9 February 2017

Manager of Licensing
Nunavut Water Board
PO Box 119
Gjoa Haven NU X0B 1J0

Re: Notification to NWB: Scope update, chemical monitoring, DEW Line Long Term Monitoring (LTM) program

Dear Manager of Licensing:

The purpose of this letter is to notify the Nunavut Water Board of an update to the monitoring plans associated with the post-cleanup landfill monitoring at the former DEW Line sites in Nunavut that are managed by the Department of National Defence (DND). DEW Line landfill monitoring activities include soil and groundwater sampling, as well as the collection of ground temperature and geophysical data. Refer to Table 1 for a list of the sites included in the DEW Line Long Term Monitoring (LTM) program and their associated water use licences.

The monitoring plans submitted with the licence applications for the sites listed in Table 1 included the analysis of the following chemical parameters for all soil and groundwater samples: arsenic, cadmium, chromium, cobalt, copper, lead, mercury, nickel, zinc, polychlorinated biphenyls (PCBs) and petroleum hydrocarbons.

In 2013, a report titled *DEW Line Cleanup Landfill Monitoring Program – Review of Phase I and Phase II Chemical Data* was prepared by Environmental Sciences Group (ESG). The purpose of the report was to evaluate if the data requirements under the current soil and groundwater monitoring plan for the first 25 years of landfill monitoring at the DEW Line sites are sufficient to determine whether or not the landfills are successfully containing the encapsulated contaminants and if they are likely to continue to do so in the foreseeable future.

The 2013 report noted that there were very few detectable concentrations of mercury in the soil and groundwater samples collected at the DEW Line sites to date and very few detectable concentrations of PCBs in the groundwater samples. It was concluded that mercury and PCBs in groundwater, as well as mercury in soil, are not useful indicators of potential landfill failure; the other, more easily detectable and more mobile contaminants in the soil and groundwater monitoring plans are more effective indicators. Consequently, ESG recommended that mercury analysis be removed from the DEW Line soil and groundwater monitoring program and that PCB analysis be removed from the DEW Line groundwater monitoring program.

As per the 1998 agreement between Nunavut Tunngavik Incorporated (NTI) and DND, an Environmental Working Group (EWG) was established to provide technical oversight to the DEW Line Cleanup; two members of the EWG were chosen by NTI and two were chosen by DND. The EWG evaluates the results of the landfill monitoring program and reports the results of their assessments to the DEW Line Steering Committee (two members named by NTI and two members named by DND). The EWG reviewed the 2013 report and agreed with the recommendations to remove mercury from the soil and groundwater monitoring plans and to remove PCBs from the groundwater monitoring plans at all the DEW Line sites listed in Table 1. The EWG decision was subsequently endorsed by the DEW Line Steering Committee in February of 2016.

Consequently, as of 2017, the scope of the soil and groundwater monitoring program for the DEW Line sites in Nunavut will not include mercury analysis from the soil and groundwater monitoring program or PCB analysis from the groundwater monitoring program.

Do not hesitate to contact the undersigned with any questions on the above,

Sincerely,

Cynthia Tremblay, P.Eng.
Senior Project Manager, Department of National Defence

Bert Dean
Assistant Director, Department of Wildlife and Environment, NTI
On Behalf of the DEW Line Steering Committee (NTI)

Appendices:

1. Table 1: List of DND DEW Line Sites and Associated Monitoring WULs
2. *DEW Line Cleanup Landfill Monitoring Program – Review of Phase I and Phase II Chemical Data* (ESG, 2013)
3. EWG Recommendation letter (October 28, 2015)

Table 1: List of DND DEW Line Sites and Associated Monitoring WULs

Region	Site	Location	Licence Number	Expiry Date
Kitikmeot	PIN-2	Cape Young	1BR-CAP1623	24-Oct-23
	PIN-3	Lady Franklin Point	1BR-FRA1016	30-Oct-16
	PIN-4	Byron Bay	1BR-BYR1320	19-Aug-20
	CAM-M	Cambridge Bay	NWB5CAM0520	01-Oct-20
	CAM-1	Jenny Lind Island	1BR-JEN1323	09-Oct-23
	CAM-2	Gladman Point	1BR-GLA1531	12-Oct-31
	CAM-3	Shepherd Bay	1BR-SHE1016	30-Dec-16
	CAM-4	Pelly Bay	1BR-PEL1016	30-Oct-16
Qikiqtaaluk	CAM-5	Mackar Inlet	1BR-MAC1323	13-Aug-23
	FOX-M	Hall Beach	1BR-HAL1533	01-Jun-33
	FOX-2	Longstaff Bluff	1BR-LON1422	16-Mar-22
	FOX-3	Dewar Lakes	1BR-FOD1320	14-Oct-20
	FOX-4	Cape Hooper	1BR-FOX1118	30-Aug-18
			1BR-FOX1523	20-Oct-23
	FOX-5	Broughton Island	1BR-QIK1320	22-Aug-20
	DYE-M	Cape Dyer	1BR-DYE1623	26-Oct-23

DEW Line Cleanup Landfill Monitoring Program Review of Phase I and Phase II Chemical Data

Prepared by

Environmental Sciences Group
Royal Military College
Kingston, Ontario

February 2013
RMC-CCE-ES-13-12

This report was commissioned by the Distant Early Warning (DEW) Line Clean Up (DLCU) Project Management Office of Defence Construction Canada (DCC). The study reported here was undertaken by the Environmental Sciences Group (ESG) of the Royal Military College of Canada, in Kingston, ON, under the direction of Dr. Ken Reimer. The landfill monitoring results used for this study were collected by a variety of consulting firms and ESG and have been provided by DCC.

The report was written by Maeve Moriarty with support from Shari Reed and Dr. Daniela Loock. The report was edited by Susie Rance and reviewed by Dr. Daniela Loock and Dr. Ken Reimer.

EXECUTIVE SUMMARY

This report was commissioned to review the findings of the long-term monitoring program currently in place for landfills remediated as part of the Distant Early Warning (DEW) Line Cleanup (DLCU) Project.

There are four types of landfill facilities present on DEW Line sites after remediation: historic landfills remaining from DEW Line operations and remediated through the DLCU Project, either through installation of leachate containment or through regrading and newly constructed Tier II disposal facilities (in Nunavut only) and non-hazardous waste landfills (NHWLs). These facilities are constructed as part of the DLCU Program and operated during site remediation, typically for two to three years. Tier II facilities are built to contain soil contaminated with inorganic elements and PCBs in excess of Tier II DEW Line Cleanup Criteria (DLCC) but below CEPA criteria. Waste disposed in the NHWL includes non-hazardous demolition waste, site debris and soils with concentrations of inorganic elements and PCBs below the Tier II DLCC. The contents of historic landfills that have been remediated as part of the DLCU are unknown but it is likely that little organic material has been buried.

The requirements to provide long-term monitoring are contained within agreements formed between the Department of National Defence (DND) and Nunavut Tunngavik Incorporated (NTI) for sites in Nunavut and with the Inuvialuit Regional Corporation (IRC) for sites in the Yukon and Northwest Territories.The details of the monitoring program are provided in the Long Term Monitoring Plan and include three phases. Phase I requires annual or biennial chemical monitoring for the first five years following remediation, Phase II outlines more infrequent monitoring up to year 25, whereas the specifics for Phase III have yet to be defined. To date, 83 landfills in Nunavut, 19 landfills in the Northwest Territories and five landfills in the Yukon are part of the Phase I or II DEW Line long-term monitoring program. Monitoring data spanning 13 years, acquired over seven monitoring events, have been collected.

The landfill monitoring program includes a combination of groundwater and soil analyses, visual monitoring and thermal monitoring depending on the landfill design. The chemical component of the monitoring program is designed to detect whether contaminants are migrating into the environment. The chemicals selected for the long-term monitoring program are the contaminants of concern remediated as part of the DEW Line Cleanup: arsenic, cadmium, chromium, cobalt, copper, lead, mercury, nickel, zinc, polychlorinated biphenyls (PCBs), and petroleum hydrocarbons. Analytical methods with low detection limits are used to analyze monitoring samples so that releases of contaminants can be detected well before the concentrations of these parameters exceed remediation criteria. Groundwater samples are

collected to indicate any releases from the landfill at the time of the monitoring, while soil samples provide a measure of ongoing leaching of contaminants from the landfills.

This report reviews the results of the chemical monitoring component of soil and groundwater of a representative subset (20) of these landfills.

Baseline data for soil and groundwater are collected around landfill facilities during remediation of the sites, generally over a period of one or two years. These values are used to determine the existing conditions at each facility and create a baseline average that can be used for comparison to data collected over time. A review of the soil data highlighted the natural variability of inorganic element concentrations in the environment and monitoring data can be viewed to fall within baseline conditions when it is within three standard deviations of the baseline average.

Results of the groundwater monitoring data were evaluated for trends in contaminant concentrations over time using a Mann-Kendall statistic. A minimum of three monitoring events is required for this type of analysis. Decreasing trends for inorganic elements were noted at a number of facilities. Further, increasing trends were not noted for contaminant levels at any monitoring well of the landfills where sufficient data were collected.

Soil data collected over time was analyzed using linear regression and an analysis of covariance to indicate trends in contaminant concentrations over time and was also evaluated for any exceedances of baseline values. No consistent trends were observed for any of the facilities evaluated as part of this review. In two instances, soil data indicated a potential increasing trend for certain chemical parameters. At FOX-4, the data indicated the migration of an existing hydrocarbon plume from the Helipad West Landfill and additional remediation activities are scheduled for 2013. The BAR-4 Northwest Landfill was identified as having statistically significant trends of increasing nickel and cobalt levels in soil, although the most recently collected data (2009) is indistinguishable from baseline values. Future data from this landfill will confirm whether or not these trends are real. Soil data occasionally exceeded the DEW Line Cleanup Criteria in isolated locations and additional sample collection as part of subsequent monitoring events confirmed that these exceedances are likely the result of small amounts of soil remaining from original site activities. Monitoring results periodically exceeded the baseline levels for all analytes, although never for consecutive years at any monitoring location.

The findings in this report confirm that landfills remediated or constructed as part of the DLCU Project effectively contain contaminants within the time period studied. The overall performance of landfills is established during baseline, Phase I and Phase II and sufficient chemical data will have been collected to ensure that any future data can be interpreted correctly as to whether or not contaminant releases have occurred. A minimum of seven monitoring events is recommended to provide confidence in the trend analysis. To increase the data set and to confirm trends, it is recommended to conduct soil monitoring at regrade landfills in year 2 and 4 of the Phase I program in addition to the visual inspection.

As the objective of the chemical component of the long-term monitoring program is to ensure that contaminants are not migrating from the landfills into the environment, collection of soil and groundwater data during Phase III landfill monitoring would only be required following significant environmental changes that suggest the failure of the structural stability if the landfills.

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Glossary and List of Abbreviations

AECOM	AECOM Canada Ltd.
ANCOVA	analysis of covariance
ANOVA	analysis of variance
As	arsenic
BMW	background monitoring well
CCME	Canadian Council of Ministers of the Environment
Cd	cadmium
Co	cobalt
CoC	contaminant of concern
Cr	chromium
Cu	copper
CWS	Canada-wide Standard
DCC	Defence Construction Canada
DEW	Distant Early Warning
DLCC	Dew Line Cleanup Criteria
DLCU	DEW Line Clean Up
EBA	EBA Engineering Consultants Ltd.
ESG	Environmental Sciences Group
HC	hydrocarbon
Hg	mercury
IRC	Inuvialuit Regional Corporation
ISR	Inuvialuit Settlement Region
MW	monitoring well
n/a	not applicable
NHWL	non-hazardous waste landfill
Ni	nickel
NTI	Nunavut Tunngavik Incorporated
Pb	lead
PCBs	polychlorinated biphenyls
PHCs	petroleum hydrocarbons
PHC F1	first fraction of petroleum hydrocarbons; includes compounds containing 6–10 carbon atoms
PHC F2	second fraction of petroleum hydrocarbons; includes compounds containing >10–16 carbon atoms
PHC F3	third fraction of petroleum hydrocarbons; includes compounds containing >16–34 carbon atoms
PHC F4	fourth fraction of petroleum hydrocarbons; includes compounds containing >34–50 carbon atoms

GLOSSARY AND LIST OF ABBREVIATIONS, CONT'D

ppm	parts per million; equivalent to μg/g (microgram of substance per gram of soil) and mg/L (milligrams of substance per litre of aqueous solution)
SSC	site-specific criteria
Tier I soil	Soil containing contaminants (specifically, PCBs and Pb) at concentrations that are considered high enough that there is potential for them to migrate via aerial transport.
Tier II soil	Soil containing contaminants (specifically, PCBs, As, Cd, Cr, Co, Cu, Pb, Hg, Ni and Zn) at concentrations that are high enough to transfer to the food chain through plant uptake.
TPH	total petroleum hydrocarbons
Zn	Zinc

I. INTRODUCTION

The Department of National Defence (DND) is restoring twenty one former Distant Early Warning (DEW) sites to an environmentally safe condition as part of the The DEW Line Cleanup (DLCU) Project. The cooperation agreements that DND formed with the Nunavut Tunngavik Incorporated (NTI) for sites in Nunavut (DGE 1998) and with the Inuvialuit Regional Corporation (IRC) for sites in the Yukon and Northwest Territories (DGE 1996) include the monitoring of remediated historical landfills and of new landfills constructed during the remediation. Depending on the level of potential environmental risk posed by the landfill, the monitoring program may include a combination of groundwater analysis, soil analysis, visual monitoring and, if reestablishment of permafrost was a component of the landfill design, thermal monitoring. The monitoring program is designed to ensure that landfills are maintaining their physical integrity so that no contaminants are migrating into the environment, and to provide early warning that remedial/risk management action may soon be necessary.

A 25-year monitoring plan was provided for the Nunavut Settlement Area (UMA 1999) and the Inuvialuit Settlement Area (UMA 2001), and baseline data were collected for all landfills prior to and during site remediation. The 25 years of monitoring are divided into two phases, with up to nine monitoring events for each site. Phase I, which covers the first five years of the program, requires annual or biennial sampling of soil and groundwater to identify critical failures of newly remediated landfills, while the second phase, spanning years six to 25, requires less frequent sampling, at years 7, 10, 15 and 25, to ensure that facilities continue to function as designed. To date, 83 landfills in Nunavut, 19 landfills in the Northwest Territories and five landfills in the Yukon are in Phase I or II of the monitoring program, and currently up to 13 years of monitoring data (seven monitoring events) have been collected. Baseline data are collected for each landfill during the remediation program and prior to final completion of each facility.

The requirements for monitoring during Phase III, which begins after year 25, have yet to be determined, but must include appropriate exit criteria to allow for reduction or termination of monitoring and appropriate trigger levels for action when necessary. Proposed monitoring frequency, action triggers, exit criteria and other elements of the Phase III monitoring program will be discussed in a separate report.

The purpose of this report is to examine if the chemical data collected during the Phase I and II long-term monitoring program are sufficient to determine whether the landfills are containing the encapsulated contaminants and are likely to continue to do so in the foreseeable future. This report will review the chemical data collected from soil and groundwater monitoring program only; geotechnical data will be discussed in a separate report produced by AECOM.

II. APPROACH

Twenty landfills located in the western, central and eastern Arctic regions were selected for review of groundwater and soil data for this report. The landfills selected represent the four types of landfills that require monitoring:

- historical landfills where leachate containment was implemented as remedial solution;
- newly constructed lined Tier II soil disposal facilities;
- newly constructed landfills to contain non-hazardous waste and Tier I soil (non-hazardous waste landfills, or NHWLs);
- landfills closed by placement of additional granular fill and regrading ("regraded landfills").

A Quality Assurance review of all landfills remediated at 12 DEW line Sites was conducted by UMA/AECOM in 2007 to review the performance of these landfills to date (UMA/AECOM 2008). Six of the 20 landfills reviewed in this report were identified as having specific engineering concerns which are outlined below. These landfills were included in this study because they are most likely to reveal indications of chemical containment failure.

- Significant water pressure was noted beneath the liner during construction of the leachate containment system at the BAR-2 USAF Landfill. An erosion channel was repaired and a drainage channel was built in 2008, and additional erosion control work was performed in 2012.
- The BAR-4 North Landfill is a leachate containment landfill located on a steep slope. Erosion gullies were noted before remediation, and settlement or tension cracking was observed during post-remediation monitoring.
- The PIN-1 Station Area Landfill Southwest is a regraded landfill that has a steep slope. Two years after the remediation was complete, erosion channels were noted on the slopes during monitoring.
- The CAM-M Main Landfill North is a leachate containment landfill and appears to be performing satisfactorily according to visual and thermal data collected to date. There was limited quality assurance during the installation of the leachate containment system and the as-built installation record is incomplete.

- The FOX-M East Beach Landfill is a leachate containment landfill located within 30 m of the ocean, and climate change and resultant potential geological effects such as erosion and changes of water level are of concern.
- The FOX-5 Main Landfill is a leachate containment landfill located on a steep slope and a large amount of surface water drains through the area. A number of erosion protection and surface water drainage redirection engineering controls were constructed in 2011.

The remediation of FOX-4 was conducted as a demonstration site before the 1996 and 1998 cooperation agreements were signed, and landfill remediation standards had not yet been finalized. Using current protocols, some landfills at FOX-4 would have been further remediated. The monitoring program raised possible concerns for certain landfills, and, as a result, additional landfill monitoring events were added to the FOX-4 schedule. The FOX-4 Helipad East Landfill was evaluated in 2010 when exposed debris on the surface and the presence of a migrating hydrocarbon plume were noted. In part because of the significant slope in the area, this landfill is scheduled to be excavated in 2013 while additional work is being performed at FOX-4. The effectiveness of the chemical containment at remediated landfills at FOX-4 does not reflect the expected performance of landfills at more recently remediated sites, and improvements were made on the designs used at future remediation sites as a result of the monitoring program.

This review is divided into six sections: Background, Groundwater Data, Soil Data, Summary of Groundwater and Soil Data, Conclusions, and Next Steps. Groundwater and soil data are analyzed to identify trends in all contaminants of concern (CoCs) at each landfill. The maximum analytical results for all CoCs are discussed, and any exceedances of the DEW Line Cleanup Criteria (DLCC) or site-specific criteria (SCC) in the soil monitoring data are noted. The Phase I and II chemical monitoring information is summarized and conclusions are provided for these two segments of the monitoring program. Finally, recommendations are made regarding potential further steps in the DLCU monitoring program.

III. BACKGROUND

Historical landfills, created during the operation of the DEW Line, were classified as posing either a high, moderate or low potential environmental risk during the site investigation. High-risk landfills are not left on the site; they are excavated completely during remediation and their contents disposed of appropriately. Moderate-risk landfills generally have been identified as a source of contaminated leachate; their remediation typically involves the excavation of a key trench, placement of a saturated layer of Type 4 granular fill materials, installation of geotextile and HDPE liners anchored into the permafrost and covering either the toe of the landfill or the entire landfill surface, placement of a protective thermal cover of granular fill and installation of monitoring equipment. These landfills are commonly referred to as leachate containment landfills. Remediation of low-risk landfills consists of removal of surface debris and placement and compaction of granular material to cover the landfill. These are referred to as regrade landfills. Both moderate-risk and low-risk landfills are included in the long-term monitoring program. Monitoring wells are installed at moderate-risk landfills.

Landfills found on site dating from DEW Line operations contain a variety of materials, primarily those listed below in Table III-1 (UMA 1999).

Table III-1: Materials commonly found in historical DEW Line site landfills

Waste oil	Meters
PCB transformers/capacitors	Transmission fluid
Asbestos	Batteries
Scrap metal	Paper
Fuel drums	Plastics
Antifreeze	Generators
Wood	Vehicles

All household organic waste generated during site operation was typically placed in one particular landfill on the site or incinerated. Because of decomposition reactions that occur over time, this type of waste has the potential to generate chemical leachate. Therefore, landfills with high amounts of organic waste content typically fall into the high-risk or moderate-risk category. As most of the landfills found at DEW Line sites contain primarily non-organic waste and so have a low likelihood of producing leachate, they fall into the low-risk category.

Monitoring of a leachate containment landfill requires groundwater and soil monitoring, thermal monitoring, and visual inspection of the physical integrity, and may also include pore pressure monitoring. During Phase I of the monitoring program, these landfills are monitored annually.

Regrade landfill monitoring requirements consist of soil monitoring and a visual inspection of the physical integrity. Groundwater monitoring is not required and no wells are installed at these facilities. During Phase I, these landfills are monitored in years 1, 3 and 5.

As part of the DLCU Program, Tier II disposal facilities and/or non-hazardous waste landfills (NHWL) are constructed on the sites.

Tier II disposal facilities are designed to contain moderately contaminated soils (soil containing inorganic contaminants and/or PCBs at concentrations high enough that they have the potential to be transferred from soils into plants and into the food chain, defined by the DLCC as Tier II). Debris is not placed within this type of facility. The design of the facility includes frozen core berms, full encapsulation of the waste layer within a synthetic liner, and sufficient capping material to keep the waste layer permanently frozen. Monitoring requirements for the Tier II disposal facility include groundwater and soil monitoring, thermal monitoring and visual inspection of the physical integrity. During Phase I of the monitoring program, these landfills are monitored annually. Tier II disposal facilities are constructed only at sites in Nunavut; they are not constructed at sites in the Yukon or the Northwest Territories as the IRC/DND Cooperation Agreement stipulates that Tier II-contaminated soil be disposed of outside the boundaries of the Inuvialuit Settlement Region (ISR) (DGE 1996).

NHWLs contain non-hazardous demolition debris, including bagged asbestos-containing insulation, and Tier I-contaminated soil (soil containing contaminants (specifically, PCBs and/or lead) at concentrations high enough that there is potential for them to migrate via aerial transport, as defined by the DLCC). This type of facility does not contain domestic and organic waste generated by the construction camp, which is incinerated on site. The design of the NHWL includes perimeter berms and cover material to contain the material. The monitoring program for the NWHL includes groundwater and soil monitoring and a visual inspection of the physical integrity of the facility. During Phase I, the NHWL is monitored in years 1, 3, and 5.

Both the Tier II disposal facility and the NHWL are operated only for the duration of the site remediation, typically 2–3 years. The Tier II facility contains only soil, while the NHWL contains soil and demolition debris. Neither facility contains organic waste material; as a result, there is a low potential for leachate generation in these facilities, as is the case with regrade landfills.

The landfills selected for monitoring data evaluation in this report are described in Table III-2.

Table III-2: Former DEW Line site landfills selected for review

Site	Landfill	Year remediation completed	# of monitoring wells*	Span of monitoring data	# of monitoring events
Leachate containment landfills					
BAR-4	North Landfill	1999	5 (1)	2001–2009	6
BAR-2	USAF Landfill	2000	6 (1)	2002–2011	7
CAM-M	Main Landfill North	2000	5 (4)	2001–2010	7
FOX-5	Main Landfill	2006	5 (1)	2007–2012	5
FOX-M	East Beach Landfill	2007	12 (10)	2008–2011	4
Tier II disposal facilities					
FOX-4	Tier II facility	1998**	5 (1)	1999–2008	8
CAM-M	Tier II facility	2000	4 (3)	2001–2010	7
PIN-3	Tier II facility	2004	4 (2)	2004–2011	7
FOX-5	Tier II facility	2006	5 (1)	2007–2012	5
Non-hazardous waste landfills					
FOX-4	Lower Site Landfill	1998**	3 (1)	1999–2008	8
BAR-2	NHWL	2000	4 (2)	2001–2011	5
PIN-M	NHWL	2003	5 (4)	2003–2008	5
PIN-3	NHWL	2004	4 (1)	2004–2011	6
CAM-4	NHWL	2006	3	2007–2011	3
Regraded historical landfills					
PIN-M	Westpoint Landfill	1998	n/a	2003–2008	5
FOX-4	Helipad East Landfill	1998**	3 (3)	1999–2008	8
FOX-4	Helipad West Landfill	1998**	4 (2)	1999–2008	8
BAR-4	Northwest Landfill	1999	n/a	2001–2009	5
PIN-1	Station Area Landfill Southwest	2002	n/a	2003–2009	5
CAM-3	Northeast Landfill	2007	n/a	2008–2011	2

*Number in brackets refers to the number of unreliable wells out of the total number of wells, defined as wells that did not contain sufficient water for sampling every year, whether because of freezing, damage or low yield.

**Additional work is being conducted on these FOX-4 landfills in 2012 and 2013. This will need to be taken into consideration if data from before and after that point are compared.

n/a: No monitoring wells were installed as part of the monitoring program.

A. DEW Line Landfill Characteristics

Landfills at former DEW Line sites differ from landfills located in southern regions with more temperate climates with respect to waste composition, potential for leachate formation and collection, and groundwater flow (EBA 2008b). The waste in former DEW Line site landfills consists primarily of demolition waste and soils containing limited organic material. As a result, decomposition and leachate generation are minimal, especially given the cold temperatures which hinder decomposition. As leachate generation is anticipated to be low, the installation of a leachate collection system would be redundant. Additionally, as the former DEW Line site landfills are located in permafrost-affected areas, leachate collection systems are likely to freeze and not function. In southern regions, groundwater monitoring is typically carried out three to four times a year, while at former DEW Line sites, as groundwater is frozen most of the year and the sites are difficult to access, it is monitored once a year, at the time of maximum thaw (EBA 2008b).

At remediated DEW Line landfills, the main mechanism of containment is permafrost encapsulation of contaminated materials. Loss of containment would be manifested by mobilization of soil-sorbed contaminants to the aqueous phase and transport of contaminants beyond the boundaries of the landfill. Groundwater data provide information about seasonal movement of contaminants within the active layer and is one of the primary chemical indicators used to evaluate the integrity of DEW Line landfills. Soil data provides a measure for chronic inputs of contaminants to the environment since a portion of contaminants released through groundwater transport would re-sorb to the soil.

B. Landfill Monitoring Analytes

The contaminants in soil and groundwater that are assessed through the DLCU monitoring program are inorganic elements, polychlorinated biphenyls (PCBs) and petroleum hydrocarbons. The inorganic elements analyzed during monitoring are the Arctic suite of elements to which the DLCC apply and that have been identified as the CoCs in these landfills: arsenic (As), cadmium (Cd), chromium (Cr), cobalt (Co), copper (Cu), lead (Pb), mercury (Hg), nickel (Ni), and zinc (Zn).

During the site assessment and baseline monitoring program, hydrocarbons were typically analyzed in the laboratory as total petroleum hydrocarbons (TPH) using hexane extraction. The analysis of hydrocarbons (HCs) performed for the long-term monitoring program is conducted according to the Canadian Council of Ministers of Environment (CCME 2008) Tier

I Method –Rev. 5 Analysis of Petroleum Hydrocarbons (PHC) in Soil for F1 to F4 HC fractions. PHC F1 first fraction of petroleum hydrocarbons includes compounds containing 6–10 carbon atoms, PHC F2 second fraction of petroleum hydrocarbons includes compounds containing >10–16 carbon atoms, PHC F3 third fraction of petroleum hydrocarbons includes compounds containing >16–34 carbon atoms and PHC F4 fourth fraction of petroleum hydrocarbons includes compounds containing >34–50 carbon atoms and TPH is the sum of the four fractions together. However, the extraction method used to measure F1 to F4 PHC fractions is more aggressive than the ultrasonic extraction method used in hexane extraction TPH analysis (Kebbekus and Mitr 1998) and therefore the F1 to F4 PHC fraction analysis yields much higher results than does the hexane extraction TPH analysis (Sanscartier et al. 2007). During the hexane extraction TPH analysis, there is also a higher loss of the lighter hydrocarbons so lower overall levels of HCs measured. As a result, it is important to note that the results obtained by adding the F1 to F4 CCME fractions together are likely to be higher than the baseline values obtained by hexane extraction.

C. Sampling Program

Both soil and groundwater samples are collected as part of the long-term monitoring program. Groundwater samples are collected to indicate any releases from the landfill at the time of the monitoring, while soil samples provide a measure of ongoing inputs of contaminants from leachate into the environment. If the sampling period misses the release of contaminants in the groundwater, the release should still be captured by the soil monitoring. Soil samples are collected at surface (0-10 cm) and at shallow depth (30–50 cm) at all monitoring locations. If a monitoring well is present, the soil samples are collected between 1 and 5 m from the well. If only soil monitoring is conducted, samples are collected within a few metres of a specified location, downgradient locations are approximately 8–12 m from the landfill toe.

For low-risk regraded landfills at sites in the ISR (includes BAR-2, BAR-4 and PIN-M and PIN-1 landfills reviewed here), deep test pits are excavated upgradient of the landfill, 8 m from the downgradient toe, and 15 m from the downgradient toe, to the depth of maximum thaw (approximately 1.2 to 2.2 m below ground surface), and samples are collected at every change in stratigraphy or every 50 cm. The number of test pits depends on the size of the landfill. This program is conducted once to establish baseline conditions after remediation and again at year 5 (UMA 2001). A review of deep test pit data completed by EBA Engineering for the development of the Abandoned Military Site Remediation Protocol for Indian and Northern Affairs Canada determined that there was little difference in the contaminant levels at the surface and at all measured depths (EBA 2008b). Because of this finding, soil sample data collected at these depths was not included in this review; only surface and shallow depth soil data were used in the trend analysis.

Samples are collected for the long-term monitoring program to provide background and baseline information about the site and the landfills, and for post-remediation monitoring of landfills to confirm that no chemical releases have occurred.

