Technical Appendix

This document outlines the methodology and approach for estimating greenhouse gas (GHG) reductions associated with the Advancing Clean Transportation (ACT) in Hampton Roads Program that is seeking funding under the Climate Pollution Reduction Grant (CPRG) Implementation Grant Program. Please see the GHG Reductions Calculation Spreadsheet Attachment (*GHGcalcs_HamptonRoadsPlanningDistrict Commission.xlsx)* for the complete set of estimates.

Measure 1: Electric Vehicle Support Equipment (EVSE)

GHG Reduction Estimate Method

HRPDC calculated the GHG reductions resulting from installing a total of 452 public Level 2 and DC fast charging stations at eligible schools by estimating the total displaced vehicle miles traveled (VMT) by internal combustion engine (ICE) light duty vehicles (LDVs) to electric LDVs, using total electricity supplied by the chargers:

$$GHG = \sum N_i \times P \times U \times H \div \eta_{EV,LDV} \times EF_{LDV} \qquad (1)$$

Table 1. Variables Included in Equation 1

ID	Variable	Value	Notes
GHG	GHG emissions reductions ($MTCO_2e$)	N/A	
i	Year of implementation	2025, 2026, or 2027	
$\mathbf{N}_i$	Number of chargers installed in year *i*	2025: 152; 2026: 150; 2027: 150	
P	Charger power level	Various values; units of kW	Where charger power level was not provided by the locality, 15.4 kW and 100 kW were assumed for Level 2 and DC fast chargers, respectively
U	Average charger utilization rate	10%	Estimated using current national average[1]; can be replaced with project-specific input using total time a charger is actively used divided by the evaluation period[2]
H	Total annual hours in use	8,760 hour/year	Assuming charger in use 24/7.
$\boldsymbol{\eta}_{\mathbf{EV,LDV}}$	Average LDV EV energy efficiency	0.30 kWh/mile	AFLEET 2023 average of passenger car and SUV

[1] Bauer, Hsu, Nicholas, & Lutsey, 2021. https://theicct.org/sites/default/files/publications/charging-up-america-jul2021.pdf
[2] For example, if a charger is actively used 2 hours in a day, the daily utilization rate would be $2\ \mathrm{h}/24\ \mathrm{h} = 8.3\%$.

$\mathbf{EF_{LDV}}$	Cumulative light duty vehicle emission factor	Sum of grams per mile emission rates over the chargers' lifetimes. The longer the project lifetime, the higher the emission rate.	Based on EPA MOVES4 model[3]

HRPDC then estimated cumulative GHG increases from the EV chargers calculating electricity supplied by the chargers over the chargers' lifetimes, and multiplying by the Southern California Edison projected electricity emission factor:

$$GHG = \sum N_j \times P \times U \times H \times EF_{e,j} \tag{2}$$

Table 2. Variables Included in Equation 2

ID	Variable	Value	Notes
GHG	Electricity GHG emissions ($MTCO_2e$)	N/A	
$\boldsymbol{j}$	Year of implementation	2025-2036	
$\mathbf{N}_{\boldsymbol{j}}$	Number of chargers that have been installed in year *j*	2025: 152; 2026: 302; 2027: 452	2 Level 2 EV chargers per school in eligible districts and 1 Level 2 charger for every 2 schools in LAUSD
P	Charger power level	Various values; units of kW	Where charger power level was not provided by the locality, 15.4 kW and 100 kW were assumed for Level 2 and DC fast chargers, respectively
U	Average charger utilization rate	10%	Estimated using current national average[1]; can be replaced with project-specific input using total time a charger is actively used divided by the evaluation period.[4]
H	Total annual hours in use	8,760 hour/year	Assuming charger in use 24/7.
$\mathbf{EF_{e,j}}$	Hampton Roads regional electricity emission factor in year j	Various values, $MTCO_2e/kWh$	Derived from EIA AEO 2023 reference case and eGRID.

Finally, HRPDC subtracted the cumulative GHG emissions from charger supplied electricity from the ICE light duty vehicle GHG reductions to find the GHG reductions from installing community EV chargers.

[3] USEPA (2023) Motor Vehicle Emission Simulator: MOVES4. Office of Transportation and Air Quality. US Environmental Protection Agency. Ann Arbor, MI. August 2023. https://www.epa.gov/moves/latest-version-motor-vehicle-emission-simulator-moves

[4] For example, if a charger is actively used 2 hours in a day, the daily utilization rate would be $2\ \mathrm{h}/24\ \mathrm{h} = 8.3\%$.

