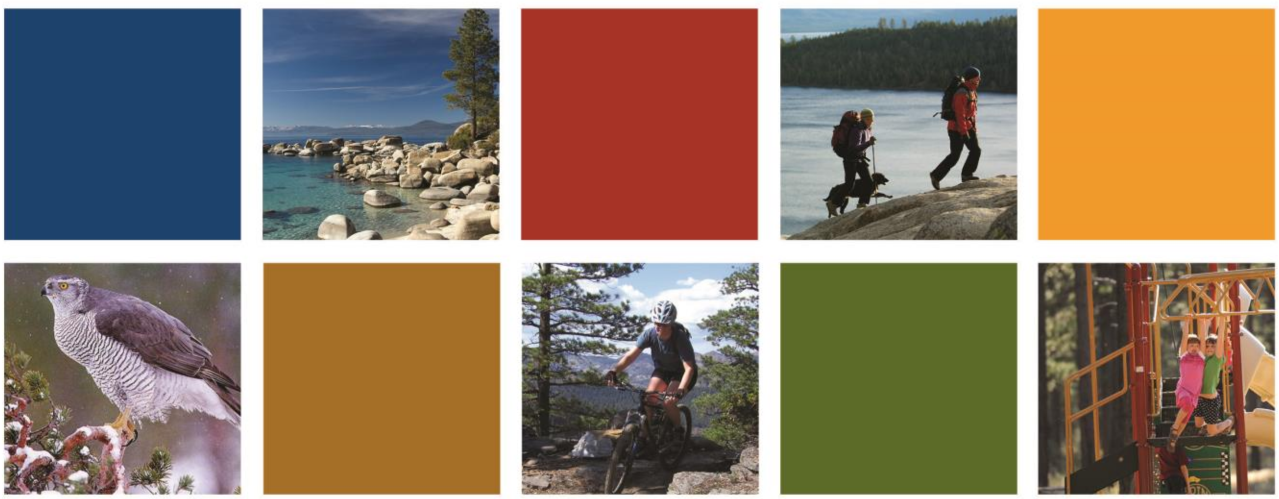
Lake Tahoe Sustainable Communities Program Documents Series #2

Sustainability Action Plan Background

January 2013



lake Tahoe
Sustainable Communities Program

California Strategic Growth Council

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Acknowledgements

Tahoe Metropolitan Planning Organization Governing Board

The Tahoe Metropolitan Planning Organization (TMPO) Governing Board is comprised of the members of the Tahoe Regional Planning Agency (TRPA) Governing Board and one representative of the US Forest Service. The TRPA staff serves both the TMPO and TRPA. The TRPA Governing Board is responsible for adopting the Lake Tahoe Regional Plan and Code of Ordinances. The TMPO Governing Board is responsible for adopting the Regional Transportation Plan and Sustainable Communities Strategy.

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Lake Tahoe Sustainability Collaborative

This citizens group is responsible for sustainability planning recommendations, projects, and programs. More information is available at www.sustainabilitycollaborative.org.

Tahoe Basin Partnership for Sustainable Communities

This group, comprised of representatives from the Tahoe Regional Planning Agency, Tahoe Metropolitan Planning Organization, California Tahoe Conservancy, El Dorado County, Placer County, City of South Lake Tahoe, North Lake Tahoe Resort Association, and Sierra Nevada Alliance, was responsible for preparing the original SGC Round 1 Sustainable Community Planning Grant application and has provided ongoing support for completion of these SGC grant-funded tasks.

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Introduction to the Lake Tahoe Sustainable Communities Program

The need to embrace sustainability in all planning and implementation activities in the Lake Tahoe Region and beyond has been recognized in a number of ways. At the national level, the Department of Housing and Urban Development has created the Sustainable Communities Regional Planning Grant Program and the Department of Interior Bureau of Reclamation has initiated the Truckee River Basin Study that will include adaptive strategies to respond to climate change and other uncertainties. At the state level, California has adopted the Sustainable Communities and Climate Protection Act of 2008 requiring greenhouse gas emission reduction targets for passenger vehicles for 2020 and 2035 for each region covered by a metropolitan planning organization (MPO) and created the Strategic Growth Council, which has awarded grants for sustainable community planning and natural resource conservation. At the Lake Tahoe Region level, the Tahoe Regional Planning Agency (TRPA) has updated the Lake Tahoe Regional Plan to include sustainability policies and mitigation measures, and the Tahoe Metropolitan Planning Organization (TMPO) has adopted a Sustainable Communities Strategy as required by the Sustainable Communities and Climate Protection Act of 2008. At the local level, local governments in the Lake Tahoe Region are in the process of integrating sustainability principles into their local plans.

