CHAPTER 3
Air Quality

Air quality conditions in the Lake Tahoe Region can affect human health, visibility, forest health, and regional lake water quality, including the famed clarity of Lake Tahoe. The primary factors known to influence the basin's air quality are motor vehicle emissions, vehicle entrainment of road dust, wildfire, residential wood smoke, topography, meteorology, and pollutants transported from sources outside the Region (Green et al. 2011; Chen, Watson, and Wang 2011; Zhu, D. et al. 2009; Zhu et al. 2011; Gertler, A.W. et al. 2006; Gertler, A.W. et al. 2008; Cliff and Cahill 2000). Attainment of state, federal and TRPA air quality threshold standards represent conditions that reflect the public's values for protecting human and environmental health. Achievement of air quality threshold standards could also provide partial evidence that the TRPA Regional Plan and associated programs, and state and federal air quality regulations and programs, are effective at improving air quality in the Region.

This chapter provides an evaluation of current air quality conditions and trends in air pollutants relative to adopted air quality threshold standards and applicable state and federal air quality standards. It also assesses indicators related to factors such as traffic volume that potentially influence air pollutant concentrations. In TRPA Resolution 82-11, TRPA adopted threshold standards for carbon monoxide, ozone, visibility (atmospheric haze), respirable and fine particulate matter, nitrate deposition and odor. National Ambient Air Quality Standards (NAAQS) addressed in this evaluation fulfill requirements of the Bi-State Compact to measure and address the status of compliance with state and federal standards, and in part, requirements of California Air Resources Board (Mulford-Carrell Act) and the Federal Clean Air Act (40 CFR part 50). For air quality threshold standards, this evaluation addresses the status of several numerical standards, management standards with numerical targets, and one policy statement (Table 3-1). This threshold evaluation follows the conventions of the 2011 threshold evaluation report and organizes the findings based on the indicator reporting categories adopted in TRPA Resolution 82-11 (Table 3-1). Overall, 16 of 20indictors were in attainment with almost all having improving trends. Two indicators had insufficient data to make a status determination.

Table 3-1. *TRPA threshold standards and state and federal air quality standards addressed for Tahoe regional air quality.*

Indicator Category	Name of Standard	Standard Type	Adopted TRPA Threshold Standard (TRPA Resolution 82-11)	Applicable State and Federal Standards	TRPA Indicator	Unit of Measure
Carbon Monoxide (CO)	8-hour Carbon Monoxide	Numerical	Maintain carbon monoxide concentrations at or below 6 parts per million averaged over 8 hours.	**Carbon Monoxide 8-hour Average** California and Nevada: Not to exceed 6 ppm Federal: Not to exceed 9 ppm more than once per year.	First and second highest CO concentration measured at Stateline, Nevada monitoring station	Parts Per Million (ppm)
	1-hour Carbon Monoxide	Numerical (State Standard)	No adopted standard	**Carbon Monoxide 1-hour Average** California: Not to exceed 20 ppm Federal and Nevada: Not to exceed 35 ppm more than once per year.	Highest CO concentration measured at Stateline, Nevada monitoring station	Parts Per Million (ppm)
	Winter Traffic Volume	Management (With Numerical Target)	Reduce traffic volumes on the U.S. Highway 50 Corridor by 7 percent during the winter from the 1981 base year between 4 p.m. and midnight, provided that those traffic volumes shall be amended as necessary to meet any state standards if they are developed.	No standard	Percent increase/decrease from 1981 winter (December through March) traffic volumes on U.S. Highway 50 at Park Avenue	Percent (%)
Ozone (O_3)	1-hour Ozone	Numerical	Maintain ozone concentrations at or below 0.08 parts per million averaged over 1 hour.	**Ozone 1-hour Average** California: Not to exceed 0.09 ppm Nevada: Not to exceed 0.10 ppm	Highest 1-hour average ozone concentration measured within a year at any monitoring station	Parts Per Million (ppm)

Indicator Category	Name of Standard	Standard Type	Adopted TRPA Threshold Standard (TRPA Resolution 82-11)	Applicable State and Federal Standards	TRPA Indicator	Unit of Measure
	8-hour Ozone	Numerical (State Standard)	No adopted standard	**8-hour Average** California: Not to exceed 0.070 ppm Nevada: no standard Federal: 0.070 ppm, 3-year average of the fourth-highest daily maximum must not exceed concentration standard.	Highest 8-hour average ozone concentration measured within a year at any monitoring station	Parts Per Million (ppm)
	Oxides of Nitrogen	Numerical	Maintain oxides of nitrogen (NO_x) emissions at or below the 1981 level.	**Nitrogen Dioxide Annual Average** Nevada and Federal: Not to exceed 53 ppb California: Not to exceed 30 ppb **Nitrogen Dioxide 1-hour Average** Federal: 100 ppb, 3-year average of the 98th percentile of the daily maximum 1-hour average must not be exceeded California: Not to exceed 0.18 ppm	**Nitrogen Dioxide Annual Average** Highest annual average concentration of NO_x and NO_2 **Nitrogen Dioxide 1-hour Average** Federal: 3-year average of the 98th percentile of the daily maximum 1-hour average of NO_2 California: Highest 1-hour concentration measured within a year at any site	Federal: Parts Per Billion (ppb) California: Parts Per Million (ppm)

Indicator Category	Name of Standard	Standard Type	Adopted TRPA Threshold Standard (TRPA Resolution 82-11)	Applicable State and Federal Standards	TRPA Indicator	Unit of Measure
Visibility	Regional Visibility	Numerical	Achieve an extinction coefficient of 25 Mm^{-1} at least 50 percent of the time as calculated from aerosol species concentrations measured at the Bliss State Park monitoring site (visual range of 97 miles); Calculations will be made on three year running periods using the existing monitoring data as the performance standards to be met or exceeded.	California: 8-hour average extinction coefficient of 0.07 per kilometer – visibility of 30 miles or more due to particles when relative humidity is less than 70%.	Extinction coefficient and distance of visibility.	3-year running average of Extinction coefficient. Light extinction (Mm^{-1}) and Miles or Kilometers
		Numerical	Achieve an extinction coefficient of 34 Mm^{-1} at least 90 percent of the time as calculated from aerosol species concentrations measured at the Bliss State Park monitoring site (visual range of 71 miles). Calculations will be made on three year running periods using the existing monitoring data as the performance standards to be met or exceeded.	California: 8-hour average extinction coefficient of 0.07 per kilometer – visibility of 30 miles or more due to particles when relative humidity is less than 70%.	Extinction coefficient and distance of visibility.	3-year running average of Extinction coefficient. Light extinction (Mm^{-1}) and Miles or Kilometers
	Sub-Regional Visibility	Numerical	Achieve an extinction coefficient of 50 Mm^{-1} at least 50 percent of the time as calculated from aerosol species concentrations measured at the South Lake Tahoe monitoring site (visual range of 48 miles);	No standard	Extinction coefficient and distance of visibility. 3-year running average of extinction coefficient.	Light extinction (Mm^{-1}) and Miles or Kilometers
		Numerical	Achieve an extinction coefficient of 125 Mm^{-1} at least 90 percent of the time as calculated from aerosol species concentrations measured at the South Lake Tahoe monitoring site (visual range of 19 miles).	No standard	Extinction coefficient and distance of visibility. 3-year running average of extinction coefficient.	Light extinction (Mm^{-1}) and Miles or Kilometers

Indicator Category	Name of Standard	Standard Type	Adopted TRPA Threshold Standard (TRPA Resolution 82-11)	Applicable State and Federal Standards	TRPA Indicator	Unit of Measure
Respirable and Fine Particle Matter	Respirable Particulate Matter (PM_{10})	Numerical	Maintain PM_{10} at or below 50 µg/m³ measured over a 24-hour period in the portion of the Region within California, and maintain PM_{10} at or below 150 µg/m3 measured over a 24-hour period in the portion of the Region within Nevada.	Federal: 150 µg/m³ (24-hr mean, not to be exceeded more than 3 times in 3 years) California: 50 µg/m³	Number of 24-hr periods exceeding the applicable federal or state standards at any monitoring station	Micrograms per cubic meter (µg/m³)
		Numerical	Maintain PM_{10} at or below annual arithmetic average of 20 µg/m3 in the portion of the Region within California, and maintain PM_{10} at or below annual arithmetic average of 50 µg/m3 in the portion of the Region within Nevada.	California: 20 µg/m³	Annual average PM_{10} concentrations at any permanent monitoring station (µg/m³)	Micrograms per cubic meter (µg/m³)
	Fine Particulate Matter ($PM_{2.5}$)	Numerical	Maintain Particulate Matter2.5 at or below 35µg/m3 measured over a 24-hour period using gravimetric or beta attenuation methods or any equivalent procedure which can be shown to provide equivalent results at or near the level of air quality standard.	Federal: 35 µg/m³, 3-year average of the 98th percentile of 24-hour concentration must not exceed concentration standard	Number of 24-hr periods exceeding the applicable federal or state standards at any monitoring station (µg/m³)	Micrograms per cubic meter (µg/m³)

Indicator Category	Name of Standard	Standard Type	Adopted TRPA Threshold Standard (TRPA Resolution 82-11)	Applicable State and Federal Standards	TRPA Indicator	Unit of Measure
		Numerical	Maintain Particulate Matter2.5 at or below annual arithmetic average of 12μg/m3 in the portion of the Region within California and maintain Particulate Matter2.5 at or below annual arithmetic average of 15μg/m3 in the portion of the Region within Nevada. Particulate Matter2.5 measurements shall be made using gravimetric or beta attenuation methods or any equivalent procedure which can be shown to provide equivalent results at or near the level of air quality standard	Federal: 12.0 $\mu g/m^3$, 3-year average of weighted annual mean concentration must not exceed. California: 12 $\mu g/m^3$ Annual concentration must not be exceeded.	Annual average $PM_{2.5}$ concentrations at any permanent monitoring station ($\mu g/m^3$)	Micrograms per cubic meter ($\mu g/m^3$)
Nitrate Deposition	Vehicle Mile Traveled	Numerical	Reduce vehicle miles traveled in the basin by 10% of the 1981 base year values.	No standard	A10% reduction from 1981 base year estimated VMT is 2,030,938 VMT (Source: TRPA TransCAD Model)	Vehicle Miles Traveled (VMT) and Percent (%)
	Nitrate Deposition	Management	Reduce the transport of nitrates into the basin and reduce oxides of nitrogen (NOx) produced in the basin consistent with the water quality thresholds.	No standard	Implementation of management standard into the Regional Plan	N/A
Odor	Odor	Policy Statement	It is the policy of the TRPA Governing Board in the development of the Regional Plan to reduce fumes from diesel engines to the extent possible.	No standard	Implementation of policy statement into the Regional Plan	N/A

Information Sources: *Federal Standards:* http://www3.epa.gov/ttn/naaqs/criteria.html*; California Standards:* http://www.arb.ca.gov/research/aaqs/aaqs2.pdf*; Nevada Standards:* http://ndep.nv.gov/baqp/monitoring/docs/445b391.pdf*: TRPA Threshold Standards:* http://www.trpa.org/wp-content/uploads/Adopted-Regional-Plan_20160614_Clean.pdf*(Attachment C)*

Air Quality Data Sources

The data used to compare air pollutant concentrations to the established threshold standards in this chapter were sourced from TRPA, U.S. Environmental Protection Agency (EPA), California Air Resources Board (CARB), Nevada Department of Environmental Protection, Bureau of Air Pollution Control (NDEP), Placer County Air Pollution Control District and other state and local air quality monitoring. Data were analyzed for comparison by Desert Research Institute using evaluation methodologies established by the EPA, CARB, and NDEP.

Data Limitations

Three factors affect the ability to comprehensively evaluate the status and trends of air quality indicators in the Lake Tahoe Basin: 1) degree of spatial coverage of monitoring sites, 2) extent of long-term operations of monitors at a given site, and 3) the nature of existing indicators used to evaluate air quality in the Region. A substantial expansion of the spacing and density of monitoring sites would be needed to know the distribution of maximum and minimum pollutant concentrations throughout the basin.

Cost and maintenance of equipment, land access agreements and vandalism have caused variability overtime in monitoring locations and data. Monitoring sites have been operated intermittently or shut down after a few years, with the exception of the Bliss visibility monitoring site. Locations of monitoring sites have also been changed, making it more difficult to determine with a high degree of certainty whether a trend was due to a real change in the atmosphere or a result of the site change. These circumstances are accounted for by reducing the confidence rating for a given status and trend determination as noted in indicator summaries. These data limitations are being addressed. TRPA and state and county air quality authorities are working to increase the spatial coverage and robustness of air quality monitoring data for the Region.

The indicators presented here are related to state, federal and TRPA standards. In most instances, each indicator only takes into account the highest recorded measurements (e.g. highest, second highest) and does not take into account the distribution of measurements throughout a given year. As a consequence, these indicators do not completely characterize the range of conditions that occur within a year. Thus, the measurements could be significantly better than the standard most of the year, but one high measurement could trigger a determination that the standard is out of attainment.

Table 3-2 summarizes the results of the 2015 assessment. The table provides a summary of the status and trend of standards in the air quality reporting categories as well as the results from the 2011 Threshold Evaluation Report for comparison. Figure 3-1 and Table 3-3 provide a key to the symbols used to communicate status, trends, and confidence. A detailed description of how these conclusions are reached is provided in the methodology section. The indicator sheets that follow contain more detailed assessment of the status and trend of each indicator, descriptions of the methods used, and recommendations for modification of the standard or analytic approach used to assess the standard.

Table 3-2: *Summary of status and trend of air quality indicator reporting categories from the 2011 and 2015 Threshold Evaluation Reports.*

Standard	2011	2015
Carbon Monoxide		
Highest 1-hour Concentration of Carbon Monoxide		
Highest 8-hour Average Concentration of Carbon Monoxide		
Average Daily Winter Traffic Volume, Presidents Weekend		
Ozone		
Highest 1-hour Average Concentration of Ozone		
Highest 8-hour Average Concentration of Ozone		
3Year Average of the 4th Highest 8-hour Concentration of Ozone		
Oxides of Nitrogen Emissions		
Regional Visibility		
Regional Visibility 50th Percentile ("Average Visibility Days")		
Regional Visibility 90th Percentile ("Worst Visibility Days")		
Subregional Visibility		
Subregional Visibility 50th Percentile ("Average Visibility Days")		
Subregional Visibility 90th Percentile ("Worst Visibility Days")		
Respirable and Fine Particulate Matter		

Standard	2011	2015
Highest 24-hour PM_{10} Concentration		
Annual Average PM_{10} Concentration		
24-hour $PM_{2.5}$ Concentration		
Annual Average $PM_{2.5}$Concentration		
Nitrate Deposition		
Reduce generation and transport of nitrate to achieve water quality standards		
Vehicle Miles Traveled (VMT)		
Odor - Reduce diesel engine fumes		

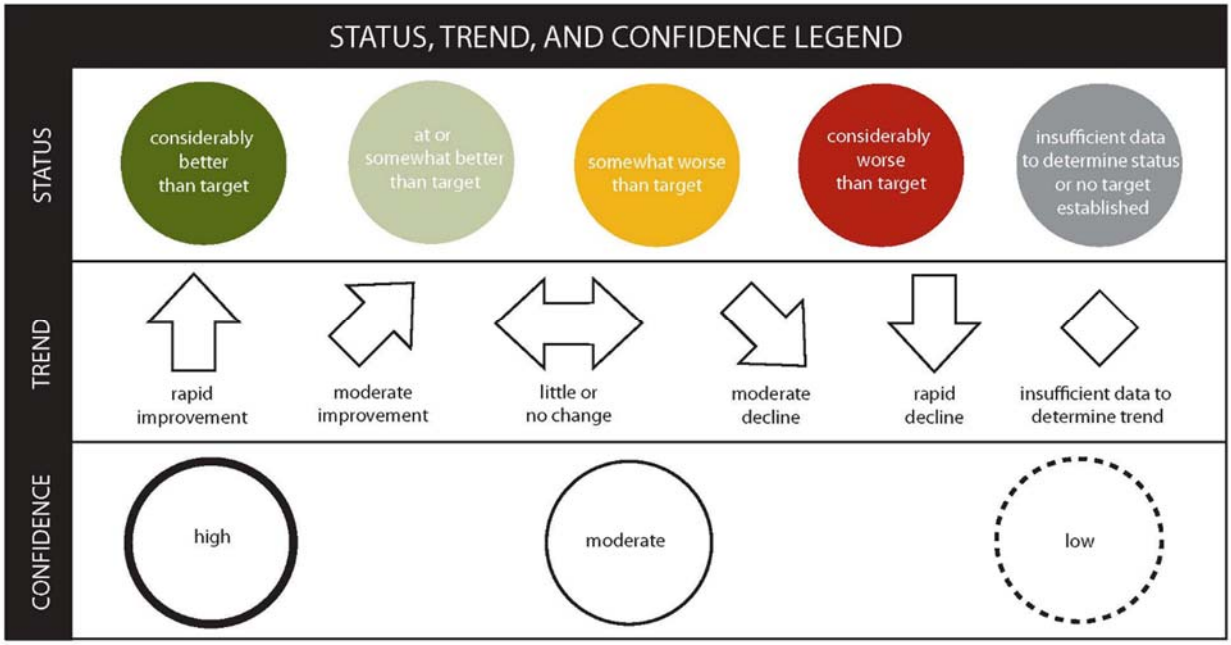


Figure 3-1: *A key to the symbols used to assess status, trends, and confidence levels.*

Table 3-3. *Key to the reporting icon used to characterize the implementation status of management standards and policy statements.*

Status Category	Description	Reporting Icon
Implemented	The management standard or policy statement has been integrated into the Regional Plan and is consistently applied to a project design or as a condition of project approval as a result of project review process. Examples of programs or actions can be identified to support the management standard's implementation. Adopted programs or actions support all aspects of the management standard or policy statement's implementation, or address all major threats to implementation.	
Partially Implemented	The management standard or policy statement has been integrated into the Regional Plan, but is not consistently applied during the project review process. No more than two examples of programs or actions can be identified to support the management standard's implementation and/or adopted programs or actions support some aspects of the management standard or policy statement's implementation, or address some major threats to implementation.	
Not Implemented	The management standard or policy statement has not been integrated into the Regional Plan and is not applied during the project review process. No examples of programs or actions can be identified to support implementation.	

Carbon Monoxide

Carbon monoxide (CO) is a tasteless, odorless, and colorless gas. It is a public health concern because elevated concentrations affect human and animal health by reducing the supply of oxygen to body tissues. This can result in shortness of breath, seizures, coma, or even death. Carbon monoxide is created through the incomplete combustion of carbon-based fuels. The primary anthropogenic sources of CO are on-road motor vehicles (30 percent), residential wood burning (28 percent), motorized watercraft (16 percent), and off-highway vehicles (8 percent) (California Air Resources Board 2006). Wildfires are a natural source of CO. Meteorology also plays a key role in influencing the concentration of CO within the Region as wind and inversion layers can affect concentrations.

Policy and management actions implemented through the TRPA Regional Plan to control CO emissions focus on reducing private automobile use through improvements to public transportation and bike/pedestrian trail infrastructure. Vehicle emission standards enacted by state and federal governments have also reduced CO emissions in the Region, mainly by requiring improvements in engine and exhaust technologies. State air quality agencies regulate the timing and magnitude of forest biomass prescribed burning or pile burning.[1]

The status and trends of three indicators, 1-hour and 8-hour CO standards and winter traffic volume, were evaluated to characterize the overall status and trend of the carbon monoxide indicator reporting category. Following this introduction for carbon monoxide are indicator summaries that provide a more detailed evaluation of each indicator relative to adopted threshold standards. In general, each of the carbon monoxide indicators were considerably better than the threshold standards in almost all years since monitoring began and trends are improving. During the summer months, exceptional events such as uncontrolled forest fires can cause uncharacteristic spikes in carbon monoxide concentrations. In 2007, the EPA promulgated the Exceptional Events Rule that allows for the exclusion of air quality monitoring data influenced by exceptional events from use in determinations of exceedances or violations of the air quality standards.

