

## Fine Particulate Matter



Particles smaller than 2.5 micrometers in diameter suspended in outdoor air are called “fine” particulate matter, or  $PM_{2.5}$ . These particles are approximately 1/30<sup>th</sup> the width of a human hair.

While we’ve made progress with  $PM_{2.5}$  reductions in the last 15 years, we still don’t meet our health goal in three of our four counties. Additionally, current monitored levels in two counties would violate recently-proposed federal standards.<sup>1</sup> Unless more aggressive reduction strategies are successfully implemented, we will continue to fall short of our health goal and will likely violate a new federal standard.

$PM_{2.5}$  is the most important criteria air pollutant challenge facing our region, both now and in the future. Serious current health risks, no change in measured levels, and the likelihood of violating new federal standards combine to make  $PM_{2.5}$  reductions a priority.

### Health and Environmental Impacts

Of the criteria pollutants (those pollutants with federal outdoor air quality standards) and at the levels monitored in the Puget Sound area, fine particulate is associated with the most serious health effects.  $PM_{2.5}$  exposure is linked with respiratory disease, decreased lung function, asthma attacks, heart attacks, and premature death.<sup>2,3,4,5</sup> Children, older adults, and people with some illnesses are more sensitive and susceptible to  $PM_{2.5}$  health effects.<sup>6,7</sup> Recent research has raised additional concern about the health effects of the smallest “ultrafine” particles (less than 0.1 micrometers) may be even more harmful because of their very small size.<sup>8</sup>

As well as being harmful themselves, fine particles often act as a mode of transportation into the body for other pollutants that adsorb to them. Many of these pollutants are carcinogenic and have other health effects.

In addition to health effects, PM<sub>2.5</sub> affects visibility. Fine particulate matter can remain suspended for a long time, diminishing views and contributing to regional haze.<sup>9</sup>

### Federal Fine Particulate Standards

The Environmental Protection Agency (EPA) set a national ambient air quality standard for PM<sub>2.5</sub> in 1997. The Puget Sound area has not violated this standard and is currently in compliance for fine particulate matter. The federal standard includes both a daily (65 micrograms per cubic meter [ $\mu\text{g}/\text{m}^3$ ]) and annual (15  $\mu\text{g}/\text{m}^3$ ) standard.

EPA is in the process of revising the fine particulate national ambient air quality standard. EPA released proposed fine particle standards on December 20<sup>th</sup>, 2005 of 35  $\mu\text{g}/\text{m}^3$  (daily) and 15  $\mu\text{g}/\text{m}^3$  (annual). The proposed standards are based on preliminary recommendations made by EPA staff and the Clean Air Science Advisory Committee.<sup>10,11,12</sup> Preliminary recommendations ranged from 25  $\mu\text{g}/\text{m}^3$  to 40  $\mu\text{g}/\text{m}^3$  for the daily standard and 12 to 15  $\mu\text{g}/\text{m}^3$  for the annual standard.<sup>13</sup> EPA will be taking comment on these ranges (as well as proposals for no change to the current standard) and is scheduled to finalize a new standard in September 2006.

The proposed daily standard is more protective of human health than the current one and brings the federal standard closer to the Puget Sound region's fine particulate daily health goal of 25  $\mu\text{g}/\text{m}^3$ . ***Based on monitoring data, the Puget Sound region would currently violate the proposed EPA standard.***<sup>14,15</sup>