Estimates of criteria pollutants reduced by installing public EV charging infrastructure followed a similar methodology. Equation 3 estimates tailpipe CO, NOx, and PM2.5 emission reductions

$$CAP = \sum N_i \times P \times U \times H \div \eta_{EV,LDV} \times EF_{CAP} \quad (3)$$

Table 3. Variables Included in Equation 3

ID	Variable	Value
CAP	Criteria air pollutants reduced, tonnes	N/A
$\mathbf{N}_i$	Number of chargers installed in year *i*	2025: 152; 2026: 150; 2027: 150
P	Charger power level	Various values; units of kW
U	Average charger utilization rate	10%
H	Total annual hours in use	8,760 hour/year
$\eta_{EV,LDV}$	Average LDV EV energy efficiency	0.30 kWh/mile
EF_{CAP}	Criteria air pollutant emission factor for CO, NOx, or PM2.5 sourced from the Bureau of Transportation Statistics[5]	Varies by fuel and vehicle type; units of tonnes/mi

Measure 2: Trail Expansion

GHG Reduction Estimate Method

HRPDC calculated the GHG reductions resulting from connecting existing and developing a new trail system. These actions will expand the bikeway network and improvements on the pedestrian network, resulting in a decrease in overall VMT.

The potential VMT reduction due to each of these actions was calculated based on the methodology outlined in the *Handbook for Analyzing Greenhouse Gas Emission Reductions, Assessing Climate Vulnerabilities, and Advancing Health and Equity*,[6] a document compiled for the California Air Pollution Control Officers Association to provide methods for estimating GHG reductions resulting from various measures.

Where calculations input data from specific plans were not available, conservative estimates were made for each active transportation strategy based on the maximum input value listed in the *Handbook*. The following additional key assumptions were made throughout the analysis:

- VMT reduction only applies to passenger vehicles.

[5] Bureau of Transportation Statistics (2023) Estimated Average Vehicle Emissions Rates per Vehicle by Vehicle Type Using Gasoline and Diesel. https://www.bts.gov/content/estimated-national-average-vehicle-emissions-rates-vehicle-vehicle-type-using-gasoline-and#:~:text=Emissions%20factors%20are%20averages%20based,properties%20in%20that%20calendar%20year.
[6] California Air Pollution Control Officers Association (2021) Handbook for Analyzing Greenhouse Gas Emission Reductions, Assessing Climate Vulnerabilities, and Advancing Health and Equity. https://www.airquality.org/ClimateChange/Documents/Handbook%20Public%20Draft_2021-Aug.pdf

- VMT reduction only applies to passenger vehicles.
- VMT reductions are taken from the baseline develop in the Hampton Road Priority Climate Action Plan.
- Maximum VMT reductions are assumed to be achieved in 2050. Half of maximum reductions are achieved by 2030, except for electric bikeshare which is assumed to be implemented after 2030.

Measure 3: Streetlight Conversion

GHG Reduction Estimate Method

HRPDC calculated the GHG reductions resulting from transitioning streetlights from the traditional high-pressure sodium vapor, mercury vapor, old LED, and metal halide streetlights to new LED streetlights. Energy consumption for each streetlight type were derived based on industry averages, and it was assumed that streetlights would be used for 10 hours a day for the whole year. A summary of streetlight energy consumption assumptions is summarized in Tabel 4 below.

Table 4. Streetlight Energy Consumption Assumptions

Streetlight Type	Watts	kWh per Year
Metal Halide (MHLD)	400	1,460
Mercury Vapor (MV)	250	913
High-Pressure Sodium Vapor (HPS)	200	730
Old LED Streetlights	100	365
New LED Streetlights	50	183

A total of 76,044 streetlights will be converted to new LED streetlights within the MSA region. The baseline energy consumption of the streetlights was calculated by multiplying the kWh energy consumption of each streetlight type by the total number of streetlights. Similarly, the converted streetlights energy consumption was calculated by multiplying all the number of streetlights by the new LED streetlights energy consumption value. An electricity emissions factor was then applied to the difference between the baseline and the converted streetlights value to obtain the overall GHG reduction.

Low-income and Disadvantaged Communities (LIDACs)

Emissions specific to LIDACs were estimated using GIS mapping, with anticipated infrastructure installation locations mapped and then overlaid with maps of the EJ Screen LIDAC census block groups.

For Measure 1, anticipated EV charger locations were mapped in GIS, determining the percentage of chargers within LIDACs. This percentage (51%) was then multiplied by the total estimated emissions reductions for Measure 1.

For Measure 2, anticipated trail projects were mapped in GIS and approximate mileage of trail both within and outside of LIDACs was identified. Miles of trail within LIDACs were then divided by the total anticipated miles of trail to be installed to determine the percentage trail within LIDACs. This percentage (68%) was then multiplied by the total estimated emissions reductions for Measure 2.

For Measure 3, streetlight locations were mapped. Miles of trail within LIDACs were then divided by the total anticipated miles of trail to be installed to determine the percentage trail within LIDACs. This percentage (31%) was then multiplied by the total estimated emissions reductions for Measure 3.