Operations*, March 2004. Available at URL: http://www.cppi.ca/tech/BMPwash.pdf

3. Rhode Island Department of Environmental Management, *Environmental/Occupational Health Compliance Certification Program: Certification Workbook for Autobody Repair Facilities*, 2002-2003. Available at URL: http://www.dem.ri.gov/programs/benviron/assist/abdycert/workbook.pdf

4. Portland Regional Pollution Prevention Outreach Team, *Keep Your Shop in Tune: A Best Management Practices Guide for Automotive Industries*, Available at URL: http://www.ecobiz.org/pdf/Keep-Shop.pdf

5. City of Toronto, *Environmental Regulations and Best Management Practices For Automotive Repair Operations in the City of Toronto.* Available at URL: http://www.toronto.ca/water/protecting_quality/pollution_prevention/pdf/automotive_repair.pdf

6. City of Toronto, *Environmental Regulations and Best Management Practices For Vehicle Wash Operations in the City of Toronto.* Available at URL: http://www.toronto.ca/water/protecting_quality/pollution_prevention/pdf/car_wash.pdf

7. GLOSSARY OF TERMS

Best Management Practices (BMPs) to reduce or eliminate pollutants encompass a wide range of activities including changes to materials or processes, operating procedures, housekeeping activities, and treatment techniques. BMPs may also include management activities, such as education and training, record-keeping and reporting, information systems, and communication with stakeholders, customers, and supply chain partners. BMPs can also include management approaches such as loss control programs and environmental management systems.

Canadian Environmental Protection Act 1999 (CEPA 1999) is federal legislation that was first created in 1988 and consolidated various pieces of 1970s environmental legislation.[19] In addition, CEPA 1999 added many new Ministerial authorities and obligations, including new requirements for risk assessment and risk management of toxic substances and a strengthened pollution prevention approach.

Criteria are the reference criteria identified for analysis. There are three reference criteria, with Reference Criteria 1 being the most stringent and Reference Criteria 3 the least stringent.

Environmental Management System (EMS)[20] refers to management systems focussed on the minimization of harmful effects on the environment caused by corporate activities. Management systems in general are part of an organization's structure for managing its processes or activities that transform inputs of resources into a product or service, which meet the organization's objectives, such as satisfying the customer's quality requirements, complying with regulations, or meeting environmental objectives. Environmental management is what the organization does to minimize harmful effects and to achieve continual improvement of its environmental performance.

Hazardous Substances refers to substances that are potentially harmful to the environment or human health and safety. Hazardous substances include substances considered toxic under the Canadian Environmental Protection Act 1999, as well as other substances of interest subject to international agreement and reporting requirements. Refer to the Appendices for a list of substances of particular interest in this series of BMP documents.

Industrial Facility Representatives may include any industrial employee or contractor of an industrial sector with responsibility, for example, for facility operations, facility design, public relations, compliance.

National Pollution Release Inventory (NPRI) is a database of information on annual releases to air, water, land, and disposal or recycling from all sectors -

[19] Refer to the CEPA 1999 Environmental Registry for more information at URL: http://www.ec.gc.ca/CEPARegistry/default.cfm

[20] Definition adapted from definitions by the International Organization for Standardization, URL: http://www.iso.org/iso/en/iso9000-14000/understand/inbrief.html

industrial, government, commercial, and others.[21] The NPRI is a national reporting system legislated under the Canadian Environmental Protection Act 1999.

Municipal Representatives may include any municipal employee or contractor with responsibility, for example, wastewater quality, wastewater infrastructure management, industrial sewer use programs, industrial relations, public outreach, and/or by-law enforcement.

NAICS Code is the North American Industry Classification System (NAICS), which assigns numerical codes to industrial sectors and sub-sectors in North America. This system has replaced an older system of classification, known as the U.S. Standard Industrial Classification (SIC) system. Statistics Canada uses the NAICS classification system in its analysis of industrial activities in Canada.

Pollution Prevention (P2) is "the use of processes, practices, materials, products, substances or energy that avoids or minimizes the creation of pollutants and waste, and reduces the overall risk to the environment or human health."[22]

Reference Criteria are the maximum desired final effluent concentrations for the harmful substances identified. Three reference criteria were identified for analysis in terms of pollution prevention measures and treatment measures required to achieve the reference criteria.

Rules of Thumb are sets of engineering estimates based on similar or related datasets, professional judgement, and stated assumptions. Rules of Thumb are applied where specific information is not available. In the absence of specific information, Rules of Thumb can be used to develop reasonable ranges of potential outcomes or effects resulting from actions taken (such as implementation of certain P2 or treatment measures, for example).

