Follow-up Report on a PSL1 Substance For Which There Was Insufficient Information to Conclude Whether the Substance Constitutes a Danger to the Environment

Waste/Used Crankcase Oils

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List of Acronyms and Abbreviations

CCME	Canadian Council of Ministers of the Environment
CEPA	*Canadian Environmental Protection Act*
CEPA 1999	*Canadian Environmental Protection Act*, *1999*
CSA	Canadian Standards Association
CTV	Critical Toxicity Value
DIY	do-it-yourself oil changer
EEV	Estimated Exposure Value
EIHWR	Export and Import of Hazardous Wastes Regulations
ENEV	Estimated No-Effects Value
HWTG	Hazardous Waste Task Group
NOEC	No-Observed-Effect Concentration
OMEE	Ontario Ministry of Environment and Energy
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PSL	Priority Substances List
PSL1	first Priority Substances List
TEL	Threshold Effects Level
ULC	Underwriters’ Laboratories of Canada
UCO	used crankcase oils
WCO	waste crankcase oils

SYNOPSIS

Waste crankcase oils (WCO), which appeared on the first Priority Substances List (PSL1), were assessed to determine whether they should be considered "toxic" as defined under the *Canadian Environmental Protection Act* (CEPA). With the data available at that time, it was concluded in the PSL1 assessment that there was insufficient information to conclude whether WCOs constituted a danger to the environment under paragraph 11(a) of CEPA, due to lack of exposure and effects data for the selected scenarios of concern (i.e., re-refining, burning as fuel, dust suppressant and land disposal) (Government of Canada, 1994).

Various components of WCO are listed on Schedule 1, List of Toxic Substances, under CEPA 1999, including arsenic and its compounds; benzene; cadmium; chromium and its compounds; acidic, sulfidic and soluble inorganic nickel; PAHs; and lead.

Since the publication of the PSL1 report on WCO, no new exposure or effects data have been found in the literature for the above-noted scenarios. However, new information on exposure and effects from leakage of WCO from the crankcases of vehicles was found in the literature. Studies on roadway runoff provide a link between release of WCO from vehicles and effects on benthic organisms, which also include changes in the biodiversity of sediment fauna. As a result, this new information was used as a surrogate for the dust suppressant and land disposal scenarios to show possible effects on sediment biota and change in species diversity that can result from exposure to WCO.

For the purpose of the follow-up report, the name Waste Crankcase Oils (WCO) has been changed to Used Crankcase Oils (UCO) to better represent the substance assessed..

Based on the findings of the analysis of data published between 1993 and 2000 on the exposure and effects of used crankcase oils to aquatic ecosystems, it is concluded that used crankcase oils are entering the environment in a quantity or concentration or under conditions that have or may have an immediate or long-term harmful effect on the environment or its biological diversity. It is concluded that used crankcase oils be considered "toxic" under paragraph 64(a) of the *Canadian Environmental Protection Act, 1999* (CEPA 1999).

1.0 INTRODUCTION

Waste Crankcase Oils (WCO) appeared on the first Priority Substances List (PSL1) of the *Canadian Environmental Protection Act* (CEPA), which was published in the *Canada Gazette*, Part I, on February 11, 1989. WCO are defined as used lubricating oil removed from the crankcase of internal combustion engines. An assessment was completed in 1993 to determine whether WCO should be considered “toxic” as defined under CEPA (Government of Canada, 1994)[1]. The lack of exposure and effects data for the selected scenarios of concern (i.e., re-refining, burning as fuel, dust suppressant and land disposal) led to the conclusion that there was insufficient information available to determine whether this substance should be considered “toxic” under paragraph 11(a) of CEPA.

In 1994, a scoping exercise was initiated to determine a course of action for determining whether WCO should be considered CEPA “toxic.” The results of a 1995–1996 telephone survey showed that the Canadian Petroleum Products Institute, provinces, territories and federal government departments with vehicular fleets had initiated guidelines or legislation controlling the management of used oils, which included WCO. These controls included permits for re-refineries, contaminant emission standards for burning of used oil, banning of used oil for dust suppression, banning of disposal in landfills, on land or in sewers, and development of collection alternatives for do-it-yourself oil changers (DIYs).

As a follow-up to the 1995–1996 telephone survey, a second telephone survey of provincial, territorial, aboriginal and federal agencies in the fall of 1999 and winter of 2000 revealed that most of the initiatives were now legislated into law (see Appendix A).

A revised CEPA, CEPA 1999, came into effect on March 31, 2000. A review of scientific data published since the PSL1 report was released to March 2000 found new information on the exposure and effects of WCO, now referred to as Used Crankcase Oils (UCO)[2], that are discharged to the environment and runoff from roadways to aquatic ecosystems. This information was used to conduct a follow-up ecological risk assessment on UCO. Details of the literature search strategy are described in Appendix B.

New information on exposure and effects from leakage of UCO from the crankcases of vehicles was found in the literature. Studies on roadway runoff provide a link between release of UCO from vehicles and effects on benthic organisms, which also include changes in the biodiversity of sediment fauna. This new information was used as a surrogate to assess UCO used for dust suppression and UCO released through land disposal to show possible effects on sediment biota and change in species diversity as a result of exposure to UCO.

[1] The PSL1 Assessment Report for Used Crankcase Oils is available on the following websites: http://www.hc-sc.gc.ca/ewh-semt/pubs/contaminants/psl1-lsp1/crankcase_oils_huiles_moteur/index_e.html or http://www.ec.gc.ca/substances/ese/eng/psap/PSL1_waste_crankcase_oils.cfm.

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[2] The word “waste” has a preconceived condition, value or connotation while “used” more appropriately represents this substance.