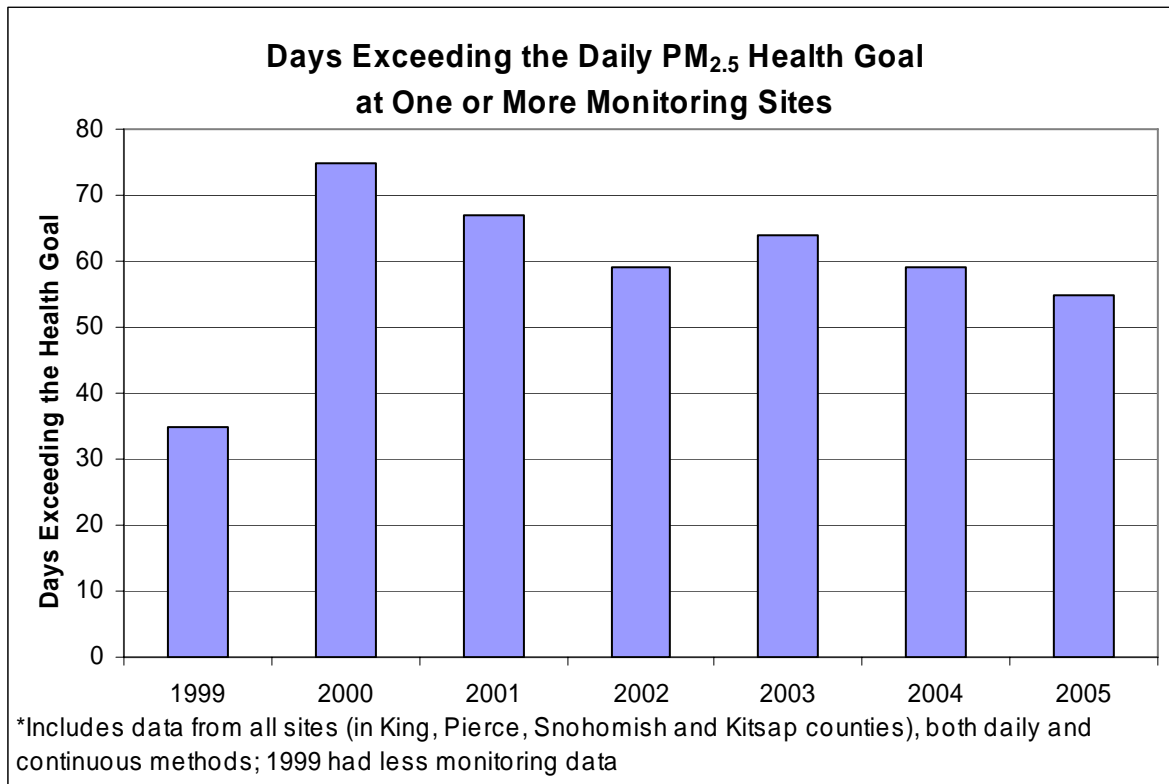
### Local Fine Particulate Health Goal

The Agency has developed an air quality health goal for PM<sub>2.5</sub>. The Agency convened a Particulate Matter Health Committee, comprised of local health professionals, who extensively examined the fine particulate standard.<sup>16</sup> The Health Committee did not consider the federal standard to be sufficiently protective of human health.

Based on the committee's recommendations, the Agency adopted a health goal of 25  $\mu\text{g}/\text{m}^3$  in 1999 for a daily average, well below the current 65  $\mu\text{g}/\text{m}^3$ . The committee recommended a health goal of 15  $\mu\text{g}/\text{m}^3$  for the annual average,

consistent with the federal standard. *Measured daily concentrations of PM<sub>2.5</sub> do not meet the local health goal at monitoring stations in three of the Agency's four counties.* Kitsap County's two monitoring sites meet the goal.

Our local daily health goal was written and adopted with the intent that it is never exceeded. The graph below shows that we're falling far short of that intent. *We typically exceed the health goal for an entire two months out of each year.* Significant emission reductions are clearly needed to get levels firmly below the health goal, with no days exceeding the health goal each year.



