Tsawwassen Particulate Air Quality Study, 2002
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Air Quality Monitoring and Assessment Division
Policy and Planning Department
Greater Vancouver Regional District

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1. **Introduction**

This report summarizes the findings of a special air quality monitoring program recently completed by the Air Quality Monitoring and Assessment Division of the Policy and Planning Department of the Greater Vancouver Regional District (GVRD). The study was conducted in the Tsawwassen area of Delta after enquiries by local citizen groups and civic officials.

The purpose of the study was to:

- Determine the levels of ambient inhalable particulate (PM10) and fine particulate (PM2.5) in the Tsawwassen area and to compare them to established standards and/or objectives;
- Compare levels of PM10 and PM2.5 in the Tsawwassen area with other areas of the GVRD;
- Determine the representativeness of the existing monitoring site at English Bluff School for determining levels of particulates in the greater Tsawwassen area; and
- Conduct a preliminary visual assessment of selected particulate samples for the presence of coal or other identifiable particulate matter.

The study was conducted at three sites in the Tsawwassen area during the period June 1, 2002 through August 24, 2002.

2. **Monitoring Sites and Methods**

The primary equipment used for this study were three R&P 2025 Dichotomous Partisol-Plus Sequential Air Samplers. The units are equipped with a PM10 size selective inlet. The sample stream is split into the PM10-PM2.5 (course) fraction and <PM2.5 (fine) fraction which are collected on two separate 47mm diameter filters. Gravimetric analyses were conducted on the filters using a Sartorius Microbalance.

Samples were collected simultaneously over a 24-hour period every third day.
In addition, data from the existing Total Suspended Particulate (TSP) high volume sampler were also incorporated into this analysis. This data was collected every sixth day according to the National Air Pollution Surveillance (NAPS) schedule and protocols.

PM10 and PM2.5 data from continuous TEOM samplers located at Pitt Meadows and the Vancouver International Airport are also incorporated into this report for comparison purposes. Data from the continuous TEOM samplers, while useful for comparison purposes, may vary quantitatively from data collected by the dichotomous samplers, due to differences in sampling methodologies and analytical procedures.

The dichotomous samplers were located at three sites in the Tsawwassen area: (i) English Bluff Elementary School, (ii) Cliff Drive Elementary School and (iii) a private residence located near central Tsawwassen. The locations of these sites were selected to give a representative cross section of the particulate air quality in the Tsawwassen area, as illustrated in Figure 1.

**Figure 1**

![Map of Tsawwassen](image-url)
3. Measures of Air Quality

The potential health and environmental concern afforded by the measured concentrations of some air pollutants can be assessed by comparing the measured concentrations to ambient air quality objectives. This Section provides a description of the ambient air quality objectives used as guidance by the GVRD and the new Canada-Wide Air Quality Standards for particulate matter and ground-level ozone.

3.1 Ambient Air Quality Objectives

The objectives used as guidance by the GVRD are the *National Ambient Air Quality Objectives* (NAAQO). In addition, the GVRD has established air quality objectives for some contaminants for which federal standards or objectives do not exist.

The NAAQO consist of three levels that are designated as the *maximum desirable*, *maximum acceptable* and *maximum tolerable* levels (Tables 1 and 2). From an air quality management perspective, *maximum desirable* levels represent concentrations that should not be exceeded in sparsely populated areas where the number of sources of air contaminants is small. For large urban centres, more realistic short-term goals could be to avoid occurrences of air quality deterioration beyond *maximum acceptable* levels, while long-term goals might be to achieve the *maximum desirable* levels. The *maximum tolerable* levels are guidelines for when immediate emission control measures may be necessary to prevent further deterioration of air quality.

**Table 1**: Description of the National Ambient Air Quality Objectives

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maximum desirable</strong></td>
<td>This level defines the long-term goal for air quality and provides a basis for an anti-degradation policy for unpolluted parts of the country and for the continuing development of control technology.</td>
</tr>
<tr>
<td><strong>Maximum acceptable</strong></td>
<td>This level is intended to provide adequate protection against effects on soil, water, vegetation, materials, animals, visibility, and personal comfort and well-being.</td>
</tr>
<tr>
<td><strong>Maximum tolerable</strong></td>
<td>This level denotes concentrations beyond which, due to a diminishing margin of safety, appropriate action is required without delay to protect the health of the general population.</td>
</tr>
</tbody>
</table>
### Table 2: Concentration Levels of the National Ambient Air Quality Objectives and the GVRD Objectives