2.0 ENTRY CHARACTERIZATION

UCO are generated by the following sectors: automotive (cars and trucks); railway (diesel locomotives); marine and aviation transportation (diesel-powered boats and piston-driven aircraft); mining and forestry (off-road vehicles and equipment); and agricultural (off-road machinery such as tractors) (CCME, 1989a; CH2M Hill Engineering Ltd., 1992). Estimates of the volume of UCO generated, however, are available only for the automotive sector. In 1990, the volume of crankcase oils sold in the automotive sector in Canada was estimated to be 413.3 million litres; 55% of this volume (227.1 million litres) was for gasoline engines, and 45% (186.3 million litres) was for diesel engines (CPPI, 1993). Private vehicles use approximately 75% (170.3 million litres) of crankcase oils sold for gasoline engines, and light commercial vehicles that run on gasoline or propane use the remaining 25% (56.8 million litres). Heavy commercial on-road vehicles use 70% (130.4 million litres) of the crankcase oils sold for diesel engines, and industrial off-road vehicles use the remaining 30% (55.9 million litres) (CH2M Hill Engineering Ltd., 1992).

Various components of UCO are on the List of Toxic Substances in Schedule 1 of CEPA 1999, including arsenic and its compounds; benzene; cadmium; chromium and its compounds; acidic, sulfidic and soluble inorganic nickel; polycyclic aromatic hydrocarbons (PAHs); trichloroethylene; tetrachloroethylene; 1,1,1-trichloroethane; lead; and polychlorinated biphenyls (PCBs) (CCME, 1989b; Environment Canada, 1993). Concentrations of these substances in UCO are listed in Section 3.2.

The environment may be subjected to releases from both non-recoverable UCO (e.g., uncontrolled discharge) and recoverable UCO (e.g., land disposal). In 1990 there was an estimated 229 million litres of recoverable UCO in Canada (CCME 1993). Use and disposal percentages for the 229 million liters of recoverable UCO have been estimated as follows: re-refining (50.6%); fuel, including small space heaters (33.6%); landfill (7.2%); dust suppression (2.97%); land disposal (2.8%); sewers (1.75%); and unknown (1.08%) (CH2M Hill Engineering Ltd., 1992). While these estimates are dated, the number of vehicles has increased significantly over the past 11 years, as has the use of crankcase oils.

A significant amount of recoverable UCO is lost to the environment due to improper management practices of DIYs who change their own oil. A CCME (1993) fact sheet on recycling indicates that in 1990, DIYs and farm/rural consumers with large equipment together accounted for 90% of the 100 million litres of UCO lost to the environment.

Although no new data are available for the amount of UCO used for dust suppression, it is expected to be smaller than the estimated amount used in 1990 due to provincial and territorial bans on this practice (see Appendix A). UCO normally collected for this practice may now be sent to re-refineries or burned as fuel at provincially licensed facilities.

Tracking of the transboundary movement of waste oils under the Export and Import of Hazardous Wastes Regulations indicates that a significant amount consists of UCO (Code, 2001). A total of 14 800 tonnes of waste oils was exported from Canada to the United States between 1997 and 1999. In this same time period, 201 tonnes were imported from the United States, to be used either for re-refining or for fuel for energy recovery (Code, 2001).

2.1 Re-refining

No information was identified regarding the amounts of residual UCO found in re-refinery effluents, solid wastes or air emissions. In 1990, 116 million litres of UCO were sent for re-refining (CH2M Hill Engineering Ltd., 1992). No new information on the amount sent for re-refining was identified.

2.2 Fuel

In 1990, 75.4 million litres of recoverable UCO were sent for use as industrial boiler fuel and 1.6 million litres were sent for use in space heaters (CH2M Hill Engineering Ltd., 1992). Discussions with provincial contacts indicate that there are probably several thousand oil-burning space heaters in use across Canada, predominantly in service stations where oil changes are conducted (Armiento, 1999; Nadeau, 1999).

2.3 Dust suppressant

As of 2000, the practice of using UCO as a dust suppressant has been banned (or continues to be banned) in eight provinces and three territories (see Appendix A). Therefore, it is expected that the amount of UCO applied for dust suppression has been reduced significantly from the amount of 6.8 million litres applied to roads in 1990 (CH2M Hill Engineering Ltd., 1992).

2.4 Land disposal

In 1990, UCO were released to the environment by DIY (0.2 million litres) and off-road fleet shops (6.2 million litres) (CH2M Hill Engineering Ltd., 1992). There is no new information on the amount of UCO disposed of on land. However, this remains a direct route for the entry of UCO into the environment.

3.0 EXPOSURE CHARACTERIZATION

3.1 Environmental fate

The fate of UCO in the environment depends on how they are managed and re-used. For example, when UCO are re-refined, the potential environmental exposure pathways are via air, receiving waters and solid waste from the re-refining facility. Similarly for fuel, exposure is via air and ash. For dust suppression and land disposal, key exposure routes are via land and runoff to water. When used for dust suppression, only 1% of the estimated amount of used mineral-based crankcase oil applied to two rural roads in New Jersey remained on the top 2.5 cm of the road surface material (Freestone, 1979). The majority of oil runoff from road surfaces was during the first few rainfalls following the oil application. During dry periods, the primary forms of transport were volatilization and dust transport. Dust particles may be carried by wind and may contaminate crops located near the oiled roads (ATSDR, 1997). In general, biodegradation on road surfaces is minimal compared with losses from volatilization and runoff (ATSDR, 1997). In rural areas, the most common way to dispose of oil was pouring onto gravel roads and driveways (ATSDR, 1997).

The types of PAHs present in UCO can provide a fingerprint to distinguish the source of combustion (i.e., on-road vehicles vs. other combustion sources, such as home heating oil, coal and wood) (O'Malley *et al*., 1996; Barrie *et al*., 1997). Advances in analytical chemistry allow the identification of specific PAHs to provide a better understanding of the sources of petroleum hydrocarbons in urban runoff, specifically whether PAHs in environmental samples are attributable to UCO. Latimer *et al.* (1990) analysed samples of petroleum products and probable source materials (e.g., roadside soil, street dust, roadside vegetation, atmospheric deposition) for hydrocarbons and trace metals and compared them with urban runoff samples from four different land use sites — commercial, residential, interstate highway and industrial — in various cities in Rhode Island in the United States. The chromatographic distributions of saturated and aromatic hydrocarbons revealed that PAHs in urban runoff at all four land use sites primarily originated from UCO. The PAHs in the UCO were two- to six-ring aromatics composed of approximately 36% fluoranthene and 38% pyrene, with smaller amounts (about 12–14%) of the benzopyrenes.

