SAN JOSÉ GENERAL PLAN 4-YEAR REVIEW – MOBILE AIR QUALITY AND GREENHOUSE GAS EMISSIONS ASSESSMENT

San José, California

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Introduction

This report computes changes in air pollutant and greenhouse gas (GHG) emissions for the City of San José that is associated with the long-range transportation planning. The City's long-range transportation analysis completed for the City of San José 2020 General Plan 4-Year Review of the Envision San José 2040 General Plan was used in this emissions assessment. This transportation analysis examines baseline conditions for 2015 and 2040 Envision San José 2040 General Plan travel conditions in terms of trips and vehicle miles travelled. Recommendations of the Envision Task Force related to Growth Areas, horizon phasing, vehicle miles traveled (VMT), and affordable housing are incorporated into the transportation analysis and forecasted for 2040 as "Project" conditions.

A Major Strategy of the General Plan is to focus new growth capacity in specifically identified "Growth Areas," while most of the City is not planned for additional growth or intensification. This approach reflects the built-out nature of San José, the limited availability of additional infill sites for development compatible with established neighborhood character, and the emphasis in the General Plan to reduce environmental impacts while fostering transit use and walkability.

The proposed project would add new Growth Areas to, and eliminate other Growth Areas from, the General Plan while maintaining the overall citywide growth capacity of 382,000 jobs and 120,000 residential units.

From an air quality and GHG perspective, these changes primarily affect mobile emissions since they do not change the number of residential units or jobs. These changes will affect the number of vehicle trips, change the VMT and change the speed characteristics associated with VMT. This report focuses on predicting the change in emissions associated with this 4-year General Pan Review Update (i.e., the Project).

Air Pollutants of Concern

High ozone levels are caused by the cumulative emissions of reactive organic gases (ROG) and nitrogen oxides (NO_X). These precursor pollutants react under certain meteorological conditions to form high ozone levels. Controlling the emissions of these precursor pollutants is the focus of the Bay Area's attempts to reduce ozone levels. The highest ozone levels in the Bay Area occur in the eastern and southern inland valleys that are downwind of air pollutant sources. Particulate matter is another problematic air pollutant of the Bay Area. Particulate matter is assessed and measured in terms of respirable particulate matter or particles that have a diameter of 10 micrometers or less (PM_{10}) and fine particulate matter where particles have a diameter of 2.5 micrometers or less ($PM_{2.5}$). Elevated concentrations of PM_{10} and $PM_{2.5}$ are the result of both region-wide (or cumulative) emissions and localized emissions. The specifics of each of these pollutants are discussed below.

Ozone

Ground-level ozone is the principal component of smog. Ozone is not directly emitted into the atmosphere, but instead forms through a photochemical reaction of ROG and nitrogen oxides, which are known as ozone precursors. Ozone levels are highest from late spring through autumn when precursor emissions are high and meteorological conditions are warm and stagnant. Motor vehicles create the majority of ROG and NOx emissions in California. Exposure to levels of ozone above current ambient air quality standards can lead to human health effects such as lung inflammation and tissue damage and impaired lung functioning. Ozone exposure is also associated with symptoms such as coughing, chest tightness, shortness of breath, and the worsening of asthma symptoms[1]. The greatest risk for harmful health effects belongs to outdoor workers, athletes, children, and others who spend greater amounts of time outdoors during periods of high ozone levels.

Particulate Matter

Particulate matter (PM) is a complex mixture of tiny particles that consists of dry solid fragments, solid cores with liquid coatings, and small droplets of liquid. These particles vary greatly in shape, size, and chemical composition, and can be made up of many different materials such as metals, soot, soil, and dust. Particles 10 microns or less in diameter are defined as "respirable particulate matter" or "PM_{10}." Fine particles are 2.5 microns or less in diameter ($PM_{2.5}$) and, while also respirable, can contribute significantly to regional haze and reduction of visibility. Inhalable particulates come from smoke, dust, aerosols, and metallic oxides. Although particulates are found naturally in the air, most particulate matter found in the vicinity of the project site is emitted either directly or indirectly by motor vehicles, industry, construction, agricultural activities, and wind erosion of disturbed areas. Most $PM_{2.5}$ is comprised of combustion products such as smoke. Extended exposure to PM can increase the risk of chronic respiratory disease[2, 3]. PM exposure is also associated with increased risk of premature deaths, especially in the elderly and people with pre-existing cardiopulmonary disease.