Background samples collected at a distance from landfills, are used to determine natural levels of inorganic elements present on the site. A more intensive background sampling program is conducted at sites with significantly elevated levels of naturally occurring elements; at these sites, site-specific criteria (SSC) that differ from the DLCC are developed to minimize unnecessary excavation and destruction of large portions of natural tundra. The only site discussed in this report with SSC is FOX-4. The DLCC and the FOX-4 SSC are listed in Table III-3.

Table III-3: DEW Line Cleanup Criteria and FOX-4 site-specific criteria for soil

Analyte	DLCC – Tier I [ppm]	DLCC – Tier II [ppm]	FOX-4 SSC [ppm]
As	-	30	130
Cd	-	5.0	-
Cr	-	250	-
Co	-	50	-
Cu	-	100	-
Pb	200	500	-
Hg	-	2.0	-
Ni	-	100	-
Zn	-	500	-
PCBs	1.0	5.0	-
TPH	-	2,500 (action level)	-

Baseline samples are collected from the same locations that are later sampled during the long-term monitoring program. Samples are collected around historical landfills during the site assessment and remediation of the landfills, and from around new landfills during their construction. These values are used to determine the existing conditions for the facilities and create a baseline average for the facilities that can be later used to compare the long-term monitoring values. A minimum of four or five baseline values are required in order to assess the natural variability of analytes and the heterogeneity of soils at each landfill. Baseline samples are generally collected over two or three years at each facility during the site remediation phase.

Figure III-1 provides an example of baseline data collection: all data collected for the FOX-M East Beach Landfill up to 2007, when the FOX-M remediation was completed, are used as baseline data and included in the baseline average for the landfill. Also displayed on the graph are the baseline average plus three standard deviations.

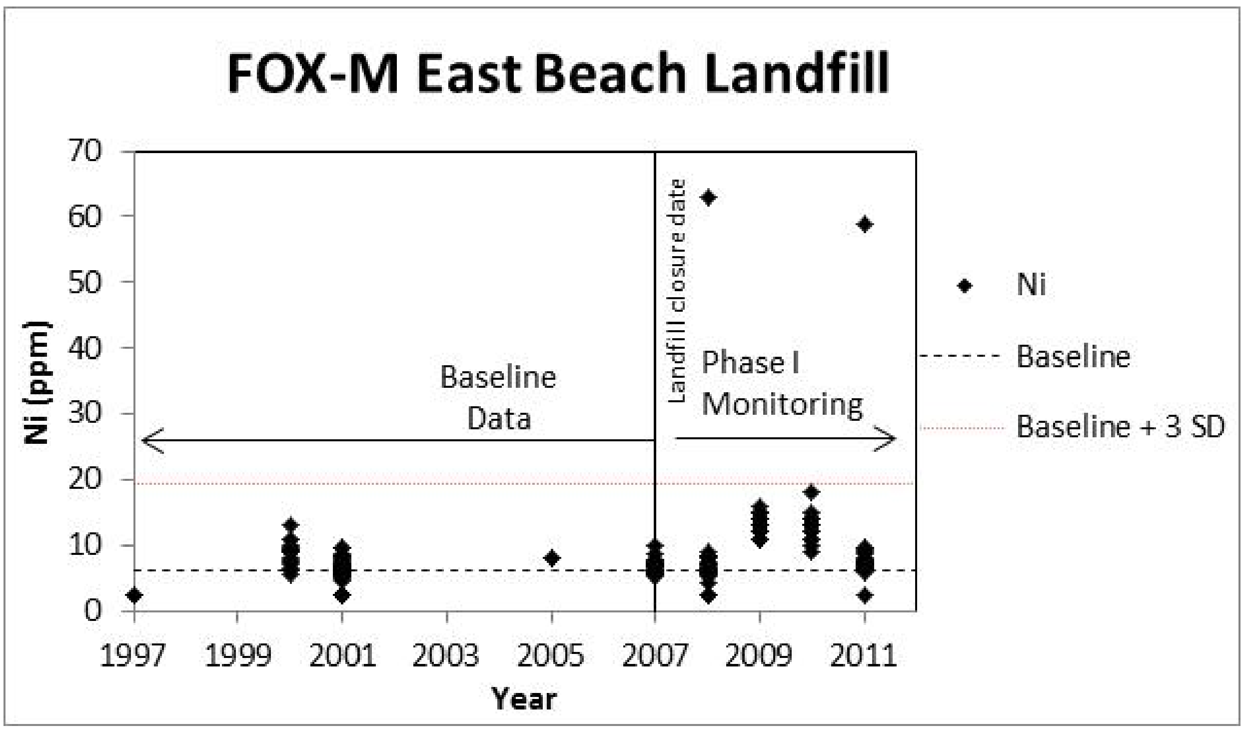

Figure III-1: FOX-M East Beach Landfill baseline and post-construction soil results for Ni.

Post-remediation samples for the long-term monitoring program are collected at set intervals between years 1 and 25 after remediation of the site is complete.

Temporal data may be examined for trends (detection monitoring), or they may be compared to trigger levels (compliance monitoring). A trigger level is a value which indicates further action must be taken if contaminants are measured above this level. Trigger levels are usually either a criterion or a set of values plus or minus a number of standard deviations. A common trigger level used in the evaluation of landfill data is the baseline average for an analyte plus three standard deviations (which corresponds to a 99% confidence limit). Analytical methods used in the long-term monitoring program are chosen with detection limits far below the DLCC, and when possible are below the naturally occurring levels, so any increasing trends can be identified with confidence (see Table III-4 for a list of detection limit requirements and the chemical concentrations found at DEW Line landfills reviewed here).

Table III-4: 2012 inorganic element detection limit requirements and range of measured average baseline concentrations at landfills included in LTM data review

Analyte	Soil		Water	
	Detection limit [mg/kg, ppm]	Baseline average [mg/kg, ppm]	Detection limit [mg/L]	Baseline average [mg/L]
As	0.20	1.3–20	0.050	<0.0030–0.12
Cd	1.0	0.08–1.1	0.0010	<0.0010–0.007
Cr	20	14–34	0.0050	<0.0050–3.0
Co	5.0	3.0–12	0.0050	<0.0030–0.95
Cu	3.0	4.8–42	0.0050	<0.0050–1.1
Pb	10	7.2–24	0.010	<0.010–0.80
Hg	0.10	0.030–0.090	0.0010	<0.00040–0.0050
Ni	5.0	<5.0–27	0.010	<0.0050–1.7
Zn	15	<15–99	0.0050	0.020–27

In this report, post-remediation monitoring data are assessed to determine whether there are any trends beyond natural variability. The highest levels of contaminants measured at each landfill (maximum values) for each facility are reviewed and discussed. Additionally, soil data are compared to the DLCC (see Table III-3).

IV. GROUNDWATER DATA

Groundwater may be present within the active layer in permafrost environments and the flow characteristics are determined by soil type, hydrogeological characteristics, presence of permafrost and infiltration. The depth of the active layer can vary considerably from year to year and tends to be relatively shallow. As a result, the groundwater table responds quickly to precipitation events. The timing of sampling relative to the thaw of the active layer will influence the water chemistry and conditions in the same well can vary considerably, depending on the time of sampling (EBA 2008b)

Monitoring wells are located strategically based on the groundwater flow of the area, and they are spaced to monitor the landfill's performance, with at least one well placed upgradient of each facility. In the Arctic, water in monitoring wells may be still frozen when sampling trips take place, or they may be damaged over time as the result of frost jacking. In some cases, wells are found to produce no water. Wells are considered unreliable if they cannot be sampled every year, but in many cases a well will be frozen during one monitoring event but will function as designed the following year. Only rarely (as at the FOX-M East Beach Landfill) are there a large number of monitoring wells that turn out to be unreliable and cannot be sampled during many sampling events, generally due to a variety of causes such as dry, frozen or damaged wells. For the landfills assessed in this report, the percentage of occasionally or always-unreliable wells varies among landfills, from 13–80%, with an average of 53%.

A. Trend Analysis

In this report, groundwater data were analyzed using the non-parametric trend analysis Mann-Kendall test with the help of the Monitoring and Remediation Optimization System (MAROS) software V2.2 developed by the United States Air Force Center for Environmental Excellence (AFCEE 2006). The Mann-Kendall test is used to identify monotonic trends in data and is frequently used for evaluation of groundwater monitoring data. This test considers each monitoring well individually and is recommended when fewer than 40 measurements are available. It is robust to irregular monitoring (which may occur if a well is frozen for one year), does not assume any data distribution, and is robust to occasional non-detects (Gibbons 2009). For the current analyses, duplicate analyses were averaged and all non-detects were replaced with ½ of the lowest detection limit reported for that analyte. MAROS recommends a minimum of four data measurements per well to be able to characterize the behaviour of a contaminant of concern and recommends that data not be missing for more than two consecutive sampling events. DEW Line site monitoring sampling takes place annually, at the same time of year, allowing for direct comparison of data between years. Figure IV-1 illustrates the data for the CAM-M Main Landfill North, which is a leachate containment landfill, where a decreasing trend was identified for MW-7. Only MW-7 had more than three samples collected, allowing for the determination of a trend using the MAROS software although MW-5 also appears downward-trending.

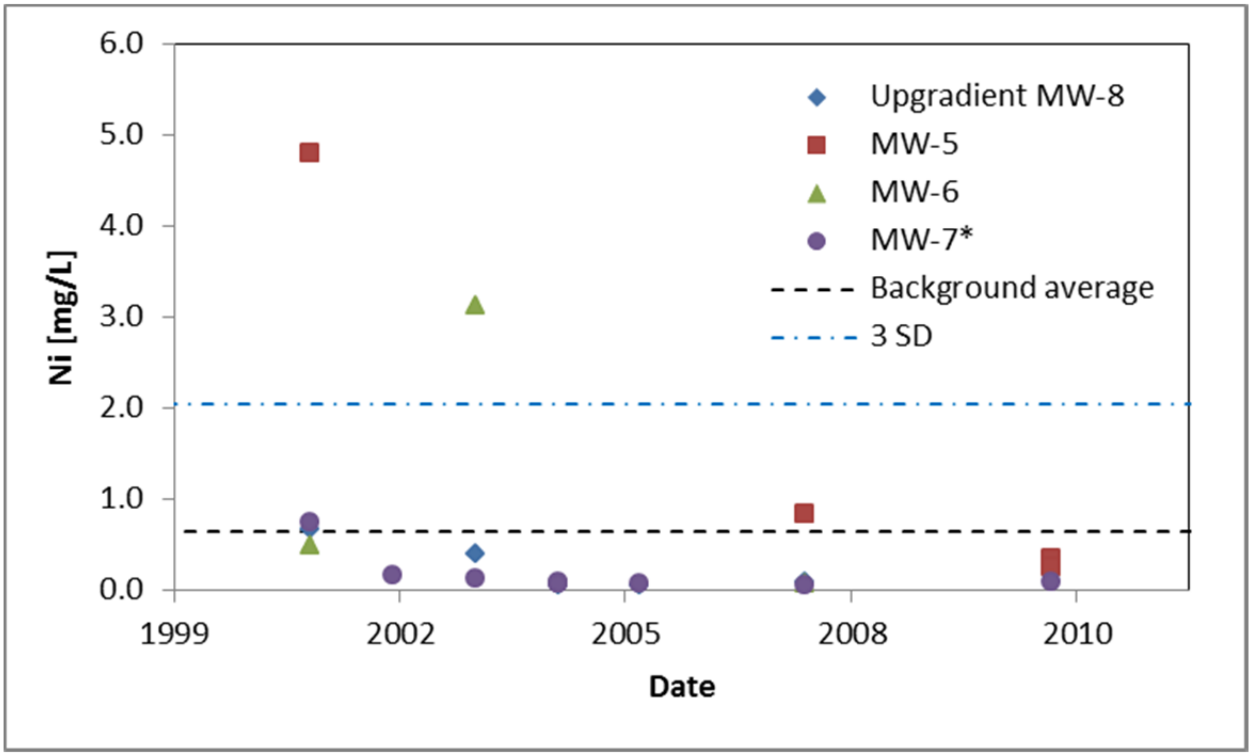

Figure IV-1: CAM-M Main Landfill North nickel groundwater concentrations over time.

Figure IV-2 illustrates that when more data points are collected (more reliable wells) with results above the detection limit, the natural variability of analyte concentrations is more easily measured and any trends present are more likely to be identified. Figure IV-2 shows the natural variability of Zn concentrations at the BAR-2 USAF Landfill, as well as differences in groundwater concentrations between wells.

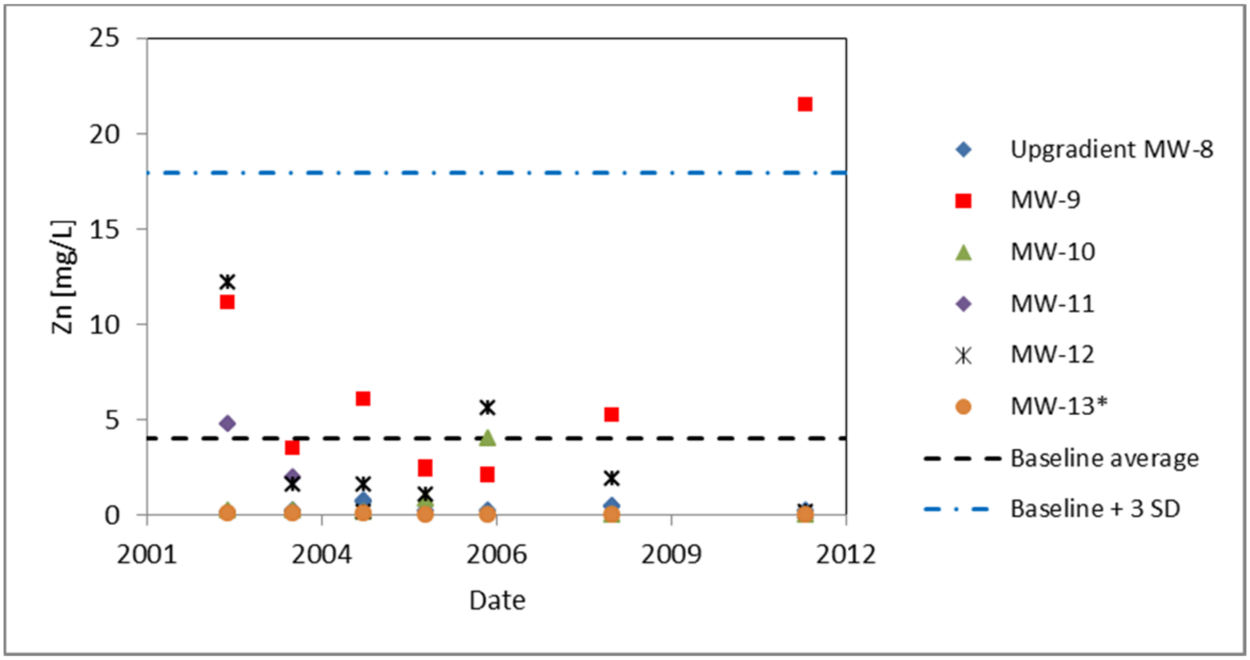

Figure IV-2: BAR-2 USAF Zn groundwater concentrations. All wells except for MW-11 had seven detectable Zn concentrations. A decreasing trend was identified for MW-13.

All the data for each landfill were analyzed for trends, and a summary of the results is present in Table IV-1. Trends with a confidence of >95% are indicated by an arrow pointing in the direction of the trend. A minimum of four data points are required to be able to identify a groundwater trend.When no trend is identified, the number of results above the detection limit is indicated for the downgradient well with the highest number of detectable results. The number of detectable results provides an indication of how many more detectable results are required for a trend to be identified.

Table IV-1: Groundwater trends with >95% confidence. An * indicates that at least one monitoring well had a 99% confidence in the decreasing trend (*p* < 0.01).

Site	Landfill	Years of monitoring (# monitoring events)	As	Cd	Cr	Co	Cu	Pb	Hg	Ni	Zn	PCBs	TPH
1. Leachate-contained Landfills													
BAR-4	North	12 (6)	6	↘	5	6	6	↘	↘	↘	6	0	2
BAR-2	USAF	11 (7)	↘	2	↘*	↘*	↘*	1	1	↘*	↘*	0	2
CAM-M	Main Landfill North	11 (7)	5	2	5	↘	↘	5	0	↘	↘	0	0
FOX-5	Main Landfill	6 (5)	0	3	3	4	5	2	0	3	↘	0	1
FOX-M	East Beach Landfill	4 (4)	3	1	4	2	3	1	0	3	3	0	0
2. Tier II Landfills													
FOX-4	Tier II	13 (8)	5	↘	6	↘	6	5	0	↘*	↘*	0	3
CAM-M	Tier II	11 (7)	3	2	4	4	4	2	0	4	4	0	1
PIN-3	Tier II	7 (5)	2	2	4	3	5	4	1	5	5	1	0
FOX-5	Tier II	6 (5)	0	3	4	4	5	2	0	2	5	0	1
3. Non-Hazardous Waste Landfills													
FOX-4	Lower Site Landfill	13 (8)	4	2	6	4	6	3	0	6	7	0	3
BAR-2	NHWL	11 (7)	6	1	↘	6	↘	↘	1	↘	↘*	1	1
PIN-M	NHWL	8 (3)	2 years of data for one downgradient well										
PIN-3	NHWL	7 (5)	3	2	5	3	4	2	1	5	5	0	0
CAM-4	NHWL	5 (3)	3 monitoring events- insufficient to determine a trend										
4. Regraded Landfills													
PIN-M	Westpoint	13 (3)	No wells										
FOX-4	Helipad East	13 (8)	4	0	5	5	5	4	0	2	5	0	0
FOX-4	Helipad West	13 (8)	↘	0	7	7	7	5	0	↘	8	0	6
BAR-4	Northwest	12 (6)	No wells										
PIN-1	Station Area Landfill Southwest	9 (7)	No wells										
CAM-3	Northeast Landfill	4 (4)	No wells										

None of the landfills had any wells where a statistically significant increasing trend for any of the parameters analyzed was found. Decreasing trends were identified with a confidence of greater than 95% for a number of inorganic elements at seven landfills at five sites. If the confidence was increased to 99% (+/- three standard deviations), decreasing trends could only be confirmed for three landfills at two sites. Trends could not be determined for a number of the landfills. If samples collected over several (more than four) sampling events contain detectable levels of analytes, this indicates that the variations in measured concentrations between sampling events cannot be distinguished from natural variability as there is sufficient data to detect a trend using the Mann-Kendall test. For example, a decreasing trend could be identified for lead at the NHWL at BAR-2 with four sampling events whereas no trends could be identified following eight sampling events at the Lower Site Landfill and the Helipad East Landfill at FOX-4, a site with naturally abundant inorganic elements and high spatial variability.

B. Highest Analyte Concentrations Detected in Groundwater Downgradient of Landfills

There are no DLCC for groundwater. The Ontario shallow non-potable groundwater standards are listed for reference in Table IV-2, as there are no appropriate federal criteria for comparison (OMOE 2011). Municipal waste landfills located in more temperate climates in southern Canada have leachate collection systems; the ranges of measured leachate concentrations at these municipal waste landfills as reported by Kjeldsen *et al.* 2002, are listed in Table IV-2 for reference. Municipal waste landfills contain much higher proportions of organic waste and the temperatures of the landfills are higher, so more leachate generation occurs than in northern DEW Line landfills. As part of the baseline program, groundwater concentrations were measured at the following landfills: BAR-4 North Landfill, BAR-2 USAF Landfill, CAM-M Main Landfill North, FOX-5 Main Landfill, FOX-M East Beach Landfill, FOX-5 Tier II disposal facility, BAR-2 NHWL, PIN-3 NHWL and CAM-4 NHWL. Baseline groundwater concentrations were not measured at: FOX-4 landfills (includes the Tier II, Lower Site Landfill and Helipad East and West landfills reviewed here), the CAM-M Tier II facility, the PIN-3 Tier II facility, and the PIN-M NHWL. The maximum value for each CoC measured at a downgradient monitoring well at any of the 20 landfills reviewed is listed in Table IV-2. Of the five landfills at which the highest concentrations were identified, baseline groundwater samples were collected at three: CAM-M Main Landfill North, CAM-4 NHWL, and FOX-5 Main Landfill.

Table IV-2: Highest analyte concentrations in groundwater at downgradient monitoring wells at former DEW Line site landfills reviewed in this report, contrasted to baseline concentrations, concentrations at southern Canadian municipal landfills, and Ontario groundwater standards

Analyte	Highest concentration at downgradient monitoring wells (site/landfill) [mg/L]	Range of baseline groundwater concentrations at landfills [mg/L]	Range of landfill leachate composition in Canadian municipal landfills* [mg/L]	Ontario shallow non-potable groundwater standards** [mg/L]
As	0.057 (CAM-4 NHWL)	<0.0030–0.12	0.010–1.0	1.5
Cd	0.24 (CAM-4 NHWL)	<0.0010–0.007	0.0001–0.4	0.0021
Cr	2.0 (CAM-M Main North)	<0.0050–3.0	0.020–1.5	0.064
Co	0.072 (CAM-M Main North)	<0.0030–0.95	0.005–1.5	0.052
Cu	0.48 (PIN-3 Tier II)	<0.0050–1.1	0.005–10	0.069
Pb	2.3 (PIN-3 Tier II)	<0.010–0.80	0.001–5.0	0.020
Hg	0.97 (CAM-4 NHWL)	<0.0050	0.000050–0.16	0.00010
Ni	4.8 (CAM-M Main North)	<0.0050–1.7	0.015–13	0.39
Zn	86 (CAM-M Main North)	0.020–27	0.030–1,000	0.89
PCBs	<0.0030	<0.00020	Not measured	0.00020
PHC F1	0.85 (CAM-4 NHWL)	Not measured	Not measured	0.42
PHC F2	2.0 (FOX-4 Helipad West)	Not measured	Not measured	0.15
PCH F3	0.60 (FOX-5 Main)	Not measured	Not measured	0.50
TPH (F1-F4)	2.6 (FOX-4 Helipad West)	<1.0–1,200	Not measured	2.0

*From Kjeldsen et al. (2002).
**OMOE 2011.

1. CAM-M Main Landfill North

The highest total Ni (4.8 mg/L) and Co (0.072 mg/L) concentrations were measured at MW-5 at CAM-M Main Landfill North in 2001, while the highest total Cr (2.0 mg/L) and Zn (86 mg/L) concentrations were measured at MW-6 at the same landfill in 2003 (see Figure IV-1 for graph of Ni concentrations). Baseline concentrations at the CAM-M Main Landfill North were measured at 0.6 ± 0.7 mg/L Ni, 0.06 ± 0.12 mg/L Co, 0.05 ± 0.06 mg/L Cr and 0.6 ± 1.2 mg/L Zn (n = 8). Both Co and Cr concentrations are within the range of values expected at this facility based on natural variability (≤ baseline + 3SD). Two wells (MW-5 and MW-6) had one Ni value above the baseline + 3SD in 2001 and 2003 respectively, while one well (MW-6) had one Zn value above the baseline + 3SD in 2003. MW-5 was sampled in 2001, 2007 and 2010, and MW-6 was sampled in 2001, 2003 and 2010. All other measured values did not exceed baseline values. As reported in the previous section, concentrations of Cu, Ni, Co and Zn were decreasing in at least one well at this landfill.

2. CAM-4 NHWL

The highest total Cd, As and Hg concentrations were measured at the CAM-4 NHWL in 2009. The highest Cd concentration (0.24 mg/L) was measured at MW-6B and the highest As concentration (0.057 mg/L) and highest total Hg concentration (0.97 mg/L) were measured at MW-7B. Cd was above the baseline concentration (<0.001 mg/L Cd, n = 7) but As was well within the expected range (baseline: 0.027 ± 0.045 mg/L). In 2011, the concentrations were <0.0002 mg/L Cd at MW 6B, 0.004 mg/L As and 0.072 mg/L Hg at MW-7B. The highest F1 hydrocarbon fraction concentration (0.85 mg/L) measured downgradient from a landfill was at MW-6B at the CAM-4 NHWL in 2009, and the highest concentration of TPH (17 mg/L) was measured in this same well in 2011. Higher concentrations of hydrocarbons were measured upgradient of the NHWL (free product was found in BMW-1) as the result of a known hydrocarbon plume present at the Station Area. Additional wells were installed in this area during the site remediation to monitor any plume migration. There have been insufficient monitoring events to identify any trends with confidence to date.

3. PIN-3 Tier II Disposal Facility

The highest total Cu (0.48 mg/L) and Pb (2.3 mg/L) concentrations were measured at MW-11 at the PIN-3 Tier II Disposal Facility in 2009. Lower levels were detected at the same well in 2011. Six groundwater samples were collected from this well between 2004 and 2011; five samples were above the detection limit for Cu and four samples were above the detection limit for Pb, but no trends were found. No baseline water samples were collected during remediation due to time constraints after installation of wells. Further, due to the topography of the area no locations can reliably be identified as upgradient. PCBs were detected once in 2004, at MW-11, at a concentration of 0.00004 mg/L and corresponded to soil PCB concentrations of 0.005 mg/kg in surficial soils in the same year. All subsequent groundwater analyses at MW-11 were below PCB detection limits (reported PCB detection limits ranged from 0.00005 to 0.010 mg/L).

4. FOX-4 Helipad West Landfill

The highest concentration of F2 hydrocarbon fraction (2.0 mg/L) was measured at MW-2 at the FOX-4 Helipad West Landfill in 2003. The measured concentrations were lower in 2005, 2006, and 2008. A hydrocarbon plume surrounds this landfill; the soil HC results are discussed in Section V.B.7. This landfill is scheduled to be excavated in 2013.

5. FOX-5 Main Landfill

The highest F3 hydrocarbon fraction concentration (0.6 mg/L) was measured at downgradient MW-13 at the FOX-5 Main Landfill in 2010. No hydrocarbons had been detected previously at this facility. Additional work was completed at this facility in 2011 to install a number of erosion protection and surface water drainage redirection engineering controls. There was not enough water in the well to analyze for hydrocarbons at MW-13 during the 2012 monitoring season.

6. Summary of Highest Analyte Concentrations Detected in Groundwater Downgradient of Landfills

Groundwater composition can vary considerably depending on the time of sampling. Baseline groundwater concentrations of analytes reviewed as part of a groundwater fate transport model for former arctic military sites (EBA 2008b) were found to vary over time, with some parameters changing concentration by orders of magnitude at the same well. The natural variability in the groundwater, combined with the tendency for wells to freeze or become unusable over time, means that baseline data collected over one or two years may not represent all of the climatic conditions that may affect groundwater and baseline averages should be updated at the end of Phase II monitoring to capture the magnitude of natural variability at each landfill.

Table IV-3 summarizes the landfills where groundwater concentrations exceeding the baseline average plus three standard deviations were measured.

Table IV-3. Groundwater monitoring data exceeding baseline data

Analyte	Landfills with values exceeding baseline plus three standard deviations
As	**CAM-M Main Landfill North —** MW-7 in 2010 **PIN-3 NHWL —** MW-14 in 2009
Cd	**BAR-2 USAF —** MW-10 in 2004 **BAR-4 North Landfill —** MW-4 and MW-6 in 2001
Cr	**BAR-2 USAF —** MW-9 in 2002 **BAR-4 North Landfill —** MW-3, MW-4 and MW-5 in 2000 and 2004 and MW-6 in 2000 **CAM-M Main Landfill North —** A number of values for MW-5, MW-6 and MW-7 between 2001 and 2004 **PIN-3 NHWL —** MW-14 in 2009
Co	**BAR-4 North Landfill —** Six results over a number of years and wells **PIN-3 NHWL —** MW-15 in 2007
Cu	**BAR-4 North Landfill —** MW-3 in 2001; MW-3, MW-5 and MW-6 in 2003
Pb	**BAR-2 NHWL —** MW-5 in 2002
Hg	**CAM-4 NHWL —** All upgradient and downgradient values above baseline for 2009 and 2011 monitoring events **PIN-3 NHWL —** All wells (MW-13, MW-14, MW-15 and MW-16) in 2009
Ni	**BAR-2 NHWL —** MW-4 in 2004 **CAM-M Main Landfill North —** MW-5 in 2001 and MW-6 in 2003 **PIN-3 NHWL —** MW-14 in 2009
Zn	**BAR-2 USAF —** MW-9 in 2011 **BAR-4 North Landfill —** MW-3 in 2000 and 2001 and MW-5 in 2006 **CAM-M Main Landfill North —**MW-6 in 2003 **PIN-3 NHWL —** MW-13 in 2009 and 2011 and MW-15 in 2011
PCBs	None
TPH	None

High analyte concentrations are relatively frequently observed at DEW Line monitoring wells when later monitoring events confirmed there has been no release of the contaminant from landfill. However, a high reading for metals in groundwater can be considered as a warning; if a CoC has a high result one year, it should be rechecked the following year to determine whether the high reading is an outlier. Groundwater samples from all landfills were analyzed for all CoCs, and none of the highest readings reported here have been identified as being related to a contaminant release from a landfill. Maximum values were found at both newly constructed facilities and historical landfills.