PAHs in stormwater runoff, where about 95% of the total aromatics were associated with the particulate phase, may be attributed primarily to UCO (MacKenzie and Hunter, 1979; Carr *et al*., 2000). In a study performed by O'Malley *et al.* (1996), the primary sources of PAHs to marine surface sediments of St. John's Harbour, Newfoundland, were quantitatively assessed using a combination of molecular abundance and carbon isotope measurements of individual (four- and five-ring) PAHs. Mass balance calculation using a two-component mixing model showed that approximately 20–50% of four- and five-ring PAHs detected in the sediments originated from UCO that originated from the crankcases of vehicles and entered the harbour in surface runoff (O'Malley *et al*.1996).

3.2 Environmental concentrations

Various components of UCO are listed on Schedule 1 under CEPA 1999 and were found in the following concentrations (μg/g wet weight): arsenic (<6.67); benzene (28); cadmium (0.479–0.93); chromium (1–21); PAHs, including pyrene (<0.128–326), phenanthrene (<0.224) and fluoranthene (<0.19–109); nickel (≤2); and lead (8.5).[3] Schedule 1 substances that may be

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[2] This value represents the lower boundary of the concentration of lead in gasoline taken from a sample of UCOs

found in UCO as contaminants include trichloroethylene (84); tetrachloroethylene (453); 1,1,1-trichloroethane (445); and PCBs (0–38 000) (CCME, 1989b; Environment Canada, 1993).

3.2.1 Dust suppressant and land disposal

No new monitoring data were found for the dust suppressant or disposal on land scenarios. However, data from Maltby *et al*. (1995a), O'Malley *et al*. (1996), Marsalek *et al*. (1997), and Abrajano (2000) on concentrations of UCO in roadway runoff from vehicles leaking UCO can be used as a surrogate for dust suppressant and land disposal concentrations released to the environment. This is possible since the route of entry from vehicular leakage of UCO is the same as that for dust suppressant application and dumping on land, except the quantities involved for the two latter scenarios are expected to be considerably greater than that from roadway runoff.

Abrajano (2000) reported sediment concentrations for pyrene, fluoranthene and phenanthrene in ongoing work on source inputs of PAHs to the St. Lawrence River. By combining the molecular approach of identifying source inputs of PAHs with the compound-specific carbon isotope ($^{13}C/^{12}C$) signatures, it is possible to obtain a more quantitative assessment of the sources for PAHs in natural sedimentary environments (O'Malley, 1994; O'Malley *et al*., 1994). Table 1 lists sampling sites in the St. Lawrence River where petroleum-source PAHs were obtained. Using the carbon isotope apportionment model, the percentage of PAHs in these samples attributed as originating from UCO is listed. Multiplication of total petroleum PAHs by the fraction of PAHs originating from UCO provides the corresponding absolute contribution of UCO to the sediment inventory of PAHs. The fraction of PAHs originating from UCO was derived by mass balancing the carbon isotopes. For example, the total petroleum PAH concentration for pyrene in a sample taken near Cornwall is 1.558 µg/g dry weight and the percent UCO-derived PAHs is 56; therefore, the concentration of PAHs that originated from UCO at this site is 1.558 × 0.56 = 0.872 µg/g dry weight. The likely source of UCO in sediment is runoff from roadways. Leaching of PAHs from asphalt was not considered a significant contributing factor. While contribution from land disposal, dust suppression and sewer release is possible, an actual amount is not known (Abrajano, 2000).

Table 1 Concentrations of three petroleum-derived PAHs found in sediment in the St. Lawrence River and percentage attributable to UCO

Site	**Concentration of petroleum-derived PAHs in sediment (µg/g dry weight)**			**% UCO**	**Concentration of UCO-derived PAHs in sediment (µg/g dry weight)**		
	Phenanthrene	**Fluoranthene**	**Pyrene**		**Phenanthrene**	**Fluoranthene**	**Pyrene**
Off Kingston	0.975	1.055	0.892	12	0.117	0.127	0.107
Cornwall	1.822	2.211	1.558	56	1.020	1.238	0.872
Maitland	1.239	1.186	1.054	34	0.421	0.403	0.358

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before the lead in gasoline limit of 5 mg/L came into effect in 1990 (Environment Canada, 1990). More recent data on concentrations of lead in UCOs were not found.

In a study on highway runoff from the James N. Allen Skyway Bridge in Burlington, Ontario, Marsalek *et al*. (1997) reported maximum sediment event mean concentrations for pyrene, fluoranthene and phenanthrene of 3.00, 4.03 and 3.88 µg/g dry weight, respectively. The sediment event mean concentration is a constituent of the concentration and is calculated as the concentration mass in the storm runoff event divided by the event runoff volume. In this study, composite flow proportional samples were collected whereupon analysis of these samples yields the sediment event mean concentration directly. These sediment event mean concentrations represent averages of “instantaneous” concentrations (Marsalek, 2000).

In a British study by Maltby *et al*. (1995a), concentrations of PAHs in sediments collected at the Pigeon Bridge Brook location downstream from a major motorway were 10.16 µg/g wet weight for pyrene, 3.2 µg/g wet weight for fluoranthene and 5.62 µg/g wet weight for phenanthrene. Downstream sediments at this same location also contained significantly elevated median concentrations (µg/g dry weight) of metals compared with samples taken upstream of the motorways, as follows: zinc — 137 (upstream), 338 (downstream); cadmium — 0.93 (upstream), 2.28 (downstream); lead — 86 (upstream), 133 (downstream); and chromium — 21 (upstream), 76 (downstream). Carbonyl compounds were also present in contaminated sediments but were absent from uncontaminated sediments.

