Government of Canada / Gouvernement du Canada

Risk Management Approach

for

Cobalt and Soluble Cobalt Compounds

under the

Cobalt-containing Substance Grouping

Environment and Climate Change Canada

Health Canada

May 2017

Canada

Summary of Proposed Risk Management

This document outlines the proposed risk management actions for cobalt and soluble cobalt compounds. In particular, Environment and Climate Change Canada (ECCC) is proposing measures to manage anthropogenic release of cobalt to water from the following industrial sectors or activities:

- **Metal mining:** by amending Schedule 5 of the *Metal Mining Effluent Regulations* with the intent to collect data to better understand cobalt releases from metal mines and determining whether cobalt should be added to Schedule 4 in the future.
- **Mineral exploration:** by continuing to monitor this activity through existing programs and determining appropriate risk management, if required.
- **Closed and abandoned mines:** by continuing to promote the application of the existing *Environmental Code of Practice for Metal Mines* for every stage of a mine's life cycle, including its closure, and continuing the Federal Contaminated Sites Action Plan program and the National Orphaned/Abandoned Mines Initiative.
- **Base metals smelting and refining:** by addressing facilities that combine their effluent with mining operations through the action proposed for metal mining, and by working with industry to gather information through a voluntary initiative with the stand-alone facilities. If the voluntary initiative is not feasible, ECCC will examine other data collection methods, such as a mandatory section 71 notice under the *Canadian Environmental Protection Act, 1999*.
- **Pulp and paper:** by working with the affected industry to gather additional information to determine the source of cobalt releases in pulp and paper effluent and to determine whether there is a need for risk management.
- **Waste management:** by working with the provinces and territories to gather additional information to determine whether there is a need to limit cobalt concentrations released from landfill leachate directly to the aquatic environment.
- **Chemical manufacturing:** by working with one specific chemical manufacturing facility to monitor its yearly cobalt releases in effluent from the use of a cobalt catalyst.

Environment and Climate Change Canada is also updating the *Federal Environmental Quality Guidelines* for cobalt, and will recommend its adoption by the Canadian Council of Ministers of the Environment.

Additional information is required on the following items to inform risk management decision making:

- concentrations of cobalt in the effluent of stand-alone base metal smelters and refineries;

- the source of cobalt in pulp and paper mills' influent and effluent; and
- identity of landfills releasing leachate directly to the aquatic environment, the concentrations of cobalt in the leachate, existing requirements for the control and monitoring of cobalt releases to the aquatic environment, and available control technologies.

The risk management actions outlined in this Risk Management Approach may evolve from additional information obtained from the public comment period or through consideration of assessments and risk management actions published for other Chemicals Management Plan substances to ensure effective, coordinated and consistent risk management decision making.

Note: The above summary is an abridged list of actions proposed to manage these substances and to seek information on identified information gaps and uncertainties. Refer to section 3 of this document for more complete details in this regard.

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1. Context

The *Canadian Environmental Protection Act, 1999* (CEPA) (Government of Canada, 1999) provides the authority for the Minister of the Environment and the Minister of Health (the Ministers) to conduct assessments to determine if substances are toxic to the environment and/or harmful or dangerous to human health as set out in section 64 of CEPA,[1,2] and if so, to manage the associated risks.

As part of the second phase of the Chemicals Management Plan, the Ministers plan to assess and manage, where appropriate, the potential ecological and health risks associated with approximately 500 substances in 9 substance groupings (Government of Canada, 2011a). The 50 substances listed in Annex A are included in the Cobalt-containing Substance Grouping of the Substance Groupings Initiative of the Chemicals Management Plan (Government of Canada, 2012).

2. Issue

2.1 Final Screening Assessment Report Conclusion

Environment and Climate Change Canada (ECCC) and Health Canada conducted a joint scientific assessment relevant to the evaluation of cobalt and cobalt-containing substances in Canada. A notice summarizing the scientific considerations of the final Screening Assessment Report for these substances was published in the *Canada Gazette*, Part I, on May 20, 2017 (ECCC and Health Canada, 2017).

On the basis of the information available, the final Screening Assessment Report concludes that cobalt and soluble cobalt compounds are toxic under section 64(*a*) of CEPA because they are or may be entering the environment in a quantity or concentration or under conditions that have or may have an

[1] Section 64 [of CEPA]: *For the purposes of* [Parts 5 and 6 of CEPA]*, except where the expression "inherently toxic" appears, a substance is toxic if it is entering or may enter the environment in a quantity or concentration or under conditions that*

- *(a) have or may have an immediate or long-term harmful effect on the environment or its biological diversity;*
- *(b) constitute or may constitute a danger to the environment on which life depends; or*
- *(c) constitute or may constitute a danger in Canada to human life or health.*

[2] A determination of whether one or more of the criteria of section 64 are met is based upon an assessment of potential risks to the environment and/or to human health associated with exposures in the general environment. For humans, this includes, but is not limited to, exposures from ambient and indoor air, drinking water, foodstuffs, and the use of consumer products. A conclusion under CEPA on the substances in the Chemicals Management Plan is not relevant to, nor does it preclude, an assessment against the hazard criteria for WHMIS (Workplace Hazardous Materials Information Systems) that are specified in the *Controlled Products Regulations* for products intended for workplace use. Similarly, a conclusion based on the criteria contained in section 64 of CEPA does not preclude actions being taken under other sections of CEPA or other Acts.

immediate or long-term harmful effect on the environment or its biological diversity.

The risks of concern, identified in the final Screening Assessment Report, are based on anthropogenic releases of cobalt and soluble cobalt compounds to water from metal mining, historical mining, and base metals smelting and refining. To a lesser extent, pulp and paper, waste management, and metal mining exploration were also identified. This document will focus on these activities and exposure sources of concern (refer to section 5.2).

Of note, the proposed risk management actions described in this document are preliminary and may be subject to change. For further information on the final Screening Assessment, refer to the final Screening Assessment Report for Cobalt and Cobalt-containing Substances.

2.2 Recommendation under CEPA

On the basis of the findings of the final Screening Assessment conducted as per CEPA, the Ministers recommend that cobalt and soluble cobalt compounds be added to the List of Toxic Substances in Schedule 1 of the Act.[3] The potential scope and implications of this recommendation are described below.

Placing a substance on Schedule 1 of the Act allows the Ministers to take certain actions with respect to the substance. It also triggers an obligation for the Ministers to develop a regulation or instrument establishing "preventive or control actions" for managing the substance. A proposed regulation or instrument must be published in the *Canada Gazette*, Part I, for a 60-day comment period, within 24 months of the recommendation to add the substance to Schedule 1. Once proposed, the Ministers have a further 18 months to finalize the regulation or instrument (Environment Canada, 2004). If needed, additional regulations or instruments can be developed within that period or afterwards.

Once cobalt and soluble cobalt compounds are added to the List of Toxic Substances, any cobalt-containing substance that contributes or could contribute, presently or in the future, to concentrations of total or dissolved cobalt in the environment above levels of concern could be subject to risk management actions. Where the uses of cobalt-containing substances do not pose a risk to the environment throughout their life cycle, ECCC does not intend to develop risk management instruments. ECCC will continue to inform stakeholders of any proposed risk management actions and ensure they are consulted in accordance with due process.

[3] When a substance is found to meet one or more of the criteria under section 64 of CEPA, the Ministers can propose to take no further action with respect to the substance, to add the substance to the Priority Substances List for further assessment, or recommend the addition of the substance to the List of Toxic Substances in Schedule 1 of the Act.

The Ministers have taken into consideration comments made by stakeholders during the 60-day public comment period on the draft Screening Assessment Report and the Risk Management Scope document.

2.3 Public Comment Period on the Risk Management Scope

The Risk Management Scope document for cobalt and its compounds, which summarized the proposed risk management actions under consideration at that time, was published on December 6, 2014. Industry and other interested stakeholders were invited to submit comments on the Risk Management Scope document during a 60-day comment period. Comments received on the Risk Management Scope document were taken into consideration in the development of this document. For further information on the summary of responses to public comments received refer to the public comments summary table.

3. Proposed Risk Management

Section 3 presents the environmental and risk management objectives, as well as the proposed actions to achieve them for each sector of concern, i.e., metal mining, base-metal smelting, waste management – landfills, and pulp and paper. Proposed actions for other sectors releasing cobalt are also presented. For more information on the context and rationale for these actions, please consult sections 4 and 5 titled “Background” and “Exposure Sources and Identified Risks,” respectively.

Following the publication of this Risk Management Approach, additional information obtained from the public comment period and from other sources will be considered. The risk management actions outlined in this document may evolve through consideration of assessments and risk management actions published for other Chemicals Management Plan substances to ensure effective, coordinated and consistent risk management decision making.

