

ATTACHMENT 2: TCAT Emissions Table & Analysis

(Note: The Thurston Climate Action Team prepared the following jurisdictional emissions table and status report for TRPC in spring 2018. TRPC made minor formatting changes, so TCAT's work could be saved as one attachment to TRPC's May 11 memo to the regional climate mitigation plan project team.)

Estimated Greenhouse Gas Emissions (April 30, 2018 Draft) - Expressed as MTCO ₂ e									
	Original TCAT 2010 (1)	Preliminary TCAT 2018 Emission Calculations (2)							% Change
		2010	2011	2012	2013	2014	2015	2016	
Total Greenhouse Gas Emissions									
Olympia	560,671	663,831	640,474	622,481	648,493	649,835	656,814	678,177	2.2%
<i>Per capita (MTCO₂e/person)</i>	<i>10.91</i>	<i>14.3</i>	<i>13.7</i>	<i>13.1</i>	<i>13.4</i>	<i>13.1</i>	<i>12.9</i>	<i>13.1</i>	<i>-8.0%</i>
Lacey	388,551	437,337	421,547	411,259	446,123	440,973	449,770	474,392	8.5%
<i>Per capita (MTCO₂e/person)</i>	<i>9.17</i>	<i>10.3</i>	<i>9.8</i>	<i>9.4</i>	<i>10.1</i>	<i>9.7</i>	<i>9.8</i>	<i>10.0</i>	<i>-3.3%</i>
Tumwater	287,069	340,847	325,392	317,158	341,030	315,580	324,748	366,598	7.6%
<i>Per capita (MTCO₂e/person)</i>	<i>16.53</i>	<i>19.6</i>	<i>18.5</i>	<i>17.7</i>	<i>18.6</i>	<i>16.8</i>	<i>17.0</i>	<i>15.9</i>	<i>-18.9%</i>
Unincorporated	1,443,200	1,327,519	1,278,518	1,230,152	1,295,438	1,288,182	1,296,796	1,336,851	0.7%
<i>Per capita (MTCO₂e/person)</i>	<i>10.68</i>	<i>9.8</i>	<i>9.4</i>	<i>9.0</i>	<i>9.4</i>	<i>9.3</i>	<i>9.3</i>	<i>9.7</i>	<i>-1.3%</i>
County (3)	2,752,803	2,904,854	2,798,517	2,697,441	2,855,241	2,813,635	2,840,005	2,972,354	2.3%
<i>Per capita (MTCO₂e/person)</i>	<i>10.91</i>	<i>11.5</i>	<i>11.0</i>	<i>10.5</i>	<i>11.0</i>	<i>10.7</i>	<i>10.6</i>	<i>10.9</i>	<i>-5.3%</i>

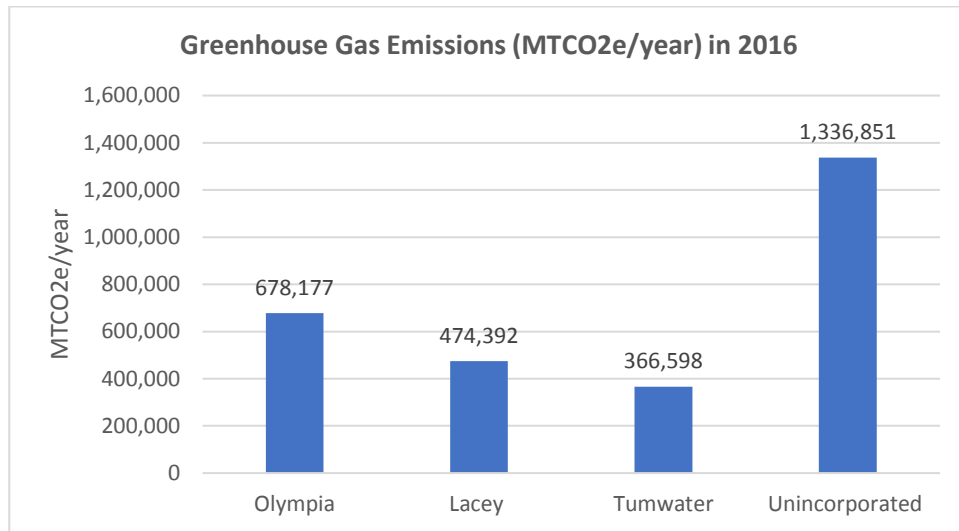
Status Report on Estimates of GHG Emissions for Olympia, Lacey, Tumwater and Unincorporated Areas of Thurston County (2010 – 2016) Overview