Substances of Interest are the potentially hazardous substances or toxic substances examined within this series of best management practices. Refer to the Appendices for a list of substances of particular interest in this series of BMP documents.

Supply Chain refers to the network of organizations that provide materials, products, and services to industrial sectors in order that the industry can produce, market, and sell its products. The supply chain can include organizations selling raw materials, organizations selling semi-finished and finished goods, retail outlets, customers, etc.

Treatment in this document refers to wastewater treatment processes used to remove or transform pollutants in the wastewater stream. Treatment is not

[21] See the NPRI website at URL: http://www.ec.gc.ca/pdb/npri/npri_home_e.cfm

[22] Definition in Guidelines for the Implementation of the Pollution Prevention Planning Provisions of Part 4 of the *Canadian Environmental Protection Act*, 1999 (CEPA 1999), National Office of Pollution Prevention, Environment Canada, 2001

considered a pollution prevention measure since it occurs after pollutants have been introduced or used in a process; pollutants that are present in a wastewater stream indicate that opportunities to prevent pollution have passed and treatment must therefore be used to reduce release of the pollutants to the environment.

APPENDIX A

BEST MANAGEMENT PRACTICES DOCUMENTS

APPENDIX A: BEST MANAGEMENT PRACTICES DOCUMENTS

Table A.1 identifies the available Best Management Practices Documents in this series, and the industrial sectors and harmful pollutants which are addressed in each.

Table A.1 Industrial Sectors and Substances Addressed in BMP Documents

Document Name	Sector and Sub-Sector Titles and NAICS Codes	Harmful Pollutants
Best Management Practices. Textiles Sector: Nonylphenol and its Ethoxylates and Chromium	Textiles Sector (313) Fibre, Yarn, Thread Mills Fabric Mills Textile and Fabric Finishing and Fabric coating	Nonylphenol and its ethoxylates Chromium
Best Management Practices. Fabricated Metal Product Manufacturing: Cadmium, Lead and Copper	Fabricated Metal Product Manufacturing (332) Forging and Stamping Architectural and Structural Metals Manufacturing Boiler, Tank and Shipping Container Manufacturing Spring and Wire Product Manufacturing Coating, Engraving, Heat Treating and Allied Activities Other Fabricated Metal Product Manufacturing	Cadmium Lead Copper
Best Management Practices. Motor Vehicle Parts Manufacturing: Cadmium and Nonylphenol and its Ethoxylates	Motor Vehicle Parts Manufacturing (3363) Motor Vehicle Gasoline Engine and Engine Parts Manufacturing Motor Vehicle Electrical and Electronic Equipment Manufacturing Motor Vehicle Metal Stamping Motor Vehicle Steering and Suspension Components (except Spring)Manufacturing Motor Vehicle Brake System Manufacturing Motor Vehicle Transmission and Power Train Parts Manufacturing	Cadmium Nonylphenol and its ethoxylates

Document Name	Sector and Sub-Sector Titles and NAICS Codes	Harmful Pollutants
Best Management Practices. Automotive Repair and Maintenance: Cadmium and PAHs	Automotive Repair and Maintenance (8111) Automotive Repair and Maintenance Automotive Body, Paint and Interior Repair and Maintenance Car Washes	Cadmium PAHs
Best Management Practices. Dry Cleaning and Laundry Services: Nonylphenol and its Ethoxylates, Cadmium, and Mercury	Dry Cleaning and Laundry Services (8123) Dry Cleaning and Laundry Services (except Coin-Operated) Linen and Uniform Supply	Nonylphenol and its ethoxylates Cadmium Mercury
Best Management Practices. Chemical Manufacturing Sector: Cadmium, Chromium, Copper, Mercury, Zinc, Nonylphenol and its Ethoxylates, and Vinyl Chloride	Chemical Manufacturing Sector (325) Basic Chemical Manufacturing (NAICS 3251); Pharmaceutical and Medicine Manufacturing (NAICS 3254); Soap, Cleaning Compound and Toilet Preparation Manufacturing (NAICS 3256) Other Chemical Product Manufacturing (NAICS 3257)	Cadmium Chromium Copper Mercury Zinc Nonylphenol and its ethoxylates Vinyl chloride
Best Management Practices. Chemical Manufacturing Sector: Resin, Synthetic Rubber, and Artificial and Synthetic Fibres and Filaments Manufacturing: Cadmium, Chromium, Copper, Mercury, Zinc, Nonylphenol and its Ethoxylates, and Vinyl Chloride	Chemical Manufacturing Sector (325) Resin, Synthetic Rubber, and Artificial and Synthetic Fibres and Filaments Manufacturing (NAICS 3252)	Cadmium Chromium Copper Mercury Zinc Nonylphenol and its ethoxylates Vinyl chloride