Carbon Monoxide

Carbon monoxide, or CO, is a public health concern because it combines readily with hemoglobin in the bloodstream, reducing the amount of oxygen transported by blood[4]. Motor vehicles are the dominant source of CO emissions in most areas. High CO levels develop primarily during winter, when high emissions and light winds combine with strong ground-level temperature inversions (typically between evening and early morning). These conditions result in reduced dispersion of vehicle emissions. Also, motor vehicles emit CO at higher rates when air temperatures are low. Because CO levels are found at relatively low levels throughout the Bay Area and show no evidence of increasing, the region is considered attainment and CO is not a pollutant of concern for land use environmental analyses.

Nitrogen Dioxide

Nitrogen dioxide (NO_2) is an essential ingredient in the formation of ground-level ozone pollution. NO_2 is a portion of NOx emitted from high-temperature combustion processes, such as those occurring in trucks, cars, and power plants. Home heaters and gas stoves also produce NO_2 in indoor settings. Besides causing adverse health effects, NO_2 is responsible for the visibility

[1] BAAQMD 2017. CEQA Air Quality Guidelines. May.
[2] BAAQMD 2016. Planning Healthy Places. May Accessed at http://www.baaqmd.gov/~/media/files/planning-and-research/planning-healthy-places/php_may20_2016-pdf.pdf?la=en on August 24, 2016
[3] BAAQMD 2017. CEQA Air Quality Guidelines. May.
[4] BAAQMD 2017. CEQA Air Quality Guidelines. May.

reducing reddish-brown tinge seen in smoggy air in California. NO_2 is a reactive, oxidizing gas capable of damaging cells lining the respiratory tract. Studies suggest that NO_2 exposure can increase the risk of acute and chronic respiratory disease.[5] Given the lack of pollution sources and history of ambient air monitoring results, NO_2 is not an air pollution concern in the North Coast Air Basin.

Sulfur Dioxide

Sulfur dioxide is a colorless gas with a strong odor. It can damage materials through acid deposition. It is produced by the combustion of sulfur-containing fuels, such as oil and coal. Refineries, chemical plants, and pulp mills are the primary industrial sources of sulfur dioxide emissions. Sulfur dioxide concentrations in the Bay Area, especially this portion of the region, are well below the ambient standards and are not a concern for land use air quality studies. Adverse health effects associated with exposure to high levels of sulfur dioxide include irritation of lung tissue, as well as increased risk of acute and chronic respiratory illness.[6]

Lead

Lead occurs in the atmosphere as particulate matter. It was primarily emitted by gasoline-powered motor vehicles, although the use of lead in fuel has been virtually eliminated. As a result, levels throughout the State have dropped dramatically and lead is not an air pollutant of concern for land use air quality studies.

Greenhouse Gases

Climate change is caused by greenhouse gases (GHGs) emitted into the atmosphere around the world from a variety of sources, including the combustion of fuel for energy and transportation, cement manufacturing, and refrigerant emissions. GHGs are those gases that have the ability to trap heat in the atmosphere, a process that is analogous to the way a greenhouse traps heat. GHGs may be emitted as a result of human activities, as well as through natural processes. GHGs have been accumulating in the earth's atmosphere at a faster rate than has occurred historically. Increasing GHG concentrations in the atmosphere are leading to global climate change.

Carbon dioxide (CO_2) is the most important anthropogenic GHG because it comprises the majority of total GHG emissions emitted per year and it is very long-lived in the atmosphere. Common GHGs include carbon dioxide, methane, nitrous oxides, and halocarbons (a group of gases containing fluorine, chlorine, or bromine). Typically, when evaluating GHG emissions they are expressed as carbon dioxide equivalents, or CO_2e, which is a means of weighting the global warming potential (GWP) of the different gases relative to the global warming effect of CO_2, which has a GWP value of one. Other GHGs, such as methane and nitrous oxide which are commonly found in the atmosphere, but at much lower concentrations, have a GWP of 21 and 310, respectively. In the United States, CO_2 emissions account for about 85 percent of the CO_2e emissions, followed by methane at about eight percent and nitrous oxide at about five percent.