The Thurston Climate Action Team (TCAT) is developing estimates of greenhouse gas emissions for Olympia, Lacey, Tumwater (“Phase 1 Cities”) and unincorporated areas of Thurston County for the 2010 – 2016 time period. This status report includes the following information:

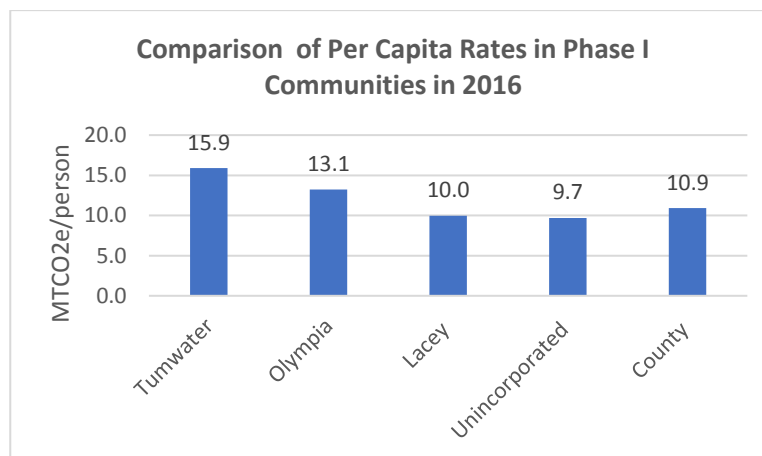
- **Preliminary Emission Estimates.** This paper summarizes the preliminary greenhouse gas emission estimates for each jurisdiction and the trends in those emissions. TCAT has also provided comparisons with other communities in the Pacific Northwest.
- **Methods:** This paper briefly describe the methods used to prepare the preliminary greenhouse gas emission estimates. TCAT used an internationally-accepted method to prepare the preliminary estimates. This method was also used by (1) TCAT in 2010 to prepare the initial emission estimates for Thurston county and individual cities, (2) the City of Olympia to prepare emission inventories for 2010 – 2013 time period and (3) the Thurston Regional Planning Council to prepare baseline emissions for 2015 as part of the TRPC carbon wedge analysis.
- **Similarities and Differences:** This paper briefly describes the similarities and differences between the data and assumptions used in earlier efforts and those used by TCAT to prepare the preliminary estimates. This comparison highlights the need for local governments to develop consistent methods and assumptions that are flexible enough to evolve based on available data and implementation experience.
- **Next Steps:** This paper briefly describes additional work that TCAT plans to complete over the next several months in order to evaluate and refine the preliminary estimates.

What was the 2016 carbon footprint for the Phase 1 Cities and unincorporated areas of Thurston County?