In the summer of 2010, a partnership of agencies, organizations, and jurisdictions came together as "The Tahoe Basin Partnership for Sustainable Communities" in order to apply for a grant from the Strategic Growth Council. Collectively, the Partnership is supporting execution of the Strategic Growth Council 2011 Sustainable Communities Planning Grant that was officially awarded to the TMPO in August of 2011. The Partnership is comprised of Tahoe Metropolitan Planning Organization, Tahoe Regional Planning Agency, El Dorado County, Placer County, City of South Lake Tahoe, California Tahoe Conservancy, and Sierra Nevada Alliance.

The TRPA, in partnership with other key stakeholders in the Lake Tahoe Region, is a participant in all of these national, state, regional and local efforts. Often they are complementary and of common interest to stakeholders. Hence, the Lake Tahoe Sustainable Communities Program has been created as a Basin-wide program with staff from different agencies and organizations participating in the various efforts. To the extent possible, the products from these efforts will be available through the Lake Tahoe Sustainable Communities Program website and as a series of documents.

Lake Tahoe Sustainable Communities Program Documents Series

This series of documents is organized to generally reflect the tasks associated with the grants received from the California Strategic Growth Council (SGC). The series as currently envisioned includes the following:

1. **Sustainability Framework and Vision** – This document accompanies the California Tahoe Conservancy *Tahoe Basin Sustainability Planning Guidebook* document (Appendix A) and includes an overview of the Sustainable Communities Program, the framework within which all of the regional and local level plans work, and the vision for sustainability based on input from over 5,000 participants in the regional planning process. The *Tahoe Basin Sustainability Planning Guidebook* was prepared in 2011 and describes how this effort was originally envisioned. The Sustainability Framework and Vision has more detailed and updated language related to the newly adopted Regional Plan and the framework for Area Plans, input from participants in that

process, and the interaction of sustainability components. This serves as the "deliverable" for the SGC Round 1 Sustainable Community Planning Grant Task 1: Roadmap & Organizational Structure.

2. **Sustainability Action Plan Background** – This document; it includes the initial greenhouse gas emissions inventory and reduction targets, and climate change adaptation and mitigation strategies. It reflects the adopted Regional Plan, Regional Transportation Plan, and Sustainable Communities Strategy policies, and is the basis for the sustainability (a.k.a., climate change) action plan. This document serves as the "deliverable" for the SGC Round 1 Sustainable Community Planning Grant Task 3: Goals, Objectives, & Strategies.

3. **Sustainability Action Plan: A Sustainability Action Toolkit for Lake Tahoe** – This includes the revised greenhouse gas emissions inventory and reduction targets, and climate change and adaptation strategies vetted through the Lake Tahoe Sustainability Collaborative and the Tahoe Basin Partnership for Sustainable Communities. This document also includes community level outreach and action strategies. This document serves as the "deliverables" for the SGC Round 1 Sustainable Community Planning Grant Tasks 3.D, 4.A, and 4.D: Lake Tahoe Sustainability Action Plan and Outreach Activities.

4. **Sustainability Indicators Reporting Plan**– This includes: (1) an assessment of existing Lake Tahoe Region measurement and monitoring efforts, (2) identification of a suite of sustainability indicators, (3) development of a sustainability metrics reporting plan, and (4) initiation of a sustainability dashboard. This measurement and tracking approach is intended to be consistent with and a key element of the larger Lake Tahoe Basin Monitoring, Evaluation, and Reporting Program required by California State Appropriations Bill #3110-0140 in addition to serving as the 'deliverables' for SGC Round 1 Task 4.B: Develop Performance Measures, Indicators and Monitoring Program, including a Tracking and Accounting System and SGC Round 2 Task 4.A: Obtain Regional Indicators Data.

5. **Area Plans Framework** – This includes the framework for Area Plans and initiation of those Area Plans. The framework (i.e., Regional Plan policies and code, conformance review checklist, and model Area Plan contents) serves as the "deliverable" for SGC Round 1 Sustainable Community Planning Grant Task 4, Subtask C: Lake Tahoe Livable Communities Program.