There were very few results for two of the CoCs measured in groundwater: Hg and PCBs. The current detection limit required for Hg is 0.001 mg/L and groundwater concentrations of naturally occurring Hg in the Arctic are much lower, on the order of 5 $x10^{-9}$ mg/L (Dickson 2008). Therefore, data obtained using the current detection will not be able to discern the natural variability of Hg in groundwater, and it is unlikely that a Hg trend would be identified before a trend for other CoCs was detected as a landfill failure would lead to the release of multiple CoCs. Groundwater samples at the BAR-2 USAF Landfill, BAR-4 North Landfill, CAM-4 NHWL, PIN-3 NHWL and PIN-3 Tier II Disposal Facility had Hg levels above the detection limit. No well had more than two detectable Hg results, and therefore no well had enough analytical results to complete a trend analysis. PCBs are not naturally occurring and were not detected in any groundwater sample above regular monitoring detection limits (in 2012, the terms of reference detection limit was 0.0030 mg/L). PCBs were detected in groundwater only twice at these 20 landfills: at a well downgradient from the PIN-3 Tier II Landfill (0.00004 mg/L), and at a well upgradient from the BAR-2 NHWL (0.00003 mg/L). PCBs are sparingly soluble in water and sorb strongly to soil. PCBs are not expected to be found in water, and when they were detected, they were an order of magnitude lower in concentration than current detection limits.

V. SOIL DATA

Soil data are particularly useful for monitoring of regraded landfills, which have no monitoring wells, and at landfills with a large number of unreliable monitoring wells. Whereas groundwater data identify the initial release of contaminants, soil data identify chronically increasing contaminant concentrations and contaminant plume formation. Of note here is that analytical data for soil samples can be highly variable. Sources for uncertainty in the analysis of soil samples include factors relating to the collection of the sample such as spatial heterogeneity (non-random spatial distribution of sample components); compositional heterogeneity which arises from the complexity of the soil (clay, silt, and sand content) and sample handling practises. In addition, there are the sources of uncertainty introduced through the laboratory measurements. For example, the variability in analytical results for duplicate samples of ± 30% is considered acceptable (ESG QAPP 2011) and higher variability can be expected when comparing samples collected at different locations.

Soil samples are collected 1–5 m from each monitoring well or designated location, at a slightly different location each year. To mitigate sources of uncertainty for the data evaluation in this report, all data from downgradient samples at each landfill are pooled, so small differences in sampling locations of a few metres and sample heterogeneity are not expected to affect whether or not a chronic release is detected.

A. Trend Analysis

Soil data were examined to identify whether any chronic input of contaminants was occurring because of the presence of the landfills. In contrast to groundwater data, for which the results of each monitoring well were considered separately, all downgradient soil sample data are pooled and considered together, and the same is done for all upgradient soil sample data. This allows for detection of the formation or migration of contaminant plumes, rather than detection of isolated small releases that can be detected with monitoring wells, and allows for evaluation of the entire area downgradient of the landfill. Soil data were first evaluated using a linear regression on downgradient soil data over time to determine whether a contaminant plume could be forming downgradient of the landfill. If downgradient soil data for an analyte showed an increasing trend ($p \leq 0.05$), an analysis of covariance (ANCOVA), which is an analysis of variance (ANOVA) combined with a linear regression, was performed on log-transformed data to determine whether trends observed in downgradient soils differ from those observed in upgradient soils. The ANCOVA accounts directly for influences due to climate and hydrology in a short-term data set (NNPSMP 2011).

In performing an ANCOVA, the linear regression is the log-transform of the concentration of a particular contaminant (the dependent variable) compared to time (the covariate). The independent variable is the categorical variable upgradient/downgradient. A number of assumptions are made:

1. Normal distribution of data
   - Normality was checked using both histograms and the Shapiro-Wilk test for combined data sets.
   - Data was log-transformed to obtain a normal distribution for all analytes.
2. Homogeneity of variances
   - Levene's test confirmed that the data variance is equal for upgradient/downgradient at all dates.
3. Independence of variables
   - Date and location are not related.
4. Linearity
   - Slope of the line predicting contaminant concentration from date should be equal for both upgradient and downgradient results at each date

The following section determines whether up and downgradient data have the same trends over time — that is, whether or not the rate of contaminant change is significantly different between upgradient and downgradient locations. If the landfill is having no effect on the surrounding environment, whatever trends are observed in the upgradient soils should also be observed in the downgradient soils and none of the assumptions of the ANCOVA are violated. If there is a difference between the upgradient and downgradient rate of change, this would be determined in the ANCOVA in the interaction between upgradient/downgradient and date ($p \leq 0.05$).

Running an ANCOVA model, including both upgradient/downgradient and upgradient/downgradient x time, compares the rate of change over time between upgradient and downgradient locations so that changes attributed to the landfill can be differentiated from temporal general chemical changes in the area. An example of this is provided in Figure V-1, where a trend was tentatively identified in downgradient As concentrations at the PIN-1 Station Area Landfill using a linear regression. This trend was not different from the concentration pattern identified in the upgradient soils and, as a result this downgradient As soil trend was judged not to be caused by the landfill and is likely naturally occurring As (note the similarity of slopes for up- and downgradient soils for As over time).

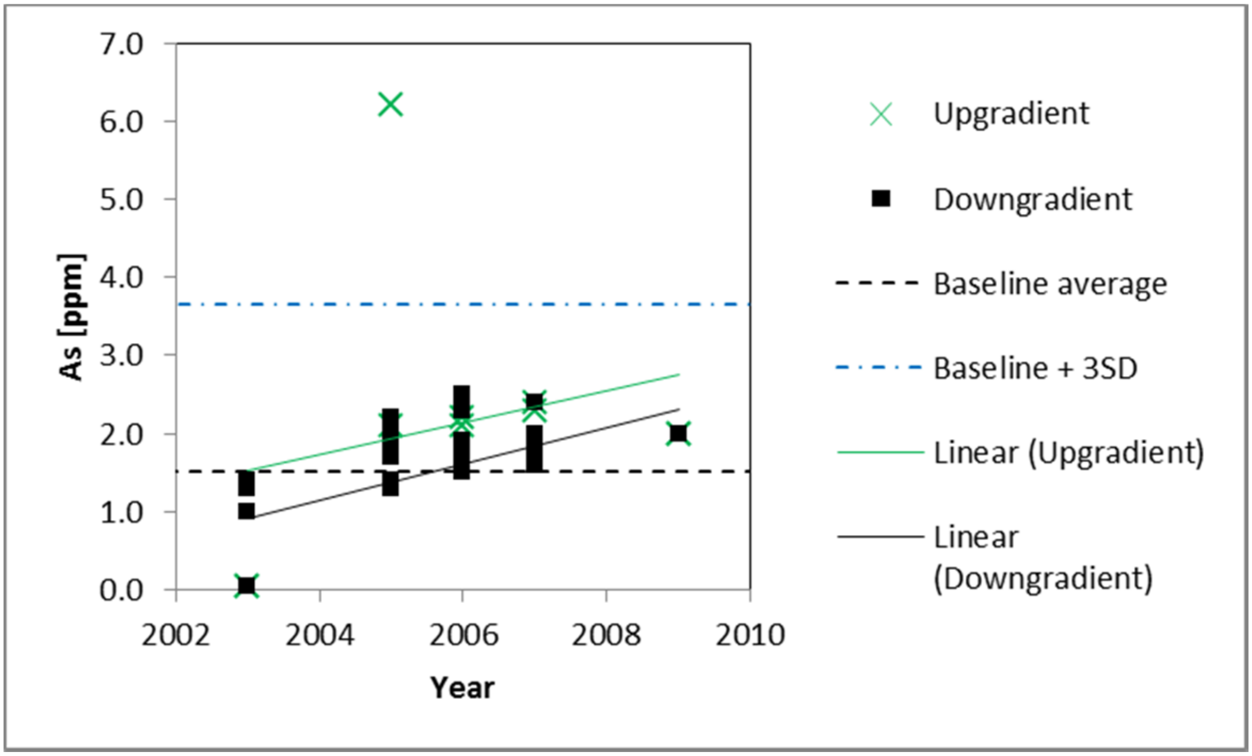

Figure V-1: Arsenic soil concentrations at PIN-1 Station Area Landfill.

An ANCOVA is only performed when an increasing trend is identified in downgradient soils using a simple linear regression. When the slope, or rate of contaminant change, of the upgradient data differs from that of the downgradient data, the increasing trend may be due to a landfill release. Figures V-2 and V-3 illustrate the trend analysis conducted on soil results for hydrocarbons at the FOX-4 Helipad West Landfill and for two metals at the BAR-4 Northwest Landfill, the two landfills at which downgradient trends that differed from those in upgradient soils were identified. This type of analysis was conducted for all parameters at all landfills, but no other significantly increasing downgradient trends (probability, $p \leq 0.05$ in the interaction term of upgradient/downgradient *versus* time) were determined.

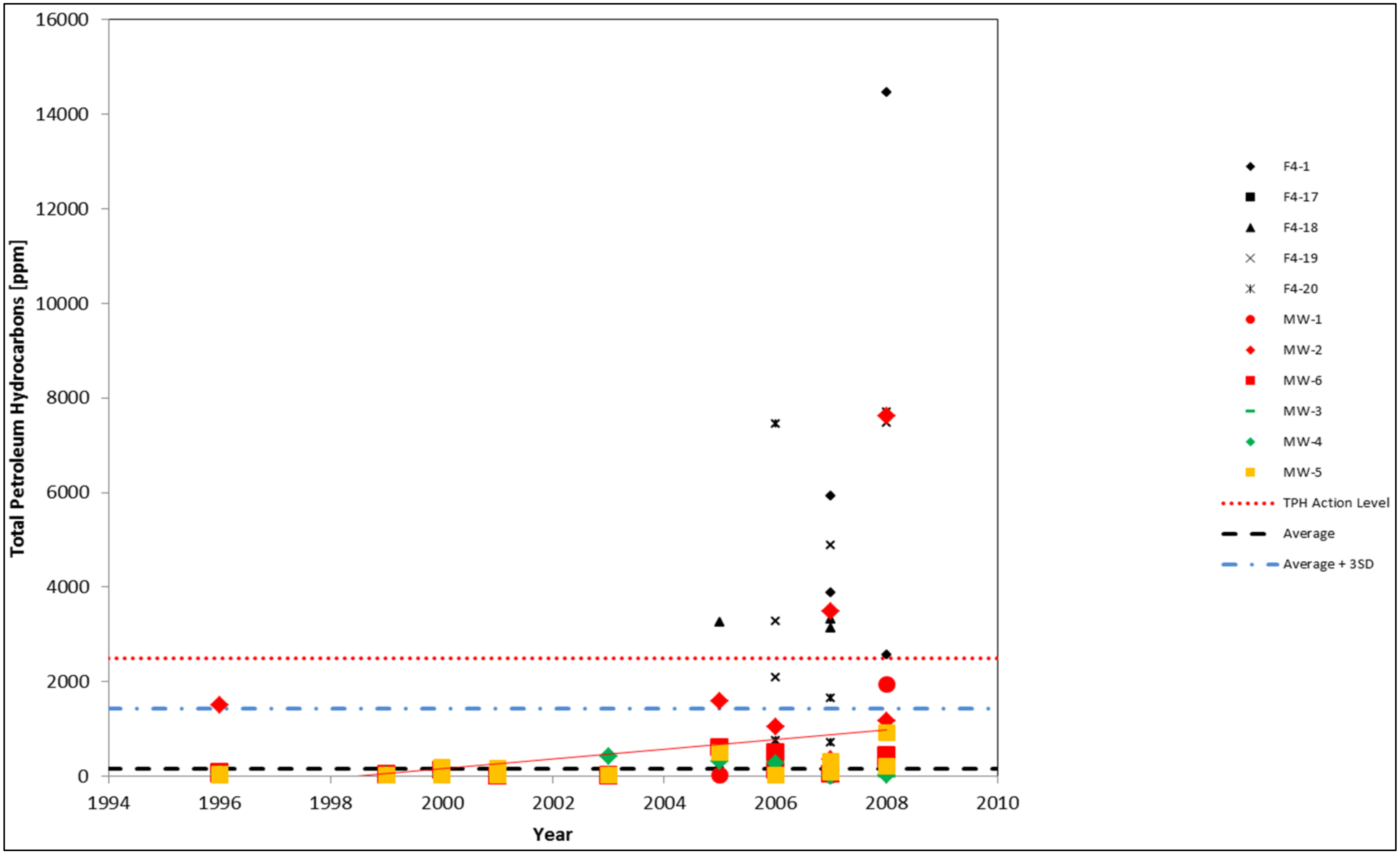

Figure V-2: Hydrocarbon trend analysis for soils at the FOX-4 Helipad Landfill West. Downgradient slope is the dark straight solid trend line. Note that the upgradient trend line can not be discerned within the baseline data and only the downgradient trend line is easily visible.

Only the FOX-4 Helipad West Landfill, a regrade landfill, was found to have an increasing trend and soil samples above the level of the DLCU action criteria for hydrocarbons were collected during the most recent monitoring events. This landfill was found to have increasing concentrations of hydrocarbons downgradient of the landfill, possibly due to movement of a hydrocarbon plume left in place during remediation. For reference, groundwater data at MW-2 (where elevated hydrocarbon soil concentrations were measured) had detectable hydrocarbons and indicated stable, elevated concentration of fuel in the groundwater with the six measurements to date (50% confidence in trend). Additional soil sample were collected and analyzed in recent years to further monitor this hydrocarbon plume (see F4-1, F4-17, F4-18, F4-19 and F4-20 in Figure V-2).

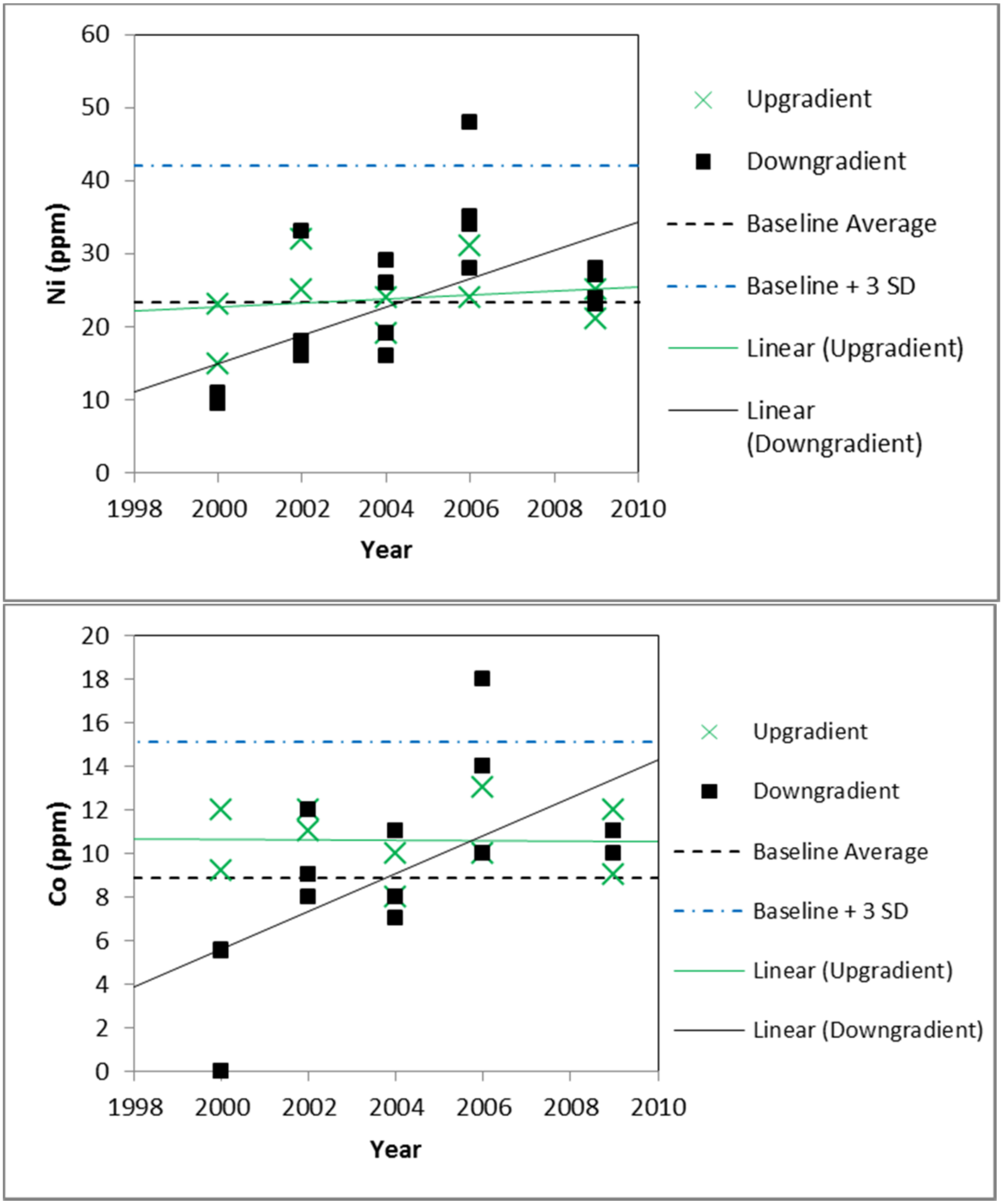

Figure V-3: Nickel and cobalt concentrations at the BAR-4 Northwest Landfill.

The downgradient Ni and Co concentrations at the regraded BAR-4 Northwest Landfill indicate a slowly increasing trend ($p \leq 0.05$) (Figure V-3). Ni is increasing at a rate of 0.44 ppm/year ($p = 0.004$) and Co is increasing at a rate of 0.17 ppm/year ($p = 0.005$). These results are based on five years of data, but while initially soil concentrations appeared to be increasing at a very low rate, only one result was above the trigger level of background average plus three standard deviations for each of the two metals, and the data collected most recently (in 2009) suggest that these metals are not continuing to increase in concentration. All measured concentrations for these two metals are well below the action limit for remediation of contaminated soils (DLCU criteria). In samples collected at the most recent sampling event, concentrations were not significantly higher than in upgradient samples or than background levels.

None of the landfills had sufficient Hg soil data to look for soil concentration trends because Hg was not detected in the majority of soil samples using the regularly reported detection limit of 0.10 ppm Hg. Baseline Hg concentrations in soil at facilities were established at two of the twenty landfills where lower detection limits were reported: 0.09 ± 0.06 ppm Hg at the BAR-2 NHWL and 0.03 ± 0.02 ppm Hg at the BAR-4 Northwest Landfill. These values are consistent with the average terrestrial concentration of 0.10–0.40 ppm Hg (CCME 1999). Global anthropogenic inputs of mercury through atmospheric deposition are thought to account for increases of 15% in mercury concentrations in soil in the Arctic (Selin 2009). Lower detection limits would be required to measure changes in Hg soil concentrations due to atmospheric deposition. Using current detection limits, only large Hg releases from landfills would be detected.

In conclusion, no trends were identified except at the FOX-4 Helipad West Landfill, where there is a known hydrocarbon plume present. Although there may be an increasing trend at the BAR-4 Northwest Landfill for Ni and Co, further sampling events are required to confirm this. Both landfills with possible increasing trends were historical landfills that were regraded as part of the remediation program. No trends for PCBs, Hg, Cu, Cd, Pb, Zn, Cr or As were identified at any of the existing landfills or new facilities.

B. Highest Analyte Concentrations in Soil Detected Downgradient of Landfills

This section examines the highest analyte concentrations measured in soil for the 20 landfills reviewed in the study and evaluates whether these high levels are related to a landfill contaminant release. Table V-1 presents the highest concentration of each analyte measured during the monitoring program, in contrast to the DLCC. The analyte level is shown in bold type if it exceeds the DLCC. All landfills with analyte values above the DLCC are also listed.

Table V-1: Highest analyte concentrations in soil downgradient of the 20 DEW Line site landfills reviewed in this report, contrasted to DLCC

Analyte	Highest concentration in soil (site/landfill) [ppm]	DLCC [ppm]
As	**35** (BAR-4 North Landfill)*	30 (FOX-4 SSC: 130)
Cd	**9.0** (CAM-M Main Landfill North)	5.0
Cr	200 (BAR-2 USAF Landfill)	250
Co	20 (BAR-2 USAF Landfill)	50
Cu	**320** (BAR-4 North Landfill) **110** (FOX-M East Beach Landfill) **101** (BAR-2 NHWL)	100
Pb	**620** (FOX-M East Beach Landfill)	500
Hg	0.33 (BAR-2 NHWL)	2.0
Ni	**130** (BAR-2 USAF Landfill)	100
Zn	240 (FOX-M East Beach Landfill)	500
PCBs	1.5 (BAR-4 North Landfill)	1.0/5.0
PHC F1	310 (FOX-4 Helipad East Landfill)	n/a
PHC F2	12,000 (FOX-4 Helipad East Landfill)	n/a
PHC F3	12,000 (CAM-M Main Landfill North)	n/a
TPH (F1–F4)	**18,000** (CAM-M Main Landfill North) **14,000** (FOX-4 Helipad East Landfill) **7,700** (FOX-4 Helipad West Landfill) **3,400** (PIN-3 NHWL)	2,500

*Higher arsenic concentrations (up to 120 ppm) were measured at all four of the FOX-4 landfills, but those concentrations are all lower than the FOX-4 SSC of 130 ppm.

As indicated in Table V-1, contaminant levels in landfill monitoring samples occasionally exceed the DLCU. The following paragraphs discuss the maximum values measured as part of the monitoring program.

1. BAR-4 North Landfill

At the BAR-4 North landfill, all high analyte concentrations were measured in proximity of downgradient MW-4. The highest concentration of Cu (320 ppm) was measured in surficial soils near MW-4 in 2006. This sample was one of six additional soil samples collected near MW-4 because of concerns about earlier monitoring results. Cu concentrations in the other five of these soil samples were one order of magnitude lower, indicating that this high value is not representative of a large contaminant plume.

Arsenic at a concentration above the DLCC of 30 ppm (35 ppm) was measured at shallow depth in 2004, also at MW-4. Eight shallow-depth soil samples were collected at MW-4 in 2006, and all were well below the DLCC (between 5.7 and 11 ppm).

The highest level of PCBs detected downgradient of the landfill during the monitoring program was 1.5 ppm, measured near MW-4 at depth (2002) and at surface (2006). This value is above the Tier I criterion (1.0 ppm) but below the Tier II criterion (5.0 ppm). PCBs were detected again at this location (0.02 ppm at surface and 0.01 ppm at shallow depth) in 2009, the last year for which data were reviewed. PCBs were previously identified downgradient of this landfill during the 1998 site investigation (ESG 1998) and it is likely that there were some residual soils left in place during the remedial work.

Levels of hydrocarbons above 2,500 ppm were found in soil at MW-4 in 2006, but higher baseline concentrations were measured at this landfill. Only inorganic elements and PCBs were assessed during the site investigation of the BAR-4 North landfill (ESG 1998). Samples collected at MW-4 and additional samples collected around MW-4 in 2009 were lower than the levels found in 2006 indicating a localized area of contamination.

The analysis of groundwater data for this landfill indicated decreasing trends for most analytes but also identified levels of inorganic elements in excess of baseline concentrations on several occasions.

Engineering concerns about the BAR-4 North Landfill were identified as part of the 2007 landfill QA review as the landfill is located on a steep slope and settlement or tension cracking were noted during the landfill monitoring program which could provide a path for water infiltration into this landfill (UMA/AECOM 2008). Additional samples collected near MW-4 in 2009 confirmed that the higher contaminant concentrations are localized to the area around MW-4. Therefore there is insufficient evidence at this time to suggest that the engineering concerns are related to the contaminant concentrations measured at MW-4.

2. BAR-2 USAF Landfill

The BAR-2 USAF Landfill was leachate contained during site remediation. In 2008, the landfill was found to have 130 ppm Ni (above the DLCC of 100 ppm) in a surface soil sample at MW-10. The Ni concentration measured in a duplicate sample at the same location was 28 ppm, indicating possible sample or soil heterogeneity.

The highest level of Cr (200 ppm) was measured at depth at the same monitoring well in 2006, but there was also an indication of possible soil heterogeneity as a duplicate sample contained 21 ppm. In 2008, results for surface samples and duplicate samples for Cr at the same location indicated similar heterogeneity. In 2011, one sample contained 33 ppm Ni and 29 ppm Cr; no duplicate samples were collected.

The highest concentration of Co (20 ppm) was recorded at this landfill in 2008, in a depth sample collected at downgradient MW-11. The Co concentration, however, was below the baseline average plus three standard deviations at this site (29 ppm). The Co concentration was measured at 8.0 ppm in 2011, and no trends were identified.

Decreasing trends were identified for most parameters in groundwater at this landfill but levels of inorganic elements in excess of baseline concentrations were reported for Cd, Cr and Zn at MW-9 and MW-10.

Engineering concerns were also identified for the BAR-2 USAF Landfill (UMA/AECOM 2008) and an erosion channel was repaired in 2008, with minor additional work completed in 2012. None of the soil concentrations reviewed here appear to be linked with the physical concerns identified.

3. BAR-2 NHWL

The highest level of Hg (0.33 ppm) was measured in surface soil at MW-6 at the BAR-2 NHWL in 2002. Lower levels of Hg (0.06–0.12 ppm) were measured during subsequent years (2004, 2006, 2008); these levels were either below or near the terms of reference detection limit of 0.10 ppm.

The analysis of groundwater data for this landfill indicated decreasing trends for most analytes but also identified levels of lead and nickel in excess of baseline concentrations in 2002 which since have been decreasing.

4. CAM-M Main Landfill North

Samples collected at MW-6 were found to have a number of elevated analytes. MW-6 had the highest Cd concentration (9.0 ppm) in 2003 and was the only soil sample above the DLCC of 5.0 ppm. No results above the detection limit were recorded in 2004 and 2005 at this monitoring well location.

The highest level of F3 hydrocarbon fraction (C_{16}–C_{34}) at 12,000 ppm was measured at surface and at depth, downgradient of the landfill near MW-6 in 2005. Levels of hydrocarbons measured in baseline soils collected in 1999 and 2000 (21 samples) were all below detection limits except for a surface soil sample collected at MW-6 in 2000 with 280 ppm TPH. Additional samples were collected to assess the situation and lower levels (~1,000 ppm) were measured in 2007 and 2010. Therefore no increasing trend in downgradient soils was noted.

Hydrocarbons were measured in groundwater in this well in 2007 (0.17 mg/L TPH), but the well was dry in 2010. No remediation of hydrocarbons was conducted at CAM-M, and the EWG concluded that impacted soil indicates a small area of historical contamination rather than contaminant migration from the landfill.

The analysis of groundwater data for this landfill indicated decreasing trends for most analytes but also identified levels of inorganic elements in excess of baseline concentrations on several occasions.

The CAM-M Main Landfill North was built with less supervision than subsequent leachate containment landfills (UMA/AECOM 2008) and hydrocarbons were not remediated at this site. Although chemical data to date indicates that hydrocarbon contamination is present in vicinity of the landfill, it does not seem to indicate failure of landfill containment.

5. FOX-M East Beach Landfill

A surficial soil sample collected in 2008 at MW-25 at the FOX-M East Beach Landfill (leachate containment) had the highest Pb concentration (620 ppm) and was the only soil sample above the DLCC of 500 ppm. Low levels (4.0 and 45 ppm) were recorded in 2009 and 2010, but higher levels (480 ppm) were recorded again in 2011. These data are thought to not be indicative of a large plume migrating from the facility but rather may indicate a small area of localized high Pb concentration around this monitoring well resulting from historical contamination.

The highest Zn concentration (240 ppm) was measured at depth at MW-23 in 2008 (the baseline mean plus three standard deviations for Zn at this landfill is 210 ppm), with 90 ppm Pb measured in the same soil sample. Lower levels of Zn (11–21 ppm) were measured at the same location in the three subsequent years (2009–2011).

Insufficient groundwater data is available for this landfill to determine any trends.

6. FOX-4 Helipad East Landfill

The highest levels of F1 hydrocarbon fraction (C_6–C_{10}) (310 ppm), F2 fractions (C_{10}–C_{16}) (12,000 ppm) and TPH (14,000 ppm) were measured at depth downgradient of the FOX-4 Helipad East Landfill near MW-2 in 2008, with similar levels measured at monitoring locations F-18, F-19 and F-20 (see Figure V-2). Concentrations in both surface and depth soils appeared to be increasing from 2003, when no hydrocarbons were detected, to 2008. Hydrocarbons were not initially included in the remediation of FOX-4, but this landfill is scheduled to be excavated in 2013. The results at this landfill illustrate how soil sampling can detect the development of a contaminant plume.

7. FOX-4 Helipad West Landfill

Levels of hydrocarbons above 2,500 ppm were found at monitoring location F4-1 but no trends have been identified. Hydrocarbons were not initially included in the remediation of FOX-4. This landfill is scheduled to be regraded in 2013.

8. PIN-3 NHWL

Levels of hydrocarbons above 2,500 ppm were found near MW-14 in 2004 (3,400 ppm). Similar elevated levels of hydrocarbons were identified in the baseline data. No trends were identified for groundwater data at this facility.

9. Summary of highest analyte level in soil data

Natural variability in soil data is expected to be high. The baseline average plus three standard deviations appears to be a good trigger level for future action in a monitoring program since it is a measure for the natural variability of soil data at each landfill. All landfills examined as part of this report, with the exception of the CAM-4 NHWL, had at least one soil monitoring analyte that exceeded the baseline average plus three standard deviations and Table V-2 presents a summary of these exceedances. Further, values observed in the monitoring data exceeded the DLCC for five analytes (Cu, Ni, Cd, Pb and As). However, these exceedances were isolated occurrences, and follow-up monitoring indicated exceedences were caused by natural variability or by possible small areas of contaminated soil that were not remediated but pose little environmental risk. It is recommended to update baseline values to include data from the first phase of monitoring at the completion of Phase I and/or Phase I and II monitoring if no releases are identified, as the large number of analyte concentrations above baseline in soil samples suggests that perhaps soil variability was not properly captured during the collection of baseline soil samples.