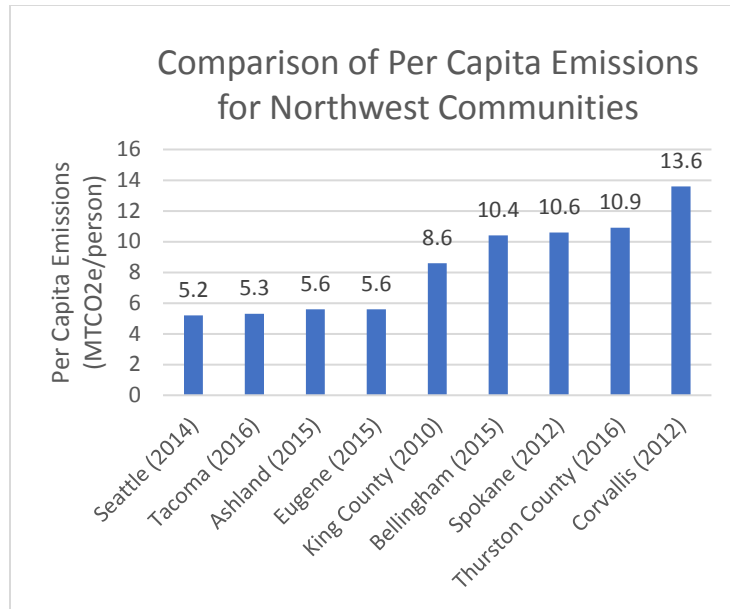
TCAT estimates that the carbon footprint for the Phase I cities and the unincorporated areas of Thurston County in 2016 was 2,856,018 MTCO₂e. This represents 96% of the carbon footprint for the whole county for that year (2,972,354 MTCO₂e). Estimated emissions from the individual jurisdictions are shown below.



County-wide per capita emissions were 10.9 MTCO₂e/person in 2016. Per capita emissions ranged from 15.9 MTCO₂e/person in Tumwater to 9.7 MTCO₂e/person in the unincorporated areas of Thurston County.

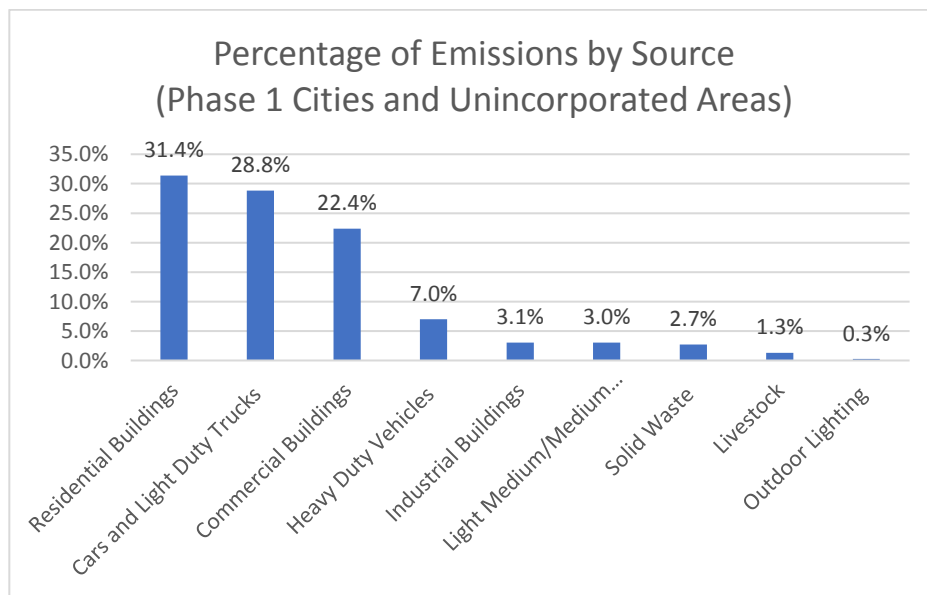


Per-capita emissions for most jurisdictions are lower than the most recent per-capita emissions estimates in Washington (13.7 MTCO₂e in 2013) and the United States (20.5 MTCO₂e in 2015), but are generally higher than per capita emissions reported in number of recent inventories prepared by other Northwest communities. In general, these other communities have higher population densities and more multi-family homes that tend to produce lower per capita building and transportation emissions. In most cases, these communities also have cleaner sources of electricity (lower emissions of greenhouse gases per kilowatt-hour) where a larger share of the electricity used by the community is produced from hydropower and wind generation.



What were the major sources of GHG emissions in 2016?

