REPORT

Air Emissions from the Ashbridges Bay Treatment Plant

APRIL 2005

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EXECUTIVE SUMMARY

GENERAL OVERVIEW

Local residents of South Riverdale and the Beaches have been concerned about effects of local industries on the local environment and their health. While many large industrial facilities have either closed or relocated by the end of the 1990s, the residents of these communities remain concerned about what they expressed as the "cumulative effects" of previous and current exposures to pollutants from these industries. Today the Ashbridges Bay Treatment Plant (ABTP) is one of the few large-scale industrial plants remaining at the waterfront bordering these two communities.

In the early 1990s, major modification and improvement were planned for the ABTP. An environmental assessment process was initiated as required under the Ontario Environmental Assessment Act. A mediation process was initiated in 1998 between the City of Toronto and the community to address some outstanding concerns in the environmental assessment. The City agreed in June 2001 to community groups' request to fund a number of studies, including a Community Health Status Study and Air Emissions Study. The emission study was undertaken to give a more comprehensive picture of total air emissions from the ABTP and to assess its impact on the surrounding South Riverdale and Beaches community.

The ABTP has undergone significant process changes since 1995 including the discontinuation of incineration, the addition of a pelletizer, and the addition of biofilters. These past changes as well as proposed changes alter the emission profile of the facility. Toronto Public Health (TPH) commissioned an evaluation of the ABTP impact on air quality in South Riverdale and the Beaches (the two (2) study areas). The modelling analysis evaluated the past, present and future potential concentrations of various chemicals in the two study areas resulting from the ABTP against the Ontario Point of Impingement (POI) standard, Ambient Air Quality Criteria (AAQCs) and various health benchmarks provided by TPH.

To evaluate the past, present and future emissions from the ABTP, four (4) emission scenarios were developed based on available emission testing data, literature information and engineering knowledge of the plant following standard U.S. Environmental Protection Agency (EPA) and Ontario Ministry of the Environment (MOE) guidelines. The four air emission modelling scenarios developed were:

Scenario 1   air emissions from all stationary sources within the treatment plant including the incinerator when it was in full operation (pre 1996);

Scenario 2   air emissions from all stationary sources within the treatment plant including the incinerator when it was in partial operation (2000-2002);

Scenario 3   air emissions from all stationary sources within the treatment plant after incineration was discontinued (2003-2004)

Scenario 4   air emissions from all stationary sources within the treatment plant once incineration is discontinued and all planned odour control measures have been implemented (by 2010).

EMISSION INVENTORY

Emissions potentially emitted from ABTP to the atmosphere were estimated for 186 chemicals. Emissions were calculated using conventional and well documented emission estimation techniques including direct measurements, emission factors from the technical literature, engineering estimates (e.g. occupational hygiene data, ventilation rates) and mass balance (what comes in must go out). Direct measurements were obtained from site-specific reports spanning more than a decade (1989 – 2002). Where multiple measurements were made of the same source over the same time period, the highest measurement was used for the emission estimation. Emissions were also estimated for chemicals that were not detected by the analytical methods used (i.e., they were below the detection limit of the analytical method if present). For these chemicals, a concentration equal to the detection limits was used to calculate emissions, even if it is unlikely that these chemicals were actually present. Furthermore, even though many of these chemicals have a low vapour pressure and do not readily form a gas, they were assumed to have completely evaporated and released into the air. As a result, the emissions for these chemicals were over-stated. The resulting inventory for the four scenarios is very conservative (i.e., it overestimates rather than underestimates the actual emissions).

Table I   Chemicals of Concern, their AAQC and Health Benchmarks

Chemical	CAS Number	Units	AAQC 24 hr	Health Benchmark 24 hr
Arsenic	7440-38-2	(µg/m³)	0.3	0.00066[a]
Benzene	71-43-2	(µg/m³)	N/A	0.3[a]
Benzo[a]pyrene (B[a]P)[d]	50-32-8	(µg/m³)	0.0011[b]	0.000012[a, c]
Bis(2-ethylhexyl)phthalate	117-81-7	(µg/m³)	50	
Cadmium[d]	7440-43-9	(µg/m³)	2	0.0006[a]
Di-n-octyl phthalate	117-84-0	(µg/m³)	120	
Hexachlorobutadiene	87-68-3	(µg/m³)	N/A	1.19
Hydrogen Sulphide[d]	7783-06-4	(µg/m³)	N/A	2 -10
Lead	7439-92-1	(µg/m³)	2	
Mercury[d]	7439-97-6	(µg/m³)	2	0.3
Nitrogen Oxides	10102-44-0	(µg/m³)	200	
PM$_{2.5}$		(µg/m³)	30	
PCBs[e] with 4 or More Cl (total)[d]		(µg/m³)	0.15	0.00175[a]
Sulphur Dioxide	7446-09-5	(µg/m³)	275	
Total Dioxins and Furans (as 2,3,7,8 TCDD eq)		(TEQ µg/m³)	0.000005	
Total PAHs[f]		(µg/m³)	N/A	
Vinyl Chloride[d]	75-01-4	(µg/m³)	1	0.1[a]

[a] - The health benchmark corresponds to an one-in-one million (or 1 E-6) increased risk of cancer over a lifetime, which meets Health Canada and MOE benchmark of negligible risk.

[b] - Based on B[a]P only.

[c] - Based on B[a]P as a surrogate for the toxicity of the whole PAH mixture. The risk from exposure to total PAHs in the air would be negligible if B[a]P level is found to be below this health benchmark for B[a]P.

[d] - These chemical species have been identified by MOE for regulatory review of their AAQCs (24 hr) and POI (1/2 hr) standards.

[e] - Polychlorinated biphenyls

[f] – Polycyclic aromatic hydrocarbons

N/A – No 24-hour AAQC

Since it was not feasible to evaluate all 186 chemicals, a protocol to select the Chemicals of Concern (COC) for air dispersion modelling was developed. This protocol took into account the quantity of emissions, potential health impacts, persistence in the environment, accumulation in the biota, availability to humans and community's input (through consultation with community members of the Project Advisory Committee). This selection process resulted in a final list of 17 COCs (Table I) for dispersion modelling analysis. These chemicals were selected because they represent the chemicals with the greatest risk to human health overall based on toxicity and potential for human exposure. All 17 COCs were modelled in all the 4 scenarios even though in some scenarios not all 17 were emitted. Of the 17 COCs, 15 were actually detected while the remaining two (PAH/B[a]P) were below analytical detection limits.

To assess the potential impacts of the estimated emissions on health, results from the modelling were compared to Ambient Air Quality Criteria (AAQC). However, in the case where the Ministry of the Environment is currently updating criteria or where criteria did not exist, TPH provided health benchmarks below which no or negligible health risks would be expected to use in the comparison. These health benchmarks were selected from published values by reputable international and regulatory agencies that have gone through a thorough scientific peer review. The selection was conducted on a chemical-by-chemical basis to identify those values that are applicable to the study objectives and least uncertain based on current knowledge and understanding of the substances and risk assessment method.

MODELLING APPROACH

To determine the impact of the ABTP on the two communities' air quality, a sophisticated state-of-the-science computer modelling system (CALPUFF/CALMET) was selected to model the transportation and dispersion of the air emissions. CALMET provides the meteorological patterns (e.g. wind speeds and directions) that influence the dispersion and CALPUFF models the dispersion of emissions over the area surrounding the emission source. This modelling system was used for the analysis because of the model's ability to handle complex geophysical conditions such as a shoreline and urban environment.

A one-year (1996) hourly meteorological data set was created and was found to adequately represent the conditions around the ABTP. To ensure the effects of the lake were adequately modelled, the meteorological information from the area extending from Oakville to Ajax to just north of Stouffville (70 km by 64 km) was incorporated into the meteorological model (CALMET). The meteorology output from CALMET was used in CALPUFF to calculated the transport and dispersion of the chemicals emitted from the ABTP. The effects that various obstacles, such as physical barriers (e.g. building profile of ABTP) and geographical features have on the transport and dispersion of emissions were also taken into consideration. The dispersion of the ABTP emissions was modelled over an area that extended out 15 kilometres from the ABTP, reaching Finch Avenue in the north, Royal York Road to the west and Morningside Drive to the east. A nested-grid (i.e., a smaller grid within a larger grid) system was used for the ABTP modelling. This increases the resolution of the modelled results by focussing on a smaller area within the larger boundaries. The two study areas (Beaches and South Riverdale) were analyzed separately to allow individual impacts to be evaluated.

MODELLING RESULTS

The impact of the ABTP emissions on the surrounding area is influenced by the elevation of the emission sources as well as the local wind speeds and directions, which leads to a different impact on the two neighbourhoods. Due to the strong winds from the southwest, emissions released from elevated stacks are expected to impact the Beaches community, northeast and directly adjacent to the ABTP more than the South Riverdale community. On the other hand, due to lighter winds from the southeast, the lower elevation sources (e.g. open tanks) have a greater impact on the South Riverdale community (to the northwest of ABTP). However, in Scenarios 1 and 2, levels of COCs associated with incineration (e.g., arsenic, cadmium) were estimated to be slightly higher in South Riverdale than in the Beaches. Despite these differences, modelled concentrations in South Riverdale and Beaches are in the same range for all COCs and time-averaging periods. Under the future scenario (Scenario 4), concentration differences between the communities are insignificant.

For all COCs, except nitrogen dioxide (NO_2), CALPUFF predicted lower concentrations in the future scenario (scenario 4) than in scenarios 1, 2 and 3. The addition of new structures to ABTP create building wakes (areas on the leeside of the building sheltered from the wind) that influence the dispersion (i.e., rapid spreading of a plume) and reduce the height of a plume released from a point source such as boiler stacks. As a result of this, the boiler NO_2 emissions create moderately higher NO_2 concentrations in the Beaches community under Scenario 4.

After 2002, once the incinerator is no longer in operation (scenarios 3 and 4), the model shows no impacts related to arsenic, cadmium, lead, PCBs and dioxins emissions on the community. Since the emission estimates for scenario 3 and 4 were derived using the analytical data for chemicals in the wastewater and over-estimated, actual levels of COCs in these two scenarios are likely to be even lower than those predicted in this study. In addition, the levels of many wastewater chemicals are expected to decline due to the implementation of the City's revised Sewer Use By-law as of June 2001.

The maximum predicted concentrations in each community were compared to the Ontario AAQC, the POI standards, Health Benchmarks selected by TPH and the ambient measurements of COCs within the City of Toronto. Of the 17 COCs, all chemicals (15) which were detected met their appropriate AAQC/POI for all scenarios and their 24-hour Health Benchmark under Scenario 4 (Future) in both communities. Most of these chemicals also met their 24-hour Health Benchmark for scenarios 1, 2, and 3. Cadmium was estimated to be above its Health Benchmark when the incinerator was in operation. The estimated maximum levels of hydrogen sulphide were between the lower (2 $\mu g/m^3$) and higher (10 $\mu g/m^3$) Health Benchmarks for scenario 1, 2 or 3.

The only chemical that was estimated to be above the AAQC/POI was benzo[a]pyrene (B[a]P), a representative of the polycyclic aromatic hydrocarbons (PAHs) family of compounds. However, this compound was never actually detected in the ABTP emissions and was estimated to be below the 24-hour and annual time averages in the future scenario (Scenario 4). B[a]P was estimated to be above the 24-hour Health Benchmark for all scenarios in both communities.

Environment Canada/MOE operates monitoring stations around but not within the South Riverdale/Beaches communities. However, these air quality measurements can provide a point of comparison for the model results for Scenarios 1 and 2. The predicted maximum 24-hour COC levels are generally below the maximum levels measured in Toronto's air, with the exception of B[a]P and PAH, which were not actually detected at the ABTP.

While the above modelling results suggest the levels of B[a]P (and total PAHs) are high in the community, emissions were over-estimated due to several factors. Concentrations of B[a]P (similarly for other PAHs) in the stack and in the wastewater were assumed to be equal to the detection limits of the analytical methods used even though the chemical was never detected. In addition. when estimating B[a]P (similarly for other PAHs) emissions from wastewater, B[a]P was assumed to have completely evaporated from the wastewater and stayed in the air as a gas. However, B[a]P and other PAHs are known to adhere to particles (e.g. sewage sludge) in the wastewater and not volatilize easily into the air. These two assumptions result in substantial over-estimation of B[a]P and other PAHs releases to air, especially since volatilization from wastewater is the dominant contributor to the emission estimates for PAHs. Therefore, actual levels of PAHs (including B[a]P) are likely to be very much lower than the modelled concentrations.

CONCLUSIONS AND RECOMMENDATIONS

Dispersion modelling of past, present and future emissions from the ABTP on the communities of South Riverdale and the Beaches was carried out with the aid of the US EPA CALPUFF modelling system. The modelled results are a function of the amount of emissions released, characterization of sources, as well as transport and dispersion of the emissions. The following findings were determined.

1. Changes to the processes at the ABTP have changed the emission profile of the facility; this is most noticeable once incineration is stopped.

2. The addition of the Pelletizer Building has changed the dispersion pattern around the ABTP, which has increased the impacted area around the plant.

3. The impact of the ABTP on the air quality of the adjacent neighbourhoods (South Riverdale and Beaches) is reduced once incineration is terminated and odour controls are in place (Scenario 4).

4. After 2002, when the incinerators are no longer in operation, the model shows that some of the chemicals that are associated with incineration, which include arsenic, cadmium, lead, PCBs and dioxins, no longer impact the air quality in the South Riverdale and Beaches community. In contrast, the levels of a few other chemicals (e.g. benzene, hydrogen sulphide) are expected to increase in the two communities once incineration ends and before odour controls are in place (Scenario 3), though the difference is not large.

5. Predicted Chemicals of Concern concentrations were compared with Ontario Ambient Air Quality Criteria, Point of Impingement (POI) standards, Health Benchmarks as well as ambient measurements of COCs within the City of Toronto. Of the 17 COCs, all chemicals (15) that were detected during monitoring met their appropriate AAQC/POI for all time-averaging periods and scenarios.

6. In both communities, most of the Chemicals of Concern that were detected during monitoring met their 24-hour Health Benchmarks in all scenarios with the exception of cadmium and hydrogen sulphide. Cadmium was above the Health Benchmark only when the incinerator was in operation (Scenarios 1 and 2). Hydrogen sulphide exceeded the lower Health Benchmark in Scenario 1, 2, or 3, but not the higher benchmark.

7. For Scenario 1 (Pre-1996) and 2 (2000-2002) in both communities, the predicted maximum 24-hour air concentrations of the COCs that were detected in the ABTP are below the measured air levels across Toronto. The ABTP typically represents a small portion of total pollutants in the air and the total concentrations (Toronto ambient air plus ABTP emissions) are below their respective Ambient Air Quality Criteria (AAQC)

8. Benzo[a]pyrene was used as a representative for all polycyclic aromatic hydrocarbons (PAHs) compounds. These chemicals were never detected in the monitoring at the ABTP. The modelling estimated that B[a]P could be above the 24-hour Health Benchmark for all scenarios in both communities. In addition, B[a]P was estimated to exceed the AAQC/POI except for the 24-hour and annual averages in Scenario 4 (Future). For Scenarios 1 (Pre-1996) and 2 (2000-2002), the estimated maximum concentrations of B[a]P and PAHs were above the maximum air quality observations across Toronto.

9. Given the very conservative assumptions used, B[a]P and PAH emissions from ABTP were substantially over-estimated. This suggests that B[a]P and PAH are not likely to impact the communities to the extent predicted by the modelling.   Future (Scenario 4) concentrations of B[a]P are lower, therefore, the expected cumulative impact in the two communities will be less once all the odour controls are in place.

10. The modelling shows that emissions released from elevated stacks tend to generate higher concentrations to the northeast of the ABTP due to the stronger winds from the southwest. These emissions therefore impact areas of the Beaches more than South Riverdale. In contrast, since lighter winds are from the southeast, emissions from the low elevation sources (e.g. open tanks) tend to have greater impact on areas of South Riverdale to the northwest of the ABTP.

11. There is little difference between the maximum predicted concentrations due to the ABTP on South Riverdale and the Beaches. Small differences in concentrations are likely due to the meteorological pattern around the facility. Although the ABTP is a large source of emissions, its contribution is relatively small when compared to the Ontario AAQC, Health Benchmarks and City wide air quality measurements.

The following recommendations are proposed to improve the modelling results.

1. The ABTP continue to monitor effluent into and released from the plant to gain a better understanding of potential emissions from the plant.

2. Testing for PAHs in air emissions at large release points (e.g. stacks) should be carried out to confirm that these emissions are indeed insignificant.

3. The emission inventory should be periodically updated to reflect new information on on-site new and existing equipment or changes to the wastewater.

4. The potential emissions from the Final Clarifiers should be tested using an appropriate and approved method to determine the flux of sulphur bearing substances.

5. The City could examine the air quality impact of emissions of all the sources in these communities, including the ABTP.

LIMITATIONS OF STUDY

Measurements of emissions from the Final Clarifiers have been excluded from the emission inventory because there is some questions with respect to the validity of these measurements. The Project Team believes that the emissions from this source are insignificant with respect to health but should be re-tested for sulphur-bearing substances.

Dispersion models are used as tools to predict the likelihood of events (i.e., concentrations) occurring. Models do not provide absolute values but a means of calculating the concentrations when ambient air monitors are not available or practical to measure actual concentrations or when there is no technology available to measure a particular component in the ambient air.

The results of this study cannot be used to determine compliance of the ABTP with Ontario air quality standards or objectives. The study is limited to examining the impact of the ABTP on the two local communities and the changes in air quality that have occurred as a result of modification at the facility.

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1.1   GENERAL OVERVIEW

The Toronto communities of South Riverdale and the Beaches are situated adjacent to each other bordering Lake Ontario. Since the early 1970s, local residents of South Riverdale have been concerned about effects of local industries on the local environment and their health. While some of the large industrial facilities had either closed or re-located by the end of the 1990s, the residents of these communities remain concerned about the effects of past and current exposures to pollutants from these industries.

Today the Ashbridges Bay Treatment Plant (ABTP) is the only large-scale industrial plant remaining at the waterfront. In the early 1990s, the former Toronto Metro Works planned to make major modification and improvement to the operation of the ABTP. An environmental assessment process was initiated as required under the Ontario Environmental Assessment Act. Many studies were conducted and options considered. Various pilot projects were initiated, including applying 50% of the biosolids on agricultural land. In 1998, Toronto City Council made a decision to pursue 100% beneficial biosolids use, to construct a pelletizer plant to convert 50% of the dewatered cake into dry fertilizer pellets, to construct a new truck loading facility to permit biosolids shipment to agricultural land, and to close down the biosolids incinerator process (2003).

As part of the ABTP environmental assessment, a mediation process was initiated in 1998 between the City and nine (9) community groups or individuals. As a result of the negotiations, the City agreed in June 2001 to the groups' request to fund a number of studies, including a Community Health Status Study with a component of community exposure information with respect to the ABTP.

The South Riverdale and the Beaches community representatives have expressed interest in exploring whether emissions from the ABTP contribute to their perceived poor air quality. Works and Emergency Services have conducted several studies over the past decades to measure the in-stack concentrations of chemicals emitted during incineration of dewatered biosolids. Dispersion analysis using the Regulation 346 air dispersion model was carried out each time to assess the impact of the emissions on the ambient air.

To have an overall comprehensive picture of total air emissions from the ABTP and the resulting impact on the surrounding community, the community requested that the data generated piece-meal be compiled and interpreted. Since the current Regulation 346 air dispersion model is out-of-date and very limited, it is appropriate that the ambient air concentrations due to the emissions from the ABTP be remodelled using a state-of-the-science model, namely CALPUFF.

To determine the effects of the changes at ABTP on the surrounding communities, four (4) different emission scenarios were modelled. The four (4) modelling scenarios are:

Scenario 1   air emissions from the incinerator when it was in full operation (pre 1996) and accounting for air emissions from all other sources within the treatment plant;

Scenario 2   air emissions from the incinerator when it was in partial operation (2000-2002) and accounting for air emissions from all other sources within the treatment plant;

Scenario 3   air emissions from the treatment plant after incineration is discontinued (2003-2004)

Scenario 4   air emissions from the treatment plant after incineration is discontinued and odour control measures have been implemented (by 2010).

Toronto Public Health (TPH) commissioned an emission inventory and dispersion modelling assessment of ABTP emissions on the surrounding areas. Modelling was carried out with the aid of the US EPA CALMET/CALPUFF modelling system. The modelling analysis evaluated the potential concentrations of various chemicals in South Riverdale and the Beaches, attributable to the ABTP, against the Ontario Point of Impingement (POI) and Ambient Air Quality Criteria (AAQCs) as well as various health benchmarks provided by TPH.

2.0   DESCRIPTION OF ASHBRIDGES BAY TREATMENT PLANT

The ABTP is located at the foot of Leslie Street, east of Toronto harbour, and west of Ashbridges Bay. The plant is on a site of approximately 40.5 hectares as shown in Figure 2-1.

It is the largest, complete wastewater treatment plant in Canada, and serves a connected population of 1,400,000 people. A conceptual site diagram is presented in Figure 2-2 and a detailed diagram, along with processes block diagrams are found in Appendix A.

Figure 2-1   Aerial Photograph of Ashbridges Bay Treatment Plant

Figure 2-2 **Concept Plan for Key Plant Areas - Ashbridges Bay Treatment Plant**

CONCEPT PLAN
FOR KEY PLANT AREAS
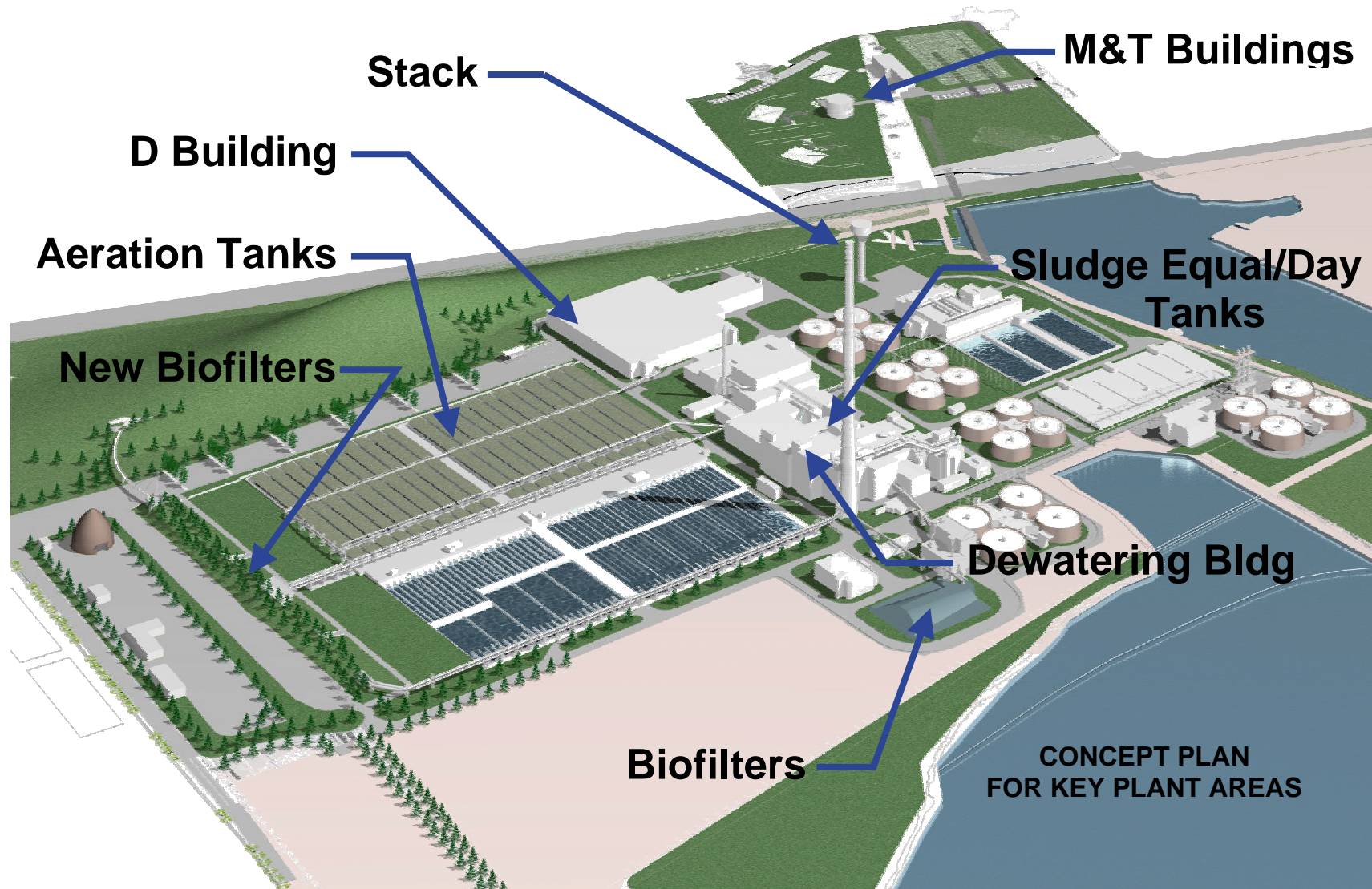
2.1   FACILITY PROCESSES

The process at the main treatment plant serves the former municipalities of East York, Toronto, and parts of North York and Scarborough. The plant provides complete wastewater treatment including removal of suspended and biological solids, phosphorus removal, disinfection and biosolids management. The following describes the eleven (11) main steps in the wastewater treatment process. Block process flow diagrams are provided in Appendix A.

Influent Sewers and Pumping Stations – Wastewater is carried to the Main Treatment Plant via two (2) pumping stations or lift stations with a total capacity of 2,135,898 m^3/day as well as gravity sewers with a capacity of 1,090,000 m^3/day.

Grit and Screening Facilities – Wastewater from the pumping stations flows through rectangular conduits to grit removal facilities, which house six grit channels and ten aerated grit channels. Flow velocity is greatly reduced in the channels to allow the heavier particles of grit to settle to the bottom. The grit is then removed and trucked to a sanitary landfill site. There are fourteen (14) automatic self cleaning bar screens (19 mm screens) located downstream of the grit tanks where large debris, such as rags and sticks, are removed from the wastewater. Ferric chloride is added to the influent to precipitate and control the phosphate level.