### PM<sub>2.5</sub> Monitoring Network and Trends

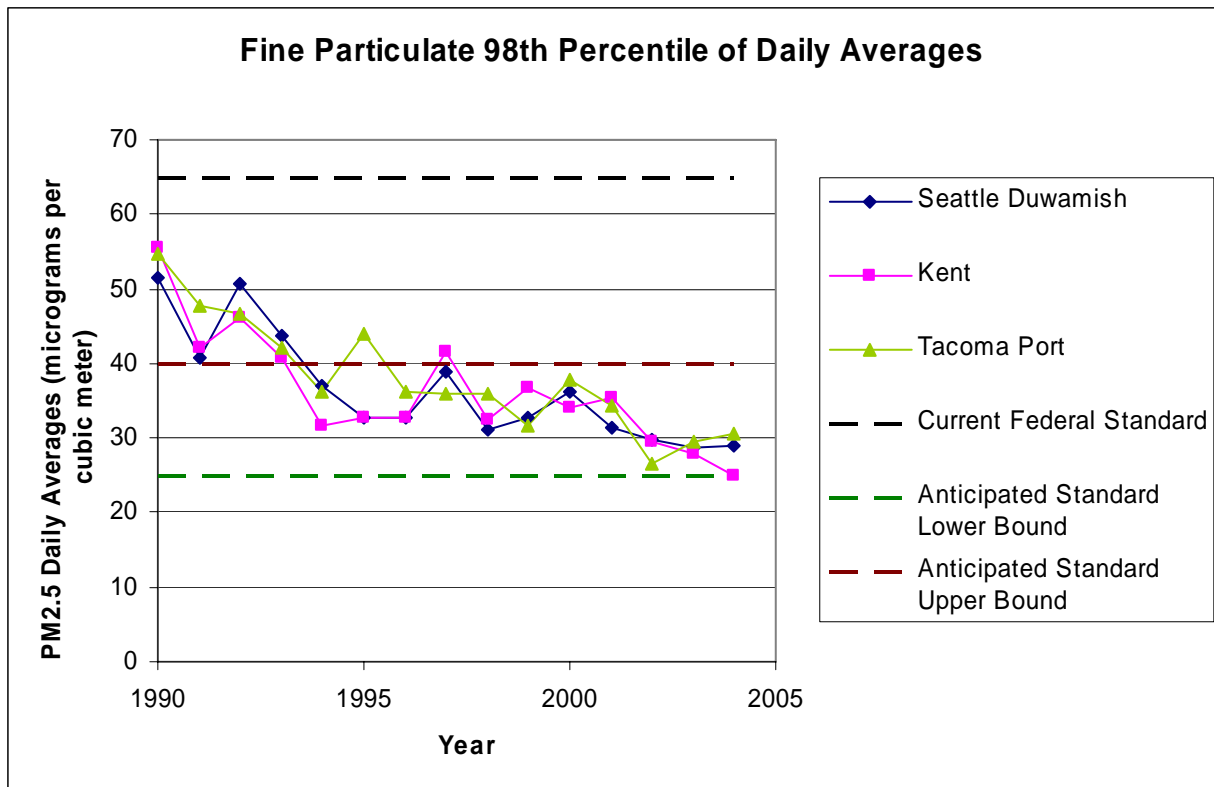
The Agency maintains a particulate monitoring network in its four counties.<sup>17</sup> This network goes well beyond national ambient air quality standard monitoring requirements, and gathers valuable information used to educate people about health risks, guide emissions reduction strategies, and reinforce emissions inventories.

The following graph shows the history of PM<sub>2.5</sub> concentrations at three long-term monitoring locations.<sup>18</sup> Concentrations have not decreased as significantly in recent years as they did in the early 1990s

The 98<sup>th</sup> percentile of the daily averages is shown, as this is the statistic required to compare to the federal standard.<sup>19</sup> The current federal standard (implemented in

1999) is shown as the dashed black line. The upper bound and lower bounds showing the ranges for comment on the proposed federal standard are shown in dashed brown and green lines, respectively.

Some monitoring locations with our highest fine particulate levels are not shown because they don't have a long monitoring history. These locations are typically close to wood-burning areas and include two locations that would currently violate the proposed standard of  $35 \mu\text{g}/\text{m}^3$ . Three additional monitoring locations that have a very slim "margin of safety" (less than  $5 \mu\text{g}/\text{m}^3$ ) that places them at risk of violating the proposed standard.