[1] *http://www.arb.ca.gov/smp/progdev/pubeduc/pbfs.pdf*

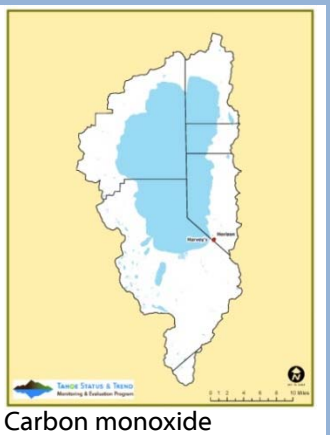
Carbon Monoxide: **Highest 1-Hour Concentration of Carbon Monoxide**

Status

HIGHEST 1-HOUR CONCENTRATION OF CARBON MONOXIDE

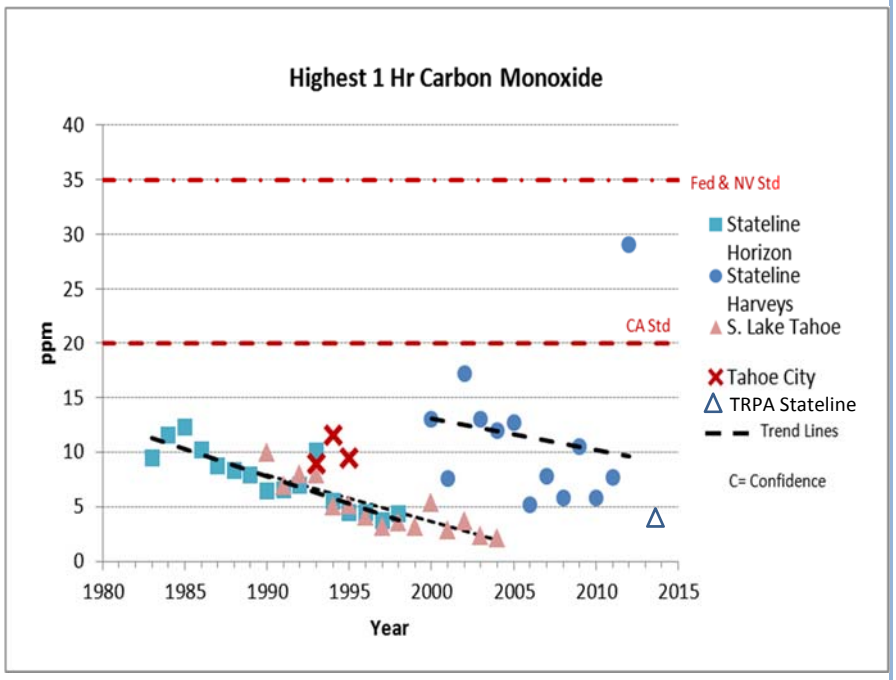
Status: **Considerably Better than Target**
Trend: **Moderate Improvement**
Confidence: **Moderate**

Map



Carbon monoxide monitoring sites located at Horizon and Harvey's Casinos in the Lake Tahoe Basin.

Trend



Annual maximum 1-hour CO in the Tahoe Basin from 1983 to present. The extremely high 2012 CO reading is likely a false reading and is therefore not used to assess the current status (please see "Status" section for further description). In lieu of an adopted TRPA standard, the stricter California state standard is used to assess the indicator. Source: Desert Research Institute

Data Evaluation and Interpretation

BACKGROUND

Relevance – Carbon monoxide (CO) in high concentrations affects human health by reducing the supply of oxygen to the tissues of the body. Health effects can include headaches, nausea, reduced mental alertness, and even death at very high concentrations. Federal and state standards with varying time-averaging periods have been adopted to protect the public from this pollutant. This indicator addresses the highest CO concentrations averaged over every 1 hour for the calendar year.

TRPA Threshold Category – Air Quality

TRPA Threshold Indicator Reporting Category – Carbon Monoxide (CO)

Adopted Standards – TRPA does not have an adopted standard for this indicator so the strictest California state standard is used instead. California standard: Maintain 1-hour concentrations of carbon monoxide at or below 20 ppm. Nevada and federal standard: Maintain 1-hour concentrations of carbon monoxide below 35 parts per million (PPM).

Type of Standard – Numerical

Indicator (Unit of Measure) – Highest 1-hour concentration in parts per million (ppm) of carbon monoxide measured within a calendar year.

Human & Environmental Drivers – Carbon monoxide is created by incomplete fuel combustion and emitted by sources such cars, trucks, boats, construction equipment, fireplaces, woodstoves, furnaces, and wildfire.

MONITORING AND ANALYSIS

Monitoring Partners – Nevada Division of Environmental Protection (NDEP), U.S. Environmental Protection Agency (EPA), Desert Research Institute (DRI), California Air Resources Board CARB)

Monitoring Approach – Between 1983 and 1998, CO was monitored at the Horizon Hotel in Stateline, Nevada. In 1999, the monitoring site was relocated to Harvey's Resort in Stateline, Nevada. The site was located to monitor the highest CO concentrations in the Lake Tahoe Basin because historically this area received the highest traffic volume, and was intended to be representative of both the California and Nevada sides of the South Shore Resort District. NDEP successfully petitioned the EPA to remove this monitoring site on June 30, 2012 because of the continued compliance with established CO concentration standards. The CARB provided TRPA with a CO monitor which was installed on the roof the building at TRPA building in Stateline, NV in 2013.

Analytic Approach – Trend was calculated using the Theil-Sen robust regression method (Theil 1950). Trend was analyzed beginning in 2000 for the Stateline Harvey's site to account for the change in monitoring location. Trend analysis of the resulting indicator values was performed by DRI under TRPA contract.

INDICATOR STATE

Status – Considerably better than target. The Region has been well within compliance with the TRPA, State and Federal standards for many years. In April of 2012, The NDEP submitted its' second 10-year Maintenance Plan to EPA recommending that the monitoring site be discontinued due to the low concentrations recorded at the site. In explaining the decision to discontinue monitoring, NDEP writes, "NDEP concludes that 33 years of clean data, all of it under 80 percent of the NAAQS and most recently at 34 percent, with on-going downward trends is sufficient evidence of continued attainment through 2024…(NDEP 2012)." Prior to discontinuation of the monitoring site, a high recording of 29.1 ppm was recorded, but is believed to a be a false/faulty reading. The 2012 reading was nearly double the "exceptional events" readings recorded during wildfire 2003/2004 and was almost three times the level that would be expected based on the long term trend in the data. The 2012 reading did not exceed the 1hr NV state standard (35 ppm) and was thus not flagged for additional analysis by NDEP.

Surrogate monitoring conducted by TRPA recorded a maximum 1-hour CO reading of 4 ppm during the current monitoring period. While the TRPA monitor is not "official" data because the monitoring station has not been approved by the EPA, it provides quality assured data and is further evidence to support the belief that the 29.1ppm levels recorded in 2012 were not accurate. For these reasons, the 2012 reading is not used to assess status and instead the long term trend line is used. The long term trend line shows the current status as considerably better than target.

Trend – Moderate improvement. The long-term trend lines indicate statistically significant decreasing trends at the Horizon site between 1983 and 1998, and at the Harvey's site between 2000 and 2012 (Campbell 2015). 1-hour CO concentrations decreased by an average of 0.3 ppm per year at the Harvey's

site, which is a decrease of 1.5 percent per year in relation to the standard of 20 ppm. Therefore, a trend of moderate improvement was determined. The 2012 data appears to be an anomaly and was not indicative of the overall trend.

Confidence –

Status – Moderate. There is moderate confidence in the status because data was collected using widely accepted protocols, are subject to quality assurance requirements, and were collected consistently between 1983 and 2012 with the exception of moving the monitoring site approximately one-quarter mile in 1999. While only one monitoring site is used to determine indicator status, the monitoring site is located within the South Shore Resort District that represents the greatest volume of vehicle traffic in the Region, and the measurements are thought to represent the highest source of CO emissions. Confidence would be "high," but moving the monitoring location one-quarter mile in 1999 significantly changed CO levels, raising questions about the representative nature of data (Campbell, D. 2016)

Trend – Moderate. Confidence in the trend at the Stateline Harvey's site is moderate ($p = 0.18$).

Overall – Moderate.

IMPLEMENTATION AND EFFECTIVENESS

Programs and Actions Implemented to Improve Conditions – Public transit operations, state and federal vehicle emission standards, TRPA and country wood stove retrofit programs, intersection improvements, bicycle trail infrastructure improvements, the Heavenly Gondola Project, among others factors, all contribute to reduced emissions.

Effectiveness of Programs and Actions – Current CO status and trends suggest TRPA, state, and federal actions to reduce CO emissions and decrease traffic volumes are effective at reducing 1-hour CO concentrations at this location.

Interim Target – While the most recent data from 2012 was out of attainment, all signs points to this data being an anomaly, and overall it is likely the Region is an attainment. Therefore, it is not necessary to establish an interim target.

Target Attainment Date – While the most recent data from 2012 was out of attainment, all signs points to this data being an anomaly, and overall it is likely the Region is an attainment. Therefore, it is not necessary to establish a target attainment date.

RECOMMENDATIONS

Analytic Approach – Clarification is needed on whether to assess the indicator based on the most current year of data available or on a multi-year average.

Monitoring Approach – No changes recommended. TRPA continues to monitor CO at a site on the roof of the TRPA building in Stateline, NV. In response to the long term record of attainment, and direction from EPA, NDEP discounted monitoring at the Horizon Stateline site in 2012.

Modification of the Threshold Standard or Indicator – No changes recommended.

Attain or Maintain Threshold – No changes recommended.

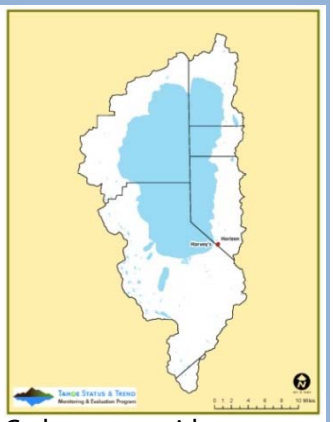
Carbon Monoxide: **Highest 8-hour Average Concentration of Carbon Monoxide**

Status

HIGHEST 8-HOUR AVERAGE CONCENTRATION OF CARBON MONOXIDE

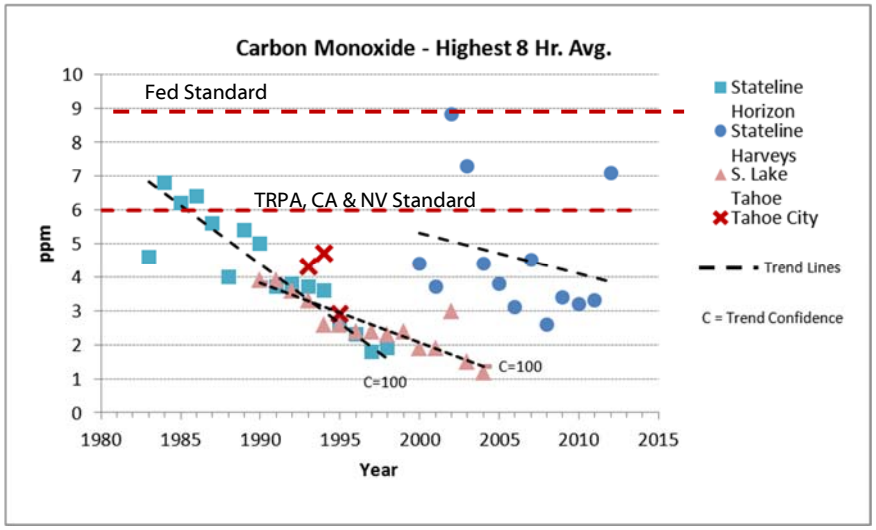
Status: **Considerably Better than Target**
Trend: **Moderate Improvement**
Confidence: **Moderate**

Map



Carbon monoxide monitoring sites located at Horizon and Harvey's Casinos in the Lake Tahoe Basin.

Trend



Highest and second highest annual maximum 8-hour CO in the Tahoe Basin from 1980 to present. The 2012 CO reading was not due to any "exceptional event" such as wildfire. However, it is likely a false reading and is not used to assess the current status (please see "status" section for further description). High CO readings in 2003/2004 were "exceptional events" caused by wildfire. Source: Desert Research Institute

Data Evaluation and Interpretation

BACKGROUND

Relevance – Carbon monoxide (CO) in high concentrations affects human health by reducing the supply of oxygen to the tissues of the body. Health effects can include headaches, nausea, reduced mental alertness and even death, at very high concentrations. TRPA, federal and state standards have been adopted to protect the public from this harmful pollutant. This indicator addresses the highest CO concentrations averaged over every 8-hours for the calendar year.

TRPA Threshold Category – Air Quality

TRPA Threshold Indicator Reporting Category – Carbon Monoxide (CO)

Adopted Standards – Maintain carbon monoxide concentrations at or below 6 parts per million (7 mg/m3) averaged over 8 hours. California and Nevada: Highest 8-hour average of 6 ppm is not to be exceeded.

Type of Standard – Numerical

Indicator (Unit of Measure) –Highest 8-hour average CO concentration (ppm). The second highest is provided to demonstrate the magnitude of difference between the highest and second highest 8-hour concentrations in the Region.

Human & Environmental Drivers – Carbon monoxide is emitted from incomplete fuel combustion by sources such as cars, trucks, boats, construction equipment, fireplaces, woodstoves, furnaces, and wildfire. The ambient concentration of CO is highly dependent on meteorological conditions such as temperature, wind speed, and mixing conditions.

MONITORING AND ANALYSIS

Monitoring Partners – Nevada Division of Environmental Protection (NDEP), U.S. Environmental Protection Agency (EPA), Desert Research Institute (DRI), and Tahoe Regional Planning Agency (TRPA).

Monitoring Approach – Between 1983 and 1998, CO was monitored at the Horizon Hotel in Stateline, Nevada. In 1999, the monitoring site was relocated to Harvey's Resort parking garage in Stateline, Nevada. The site is located to monitor the highest CO concentrations in the Lake Tahoe Basin because historically this area received the highest traffic volume, and is intended to be representative of both the California and Nevada sides of the South Shore Resort District. NDEP successfully petitioned the EPA to remove this monitoring site on June 30, 2012 because of the continued compliance with established CO concentration standards. The CARB provided TRPA with a CO monitor which was installed on the roof the building at TRPA building in Stateline, NV in 2013.

Analytic Approach – Trend was calculated using the Theil-Sen robust regression method (Theil 1950). Trend for the highest 8-hour average CO was analyzed beginning in 2000 for the Stateline Harvey's site to account for the change in monitoring location. Trend analysis of the resulting indicator values was performed by DRI under TRPA contract.

INDICATOR STATE

Status – Considerably better than target. The Region has been well within compliance with the strictest adopted threshold standard every year except 2012 (Campbell 2015). In 2012, the maximum 8-hour CO concentration at the Stateline Harvey's site and was 7.1ppm. However, this is likely a false reading. Surrogate monitoring of the 8-hr standard supports the conclusion that the 2012 observation was an anomaly. Further, NDEP and EPA deemed it no longer necessary to monitor CO at this location because recorded levels were consistently below state and federal standards. In explaining the decision to discontinue monitoring, NDEP writes, "NDEP concludes that 33 years of clean data, all of it under 80 percent of the NAAQS and most recently at 34 percent, with on-going downward trends is sufficient evidence of continued attainment through 2024…(NDEP 2012)." For these reasons, the 2012 reading is not used to assess status and instead the long term trend line is used. The long term trend line shows the current status as considerably better than target.

Trend – Moderate improvement. The trend line at the Stateline Harvey's site shows a decrease of 0.1ppm per year, which is a 1.7 percent decrease per year in relation to the standard of 6ppm (Campbell 2015). Therefore, a trend of moderate improvement was determined.

Confidence –

Status – Moderate. There is moderate confidence in the status because data was collected using widely accepted protocols, are subject to quality assurance requirements, and were collected consistently between 1983 and 2012 with the exception of moving the monitoring site approximately ¼ mile in 1999. The one monitoring site used to determine indicator status is located at the South Shore Resort District which represents the greatest volume of vehicle

traffic in the Region, and consequently the measurements are thought to be representative of the highest concentrations in the basin. Confidence would be high, however, changes in the monitoring location of less than ¼ mile in 1999 significantly changed CO levels, raising questions about the representative nature of the data collected at other sites (Campbell, D. 2016).

Trend – Moderate. The confidence in the trend is moderate (p = 0.13).

Overall – Moderate.

IMPLEMENTATION AND EFFECTIVENESS

Programs and Actions Implemented to Improve Conditions – Public transit operations, state and federal vehicle emission standards, TRPA and country wood stove retrofit programs, intersection improvements, bicycle trail infrastructure improvements, the Heavenly Gondola Project, among others factors, all contribute to reduced emissions.

Effectiveness of Programs and Actions – Current CO status and trends suggest TRPA, state, and federal actions to reduce CO emissions and decrease traffic volumes are effective at reducing 8-hour CO concentrations at this location.

Interim Target – Not applicable. The long term trend suggests the 2012 exceedance was an anomaly and CO concentrations should return to within the current standard.

Target Attainment Date – Not applicable. The long term trend suggests the 2012 exceedance was an anomaly and CO concentrations should return to within the current standard.

RECOMMENDATIONS

Analytic Approach – Clarification is needed on whether to assess the indicator based on the most current year of data available (current approach) or on a multi-year average.

Monitoring Approach – No changes recommended. TRPA continues to monitor CO at a site on the roof of the TRPA building in Stateline, NV. In response to the long term record of attainment, and direction from EPA, NDEP discounted monitoring at the Horizon Stateline site in 2012.

Modification of the Threshold Standard or Indicator – No changes recommended.

Attain or Maintain Threshold – No changes recommended.

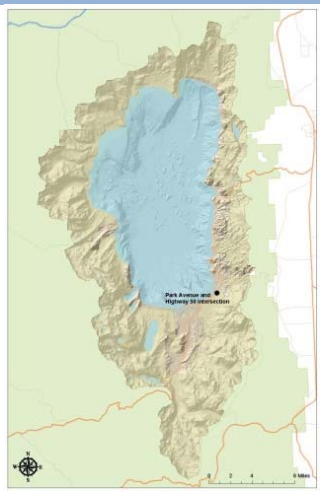
Carbon Monoxide: **Average Daily Winter Traffic Volume, Presidents' Weekend**

Status

AVERAGE DAILY WINTER TRAFFIC VOLUME, PRESIDENTS' WEEKEND

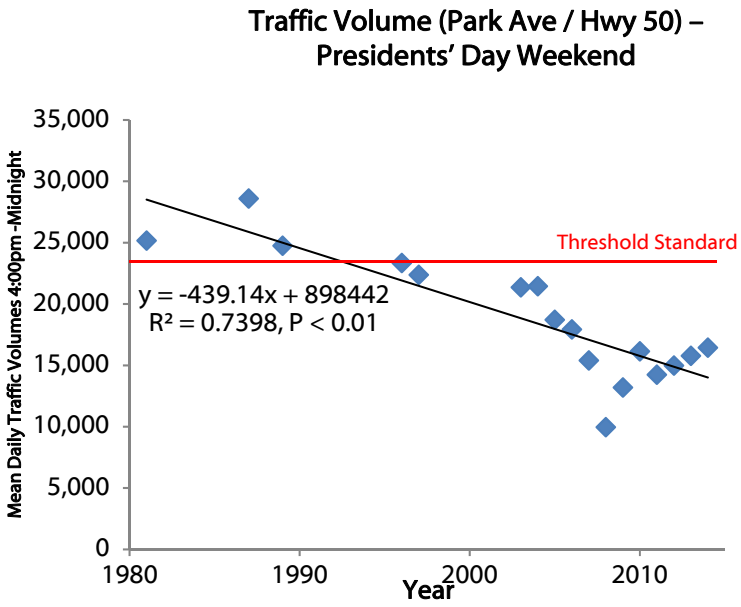
Status: **Considerably Better than Target**
Trend: **Moderate Improvement**
Confidence: **Moderate**

Map



Location of Presidents' Day Weekend traffic volume monitoring at the Hwy. 50/Park Ave site.

Trend



Average daily winter traffic volume measured between 4 p.m. and midnight (vehicles/day) on Presidents' Day Weekend at U.S. Highway 50 and Park Avenue, South Lake Tahoe, California, 1981 to 2014. Note: data not collected for 1982-1986, 1990–1995, and 1998-2002 periods resulting in a decrease in confidence in trend determination. Data Source: Caltrans and TRPA

Data Evaluation and Interpretation

BACKGROUND

Relevance – This indicator measures traffic volumes during winter months and provides a proxy measure of carbon monoxide concentration levels according to TRPA Resolution 82-11.