Document Name	Sector and Sub-Sector Titles and NAICS Codes	Harmful Pollutants
Best Management Practices. Chemical Manufacturing Sector: Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing: Cadmium, Chromium, Copper, Mercury, Zinc, and Nonylphenol and its Ethoxylates	Chemical Manufacturing Sector (325) Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing (NAICS 3253)	Cadmium Chromium Copper Mercury Zinc Nonylphenol and its ethoxylates
Best Management Practices. Chemical Manufacturing Sector: Paint, Coating, and Adhesive Manufacturing: Cadmium, Chromium, Copper, Mercury, Zinc, and Nonylphenol and its Ethoxylates	Chemical Manufacturing Sector (325) Paint, Coating, and Adhesive Manufacturing (NAICS 3255)	Cadmium Chromium Copper Mercury Zinc Nonylphenol and its ethoxylates
Best Management Practices. 1,4-Dichlorobenzene, 3,3-Dichlorobenzidine, Hexachlorobenzene, and Pentachlorophenol: Non-Sector Specific Practices	Not applicable.	1,4-Dichlorobenzene 3,3-Dichlorobenzidine Hexachlorobenzene Pentachlorophenol

APPENDIX B

TEMPLATES (TASK 5)

APPENDIX B – TEMPLATES (TASK 5)

To be provided upon completion of Task 5.

APPENDIX C

SUB-SECTOR DEFINITIONS

APPENDIX C – SUB-SECTOR DEFINITIONS

Definitions for the automotive repair and maintenance sub-sectors are: [23]

- Automotive Repair and Maintenance (NAICS 8111)

  This industry group comprises establishments primarily engaged in repairing and maintaining motor vehicles, such as cars, trucks, vans and commercial trailers.

- Automotive Body, Paint and Interior Repair and Maintenance (NAICS 811121)

  This Canadian industry comprises establishments primarily engaged in repairing, customizing and painting motor vehicle bodies, and repairing and customizing motor vehicle interiors. Excluded establishments from this NAICS group include those primarily involved in:

  – manufacturing motor vehicles and converting vehicles on a factory basis (336, Transportation Equipment Manufacturing)

  – glass replacement and repair (811122, Automotive Glass Replacement Shops)

- Car Washes (NAICS 811192)

  This Canadian industry comprises establishments primarily engaged in washing and cleaning motor vehicles.

[23] http://stds.statcan.ca/english/naics/2002/naics02-class-search.asp?criteria=8111 (accessed December 20, 2005)

APPENDIX D

AGREEMENTS FOR TOXIC REDUCTION AND SUBSTANCES OF CONCERN

APPENDIX D – AGREEMENTS FOR TOXIC REDUCTION AND SUBSTANCES OF CONCERN

Following is the list of agreements and programs identified by the Ontario MOE to be of particular concern. These agreements and programs were the impetus behind the development of this series of BMP documents.

- The 2002 Canada-Ontario Agreement respecting the Great Lakes Basin Ecosystem (COA), which identifies the goal of virtual elimination Tier I substances, reductions of Tier II substances and virtual elimination of 17 PAHs.
- The *Canadian Environmental Protection Act, 1999* (CEPA).
- The 1997 Bi-National Toxics Strategy (BNTS), signed by Environment Canada and the USEPA.
- The Ontario government's commitment to implement recommendation #32 of Commissioner O'Connor's Report on the Walkerton Inquiry Part 2 to support major wastewater plant operators to identify practical methods to reduce or remove heavy metals and priority organics that are not removed by conventional treatment.

The following hazardous substances are subject of the agreements identified above and/ or subject of potential concern due to environmental and human health effects. (Note that not all of these substances have been addressed in the series of BMP documents for the six sectors.)

Table D.1 Substances of Concern Subject to Agreements

Substance	COA	CEPA	BNTS
1,4-dichlorobenzene	Tier II	n/a	Level II
3,3-dichlorobenzidine	Tier II	Schedule 1	Level II
alkyl-lead	Tier I	n/a	Level I
cadmium	Tier II	n/a	Level II
chromium	n/a	n/a	n/a
copper	n/a	n/a	n/a
dioxins and furans	Tier I	n/a	Level I
hexachlorobenzene	Tier I	Schedule 1	Level I
hexachlorobutadiene/hexachloro-1,3-butadiene	n/a	Schedule 1	Level II
hexachlorocyclohexane	Tier II	n/a	Level II
lead	n/a	Schedule 1	n/a
mercury	Tier I	Schedule 1	Level I
nonylphenol and ethoxylates	n/a	Schedule 1	n/a
octachlorostyrene	Tier I	n/a	Level I
polynuclear aromatic hydrocarbons (PAHs)	Tier II	Schedule 1	Level II
pentachlorophenol	Tier II	n/a	Level II
vinyl chloride	n/a	Schedule 1	n/a
zinc	n/a	n/a	n/a

APPENDIX E

CASE STUDY EXAMPLES DEMONSTRATING BENEFITS OF P2 MEASURES

APPENDIX E: CASE STUDY EXAMPLES DEMONSTRATING BENEFITS OF P2 MEASURES

The following case studies pertain to facilities among the six industrial sectors of interest for this BMP series. The case studies demonstrate the reduction effectiveness of P2 measures for specific applications while, at the same time, demonstrating the benefits of undertaking P2 measures. Reference information is provided for further investigation of the case study experience.