The three largest emission sources in 2016 in the Phase I cities and unincorporated areas of Thurston County were residential buildings (31.4%), cars and light duty trucks (28.8%) and commercial buildings (22.4%). At the other end of the spectrum was outdoor lighting which contributed less than 1% of the carbon footprint. This was the fastest growing source over the 2010 – 2016 time period growing by over 150%. Fortunately, the data show declining emissions/ customer in 2016 as communities (particularly Olympia and unincorporated areas) begin to switch to LED lighting.



Residential buildings, commercial buildings and cars/light duty trucks were the top three source categories in all jurisdictions, but there were some variations in the relative importance in 2016 emissions. Commercial buildings were

the top source category in Olympia and Lacey, while cars and light duty trucks were the top source category in Tumwater. Residential buildings were the top source category in the unincorporated areas of Thurston County.

Summary of Source Category Emissions (MTCO ₂ e) in 2016										
	Olympia		Lacey		Tumwater		Unincorporated		Total	
	MTCO ₂ e	%	MTCO ₂ e	%	MTCO ₂ e	%	MTCO ₂ e	%	MTCO ₂ e	%
Residential Buildings	164,000	24.1%	146,984	31.0%	77,994	21.3%	507,761	38.0%	896,740	31.4%
Commercial Buildings	236,409	34.8%	153,029	32.3%	97,366	26.6%	152,613	11.4%	639,417	22.4%
Industrial Buildings	19,477	2.9%	1,923	0.4%	47,844	13.1%	18,270	1.4%	87,514	3.1%
Outdoor Lighting	3,390	0.5%	2,014	0.4%	620	0.2%	1,465	0.1%	7,490	0.3%
Cars/ Light Duty Truck	178,946	26.3%	116,240	24.5%	101,721	27.7%	427,016	31.9%	823,923	28.8%
Light Medium/ Medium Trucks	18,838	2.8%	12,237	2.6%	10,709	2.9%	44,953	3.4%	86,737	3.0%
Heavy Duty Vehicles	43,600	6.4%	28,321	6.0%	24,784	6.8%	104,041	7.8%	200,747	7.0%
Solid Waste	14,877	2.2%	13,569	2.9%	5,560	1.5%	43,249	3.2%	77,256	2.7%
Livestock	0	0.0%	0	0.0%	0	0.0%	37,482	2.8%	37,482	1.3%
Totals	679,536		474,316		366,598		1,336,851		2,857,305 ¹	

How did greenhouse gas emissions change between 2010 and 2016?

The Thurston region's per capita emissions fell by 5% between 2010 and 2016. The rate of decline in per capita emissions in individual jurisdictions ranged from -18.9% in Tumwater to -1.3% in the unincorporated areas of Thurston County.

Per Capita Emissions (MTCO ₂ e/person) and Percent Change Between 2010 and 2016				
	2010	2016	% Change	Average Annual Change
Tumwater	19.6	15.9	-18.9%	-3.2%
Olympia	14.3	13.1	-8.0%	-1.3%
Lacey	10.3	10.0	-3.3%	-0.5%
Unincorporated	9.8	9.7	-1.3%	-0.2%
County	11.5	10.9	-5.3%	-0.9%

The average annual rate of change in Thurston communities falls within the range of annual changes in other Northwest communities that have prepared inventories that span more than one year.

Comparison of Trends in Per Capita Greenhouse Gas Emissions in Several Northwest Communities

¹ Total is about 1,000 MTCO₂e higher than estimate presented in earlier section. Needs rechecking.

Community	Time Period	Change in per Capita Emissions (%)	Average Annual Change (%/yr)
Tacoma - with Industry ²	2012 - 2016	-21%	-5.3%
Ashland	2011 - 2015	-18.0%	-4.5%
Seattle	2008 - 2014	-16.1%	-2.7%
Eugene	2010 - 2015	-12.5%	-2.5%
Thurston Region	2010 - 2016	-5.3%	-0.9%
King County	2008 - 2010	-1.1%	-0.6%
Tacoma – w/o industry	2012 - 2016	2%	-0.5%
Spokane	2010 - 2012	0.8%	0.4%
Bellingham	2012 - 2015	10.6%	3.5%

What methods did TCAT use to prepare the preliminary estimates?