TRPA Threshold Category – Air Quality

TRPA Threshold Indicator Reporting Category – Carbon Monoxide (CO)

Adopted Standards – Reduce traffic volumes on the U.S. 50 Corridor by 7 percent during the winter from the 1981 base year between 4:00 p.m. and 12:00 midnight, provided that those traffic volumes shall be amended as necessary to meet the respective state standards.

Type of Standard – Management standard with a numeric target

Indicator (Unit of Measure) – Average daily traffic volumes measured at Park Avenue and U.S. Highway 50 between 4 p.m. and midnight on the Saturday of Presidents Day weekend (vehicles per day).

Human & Environmental Drivers – Several factors can influence traffic volumes measured on Presidents' Day weekend, including weather, economy, and availability of alternative modes of transportation. In winter 2001/2002, Heavenly Resort improved its free skier shuttle services and installed a Gondola near the site where traffic volumes are measured. It is presumed that the continuing availability of these alternative modes of transportation and the Gondola project have helped reduce traffic volumes to a level below the TRPA threshold standard.

MONITORING AND ANALYSIS

Monitoring Partners – California Department of Transportation (Caltrans) and TRPA

Monitoring Approach – Caltrans measures this indicator continuously using automated counters placed in the roadway at the intersection of Park Avenue and U.S. Highway 50 in South Lake Tahoe, including on the Saturday of Presidents' Day weekend from 4 p.m. and midnight, coinciding with the historical period of the most frequent exceedance of California's carbon monoxide (CO) standards. Data are summarized by Caltrans and subsequently accessed by TRPA for reporting purposes.

Analytic Approach – Simple linear regression is used to assess trend.

INDICATOR STATE

Status – Considerably better than target. Data from winter 2014 indicate that average daily traffic volume measured on Presidents' Day weekend is 16,453, 70.3 percent of the standard of 23,411 vehicles per day. Consequently, the Region is considerably better than the target to reduce by 7 percent 1981 traffic volume levels. Every year during the current monitoring period (2011 to 2014) was better than the target. The seven percent reduction from 1981 base year value of 25,173 vehicles per day between 4 p.m. and midnight, establishes a target of 23,411 vehicles per day.

Trend – Moderate Improvement. The long-term trend shows an average decrease in traffic volume at the monitoring site of 439 vehicles per day per year between 1981 and 2014, a 1.8 percent annual decrease in relation to the standard of 23,411 vehicles per day. Therefore, the overall trend is one of moderate improvement.

While the overall trend has been decreasing traffic volumes, since 2011 there is an upward trend. Daily traffic volumes between 2011 and 2014 grew by 2,210 vehicles overall, which is approximately four percent per year. This is still within the target.

Confidence –

Status – High. Traffic volume is continuously measured with an automated traffic counter at Park Avenue and U.S. Highway 50 that is regularly calibrated according to protocols and maintained by Caltrans. There is high confidence in the current status determination because established protocols are used, data has been continuously collected since 2003, and current data is available.

Trend – Moderate. Confidence in the long term trend line is moderate ($r^2 = 0.7398$, $P < 0.01$). There were several gaps in data collection between 1982 to1986, 1990 to 1995, and 1998 to 2002 that resulted in reduced confidence in data presented prior to 2003.

Overall – Moderate. Overall confidence takes the lower of the two confidence determinations.

IMPLEMENTATION AND EFFECTIVENESS

Programs and Actions Implemented to Improve Conditions – Public transit operations such as free skier shuttle service, BlueGo, and Tahoe Area Rapid Transit, intersection improvements, improved walkability through environmental redevelopment at Stateline, and the Heavenly Gondola project.

Effectiveness of Programs and Actions – Since overall traffic volumes have decreased since 1982, programs and actions appear to be somewhat effective. However, recent traffic increases since 2011 show that there is continued work that needs to be done to address traffic volumes.

Because the Park Avenue monitoring site is located in close proximity to the Heavenly Gondola project, it allows direct measurement of the impacts of the Gondola project on traffic volumes. Average winter traffic volumes and rate of traffic volume change were compared between dates prior to and after the Heavenly Gondola project implementation in 2001. The average daily traffic volume before the Heavenly Gondola project was 24,854 vehicles per day, and post-project was 16,307 vehicles per day, representing an average reduction of 8,547 vehicles per day. While outside factors beyond the Gondola project could be partly responsible for this decrease, this analysis suggests the Gondola project may have reduced overall winter traffic volumes, and resulted in a more rapid decline in traffic volumes than if the project had not been implemented.

Interim Target – Not applicable. In attainment.

Target Attainment Date – Not applicable. In attainment.

RECOMMENDATIONS

Analytic Approach – No changes recommended.

Monitoring Approach – No changes recommended.

Modification of the Threshold Standard or Indicator – No changes recommended.

Attain or Maintain Threshold – No changes recommended.

Ozone

Ozone (O_3) is created through a photochemical reaction between atmospheric oxygen, hydrocarbons and/or carbon monoxide, oxides of nitrogen, and sunlight. At high concentrations at ground level in the lower atmosphere, O_3 is an air pollutant that can harm the respiratory systems of people and animals and damage plant tissue. Young and elderly people are especially susceptible to elevated O_3 levels, which can cause lung and other respiratory illnesses. Ozone damages trees and plants, particularly ponderosa pines, Jeffrey pines, and quaking aspen that make up a large portion of the basin's tree population (Davis and Gerhold 1976).
Ground-level ozone is not directly emitted from typical pollutant sources like automobiles or industrial activities, but instead is created through a complex photochemical reaction between precursor gases such as hydrocarbons and oxides of nitrogen and sunlight in the lower atmosphere. The primary sources of the precursor gases in the Lake Tahoe Basin include on-road motor vehicles, residential fuel combustion, motorized watercraft, off-road equipment, solvent and fuel evaporation, and off-road recreational vehicles (California Air Resources Board 2006). Ozone can also be transported into the Lake Tahoe Basin from outside sources, although these sources are reported not to substantially contribute to overall O_3 concentrations (CARB 2004). Research into the amount of ozone transport from outside ozone sources is on-going. Because ozone formation is a photochemical process, higher concentrations are created on cloud-free summer days when the sun's radiation is at its peak. Overall, all the indicators for ozone are in attainment and have an improving or level trend.

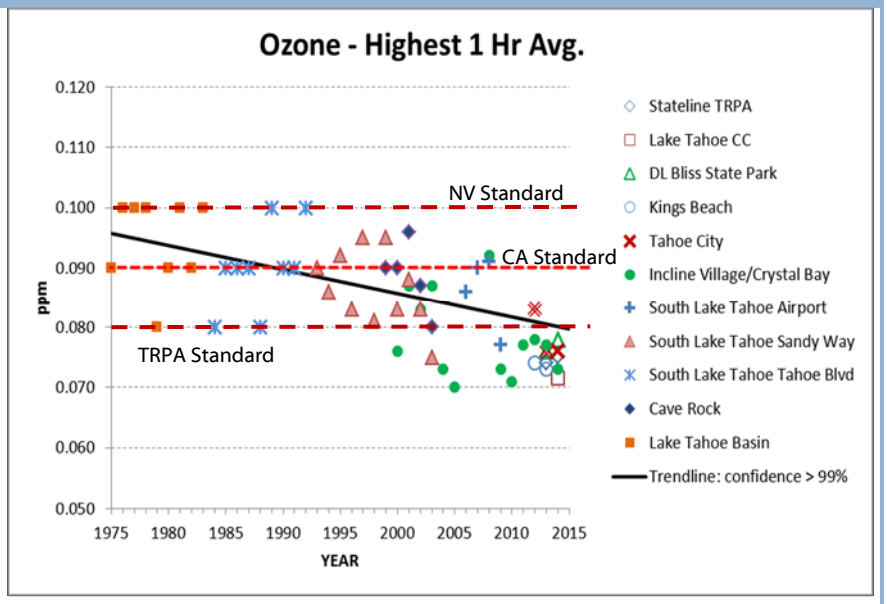
Ozone: **Highest 1-Hour Average Concentration of Ozone**

Status

HIGHEST 1-HOUR AVERAGE CONCENTRATION OF OZONE

Status: **At or Somewhat Better than Target**
Trend: **Moderate Improvement**
Confidence: **High**

Trend



The highest 1-hour ozone concentration in parts per million (ppm) measured at all monitoring sites in the Lake Tahoe Region. Hollow symbols represent data that does not meet regulatory requirements for data completeness or validation. Source: Desert Research Institute

Map

Current ozone monitoring locations in the Lake Tahoe Basin.

Data Evaluation and Interpretation

BACKGROUND

Relevance – Ozone (O_3) in high concentrations can cause health effects such as lung inflammation and other respiratory illness. Ozone can also cause damage to trees and plants at concentrations lower than the human health based ambient air quality standards. TRPA, federal and state standards have been adopted to protect human health. This indicator addresses the highest monitored O_3 concentration averaged over every 1-hour for the calendar year.

TRPA Threshold Category – Air Quality

TRPA Threshold Indicator Reporting Category – Ozone

Adopted Standards – TRPA: Maintain ozone concentrations at or below 0.080 parts per million averaged over 1-hour; California: not to exceed 0.090 ppm**;** Nevada: not to exceed 0.10 ppm.

Type of Standard – Numerical

Indicator (Unit of Measure) – Highest 1-hour average concentration of ozone measured at any monitoring station in the Lake Tahoe Basin.

Human & Environmental Drivers – Ozone is a secondary pollutant created by photochemical reactions between hydrocarbons (HC) and oxides of nitrogen (NOx) in sunlight. The primary sources of HC and NOx include in-basin mobile sources such as cars, trucks, boats, aircraft and off-road vehicles; biomass burning such as wood stoves, wildfires and prescribed burning; and consumer products such as solvents. Ozone is also transported into the basin to a lesser extent from populated areas surrounding the basin. The ambient concentration of O_3 is highly dependent on meteorological conditions such as sunlight, temperature, wind speed, and mixing conditions. Typically, the greater the volume of sources such as increased traffic contributing to precursor gas concentration during optimal weather conditions, the higher the concentration of ozone.

MONITORING AND ANALYSIS

Monitoring Partners – California Air Resources Board, Washoe County Air Quality Management Division, U.S. Environmental Protection Agency, Desert Research Institute (DRI), Placer County Air Pollution Control District and Tahoe Regional Planning Agency.

Monitoring Approach – Ozone is monitored at a number of locations around the Lake Tahoe Basin through the years by a variety of partners. Data is collected, analysed, and reported by the respective agency.

Analytic Approach – Trend was calculated using the Theil-Sen robust regression method (Theil 1950). Trend analysis of the resulting indicator values was performed by DRI under TRPA contract.

INDICATOR STATE

Status – At or somewhat better than target. For 2014, the latest year data is available, the maximum 1-hour average ozone concentration at sites that met regulatory reporting requirements was 0.076 ppm at Tahoe City, approximately 95 percent of the target of 0.080 ppm (Campbell 2015). Therefore, a status of at or somewhat better than target is determined. Additionally, only one location and year, Tahoe City in 2012, was above the threshold standard during the current 2012 to 2015 monitoring period.

Trend – Moderate improvement. There is a statistically significant downward trend based on the long term trend line of sites that met regulatory reporting requirements. The trend line shows a 0.0004 ppm per year decrease from 1975 to 2013, a decrease of 0.5 percent per year in relation to the standard of 0.080 ppm (Campbell 2015). Therefore, a trend of moderate improvement was determined.

Confidence –

Status – High. There is high confidence in the status determination because the data was collected using widely accepted protocols, was subject to quality assurance requirements, and has been collected continuously across the Region since 1975.
Trend – High. The confidence in the long term trend is high ($p = 0.01$)
Overall Confidence – High.

IMPLEMENTATION AND EFFECTIVENESS

Programs and Actions Implemented to Improve Conditions – Regional, state and federal emission standards for motor vehicles, motorized watercraft, gas appliances, and woodstoves. Transportation infrastructure improvements such as more efficient intersections, sidewalks, and bicycle infrastructure development. Public transportation systems. Regional and state restrictions on prescribed burning days.

Restricted development of "drive-up window" commercial uses.

Effectiveness of Programs and Actions – Based on current 2012 to 2015 monitoring period results, it appears current programs and actions are successful in reducing 1-hour maximum ozone values. If data continues to show the indicator below the threshold in the future, there will be higher confidence in this statement.

Interim Target – Not applicable. Currently the indicator is in attainment.

Target Attainment Date – Not applicable. Currently the indicator is in attainment.

RECOMMENDATIONS

Analytic Approach – A specific definition of how the indicator will be evaluated is needed. Potential options include:

1. Take the average maximum 1-hour readings of all monitoring stations during current monitoring period and compare it to the standard.
2. Take the average maximum 1-hour readings of all monitoring stations during the most recent monitoring period and compare it to the standard.
3. Report on the number of exceedances during the current monitoring period.
4. Report on the number of exceedances during the most recent monitoring period.
5. Use the highest reading from the current monitoring period and compare it to the standard.
6. Use the highest reading from the most recent monitoring period and compare it to the standard. This is the current evaluation method.

Monitoring Approach – No changes recommended.

Modification of the Threshold Standard or Indicator – No changes recommended.

Attain or Maintain Threshold – No changes recommended.

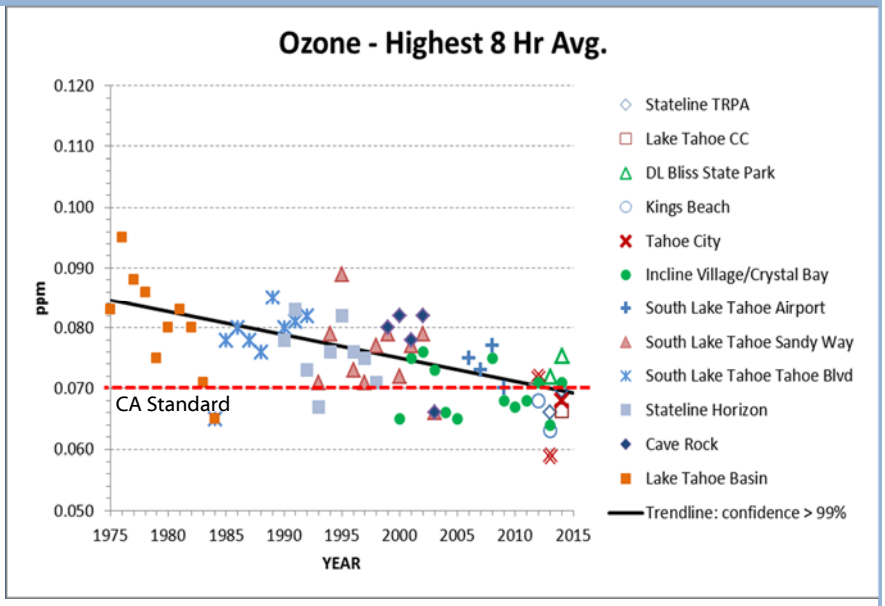
Ozone: **Highest 8-Hour Average Concentration of Ozone**

Status

HIGHEST 8-HOUR AVERAGE CONCENTRATION OF OZONE

Status: **Somewhat Worse than Target**
Trend: **Moderate Improvement**
Confidence: **High**

Trend



The highest 8-hour ozone concentration in parts per million (ppm) measured at all monitoring sites in the Lake Tahoe Basin. Hollow symbols represent data that does not meet regulatory requirements for completeness or validation. Source: Desert Research Institute

Map

Current ozone monitoring locations in the Lake Tahoe Basin.

Data Evaluation and Interpretation

BACKGROUND

Relevance – This indicator addresses the highest monitored ozone concentration averaged over every 8 hours for the calendar year. Ozone (O_3), in high concentrations, can cause health effects such as lung inflammation and other respiratory illness. O_3 can also cause damage to trees and plants at concentrations lower than the human health based ambient air quality standards. Standards, with varying time averaging periods, have been adopted to protect human health.

TRPA Threshold Category – Air Quality

TRPA Threshold Indicator Reporting Category – Ozone

Adopted Standards – TRPA and Nevada: no standard. California: not to exceed 0.070 ppm 8-hour average concentration.

Type of Standard – Numerical

Indicator (Unit of Measure) – Highest 8-hour average concentration measured at any monitoring site.

Human & Environmental Drivers – Ozone is a secondary pollutant created by reactions between sunlight and hydrocarbons (HC) and oxides of nitrogen (NOx). The primary sources of HC and NOx include in-basin mobile sources such as cars, trucks, boats, aircraft and off-road vehicles; biomass burning such as wood stoves, wildfires and prescribed burning; and consumer products such as solvents. Ozone is also transported into the basin to a lesser extent from populated areas surrounding the basin, and the ambient concentration of O_3 is highly dependent on meteorological conditions such as sunlight, temperature, wind speed, and mixing conditions.

MONITORING AND ANALYSIS

Monitoring Partners – California Air Resources Board, Washoe County Air Quality Management Division, U.S. Environmental Protection Agency, Placer County Air Pollution Control District, Lake Tahoe Community College and the Tahoe Regional Planning Agency.

Monitoring Approach – Ozone is monitored at a number of locations around the Lake Tahoe Region through the years by a variety of partners. Data is collected, analyzed, and reported by the respective agency.

Analytic Approach – Trend was calculated using the Theil-Sen robust regression method (Theil 1950). Trend analysis of the resulting indicator values was performed by DRI under TRPA contract.

INDICATOR STATE

Status – Somewhat worse than target. For 2014, the latest year data is available, the maximum 8-hour ozone concentration at sites that met regulatory reporting requirements was located at Incline Village and was 0.071ppm, approximately 101 percent of the standard of 0.070ppm (Campbell 2015). Therefore, a status of somewhat worse than target was determined.

Trend – Moderate improvement. There is a statistically significant downward trend based on the long term trend line of sites that meet regulatory reporting requirements. The trend line shows a 0.0004 ppm per year decrease from 1975 to 2014, a decrease of 0.57 percent per year in relation to the standard of 0.70 ppm (Campbell 2015). Therefore, a trend of moderate improvement was determined.

Confidence –

Status – High. There is high confidence in the status determination because the data was collected using widely accepted protocols, was subject to quality assurance requirements, and has been collected continuously across the Region since 1975.
Trend – High. The confidence in the long term trend is high, with confidence level in a trend of over 99 percent (P = 0.01)
Overall Confidence - High.

IMPLEMENTATION AND EFFECTIVENESS

Programs and Actions Implemented to Improve Conditions – Regional, state and federal emission standards for motor vehicles, motorized watercraft, gas appliances and woodstoves. Transportation infrastructure improvements such as more efficient intersections, sidewalks, and bicycle infrastructure development. Public transportation systems. Regional and state restrictions on prescribed burning days.

Restricted development of "drive-up window" commercial uses.

Effectiveness of Programs and Actions – Current programs appear to be effective in reducing ozone, although a continued downward trend is needed for attainment.

Interim Target – No interim target needed. Current trends show the current standard is achievable in the near term.

Target Attainment Date – While it is clear that the Basin is moving towards attainment in the near term, due to the variability of the data, it is not possible to estimate an attainment date.

RECOMMENDATIONS

Analytic Approach – A specific definition of how the indicator will be evaluated is needed. Potential options include:

1. Take the average maximum eight-hour readings of all monitoring stations during current monitoring period (e.g. 2012 to 2015) and compare it to the standard.
2. Take the average maximum eight-hour readings of all monitoring stations during the most recent (ex. 2015) monitoring period and compare it to the standard.
3. Report on the number of exceedances during the current monitoring period.
4. Report on the number of exceedances during the most recent monitoring period.
5. Use the highest reading from the current monitoring period and compare it to the standard.
6. Use the highest reading from the most recent monitoring period and compare it to the standard. This is the current evaluation method.

Monitoring Approach – No changes recommended.

Modification of the Threshold Standard or Indicator – No changes recommended.

Attain or Maintain Threshold – No changes recommended.