3.1 Proposed Environmental Objective

Proposed environmental objectives are quantitative or qualitative statements of what should be achieved to address environmental concerns.

For these substances, the proposed objective is focused on addressing the exposure sources of concern from the sectors identified in the final Screening Assessment Report, as outlined in section 5 of this document. As such, the proposed environmental objective for cobalt and soluble cobalt compounds is to reduce anthropogenic releases of cobalt to water so as not to exceed levels observed to cause adverse effects to aquatic organisms.

3.2 Proposed Risk Management Objective and Proposed Actions

Proposed risk management objectives set quantitative or qualitative targets to be achieved by the implementation of risk management regulations, instrument(s) and/or tool(s) for a given substance or substances.

The proposed risk management objective for cobalt and soluble cobalt compounds is to achieve the lowest level of releases of cobalt and soluble cobalt compounds to water that is technically and economically feasible, taking into consideration socio-economic factors.

To achieve the proposed risk management objective and to work towards achieving the proposed environmental objective, the proposed risk management actions for cobalt and soluble cobalt compounds will focus on reducing releases of cobalt and soluble cobalt compounds to water from the sectors of concern identified in the final Screening Assessment Report, namely metal mining, base metal smelting, waste management – landfills, and pulp and paper.

The proposed actions for the sectors of concern are described below, along with other sectors releasing cobalt. Context and rationale for these actions are discussed in section 5.

3.2.1 Metal mining

Effluent from the metal mining sector is regulated by the *Metal Mining Effluent Regulations* (MMER) under the *Fisheries Act*. These regulations authorize the deposit of eight deleterious substances in mine effluent. The eight substances are listed on Schedule 4 of the MMER and do not include cobalt. The regulatory framework under the *Fisheries Act* does not authorize the deposit of other deleterious substances, such as cobalt, that are not listed on Schedule 4 of the MMER. All effluent release concentration limits from metal mines, including releases of substances not listed on Schedule 4 of the MMER, are enforced in accordance with the Compliance and Enforcement Policy for the Habitat Protection and Pollution Prevention Provisions of the *Fisheries Act* (Environment Canada, 2001).

As part of a review of the MMER, ECCC has proposed to amend Schedule 5, Environmental Effects Monitoring Studies, to add cobalt to the list of substances to be included in effluent characterization. This amendment would require mines subject to the MMER to analyze and report cobalt concentrations in samples collected as part of effluent and water quality monitoring. In addition, this would also require mines to consider cobalt in any investigation of case studies carried out where effects from mine effluent have been identified from the environmental effects monitoring conducted in accordance with the MMER. This will allow ECCC to more effectively monitor the releases of cobalt in metal mine effluent.

Future actions, such as adding a cobalt release limit to Schedule 4 of the MMER, will be determined on the basis of an analysis of the information received through Schedule 5.

3.2.2 Mineral exploration

Elevated cobalt concentrations have been detected in surface waters downstream of mineral exploration at certain sites. However, mineral exploration is typically conducted in areas with high background mineralization. In the absence of corresponding upstream sample concentrations at these mineral exploration sites and reference values, the contribution from mineral exploration remains uncertain. Environment and Climate Change Canada is therefore proposing to continue monitoring mineral exploration through existing programs and databases, such as the Biomonitoring Information System for the Yukon (BISY). This will allow ECCC to determine what risk management measures should be developed, if any.

3.2.3 Closed and abandoned mines

Current acts and regulations across Canada should help ensure that more mining sites are properly decommissioned in the future. With the same objective, ECCC recommends that mine operators follow the existing *Environmental Code of Practice for Metal Mines* for every stage of a mine's life cycle, including its closure.

For abandoned mines, ECCC proposes to continue its work under the Federal Contaminated Sites Action Plan program and the National Orphaned/Abandoned Mines Initiative.

Through the Chemicals Management Plan's Monitoring and Surveillance Program, ECCC is also considering additional monitoring and surveillance of the water and sediment quality in areas with closed and abandoned mines. This information could be used to evaluate whether additional risk management measures are needed for closed and abandoned mines.

3.2.4 Base metal smelting and refining

Facilities in the base metal smelting and refining sector vary significantly in terms of their processes and products. It is therefore expected that these facilities would have varied levels of cobalt in their effluent, ranging from insignificant to high enough to be a source of concern.

Smelters and refineries that combine their effluent with the effluent of a metal mine (i.e. 5 of the 12 facilities in Canada) would be captured as part of the proposed actions for metal mines described in section 3.2.1 above. As for the 7 stand-alone facilities (i.e., those that do not combine their effluent with that of

metal mines), ECCC is proposing to work with them to gather data on their cobalt effluent concentrations through a voluntary initiative. If a voluntary initiative is not feasible, ECCC will examine other data collection methods, such as a mandatory section 71 notice under CEPA. This will allow ECCC to determine what risk management measures should be developed, if any, for these stand-alone facilities.

While the focus of risk management action is releases of cobalt and soluble cobalt compounds to water, atmospheric emissions from smelters and refineries are also identified as potentially significant contributors to the environmental loading of cobalt near these facilities: Cobalt is released to air principally in the form of fine particulate matter and will be eventually deposited to aquatic or terrestrial environments.

As a result of the implementation of base-level industrial emissions requirements (BLIERs), it is estimated that particulate matter emissions will be reduced by about 75% from those of 2006 levels by 2018. Since most metals from these facilities are released to the atmosphere as particulate matter emissions, it is anticipated that emissions of metals, including cobalt, would also be reduced as a co-benefit of particulate matter emission reductions. However, due to uncertainties and site-specific characteristics, it is not possible to quantify those co-benefits. While cobalt will not be specifically monitored in emissions or in the environment as part of the BLIERs program, it is expected that cobalt reductions will be reflected in the annual emissions data reported by smelters and refineries to the National Pollutant Release Inventory (NPRI).

3.2.5 Pulp and paper

There are several uncertainties regarding the presence of cobalt in pulp and paper mill effluent. Measured data indicate that cobalt is found in increased concentrations in the effluent of some facilities, but it is unclear how and in what form this cobalt is being released. This suggests that higher releases of cobalt from pulp and paper mills may be related to site-specific conditions, such as the type of pulping process or the use of additives or chemicals containing cobalt, rather than the general operations of the sector. For these reasons, the Screening Assessment Report found that there is insufficient evidence to conclude that the sector as a whole or a particular sub-sector (manufacturing process) is of concern. Environment and Climate Change Canada is therefore proposing to work with the industry to identify the source of cobalt and to determine what risk management measures should be developed, if any.

3.2.6 Waste management – landfills

According to the final Screening Assessment Report, the risk of cobalt releases from landfill leachate is low, with only one site posing a potential risk for the environment. Since waste management is a shared jurisdictional responsibility,

ECCC is proposing to work with the provinces and territories to gather additional information to determine whether there is a need to limit cobalt concentrations released from landfill leachate directly to the aquatic environment.

3.2.7 Chemical manufacturing

The chemical manufacturing facility that reported cobalt releases in 2011 switched to another cobalt catalyst to reduce its cobalt releases. It also installed a new treatment system to remove metals in its effluent before discharging to the city sewer.

These actions have resulted in an effective reduction in the quantity of cobalt being released in the facility's effluent. Environment and Climate Change Canada will continue to communicate with this company on a yearly basis, at a minimum, to determine whether the concentration of cobalt in surface water near the WWTP to which the facility discharges its effluent is below the level expected to cause harm to aquatic organisms. Preliminary 2016 cobalt effluent data from the facility indicate that it should be below this level of concern.

3.2.8 Unidentified sources

Through provincial and federal environmental monitoring programs, a few sites were identified where cobalt levels in the environment posed a risk. However, even after analysis of the sites in question and of the potential sources nearby, a definite source could not be identified for some sites. These sites are labelled as "unidentified sources" in the final Screening Assessment Report. However, it is expected that addressing the significant sources as previously proposed above could reduce the number of sites where levels of cobalt exceed the predicted no-effect concentration (PNEC) in data collected under environmental monitoring programs. If there continue to be sites exceeding the PNEC with no clear contributing source, then further investigation may be done to attempt to identify the source(s).

The *Wastewater Systems Effluent Regulations*, which set standards for wastewater systems effluent quality that can be achieved through secondary wastewater treatment, could play a significant role in further capturing releases of cobalt from various industries that send their effluent to publicly owned wastewater treatment plants (WWTPs). As indicated in the data presented in the final Screening Assessment Report, a secondary level of wastewater treatment results in additional cobalt removal. Using site-specific information for the largest facilities that are expected to have to improve their treatment processes, the potential co-benefit of these regulations is an estimated reduction in cobalt releases to water of 1.7 tonnes per year by 2040. Note that this estimate includes the actions taken by the chemical manufacturer to reduce cobalt releases (see section 3.2.7). Finally, additional reductions are expected for smaller facilities by 2040.