TCAT prepared this inventory using the *U.S. Community Protocol for Accounting and Reporting Greenhouse Gas Emissions prepared by the International Council of Local Environmental Initiatives (ICLEI 2013a)*.³ The ICLEI protocol provides an internationally-accepted method that enables comparisons with emission inventories prepared by other cities and counties.

The US and Global Protocols establish a four-step process for estimating GHG emissions:

1. **Identify relevant source categories.** ICLEI encourages local governments to include as many emission sources as possible. TCAT developed preliminary estimates for the following types and sources:
 - Build Environment (residential, commercial and industrial buildings and outdoor lighting);
 - On-Road Transportation (passenger vehicles, commercial vehicles and heavy duty vehicles);
 - Solid Waste (waste processing, waste transportation and methane emissions from landfills);
 - Agricultural Livestock.
2. **Obtain activity data for source categories.** The ICLEI Protocol uses information on electricity and natural gas use, vehicle miles traveled and other activity measures to develop GHG emission estimates. The TRPC has compiled much of the activity data needed to prepare these preliminary estimates:
 - The number of customers and amount of electricity used for residential, commercial and industrial buildings and outdoor lighting during the 2010 – 2016 time period.
 - The number of customers and amount of natural gas used for residential, commercial and

² The City of Tacoma (2016) prepared two community emission estimates: one included industrial energy use and one did not. The authors stated that "...[c]ommunity estimated emissions show a fairly dramatic decline of about 20%, but this is a result of a large drop in natural gas consumption by one industrial customer. There was an 84% decline in emissions within the industrial energy sector; a condition which will not remain in place and does not indicate a trend...". (p. 6)

³ This protocol was supplemented by the more recent '*Global Protocol for Community-Scale Greenhouse Gas Emissions Inventories*' prepared by the World Resource Institute and ICLEI (WRI and ICLEI 2014).

industrial buildings during the 2010 – 2016 time period.

- The number of vehicle miles traveled in Thurston County during the 2010 – 2016 time period.
- The amount of solid waste generated by Thurston County residents and businesses during the 2010 – 2016 time period.

The TRPC information was supplemented with (1) information on other residential heating fuels from the US Energy Information Administration and the US Census Bureau and (2) information on the number of agricultural livestock in Thurston County compiled by the US Department of Agriculture.

3. Identify appropriate emission factors. The ICLEI Protocol uses standard emission factors for converting activity data to GHG emission estimates. TCAT supplemented the default emission factors with information from the annual Puget Sound Energy emission reports, the 2015 and 2016 United States inventory reports and solid waste composition information from Thurston County Solid Waste.
4. Calculate GHG emissions. TCAT used an Excel spreadsheet model that incorporated the formulae from the ICLEI guidance in order to calculate the preliminary estimates. About twenty percent of the calculations were checked using the web-based ClearPath Community-Scale Emissions Management Software (ICLEI 2013b) that was also used to calculate GHG emissions for the Thurston Region. Emissions of individual GHGs were converted to MTCO₂e using the global warming potentials (GWP) published in *the International Panel on Climate Change's 5th Assessment Report* (IPCC 2013).

How do the preliminary estimates compare with the original 2010 emission estimates prepared by TCAT in 2013?

In 2013, TCAT published a community based greenhouse gas (GHG) emission inventory for calendar year 2010. Since TCAT prepared the original report, there have been several methodological changes and refinements in the underlying data used in the ICLEI protocol.

TCAT decided to update the 2010 emission estimate using these more recent refinements in order to provide an “apples to apples” comparison of emission changes during the 2010 - 2016 time period. The updated 2010 county-wide emission estimate is approximately 5% higher than the initial 2010 county-wide estimate published in 2013.

