



MEMORANDUM

TO: Board of Directors, Placer County Air Pollution Control District

FROM: Yushuo Chang, Planning and Monitoring Manager

AGENDA DATE: August 14, 2008

SUBJECT: Report of Data Analysis on the Roseville Railyard Air Monitoring Project (RRAMP) (Information)

Action Requested:

No action required. This is an information item to present the third annual report describing the analyses of the RRAMP data. This report covers the data collected in 2007.

Background:

On December 9, 2004, this Board approved Resolution #04-21 authorizing the Chairperson and the APCO to sign an Agreement with Union Pacific Rail Road (UPRR) in regard to diesel particulate matter (DPM) resources toward the District's effort in conducting a PM air-monitoring project. The Roseville Railyard Air Monitoring Project (RRAMP) had a three-year cycle (2005-2007) associated with the mitigation plan. The third-year monitoring took place between June and October 2007, and focused on air monitoring at locations upwind and downwind of the Railyard. At the conclusion of monitoring, the collected data set was forwarded to the Desert Research Institute (DRI) to conduct a comprehensive data analysis. This staff report represents the summary of DRI data analysis results for the third-year monitoring data.

Discussion:

Objective of RRAMP Data Analysis

In this report, DRI performed the necessary data review, analysis, and interpretation to determine the impacts from the UPRR facility as measured as the differences between upwind and downwind monitoring site pairs. In addition to the review and analysis of 2007 summer data, DRI also conducted two additional tasks to 1) estimate the amount of DPM impacting the downwind area and 2) determine any discernible trends in reduced impacts over a three-year period as a result of emissions mitigations implemented by UPRR. The

DRI report (Report) is the third annual report to be provided by DRI. This 81 page report is available to the public by request and will be posted on the District website.

Evaluation and Validation of RRAMP Data

Consistent with previous years, each RRAMP monitoring site consisted of the following instruments: continuous monitors for PM_{2.5}, black carbon [BC] (indicative of diesel particulates), and nitrogen oxides [NO_x]; filter-based samplers for PM_{2.5} mass, organic and elemental carbon; and meteorological and ancillary equipment. Continuous monitors and meteorological equipment provide hourly average concentration measurements that can be analyzed with respect to specific wind conditions. Filter-based samplers, on the other hand, collect PM samples over a range of wind conditions for a 7-hour period, which is the period of time that winds blow from upwind toward downwind sites. The meteorological monitors measure and record wind speed and wind direction.

The third-year monitoring of the project began on June 15 and was ended on October 15, 2007. The same pairs of upwind/downwind sites (Denio-Pool and Church St.-Vernon St.) were used. Both pairs of upwind/downwind sites functioned during the entire third-year monitoring period. A summary of the continuous data collected during the 2007 study period is shown in Table 1 (next page).

According to the table, a very high percentage of possible data was successfully captured, thus reflecting a successful field operations program.

Results

The Report describes a number of detailed statistical analyses; some of the key results are summarized here. Three screening criteria were established to determine the conditions upon which upwind-downwind analyses are appropriate: (1) winds need to be from a semi-circular arc between 45 degrees (i.e., northeasterly) through 225 degrees (i.e., southwesterly); (2) only winds from 0.5 to 4 m/s were used to avoid calm or windy conditions; and (3) only overnight hours from 10 PM to 5 AM PST were used. This is the time frame when the winds blow most consistently across the rail facility directly from the upwind to the downwind locations, and therefore the emissions from the rail facility can most readily be detected.

Once the subset of appropriate data was determined, the Report evaluated the differences between upwind and downwind site concentrations of BC, PM_{2.5}, NO, and NO_x. These results are shown in Figures 1 through 4. The data collected during the Moonlight wild fire incident period were excluded from the data analysis.

Table 1 Summary of RRAMP Continuous Measurements During Summer 2007.

	Denio Site					
	Wind Spd/Dir (EBAM)	NO/NOx (TECO-42)	Aeth BC (A330)	EBAM PM2.5 (2238)	Teflon Filter	Quartz Filter
monitoring period	6/15~10/15	6/15~10/15	6/15~10/15	6/15~10/15	6/17~10/15	6/16~10/14
total observations	2952	2952	34317	2952	41	41
count	2952	2951	33827	2952	36	41
%	100%	100%	98.6%	100%	88%	100%