It is expected that continued environmental monitoring for cobalt will assist in determining whether reductions are achieved from both known and unknown sources.

3.2.9 Other initiatives

Considering that new information is presented in the final Screening Assessment Report, ECCC is updating the current Federal Environmental Quality Guidelines (FEQG) for cobalt (February 2013). The revised guidelines will provide updated benchmarks for the quality of the ambient environment and serve three functions. First, they can be an aid to prevent or control pollution by providing targets for acceptable environmental quality. To that end, ECCC will use the revised FEQG to establish a quantitative environmental objective for the Risk Management Approach for cobalt. The FEQG will also be taken into consideration in the development of instruments, especially if thresholds or objectives need to be established. Second, they will assist ECCC and stakeholders in evaluating the significance of concentrations of cobalt found in the environment. Third, they will allow ECCC to evaluate the success of risk management activities.

The Canadian Environmental Quality Guidelines, published by the Canadian Council of Ministers of the Environment (CCME), are a widely recognized reference for environmental monitoring and management. The CCME has not yet published a water quality guideline for the protection of aquatic life for cobalt. A CCME guideline could raise further awareness of the potential impacts to aquatic organisms from elevated exposures to cobalt and could inform additional pollution prevention or mitigation actions. In practice, CCME guidelines are often referenced in environmental assessments and used to establish conditions in permits. ECCC will therefore recommend that the CCME adopt the cobalt FEQG.

In 2015, ECCC proposed a change to the NPRI reporting threshold for “cobalt (and its compounds)” to a 50-kg manufacture, process or otherwise use threshold and a 0.1% concentration threshold, commencing with the 2016 reporting year. The proposal to lower the NPRI threshold was subject to public consultation in accordance with the NPRI Consultation and Engagement Framework. In the past, cobalt (and its compounds) was listed on the NPRI at the standard 10-tonne manufacture, process or otherwise use threshold and 1% concentration threshold. The change will increase the number of companies reporting, improve the data gathered through the NPRI, establish a clear baseline for cobalt releases, and more accurately reflect releases of cobalt to the environment.

3.3 Risk Management Information Gaps

To further inform decisions on proposed risk management, additional information is being sought on the following:

Closed and abandoned mines: concentrations of dissolved or total cobalt in the water and sediment upstream and downstream of areas with closed and abandoned mines;

Base metals smelting and refining: concentrations of dissolved cobalt in the effluent of stand-alone smelters and refineries, as well as concentrations of dissolved or total cobalt upstream and downstream of their discharge point(s);

Pulp and paper mills: concentrations of dissolved cobalt in the effluent of pulp and paper mills, concentrations of dissolved or total cobalt upstream and downstream of the discharge point(s), and additional information on the possible source of cobalt in pulp and paper mill effluent (e.g., additives and chemicals containing cobalt, other); and

Waste management – landfills: total number and locations of landfills releasing landfill leachate, either treated on-site or not, directly to the aquatic environment; concentrations of dissolved cobalt at the points of discharge of leachate to the aquatic environment from the individual landfills; existing provincial and territorial requirements for the control and monitoring of cobalt releases to the aquatic environment; and availability of technically and economically feasible control technologies.

4. Background

4.1 General Information on Certain Cobalt-containing Substances

Four cobalt-containing substances were previously assessed during the earlier Challenge initiative of the Chemicals Management Plan: elemental cobalt (CAS RN 7440-48-4), cobalt chloride (CAS RN 7646-79-9), and two cobalt sulfates (CAS RN 10124-43-3 and CAS RN 10393-49-4) (Government of Canada, 2011b). These substances were found not to meet any of the criteria set out in section 64 of CEPA when considered as isolated substances. However, in order to consider combined exposure to cobalt, these four substances were included in the 2014 assessment of cobalt and cobalt-containing substances.

Since the 2015 final Screening Assessment Report proposes that cobalt and soluble cobalt compounds are toxic under section 64 of CEPA, these four cobalt-containing substances are also included in the proposed toxic conclusion.

4.2 Current Uses and Identified Sectors

Cobalt and soluble cobalt compounds are used in multiple sectors, where they may have varied uses. In addition, cobalt and some cobalt compounds occur

naturally and may be concentrated and released by certain industrial processes. The information that was collected on these uses and sectors was reviewed and presented in detail in the final Screening Assessment Report. The sections below provide a summary of the uses and sectors where a potential risk was identified in the final Screening Assessment Report, and the uses for other sectors releasing cobalt.

4.2.1 Cobalt production

Elemental cobalt is rarely the exclusive metal isolated from a mine but is rather an additional product of either copper or nickel smelting. A total of 2275 tonnes of cobalt was extracted and refined in Canada in 2009 (Natural Resources Canada, 2015).

4.2.2 Metal mining

Mines and mills, even if they do not produce cobalt, may release cobalt to the environment, given that this metal is present in a variety of ores and waste rock. While most mines reporting cobalt releases to the NPRI were metal mines, there were a few non-metal mines as well (phosphate, potash, diamond and coal). According to data reported in response to section 71 notices published for cobalt-containing substances,[4] the metal mining sector is responsible for almost all the manufactured and used quantities of cobalt and for more than 75% of the imports.

4.2.3 Mining exploration

The first phase of the mineral development cycle is mining exploration. Its purpose is to locate new sources of minerals that can be economically mined. If early findings are positive, intermediate and advanced exploration activities may then be undertaken. These latter stages of exploration involve more intrusive and larger scale sampling to characterize the mineral zone (e.g., bulk sampling, digging and drilling) (Government of Canada, 2013). These activities may release cobalt to the environment by exposing the ore and waste rock to weathering.

4.2.4 Closed and abandoned mines

Once mineral resources are exhausted or operations are no longer profitable, a mine undergoes closure. Proper mine closure involves an orderly, safe, and environmentally sound conversion of an operating mine to a closed state. It

[4] A notice to industry, as set out in section 71 of CEPA, was released on June 2, 2012, requesting that relevant data be submitted on 16 cobalt-containing substances. This information supplements data obtained through previous section 71 notice surveys, namely a 2009 notice survey for the Challenge initiative (4 cobalt-containing substances) and a 2009 notice survey for the Domestic Substances List Inventory Update initiative (35 cobalt-containing substances). As a result, submissions of some information pertaining to the properties, hazard, uses and exposure of the substances were received.

typically involves the following steps: shut-down, decommissioning, reclamation, and post-closure activities. Mining sites can continue to release metals, including cobalt, into the environment long after they cease operations. To mitigate these releases, treatment and monitoring of contaminated water at the site's final discharge point are often conducted as part of post-closure activities (Government of Canada, 2013).

Orphaned or abandoned mines are of particular concern in that regard as they may not have been properly decommissioned and, as a result, their effluent could have elevated levels of cobalt. Orphaned or abandoned mines are sites where advanced exploration, mining or mine production has ceased without rehabilitation having been completed and whose ownership has reverted to the Crown, either provincially or federally depending on the jurisdiction, because the last owner was financially unable or unwilling to properly close the site or because no owner could be found (Macksey, 2000; Government of Canada, 2013; Castrilli, 2007).

4.2.5 Base metals smelting and refining

Base metals smelting and refining facilities produce one or more metals, such as copper, lead, nickel, zinc and cobalt, from feed material that primarily comes from ores. They also produce intermediate and compound products and other saleable metals, such as precious metals.

The smelting process uses heat and chemical reduction to extract the metal from mined ores. Traces of cobalt are found in many mined ores, but primarily ores with nickel deposits. Cobalt and cobalt-containing substances may be intermediate products, residues or main products from the smelting or refining process.

4.2.6 Manufacture, import and uses of cobalt-containing substances, products and manufactured items

Data on the use of specific cobalt compounds were obtained through three notices under section 71 of CEPA. Table B-1 in Annex B presents data on the quantities manufactured, imported or used, and Table B-2 presents the top three activities for each of the cobalt compounds. The sector identified below is that in which a potential risk was identified in the draft Screening Assessment Report from the use of a cobalt compound, but not in the final Screening Assessment Report.

4.2.6.1 Chemical Manufacturing

In 2011, a cobalt catalyst was reported to be used in the chemical manufacturing process of one company. By definition, a catalyst is not consumed during a reaction and thus it may be subsequently recovered or released in wastewater.