Proponents are encouraged to document their experience with P2 measures for publication as case studies. Several organizations recognize leadership in Canada in the area of P2 implementation, including the Canadian Council of Ministers of the Environment (CCME).

Case Study for P2 Measure: Material Substitution

Hafner Inc., with four facilities in Granby, Quebec, is the largest Canadian manufacturer of furniture fabric and stretch knitted fabric. Material substitution enabled the company to reduce its nonylphenol and nonylphenol ethoxylated derivatives load from 6,800 kilograms in 2001 to 68 kilograms in 2003. The chemical oxygen demand (COD) of the wastewater was reduced from 210,000 kilograms per year to 110,000 kilograms per year. The reduction in COD reduced the annual effluent disposal costs by $15,000. For further information, see the following:

Environment Canada's Pollution Prevention Success Stories website: Hafner Inc.
http://www.ec.gc.ca/pp/en/storyoutput.cfm?storyid=111

Case Study for P2 Measure: Process Modification

Monsanto Company, Muscatine, Iowa Plant, is a large agricultural herbicide manufacturing facility. Through internal recycling and process modifications, the facility reduced wastewater biochemical oxygen demand (BOD) loading by 97 %. For further information, see the following:

U.S. Environmental Protection Agency's National Environmental Performance Track website: Performance Track Case Study Monsanto Company – Muscatine, Iowa Plant
http://www.epa.gov/performancetrack/tools/casestudies/MonsantoCaseStudy.pdf

Case Study for P2 Measure: Operating Procedures and Housekeeping

Hendersons Automotive Group, a major supplier of seating components, has implemented several good housekeeping measures which have helped raise pollution prevention consciousness among the 180 employees at the company's Melrose Park plant in South Australia. Cleaner production measures introduced have resulted in annual savings of $270,000. The measures cost a total of $309,000 and paid for themselves in only 18 months after implementation. For more information, see the following:

Australian Department of the Environment and Heritage's Eco-Efficiency and Cleaner Production website: Hendersons Automotive Group Cleaner Production – Continuous Improvement Programs
http://www.deh.gov.au/settlements/industry/corporate/eecp/case-studies/hendersons.html

Case Study for P2 Measure: Process Modification

Monroe Australia is a leading Adelaide-based manufacturer of shock absorbers and strut suspension units for the automotive industry. The company has implemented a major waste minimization strategy that has enabled it to process liquid waste, reduce water usage, reduce chemical and waste disposal costs, and eliminate pollution. It installed new equipment which treats wastewater to remove emulsified fats and oils, grease, heavy metals and all forms of suspended, colloidal and some dissolved solids. Monroe's mains water usage has been reduced by over 10 ML per year; wastewater discharge to sewer has been reduced by 50 percent. The new technology has produced a savings of $250,000 per year with total outlay of $530,000 for a payback period of approximately two years. For more information, see the following:

Australian Department of the Environment and Heritage's Eco-Efficiency and Cleaner Production website: Monroe Australia Pty Ltd Cleaner Production – Waste Minimisation Strategy
http://www.deh.gov.au/settlements/industry/corporate/eecp/case-studies/monroe.html

Case Study for P2 Measure: Process Modification and Operating Procedures

Specific Plating is a small metal finishing company where parts are plated with metals such as copper, nickel, zinc, silver, and gold. Specific Planting has dramatically reduced its sewer discharges of copper and nickel through pollution prevention efforts including both modifications of industrial processes and improved waste handling and treatment techniques. After the completion of the P2 projects, a reduction of approximately 88% for copper discharges and 85% for nickel discharges was achieved. Wastewater discharge flow has been reduced 27% and off-site sludge disposal has been reduced 53%.

Installation of equipment or changes in operating procedures required an investment of $63,000. Annual savings of $30,000 was realized with the payback period ranging from 1.5 years to just under 3 years. For more information, see the following:

City of Palo Alto's website: Pollution Prevention at Specific Plating Company
http://www.city.palo-alto.ca.us/public-works/documents/cb-specific.pdf