6. **Area Plans Background** – This includes an assessment of the sustainability and livability measures needed in each planning area and the barriers to local implementation of those sustainability measures. This document serves as the "deliverable" for the SGC Round 1 Sustainable Community Planning Grant Task 2: Situation Assessments.

7. **Development Commodities Transfer Policies Analysis** – This includes identification and analysis of the potential market effectiveness of proposed transfer of development rights and bonus unit policies considered for inclusion in the Regional Plan. This serves as the "deliverable" for the SGC Round 1 Sustainable Community Planning Grant Task 4, Subtask E: Development Rights Incentives Program.

8. **Development Commodities Tracking and Exchange System** – This includes the concepts, processes, software requirements, and other system specifications, as well as the results of implementing the development commodities and exchange system. This serves as the "deliverable" for the SGC Round 2 Sustainable Community Planning Grant Task 3: Regional Development Rights Tracking System.

9. **Economic Development Strategy** – This includes analysis of existing and targeted industry clusters and recommendations on the clusters and incentives that will be most effective in

creating and maintaining a sustainable economy for the Lake Tahoe Region. Also included is stakeholder outreach resulting in recommendations for implementation of commodities transfer policies. This serves as the “deliverable” for the SGC Round 1 Sustainable Community Planning Grant Task 4, Subtask F: Economic Incentives Strategy.

10. **Lake Tahoe Sustainability Collaborative Strategic Plan** – This document includes the LTSC’s mission, charter, and business plan which provides the strategy for the Lake Tahoe Sustainability Collaborative to continue, on an ongoing basis, to act as an independent entity that “champions” sustainability in the Lake Tahoe Region. This serves as the “deliverables” for the SGC Round 1 Sustainable Community Planning Grant Task 1.B: Establish Lake Tahoe Sustainability Collaborative and SGC Round 2, Task 4.E: Lake Tahoe Sustainability Collaborative Support.

11. **Annual Report** – This is the initial annual report on the Lake Tahoe Sustainable Communities Program and will be included as part of future TRPA annual reports. It will be updated using current sustainability indicators data, and can act as a template for similar sustainability planning reports in other regions. This serves as the “deliverables” for the SGC Round 2 Sustainable Community Planning Grant Tasks 4.B: Implement Regional Data Sharing/Management Program, 4.C: Web-Based Dashboard Implementation, and 4.D: Prepare and Publish Final Tahoe Annual Report.

12. **Lake Tahoe Sustainable Communities Program Summary** - Other documents that are an integral part of the sustainability efforts in the Lake Tahoe Region include the Lake Tahoe Regional Plan, Regional Transportation Plan and Sustainable Communities Strategy, and various local government Area Plans. This document provides a summary of these plans, the products described in previous reports in this series, and how they work together within the Sustainability Framework for the Lake Tahoe Region. This serves as the “deliverable” for the SGC Round 2 Sustainable Community Planning Grant Task 2: SB375 Local Planning and Implementation Tool-Kit.

While providing valuable information about the Lake Tahoe Sustainable Communities Program to Lake Tahoe Region stakeholders, this series is also designed to provide a reference for other regions involved in addressing the critical issue of sustainability.

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Greenhouse Gas Emissions

The greenhouse gas emissions information that serves as the background for the Sustainability Action Plan comes primarily from the Draft Final Report *Development of a Regional Greenhouse Gas Emissions Inventory for the Lake Tahoe Basin* which was prepared for the California Tahoe Conservancy by Sonoma Technology, Inc. The final version of this report should be available for preparation of the Sustainability Action Plan. It is also anticipated that as the Sustainability Action Plan developed, and in the future, changes in the emissions inventory and targets may occur as a result of:

- Better information (e.g., more specific data about the emissions from a particular category)
- Changes in policies that affect the amount of an activity that generates emissions. For example, changes in the amount of development such as a reduction in motel rooms will result in a reduction in the number of vehicle miles travelled and emissions from automobiles.
- Changes in policies that affect the amount of emissions that a particular activity generates. For example, changes in federal or state vehicle emission standards will result in lower emissions per vehicle and lower emissions from automobiles.