Primary Sedimentation (Clarifier) Tanks – Settleable matter in the wastewater is collected in twelve (12) primary sedimentation tanks (total volume approximately 115,000 m^3). A collector mechanism moves the solids on the bottom of the tank to large sumps from where it is pumped to the primary digestion tanks. Primary effluent flows from the primary tanks to the aeration tanks for further treatment.

Aeration Tanks – Primary effluent flows to eleven (11) aeration tanks (total volume approximately 192,720 m^3) and is mixed with return activated sludge. Air from ten (10) centrifugal blowers is diffused into the mixture to provide an aerobic environment for biological growth. Microorganisms consume colloidal and dissolved solids and convert this into cell mass, carbon dioxide and water.   Air collected from the process is either emitted through the annular space around the main incinerator stack or from dedicated local scrubbers (Tanks 10 & 11) as well as from tank cover leaks as fugitive emissions.

Final Sedimentation (Clarifier) Tanks – Mixed liquor flows from the aeration tanks into eleven (11) sedimentation tanks (total volume approximately 127,017 m^3) and a solids collector mechanism scrapes the settled solids on the tank floor into hoppers. Most of this material is returned to the aeration tanks as biological seed for the treatment process. A small amount of excess material is sent to the dissolved air floatation tanks for thickening, or diverted back to the head of the plant. After disinfection, the final effluent from the sedimentation tanks discharges to Lake Ontario through an offshore outfall.

Chlorination – Liquid chlorine is used for the disinfection of the final effluent. It destroys pathogenic microorganisms and renders it suitable for discharge into the Lake.

Dissolved Air Flotation – Waste activated sludge is thickened from approximately 1% to 5% solids, utilizing a process known as dissolved air floatation. In this process dissolved air in water and a polymer coagulant are used to separate solids from liquid in an upward direction by attaching air bubbles to particles of suspended solids. There are ten (10) dissolved air flotation tanks, each with a surface area of 75 m^2.

Anaerobic Digestion – Raw sludge and scum from the primary sedimentation tanks and thickened waste activated sludge from the dissolved air floatation units are pumped to sixteen (16) anaerobic digestion tanks which are maintained at a constant temperature of 35 °C. Digestion stabilizes the solids, reducing organic mass and pathogens. The digestion process produces digester gas and biosolids. This gas is approximately 70% methane and 30% carbon dioxide. Total capacity of the digesters is approximately 130,000 m^3.

Biosolids Dewatering – Anaerobically digested biosolids containing approximately 2% solids is chemically conditioned with polymer and dewatered using centrifuges. Dewatered biosolids, approximately 30% solids, were pumped to the incinerator building (pre 2003) or currently to the biosolids management facilities.

2.1.1 BIOSOLID MANAGEMENT FACILITIES

Incineration – Prior to December 2002, dewatered biosolids cake was disposed through multiple hearth incinerators, which operated at approximately 760 °C. The emissions from incineration were scrubbed with water and discharged to the atmosphere through a 185 m stack. The resultant ash was then slurried with water, discharged from the scrubbers and pumped to lagoons. Four (4) waste heat recovery boilers were used to reclaim heat from the incinerator.

Truck Loading Facility - Prior to the biosolids management program at the ABTP, dewatered biosolids would be incinerated in one (1) of six (6) of the plant's incinerators. With the initiation of the Biosolids Beneficial Use Program in 1995, the City of Toronto constructed a temporary biosolids loading facility adjacent to the incinerator building. Realisation of the benefits associated with recycling municipal sewage biosolids and the increased demand for land application of biosolids prompted the need for the construction of a more permanent facility. The new loading facility is capable of handling 100% of the biosolids production.

Biosolids Pelletizer Facility - Prior to the biosolids management program at the Ashbridges Bay Treatment Plant, dewatered biosolids would be incinerated. With the initiation of the Biosolids Beneficial Use Program in 1998, the City of Toronto constructed a biosolids pelletizer facility to convert the biosolids to a dry pellet that can be used as commercial fertilizer. The facility has the capacity to process up to 50% of the biosolids production. Although the Pelletizer Plant became inoperable in 2003, for the purposes of the study, it was assumed operational.

2.2   EMISSION SCENARIOS

To determine the effects of the changes at ABTP on the surrounding communities, four (4) different emission scenarios were developed. Each scenario presents a major process/emission milestone. The first scenario represents the base line (Scenario 1) with all biosolids being incinerated. The second scenario indicates the beginning of the implementation of the Biosolids management program with partial closure of the incinerators (Scenario 2). The third scenario reflects the final implementation of the Biosolids management program with the closure of the incinerators (Scenario 3). The final scenario represents the future implementation of a facility wide odour reduction program including process modification/improvement in 2010 (Scenario 4).

2.2.1   SCENARIO 1 – (PRE 1996)

Scenario 1 is the base line scenario. The pre 1996 operations include all process emissions, with odour control systems as they existed in 1996, and three (3) incinerators operating to handle 100% of the biosolids.

2.2.2   SCENARIO 2 – (2000-2002)

Scenario 2 represents the facility emissions in 2000, with only two (2) operational incinerators, partial (50%) implementation of the Biosolids management program, partial replacement of the central heating facility, and a biofilter treating foul air from the dewatering process and the new biosolids truck loading facility.

2.2.3   SCENARIO 3 – (2003-2004)

Scenario 3 represents the current facility emission profile (2003), with full implementation of the Biosolids management program, replacement of the central heating facility, the shutdown of the incinerators, and the operation of the pelletizer plant.

2.2.4   SCENARIO 4 – (2010)

Scenario 4 represents the facility after the implementation of the Zorix (2002d) report recommendations. Under the future scenario (2010), the odorous facility emission points will be collected and treated in a central biofilter. The new central biofilter, the existing biosolids biofilter, and the dewatering day tanks scrubber will be exhausted through the existing tall stack. The incinerator will not be operational and all biosolids will be either disposed through land application or processed by the Pelletizer facility.

The New Central Biofilter will treat the air from the following sources:
➢ P Building Process exhausts;
➢ Screens 7-12 Building;
➢ Primary Clarifier Tanks (1-6) Scum Scrubber;
➢ Primary Clarifier 7-9;
➢ "D" Building; and
➢ Aeration Tanks.

Under the future scenario, the following air flows will be collected and conveyed to the Incinerator Stack Annular Space:

➢ Dewatering Day Tanks Scrubber;
➢ Biosolids Biofilter; and
➢ New Central Biofilter.

3.0   EMISSION INVENTORY

As previously discussed, four (4) emission scenarios are to be modelled for ABTP, namely:

Scenario 1   air emissions from the incinerator when it was in full operation (pre 1996) and accounting for air emissions from all other sources within the treatment plant;

Scenario 2   air emissions from the incinerator when it was in partial operation (2000-2002) and accounting for air emissions from all other sources within the treatment plant;

Scenario 3   air emissions from the treatment plant after incineration is discontinued (2003-2004)

Scenario 4   air emissions from the treatment plant after incineration is discontinued and odour control measures have been implemented (by 2010).

The following provides details on the emission inventory, including the methods used to create the inventory as well as sources of the data. Past and current emission scenarios (1-3) are primarily based on existing source testing data. Future emissions (Scenario 4) are based on Zorix (2002d) recommendations. Hydrogen sulphide (H_2S) is used as an example to demonstrate how the emissions are calculated. Hydrogen sulphide was selected for its abundance at the site and since it can be found at virtually all the processes at the ABTP. The emissions from the other chemicals are calculated in a similar fashion.

3.1   IDENTIFICATION OF POINT SOURCES

A point source is any stack that exhausts vertically and is above the roofline. This includes capped stacks, roof vents, gooseneck vents, and building ventilation. The inventory of 45 point sources is based on Zorix (2002d) and Project Team site visits. Appendix B presents the stack exit characteristics and building parameters which are used in the modelling.

3.2   IDENTIFICATION OF AREA AND FUGITIVE SOURCES

Area sources are low level or ground releases (i.e., biofilters and open source). There are 15 area sources at ABTP and their emission characteristics are provided in Appendix B. Fugitive sources are sources including leaks from equipment, doors/windows and cracks.

3.3   EMISSIONS INVENTORY METHODOLOGY

There are four (4) Emission Estimation Techniques (Its) that can be used to generate facility-wide emissions estimates, namely:

➢ Sampling or direct measurement;
➢ Mass balance;
➢ Fuel analysis or other engineering calculations; and
➢ Emission factors.

Typically, a facility will use more than one type of EET. For example, a mass balance may be used to estimate fugitive emissions from leaks, direct measurements for stack emissions and emission factors for combustion equipment.

With respect to ABTP, emissions were primarily calculated using direct measurements. In some instances, volume air flowrates were not available and an estimate of the flowrate was required. The generalized emission equation is given in Equation 3-1.

$$E_i = \frac{(C_i \times MW_i \times Q_d)}{[0.024 \times 10^6]} \times \frac{293}{273 + T} \times (1 - Eff)$$

Equation 3-1

Where:

E_i	=	emissions of chemical i, g/s
C_i	=	pollutant concentration at inlet to pollution control device, $ppm_{v,d}$
$ppm_{v,d}$	=	parts per million, volume dry
MW_i	=	molecular weight of the pollutant, g/g-mole
Q_d	=	stack gas volumetric flow rate (m^3/s) at temperature T (dry)
0.024	=	volume occupied by one mole of gas at standard temperature and pressure (20 °C and 101.3 kPa), m^3/g-mole
T	=	temperature of gas sample, °C
10^6	=	conversion factor, ppm·g/g
Eff	=	Control Efficiency

A variation of Equation 3-1 is where the concentration is given as mass per volume (i.e., mg/L or μg/m³). Equation 3-1 becomes:

$$E_i = C_i \times Q_d \times \frac{1}{1000} \times \left(\frac{293}{273 + T} \right) \times (1 - Eff)$$

Equation 3-1a

where:

E_i	=	emissions of chemicals i, g/s
C_i	=	concentration of chemicals i at inlet, mg/m³ at 20 °C
Q_d	=	stack gas volumetric flow rate at temperature T, m³/s
T	=	temperature of the gas sample, °C

In addition, combining the inlet concentration with the control efficiency results in the outlet concentration of the control device as

$$C_i^{'} = C_i \times (1 - Eff)$$

Equation 3-1b

where:

C'_i = concentration of chemical i at the outlet of the APC, $ppm_{v,d}$ or mg/m^3

For direct measurements of a surface such as the Primary Clarifiers where a flux chamber was used, the emission equation becomes:

$$E_{Flux_i} = \frac{C_i \times Q_s}{A \times 1,000,000} \times A_T$$

Equation 3-2

where:

$E_{Flux\ i}$ = surface emissions of chemical i, $g/m^2/s$
C_i = concentration of chemical i in the flux chamber, $\mu g/m^3$
Q_s = Sample flow rate, m^3/s
A = Surface area covered by the flux chamber, m^2
A_T = Total surface area of source, m^2

In the above equations, C_i is the uncontrolled concentration above the surface.

Material balance (also known as mass balance) is a method commonly used for estimating emissions from many source categories. The material balance method can be used where source test data, emission factors, or other developed methods are not available. In fact, a material balance is the only practical method to estimate emissions accurately for some sources.

The general form of the equation is given as:

$$E_i = \frac{Q_i \times (C_{in} - C_{out})}{24 \times 3600 \times 1000000} \times \%Volz$$

Equation 3-3

Where:

E_i = Total emissions of chemical i, g/s
C_{in} = Concentration of chemical entering the system ($\mu g/L$)
C_{out} = Concentration of chemical leaving the system ($\mu g/L$)
ΔC = $C_{in} - C_{out}$ ($\mu g/L$)
Q_i = Flowrate (L/day)
% Volz = Volatilization (%)

In the above equation, it is assumed that the difference between the concentration entering the system and leaving the system is volatilized into the atmosphere. For conservatism, it is generally assumed as 100% volatilization. This is a very conservative assumption.

In other cases, EPA emission factors were used to calculate the emissions for sources, which had limited data. Emission factors are generally constructed based on a range of source tests conducted on a typical process under varying operating conditions. From this, a ratio is developed which expresses atmospheric emissions as a function of process activity level (such as production rate, material throughput or full consumption). Emissions can be simply estimated by knowing the applicable activity level.

Emission factors are used to estimate a facility's emissions by the general equation:

$$E_{kpy,i} = A \times EF_i \times \left(1 - \frac{CE_i}{100}\right)$$

Equation 3-4

Where:

$E_{kpy,i}$	=	emission rate of chemical i, kg/yr
A	=	activity rate, t/yr
EF_i	=	uncontrolled emission factor of chemical i, kg/t
CE_i	=	overall control efficiency of chemical i, %

Activity data are usually directly related to the emitting process. For industrial processes, activity data are generally reported as process weight rates (e.g., kilograms, tons, or litres per month of material used or manufactured). Similarly, for fuel-burning equipment, activity data are reported as fuel consumption rates (e.g., tons, litres, cubic meters, or megajoules per hour or per month). In many instances, conversion factors must be applied to convert reported consumption or production values to units that correspond to the emission factor throughput units (e.g., tons, barrels).

3.3.1   SITE-SPECIFIC INFORMATION

The following site-specific reports are used to estimate emissions:

A.   Zorix Comprehensive Odour Reports – Interim Reports (Zorix, 2001, 2002a, 2002b, and 2002c) and Final Reports (Zorix, 2002d);

B.   Bovar-Concord Environmental Report BCE441-3345 (Ciccone et al., 1994);

C.   Annual Reports 1988, 1999, 2000 and 2001 prepared for the City of Toronto (City of Toronto, 1997, 2000, 2001, 2002 and Zenon 1989) and;

D.   Incinerator Emission Test Program Reports (EER Canada, 1994 and 1998).

Where multiple measurements were made of the same source, the highest value measured was used to provide conservative estimates. The 1994 EER Canada source testing report was used for Scenario #1 as

all incinerators were in operation at this time and it was the most representative dataset available. Similarly, the 1998 report was used for Scenario 2 as only two incinerators were in operation and these sets of test are the most representative of the period of interest.

3.3.2   ENGINEERING ESTIMATES AND DATA QUALITY

The emission estimates developed for this application have been assigned a data quality rating based on the estimation methodology and information resources used. The terminology used for describing the emission estimation technique and the resulting data quality were based on the Ontario Ministry of the Environment (MOE) guideline document "Procedure for Preparing an Emission Summary and Dispersion Modelling Report" (MOE, June 1998) and are contained in Table 3-1.

Table 3-1   Reference Terminology for Data Quality

Reference	Estimation Method	Data Quality
EC	Engineering Calculation using known data on similar sources or sound engineering judgement	Conservative
EF	Emission Factor published by the USEPA, AP-42 (5th Edition) or other published sources	A, B, C, D or E*
MB	Mass Balance Calculations accounting for the material that enters and leaves a process	Conservative
EE	Engineering Estimate based on scientific principles	Conservative
SM	Source Measurement following the USEPA sampling protocol	Documented

* A is the highest rating (high confidence in the emission factor) and E is lowest rating (low confidence in the emission factor)

Emission estimates based on source testing refer to measurements which have followed an appropriate protocol and have been witnessed by the MOE. In some cases, measurements by Zorix Consultants were used to estimate emissions of various compounds. These measurements were taken for an overall odour assessment and not to quantify specific emissions. Although Zorix Consultants did not follow standard source testing protocols, they do provide useful information for emission estimates.

Descriptions of emission estimation techniques are presented below as per the process described in the previous section. Fugitive emissions, with the exception of road dust or tail-pipe emissions are included as part of this inventory.

To estimate the emission rates for those compounds deemed below method detection limit, the detection limit was used in the calculations. This occurred for mass balance estimates as well as in source testing measurements.

In the case of sources without source testing data, emission factors and engineering calculations were used. For example, emission factors were used for emissions from boilers and flares while a mass balance approach was used to estimate volatile organic compound (VOC) emissions from wastewater.

3.4   EMISSIONS CALCULATIONS FOR ABTP SOURCES

The following sections describe the calculation methods used to calculate hydrogen sulphide (H_2S) emissions from the various sources using the above EETs. The other chemicals such as VOCs, polycyclic aromatic hydrocarbons (PAHs), were calculated in a similar manner.

3.4.1   PUMPING OR LIFT STATIONS

3.4.1.1   M BUILDING

The M Building has four (4) sources of emissions, namely; the M Building Scrubber Exhaust (#1), M Building Roof Exhausts (#2A and #2B) and New M Building Stack without a Scrubber (#3).

Hydrogen sulphide emissions and the flow rates from the M Building (Sources #1, #2A and #2B) were determined by source testing carried out by Zorix in June/July 2001 (Zorix, 2001). Source #2 is divided into Source #2A and #2B and it is assumed that one-half of the flow rate was assigned to each source. In addition, it was also assumed that the other chemicals (i.e., VOCs) emitted from the T Building Roof Exhaust (Source #5) would also be emitted by Sources #2A and #2B at the same concentration. For Scenarios 1 to 3, in-stack concentrations, flow rates and emission rates do not change from scenario to scenario. In Scenario 4, these sources will be rerouted to a new single tall stack, without a scrubber (Source #3). All the emission rates from Sources #1, #2A and 2B were calculated in the same manner. For Source #1, the hydrogen sulphide emission rate was calculated with the aid of Equation 3-1, where

$$C'_i = 0.013 \text{ ppm}$$
$$Q_d = 14.66 \text{ m}^3/\text{s at } 20°C.$$
$$MW_i = 34 \text{ g/mol}$$

Substitution into Equation 3-1 results in the following:

$$E_i = \frac{(0.013 \times 34 \times 14.66)}{\left[0.024 \times 10^6\right]} \times \frac{293}{273 + 20} = 2.70 x 10^{-4} \, g/s$$

The control efficiency of the existing scrubber was integrated into Equation 3-1 with the aid of Equation 3-1b as the measurement was taken after the scrubber.

Source #3 was only included in the future scenario (Scenario 4). The flow rate was calculated by summing the flow rates of Sources #1, 2A and 2B with an additional 1 m³/s as the inlet pipe would also be captured in this source. The concentration of hydrogen sulphide from Source #3 was calculated by dividing the total emission rate from Sources #1, 2A and 2B by the flow rate of Sources #1, 2A and 2B. The hydrogen sulphide emission rate is calculated using Equation 3-1. The other chemicals emitted from Sources #2A and 2B would also be emitted by Source #3 in the future scenario with no scrubber (i.e., emission reduction).

3.4.1.2   T BUILDING

The T Building has four (4) sources of emissions including the T Building Scrubber Exhaust (#4), T Building Roof Exhaust (#5), Control Gate Monument (#55) and New T Building Biofilter Scrubber (#6).

The concentration and flow rates of the T building scrubber exhaust (Source #4), general building ventilation system roof exhaust (Source #5), and control gates (Monument, Source #55) vents were determined from the Zorix Round 1 source testing (Zorix, 2002) in June/July 2001. In Scenario 4, these sources will no longer vent directly to the atmosphere but will vent through a local Biofilter Scrubber (Source #6).

The emission rates for the first three (3) scenarios are identical. The hydrogen sulphide emission rate from the T Building Scrubber (Source #4) was calculated with the aid of Equation 3-1, where

$$
\begin{aligned}
C'_i &= 0.003 \text{ ppm} \\
Q_d &= 2.58 \text{ m}^3\text{/s at } 20°C \\
MW_i &= 34 \text{ g/mol}
\end{aligned}
$$

Substitution into Equation 3-1 results in the following:

$$ E_i = \frac{(0.003 \times 34 \times 2.58)}{[0.024 \times 10^6]} \times \frac{293}{273 + 20} = 1.1x10^{-5} \, g/s $$

The control efficiency of the existing scrubber was integrated into Equation 3-1 with the aid of Equation 3-1b as the measurement was taken after the scrubber.

A future scrubber was added as Source #6. The hydrogen sulphide emission rate for Source #6 was calculated as the sum of emission rates from Sources #4, 5, and 55 with a scrubber efficiency of 95% on hydrogen sulphide. The calculations for hydrogen sulphide for the future scenario only are shown below:

$$
\begin{aligned}
E &= (E_{Source\#4} + E_{Source\#5} + E_{Source\#55}) \times (1 - Eff) \\
&= (1.10 \text{ x } 10^{-5} + 1.96 \text{ x } 10^{-3} + 7.68 \times 10^{-4}) \times (1 - 95\%) \\
&= 1.37 \times 10^{-4} \, g/s
\end{aligned}
$$

Scrubber removal efficiencies for the other chemicals were also taken as 95%.

3.4.2 GRIT TANKS

3.4.2.1 P BUILDING – GRIT TANKS (1-6) BUILDING

The P Building emission sources include the P Building Scrubber Outlet (#10) and P Building Room Air (#11A to #11F).

The P Building (Grit Tanks 7-12) has seven (7) emissions sources, namely: Scrubber Outlet (Source #10) and five (5) room exhausts and one standby (Sources #11A to #11F). All seven (7) sources emit hydrogen sulphide, determined from source testing carried out by Zorix in June/July 2001 (Zorix, 2001).

For the first three (3) scenarios, the flow rate for the scrubber outlet was determined from Zorix's Round 1 source testing (Zorix, 2002a). Under the future scenario, that source will no longer be active and exhaust air will be conveyed to the central biofilter.

The flow rates for P Building Room exhausts (Sources #11A to F) were assumed to be distributed among the operating exhaust fans at one-sixth of the flow rate provided in the Zorix Final Report (Zorix, 2002d). Source #11B is a spare fan so Source #11A was assigned two-sixths of the flow rate. Under the future scenario, these sources will continue to be directly exhausted to the environment without treatment.

Under the future scenario, a new ventilation system will be installed to capture the foul air from the new grit processing and storage. The new system exhaust will be captured and conveyed to the central biofilter.

The hydrogen sulphide emission rate from the P Building Scrubber (Source #10) is calculated with the aid of Equation 3-1, where

$$
\begin{aligned}
C'_i &= 0.447 \text{ ppm} \\
Q_d &= 14.07 \text{ m}^3/\text{s at } 20°C \\
MW_i &= 34 \text{ g/mol}
\end{aligned}
$$

Substitution into Equation 3-1 results in the following:

$$ E_i = \frac{(0.447 \times 34 \times 14.07)}{[0.024 \times 10^6]} \times \frac{293}{273+20} = 8.91x10^{-3} \, g/s $$

The control efficiency of the existing scrubber was integrated into Equation 3-1 with the aid of Equation 3-1b as the measurement was taken after the scrubber.

3.4.2.2 GRIT TANKS (7-12) BUILDING

The Grit Tank (7-12) Building includes two (2) sources, namely; the Screen 7-12 Odour Control (Scrubber) (#122), and the General Building Ventilation (#123).

The above sources are old and the City plans to refurbish the grit tanks and ventilation system. It has been assumed that the emissions have the same characteristics (i.e., chemicals and concentrations) as the P Building. Source #122 is assumed to have the same concentration as Source #10 and a flow rate of 1 m^3/s. Source #123 is assumed to have a concentration equal to the average concentration of hydrogen sulphide from Sources #11A to 11F and a flow rate of 2.3 m^3/s.

Under the future scenario, the general building ventilation will be vented directly to the atmosphere without treatment.

For hydrogen sulphide, the emissions for the Screen 7-12 Odour Control (Scrubber) (#122) was calculated with the aid of Equation 3-1, where

$$
\begin{aligned}
C'_i &= 0.447 \text{ ppm} \\
Q_d &= 1.0 \text{ } m^3\text{/s at } 20°C. \\
MW_i &= 34 \text{ g/mol}
\end{aligned}
$$

Substitution into Equation 3-1 results in the following:

$$ E_i = \frac{(0.447 x 34 \times 1.0)}{\left[0.024 \times 10^6\right]} \times \frac{293}{273+20} = 6.33 x 10^{-4} \text{ } g/s $$

The control efficiency of the existing scrubber was integrated into Equation 3-1 with the aid of Equation 3-1b as the measurement was taken after the scrubber.

3.4.2.3 GRIT TANKS (13-16) BUILDING

The Grit Tank (13-16) Building includes six (6) sources, namely; the D Building Grit Area Exhaust NEF-2 (grit Removal) (#15), D Building Grit Area Exhaust NEF-1 (grit Removal) (#16), and four (4) exhausts fans (#NEF–6, # NEF–7, #NEF–8, and #NEF–9).

The concentration and flow rates of these six (6) sources were determined from the Zorix Round 1 source testing (Zorix, 2002) in June/July 2001. These sources exhaust during all four scenarios.

There are three (3) additional fans NEF-21, NEF-22, and NEF-23 in this building which are not operational under normal operations and are there for emergency purposes only.

The emission rates for the four (4) scenarios are identical. The hydrogen sulphide emission rate from the D Building Grit Area Exhaust NEF-2 (Source #15) was calculated with the aid of Equation 3-1, where

C_i = 0.054 ppm
Q_d = 16.7 m^3/s at 20°C
MW_i = 34 g/mol

Substitution into Equation 3-1 results in the following:

$$E_i = \frac{(0.054 \times 34 \times 16.7)}{\left[0.024 \times 10^6\right]} \times \frac{293}{273 + 20} \times (1-0) = 1.3 x 10^{-3} g/s$$

There is no emission control for this source.

3.4.3   PRIMARY CLARIFIERS

There are 12 Primary Clarifiers at ABTP, of which three are open area sources (7 to 9) while the other nine are within enclosed buildings.

3.4.3.1   PRIMARY CLARIFIERS (1 TO 6)

Emissions associated with the Primary Clarifiers include the Primary Clarifier Three Scum Tanks (#23A, B, and C)

The hydrogen sulphide emissions and flowrates from the Primary Clarifier (1 to 6) and three (3) Scum Tanks (Sources #23A, 23B and 23C) were determined from source testing carried out by Zorix in June/July 2001 (Zorix, 2001). Under the future scenario, these sources will no longer vent directly into the atmosphere via vents but the exhaust air will be conveyed to the central biofilter.

The hydrogen sulphide emission rate for source #23A was calculated with the aid of Equation 3-1, where:

C_i = 0.137 ppm
Q_d = 0.93 m^3/s at 20°C.
MW_i = 34 g/mol

Substitution into Equation 3-1 results in the following;

$$E_i = \frac{(0.137 \times 34 \times 0.93)}{\left[0.024 \times 10^6\right]} \times \frac{293}{273 + 20} \times (1-0) = 1.81 x 10^{-4} g/s$$

There is no emission control for this source.