Table V-2. DEW Line landfills reviewed in this report with analytes above baseline average plus three standard deviations.

Where "•" indicates an analyte above the trigger value of baseline average plus three standard deviations. If a downgradient soil sample was above the DLCC, that criterion is stated (Tier I exceedence = T1, Tier II exceedence = T2, Action level exceedence = AL).

Site	Landfill	As	Cd	Cr	Co	Cu	Pb	Hg	Ni	Zn	PCB	TPH
Leachate-contained landfills												
BAR-4	North Landfill	T2				•					T1	AL
BAR-2	USAF Landfill			•					T2			AL
CAM-M	Main Landfill North	•	T2		•					•		AL
FOX-5	Main Landfill	•				•			•		•	•
FOX-M	East Beach Landfill	•		•			T2		•	•	•	
Non-hazardous waste landfills												
FOX-4	Lower Site Landfill	•								•		•
BAR-2	NHWL				•	T2		•			•	•
PIN-M	NHWL									•	•	
PIN-3	NHWL	•		•		•			•	•	•	AL
CAM-4	NHWL											
Regrade landfills												
PIN-M	Westpoint						•		•	•		•
FOX-4	Helipad East	•		•		•						AL
FOX-4	Helipad West	•		•								AL
BAR-4	Northwest		•		•	•			•			•
PIN-1	Station Area Landfill SW										•	
CAM-3	Northeast Landfill	•										•
Tier II disposal facilities												
FOX-4	Tier II	•	•				•					x
CAM-M	Tier II	•				•			•	•		•
PIN-3	Tier II	•							•	•		•
FOX-5	Tier II	•			T2	•			•	•		•
Landfills exceeding baseline average + 3 standard deviations in any monitoring event		13	3	5	4	8	3	1	9	9	7	16
Landfills exceeding baseline average + 3 standard deviations in last two monitoring events		1	0	0	0	0	0	0	1	0	0	8

Trends indicating possible chronic inputs to the environment were identified at two landfills: FOX-4 Helipad East and BAR-4 North Landfill. Further remedation is being carried out at FOX-4 currently. The trend at the BAR-4 landfill has to be confirmed with future data because the most recent monitoring event appears to be within baseline concentrations again and does not currently exceed trigger levels.

VI. SUMMARY OF GROUNDWATER AND SOIL DATA

The DLCU landfill monitoring program is designed to ensure that landfills remediated or newly constructed as part of the DEW Line Clean Up Project function as designed and keep contaminants contained. The groundwater and soil sampling component of the monitoring program is a detection monitoring program, through which chemical data are compared to baseline values that were collected during the remediation of the site. Analysis of groundwater allows the detection of small, chronic releases of contaminants from landfills and is sensitive to small increases in contaminant concentrations. If a release is large enough that it affects the surrounding soil occurs, soil data will reveal the resultant contaminated soil plume.

Up to eight monitoring events have taken place to date after final closure of some of the landfills. By the end of the Phase II monitoring program, there will be data from up to nine monitoring events for each leachate-contained landfill and Tier II disposal facility and data from seven monitoring events for regraded landfills and NHWLs.

Groundwater and soil data were collected and analyzed for the 20 landfills included in this review. No increasing groundwater trends were found in the data collected, indicating that landfills are functioning as designed. The highest concentrations observed in groundwater at the landfills were not identified as being part of a landfill release.

Two regraded historical landfills were found to have increasing trends in contaminant concentrations in soil. One of these, the FOX-4 Helipad West Landfill, had an existing hydrocarbon plume prior to monitoring. The plume may be migrating over time; it is displaying an increasing trend at the downgradient monitoring locations. The other landfill with an increasing trend, the BAR-4 Northwest Landfill, yielded a statistically significant increasing trend for concentrations of Ni and Co in soil. However, the rate of increase was less than 1 ppm/year, and the most recently collected data do not support the trend observed during the first four years of data collection. There are currently five monitoring events from BAR-4; data from a minimum of seven monitoring events is recommended to provide confidence in small but statistically significant increasing linear trends.

The behaviour of landfills and their leachate is fairly well understood, and the CoCs in leachate and groundwater (if present) are known to decrease with time in properly constructed facilities (Morris 2011). Groundwater fate transport modelling was conducted for the inorganic elements of concern and PCBs present in the former DEW Line site landfills by EBA for the development of the Abandoned Military Site Remediation for the Northern Contaminated Sites Program (EBA 2008a). Using a simplified model of Arctic landfills it was estimated that CoCs would reach a maximum concentration in groundwater after hundreds of years. The limited mobility of contaminants has been confirmed based on data from existing landfills in more temperate regions (Morris 2011). In the EBA model, Pb was found to migrate up to 65 m from the base of an unlined landfill in five years (further than the distance of monitoring wells from landfills), indicating that if any migration should occur it would be captured by monitoring wells within the Phase II monitoring period if construction deficiencies are present.

As metals are relatively immobile and are not expected to migrate from constructed facilities (Kjeldsen et al. 2002), the US Environmental Protection Agency has not set limits for metal concentrations in landfill leachate. In municipal landfills, metals including Co, Cr and Zn were found to exhibit short-term (study length = 12 years) decreasing trends (Statom et al. 2004) similar to the trends seen in this report at landfills at former DEW Line sites. In mixed-waste landfills (leachate containment landfills), metals may become mobilized if a landfill switches from an anaerobic to an aerobic condition, as this may result in a decrease in pH and an increase metal solubility (Barlaz et al. 2002). This is likely to occur only in an extreme situation, as metal release is not seen in properly constructed landfills in more temperate climates.

Mercury is known to be transported to the Arctic aerially via long-range transport, but current detection limits for mercury in both water and soil are much higher than naturally occurring mercury concentrations, so natural variation of mercury concentrations cannot be measured in the current monitoring program; only large releases would be detectable.

The other two CoCs are PCBs and petroleum hydrocarbons. Non-polar PCBs sorb strongly to soils and organic particles and so are not likely to migrate. Landfill disposal of PCB-containing wastes can lead to contamination of groundwater, especially when liquid PCBs are disposed of (EC 2001). No liquid PCBs were disposed of in newly constructed DEW Line landfills but they may be present in regraded and leachate-contained landfills. The ambient temperature is the major factor increasing the volatilization/migration of PCBs, as their solubility is related directly to temperature. With the low temperatures in the Arctic, very little mobility of PCBs is anticipated, and no movement of PCBs out of landfills has been noted to date.

Petroleum hydrocarbons are mobile in the environment but were only placed in Tier II disposal facilities in small quantities. They may be of potential concern at regraded historical landfills and leachate-contained landfills or at landfills with an existing hydrocarbon plume.

Six of the 20 landfills reviewed here were identified as having specific engineering concerns during a landfill QA review conducted in 2007: BAR-2 USAF Landfill, PIN-1 Station Area NHWL, BAR-4 North Landfill, CAM-M Main Landfill North, FOX-M East Beach Landfill and FOX-5 Main Landfill (UMA/AECOM 2008). Of these, only one landfill shows potential chemical concerns. The CAM-M Main Landfill North had groundwater metal concentrations that were higher than those measured at other landfills and higher than background values, but the metal values also had a decreasing trend in groundwater and no increasing trends in soil were identified. Elevated hydrocarbons have also been measured in soil at one MW downgradient of the CAM-M Main Landfill, but no trends have been identified and the landfill was deemed to be stable. Therefore, the data to date suggests that this landfill continues to contain any contaminants. No other chemical concerns were noted for the landfills with engineering concerns.

VII. CONCLUSIONS

The landfill monitoring program chemical data for metals, PCBs and hydrocarbons have been evaluated separately for groundwater and for soil. The groundwater data review indicated decreasing trends for a number of metals at a number of landfills. If a decreasing trend was not present, there was no observable trend in the data; this is indicative of natural variability. Additionally, monitoring wells were often unreliable, so it is difficult to obtain sufficient data for trend analysis.

For groundwater, a minimum of 4 sampling events are required to discern trends. At landfills with 8 or more events, decreasing trends can generally be identified except at sites with high natural variability. To this end, special attention should be paid at sites on Baffin Island with known natural variability in inorganic elements. Typically, the highest values are obtained in the first five years following remediation with conditions stabilizing after that. It is recommended to continue groundwater monitoring for at least seven events to confirm that the landfill sites are in stable conditions. Data collected for PCBs and Hg have provided little value to date and it is recommended to discontinue groundwater analysis for these two parameters for the remainder of Phase I and II.

Review of the soil data highlighted the natural variability of the results. While occasional exceedances of the DLCC occurred, these were typically isolated pockets of contamination relating to historical site activity. The landfill monitoring program responded to triggers of either increasing results or values that exceeded the baseline mean plus three standard deviations by initiating additional sampling locations at the BAR-4 and CAM-M landfills or by adding monitoring events to the FOX-4 Phase II monitoring program. For BAR-4 and CAM-M, the additional data revealed no concerns. Potentially increasing soil trends and maximum values were identified for historical regraded or leachate-contained landfills, whereas no trends or maximum values were noted for newly constructed facilities. Soil sampling should be added in Phase I for year 2 and 4 for the regrade landfills to provide a larger data set to identify stasitically significiant trends earlier for these landfills. Soil sampling should continue until the end of Phase II for all landfills to confirm that the landfill sites are in stable conditions. It is recommended to discontinue analysis of mercury in soil for the remainder of Phase I and II.

Overall, the soil and groundwater data established that contaminants are not escaping from the remediated or newly built facilities. Low mobility is anticipated for the contaminated materials disposed of in newly built landfills. To date, facilities with the most significant results from the review of the data are the historical (regraded) landfills. There is no indication of any contaminants leaking out at any of the 20 landfills evaluated.

VIII. NEXT STEPS

A preliminary review of the chemical monitoring data (EBA 2008b) and the results and assessments presented in this report suggests that the requirements for groundwater and soil sampling at DEW Line landfills during the long-term monitoring program be re-evaluated. As post-remediation values for CoCs have been established, the list of parameters may be reduced to those least likely to be attenuated in the natural environment and those most likely to have high leachate concentrations (CCME 2006). PCBs have low solubility in water and mercury is not likely to be present in landfills in large amounts and has not been measured as part of the program to date. As a result, it is recommended to discontinue the analysis of mercury in soil samples and the analysis of mercury and PCBs in groundwater samples during the remaining years of the Phase I and II program.

At the completion of Phase II monitoring, a management decision about whether continued chemical monitoring is required must be made (US EPA 2004). Exit criteria for chemical monitoring would include decreasing trends or stable conditions for groundwater and soil data. Review of Phase II chemical data may produce two possible conclusions:

1. Chemical data meet exit criteria and monitoring may be terminated if other monitoring metrics (visual and thermal monitoring) also indicate acceptable landfill performance.
2. Chemical data do not meet exit criteria and are trending away from success; site activity must be revised (increase in monitoring frequency or develop landfill remediation plan).

Phase III of the long-term monitoring program would not require continued collection of soil and groundwater samples except in a case where severe structural failure is observed or if a team is present on the site for other monitoring work. It is recommended that at the end of Phase II for each site, the performance all landfills is reviewed comprehensively to determine which landfills will require continued monitoring based on past and expected future performance. For example, landfills with known hydrocarbon plumes will likely require monitoring because of their increased potential for contaminant migration. Other landfills may not require chemical monitoring after post-remediation conditions are established. If future sampling events are required, it is recommended that downgradient samples be collected from multiple locations at the landfill of concern in duplicate to ensure sufficient data to compare with baseline data and to determine accurately whether there is an associated chemical containment issue.

IX. REFERENCES

Air Force Center for Environmental Excellence (AFCEE 2006). Monitoring and Remediation Optimization System (MAROS) SOFTWARE V 2.2 User's Guide. San Antonio, Texas. March 2006.

Barlaz, M.A., A.P. Rooker, P. Kjeldsen, M.A. Gabr, and R.C. Borden (Barlaz et al. 2002). "Critical evaluation of factors required to terminate the postclosure monitoring period of solid waste landfills." *Environmental Science and Technology* 36 (16): 3457–3464.

Canadian Council of Ministers of the Environment (CCME 1999). Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health: Mercury (inorganic) fact sheet.

Canadian Council of Ministers of the Environment (CCME 2006). National Guidelines for Hazardous Waste Landfills. PN1365. Winnipeg, Manitoba.

Canadian Council of Ministers of the Environment (CCME 2008). Canada-wide Standard for Petroleum Hydrocarbons (PHC) in Soil: Scientific Rationale Supporting Document. Winnipeg, Manitoba. January 2008.

Dickson, A.L. (Dickson 2008). "Mercury partitioning in super-permafrost groundwater, Truelove Lowland, Devon Island, Nunavut" (master's thesis, University of Saskatchewan, 2008).

Director General Environment (DGE 1996). Cooperation Agreement between the Inuvialuit Regional Corporation and the Department of National Defence Concerning the Restoration and Cleanup of DEW Site within the Inuvialuit Settlement Region. Ottawa, Ontario. February 12, 1996.

Director General Environment (DGE 1998). Agreement between the Nunavut Tunngavik Incorporated and the Department of National Defence for the Cleanup and Restoration of Distant Early Warning Sites within the Nunavut Settlement Area (Environmental Provisions). Ottawa, Ontario. September 1, 1998.

EBA Engineering Consultants Ltd. (EBA 2008a). "Groundwater fate transport modelling abandoned military site remediation protocol northern contaminated sites program." November 2008. In Indian and Northern Affairs Canada (INAC 2009). Abandoned Military Site Remediation Protocol, Volume II — Supporting Technical Documentation, (Chapter 10). Ottawa, Ontario.

EBA Engineering Consultants Ltd. (EBA 2008b). "Post-construction monitoring." December 2008. In Indian and Northern Affairs Canada (INAC 2009). Abandoned Military Site

Remediation Protocol Volume II —Supporting Technical Documentation (Chapter 11). Ottawa, Ontario.

Environment Canada (EC 2001). Canadian soil quality guidelines for polychlorinated biphenyls (PCBs): Environmental health. Scientific supporting document. Ecosystem health: Science-based solutions report 1-2. National Guidelines and Standards Office, Environmental Quality Branch. Environment Canada. Ottawa.

Environmental Sciences Group (ESG 1998). BAR-4 Nicholson Peninsula, NWT Site Remediation Phase I: Delineation. March 1998. Kingston, ON

Gibbons, R.D. (Gibbons 2009). Statistical methods for groundwater monitoring. 2nd Edition. D.K. Bhaumik and S. Aryal. John Wiley and Sons. Hoboken, New Jersey, USA.

Kebbekus, B.B. and S. Mitr (Kebbekus and Mitr 1998). *Environmental Chemical Analysis*. New York: Thomson Science.

Kjeldsen, P. M.A. Barlaz, A.P. Rooker, A. Baun, A. Ledin, and T.H. Christensen (Kjeldsen et al. 2002). “Present and long-term composition of MSW landfill leachate: A review.” *Critical Reviews in Environmental Science and Technology* 32 (4): 297–336.

Morris, J.W.F. and M.A. Barlaz (Morris and Barlaz 2011). “A performance-based system for the long-term management of municipal waste landfills.” *Waste Management* 31 (4) 649–662.

National Nonpoint Source Monitoring Program (NNPSMP 2011). Technotes: Statistical analysis for monotonic trends. Prepared for the Office of Water, US Environmental Protection Agency. November 2011.

Ontario Ministry of the Environment (OMOE 2011). Soil, ground water and sediment standards for use under Part XV.1 of the *Environmental Protection Act*. April 15, 2011.

Sanscartier, D., K. Reimer, B. Zeeb and K. George (Sanscartier et al. 2007). “Comparison of analytical techniques for petroleum hydrocarbon-contaminated soil in remote Arctic locations.” *Proceedings of the Fifth Biennial Workshop on Assessment and Remediation of Contaminated Sites in Arctic and Cold Climates (ARCSACC)*. Edmonton, Alberta. May 2007.

Selin, N.E. (Selin 2009). “Global biogeochemical cycling of mercury: A review.” *Annual Reviews of Environmental Resources* 34: 43–63.

Statom, R.A., G.D. Thyne, and J.E. McCray (Statom et al. 2004). “Temporal changes in leachate chemistry of a municipal solid waste landfill cell in Florida, USA.” *Environmental Geology* 45 (7): 982–991.

UMA Engineering Ltd. (UMA 1999). Landfill Monitoring Plan Part B: Nunavut Settlement Area. Prepared for Department of National Defence, Edmonton, Alberta. February 1999.

UMA Engineering Ltd. (UMA 2001). Defence Construction Canada Landfill Monitoring Plan: Inuvialuit Settlement Region DEW Line Sites. Prepared for Defence Construction Canada, Edmonton, Alberta. November 2001.

UMA Engineering Limited and AECOM Engineering Ltd. (UMA/AECOM 2008). DEW Line Clean Up Project: Quality Assurance Review of Landfill Designs. Prepared for Department of National Defence, Alberta. March 2008..

United States Environmental Protection Agency (US EPA 2004). Guidance for monitoring at hazardous waste sites: Framework for monitoring plan development and implementation.

APPENDIX A: STATISTICAL ANALYSES

A. Groundwater MAROS Output

Groundwater data were analyzed using the non-parametric trend analysis Mann-Kendall test with the help of the Monitoring and Remediation Optimization System (MAROS) software V2.2 developed by the United States Air Force Center for Environmental Excellence (AFCEE 2006). This test considers each monitoring well individually and is recommended when fewer than 40 measurements are available. It is robust to irregular monitoring (which may occur if a well is frozen for one year) and to occasional non-detects, and does not assume any data distribution (Gibbons 2009). For the current analyses, duplicate analyses were averaged and all non-detects were replaced with ½ of the lowest detection limit reported for that analyte.

Reports were generated for all analytes where over 50 percent of the results for a given landfill were above detection limits. Upgradient wells are marked Source or "S" while downgradient wells are marked Tail or "T" in the outputs, except in the case of the PIN-3 NHWL, FOX-M East Beach Landfill and the PIN-3 Tier II Disposal Facility, as these facilities did not have functional upgradient wells.

Summary tables showing the maximum and minimum value detected, as well as the mean, median and standard deviation are provided for all groundwater data analysed in this report in Appendix A.

B. Soil ANCOVA Analysis

Soil data were examined to identify whether any chronic input of contaminants was occurring because of the presence of the landfills. All downgradient soil sample data were pooled and considered together, and the same was done for all upgradient soil sample data. Soil data were first evaluated using a linear regression on downgradient soil data over time to determine whether a contaminant plume could be forming downgradient of the landfill. If downgradient soil data for an analyte showed an increasing trend ($p \leq 0.05$), an analysis of covariance (ANCOVA), which is an analysis of variance (ANOVA) combined with a linear regression, was performed on log-transformed data to determine whether trends observed in downgradient soils differ from those observed in upgradient soils. The results are reported as the slope trend in the summary tables.

Upgradient soils were also analyzed separately. In the case of upgradient soils, data were evaluated using a linear regression and a trend was identified if the trend was significant ($p \leq 0.05$).

Summary statistics, showing the slope trend as well as the maximum and minimum value detected, the mean, median and standard deviation are presented in Appendix A.

C. Monitoring Data and Graphs

MAROS Mann-Kendall Statistics Summary

Project: BAR-4

User Name: Maeve Moriarty

Location: North Landfill

State: Other

Time Period: 8/01/2000 **to** 8/01/2009

Consolidation Period: No Time Consolidation

Consolidation Type: Median

Duplicate Consolidation: Average

ND Values: 1/2 Detection Limit

J Flag Values : Actual Value

Well	Source/ Tail	Number of Samples	Number of Detects	Coefficient of Variation	Mann-Kendall Statistic	Confidence in Trend	All Samples "ND" ?	Concentration Trend
ARSENIC								
MW-1	S	4	4	0.98	-3	72.9%	No	S
MW-3	T	6	6	0.55	-7	86.4%	No	S
MW-4	T	6	5	0.39	-1	50.0%	No	S
MW-5	T	6	5	0.55	-7	86.4%	No	S
MW-6	T	6	5	0.75	5	76.5%	No	NT
CADMIUM								
MW-1	S	4	2	0.78	-1	50.0%	No	S
MW-3	T	6	3	1.21	-12	98.2%	No	D
MW-4	T	6	3	1.51	-6	81.5%	No	NT
MW-5	T	6	3	0.44	-11	97.2%	No	D
MW-6	T	6	3	1.90	-8	89.8%	No	NT
CHROMIUM, TOTAL								
MW-1	S	4	3	1.25	4	83.3%	No	NT
MW-3	T	6	5	0.81	1	50.0%	No	NT
MW-4	T	6	3	0.91	-6	81.5%	No	S
MW-5	T	6	5	0.74	-3	64.0%	No	S
MW-6	T	6	5	1.15	-4	70.3%	No	NT
COBALT								
MW-1	S	4	2	0.65	-1	50.0%	No	S
MW-3	T	6	6	0.46	-7	86.4%	No	S
MW-4	T	6	6	0.49	-7	86.4%	No	S
MW-5	T	6	6	0.47	2	57.0%	No	NT
MW-6	T	6	6	0.49	-5	76.5%	No	S
COPPER								
MW-1	S	4	4	0.23	-2	62.5%	No	S
MW-3	T	6	5	0.70	-9	93.2%	No	PD
MW-4	T	6	4	0.83	-3	64.0%	No	S
MW-5	T	6	6	0.74	-5	76.5%	No	S
MW-6	T	6	5	1.08	-3	64.0%	No	NT

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A)- Due to insufficient Data (< 4 sampling events); Source/Tail (S/T)

The Number of Samples and Number of Detects shown above are post-consolidation values.

MAROS Mann-Kendall Statistics Summary

Project: BAR-4

User Name: Maeve Moriarty

Location: North Landfill

State: Other

Time Period: 8/01/2000 **to** 8/01/2009

Consolidation Period: No Time Consolidation

Consolidation Type: Median

Duplicate Consolidation: Average

ND Values: 1/2 Detection Limit

J Flag Values : Actual Value

Well	Source/ Tail	Number of Samples	Number of Detects	Coefficient of Variation	Mann-Kendall Statistic	Confidence in Trend	All Samples "ND" ?	Concentration Trend
LEAD								
MW-1	S	4	1	1.62	1	50.0%	No	NT
MW-3	T	6	3	0.97	-11	97.2%	No	D
MW-4	T	6	2	0.98	-11	97.2%	No	D
MW-5	T	6	4	0.53	-3	64.0%	No	S
MW-6	T	6	4	0.41	-4	70.3%	No	S
MERCURY								
MW-1	S	3	1	0.00	0	0.0%	No	N/A
MW-3	T	5	2	0.79	-5	82.1%	No	S
MW-4	T	5	1	0.91	-7	92.1%	No	PD
MW-5	T	5	2	1.01	-7	92.1%	No	PD
MW-6	T	5	2	0.98	-8	95.8%	No	D
NICKEL								
MW-1	S	4	4	0.43	-2	62.5%	No	S
MW-3	T	6	6	0.45	-3	64.0%	No	S
MW-4	T	6	6	1.39	-11	97.2%	No	D
MW-5	T	6	6	0.39	-1	50.0%	No	S
MW-6	T	6	6	0.28	-3	64.0%	No	S
ZINC								
MW-1	S	4	4	0.41	4	83.3%	No	NT
MW-3	T	6	6	0.80	-7	86.4%	No	S
MW-4	T	6	5	1.37	2	57.0%	No	NT
MW-5	T	6	6	0.90	1	50.0%	No	NT
MW-6	T	6	6	0.59	7	86.4%	No	NT

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A)-Due to insufficient Data (< 4 sampling events); Source/Tail (S/T)

The Number of Samples and Number of Detects shown above are post-consolidation values.

MAROS Mann-Kendall Statistics Summary

Project: BAR-2

User Name: Maeve Moriarty

Location: USAF Landfill

State: Other

Time Period: 8/01/2002 **to** 8/15/2011

Consolidation Period: No Time Consolidation

Consolidation Type: Median

Duplicate Consolidation: Average

ND Values: 1/2 Detection Limit

J Flag Values : Actual Value

Well	Source/ Tail	Number of Samples	Number of Detects	Coefficient of Variation	Mann-Kendall Statistic	Confidence in Trend	All Samples "ND" ?	Concentration Trend
ARSENIC								
MW-10	T	7	7	0.44	-13	96.5%	No	D
MW-11	T	2	2	0.00	0	0.0%	No	N/A
MW-12	T	7	7	0.43	-11	93.2%	No	PD
MW-13	T	7	7	0.22	-5	71.9%	No	S
MW-8	S	7	7	1.24	-15	98.5%	No	D
MW-9	T	7	7	0.57	-5	71.9%	No	S
CHROMIUM, TOTAL								
MW-10	T	7	5	1.88	-12	94.9%	No	PD
MW-11	T	2	2	0.00	0	0.0%	No	N/A
MW-12	T	7	5	1.44	-9	88.1%	No	NT
MW-13	T	7	6	1.42	-16	99.0%	No	D
MW-8	S	7	3	2.08	-12	94.9%	No	PD
MW-9	T	7	5	2.18	-11	93.2%	No	PD
COBALT								
MW-10	T	7	7	0.36	-11	93.2%	No	PD
MW-11	T	2	2	0.00	0	0.0%	No	N/A
MW-12	T	7	7	1.04	-8	84.5%	No	NT
MW-13	T	7	7	0.16	-16	99.0%	No	D
MW-8	S	7	7	0.44	-6	76.4%	No	S
MW-9	T	7	7	0.69	-13	96.5%	No	D
COPPER								
MW-10	T	7	7	0.72	-16	99.0%	No	D
MW-11	T	2	1	0.00	0	0.0%	No	N/A
MW-12	T	7	7	1.27	-11	93.2%	No	PD
MW-13	T	7	7	1.38	-17	99.5%	No	D
MW-8	S	7	7	1.12	-17	99.5%	No	D
MW-9	T	7	7	1.68	-10	90.7%	No	PD
LEAD								
MW-10	T	1	1	0.00	0	0.0%	No	N/A
MW-12	T	1	1	0.00	0	0.0%	No	N/A
MW-13	T	1	1	0.00	0	0.0%	No	N/A
MW-8	S	1	0	0.00	0	0.0%	Yes	ND
MW-9	T	1	1	0.00	0	0.0%	No	N/A

Project: BAR-2

User Name: Maeve Moriarty

Location: USAF Landfill

State: Other

Well	Source/ Tail	Number of Samples	Number of Detects	Coefficient of Variation	Mann-Kendall Statistic	Confidence in Trend	All Samples "ND" ?	Concentration Trend
LEAD								

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A)-Due to insufficient Data (< 4 sampling events); Source/Tail (S/T)

The Number of Samples and Number of Detects shown above are post-consolidation values.

MAROS Mann-Kendall Statistics Summary

Project: BAR-2

User Name: Maeve Moriarty

Location: USAF Landfill

State: Other

Time Period: 8/01/2002 **to** 8/15/2011
Consolidation Period: No Time Consolidation
Consolidation Type: Median
Duplicate Consolidation: Average
ND Values: 1/2 Detection Limit
J Flag Values : Actual Value

Well	Source/ Tail	Number of Samples	Number of Detects	Coefficient of Variation	Mann-Kendall Statistic	Confidence in Trend	All Samples "ND" ?	Concentration Trend
NICKEL								
MW-10	T	7	7	0.31	-11	93.2%	No	PD
MW-11	T	2	2	0.00	0	0.0%	No	N/A
MW-12	T	7	6	1.12	-7	80.9%	No	NT
MW-13	T	7	7	0.72	-18	99.7%	No	D
MW-8	S	7	7	1.03	-3	61.4%	No	NT
MW-9	T	7	7	0.82	-3	61.4%	No	S
ZINC								
MW-10	T	7	7	1.84	-7	80.9%	No	NT
MW-11	T	2	2	0.00	0	0.0%	No	N/A
MW-12	T	7	7	1.28	-7	80.9%	No	NT
MW-13	T	7	7	0.59	-17	99.5%	No	D
MW-8	S	7	7	0.63	1	50.0%	No	NT
MW-9	T	7	7	0.93	-1	50.0%	No	S

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A)-Due to insufficient Data (< 4 sampling events); Source/Tail (S/T)

The Number of Samples and Number of Detects shown above are post-consolidation values.