The recently adopted Regional Plan, Regional Transportation Plan and Sustainable Communities Strategy contain policies that, as implemented, will result in changes to emissions levels. These policies must be considered in preparation of the Sustainability Action Plan. Additionally, unlike many other regions, the Lake Tahoe Region has a cap on the amount of development that is remaining. Most development will occur through movement of existing development commodities from one site to another and/or redevelopment at existing sites (see *Development Commodities Transfer Policies Analysis* which is part of the Lake Tahoe Sustainable Communities Program Document Series). This must also be considered in forecasting emissions and target reductions.

Inventory

The emissions inventory for the Lake Tahoe Region covers the area under TRPA jurisdiction and provides baseline and future-year inventories of greenhouse gas (GHG) emissions. The baseline years selected were 2005 to be consistent with other planning efforts in the Region and 2010 to quantify the effects of the economic downturn after 2005. The forecast years used are 2020 and 2035 which correspond to California SB375 (Sustainable Communities and Climate Protection Act) and other planning horizons used in the Region (e.g., Regional Transportation Plan).

The source categories were determined based on the unique characteristics of the Tahoe Region. There are sources such as forestry, wildfires, and recreational boating which are not typically significant in urban areas. Similarly, urban area sources such as industrial production are not significant in the Region. Using these categories and industry standard methods for estimating emissions, the 2005 and 2010 emissions inventory shown in the following table was generated.

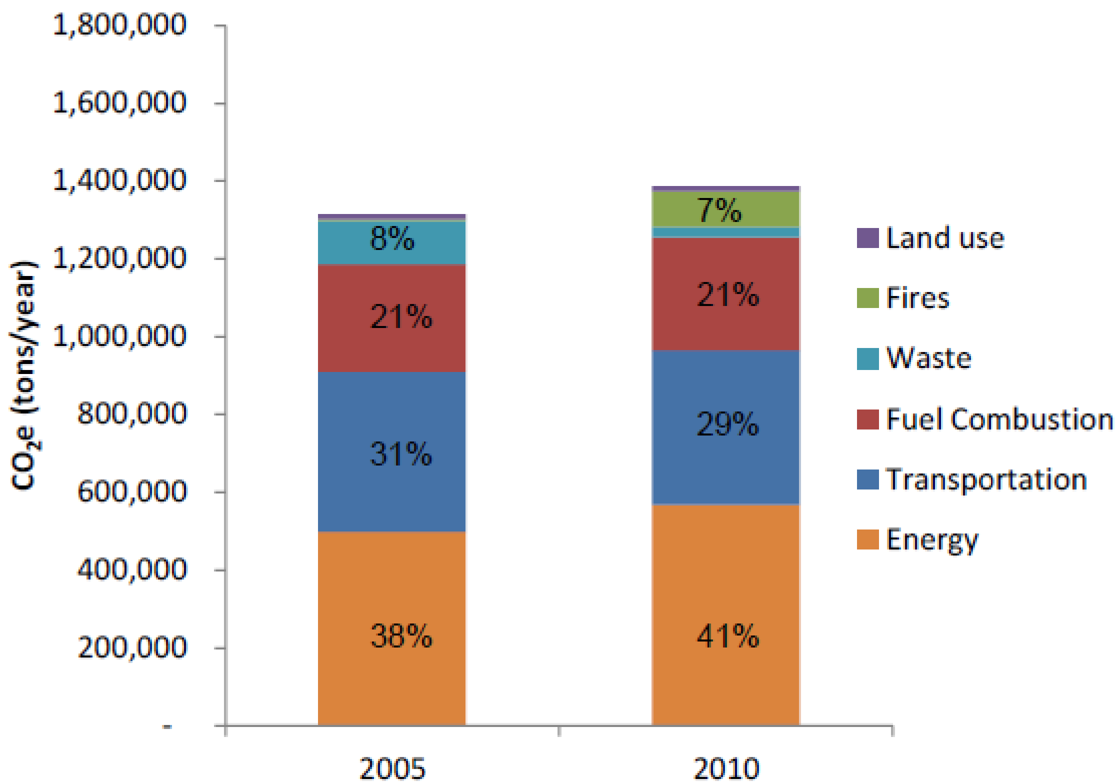
The emissions estimates are classified as direct and indirect. Direct emissions are those that result from activity contained entirely within the basin (e.g., wood stove use). Indirect sources take into account emissions from activities outside of the Region that are attributable to activity levels within the Region (e.g., electricity generated outside of the Region that is consumed within the Region). It is important to distinguish between these classifications as the approaches to reduce these emissions may be distinctly different. The largest sources of emissions are electricity generation (indirect) representing 38% of total emissions, transportation (direct) representing 31% of total emissions in 2005 and 31% in 2010, and fuel combustion (direct) representing 20% of total emissions.