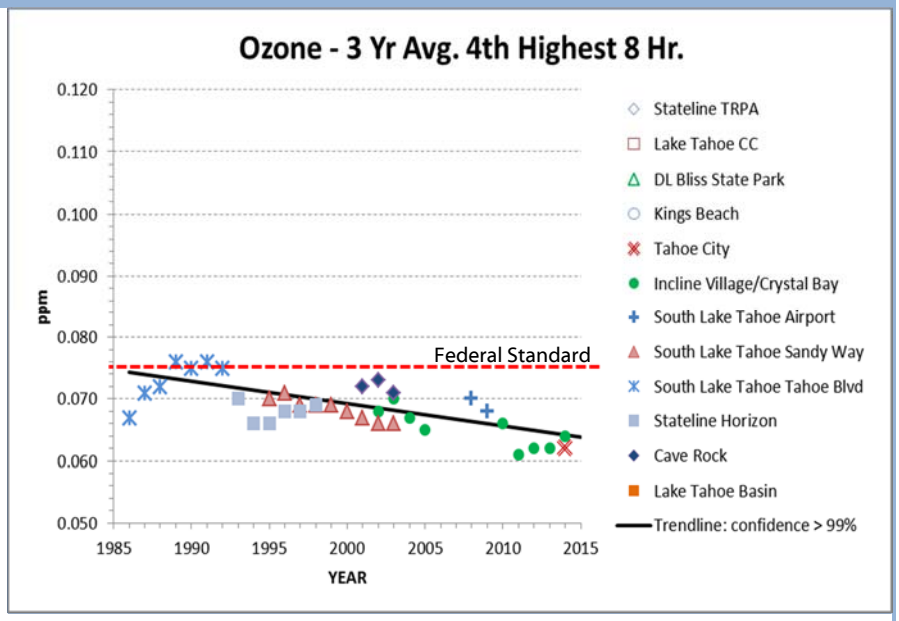
Ozone: 3-Year Average of the 4th Highest 8-hour Average Concentration of Ozone

Status

3-YEAR AVERAGE OF 4th HIGHEST 8-HOUR AVERAGE CONCENTRATION OF OZONE

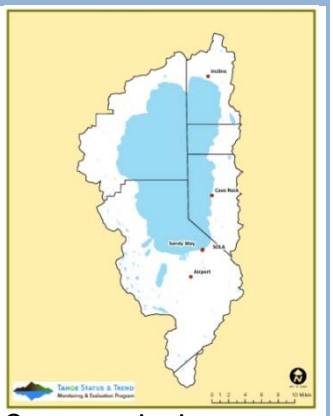
Status: **At or Somewhat Better than Target**
Trend: **Moderate Improvement**
Confidence: **High**

Trend



NAAQS ozone design value in the Tahoe Region from 1985 to present. Because TRPA has no adopted standard, the federal standard is used.
Source: Desert Research Institute

Map



Ozone monitoring locations in the Lake Tahoe Basin.

Data Evaluation and Interpretation

BACKGROUND

Relevance – This indicator addresses the 3-year average of the 4th-highest 8-hour average ozone concentration, which is the basis of the federal standard. Ozone (O_3), in high concentrations can cause health effects such as lung inflammation and other respiratory illness. Ozone can also cause damage to trees and plants at concentrations lower than the human health based ambient air quality standards. TRPA, and federal and state standards, with varying time averaging periods, have been adopted to protect the public from this harmful pollutant.

TRPA Threshold Category – Air Quality

TRPA Threshold Indicator Reporting Category – Ozone

Adopted Standards – Federal: The 3-year average of the 4th-highest daily maximum must not exceed concentration standard of 0.075 ppm. Because TRPA does not have a standard the federal standard is used.

Type of Standard – Numerical

Indicator (Unit of Measure) – 3-year average of the 4th-highest daily maximum ozone concentration in parts per million (ppm) at any monitoring location.

Human & Environmental Drivers – Ozone is considered a secondary pollutant, created by photochemical reactions between hydrocarbons (HC) and oxides of nitrogen (NOx) in sunlight. The sources of HC and NOx include mobile sources (cars, trucks, boats, aircraft, off-road vehicles, etc.), biomass burning (wood stoves, wildfires, prescribed burning), and consumer products such as solvents. Ozone is transported from populated areas around the Lake Tahoe Region into the basin, and the ambient concentration of O_3 is highly dependent on meteorological conditions such as sunlight, temperature, wind speed and mixing conditions.

MONITORING AND ANALYSIS

Monitoring Partners – California Air Resources Board, Washoe County Air Quality Management Division, U.S. Environmental Protection Agency, Desert Research Institute (DRI), Placer County Air Pollution Control District, Lake Tahoe Community College and the Tahoe Regional Planning Agency (TRPA).

Monitoring Approach – Ozone is monitored at a number of locations around the Lake Tahoe Region through the years by a variety of partners. Data is collected, analyzed, and reported by the respective agency.

Analytic Approach – Trend was calculated using the Theil-Sen robust regression method (Theil 1950). Trend analysis of the resulting indicator values was performed by DRI under TRPA contract.

INDICATOR STATE

Status – Somewhat better than target. Of all the monitoring stations where recent data is available, the highest 3-year average of the 4th-highest daily maximum ozone concentration was 0.064 ppm in Incline Village, 85 percent of the standard (Campbell 2015). Therefore, a status of "somewhat better than target" was determined. The indicator has been in attainment at all monitoring locations since 1993.

Trend – Moderate improvement. The trend line for all monitoring stations since 1986 shows a decrease of 0.0004 ppm per year, a decrease of 0.53 percent per year in relation to the standard of 0.075 ppm (Campbell 2015). Therefore, a trend of moderate improvement is determined.

Confidence –

Status – High. There is high confidence in the status determination because data is collected using federal reference methods (EPA 2011a), are subject to quality assurance requirements, and are collected continuously across the Region since 1975.
Trend – High. Confidence in the trend is high with a confidence in a trend of 99 percent (P = 0.01)
Overall Confidence – High.

IMPLEMENTATION AND EFFECTIVENESS

Programs and Actions Implemented to Improve Conditions – Regional, state and federal emission standards for motor vehicles, motorized watercraft, gas appliances, and woodstoves. Transportation infrastructure improvements such as more efficient intersections, sidewalks, and bicycle infrastructure development. Public transportation systems. Regional and state restrictions on prescribed burning days.

Restricted development of "drive-up window" commercial uses.

Effectiveness of Programs and Actions – Existing programs and actions implemented are effective based on the long-term indicator data, which shows that the standard has not been exceeded in the years that monitoring occurred.

Interim Target – Not applicable. Indicator is in attainment.

Target Attainment Date – Not applicable. Indicator is in attainment.

RECOMMENDATIONS

Analytic Approach – A specific definition of how the indicator will be evaluated is needed. Potential options include:

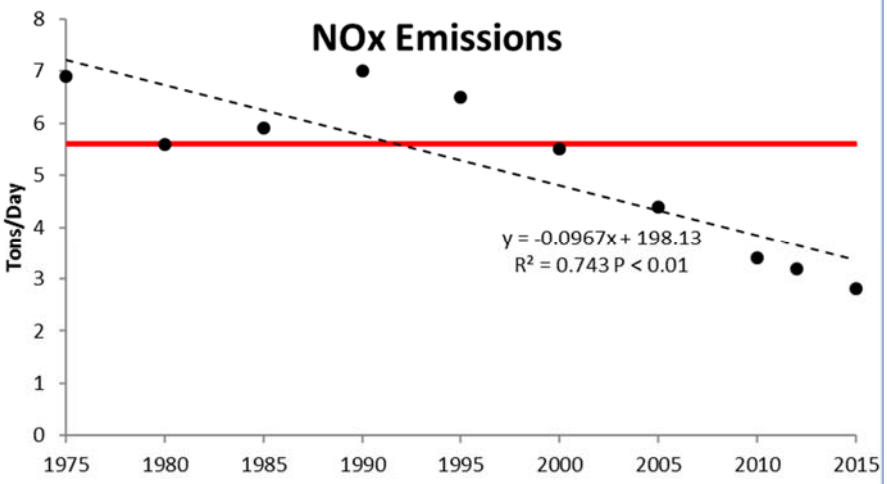
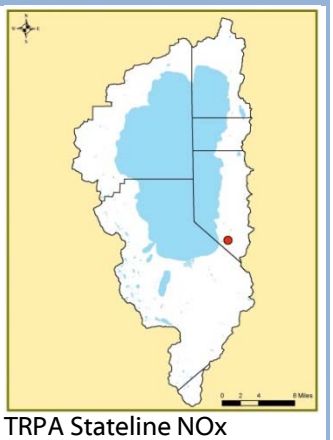
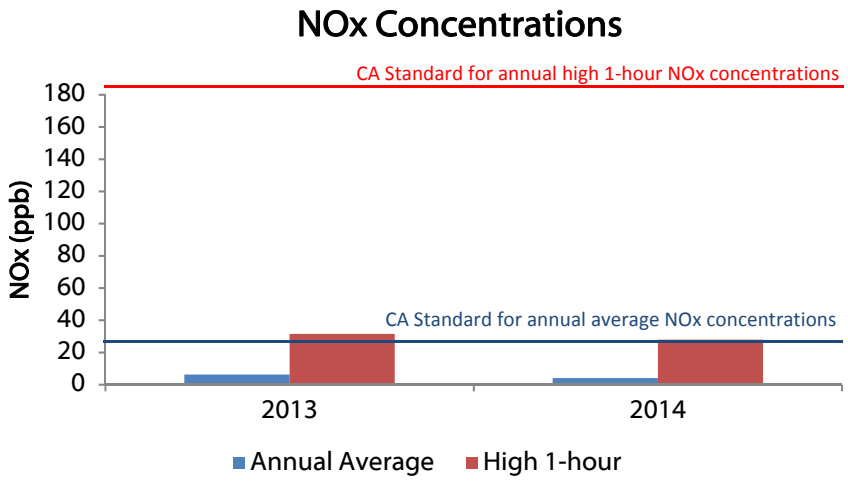
1. Take the average maximum 1-hour readings of all monitoring stations during current monitoring period (e.g. 2012 to 2015) and compare it to the standard
2. Take the average maximum 1-hour readings of all monitoring stations during the most recent (ex. 2015) monitoring period and compare it to the standard
3. Report on the number of exceedances during the current monitoring period
4. Report on the number of exceedances during the most recent monitoring period
5. Use the highest reading from the current monitoring period and compare it to the standard
6. Use the highest reading from the most recent monitoring period and compare it to the standard. This is the current evaluation method.

Monitoring Approach – No changes recommended.

Modification of the Threshold Standard or Indicator – No changes recommended.

Attain or Maintain Threshold – No changes recommended.

Ozone: **Oxides of Nitrogen Emissions**

Status	Trend
OXIDES OF NITROGEN EMISSIONS Status: **Considerably Better than Target** Trend: **Moderate Improvement** Confidence: **Moderate**	 Annual estimated nitrogen oxide emissions (tons/day) for the California portion of the Lake Tahoe Region. While the TRPA 1982 Threshold Study Report estimated 1981 NOx daily emissions to be 9.4 tons, CARB estimated 1980 levels to be 5.6 tons/day (red line). Because consistent CARB data exists, CARB estimates are used as the threshold standard. Source: CARB (2015) emission inventory for the California portion of the Lake Tahoe Air Basin and TRPA.
Map	
 TRPA Stateline NOx monitoring location.	 NOx concentrations as measured at the newly established TRPA Stateline monitoring location. While no official TRPA standards exist for NOx concentrations, this data is used to evaluate NOx concentrations against CA and Federal standards. Source: TRPA

Data Evaluation and Interpretation

BACKGROUND

Relevance – This indicator estimates daily emissions of nitrogen oxides (NOx) based on the California Air Resources Board (CARB) emission inventory for the California portion of the Lake Tahoe Region and the recently installed monitoring at the TRPA offices in Stateline, Nevada. Nitrogen dioxide (NO2) is one of a group of highly reactive gasses known as "nitrogen oxides." Other nitrogen oxides include nitrous acid

and nitric acid. While federal standards cover the entire group of NO_x. NO_2 is the component of greatest interest and the indicator for the larger group of NO_x. In addition to contributing to the formation of ground-level ozone and fine particle pollution, NO_2 is linked with regional haze, global warming, water quality degradation, and a number of adverse effects on the respiratory system (EPA 2011c). Current scientific evidence links short-term NO_2 exposure ranging from 30 minutes to 24-hours with adverse respiratory effects, including airway inflammation in healthy people, and increased respiratory symptoms in people with asthma (EPA 2011b).

TRPA Threshold Category – Air Quality

TRPA Threshold Indicator Reporting Category – Ozone

Adopted Standards –

- ***Total Emissions*** **-** TRPA**:** Maintain oxides of nitrogen (NOx) emissions at or below the 1981 levels (9.4 tons per day) for an average summer day, as reported in the Study Report for the Establishment of Environmental Threshold Carrying Capacities (TRPA 1982).

- ***Concentrations*** **–** TRPA standards for concentrations exist. California: Annual average NO_2 concentration not to exceed 0.030 ppm, highest one-hour, not to exceed 0.18 ppm; Nevada/Federal: Annual average NO_2 concentration not to exceed 0.053 ppm and highest one-hour concentration not to exceed 0.10 ppm.

Type of Standard – Numerical

Indicator (Unit of Measure) – Average tons per day of NOx emission (tons/day)

Human & Environmental Drivers – Ozone is considered a secondary pollutant, created by photochemical reactions between hydrocarbons (HC) and oxides of nitrogen (NOx) in sunlight. The sources of HC and NOx include mobile sources (cars, trucks, boats, aircraft, off-road vehicles, etc.), biomass burning (wood stoves, wildfires, prescribed burning), and consumer products such as solvents. Ozone is transported from populated areas around the Lake Tahoe Region into the basin, and the ambient concentration of O_3 is highly dependent on meteorological conditions such as sunlight, temperature, wind speed and mixing conditions.

MONITORING AND ANALYSIS

Monitoring Partners – California Air Resources Board (CARB), Washoe County Air Quality Management Division, U.S. Environmental Protection Agency, Desert Research Institute, Placer County Air Pollution Control District and the Tahoe Regional Planning Agency.

Monitoring Approach – CARB compiles data to create the criteria pollutant emission inventory, which includes information on the emissions of reactive organic gases (ROG), oxides of nitrogen (NOx), oxides of sulfur (SOx), carbon monoxide (CO), and particulate matter (PM_{10}). Data are gathered continuously and stored in the California Emission Inventory Development and Reporting System (CEIDARS). A summary of the criteria pollutant inventory is published annually. The California emission inventory contains information on the following air pollution sources:

- Stationary sources - approximately 13,000 individual facilities defined as point sources. Point sources are fixed pollution sources such as electric power plants and refineries.

- Area-wide sources - approximately 80 source categories. An area-wide source category is made up of sources of pollution mainly linked to human activity. Examples of these sources include consumer products and architectural coatings used in a region

- Mobile sources - all on-road vehicles such as automobiles and trucks; off-road vehicles such as trains, ships, aircraft; and farm equipment

The principal agencies contributing data to the stationary and area-wide source inventory are the CARB and the California air pollution control and air quality management districts. The CARB, the California Department of Transportation (Caltrans), and regional transportation agencies are the principal agencies involved in developing the mobile source inventory. Information represented in the California emission inventory is a snap-shot of a variety of dynamic and variable processes. As such, the emission inventory can only represent an estimate of what is actually occurring. In summer 2011, a new NO_x monitoring station was installed at the TRPA offices in Stateline, Nevada. Data from 2013 and 2014 for this site are now available.

Analytic Approach –Linear regression was used to assess trend.

INDICATOR STATE

Status – Considerably better than target.

- **Total Emissions (NOx tons/day):** In 2015, CARB estimated an average of 2.8 tons per day of NOx emissions for the Tahoe Basin. This is 50 percent of the CARB estimates for 1980 of 5.6 tons per day. Therefore, the status is determined to be "considerably better than target." CARB estimates are used instead of earlier TRPA estimates because they have been measured consistently.
- **Concentrations (NOx ppb):** *Annual Average Concentration:* 2014 data from the TRPA Stateline site shows an annual average concentration of 4.1 ppb, 14 percent of the strictest California standard of 30 ppb. *Highest 1-hour Concentrations:* 2014 data from the TRPA Stateline site shows an annual high 1-hour concentration of 27.9 ppb, 15.5 percent of the strictest California standard of 180 ppb. Both of these are "considerably better than target."

Trend – Moderate improvement. The long-term trend line for average tons per day of NOx emissions shows an annual decrease of 1.5 percent. Therefore, a trend of moderate improvement was determined. Additionally, a very strong decreasing trend is evident from 1990 onward with consistent reductions in NOX levels.

Confidence –

Status – High. Data is collected following well-established protocols for air quality monitoring, therefore confidence in the status is high.

Trend – Moderate. The overall improving trend in emissions reported by CARB is moderate (R^2 = 0.5538, P = 0.014). Trend from the Stateline site is not applicable because only two years of data exists.

Overall Confidence – Moderate. Overall confidence takes the lower of the two confidence determinations.

IMPLEMENTATION AND EFFECTIVENESS

Programs and Actions Implemented to Improve Conditions – Regional, state and federal emission standards for motor vehicles, motorized watercraft, gas appliances and woodstoves. Transportation infrastructure improvements such as more efficient intersections, sidewalks, and bicycle infrastructure development. Low emission public transportation systems. Restricted development of "drive-up window" commercial uses.

Effectiveness of Programs and Actions – Existing federal, state and regional programs and actions are effective, based on CARB emission estimates and TRPA monitoring data. The CARB emission inventory indicates a decreasing trend in NOx emissions, which indicates the effectiveness of state and federal vehicle emission standards and programs implemented through the Regional Transportation Plan.

Interim Target – Not applicable. Indicator is in attainment.

Target Attainment Date – Not applicable. Indicator is in attainment.

RECOMMENDATIONS

Analytic Approach – No changes recommended.

Monitoring Approach – No changes recommended.

Modification of the Threshold Standard or Indicator – A threshold standard amendment is recommended to clarify the existing TRPA NO_x standard. It is also recommended to favor the adoption of a numerical standard consistent with state and federal concentration standards because baseline NO_x emissions in 1981 were not documented (only 1980 NO_x emission estimates were reported). Measurement of NO_x concentration would more accurately represent contributions from all sources of NO_x, not just vehicle associated NO_x as represented by modeled NO_x values presented here. It is recommended to continue monitoring modeled NO_x emissions for an additional five years, contemporaneously with NO_2 concentrations for comparison purposes.

Attain or Maintain Threshold – No changes recommended.

Visibility

TRPA established threshold standards for "visibility" to protect the unique aesthetic scenic values of the Tahoe Region. Visibility measures the distance at which an object or light can be clearly discerned by the human eye. Light through the atmosphere is scattered, or absorbed by gases and airborne particles, causing a reduction in visibility. Without anthropogenic influences, visual range can be up to 248.5 miles. Several natural phenomenon and human generated pollutants are known to impair visibility, including fog, ice fog, mist, haze, smoke, volcanic ash, dust, sand, and snow. Haze is a term used to describe an atmospheric phenomenon where dust, smoke, and other dry particles obscure the clarity of the sky. When viewed from around Lake Tahoe's shoreline or atop the basin's ridgeline, haze may appear brownish or bluish, while mist or fog tends to be bluish-grey. Sources of locally generated haze pollutants include entrained/suspended roadway particles, vehicle emissions, residential wood burning, campfires, prescribed fires, and wildfires (Green et al. 2011; Kuhns, H. et al. 2004). Some particles responsible for the degradation of regional visibility in the Lake Tahoe Region include dust and other pollutants transported into the basin from areas as far as Asia (Green et al. 2011).

TRPA's visibility threshold standards aim to improve and then maintain air quality at the regional and sub-regional scale. The regional visibility threshold standard established visibility objectives for the entire basin, while the sub-regional visibility threshold standard established a local visibility objective for the South Lake Tahoe portion of the Tahoe Basin.

TRPA Resolution 82-11 identifies two numerical standards for regional visibility. These standards are:

1. Achieving an extinction coefficient[2] of 25 Mm^{-1} at least 50 percent of the time, as calculated from aerosol species concentrations measured at the Bliss State Park monitoring site (visual range of 97 miles).
2. Achieving an extinction coefficient of 34 Mm^{-1} at least 90 percent of the time, as calculated from aerosol species concentrations measured at the Bliss State Park monitoring site (visual range of 71 miles).

In addition, there are two numerical standards for sub-regional visibility. These standards are:

1. Achieving an extinction coefficient of 50 Mm^{-1} at least 50 percent of the time, as calculated from aerosol species concentrations measured at the South Lake Tahoe monitoring site (visual range of 48 miles).
2. Achieving an extinction coefficient of 125 Mm^{-1} at least 90 percent of the time, as calculated from aerosol species concentrations measured at the South Lake Tahoe monitoring site (visual range of 19 miles).

Calculations for regional and sub-regional visibility standards are to be made on three year running periods. Beginning with the 1991 to 1993 monitoring data as the performance standard to meet or exceed.

Both regional visibility standards were in attainment, but there was insufficient data to determine the status of the two sub regional standards.