MAROS Mann-Kendall Statistics Summary

Project: CAM-M

User Name: Maeve Moriarty

Location: Main Landfill North

State: Other

Time Period: 8/01/2001 **to** 8/01/2010

Consolidation Period: No Time Consolidation

Consolidation Type: Median

Duplicate Consolidation: Average

ND Values: 1/2 Detection Limit

J Flag Values : Actual Value

Well	Source/ Tail	Number of Samples	Number of Detects	Coefficient of Variation	Mann-Kendall Statistic	Confidence in Trend	All Samples "ND" ?	Concentration Trend
ARSENIC								
MW-5	T	3	2	0.00	0	0.0%	No	N/A
MW-6	T	3	2	0.00	0	0.0%	No	N/A
MW-7	T	7	5	1.11	7	80.9%	No	NT
MW-8	S	5	3	0.81	-4	75.8%	No	S
CHROMIUM, TOTAL								
MW-5	T	3	2	0.00	0	0.0%	No	N/A
MW-6	T	3	3	0.00	0	0.0%	No	N/A
MW-7	T	7	5	2.44	-9	88.1%	No	NT
MW-8	S	5	5	1.33	-8	95.8%	No	D
COBALT								
MW-5	T	3	3	0.00	0	0.0%	No	N/A
MW-6	T	3	3	0.00	0	0.0%	No	N/A
MW-7	T	7	6	0.61	-14	97.5%	No	D
MW-8	S	5	4	0.74	0	40.8%	No	S
COPPER								
MW-5	T	3	3	0.00	0	0.0%	No	N/A
MW-6	T	3	3	0.00	0	0.0%	No	N/A
MW-7	T	7	6	1.33	-14	97.5%	No	D
MW-8	S	5	4	1.37	-8	95.8%	No	D
NICKEL								
MW-5	T	3	3	0.00	0	0.0%	No	N/A
MW-6	T	3	3	0.00	0	0.0%	No	N/A
MW-7	T	7	7	1.29	-15	98.5%	No	D
MW-8	S	5	5	1.17	-6	88.3%	No	NT

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A)-Due to insufficient Data (< 4 sampling events); Source/Tail (S/T)

The Number of Samples and Number of Detects shown above are post-consolidation values.

MAROS Mann-Kendall Statistics Summary

Project: CAM-M

User Name: Maeve Moriarty

Location: Main Landfill North

State: Other

Time Period: 8/01/2001 **to** 8/01/2010
Consolidation Period: No Time Consolidation
Consolidation Type: Median
Duplicate Consolidation: Average
ND Values: 1/2 Detection Limit
J Flag Values : Actual Value

Well	Source/ Tail	Number of Samples	Number of Detects	Coefficient of Variation	Mann-Kendall Statistic	Confidence in Trend	All Samples "ND" ?	Concentration Trend
ZINC								
MW-5	T	3	3	0.00	0	0.0%	No	N/A
MW-6	T	3	3	0.00	0	0.0%	No	N/A
MW-7	T	7	7	0.64	-1	50.0%	No	S
MW-8	S	5	5	1.30	-10	99.2%	No	D

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A)-Due to insufficient Data (< 4 sampling events); Source/Tail (S/T)

The Number of Samples and Number of Detects shown above are post-consolidation values.

MAROS Mann-Kendall Statistics Summary

Project: FOX-5 **User Name:** Maeve Moriarty

Location: Main Landfill **State:** Other

Time Period: 8/01/2007 **to** 8/01/2012
Consolidation Period: No Time Consolidation
Consolidation Type: Average
Duplicate Consolidation: Average
ND Values: 1/2 Detection Limit
J Flag Values : Actual Value

Well	Source/ Tail	Number of Samples	Number of Detects	Coefficient of Variation	Mann-Kendall Statistic	Confidence in Trend	All Samples "ND" ?	Concentration Trend
CADMIUM								
MW-10	S	5	3	0.96	-5	82.1%	No	S
MW-11	T	5	3	0.62	-1	50.0%	No	S
MW-12	T	1	1	0.00	0	0.0%	No	N/A
MW-13	T	5	2	0.61	-2	59.2%	No	S
MW-14	T	5	3	0.89	-6	88.3%	No	S
CHROMIUM, TOTAL								
MW-10	S	5	3	2.05	-3	67.5%	No	NT
MW-11	T	5	3	2.01	-5	82.1%	No	NT
MW-12	T	1	0	0.00	0	0.0%	Yes	ND
MW-13	T	5	3	1.47	1	50.0%	No	NT
MW-14	T	5	3	1.90	-1	50.0%	No	NT
COPPER								
MW-10	S	5	3	1.67	-3	67.5%	No	NT
MW-11	T	5	4	1.46	-4	75.8%	No	NT
MW-12	T	1	1	0.00	0	0.0%	No	N/A
MW-13	T	5	5	1.01	-2	59.2%	No	NT
MW-14	T	5	3	1.09	-5	82.1%	No	NT
NICKEL								
MW-10	S	5	2	1.83	-1	50.0%	No	NT
MW-11	T	5	3	1.76	-5	82.1%	No	NT
MW-12	T	1	0	0.00	0	0.0%	Yes	ND
MW-13	T	5	2	1.16	-5	82.1%	No	NT
MW-14	T	5	3	1.56	-3	67.5%	No	NT
ZINC								
MW-10	S	5	4	1.09	-2	59.2%	No	NT
MW-11	T	5	3	0.47	-9	97.5%	No	D
MW-12	T	1	1	0.00	0	0.0%	No	N/A
MW-13	T	5	5	0.77	-6	88.3%	No	S
MW-14	T	5	5	1.13	-2	59.2%	No	NT

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A)-Due to insufficient Data (< 4 sampling events); Source/Tail (S/T)

The Number of Samples and Number of Detects shown above are post-consolidation values.

MAROS Mann-Kendall Statistics Summary

Project: FOX-M

User Name: Maeve Moriarty

Location: East Beach Landfill

State: Other

Time Period: 8/01/2008 **to** 8/01/2011
Consolidation Period: No Time Consolidation
Consolidation Type: Median
Duplicate Consolidation: Average
ND Values: 1/2 Detection Limit
J Flag Values : Actual Value

Well	Source/ Tail	Number of Samples	Number of Detects	Coefficient of Variation	Mann-Kendall Statistic	Confidence in Trend	All Samples "ND" ?	Concentration Trend
ARSENIC								
MW-29	S	2	2	0.00	0	0.0%	No	N/A
MW-30	T	3	3	0.00	0	0.0%	No	N/A
CHROMIUM, TOTAL								
MW-29	S	3	3	0.00	0	0.0%	No	N/A
MW-30	T	4	4	1.85	0	37.5%	No	NT
MW-31	T	1	1	0.00	0	0.0%	No	N/A
COBALT								
MW-29	S	2	2	0.00	0	0.0%	No	N/A
MW-30	T	2	2	0.00	0	0.0%	No	N/A
MW-31	T	1	1	0.00	0	0.0%	No	N/A
COPPER								
MW-29	S	4	3	0.53	2	62.5%	No	NT
MW-30	T	4	3	1.40	0	37.5%	No	NT
MW-31	T	2	2	0.00	0	0.0%	No	N/A
NICKEL								
MW-29	S	4	3	0.46	-6	95.8%	No	D
MW-30	T	4	3	1.08	4	83.3%	No	NT
MW-31	T	2	0	0.00	0	0.0%	Yes	ND

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A)-Due to insufficient Data (< 4 sampling events); Source/Tail (S/T)

The Number of Samples and Number of Detects shown above are post-consolidation values.

MAROS Mann-Kendall Statistics Summary

Project: FOX-M

User Name: Maeve Moriarty

Location: East Beach Landfill

State: Other

Time Period: 8/01/2008 **to** 8/01/2011
Consolidation Period: No Time Consolidation
Consolidation Type: Median
Duplicate Consolidation: Average
ND Values: 1/2 Detection Limit
J Flag Values : Actual Value

Well	Source/ Tail	Number of Samples	Number of Detects	Coefficient of Variation	Mann-Kendall Statistic	Confidence in Trend	All Samples "ND" ?	Concentration Trend
ZINC								
MW-29	S	3	3	0.00	0	0.0%	No	N/A
MW-30	T	2	2	0.00	0	0.0%	No	N/A
MW-31	T	1	1	0.00	0	0.0%	No	N/A

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A)-Due to insufficient Data (< 4 sampling events); Source/Tail (S/T)

The Number of Samples and Number of Detects shown above are post-consolidation values.

MAROS Mann-Kendall Statistics Summary

Project: FOX-4

User Name: Maeve Moriarty

Location: Tier II Landfill

State: Other

Time Period: 8/01/1999 **to** 8/01/2008

Consolidation Period: No Time Consolidation

Consolidation Type: Median

Duplicate Consolidation: Average

ND Values: 1/2 Detection Limit

J Flag Values : Actual Value

Well	Source/ Tail	Number of Samples	Number of Detects	Coefficient of Variation	Mann-Kendall Statistic	Confidence in Trend	All Samples "ND" ?	Concentration Trend
ARSENIC								
MW-10	T	8	4	0.93	-7	76.4%	No	S
MW-11	T	2	0	0.00	0	0.0%	Yes	ND
MW-12	T	7	4	0.92	-11	93.2%	No	PD
MW-13	T	7	5	0.83	-7	80.9%	No	S
MW-15	S	7	4	1.11	-6	76.4%	No	NT
CADMIUM								
MW-10	T	8	4	1.10	-15	95.8%	No	D
MW-11	T	2	2	0.00	0	0.0%	No	N/A
MW-12	T	7	3	1.43	1	50.0%	No	NT
MW-13	T	7	3	1.12	-7	80.9%	No	NT
MW-15	S	7	2	1.40	-4	66.7%	No	NT
CHROMIUM, TOTAL								
MW-10	T	8	6	1.36	7	76.4%	No	NT
MW-11	T	2	0	0.00	0	0.0%	Yes	ND
MW-12	T	7	5	0.66	5	71.9%	No	NT
MW-13	T	7	6	1.05	-1	50.0%	No	NT
MW-15	S	7	6	0.83	8	84.5%	No	NT
COBALT								
MW-10	T	7	3	0.77	-4	66.7%	No	S
MW-11	T	2	1	0.00	0	0.0%	No	N/A
MW-12	T	6	6	0.70	-11	97.2%	No	D
MW-13	T	6	6	0.80	-7	86.4%	No	S
MW-15	S	6	4	1.23	-6	81.5%	No	NT
COPPER								
MW-10	T	8	6	0.97	2	54.8%	No	NT
MW-11	T	2	1	0.00	0	0.0%	No	N/A
MW-12	T	7	5	1.73	6	76.4%	No	NT
MW-13	T	7	6	0.94	-7	80.9%	No	S
MW-15	S	7	6	0.78	0	43.7%	No	S

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A)-
Due to insufficient Data (< 4 sampling events); Source/Tail (S/T)

The Number of Samples and Number of Detects shown above are post-consolidation values.

MAROS Mann-Kendall Statistics Summary

Project: FOX-4

User Name: Maeve Moriarty

Location: Tier II Landfill

State: Other

Time Period: 8/01/1999 **to** 8/01/2008
Consolidation Period: No Time Consolidation
Consolidation Type: Median
Duplicate Consolidation: Average
ND Values: 1/2 Detection Limit
J Flag Values : Actual Value

Well	Source/ Tail	Number of Samples	Number of Detects	Coefficient of Variation	Mann-Kendall Statistic	Confidence in Trend	All Samples "ND" ?	Concentration Trend
LEAD								
MW-10	T	8	4	1.65	-5	68.3%	No	NT
MW-11	T	2	0	0.00	0	0.0%	Yes	ND
MW-12	T	7	4	0.62	0	43.7%	No	S
MW-13	T	7	5	1.44	-8	84.5%	No	NT
MW-15	S	7	3	0.76	-8	84.5%	No	S
NICKEL								
MW-10	T	7	7	0.94	-3	61.4%	No	S
MW-11	T	2	2	0.00	0	0.0%	No	N/A
MW-12	T	6	6	0.85	-13	99.2%	No	D
MW-13	T	6	6	0.80	-7	86.4%	No	S
MW-15	S	6	6	1.78	-3	64.0%	No	NT
ZINC								
MW-10	T	8	8	1.08	8	80.1%	No	NT
MW-11	T	2	2	0.00	0	0.0%	No	N/A
MW-12	T	7	7	0.53	-17	99.5%	No	D
MW-13	T	7	7	0.84	-7	80.9%	No	S
MW-15	S	7	7	1.29	-7	80.9%	No	NT

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A)- Due to insufficient Data (< 4 sampling events); Source/Tail (S/T)

The Number of Samples and Number of Detects shown above are post-consolidation values.

MAROS Mann-Kendall Statistics Summary

Project: CAM-M

User Name: Maeve Moriarty

Location: Tier II Disposal Facility

State: Other

Time Period: 8/01/2001 **to** 8/01/2010

Consolidation Period: No Time Consolidation

Consolidation Type: Median

Duplicate Consolidation: Average

ND Values: 1/2 Detection Limit

J Flag Values : Actual Value

Well	Source/ Tail	Number of Samples	Number of Detects	Coefficient of Variation	Mann-Kendall Statistic	Confidence in Trend	All Samples "ND" ?	Concentration Trend
ARSENIC								
MW-10	S	1	1	0.00	0	0.0%	No	N/A
MW-11	T	3	1	0.00	0	0.0%	No	N/A
MW-12	T	4	3	1.25	0	37.5%	No	NT
MW-13	T	2	2	0.00	0	0.0%	No	N/A
CHROMIUM, TOTAL								
MW-10	S	1	1	0.00	0	0.0%	No	N/A
MW-11	T	2	2	0.00	0	0.0%	No	N/A
MW-12	T	4	4	1.66	-2	62.5%	No	NT
MW-13	T	2	2	0.00	0	0.0%	No	N/A
COBALT								
MW-10	S	1	1	0.00	0	0.0%	No	N/A
MW-11	T	3	3	0.00	0	0.0%	No	N/A
MW-12	T	4	4	0.87	-2	62.5%	No	S
MW-13	T	2	2	0.00	0	0.0%	No	N/A
COPPER								
MW-10	S	1	1	0.00	0	0.0%	No	N/A
MW-11	T	3	3	0.00	0	0.0%	No	N/A
MW-12	T	4	4	1.05	-4	83.3%	No	NT
MW-13	T	2	2	0.00	0	0.0%	No	N/A
LEAD								
MW-10	S	1	0	0.00	0	0.0%	Yes	ND
MW-11	T	3	1	0.00	0	0.0%	No	N/A
MW-12	T	4	2	1.84	-4	83.3%	No	NT
MW-13	T	2	2	0.00	0	0.0%	No	N/A

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A)-Due to insufficient Data (< 4 sampling events); Source/Tail (S/T)

The Number of Samples and Number of Detects shown above are post-consolidation values.

MAROS Mann-Kendall Statistics Summary

Project: CAM-M

User Name: Maeve Moriarty

Location: Tier II Disposal Facility

State: Other

Time Period: 8/01/2001 **to** 8/01/2010
Consolidation Period: No Time Consolidation
Consolidation Type: Median
Duplicate Consolidation: Average
ND Values: 1/2 Detection Limit
J Flag Values : Actual Value

Well	Source/ Tail	Number of Samples	Number of Detects	Coefficient of Variation	Mann-Kendall Statistic	Confidence in Trend	All Samples "ND" ?	Concentration Trend
NICKEL								
MW-10	S	1	1	0.00	0	0.0%	No	N/A
MW-11	T	3	3	0.00	0	0.0%	No	N/A
MW-12	T	4	4	1.02	-4	83.3%	No	NT
MW-13	T	2	2	0.00	0	0.0%	No	N/A
ZINC								
MW-10	S	1	1	0.00	0	0.0%	No	N/A
MW-11	T	3	3	0.00	0	0.0%	No	N/A
MW-12	T	4	4	1.76	-4	83.3%	No	NT
MW-13	T	2	2	0.00	0	0.0%	No	N/A

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A)-
Due to insufficient Data (< 4 sampling events); Source/Tail (S/T)

The Number of Samples and Number of Detects shown above are post-consolidation values.

MAROS Mann-Kendall Statistics Summary

Project: PIN-3

User Name: Maeve Moriarty

Location: Tier II

State: Alabama

Time Period: 8/01/2004 **to** 8/01/2011

Consolidation Period: No Time Consolidation

Consolidation Type: Average

Duplicate Consolidation: Average

ND Values: 1/2 Detection Limit

J Flag Values : Actual Value

Well	Source/ Tail	Number of Samples	Number of Detects	Coefficient of Variation	Mann-Kendall Statistic	Confidence in Trend	All Samples "ND" ?	Concentration Trend
CHROMIUM, TOTAL								
MW-11	S	6	4	0.89	1	50.0%	No	NT
MW-12	T	6	3	1.38	0	42.3%	No	NT
COPPER								
MW-11	S	6	5	1.56	1	50.0%	No	NT
MW-12	T	6	3	1.78	0	42.3%	No	NT
LEAD								
MW-11	S	6	4	2.14	1	50.0%	No	NT
MW-12	T	6	2	2.13	-4	70.3%	No	NT
NICKEL								
MW-11	S	6	4	0.78	-3	64.0%	No	S
MW-12	T	6	5	1.11	-5	76.5%	No	NT
ZINC								
MW-11	S	6	5	1.27	-1	50.0%	No	NT
MW-12	T	6	3	1.45	-1	50.0%	No	NT

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A)-Due to insufficient Data (< 4 sampling events); Source/Tail (S/T)

The Number of Samples and Number of Detects shown above are post-consolidation values.

MAROS Mann-Kendall Statistics Summary

Project: FOX-5 LTM

User Name: Maeve Moriarty

Location: Tier II NHWL

State: Other

Time Period: 8/01/2007 **to** 8/01/2012
Consolidation Period: No Time Consolidation
Consolidation Type: Median
Duplicate Consolidation: Average
ND Values: Fraction of Detection Limit
J Flag Values : Actual Value

Well	Source/ Tail	Number of Samples	Number of Detects	Coefficient of Variation	Mann-Kendall Statistic	Confidence in Trend	All Samples "ND" ?	Concentration Trend
CADMIUM								
MW-5	S	5	2	1.05	-3	67.5%	No	NT
MW-6	T	5	2	0.87	-2	59.2%	No	S
MW-7	T	4	0	1.38	-3	72.9%	Yes	ND
MW-8	T	5	3	0.74	-3	67.5%	No	S
MW-9	T	5	2	0.86	-5	82.1%	No	S
CHROMIUM, TOTAL								
MW-5	S	5	4	1.99	-3	67.5%	No	NT
MW-6	T	5	3	2.17	-1	50.0%	No	NT
MW-7	T	4	4	1.89	-3	72.9%	No	NT
MW-8	T	5	3	2.12	-3	67.5%	No	NT
MW-9	T	5	2	2.18	-1	50.0%	No	NT
COPPER								
MW-5	S	5	5	0.76	-6	88.3%	No	S
MW-6	T	5	5	1.56	-1	50.0%	No	NT
MW-7	T	4	4	1.06	-4	83.3%	No	NT
MW-8	T	5	4	1.01	-4	75.8%	No	NT
MW-9	T	5	5	1.37	-6	88.3%	No	NT
NICKEL								
MW-5	S	5	2	1.67	-1	50.0%	No	NT
MW-6	T	5	2	1.97	-1	50.0%	No	NT
MW-7	T	4	1	1.76	-3	72.9%	No	NT
MW-8	T	5	2	1.82	-1	50.0%	No	NT
MW-9	T	5	2	1.98	-1	50.0%	No	NT
ZINC								
MW-5	S	5	4	1.25	-4	75.8%	No	NT
MW-6	T	5	4	0.94	-2	59.2%	No	S
MW-7	T	4	1	1.14	-3	72.9%	No	NT
MW-8	T	5	5	1.29	-7	92.1%	No	PD
MW-9	T	5	3	1.02	-5	82.1%	No	NT

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A)-Due to insufficient Data (< 4 sampling events); Source/Tail (S/T)

The Number of Samples and Number of Detects shown above are post-consolidation values.

MAROS Mann-Kendall Statistics Summary

Project: FOX-4

User Name: Maeve Moriarty

Location: Lower Site Landfill

State: Other

Time Period: 8/01/1999 **to** 8/01/2008

Consolidation Period: No Time Consolidation

Consolidation Type: Median

Duplicate Consolidation: Average

ND Values: 1/2 Detection Limit

J Flag Values : Actual Value

Well	Source/ Tail	Number of Samples	Number of Detects	Coefficient of Variation	Mann-Kendall Statistic	Confidence in Trend	All Samples "ND" ?	Concentration Trend
ARSENIC								
MW-14	S	7	3	1.17	-7	80.9%	No	NT
MW-15	T	7	4	1.11	-6	76.4%	No	NT
MW-16	S	6	3	1.35	-3	64.0%	No	NT
CADMIUM								
MW-14	S	7	2	1.49	1	50.0%	No	NT
MW-15	T	7	2	1.40	-4	66.7%	No	NT
MW-16	S	6	1	0.38	5	76.5%	No	NT
CHROMIUM, TOTAL								
MW-14	S	7	4	1.21	4	66.7%	No	NT
MW-15	T	7	6	0.83	8	84.5%	No	NT
MW-16	S	6	3	1.42	2	57.0%	No	NT
COBALT								
MW-14	S	6	6	0.48	3	64.0%	No	NT
MW-15	T	6	4	1.23	-6	81.5%	No	NT
MW-16	S	5	2	0.10	6	88.3%	No	NT
COPPER								
MW-14	S	7	5	0.69	-9	88.1%	No	S
MW-15	T	7	6	0.78	0	43.7%	No	S
MW-16	S	6	3	1.16	0	42.3%	No	NT

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A)-Due to insufficient Data (< 4 sampling events); Source/Tail (S/T)

The Number of Samples and Number of Detects shown above are post-consolidation values.

MAROS Mann-Kendall Statistics Summary

Project: FOX-4

User Name: Maeve Moriarty

Location: Lower Site Landfill

State: Other

Time Period: 8/01/1999 **to** 8/01/2008

Consolidation Period: No Time Consolidation

Consolidation Type: Median

Duplicate Consolidation: Average

ND Values: 1/2 Detection Limit

J Flag Values : Actual Value

Well	Source/ Tail	Number of Samples	Number of Detects	Coefficient of Variation	Mann-Kendall Statistic	Confidence in Trend	All Samples "ND" ?	Concentration Trend
LEAD								
MW-14	S	7	3	0.76	-2	55.7%	No	S
MW-15	T	7	3	0.76	-8	84.5%	No	S
MW-16	S	6	4	1.29	-5	76.5%	No	NT
NICKEL								
MW-14	S	6	6	0.47	5	76.5%	No	NT
MW-15	T	6	6	1.78	-3	64.0%	No	NT
MW-16	S	5	4	0.46	5	82.1%	No	NT
ZINC								
MW-14	S	7	7	0.78	1	50.0%	No	NT
MW-15	T	7	7	1.29	-7	80.9%	No	NT
MW-16	S	6	6	0.83	7	86.4%	No	NT

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A)-Due to insufficient Data (< 4 sampling events); Source/Tail (S/T)

The Number of Samples and Number of Detects shown above are post-consolidation values.

MAROS Mann-Kendall Statistics Summary

Project: BAR-2

User Name: Maeve Moriarty

Location: NHWL

State: Other

Time Period: 8/01/2001 **to** 8/16/2011
Consolidation Period: No Time Consolidation
Consolidation Type: Median
Duplicate Consolidation: Average
ND Values: 1/2 Detection Limit
J Flag Values : Actual Value

Well	Source/ Tail	Number of Samples	Number of Detects	Coefficient of Variation	Mann-Kendall Statistic	Confidence in Trend	All Samples "ND" ?	Concentration Trend
ARSENIC								
MW-4	T	4	4	0.33	0	37.5%	No	S
MW-5	T	5	5	0.54	-4	75.8%	No	S
MW-6	T	6	6	0.80	-9	93.2%	No	PD
MW-7	S	4	4	0.40	-6	95.8%	No	D
CADMIUM								
MW-5	T	1	1	0.00	0	0.0%	No	N/A
MW-6	T	1	1	0.00	0	0.0%	No	N/A
MW-7	S	1	1	0.00	0	0.0%	No	N/A
CHROMIUM, TOTAL								
MW-4	T	4	4	0.64	-6	95.8%	No	D
MW-5	T	5	4	0.88	-8	95.8%	No	D
MW-6	T	6	4	1.37	-5	76.5%	No	NT
MW-7	S	4	2	1.28	-6	95.8%	No	D
MERCURY								
MW-5	T	1	1	0.00	0	0.0%	No	N/A
MW-6	T	1	1	0.00	0	0.0%	No	N/A
MW-7	S	1	1	0.00	0	0.0%	No	N/A

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A)- Due to insufficient Data (< 4 sampling events); Source/Tail (S/T)

The Number of Samples and Number of Detects shown above are post-consolidation values.

MAROS Mann-Kendall Statistics Summary

Project: BAR-2

User Name: Maeve Moriarty

Location: NHWL

State: Alabama

Time Period: 8/01/2001 **to** 8/16/2011
Consolidation Period: Yearly
Consolidation Type: Average
Duplicate Consolidation: Average
ND Values: 1/2 Detection Limit
J Flag Values : Actual Value

Well	Source/ Tail	Number of Samples	Number of Detects	Coefficient of Variation	Mann-Kendall Statistic	Confidence in Trend	All Samples "ND" ?	Concentration Trend
COBALT								
MW-4	T	4	4	0.23	-2	62.5%	No	S
MW-5	T	5	5	0.47	-6	88.3%	No	S
MW-6	T	6	6	0.65	-7	86.4%	No	S
MW-7	S	4	4	0.19	-4	83.3%	No	S
COPPER								
MW-4	T	4	4	0.57	-2	62.5%	No	S
MW-5	T	5	5	0.92	-8	95.8%	No	D
MW-6	T	6	6	1.15	-11	97.2%	No	D
MW-7	S	4	4	1.22	-6	95.8%	No	D
LEAD								
MW-4	T	4	3	0.65	1	50.0%	No	NT
MW-5	T	5	5	0.92	-6	88.3%	No	S
MW-6	T	6	3	1.23	-10	95.2%	No	D
MW-7	S	4	0	0.75	-5	89.6%	Yes	ND
NICKEL								
MW-4	T	4	4	0.56	0	37.5%	No	S
MW-5	T	5	5	0.43	-8	95.8%	No	D
MW-6	T	6	6	0.55	-5	76.5%	No	S
MW-7	S	4	4	0.82	-6	95.8%	No	D
ZINC								
MW-4	T	4	4	1.08	0	37.5%	No	NT
MW-5	T	5	5	1.00	0	40.8%	No	S
MW-6	T	6	6	1.21	-13	99.2%	No	D
MW-7	S	4	4	0.80	-4	83.3%	No	S

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A)- Due to insufficient Data (< 4 sampling events); Source/Tail (S/T)

The Number of Samples and Number of Detects shown above are post-consolidation values.

MAROS Mann-Kendall Statistics Summary

Project: PIN-3

User Name: Maeve Moriarty

Location: NHWL

State: Alabama

Time Period: 8/01/2003 **to** 8/01/2011

Consolidation Period: No Time Consolidation

Consolidation Type: Average

Duplicate Consolidation: Average

ND Values: 1/2 Detection Limit

J Flag Values : Actual Value

Well	Source/ Tail	Number of Samples	Number of Detects	Coefficient of Variation	Mann-Kendall Statistic	Confidence in Trend	All Samples "ND" ?	Concentration Trend
CHROMIUM, TOTAL								
MW-13	S	5	5	0.73	-2	59.2%	No	S
MW-14	T	5	4	1.29	-4	75.8%	No	NT
MW-15	T	5	3	0.62	-2	59.2%	No	S
MW-16	T	5	4	0.70	0	40.8%	No	S
COPPER								
MW-13	S	5	4	0.64	-6	88.3%	No	S
MW-14	T	5	3	0.93	-4	75.8%	No	S
MW-15	T	5	3	0.82	-6	88.3%	No	S
MW-16	T	5	3	0.65	-6	88.3%	No	S
NICKEL								
MW-13	S	5	5	0.73	-6	88.3%	No	S
MW-14	T	5	5	0.95	-4	75.8%	No	S
MW-15	T	5	5	0.55	0	40.8%	No	S
MW-16	T	5	5	0.40	-1	50.0%	No	S
ZINC								
MW-13	S	5	5	1.11	6	88.3%	No	NT
MW-14	T	5	4	0.75	2	59.2%	No	NT
MW-15	T	5	4	0.87	4	75.8%	No	NT
MW-16	T	5	3	0.96	3	67.5%	No	NT

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A)-Due to insufficient Data (< 4 sampling events); Source/Tail (S/T)

The Number of Samples and Number of Detects shown above are post-consolidation values.

MAROS Mann-Kendall Statistics Summary

Project: FOX-4

User Name: Maeve Moriarty

Location: Helipad E and W

State: Alabama

Time Period: 8/01/1999 **to** 8/01/2008

Consolidation Period: No Time Consolidation

Consolidation Type: Average

Duplicate Consolidation: Average

ND Values: 1/2 Detection Limit

J Flag Values : Actual Value

Well	Source/ Tail	Number of Samples	Number of Detects	Coefficient of Variation	Mann-Kendall Statistic	Confidence in Trend	All Samples "ND" ?	Concentration Trend
ARSENIC								
MW-1	T	8	5	0.85	-18	98.4%	No	D
MW-2	T	8	6	0.55	-4	64.0%	No	S
MW-3	S	2	1	0.00	0	0.0%	No	N/A
MW-4	S	2	1	0.00	0	0.0%	No	N/A
MW-5	T	5	4	0.79	-6	88.3%	No	S
MW-6	T	1	1	0.00	0	0.0%	No	N/A
COBALT								
MW-1	T	7	7	0.60	-8	84.5%	No	S
MW-2	T	7	6	0.57	6	76.4%	No	NT
MW-3	S	2	1	0.00	0	0.0%	No	N/A
MW-4	S	2	0	0.00	0	0.0%	Yes	ND
MW-5	T	5	5	0.81	-4	75.8%	No	S
MW-6	T	1	1	0.00	0	0.0%	No	N/A
COPPER								
MW-1	T	8	7	0.97	-11	88.7%	No	S
MW-2	T	8	6	1.48	-6	72.6%	No	NT
MW-3	S	2	1	0.00	0	0.0%	No	N/A
MW-4	S	2	2	0.00	0	0.0%	No	N/A
MW-5	T	5	5	0.85	-6	88.3%	No	S
MW-6	T	1	1	0.00	0	0.0%	No	N/A
LEAD								
MW-1	T	8	5	1.29	-13	92.9%	No	PD
MW-2	T	8	5	1.96	-10	86.2%	No	NT
MW-3	S	2	1	0.00	0	0.0%	No	N/A
MW-4	S	2	2	0.00	0	0.0%	No	N/A
MW-5	T	5	4	1.24	-2	59.2%	No	NT
MW-6	T	1	1	0.00	0	0.0%	No	N/A
NICKEL								
MW-1	T	7	7	1.56	-9	88.1%	No	NT
MW-2	T	7	7	1.01	-13	96.5%	No	D
MW-3	S	2	2	0.00	0	0.0%	No	N/A
MW-4	S	2	2	0.00	0	0.0%	No	N/A
MW-5	T	5	5	1.41	-7	92.1%	No	PD

Project: FOX-4

User Name: Maeve Moriarty

Location: Helipad E and W

State: Alabama

Well	Source/ Tail	Number of Samples	Number of Detects	Coefficient of Variation	Mann-Kendall Statistic	Confidence in Trend	All Samples "ND" ?	Concentration Trend
NICKEL								
MW-6	T	1	1	0.00	0	0.0%	No	N/A

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A)-Due to insufficient Data (< 4 sampling events); Source/Tail (S/T)

The Number of Samples and Number of Detects shown above are post-consolidation values.