Latimer *et al*. (1990) reported that the mean concentrations (µg/g dry weight) of total weighted hydrocarbons (includes PAHs) in particulates from urban runoff from four types of land use sites in Rhode Island were as follows: industrial, 211 000; commercial, 248 000; interstate highway, 248 000; and residential, 42 000. Latimer *et al.* (1990) also measured hydrocarbon and metal concentrations originating from UCO in four source materials: street dust, roadside soil, vegetation and atmospheric deposition. Taken together, the street dust, roadside soil, vegetation and atmospheric deposition accounted for 20% of the particulate in urban runoff. Yet the urban runoff from the various land uses had higher concentrations of UCO and PAHs than did the source materials. Direct dumping of oil down storm drains by DIYs was expected to account for the difference in hydrocarbon concentration (including PAHs) between urban runoff and source materials (Latimer *et al*., 1990). The same explanation for the difference in hydrocarbon concentrations was also suggested in a survey in the same geographic location by Hoffman *et al.* (1980). The PAH distributions in the source materials were similar for all four land uses. Phenanthrene, fluoranthene and pyrene were the dominant compounds, with approximately 20% of the total being the benzopyrenes (Latimer *et al*., 1990).

Metal concentrations in urban runoff were also measured, and their concentrations and chemical distributions in the runoff and the source materials were similar. In roadside source materials, concentration ranges, in dry weight, were 0.02–3.40 µg/g particulate matter for cadmium, 10.4–228 µg/g for copper, 123–1410 µg/g for lead and 47.8–655 µg/g for zinc (Latimer *et al.*, 1990).

3.2.2 Re-refining

No new monitoring data were found for this scenario.

3.2.3 Fuel

No new monitoring data were found for this scenario.

4.0 EFFECTS CHARACTERIZATION

In addition to previously existing reports (Ingersoll *et al*., 1993), new data identify constituents of UCO (particularly the PAHs, such as pyrene, fluoranthene and phenanthrene) as causal agents in the toxicity of sediment biota (Maltby, 1995a,b; Lefcort *et al*., 1997; Marsalek *et al*., 1997; Environment Canada, 1999; Forrow and Maltby, 2000). Following evaluation of these studies, the study by Ingersoll *et al*. (1993) is the basis for determining the Critical Toxicity Value (CTV).

Maltby *et al.* (1995a) investigated the effects of motorway runoff on the water quality, sediment quality and biota of small streams over a 12-month period in the United Kingdom. Sediment quality results indicated that the concentration of PAHs was elevated at all the sites receiving motorway drainage. Of seven streams sampled, macroinvertebrate biodiversity was reduced in four of the stations receiving road runoff of UCO. The reduction was significant only at a stream (Pigeon Bridge Brook) receiving drainage from a 1500-m stretch of the M1 motorway. A decrease in the number of macroinvertebrate taxa present in the stream below the motorway runoff discharge was observed. There was a loss of pollution-sensitive taxa below the motorway discharge and a change from an assemblage of benthic algae dependent on coarse particulate organic matter to one dependent upon fine particulate organic matter and dominated by taxa known as collectors. The diversity of the hyphomycete assemblage was significantly increased downstream of the discharge. Moreover, there was a significant reduction in the loss of leaf material from coarse-mesh bags deployed at the downstream station, suggesting an inhibition of leaf decomposition by macroinvertebrates. There was little evidence to suggest that changes in the physical structure of the habitat or reductions in the abundance of macroinvertebrate food sources were responsible for the observed changes in the macroinvertebrate distributions. However, subsequent investigations indicated that direct toxicity and contaminant-induced changes in food quality were important in determining macroinvertebrate abundance (Forrow and Maltby, 2000).

As a follow-up to this study, Maltby *et al.* (1995b) assessed the toxicity of sediments and water contaminated with motorway runoff to identify the group(s) of chemical compounds responsible for the observed toxicity. The experiments were concentrated on the benthic amphipod *Gammarus pulex* at the Pigeon Bridge Brook study site. Stream water contaminated with motorway runoff did not cause any harmful effects on *G. pulex*. However, exposure to contaminated sediments resulted in a slight but significant increase in mortality over 14 days, with a consistent 10.3% average mortality (experiment repeated three times) at the downstream site (compared with =5% mortality at the upstream control site). Sediment manipulation experiments indicated that most of the observed toxicity at the downstream site was due to the fraction containing PAHs.

Marsalek *et al*. (1997) collected samples of stormwater runoff from the James N. Allen Skyway Bridge in Burlington, Ontario, and analysed for five heavy metals and 14 PAHs in dissolved and particulate-bound phases. Dissolved-phase PAHs represented less than 11% of whole-water concentrations, while the remaining PAHs were bound to the particulate fraction of the highway runoff. While the results of the study indicated that heavy metals were the major pollutants, the authors indicated that there is the potential for chronic toxicity effects from PAHs in sediment due to their persistence in the sediment and continual addition of PAHs over time (Marsalek *et al.*, 1997).

A 28-day flow-through sediment toxicity test was conducted on the benthic amphipod *Hyalella azteca* with whole sediment taken from the Clark Fork River in Montana (United States) and tested for effects due to 16 PAHs, including pyrene, fluoranthene and phenanthrene (Ingersoll *et al.*, 1993). *H. azteca* is typically more sensitive than *Chironomus riparius* to contaminated sediments (Ingersoll and Nelson, 1990; Nelson *et al.*, 1993). In this study, relative sensitivity (most sensitive to least sensitive) of test organisms was as follows: *H. azteca* > *C. riparius* > *Oncorhynchus mykiss* > *Daphnia magna*. The results of the 28-day whole-sediment toxicity tests indicated that phenanthrene, fluoranthene and pyrene caused significant harmful effects (95% mortality in mature adult males) on *H. azteca* at concentrations of 0.050, 0.083 and 0.083 µg/g dry weight, respectively (Ingersoll *et al.*, 1993). *H. azteca* is also a relevant Canadian species. These values are very close to the Threshold Effects Level (TEL) that is used in developing the Canadian sediment quality guidelines for PAHs (CCME, 1999). Using the modified U.S. National Status and Trends Program approach (Long and Morgan, 1991), TELs for pyrene, fluoranthene and phenanthrene have been calculated as 0.053, 0.111 and 0.0419 µg/g dry weight, respectively (CCME, 1999; Environment Canada, 1999).