Since this cobalt compound was not recovered during the manufacturing process, cobalt was found in significant quantities in both the facility's sludge and treated effluent. The facility recently confirmed that they are using another cobalt catalyst and have installed a wastewater treatment system that reduces cobalt releases.

4.2.7 Incidental manufacture or presence

Data on the incidental manufacture or presence of cobalt in several sectors were gathered through the three section 71 notice surveys described previously or through the environmental monitoring of cobalt levels in effluent or near known point sources. The sectors described below are limited to those where a potential risk was identified in the final Screening Assessment Report.

4.2.7.1 Pulp and paper

In this sector, cobalt is suspected to be incidentally present in the various fuels burnt to meet the facilities' energy demand as well as in the raw material. Cobalt is also present in dyes and pigments used to improve the appearance of the final products (Dr. Jeff Louch [NCASI], 2015). When these cobalt-containing products or the raw material enter into contact with water, there is a possibility that cobalt could be released.

4.2.7.2 Waste management – landfills

Cobalt is not used by landfills during the waste management process. Rather, it is present in products, manufactured items or other materials that are received for disposal and from which cobalt could potentially leach out and partition to landfill leachate.

4.2.8 Other uses and sectors

Cobalt and soluble cobalt compounds are used or found in a variety of other sectors; however, risks were not identified from these uses or from the releases from these activities.

The sectors involved were described in detail in the final Screening Assessment Report and include rubber, paints and coatings, plastics, fertilizers and animal feed, alloy and superalloy manufacturing, iron and steel, electricity (power generation), oil sands, petroleum refining, electrical and electronic equipment, battery recycling, and wastewater treatment.

5. Exposure Sources and Identified Risks

5.1 Natural Sources

Cobalt is a naturally occurring element in the Earth's crust. Cobalt concentrations in the upper continental crust have been determined to average about 25 ppm and to range between 0.1 and 110 ppm (Reimann, C. & Caritat, P. de, 1998). Cobalt is not known to exist naturally in its elemental (metallic) form. Naturally occurring cobalt comprises various minerals, oxides and salt forms.

Global natural emissions to the atmosphere have been estimated to range between 690 and 11 000 tonnes of cobalt per year, with a median of 6100 tonnes per year (Nriagu, J.O., 1989). Sources include windblown continental dusts, weathering of rocks, seawater spray, forest fires and volcanoes (International Programme on Chemical Safety, 2006). Atmospheric deposition and introduction of cobalt into surface water and soil as a result of these natural processes are reflected in the geochemical background levels in these media.

Naturally occurring background levels of cobalt were identified in the final Screening Assessment Report and were taken into consideration when estimating the exposure of ecological receptors to cobalt-containing substances. For instance, the final Screening Assessment Report associated higher concentrations of cobalt at a few sites in Yukon with natural mineralization.

5.2 Anthropogenic Releases to the Environment

Anthropogenic releases of cobalt to the environment have been identified in the final Screening Assessment Report as posing a risk in some sectors, which are identified below, particularly when released directly to the aquatic environment. Chemical manufacturing facilities are also discussed here to provide some clarification on the risk characterization for this sector.

5.2.1 Metal mining

As of November 2016, 44 mines and mills reported on cobalt and its compounds to the NPRI of ECCC for the year 2014. These facilities reported on-site releases to air (1.1 tonnes), water (1.0 tonnes) and land (4.8 tonnes), while on-site disposal amounted to 5805 tonnes and off-site disposal was 0 (National Pollutant Release Inventory, 2014). The water releases exclude the 410 tonnes of cobalt released from Mount Polley Mine in 2014, which had a one-time catastrophic release due to the failure of its tailings dam. It should be noted that "disposal" includes information on the disposal of tailings and waste rock, which tend to be disposed of on-site.

Data presented in the final Screening Assessment Report, drawing largely from provincial environmental monitoring databases and from laboratory reports that

were submitted under the Environmental Effects Monitoring program of the MMER and that voluntarily included cobalt information, indicate that cobalt releases from this sector are likely the cause of the elevated cobalt levels found near a number of sites. For this sector, it was concluded in the final Screening Assessment Report that cobalt concentrations in water bodies and in sediment near sources of releases may exceed estimated no-effect levels for aquatic and sediment-dwelling organisms.

5.2.2 Mining exploration

At the early stage of mining exploration, a potential mining site is not yet regarded as a "facility" under the NPRI. For this reason, releases from mining exploration are not reported to the NPRI (Environment Canada, 2013b).

Instead, the final Screening Assessment Report presents surface water samples from the Yukon database. Most samples taken near mining exploration sites in the Yukon show cobalt concentrations below or near the predicted no-effect concentration. Higher measurements recorded in the provincial database indicate that mining exploration may be releasing cobalt at harmful levels for aquatic organisms. However, in the absence of corresponding upstream sample concentrations at these mineral exploration sites and reference values, the contribution from mineral exploration remains uncertain.

5.2.3 Closed and abandoned mines

With time, closed and abandoned mines stop meeting the NPRI employee threshold[5] and, therefore, are no longer required to report their releases to the inventory. For this reason, a release profile from the NPRI cannot be provided for these sites.

In the final Screening Assessment Report, high levels of cobalt in surface waters in northern Ontario and Yukon were linked to historical mining activities. While a risk has been identified for historical mining activities, a distinction between closed and abandoned mines, or the type of minerals extracted, could not be made. Despite the information gap, abandoned mines, especially those where metals were once extracted, are expected to release much higher quantities of metals, including cobalt, than mines that were responsibly closed.

The source of cobalt releases and the best management practices used to control them are similar for closed, abandoned, and operating mines. Compared to operating mines, the final Screening Assessment Report also found a

[5] Facilities where the employees work a total of 20 000 hours or more during the calendar year (the employee threshold) are required to report to the NPRI if the thresholds for at least one substance are met or if an activity-based threshold is met (Environment Canada, 2015).

significant risk for historical mines, but to a lesser extent due to fewer identified locations of concern.

5.2.4 Base metals smelting and refining

As of November 2016, seven smelters and refineries reported to the NPRI for the year 2014. These facilities reported total releases of 3.0 tonnes of cobalt and its compounds (2.9 tonnes to air and 154 kg to water), while amounts reported to be disposed of on-site were 1.4 tonnes (National Pollutant Release Inventory, 2014). Releases varied significantly among facilities, as expected, owing to their different processes and products. Modelled data of releases to water and measured data in water, sediment and soil indicate that releases from this industrial activity may contribute to the elevated levels of cobalt found near some of these facilities.

While the focus of risk management will be the release of cobalt to water, the final Screening Assessment Report also identifies the release of cobalt to air from the base metals smelting and refining sector as a potentially significant contributor to cobalt levels in environmental media.

5.2.5 Pulp and paper

As of November 2016, no pulp and paper mill has reported for cobalt since 2012. At that time, only 1 pulp mill reported releases of cobalt to the NPRI (264 kg to air) (National Pollutant Release Inventory, 2014).However, in response to a section 71 notice survey, 9 pulp and paper mills reported total releases of 2,134 kg of cobalt from air stacks, and 2 of these mills reported total releases of 22 kg of cobalt to water. While measured data in the vicinity of pulp and paper mills do not clearly demonstrate a risk, data submitted to Environment Canada in a draft unpublished report identify 3 out of 58 mills where a risk may be present. The risk was identified on the basis of the total cobalt concentration in the mills' effluent and the modelled predicted environmental concentration. While some facilities may release higher quantities of cobalt, there is insufficient evidence to conclude that the sector as a whole or a particular sub-sector (manufacturing process) is of concern.

5.2.6 Waste management – landfills

The total quantity of cobalt entering landfills through end-of-life products, manufactured items or other materials is not known. At 94% of large landfill sites in Canada (permitted to receive 40 000 tonnes of waste annually), leachate is collected and treated on-site and/or off-site by nearby publicly owned WWTPs prior to being released to receiving waters. However, leachate is most likely not collected at smaller landfills. From 2008 to 2012, leachate from 13 large municipal solid waste landfills was sampled and analyzed for a range of substances, including cobalt, as part of the Chemicals Management Plan

monitoring program. Results indicated that landfill leachate could contain cobalt concentrations of concern. When leachate is transferred to a publicly owned WWTP, it is expected that the dilution and treatment occurring at these WWTPs reduce the cobalt concentrations in effluent and subsequently reduce the predicted environmental concentration in the receiving water body. In the case of landfill sites where the leachate is released directly or is treated on-site before being released to the aquatic environment, modelling predicts that the cobalt concentration in the receiving aquatic environment could pose a risk for aquatic organisms. Under the monitoring program, 1 of the 13 landfills for which cobalt in leachate was measured discharge treated leachate directly to an aquatic environment. There could potentially be other landfills in similar situations.