<table>
<thead>
<tr>
<th>Contaminant</th>
<th>Concentration Averaging Period</th>
<th>Objective Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Maximum desirable Level</td>
</tr>
<tr>
<td>Inhalable Particulate Matter (PM$_{10}$)$^1$</td>
<td>24-hour</td>
<td>50 $\mu$g/m$^3$</td>
</tr>
<tr>
<td></td>
<td>1-year$^2$</td>
<td>30 $\mu$g/m$^3$</td>
</tr>
<tr>
<td>Ozone (O$_3$)</td>
<td>1-hour</td>
<td>51 ppb</td>
</tr>
<tr>
<td></td>
<td>1-hour</td>
<td>210 ppb</td>
</tr>
<tr>
<td></td>
<td>24-hour</td>
<td>110 ppb</td>
</tr>
<tr>
<td></td>
<td>1-year</td>
<td>30 ppb</td>
</tr>
<tr>
<td>Nitrogen Dioxide (NO$_2$)</td>
<td>1-hour</td>
<td>170 ppb</td>
</tr>
<tr>
<td></td>
<td>24-hour</td>
<td>60 ppb</td>
</tr>
<tr>
<td>Sulphur Dioxide (SO$_2$)</td>
<td>1-hour</td>
<td>13 ppm</td>
</tr>
<tr>
<td></td>
<td>8-hour</td>
<td>5 ppm</td>
</tr>
<tr>
<td>Carbon Monoxide (CO)</td>
<td>1-hour</td>
<td></td>
</tr>
</tbody>
</table>

1 – These are objectives adopted by the GVRD.
2 – It is the annual geometric mean that is to be compared to this objective.

### 3.2 Canada-Wide Standards

New national air quality standards for fine particulate matter (PM$_{2.5}$) and ozone (O$_3$) were endorsed by the Canadian Council of Ministers of the Environment on June 5-6, 2000. These new standards, termed Canada-Wide Standards (CWS) are in addition to the NAAQO detailed in Section 3.1.

The CWS and related provisions for PM$_{2.5}$ are:

- A CWS for PM$_{2.5}$ of 30 $\mu$g/m$^3$, over a 24-hour averaging time, to be achieved by year 2010.
- Achievement is based on the 98$^{th}$ percentile ambient measurement annually, averaged over 3 consecutive years.

The CWS and related provisions for ozone are:
• A CWS of 65 ppb, over an 8-hour averaging time, to be achieved by year 2010.
• Achievement is based on the 4\textsuperscript{th} highest measurement annually, averaged over 3 consecutive years.

4. **Measured Levels of Air Quality**

The following section describes the measured levels of air quality during the study period in terms of the four established purposes of the study.

4.1 **Comparison of Measured Levels to Objectives/Standards**

Figures 2 and 3 illustrate measured PM10 and PM2.5 respectively during the study period.

During the study period, all PM10 measurements in the Tsawwassen area were well below the established GVRD and B.C. Objective of 50 \text{ug/m}^3. Slight day-to-day
variations do typically occur due to local influences, however the three locations show similar values and trends.

As illustrated in Figure 3, PM2.5 data show similar homogeneity (as PM10) across the Tsawwassen region with all values being 1/3 or less of the established Canada-Wide Standard of 30 ug/m³.

Based upon the data collected, it is concluded that measured inhalable particulate (PM10) and fine particulate (PM2.5) levels in the Tsawwassen area are well below the most stringent established health-based objectives and/or standards.

4.2 Comparison of Measured Levels to Other Areas within the GVRD

Figures 4 and 5 compare PM10 and PM2.5 values measured in the Tsawwassen area with comparable data from two other sites within the GVRD: Pitt Meadows and Vancouver International Airport (YVR). As illustrated, values measured in the Tsawwassen region during the study period are most similar to data from YVR while values at Pitt Meadows,
downwind from the built up regions of the northern GVRD, generally shows slightly higher values. While some of these relatively small differences may be due to the proximity of the monitoring sites to various sources, some may be due to the different measurement techniques employed (ie: Tsawwassen monitoring using dichotomous samplers and other monitoring using real-time TEOM samplers). The trends of all data sets, however, are similar.
Based upon the above analysis, it is concluded that measured concentrations of PM10 and PM2.5 are similar in magnitude (but slightly lower) and pattern to values measured elsewhere within the region.

4.3 Monitoring Location Representativeness

One of the issues to be addressed by the monitoring program, was to assess the representativeness of the existing English Bluff School site to reflect particulate levels in other areas of Tsawwassen. To conduct this analysis, monitoring data collected at English Bluff School was compared to data from both the Central Tsawwassen and Cliff School locations using various statistical techniques.

Figures 6 and 7 illustrate the statistical relationship between PM10 and PM2.5 (respectively) measured at English Bluff School and the Central Tsawwassen site, for the study period. Both parameters correlate well between the locations and the regression equations approach the 1:1 slope line. The major point to note is that for PM10,
measurements at English Bluff tend to be marginally greater than those in Central Tsawwassen at the higher concentrations.

Figure 6: Relationship Between Central Tsawwassen and English Bluff PM10 (\(\text{ug/m}^3\))

\[ r^2 = 0.96 \]
\[ y = 0.83x + 1.17 \]

Figure 7: Relationship Between Central Tsawwassen and English Bluff PM2.5 (\(\text{ug/m}^3\))

\[ r^2 = 0.96 \]
\[ y = 0.94x + 0.31 \]
Figures 8 and 9 illustrate the statistical relationship between PM10 and PM2.5 (respectively) measured at English Bluff School and the Cliff School site, for the study period. In both analyses, the relationship between the English Bluff and Cliff School location is not as strong as that noted in Figures 6 and 7. One of the reasons for this is that on two sampling periods, levels at Cliff school were significantly higher than those recorded at the other sites in the Tsawwassen area, thereby skewing the statistical relationships. Although the reasons for this are thought to be local emissions impacting this site at those times, no definitive cause could be determined to explain these differences. These anomalies, along with a relatively smaller database than the analysis in Figures 6 and 7, combine to add less confidence to the statistical results calculated and illustrated in Figures 8 and 9.