Indirect effects of UCO were also recorded in the literature. One of four experiments by Lefcort *et al.* (1997) was a micromesocosm study in which 5-week-old salamander (*Ambystoma opacum* and *A. tigrinum*) larvae were placed in artificial ponds that were inoculated with plankton from the salamanders' native pond. Only one concentration of UCO (i.e., 100 mg/L) was tested aside from the control. Oil was added at monthly intervals to compensate for degradation after 13 weeks. After 13 weeks, the animals were sampled for length and weight, and the experiment was terminated shortly thereafter. Animals in the control treatment were larger than animals exposed to UCO and also had longer snout to vent lengths, longer total lengths and wider heads. The authors concluded that the toxicity was indirect, as the food source, i.e., algae, grew slower due to the presence of the oil, thereby affecting the size and weight of the salamanders.

5.0 ASSESSMENT OF "TOXIC" UNDER CEPA 1999

The environmental risk assessment of a PSL substance is based on the procedures outlined in Environment Canada (1997). Analysis of exposure pathways and subsequent identification of sensitive receptors are used to select environmental assessment endpoints (e.g., adverse reproductive effects on sensitive fish species in a community). For each endpoint, a conservative Estimated Exposure Value (EEV) is selected and an Estimated No-Effects Value (ENEV) is determined by dividing a CTV by an application factor. A hyperconservative or conservative quotient (EEV/ENEV) is calculated for each of the assessment endpoints in order to determine whether there is potential ecological harm in Canada. If these quotients are less than one, it can be concluded that the substance poses no significant risk to the environment, and the risk assessment is completed. If, however, the quotient is greater than one for a particular assessment endpoint, then, for most substances, the risk assessment for that endpoint proceeds to an analysis where more realistic assumptions are used and the probability and magnitude of effects are considered. This latter approach involves a more thorough consideration of sources of variability and uncertainty in the risk analysis.

5.1 Assessment endpoints

Analysis of exposure pathways for UCO and subsequent identification of sensitive receptors were used to select environmental assessment endpoints. In this evaluation, the assessment endpoints of interest were adverse effects on populations of benthic species.

5.2 Environmental risk characterization

5.2.1 Dust suppressant and land disposal

The dust suppressant and land disposal scenarios involve releases directly to the roadway and land. Since leakage from crankcase oils is a direct release to the roadway, new effects and exposure data from this source will be used as a surrogate for the dust suppressant and land disposal scenarios. In turn, pyrene, fluoranthene and phenanthrene will be used as representative components of UCO to determine whether UCO are harmful to the Canadian environment as defined under CEPA 1999.

In field situations, Landrum *et al.* (1991) suggested that for mixtures of PAHs, the toxic mode of action is additive, with no overt evidence of synergism or antagonism. This indicates that the molar concentration of a single PAH (e.g., pyrene) required to produce toxicity is the same if the PAH (pyrene) is the only substance in the sediment or if the PAH (pyrene) is found in a mixture with other PAHs in the sediment (Environment Canada, 1999). The toxicity of a complex substance can be determined by identifying constituents with similar modes of action and by calculating their joint toxicity (Environment Canada, 1997). Therefore, the ratio of each constituent concentration (EEV) and toxicity (ENEV) is calculated separately and reported as the Toxic Unit. The Toxic Units for pyrene, fluoranthene and phenanthrene will be summed to determine the total toxicity of these PAHs in UCO.

5.2.1.1 Risk analysis for pyrene, fluoranthene and phenanthrene, and total toxicity

Concentrations of pyrene, fluoranthene and phenanthrene in St. Lawrence River sediment were identified as originating from UCO. The conservative EEV for benthic organisms is 0.872 µg/g for pyrene, 1.238 µg/g for fluoranthene and 1.020 µg/g for phenanthrene and represents the highest reported concentration for these three PAHs that originates from UCO (see Table 1) (Abrajano, 2000).

The most sensitive freshwater organism found in the literature was the benthic amphipod *Hyalella azteca*, with 95% mortality in mature adult males in a 28-day sediment toxicity test using field sediment at a concentration of 0.083 µg pyrene/g dry weight (Ingersoll *et al*., 1993). This study is considered as the CTV. The ENEV is determined by dividing the CTV by an application factor of 10 to account for inter- and intraspecies variability, uncertainty surrounding the extrapolation from a 95% mortality effect to a No-Observed-Effect Concentration (NOEC) and extrapolation from laboratory to field conditions. An additional application factor of 10 is used to account for the presence of other components of UCO. Dividing the CTV of 0.083 µg/g dry weight by the resulting application factor of 100 yields an ENEV of 0.000 83 µg/g. The conservative quotient for pyrene, fluoranthene and phenanthrene is calculated by dividing the EEV by the ENEV for each of the three PAHs. Table 2 illustrates the development of this risk analysis.

Table 2 Summary of the conservative risk analysis for UCO using *Hyalella azteca*

PAH	EEV (µg/g dry weight in sediment)	CTV (µg/g dry weight)	Application factors		ENEV (µg/g dry weight)	Quotient (EEV/ENEV)
			Inter- and intraspecies variation; 95% mortality to NOEC; laboratory to field	Other components of UCO		
Pyrene	0.872	0.083	10	10	0.000 83	1051
Fluoranthene	1.238	0.083	10	10	0.000 83	1492
Phenanthrene	1.020	0.050	10	10	0.000 50	2040
Total toxicity						**4583**

5.2.2 Re-refining

No monitoring or effects data were available for this scenario. However, wastewater effluents and solid waste from re-refineries can be expected to contain trace metals, dissolved phenols, chlorinated solvents, PAHs and other organics, as well as suspended or emulsified oil (U.S. EPA, 1974; Surprenant *et al.*, 1983; Franklin Associates Ltd., 1985). Since PAHs, such as pyrene, fluoranthene and phenanthrene, are likely major components of the UCO and if released into the effluent, then it is possible that the effluent could have direct effects on sediment biota and cause a change in species diversity.