5.2.7 Chemical manufacturing

The chemical manufacturing facility that was identified in the draft Screening Assessment Report as a source of cobalt releases switched to another cobalt catalyst and installed a new treatment system to further reduce metals before discharging to city sewers.

These actions effectively reduce the quantity of cobalt being released in the facility's effluent and as a result, current releases should be below levels of concern.

6. Risk Management Considerations

6.1 Alternatives and Alternate Technologies

For most sectors of concern identified in the final Screening Assessment Report, it is not expected that chemical alternatives or alternate process technologies would be a practical approach to minimizing releases of cobalt. For the chemical manufacturing sector, operating with more efficient catalysts can reduce the quantity of cobalt used and, in turn, the cobalt released to the environment.

Additional effluent control technologies (e.g., additional on-site or off-site effluent treatment) would likely be effective approaches for most sectors, as appropriate and economically feasible.

6.2 Socio-economic and Technical Considerations

Where information was available, socio-economic factors have been considered in the selection process for an instrument respecting preventive or control actions, and in the development of the risk management objective. Socio-economic factors will also be considered in the development of regulations, instrument(s) or tool(s) as identified in the *Cabinet Directive on Regulatory Management* (Treasury Board of Canada Secretariat, 2012) and the guidance provided in the Treasury Board document *Assessing, Selecting, and*

Implementing Instruments for Government Action (Treasury Board of Canada Secretariat, 2007).

7. Overview of Existing Risk Management

7.1 Related Canadian Risk Management Context

7.1.1 Metal mines

The *Metal Mining Effluent Regulations*, under the *Fisheries Act*, authorize the deposit of deleterious substances[6] into natural fish-bearing waters. Schedule 4 of these regulations list authorized release limits, and Schedule 5 lists the requirements of environmental effects monitoring. Cobalt is not listed in either schedule, and there is therefore no authorized release limit for cobalt or requirement to consider cobalt in environmental effects monitoring. Of note, the *Metal Mining Effluent Regulations* can also apply to base metal smelters and refineries if their effluent is combined with those of a mine.

In 2009, Environment Canada published the *Environmental Code of Practice for Metal Mines* to support the *Metal Mining Effluent Regulations*. The code recommends environmental management practices for every stage of a mine's life cycle to help operators comply with the requirements of the regulations. While the code specifically targets metal mines, it also provides useful guidance for all sectors of the mining industry.

7.1.2 Mineral exploration

Mineral exploration activities in Canada are subject to licences and permits, which can include requirements to mitigate environmental impacts. Such conditions can vary between provinces and territories depending on the type of exploration work being done. For example, authorities may require that larger exploration projects prepare spill response plans (e.g., for fuels) and waste disposal plans (Government of Canada, 2013).

7.1.3 Closed and abandoned mines

Abandoned mines are a result of irresponsible closures prior to the implementation of current laws and regulations. Under present requirements, proponents must provide mine closure plans, with funds to support them, to regulators before commencing any mining activities. Regulators will use closure plans and funds to rehabilitate the sites should the proponents be unable to do so in the future (Cowan Minerals Ltd., 2010).

[6] A deleterious substance is defined by the *Fisheries Act* as any substance that, if added to water, makes the water deleterious to fish or fish habitat or any water containing a substance in such quantity or concentration or has been changed by heat or other means, that if added to water makes that water deleterious to fish or fish habitat.

In addition to existing guidelines and requirements from other jurisdictions, Environment Canada's 2009 *Environmental Code of Practice for Metal Mines* includes recommendations for the proper closure of a mine. In Canada, a closed mine continues to be subject to the *Metal Mining Effluent Regulations* until the mine applies for recognized closed mine status.

In the provinces and Yukon, the management of abandoned mines is the responsibility of the provincial or territorial government. Responsibility for sites located in Nunavut, in the Northwest Territories and on Indian reserves falls to the federal government (Cowan Minerals Ltd., 2010; Government of Canada, 2013). To address common issues posed by abandoned mines across Canada, governments, industry, and civil society created the National Orphaned/Abandoned Mines Initiative (NOAMI) in 2002. As an active member of its advisory committee, ECCC plays an important role in guiding the work under the NOAMI. Other members of the advisory committee include representatives of the mining industry, the federal, provincial and territorial governments, environmental organizations, and First Nations (NOAMI, 2000a; NOAMI, 2000b). In 2005, the Government of Canada launched the Federal Contaminated Sites Action Plan program to assess and remediate federal contaminated sites, including abandoned mines. To date, remediation activities have been conducted at 1400 sites, and remediation has been completed at 650 sites. The 15-year program administered by ECCC is ongoing (Government of Canada, 2014).

7.1.4 Base metals smelting and refining

Base metals smelting and refining facilities are subject to air emission requirements set under the Pollution Prevention Planning Notice published in the *Canada Gazette* in 2006. The Notice includes annual release limits for particulate matter, which contains most of the metals emitted to air, such as cobalt. The Notice requires facilities to take into consideration a number of factors including the Environmental Code of Practice for Base Metals Smelters and Refineries, which recommends particulate matter emission limits to air and effluent limits for chemical parameters and certain metals. It does not include an effluent limit for cobalt specifically.

7.1.5 Pulp and paper

The *Pulp and Paper Effluent Regulations*, under the *Fisheries Act*, govern the discharge of deleterious substances into waters frequented by fish. The *Pulp and Paper Effluent Regulations* limit the deposition of biochemical oxygen-demanding matter and total suspended solids and prohibit deposits of effluents that display acute lethality to fish.

Some provinces, such as Ontario and Quebec, also prescribe effluent limits in their regulations for the pulp and paper sector. Some provinces go beyond the

Pulp and Paper Effluent Regulations by also limiting concentrations of specific substances, including some heavy metals, but do not specify any limits for cobalt.

7.1.6 Waste management – landfills

Criteria and standards for landfills fall within provincial jurisdiction and are consequently prescribed by provincial regulations and guidelines. Although there are no provincial standards for concentrations of cobalt released from landfills, one province (British Columbia) has a provincial performance standard that specifies a concentration for dissolved cobalt released in effluent of hazardous waste facilities.

From a products perspective, there are existing provincial programs, such as Extended Producer Responsibility, that divert end-of-life products from entering landfills. Some of the diverted products may contain cobalt (e.g., batteries).

7.1.7 Chemical Manufacturing

The chemical manufacturing facility is subject to a municipal government sewer-use bylaw. This by-law sets a cobalt concentration limit which is required to be met before releasing the industrial effluent to the city's wastewater collection system.

To control the release of cobalt, the facility switched to another cobalt catalyst and installed a new wastewater treatment system. As a result of these actions, the release of cobalt in surface water near the WWTP to which the facility discharges its effluent is expected to be below the level of concern.

7.1.8 Wastewater and other sectors

The *Wastewater Systems Effluent Regulations*, established under the *Fisheries Act*, include mandatory minimum effluent quality standards that can be achieved through secondary wastewater treatment (Environment Canada, 2013c). Although the Regulations do not directly target cobalt, the requirement for additional treatment at some publicly owned wastewater systems is expected to generate co-benefits for industrial sectors that send their effluent to a publicly owned WWTP, as additional levels of treatment (e.g., secondary treatment) have been shown to further reduce the quantities of cobalt released (ECCC and Health Canada, 2017). The potential co-benefit of these regulations is an estimated reduction in cobalt releases to water of at least 1.7 tonnes per year by 2040.

7.1.9 Federal, provincial and territorial water quality guidelines

In 2013, Environment Canada published the *Federal Environmental Quality Guidelines* for cobalt. They recommend a federal water quality guideline for toxicity to freshwater organisms of 2.5 µg/L (Environment Canada, 2013a).

Considering the new information presented in the final Screening Assessment Report of Cobalt and Cobalt-containing Substances (published on May 20, 2017) under Phase 2 of the Chemicals Management Plan, ECCC is updating this guideline.

In Canada, three provinces and one territory were found to have surface water quality guidelines intended for the protection of aquatic life from exposure to cobalt. Ontario has a limit of 0.9 µg/L to protect aquatic organisms from indefinite exposure to cobalt (Ontario Ministry of the Environment, 1994). British Columbia has a maximum and 30-day average exposure to cobalt of 110 and 4 µg/L respectively (Nagpal, N.K., 2004). Finally, Quebec has limits of 370 and 100 µg /L to prevent acute and chronic effects on aquatic life, respectively (Gouvernement du Quebec, 2002). The Northwest Territories have guidelines for additional parameters that can be included in a licence issued for the discharge of wastewater, normally for industrial effluents. Dissolved cobalt concentration at the point of discharge can be limited to a maximum of 100 µg/L. However, the water quality objective for metals in receiving water bodies is to not have more than a 10% increase in background levels. These guidelines are under review (Northwest Territories Water Board, 1992).