### PM<sub>2.5</sub> Concentrations – Seasonal Variation

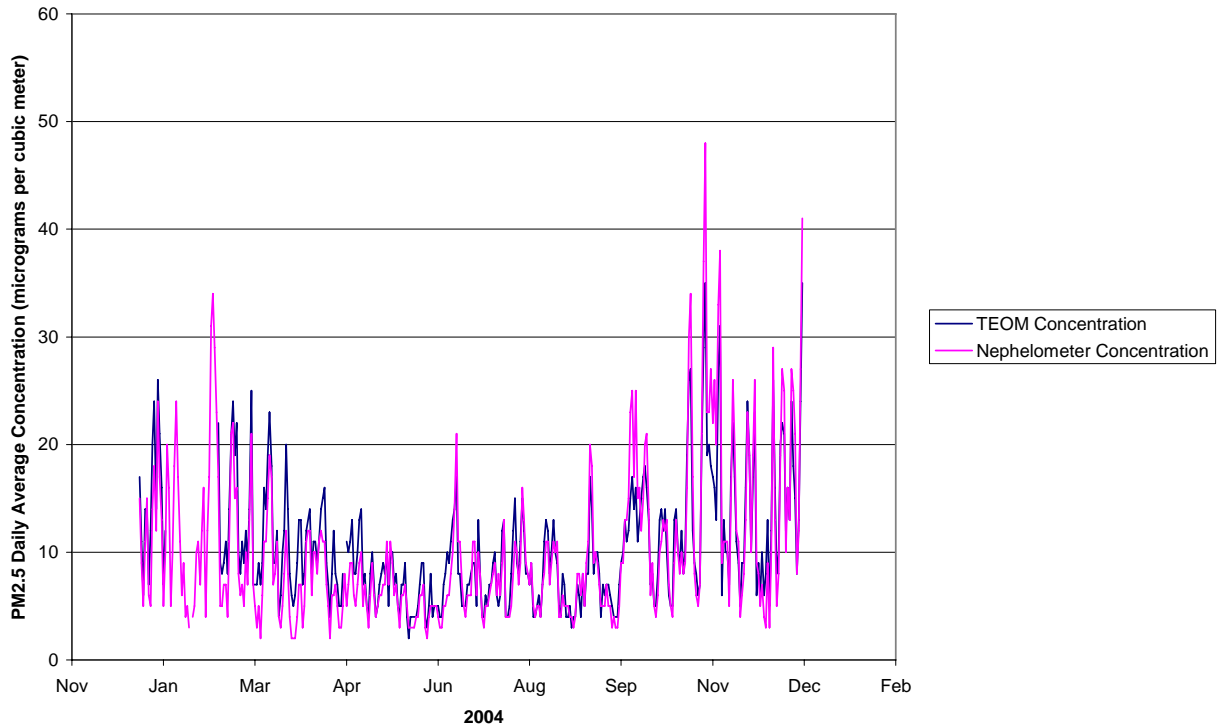
Fine particulate matter levels in the Puget Sound area are often higher in the winter months due to meteorology (stagnant air inversions) and wood burning in fireplaces and wood stoves.

The graph below is an example of a monitoring site influenced by wintertime wood stove and fireplace burning. The red and blue lines both show PM<sub>2.5</sub> concentrations, measured with two different instruments.

During the spring and summer months, outdoor burning and motor vehicles contribute more heavily to fine particulate levels. Although summer months

generally have lower PM<sub>2.5</sub> concentrations, this “baseline” level is important as it contributes to both daily concentrations and annual averages. Monitors placed by roadways reflect the influence of traffic on PM<sub>2.5</sub> concentrations; concentrations closely mirror traffic volumes.