	Pool Site					
	Wind Spd/Dir (EBAM)	NO/NOx (TECO-42)	Aeth BC (A479)	EBAM PM2.5 (2237)	Teflon Filter	Quartz Filter
monitoring period	6/15~10/15	6/15~10/15	6/15~10/15	6/15~10/15	6/17~10/15	6/16~10/14
total observations	2952	2952	34317	2952	41	41
count	2952	2943	34105	2952	41	41
%	100%	99.7%	99.4%	100%	100%	100%

	Church St. Site					
	Wind Spd/Dir (EBAM)	NO/NOx (TECO-42)	Aeth BC (624)	BAM PM2.5 (4514)	Teflon Filter	Quartz Filter
monitoring period	6/15~10/15	6/15~10/15	6/15~10/15	6/15~10/15	6/17~10/15	6/16~10/14
total observations	2952	2952	34317	2952	41	41
count	2952	2946	33644	2952	41	41
%	100%	99.8%	98.0%	100%	100%	100%

	Vernon St. Site					
	Wind Spd/Dir (EBAM)	NO/NOx (TECO-42)	Aeth BC (623)	BAM PM2.5 (4515)	Teflon Filter	Quartz Filter
monitoring period	6/15~10/15	6/15~10/15	6/15~10/15	6/15~10/15	6/17~10/15	6/16~10/14
total observations	2952	2952	34317	2952	41	41
count	2952	2948	31198	2952	41	40
%	100%	99.9%	90.9%	100%	100%	98%

Figure 1 shows the 7-hour average concentrations of black carbon. This bar chart shows the average concentrations over the third year study period for which data is available from both pairs of upwind and downwind sites. The concentrations at both downwind sites (Denio and Church) are significantly higher than at their corresponding upwind sites (Pool and Vernon). The red bars depict the uncertainty of the values depicted, and as can be seen, these are small in comparison to the observed concentrations. From a statistical standpoint, there is greater than a 99.9% confidence that these findings are real and not due to chance alone. Also shown in Figure 1, are the differences between the upwind and downwind pairs which show the presumed impact from the rail yard facilities. In the 2007 intensive sampling period, the difference between Denio/Pool and Church/Vernon pair are all over $2 \mu\text{g}/\text{m}^3$. In addition, the comparisons of both upwind sites and both downwind sites are shown as the

two rightmost bars. The difference between two upwind sites is relatively small indicating that the upwind consistently reflect the same conditions. But in 2007 the measurements from Church site were significantly higher than at Denio site resulting in larger difference between Church/Vernon pair than Denio/Pool pair.

Figure 1 Black Carbon 7-hour average concentrations

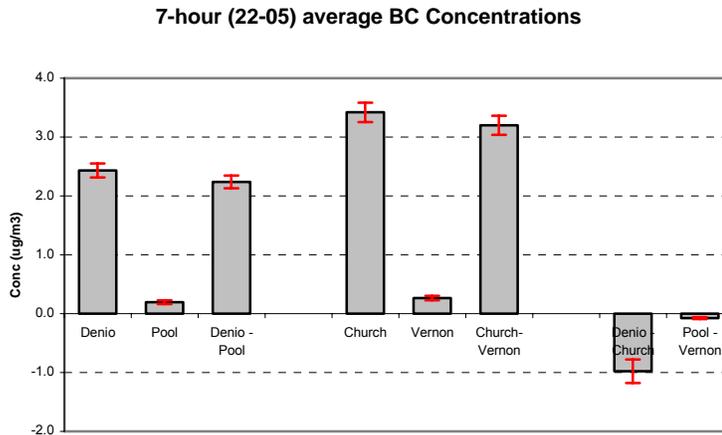


Figure 2 shows the same depiction for PM_{2.5}. While the downwind sites have levels which are statistically higher than the upwind sites, these differences are not as pronounced as for BC. This is because PM_{2.5} is a regional pollutant that could be from road dusts which affects both upwind and downwind sites. Nevertheless, the differences between upwind and downwind sites are in the order of 7 to 9 µg/m³.