7.2 Pertinent International Risk Management Context

7.2.1 United States

Under the *Clean Air Act*, the United States Environmental Protection Agency (EPA) regulates and controls airborne emissions of hazardous air pollutants from industrial sources, including cobalt compounds. The EPA developed a list of source categories and control technology requirements for each industry aimed at the specific air pollutants they emit (United States Environmental Protection Agency, 2013).

Effluent containing cobalt is controlled by the Effluent Limitations Guidelines under Title 40: *Protection of Environment* in the United States *Code of Federal Regulations*. Based on best practicable control technology currently available, these guidelines recommend different maximum daily limits and maximum monthly averages for the release of cobalt for various point source categories (U.S. Government Printing Office, 2013). Of those, only two were found to have limits for cobalt: Centralized Waste Treatment and Battery Manufacturing.

7.2.2 Europe

Five cobalt compounds (cobalt dichloride, cobalt (II) carbonate, cobalt (II) diacetate, cobalt (II) dinitrate and cobalt (II) sulphate) are currently listed on the Candidate List of Substances of Very High Concern for Authorisation, as part of the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) Regulation implemented by the European Union. Substances on this list are expected to pose a high concern for human health and/or the

environment. In 2011, these five cobalt compounds were recommended for inclusion in Annex XIV. If included in Annex XIV, these substances would no longer be allowed on the European market after a set date, unless an authorization is granted (European Chemicals Agency, 2013).

7.2.3 Australia

The Environment Protection Authority in South Australia manages the releases of cobalt with the *Standard for the Production and Use of Waste Derived Fill*, as listed in the *Environment Protection Regulations 2009* under the *Environment Protection Act 1993*. This standard limits chemical substances found in the treatment of waste or waste materials to be used as fill by setting a maximum concentration of 170 mg/kg for cobalt in waste (Government of South Australia, 2013).

The *Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 3, Primary Industries* suggests a maximum limit of total cobalt in irrigation waters of 0.05 mg/L for long term use and 0.1 mg/L for short term use. The maximum limit for total cobalt in drinking water for livestock is 1 mg/L. These guidelines have been under review since 2009. (Governments of Australia and New Zealand, 2000)

8. Next Steps

8.1 Public Comment Period

Industry and other interested stakeholders are invited to submit comments on the content of this Risk Management Approach or other information that would help to inform decision making (such as outlined in section 3.3). Please submit additional information and comments prior to July 19, 2017.

Comments and information submissions on the Risk Management Approach should be submitted to the address provided below:

Environment and Climate Change Canada
Chemicals Management Division
Gatineau QC K1A 0H3
Tel.: 1-800-567-1999 or 819-938-3232
Fax: 819-938-3231
Email: eccc.substances.eccc@canada.ca

Companies that have a business interest in cobalt and soluble cobalt compounds are encouraged to identify themselves as stakeholders. Stakeholders will be informed of future decisions regarding cobalt and soluble cobalt compounds and may be contacted for further information.

8.2 Timing of Actions

Publication of the final Screening Assessment Report and the Risk Management Approach document: May 20, 2017

Electronic consultation on the Risk Management Approach: May 20, 2017 to July 19, 2017

Publication of responses to public comments on the Risk Management Approach document: On or before May 2019

9. References

Castrilli, J. (2007). *Report on the Legislative, Regulatory, and Policy Framework Respecting Collaboration, Liability, and Funding Measures in relation to Orphaned/Abandoned, Contaminated, and Operating Mines in Canada*. Retrieved from http://www.abandoned-mines.org/wp/wp-content/uploads/2015/06/JurisdictionalLegislativeReview2007.pdf

Cowan Minerals Ltd. (2010). *Policy Framework in Canada for Mine Closure and Management of Long-term Liabilities: A Guidance Document*. Retrieved August 19, 2015, from http://www.abandoned-mines.org/pdfs/PolicyFrameworkCanforMinClosureandMgmtLiabilities.pdf

Dr. Jeff Louch [NCASI]. (2015, November 1). Presence of cobalt in dyes and pigments used in the pulp and paper sector. (Environment Canada, Interviewer)

ECCC and Health Canada. (2017). *Final Screening Assessment Cobalt and Cobalt-Containing Substances Grouping.* Retrieved MMM DD, YYYY, from ECCC: http://www.ec.gc.ca/ese-ees/default.asp?lang=En&n=4A8C8BC4-1

Environment Canada. (2001). *Compliance and Enforcement Policy for the Habitat Protection and Pollution Prevention Provisions of the Fisheries Act.* Retrieved January 13, 2016, from Environment Canada: https://www.ec.gc.ca/alef-ewe/default.asp?lang=En&n=D6B74D58-1

Environment Canada. (2004). *A Guide to Understanding the Canadian Environmental Protection Act, 1999*. Retrieved October 21, 2015, from Environment Canada: http://www.ec.gc.ca/lcpe-cepa/default.asp?lang=En&n=E00B5BD8-1

Environment Canada. (2013a). *Federal Environmental Quality Guidelines, Cobalt*. Retrieved October 15, 2015, from Environment Canada: http://www.ec.gc.ca/ese-ees/default.asp?lang=En&n=92F47C5D-1

Environment Canada. (2013b). *Guidance on the Reporting of Tailings and Waste Rock to the National Pollutant Release Inventory*. Retrieved August 31, 2015, from

Environment Canada: http://www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=E38E61E8-1

Environment Canada. (2013c). *Wastewater*. Retrieved November 6, 2013, from Environment Canada: www.ec.gc.ca/eu-ww/

Environment Canada. (2015). *Annual Guide for Reporting to the National Pollutant Release Inventory*. Retrieved August 31, 2015, from Environment Canada: http://www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=AFC98B81-1

European Chemicals Agency. (2013). *Candidate List of Substances of Very High Concern for Authorisation*. Retrieved November 6, 2013, from ECHA European Chemicals Agency: http://echa.europa.eu/web/guest/candidate-list-table

Gouvernement du Quebec. (2002). *Critères de qualité de l'eau de surface (in French only)*. Retrieved August 17, 2016, from Ministre du Développement durable, de l'Environnement et lutte contre les changements climatiques: www.mddelcc.gouv.qc.ca/eau/criteres_eau/details.asp?code=S0122

Government of Canada. (1999). *Canadian Environmental Protection Act, 1999. S.C., 1999, ch. 33.* Retrieved November 5, 2013, from Canada Gazette (Part III, vol. 22, no. 3): http://publications.gc.ca/gazette/archives/p3/1999/g3-02203.pdf

Government of Canada. (2011a). *Canadian Environmental Protection Act, 1999: Announcement of planned actions to assess and manage, where appropriate, the risks posed by certain substances to the health of Canadians and the environment.* Retrieved November 5, 2013, from Canada Gazette (Part I, vol. 145, no. 41, p. 3125-3129): www.gazette.gc.ca/rp-pr/p1/2011/2011-10-08/html/notice-avis-eng.html#d127

Government of Canada. (2011b). *Canadian Environmental Protection Act, 1999: Publication of Final Decision after Screening Assessment of Substances – Batch 10*. Retrieved November 5, 2013, from Canada Gazette (Part I, vol. 145, no. 3).: www.gazette.gc.ca

Government of Canada. (2012). *Profile for the Cobalt-Containing Substance Grouping*. Retrieved November 6, 2013, from Chemical Substances: www.chemicalsubstanceschimiques.gc.ca/group/cobalt-eng.php

Government of Canada. (2013). *Exploration and Mining Guide for Aboriginal Communities*. Retrieved August 19, 2015, from http://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/mineralsmetals/files/pdf/abor-auto/mining-guide-eng.pdf

Government of Canada. (2014). *Federal Contaminated Sites Action Plan*. Retrieved August 20, 2015, from Federal Contaminated Sites Portal: http://www.federalcontaminatedsites.gc.ca/default.asp?lang=En&n=BAC292EB-1

Government of South Australia. (2013). *Environment Protection Regulations 2009*. Retrieved November 6, 2013, from South Australia Legislation: www.legislation.sa.gov.au/LZ/C/R/Environment%20Protection%20Regulations%202009.aspx

Governments of Australia and New Zealand. (2000). *Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 3, Primary Industries*. Retrieved April 18, 2017, from Department of the Environment and Energy (Australian Government):

https://www.environment.gov.au/system/files/resources/e080174c-b267-455e-a8db-d3f79e3b2142/files/nwqms-guidelines-4-vol3.pdf