[5] BAAQMD 2017. CEQA Air Quality Guidelines. May.
[6] *Ibid.*

Mobile Emissions Modeling

Emissions modeling was conducted by combining forecasted traffic activity with emissions rates. Traffic forecasted activity was based on traffic information for vehicle trips and VMT provided by *Hexagon Transportation Consultants, Inc*. For this analysis, Hexagon specifically provided VMT data by 5 miles-per-hour (mph) speed bins for each evaluated scenario. Mobile emissions are predicted in the following steps:

1. Trip end emissions that include start and idle emissions;
2. Running emissions that include tailpipe exhaust for all pollutants and GHG;
3. Running evaporative losses for ROG;
4. Brake and tire wear for PM_{10} and $PM_{2.5}$; and
5. Re entrained roadway dust for PM_{10} and $PM_{2.5}$.

<u>Travel Forecast Data</u>

Trip end and idle emissions are forecasted using vehicle trip data. Trip generation for this project involves estimating the number of trips that would occur with the proposed General Plan land uses. Hexagon provided trip generation based on the City’s Travel Demand Forecasting (TDF) model trip generation formulas that are based on the Metropolitan Transportation Commission (MTC) regional travel demand model. Trip generation is estimated based on the type and amount of specific land uses within each travel analysis zone (TAZ). The TDF model produces trip estimates in person trips (as opposed to vehicle trips, which are typically used in near-term traffic analyses). This analysis uses the vehicle trips derived by Hexagon from these data as reported in Table 1. The redistribution of these trips will change both travel distances and travel speed. Hexagon provided the distribution of VMT by speed and time. These data are summarized daily in Table 2.

Growth in San José between 2015 and 2040 is forecasted to increase both the number of vehicles trips and VMT. The number of daily vehicle trips is forecasted to increase by 48 percent for the existing General Plan and 44 percent under the proposed General Plan. The proposed General Plan is forecasted to generate less vehicle trips than the existing General Plan but increased transit, bicycle, and pedestrian trips. The existing General Plan is forecasted to increase VMT by 60 percent, while the proposed General Plan would increase VMT by 58 percent. While VMT decreases overall with the proposed General Plan, it is important to note that overall travel speeds will decrease. This is illustrated in Table 2 where the proposed General Plan would have higher VMT in the 0-5, 5-10 and 10-15 mph speed bins. This is important to note because vehicle emissions are sensitive to travel speed.

The increase in trips and VMT occurs while the service population (residents plus jobs) increases by 47 percent under both scenarios. The population in San José is anticipated to increase by 27 percent. In either the existing or the proposed General Plan, VMT is forecasted to increase at a greater rate than service population and residential population.

Emission Factors

Vehicle emission factors were computed using the California Air Resources Board (CARB) Emission Factor (EMFAC) model, Version EMFAC2021v1.0.1. The project-level (PL) web tool provided emission rates under customized meteorological conditions (temperature and relative humidity) and default traffic mix of vehicle types for Santa Clara County. This tool provides trip start/end, idle, and running emissions.

EMFAC2021 is the latest emission inventory model that CARB uses to assess emissions from on-road motor vehicles including cars, trucks, and buses in California, and to support CARB's planning and policy development.[7] This newest model reflects CARB's current understanding of statewide and regional vehicle activities, emissions, and recently adopted regulations such as Advanced Clean Trucks (ACT) and Heavy-Duty Omnibus regulations. It represents the next step forward in the ongoing improvement for predicting statewide mobile emissions using the continuously updated EMFAC model.

EMFAC computes emission rates for criteria air pollutants or their precursors and the primary GHGs associated with traffic. Emissions are predicted for various vehicle categories (i.e., light duty passenger vehicles, trucks, buses, etc.), different vehicle technologies (i.e., gasoline, diesel, hybrid, compressed natural gas, electric), different operating conditions (i.e., speed), different geographical areas, and different meteorological conditions (i.e., temperature and humidity).