5.2.3 Fuel

Emissions of heavy metals and PAHs from commercial combustion units are regulated by most provincial/territorial jurisdictions (see Appendix A). Concerns arise regarding smaller oil-burning space heaters that are not maintained and, as a result, cause emissions of heavy metals and PAHs to the environment. In a 1994 province-wide survey of space heaters (waste-derived fuel furnaces), 352 of 422 (i.e., 83%) were in non-compliance with the Ontario Ministry of Environment and Energy's *Environmental Protection Act* regulations (OMEE, 1995). All 52 waste-derived fuel incinerators in eastern Ontario were out of compliance based on the results of this survey (OMEE, 1994). Reasons for non-compliance included failure to obtain a Certificate of Approval, paperwork burden and lack of maintenance of the space heaters. From discussions with provincial contacts, it is apparent that there are probably a few thousand of these units in use across Canada — predominantly in service stations where oil changes are conducted. The level of compliance across Canada is not known. Pyrene, fluoranthene and phenanthrene found in the Arctic have been determined to originate mainly from the burning of oil, coal and wood (Barrie *et al*., 1997). Therefore, unmaintained combustion sources using UCO may be contributing to PAH concentrations in the Arctic (Jensen *et al*., 1997).

5.2.4 Status of Canadian Provincial, Territorial and Federal Initiatives for Used Crankcase Oils

The concern over the hazardous nature of UCO has been captured in various government initiatives, from guidelines to regulations, within Canada and internationally, to control the release of UCO to the environment (see Appendices A and C).

Information from other jurisdictions indicates that reducing releases of UCO to the environment is an important issue. Used oils (including UCO), in general, are of concern to provincial, territorial, aboriginal and federal jurisdictions. The Canadian Council of Ministers of the Environment (CCME) has developed guidelines to control used oils, which include UCO. Internationally, Canada, as a signatory to the Basel Convention, has agreed to control the movement of used oils, including UCO, as a hazardous substance in order to protect human health and the environment. The Export and Import of Hazardous Wastes Regulations were the means by which Canada was able to ratify the Basel Convention and implement the conditions of the Organisation for Economic Co-operation and Development Council Decision (92)39/Final concerning the control of transboundary movements of wastes destined for recovery operations (see Appendix C). The main reasons for initiating controls were the leachable amounts of lead, PAHs and chlorinated hydrocarbons in the used oils, especially given the large volumes of used oils in circulation (Wittwer, 2000).

5.2.5 Other CEPA "toxic" substances

The following substances are listed under Schedule 1, List of Toxic Substances, of CEPA 1999 and are components of UCO: arsenic and its compounds; benzene; cadmium; chromium and its compounds; acidic, sulfidic and soluble inorganic nickel and PAHs. Most of these substances were found to be CEPA "toxic" due to the exposure of sensitive organisms to them in the water or the sediment phase. The PAHs Assessment Report (Government of Canada, 1994b), in particular, identified a change in biodiversity of sediment-dwelling organisms as one of the reasons to conclude for CEPA "toxic." Other CEPA Schedule 1 substances also found in UCO include lead (gasoline engine blow-by, from normal engine wear and as the additive, lead naphthenate) and trichloroethylene, tetrachloroethylene, 1,1,1-trichloroethane and PCBs (as contaminants in collection activities). The presence of all of these substances in UCO likely contributes to the toxicity of UCO (Maltby *et al*., 1995b).

5.3 Sources of uncertainty

There are several sources of uncertainty associated with the environmental assessment of UCO. Due to the numerous possible sources of entry of UCO into the environment, concentrations of UCO in some areas in Canada could be higher than those identified. Concentrations of pyrene, fluoranthene and phenanthrene that were attributed to originating from UCO were used to make the link to the presence of UCO in the sediment. While these PAHs in sediments are from UCO, it is not certain whether they originate totally from crankcases or originate from other sources, such as air deposition of combustion sources using UCO as fuel or from vehicle exhaust emissions of UCO. There were no acute or chronic toxicity studies for whole UCO on benthic organisms. Therefore, the toxicity of UCO constituents pyrene, fluoranthene and phenanthrene to benthic organisms was used as a surrogate for whole-UCO toxicity. There is uncertainty in the extrapolation from available toxicity data to potential ecosystem effects. To counter uncertainties in extrapolation, application factors were used in the environmental risk analysis to derive an ENEV.

5.4 Conclusion

Based on the findings of the analysis of data published between 1993 and 2000 on the exposure and effects of used crankcase oils to aquatic ecosystems, it is concluded that used crankcase oils are entering the environment in a quantity or concentration or under conditions that have or may have an immediate or long-term harmful effect on the environment or its biological diversity. It is concluded that used crankcase oils be considered “toxic” under Paragraph 64(a) of the *Canadian Environmental Protection Act, 1999* (CEPA 1999).

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APPENDIX A. STATUS OF THE MANAGEMENT OF USED OIL[1] IN CANADIAN PROVINCES AND TERRITORIES BY RELEASE CATEGORY (DECEMBER 1999)