3.4.3.2   PRIMARY CLARIFIERS (7 TO 9)

Primary Clarifiers 7-9 include Scum Tanks between Primary Tanks 7-8 (#13A to #13C), Primary Tanks 7-9 Distribution Channels (#19A to #19C), Primary Tank 7 (#20A), Primary Tank 8 (#20B), Primary Tank 9 (#20C), Weirs on Primary Tank 7 (#21A), Weirs on Primary Tank 8 (#21B) and Weirs on Primary Tank 9 (#21C).

The Primary Clarifiers consist of three (3) units (7, 8 and 9). Each clarifier has a scum tank (Sources #13A to 13C), a distribution channel (Sources #19A to 19C), the primary tank itself (Sources #20A to 20C) and the Weirs (Sources #21A to 21C).   The hydrogen sulphide emissions from these sources were determined from source testing carried out by Zorix in June/July 2001 (Zorix, 2001).

The flow rates from the Scum Tanks (sources #13A to C) were calculated from the Bovar-Concord Environmental Report BCE441-3345 (Ciccone et al., 1994). For Sources #13A to 13C, each was assigned one-third of the flow rate (i.e., 1/3 of 1.5 m^3/s).

These sources will no longer exhaust into the atmosphere under the future scenario, as a new building will cover Primary Clarifiers 7 to 9 and the exhaust will be conveyed to the biofilter.

The hydrogen sulphide emission rates for each scenario were calculated with the aid of Equation 3-1 as follows for Source #13A, where

$$C_i \quad = \quad 0.110 \text{ ppm}$$
$$Q_d \quad = \quad 0.5 \text{ m}^3/\text{s at } 20°C$$
$$MW_i \quad = \quad 34 \text{ g/mol}$$

Substitution into Equation 3-1 results in the following:

$$E_i = \frac{(0.110 \times 34 \times 0.5)}{[0.024 \times 10^6]} \times \frac{293}{273 + 20} \times (1 - 0) = 7.79 x 10^{-5} \, g/s$$

There is no emission control for this source.

The amount of hydrogen sulphide released from the Primary Tanks 7-9 Distribution Channel (Sources #19A to C), the primary tanks (Sources #20A to C) and the Weirs (Sources #21 A to C) were calculated with the aid of Equation 3-2, where a flux chamber was used to measure the quantity of hydrogen sulphide leaving the surface of the Primaries. In the following example, the total area for each primary clarifier distribution channel (i.e., 19A, B and C) is divided into three (3) equal sections of 129 m^2. The variables for Equation 3-2 are given as

$$C_i \quad = 198.4 \text{ µg/m}^3$$
$$Q_s \quad = 0.25 \text{ m}^3/\text{s}$$
$$A \quad = 0.38 \text{ m}^2$$

$$A_T \qquad = 129 \text{ m}^2$$

Substitution into Equation 3-2 results in:

$$E_{Flux_i} = \frac{198.4 \times 0.25}{0.38 \times 1,000,000} \times 129 = 1.68x10^{-2} \, g/s$$

Volatile compounds are expected to volatilize into the atmosphere when the wastewater is rapidly mixed with air at the Primary Clarifiers (Source #19A, B and C). The list of chemicals includes VOCs, semi-volatile organic compounds and mercury and was developed from the water sampling data in the Annual reports between 1988 and 2001 (Zenon, 1989 and City of Toronto, 1999, 2000, 2001, 2002). The emission rates of the volatile compounds were estimated by determining the difference in the concentration of each volatile compound in the water entering ABTP (influent) and the concentration in the water released from ABTP (effluent). The emissions were calculated using this difference for each compound in a representative annual report (Table 3-3) times the flow of wastewater and assuming that 100% of the compound is volatilized.

Table 3-3   Representative Annual Report for VOCs in the Water Analysis

Scenario #		Scenario Year	Representative Annual Report (Year)
Scenario 1	incinerator in full operation (pre 1996)	1995 & earlier	1988
Scenario 2	incinerator in partial operation (2000-2002)	2000	2000
Scenario 3	incineration discontinued (2003-2004)	2003	2001
Scenario 4	incineration discontinued and odour control measures implemented.	2010	2001

It is assumed that all the compounds that will volatilize out of the water will do so early in the process. For simplicity, it was assumed that all of the VOCs in the wastewater are emitted from the primary clarifiers only. This is a very conservative assumption as heavier VOCs will likely be found in the biosolids or released in other locations. Also, a significant portion of the VOCs are biodegraded in the secondary treatment process. Pesticides were not assumed to be released from the wastewater due to their low vapour pressure.

The emission rates are based on the average flow of water entering the plant each day. Since the average amount of wastewater entering the plant (not including heavy rain days) does not have a large variance from year to year, a flow rate of 700,000 m³/day was used for all scenarios (http://www.city.toronto.on.ca/water/wastewater_treatment/treatment_plants/ashbridges_bay.htm). It is also assumed that Primary Clarifiers 7-9 handle 50% of the wastewater flow and the remaining wastewater is sent to the covered Primary Clarifiers 10-12.

As an example, the methylene chloride emissions from Primary Clarifiers 7, 8 and 9 (Source #19A, B and C) were calculated with the aid of Equation 3-3, where

ΔC	=	23.07 µg/L (Methylene Chloride)
C_{in}	=	35 µg/L (Methylene Chloride in the Influent (1988))
C_{out}	=	11.93 µg/L (Methylene Chloride in the Effluent (1988))
Q_i	=	350,000,000 L/day
% Volz	=	100%

$$E_i = \frac{350,000,000 \times (23.07)}{24 \times 3600 \times 1000000} \times 100\% = 0.093 g/s$$

These emissions are evenly distributed across the three (3) Primary Clarifiers (7 to 9). As mentioned above, these are very conservative assumptions with respect to 100% volatilization and location. It should be expected that most of the heavier VOCs with low vapour pressure would be found in the sludge. The rest of the wastewater VOCs would be emitted from the other Clarifiers in the D Bldg.

In the future scenario, the above emissions will be captured and conveyed to the central biofilter for emission control.

3.4.3.3   D BUILDING – PRIMARY CLARIFIERS (10-12)

The remaining sources at the "D" Building – Grit Tanks 13-16, Screenings and Primary Clarifier 10-12 are ventilated and exhausted in the distribution channel of the Aeration Tanks. All the wastewater VOCs will be accounted for at the Aeration Tanks.

In the future scenario the D Building primary clarifier exhaust will be conveyed directly to the biofilter for emission control.

3.4.4   AERATION TANKS ODOUR CONTROL BUILDING

3.4.4.1   QUAD SCRUBBER OUTLET #10 (#25) AND #11 (#27)

The emissions (concentration and flowrate) from Quad Scrubber #10 and #11 were determined from source testing carried out by Zorix in June/July 2001 (Zorix, 2001). It is expected that the emissions released from Quad Scrubber #10 are the same as Quad Scrubber #11. These sources will no longer be in operation under the future scenario, as exhaust air will be conveyed to the central biofilter.

The hydrogen sulphide emission rate (Scrubber #10) was calculated with the aid of Equation 3-1, Where

C'_i	=	0.48 ppm
Q_d	=	16.7 m³/s at 20°C
MW_i	=	34 g/mol

Substitution into Equation 3-1 results in the following:

$$E_i = \frac{(0.48 \times 34 \times 16.7)}{[0.024 \times 10^6]} \times \frac{293}{273 + 20} = 1.14 x 10^{-2} \, g/s$$

The control efficiency of the existing scrubber was integrated into Equation 3-1 with the aid Equation 3-1b as the measurement was taken after the scrubber.

3.4.4.2   AERATION TANKS (1-9) (#56) AND AERATION TANKS (10-11) (#119)

Aeration Tanks 1-9 (Source #56) are separate from Aeration Tanks 10 and 11 (Source #119) as Tanks 10 and 11 are newer tanks with tight seals and no fugitive emissions (i.e., leaks) are expected. The seals around Aeration Tanks 1-9 covers are not as tight resulting in fugitive emissions. The chemicals released from the Aeration Tanks 1-9 are assumed to be of the same concentration as those from Quad Scrubber #10 and #11 (Sources #25 and #27) prior to scrubbing.

The airflow enters the Aeration Tanks 1-9 from the D Building at 42.5 m^3/s (Zorix, 2002d) and the Blower Building at 138.6 m^3/s (Zorix 2002d) for a total airflow of 181.1 m^3/s. From the Aeration Tanks 1-9, air is conveyed to the Incinerator Stack Annular Space (Source #29) with an average flow rate of 27 m^3/s (Zorix, 2002d). The difference between the flow entering the Aeration Tanks and the Annular Space is assumed to be lost through the split in the seals of the tanks.

The average inlet concentrations to the Quad Scrubbers #10 were used as the concentrations at the Aeration Tanks 1 to 9.

The hydrogen sulphide emission rate from the Aeration Tanks leaks for each scenario was calculated with the aid of Equation 3-1, where

C'_i =   0.47 ppm
Q_d =   181.1 m^3/s – 27 m^3/s = 154.1 m^3/s at 20 °C
MW_i =   34 g/mol

Substitution into Equation 3-1 results in the following:

$$E_i = \frac{(0.47 \times 34 \times 154.1)}{[0.024 \times 10^6]} \times \frac{293}{273 + 20} = 1.03 x 10^{-1} \, g/s$$

The control efficiency of the existing scrubber was integrated into Equation 3-1 with the aid of Equation 3-1b as the measurement was taken after the scrubber.

In addition, the emission from wastewater (i.e., "D" Bldg Primary Clarifiers 10-12) will also be released in the same proportions as the airflow between the fugitives and the Annular Space.

In the future scenario, the Aeration Tanks will be converted to fine bubbling (air flow reduction), "D" Building exhaust will be conveyed directly to the biofilter, Aeration Tanks cover will be repaired and no fugitive emissions will occur, and all above emissions will be captured and conveyed to the biofilter for emission control.

3.4.5   DEWATERING BUILDING

The Dewatering Building includes eight (8) sources of emissions, namely; Day Tank #1 Scrubber Outlet (#35A), Day Tank #3 Scrubber Outlet (#35B), Dewatering Building EF1 exhaust Fan (#38), Dewatering Building EF16 exhaust Fan (#39), Dewatering Building EF4 exhaust Fan (#40), Dewatering Building EF5 exhaust Fan (#103), Dewatering Building EF2 exhaust Fan (#104) and Dewatering Building EF3 exhaust Fan (#105).

The emissions for sources from the Day Tanks (#35A and #35B) and the Dewatering Building Exhaust Fans EF1, EF16, EF4, EF3 and EF 5 (Sources #38, #39, #40, #103 and #105) were calculated from source testing carried out by Zorix in June/July 2001 (Zorix, 2001). It was assumed that the concentrations from Source #35B and Source #35A are the same. The flow rates for these sources were taken from the Zorix Final Report (Zorix, 2002d). The additional exhaust on the Dewatering Building (Exhaust Fan EF2 (Source #104)) was added to the emissions inventory. It was assumed that Source #104 has the same flow rate and hydrogen sulphide concentration as Source #43. The emission rates were calculated using Equation 3-1 as above. Sources #103, #104 and #105 were assumed to have the same emission rates for all four (4) scenarios.

Under the future scenario, Sources #35A, #35B, #38, #39, #40 exhaust will be redirected to the inlet of the blower building, the air will be used in the Aeration Tanks. Source #103, 104 and 105 will be exhausting directly to the atmosphere without treatment. Day Tanks # 35A, 35B and 35C (new) will be ventilated through a dedicated scrubber (activated carbon) and exhaust directly to the incinerator stack.

The hydrogen sulphide emission rate for Source #35A was calculated with the aid of Equation 3-1, where

$$C'_i \quad = \quad 0.111 \text{ ppm}$$
$$Q_d \quad = \quad 0.05 \text{ m}^3/\text{s at } 20°C$$
$$MW_i \quad = \quad 34 \text{ g/mol}$$

Substitution into Equation 3-1 results in the following:

$$E_i = \frac{(0.111 \times 34 \times 0.05)}{[0.024 \times 10^6]} \times \frac{293}{273+20} = 7.86 x 10^{-6} \, g/s$$

The control efficiency of the existing scrubber was integrated into Equation 3-1 with the aid of Equation 3-1b as the measurement was taken after the scrubber.

3.4.6   FINAL CLARIFIERS

The Final Clarifiers source includes the Final Clarifiers Distribution Channels (#30A to K) and Final Clarifiers (#31).   There is some question with respect to the validity of the measurements which seem to be exceptionally high for these sources. The Study Team decided to exclude these emissions from the emissions inventory, as they are not representative.

3.4.7   BIOSOLID BIOFILTERS

As of 2003, there are four (4) Biofilters (#54A to D) at ABTP and emissions were calculated from source testing carried out by Zorix in June/July 2001 (Zorix, 2001). The flowrates for these sources were taken from Zorix "Drawing 1 Design".

The Biosolid Biofilter was built in 2000 but prior to its erection foul air was treated by incineration. For the future scenario the Biosolid Biofilter will be covered and the exhaust will be conveyed to the incinerator stack annular space.

For Scenarios 2 and 3, the emission rates were calculated with the aid of Equation 3-1 (example shows hydrogen sulphide emissions from Source #54A for Scenario 2). The hydrogen sulphide emissions for scenarios 2 and 3 from all four Biosolid Biofilters are identical.

Given:

$$C'_i \quad = \quad 0.015 \text{ ppm}$$
$$Q_d \quad = \quad 5 \text{ m}^3/\text{s at 20 °C}$$
$$MW_i \quad = \quad 34 \text{ g/mol}$$

Substitution into Equation 3-1 results in the following:

$$E_i = \frac{(0.015 \times 34 \times 5)}{[0.024 \times 10^6]} \times \frac{293}{273 + 20} = 1.06 x 10^{-4} \, g/s$$

Here, the control efficiency of the biofilter is integrated with the concentration, as the measurement was taken at the outlet of the system.

3.4.8   OLD BIOSOLIDS TRUCK LOADING BUILDING

Emissions from the Old Truck Loading Building (#120A and B) occur only under Scenario 1 (Pre 1996) since its operation was discontinued in late 1999 to early 2000.   The air flowrate and the hydrogen sulphide concentration were estimated to be 3.3 m³/s and 0.01 ppm respectively. The hydrogen sulphide emission rate for Source #120A was estimated with the aid of Equation 3-1, where

$$C_i \quad = \quad 0.01 \text{ ppm}$$
$$Q_d \quad = \quad 3.3 \text{ m}^3/\text{s at 20 °C}$$
$$MW_i \quad = \quad 34 \text{ g/mol}$$

Substitution into Equation 3-1 results in the following:

$$E_i = \frac{(0.01 \times 34 \times 3.3)}{\left[0.024 \times 10^6\right]} \times \frac{293}{273+20} \times (1-0) = 4.68x10^{-5} \, g/s$$

There is no emission control for this source.

3.4.9 PELLETIZER BUILDING

Sources at the Pelletizer Building include the Pelletizer Building Reactor Vent (#112), Pelletizer Building Reactor Vent (#113), Pelletizer Building Process Vent (#116), Pelletizer Building Ventilation (#117) and Pelletizer Building Carbon System Vents (#107 to 111).

Hydrogen Sulphide emissions are negligible from the Pelletizer building but combustion emissions (NOx, SO_2, CO and particulate) from the natural gas heaters have been accounted for.

3.4.10 INCINERATOR

3.4.10.1 ANNULAR SPACE

The emissions (concentration and flowrate) from the Annular Space (#29) were determined from source testing carried out by Zorix in June/July 2001 (Zorix, 2001). Under the first three (3) scenarios the emissions do not change. The hydrogen sulphide emissions from the Annular Space was calculated with the aid of Equation 3-1, where

C_i =   0.103 ppm
Q_d =   27 m^3/s at 20°C
MWi   =   34 g/mol

Substitution into Equation 3-1 results in the following;

$$E_i = \frac{(0.103 \times 34 \times 27)}{\left[0.024 \times 10^6\right]} \times \frac{293}{273+20} \times (1-0) = 3.95x10^{-3} \, g/s$$

There is no emission control for this source.

Under the future scenario the Annular Space exhaust will be comprised of:

➢ Dewatering Day Tanks Scrubber (0.15 m^3/s);
➢ Biosolid Biofilter (20 m^3/s); and
➢ New Biofilter (217 m^3/s)

The New Biofilter will treat the air from:

➢ P Building Scrubber Outlet (20.1 m³/s);
➢ Screens 7-12 Building (3.0 m³/s);
➢ Primary Clarifier Tanks (1-6) Scum Scrubber (2.8 m³/s);
➢ Primary Clarifier 7-9 (33.9 m³/s);
➢ "D" Building (43.5 m³/s); and
➢ Aeration Tanks (111.8 m³/s)

Emission rates were calculated as the sum of each source and applying a removal efficiency of 95% to sulphur bearing compounds (i.e., hydrogen sulphide and mercaptans) for the biofilter. For other compounds, a conservative 40% removal efficiency was assumed. If a source had a control device, the emissions were adjusted to account for the device (i.e., the emissions were converted to uncontrolled before passing to the biofilter).

3.4.10.2   INCINERATOR BUILDING

The Incinerator Building Exhaust (#43A to D) can be separated into four (4) sources. Sources #43A and 43B are existing building exhausts while 43C and 43D are old exhausts (decommissioned in 2000). The only chemical emitted from these sources is hydrogen sulphide. Emissions were calculated from source testing carried out by Zorix in June/July 2001 (Zorix, 2001, 2002d). It was assumed that the hydrogen sulphide concentration remains the same in each exhaust.

The first scenario (Pre 1996) has all four (4) sources operating (#43A to D) while scenarios 2 (2000-2002), 3 (2003-2004) and 4 (2010) only have Sources #43A and 43B operating and #43C and 43D are exhausted into the incinerator stack. The hydrogen sulphide emission rate from each exhaust was calculated with the aid of Equation 3-1, where

$$
\begin{aligned}
C_i &= && 0.001 \text{ ppm} \\
Q_d &= && 23.25 \text{ m}^3/\text{s at 20 °C} \\
MW_i &= && 34 \text{ g/mol}
\end{aligned}
$$

Substitution into Equation 3-1 results in the following;

$$
E_i = \frac{(0.001 \times 34 \times 23.25)}{\left[0.024 \times 10^6\right]} \times \frac{293}{273 + 20} \times (1 - 0) = 3.29x10^{-5} \, g/s
$$

There is no emission control for this source.

3.4.10.3   INCINERATOR STACK

The emissions from the Incinerator Stack (#58) change from scenario to scenario (Table 3-5). Scenario 1 (Pre 1996) is based on three incinerators operating; Scenario 2 (2000) is based on two incinerators operating with a third incinerator on standby; while the current and future scenarios assume that the incinerators are not operating. The emission rates were obtained from the 1994 Incinerator Emission Test Program (EER Canada, 1994) for the first scenario and the 1998 Incinerator Emission Test Program (EER Canada, 1998) for the second.

Table 3-5   Incinerator Operating Schedule for All Four Emission Scenarios

Scenario		# of Incinerators Operating	# of Incinerators on Standby	Flow Rate (m^3/s)
Scenario 1	Incinerator in full operation (pre 1996)	3	0	63.3
Scenario 2	Incinerator in partial operation (2000-2002)	2	1	42.2
Scenario 3	Incineration discontinued (2003-2004)	0	0	--
Scenario 4	Incineration discontinued and odour control measures implemented	0	0	--

3.4.11 BOILER STACK

The emissions from the natural gas boiler (#121) change for each scenario. There are four (4) large ('new') boilers, eighteen (18) small ('old') boilers and two (2) medium sized ('old) boilers. Table 3-7 shows which boilers were operating during the different scenarios. The older boilers do not have low-NO_x burners. The new boilers have low-NO_x burners so the appropriate emission factor for the size of the boilers was used, as per U.S. EPA AP 42.

Table 3-7   Boiler Operations for Each Emissions Scenario

Boiler Type	*Scenario*			
	Scenario #1	*Scenario #2*	*Scenario #3*	*Scenario #4*
NG Fired Boiler - (4 Large Boilers)	Not Operating	50%	Full Operation	Full Operation
NG Fired Boiler - (2 Medium Sized Boilers)	Full Operation	50%	Not Operating	Not Operating
NG Fired Boiler - (18 Small Boilers)	Full Operation	50%	Not Operating	Not Operating

Scenario 1   incinerator in full operation (pre 1996)
Scenario 2   incinerator in partial operation (2000-2002)
Scenario 3   incineration discontinued (2003-2004)
Scenario 4   incineration discontinued and odour control measures implemented.

The emission calculations for the boilers were completed based on the thermal rating (Btu/hr) or the natural gas consumption of each boiler. Using the natural gas heat content of 1012 Btu/ft^3, the emissions were calculated with the aid of Equation 3-5, where

$$
\begin{aligned}
A \quad &= \quad \text{Rate of Natural Gas consumed} \\
EF_i \quad &= \quad \text{uncontrolled emission factor of NOx} = 0.068 \text{ lb/}10^6 \text{ Btu} \\
CE_i \quad &= \quad \text{overall control efficiency 0\%}
\end{aligned}
$$

Substitution into Equation 3-5 results in the following:

$$
E = A \times 1012 \times 0.068 \times 454 \times \left(1 - \frac{CE_i}{100}\right)
$$

In the above, CE_i was assumed to be negligible.

3.4.12 FLARES

The emissions from the Digestor Flares (#118A to C) are based on U.S. EPA AP-42 Emission Factors for Industrial Flares (Section 13.5). It is assumed that the digester gas has a British thermal unit (Btu) rating of 1012 Btu/ft^3. The only chemicals calculated for the flares are nitrogen oxides (NO$_x$) and SO$_2$. The emissions are calculated with the aid of Equation 3-5, where

$$
\begin{aligned}
A \quad &= \quad \text{Rate of digester gas consumed} \\
EF_i \quad &= \quad \text{uncontrolled emission factor of NOx} = 0.068 \text{ lb/}10^6 \text{ Btu} \\
CE_i \quad &= \quad \text{overall control efficiency 0\%}
\end{aligned}
$$

Substitution into Equation 3-4

$$
E = A \times 1012 \times 0.068 \times 454 \times \left(1 - \frac{CE_i}{100}\right)
$$

In the above, CE_i is assumed to be negligible. The flares are for emergency situations only. Under normal operations all digested gases will be consumed at the boilers and there are no emissions from the flares for all four (4) scenarios.

3.4.13 NEGLIGIBLE OR TRACE EMISSIONS

Emergency Diesel Generators will be included as part of the emissions inventory but will not be modelled since many other processes are not operating when the generators are in use. In addition, tail-pipe emissions from vehicles and road dust arising from the vehicular traffic on the ABTP property are not included, as these sources represent insignificant sources at the ABTP.

3.5   SUMMARY OF EMISSIONS

Application of the emission estimation techniques discussed above, resulted in an emission inventory of 186 chemicals from the ABTP. Emissions from the facility include

- Criteria Air Contaminants (Sulphur Dioxide (SO_2), Nitrogen Oxides (NOx), Carbon Monoxide (CO), Particulate Matter (PM), Particulate Matter less than 10 microns (PM_{10}) and Particulate Matter less than 2.5 microns ($PM_{2.5}$);
- Sulphur Bearing Compounds (Hydrogen Sulphide (H_2S) & Mercaptans);
- Volatile Organic Compounds (VOCs);
- Dioxin and Furans;
- Polycyclic Aromatic Hydrocarbons (PAHs);
- Chlorobenzenes;
- Polychlorinated Biphenyls (PCBs);
- Chlorophenols; and
- Metals

An overall summary of the frequency of estimation technique used to develop the ABTP emissions inventory is presented in Table 3-9. As illustrated, Zorix source testing was used for a majority of the emission estimations followed by Mass Balance calculations.

The potential emissions from each chemical per scenario are summarized in Table 3-11. All of the emissions are attached in Appendix B (in a CD). Appendix B includes a summary of estimation techniques by chemical.