Table 1. Trip Generation by Travel Mode

Travel Mode	Year 2015 Baseline Trips	Year 2040 Current GP Trips	Year 2040 Proposed GP Trips
Drive Alone	753,264	1,092,462	1,064,205
Carpool	114,022	192,562	187,434
Transit	48,181	182,827	206,582
Bicycle	14,120	26,337	28,645
Walk	15,666	29,451	33,584

[7] CARB. 2021. EMFAC2021 Volume III Technical Document, Version 1.0.1. April (see https://arb.ca.gov/emfac/)

Table 2. Daily VMT Distributed by Speed

Speed Bin (in mph)	Baseline	2040 Existing GP	2040 4-Year Review
0-5	55,363	183,697	223,310
5-10	50,288	672,895	794,096
10-15	208,523	1,767,565	1,811,406
15-20	992,072	3,346,421	3,296,454
20-25	3,256,825	5,727,685	5,642,599
25-30	3,155,151	4,713,070	4,405,837
30-35	1,538,185	2,370,588	2,293,899
35-40	1,049,346	1,431,962	1,501,255
40-45	1,070,317	1,447,049	1,383,446
45-50	841,415	1,056,209	970,069
50-55	1,028,006	1,132,093	1,192,642
55-60	2,543,837	2,476,262	2,472,209
60-65	1,715,760	1,710,012	1,699,510
65-70	-	-	-
>70	-	-	-
TOTAL	17,505,088	28,035,508	27,686,732

Modeled Mobile Emissions

The trip and idle emissions output from EMFAC2021 are emissions that apply to each trip. These emissions along with the number of vehicle trips are shown in Table 3.

Table 3. Daily Trip and Idle Emissions (tons/day)

	Measure	2015 Baseline	2040 Existing GP	2040 Proposed GP
Trip Source Vehicle Emissions	Daily Trips (personal vehicles)	867,286	1,285,024	1,251,639
		Change from 2015	417,738	384,353
		Change from Existing GP		-33,385 trips
	PM2.5 (ton/day)	0.00031	0.00123	0.00120
		Change from 2015	0.0009	0.0009
		Change from Existing GP		-0.00 tons/day **-0.00 tons/year**
	PM10 (ton/day)	0.00034	0.0013	0.0013
		Change from 2015	0.0010	0.0010
		Change from Existing GP		-0.00 tons/day **-0.00 tons/year**
	NOx (ton/day)	0.1082	0.3238	0.3154
		Change from 2015	0.2155	0.2071
		Change from Existing GP		-0.01 tons/day **-0.30 tons/year**
	CO (ton/day)	0.8799	2.7002	2.6301
		Change from 2015	1.8204	1.7502
		Change from Existing GP		-0.07 tons/day **-2.53 tons/year**
	ROG (ton/day)	0.2270	1.2206	1.1889
		Change from 2015	0.9936	0.9619
		Change from Existing GP		-0.03 tons/day **-1.14 tons/year**
	CO2e (MT/Day)	15.66	84.30	82.11
		Change from 2015	68.65	66.46
		Change from Existing GP		-2.19 MT/day **-78.85 MT/year**

For running exhaust and brake wear, EMFAC2021 provides emission rates for each speed bin (5-mph increment). The California Department of Transportation (Caltrans) has developed their version of EMFAC, with the latest version being Ct-EMFAC2017. This model combines vehicle activity in terms of VMT by speed bin with the appropriate emission factors from EMFAC. The latest version of Ct-EMFAC is based on the older EMFAC2017 model. Therefore, the emission rate output generated by Ct-EMFAC2017 were replaced with EMFAC2021 output rates. The Ct-EMFAC model then combined the emission rates output with the vehicle activity (i.e., VMT by speed bin) to predict daily running emissions. Table 4 summarizes the running emissions associated with the General Plan.

Table 4. Daily Running Emissions and Annual Change

	Measure	2015 Baseline	2040 Existing GP	2040 Proposed GP
Emissions from VMT (tailpipe, tire and brake wear, and re entrained roadway dust)	Daily VMT in miles per day	17,505,088	28,035,508	27,686,732
		Change from 2015	10,530,420	10,181,644
		Change from Existing GP	-348,776 miles/day	
	PM2.5 (ton/day)	1.1479	2.3072	2.3069
		Change from 2015	1.1593	1.1590
		Change from Existing GP	-0.00 tons/day **-0.01 tons/year**	
	PM10 (ton/day)	6.3060	14.3343	14.3446
		Change from 2015	8.0282	8.0386
		Change from Existing GP	0.01 tons/day **+0.37 tons/year**	
	NOx (ton/day)	9.8210	3.0391	3.0423
		Change from 2015	-6.7819	-6.7787
		Change from Existing GP	0.00 tons/day **+0.11 tons/year**	
	CO (ton/day)	39.0527	17.8173	17.6561
		Change from 2015	-21.2354	-21.3966
		Change from Existing GP	-0.16 tons/day **-5.80 tons/year**	
	ROG (ton/day)	2.2706	1.0289	1.0223
		Change from 2015	-1.2417	-1.2483
		Change from Existing GP	-0.01 tons/day **-0.24 tons/year**	
	CO2e (MT/Day)	7,254	9,408	9,353
		Change from 2015	2,154	2,098
		Change from Existing GP	-55.67 MT/day **-2,000.23 MT/year**	

The combination of trip, idle, and running emissions are summarized in Table 5. Emissions are shown in tons per year, assuming 365-day operation and pounds per day.