Province/ territory	**Re-refineries**	**Burning**	**Dust suppression**	**Land disposal**
Yukon	No re-refineries; some UCO shipped south; *Yukon Environment Act*, Special Waste Regulations	Allowed — *Yukon Environment Act*, permit under Special Waste Regulations, contaminant levels specified	Banned — policy ban not to issue a special waste permit under the *Yukon Environment Act*, Special Waste Regulations	Prohibited — *Yukon Environment Act*, Special Waste Regulations
Northwest Territories	No re-refineries; some UCO shipped south; *Environmental Protection Act*, draft Used Oil/Waste Fuel Regulations (expected to be proclaimed in fall 2001 and come into force in Spring 2002)	Allowed — proposed under the *Environmental Protection Act*, draft Used Oil/Waste Fuel Regulations (expected to come into force in Spring 2002) requiring use of equipment approved by Canadian Standards Association (CSA) and Underwriters' Laboratories of Canada (ULC); open burning will be prohibited	Banned — Guidelines for Dust Suppression do not allow road oiling; *Environmental Protection Act*, draft Used Oil/Waste Fuel Regulations to prohibit it	Prohibited — *Environmental Protection Act*, draft Used Oil/Waste Fuel Regulations will prohibit disposal on land or in landfills
Nunavut	No re-refineries	Permitted in CSA- or ULC-approved devices designed for the purpose; proposed Used Oil and Waste Fuel Management Regulations (Nunavut intends to adopt this legislation once in force in the Northwest Territories, anticipated for late 2001 or early 2002) will further govern emissions — periodic testing and maximum limits will be implemented	Prohibited — Guidelines for Dust Suppression do not allow road oiling (legislation adopted from the Northwest Territories); *Environmental Protection Act*, draft Used Oil and Waste Fuel Management Regulations to prohibit it	Prohibited — *Environmental Protection Act*, draft Used Oil and Waste Fuel Management Regulations will prohibit disposal on land or in landfills

Province/ territory	**Re-refineries**	**Burning**	**Dust suppression**	**Land disposal**
British Columbia[2]	One re-refinery (changed ownership in 1999); permits issued under the *Waste Management Act* for effluent discharges from the facility to the environment, air emissions controlled under local (Greater Vancouver Regional District) Air Regulations, also pursuant to the *Waste Management Act*	Allowed — Burning as a fuel is authorized by the Special Waste Regulation (pursuant to the *Waste Management Act*); consideration is being given to amending the Special Waste Regulation to prohibit burning in space heaters	Banned — *Waste Management Act*, Special Waste Regulation 1988, amended 1992	Prohibited — *Waste Management Act*
Alberta	One re-refinery and two reprocessing facilities; *Environmental Protection and Enhancement Act*, Waste Control Regulations, limits disposal options; Activities Designation Regulations Schedule 1: Division 1: Waste Management controls re-refineries	Allowed — *Environmental Protection and Enhancement Act*, approvals required under Activities Designation Regulations Schedule 1: Division 1: Waste Management; "a code of practice for the production of alternative fuel and the burning of fuel derived from waste" (draft) has been developed	Allowed — Interim Guidelines for the Application of Used or Waste Refined Oil to Road Surfaces for Dust Control recommend contaminant limits; continued use of used or waste oil on roads was reviewed and guidelines were revised in April 1999	Prohibited — *Environmental Protection and Enhancement Act*
Saskatchewan	Two reprocessing facilities; *Environmental Management and Protection Act*, *Clean Air Act*: permits required	Allowed — *Environmental Management and Protection Act* and *Clean Air Act*, permits required under Clean Air Regulations	Banned — *Environmental Management and Protection Act*, Hazardous Substances and Waste Dangerous Goods Regulations, Used Oil Collection Regulations	Prohibited — *Litter Control Act*; *Dangerous Goods Transportation Act* and Regulations; *Environmental Management and Protection Act*, Used Oil Collection Regulations

Province/ territory	**Re-refineries**	**Burning**	**Dust suppression**	**Land disposal**
Manitoba	One reprocessing facility; *Dangerous Goods Handling and Transportation Act*; *Environment Act*; *Waste Reduction and Prevention Act*, controls re-refineries and reprocessing facilities	Allowed — *Dangerous Goods Handling and Transportation Act*, draft provincial policy also allows burning in space heaters under tightly controlled conditions	Banned — *Dangerous Goods Handling and Transportation Act*	Prohibited — *Dangerous Goods Handling and Transportation Act*
Ontario	One re-refinery: *Environmental Protection Act*, Regulation 347, also grants an exemption to simplify collection and transportation of used oil to re-refinery	Allowed — *Environmental Protection Act*, Regulation 347, also allows burning in small space heaters; however, no new approvals will be issued for space heaters that burn used oil; burning used oil is still allowed in other industrial uses (e.g., cement kilns) subject to regulatory approvals	Banned — *Environmental Protection Act*, Regulation 347	Prohibited — *Environmental Protection Act*
Quebec	No re-refineries; *Environmental Quality Act*; 75% of recoverable oil is effectively recovered (=38% of vehicle oil); 57% of recovered oil goes for energy recovery; 43% is re-refined	Allowed — *Environmental Quality Act*, Hazardous Materials Regulations for large burning units only (>10 MW), Hazardous Waste Regulations allow burning of used oil in greenhouses	Banned — *Environmental Quality Act*, Hazardous Waste Regulations	Prohibited — *Environmental Quality Act*, Hazardous Waste Regulations
New Brunswick	Reprocessing facilities; *Clean Air Act*, draft Used Oil Handling Regulations (to be presented to cabinet in Summer 2001); air emissions and effluents controlled under Regulations 97-133 and 82-126, respectively	Allowed — *Clean Environment Act*, Air Quality Regulation, Certificate of Approval required for large burners, small burners follow the Small Quantity Waste Oil Burning Guideline; guideline to become part of Used Oil Handling Regulations	Banned — *Clean Environment Act*, Regulation 8797, Petroleum Products Storage and Handling Regulations	Prohibited — *Clean Environment Act*
Nova Scotia	One re-refinery; *Environment Act*, Activities Designation Regulations identify this as an activity that requires approval	Allowed — *Environment Act*, Used Oil Regulations, all units including space heaters, limits imposed; Air Quality Regulations prohibit open burning	Banned — *Environment Act*, Used Oil Regulations	Prohibited — *Environment Act*, Used Oil Regulations