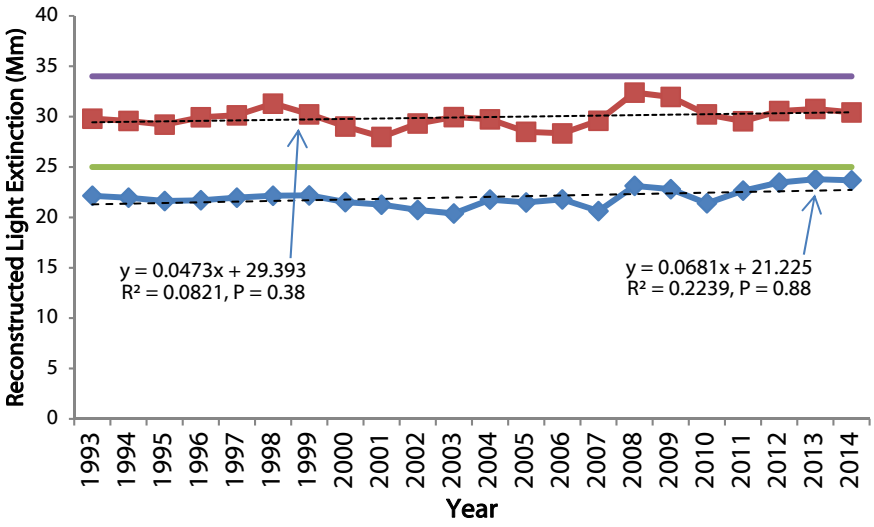
[2] *A measure of light absorption and scattering in the atmosphere measured in inverse megameters (Mm^{-1})*

Visibility: **Regional Visibility**

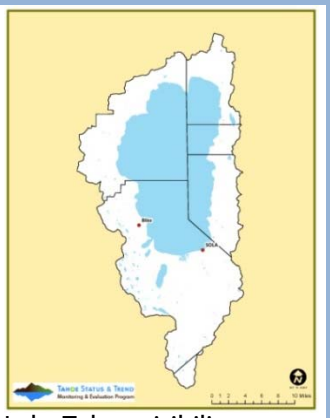
Status	Trend

REGIONAL VISIBILITY AND 50th PERCENTILE REGIONAL VISIBILITY 90th PERCENTILE

Status: **At or Somewhat Better than Target**
Trend: **Little or No Change**
Confidence: **Moderate**



Map



Lake Tahoe visibility monitoring locations (D.L. Bliss State Park was used for Regional measurements and South Lake Tahoe "SOLA" was used for sub-regional measurements).

Regional visibility conditions were monitored at the D. L. Bliss IMPROVE monitoring station (western portion of the basin) from 1991 through 2014 using the 3-year running average reconstructed light extinction (b_{ext}) indicator. Light extinction measures the amount of absorption and dispersion of light in the atmosphere. The Tahoe Region is currently meeting adopted regional visibility threshold standards for the 3-year running average indicator and has throughout the monitoring record. Trends for both "average days" (50th percentile) and "worst day" (90th percentile) exhibit little or no change."

Data Evaluation and Interpretation

BACKGROUND

Relevance – This indicator measures regional visibility and the distance that the human eye can see. It is measured by using a reconstructed light extinction (b_{ext}) value, which is derived from an equation that combines measured concentrations of several gasses and particles. The equation is corrected for humidity and natural "background" light scattering. B_{ext} is summarized by "average visibility days" (50th percentile values) and "worst visibility days" (90th percentile values) for each year, followed by

calculating the 3-year running average. This threshold standard has been adopted to protect regional visibility and air quality.

TRPA Threshold Category – Air Quality

TRPA Threshold Indicator Reporting Category – Visibility

Adopted Standards – TRPA: 1) Achieve an extinction coefficient of 25 Mm^{-1} at least 50 percent of the time as calculated from aerosol species concentrations measured at the D.L. Bliss State Park monitoring site (visual range of 97 miles), and 2) Achieve an extinction coefficient of 34 Mm^{-1} at least 90 percent of the time, as calculated from aerosol species concentrations measured at the D.L. Bliss State Park monitoring site (visual range of 71 miles). Calculations will be made on three year running periods, beginning with the existing 1991 to 1993 monitoring data as the performance standards to be met or exceeded.

Type of Standard – Numerical

Indicator (Unit of Measure) – 3-year running average of the reconstructed light-extinction (Mm^{-1}, "inverse mega meters") from data collected at the D.L. Bliss Monitoring Site.

Human & Environmental Drivers – Particulate matter in the atmosphere is the primary driver of visibility impairment because of the optical properties and long retention times in the air (Green et al. 2011, 201). The main sources of particulate matter in the basin are residential and wildfire smoke, and entrained roadway dust (DRI 2011a). Effective motor vehicle tail pipe emission controls, residential wood combustion controls, appropriately managed prescribed burning, and road dust emission control aid in improving regional visibility conditions (Chen, Watson, and Wang 2011). There is uncertainty related to visibility condition in the future due to predicted increases in frequency and intensity of wildfires in the western U.S.

MONITORING AND ANALYSIS

Monitoring Partners – U.S. Forest Service, U.C. Davis, U.S. National Park Services, Desert Research Institute, Colorado State University, California State Parks and TRPA.

Monitoring Approach – Air samples needed to calculate b_{ext} were collected at least every six days at D.L. Bliss State Park. This is an appropriate site for monitoring regional conditions because it is not influenced by urban sources ((L.-W. Antony Chen, Watson, John G., and Wang, Xiaoliang 2011)). Data are collected, analyzed, and reported by the IMPROVE (national Interagency Monitoring of Protected Environments) network using nationally accepted protocols.

Analytic Approach – Simple linear regression was used to analyze trend.

INDICATOR STATE

Status – At or somewhat better than target. The most recent data for the 3-year average visibility from 2012 to 2014 show that "average visibility days" are 23.67 Mm^{-1}, and "worst visibility days" are 30.43 Mm^{-1}. The most recent 3-year running average values for "average visibility days" were 95 percent of the target, while 3-year running average values for "worst days" were 90 percent of the target. Therefore, both were determined to be at or somewhat better than target. According to the monitoring record, the Region has been in compliance with regional standards for "average days" and "worst days" in all years. Decreases in visibility occurring in 2008 and 2009 running average values were attributed to wildfires burning outside the Lake Tahoe Region; more than 2.3 million acres were consumed by wildfires in California according to (L.-W. Antony Chen, Watson, John G., and Wang, Xiaoliang 2011)) and the CAL Fire incident database, similar effects are likely for the 2013 and 2014 Rim and King fires.

Trend – Little to no change. Both indicators show a statistically insignificant upward trend small enough to be considered little to no change.

Confidence –

Status – High. There is high confidence in the determination of regional visibility conditions because current b_{ext} data were compared with optical measurements from 1999 to 2003 and showed a good correspondence ((L.-W. Antony Chen, Watson, John G., and Wang, Xiaoliang 2011)). Results of the Lake Tahoe Atmospheric Deposition Study (California Air Resources Board 2006) and satellite remote sensors confirmed that the location of the regional monitoring site at D.L. Bliss State Park was representative of visibility conditions for the Tahoe Region (Chen, Watson, and Wang 2011). B_{ext} data are also collected using the IMPROVE national protocol that has been reviewed extensively.

Trend – Moderate. Although data has been consistently collected according to the IMPROVE protocol, overall confidence for trend would be low according to the methodology laid out in this report ($R^2 = 0.0821$, $P = 0.38$; $R^2 = 0.22$, $P = 0.88$). However, because low R^2 values often correlate with data that shows little or no trend, the confidence in trend has been increased to moderate.

Overall Confidence – Moderate. Overall confidence takes the middle of the two confidence determinations when high and low.

IMPLEMENTATION AND EFFECTIVENESS

Programs and Actions Implemented to Improve Conditions – Prescribed burning controls, residential woodstove replacement programs and emission standards, public transportation systems, pedestrian sidewalks and bikeways projects, automobile trip reduction programs, state and federal vehicle emission standards.

Effectiveness of Programs and Actions – The improving long-term trend for "average visibility days" suggests that the programs and actions were effective at maintaining and improving visibility between 1991 and 2014. Wildfires from outside of the basin appear to negatively influence visibility conditions in the Region; the agency has no ability to regulate or otherwise control this source of visibility impairment. Prescribed burning and burn days should continue to be regulated by appropriate state authorities.

Interim Target – Not applicable. Indicator is in attainment.

Target Attainment Date – Not applicable. Indicator is in attainment.

RECOMMENDATIONS

Analytic Approach – No changes recommended.

Monitoring Approach – No changes recommended.

Modification of the Threshold Standard or Indicator – No changes recommended.

Attain or Maintain Threshold – No changes recommended.

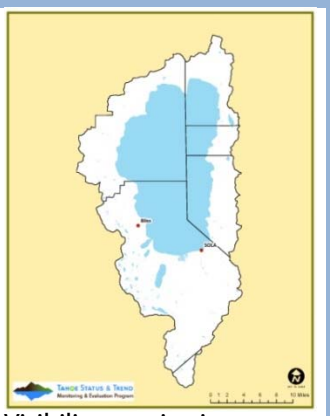
Visibility: **Sub-Regional Visibility**

Status

SUB-REGIONAL VISIBILITY 50th PERCENTILE AND SUB-REGIONAL VISIBILITY 90th PERCENTILE

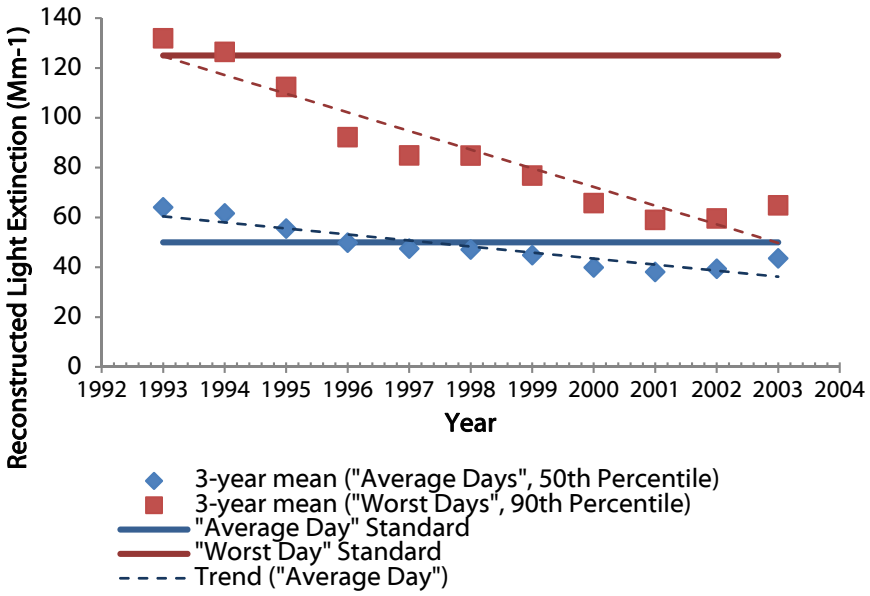
Status: **Insufficient Data to Determine Status**
Trend: **Insufficient Data to Determine Trend**
Confidence: **Not Applicable**

Map

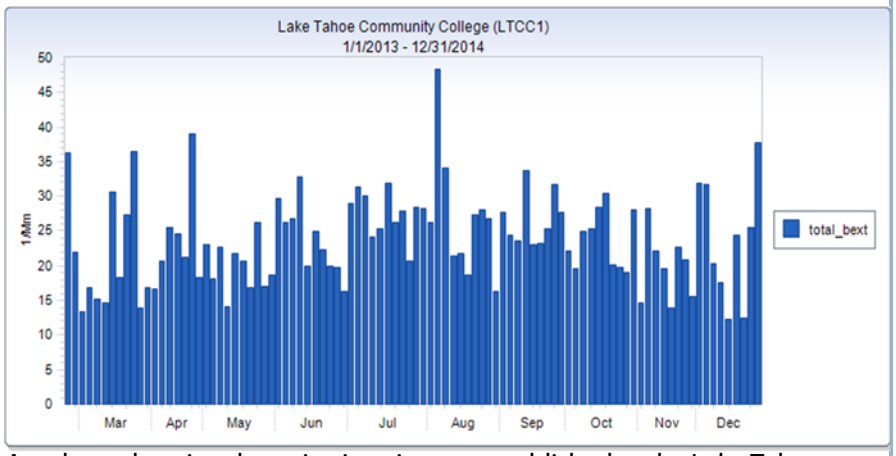


Visibility monitoring stations in the Lake Tahoe Region. The South Lake Tahoe ("SOLA") monitoring site, located in the southern portion of the Region, was used to characterize sub-regional visibility conditions from 1991 to 2003.

Trend



Sub-regional visibility conditions were monitored at the South Lake Tahoe monitoring station (southern urbanized portion of the Region) from 1991 through 2003 using the 3-year running average reconstructed light extinction (b_{ext}) indicator. Light extinction measures the amount of absorption and dispersion of light in the atmosphere. Prior to 2004, trends for both "average days" and "worst days" indicators showed moderate to rapid improvement ($P<0.01$).



Another subregional monitoring site was established at the Lake Tahoe Community College in 2014, but 3-year running averages will not be available until 2017. Monthly reconstructed light extinction (b_{ext}) monitoring data for the Lake Tahoe Community College site are shown between the months of January 2013 and December 2014.

Data Evaluation and Interpretation

BACKGROUND

Relevance – This indicator measures sub-regional visibility in South Lake Tahoe and the distance that the human eye can see. It is measured by using a reconstructed light extinction (b_{ext}) value derived from an equation that combines measured concentrations of several gasses and particles. The equation is corrected for humidity and natural "background" light scattering. B_{ext} is summarized by "average visibility days" (50th percentile values) and "worst visibility days" (90th percentile values) for each year followed by calculating the 3-year running average. This threshold standard has been adopted to protect sub-regional visibility and air quality.

TRPA Threshold Category – Air Quality

TRPA Threshold Indicator Reporting Category – Visibility

Adopted Standards – TRPA: 1) Achieve an extinction coefficient of 50 Mm^{-1} at least 50 percent of the time as calculated from aerosol species concentrations measured at the South Lake Tahoe monitoring site (visual range of 48 miles), and 2) Achieve an extinction coefficient of 125 Mm^{-1} at least 90 percent of the time as calculated from aerosol species concentrations measured at the South Lake Tahoe monitoring site (visual range of 19 miles).

Type of Standard – Numerical

Indicator (Unit of Measure) – 3-year running average of the reconstructed light-extinction (Mm^{-1}, "inverse mega meters") from data collected at the South Lake Tahoe SOLA monitoring site.

Human & Environmental Drivers – Particulate matter in the atmosphere is the primary driver of visibility impairment because of the optical properties and long retention times in the air ((Green et al. 2011)). The main sources of particulate matter in the basin are smoke and entrained roadway dust (Chen, Watson, and Wang 2011). Improving visibility trends are attributable to effective controls over motor vehicle, residential wood combustion, regulatory controls over prescribe burn days and road dust emissions (Chen, Watson, and Wang 2011). The most substantial risk to visibility is the increased frequency and intensity of wildfires in the Western U.S.

MONITORING AND ANALYSIS

Monitoring Partners – U.S. Forest Service, U.C. Davis, U.S. National Park Services, Lake Tahoe Community College and Colorado State University.

Monitoring Approach – Air samples needed to calculate b_{ext} were collected at least every six days at a South Lake Tahoe site. Data were collected, analyzed and reported by the IMPROVE network using nationally accepted protocols. A monitoring site was set up at Lake Tahoe Community College in 2014, but 3-year running averages will not be available until 2017.

Analytic Approach – Simple linear regression was used to analyze trend.

INDICATOR STATE

Status – Insufficient data to determine status. A monitoring site was set up at Lake Tahoe Community College in 2014 and 3-year running averages will not be available until 2017. Therefore, due to insufficient data the current status is unknown for both "average visibility days" and "worst visibility days" at the sub-regional scale. Historical annual average data from 2003 showed that "average visibility days" were 42.62 Mm^{-1} and "worst visibility days" were 72.73 Mm^{-1} at the sub-regional scale. The 3-year running average for 2003 showed that "average visibility days" were 43.55 Mm^{-1} and "worst visibility days" were 64.89 Mm^{-1} at the sub-regional scale. The most recent 3-year running average values (2003) for "average visibility days" were 12.9 percent better than the regional 50th percentile standard of 50

Mm^{-1} resulting in a determination of "somewhat better than the target." The most recent 3-year running average values (2003) for "worst days" were 48 percent better than the regional 90th percentile standard resulting in a determination of "considerably better than target." According to the monitoring record, the Region has been in compliance with regional standards for "average days" and "worst days" since 1996.

Although not official, preliminary data available from the LTCC site shows a running average (based on slightly more than 1 year of data) of approximately 23 Mm^{-1}, which would be well within the standard.

Trend – Insufficient data to determine trend. A Theil regression analysis was used to determine trends for the sub-regional 3-year running average visibility indicator prior to 2004. The estimated trend for the 3-year running average of the historical "average visibility days" data (1991 to 2003) for reconstructed light extinction was improving (less light extinction) at a rate of 4.47 percent per year ($P<0.01$) indicating a rapid improvement. The trend for the 3-year running average estimated for "worst visibility days" based on historical data (1991 to 2003) was improving at a rate of six percent per year also indicating a rapid improvement ($P<0.01$).

Confidence –Not applicable. Because of insufficient data for 2004 to 2015, confidence in the determination of status and trends was not applicable.

IMPLEMENTATION AND EFFECTIVENESS

Programs and Actions Implemented to Improve Conditions – Prescribed burning controls, residential woodstove emission standards, public transportation systems, pedestrian sidewalks and bikeways projects, automobile trip reduction programs, state and federal vehicle emission standards.

Effectiveness of Programs and Actions – Historical trends for "average visibility days" and "worst visibility days" suggest that programs and actions were effective at maintaining and improving visibility between 1991 and 2003.

Interim Target – Not applicable. Indicator state is currently unknown.

Target Attainment Date – Not applicable. Indicator state is currently unknown.

RECOMMENDATIONS

Analytic Approach – No changes recommended.

Monitoring Approach – The South Lake Tahoe monitoring site (SOLA) was decommissioned in 2004 as a result of the property being sold. A monitoring site was set up at Lake Tahoe Community College in 2014, but 3-year running averages will not be available until 2017.

Modification of the Threshold Standard or Indicator – No changes recommended.

Attain or Maintain Threshold – No changes recommended.

Respirable and Fine Particulate Matter

Atmospheric particulate matter consists of very small liquid and solid particles, designated PM_{10} for particulate matter of 10 microns (10µ) or less in diameter. The primary sources of PM_{10} in the basin are motor vehicles, pulverized road-traction abrasives, decomposed road surfaces, salt, fugitive dust from local sources and abroad, and smoke from residential burning, prescribed burning, and wildfires. PM_{10} is among the most harmful of air pollutants. When inhaled, these particles invade the respiratory system's natural defenses and lodge deep in the lungs. PM_{10} can increase the number and severity of asthma attacks, cause or aggravate bronchitis and other lung diseases, and reduce the body's ability to fight infections. These effects are particularly harmful to children, active adults, and the elderly.

Particles small enough to be inhaled into the deepest parts of the lungs are another concern to public health. These fine particles are known as $PM_{2.5}$ for particulate matter of 2.5 microns (2.5µ) or less in diameter. Due to this pollutant's tiny size, it can be inhaled deep into the lungs and can make its way directly into the bloodstream. Some of these particles are generated by combustion and they can contain carcinogens. For this reason, state and federal governments have adopted standards and placed increasing efforts on the study of this pollutant.

Atmospheric particles are also known to settle out of the air and deposit onto the landscape, including into Lake Tahoe. Lahontan Water Quality Control Board has implicated particles equal or smaller than 16µ diameter in the decline of Lake Tahoe transparency, and estimated that about 15 percent of the particle loads to Lake Tahoe are from atmospheric sources (Lahontan 2010). Measures of PM10 and PM2.5 concentrations may in part provide a surrogate measure of this atmospheric pollutant known to affect Lake Tahoe's transparency.