Emissions of the ozone precursor pollutants, ROG, and NOx will decrease under both General Plan Build-out scenarios. However, emissions of PM_{10} and $PM_{2.5}$ are forecasted to increase as a result of increased VMT. Emissions of PM_{10} are very much affected by VMT as a large portion of these emissions are from brake wear and re entrained roadway dust that are directly proportional to VMT. The $PM_{2.5}$ emissions are comprised more of exhaust components, and therefore, influenced less by brake wear and roadway dust generation.

Under the proposed General Plan, emission of precursor pollutant and $PM_{2.5}$ would be less when compared to the existing General Plan. Emissions of PM_{10} would increase slightly. While the proposed General Plan decreases the number of trips and VMT, when compared to the existing General Plan, there is a more VMT at slower travel speeds. As a result, emissions are higher for this portion of vehicle travel. In the case of PM_{10}, this effect overcomes the reductions in emissions from less travel under the proposed General Plan. $PM_{2.5}$ is less sensitive to travel speed and the change in emissions is negligible. The changes in emissions between the General Plan scenarios are not substantial for any of the pollutants or their precursors.

GHG emissions are more sensitive to overall VMT and fuel use. As a result, GHG emissions will increase by 31 percent under the existing General Plan and slightly less, 30 percent, under the proposed General Plan. The difference between the existing and proposed General Plan in 2040 is a reduction of 21,120 metric tons per year.

These are changes in emissions that are only affected by the General Plan as a result of new residents and jobs that occur in the City. In other words, these are not necessarily new global emissions, and rather reflect a change in emissions in the San José area. This analysis does not reflect the change in emissions outside of the General Plan area that may indirectly result from the General Plan. For example, intensifying the City's urban areas may attract residents and jobs from outside the area that currently generate more trips and VMT, and therefore, more GHG emissions. Therefore, it would be unsupportable to state that the General Plan increases GHG emissions by 30 to 31 percent (on the order of 790,000 metric tons per year) over baseline conditions on a global scale. However, this analysis does support the finding that the changes proposed to the General Plan would decrease GHG emissions both locally and globally by about 21,120 metric tons per year in 2040.

Table 5. Summary of Project Emissions

Scenario	ROG	NOx	PM_{10}	$PM_{2.5}$	CO2e
Baseline - 2015	*2.50 tons/day*	*9.93 tons/day*	*6.31 tons/day*	*1.15 tons/day*	*7,270 MT/day*
2040 Existing GP	*2.25 tons/day*	*3.36 tons/day*	*14.34 tons/day*	*2.31 tons/day*	*9,493 MT/day*
2040 Proposed GP	*2.21 tons/day*	*3.36 tons/day*	*14.35 tons/day*	*2.31 tons/day*	*9,435 MT/day*
Difference in 2040 Proposed GP Emissions Over 2015 Baseline (tons/year) [1]	-105 tons/year	-2,399 tons/year	+2,934 tons/year	+423 tons/year	+790,111 MT/year
Difference in Proposed GP Emissions Over Existing GP in 2040 (tons/year) [1]	**-14 tons/year**	**-2 tons/year**	**+4 tons/year**	**-0 tons/year**	**-21,120 MT/year**
BAAQMD Project Thresholds	***10 tons/year***	***10 tons/year***	***15 tons/year***	***10 tons/year***	***660 MT/Year***
Difference in Proposed GP Emissions Over Existing GP in 2040 (lbs/day) [1]	**-76.6 lbs./day**	**-10.5 lbs./day**	**+20.6 lbs./day**	**-0.5 lbs./day**	**--**
BAAQMD Project Thresholds	***54 lbs./day***	***54 lbs./day***	***82 lbs./day***	***54 lbs./day***	**--**

[1]Assumes 365-day operation.