MAROS Mann-Kendall Statistics Summary

Project: FOX-4

User Name: Maeve Moriarty

Location: Helipad E and W

State: Alabama

Time Period: 8/01/1999 **to** 8/01/2008

Consolidation Period: No Time Consolidation

Consolidation Type: Average

Duplicate Consolidation: Average

ND Values: 1/2 Detection Limit

J Flag Values : Actual Value

Well	Source/ Tail	Number of Samples	Number of Detects	Coefficient of Variation	Mann-Kendall Statistic	Confidence in Trend	All Samples "ND" ?	Concentration Trend
CHROMIUM, TOTAL								
MW-1	T	8	7	2.14	-8	80.1%	No	NT
MW-2	T	8	7	0.91	-6	72.6%	No	S
MW-3	T	2	2	0.00	0	0.0%	No	N/A
MW-4	S	2	2	0.00	0	0.0%	No	N/A
MW-5	T	5	5	1.64	-2	59.2%	No	NT
MW-6	S	1	1	0.00	0	0.0%	No	N/A
EXTRACTABLE PETROLEUM HYDROCARBONS C1								
MW-2	T	6	6	0.81	3	64.0%	No	NT
ZINC								
MW-1	T	8	7	1.46	-6	72.6%	No	NT
MW-2	T	8	8	0.95	-2	54.8%	No	S
MW-3	T	2	2	0.00	0	0.0%	No	N/A
MW-4	S	2	2	0.00	0	0.0%	No	N/A
MW-5	T	5	5	1.18	0	40.8%	No	NT
MW-6	S	1	1	0.00	0	0.0%	No	N/A

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A)- Due to insufficient Data (< 4 sampling events); Source/Tail (S/T)

The Number of Samples and Number of Detects shown above are post-consolidation values.

Table A1. Summary of BAR-4 North Landfill Downgradient Groundwater Monitoring Data, up to 2009

Parameter	Number of monitoring events	Number of downgradient wells	Any increasing trends?	Number of samples	Number of detects	High value	Low value	Mean	Median	Standard deviation
Cu	6	4	No	24	20	0.022	0.003	0.010	0.008	0.0058
Ni	6	4	No	24	24	0.098	0.005	0.036	0.034	0.023
Co	6	4	No	24	24	0.038	0.003	0.019	0.021	0.01
Cd	6	4	No	24	12	0.0086	0.00005	0.0021	0.001	0.0026
Pb	6	4	No	24	13	0.036	0.003	0.011	0.0075	0.0091
Zn	6	4	No	24	23	4.8	0.0030	1.3	0.81	1.3
Cr	6	4	No	24	18	0.038	0.0017	0.013	0.0075	0.01
As	6	4	No	24	21	0.041	0.0016	0.01	0.0079	0.0092
Hg	6	4	No	24	7	0.00050	0.00001	0.00026	0.00030	0.00021
PCBs	6	4	BDL	24	0					
F1	6	4	BDL	4	0					
F2	6	4	BDL	4	0					
F3	6	4	BDL	4	0					
TPH	6	4	BDL	13	1	0.060	0.060	0.060	0.060	

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A2. Summary of BAR-4 North Landfill Upgradient Groundwater Monitoring Data, up to 2009

Parameter	Number of monitoring events	Number of upgradient wells	Any increasing trends?	Number of samples	Number of detects	High value	Low value	Mean	Median	Standard deviation
Cu	6	1	No	4	4	0.017	0.0100	0.014	0.014	0.0031
Ni	6	1	BDL	4	4	0.034	0.013	0.023	0.022	0.010
Co	6	1	BDL	4	2	0.0038	0.0030	0.0034	0.0034	0.0006
Cd	6	1	No	4	2	0.0020	0.0007	0.0014	0.0014	0.0009
Pb	6	1	BDL	4	1	0.036	0.036	0.036	0.036	
Zn	6	1	No	4	4	2.4	0.76	1.7	1.7	0.67
Cr	6	1	No	4	3	0.04	0.0057	0.017	0.007	0.018
As	6	1	BDL	4	4	0.0032	0.0016	0.0021	0.0016	0.0009
Hg	6	1	BDL	3	1	0.00030	0.00030	0.00030	0.00030	
PCBs	6	1	BDL	4	0					
F1	6	1	BDL	0	0					
F2	6	1	BDL	0	0					
F3	6	1	BDL	0	0					
TPH	6	1	BDL	3	0					

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A3. Summary of BAR-4 North Landfill Downgradient Soil Monitoring Data, up to 2009

Parameter	Number of monitoring events	Number of downgradient locations	Number of samples	Number of detects	Slope trend	High value	Low value	Mean	Median	Standard deviation
Cu	6	4	69	69	NT	320	8.3	21	14	41
Ni	6	4	69	69	NT	36	10	22	21	6.4
Co	6	4	69	68	NT	18	1.2	8.9	8.6	3.3
Cd	6	4	69	60	NT	2.2	0.28	0.93	0.85	0.35
Pb	6	4	69	61	NT	15	3	8.7	9	2.3
Zn	6	4	69	69	NT	200	34	72	67	28
Cr	6	4	69	63	NT	33	5.3	14	14	6.0
As	6	4	69	69	NT	35	3	10	10	3.9
Hg	6	4	69	14	BDL	0.10	0.020	0.047	0.050	0.024
PCBs	6	4	69	10	BDL	1.5	0.0034	0.46	0.065	0.63
F1	6	4	69	0	BDL					
F2	6	4	69	24	BDL	160	6	36	18	42
F3	6	4	69	60	Increasing	7,800	17	990	240	1,800
TPH	6	4	69	55	Increasing	9,700	17	1,300	260	2,200

NT = No trend detected

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A4. Summary of BAR-4 North Landfill Upgradient Soil Monitoring Data, up to 2009

Parameter	Number of monitoring events	Number of upgradient locations	Number of samples	Number of detects	Slope trend	High value	Low value	Mean	Median	Standard deviation
Cu	6	2	27	27	Increasing	23	5.0	11	11	4.3
Ni	6	2	27	27	NT	36	12	20	20	5.2
Co	6	2	27	26	NT	12	4.0	8.2	8.0	1.7
Cd	6	2	27	23	NT	2.1	0.43	0.88	0.72	0.41
Pb	6	2	27	22	NT	11	5.0	7.6	7.0	1.6
Zn	6	2	27	27	NT	110	20	56	57	22
Cr	6	2	27	24	NT	22	4.2	10	10	3.7
As	6	2	27	27	NT	15	5.0	11	11	2.1
Hg	6	2	27	6	BDL	0.060	0.020	0.035	0.030	0.016
PCBs	6	2	27	3	BDL	0.17	0.0060	0.06	0.015	0.09
F1	6	2	27	1	BDL	33	33	33	33	
F2	6	2	27	1	BDL	56	56	56	56	
F3	6	2	27	19	NT	1,300	7.0	170	42	350
TPH	6	2	27	14	NT	1,300	7.0	200	32	420

NT = No trend detected

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A5. Summary of BAR-2 USAF Landfill Downgradient Groundwater Monitoring Data, up to 2011

Parameter	Number of monitoring events	Number of downgradient wells	Any increasing trends?	Number of samples	Number of detects	High value	Low value	Mean	Median	Standard deviation
Cu	7	5	No	30	29	0.11	0.0004	0.012	0.006	0.022
Ni	7	5	No	30	29	0.19	0.0021	0.037	0.032	0.034
Co	7	5	No	30	29	0.064	0.0008	0.027	0.025	0.018
Cd	7	5	BDL	30	9	0.0040	0.00002	0.0011	0.0013	0.0013
Pb	7	5	BDL	30	13	0.053	0.0002	0.016	0.015	0.015
Zn	7	5	No	30	30	22	0.0050	2.9	1.3	4.7
Cr	7	5	No	30	22	0.25	0.006	0.033	0.011	0.056
As	7	5	No	30	30	0.040	0.0018	0.014	0.011	0.010
Hg	7	5	BDL	20	4	0.00060	0.00030	0.00038	0.00030	0.00015
PCBs	7	5	BDL	30	0					
F1	7	0	N/A							
F2	7	0	N/A							
F3	7	0	N/A							
TPH	7	5	BDL	30	2	0.09	0.029	0.060	0.060	0.043

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A6. Summary of BAR-2 USAF Landfill Upgradient Groundwater Monitoring Data, up to 2011

Parameter	Number of monitoring events	Number of downgradient wells	Any increasing trends?	Number of samples	Number of detects	High value	Low value	Mean	Median	Standard deviation
Cu	7	1	No	7	7	0.021	0.0013	0.0081	0.003	0.0087
Ni	7	1	No	7	7	0.068	0.0040	0.021	0.015	0.021
Co	7	1	No	7	7	0.0080	0.0011	0.0049	0.0053	0.0022
Cd	7	1	BDL	7	1	0.00025	0.00025	0.00025	0.00025	
Pb	7	1	BDL	7	0					
Zn	7	1	No	7	7	0.77	0.16	0.34	0.25	0.22
Cr	7	1	No	7	3	0.12	0.0060	0.049	0.017	0.066
As	7	1	No	7	7	0.029	0.0010	0.0088	0.0028	0.011
Hg	7	1	BDL	5	0					
PCBs	7	1	BDL	7	0					
F1	7	1	N/A	0	0					
F2	7	1	N/A	0	0					
F3	7	1	N/A	0	0					
TPH	7	1	BDL	7	2	0.12	0.060	0.090	0.090	0.042

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A7. Summary of BAR-2 USAF Landfill Downgradient Soil Monitoring Data, up to 2011

Parameter	Number of monitoring events	Number of downgradient locations	Number of samples	Number of detects	Slope trend	High value	Low value	Mean	Median	Standard deviation
Cu	7	5	71	71	NT	33	14	22	22	4.0
Ni	7	5	71	71	NT	40	9.0	27	27	5.4
Co	7	5	71	71	NT	20	5.0	11	11	2.4
Cd	7	5	71	15	BDL	0.70	0.10	0.30	0.30	0.15
Pb	7	5	71	70	NT	45	7.0	12	11	5.2
Zn	7	5	71	71	NT	130	60	85	81	14
Cr	7	5	71	69	NT	201	9.8	22	20	22
As	7	5	71	71	NT	17	5.5	11	11	2.2
Hg	7	5	71	19	BDL	0.11	0.050	0.067	0.060	0.015
PCBs	7	5	71	10	BDL	0.20	0.0034	0.041	0.021	0.059
F1	7	5	61	0	BDL					
F2	7	5	61	18	BDL	33	5.0	13	12	6.8
F3	7	5	61	58	NT	1400	18	187	95	250
TPH	7	5	71	58	NT	7303	30	336	119	965

NT = No trend detected

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A8. Summary of BAR-2 USAF Landfill Upgradient Soil Monitoring Data, up to 2011

Parameter	Number of monitoring events	Number of upgradient locations	Number of samples	Number of detects	Slope trend	High value	Low value	Mean	Median	Standard deviation
Cu	7	1	14	14	NT	33	21	27	27	3.2
Ni	7	1	14	14	NT	38	28	34	34	3.2
Co	7	1	14	14	NT	14	9.0	12	12	1.4
Cd	7	1	14	2	BDL	0.40	0.30	0.35	0.35	0.07
Pb	7	1	14	14	NT	16	10	12	12	1.8
Zn	7	1	14	14	NT	110	20	88	90	22
Cr	7	1	14	14	Decreasing	34	17	23	23	4.8
As	7	1	14	14	NT	16	9.6	12	12	1.9
Hg	7	1	14	3	BDL	0.10	0.050	0.073	0.070	0.025
PCBs	7	1	14	0	BDL					
F1	7	1	12	0	BDL					
F2	7	1	12	4	BDL	11	5.0	7.8	7.5	2.5
F3	7	1	12	11	NT	450	14	140	64	150
TPH	7	1	14	11	NT	455	40	160	120	140

NT = No trend detected

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A9. Summary of CAM-M Main Landfill North Downgradient Groundwater Monitoring Data, up to 2010

Parameter	Number of monitoring events	Number of downgradient wells	Any increasing trends?	Number of samples	Number of detects	High value	Low value	Mean	Median	Standard deviation
Cu	7	3	None	14	13	0.20	0.0007	0.045	0.022	0.064
Ni	7	3	None	14	14	4.8	0.060	0.803	0.21	1.4
Co	7	3	None	14	13	0.072	0.002	0.024	0.010	0.024
Cd	7	3	BDL	14	6	0.0030	0.00011	0.00079	0.00024	0.0011
Pb	7	3	BDL	14	6	0.015	0.0002	0.0092	0.011	0.005
Zn	7	3	None	14	14	86	0.083	6.8	0.44	23
Cr	7	3	None	14	10	2.0	0.0054	0.435	0.095	0.633
As	7	3	None	14	9	0.023	0.001	0.006	0.005	0.007
Hg	7	3	BDL	14	0					
PCBs	7	3	BDL	12	0					
F1	7	3	BDL	8	0					
F2	7	3	BDL	8	0					
F3	7	3	BDL	8	0					
TPH	7	3	BDL	13	1	0.17	0.17	0.17	0.17	

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A10. Summary of CAM-M Main Landfill North Upgradient Groundwater Monitoring Data, up to 2010

Parameter	Number of monitoring events	Number of upgradient wells	Any increasing trends?	Number of samples	Number of detects	High value	Low value	Mean	Median	Standard deviation
Cu	7	1	None	5	4	0.096	0.004	0.037	0.024	0.043
Ni	7	1	None	5	5	0.66	0.030	0.24	0.068	0.28
Co	7	1	None	5	4	0.010	0.0020	0.0068	0.0075	0.0034
Cd	7	1	BDL	5	1	0.0010	0.0010	0.0010	0.0010	
Pb	7	1	BDL	5	1	0.030	0.030	0.030	0.030	
Zn	7	1	None	5	5	2.4	0.016	0.921	0.120	1.194
Cr	7	1	None	5	5	0.56	0.0009	0.22	0.016	0.30
As	7	1	BDL	5	3	0.0050	0.0008	0.0029	0.0030	0.0021
Hg	7	1	BDL	5	0					
PCBs	7	1	BDL	4	0					
F1	7	1	BDL	2	0					
F2	7	1	BDL	2	0					
F3	7	1	BDL	2	0					
TPH	7	1	BDL	4	0					

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A11. Summary of CAM-M Main Landfill North Downgradient Soil Monitoring Data, up to 2010

Parameter	Number of monitoring events	Number of downgradient locations	Number of samples	Number of detects	Slope trend	High value	Low value	Mean	Median	Standard deviation
Cu	7	3	61	61	NT	43	4.0	13	12	6.6
Ni	7	3	61	61	NT	27	4.6	12	12	5.2
Co	7	3	61	55	NT	15	1.3	5.6	5.0	2.6
Cd	7	3	61	11	BDL	9.0	0.10	1.4	0.50	2.6
Pb	7	3	61	14	BDL	11	2.3	6.9	6.9	2.0
Zn	7	3	61	58	NT	111	5.9	23	19	18
Cr	7	3	61	54	NT	31	5.8	16	16	6.6
As	7	3	61	47	NT	10	0.70	4.1	3.7	2.4
Hg	7	3	61	22	BDL	0.25	0.004	0.057	0.025	0.066
PCBs	7	3	49	1	BDL	0.0040	0.0040	0.0040	0.0040	
F1	7	3	45	1	BDL	36	36	36	36	
F2	7	3	45	4	BDL	5,100	150	1,500	270	2,400
F3	7	3	45	10	BDL	12,000	20	3,300	730	5,000
TPH	7	3	61	11	BDL	18,000	20	2,900	710	5,300

NT = No trend detected

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A12. Summary of CAM-M Main Landfill North Upgradient Soil Monitoring Data, up to 2010

Parameter	Number of monitoring events	Number of upgradient locations	Number of samples	Number of detects	Slope trend	High value	Low value	Mean	Median	Standard deviation
Cu	7	1	14	14	NT	16	7.3	11	12	2.4
Ni	7	1	14	14	NT	21	5.8	11	12	4.1
Co	7	1	14	13	NT	9.6	3.4	6.0	5.8	2.2
Cd	7	1	14	3	BDL	1.7	0.1	0.70	0.3	0.87
Pb	7	1	14	4	BDL	8.2	5.6	6.9	6.9	1.1
Zn	7	1	14	14	NT	48	8.4	21	18	11
Cr	7	1	14	13	NT	25	6.4	14	13	5.8
As	7	1	14	12	NT	3.1	1.7	2.6	2.8	0.5
Hg	7	1	14	6	BDL	0.085	0.0060	0.039	0.040	0.029
PCBs	7	1	10	3	BDL	0.20	0.0076	0.093	0.070	0.098
F1	7	1	10	0	BDL					
F2	7	1	10	0	BDL					
F3	7	1	10	0	BDL					
TPH	7	1	14	0	BDL					

NT = No trend detected

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A13. Summary of FOX-5 Main Landfill Downgradient Groundwater Monitoring Data, up to 2012

Parameter	Number of monitoring events	Number of downgradient wells	Any increasing trends?	Number of samples	Number of detects	High value	Low value	Mean	Median	Standard deviation
Cu	5	4	No	16	13	0.069	0.0010	0.013	0.0057	0.019
Ni	5	4	No	16	8	0.081	0.0038	0.038	0.049	0.032
Co	5	4	BDL	16	4	0.0040	0.00053	0.0028	0.0039	0.0020
Cd	5	4	No	16	9	0.0010	0.00010	0.00053	0.00050	0.00036
Pb	5	4	BDL	16	4	0.011	0.0014	0.0062	0.0062	0.0068
Zn	5	4	No	16	14	0.23	0.0045	0.067	0.033	0.074
Cr	5	4	No	16	11	0.16	0.001	0.053	0.026	0.058
As	5	4	BDL	16	0					
Hg	5	4	BDL	16	0					
PCBs	5	4	BDL	15	0					
F1	5	4	BDL	15	0					
F2	5	4	BDL	15	0					
F3	5	4	BDL	15	1	0.60	0.60	0.60	0.60	
TPH	5	4	BDL	15	1	0.60	0.60	0.60	0.60	

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A14. Summary of FOX-5 Main Landfill Upgradient Groundwater Monitoring Data, up to 2012

Parameter	Number of monitoring events	Number of downgradient wells	Any increasing trends?	Number of samples	Number of detects	High value	Low value	Mean	Median	Standard deviation
Cu	5	1	No	5	3	0.014	0.0010	0.0055	0.0016	0.0073
Ni	5	1	BDL	5	2	0.067	0.0038	0.035	0.035	0.045
Co	5	1	BDL	5	2	0.0040	0.00053	0.0023	0.0023	0.0025
Cd	5	1	No	5	3	0.00020	0.00010	0.00013	0.00010	0.00006
Pb	5	1	BDL	5	0					
Zn	5	1	No	5	4	0.070	0.010	0.029	0.019	0.028
Cr	5	1	No	5	3	0.13	0.0010	0.046	0.0073	0.073
As	5	1	BDL	5	0					
Hg	5	1	BDL	5	0					
PCBs	5	1	BDL	5	0					
F1	5	1	BDL	5	0					
F2	5	1	BDL	5	0					
F3	5	1	BDL	5	0					
TPH	5	1	BDL	5	0					

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A15. Summary of FOX-5 Main Landfill Downgradient Soil Monitoring Data, up to 2012

Parameter	Number of monitoring events	Number of downgradient locations	Number of samples	Number of detects	Slope trend	High value	Low value	Mean	Median	Standard deviation
Cu	5	4	41	39	NT	22	3.0	7.6	7.0	3.5
Ni	5	4	41	34	NT	32	2.8	11	10	6.8
Co	5	4	41	34	NT	10	2.1	4.3	4.0	1.8
Cd	5	4	41	1	BDL	0.60	0.60	0.60	0.60	
Pb	5	4	41	34	NT	21	6.0	11	11	3.7
Zn	5	4	41	41	NT	76	19	38	35	14
Cr	5	4	41	33	NT	56	5.7	20	20	10.7
As	5	4	41	38	NT	25	1.0	3.1	2.2	3.8
Hg	5	4	41	0	BDL					
PCBs	5	4	41	3	BDL	0.43	0.0052	0.17	0.064	0.23
F1	5	4	41	14	BDL	77	13	36	36	19
F2	5	4	41	0	BDL					
F3	5	4	41	8	BDL	8.1	4.1	6.1	6.2	1.2
TPH	5	4	41	14	BDL	77	9.2	34	33	20

NT = No trend detected
BDL = Insufficient samples were above reported detection limits to determine a trend

Table A16. Summary of FOX-5 Main Landfill Upgradient Soil Monitoring Data, up to 2012

Parameter	Number of monitoring events	Number of upgradient locations	Number of samples	Number of detects	Slope trend	High value	Low value	Mean	Median	Standard deviation
Cu	5	1	10	10	NT	13	4.4	7.9	7.0	2.9
Ni	5	1	10	8	NT	27	5.8	15	14	8.1
Co	5	1	10	8	NT	7.0	3.2	4.9	4.5	1.6
Cd	5	1	10	0	BDL					
Pb	5	1	10	8	NT	10	7.0	9.0	9.0	1.0
Zn	5	1	10	10	NT	60	31	40	36	9
Cr	5	1	10	8	NT	55	13	28	23	17
As	5	1	10	8	NT	2.7	1.0	2.2	2.4	0.6
Hg	5	1	10	0	BDL					
PCBs	5	1	10	0	BDL					
F1	5	1	10	3	BDL	1,750	15	590	16	1,000
F2	5	1	10	0	BDL					
F3	5	1	10	2	BDL	4.5	4.0	4.3	4.3	0.4
TPH	5	1	10	3	BDL	1,750	11	590	11	1,000

NT = No trend detected
BDL = Insufficient samples were above reported detection limits to determine a trend

Table A17. Summary of FOX-M East Beach Landfill Downgradient Groundwater Monitoring Data, up to 2011

Parameter	Number of monitoring events	Number of downgradient wells	Any increasing trends?	Number of samples	Number of detects	High value	Low value	Mean	Median	Standard deviation
Cu	4	3	None	11	8	0.016	0.0010	0.0055	0.0045	0.0049
Ni	4	3	None	11	7	0.079	0.0060	0.025	0.014	0.026
Co	4	3	BDL	11	4	0.0098	0.00020	0.0027	0.00040	0.0047
Cd	4	3	BDL	11	2	0.0010	0.00020	0.00060	0.00060	0.00057
Pb	4	3	BDL	11	2	0.013	0.0014	0.0072	0.0072	0.0082
Zn	4	3	BDL	11	6	0.19	0.011	0.063	0.043	0.069
Cr	4	3	None	11	9	0.22	0.0020	0.034	0.0080	0.070
As	4	3	BDL	11	6	0.014	0.0030	0.0067	0.0058	0.0041
Hg	4	3	BDL	11	0					
PCBs	4	3	BDL	11	0					
F1	4	3	BDL	11	0					
F2	4	3	BDL	11	0					
F3	4	3	BDL	11	0					
TPH	4	3	BDL	11	0					

BDL = Insufficient samples were above reported detection limits to determine a trend

* No upgradient wells at this facility

Table A18. Summary of FOX-M East Beach Landfill Downgradient Soil Monitoring Data, up to 2011

Parameter	Number of monitoring events	Number of downgradient locations	Number of samples	Number of detects	Slope trend	High value	Low value	Mean	Median	Standard deviation
Cu	4	12	106	100	NT	110	2.4	9.0	5.0	14
Ni	4	12	106	102	NT	63	4.2	11	11	7.8
Co	4	12	106	53	BDL	15	2.0	3.6	3.0	1.9
Cd	4	12	106	0	BDL					
Pb	4	12	106	67	NT	620	3.0	39	8.0	97
Zn	4	12	106	68	NT	240	7.0	20	13	29
Cr	4	12	106	54	NT	120	11	20	16	17
As	4	12	106	106	NT	19	0.2	2.4	2.0	1.9
Hg	4	12	106	0	BDL					
PCBs	4	12	106	16	BDL	0.28	0.0024	0.049	0.019	0.072
F1	4	12	106	33	BDL	137	6.9	32	20	32
F2	4	12	106	1	BDL	4.1	4.1	4.1	4.1	
F3	4	12	106	10	BDL	57	9.0	17	13	14
TPH	4	12	106	35	BDL	137	6.9	31	19	31

NT = No trend detected

BDL = Insufficient samples were above reported detection limits to determine a trend

* No upgradient locations at this facility

Table A19. Summary of FOX-4 Tier II Disposal Facility Downgradient Groundwater Monitoring Data, up to 2008

Parameter	Number of monitoring events	Number of downgradient wells	Any increasing trends?	Number of samples	Number of detects	High value	Low value	Mean	Median	Standard deviation
Cu	8	4	None	24	18	0.12	0.005	0.020	0.010	0.027
Ni	8	4	None	21	21	0.18	0.010	0.062	0.040	0.056
Co	8	4	None	21	16	0.026	0.0000	0.012	0.009	0.010
Cd	8	4	None	24	12	0.0060	0.0003	0.0016	0.0010	0.0017
Pb	8	4	None	24	13	0.080	0.001	0.019	0.010	0.025
Zn	8	4	None	24	24	5.5	0.00050	1.5	1.3	1.5
Cr	8	4	None	24	17	0.46	0.003	0.063	0.011	0.12
As	8	4	None	24	13	0.050	0.0040	0.016	0.0090	0.014
Hg	8	4	BDL	24	0					
PCBs	8	4	BDL	24	0					
F1	8	4	BDL	8	1	0.026	0.026	0.026	0.026	
F2	8	4	BDL	8	0					
F3	8	4	BDL	8	0					
TPH	8	4	BDL	23	4	0.19	0.026	0.083	0.058	0.074

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A20. Summary of FOX-4 Tier II Disposal FacilityUpgradient Groundwater Monitoring Data, up to 2008

Parameter	Number of monitoring events	Number of upgradient wells	Any increasing trends?	Number of samples	Number of detects	High value	Low value	Mean	Median	Standard deviation
Cu	8	1	None	7	6	0.020	0.000005	0.0082	0.0060	0.0070
Ni	8	1	None	6	6	0.500	0.010	0.11	0.034	0.193
Co	8	1	None	6	4	0.022	0.0010	0.0088	0.0060	0.010
Cd	8	1	BDL	7	2	0.0010	0.0009	0.00095	0.00095	0.0001
Pb	8	1	BDL	7	3	0.010	0.0030	0.0060	0.0050	0.0036
Zn	8	1	None	7	7	1.0	0.000055	0.25	0.12	0.34
Cr	8	1	None	7	6	0.020	0.000006	0.0082	0.0070	0.0066
As	8	1	None	7	4	0.010	0.0010	0.0058	0.0060	0.0049
Hg	8	1	BDL	7	0					
PCBs	8	1	BDL	7	0					
F1	8	1	BDL	3	0					
F2	8	1	BDL	3	0					
F3	8	1	BDL	3	0					
TPH	8	1	BDL	7	1	0.084	0.084	0.084	0.084	

Table A21. Summary of FOX-4 Tier II Disposal Facility Downgradient Soil Monitoring Data, up to 2008

Parameter	Number of monitoring events	Number of downgradient locations	Number of samples	Number of detects	Slope trend	High value	Low value	Mean	Median	Standard deviation
Cu	8	4	56	56	NT	21	3.0	9.9	9.4	3.6
Ni	8	4	56	56	NT	17	4.0	9.8	9.2	2.9
Co	8	4	56	43	NT	5.0	2.0	3.2	3.0	1.0
Cd	8	4	56	2	BDL	1.00	1.00	1.00	1.00	
Pb	8	4	56	22	BDL	110	2.0	8.9	3.5	23
Zn	8	4	56	48	NT	29	12	20	18	4
Cr	8	4	56	56	NT	33	10	21	20	5.7
As	8	4	56	56	NT	70	1.5	11	7.1	12
Hg	8	4	56	0	BDL					
PCBs	8	4	56	5	BDL	0.011	0.0061	0.01	0.0073	0.0021
F1	8	4	36	0	BDL					
F2	8	4	36	3	BDL	10	10	10	10	
F3	8	4	36	14	BDL	50	10	24	20	12
TPH	8	4	56	19	BDL	101	10	41	30	29