**Figure 8: Relationship Between Cliff School and English Bluff PM10 (ug/m³)**

\[ y = 0.55x + 6.66 \]

\[ r^2 = 0.58 \]
Figures 8 and 9 also illustrate that for the period of record, measurements of PM10 and PM2.5 at Cliff School were generally slightly higher than those measured at English Bluff.

Based on these analyses, it is concluded that, particulate levels measured at English Bluff are representative of those experienced in other parts of the Tsawwassen area.

4.4 Other Monitoring Results/Analyses

Total suspended particulate (TSP) has been measured every sixth day at English Bluff School for an extended number of years. TSP includes the collection of PM10 particles as well as larger particles up to 30-40 micrometers in aerodynamic diameter. These larger particles generally do not stay suspended in the atmosphere as long as the smaller fractions. Consequently, sources of these larger particles such as wind-blown material from storage piles, may be captured with a TSP sampler but might have limited impact on instruments measuring only the smaller size fractions.
To assess the relative relationship between TSP and PM10 in the Tsawwassen area during the study period, TSP measurements from English Bluff were reviewed. Figure 10 illustrates PM10 and TSP measurements from English Bluff during the study period. Visually, TSP values follow the same basic patterns as PM10 measurements. Statistically, average PM10 represents about 75% of the TSP during the study period with some individual days being more or less than this average.

Figure 10: English Bluff School TSP vs PM10

Based on previous studies within the Lower Fraser Valley, the ratio of PM2.5 to PM10 has been shown to be consistent with other urbanized regions of Canada at 0.40 to 0.60, depending upon the location of the site relative to major emission sources and the time of year. For the study period, the ratio of PM2.5 to PM10 was calculated for each sampling date. The results of this analysis (see Figure 11) indicate that, with the exception of a few sampling points, this relationship holds in the Tsawwassen area with relative consistency between the sampling locations. This further illustrates that results from English Bluff may be considered representative of the larger area.
In order to assess the consistency of this relationship with other areas within the GVRD, the PM2.5/PM10 ratio at English Bluff was compared to similar ratios determined for Vancouver Airport and Pitt Meadows. As illustrated in Figure 12, Pitt Meadows and Vancouver Airport show similar results both numerically and in trend. This indicates that similar types of sources influenced these sites during the study period. English Bluff, located away from the major urbanized portion of the region, shows a ratio that is generally higher, indicating a slightly higher proportion of PM2.5 at this site. This may in part be due to the aforementioned differences in monitoring methods between the English Bluff site and the other two locations.
From this analysis, it is concluded that PM2.5/PM10 ratios in the Tsawwassen area are similar but generally higher than other sites located in the GVRD.

4.5 Visual Assessment of Selected Particulate Samples

Four PM10 and four TSP filters from English Bluff School were selected for a visual inspection. The analysis was conducted using a Motic Digital Microscope. Sample filters were visually analyzed and results were compared to visual images of a series of known contaminants.

None of the PM10 filters analyzed had any visible particles. Of the TSP filters, two (2) had a couple of identifiable coal particles representing less than 1% of the visible particles. One filter also had some other carbonaceous particles which were identified as possibly burned wood residue.
One filter had numerous salt crystals which were estimated to represent up to 25% of the total sample. A second filter had fewer salt crystals representing approximately 10% of the sample.

Overall, the TSP samples analyzed had very few visible particles of which only a very small percentage was identifiable as coal.

5. Conclusions and Recommendations

From the analysis conducted during the study period, it is concluded that:

• measured inhalable particulate (PM10) and fine particulate (PM2.5) levels in the Tsawwassen area are well below the most stringent established health-based objectives and/or standards;
• measured concentrations of PM10 and PM2.5 are similar in magnitude and pattern to values measured elsewhere within the region;
• particulate levels measured at English Bluff are representative of those experienced in other parts of the Tsawwassen area;
• no site in the Tsawwassen area was unduly influenced by any one emission source (based on statistical and visual analyses); and that
• the ratio of PM2.5/PM10 are similar to other sites located in the GVRD.

Based upon the studies conducted and the conclusions noted above, it is recommended that:

• English Bluff School continue to be operated as the sampling site representative of the greater Tsawwassen area;
• consideration be given to enhancing the English Bluff School monitoring site with a dichotomous sampler to be operated on the NAPS schedule (for long-term monitoring of health-related particulate levels); and that
• staff at the GVRD continues to work with staff for the Corporation of Delta and local residents to address periodic nuisance dust issues in the Tsawwassen area, as they arise.
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