Figure 2 PM_{2.5} 7-hour average concentrations

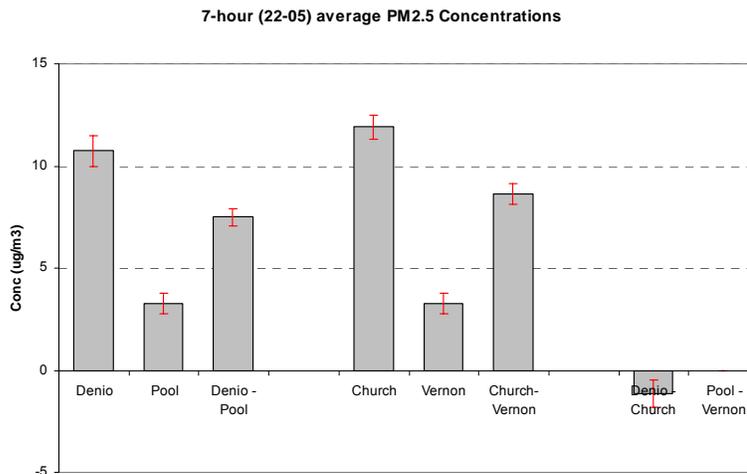


Figure 3 is a similar chart for NO concentrations. NO is a good indicator of fresh NO_x emissions, since ultimately with time, NO converts to other nitrogen products. This chart may be the most indicative of all that the downwind sites are picking up the emissions from

the rail yard facility. While downwind sites show concentrations about 80~100 parts per billion (ppb), the upwind sites are near 0 ppb.

Figure 3 NO 7-hour average concentrations

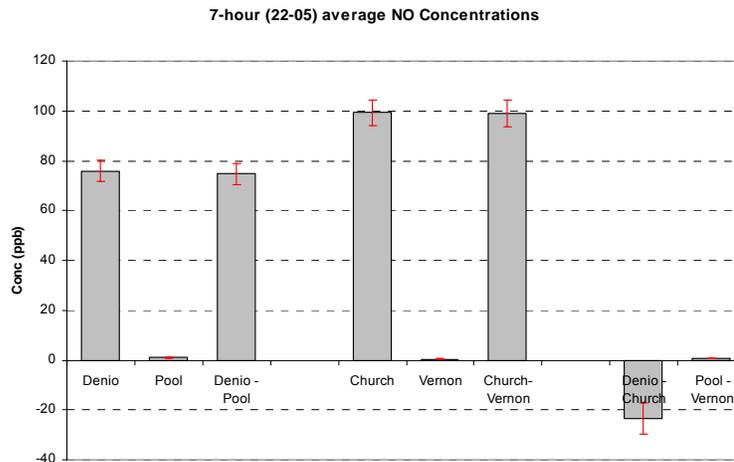
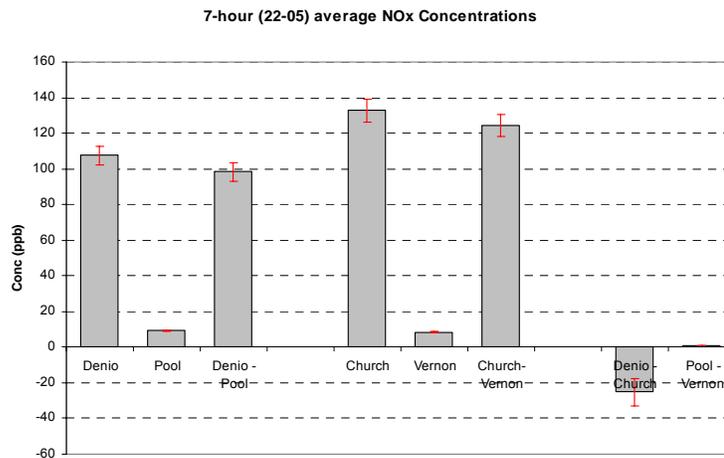


Figure 4 shows the results for NO_x, which is NO plus other oxides of nitrogen, often nitrogen dioxide (NO₂). While the results of Figures 3 and 4 are very similar, there are some interesting differences. The downwind sites show a very high percentage of NO_x as NO, meaning these sites are dominated by fresh emissions. Conversely, the upwind sites have a low percentage of NO_x as NO, meaning the upwind areas are affected to a much greater degree from aged NO_x emissions, perhaps attributable to earlier mobile source emissions in the local or greater Sacramento area. In any case, the differences between upwind and downwind influences are dramatic.

Figure 4 NO_x 7-hour average concentrations



The interesting aspect of the overall scope of the data analyses is that all the results consistently show that the downwind sites have greater concentrations than upwind sites. In

addition, in 2007 the results show that the difference between the Church/Vernon pair is higher than at Denio/Pool pair, this indicates that the monitors are capturing effects of the rail yard emissions.