Table 1: Regional CO2 Equivalent Emissions by Source Sector and Category (metric tons/year)

Type	Source Sector	Source Category	2005	2010
Direct	Transportation	On-road mobile sources	331,476	319,106
		Recreational boats	22,403	15,994
		Other off-road equipment	53,860	58,751
	Fuel combustion	Wood combustion	97,700	104,297
		Natural gas combustion	179,885	187,755
		Other fuel combustion	5,858	6,161
	Fires	Wildfires and prescribed burns	4,284	91,652
	Land use	Livestock	12,734	12,734
Indirect	Energy	Electricity consumption	487,553	562,543
		Wastewater treatment	2,115	2,300
	Transportation	Aircraft	5,131	4,739
	Waste	Municipal solid waste	110,512	26,704
Total Emissions			**1,313,511**	**1,392,737**

Source: Draft Final Report *Development of a Regional Greenhouse Gas Emissions Inventory for the Lake Tahoe Basin*, page 1-6.

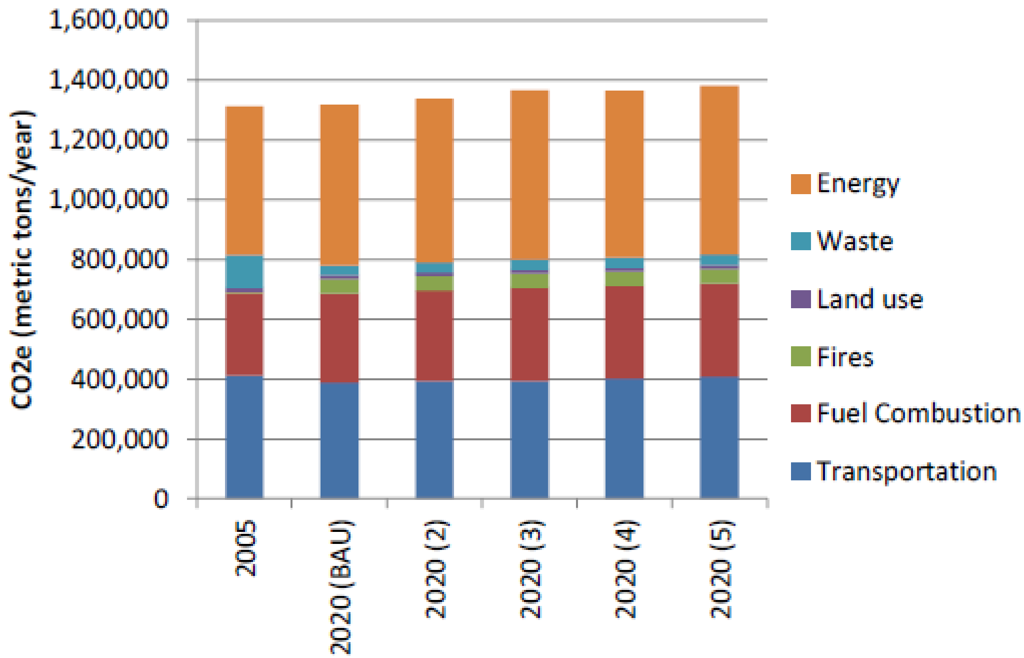
Figure 1: Regional C02 Equivalent Emissions by Source Sector and Category (% of total emissions)



Source: Draft Final Report *Development of a Regional Greenhouse Gas Emissions Inventory for the Lake Tahoe Basin*, page 1-6.