NT = No trend detected

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A22. Summary of FOX-4 Tier II Disposal Facility Upgradient Soil Monitoring Data, up to 2008

Parameter	Number of monitoring events	Number of upgradient locations	Number of samples	Number of detects	Slope trend	High value	Low value	Mean	Median	Standard deviation
Cu	8	1	13	13	NT	16	1.8	7.7	7.0	4.0
Ni	8	1	13	13	NT	12	5.0	7.4	6.6	2.5
Co	8	1	13	9	NT	3.0	2.0	2.3	2.0	0.4
Cd	8	1	13	0	BDL					
Pb	8	1	13	4	BDL	4.0	1.0	2.5	2.5	1.3
Zn	8	1	13	11	NT	72	10	19	14	18
Cr	8	1	13	12	NT	28	10	16	14	6.1
As	8	1	13	13	NT	33	2.3	9.3	6.2	9.2
Hg	8	1	13	0	BDL					
PCBs	8	1	13	0	BDL					
F1	8	1	8	0	BDL					
F2	8	1	8	1	BDL	31	31	31	31	
F3	8	1	8	2	BDL	30	20	25	25	7.1
TPH	8	1	13	5	BDL	81	20	46	31	27

NT = No trend detected

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A23. Summary of CAM-M Tier II Disposal Facility Downgradient Groundwater Monitoring Data, up to 2010

Parameter	Number of monitoring events	Number of downgradient wells	Any increasing trends?	Number of samples	Number of detects	High value	Low value	Mean	Median	Standard deviation
Cu	4	3	None	10	10	0.099	0.0040	0.035	0.022	0.036
Ni	4	3	None	10	10	1.8	0.028	0.64	0.43	0.65
Co	4	3	None	10	10	0.040	0.0016	0.012	0.0088	0.012
Cd	4	3	BDL	10	4	0.0080	0.00007	0.0021	0.00013	0.0039
Pb	4	3	None	10	6	0.11	0.00030	0.023	0.0036	0.043
Zn	4	3	None	10	10	5.4	0.0030	1.1	0.22	2.0
Cr	4	3	None	10	9	1.7	0.0061	0.38	0.14	0.57
As	4	3	None	10	7	0.021	0.00070	0.0054	0.0013	0.0073
Hg	4	3	BDL	10	0					
PCBs	4	3	BDL	10	0					
F1	4	3	BDL	3	0					
F2	4	3	BDL	3	0					
F3	4	3	BDL	3	1	0.064	0.064	0.064	0.064	
TPH	4	3	BDL	5	1	0.064	0.064	0.064	0.064	

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A24. Summary of CAM-M Tier II Disposal Facility Upgradient Groundwater Monitoring Data, up to 2010

Parameter	Number of monitoring events	Number of upgradient wells	Any increasing trends?	Number of samples	Number of detects	High value	Low value	Mean	Median	Standard deviation
Cu	4	1	BDL	1	1	0.0057	0.0057	0.0057	0.0057	
Ni	4	1	BDL	1	1	0.12	0.12	0.12	0.12	
Co	4	1	BDL	1	1	0.022	0.022	0.022	0.022	
Cd	4	1	BDL	1	1	0.00005	0.00005	0.00005	0.00005	
Pb	4	1	BDL	1	0					
Zn	4	1	BDL	1	1	0.017	0.017	0.017	0.017	
Cr	4	1	BDL	1	1	0.036	0.036	0.036	0.036	
As	4	1	BDL	1	1	0.00070	0.00070	0.00070	0.00070	
Hg	4	1	BDL	1	0					
PCBs	4	1	BDL	1	0					
F1	4	1	N/A	0	0					
F2	4	1	N/A	0	0					
F3	4	1	N/A	0	0					
TPH	4	1	BDL	1	0					

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A25. Summary of CAM-M Tier II Disposal Facility Downgradient Soil Monitoring Data, up to 2010

Parameter	Number of monitoring events	Number of downgradient locations	Number of samples	Number of detects	Slope trend	High value	Low value	Mean	Median	Standard deviation
Cu	7	3	40	40	NT	21	3.0	9.3	8.8	4.7
Ni	7	3	40	35	NT	19	2.2	7.5	6.3	4.2
Co	7	3	40	31	NT	5.3	1.0	2.9	2.7	1.1
Cd	7	3	40	4	BDL	1.4	0.20	0.55	0.30	0.57
Pb	7	3	40	8	BDL	5.7	1.8	4.1	4.3	1.3
Zn	7	3	40	38	NT	46	4.0	16	12	11
Cr	7	3	40	34	NT	29	3.0	7.9	6.0	4.9
As	7	3	40	25	NT	8.9	0.50	1.8	1.3	1.6
Hg	7	3	40	18	BDL	0.17	0.0040	0.047	0.040	0.043
PCBs	7	3	34	0	BDL					
F1	7	3	29	0	BDL					
F2	7	3	29	0	BDL					
F3	7	3	29	6	BDL	395	19	142	73	144
TPH	7	3	40	6	BDL	395	19	151	80	148

NT = No trend detected

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A26. Summary of CAM-M Tier II Disposal Facility Upgradient Soil Monitoring Data, up to 2010

Parameter	Number of monitoring events	Number of upgradient locations	Number of samples	Number of detects	Slope trend	High value	Low value	Mean	Median	Standard deviation
Cu	7	1	14	14	Decreasing	23	3.5	7.9	6.2	4.9
Ni	7	1	14	13	NT	14	2.9	7.2	6.6	2.7
Co	7	1	14	12	NT	5.0	1.6	3.2	3.1	0.92
Cd	7	1	14	1	BDL	0.10	0.10	0.10	0.10	
Pb	7	1	14	2	BDL	3.4	3.3	3.4	3.4	0.07
Zn	7	1	14	13	NT	19	9.0	13	12	3.5
Cr	7	1	14	12	NT	21	6.7	11	9.2	4.4
As	7	1	14	8	NT	2.0	0.8	1.4	1.5	0.40
Hg	7	1	14	4	BDL	0.12	0.0050	0.041	0.019	0.054
PCBs	7	1	12	0	BDL					
F1	7	1	10	0	BDL					
F2	7	1	10	0	BDL					
F3	7	1	10	0	BDL					
TPH	7	1	14	1	BDL	21	21	21	21	

NT = No trend detected

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A27. Summary of PIN-3 Tier II Disposal Facility Downgradient Groundwater Monitoring Data, up to 2011

Parameter	Number of monitoring events	Number of downgradient wells	Any increasing trends?	Number of samples	Number of detects	High value	Low value	Mean	Median	Standard deviation
Cu	6	2	None	10	5	0.48	0.0017	0.20	0.16	0.20
Ni	6	2	None	10	7	0.077	0.005	0.034	0.028	0.028
Co	6	2	BDL	10	4	0.023	0.001	0.011	0.0070	0.0093
Cd	6	2	BDL	10	3	0.00078	0.00005	0.00033	0.00024	0.00034
Pb	6	2	None	10	5	2.3	0.0030	0.58	0.17	0.90
Zn	6	2	None	10	6	0.88	0.028	0.29	0.11	0.33
Cr	6	2	None	10	6	0.15	0.010	0.07	0.065	0.061
As	6	2	BDL	10	4	0.015	0.0030	0.011	0.012	0.0057
Hg	6	2	BDL	10	2	0.26	0.037	0.15	0.15	0.15
PCBs	6	2	BDL	10	1	0.000040	0.000040	0.000040	0.000040	
F1	6	2	BDL	8	0					
F2	6	2	BDL	6	0					
F3	6	2	BDL	6	0					
TPH	6	2	BDL	10	0					

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A28. Summary of PIN-3 Tier II Disposal Facility Downgradient Soil Monitoring Data, up to 2011

Parameter	Number of monitoring events	Number of downgradient locations	Number of samples	Number of detects	Slope trend	High value	Low value	Mean	Median	Standard deviation
Cu	7	3	45	42	NT	42	2.3	12	8.4	9.1
Ni	7	3	45	26	NT	18	2.3	7.4	6.2	3.8
Co	7	3	45	26	NT	3.7	1.0	2.3	2.2	0.71
Cd	7	3	45	1	BDL	0.20	0.20	0.20	0.20	
Pb	7	3	45	14	BDL	22	1.0	4.4	2.2	5.9
Zn	7	3	45	28	NT	47	4.2	11	7.2	9.0
Cr	7	3	45	32	NT	23	3.0	6.9	5.3	4.5
As	7	3	45	31	NT	4.0	0.68	1.6	1.3	0.90
Hg	7	3	45	8	BDL	0.052	0.0040	0.020	0.014	0.017
PCBs	7	3	45	1	BDL	0.0050	0.0050	0.0050	0.0050	
F1	7	3	39	2	BDL	17	11	14	14	4.2
F2	7	3	39	5	BDL	16	5.4	11	12	4.5
F3	7	3	39	24	NT	740	9.0	86	32	156
TPH	7	3	45	27	NT	773	5.0	86	35	153

NT = No trend detected

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A29. Summary of PIN-3 Tier II Disposal Facility Upgradient Soil Monitoring Data, up to 2011

Parameter	Number of monitoring events	Number of upgradient locations	Number of samples	Number of detects	Slope trend	High value	Low value	Mean	Median	Standard deviation
Cu	7	1	14	14	NT	18	6.0	11	10	3.0
Ni	7	1	14	7	Increasing	21	5.2	11	9.0	6.9
Co	7	1	14	10	NT	4.0	2.0	2.9	2.8	0.53
Cd	7	1	14	0	BDL					
Pb	7	1	14	6	BDL	3.8	2.0	2.9	3.2	0.74
Zn	7	1	14	8	NT	16	4.7	11	10	4.4
Cr	7	1	14	10	Increasing	32	5.3	12	6.6	10
As	7	1	14	7	NT	1.6	1.2	1.4	1.4	0.13
Hg	7	1	14	6	BDL	0.050	0.0040	0.016	0.0074	0.018
PCBs	7	1	14	2	BDL	0.0038	0.0033	0.0036	0.0036	0.00035
F1	7	1	12	0	BDL					
F2	7	1	12	1	BDL	6.8	6.8	6.8	6.8	
F3	7	1	12	6	NT	31	9.1	19	17	8.4
TPH	7	1	14	8	Increasing	53	14	28	24	15

NT = No trend detected

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A30. Summary of FOX-5 Tier II Disposal Facility Downgradient Groundwater Monitoring Data, up to 2012

Parameter	Number of monitoring events	Number of downgradient wells	Any increasing trends?	Number of samples	Number of detects	High value	Low value	Mean	Median	Standard deviation
Cu	5	4	No	20	19	0.029	0.0010	0.0066	0.0030	0.0077
Ni	5	4	No	20	7	0.10	0.0027	0.050	0.062	0.046
Co	5	4	BDL	20	4	0.0040	0.00020	0.00122	0.00035	0.0018
Cd	5	4	No	20	8	0.00050	0.00010	0.00028	0.00020	0.00015
Pb	5	4	BDL	20	0					
Zn	5	4	No	20	14	0.18	0.0063	0.038	0.025	0.044
Cr	5	4	No	20	12	0.21	0.0010	0.058	0.0029	0.086
As	5	4	BDL	20	0					
Hg	5	4	BDL	20	0					
PCBs	5	4	BDL	20	0					
F1	5	4	BDL	20	1	0.70	0.70	0.70	0.70	
F2	5	4	BDL	20	0					
F3	5	4	BDL	20	0					
TPH	5	4	BDL	20	1	0.70	0.70	0.70	0.70	

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A31. Summary of FOX-5 Tier II Disposal Facility Upgradient Groundwater Monitoring Data, up to 2012

Parameter	Number of monitoring events	Number of upgradient wells	Any increasing trends?	Number of samples	Number of detects	High value	Low value	Mean	Median	Standard deviation
Cu	5	1	No	5	5	0.012	0.0020	0.0064	0.0040	0.0048
Ni	5	1	BDL	5	2	0.044	0.004	0.024	0.024	0.029
Co	5	1	BDL	5	4	0.00066	0.00020	0.00046	0.00050	0.00021
Cd	5	1	BDL	5	2	0.0002	0.0001	0.00015	0.00015	0.00007
Pb	5	1	BDL	5	2	0.0020	0.0011	0.0016	0.0016	0.0006
Zn	5	1	No	5	4	0.086	0.010	0.032	0.017	0.036
Cr	5	1	No	5	4	0.089	0.002	0.024	0.003	0.043
As	5	1	BDL	5	0					
Hg	5	1	BDL	5	0					
PCBs	5	1	BDL	5	0					
F1	5	1	BDL	5	0					
F2	5	1	BDL	5	0					
F3	5	1	BDL	5	0					
TPH	5	1	BDL	5	0					

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A32. Summary of FOX-5 Tier II Disposal Facility Downgradient Soil Monitoring Data, up to 2012

Parameter	Number of monitoring events	Number of downgradient locations	Number of samples	Number of detects	Slope trend	High value	Low value	Mean	Median	Standard deviation
Cu	5	4	41	41	NT	12	4.5	7.8	7.5	2.0
Ni	5	4	41	38	NT	22	4.5	10	11	4.3
Co	5	4	41	37	Decreasing	56	2.3	6.3	5.0	8.5
Cd	5	4	41	0	BDL					
Pb	5	4	41	33	NT	9.0	5.0	7.0	7.0	0.9
Zn	5	4	41	41	NT	57	24	37	35	8
Cr	5	4	41	33	NT	40	10	21	22	7.8
As	5	4	41	33	NT	3.9	1.0	2.4	2.2	0.9
Hg	5	4	41	4	BDL	0.015	0.012	0.013	0.012	0.002
PCBs	5	4	41	0	BDL					
F1	5	4	41	13	BDL	67	18	40	38	15
F2	5	4	41	0	BDL					
F3	5	4	41	7	BDL	8.7	4.1	6.1	6.2	1.6
TPH	5	4	41	13	BDL	63	12	36	30	16

NT = No trend detected

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A33. Summary of FOX-5 Tier II Disposal Facility Upgradient Soil Monitoring Data, up to 2012

Parameter	Number of monitoring events	Number of upgradient locations	Number of samples	Number of detects	Slope trend	High value	Low value	Mean	Median	Standard deviation
Cu	5	1	10	10	NT	16	5.3	9.5	9.0	3.9
Ni	5	1	10	9	NT	18	4.4	12	13	5.3
Co	5	1	10	9	NT	9.0	2.4	5.9	6.2	2.3
Cd	5	1	10	0	BDL					
Pb	5	1	10	8	NT	11	5.6	7.8	7.6	1.9
Zn	5	1	10	10	NT	63	24	42	41	12
Cr	5	1	10	8	NT	41	10	28	30	11
As	5	1	10	9	NT	3.6	1.0	2.1	2.4	0.9
Hg	5	1	10	0	BDL					
PCBs	5	1	10	0	BDL					
F1	5	1	10	2	BDL	120	31	76	76	63
F2	5	1	10	0	BDL					
F3	5	1	10	2	BDL	11	5.3	8.2	8.2	4.0
TPH	5	1	10	2	BDL	110	26	68	68	59

Table A34. Summary of FOX-4 Lower Site Landfill Downgradient Groundwater Monitoring Data, up to 2008

Parameter	Number of monitoring events	Number of downgradient wells	Any increasing trends?	Number of samples	Number of detects	High value	Low value	Mean	Median	Standard deviation
Cu	8	1	No	7	6	0.020	0.000005	0.0082	0.0060	0.0070
Ni	8	1	No	6	6	0.50	0.010	0.11	0.034	0.19
Co	8	1	No	6	4	0.022	0.0010	0.0088	0.0060	0.010
Cd	8	1	BDL	7	2	0.0010	0.00090	0.00095	0.00095	0.00007
Pb	8	1	BDL	7	3	0.010	0.003	0.006	0.005	0.003606
Zn	8	1	No	7	7	1.0	0.000055	0.25	0.12	0.34
Cr	8	1	No	7	6	0.020	0.000006	0.0082	0.0070	0.0066
As	8	1	No	7	4	0.010	0.0010	0.0058	0.0060	0.0049
Hg	8	1	BDL	7	0					
PCBs	8	1	BDL	7	0					
F1	8	1	BDL	3	0					
F2	8	1	BDL	3	0					
F3	8	1	BDL	3	0					
TPH	8	1	BDL	7	1	0.084	0.084	0.084	0.084	

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A35. Summary of FOX-4 Lower Site Landfill Downgradient Groundwater Monitoring Data, up to 2008

Parameter	Number of monitoring events	Number of upgradient wells	Any increasing trends?	Number of samples	Number of detects	High value	Low value	Mean	Median	Standard deviation
Cu	8	2	No	13	8	0.017	0.002	0.010	0.009	0.005
Ni	8	2	No	11	10	0.080	0.010	0.038	0.030	0.026
Co	8	2	No	11	8	0.028	0.0030	0.012	0.012	0.0086
Cd	8	2	BDL	13	3	0.00070	0.00030	0.00047	0.00040	0.00021
Pb	8	2	No	13	7	0.030	0.0020	0.011	0.010	0.0091
Zn	8	2	No	13	13	0.74	0.00020	0.21	0.17	0.21
Cr	8	2	No	13	7	0.060	0.00001	0.018	0.0050	0.026
As	8	2	No	13	6	0.0090	0.0010	0.0040	0.0030	0.0033
Hg	8	2	BDL	13	0					
PCBs	8	2	BDL	13	0					
F1	8	2	BDL	6	2	0.28	0.097	0.19	0.19	0.13
F2	8	2	BDL	6	3	0.40	0.00014	0.13	0.00030	0.23
F3	8	2	BDL	6	0					
TPH	8	2	BDL	13	5	2.9	0.00014	0.91	0.68	1.2

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A36. Summary of FOX-4 Lower Site Landfill Downgradient Soil Monitoring Data, up to 2008

Parameter	Number of monitoring events	Number of downgradient locations	Number of samples	Number of detects	Slope trend	High value	Low value	Mean	Median	Standard deviation
Cu	8	1	13	13	NT	16	1.8	7.7	7.0	4.0
Ni	8	1	13	13	NT	12	5.0	7.4	6.6	2.5
Co	8	1	13	9	NT	3.0	2.0	2.3	2.0	0.4
Cd	8	1	13	0	BDL					
Pb	8	1	13	4	BDL	4.0	1.0	2.5	2.5	1.3
Zn	8	1	13	11	NT	72	10	19	14	18
Cr	8	1	13	12	NT	28	10	16	14	6.1
As	8	1	13	13	NT	33	2.3	9.3	6.2	9.2
Hg	8	1	13	0	BDL					
PCBs	8	1	13	0	BDL					
F1	8	1	8	0	BDL					
F2	8	1	8	1	BDL	31	31	31	31	
F3	8	1	8	2	BDL	30	20	25	25	7.1
TPH	8	1	13	5	BDL	81	20	46	31	27

NT = No trend detected

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A37. Summary of FOX-4 Lower Site Landfill Upgradient Soil Monitoring Data, up to 2008

Parameter	Number of monitoring events	Number of upgradient locations	Number of samples	Number of detects	Slope trend	High value	Low value	Mean	Median	Standard deviation
Cu	8	2	28	28	NT	26	2.6	11	8.6	6.9
Ni	8	2	28	28	NT	22	4.0	7.7	6.2	3.9
Co	8	2	28	22	NT	6.0	1.5	2.7	2.6	1.1
Cd	8	2	28	0	BDL					
Pb	8	2	28	8	BDL	16	1.0	5.3	3.0	5.3
Zn	8	2	28	26	NT	35	8.8	17	16	7.3
Cr	8	2	28	25	Increasing	56	9.3	18	17	10
As	8	2	28	28	NT	162	2.4	17	7.6	31
Hg	8	2	28	0	BDL					
PCBs	8	2	28	3	BDL	0.04	0.0072	0.02	0.016	0.02
F1	8	2	18	2	BDL	92	27	60	60	46
F2	8	2	18	7	BDL	3,100	20	1,100	360	1,320
F3	8	2	18	9	NT	860	10	410	220	350
TPH	8	2	28	14	NT	4,000	10	910	250	1,300

NT = No trend detected

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A38. Summary of BAR-2 NHWL Downgradient Groundwater Monitoring Data, up to 2011

Parameter	Number of monitoring events	Number of downgradient wells	Any increasing trends?	Number of samples	Number of detects	High value	Low value	Mean	Median	Standard deviation
Cu	5	3	No	15	15	0.088	0.0004	0.027	0.017	0.025
Ni	5	3	No	15	15	0.282	0.0084	0.085	0.063	0.065
Co	5	3	No	15	15	0.066	0.0082	0.032	0.030	0.017
Cd	5	3	BDL	15	6	0.0022	0.0001	0.0011	0.0013	0.0009
Pb	5	3	No	15	11	0.033	0.001	0.011	0.010	0.010
Zn	5	3	No	15	15	27	0.17	5.9	2.3	8.3
Cr	5	3	No	15	12	0.13	0.010	0.055	0.045	0.042
As	5	3	No	15	15	0.029	0.0024	0.012	0.010	0.0086
Hg	5	3	BDL	12	2	0.000036	0.000036	0.000036	0.000036	
PCBs	5	3	BDL	13	0					
F1	5	3	BDL	0	0					
F2	5	3	BDL	0	0					
F3	5	3	BDL	0	0					
TPH	5	3	BDL	15	2	1.2	0.40	0.80	0.80	0.57

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A39. Summary of BAR-2 NHWL Upgradient Groundwater Monitoring Data, up to 2011

Parameter	Number of monitoring events	Number of upgradient wells	Any increasing trends?	Number of samples	Number of detects	High value	Low value	Mean	Median	Standard deviation
Cu	5	1	No	4	4	0.070	0.0021	0.025	0.015	0.031
Ni	5	1	No	4	4	0.10	0.0077	0.048	0.042	0.039
Co	5	1	No	4	4	0.011	0.0069	0.0092	0.010	0.0017
Cd	5	1	BDL	4	2	0.0012	0.000059	0.00063	0.00063	0.00081
Pb	5	1	BDL	4	0					
Zn	5	1	No	4	4	5.2	0.63	2.7	2.5	2.2
Cr	5	1	No	4	2	0.10	0.042	0.071	0.071	0.041
As	5	1	No	4	4	0.0040	0.0013	0.0028	0.0030	0.0011
Hg	5	1	BDL	3	1	0.000026	0.000026	0.000026	0.000026	
PCBs	5	1	BDL	4	1	0.000030	0.000030	0.000030	0.000030	
F1	5	1	BDL	0	0					
F2	5	1	BDL	0	0					
F3	5	1	BDL	0	0					
TPH	5	1	BDL	4	0					

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A40. Summary of BAR-2 NHWL Downgradient Soil Monitoring Data, up to 2011

Parameter	Number of monitoring events	Number of downgradient locations	Number of samples	Number of detects	Slope trend	High value	Low value	Mean	Median	Standard deviation
Cu	5	3	30	30	NT	101	6	21	17	17
Ni	5	3	30	30	NT	32	0.20	18	20	8.4
Co	5	3	30	30	NT	29	5.0	11	9.0	6.2
Cd	5	3	30	9	BDL	6.0	0.60	3.3	5.0	2.5
Pb	5	3	30	28	NT	18	5.0	12	12.0	2.7
Zn	5	3	30	30	NT	100	10	66	70	25
Cr	5	3	30	28	NT	27	0.09	20	24	9.2
As	5	3	30	30	NT	22	1.4	11	9.9	4.8
Hg	5	3	30	20	NT	66	0.06	14	0.10	27
PCBs	5	3	30	4	BDL	0.015	0.0071	0.0091	0.0071	0.0040
F1	5	3	24	0	BDL					
F2	5	3	24	11	BDL	77	5.0	35	26	26
F3	5	3	24	24	Decreasing	1,800	30	551	400	505
TPH	5	3	30	24	NT	1,870	30	618	424	582

NT = No trend detected

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A41. Summary of BAR-2 NHWL Upgradient Soil Monitoring Data, up to 2011

Parameter	Number of monitoring events	Number of upgradient locations	Number of samples	Number of detects	Slope trend	High value	Low value	Mean	Median	Standard deviation
Cu	5	1	9	9	NT	30	16	21	18	5.7
Ni	5	1	9	9	Decreasing	31	16	22	18	5.3
Co	5	1	9	9	NT	15	6.6	9.1	8.0	2.6
Cd	5	1	9	3	BDL	1.5	0.5	0.9	0.6	0.6
Pb	5	1	9	9	Increasing	14	6	11	12	2.4
Zn	5	1	9	9	Decreasing	90	60	76	76	9.5
Cr	5	1	9	8	NT	30	10	22	25	7.0
As	5	1	9	9	NT	26	4.0	15	16	7.1
Hg	5	1	9	6	NT	0.20	0.060	0.13	0.12	0.052
PCBs	5	1	9	0	BDL					
F1	5	1	7	0	BDL					
F2	5	1	7	4	BDL	51	7.0	37	45	20
F3	5	1	7	7	NT	2,600	140	879	740	855
TPH	5	1	9	7	Increasing	2,600	140	900	740	848

NT = No trend detected

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A42. Summary of PIN-M NHWL Downgradient Groundwater Monitoring Data, up to 2008

Parameter	Number of monitoring events	Number of downgradient wells	Any increasing trends?	Number of samples	Number of detects	High value	Low value	Mean	Median	Standard deviation
Cu	3	3	N/A	2	2	0.017	0.0070	0.012	0.012	
Ni	3	3	N/A	2	2	0.063	0.015	0.039	0.039	
Co	3	3	N/A	2	0					
Cd	3	3	N/A	2	0					
Pb	3	3	N/A	2	0					
Zn	3	3	N/A	2	2	0.030	0.0040	0.017	0.017	
Cr	3	3	N/A	2	2	0.021	0.010	0.016	0.016	
As	3	3	N/A	2	1	0.00070	0.00070	0.00070	0.00070	
Hg	3	3	N/A	2	0					
PCBs	3	3	N/A	1	0					
F1	3	3	N/A	0						
F2	3	3	N/A	0						
F3	3	3	N/A	0						
TPH	3	3	N/A	1	0					

Fewer than four sampling events are included so no trend analysis was possible

Table A43. Summary of PIN-M NHWL Upgradient Groundwater Monitoring Data, up to 2008

Parameter	Number of monitoring events	Number of downgradient wells	Any increasing trends?	Number of samples	Number of detects	High value	Low value	Mean	Median	Standard deviation
Cu	3	2	N/A	5	5	0.051	0.005	0.024	0.023	0.019
Ni	3	2	N/A	5	5	0.51	0.016	0.15	0.10	0.21
Co	3	2	N/A	5	4	0.005	0.002	0.004	0.0045	0.0014
Cd	3	2	N/A	5	0					
Pb	3	2	N/A	5	0					
Zn	3	2	N/A	5	5	0.11	0.012	0.053	0.045	0.042
Cr	3	2	N/A	5	5	0.25	0.007	0.094	0.085	0.099
As	3	2	N/A	5	4	0.0016	0.0004	0.0011	0.0011	0.0005
Hg	3	2	N/A	5	0					
PCBs	3	2	N/A	5	0					
F1	3	2	N/A	0						
F2	3	2	N/A	0						
F3	3	2	N/A	0						
TPH	3	2	N/A	5	2	4.6	0.84	2.7	2.7	2.7

Fewer than four sampling events are included so no trend analysis was possible

Table A44. Summary of PIN-M NHWL Downgradient Soil Monitoring Data, up to 2008

Parameter	Number of monitoring events	Number of downgradient locations	Number of samples	Number of detects	Slope trend	High value	Low value	Mean	Median	Standard deviation
Cu	5	3	26	26	NT	18	7.0	11	10	3.1
Ni	5	3	26	26	NT	12	5.9	9.1	10	2.0
Co	5	3	26	23	NT	6.0	1.8	3.6	4.0	1.1
Cd	5	3	26	4	BDL	0.11	0.060	0.088	0.090	0.022
Pb	5	3	26	19	NT	7.0	3.6	5.4	6.0	1.0
Zn	5	3	26	26	NT	50	17	30	30	7.4
Cr	5	3	26	22	NT	19.6	6.4	9.3	8.6	2.9
As	5	3	26	26	NT	4.0	1.9	2.7	2.7	0.44
Hg	5	3	26	0	BDL					
PCBs	5	3	26	3	BDL	0.11	0.0051	0.047	0.027	0.055
F1	5	3	22	0	BDL					
F2	5	3	22	0	BDL					
F3	5	3	22	8	BDL	27	7.0	15	15	7.1
TPH	5	3	26	8	BDL	27	7.0	15	15	7.1

NT = No trend detected

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A45. Summary of PIN-M NHWL Upgradient Soil Monitoring Data, up to 2008

Parameter	Number of monitoring events	Number of upgradient locations	Number of samples	Number of detects	Slope trend	High value	Low value	Mean	Median	Standard deviation
Cu	5	2	16	16	NT	21	5.9	10	9.0	4.1
Ni	5	2	16	15	NT	11	3.0	7.4	8.0	2.6
Co	5	2	16	14	NT	4.0	1.4	2.6	2.1	0.89
Cd	5	2	16	2	BDL	0.12	0.11	0.12	0.12	0.007
Pb	5	2	16	13	NT	122	5.2	17	7.0	32
Zn	5	2	16	16	NT	78	18	39	33	17
Cr	5	2	16	15	Decreasing	21	4.1	8.0	7.0	4.5
As	5	2	16	16	NT	2.9	1.3	2.1	2.3	0.57
Hg	5	2	16	0	BDL					
PCBs	5	2	16	11	Increasing	0.79	0.0080	0.22	0.15	0.28
F1	5	2	14	1	BDL	13	13	13	13	
F2	5	2	14	4	BDL	29	12	20	20	
F3	5	2	14	7	BDL	58	11	34	28	18
TPH	5	2	16	7	BDL	87	11	48	48	26