DPM estimates

The amount of diesel PM impacting the downwind area can be estimated from the difference in measured BC concentrations between the downwind and upwind sites using observed relationships between PM2.5 and elemental Carbon (EC) in diesel exhaust and between BC and EC in this study. DRI conducted a literature research that established equations based on applicable data (average increase in elemental carbon [ΔEC], average increase in black carbon [ΔBC], and PM2.5/EC ratio) to estimate the potential DPM at two downwind sites. However, in 2007 the filter-based sampling was added. Additional pre-fired treatment for quartz filters and sufficient field blanks were collected to characterize the large passive sampling artifact. This provided more reliable observed relationships between ΔEC and ΔBC by site.

Therefore, the Report estimates DPM for 2005 and 2006 as: $DPM = 2 * [\Delta BC - 0.66] / 0.60$

For 2007 the Report provided site-specific relationships:

$$\text{Denio DPM} = 2 * [\Delta BC - 0.70] / 0.48$$

$$\text{Church DPM} = 2 * [\Delta BC - 0.65] / 0.71$$

Three-Year Trend

DRI examined trends in the mean values and variations in the upwind/downwind differences for NO, NOx, BC, PM2.5 and DPM concentrations over the three-year of the RRAMP (2005~2007). The Report compared the resulting average values and downwind-upwind differences to look for indication of trends in the pollutant concentrations impacting the downwind area that may result from mitigation efforts in the Railyard. Because data from the Church and Vernon sites was only collected for about 1 month at the end of the summer in 2005, the wind data from the Denio site was used to determine hours meeting the wind speed and direction criteria for that year. In addition, DRI re-processed the data collected in 2005 by using the same methods as for 2006 and 2007 to ensure the consistency for analysis of data from all years.

Figure 5 shows the mean BC, PM2.5 NO and NOx concentrations at the four RRAMP monitoring sites and the difference of the two pairs of upwind and downwind sites for 2005 – 2007. In Figure 5, NO, NOx, and PM2.5 show a decrease each year at Denio site. Since there is no corresponding decrease in NO and NOx at Pool, it appears that reductions in the impact of the Railyard concentrations at Denio are responsible for the decrease in NO. No decreasing trend in NO and NOx is evident for Church and Vernon, particularly if the limited amount of 2005 data is considered. Although PM2.5 shows a consistent decrease each year,

there is also a decrease at the upwind sites for 2007 so no clear trend in the impact of the Railyard on PM2.5 at downwind sites is indicated. No consistent temporal pattern is evident for BC at any of the sites. This is somewhat surprising since excess BC is expected to track excess NO at the downwind sites because they presumably originate from the same source. The lack of a decrease similar to that for NO may be an indication of variations in the composition of emissions from the Railyard activities.

Figure 5 Mean BC, PM2.5 NO and NOx concentrations at the four RRAMP monitoring sites and the difference of the two pairs of upwind and downwind sites for 2005 -2007

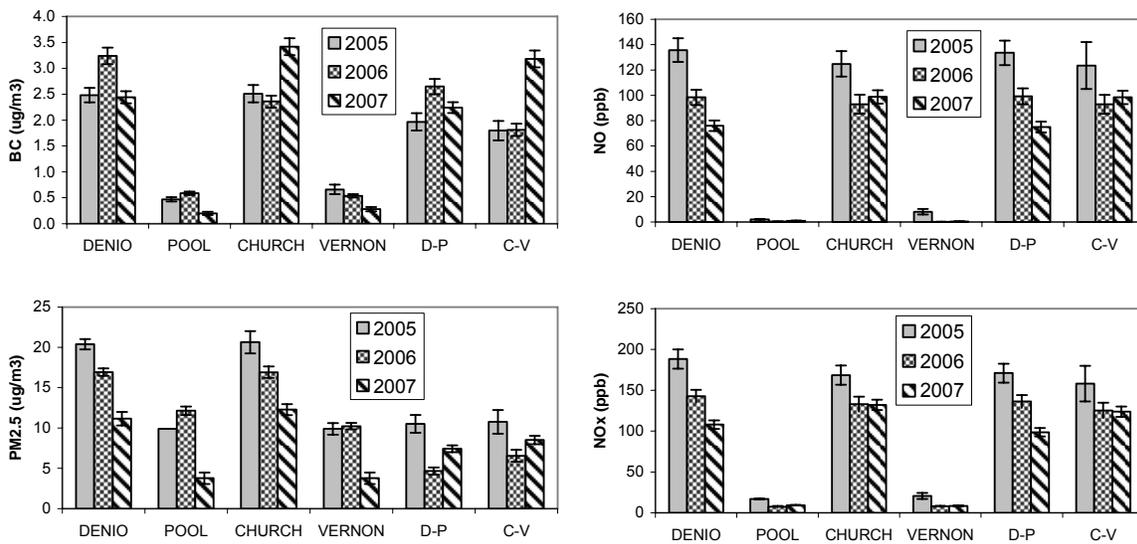
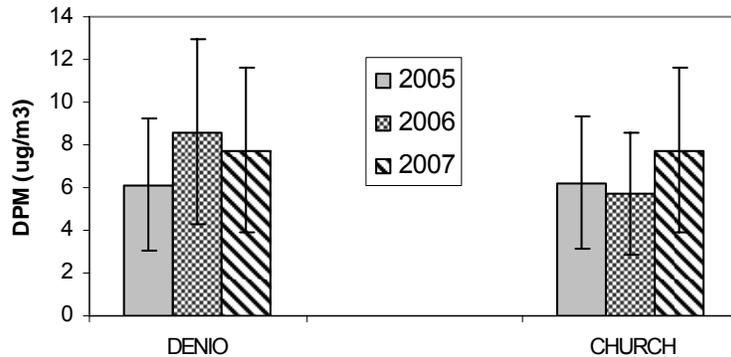