Important differences between the original and updated 2010 emission estimates include:

1. Global Warming Potential (GWP). The 5th Assessment Report (AR5) values used to prepare this report are slightly different than the values in the 2nd Assessment Report (SAR) that were used by TCAT to prepare the initial 2010 emission estimates. The AR5 value for methane (28) is higher than the SAR value (21) which explains much of the increases in the revised 2010 estimates for solid waste and agricultural livestock.
2. Emission Factor for Electricity Production. TCAT used emission factors published by Puget Sound Energy in their annual emission reports to prepare the preliminary estimates. The PSE values are higher than the default values used to prepare the initial 2010 emission estimates. The higher emission factors explain why the revised 2010 emission estimates for electricity use in buildings are higher than the emission estimates in the initial TCAT report.
3. Emission Factors for Methane Generation. TCAT used the Solid Waste Characterization Study (Green Solutions, 2014) to calculate a Thurston County emission factor that was used to prepare the preliminary estimates. The county-specific emission factor is higher than the default emission factor used to prepare the initial 2010 emission estimates.

4. Vehicle Miles Traveled. TCAT used information from the Thurston Regional Planning Council on the vehicle miles traveled by various types of vehicles. Subsequent to the original TCAT report, TRPC modified the methods for allocating county wide VMT to individual communities. The changes in the allocation methods (in combination with the changes in the vehicle fleet mix assumptions) resulted in higher estimated on-road emissions in the three Phase I cities and lower estimated emissions in unincorporated areas (relative to the original TCAT estimates).
5. Vehicle Fleet Mix. TCAT used information from TRPC to estimate the amount of vehicle miles driven by passenger vehicles, commercial vehicles and heavy-duty vehicles. The TRPC are similar to fleet mix information compiled by the Energy Information Administration (EIA) that are consistent with the EIA fuel efficiency data used in the current TCAT evaluations. The TRPC percentages are different than the default percentages used to prepare the initial 2010 emission estimates.

How do the preliminary estimates compare with the county-wide emission estimates distributed for review earlier this year?

The preliminary 2016 emission estimates for the Phase I cities and the unincorporated areas of Thurston County was 2,856,018 MTCO_{2e} which represents 96% of the carbon footprint for the whole county for that year. The two evaluations were performed using the same methods and assumptions. The primary differences between the two estimates are (1) the county-wide estimates include emissions from the four other cities in Thurston County (Yelm, Tenino, Rainier and Bucoda) and (2) the US Census Bureau data on the number of households using other residential heating fuels (wood, LPG and fuel oil) in individual cities does not sum to the county wide estimates provided by the Census Bureau. In other words, the whole is greater than the sum of the parts. As discussed below, TCAT plans to evaluate this issue further.

How do the preliminary estimates for Olympia (2010 – 2013) compare with emission estimates prepared by the City of Olympia for those years?

The City of Olympia has used the ICLEI guidance to complete greenhouse gas inventories for 2010 through 2013 that are currently posted on the ICLEI website. The TCAT emission estimates are consistently higher than the City of Olympia estimates even though both sets of inventories were prepared using the ICLEI methodology and generally used the same activity data.

Estimated Annual Emissions for the City of Olympia				
Inventory	2010	2011	2012	2013
City of Olympia	584,649	587,551	515,571	587,063
TCAT	663,831	640,566	622,560	648,669

In order to better understand these differences, TCAT has compared the most recent inventory posted by the City of Olympia (2013) with the TCAT estimates for that year. As summarized below, much of the difference in the two estimates is related to (1) the emission intensities used to estimate emissions from the use of electricity and (2) the global warming potential (GWP) for methane. Key differences for emission sectors reported by Olympia in the ICLEI database are summarized below. NOTE: TCAT hopes to work with the City of Olympia and TRPC to explore this issue further.