International Programme on Chemical Safety. (2006). *Concise International Chemical Assessment Document 69 – Cobalt and inorganic cobalt compounds. In IPC INCHEM Home*. Retrieved November 5, 2013, from www.inchem.org/documents/cicads/cicads/cicad69.htm

Macksey, W. O. (2000). *Abandoned Mines in Canada*. Retrieved August 19, 2015, from http://www.miningwatch.ca/files/Mackasey_abandoned_mines_0.pdf

Nagpal, N.K. (2004). *Ambient Water Quality Guidelines for Cobalt*. Retrieved April 18, 2017, from Government of British Columbia Ministry of Environment: http://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/wqgs-wqos/approved-wqgs/cobalt_tech.pdf; http://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/wqgs-wqos/approved-wqgs/coblat-or.pdf

National Pollutant Release Inventory. (2014). *NPRI data search for "Cobalt (and its compounds)"*. Retrieved November 3, 2016, from Environment Canada: www.ec.gc.ca/inrp-npri/donnees-data/index.cfm?lang=En

Natural Resources Canada. (2015). *Statistics on Annual Mineral Production*. Retrieved September 9, 2015, from http://sead.nrcan.gc.ca/prod-prod/ann-ann-eng.aspx?FileT=2009&Lang=en

NOAMI. (2000a). *Home*. Retrieved August 21, 2015, from National Orphaned/Abandoned Mines Initiative: http://www.abandoned-mines.org/en/

NOAMI. (2000b). *Advisory Committee*. Retrieved August 21, 2015, from National Orphaned/Abandoned Mines Initiative: http://www.abandoned-mines.org/en/advisory-committee/

Northwest Territories Water Board. (1992). *Guidelines for the Discharge of Treated Municipal Wastewater in the Northwest Territories*. Retrieved November 7, 2016, from Northwest Territories Water Board: http://www.nwb-oen.ca/public/other%20documents/Guidelines/920101%20NWT%20bguidelines%20treated%20municipal%20wastewater-FTAE.pdf

Nriagu, J.O. (1989). *A global assessment of natural sources of atmospheric trace metals. Nature, 338, 47–49.*

Ontario Ministry of the Environment. (1994). *Water Management, Policies, Guidelines: Provincial Water Quality Objectives of the Ministry of the Environment*. Retrieved November 5, 2013, from Ontario Ministry of the Environment: www.ontario.ca/environment-and-energy/water-management-policies-guidelines-provincial-water-quality-objectives

Reimann, C. & Caritat, P. de. (1998). *Chemical Elements in the Environment. Factsheets for the Geochemist and Environmental Scientist. 398 pp. Berlin (Germany). Springer-Verlag.*

Treasury Board of Canada Secretariat. (2007). *Assessing, Selecting, and Implementing Instruments for Government Action*. Retrieved July 11, 2014, from Treasury Board of Canada Secretariat: www.tbs-sct.gc.ca/rtrap-parfa/asses-eval/asses-evaltb-eng.asp

Treasury Board of Canada Secretariat. (2012). *Cabinet Directive on Regulatory Management*. Retrieved November 5, 2013, from Treasury Board of Canada Secretariat: www.tbs-sct.gc.ca/rtrap-parfa/cdrm-dcgr/cdrm-dcgrtb-eng.asp

U.S. Government Printing Office. (2013). *Title 40: Protection of Environment*. Retrieved from Code of Federal Regulations (Volume 31, Parts 425 to 699): www.gpo.gov/fdsys/browse/collectionCfr.action;jsessionid=JqP5S5lKHvn1k2JwTlsSy0JfPgrJTnqwG2n1B6FXLgzJXSd5Byh2!1624002798!-715099904?selectedYearFrom=2013&go=Go

United States Environmental Protection Agency. (2013). *Original list of hazardous air pollutants*. Retrieved November 6, 2013, from EPA United States Environmental Protection Agency: www.epa.gov/ttn/atw/188polls.html

Annex A. Cobalt-containing substances that were identified for further action during categorization

CAS RN	DSL name (English)	Common name/Simplified name	Chemical formula	Substance category
513-79-1	Carbonic acid, cobalt(2+) salt (1:1)	Cobalt(II) carbonate	$CoCO_3$	Inorganics
1307-86-4	Cobalt hydroxide	Cobalt(III) hydroxide	$Co(OH)_3$	Inorganics
1307-96-6	Cobalt oxide	Cobalt oxide	CoO	Inorganics
1317-42-6	Cobalt sulfide	Cobalt sulphide	CoS	Inorganics
7440-48-4[a]	Cobalt	Elemental cobalt	Co	Inorganics
7542-09-8	Carbonic acid, cobalt salt	Cobalt carbonate	$CH_2O_3.xCo$	Inorganics
7646-79-9[a]	Cobalt chloride	Cobalt chloride	$CoCl_2$	Inorganics
10124-43-3[a]	Sulfuric acid, cobalt(2+) salt (1:1)	Cobalt(II) sulfate	$CoSO_4$	Inorganics
10141-05-6	Nitric acid, cobalt(2+) salt	Cobalt nitrate	$Co(NO_3)_2$	Inorganics
10393-49-4[a]	Cobalt sulfate	Cobalt sulfate	$Co.xH_2O_4S$	Inorganics
10534-89-1	Cobalt(3+), hexaammine-, trichloride, (OC-6-11)-	Cobalt hexammine chloride	$Cl.^1/_3CoH_{18}N_6$	Inorganics
12602-23-2	Cobalt, bis[carbonato(2-)]hexahydroxypenta-	Cobalt hydroxide carbonate	$Co_5(OH)_6(CO_3)_2$	Inorganics
13455-25-9	Chromic acid (H_2CrO_4), cobalt(2+) salt (1:1)	Cobalt chromate	$CrCoO_4$	Inorganics
13455-36-2	Phosphoric acid, cobalt(2+) salt (2:3)	Cobalt phosphate	$Co_3(PO_4)_2$	Inorganics
13782-01-9	Cobaltate(3-), hexakis(nitrito-N)-, tripotassium, (OC-6-11)-	C.I. Pigment Yellow 40	$CoN_6O_{12}.3K$	Inorganics
21041-93-0	Cobalt hydroxide	Cobalt(II) hydroxide	$Co(OH)_2$	Inorganics
71-48-7	Acetic acid, cobalt(2+) salt	Cobalt acetate	$C_2H_4O_2.^1/_2Co$	Organic-metal salt
136-52-7	Hexanoic acid, 2-ethyl-, cobalt(2+) salt	Cobalt(II) 2-ethylhexanoate	$C_8H_{16}O_2.^1/_2Co$	Organic-metal salt
1560-69-6	Propanoic acid, cobalt(2+) salt	Cobalt propionate	$C_3H_6O_2.^1/_2Co$	Organic-metal salt
6700-85-2	Octanoic acid, cobalt salt	Cobalt octanoate	$C_8H_{16}O_2.xCo$	Organic-metal salt
13586-82-8	Hexanoic acid, 2-ethyl-, cobalt salt	Cobalt 2-ethylhexanoate	$C_8H_{16}O_2.xCo$	Organic-metal salt
13586-84-0	Octadecanoic acid, cobalt salt	Cobalt stearate	$C_{18}H_{36}O_2.xCo$	Organic-metal salt
27253-31-2	Neodecanoic acid, cobalt salt	Cobalt neodecanoate	$C_{10}H_{20}O_2.xCo$	Organic-metal salt
27685-51-4	Cobaltate(2-), tetrakis(thiocyanato-N)-, mercury(2+) (1:1), (T-4)-	Cobalt mercury isothiocyanate	$HgCo(NCS)_4$	Organic-metal salt
38582-17-1	Cyclohexanebutanoic acid, cobalt(2+) salt	Cobalt cyclohexylbutyrate	$C_{10}H_{18}O_2.^1/_2Co$	Organic-metal salt