Figure 6 contains the estimated mean overnight concentration of diesel PM from Railyard activities impacting the two downwind monitoring sites based on the equation developed for the sites. Results are very similar for the two downwind sites for 2005 and 2007 and higher at Denio for 2006. However, the difference is within the uncertainty. According to the large uncertainty in the estimation of DPM, the figure cannot discern any temporal trend in impact on the downwind area.

Figure 6 Estimated mean overnight concentration of DPM at two downwind sites from 2005 -2007



Conclusion

The Report showed generally good agreement with no significant biases between the paired instruments. The improved operating procedures adopted in the second year greatly improve data quality. The value of the analyses is strongest when time-averaging the data over periods of seven hours. The differences in mean concentrations between the two pairs of downwind and upwind sites (Denio-Pool and Church-Vernon) are all significant at above the 99% confidence level.

Overall, there is evidence of substantial impact on the downwind sites. There was a substantial increase in NO, NO_x, BC, and PM_{2.5} at the downwind sites relative to the upwind sites, with the largest differential for NO. The magnitude of the mean concentrations and downwind-upwind site deltas in 2007 are somewhat different than those observed during the prior years of monitoring but the comparison may not be valid unless differences in sampling period and schedule are accounted for.

In three-year trend analysis, it appears that reductions in the impact of the Railyard concentrations at Denio are responsible for the decrease in NO. No clear temporal pattern in NO and NO_x is evident for Church and Vernon. In addition, there is no consistent temporal pattern evident for BC at any of the sites.

A large uncertainty exists in the estimation of DPM ($\pm 50\%$). The report states that it cannot be discerned if any variations in impact on the downwind area have occurred from year to year. The application of more appropriate PM_{2.5}/EC ratios to the calculation, when they become available, may reduce the uncertainties substantially but it is not expected to change the relative magnitude of the annual averages since the same BC data will be used.

Fiscal Impact:

None. This data analysis report is the third annual report that provides descriptive and statistical analyses of the RRAMP data. The District's FY 2006/07 and FY 2007/08 Budgets contained the funding needed to support the contract signed between DRI and the District.

The RRAMP Technical Advisory Committee (TAC) recommended that the District extend the summer study into 2008. The rationale for this extension is due to the major reductions in diesel locomotive emissions that are expected to occur at the Roseville Railyard facility in late 2007 and beyond because of mitigation measures implemented by UPRR (e.g., reduction of unnecessary idling, switcher locomotive fleet replacements/upgrades, and installation of control equipment). The emissions reductions due to these changes may be captured in the 2008 summer monitoring. Thus, the District accepted the TAC's recommendation to continue another summer study in 2008. DRI will continue to conduct another year of data analysis and a multi-year trend analysis after the 2008 summer monitoring period. The EPA Region IX Office has awarded funding of \$50,000 for the 2008 summer study in which is in the FY 2008-09 Budget. UPRR has also provided \$30,000 for this project. This funding will be applied to the existing contracts with DRI and Countess Environmental.

The funding from EPA Regional IX Office will be enough to cover the cost for the contracts of DRI and Dr. Richard Countess (Countess Environmental) for data analysis and consultant service. At this time, there will be no significant fiscal impact on the District to finish the fourth annual report of RRAMP data analysis and multiple-year trend analysis.

Recommendation:

None. This is an informational item to provide an overall status to the Board on the RRAMP third-year data analysis. The Report will be posted on the District's website in the section containing rail road related information.