Table 3-9   Frequency of Emission Estimation Techniques Applied at ABTP

Reference	Description	% Applied
MB	Mass Balance Calculations	12.7%
EF	Emission Factor published by the USEPA	0.4%
ZORIX	Source Testing Conducted by ZORIX	80.8%
EE	Engineering Estimation	0.1%
SM	Source Measurement	6.1%

Table 3-11   Summary of Annual ABTP Emissions

	Chemical	CAS #	Scenario 1 (Pre-1996) (kg/day)	Scenario 2 (2000-2002) (kg/day)	Scenario 3 (2003) (kg/day)	Scenario 4 (Future) (kg/day)
1	1,1 - Dichloroethene	75-35-4	0.35	2.03	3.71	1.48
2	1,1,2 - Trichloroethane	79-00-5	0.99	0.52	0.31	0.15
3	1,2 - Dichloroethane	107-06-2	0.87	0.36	0.36	0.16
4	1,1,2,2 - Tetrachloroethane	79-34-5	1.75	0.75	0.75	0.35
5	1,1 Dichloroethane	75-34-3	1.37	1.13	0.89	0.41
6	1,2 - Dibromoethane	106-93-4	0.56	0.45	0.59	0.27
7	1,1,1 - Trichloroethane	71-55-6	1.48	0.44	0.44	0.19
8	1,2 - Dichlorotetrafluoroethane	76-14-2	0.85	0.90	0.90	0.43
9	1,2 - Dichloropropane	78-87-5	1.69	0.66	0.66	0.29
10	1,2,4 - Trimethylbenzene	95-63-6	1.02	1.05	1.05	0.41
11	1,3,5 - Trimethylbenzene	108-67-8	0.60	0.63	0.63	0.27
12	2,4 - Dichlorophenol	120-83-2	1.40	0.35	0.35	0.14
13	Acetic acid	64-19-7	2.31	2.46	2.46	1.16
14	Ammonia	7664-41-7	0.82	5.82	5.82	5.29
15	Benzene	71-43-2	6.60	1.88	1.77	0.67
16	Bis(2-ethylhexyl)phthalate	117-81-7	17.03	3.50	7.70	3.08
17	Bromoethane	74-83-9	0.81	1.97	0.85	0.39
18	Butylbenzyl phthalate	85-68-7	7.09	0.35	0.35	0.14
19	Butyric acid	107-92-6	2.31	2.46	2.46	0.53
20	Carbon disulphide	75-15-0	3.25	3.47	3.47	1.04
21	Carbon Tetrachloride	56-23-5	1.06	1.02	0.56	0.25
22	Chlorobenzenes	108-90-7	0.95	0.47	0.44	0.20
23	Chloroform	67-66-3	4.19	2.89	2.85	1.10
24	Chloromethane	74-87-3	8.50	1.80	0.68	0.31
25	cis-1,2-Dichloroethene	156-59-2	0.44	0.70	0.46	0.20
26	cis-1,3-dichloropropylene	10061-01-5	0.33	4.36	0.34	0.04
27	Dichlorodifluoromethane	75-71-8	1.13	1.16	0.63	0.29
28	Dichloromethane	75-09-2	0.70	0.74	0.74	0.33
29	Diethylphthalate	84-66-2	10.57	0.35	0.35	0.14
30	Dimethyl disulphide	624-92-0	5.03	5.37	5.37	1.62
31	Di-n-butyl phthalate	84-74-2	8.98	2.80	0.35	0.14
32	Di-n-octyl phthalate	117-84-0	0.63	0.14	1.26	0.50
33	Diphenyl ether	101-84-8	9.70	0.35	0.35	0.14
34	Ethyl Benzene	100-41-4	47.97	1.41	0.50	0.22
35	Ethyl Mercaptan/Dimethyl Sulfide	75-08-1	3.32	3.54	3.54	1.07
36	Formic acid	64-18-6	2.31	2.46	2.46	1.16
37	Hexachlorobutadiene	87-68-3	1.26	0.78	0.78	0.35
38	Hydrogen Sulphide	7783-06-4	118.67	119.97	125.54	11.77
39	Hydrogen Sulphide/carbonyl sulphide	7783-06-4	118.67	119.97	125.54	11.77
40	Indole	10075-50-0	0.35	23.45	30.80	12.32
41	Lactic acid	50-21-5	2.31	2.46	2.46	0.53

	Chemical	CAS #	Scenario 1 (Pre-1996) (kg/day)	Scenario 2 (2000-2002) (kg/day)	Scenario 3 (2003) (kg/day)	Scenario 4 (Future) (kg/day)
42	Methyl Mercaptan	74-93-1	2.89	3.06	3.06	0.84
43	Methyl phenol	1319-77-3	18.90	0.35	0.35	0.14
44	Nitrobenzene	98-95-3	3.78	0.35	0.35	0.14
45	m-cresol	108-39-4	-	-	-	-
46	p-cresol	106-44-5	0.35	16.45	0.35	0.14
47	Pentachlorophenol	87-86-5	3.50	0.35	0.35	0.14
48	Phenol	108-95-2	30.57	6.09	0.35	0.14
49	Propionic acid	79-09-04	2.31	2.46	2.46	1.16
50	Propyl mercaptan/Methyl Ethyl Sulfide	107-03-9	8.13	8.68	8.68	4.09
51	Styrene	100-42-5	1.50	0.62	0.66	0.30
52	Tellurium	13494-80-9	0.01	0.00	-	-
53	Tetrachloroethene	127-18-4	13.98	15.26	14.39	7.32
54	Toluene	108-88-3	98.82	8.56	3.63	0.47
55	1,2-dichloropropane.		1.69	0.66	0.66	0.29
56	Trichloroethene	79-01-6	0.99	0.48	0.48	0.21
57	Trichlorofluoromethane	75-69-4	3.85	3.93	3.37	1.20
58	Trichlorotrifluoroethane	26523-64-8	2.58	2.75	2.75	1.30
59	Vinyl chloride	75-01-4	1.59	1.75	0.56	0.26
60	Xylene	1330-20-7	53.92	3.02	0.64	0.30
	Criteria Air Contaminants					
61	Particulate Matter (as $PM_{2.5}$)	N/A-PM	48.51	60.74	6.87	6.87
62	Carbon Monoxide	630-08-0	-	-	-	-
63	Nitrogen Oxides	10102-44-0	548.12	492.54	163.35	163.35
64	Sulphur Dioxide	7446-09-5	82.38	84.27	29.76	9.33
	Dioxins and Furans					
65	2,3,7,8-Tetrachlorodibenzofuran	51207-31-9	3.53E-08	3.76E-08	-	-
66	2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	1746-01-6	3.14E-08	1.38E-08	-	-
67	1,2,3,7,8-Pentachlorodibenzofuran	--	3.79E-08	6.45E-09	-	-
68	2,3,4,7,8-Pentachlorodibenzofuran	57117-31-4	3.79E-08	1.02E-08	-	-
69	1,2,3,7,8-Pentachlorodibenzo-p-dioxin	--	3.12E-08	5.56E-09	-	-
70	1,2,3,4,6,7,8-Heptachlorodibenzofuran	--	5.26E-08	7.98E-09	-	-
71	1,2,3,4,6,7,8-Heptachlorodibenzop-dioxin	--	4.37E-08	2.71E-08	-	-
72	1,2,3,4,6,7,8,9-Octachlorodibenzofuran	--	3.70E-08	2.08E-08	-	-
73	1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin	--	6.96E-08	6.73E-08	-	-
74	1,2,3,4,7,8-Hexachlorodibenzofuran	70648-26-9	2.71E-08	7.09E-09	-	-
75	1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	--	4.01E-08	1.81E-08	-	-
76	1,2,3,6,7,8-Hexachlorodibenzofuran	--	1.62E-08	3.99E-09	-	-
77	2,3,4,6,7,8-Hexachlorodibenzofuran	--	2.71E-08	4.64E-09	-	-
78	1,2,3,7,8,9-Hexachlorodibenzofuran	--	3.07E-08	4.75E-09	-	-
79	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	--	2.12E-08	3.47E-09	-	-
80	1,2,3,7,8,9-Hexachlordibenzo-p-dioxin	--	3.00E-08	4.15E-09	-	-
81	1,2,3,4,7,8,9-Heptachlorodibenzofuran	--	3.22E-08	7.50E-09	-	-
82	Total Dioxins and Furans (as 2,3,7,8-TCDD eq)	--	9.21E-08	3.09E-08	-	-

	Chemical	CAS #	Scenario 1 (Pre-1996) (kg/day)	Scenario 2 (2000-2002) (kg/day)	Scenario 3 (2003) (kg/day)	Scenario 4 (Future) (kg/day)
	PAH's					
83	1-methylnaphthalene	90-12-0	0.35	0.35	0.35	0.14
84	1-Methylphenanthrene	832-69-9	0.00016	0.00017	-	-
85	2-Chloronaphthalene	91-58-7	1.40	0.35	0.35	0.14
86	2-Methylanthracene	613-12-7	0.00016	0.00017	-	-
87	2-Methylnaphthalene	91-57-6	0.35	0.35	0.35	0.14
88	3-Methylcholanthrene	56-49-5	0.0031	0.0035	-	-
89	7, 12-Dimethylbenz[a]anthracene	57-97-6	0.00016	0.00017	-	-
90	9,10 - Dimethylanthracene	781-43-1	0.00063	0.00069	-	-
91	9-Methylphenanthrene	883-20-5	0.00016	0.00017	-	-
92	Acenaphthene	83-32-9	12.32	0.35	0.35	0.14
93	Acenaphthylene	208-96-8	2.10	0.35	0.35	0.14
94	Anthracene	120-12-7	18.20	0.35	0.35	0.14
95	Benzo[a]anthracene	56-55-3	6.58	0.35	0.35	0.14
96	Benzo[a]fluorene	238-84-6	0.00016	0.00017	-	-
97	Benzo[a]pyrene	50-32-8	1.40	0.35	0.35	0.14
98	Benzo[b&k]fluoranthene	205-99-2	1.40	0.35	0.35	0.14
99	Benzo[b]fluoranthene	205-99-2	1.40	0.35	0.35	0.14
100	Benzo[b]fluorene	243-17-4	0.00016	0.00017	-	-
101	Benzo[e]pyrene	192-97-2	0.00016	0.00017	-	-
102	Benzo[g,h,i]perylene	191-24-2	3.50	0.35	0.35	0.14
103	Benzo[k]fluoranthene	207-08-9	0.35	0.35	0.35	0.14
104	Biphenyl	92-52-4	0.35	0.56	0.35	0.14
105	Chrysene	218-01-9	2.38	0.35	0.35	0.14
106	Coronene	191-07-1	0.00016	0.00017	-	-
107	Dibenzo[a, l]pyrene	129-00-0	5.57	0.35	0.35	0.14
108	Dibenzo[a,h]anthracene	53-70-3	3.50	0.35	0.35	0.14
109	Fluoranthene	206-44-0	4.55	0.35	0.35	0.14
110	Fluorene	7782-41-4	11.20	0.35	0.35	0.14
111	Indeno[1,2,3-c,d]pyrene	193-39-5	1.40	0.35	0.35	0.14
112	m-Terphenyl	92-06-8	0.00016	0.00017	-	-
113	Naphthalene	91-20-3	16.57	0.15	0.35	0.14
114	o-Terphenyl	84-15-1	0.00016	0.00017	-	-
115	Perylene	198-55-0	0.35	0.35	0.35	0.14
116	Phenanthrene	85-01-8	6.42	0.35	0.35	0.14
117	Picene	213-46-7	0.00016	0.00017	-	-
118	p-Terphenyl	92-94-4	0.00016	0.00017	-	-
119	Pyrene	129-00-0	5.57	0.35	0.35	0.14
120	Quinoline	91-22-5	0.0002	0.0003	-	-
121	Tetralin	119-64-2	0.0030	0.0025	-	-
122	Triphenylene	217-59-4	0.0002	0.0001	-	-

	Chemical	CAS #	Scenario 1 (Pre-1996) (kg/day)	Scenario 2 (2000-2002) (kg/day)	Scenario 3 (2003) (kg/day)	Scenario 4 (Future) (kg/day)
	Chlorobenzenes					
123	1,2 - Dichlorobenzene	95-50-1	2.26	2.22	1.10	0.43
124	1,2,3 - Trichlorobenzene	87-61-6	0.00016	0.00017	-	-
125	1,2,3,4 - Tetrachlorobenzene	634-66-2	0.00016	0.00017	-	-
126	1,2,4 - Trichlorobenzene	120-82-1	1.20	0.71	0.71	0.32
127	1,3 - Dichlorobenzene	541-73-1	0.96	0.94	0.45	0.20
128	1,3,5 - Trichlorobenzene	108-70-3	0.00016	0.00017	-	-
129	1,4 - Dichlorobenzene	106-46-7	1.55	1.19	0.67	0.30
130	Hexachlorobenzene	118-74-1	1.40	0.35	0.35	0.14
131	Pentachlorobenzene	608-93-5	0.00016	0.00017	-	-
	PCB's					
132	Chlorobiphenyl	37324-23-5	0.00016	0.00017	-	-
133	Decachlorobiphenyl	2051-24-3	0.00016	0.00017	-	-
134	Dichlorobiphenyl	2050-68-2	0.00016	0.00017	-	-
135	Heptachlorobiphenyl	28655-71-2	0.00016	0.00017	-	-
136	Hexachlorobiphenyl	26601-64-9	0.00016	0.00017	-	-
137	Nonachlorobiphenyl	53742-07-7	0.00016	0.00017	-	-
138	Octachlorobiphenyl	55722-26-4	0.00016	0.00017	-	-
139	Pentachlorobiphenyl	25429-29-2	0.00016	0.00017	-	-
140	Tetrachlorobiphenyl	26914-33-0	0.00016	0.00017	-	-
141	Trichlorobiphenyl		0.00016	0.00017	-	-
	Chlorophenols					
142	2,3 - Dichlorophenol	576-24-9	0.00016	0.00017	-	-
143	2,3,4 - Trichlorophenol	15950-66-0	0.35	0.35	0.35	0.14
144	2,3,4,5 - Tetrachlorophenol	4901-51-3	0.35	0.35	0.35	0.14
145	2,3,4,6 - Tetrachlorophenol	58-90-2	0.35	0.35	0.35	0.14
146	2,3,5 - Trichlorophenol	933-78-8	0.00016	0.00017	-	-
147	2,3,5,6 - Tetrachlorophenol	935-95-5	0.35	0.35	0.35	0.14
148	2,3,6 - Trichlorophenol	933-75-5	0.35	0.35	0.35	0.14
149	2,4,5 - Trichlorophenol	95-95-4	3.50	0.35	0.35	0.14
150	2,4,6 - Trichlorophenol	88-06-2	3.50	0.35	0.35	0.14
151	2,6 - dichlorophenol	87-65-0	0.35	0.35	0.35	0.14
152	3,4 - Dichlorophenol	95-77-2	0.00016	0.00017	-	-
153	3,4,5 - Trichlorophenol	609-19-8	0.00016	0.00017	-	-
154	3,5 - Dichlorophenol	591-35-5	0.00016	0.00017	-	-
	Metals					
155	Aluminum	7429-90-5	0.70	0.16	-	-
156	Antimony	7440-36-0	0.00	0.01	-	-
157	Arsenic	7440-38-2	0.01	0.03	-	-
158	Barium	7440-39-3	0.04	0.00	-	-
159	Beryllium	7440-41-7	0.0005	0.0003	-	-
160	Bismuth	7440-69-9	0.12	0.22	-	-
161	Boron	7440-42-8	0.01	0.02	-	-

	Chemical	CAS #	Scenario 1 (Pre-1996) (kg/day)	Scenario 2 (2000-2002) (kg/day)	Scenario 3 (2003) (kg/day)	Scenario 4 (Future) (kg/day)
162	Cadmium	7440-43-9	0.18	0.24	-	-
163	Calcium	7440-70-2	1.64	0.32	-	-
164	Chromium	7440-47-3	0.03	0.01	-	-
165	Cobalt	7440-48-4	0.004	0.003	-	-
166	Copper	7440-50-8	0.12	0.12	-	-
167	Iron	15438-31-0	3.22	0.38	-	-
168	Lead	7439-92-1	0.20	0.56	-	-
169	Lithium	7580-67-8	0.0023	0.01	-	-
170	Magnesium	7429-95-4	0.22	0.03	-	-
171	Manganese	7439-96-5	0.03	0.01	-	-
172	Mercury	7439-97-6	0.10	0.39	0.000049	0.000020
173	Molybdenum	7439-98-7	0.03	0.03	-	-
174	Nickel	7440-02-0	0.01	0.00	-	-
175	Phosphorus	7723-14-0	1.26	0.67	-	-
176	Potassium	7440-09-7	0.19	0.26	-	-
177	Selenium	7782-49-2	0.04	0.04	-	-
178	Silicon	7440-21-3	244.8	15.3	-	-
179	Silver	7440-22-4	0.05	0.02	-	-
180	Sodium	7440-23-5	1.33	1.65	-	-
181	Strontium	7440-24-6	0.01	0.0018	-	-
182	Thallium	7440-28-0	-	0.02	-	-
183	Tin	7440-31-5	0.18	0.34	-	-
184	Titanium	7440-32-6	0.07	0.01	-	-
185	Vanadium	7440-62-2	0.00146	0.0019	-	-
186	Zinc	7440-66-6	0.28	0.55	-	-

Scenario 1   incinerator in full operation (pre 1996)
Scenario 2   incinerator in partial operation (2000-2002)
Scenario 3   incineration discontinued (2003-2004)
Scenario 4   incineration discontinued and odour control measures implemented.

4.0   SELECTION OF CHEMICALS OF CONCERN

Chemicals of Concern (COC) were selected from the 186 chemicals estimated to be potentially emitted from the ABTP. The same COCs were used for modelling in all the 4 scenarios but were not necessarily common to all 4 scenarios. The selection process was based on the following steps:

I.   Rank chemical species

      a) Method 1a – Rank chemicals based on calculated Toxic Equivalents for carcinogenic effects
      b) Method 1b - Rank chemicals based on calculated Toxic Equivalents for non-carcinogenic effects
      c) Method 2 - Rank chemicals based on their toxicity, emissions, persistence, and bioaccumulation

II. Compare the top 25 chemicals from each method/scenario combination.

III. Identify chemicals that occur most frequently in the top 25 ranking chemicals in each method/scenario combination

IV. Identify chemicals which were found to be above laboratory detection limits.

V.   Select chemicals which are important to the communities

The above process allows for a pragmatic scientific means of selecting chemicals but also considers the community's concerns for what can be released. The ranking was carried out independently for each scenario and each method.

4.1   SHORT LISTING CHEMICALS

Prioritization of chemicals was based on two different methods. The first method is a risk-based scoring system used by the Environmental Defence Fund (EDF, 2003) to identify environmental releases of chemicals that are likely to pose the greatest risk to human health. This system was developed by Drs. Edgar Hertwich and William Pease (1998, 2001), in collaboration with colleagues at the School of Public Health at the University of California at Berkeley. This system adjusts the amount of a chemical that is released using a weighting factor (a chemical's "toxic equivalency potential" or TEP), so that chemical releases can be compared on a common scale that takes into account differences in toxicity and exposure potential. This scoring system ranks carcinogens and non-carcinogens separately – Methods 1a and 1b, respectively. The amount of information required to derive TEPs may not be readily available for some chemicals. As a result, EDF has not derived TEPS for these chemicals although some of these chemicals are known to have high toxicity.

EDF has chosen benzene as the reference chemical for cancer effects because its cancer potency is in the middle of the range of carcinogenic chemicals and the general public is familiar with the chemical name "benzene". Total emissions of each chemical were converted to the amount of benzene-equivalents, which represent the amount of benzene that would have to be released into the air to pose the same

approximate level of cancer risk as the reported release of the chemical. Chemicals were ranked based on their benzene-equivalent values (or toxic equivalents for carcinogenic effects).

In the case of non-cancer effects, EDF has chosen toluene as the reference chemical. Emissions of noncarcinogens were converted to the amount of toluene-equivalents, which represent the amount of toluene that would have to be released into the air to pose the same level of non-cancer health risk as the reported release of the chemical. Non-carcinogens were ranked based on their toluene-equivalent values (or toxic equivalents for non-carcinogenic effects).

The second method ranks chemicals using four different criteria:

➢ toxicity,
➢ emissions,
➢ persistence, and
➢ bioaccumulation.

This method relies only on total emissions information and does not take into account other factors that affect the potential for human exposure, such as degradation of the chemical, dispersion of the emission and whether a pathway for exposure can be established. Detailed descriptions of both chemical ranking methods are provided in Appendix C.

The short listing of the chemicals resulted in 76 unique chemicals being identified over the 4 scenarios. It was evident that particular chemicals were consistently among the top ranking chemical species in all the scenarios no matter which ranking method was used. The number of chemicals was subsequently reduced to those which frequently occurred and had a higher potential health impact. Appendix C presents the 30 top ranking chemicals for each scenario identified using different prioritization methods. These lists are presented alphabetically as well as by the frequency of occurrence.

In reviewing these different chemicals, it is apparent that a significant number of chemicals were questionable. Many of the chemicals that had high ranking in all four scenarios were the result of air emission testing or water sampling and were found to be below the analytical detection limit. Laboratory analyses were carried out for a suite of compounds whether they were suspected to be present or not. In developing the emission inventory, chemicals below the detection limit were assigned the detect limit. This method of managing non-detected chemicals is very conservative but avoids biasing the results early in the process. It is highly unlikely that chemicals below the detection limit are actually present. This aspect was taken into consideration in the selection of the final COCs, which are above the detection limit with one exception.

4.2   SELECTION OF FINAL CHEMICALS OF CONCERN

The initial 186 chemicals were screened using objective and transparent means to identify potential COCs for air dispersion modelling. It was agreed that a select number of chemicals were to be included even though they may or may not be in the top 25, namely

➢   Criteria Air Contaminants (SO$_2$, NOx, PM$_{2.5}$);
➢   Hydrogen Sulphide;
➢   PCB (congeners with 4 or more chlorine substitution groups or Cl ≥ 4);
➢   Benzene
➢   Dioxins and Furans; and
➢   PAH's

Table 4-1 presents the COCs selected for air dispersion modelling, their individual ranks by each method used and whether the substance was detected or not.

The criteria air chemicals were included because SO2 and NOx have been identified as precursors to respirable particulate matter (i.e., PM2.5) as ammonium sulphate and ammonium nitrate, respectively. Respirable particulate matter has been classified as Toxic under the Canadian Environmental Protection Act (CEPA). In addition, the ABTP combustion sources (i.e., boilers, flares, etc) directly release fine particulate. Since PM2.5 has been given a high profile, it has been included in the COCs.

Hydrogen sulphide is released in the greatest quantity from the facility; therefore it was prudent to include it in the analysis. PCBs, Dioxins and Furans were included because they were detected in the emissions (i.e., air testing or water) and are highly visible to the public. Although both substances were detected and were among the 25 top-ranking chemicals, benzene was chosen over tetrachloroethene since the public is more familiar with the chemical name "benzene" and its potential toxic effects. Benzene is classified as a human carcinogen by all credible international agencies (Health Canada, 1996; USEPA, 1998a; IARC, 1987). On the other hand, there is no consensus on the evaluation of carcinogenicity for tetrachloroethene, which ranges from "unlikely to be carcinogenic to humans" by Health Canada (1996) to "probably carcinogenic to humans" by International Agency for Research on Cancer (1995).

Polycyclic Aromatic Hydrocarbons (PAH) were found consistently at the top of virtually each chemical list sorted by whichever ranking method but review of the data indicated that PAHs, including benzo[a]pyrene (B[a]P) were below the analytical detection limits. It was decided to include total PAHs as well as B[a]P in the COC list because PAHs are products of incomplete burning, likely generated during incineration and B[a]P is the most toxic among the PAHs. Although each individual PAH may be below the detection limit, there are hundreds of PAHs emitted at the same time.

A significant portion of the PAH emission inventory was derived from the mass balance technique used on the wastewater entering and exiting the ABTP. It was assumed that the PAHs would be volatized into the atmosphere at the open area sources, such as the Primary Clarifiers. This assumption is highly conservative since PAHs have a low vapour pressure and are not akin to volatilizing into the atmosphere.

Both the scientific literature and measurements at the plant provide supporting evidence for these characteristics for B[a]P and other PAHs. Because of low aqueous solubility and high Kow, a larger fraction of the chemical tends to be adsorbed onto particles and dissolved organic matter in the water column rather than being volatilized (Awata H et al. 1998). The overall losses to the atmosphere have been found to be less than 1% (0.1 - 0.9%) in the field (Awata H et al. 1998; Fairey and Loehr, 2003). Also, the concentration of B[a]P in both the influent and effluent of the treatment plant in 2000 and 2001 were the same (0.5 μg/L), indicating that very little B[a]P volatized into the atmosphere. These findings suggest that assuming 100% volatilization for B[a]P (and other PAHs) overestimates the total emission of B[a]P (and other PAHs) by at least two orders of magnitude.

Table 4-1   Final List of Chemicals of Concern and their Rankings

	Chemical	CAS	Ranking												Comments
			Scenario 1			*Scenario 2*			*Scenario 3*			*Scenario 4*			
			Method 1a	*Method 1b*	*Method 2*	*Method 1a*	*Method 1b*	*Method 2*	*Method 1a*	*Method 1b*	*Method 2*	*Method 1a*	*Method 1b*	*Method 2*	
1	Arsenic	7440-38-2	10	15	6	6	9	4	6	9	4				Detect
2	Benzene	71-43-2	20			24			15			14			Detect
3	Benzo[a]Pyrene	50-32-8													ND
4	Bis(2-ethylhexyl)phthalate	117-81-7		16	13		22	17	21	11	7	21	11	7	Detect
5	Cadmium	7440-43-9	2	2	3	1	1	2							Detect
6	Di-n-octyl phthalate	117-84-0		5			6			1	10		1	10	Detect
7	Hexachlorobutadiene	87-68-3	7	8	9	8	7	9	5	3	5	5	3	5	Detect
8	Hydrogen Sulphide	6/4/7783													Detect
9	Lead	7439-92-1	23	3	16	10	3	11							Detect
10	Mercury	7439-97-6		1	12		2	7		8	21		9	20	Detect
11	Nitrogen Oxides	10102-44-0		11			14			10			8		Detect
12	PM$_{2.5}$	N/A-PM													Detect
13	PCB's (>=4 Cl)				10			8							Detect
14	Sulphur Dioxide	7446-09-5													Detect
15	Total Dioxins and Furans (as 2,3,7,8 TCDD eq)	1746-01-6		12		23	12								Detect
16	Total PAH's	50-32-8	1		1	2		1	1		1	1		1	ND
17	Vinyl chloride	75-01-4				7	11		20	18		19	17		Detect

Method 1a – Ranked chemicals based on their calculated Toxic Equivalents for carcinogenic effects

Method 1b – Ranked chemicals based on their calculated Toxic Equivalents for non-carcinogenic effects

Method 2 – Ranked chemicals based on their toxicity, emissions, persistence, and bioaccumulation

Detect   Above or at Laboratory Detection Limits

ND   Below Laboratory Detection Limits

Scenario 1   incinerator in full operation (pre 1996)

Scenario 2   incinerator in partial operation (2000-2002)

Scenario 3   incineration discontinued (2003-2004)

Scenario 4   incineration discontinued and odour control measures implemented.

The estimation technique used per COC is presented in . As illustrated, direct measurements (i.e., source testing and Zorix testing) represent a significant portion of the techniques applied (~63%), while the mass balance approach represents about 27% of the cases. Generally, we should have a high degree of confidence in the source testing data and lower confidence in the mass balance. As discussed above, in the mass balance technique, 100% of the material has been assumed to volatilize into the atmosphere even though it has a low vapour pressure and/or low fugacity.

Table 4-3   Calculation Methodology for Chemicals of Concern

	Chemical	*% of Calculation Methodology*				
		Mass Balance	*Source Tested by Zorix*	*Engineering Estimate*	*Emission Factor*	*Source Tested*
1	Arsenic	-	-	-	-	100%
2	Benzene	8%	92%	-	-	-
3	Benzo[a]pyrene	80%	-	-	-	20%
4	Bis(2-ethylhexyl)phthalate	100%	-	-	-	-
5	Cadmium	-	-	-	-	100%
6	Di-n-octyl phthalate	100%	-	-	-	-
7	Total Dioxins and Furans (as 2,3,7,8 TCDD eq)					100%
8	Hexachlorobutadiene	8%	92%	-	-	-
9	Hydrogen Sulphide	-	97%	3%	-	-
10	Lead	-	-	-	-	100%
11	Mercury	80%	-	-	-	20%
12	Nitrogen Oxides	-	-	-	100%	-
13	Total PAH's	68%	-	-	-	32%
14	Particulate Matter	-	-	-	67%	33%
15	PCB's					100%
16	Sulphur Dioxide	-	97%	-	3%	-
17	Vinyl chloride	11%	89%	-	-	-

The Ontario Ambient Air Quality Criteria (AAQC)/Point-of-Impingement (POI) standards for the COC's are presented in . The AAQCs and POI standards for many of the chemical compounds emitted at the ABTP, including arsenic, B[a]P, cadmium, hydrogen sulphide, mercury and vinyl chloride, have been identified by the Ministry as requiring regulatory review (MOE, 1999). For these species and others (e.g. benzene, hexachlorobutadiene, PCBs with 4 or more chlorine substitution groups) that MOE does not have AAQC/POI standards, an appropriate health benchmark needs to be identified for assessing air quality and health impact. In keeping with the standard development process used by the Ministry (MOE, 1998), the health benchmark[1] was selected from major regulatory agencies, including United States Environmental Protection Agency (USEPA), Health Canada, World Health Organization and California

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[1] Health benchmark for air exposure refers to guideline value (GV) by World Health Organization, Reference Concentration (RfC) by USEPA and California EPA, Tolerable Concentration (TC) by Health Canada for noncarcinogenic effects and concentration corresponding to an excess lifetime cancer risk of 1 E-6 (one in a million) for carcinogenic effects.