PM<sub>2.5</sub> Daily Averages at Marysville

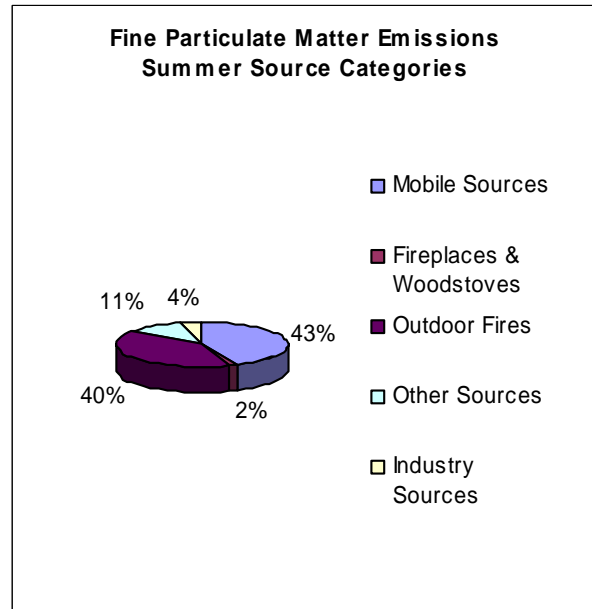
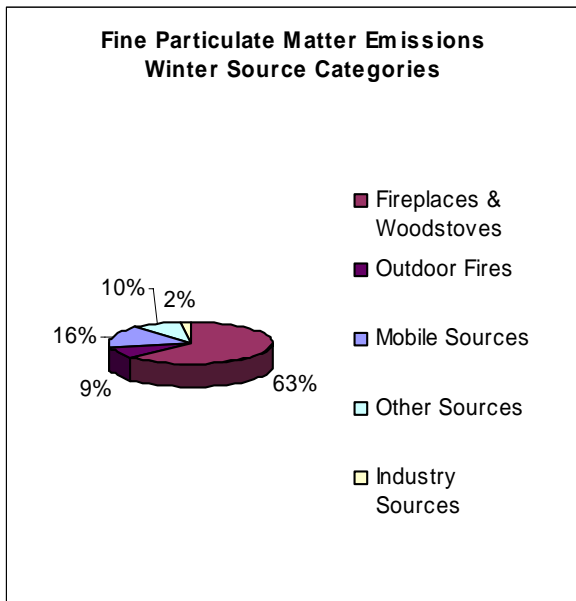


### PM<sub>2.5</sub> Sources

PM<sub>2.5</sub> comes primarily from wood burning in fireplaces and woodstoves, land-clearing burning, backyard burning of yard waste, vehicle exhaust including cars, trucks, and buses and other combustion sources. PM<sub>2.5</sub> can also be formed secondarily in the atmosphere through chemical reactions of pollutant gases.

The graphs below reinforce the seasonal differences in PM<sub>2.5</sub> sources that were noted earlier. During many months burning wood is the largest contributor to fine particulate matter in the Puget Sound area, especially at neighborhood sites such as Lake Forest Park, Marysville, and South Tacoma<sup>20</sup>

Mobile sources, particularly diesel-powered vehicles and equipment, are important year-round sources. In the summer mobile sources are the largest contributor to fine particulate emissions.



### Current Emission Reduction Strategies

In the late 1990s, the Agency evaluated, through a stakeholder process, local strategies to ensure maintaining PM<sub>2.5</sub> “attainment” status and to meet our local health goal. Based on emissions inventory and extensive monitoring information, the stakeholder group recommended a broad suite of local control strategies to reduce PM<sub>2.5</sub> in the Puget Sound area.<sup>21</sup>

Strategies that are currently implemented include:

- Several measures to reduce diesel emissions (“Diesel Solutions” program)
- Encouraging cleaner winter burning and heating practices through partnerships
- Enforcing winter burn bans (burn ban trigger recently changed to PM<sub>2.5</sub>)
- Woodstove “buy-back” programs
- Expanding zones where outdoor burning is prohibited

In addition to these strategies, implementation of Washington’s stricter vehicle standards will also result in lower PM<sub>2.5</sub> mobile emissions. The Puget Sound Climate Protection Advisory Committee recommended adopting this strategy in its final climate protection report.<sup>22</sup> The 2005 Legislature adopted these standards and the Washington State Department of Ecology is developing implementing regulations.