- Residential Energy (Electricity and Natural Gas): The TCAT emission estimates for 2013 were 24.3% higher than the City of Olympia estimates. This category includes emissions associated with use of electricity, natural gas and other heating fuels. The good news is that the estimates for natural gas combustion are virtually identical (<< 1%). The TCAT emission estimates for electricity use were approximately 50% higher than the City of Olympia estimates. This largely because the emission intensity used by TCAT (obtained from the 2013

annual Puget Sound Energy emission inventory) is approximately 50% higher than the emission factor published by EPA in the 2012 Egrid database that was used by the City of Olympia.

- Commercial Energy (Electricity and Natural Gas): Similarities and differences tracked the residential energy results.
- Industrial Energy (Electricity and Natural Gas): Similarities and differences tracked the residential energy results.
- On-Road Transportation.⁴ TCAT's emission estimate for emissions from on-road transportation were about 2% lower than the City of Olympia estimates. This is somewhat surprising given the differences in fleet mix assumptions, fuel economy and (possibly) VMT allocation methods. TCAT hopes to work with the City of Olympia and TRPC to better understand the interplay between these factors.
- Upstream Impacts of Activities. This sector includes three components: (1) emissions associated with the production of the fuels used to generate electricity; (2) emissions associated with the production of natural gas; and (3) emissions associated with the loss of electricity during transmission and distribution. With respect to the first two components, the TCAT and City of Olympia emission estimates are virtually identical (< 1% difference). TCAT estimated emissions associated with T&D losses is approximately 50% higher than the City's estimate. This is largely due to the different emission intensities used in the two analyses.
- Process and Fugitive Emissions. TCAT's emission estimates for natural gas leaks during transmission and distribution were 33% higher than the City of Olympia estimates. This is largely due to the differences in global warming potentials for methane used in the two analyses. The more recent Fifth Annual Assessment report (AR5) global warming potential is 33% higher than Second Assessment Report (SAR) global warming potential for methane (21) used by the City of Olympia.
- Solid Waste. The TCAT emission estimates for 2013 were 37.6% higher than the City of Olympia estimates. This is largely due to the differences in global warming potentials for methane used in the two analyses (See above). Differences between the extrapolated solid waste volumes used by TCAT and the actual volumes used by the City of Olympia likely explain some of the differences.

How do the methods and emission estimates for Thurston County for 2015 compare with county –wide emission estimates for 2015 included in the Thurston County Carbon Wedge Analysis?

The Thurston Regional Planning Council published a greenhouse gas wedge analysis that explored options for reducing emissions from buildings and on-road vehicles (Clean Energy Transition and Stockholm Environment Institute, 2017). As part of that evaluation, CET/SEI estimated emissions for residential, commercial and industrial buildings and on-road vehicle emissions (passenger vehicles and heavy-duty vehicles) for calendar year 2015.

The TCAT emission estimates for buildings and on-road vehicles are 3% higher than the CET/SEI estimates. The two estimates were developed using similar methods and the 3% difference appears to be mainly due to differences in the two analyses took into account emissions associated with the production and distribution of the natural gas used in residential, commercial and industrial buildings.

What additional work does TCAT plan to undertake in the next several months?

TCAT plans to work with interested parties to further evaluate and refine the preliminary emission estimates. Planned activities include:

⁴ The City of Olympia inventory also includes estimates for (1) air travel by city residents, (2) recreational boats and (3) rail emissions.

- Respond to questions from TRPC and other local officials on the methods, assumptions and preliminary emission estimates;
- Evaluate the discrepancies between the county-wide emission estimates for other residential heating fuels and the sum of the individual city emission estimates for those sources;
- Work with Waste Connections and the City of Olympia to obtain solid waste data for all jurisdictions. The current solid waste emission estimates were prorated using information from the original TCAT report;
- Further evaluate information on emissions associated with buildings (residential, commercial and industrial) and outdoor lighting. For example, an initial evaluation of Olympia's data shows that emissions associated with outdoor lighting peaked in 2014 and have begun to decline as the City has made concerted efforts to switch to LEDs;
- Further evaluate information on on-road transportation emissions;
- Continue to enter data into the Clearpath Software model in order to confirm and document the preliminary emission estimates; and
- Complete the county-wide emission report.