Environmental Protection Agency after a review of their scientific basis. The goal is to select a published health benchmark applicable to our study objective and one that is associated with the least level of uncertainty based on current knowledge and understanding about the substance and risk assessment methods. Only health benchmarks that have gone through a thorough scientific peer review were being considered. The selection was conducted on a chemical-by-chemical basis. The health benchmarks adopted by TPH for the COCs are also presented in where appropriate. The 24-hr health benchmarks adopted are typically three orders of magnitude below the 24 hr AAQC. Note that a range in limits is given for H_2S, as there are large variations in data.

Table 4-4   Comparison of Ontario AAQC/POI with Air Quality Health Benchmarks

	Chemical	CAS No.	Ambient Air Quality Criteria/POI ($\mu g/m^3$)				Health benchmark ($\mu g/m^3$)
			POI (1/2 hr)	*AAQC (1 hr)*	*AAQC (24 hr)*	*AAQC (1 yr)*	*(24 hr)*
1	Arsenic	7440-38-2	1		0.3		0.00066[d]
2	Benzene	71-43-2					0.3[d]
3	Benzo[a]pyrene [a]	50-32-8	0.0033[b]		0.0011[b]	0.00022[b]	0.000012 [c, d]
4	Bis(2-ethylhexyl)phthalate	117-81-7	100		50		
5	Cadmium [a]	7440-43-9	5		2		0.0006[d]
6	Di-n-octyl phthalate	117-84-0	100		120		
7	Hexachlorobutadiene	87-68-3					1.19
8	Hydrogen Sulphide [a]	7783-06-4	30	30			2-10
9	Lead	7439-92-1	6		2		
10	Mercury [a]	7439-97-6	5		2.5		0.3
11	Nitrogen Oxides	10102-44-0	500	400	200		
12	PM$_{2.5}$				30		30
13	PCBs with 4 or More Cl (total) [a]						0.00175[d]
14	Sulphur Dioxide	7446-09-5	830	690	275	55	
15	Total Dioxins and Furans (as 2,3,7,8-TCDD eq)		15.0E-06		5.0E-06		
16	Total PAHs						
17	Vinyl Chloride [a]	75-01-4	3		1		0.1[d]

Health Benchmarks provided by TPH

[a] - These chemical species have been identified by MOE for regulatory review of their AAQCs (24 hr) and POI (1/2 hr) standards.

[b] - Based on B[a]P only.

[c] - Based on B[a]P as a surrogate for the toxicity of the whole PAH mixture. The risk from exposure to total PAHs in the air would be negligible if B[a]P level is found to be below this health benchmark for B[a]P.

[d] - The health benchmark corresponds to an excess lifetime cancer risk of one in a million (or 1E-06), which meets Health Canada and MOE benchmark of negligible risk.

Table 4-4   Final Emission Rates Used for Modelling Scenarios

	Chemical	Total Emission Rate (g/s)			
		Scenario #1	*Scenario #2*	*Scenario #3*	*Scenario #4*
1	Arsenic	0.00010	0.00031	-	-
2	Benzene	0.076	0.022	0.020	0.0078
3	Benzo(a)pyrene	0.016	0.004	0.0041	0.0016
4	Bis(2-ethylhexyl)phthalate	0.20	0.04	0.089	0.036
5	Cadmium	0.0021	0.0028	-	-
6	Di-n-octyl phthalate	0.0073	0.0016	0.015	0.006
7	Hexachlorobutadiene	0.015	0.009	0.0090	0.0041
8	Hydrogen Sulphide	1.5	1.5	1.5	0.1
9	Lead	0.0023	0.0064	-	-
10	Mercury	0.0012	0.0045	5.7E-07	2.3E-07
11	Nitrogen Oxides	6.3	5.7	1.9	1.9
12	PM$_{2.5}$*	0.52	0.65	0.079	0.079
13	PCBs Greater or Equal to 4 Chlorines	0.000013	0.000014	-	-
14	Total Dioxins and Furans (as 2,3,7,8- TCDD eq).	1.07E-09	3.58E-10	-	-
15	Sulphur Dioxide	0.95	1.6	0.34	0.11
16	Total PAHs	1.2	1.2	0.089	0.034
17	Vinyl Chloride	0.018	0.020	0.0065	0.0030

*Direct particulate emissions only

Scenario 1   incinerator in full operation (pre 1996)
Scenario 2   incinerator in partial operation (2000-2002)
Scenario 3   incineration discontinued (2003-2004)
Scenario 4   incineration discontinued and odour control measures implemented.

5.0   AIR QUALITY MODELLING

5.1   MODEL SELECTION

The CALPUFF modelling system (Scire et al., 2000a,b) was used in the modelling analysis. CALPUFF and its meteorological model CALMET are designed to handle complexities posed by the complex terrain, long source receptor distances, and chemical transformation and deposition. The CALPUFF modelling system has been recommended by the U.S. Environmental Protection Agency (EPA) as a Guideline Model for source-receptor distances greater than 50 km, and for use on a case-by-case basis in complex flow situations for shorter distances (Federal Register, April 21, 2000). CALPUFF is recommended for Class I impact assessments by the Federal Land Managers Workgroup (FLAG, 2000) and the Interagency Workgroup on Air Quality Modelling (IWAQM, 1998).

Regulatory models such as the Industrial Source Complex Short Term (ISCST3) and AERMOD models have several important limitations rendering them not suitable for this study. One critical limitation of ISCST3 is that it is a steady-state, straight line plume model that cannot respond to the terrain-induced spatial variability in wind fields or to changes in dispersion conditions resulting from changes in surface characteristics. ISCST3 and AERMOD use spatially invariant wind fields based on single-station wind observations. Also, the steady-state formulation does not account for causality effects (i.e. the transport time required for pollutants to reach receptors), which can be important for source-receptor distances greater than a few kilometres. Lastly, ISCST3 and AERMOD cannot calculate concentrations during calm hours.

CALMET is a diagnostic meteorological model that produces three-dimensional wind and temperature fields and two-dimensional fields of mixing heights and other meteorological variables. It contains options to parameterize slope flow effects and terrain channelling of winds. CALPUFF is a non-steady-state Gaussian puff model. It includes algorithms for chemical transformation, wet deposition, and dry deposition. CALPUFF contains algorithms for assessing the impact of primary and secondary particulate matter on visibility as well as for computing deposition fluxes. One capability of CALPUFF not found in many specialized models is the ability to treat the combined effects of multiple processes (e.g., building downwash effects in complex terrain, dry deposition and chemical transformation). It is designed for assessing the impacts of multiple sources within a spatially varying meteorological field. The EPA has formally proposed CALPUFF as an Appendix A Guideline model for this type of application (Federal Register, April 21, 2000). A complete summary of the capabilities and features of CALMET and CALPUFF is provided in Appendix D.

As stated above, a one-year (1996) hourly meteorological data set was used to drive the CALMET/CALPUFF models rather than a five-year data set based on one station which is used in less sophisticated models such as ISCST. As referenced in the US Federal Register, at least one year of site specific data are acceptable for dispersion modelling purposes. Given that the CALMET data set is a gridded dataset using multiple stations and MM5 data, the use of a one year data set is considered to be acceptable.

5.2   CALMET SET-UP

The CALMET computational domain extended from Oakville, to Ajax and to just north of Stouffville. The entire modelling domain covers an area of 70 km by 64 km (Figure 5-1). A resolution of 1000 m in the horizontal was used to resolve the variations of the terrain elevations in the area. The United States Geological Survey (USGS) elevation records located within each grid cell in the computational domain were averaged to produce a mean elevation at each grid point. A 1 km resolution produces a workable number of grid cells (70 x 64) at the widest and longest section of the domain and allows adequate representation of the terrain features (Figure 5-2). In the vertical, a stretched grid was used with a fine resolution in the lower layers to resolve the mixed layer and a somewhat coarser resolution aloft. The eight (8) vertical levels are at 20, 50, 100, 250, 500, 1000, 1850, and 3000 meters.

Land use data available from the USGS and Natural Resources Canada were processed to generate a gridded field of dominant land use categories and land-use weighted values of surface and vegetation properties for each grid cell. The land use data from the USGS were obtained in Composite Theme Grid (CTG) format, with a resolution of 1000 m. The land use data from Natural Resources Canada were provided in maps with a scale of 1:50,000. Figure 5-3 presents the dominant landuse in the CALMET domain.

Appendix D presents the CALMET computational parameters and switches used in this analysis.

5.3   CALPUFF SET-UP

The CALPUFF computational domain extends out 15 kilometers from ABTP, reaching to Finch Avenue in the north, Royal York Road to the west and Morningside Drive to the east. The computational domain includes a buffer zone east, west and north of the source area. This minimizes edge effects and allows pollutants involved in flow reversals to be brought back into the ABTP airshed. The two study areas (Beaches and South Riverdale) were analyzed separately to allow individual impacts to be evaluated. The CALPUFF computational domain is presented in Figure 5-4.

Appendix D presents the CALPUFF computational parameters and switches used in this analysis.

Figure 5-1   CALMET Computation Domain
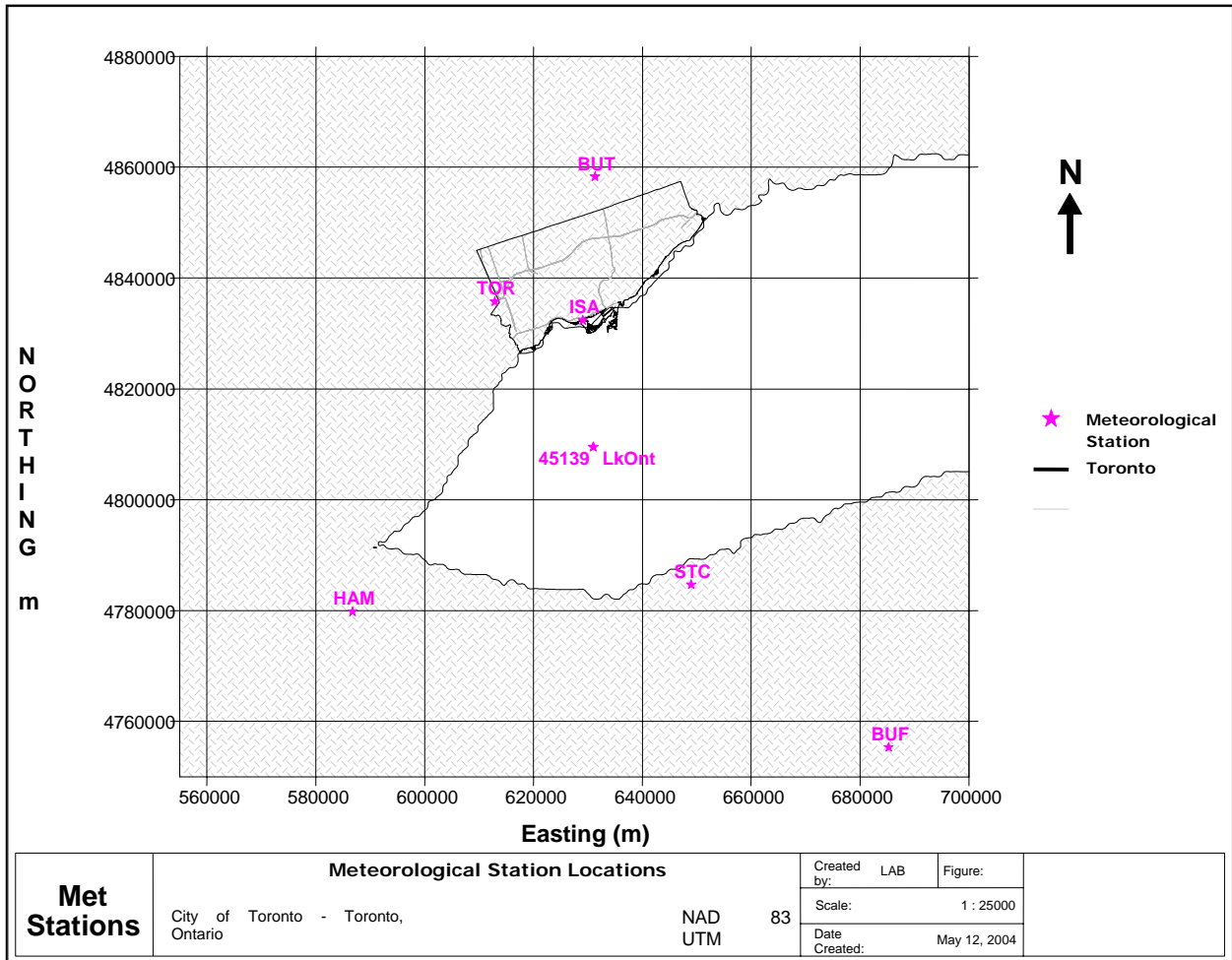
Figure 5-2   Terrain Features

Terrain	Meteorological Domain Terrain		Created by: LAB	Figure:
			Scale:	1 : 25000
	City of Toronto - Toronto, Ontario	NAD 83 UTM	Date Created:	May 13, 2004
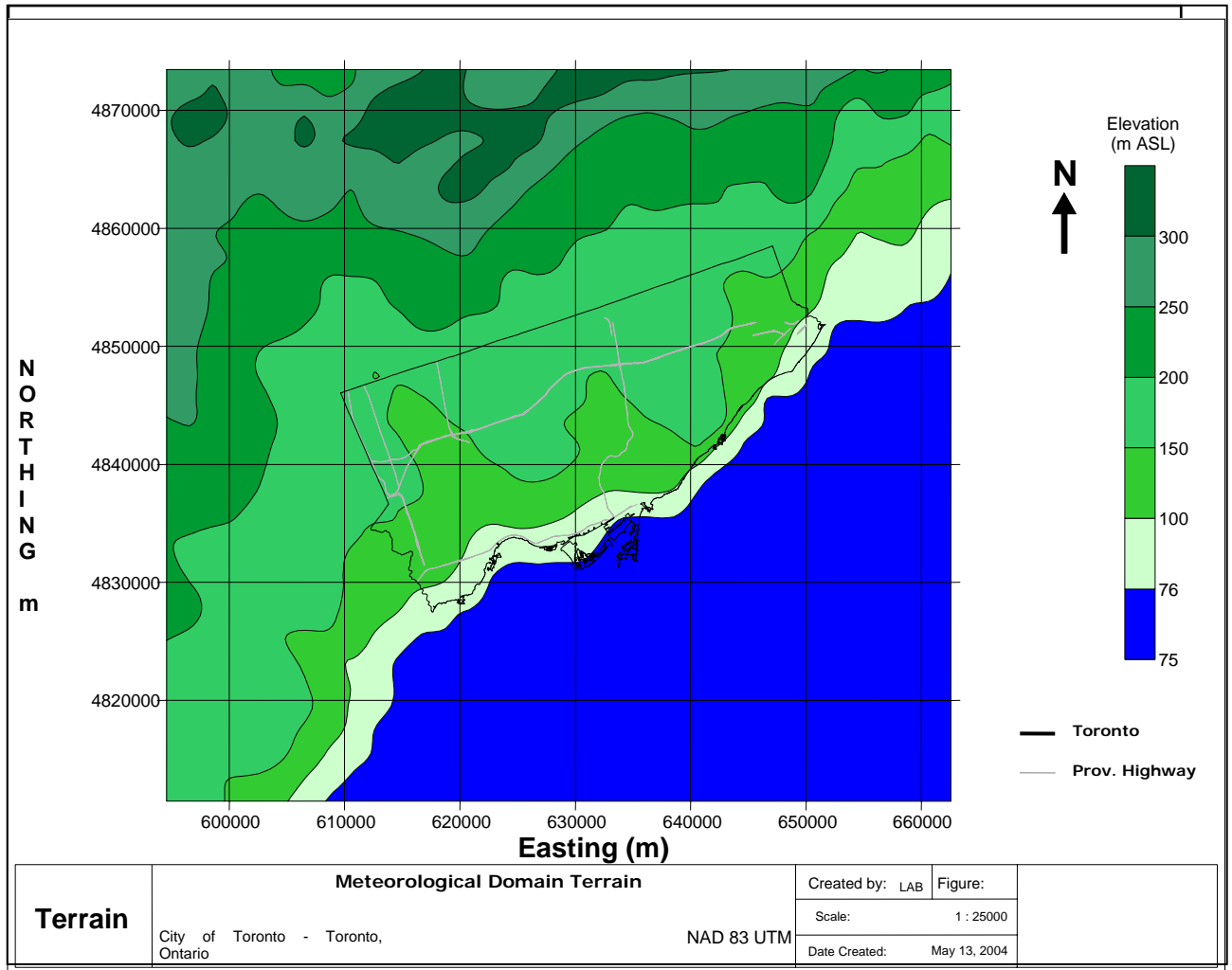
Figure 5-3   Dominant Land Use in the CALMET/CALPUFF Domain
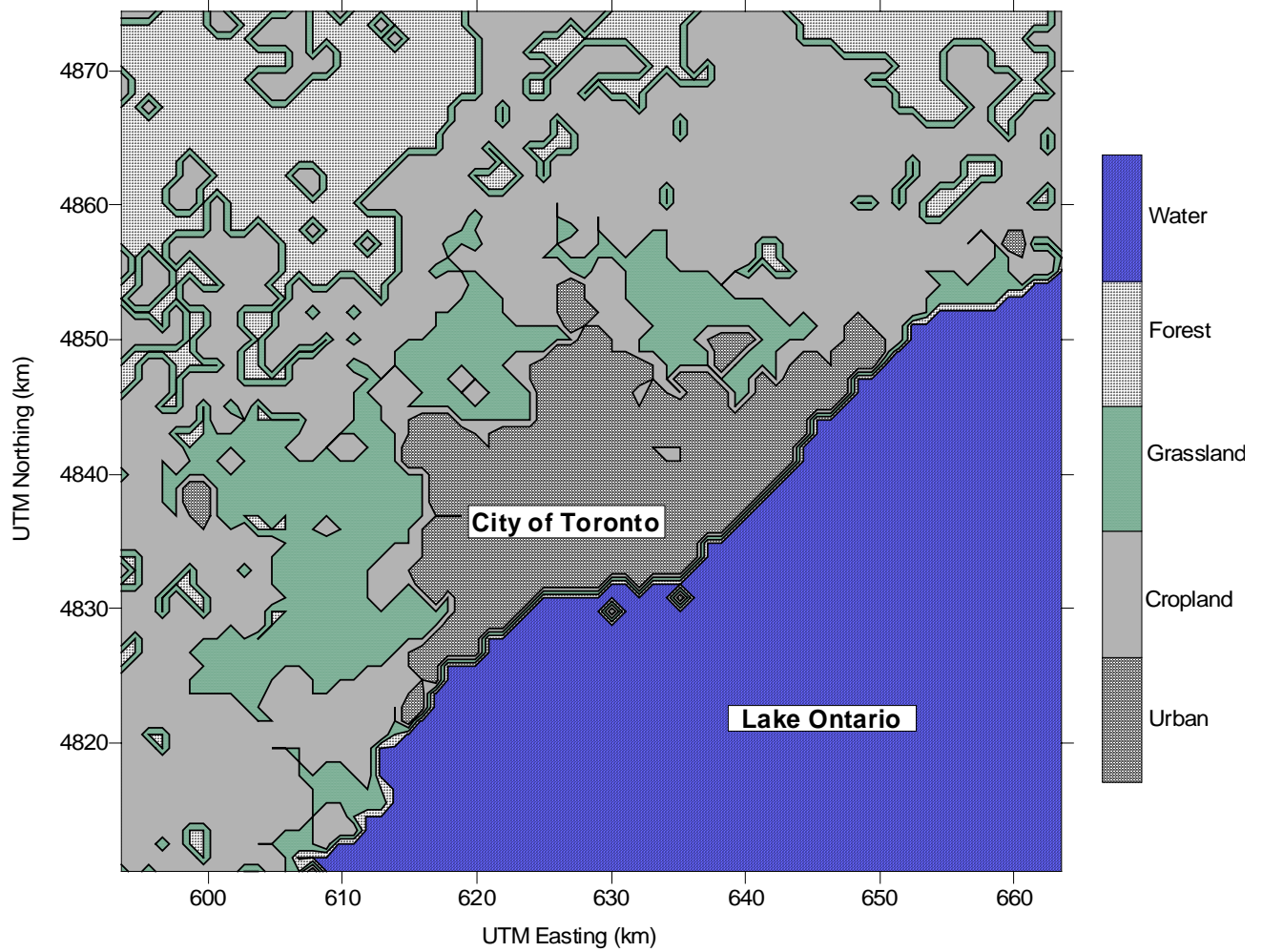
1 km by 1 km

Figure 5-4   CALPUFF Computational Domain Around ABTP
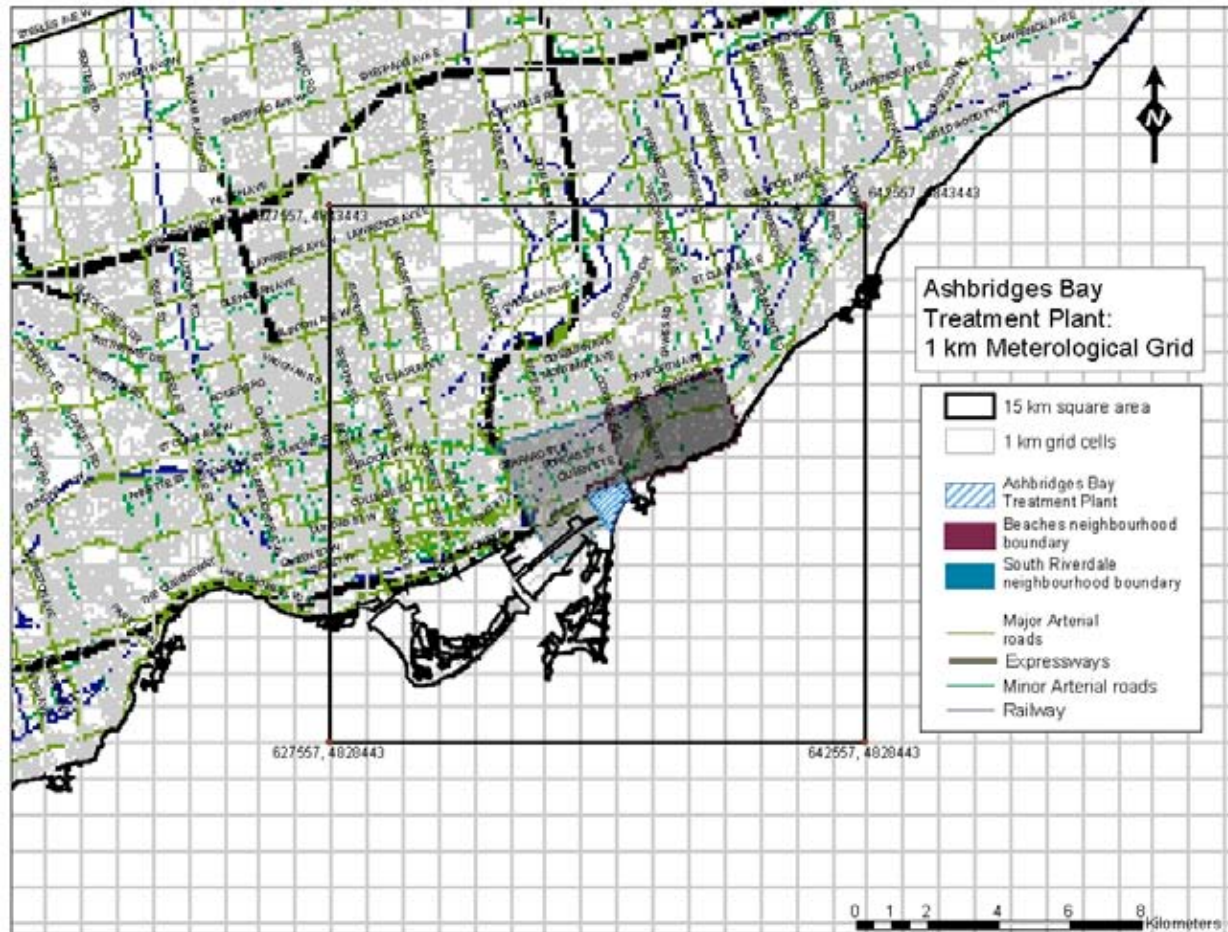
5.3.1   BUILDING DOWNWASH

CALPUFF contains the PRIME algorithms for near-source effects from building downwash. The Building Profile Input Program (BPIP) PRIME that calculates building heights and projected building widths for simple multi-tiered and group structures was used to set-up building downwash effects for each modelling scenario (i.e., a separate BPIP file was created for each scenario to account for changes in the ABTP configuration). For example, the truck loading facility and the "New" boiler building was not included in Scenario #1 as they were not built yet, but they were included in Scenarios 2, 3 and 4. Another example would be in Scenario #4 where a building over Primary Tanks 7 to 9 was included.

5.3.1.1   IMPACTS OF BUILDING DOWNWASH ON AREA SOURCES

At ABTP, the low release area sources are surrounded by obstacles (e.g., buildings, tanks) which increase the mechanically generated turbulence above and around these area sources. In addition, these sources act as blockage when the winds blow in certain directions (i.e., towards the Beaches or South Riverdale).

These obstacles will tend to enhance the degree of mixing and subsequently the dispersion and transport of the emissions.

To better approximate the manner by which the emissions would be dispersed from the area sources, the building wakes and cavities around and over the area sources were calculated using PRIME model equations (Schulman, Strimaitis and Scrie, 2000). The maximum extent of the near cavity was calculated to determine if area source emissions would be caught in the cavity created by the surrounding structures. The height of the wake from each building was calculated at the geometric midpoint of each area source (see Appendix E for tabulated results). The average wake height calculated for each area source was used to calculate initial spread of the sources (σ_z) independent of wind direction (refer to Appendix E for the Building Wake Analysis).