NT = No trend detected

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A46. Summary of PIN-3 NHWL Downgradient Groundwater Monitoring Data, up to 2011

Parameter	Number of monitoring events	Number of wells	Any increasing trends?	Number of samples	Number of detects	High value	Low value	Mean	Median	Standard deviation
Cu	6	4	None	20	13	0.022	0.0047	0.012	0.010	0.0055
Ni	6	4	None	20	20	0.11	0.005	0.022	0.0163	0.023
Co	6	4	BDL	20	8	0.010	0.0010	0.0038	0.0026	0.0034
Cd	6	4	BDL	20	6	0.00030	0.00004	0.00013	0.00008	0.00011
Pb	6	4	BDL	20	5	0.015	0.0052	0.010	0.010	0.0036
Zn	6	4	None	20	16	0.25	0.0050	0.049	0.028	0.062
Cr	6	4	None	20	16	0.33	0.0040	0.051	0.027	0.078
As	6	4	BDL	20	9	0.015	0.0013	0.0047	0.0039	0.0041
Hg	6	4	BDL	20	4	0.014	0.011	0.012	0.012	0.001
PCBs	6	4	BDL	20	0					
F1	6	4	BDL	12	0					
F2	6	4	BDL	12	0					
F3	6	4	BDL	12	0					
TPH	6	4	BDL	20	0					

BDL = Insufficient samples were above reported detection limits to determine a trend

**** Note: no clear upgradient so all data investigated together**

Table A47. Summary of PIN-3 NHWL Downgradient Soil Monitoring Data, up to 2011

Parameter	Number of monitoring events	Number of locations	Number of samples	Number of detects	Slope trend	High value	Low value	Mean	Median	Standard deviation
Cu	6	4	40	29	NT	22	3.0	8.2	7.2	3.8
Ni	6	4	40	17	BDL	41	1.0	12	4.0	14
Co	6	4	40	13	BDL	3.4	1.0	2.1	2.0	0.87
Cd	6	4	40	6	BDL	0.20	0.10	0.12	0.10	0.04
Pb	6	4	40	6	BDL	2.0	1.0	1.5	1.5	0.5
Zn	6	4	40	19	BDL	54	5.5	15	12	11
Cr	6	4	40	24	NT	83	1.0	16	4.0	25
As	6	4	40	21	NT	7.7	0.49	1.8	1.1	1.6
Hg	6	4	40	14	BDL	0.056	0.0040	0.012	0.010	0.013
PCBs	6	4	38	2	BDL	0.014	0.011	0.013	0.013	0.0021
F1	6	4	32	0	BDL					
F2	6	4	32	9	BDL	12	4.0	7.6	6.9	3.2
F3	6	4	30	24	NT	3,400	12	197	37	685
TPH	6	4	40	33	NT	3,400	5.0	189	48	590

NT = No trend detected

BDL = Insufficient samples were above reported detection limits to determine a trend

**** No clear upgradient well location at this landfill**

Table A48. Summary of CAM-4 NHWL Downgradient Groundwater Monitoring Data, up to 2011

Parameter	Number of monitoring events	Number of downgradient wells	Any increasing trends?	Number of samples	Number of detects	High value	Low value	Mean	Median	Standard deviation
Cu	3	4	N/A	10	10	0.099	0.0040	0.035	0.022	0.036
Ni	3	4	N/A	10	10	1.8	0.028	0.64	0.43	0.65
Co	3	4	N/A	10	10	0.040	0.0016	0.012	0.0088	0.012
Cd	3	4	N/A	10	4	0.0080	0.00007	0.0021	0.00013	0.0039
Pb	3	4	N/A	10	6	0.11	0.00030	0.023	0.0036	0.043
Zn	3	4	N/A	10	10	5.4	0.0030	1.1	0.22	2.0
Cr	3	4	N/A	10	9	1.7	0.0061	0.38	0.14	0.57
As	3	4	N/A	10	7	0.021	0.00070	0.0054	0.0013	0.0073
Hg	3	4	N/A	10	0					
PCBs	3	4	N/A	10	0					
F1	3	4	N/A	3	0					
F2	3	4	N/A	3	0					
F3	3	4	N/A	3	1	0.064	0.064	0.064	0.064	
TPH	3	4	N/A	5	1	0.064	0.064	0.064	0.064	

Four monitoring events are required to determine trends

Table A49. Summary of CAM-4 NHWL Upgradient Groundwater Monitoring Data, up to 2011

Parameter	Number of monitoring events	Number of upgradient wells	Any increasing trends?	Number of samples	Number of detects	High value	Low value	Mean	Median	Standard deviation
Cu	3	2	N/A	4	4	0.0540	0.0042	0.024	0.020	0.021
Ni	3	2	N/A	4	4	0.11	0.020	0.052	0.038	0.041
Co	3	2	N/A	4	4	0.010	0.004	0.006	0.006	0.003
Cd	3	2	N/A	4	1	1.3	1.3	1.3	1.3	
Pb	3	2	N/A	4	2	0.0080	0.0008	0.0044	0.0044	0.0051
Zn	3	2	N/A	4	4	0.140	0.035	0.092	0.097	0.0
Cr	3	2	N/A	4	4	0.130	0.005	0.049	0.030	0.056
As	3	2	N/A	4	1	0.00060	0.00060	0.00060	0.00060	
Hg	3	2	N/A	4	2	0.016	0.009	0.013	0.013	0.00495
PCBs	3	2	N/A	4	0					
F1	3	2	N/A	3	3	20	3.5	9.4	4.8	9.2
F2	3	2	N/A	3	3	340	53	150	57	165
F3	3	2	N/A	3	3	32	4.7	14	4.8	16
TPH	3	2	N/A	3	3	392	63	173	65	189

Four monitoring events are required to determine trends

Table A50. Summary of CAM-4 NHWL Downgradient Soil Monitoring Data, up to 2011

Parameter	Number of monitoring events	Number of downgradient locations	Number of samples	Number of detects	Slope trend	High value	Low value	Mean	Median	Standard deviation
Cu	3	6	38	32	insufficient data	11	3.1	7.0	7.0	2.0
Ni	3	6	38	38	insufficient data	20	6.2	11	12	3.3
Co	3	6	38	33	insufficient data	8.3	3.0	5.1	5.0	1.3
Cd	3	6	38	8	insufficient data	0.30	0.10	0.20	0.20	0.05
Pb	3	6	38	26	insufficient data	8.0	3.0	4.6	4.0	1.3
Zn	3	6	38	38	insufficient data	40	14	26	25	7.3
Cr	3	6	38	31	insufficient data	41	13	25	24	6.6
As	3	6	38	24	insufficient data	2.0	1.0	1.4	1.4	0.4
Hg	3	6	38	1	insufficient data	0.05	0.050	0.050	0.050	
PCBs	3	6	38	1	insufficient data	0.0056	0.0056	0.0056	0.0056	
F1	3	6	38	0	insufficient data					
F2	3	6	38	13	insufficient data	6.4	4.0	5.0	4.7	0.8
F3	3	6	38	20	insufficient data	99	15	32	26	22
TPH	3	6	38	24	insufficient data	103	4.0	28	24	23

Table A51. Summary of CAM-4 NHWL Upgradient Soil Monitoring Data, up to 2011

Parameter	Number of monitoring events	Number of upgradient locations	Number of samples	Number of detects	Slope trend	High value	Low value	Mean	Median	Standard deviation
Cu	3	2	10	10	insufficient data	20	6.0	11	10	4.1
Ni	3	2	10	10	insufficient data	26	9.7	16	16	5.5
Co	3	2	10	10	insufficient data	15	5.0	7.8	7.0	3.2
Cd	3	2	10	0	insufficient data					
Pb	3	2	10	7	insufficient data	11	4.0	6.6	5.0	2.5
Zn	3	2	10	10	insufficient data	82	29	41	37	16
Cr	3	2	10	9	insufficient data	50	18	34	31	11
As	3	2	10	10	insufficient data	3.4	1.0	2.1	2.0	0.82
Hg	3	2	10	0	insufficient data					
PCBs	3	2	10	1	insufficient data	0.0053	0.0053	0.0053	0.0053	
F1	3	2	10	0	insufficient data					
F2	3	2	10	4	insufficient data	1,100	4.3	299	45	535
F3	3	2	10	6	insufficient data	620	11	143	55	236
TPH	3	2	10	6	insufficient data	1,720	11	342	77	677

Table A52. Summary of PIN-M Westpoint Landfill Downgradient Soil Monitoring Data, up to 2008

Parameter	Number of monitoring events	Number of downgradient locations	Number of samples	Number of detects	Slope trend	High value	Low value	Mean	Median	Standard deviation
Cu	5	3	29	29	NT	28	5.9	10	9.0	5.1
Ni	5	3	29	25	NT	23	4.6	8.7	7.0	4.6
Co	5	3	29	23	NT	7.0	1.8	3.4	3.0	1.4
Cd	5	3	29	5	BDL	0.91	0.10	0.35	0.12	0.36
Pb	5	3	29	17	NT	78	4.0	12	6.0	18
Zn	5	3	29	29	NT	110	19	35	30	21
Cr	5	3	29	23	NT	44	4.3	10	6.2	9.5
As	5	3	29	29	NT	4.7	0.85	2.4	2.3	0.9
Hg	5	3	29	4	BDL	0.060	0.010	0.025	0.015	0.024
PCBs	5	3	29	0	BDL					
F1	5	3	23	0	BDL					
F2	5	3	23	3	BDL	14	7.0	10	8.0	3.8
F3	5	3	23	15	NT	290	6.0	62	30	82
TPH	5	3	29	14	BDL	290	6.0	67	31	84

NT = No trend detected

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A53. Summary of PIN-M Westpoint Landfill Upgradient Soil Monitoring Data, up to 2008

Parameter	Number of monitoring events	Number of upgradient locations	Number of samples	Number of detects	Slope trend	High value	Low value	Mean	Median	Standard deviation
Cu	5	1	10	10	NT	10	5.0	7.8	8.0	1.5
Ni	5	1	10	8	Increasing	11	4.1	6.7	5.7	2.5
Co	5	1	10	8	NT	3.0	1.9	2.5	2.6	0.54
Cd	5	1	10	2	BDL	0.12	0.12	0.12	0.12	
Pb	5	1	10	6	NT	30	5.0	11	5.7	10
Zn	5	1	10	10	NT	30	20	24	24	4.2
Cr	5	1	10	8	Decreasing	8.5	4.2	5.4	4.8	1.5
As	5	1	10	10	NT	2.5	0.90	1.8	1.9	0.4
Hg	5	1	10	2	BDL	0.020	0.010	0.015	0.015	0.007
PCBs	5	1	10	0	BDL					
F1	5	1	8	0	BDL					
F2	5	1	8	0	BDL					
F3	5	1	8	3	BDL	18	15	17	17	1.5
TPH	5	1	10	3	BDL	18	15	17	17	1.5

NT = No trend detected

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A54. Summary of FOX-4 Helipad East Downgradient Groundwater Monitoring Data, up to 2008

Parameter	Number of monitoring events	Number of downgradient wells	Any increasing trends?	Number of samples	Number of detects	High value	Low value	Mean	Median	Standard deviation
Cu	8	1	None	5	5	0.04	0.000005	0.016	0.012	0.015
Ni	8	1	None	5	5	0.43	0.000013	0.12	0.05	0.18
Co	8	1	None	5	5	0.021	0.000004	0.0082	0.0070	0.0081
Cd	8	1	BDL	5	2	0.001	0.0007	0.0009	0.0009	0.0002
Pb	8	1	None	5	4	0.030	0.000002	0.010	0.005	0.014
Zn	8	1	None	5	5	4.5	0.0002	1.5	1.2	1.8
Cr	8	1	None	5	5	0.43	0.000005	0.11	0.010	0.18
As	8	1	None	5	4	0.0090	0.000001	0.0035	0.0025	0.0039
Hg	8	1	BDL	5	0					
PCBs	8	1	BDL	4	0					
F1	8	1	BDL							
F2	8	1	BDL							
F3	8	1	BDL							
TPH	8	1	BDL	3	1	0.68	0.68	0.68	0.68	

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A55. Summary of FOX-4 Helipad East Downgradient Groundwater Monitoring Data, up to 2008

Parameter	Number of monitoring events	Number of downgradient wells	Any increasing trends?	Number of samples	Number of detects	High value	Low value	Mean	Median	Standard deviation
Cu	8	2	BDL	4	3	0.015	0.0120	0.013	0.013	0.0015
Ni	8	2	None	4	4	0.33	0.022	0.11	0.035	0.15
Co	8	2	BDL	4	1	0.0020	0.0020	0.0020	0.0020	
Cd	8	2	BDL	4	3	0.0040	0.00030	0.0016	0.00050	0.0021
Pb	8	2	BDL	4	3	0.020	0.0030	0.0093	0.0050	0.0093
Zn	8	2	None	4	4	0.99	0.047	0.45	0.38	0.44
Cr	8	2	None	4	4	0.10	0.0070	0.046	0.041	0.038
As	8	2	BDL	4	2	0.0090	0.0010	0.0050	0.0050	0.0057
Hg	8	2	BDL	4	0					
PCBs	8	2	BDL	4	0					
F1	8	2	BDL	1	0					
F2	8	2	BDL	1	0					
F3	8	2	BDL	1	0					
TPH	8	2	BDL	3	0					

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A56. Summary of FOX-4 Helipad East Landfill Downgradient Soil Monitoring Data, up to 2008

Parameter	Number of monitoring events	Number of downgradient locations	Number of samples	Number of detects	Slope trend	High value	Low value	Mean	Median	Standard deviation
Cu	8	1	24	23	NT	56	4.5	20	16	11
Ni	8	1	24	23	NT	37	7.0	16	15	6.6
Co	8	1	24	22	NT	10	3.0	5.5	5.0	1.9
Cd	8	1	24	0	BDL					
Pb	8	1	24	11	BDL	18	3.0	10	10	5.1
Zn	8	1	24	22	NT	76	17	35	32	13
Cr	8	1	24	24	NT	57	15	33	29	12
As	8	1	24	24	NT	120	6.0	27	17	28
Hg	8	1	24	0	BDL					
PCBs	8	1	24	9	BDL	0.20	0.0040	0.072	0.070	0.065
F1	8	1	18	4	BDL	310	82	147	100	110
F2	8	1	18	11	NT	12,000	20	2,195	140	3,800
F3	8	1	18	13	NT	2,000	30	370	160	520
TPH	8	1	24	14	NT	14,000	50	2,100	259	4,000

NT = No trend detected

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A57. Summary of FOX-4 Helipad East Landfill Upgradient Soil Monitoring Data, up to 2008

Parameter	Number of monitoring events	Number of upgradient locations	Number of samples	Number of detects	Slope trend	High value	Low value	Mean	Median	Standard deviation
Cu	8	2	28	28	NT	26	4.1	14	12.5	5.6
Ni	8	2	28	28	NT	19	6.0	11	10	3.1
Co	8	2	28	22	NT	6.0	2.0	3.5	3.1	1.1
Cd	8	2	28	0	BDL					
Pb	8	2	28	15	BDL	15	2.0	6.0	4.0	4.1
Zn	8	2	28	25	NT	51	12	26	23	11
Cr	8	2	28	28	NT	48	11	23	21	8.4
As	8	2	28	27	NT	95	4.0	18	12	19
Hg	8	2	28	2	BDL	0.14	0.050	0.095	0.095	0.064
PCBs	8	2	28	11	BDL	1.0	0.0047	0.32	0.049	0.41
F1	8	2	16	0	BDL					
F2	8	2	16	5	BDL	220	20	100	100	84
F3	8	2	16	8	NT	210	18	102	82	77
TPH	8	2	28	8	NT	430	18	159	81	157

NT = No trend detected

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A58. Summary of FOX-4 Helipad West Downgradient Groundwater Monitoring Data, up to 2008

Parameter	Number of monitoring events	Number of downgradient wells	Any increasing trends?	Number of samples	Number of detects	High value	Low value	Mean	Median	Standard deviation
Cu	8	3	None	17	14	0.10	0.000002	0.022	0.015	0.025
Ni	8	3	None	15	15	1.4	0.000009	0.193336	0.074	0.35
Co	8	3	None	15	14	0.042	0.000010	0.015	0.012	0.012
Cd	8	3	None	17	9	0.0040	0.00030	0.0017	0.0010	0.0014
Pb	8	3	None	17	11	0.13	0.000001	0.043	0.010	0.048
Zn	8	3	None	17	16	7.8	0.000021	1.2	0.34	2.2
Cr	8	3	None	17	15	0.47	0.000005	0.053	0.014	0.12
As	8	3	None	17	12	0.030	0.000002	0.013	0.015	0.010
Hg	8	3	BDL	17	0					
PCBs	8	3	BDL	17	0					
F1	8	3	BDL	6	3	0.29	0.13	0.19	0.16	0.085
F2	8	3	None	6	4	2.0	0.00060	0.57	0.15	1.0
F3	8	3	BDL	6	2	0.35	0.14	0.25	0.25	0.15
TPH	8	3	BDL	17	8	2.6	0.00087	0.81	0.69	0.80

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A59. Summary of FOX-4 Helipad West Upgradient Groundwater Monitoring Data, up to 2008

Parameter	Number of monitoring events	Number of upgradient wells	Any increasing trends?	Number of samples	Number of detects	High value	Low value	Mean	Median	Standard deviation
Cu	8	1	None	4	3	0.015	0.012	0.013	0.013	0.0015
Ni	8	1	None	4	4	0.33	0.022	0.11	0.035	0.15
Co	8	1	BDL	4	1	0.0020	0.0020	0.0020	0.0020	
Cd	8	1	BDL	4	3	0.004	0.0003	0.0016	0.0005	0.0021
Pb	8	1	BDL	4	3	0.020	0.0030	0.0093	0.0050	0.0093
Zn	8	1	None	4	4	0.99	0.047	0.45	0.38	0.44
Cr	8	1	None	4	4	0.10	0.0070	0.046	0.041	0.038
As	8	1	BDL	4	2	0.0090	0.0010	0.0050	0.0050	0.0057
Hg	8	1	BDL	4	0					
PCBs	8	1	BDL	4	0					
F1	8	1	BDL	1	0					
F2	8	1	BDL	1	0					
F3	8	1	BDL	1	0					
TPH	8	1	BDL	3	0					

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A60. Summary of FOX-4 Helipad West Landfill Downgradient Soil Monitoring Data, up to 2008

Parameter	Number of monitoring events	Number of downgradient locations	Number of samples	Number of detects	Slope trend	High value	Low value	Mean	Median	Standard deviation
Cu	8	7	45	45	NT	37	5.0	17	14	6.7
Ni	8	7	45	45	NT	35	6.0	15	13	5.7
Co	8	7	45	42	NT	10	2.0	5.3	5.0	1.9
Cd	8	7	45	0	BDL					
Pb	8	7	45	19	BDL	43	3.0	8.3	4.0	10
Zn	8	7	45	41	Decreasing	69	10	35	32	11
Cr	8	7	45	45	NT	57	5.0	33	31	11
As	8	7	45	45	NT	92	2.4	29	16	23
Hg	8	7	45	0	BDL					
PCBs	8	7	45	2	BDL	0.0081	0.0040	0.0061	0.0061	0.0029
F1	8	7	54	14	BDL	133	12	59	51	36
F2	8	7	54	41	Increasing	7,320	10	1,430	416	2,142
F3	8	7	54	46	Increasing	2,220	10	246	93	358
TPH	8	7	72	52	Increasing	7,700	7	1,357	414	2,137

NT = No trend detected

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A61. Summary of FOX-4 Helipad West Landfill Upgradient Soil Monitoring Data, up to 2008

Parameter	Number of monitoring events	Number of upgradient locations	Number of samples	Number of detects	Slope trend	High value	Low value	Mean	Median	Standard deviation
Cu	8	3	28	28	NT	26	4.1	14	13	5.6
Ni	8	3	28	28	NT	19	6.0	11	10	3.1
Co	8	3	28	22	NT	6.0	2.0	3.5	3.1	1.1
Cd	8	3	28	0	BDL					
Pb	8	3	28	15	BDL	15	2.0	6.0	4.0	4.1
Zn	8	3	28	25	NT	51	12	26	23	11
Cr	8	3	28	28	NT	48	11	23	21	8.4
As	8	3	28	27	NT	95	4.0	18	12	19
Hg	8	3	28	2	BDL	0.14	0.050	0.095	0.095	0.064
PCBs	8	3	28	11	BDL	1.0	0.0047	0.32	0.049	0.41
F1	8	3	16	0	BDL					
F2	8	3	16	5	NT	220	20	100	100	84
F3	8	3	16	8	NT	210	18	102	82	77
TPH	8	3	28	8	BDL	430	18	159	81	157

NT = No trend detected

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A62. Summary of BAR-4 Northwest Landfill Downgradient Soil Monitoring Data, up to 2009

Parameter	Number of monitoring events	Number of downgradient locations	Number of samples	Number of detects	Slope trend	High value	Low value	Mean	Median	Standard deviation
Cu	5	2	20	20	NT	42	7.0	16	15	8.5
Ni	5	2	20	20	Increasing	48	9.5	23	24	10
Co	5	2	20	18	Increasing	18	5.5	10	11	3.1
Cd	5	2	20	18	NT	3.0	0.6	1.3	1.2	0.59
Pb	5	2	20	16	NT	13	6.0	8.6	9.0	1.8
Zn	5	2	20	20	Increasing	120	18	64	63	23
Cr	5	2	20	19	NT	27	5.2	13	13	6.3
As	5	2	20	20	NT	19	4.2	13	13	3.1
Hg	5	2	16	2	BDL	0.050	0.050	0.050	0.050	
PCBs	5	2	20	0	BDL					
F1	5	2	16	0	BDL					
F2	5	2	16	1	BDL	13	13	13	13	
F3	5	2	16	11	NT	84	18	39	33	23
TPH	5	2	20	16	NT	360	18	62	34	95

NT = No trend detected

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A63. Summary of BAR-4 Northwest Landfill Upgradient Soil Monitoring Data, up to 2009

Parameter	Number of monitoring events	Number of upgradient wells	Number of samples	Number of detects	Slope trend	High value	Low value	Mean	Median	Standard deviation
Cu	5	1	10	10	NT	27	8.8	14	12.5	6.1
Ni	5	1	10	10	NT	32	15	24	24	5.1
Co	5	1	10	10	NT	13	8.0	11	11	1.6
Cd	5	1	10	7	NT	3.4	0.50	1.3	1.1	1.0
Pb	5	1	10	8	NT	13	7.0	8.4	7.5	2.1
Zn	5	1	10	10	NT	150	40	74	61	34
Cr	5	1	10	8	NT	14	8.6	10	10	1.6
As	5	1	10	10	NT	16	11	13	14	1.7
Hg	5	1	10	1	BDL	0.060	0.060	0.060	0.060	
PCBs	5	1	10	1	BDL	0.14	0.14	0.14	0.14	
F1	5	1	8	0	BDL					
F2	5	1	8	0	BDL					
F3	5	1	8	4	NT	140	29	63	42	52
TPH	5	1	10	5	NT	640	19	170	42	260

Table A64. Summary of PIN-1 Station Area Landfill Downgradient Soil Monitoring Data, up to 2009

Parameter	Number of monitoring events	Number of downgradient locations	Number of samples	Number of detects	Slope trend	High value	Low value	Mean	Median	Standard deviation
Cu	5	4	40	40	NT	77	16	32	29	13
Ni	5	4	40	40	NT	40	8.9	18	17	7.2
Co	5	4	40	37	NT	18	4.0	8.4	8.0	3.2
Cd	5	4	40	1	BDL	0.10	0.10	0.10	0.10	
Pb	5	4	40	15	BDL	6.0	3.0	4.3	5.0	1.1
Zn	5	4	40	38	NT	40	16	27	30	6
Cr	5	4	40	32	NT	23	7.1	13	12	3.4
As	5	4	40	34	NT	2.5	1.0	1.8	1.9	0.3
Hg	5	4	40	3	BDL	0.070	0.050	0.063	0.070	0.012
PCBs	5	4	40	2	BDL	0.013	0.0062	0.01	0.0096	0.00
F1	5	4	40	0	BDL					
F2	5	4	40	2	BDL	7.0	5.0	6.0	6.0	1.4
F3	5	4	40	20	NT	86	7.0	34	29	25
TPH	5	4	40	20	BDL	86	7.0	35	31	25

NT = No trend detected

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A65. Summary of PIN-1 Station Area Landfill Upgradient Soil Monitoring Data, up to 2009

Parameter	Number of monitoring events	Number of upgradient locations	Number of samples	Number of detects	Slope trend	High value	Low value	Mean	Median	Standard deviation
Cu	5	1	10	8	Decreasing	65	22.0	32	26.5	14.3
Ni	5	1	10	8	Decreasing	33	14	20	19	6.1
Co	5	1	10	10	Decreasing	38	7.0	14.4	8.5	11.6
Cd	5	1	10	0	BDL					
Pb	5	1	10	7	NT	7.0	5.0	5.7	6.0	0.8
Zn	5	1	10	10	Decreasing	64	24	40	40	14
Cr	5	1	10	8	Increasing	19	14.7	16	16	1.4
As	5	1	10	8	Increasing	6.2	2.0	2.7	2.2	1.4
Hg	5	1	10	1	BDL	0.070	0.070	0.070	0.070	
PCBs	5	1	10	0	BDL					
F1	5	1	10	0	BDL					
F2	5	1	10	0	BDL					
F3	5	1	10	4	BDL	24	10	18	18	7.5
TPH	5	1	10	4	BDL	24	10.0	17.5	18	7.5

NT = No trend detected

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A66. Summary of CAM-3 NorthEast Landfill Downgradient Soil Monitoring Data, up to 2011

Parameter	Number of monitoring events	Number of downgradient locations	Number of samples	Number of detects	Slope trend	High value	Low value	Mean	Median	Standard deviation
Cu	2	8	32	18	NT	8.0	4.0	5.8	5.7	1.1
Ni	2	8	32	24	NT	14	2.0	7.3	6.6	3.6
Co	2	8	32	16	BDL	5.0	2.0	3.1	3.0	1.1
Cd	2	8	32	0	BDL					
Pb	2	8	32	16	BDL	12	2.0	4.8	4.0	3.1
Zn	2	8	32	8	BDL	33	13	20	21	7.2
Cr	2	8	32	16	BDL	33	5.0	16	18	9.7
As	2	8	32	32	NT	7.0	0.77	2.8	2.3	1.4
Hg	2	8	32	0	BDL					
PCBs	2	8	32	0	BDL					
F1	2	8	32	0	BDL					
F2	2	8	32	6	BDL	39	4.5	13	8.0	13
F3	2	8	32	12	BDL	640	16	125	50	180
TPH	2	8	32	12	BDL	679	16	132	52	191

NT = No trend detected

BDL = Insufficient samples were above reported detection limits to determine a trend

Table A67. Summary of CAM-3 NorthEast Landfill Upgradient Soil Monitoring Data, up to 2011

Parameter	Number of monitoring events	Number of upgradient locations	Number of samples	Number of detects	Slope trend	High value	Low value	Mean	Median	Standard deviation
Cu	2	2	8	0	BDL					
Ni	2	2	8	4	BDL	4.0	2.0	2.5	2.0	1.0
Co	2	2	8	4	BDL	1.0	1.0	1.0	1.0	0.0
Cd	2	2	8	0	BDL					
Pb	2	2	8	4	BDL	2.0	2.0	2.0	2.0	0.0
Zn	2	2	8	0	BDL					
Cr	2	2	8	4	BDL	5.0	4.0	4.5	4.5	0.6
As	2	2	8	6	BDL	1.5	0.8	1.1	1.0	0.2
Hg	2	2	8	0	BDL					
PCBs	2	2	8	0	BDL					
F1	2	2	8	0	BDL					
F2	2	2	8	2	BDL	7.8	5.5	6.7	6.7	1.6
F3	2	2	8	2	BDL	140	58	99	99	58
TPH	2	2	8	2	BDL	146	66	106	106	56

NT = No trend detected

BDL = Insufficient samples were above reported detection limits to determine a trend

Summary of Recommendations

DILLON CONSULTING

1558 Willson Place
Winnipeg
Manitoba
Canada
R3T 0Y4
Telephone
204.453.2301
Fax
204.452.4412

Site: Report Review Request: DEW Line Cleanup Landfill Monitoring Program, Review of Phase I and Phase II Chemical Data, ESG, 2013.

Date: October 28, 2015

Report: **Landfill Monitoring Program Review of Phase I and Phase II Chemical Data, Third Party Review, Dillon Consulting, August 2015**

Recommendations:

The EWG has reviewed the Dillon Third Party Review report listed above and concurs with the interpretations and recommendations provided in the report as set out below:

- Dillon agrees with the recommendation by ESG to discontinue the analysis of mercury in soil samples, and the analysis of mercury and PCBs in groundwater samples during the remaining years of the Phase I and II program

Respectfully Submitted,

Doug Bell, M.Sc., P.Geo., FGC
On behalf of the Environmental Working Group