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.