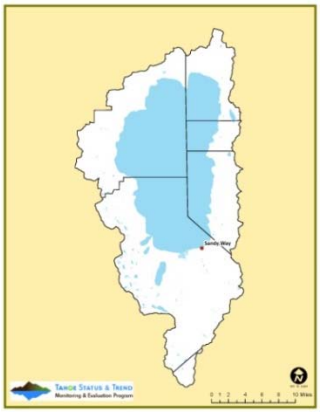
Respirable and Fine Particulate Matter: **Highest 24-Hour Average PM_{10} Concentration**

Status

HIGHEST 24-HOUR AVERAGE PM_{10} CONCENTRATION

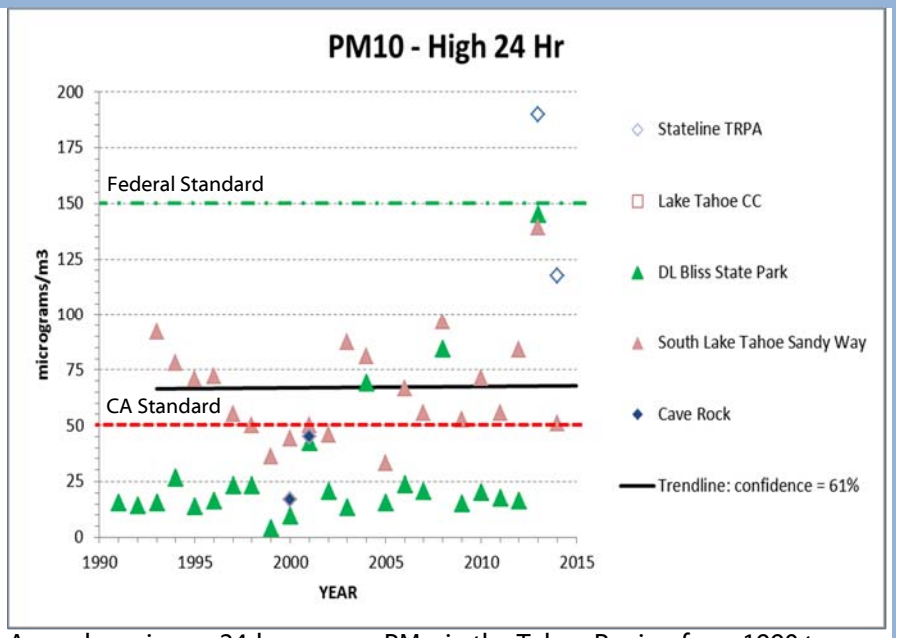
Status: **Somewhat Worse than Target**
Trend: **Little to No Change**
Confidence: **Moderate**

Map



PM_{10} monitoring location in the Lake Tahoe Basin.

Trend



Annual maximum 24-hr average PM_{10} in the Tahoe Region from 1990 to present. 2014 data for South Lake Tahoe Sandy Way site is preliminary and subject to revision. In lieu of TRPA standards, the stricter California state standard is used to assess this threshold. Hollow symbols represent data that does not meet regulatory requirements for completeness or validation. Source: Desert Research Institute

Data Evaluation and Interpretation

BACKGROUND

Relevance – This indicator measures the highest monitored PM_{10} concentration averaged over every 24-hours for the calendar year. Particulate matter in high concentrations less than or equal to 10 microns in size can lodge in the lungs and cause or aggravate the effects of asthma, lung diseases, and heart disease. Elevated concentrations of PM_{10} have also been attributed to reductions in regional visibility and increased regional haze. Federal and state standards with varying time averaging periods have been adopted to protect human health and regional visibility.

TRPA Threshold Category – Air Quality

TRPA Threshold Indicator Reporting Category – Visibility

Adopted Standards – Maintain Particulate Matter10 at or below 50μg/m3 measured over a 24-hour period in the portion of the Region within California, and maintain Particulate Matter10 at or below 150

μg/m3 measured over a 24-hour period in the portion of the Region within Nevada. Particulate Matter10 measurements shall be made using gravimetric or beta attenuation methods or any equivalent procedure which can be shown to provide equivalent results at or near the level of air quality standard.

Type of Standard – Numerical

Indicator (Unit of Measure) – Highest 24-hour average concentration of PM_{10} within a calendar year measured at any site in the Tahoe Region (micrograms per cubic meter of air, $\mu g/m^3$).

Human & Environmental Drivers – Particulate matter pollution consists of very small liquid and solid particles in the air. The primary sources of PM_{10} in the Lake Tahoe Basin are motor vehicle emissions, paved and unpaved road dust, wood smoke, wildfire smoke, and construction dust. The ambient concentration of PM_{10} is highly dependent on meteorological conditions such as wind speed and mixing conditions.

MONITORING AND ANALYSIS

Monitoring Partners – Interagency Monitoring of Protected Visual Environments (IMPROVE), California Air Resources Board, U.S. Environmental Protection Agency, Desert Research Institute (DRI), and Tahoe Regional Planning Agency (TRPA).

Monitoring Approach – Particulate matter is monitored in the Tahoe Basin as part of a national network. These sites used the IMPROVE sampler, which is not a Federal Reference Method $PM_{2.5}$ sampler but is accepted for determining compliance with regional haze regulations.

Analytic Approach – Trend was calculated using the Theil-Sen robust regression method ((Theil 1950)) applied to the highest 24-hour average measured each calendar year at any site within the basin. Trend analysis of the resulting indicator values was performed by DRI under TRPA contract.

INDICATOR STATE

Status – Somewhat worse than target. For the latest year data is available (2014) at sites that meet regulatory reporting requirements, the South Lake Tahoe Sandy Way site had the highest 24-hr PM_{10} concentration and was 50.8 micrograms/^{m3}, 102 percent of the stricter California standard (Campbell 2015). Therefore, a status of somewhat worse than target was determined.

Trend – Little to no change. The long term trend line shows an increase of 0.1 μg/m3 per year, an increase of 0.2 percent per year in relation to the stricter California standard (Campbell 2015). Therefore, a trend of little to no change was determined.

Confidence –

Status – High. There is high confidence in the status determination because the data is collected using federal reference methods (EPA 2011a), are subject to quality assurance requirements, and are collected continuously across the Region since 1992.
Trend – Moderate. Confidence in the trend is moderate with a confidence level in a trend at 61 percent (P = 0.39)
Overall Confidence – Moderate. Overall confidence takes the lower of the two confidence determinations.

IMPLEMENTATION AND EFFECTIVENESS

Programs and Actions Implemented to Improve Conditions – Prescribed burning controls, residential woodstove stove replacement programs and emission standards, public transportation systems, pedestrian sidewalks and bikeways, trip reduction programs, state and federal vehicle emission standards.

Effectiveness of Programs and Actions – The observed trends show little to no change in PM_{10}

concentrations with highly variable data, indicating that it is unclear how existing program and actions are affecting concentrations.

Interim Target – Due to highly variable data, it is not possible to set an interim target.

Target Attainment Date – Due to highly variable data, it is not possible to set a target attainment date.

RECOMMENDATIONS

Analytic Approach – A specific definition of how the indicator will be evaluated is needed. Potential options include:

1. Take the average of all monitoring stations during the current monitoring period (e.g. 2012 to 2015) and compare it to the standard,
2. Take the average readings of all monitoring stations during the most recent (e.g. 2015) monitoring period and compare it to the standard,
3. Report on the number of exceedances during the current monitoring period,
4. Report on the number of exceedances during the most recent monitoring period,
5. Use the highest reading from the current monitoring period and compare it to the standard, or
6. Use the highest reading from the most recent monitoring period and compare it to the standard. This is the current evaluation method.

Monitoring Approach – No changes recommended.

Modification of the Threshold Standard or Indicator – No changes recommended.

Attain or Maintain Threshold – This indicator not being in attainment with the most conservative standard suggests that existing programs and actions could be more effectively implemented, such as more frequent street sweeping to control entrained road dust. TRPA should continue to implement the requirement that residential woods stove meet EPA emission standards, and perhaps, if conditions decline, consider options for restricting residential or other wood burning during periods of elevated ambient PM concentrations. Respective state air quality management authorities already regulate prescribed burning of forest biomass and burning in the Region is only allowed during appropriate meteorological conditions and following conditions of an approved burn plan.

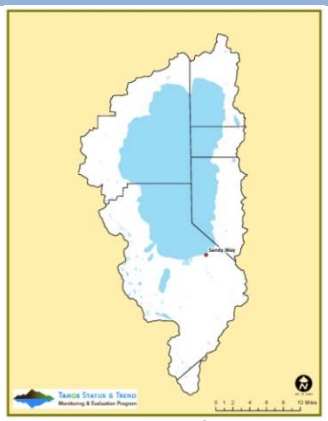
Respirable and Fine Particulate Matter: **Annual Average PM_{10} Concentration**

Status

ANNUAL AVERAGE PM_{10} CONCENTRATION

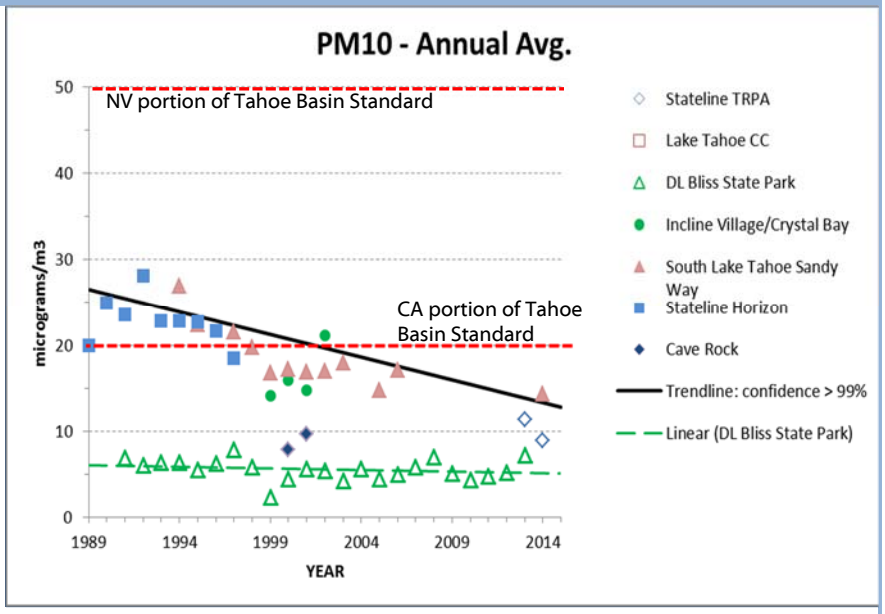
Status: **Considerably Better than Target**
Trend: **Moderate Improvement**
Confidence: **Moderate**

Map



PM_{10} monitoring location in the Lake Tahoe Basin.

Trend



Annual average PM_{10} in the Tahoe Region from 1989 to present. 2014 data for South Lake Tahoe Sandy Way site is preliminary and subject to revision. Hollow symbols are used for sites not conforming to regulatory monitoring protocols, which were not used to estimate the trend.
Source: Desert Research Institute

Data Evaluation and Interpretation

BACKGROUND

Relevance – This indicator measures the annual average concentration of particulate matter less than or equal to 10 microns in size (PM_{10}). In high concentrations this pollutant can lodge in the lungs and cause or aggravate the effects of asthma, lung diseases, and heart disease. Federal and state standards have been adopted to protect the public from this pollutant.

TRPA Threshold Category – Air Quality

TRPA Threshold Indicator Reporting Category – Respirable and Fine Particulate Matter

Adopted Standards – TRPA: Maintain Particulate Matter10 at or below annual arithmetic average of 20μg/m3 in the portion of the Region within California, and maintain Particulate Matter10 at or below annual arithmetic average of 50μg/m3 in the portion of the Region within Nevada. Particulate Matter10

measurements shall be made using gravimetric or beta attenuation methods or any equivalent procedure which can be shown to provide equivalent results at or near the level of air quality standard.

Type of Standard – Numerical

Indicator (Unit of Measure) – Annual average PM_{10} concentrations measured at any permanent monitoring station within a calendar year ($\mu g/m^3$).

Human & Environmental Drivers – Particulate matter pollution consists of very small liquid and solid particles in the air. The primary sources of PM_{10} in the Lake Tahoe Region are motor vehicles, paved and unpaved road dust, wood smoke, and construction dust. The ambient concentration of PM_{10} is dependent on meteorological conditions such as wind speed and atmospheric mixing.

MONITORING AND ANALYSIS

Monitoring Partners – Interagency Monitoring of Protected Visual Environments (IMPROVE), California Air Resources Board, Nevada Division of Environmental Protection, U.S. Environmental Protection Agency, Desert Research Institute (DRI), and Tahoe Regional Planning Agency. (TRPA)

Monitoring Approach – Particulate matter is monitored at one site in the Tahoe Basin as part of a national network. These sites used the IMPROVE sampler, which is not a Federal Reference Method $PM_{2.5}$ sampler but is accepted for determining compliance with regional haze regulations.

Analytic Approach – Trend was calculated using the Theil-Sen robust regression method (Theil 1950). Trend analysis of the resulting indicator values was performed by DRI under TRPA contract.

INDICATOR STATE

Status – Considerably better than target. The highest annual average PM_{10} concentration at monitoring sites that met regulatory reporting requirements was found at the South Lake Tahoe Sandy Way site and was 14.3 ug/m^3 for 2014, the most recent year monitoring data was available (Campbell 2015). It was approximately 70 percent of the stricter California standard. Therefore, it is considerably better than target.

Trend – Moderate improvement. The trend line shows a significant decrease in overall PM_{10} concentrations of 0.5 µg/m^3 per year across the basin, a decrease of 2.5 percent per year relative to the California standard (Campbell 2015). Therefore, a trend of moderate improvement was determined.

Confidence –

Status – Moderate. Data was collected continuously between 1989 and 2006 using federal reference methods at CARB's South Lake Tahoe Sandy Way site (EPA 2011a), and the data was subject to extensive quality assurance requirements. However, gaps exist in the data from 2007-2013 and therefore confidence is moderate.
Trend – High. Confidence in the trend is high with a confidence of greater than 99 percent.
Overall Confidence – Moderate. Overall confidence takes the lower of the two confidence determinations.

IMPLEMENTATION AND EFFECTIVENESS

Programs and Actions Implemented to Improve Conditions – Prescribed burning controls, residential woodstove replacement programs and emission standards, public transportation systems, pedestrian sidewalks and bikeways, automobile trip reduction programs, state and federal vehicle emission standards. The improving long-term trend for this indicator suggests that the programs and actions were effective at controlling concentrations of PM_{10} between 1989 and 2006; 2014 data shows that this improving trend has continued.

Effectiveness of Programs and Actions – The observed declining trends in PM_{10} concentrations suggest

that the programs and actions are effective at controlling concentrations of PM_{10}.

Interim Target – Not applicable. Indicator is in attainment.

Target Attainment Date – Not applicable. Indicator is in attainment.

RECOMMENDATIONS

Analytic Approach – A specific definition of how the indicator will be evaluated is needed. Potential options include:

1. Take the average of all monitoring stations during the current monitoring period (e.g. 2012 to 2015) and compare it to the standard,
2. Take the average readings of all monitoring stations during the most recent (e.g. 2015) monitoring period and compare it to the standard,
3. Report on the number of exceedances during the current monitoring period,
4. Report on the number of exceedances during the most recent monitoring period,
5. Use the highest reading from the current monitoring period and compare it to the standard, or
6. Use the highest reading from the most recent monitoring period and compare it to the standard. This is the current evaluation method.

Monitoring Approach – No changes recommended.

Modification of the Threshold Standard or Indicator – No changes recommended.

Attain or Maintain Threshold – No changes recommended.

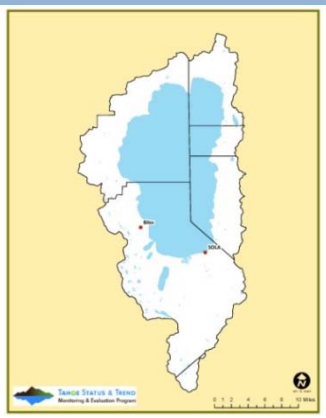
Respirable and Fine Particulate Matter: **24-hour $PM_{2.5}$ Concentration**

Status

24-HOUR $PM_{2.5}$ CONCENTRATION

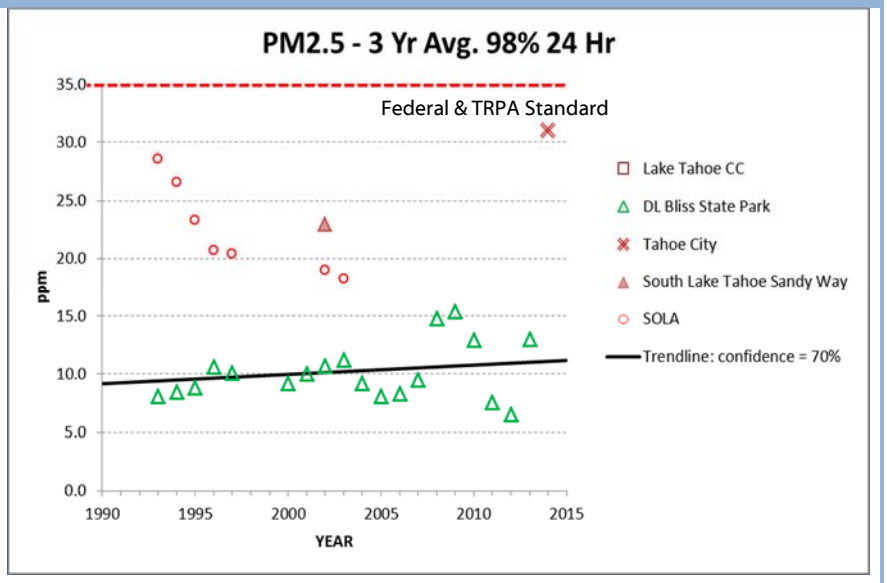
Status: **At or Somewhat Better than Target**
Trend: **Little to No Change**
Confidence: **Moderate**

Map



$PM_{2.5}$ monitoring locations in the Lake Tahoe Basin.

Trend



National Ambient Air Quality Standard design values for $PM_{2.5}$ in the Tahoe Region from 1990 to present. Insufficient valid regulatory data is available, so the regression line is based on data from Bliss State Park. Source: Desert Research Institute

Data Evaluation and Interpretation

BACKGROUND

Relevance – This indicator measures the 3-year running average of the 98th percentile 24-hour average concentration of $PM_{2.5}$. Particulate matter less than or equal to 2.5 microns in size ($PM_{2.5}$) is extremely small and can be inhaled deep into the lungs causing or aggravating asthma, lung diseases, and heart disease. Some particles pass into the bloodstream and some are considered carcinogens. Federal standards have been adopted to protect the public from this pollutant.

TRPA Threshold Category – Air Quality

TRPA Threshold Indicator Reporting Category – Respirable and Fine Particulate Matter

Adopted Standards – Maintain Particulate Matter2.5 at or below 35μg/m3 measured over a 24-hour period using gravimetric or beta attenuation methods or any equivalent procedure which can be shown to provide equivalent results at or near the level of air quality standard. Federal: The 3-year average of

the 98th percentile 24-hour $PM_{2.5}$ concentration must not exceed 35 $\mu g/m^3$.

Type of Standard – Numerical

Indicator (Unit of Measure) – 3-year average of the 98th percentile 24-hour $PM_{2.5}$ concentration at any monitoring station ($\mu g/m^3$)

Human & Environmental Drivers – Particulate matter pollution consists of very small liquid and solid particles in the air. The primary sources of $PM_{2.5}$ in the Lake Tahoe Region are residential fuel combustion, wood smoke from wildfires and prescribed fires, motor vehicles, and paved and unpaved road dust. $PM_{2.5}$ results from primary emission sources, condensation of semi-volatile organic gases, and from secondary formation from reactions of gases in the atmosphere. Small particles are also transported into the Lake Tahoe Basin, and the ambient concentration of $PM_{2.5}$ is highly dependent on meteorological conditions such as wind speed and mixing conditions.

MONITORING AND ANALYSIS

Monitoring Partners – Interagency Monitoring of Protected Visual Environments (IMPROVE), Tahoe Regional Planning Agency, Desert Research Institute and the Placer Air Quality Improvement District.

Monitoring Approach – Particulate matter is monitored at two sites around the Tahoe Region as part of a national network. These sites used the IMPROVE sampler, which is not a Federal Reference Method PM_2 sampler but is accepted for determining compliance with regional haze regulations.

Analytic Approach – Standard evaluation follows federal guidelines for attainment 24-hour $PM_{2.5}$ concentration (3-year average of the 98th percentile). 24-hour Trend was calculated using the Theil-Sen robust regression method at the Bliss State Park location. This location is the only one with a data period long enough to analyze trend (Theil 1950). Trend analysis of the resulting indicator values was performed by DRI under TRPA contract.