CALPUFF, like AERMOD-PRIME and others, only allows for one spread to be used in all directions. The average height of each building generated wake was applied. The resultant wake was transformed to an initial σ_z, as per the following

$$\sigma_{zi} = \frac{\sum H_{wji}}{N} \times \frac{1}{2.15}$$

Equation 5-1

where

σ_{zi} = Initial spread over area source i;
H_{wji} = Height of wake above area source i due to building/obstacle j and
N = Number of building obstacles affecting source i

Although the above is not exact, it does account for mechanical turbulence/blockage around the area sources.

5.3.2 TREATMENT OF CHEMICAL TRANSFORMATIONS

Chemical transformations of SO_x to SO_4 and NO to NO_3 were used following the MESOPUFF II method. Sulphates and nitrates contribute to $PM_{2.5}$ concentrations which were added to the direct emissions of $PM_{2.5}$ (primarily combustion sources). Ozone data from the nearest station was used by CALPUFF and the chemical transformations were calculated for all four (4) scenarios. Background ammonia concentrations were assumed to be 10 ppb as there are no measured data available. This background level is high as compared to measurements in other urban areas which range between 2 to 6.5 ppb (Bari, et al, 2003). A high ammonia value will tend to maximize the potential for the formation of ammonia sulphates and ammonia nitrates.

5.3.3 DEPOSITION

Deposition of chemicals was not considered in the modelling. The use of deposition will reduce the amount of available airborne concentrations.

5.3.4   AVERAGING PERIODS

Concentrations were predicted on an hourly, 24-hour (daily) and annual average basis for the seventeen (17) chemicals selected.

5.3.5   LAKE SHORE EFFECTS

CALPUFF includes a sub-grid Thermal Internal Boundary Layer (TIBL) module for cases where the position of the coastal boundary within a grid cell and growth of a TIBL must be modelled with a greater special resolution. Given the height of the incinerator and its vicinity to the shoreline, this option was activated within CALPUFF.

5.3.6   TREATMENT OF TERRAIN

For the meteorological modelling via CALMET, gridded terrain elevations derived from three (3) USGS produced arc-second digital elevation models (DEMs) were used. The USGS data are provided in files covering 1 degree by 1 degree blocks of latitude and longitude. The 1-degree DEMs are produced by the Defence Mapping Agency using cartographic and photographic sources. USGS 1:250,000 scale topographic maps are the primary source of 1-degree DEMs.

One degree DEM data consists of an array of 1201 by 1201 elevations referenced on the geographic (latitude/longitude) coordinate system of the World Geodetic System 1972 Datum. Elevations are in meters relative to mean sea level, and the spacing of the elevations along each profile is 3 arc-seconds, which corresponds to a spacing of approximately 90 meters.

5.4   RECEPTOR NETWORK

5.4.1   DESCRIPTION OF RECEPTOR GRIDS

The receptor grid consisted of both gridded receptors and discrete receptors. Discrete receptors spaced at 200 m apart covered both of the two (2) study areas. This resulted in 186 discrete receptors over the Beaches and 207 discrete receptors in South Riverdale (Figure 5-5). The elevation of each receptor was determined from USGS DEM files covering the area.

A gridded field of receptors was also located within the two (2) study areas at a grid resolution of 200 m.

Figure 5-5   Study Areas and Location of Discrete Receptors – The Beaches and South Riverdale

TORONTO ABTP
Discrete Receptors Used in CALPUFF Modelling
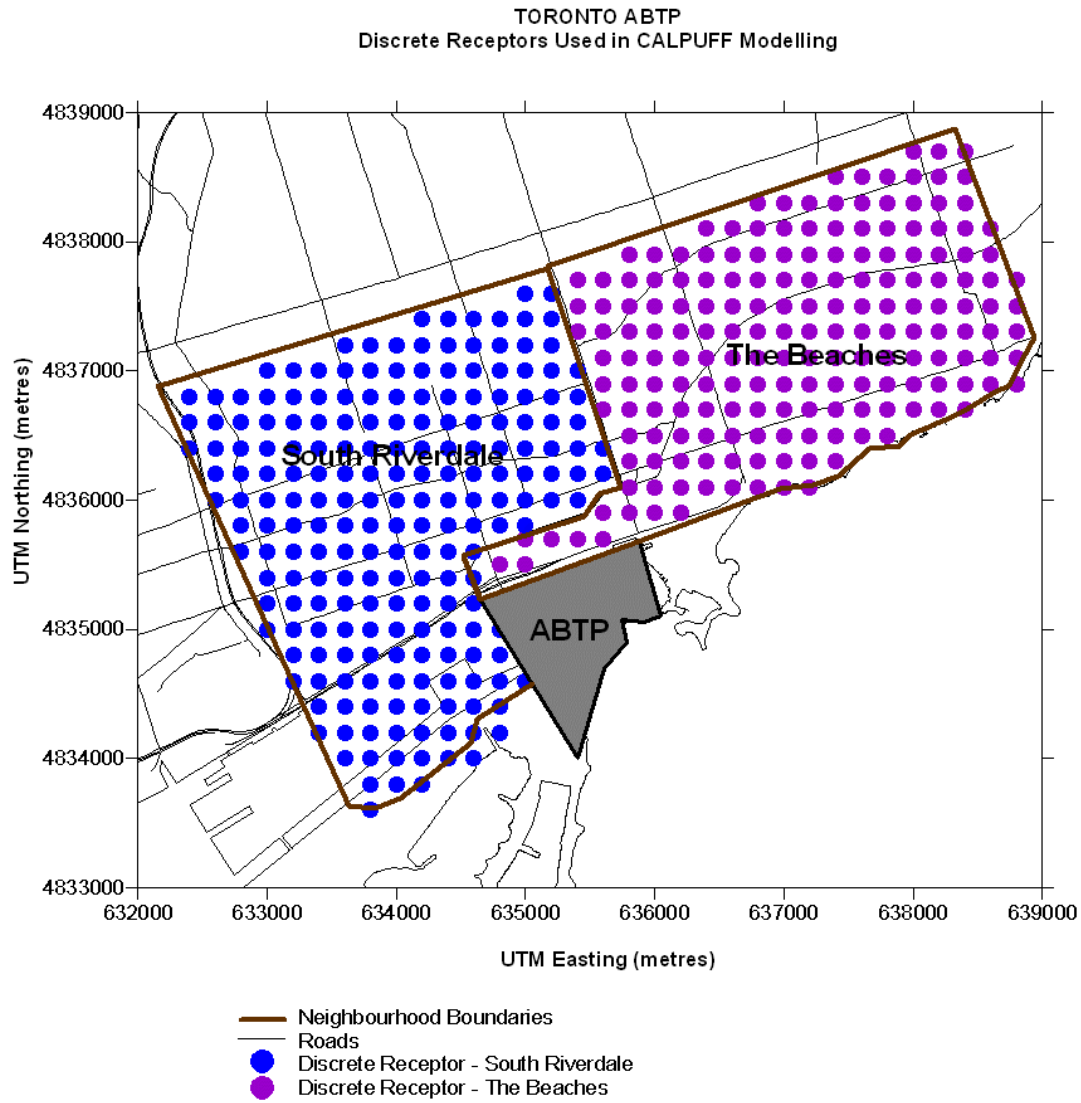
6.0   METEOROLOGY AND AMBIENT AIR QUALITY

6.1   SOURCES OF METEOROLOGICAL DATA

Different meteorological data are available in various forms.   Table 6-1 presents the typical meteorological information available from different sources.

One source of meteorological data used is the three dimensional gridded data produced by the Fifth Generation Penn State/NCAR (National Centre for Atmospheric Research) Mesoscale Model, known as MM5. The MM5 model output consist of hourly values of wind speed, wind direction, temperature and pressure on a grid that covers the entire continental United States, southern Canada, and northern Mexico. The MM5 data on a 108-km grid are available for the year 1996. In vertical, this data set has 23 levels (23 sigma l levels). The 1996 data were used in the simulations to allow inclusion of the MM5 datasets in the modelling. The MM5 data were used as the initial guess for the gridded wind fields. These wind fields are assimilated with the measured wind data and adjusted according to terrain and landuse.

The CALMET simulations used the three-dimensional gridded MM5 data along with available surface observations and upper air soundings for a one year period (Figure 5-1). Table 6-3 and Table 6-5 list the surface and upper air sounding stations included in the modelling. The 5 hourly surface meteorological stations (hourly observations) and 2 upper air stations (twice daily observations) within or near the proposed modelling domain were used in CALMET. Buffalo, New York was used as the primary upper air station and missing data were filled in from Gaylord, Michigan generating a single complete upper air station.

Table 6-1   Meteorological Data Sources and Parameters Available

Type of Dataset	Frequency	Source	Parameters
Surface	Hourly	MSC	Wind speed, wind direction, air temperature, ceiling height, cloud cover, relative humidity, surface pressure, precipitation type
Upper Air	Twice-daily	MSC/NWS	Soundings of wind speed, wind direction, temperature and pressure
Modelled Profiles	Hourly	Produced by MM5	Gridded fields of winds, temperature, pressure and humidity
Buoy Data	Hourly	NOAA and NWRI	Lake temperature and winds

MSC – Meteorological Service of Canada

NWS – National Weather Service

MM5 – Mesoscale Model Version 5

NOAA – National Oceanic & Atmospheric Administration

NWRI – National Water Research Institute

Table 6-3 **MSC Hourly Surface Stations**

Station Name	Station #	Latitude (deg. North)	Longitude (deg. West)
Hamilton A	6153194	43.17	79.93
St. Catharines A	6137287	43.20	79.17
Toronto Lester B. Pearson Int'l	6158733	43.67	79.60
Toronto Buttonville Airport	615HMAK	43.87	79.37
Toronto Island Airport	6158665	43.62	79.38

Table 6-5 **Upper Air Stations**

Station #	Station Name	Latitude (deg. North)	Longitude (deg. West)
04830	Buffalo, NY	42.70	83.47
04837	Gaylord, MI	44.55	84.43

Lake temperature and measured wind speed and direction were used to account for lakebreeze effects. Buoy data along Lake Ontario were obtained from the NOAA National Buoy Data Centre (NBDC) and National Water Research Institute (NWRI), as shown on Table 6-7. NBDC and Environment Canada operate and maintain the buoys. Data for 1996 were retrieved and formatted for use by CALMET.

Appendix D presents the CALMET computational parameters and switches.

Table 6-7 **Buoy Data within Computational Domain**

Station No.	Station Name	Latitude (deg. North)	Longitude (deg. West)
C45139	West Lake Ontario, ON	43.427	79.382

6.1.1 METEOROLOGICAL ANALYSIS

The 1996 predicted meteorological data were compared to a longer term dataset (1996-2000) in Zorix (2001) and found to be consistent and representative.

The CALMET predicted winds were also compared with measurements taken at the ABTP for 1996 (Figure 6-1). The ABTP meteorological tower was not used in the meteorological modelling. It is not a fully functional meteorological wind tower which meets Environment Canada requirements but it does provide a degree of comparison between the predicted and on-site measurements.

As shown in Figure 6-1, the wind direction frequencies are similar between measured and predicted. Both data sets show a lack of winds from the north, which is due to the blockage of the City of Toronto urban core but the ABTP measured data show an approximate 20° counter-clockwise rotation in wind direction. Subsequent investigation by the Project Team staff found that the tower is not properly aligned

with true north, by about 20° to the west. Rotating the wind speed summaries at ABTP also shows some consistency between the wind speed roses. This suggests that the model results are representative of the area.

In summary, the winds around the ABTP are strongly influenced by the City of Toronto which causes some blockage of the winds. In addition, winds are stronger from the southwest quadrant and slower from the southeast quadrant. This will tend to cause the emissions from a higher stack to impact to the northeast because of stack tip downwash and lower plume rise. The lower winds from the southeast will likely cause emissions from the lower elevations sources or area sources to have an impact to the northwest. .

Figure 6-1   Comparison of CALMET Wind Rose with ABTP Wind Rose – 1996
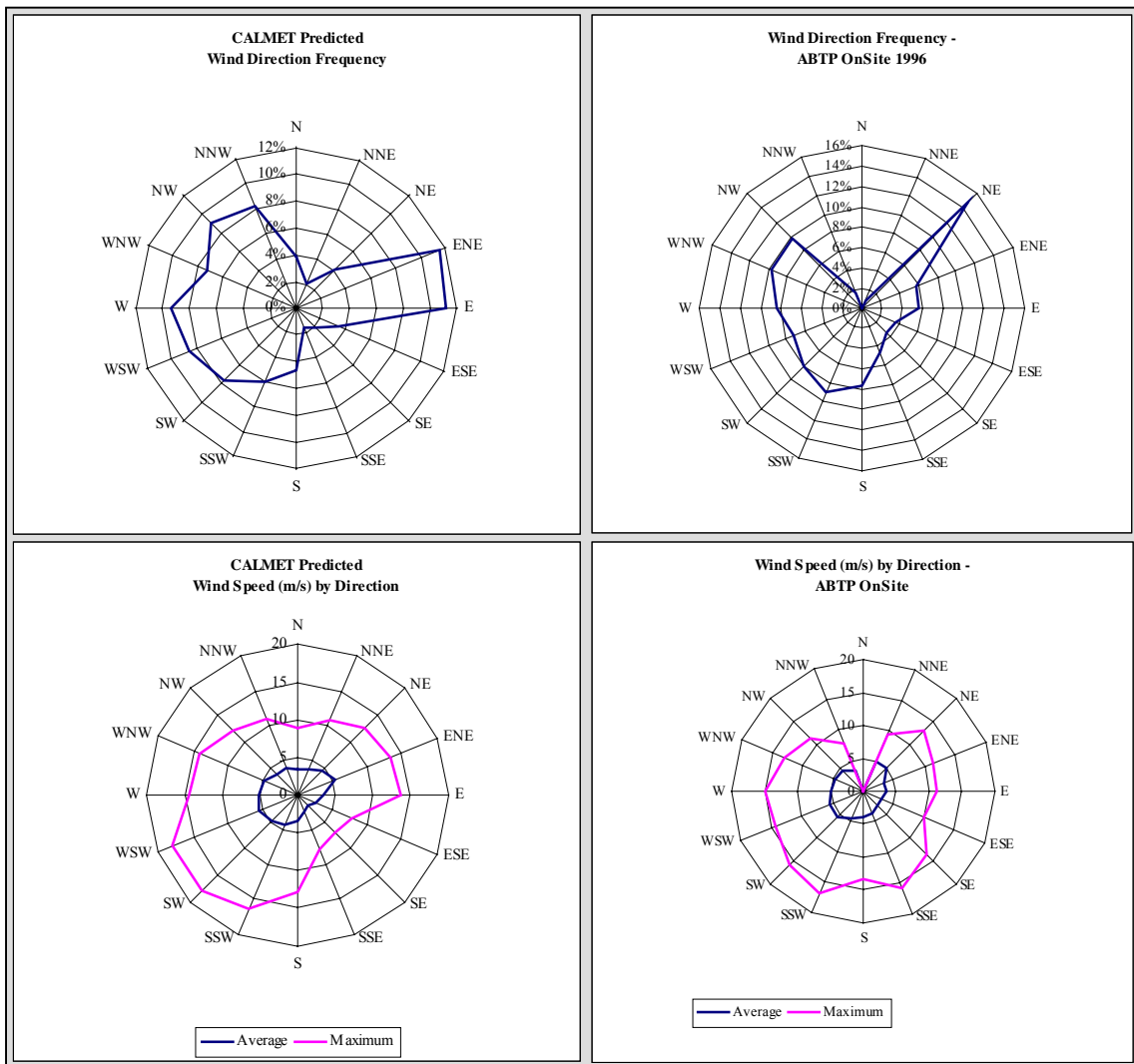
6.2 AIR QUALITY DATA

Environment Canada/MOE operate and maintain ambient air quality monitoring stations in the City. Table 6-9 presents a list of stations within the City along with their monitoring parameters between 1995 - 2002. Although none of these stations are within South Riverdale and the Beaches, they do provide a relative measure of air quality in the City and what residents within these two communities are likely exposed to.

A summary of the range of maximum measurements of the Chemicals of Concern over the City is presented in Table 6-11. As shown, not all of the species of concern are measured at the stations during the years of interest. Ambient air quality measurements are below the Ontario AAQC (Table 6-13) but some chemicals (arsenic, benzene, benzo[a]pyrene and cadmium) are above the TPH 24 hour Health Benchmarks. Average ambient air quality observations presented in Table 6-13 were calculated from the mean of the 24-hr average concentrations over each of the scenario periods. Data from all stations for 1995 were used to calculate the Toronto air quality for pre-1996. Similarly, all station data from 2000-2002 were used to calculate the Toronto air quality for 2000-2002. This method does include the contribution of the ABTP to ambient air quality since the ABTP was in operation during these periods of time. The contribution of ABTP to the general air quality can not be easily filtered out from the presented levels.

Table 6-9 **Summary of Toronto Air Monitoring Stations with Chemicals of Concern**

Station Id	Location	Station Name		Years	Arsenic	Benzene	Benzo(a)pyrene	Cadmium	Hexachlorobutadiene	Lead	NOx	PM$_{2.5}$(Hr)	PM$_{10}$ (24hr)	PM$_{10}$ (Hourly)	SO$_2$	Total Dioxins and Furans (as 2,3,7,8-TCDD eq)	Total PAH
60403	TORONTO	EVANS & ARNOLD AVE.	I	1995 - 2001	X	X	X	X	X	X	X	X	X	X	X	X	X
60410	TORONTO	LAWRENCE & KENNEDY	R	1995 - 2002							X		X	X			
60413	TORONTO	ELMCREST ROAD	R	1995 - 2002		X		X			X			X	X		
60415	TORONTO	QUEENSWAY W & HURONTARIO	R	1997 - 2002							X	X			X		
60418	TORONTO	RUSKIN & PERTH ST.	C	1995 - 2002		X	X			X						X	X
60419	TORONTO	CN TOWER	C	1995							X	X					
60421	TORONTO	YONGE ST. & FINCH AVE.	C	1995 - 2002							X	X					
60423	TORONTO	CLEARVIEW HEIGHTS	R	1995 - 2000							X						
60424	TORONTO	BAY & WELLESLEY	C	1995 - 2002	X	X		X	X	X	X	X	X		X		
60425	TORONTO	QUEEN & UNIVERSITY	C	1995 - 1998	X			X		X	X		X		X		
60426	TORONTO	MEADOW PK, APPLE LANE C C	I	1996 - 2000		X			X								
60427	TORONTO	223 COLLEGE STREET	C	1999 - 2002	X		X	X		X			X			X	X
60428	TORONTO	525 MAIN ST. N. BRAMPTON	R	2000 - 2002		X			X		X	X			X		
60429	TORONTO	185 JUDSON STREET	R	2001 - 2002	X	X	X	X	X	X	X	X	X	X	X	X	X
60430	TORONTO	125 RESOURCES ROAD	C	2000							X	X		X	X		
61602	OAKVILLE	BRONTE RD. & WOBURN CRES.	R	2001 - 2002		X			X								
63201	STOUFFVILLE	HWY 47 & HWY 48	R	1995 - 2002		X			X								

Note: Not all parameters are measured in every year listed.

Table 6-11   Summary of Chemicals of Concern Ambient Air Monitoring Measurements

		Pre-1996						2000-2002					
		Range of 1hr Max		*Range of 24 hr Max*		*Range of Ann Max*		*Range of 1hr Max*		*Range of 24 hr Max*		*Range of Ann Max*	
		(µg/m³)		(µg/m³)		(µg/m³)		µg/m³)		(µg/m³)		(µg/m³)	
Arsenic	7440-38-2	-	-	0.010	0.003	0.002	0.002	-	-	0.006	0.004	0.002	0.001
Benzene	71-43-2	-	-	13.1	4.66	2.2	1.2	-	-	13.4	1.5	1.7	0.65
Benzo[a]pyrene	50-32-8	-	-	0.00061	0.00061	0.00018	0.00018	-	-	0.00099	0.00015	0.00019	0.00007
Bis(2-ethylhexyl)phthalate	117-81-7	-	-	-	-	-	-	-	-	-	-	-	-
Cadmium	7440-43-9	-	-	0.003	0.003	0.003	0.003	-	-	0.004	0.003	0.003	0.003
Di-n-octyl phthalate	117-84-0	-	-	-	-	-	-	-	-	-	-	-	-
Hexachlorobutadiene	87-68-3	-	-	-	-	-	-	-	-	-	-	-	-
Hydrogen Sulphide	7783-06-4	-	-	-	-	-	-	-	-	-	-	-	-
Lead	7439-92-1	-	-	0.026	0.021	0.009	0.008	-	-	0.042	0.026	0.008	0.004
Mercury	7439-97-6	-	-	-	-			-	-	-	-	-	-
Nitrogen Oxides	10102-44-0	1,889	472			133	75	1,848	571			130	52
PM$_{2.5}$	N/A-PM	N/A	N/A	-	-	N/A	N/A	142	50	-	-	10	8
PCBs with 4 or More Cl (total)				-	-	-	-	-	-	-	-	-	-
Sulphur Dioxide	7446-09-5	601	143	-	-	15	8	798	97	-	-	15	8
Total Dioxins and Furans (as 2,3,7,8 TCDD eq)		-	-	N/A	N/A	N/A	N/A	-	-	2.9E-07	3.9E-08	5.6E-08	1.8E-08
Total PAHs		-	-	0.097	0.097	0.037	0.037	-	-	0.200	0.046	0.042	0.019
Vinyl Chloride	75-01-4	-	-	-	-	-	-	-	-	-	-	-	-

Table 6-13   Comparison between Chemicals of Concern Observations and AAQCs/TPH Health Benchmarks

Chemical	CAS Number	AAQC 24 hr (µg/m³)	Health Benchmark 24 hr (µg/m³)	Mean Pre-1996 (Scenario #1) Air Quality Observations (µg/m³)	Measured Pre-1996 (Scenario #1) Range of 24 hr Max (µg/m³)		Mean 2000-2002 (Scenario #2 Air Quality Observations (µg/m³)	Measured 2000-2002 (Scenario #2) Range of 24 hr Max (µg/m³)	
Arsenic	7440-38-2	0.3	0.00066	0.002	0.0096	0.0031	0.001	0.0065	0.0039
Benzene	71-43-2		0.3	1.878	13.08	4.66	1.154	13.40	1.51
Benzo[a]pyrene	50-32-8	0.0011	0.000012	0.00018	0.00061	0.00061	0.00012	0.00099	0.00015
Bis(2-ethylhexyl)phthalate	117-81-7	50		-	-	-	-	-	-
Cadmium	7440-43-9	2	0.0006	0.003	0.0033	0.0033	0.003	0.0036	0.0033
Di-n-octyl phthalate	117-84-0	120		-	-	-	-	-	-
Hexachlorobutadiene	87-68-3		1.19	-	-	-	-	-	-
Hydrogen Sulphide	7783-06-4		2 -10	-	-	-	-	-	-
Lead	7439-92-1	2		0.009	0.026	0.021	0.007	0.042	0.026
Mercury	7439-97-6	2.5	0.3	-	-	-	-	-	-
Nitrogen Oxides	10102-44-0	200		104	-	-	78	-	-
PM2.5		30		-	-	-	9	-	-
PCBs with 4 or More Cl (total)		0.15	0.00175	-	-	-	-	-	-
Sulphur Dioxide	7446-09-5	275		11.1	-	-	12	-	-
Total Dioxins and Furans (as 2,3,7,8 TCDD eq)		5.0E-06		-	-	-	3.40E-08	2.90E-07	3.87E-08
Total PAHs				0.037	0.097	0.097	0.026	0.200	0.046
Vinyl Chloride	75-01-4	1	0.1	-	-		-	-	

Mean air quality observations were calculated as the mean of the 24-hr average concentrations over the scenario periods of interest.   Data from 1995 were used for Pre-1996 levels while data between 2000-2002 was used for Scenario 2.

7.0   DISPERSION MODELLING RESULTS

The Beaches and South Riverdale domains were examined separately to gain insight on the contribution of the ABTP to each community.   Each of the four ABTP scenarios were modelled with the 1996 meteorology for all seventeen (17) Chemicals of Concern (COC) using the appropriate building and emission profile developed above.

The CALPUFF model produced short term (1-hour and 24-hour) and annual average concentrations of the COCs over each of the study areas. The results of the modelling were compared to the Ontario Ambient Air Quality Criteria (AAQC) as well as the 24-hour time-averaged health benchmarks.

7.1   COMPARISON OF PREDICTED COC CONCENTRATIONS TO ONTARIO AIR QUALITY STANDARDS OR CRITERIA

The maximum predicted concentrations in each community are compared to the Ontario AAQC/POI of each COC in Table 7-1 and Table 7-3, respectively. These tables present the maximum predicted hourly, 24-hr and annual concentrations in each of the two communities, independently.

As illustrated, 16 of the 17 COCs meet their appropriate AAQC/POI for all time-averaging periods and scenarios.   The only exception is B[a]P which exceeds the AAQC/POI for most time periods and scenarios other than the 24-hour and annual time averages on the future scenario (Scenario #4). Laboratory instruments used in the measurement of B[a]P at ABTP indicated that B[a]P was below the instrument's detection limit.   The B[a]P emissions were estimated using the instruments minimum detection limit and this approach would tend to overestimate the amount of B[a]P released into the atmosphere.

Hydrogen sulphide (H_2S) and NOx are the only other COCs for which the predicted concentrations are greater than 10% of their AAQC/POI (H_2S: ~70% to 20%; NOx: ~15%) while the remaining COCs are typically less than 3% of their respective AAQC/POI.

With the exception of NOx for 24-hour averaging period, the COC concentrations are lower under the future scenario (Scenario #4) than under scenarios 1, 2 or 3. The higher NOx levels under Scenario #4 in the Beaches are a result of the addition of new structures to ABTP. These new structures generate wakes which cause plumes from elevated point sources, such as the natural gas fired boiler, to be brought to the ground very rapidly. Under Scenarios #3 and #4, there are no impacts of arsenic, cadmium, lead, PCBs and dioxins as these emissions are associated with the incinerator which was inoperative after 2002. Comparison between Scenario #1 (full incinerator operation) and Scenario #2 (partial incineration operation) shows higher predicted concentrations under partial incineration than full incineration for some COC. This is primarily due to the change in emissions which shows higher emissions for some COCs in

Scenario #2 than # 1. The actual concentrations for Scenarios 3 and 4 are likely to be even lower than what have been predicted because the emission inventory for these scenarios were derived using 2001 wastewater analytical data. The levels of many chemical pollutants are expected to decline in the future as a result of the City's enforcement of the revised Sewer Use By-law starting June 2001[1]. The By-law has strict chemical discharge limits and requires industry to submit pollution prevention plans to the City on these pollutants.