## Future Challenges

Strategies will need to be more aggressive to reduce emissions to meet our health goal and ensure that the Puget Sound region doesn't lose its fine particulate attainment status. Reductions will need to be large enough to offset predicted population growth in this region, as well as possible changes in heating behavior linked with rising costs of non-wood energy.<sup>23</sup> Unless efforts are increased to reduce PM<sub>2.5</sub>, we

- will continue to fall short of our local health goal,
- will likely violate new federal standards,
- could backslide to higher, more harmful PM<sub>2.5</sub> levels.

## Additional Resources

- Final Report of the Puget Sound Clean Air Agency PM<sub>2.5</sub> Stakeholder group [http://www.pscleanair.org/news/other/pm2\\_5\\_report.pdf](http://www.pscleanair.org/news/other/pm2_5_report.pdf).
- 2004 Air Quality Data Summary. July 2005. <http://www.pscleanair.org/ds04/docs/2004AQDSFINAL.pdf>.
- Review of the National Ambient Air Quality Standards for Particulate Matter: Policy Assessment of Scientific and Technical Information. OAQPS Staff Paper. July 1<sup>st</sup>, 2005. EPA-452/R-05-005. [http://www.epa.gov/ttn/naaqs/standards/pm/data/pmstaffpaper\\_20050630.pdf](http://www.epa.gov/ttn/naaqs/standards/pm/data/pmstaffpaper_20050630.pdf)
- Puget Sound Clean Air Agency's Burning Web Page <http://www.pscleanair.org/burning/>.
- Puget Sound Clean Air Agency's Diesel Solutions Program <http://www.pscleanair.org/dieselsolutions/index.shtml>.

---

<sup>1</sup> Environmental Protection Agency. Fact Sheet: Proposal to Revise the National Ambient Air Quality Standards for Particulate Matter. December 20<sup>th</sup>, 2005. <http://www.epa.gov/oar/particlepollution/fs20051220pm.html>.

Monitors in Pierce and Snohomish County exceed and would violate the proposed daily standard.

<sup>2</sup> Pope et al. Lung Cancer, Cardiopulmonary Mortality, and Long-Term Exposure to Fine Particulate Air Pollution. *Journal of the American Medical Association*. 287: 1132-1141. March 6, 2002.

<sup>3</sup> Gauderman et al. The Effect of Air Pollution on Lung Development from 10 to 18 Years of Age. *The New England Journal of Medicine*. Volume 351: 1057-1067. Number 11. September 9, 2004.

<sup>4</sup> Kunzli et al. Ambient Air Pollution and Atherosclerosis in Los Angeles. *Environmental Health Perspectives*. Volume 113,2: 201-206. February 2005. <http://ehp.niehs.nih.gov/members/2004/7523/7523.pdf>

<sup>5</sup> California Air Resources Board. Staff Report: Public Hearing to Consider Amendments of the Ambient Air Quality Standards for Particulate Matter and Sulfates. May 3, 2002. <http://www.arb.ca.gov/research/aaqs/standards/pm-final/pm-final.htm>.

<sup>6</sup> Park et al. Effects of Air Pollution on Heart Rate Variability: The VA Normative Aging Study. *Environmental Health Perspectives*. Volume 113, 3. pp 304-309. March 2005. <http://ehp.niehs.nih.gov/members/2004/7447/7447.pdf>.

<sup>7</sup> Goss et al. Effect of Ambient Air Pollution on Pulmonary Exacerbations and Lung Function in Cystic Fibrosis. *American Journal of Respiratory Critical Care Medicine*. Volume 169: pp 816-821. January 12, 2004.

<sup>8</sup> Sioutas et al. Exposure Assessment for Atmospheric Ultrafine Particles (UFPs) and Implications in Epidemiologic Research. *Environmental Health Perspectives*. Volume 113, 8: 947-955.