INDICATOR STATE

Status – At or somewhat better than target. Of all the monitoring stations where recent data is available that meets regulatory reporting requirements, the highest 3-year average of the 98th percentile 24-hour $PM_{2.5}$ concentration for 2014 was 31 ug/m^3 at Tahoe City, approximately 88 percent of the standard (Campbell 2015). Therefore, it is somewhat better than target. The monitoring station at D.L. Bliss has much lower 24-hour $PM_{2.5}$ concentrations and its highest average concentration was approximately 40 percent of the target during the current 2012 to 2015 monitoring period.

Trend – Little to no change. The trend line for the D.L. Bliss monitoring site, the only site with comparable data across a long time series, shows an increase in the 98th percentile 24-hour $PM_{2.5}$ concentration of 0.1 $\mu g/m^3$ per year, an increase of 0.3 percent per year relative to the standard of 35 $\mu g/m^3$ (Campbell 2015). Therefore, a trend of little to no change was determined.

Confidence –

Status – High. There is high confidence in the determination of status. The Tahoe City site which was used to determine status is now a Federal Reference Method (FRM) $PM_{2.5}$ sampler, and can be used to judge attainment of National Ambient Air Quality Standards (NAAQS) for $PM_{2.5}$. There was extensive testing of the samplers, and rigorous quality control procedures employed at the measurement laboratories.

Trend – Moderate. Confidence in the trend at the D.L. Bliss monitoring site is moderate with confidence in a trend of 70 percent (P = 0.30). Additionally, the D.L. Bliss site does not meet regulatory reporting requirements.

Overall Confidence – Moderate. Overall confidence takes the lower of the two confidence levels.

IMPLEMENTATION AND EFFECTIVENESS

Programs and Actions Implemented to Improve Conditions – Prescribed burning controls, residential woodstove replacement programs and emission standards, public transportation systems, pedestrian sidewalks and bikeways, automobile trip reduction programs, state and federal vehicle emission standards.

Effectiveness of Programs and Actions – The current status recorded at monitoring sites for this indicator suggests that programs and actions are effective at maintaining concentrations of $PM_{2.5}$ below the adopted standard. However, the very slight increasing trend at the D.L. Bliss site warrants continued monitoring and further corrective actions if the trend continues to increase. A 2014 study by the Desert Research Institute found that prescribed burns had the largest impact on PM 2.5 levels, but during the 2010-2011 sampling season, no exceedances for PM 2.5 were caused by prescribed burns at ambient monitoring sites around the Lake Tahoe Basin. ((Chen, L.-W. Antony et al. 2014)) This report laid out recommendations for further research and actions to further mitigate air quality impacts. TRPA will continue to work with partners to implement best practices for prescribed burns based on best available science.

Interim Target – Not applicable. Indicator is in attainment.

Target Attainment Date – Not applicable. Indicator is in attainment.

RECOMMENDATIONS

Analytic Approach – No changes recommended.

Monitoring Approach – It was suggested by peer reviewers that more attention and resources be paid to assess the impacts of prescribed burns on air quality in the Tahoe Basin.

Modification of the Threshold Standard or Indicator – No changes recommended.

Attain or Maintain Threshold – No changes recommended.

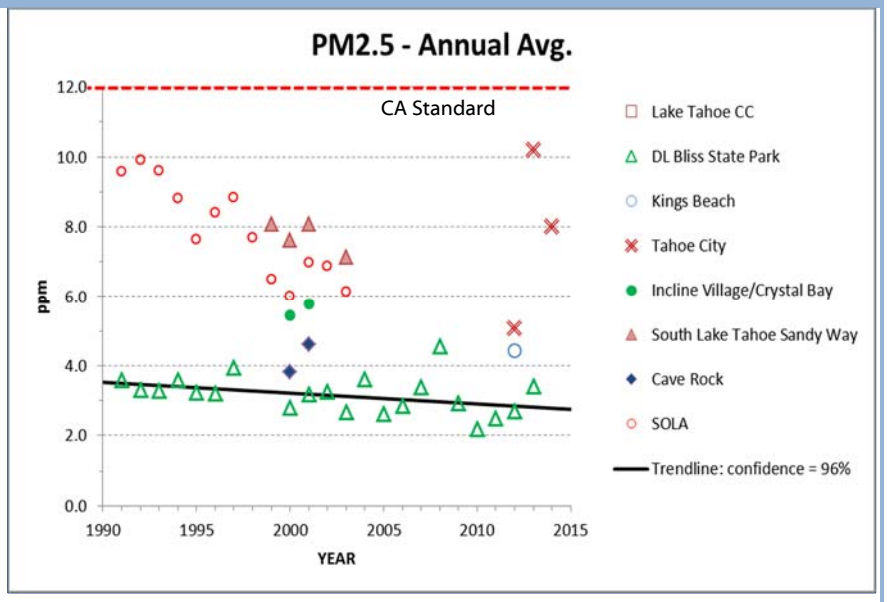
Respirable and Fine Particulate Matter: **Annual Average $PM_{2.5}$ Concentration**

Status

ANNUAL AVERAGE $PM_{2.5}$ CONCENTRATION

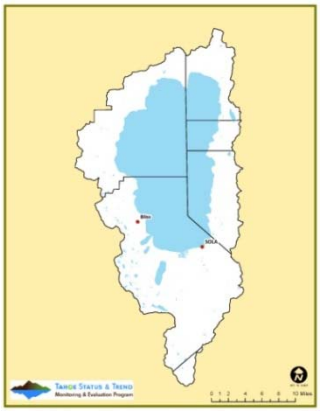
Status: **Considerably Better than Target**
Trend: **Little to No Change**
Confidence: **High**

Trend



Annual average $PM_{2.5}$ in the Tahoe Region from 1991 to present. Hollow symbols represent data that does not meet regulatory reporting requirements. The California standard of 12 µg/m³ is for the California portion of the basin. The Nevada standard of 15 µg/m³ is for the Nevada portion of the basin. Source: Desert Research Institute

Map



$PM_{2.5}$ monitoring locations in the Lake Tahoe Basin.

Data Evaluation and Interpretation

BACKGROUND

Relevance – This indicator addresses annual average $PM_{2.5}$ concentrations in the Lake Tahoe Region. Particulate matter less than or equal to 2.5 microns in size ($PM_{2.5}$) is extremely small and can be inhaled deep into the lungs, causing or aggravating asthma, lung diseases, and heart disease. Some particles pass into the bloodstream and some are considered carcinogens. Federal and state standards have been adopted to protect human health.

TRPA Threshold Category – Air Quality

TRPA Threshold Indicator Reporting Category – Respirable and Fine Particulate Matter

Adopted Standards – California portion of the basin: 12 µg/m³ annual concentration must not be exceeded; Nevada portion of the basin: 15 µg/m³, 3-year average of weighted annual mean concentration must not be exceeded.

Type of Standard – Numerical

Indicator (Unit of Measure) – Annual average $PM_{2.5}$ concentrations at any permanent monitoring station ($\mu g/m^3$).

Human & Environmental Drivers – The primary sources of $PM_{2.5}$ in the Lake Tahoe Region are residential fuel combustion, wood smoke from wildfires and prescribed fires, motor vehicles and paved and unpaved road dust. $PM_{2.5}$ results from both primary emissions ($PM_{2.5}$ directly emitted from sources) and from secondary formation from reactions of gases in the atmosphere. Small particles are also transported into the Lake Tahoe Region, and the ambient concentration of $PM_{2.5}$ is highly dependent on meteorological conditions such as wind speed, and mixing conditions.

MONITORING AND ANALYSIS

Monitoring Partners – Interagency Monitoring of Protected Visual Environments (IMPROVE), Tahoe Regional Planning Agency, Placer Air Quality Management District and the Desert Research Institute (DRI).

Monitoring Approach – Particulate matter is monitored at a variety of sites around the Tahoe Basin as part of a national network. These sites used the IMPROVE sampler, which is not a Federal Reference Method PM_2 sampler but is accepted for determining compliance with regional haze regulations.

Analytic Approach – Trend was calculated using the Theil-Sen robust regression method (Theil 1950). Trend analysis of the resulting indicator values was performed by DRI under TRPA contract.

INDICATOR STATE

Status – Considerably better than target. The highest annual average $PM_{2.5}$ concentration for 2014 at sites that met regulatory reporting requirements was 8 ug/m^3 at Tahoe City, 67 percent of the stricter California standard (Campbell 2015). Therefore, it is considerably better than target. Additionally, every other monitoring station and year during the current monitoring period 2012 to 2015 was similarly in attainment.

Trend – Little to no change. The trend line for the D.L. Bliss monitoring site (the only site with comparable data across a long time series) shows a tiny decrease in overall $PM_{2.5}$ concentrations of 0.03 $\mu g/m^3$ per year across the basin, a decrease of 0.3 percent per year relative to the California standard (Campbell 2015). Therefore, a trend of little to no change was determined.

Confidence –

Status – High. There is high confidence in the determination of status. The Tahoe City site which was used to determine status is now a Federal Reference Method (FRM) $PM_{2.5}$ sampler, and can be used to judge attainment of National Ambient Air Quality Standards (NAAQS) for $PM_{2.5}$. There was extensive testing of the samplers, and rigorous quality control procedures

Trend – High. Confidence in the trend line is "high" with confidence in a trend greater than 96 percent (P = 0.04). However, because data from the D.L. Bliss monitoring location that does not meet regulatory reporting requirements was used to assess trend, confidence is "moderate".

Overall Confidence – High.

IMPLEMENTATION AND EFFECTIVENESS

Programs and Actions Implemented to Improve Conditions – Prescribed burning controls, residential woodstove replacement programs and emission standards, public transportation systems, pedestrian sidewalks and bikeways, automobile trip reduction programs, state and federal vehicle emission standards.

Effectiveness of Programs and Actions – The current status and the stable and declining trend recorded at the D.L. Bliss monitoring site for this indicator suggest the programs and actions were effective at

controlling concentrations of $PM_{2.5}$. A 2014 study by the Desert Research Institute found that prescribed burns had the largest impact on PM 2.5 levels, but during the 2010-2011 sampling season, no exceedances for PM 2.5 were caused by prescribed burns at ambient monitoring sites around the Lake Tahoe Basin(Chen, L.-W. Antony et al. 2014). This report laid out recommendations for further research and actions to further mitigate air quality impacts. TRPA will continue to work with partners to implement best practices for prescribed burns based on best available science.

Interim Target – Not applicable. Indicator is in attainment.

Target Attainment Date – Not applicable. Indicator is in attainment.

RECOMMENDATIONS

Analytic Approach – A specific definition of how the indicator will be evaluated is needed. Potential options include:

1. Take the average of all monitoring stations during the current monitoring period (e.g. 2012 to 2015) and compare it to the standard,
2. Take the average readings of all monitoring stations during the most recent (e.g. 2015) monitoring period and compare it to the standard,
3. Report on the number of exceedances during the current monitoring period,
4. Report on the number of exceedances during the most recent monitoring period,
5. Use the highest reading from the current monitoring period and compare it to the standard, or
6. Use the highest reading from the most recent monitoring period and compare it to the standard. This is the current evaluation method.

Monitoring Approach – It was suggested by peer reviewers that more attention and resources be paid to assess the impacts of prescribed burns on air quality in the Tahoe Basin.

Modification of the Threshold Standard or Indicator – No changes recommended.

Attain or Maintain Threshold – No changes recommended.

Nitrate Deposition

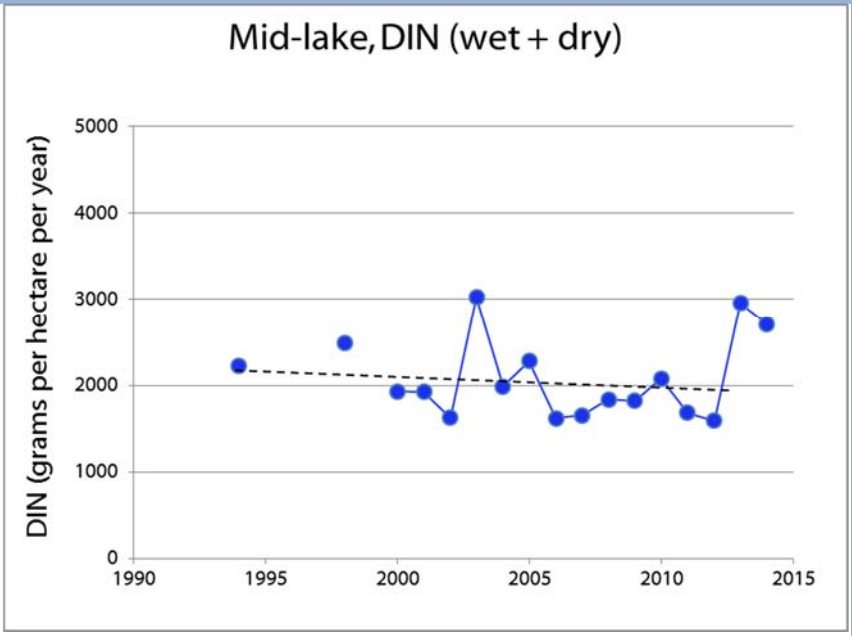
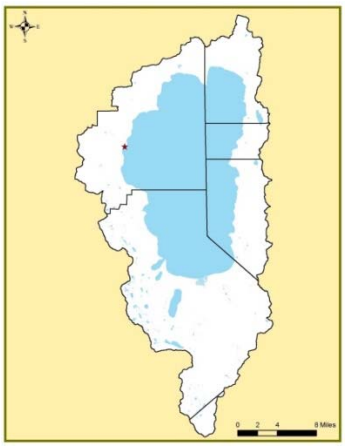
Nearly 78 percent of the air we breathe is nitrogen gas (N_2). Atmospheric N_2 is converted to nitrogen oxide by lightning, sunlight, and fossil fuel and biomass combustion. Industrial emissions and fossil fuel combustion contribute gaseous nitrous oxides and nitrate (as nitric acid) from sources sometimes hundreds of miles away. Excessive nitrate discharge into the air and subsequent deposition into water can negatively impact water quality. Atmospheric sources of biologically available forms of nitrogen have been linked to declines in lake transparency because different forms, such as nitrate and ammonium, provide nutrients for attached and free-floating algae ((TERC 2011)). Another nutrient of concern is phosphorous, which is found in the air in particulate form but has not been identified as a significant atmospheric source of lake transparency degradation ((Lahontan & NDEP 2010)). Because both gaseous nitric acid and particulate ammonium nitrate particles are small, less than 2.5 microns in diameter, they do not easily settle out of air. For this reason, they have also been linked to decreased visibility within the basin.

TRPA Resolution 82-11 identifies two standards for nitrate deposition regional visibility. These standards are:

1. Reduce the transport of nitrates into the Basin and reduce oxides of nitrogen (NOx) produced in the Basin consistent with the water quality thresholds.
2. Reducing vehicle miles traveled by 10 percent of the 1981 base values.

Both nitrate deposition standards are in attainment.

Management Standard Summary: **Nitrate Deposition**

Status	Trend
NITRATE DEPOSITION Status: **Implemented**	 Annual dissolved inorganic nitrogen "DIN" (NO3-N + NH4-N) loading at the mid-lake station Water Years 1994, 1998, 2000-2013. Red line is Generalized Additive Model (GAM) statistical line of fit r2 = 0.049, p=0.593. Trend for DIN is non-significant. Source: TERC 2015.
Map	
 Generalized location of Ward Creek nutrient deposition monitoring (red star). Source: TERC	

Data Evaluation and Interpretation

BACKGROUND

Relevance – Excessive nitrate discharge into the air and subsequent deposition into water can negatively impact air and water quality. Atmospheric sources of biologically available forms of nitrogen have been linked to declines in lake transparency because different forms, such as nitrate and ammonium, provide nutrients for attached and free-floating algae (TERC 2011). Because both gaseous nitric acid and particulate ammonium nitrate particles are small, less than 2.5 microns in diameter, they do not easily settle out of the air or water. For this reason, they have also been linked to decreased visibility within the basin.

TRPA Threshold Category – Air Quality and Water Quality

TRPA Threshold Indicator Reporting Category – Nitrate Deposition, Pelagic Lake Tahoe and Littoral Lake Tahoe

Adopted Standards – TRPA adopted two inter-connected management standards that address nitrate deposition, one under the air quality threshold category and one under the water quality threshold category. The air quality threshold standard states: "*Reduce the transport of nitrates into the basin and reduce oxides of nitrogen (NOx) produced in the basin consistent with the water quality thresholds.*" The threshold standard under the water quality threshold category is a management standard with a numeric target that states: "*Reduce direct dissolved inorganic nitrogen (DIN) load on Lake Tahoe from atmospheric sources by approximately 20 percent of the 1973-1981 annual average.*" The annual average loading level for dissolved inorganic nitrogen from the 1973 to 1981 was estimated at 40 to 66 metric tons per year ((TRPA 1982)). The accuracy of this estimate was not validated, thus, it is not a reliable target to assess attainment status.

Type of Standard – Management Standard

Indicator (Unit of Measure) – Attainment of the management standards was evaluated using the following two criteria:

- Has TRPA (or other agencies) adopted sufficient policies, ordinances, and programs in support of the management standards?
- Is there empirical evidence that demonstrates a reduction in nitrogen deposition into Lake Tahoe?

Human & Environmental Drivers – Natural sources of oxides of nitrogen, nitrate, and dissolved inorganic nitrogen include wildfire and transformation of nitrogen resulting from sunlight and electrical storms. Human-generated sources include the combustion of fossil fuels, fertilizers, and industrial emissions from outside of the basin.

MONITORING AND ANALYSIS

Monitoring Partners – This is an evaluation of a management standard. For detailed monitoring information on nitrogen deposition, see the water quality section.

Monitoring Approach – This is an evaluation of a management standard. For detailed monitoring information on nitrogen deposition, see the water quality section.

Analytic Approach – Not applicable.

INDICATOR STATE

Status – Implemented. Policies, ordinances and environmental improvements have been implemented. However, their effectiveness could not be demonstrated with available information. TRPA has adopted several policies to encourage reduction in air and water pollutants, including sources of nitrate and dissolved inorganic nitrogen deposition into Lake Tahoe. TRPA has adopted several policies ((TRPA 1986); (TRPA 1992)) that support the use of alternative modes of transportation to reduce atmospheric sources of air pollutants such as nitrate and improve air quality (e.g., bicycle and pedestrian facilities, public transportation, postal delivery, and waterborne transportation). The TRPA Code of Ordinances, Chapter 93, includes regulations requiring that combustion appliances and wood heaters meet emission standards. The TRPA Code of Ordinances also requires that potential air quality impacts from a project be addressed as a component of the environmental documentation and permitting process (see chapters 5 and 6).

For sources of nitrogen pollution associated with surface and groundwater, TRPA has adopted policies and ordinances to reduce nitrogen loads into Lake Tahoe ((TRPA 1986)). For example, TRPA requires that stormwater is infiltrated (treated) on-site for each developed parcel in the basin. Initiatives such as the

Lake Tahoe Total Daily Maximum Load program administered by the states of Nevada and California require local jurisdictions to demonstrate pollutant load reductions from various sources, including atmospheric sources. The Environmental Improvement Program (EIP) administered by the TRPA in partnership with state, federal, and local governments, has facilitated a number of projects that were designed to aid in achieving this standard. Numerous projects under the EIP, such as bicycle trails and the Heavenly Gondola Project, have been implemented to reduce dependency on private automobiles, and thus, reduce pollutant loads to Lake Tahoe.

The California Air Resources Board and U.S. Environmental Protection Agency continue to require vehicle manufacturers to equip new cars with sophisticated emission control systems. These systems generally include a "three-way" catalyst that converts carbon monoxide and hydrocarbons to carbon dioxide and water and also helps to reduce nitrogen oxides to elemental nitrogen and oxygen, as well as on-board computers and oxygen sensors to control tailpipe emissions.

Data from UC Davis Tahoe Environmental Research Center (TERC) shows the pattern for dissolved inorganic nitrogen (DIN) loading at mid-lake since 1994. There was no statistically significant trend for DIN in atmospheric deposition at mid-lake for water years 1994, 1998, and 2000-2013. DIN loads in many of the sampled water years were near the median estimated water year loading (1924.39 g ha-1 yr-1 or 5.27 g ha-1 d-1) with the exception of noticeable peaks in 2003 and 2013. A generalized additive model (GAM) analysis was done to look for trends in DIN through time. The results of the GAM analysis indicated there was no statistically significant trend for DIN in atmospheric deposition at mid-lake for the period of record at the $p \leq 0.05$ level ($r2 = -0.049$, $p=0.593$, $n=16$, $K=4$).