Comparison between South Riverdale and Beaches typically shows that concentrations are in the same range for all COCs and time-averaging periods, respectively. Closer examination shows that COCs associated with incineration (e.g., arsenic, cadmium) have a slightly higher concentration in South Riverdale than in the Beaches when comparing Scenarios # 1 and #2. Under the future scenario, concentration differences between the communities are insignificant.

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[1] City of Toronto By-law No. 457-2000. 2000. To regulate the discharge of sewage and land drainage.

Table 7-1   Comparison of Predicted COC's for Ontario AAQCs – The Beaches

Chemical	CAS No.	POI (1/2 hr)	AAQC (1 hr)	AAQC (24 hr)	AAQC (1 yr)	S1 (1/2 hr)	S1 (1 hr)	S1 (24 hr)	S1 (1 yr)	S2 (1/2 hr)	S2 (1 hr)	S2 (24 hr)	S2 (1 yr)	S3 (1/2 hr)	S3 (1 hr)	S3 (24 hr)	S3 (1 yr)	S4 (1/2 hr)	S4 (1 hr)	S4 (24 hr)	S4 (1 yr)
		AAQC or POI (ug/m³)				Scenario #1 Maximum Predicted Concentrations (µg/m³)				Scenario #2 Maximum Predicted Concentrations (µg/m³)				Scenario #3 Maximum Predicted Concentrations (µg/m³)				Scenario #4 Maximum Predicted Concentrations (µg/m³)			
Arsenic	7440-38-2	1		0.3		0.00050	0.00042	0.000083	0.0000068	0.0015	0.0013	0.00025	0.000020	-	-	-	-	-	-	-	-
Benzene	71-43-2					0.93	0.78	0.15	0.013	0.27	0.22	0.029	0.0071	0.38	0.32	0.042	0.0074	0.13	0.11	0.016	0.0028
Benzo(a)pyrene	50-32-8	0.0033		0.0011	0.00022	0.13	0.10	0.020	0.0010	0.031	0.026	0.0050	0.00024	0.030	0.025	0.0067	0.00028	0.011	0.009	0.0010	0.00007
Bis(2-ethylhexyl)phthalate	117-81-7					1.5	1.3	0.25	0.012	0.31	0.26	0.050	0.0024	0.66	0.55	0.15	0.0061	0.24	0.20	0.022	0.0016
Cadmium	7440-43-9	5		2		0.026	0.022	0.0017	0.00014	0.035	0.029	0.0023	0.00019	-	-	-	-	-	-	-	-
Di-n-octyl phthalate	117-84-0	100		120		0.056	0.047	0.0091	0.00043	0.013	0.010	0.0020	0.00010	0.11	0.090	0.024	0.0010	0.040	0.033	0.0036	0.00026
Hexachlorobutadiene	87-68-3					0.22	0.18	0.032	0.0076	0.208	0.17	0.032	0.0072	0.35	0.29	0.034	0.0074	0.15	0.13	0.018	0.0031
Hydrogen Sulphide	7783-06-4	30	30			21.4	17.9	3.6	0.57	21.5	17.9	3.6	0.57	24.2	20.1	4.6	0.60	10.6	8.8	1.0	0.24
Lead	7439-92-1	6		2		0.029	0.024	0.0019	0.00015	0.081	0.068	0.0053	0.00043	-	-	-	-	-	-	-	-
Mercury	10102-44-0	5		2		0.015	0.012	0.00095	0.000077	0.029	0.024	0.0036	0.00027	4.2E-06	3.5E-06	9.4E-07	3.9E-08	1.5E-06	1.3E-06	1.4E-07	1.0E-08
Nitrogen Oxides	N/A-PM	500	400	200		66.7	55.6	6.4	0.66	62.1	51.8	5.3	0.50	39.5	32.9	5.8	0.53	49.7	41.4	7.3	0.53
PM$_{2.5}$				30		6.8	5.7	0.56	0.040	8.5	7.1	0.66	0.049	1.9	1.6	0.28	0.025	2.2	1.8	0.29	0.044
PCBs with 4 or More Cl (total)	7446-09-5	0.45			0.035	0.00016	0.00013	0.000011	8.5E-07	0.00018	0.00015	0.000011	9.3E-07	-	-	-	-	-	-	-	-
Sulphur Dioxide		830	690	275	55	8.7	7.3	1.6	0.37	18.2	15.2	2.30	0.52	16.9	14.1	1.7	0.35	7.5	6.2	0.88	0.15
Total Dioxins and Furans (as 2,3,7,8-TCDD eq)	7439-97-6	15.0E-06		5.0E-06		1.36E-08	1.11E-08	8.52E-10	7.07E-11	4.55E-09	3.76E-09	2.97E-10	2.37E-11	-	-	-	-	-	-	-	-
Total PAHs						9.0	7.5	1.4	0.068	9.0	7.5	1.4	0.068	0.66	0.55	0.15	0.0061	0.23	0.19	0.021	0.0015
Vinyl chloride	75-01-4	3		1	0.2	0.17	0.14	0.026	0.0056	0.19	0.16	0.033	0.0059	0.24	0.20	0.024	0.0052	0.11	0.09	0.01	0.0021

Note: Predicted B[a]P concentrations are based on emissions estimated from laboratory measurements which were less than detect. Similarly for Total PAHs which were non-detect.

-        No emissions

Scenario 1   incinerator in full operation (pre 1996)

Scenario 2   incinerator in partial operation (2000-2002)

Scenario 3   incineration discontinued (2003-2004)

Scenario 4   incineration discontinued and odour control measures implemented.

Table 7-3   Comparison of Predicted COC's for Ontario AAQCs – South Riverdale

Chemical	CAS No.	POI (1/2 hr)	AAQC (1 hr)	AAQC (24 hr)	AAQC (1 yr)	S1 (1/2 hr)	S1 (1 hr)	S1 (24 hr)	S1 (1 yr)	S2 (1/2 hr)	S2 (1 hr)	S2 (24 hr)	S2 (1 yr)	S3 (1/2 hr)	S3 (1 hr)	S3 (24 hr)	S3 (1 yr)	S4 (1/2 hr)	S4 (1 hr)	S4 (24 hr)	S4 (1 yr)
Arsenic	7440-38-2	1		0.3		0.00167	0.00139	0.000124	0.000012	0.0023	0.0019	0.00037	0.000035	-	-	-	-	-	-	-	-
Benzene	71-43-2					0.81	0.67	0.09	0.011	0.69	0.58	0.069	0.0087	1.19	0.99	0.119	0.0102	0.07	0.06	0.008	0.0014
Benzo[a]pyrene	50-32-8	0.0033		0.0011	0.00022	0.09	0.08	0.008	0.0009	0.023	0.019	0.0020	0.00022	0.024	0.020	0.0034	0.00027	0.014	0.012	0.0010	0.00013
Bis(2-ethylhexyl)phthalate	117-81-7	100		50		1.1	0.9	0.10	0.011	0.23	0.19	0.020	0.0022	0.54	0.45	0.075	0.0058	0.31	0.26	0.022	0.0029
Cadmium	7440-43-9	5		2		0.034	0.028	0.0025	0.00024	0.046	0.038	0.0034	0.00032	-	-	-	-	-	-	-	-
Di-n-octyl phthalate	117-84-0	100		120		0.041	0.034	0.0035	0.00039	0.009	0.008	0.0008	0.00009	0.09	0.073	0.0123	0.00096	0.05	0.042	0.0037	0.00047
Hexachlorobutadiene	87-68-3					0.20	0.17	0.027	0.0037	0.22	0.18	0.025	0.0045	0.36	0.30	0.042	0.0051	0.08	0.07	0.008	0.0012
Hydrogen Sulphide	7783-06-4	30	30			15.2	12.7	1.6	0.22	15.2	12.7	1.6	0.22	16.9	14.1	2.6	0.23	7.7	6.4	0.8	0.10
Lead	7439-92-1	6		2		0.038	0.031	0.0028	0.0003	0.105	0.088	0.0078	0.0007	-	-	-	-	-	-	-	-
Mercury	7439-97-6	5		2		0.019	0.016	0.0014	0.0001	0.037	0.031	0.0030	0.0004	3.42E-06	2.85E-06	4.78E-07	3.72E-08	1.98E-06	1.65E-06	1.42E-07	1.83E-08
Nitrogen Oxides	10102-44-0	500	400	200		93.9	78.2	7.6	1.18	85.0	70.8	6.9	0.91	60.3	50.3	6.4	0.91	40.3	33.6	6.2	1.04
PM 2.5				30		9.1	7.6	0.66	0.066	0.19	0.16	0.033	0.006	1.8	1.5	0.28	0.044	1.8	1.5	0.24	0.04
PCBs with 4 or More Cl (total)						2.10E-04	1.75E-04	1.56E-05	1.46E-06	2.30E-04	1.91E-04	1.71E-05	1.60E-06	-	-	-	-	-	-	-	-
Sulphur Dioxide	7446-09-5	830	690	275	55	10.9	9.1	1.4	0.21	18.2	15.1	2.8	0.47	17.3	14.4	1.9	0.24	4.0	3.3	0.4	0.05
Total Dioxins and Furans (as 2,3,7,8-TCDD eq)		15.0E-06		5.0E-06		1.75E-08	1.46E-08	1.30E-09	1.22E-10	5.87E-09	4.88E-09	4.37E-10	4.09E-11	-	-	-	-	-	-	-	-
Total PAHs						6.5	5.4	0.6	0.06	6.5	5.4	0.6	0.063	0.54	0.45	0.08	0.0058	0.30	0.25	0.02	0.0027
Vinyl Chloride	75-01-4	3		1		0.15	0.13	0.020	0.0029	0.18	0.15	0.021	0.0037	0.25	0.21	0.029	0.0035	0.06	0.05	0.006	0.0009

Note: Predicted B[a]P concentrations are based on emissions estimated from laboratory measurements which were less than detect. Similarly for Total PAHs which were non-detect.

-        No emissions

Scenario 1   incinerator in full operation (pre 1996)
Scenario 2   incinerator in partial operation (2000-2002)
Scenario 3   incineration discontinued (2003-2004)
Scenario 4   incineration discontinued and odour control measures implemented.

7.2   COMPARISON OF PREDICTED COC CONCENTRATIONS TO HEALTH BENCHMARKS

For those chemicals whose AAQCs and POI standards have been identified by the MOE as requiring regulatory review, Toronto Public Health has selected a set of ambient air quality health benchmarks to compare to the predicted maximum concentrations.   The maximum predicted concentrations in each community are compared to the Health Benchmarks of each COC in Table 7-5 and Table 7-7, respectively. Cadmium, B[a]P and H_2S exceed a Health Benchmark for any scenario. Hydrogen sulphide meets the upper Health Benchmark but exceeds the lower limit.   Cadmium is above the Health Benchmark under Scenario #1 and #2 (incinerator operational) while H_2S meets the Health Benchmarks in both communities for the future scenario. B[a]P concentrations are above the Health Benchmark for all scenarios but meet the 24-hr AAQC for the future scenario (Scenario #4) in both communities. Emissions of B[a]P were estimated from analytical laboratory data which indicated that B[a]P was below the detection limits of the laboratory instrument. Using the minimum detection limit of the instrument will over-estimate the amount of B[a]P released into the airshed and the predicted concentrations.

Figure 7-1 to Figure 7-4 show the maximum 24-hour average concentrations of H_2S over the area surrounding the facility for all four (4) scenarios.   The figures are typical of the other substances, illustrating the changes in concentration between the four (4) scenarios as well as how the concentrations compare to the Health Benchmark for H_2S.   Similar figures for the other sixteen (16) chemicals can be found in Appendix F.

There are similarities between all the figures presented in Appendix F.   In general, the maximum concentrations decrease between Scenario 1 and Scenario 4 as emissions have decreased. The dispersion pattern around the ABTP also changes between scenarios. With respect to H_2S, in Scenario 1 and 2, a majority of the emissions are released from the low-elevation sources (i.e., clarifiers, grit tanks, etc) resulting in a dispersion pattern similar to concentric rings around the plant. In Scenario 3, the emissions do not change but the dispersion pattern changes as a result of the addition of the Pelletizer Building which generates building wake effects. In Scenario 4, the majority of emissions are from the tall stack which reduces the concentrations around the ABTP. In other figures, the influence of the stack is more predominant. Concentrations occur further away from the plant and follow the wind patterns for the area. In reviewing Appendix F figures, the influence of emitting emissions from an elevated source is demonstrated.

Comparison of maximum predicted COC concentrations between the two communities shows some subtle differences in concentrations as compared to the AAQC or benchmark. Under Scenario 1, South Riverdale has higher levels of arsenic, cadmium and NO_2 which are primarily released from the stack. The Beaches has higher concentrations of benzene, B[a]P/PAHs and vinyl chloride which are associated primarily from low-elevation sources. This apparent anomaly is because there is stretch of the Beaches which is adjacent to the ABTP, higher concentrations are not unexpected. Under Scenario 4, a majority of the emissions are released from the elevated stack and the impact is a function of the wind pattern. As shown in Figure 6-1, the winds are more frequent and at a higher speed from the southwest which will generate a high impact at locations to the northeast (i.e., The Beaches.)

**Table 7-5   Comparison of Maximum Predicted Concentrations to Health Benchmarks
– The Beaches**

Chemical	CAS No.	AAQC 24 hr ($\mu g/m^3$)	Health Benchmark 24 hr ($\mu g/m^3$)	24-hour Average Maximum Predicted Concentrations ($\mu g/m^3$)			
				Scenario #1	*Scenario #2*	*Scenario #3*	*Scenario #4*
Arsenic	7440-38-2		0.00066[c]	0.000083	0.000251	-	-
Benzene	71-43-2		0.3[c]	0.15	0.029	0.042	0.016
Benzo[a]pyrene	50-32-8	0.0011[a]	0.000012[b, c]	0.020	0.0050	0.0067	0.0010
Bis(2-ethylhexyl)phthalate	117-81-7	50		0.25	0.050	0.15	0.022
Cadmium	7440-43-9	2	0.0006[c]	0.0017	0.0023	-	-
Di-n-octyl phthalate	117-84-0	120		0.0091	0.0020	0.024	0.0036
Hexachlorobutadiene	87-68-3		1.19	0.032	0.032	0.034	0.018
Hydrogen Sulphide	7783-06-4		2-10	3.56	3.57	4.60	1.04
Lead	7439-92-1	2		0.0019	0.0053	-	-
Mercury	7439-97-6		0.3	0.00095	0.00356	0.00000094	0.00000015
Nitrogen Oxides	10102-44-0	200		6.38	5.26	5.75	7.26
PM$_{2.5}$	N/A-PM	30		0.56	0.66	0.28	0.29
PCBs with 4 or More Cl (total)			0.00175[c]	0.000011	0.000011	-	-
Sulphur Dioxide	7446-09-5	275		1.57	2.30	1.65	0.88
Total Dioxins and Furans (as 2,3,7,8-TCDD eq)		5.0E-06		8.78E-10	2.97E-10	-	-
Total PAHs				1.44	1.44	0.15	0.021
Vinyl Chloride	75-01-4		0.1[c]	0.026	0.033	0.024	0.013

[a] - This is based on B[a]P only

[b] - This is based on B[a]P as a surrogate for the toxicity of the whole PAH mixture. The risk from exposure to total PAHs in the air would be negligible if B[a]P level is found to be below this health benchmark for B[a]P.

[c] - The health benchmark corresponds to an excess lifetime cancer risk of one in a million (or 1 E-6), which meets Health Canada and MOE benchmark of negligible risk.

Scenario 1	incinerator in full operation (pre 1996)
Scenario 2	incinerator in partial operation (2000-2002)
Scenario 3	incineration discontinued (2003-2004)
Scenario 4	incineration discontinued and odour control measures implemented.

Table 7-7   **Comparison of Predicted Concentrations to Health Benchmarks – South Riverdale**

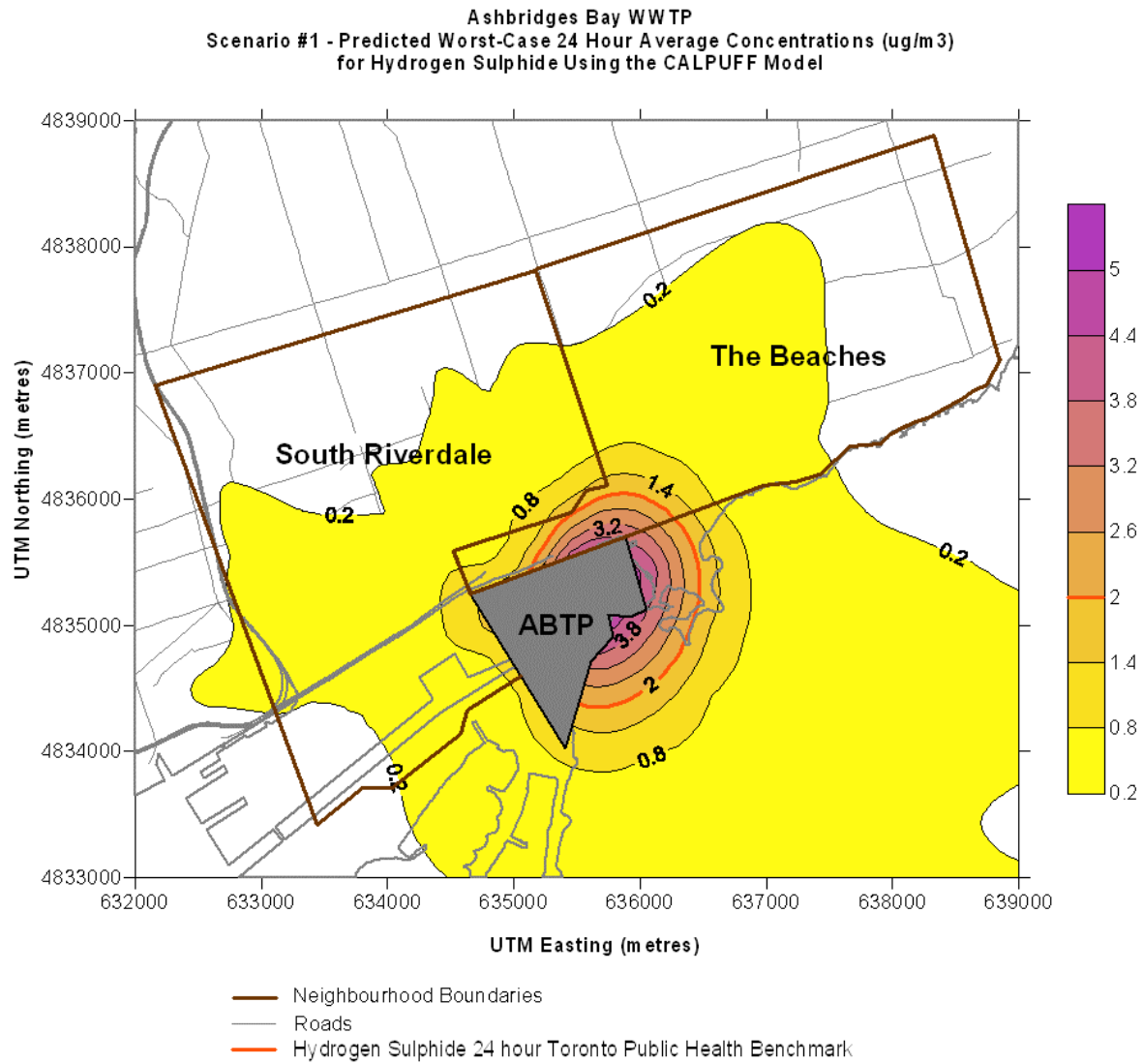| Chemical	CAS No.	AAQC 24 hr	Health Benchmark 24 hr	24-hour Average Concentration ($\mu g/m^3$)			
		($\mu g/m^3$)	($\mu g/m^3$)	*Scenario #1*	*Scenario #2*	*Scenario #3*	*Scenario #4*
Arsenic	7440-38-2		0.00066[c]	0.00012	0.00037	-	-
Benzene	71-43-2		0.3[c]	0.090	0.069	0.12	0.008
Benzo[a]pyrene	50-32-8	0.0011[a]	0.000012[b, c]	0.0079	0.0020	0.0034	0.0010
Bis(2-ethylhexyl)phthalate	117-81-7	50		0.10	0.020	0.075	0.022
Cadmium	7440-43-9	2	0.0006[c]	0.0025	0.0034	-	-
Di-n-octyl phthalate	117-84-0	120		0.0035	0.00079	0.012	0.0037
Hexachlorobutadiene	87-68-3		1.19	0.027	0.025	0.042	0.008
Hydrogen Sulphide	7783-06-4		2-10	1.6	1.6	2.6	0.8
Lead	7439-92-1	2		0.0028	0.0078	-	-
Mercury	7439-97-6		0.3	0.0014	0.0030	0.00000048	0.00000014
Nitrogen Oxides	10102-44-0	200		7.6	6.9	6.4	6.2
PM$_{2.5}$	N/A-PM	30		0.66	0.033	0.28	0.24
PCBs with 4 or More Cl (total)			0.00175[c]	0.000016	0.000017	-	-
Sulphur Dioxide	7446-09-5	275		1.4	2.8	1.9	0.38
Total Dioxins and Furans (as 2,3,7,8-TCDD eq)		5.0E-06		1.30E-09	4.37E-10	-	-
Total PAHs				0.56	0.56	0.08	0.021
Vinyl Chloride	75-01-4		0.1[c]	0.020	0.021	0.029	0.0055

[a] – This is based on B[a]P only

[b]- This is based on B[a]P as a surrogate for the toxicity of the whole PAH mixture. The risk from exposure to total PAHs in the air would be negligible if B[a]P level is found to be below this health benchmark for B[a]P.

[c] - The health benchmark corresponds to an excess lifetime cancer risk of one in a million (or 1 E-6), which meets Health Canada and MOE benchmark of negligible risk.

Scenario 1	incinerator in full operation (pre 1996)
Scenario 2	incinerator in partial operation (2000-2002)
Scenario 3	incineration discontinued (2003-2004)
Scenario 4	incineration discontinued and odour control measures implemented.

Figure 7-1   24-hour Average Hydrogen Sulphide Concentrations for Scenario #1

Ashbridges Bay WWTP
Scenario #1 - Predicted Worst-Case 24 Hour Average Concentrations (ug/m3)
for Hydrogen Sulphide Using the CALPUFF Model

There is no 24 hour AAQC for Hydrogen Sulphide.

Figure 7-2   24-hour Average Hydrogen Sulphide Concentrations for Scenario #2

Ashbridges Bay WWTP
Scenario #2 - Predicted Worst-Case 24 Hour Average Concentrations (ug/m3)
for Hydrogen Sulphide Using the CALPUFF Model

Neighbourhood Boundaries
Roads
Hydrogen Sulphide 24 hour Toronto Public Health Benchmark
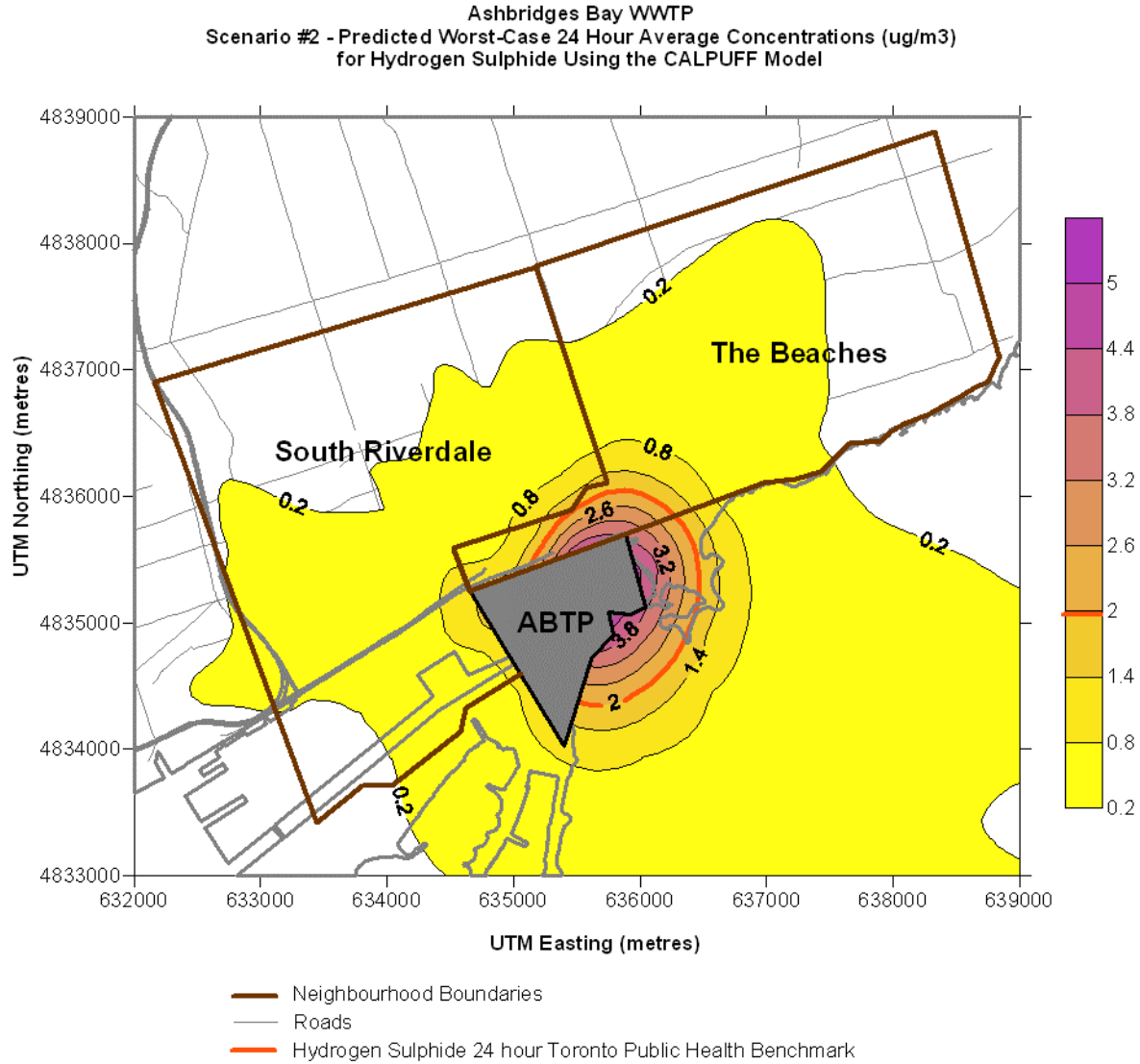
There is no 24 hour AAQC for Hydrogen Sulphide.