CAS RN	DSL name (English)	Common name/Simplified name	Chemical formula	Substance category
94246-88-5	Cobalt, (2-ethylhexanoato-O)(isooctanoato-O)-	Cobalt ethylhexanoate isooctanoate (Cobalt EHI)	$C_{16}H_{30}CoO_4$	Organic-metal salt
10210-68-1	Cobalt, di-μ-carbonylhexacarbonyldi-, (Co-Co)	Cobalt carbonyl	$C_8Co_2O_8$	Organometallics
8011-87-8	C.I. Pigment Green 19	C.I. Pigment Green 19	n/a	UVCBs-inorganic
65997-18-4	Frits, chemicals	Frits	n/a	UVCBs-inorganic
67711-89-1	Calcines, copper roasting	Calcines	n/a	UVCBs-inorganic
68186-89-0	C.I. Pigment Black 25	C.I. Pigment Black 25	n/a	UVCBs-inorganic
68187-11-1	C.I. Pigment Blue 36	C.I. Pigment Blue 36	n/a	UVCBs-inorganic
68608-93-5	C.I. Pigment Violet 48	C.I. Pigment Violet 48	n/a	UVCBs-inorganic
68610-13-9	C.I. Pigment Violet 47	C.I. Pigment Violet 47	n/a	UVCBs-inorganic
69012-71-1	Leach residues, zinc ore-calcine, cobalt repulp	n/a	n/a	UVCBs-inorganic
69012-72-2	Leach residues, zinc ore-calcine, zinc cobalt	n/a	n/a	UVCBs-inorganic
72869-37-5	Zinc sulfide (ZnS), cobalt and copper-doped	n/a	n/a	UVCBs-inorganic
91053-46-2	Leach residues, zinc ore-calcine, cadmium-copper ppt.	n/a	n/a	UVCBs-inorganic
121053-28-9	Electrolytes, cobalt-manufg.	n/a	n/a	UVCBs-inorganic
121053-29-0	Slimes and sludges, cobalt refining	n/a	n/a	UVCBs-inorganic
121053-30-3	Slimes and sludges, cobalt electrolytic	n/a	n/a	UVCBs-inorganic
124222-14-6	Flue dust, cobalt-refining	n/a	n/a	UVCBs-inorganic
124222-15-7	Residues, cobalt-refining	n/a	n/a	UVCBs-inorganic
124222-18-0	Residues, precious metal-refining	n/a	n/a	UVCBs-inorganic
129618-35-5	Electrolytes, copper-manufg.	n/a	n/a	UVCBs-inorganic
129618-36-6	Solutions, copper hydrometallurgical	n/a	n/a	UVCBs-inorganic
129618-39-9	Solutions, cobalt hydrometallurgical	n/a	n/a	UVCBs-inorganic
61789-51-3	Naphthenic acids, cobalt salts	Cobalt naphthenate	n/a	UVCBs-organic-metal salts

CAS RN	DSL name (English)	Common name/Simplified name	Chemical formula	Substance category
68457-13-6	Cobalt, borate neodecanoate complexes	Cobalt borate neodecanoate	n/a	UVCBs-organic-metal salts
68988-10-3	Zirconium, dipropylene glycol iso-Bu alc. neodecanoate propionate cobalt complexes	n/a	n/a	UVCBs-organometallic

[a] Four cobalt-containing substances previously assessed during the Challenge initiative of the Chemicals Management Plan (elemental cobalt, CAS RN 7440-48-4; cobalt chloride, CAS RN 7646-79-9; two cobalt sulfates, CAS RN 10124-43-3 and CAS RN 10393-49-4)

Annex B. Quantities, activities and uses of cobalt-containing substances identified for further action during categorization

Table B-1: Summary of the quantities of cobalt-containing substances on the DSL that were manufactured, imported and/or used in Canada according to information received from 2006, 2008 or 2011. Quantities presented are for substances, not on a cobalt basis

CAS RN	Common name / Simplified name	Total quantity[1] manufactured (tonnes)	Total quantity[1] imported (tonnes)	Total quantity[1] used (tonnes)
10124-43-3	Cobalt(II) sulfate	1 000 – 10 000	100 – 1 000	1 000 – 10 000
10393-49-4	Cobalt sulfate	64	1 550	1 463
7440-48-4	Cobalt	1 000 – 10 000	100 – 1 000	100 – 1 000
1317-42-6	Cobalt sulfide	100 – 1 000	>500	NA[2]
7646-79-9	Cobalt chloride	100 – 1 000	10 – 100	10 – 100
21041-93-0	Cobalt hydroxide	100 – 1 000	10 – 100	10 – 100
136-52-7	Hexanoic acid, 2-ethyl-, cobalt(2+) salt	10 – 100	52 – 166	NA
1307-96-6	Cobalt oxide	10 – 100	13 – 59	NA
68457-13-6	Cobalt borate neodecanoate	0.1 – 1	10 – 100	NA
27253-31-2	Cobalt neodecanoate	10 – 100[3]	10 – 100[3]	10 – 100[3]
61789-51-3	Naphthenic acids, cobalt salts	10 – 100[3]	10 – 100[3]	10 – 100[3]
10210-68-1	Cobalt carbonyl	below reporting threshold	below reporting threshold	50
13586-84-0	Cobalt stearate	below reporting threshold	10 – 100	NA

CAS RN	Common name / Simplified name	Total quantity[1] manufactured (tonnes)	Total quantity[1] imported (tonnes)	Total quantity[1] used (tonnes)
10141-05-6	Cobalt nitrate	below reporting threshold	1 – 100	NA
1560-69-6	Cobalt propionate	10 – 100[3]	10 – 100[3]	10 – 100[3]
513-79-1	Cobalt(II) carbonate	1 – 10[3]	1 – 10[3]	1 – 10[3]
71-48-7	Cobalt acetate	below reporting threshold[3]	below reporting threshold[3]	below reporting threshold[3]
12602-23-2	Cobalt hydroxide carbonate	0.1 – 1[3]	0.1 – 1[3]	0.1 – 1[3]
91053-46-2	Leach residues, zinc ore-calcine, cadmium-copper ppt.	>1 000	below reporting threshold	NA
124222-15-7	Residues, cobalt-refining	> 500	below reporting threshold	NA
69012-71-1	Leach residues, zinc ore-calcine, cobalt repulp	>500	below reporting threshold	NA
69012-72-2	Leach residues, zinc ore-calcine, zinc cobalt	>500	below reporting threshold	NA

1: quantity reported for one calendar year
2: NA: not applicable (information was not requested in the S.71 notice)
3: The range or the value represents the total quantity in commerce and may be a combinaison of: the total quantity manufactured and/or the total quantity imported and/or the total quantity used.

Table B-2. Top activities or uses in Canada of cobalt-containing substances according to information received for 2006, 2008 or 2011 in response to three separate section 71 notices

CAS RN	Common name / Simplified name	Top 1 Activity or Use #1	Top 2 Activity or Use #2	Top 3 Activity or Use #3	Reporting Year
10124-43-3	Cobalt(II) sulfate	Intermediate in metallurgical processes	–	–	2006
10393-49-4	Cobalt sulfate	Intermediate in metallurgical processes	–	–	2006
7440-48-4	Cobalt	Component in alloys and carbides for applications requiring high strength and temperature resistance	Intermediate in metallurgical processes	–	2006
1317-42-6	Cobalt sulfide	Non-ferrous metal (except aluminum) smelting and refining	–	–	2008
7646-79-9	Cobalt chloride	Intermediate in metallurgical processes	Analytical reagent	–	2006
21041-93-0	Cobalt hydroxide	Batteries	Catalyst manufacturing	Non-ferrous metal (except aluminum) smelting and refining	2011
136-52-7	Hexanoic acid, 2-ethyl-, cobalt(2+) salt	Paints and Coatings manufacturing	–	–	2008
1307-96-6	Cobalt oxide	Incidental production by-product	Catalyst manufacturing	Catalyst	2008
68457-13-6	Cobalt borate neodecanoate	Rubber	Automobile manufacturing	Paints and Coatings	2008
27253-31-2	Cobalt neodecanoate	Rubber	Paints and Coatings	Plastic	2011

CAS RN	Common name / Simplified name	Top 1 Activity or Use #1	Top 2 Activity or Use #2	Top 3 Activity or Use #3	Reporting Year
61789-51-3	Naphthenic acids, cobalt salts	Rubber	Plastic–	–	2011
10210-68-1	Cobalt carbonyl	Catalyst	–	–	2011
13586-84-0	Cobalt stearate	Rubber	Adhesives and sealants	–	2008
10141-05-6	Cobalt nitrate	Plating agent	–	–	2008
1560-69-6	Cobalt propionate	Rubber	Paints and Coatings	–	2011
513-79-1	Cobalt(II) carbonate	Animal feed	–	–	2011
71-48-7	Cobalt acetate	Food packaging	–	–	2008
12602-23-2	Cobalt hydroxide carbonate	Animal feed	–	–	2011
91053-46-2	Leach residues, zinc ore-calcine, cadmium-copper ppt.	Non-ferrous metal (except aluminum) smelting and refining	–	–	2008
124222-15-7	Residues, cobalt-refining	Non-ferrous metal (except aluminum) smelting and refining	–	–	2008
69012-71-1	Leach residues, zinc ore-calcine, cobalt repulp	Non-ferrous metal (except aluminum) smelting and refining	–	–	2008
69012-72-2	Leach residues, zinc ore-calcine, zinc cobalt	Non-ferrous metal (except aluminum) smelting and refining	–	–	2008