IMPLEMENTATION AND EFFECTIVENESS

Programs and Actions Implemented to Improve Conditions – Federal and state vehicle emission standards, state and local restrictions on open burning, TRPA policies and ordinances on land use, alternative fuels, postal service delivery, wood stove and gas-fired appliances, bicycle and pedestrian facilities, and public transit.

Effectiveness of Programs and Actions – Available information from TERC nutrient deposition monitoring at Ward Creek suggests there has been little or no statistical change in the amount of dissolved inorganic nitrogen (which include nitrate) deposited into Lake Tahoe annually, since the adoption of the TRPA Regional Plan and stricter vehicle federal and state emission standards and requirements.

RECOMMENDATIONS

Analytic Approach – No changes recommended.

Monitoring Approach – The estimate for nitrogen deposition Lake Tahoe is based primarily on monitoring at a single location on the Lake. Consideration should be given to assessing how representative the location is of the wider deposition patterns on the Lake, and monitoring nitrate deposition at multiple sites around the lake should be considered.

Modification of the Threshold Standard or Indicator – Objective determination of "attainment" status for management standards without a specific target can be challenging. The standard should be assessed against best practice for the establishment of standards and monitoring and evaluating indicators, and amended as necessary to improve the evaluability of the standard and the information it provides for management.

Attain or Maintain Threshold – Additional research is necessary to identify cost effective management actions to reduce atmospheric and other land-based sources of nitrogen reaching the lake.

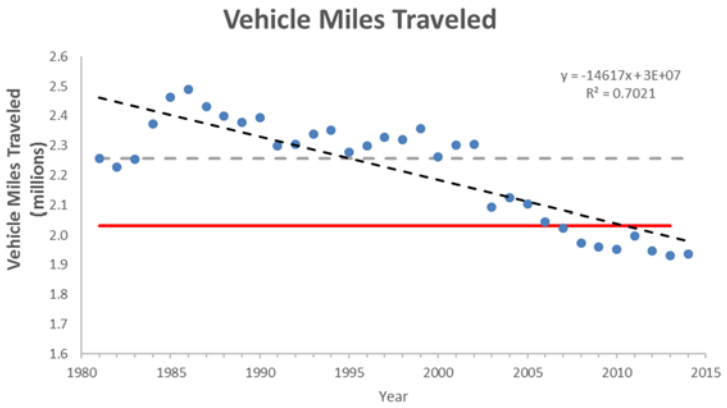
Nitrogen Deposition: **Vehicle Miles Traveled**

Status

VEHICLE MILES TRAVELED

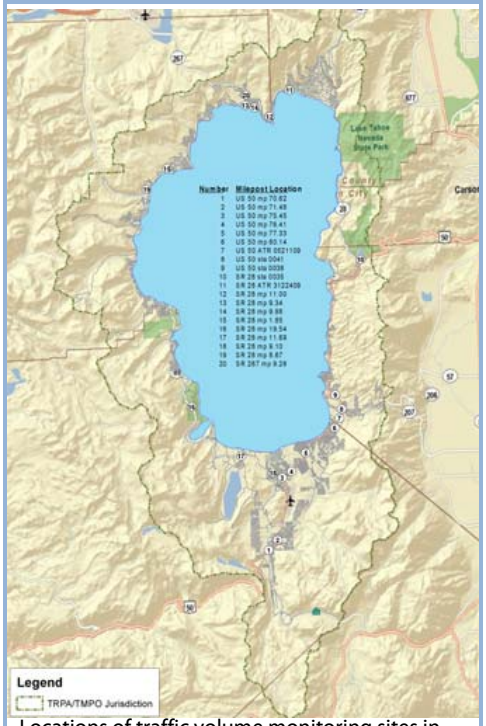
Status: **At or Somewhat Better than Target**
Trend: **Moderate Improvement**
Confidence: **Low**

Trend



Estimated annual vehicle mile travelled in the Tahoe Region 1981-2014. Source: TRPA TransCAD model using California Department of Transportation and Nevada Department of Transportation traffic counts.

Map



Locations of traffic volume monitoring sites in the Lake Tahoe Region.

Data Evaluation and Interpretation

BACKGROUND

Relevance – Vehicle miles traveled (VMT) is a proxy measure of the production of nitrates in the Region and the nitrogen deposition into lake Tahoe. Nitrogen, a nutrient promoting growth and reproduction of plants, is considered a pollutant of concern in the Lake Tahoe Basin (Lahontan & NDEP, 2010a).

TRPA Threshold Category – Air Quality

TRPA Threshold Indicator Reporting Category –Nitrate Deposition

Adopted Standards – Reduce vehicle miles of travel in the Basin by 10 percent of the 1981 base year values

Type of Standard – Management standard with a numeric target.

Indicator (Unit of Measure) – Peak day VMT.

Human & Environmental Drivers – VMT in the Region is a function of the complex interplay of a variety of factors including: population (both inside and outside the Region), gas prices, employment rates, local housing costs, demand and access for recreational opportunities in the Region, access to alternative forms of transportation, and secondary home ownership. Higher unemployment, higher fuel prices, increased congestion, work from home programs, employer car pool programs and concentration of development in centers are all linked with reductions in VMT. While population growth, higher household income, higher employment rates, increased fuel economy and greater roadway capacity are all linked to increasing VMT. Increasing access to transit services, access to bicycle and pedestrian facilities, and the relative desirability of alternative modes of transportation in comparison to the use of the personal automobile may reduce VMT.

MONITORING AND ANALYSIS

Monitoring Partners – TRPA, California Department of Transportation (Caltrans), and Nevada Department of Transportation (NDOT) and the Tahoe Regional Planning Agency.

Monitoring Approach –The identification of traffic volumes is a primary component towards tracking mobility with the Tahoe Region. Published traffic volumes are counted annually within the Lake Tahoe Region by both the California Department of Transportation (Caltrans) the Nevada Department of Transportation (NDOT) and local governmental jurisdictions. In addition to modeling compliance with the 1981 VMT Threshold, TRPA staff utilized the 1981 base year VMT estimate, and the corresponding traffic count stations that produce annual traffic counts to analyze increases or decreases in VMT.

Analytic Approach – Unlike traffic counts, which can precisely measure the number of cars passing through a specific location, all measures of VMT are approximations of actual vehicle miles traveled by automobiles in the Region. Vehicle miles traveled was estimated for 2014 using a sophisticated tour-based transportation model (TransCAD). The model uses a spatial representation of the Region's road network and parameters such as residential housing units, seasonal housing units, persons per household, income, hotel rooms and their occupancy rates, school enrollment, campgrounds and their occupancy rates, and employment to estimate VMT. Since 1981, the TRPA has used a series of progressively more sophisticated models to estimate VMT. As the VMT models improved, current day modelled VMT estimate comparisons with previous year VMT model estimates are not possible because different input parameters are used and mapped traffic zones are different. VMT estimates are calibrated with Caltrans and NDOT traffic count data. These count stations have been used consistently as a standard to calibrate previous modeled VMT estimates and give us a good understanding.

INDICATOR STATE

Status – At or somewhat better than target. In 2014, the most recent year where traffic modeling was available, there was an estimated 1,937,070 VMT, which is approximately 95 percent of the target. Therefore, a status of at or somewhat better than target was determined. This indicator has been in attainment since 2006.

Trend – Moderate improvement. The long-term trend line shows an annual decrease of 0.7 percent per year in relation to the standard of 2,030,938 VMT per year. Therefore, a determination of moderate

improvement was determined.

Confidence –

Status – Moderate. VMT data is collected and modelled following standardized procedures based on data from a wide variety of traffic sensors.

Trend – Low. There is high confidence in traffic data collected by Caltrans and NDOT that has been collected since 1981. The TransCAD model has been used to estimate VMT since 2005, and there is relatively high confidence in model output. Model output is calibrated to the Caltrans and NDOT traffic data further increasing confidence in the VMT estimates. However, over the course of the last 25 years, TRPA has used a series of progressively more sophisticated models to estimate VMT. VMT model improvement has been accompanied by a change in the suite of parameters used to estimate VMT. Change in the parameters required by the model to estimate VMT has precluded the use of the current model to back-cast VMT estimates for earlier periods, because of parameter availability. The low confidence in trend determination reflects lower confidence in VMT estimates prior to 2005.

Overall Confidence – Low. Overall confidence takes the lower of the two confidence determinations.

IMPLEMENTATION AND EFFECTIVENESS

Programs and Actions Implemented to Improve Conditions –The 2012 regional plan update contains incentives to cluster population and employment in relatively compact town centers that are well served by transit, pedestrian and bicycle infrastructure. Thoughtful land-use planning is central element of TRPA's growth management system and an important strategy used to attain the VMT and other thresholds. The Transfer of Development Rights Program (TDR) program provides incentive to transfer coverage development rights from sensitive lands and remote areas into less sensitive lands located in town centers. Within the program, if 10 tourist accommodation units (TAUs) were removed from a SEZ and transferred to a town center, an additional 20 TAUs would be awarded for this transfer, for a total of 30 TAUs (i.e. 1:3 transfer ratio). As part of the 2015 strategic initiative to review the commodities system and TDR program, TRPA is working with stakeholders to improve the program and accelerate transfers and implementation of the regional plan.

Since 2010 partners in the basin have, built over 30 miles of bicycles and pedestrian facilities, constructed 18 bus-shelters, revitalized street corridors and created new public spaces. Land-use planning, Public transportation systems, pedestrian sidewalks and bikeways projects, automobile trip reduction programs and transportation improvement projects such as the Heavenly Gondola project all contribute to reducing VMT in the Region.

Effectiveness of Programs and Actions – The status and trend in estimated VMT suggest that current programs and policies are mostly effective in reducing VMT. Lagging economic conditions and recent low-snow winters likely also contributed to lower VMT.

Interim Target – Not applicable. Indicator is in attainment.

Target Attainment Date – Not applicable. Indicator is in attainment.

RECOMMENDATIONS

Analytic Approach – No changes recommended.

Monitoring Approach – No changes recommended.

Modification of the Threshold Standard or Indicator – As fuel mix technology, vehicle emissions standards, and overall fuel economy of the nation's vehicle fleet improve, the relationship between VMT and NOx emissions has evolved. Nationally, VMT continues to increase while NOx emissions have drastically declined. On average, NOx emissions have decreased from 3.6 grams/mile in 1955 to 0.217 grams/mile in 2013, and are forecast to be 0.13 grams/mile in 2020. Consistent with the

recommendations of past threshold evaluation report, the link between the standard and the desired conditions should be assessed to ensure that it is still the appropriate air quality measure.

Recommended actions to Attain or Maintain Threshold – Continue to implement the policies in the regional plan update and the regional transportation plan project list, which contains over 100 projects designed to reduce VMT and promote other threshold gains.

Air Quality: **Odor**

Status

ODOR

Status: **Implemented**

Data Evaluation and Interpretation

BACKGROUND

Relevance – Air quality conditions in the Lake Tahoe Region can affect human health, visibility, forest health, and the clarity of Lake Tahoe. Motor vehicle emissions are one of the primary factors influencing air quality conditions. To address environmental and human health concerns from vehicle emissions, specifically fumes attributed to diesel engines, TRPA adopted ordinances in 1987 that regulate motor vehicle "odor" in the basin. According to the odor policy statement, "*...it is a policy of the TRPA Governing Board in the development of the Regional Plan to reduce fumes from diesel engines to the extent possible."*

TRPA Threshold Category – Air Quality

TRPA Threshold Indicator Reporting Category – Odor

Adopted Standards – It is the policy of the TRPA Governing Board in the development of the Regional Plan to reduce fumes from diesel engines to the extent possible.

Type of Standard – Policy statement

Indicator (Unit of Measure) – This policy statement was evaluated by determining whether TRPA and other agencies have adopted sufficient policies, ordinances, and programs in support of the odor threshold policy statement.

Human & Environmental Drivers – The main concern of TRPA when It comes to odor is the odors caused by vehicles, especially exhaust from diesel vehicles.

MONITORING AND ANALYSIS

Monitoring Partners – Not applicable. No monitoring occurs.

Monitoring Approach – Not applicable. No monitoring occurs.

Analytic Approach – This policy statement was evaluated by determining whether TRPA and other agencies have adopted sufficient policies, ordinances, and programs in support of the odor threshold

policy statement.

INDICATOR STATE

Status – Implemented. The odor threshold standard was determined to be implemented. A review of the current adopted policies, ordinances, and rules of TRPA, state and federal agencies has found support of the policy statement. These agencies have adopted policies and measures that address diesel odor. However, because no monitoring occurs, it is not possible to say whether or not these policies, ordinances, and rules are having their intended effect.

IMPLEMENTATION AND EFFECTIVENESS

Programs and Actions Implemented to Improve Conditions – TRPA policies, ordinances, and programs: support for attainment of this policy statement is comprised of adopted policies and ordinances. This policy is a component of transportation control measures in the Regional Transportation Plan, and *"…limits vehicle idling in the Region."*[3] More specifically, this policy refers to components adopted in the TRPA Code of Ordinances, Chapter 91, which addresses vehicle idling restrictions, exemptions, and compliance programs. The relevant code is cited below. These ordinances are implemented at the project scale through the project review process.

91.7 Idling Restrictions: A program to control extended vehicle idling is a Reasonably Available Control Technology in the Clean Air Acts of 1977, and is a contingency measure in the 1992 Air Quality Plan for the Lake Tahoe Basin.

91.7A Duration: No person shall control a combustion engine in a parked auto, bus, or boat to idle for more than 30 consecutive minutes in the following Plan Areas: 070A, 080, 089A, 089B, 090, 091, and 092. The following projects and activities are not subject to this limitation:

(1) Activities specifically permitted, after environmental impact analysis, to idle more than 30 minutes

(2) Emergency vehicles, snowplows, or combustion engines required in the case of emergencies or repair

(3) Vehicles in transit on public rights of way

91.7B Drive-Up Windows: New drive-up windows are prohibited.

91.7C Compliance Program: TRPA shall implement the provisions of Subsection 91.7.A primarily through educational programs, notification programs, and cooperative arrangements with charter operators, property owners in the affected plan areas, and local government. As appropriate, TRPA may take direct action to obtain compliance with this section, including, but not limited to, actions under Chapter 8 and 9 of the Code.

According to the adopted ordinance found in the TRPA Code of Ordinances, a compliance program addressing the idling restriction shall be implemented *"…primarily through educational programs, notification programs, and cooperative arrangements with charter operators, property owners in the affected plan areas, and local government."* According to TRPA's Long Range and Transportation Planning Division, the agency continuously works with local public transportation providers to fund and support the purchase of alternative fuel buses in support of this ordinance. Because of more stringent state and federal policies and tail-pipe emission standards, and ordinances and programs that reduce diesel emissions, it was found that TRPA should focus on this type of policy support, instead of focusing on

[3] *Transportation Control Measures of the Regional Transportation Plan*

specific education and outreach programs.

There are currently no monitoring efforts underway that could be used to assess the effectiveness of implemented TRPA policies and ordinances on diesel emissions. However, stringent state and federal measures and programs have been shown to be effective in reducing odor emissions.

State and Federal Odor Reduction Measures- Adopted in 1988, California diesel fuel regulations set limits on aromatic hydrocarbon content (10 percent by volume) and on sulfur content (500 parts per million by weight, ppmw). These regulations, in effect since 1993, reduce emissions from diesel engines and equipment as follows:

- 7 percent less oxides of nitrogen (NOx)
- 25 percent less particulate matter (PM)
- 80 percent less sulfur oxides (SO_2) and several other toxic substances such as benzene and polynuclear aromatic hydrocarbons (PAHs)

The California Air Resources Board (CARB) and the U.S. Environmental Protection Agency (EPA) implemented a stricter "low sulfur" diesel fuel restriction requiring a sulfur level of 15 ppmw or less beginning in 2007 (phase-in schedule 2007-2010). CARB is also responsible for an anti-idling rule, specifically applying to drivers of diesel-fueled commercial vehicles with a gross weight rating of more than 10,000 pounds. The anti-idling rule imposes a five-minute idling limit for these vehicles at any location in California. Lastly, the rule requires all 2008 and newer model-year diesel engines *"…either be equipped with a non-programmable automatic engine shutdown system that shuts the idling engine down after a minimum period of time or must be certified to a NOx idling emission standard of 30 grams per hour*." Exceptions to these idling restrictions include school buses, recreational vehicles, and military vehicles.

The following odor reduction measures have been implemented specifically by CARB:

- *CARB Specific Diesel Emission Reduction Measures*: The identification of diesel particulate matter (PM) as a toxic air contaminant in 1998 led CARB to adopt the Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles in September 2000.
- *Fleet Rule for Transit Agencies (adopted 2000):* This regulation cuts NOx and PM emissions from approximately 10,000 buses operated by transit agencies. The fleet rule for transit agencies moves forward in steps over 10 years, requiring cleaner engines, cleaner fuel, and retrofitting of older buses. Amendments proposed for 2004 will require transit agencies to clean up the buses that had not been covered in the original rule.
- *School Bus Idling Restrictions (adopted 2002):* To reduce the exposure of children to toxic PM emissions, CARB enacted a rule to stop the prolonged idling of diesel school buses and other diesel vehicles near schools. Buses and commercial diesel vehicles are required to turn off their engines after arriving at a school and are allowed to start the engine no more than 30 seconds before departing, unless required for safety or work.
- *Stationary Engines (adopted 2004):* There are approximately 26,000 stationary diesel-fueled engines in California. Most are used as emergency backup in the event of a power failure. Others are used to pump water in agricultural areas, to run compressors, cranes and other equipment. New CARB standards for these engines will bring an approximate 80 percent PM reduction by 2020 through stricter standards for new engines and requirements to retrofit existing engines.
- *Transport Refrigeration Units (adopted 2004):* Transport refrigeration units (TRUs) are diesel-powered units that cool temperature-sensitive products while they are being

shipped in trucks, trailers, shipping containers and rail cars. Although the diesel engines powering TRUs tend to be relatively small, there are about 40,000 of them operating in California. Their PM emissions will be reduced by 65 percent by 2010 and by 92 percent by 2020.

In addition to regulations and standards for diesel engine emissions, the U.S. EPA has developed assistance programs that award funding for clean diesel projects and technologies. As part of the Energy Policy Act of 2005, the Diesel Emissions Reduction Act (DERA) authorizes funding of up to $200 million annually to help fleet owners reduce diesel emissions.

Additional Reductions Attributed to State and Federal Measures – As a result of the "low sulfur" diesel fuel restriction implemented in 2007, which required a diesel fuel sulfur level of 15 ppmw or less, refiners began producing cleaner burning fuels beginning in 2006. The EPA estimates that 2.6 million tons of smog-causing nitrogen oxide emissions will be reduced each year, with particulate matter being reduced by 110,000 tons a year. In addition, this diesel fuel requirement substantially decreases negative health effects associated from these harmful emissions. According to the U.S. EPA, *"…an estimated 8,300 premature deaths, 5,500 cases of chronic bronchitis and 17,600 cases of acute bronchitis in children will be prevented annually,"* with an additionally estimated "*...360,000 asthma attacks and 386,000 cases of respiratory symptoms in asthmatic children also avoided every year*" (EPA's Office of Transportation and Air Quality 2016)

Effectiveness of Programs and Actions – Because no actual odor monitoring occurs, it is not possible to say whether or not these policies, ordinances, and rules are having their intended effect.

RECOMMENDATIONS

Analytic Approach – No changes recommended.

Monitoring Approach – One peer reviewer suggested TRPA initiate an odor "hotline" to track odor complaints. The number of complaints was suggested as a way to track the status and trend of odor over time. This recommendation should be considered during the threshold review process.

Modification of the Threshold Standard or Indicator – Resolution 82-11 intended that policy statements be incorporated into the TRPA Regional Plan. This evaluation demonstrates that TRPA and other agencies have incorporated and supported the policy statement. Consequently, it is recommended that this policy statement be removed from the list of adopted threshold standards in Resolution 82-11, or translated into a numerical standard for which an objective determination of status can be determined. For example, TRPA could instead use applicable ambient air quality standards for NO_x, SO_2, CO and PM that are directly related to diesel engine emissions to measure attainment with the diesel odor standard.

Attain or Maintain Threshold – No changes recommended.

Chapter 3 Air Quality References

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