<sup>9</sup> For more information on visibility, see the 2004 Air Quality Data Summary. July 2005.

<sup>10</sup> EPA Draft Fine Particulate Staff Paper Fact Sheet. January 2005. [http://www.epa.gov/airlinks/pdfs/pmstaff2\\_fact.pdf](http://www.epa.gov/airlinks/pdfs/pmstaff2_fact.pdf).

- 
- <sup>11</sup> Clean Air Science Advisory Committee (CASAC) DRAFT Review of Staff Paper.  
[http://www.epa.gov/sab/pdf/casac\\_pmrp\\_mtg\\_april\\_6-7\\_2005\\_2nd\\_draft\\_pm\\_staff\\_paper-ra\\_draft\\_report\\_v2.pdf](http://www.epa.gov/sab/pdf/casac_pmrp_mtg_april_6-7_2005_2nd_draft_pm_staff_paper-ra_draft_report_v2.pdf).
- <sup>12</sup> Review of the National Ambient Air Quality Standards for Particulate Matter: Policy Assessment of Scientific and Technical Information. OAQPS Staff Paper. July 1<sup>st</sup>, 2005. EPA-452/R-05-005.  
[http://www.epa.gov/ttn/naaqs/standards/pm/data/pmstaffpaper\\_20050630.pdf](http://www.epa.gov/ttn/naaqs/standards/pm/data/pmstaffpaper_20050630.pdf)
- <sup>13</sup> The daily and annual standards were often linked together in the preliminary recommendations; for example a more stringent annual range was linked with a less stringent daily range, and vice versa.
- <sup>14</sup> Two monitoring stations (Marysville and South Tacoma L Street) violate the standard based on 2004 monitoring – 3-year average of 98<sup>th</sup> percentile of daily averages for 2002, 2003, and 2004.
- <sup>15</sup> Three additional stations are at risk of violating the proposed standard, with slim “safety margins” of 5 µg/m<sup>3</sup> or less. Lynwood, Tacoma Alexander Avenue, and Puyallup South Hill monitoring stations have 98<sup>th</sup> percentile 3-year averages of 33, 33, and 30 ug/m<sup>3</sup>, respectively (based on 2002, 2003, and 2004). These are based in part on continuous monitoring.
- <sup>16</sup> Final Report of the Puget Sound Clean Air Agency PM<sub>2.5</sub> Stakeholder group.  
[http://www.pscleanair.org/news/other/pm2\\_5\\_report.pdf](http://www.pscleanair.org/news/other/pm2_5_report.pdf).
- <sup>17</sup> For more information on monitoring, see the 2004 Air Quality Data Summary. July 2005.
- <sup>18</sup> Duwamish data is all CE site – dichot 1990-1998, FRM 1999-2004. Kent data is all CW data – dichot 1990-1998, FRM 1999-2003, TEOM 2004. Tacoma is EA site 1990-1998, EQ site 1999-2004 – dichot 1990-1998, FRM 1999-2002, TEOM 2003 and 2004.
- <sup>19</sup> The 24-hour daily average national ambient air quality standard requires comparison of the 3-year average of the 98<sup>th</sup> percentile.
- <sup>20</sup> Emissions inventory graphs are from the Final Report of the Puget Sound Clean Air Agency Stakeholder Group. October 15, 1999.
- <sup>21</sup> For more information, see the PM<sub>2.5</sub> Stakeholder Report. October 1999.  
[http://www.pscleanair.org/news/other/pm2\\_5\\_report.pdf](http://www.pscleanair.org/news/other/pm2_5_report.pdf).
- <sup>22</sup> For more information, see the final climate change report.  
<http://www.pscleanair.org/specprog/globclim/cpsp/pdf/rptexecsum.pdf>.
- <sup>23</sup> Projected growth based on Puget Sound Regional Council’s growth target of almost 1 million more residents by 2022 <http://www.psrc.org/projects/monitoring/growthtargets/cover-ch1.pdf>.