Province/ territory	**Re-refineries**	**Burning**	**Dust suppression**	**Land disposal**
Prince Edward Island	No re-refineries; *Environmental Protection Act*, Used Oil Handling Regulations, some UCO shipped to Nova Scotia for re-refining	Allowed — *Environmental Protection Act*, Air Quality Regulations, burning allowed in used oil burners; permit required	Banned — *Environmental Protection Act*, Used Oil Handling Regulations	Prohibited — *Environmental Protection Act*, Used Oil Handling Regulations
Newfoundland	No refineries; *Waste Material Disposal Act*; draft Used Oil Control Regulations, Certificate of Approval required	Allowed — *Waste Material Disposal Act*, draft Used Oil Control Regulations, allowable limits will be imposed; virtually all approved burning occurs in cement kilns	Effectively banned by unwritten policy	Allowed — *Waste Material Disposal Act*, draft Used Oil Control Regulations will prohibit land disposal; anticipate that by late 2001 only most remote communities will dispose on land
Summary of used oil regulations or guidelines	Re-refineries or reprocessing facilities in seven provinces; no re-refineries or reprocessing facilities in six provinces and territories; all provinces and territories have regulations, draft regulations or guidelines that control re-refinery operation; if a province or territory does not have a re-refinery, there are limits for contamination in the used oil	Burning allowed either through permitting or through Certificates of Approval; allowable limits for contaminants are also listed in most regulations; space heaters are a problem due to the concern that burner unit will not be maintained and contaminants will be released to the environment and cause localized air degradation for humans	Banned in eight provinces and three territories; one province has a policy ban; permitted in one province with guidelines in place	Prohibited by nine provinces and three territories; one province to propose ban in upcoming legislation

[1] Provincial and territorial guidelines and regulations deal with other types of used oil (e.g., lubricating oil, industrial oils, etc.) in addition to UCO. Where a province or territory or federal department specifically referred to UCO in their reply, we indicated “UCO” instead of “used oil” for those sections. In other words, used oil includes UCO in the guidelines or regulations unless otherwise indicated.

[2] In British Columbia, since 1992, the Return of Used Lubricating Oil Regulation assures access to commercial storage facilities for do-it-yourself oil changers. Also, industry is considering possible expansion of stewardship programs to include used filters and containers as well as the residual oil.

APPENDIX B. LITERATURE SEARCH STRATEGY USED TO IDENTIFY RELEVANT DATA ON USED CRANKCASE OILS

A literature search was conducted (up to March 2000) of monitoring data in Canada (or elsewhere) and toxicological studies in animals and plants to identify critical new data for the assessment of environmental risk under Paragraph 64(a) of CEPA 1999. To identify critical new exposure and toxicological data, a search was conducted by name in the following databases: Current Contents (1994–2000); Dialog (1990–2000); Environmental Abstracts (1994–2000); and SciSearch. A search of the following web sites was also conducted (up to December 2000): Agency for Toxic Substances and Disease Registry; Canadian Petroleum Products Institute; Environment Canada; International Programme on Chemical Safety; Organisation for Economic Co-operation and Development; and U.S. Environmental Protection Agency. Searches were also conducted by the names of various authors who were known to have published papers on used oils (up to December 2000).

APPENDIX C. SUMMARY OF CANADIAN AND INTERNATIONAL INITIATIVES TO MANAGE USED CRANKCASE OILS

National initiatives for Used Crankcase Oils

Provincial and territorial legislation recognizes the inherent toxicity of Used Crankcase Oils (UCO) as well as their re-use potential. Industry also recognizes the need to control releases to the environment, especially from do-it-yourself oil changers (DIYs) who may be introducing UCO to the environment when they could be returning them to a depot if it were available. DIYs are of concern for their indiscriminant disposal of UCO in landfills, in household garbage, in ditches or down sewers. The point releases are quite dispersed, but collectively they contribute pollution to the receiving environment.

The Hazardous Waste Task Group (HWTG), which involves provincial/territorial as well as federal representatives, including Environment Canada, initiated a review of control measures for UCO in 1995 (Wittwer, 2000). Results indicated that although industrial recycling of UCO through collection contractors was very successful, DIYs were still disposing of UCO into the environment, whether dumping in the garbage, down sewers or on land. The HWTG had asked Transport Canada to amend its legislation under the *Transportation of Dangerous Goods Act* to include tracking the movement of UCO. The HWTG also cited space heater emissions of contaminants in non-maintained equipment as a major concern for some provincial/territorial authorities.

The development in 1989 of a Canadian Council of Ministers of the Environment (CCME) Code of Practice for the Management of Used Oils called attention to the need to have a national policy to deal with used oil collection, use and disposal (CCME, 1989a,b). More recently, CCME asked Transport Canada to supplement the list of hazardous waste types by adding spent/used crankcase/motor oils to Schedule II, List II of the Transportation of Dangerous

Goods Regulations. The HWTG investigated these oils and determined that lead, PAHs and chlorinated hydrocarbons present in the waste oils are hazardous to the environment, especially in light of the volumes of used oils that are in circulation (Wittwer, 2000). Transport Canada requested, however, that Environment Canada assume the responsibility for regulating hazardous waste and hazardous recyclable material under the new CEPA 1999 regulations. Transport Canada informed CCME that legally it could not expand the list of hazardous waste types under the new clear-language Transportation of Dangerous Goods Regulations.

International initiatives for Used Crankcase Oils

Canada is a signatory to the 1989 United Nations’ Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, which requires countries to track transboundary movement of their hazardous waste, including UCO. Annex VIII of the Basel Convention was developed by a multi-national working group of which Canada was an active participant. Annex VIII pertains to used oils, which includes water/oil emulsions/mixtures. Annex VIII lists those wastes that, when destined for either disposal or resource recovery (recycling), are considered hazardous waste. From this list, it is clear that the international community would consider spent or used crankcase/motor oils as hazardous and requiring pre-notification and tracking controls, in order to protect human health and the environment. The Export and Import of Hazardous Wastes Regulations (EIHWR) were the means by which Canada was able to ratify the Basel Convention and implement the conditions of the Organisation of Economic Co-operation and Development Council Decision (92)39/Final concerning the control of transboundary movements of wastes destined for recovery operations (Environment Canada, 1992). In EIHWR under CEPA 1999, Schedule III lists the wastes that require export and import notification when destined for either final disposal or recycling/recovery operations. Part III of this Schedule includes a number of entries that relate to oils, including UCO. For the purposes of the EIHWR and international movements, these oils are typically considered environmentally hazardous because they contain leachable amounts of lead, i.e., >5.0 ppm.