Figure 7-3   24-hour Average Hydrogen Sulphide Concentrations for Scenario #3

Ashbridges Bay WWTP
Scenario #3 - Predicted Worst-Case 24 Hour Average Concentrations (ug/m3)
for Hydrogen Sulphide Using the CALPUFF Model

Neighbourhood Boundaries
Roads
Hydrogen Sulphide 24 hour Toronto Public Health Benchmark
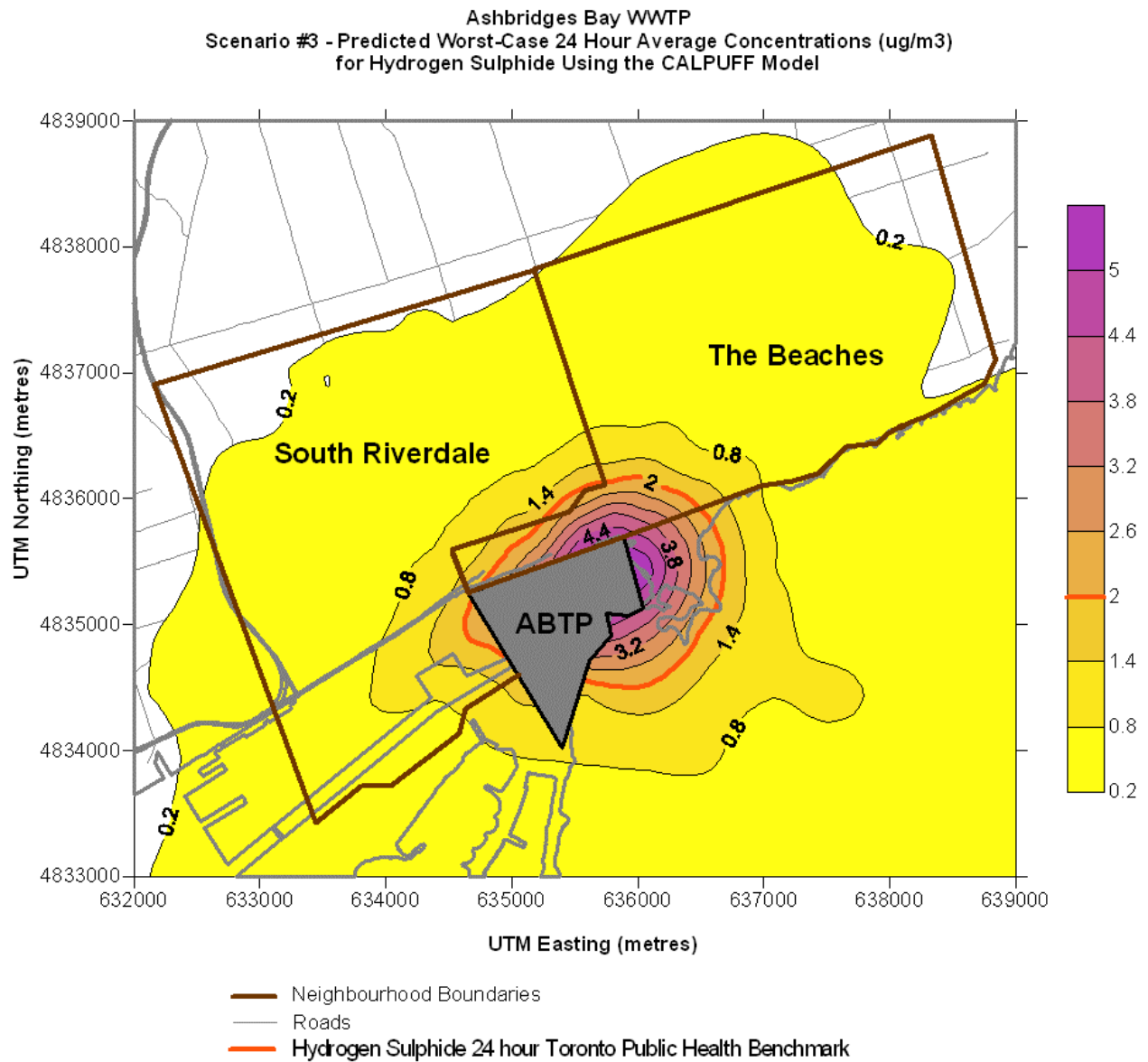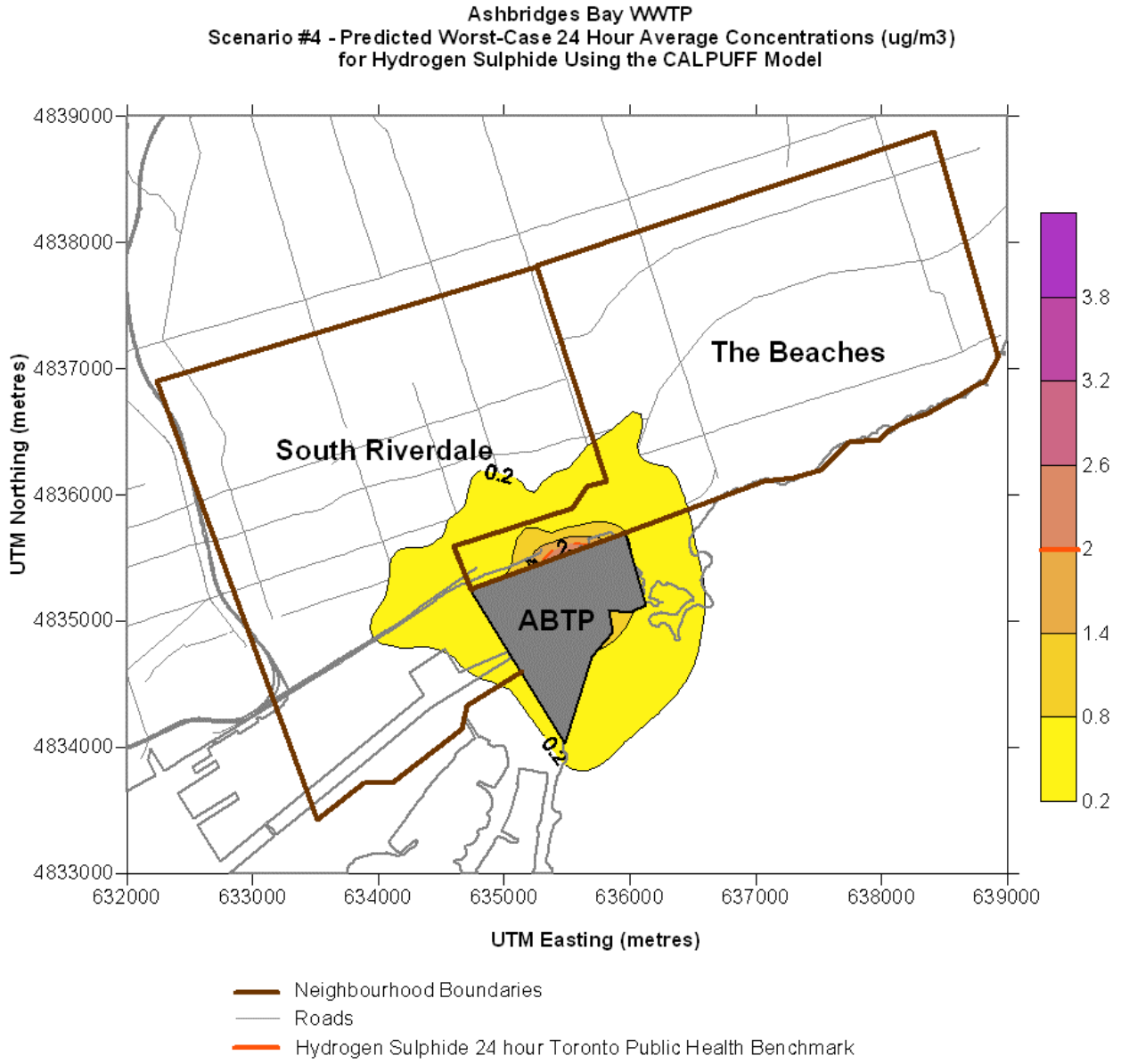
There is no 24 hour AAQC for Hydrogen Sulphide.

Figure 7-4   24-hour Average Hydrogen Sulphide Concentrations for Scenario #4

Ashbridges Bay WWTP
Scenario #4 - Predicted Worst-Case 24 Hour Average Concentrations (ug/m3)
for Hydrogen Sulphide Using the CALPUFF Model

There is no 24 hour AAQC for Hydrogen Sulphide.

7.3 **COMPARISON OF PREDICTED COC CONCENTRATIONS TO TORONTO AMBIENT**

MEASUREMENTS

Environment Canada/MOE operate air quality monitoring stations in Toronto but none of these stations are within the South Riverdale/Beaches communities. The air quality measurements provide a point of comparison for the model results.   The predicted results of Scenario #1 can be compared with measurements of 1995 as the incinerator was in full operation at this time. Similarly, Scenario #2 can be compared to measurements between 2000 and 2002 as the incinerator was in partial operation. As shown on Table 7-9, predicted maximum 24 hr COC levels are typically below the range of maximum measurements for both scenarios, with the exception of B[a]P and PAH.

Mean ambient air quality levels as described in Section 6.2, were taken as the mean of all 24-hr observations for the scenario period of interest. The worst case potential exposure to the communities can be estimated by combining these mean ambient levels with the maximum predicted concentrations in the communities.   This approach will overestimate the potential available substance in the air since the operation of the ABTP makes a contribution to the City's air quality measurements which is included in the mean ambient levels (i.e., double counting).

With the exception of B[a]P, total worst case concentrations in the Beaches and South Riverdale are below the Ontario AAQC as presented on Table 7-11 and Table 7-13, respectively . Arsenic, benzene, B[a]P and cadmium are shown to be above the TPH Health Benchmarks, but for these compounds, ambient levels are already above the TPH benchmarks.   With the exception of B[a]P, PAH, cadmium and lead, the ABTP is a minor contributor to the total potential substance present in air.

ABTP's B[a]P and PAH emissions contribute to the measured levels within the Toronto airshed, but the findings indicate that the predicted maximum 24-hr levels due to ABTP are higher than the measured levels. This supports the notion that PAH/ B[a]P emissions from ABTP were overestimated by a large margin given that PAH/B[a]P were not detected in all source measurements.

Other sources of emissions which may contribute to the Beaches and South Riverdale air quality include local expressways, heavy traffic roadways, island airport and other major industrial sources. In general, the ABTP is a relatively minor source of combustion products when compared to these other sources.

Table 7-9   Comparison of Predicted Maximum Concentrations with Maximum Toronto Ambient Air Observations

Chemical	CAS No.	AAQC 24 hr ($\mu g/m^3$)	Health Benchmark 24 hr ($\mu g/m^3$)	Maximum Predicted Beaches 24-hour Concentration Scenario #1 ($\mu g/m^3$)	Scenario #2 ($\mu g/m^3$)	Maximum Predicted South Riverdale 24-hour Concentration Scenario #1 ($\mu g/m^3$)	Scenario #2 ($\mu g/m^3$)	Measured Pre-1996 (Scenario #1) Range of 24 hr Max ($\mu g/m^3$)		Measured 2000-2002 (Scenario #2) Range of 24 hr Max ($\mu g/m^3$)	
Arsenic	7440-38-2		0.00066[c]	0.000083	0.000251	0.00012	0.00037	0.0096	0.0031	0.0065	0.0039
Benzene	71-43-2		0.3[c]	0.15	0.029	0.09	0.069	13.08	4.66	13.40	1.51
Benzo[a]pyrene	50-32-8	0.0011[a]	0.000012[b, c]	0.02	0.005	0.0079	0.002	0.00061	0.00061	0.00099	0.00015
Bis(2-ethylhexyl)phthalate	117-81-7	50		0.25	0.05	0.1	0.02	-	-	-	-
Cadmium	7440-43-9	2	0.0006[c]	0.0017	0.0023	0.0025	0.0034	0.0033	0.0033	0.0036	0.0033
Di-n-octyl phthalate	117-84-0	120		0.0091	0.002	0.0035	0.00079	-	-	-	-
Hexachlorobutadiene	87-68-3		1.19	0.032	0.032	0.027	0.025	-	-	-	-
Hydrogen Sulphide	6/4/7783		2-10	3.56	3.57	1.6	1.6	-	-	-	-
Lead	7439-92-1	2		0.0019	0.0053	0.0028	0.0078	0.026	0.021	0.042	0.026
Mercury	7439-97-6		0.3	0.00095	0.00356	0.0014	0.003	-	-	-	-
Nitrogen Oxides	10102-44-0	200		6.38	5.26	7.6	6.9	-	-	-	-
$PM_{2.5}$		30		0.56	0.66	0.66	0.033	-	-	-	-
PCBs with 4 or More Cl (total)			0.00175[c]	0.000011	0.000011	0.000016	0.000017	-	-	-	-
Sulphur Dioxide	7446-09-5	275		1.57	2.3	1.4	2.8	-	-	-	-
Total Dioxins and Furans (as 2,3,7,8-TCDD eq)		5.0E-06		8.78E-10	2.97E-10	1.30E-09	4.37E-10	-	-	2.90E-07	3.87E-08
Total PAHs				1.44	1.44	0.56	0.56	0.097	0.097	0.200	0.046
Vinyl Chloride	75-01-4		0.1[c]	0.026	0.033	0.02	0.021	-	-	-	-

[a] – This is based on B[a]P only

[b] - This is based on B[a]P as a surrogate for the toxicity of the whole PAH mixture. The risk from exposure to total PAHs in the air would be negligible if B[a]P level is found to be below this health benchmark for B[a]P. PAH/B[a]P levels are based on non-detect levels taken as the minimum detection limits and over-estimate ABTP's contribution to ambient air.

[c] - The health benchmark corresponds to an excess lifetime cancer risk of one in a million (or 1 E-6), which meets Health Canada and MOE benchmark of negligible risk.

Scenario 1   incinerator in full operation (pre 1996)
Scenario 2   incinerator in partial operation (2000-2002)

Table 7-11   Predicted Total Potential 24-Hour Concentrations – The Beaches

Chemical	CAS Number	AAQC 24 hr ($\mu g/m^3$)	Health Benchmark 24 hr ($\mu g/m^3$)	Scenario #1 (pre-1996)				Scenario # 2 (2000-2002)			
				ATBP Predicted Maximum ($\mu g/m^3$)	*Ambient Measured* ($\mu g/m^3$)	*Total Predicted Concentration* ($\mu g/m^3$)	*ABTP % of Total*	*ATBP Predicted Maximum* ($\mu g/m^3$)	*Ambient Measured* ($\mu g/m^3$)	*Total Predicted Concentration* ($\mu g/m^3$)	*ABTP % of Total*
Arsenic	7440-38-2	0.3	0.00066[c]	0.00008	0.002	0.002	5%	0.00025	0.001	0.002	16%
Benzene	71-43-2		0.3[c]	0.150	1.9	2.03	7%	0.029	1.2	1.18	2%
Benzo[a]pyrene	50-32-8	0.0011[a]	0.000012[b, c]	0.020	0.0002	0.020	99%	0.005	0.0001	0.005	98%
Bis(2-ethylhexyl)phthalate	117-81-7	50		0.250	-			0.050	-		
Cadmium	7440-43-9	2	0.0006[c]	0.002	0.003	0.004	39%	0.002	0.003	0.005	43%
Di-n-octyl phthalate	117-84-0	120		0.009	-		-	0.002	-		-
Hexachlorobutadiene	87-68-3		1.19	0.032	-		-	0.032	-		-
Hydrogen Sulphide	7783-06-4		2-10	3.560	-		-	3.570	-		-
Lead	7439-92-1	2		0.002	0.009	0.010	18%	0.005	0.007	0.012	45%
Mercury	7439-97-6	2.5	0.3	0.001	-		-	0.004	-		-
Nitrogen Oxides	10102-44-0	200		6.380	104	110	6%	5.26	78	83	6%
PM$_{2.5}$			30	0.56	-		-	0.66	8.89	9.55	6%
PCBs with 4 or More Cl (total)		0.15	0.00175[c]	0.000011	-		-	0.000011	-		-
Sulphur Dioxide	7446-09-5	275		1.57	11.1	12.7	12%	2.3	12.3	14.6	16%
Total Dioxins and Furans (as 2,3,7,8 TCDD eq)			5.0E-06	8.78E-10	-		-	2.97E-10	3.40E-08	3.43E-08	0.87%
Total PAHs				1.440	0.037	1.5	98%	1.440	0.026	1.5	98%
Vinyl Chloride	75-01-4	1	0.1[c]	0.026				0.033			-

[a] – This is based on B[a]P only

[b] - This is based on B[a]P as a surrogate for the toxicity of the whole PAH mixture. The risk from exposure to total PAHs in the air would be negligible if B[a]P level is found to be below this health benchmark for B[a]P. PAH/B[a]P levels are based on non-detect levels taken as the minimum detection limits and over-estimate ABTP's contribution to ambient air.

Scenario 1   incinerator in full operation (pre 1996)

Scenario 2   incinerator in partial operation (2000-2002)

[c] - The health benchmark corresponds to an excess lifetime cancer risk of one in a million (or 1 E-6), which meets Health Canada and MOE benchmark of negligible risk.

Total predicted concentration is maximum 24-hour predicted concentration plus measured ambient levels.

ABTP % of total is the predicted ABTP concentration divided by the total predicted concentration

Table 7-13   Predicted Total Potential 24-Hour Concentrations – South Riverdale

Chemical	CAS Number	AAQC 24 hr (µg/m³)	Health Benchmark 24 hr (µg/m³)	Scenario #1 (pre-1996)				Scenario # 2 (2000-2002)			
				ATBP Predicted Maximum (µg/m³)	Ambient Measured (µg/m³)	Total Predicted Concentration (µg/m³)	ABTP % of Total	ATBP Predicted Maximum (µg/m³)	Ambient Measured (µg/m³)	Total Predicted Concentration (µg/m³)	ABTP % of Total
Arsenic	7440-38-2	0.3	0.00066[c]	0.00012	0.002	0.002	6%	0.00037	0.001	0.002	21%
Benzene	71-43-2		0.3[c]	0.090	1.9	1.97	5%	0.069	1.2	1.22	6%
Benzo[a]pyrene	50-32-8	0.0011[a]	0.000012[b, c]	0.008	0.0002	0.008	98%	0.002	0.0001	0.002	94%
Bis(2-ethylhexyl)phthalate	117-81-7	50		0.100	-			0.020	-		
Cadmium	7440-43-9	2	0.0006[c]	0.003	0.003	0.005	48%	0.003	0.003	0.006	53%
Di-n-octyl phthalate	117-84-0	120		0.004	-		-	0.001	-		-
Hexachlorobutadiene	87-68-3		1.19	0.027	-		-	0.025	-		-
Hydrogen Sulphide	7783-06-4		2-10	1.600	-		-	1.600	-		-
Lead	7439-92-1	2		0.003	0.009	0.011	25%	0.008	0.007	0.014	54%
Mercury	7439-97-6	2.5	0.3	0.001	-			0.003	-		
Nitrogen Oxides	10102-44-0	200		7.6	104	111	7%	6.9	78	85	8%
PM$_{2.5}$		30		0.66	-		-	0.033	8.89	8.92	0.4%
PCBs with 4 or More Cl (total)		0.15	0.00175[c]	0.000016	-		-	0.000017	-		-
Sulphur Dioxide	7446-09-5	275		1.4	11.1	12.5	11%	2.8	12.3	15.1	19%
Total Dioxins and Furans (as 2,3,7,8-TCDD eq)			5.0E-06	1.30E-09	-			4.37E-10	3.40E-08	3.44E-08	1.3%
Total PAHs				0.560	0.037	0.6	94%	0.560	0.026	0.6	96%
Vinyl Chloride	75-01-4	1	0.1[c]	0.020			-	0.021			-

[a] – This is based on B[a]P only

[b] - This is based on B[a]P as a surrogate for the toxicity of the whole PAH mixture. The risk from exposure to total PAHs in the air would be negligible if B[a]P level is found to be below this health benchmark for B[a]P. PAH/B[a]P levels are based on non-detect levels taken as the minimum detection limits and over-estimate ABTP's contribution to ambient air.

[c] - The health benchmark corresponds to an excess lifetime cancer risk of one in a million (or 1 E-6), which meets Health Canada and MOE benchmark of negligible risk.

Scenario 1   incinerator in full operation (pre 1996)

Scenario 2   incinerator in partial operation (2000-2002)

Total predicted concentration is maximum 24-hour predicted concentration plus measured ambient levels.

ABTP % of total is the predicted ABTP concentration divided by the total predicted concentration

8.0   CONCLUSIONS AND RECOMMENDATIONS

Dispersion modelling of past, present and future emissions from the ABTP on the communities of South Riverdale and the Beaches was carried out with the aid of the US EPA CALPUFF modelling system. The modelled results are a function of the amount of emissions released, characterization of sources, as well as transport and dispersion of the emissions. The following findings were determined.

1. Changes to the processes at the ABTP have changed the emission profile of the facility; this is most noticeable once incineration is stopped.

2. The addition of the Pelletizer Building has changed the dispersion pattern around the ABTP, which has increased the impacted area around the plant.

3. The impact of the ABTP on the air quality of the adjacent neighbourhoods (South Riverdale and Beaches) is reduced once incineration is terminated and odour controls are in place (Scenario 4).

4. After 2002, when the incinerators are no longer in operation, the model shows that some of the chemicals that are associated with incineration, which include arsenic, cadmium, lead, PCBs and dioxins, no longer impact the air quality in the South Riverdale and Beaches community. In contrast, the levels of a few other chemicals (e.g. benzene, hydrogen sulphide) are expected to increase in the two communities once incineration ends and before odour controls are in place (Scenario 3), though the difference is not large.

5. Predicted Chemicals of Concern concentrations were compared with Ontario Ambient Air Quality Criteria, Point of Impingement (POI) standards, Health Benchmarks as well as ambient measurements of COCs within the City of Toronto. Of the 17 COCs, all chemicals (15) that were detected during monitoring met their appropriate AAQC/POI for all time-averaging periods and scenarios.

6. In both communities, most of the Chemicals of Concern that were detected during monitoring met their 24-hour Health Benchmarks in all scenarios with the exception of cadmium and hydrogen sulphide. Cadmium was above the Health Benchmark only when the incinerator was in operation (Scenarios 1 and 2). Hydrogen sulphide exceeded the lower Health Benchmark in Scenario 1, 2, or 3, but not the higher benchmark.

7. For Scenario 1 (Pre-1996) and 2 (2000-2002) in both communities, the predicted maximum 24-hour air concentrations of the COCs that were detected in the ABTP are below the measured air levels across Toronto. The ABTP typically represents a small portion of total pollutants in the air and the total concentrations (Toronto ambient air plus ABTP emissions) are below their respective Ambient Air Quality Criteria (AAQC)

8. Benzo[a]pyrene was used as a representative for all polycyclic aromatic hydrocarbons (PAHs) compounds. These chemicals were never detected in the monitoring at the ABTP. The modelling estimated that B[a]P could be above the 24-hour Health Benchmark for all scenarios in both communities. In addition, B[a]P was estimated to exceed the AAQC/POI except for the 24-hour and annual averages in Scenario 4 (Future). For Scenarios 1 (Pre-1996) and 2 (2000-2002), the estimated

maximum concentrations of B[a]P and PAHs were above the maximum air quality observations across Toronto.

9. Given the very conservative assumptions used, B[a]P and PAH emissions from ABTP were substantially over-estimated. This suggests that B[a]P and PAH are not likely to impact the communities to the extent predicted by the modelling. Future (Scenario 4) concentrations of B[a]P are lower, therefore, the expected cumulative impact in the two communities will be less once all the odour controls are in place.

10. The modelling shows that emissions released from elevated stacks tend to generate higher concentrations to the northeast of the ABTP due to the stronger winds from the southwest. These emissions therefore impact areas of the Beaches more than South Riverdale. In contrast, since lighter winds are from the southeast, emissions from the low elevation sources (e.g. open tanks) tend to have greater impact on areas of South Riverdale to the northwest of the ABTP.

11. There is little difference between the maximum predicted concentrations due to the ABTP on South Riverdale and the Beaches. Small differences in concentrations are likely due to the meteorological pattern around the facility. Although the ABTP is a large source of emissions, its contribution is relatively small when compared to the Ontario AAQC, Health Benchmarks and City wide air quality measurements.

The following recommendations are proposed to improve the modelling results.

1. The ABTP continue to monitor effluent into and released from the plant to gain a better understanding of potential emissions from the plant.

2. Testing for PAHs in air emissions at large release points (e.g. stacks) should be carried out to confirm that these emissions are indeed insignificant.

3. The emission inventory should be periodically updated to reflect new information on on-site new and existing equipment or changes to the wastewater.

4. The potential emissions from the Final Clarifiers should be tested using an appropriate and approved method to determine the flux of sulphur bearing substances.

5. The City could examine the air quality impact of emissions of all the sources in these communities, including the ABTP.

The City could examine the air quality impact of emissions of all the sources in these communities, including the ABTP.

9.0   LIMITATIONS OF STUDY

Measurements of emissions from the Final Clarifiers have been excluded from the emission inventory because there is some questions with respect to the validity of these measurements. The Project Team believes that the emissions from this source are insignificant with respect to health but should be re-tested for sulphur-bearing substances.

Dispersion models are used as tools to predict the likelihood of events (i.e., concentrations) occurring. Models do not provide absolute values but a means of calculating the concentrations when ambient air monitors are not available or practical to measure actual concentrations or when there is no technology available to measure a particular component in the ambient air.

The results of this study cannot be used to determine compliance of the ABTP with Ontario air quality standards or objectives. The study is limited to examining the impact of the ABTP on the two local communities and the changes in air quality that have occurred as a result of modification at the facility.

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