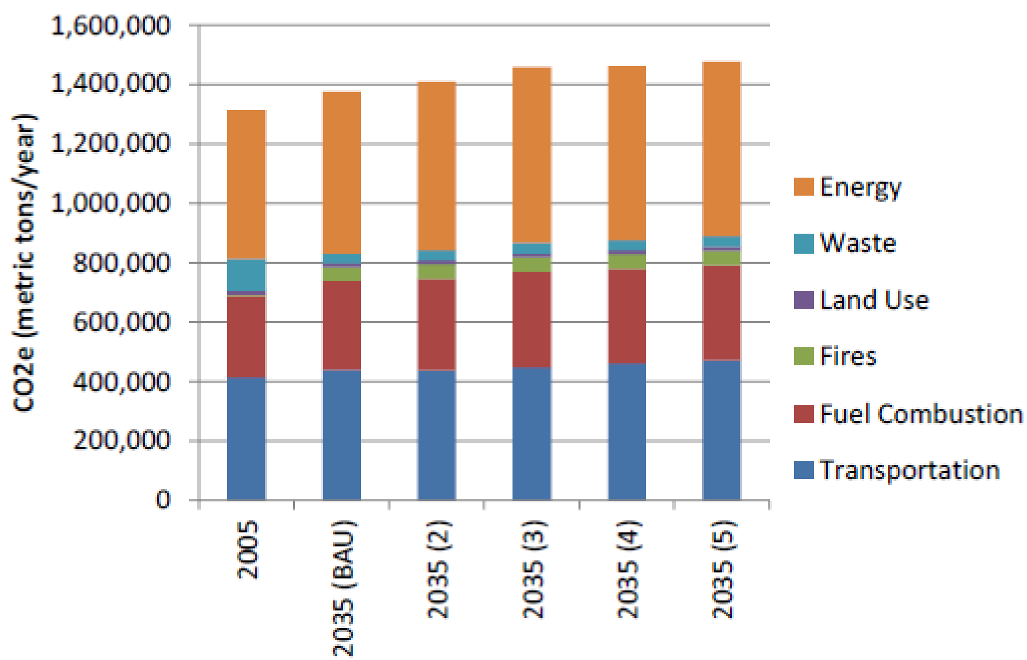
Forecasts of the 2020 and 2035 are based on the five population and vehicle miles traveled scenarios created to evaluate the 2035 Regional Transportation Plan. The forecasted emissions by source as a percentage of total emissions for 2020 and 2035 are shown in the two figures below.

Figure 2: 2020 Regional CO2 Equivalent Emissions for Regional Transportation Plan Alternatives



Source: Draft Final Report *Development of a Regional Greenhouse Gas Emissions Inventory for the Lake Tahoe Basin*, page 3-7.

Figure 3: 2035 Regional CO2 Equivalent Emissions for Regional Transportation Plan Alternatives



Source: Draft Final Report *Development of a Regional Greenhouse Gas Emissions Inventory for the Lake Tahoe Basin*, page 3-8.

Reduction Targets

California SB 375 (Sustainable Communities and Climate Protection Act) calls for a reduction of 15% below 2005 levels by 2020. The Sustainability Action Plan will identify measures that can be pursued to attain this level of reduction by 2020. Because the largest source of emissions is from electricity generated outside of the Region reductions in this source of emissions can be achieved, but not unilaterally. Conversely, the TRPA has unique authority to prepare and adopt a transportation plan, including demand reduction measures, and to regulate land use to ensure that demand management is implemented. For this reason transportation emissions reductions beyond 2020 will be a critical component of the overall reduction strategy. Reductions in the third major source of emissions, fuel combustion, will also be a key component of the overall reduction strategy beyond 2020.

The initial strategies for reduction of these three types of GHG emissions (i.e., energy, transportation, and fuel combustion) plus land use will address over 91% of the emissions identified in the 2010 inventory. Waste, fires and additional strategies address the remaining types of emissions. All of these initial strategies are discussed in greater detail in the next section of this document.

Strategies

As stated in the previous section of this document, there a number of key strategies for reducing GHG emissions in the Lake Tahoe Basin. The initial strategies for each of these are outlined in this section. The final strategies and related actions will be included in the Sustainability Action Plan.

Energy

The greatest percentage of GHG emissions in the 2010 inventory (41%) came from generation of electricity outside of the Region for use within the Region. The emissions resulting from this electricity generation can be influenced from within the region, but not changed unilaterally. However, reductions in demand can be influenced to a much greater degree from within the region.

- Reductions in GHG emissions from the generation of electricity outside of the Region will come from changing the mix of fuels and types of generation facilities used by the investor owned utilities that provide electricity to the region (Pacific Gas and Electric, Liberty Energy, NV Energy, etc.). Absent requirements from the States of California and Nevada, this will largely be determined by the cost to the utilities to build and operate these facilities. Lower costs are considered desirable because they keep rates to consumers lower and make the price for energy sold to providers outside the service area more competitive. Of course the facilities used to generate this energy have to comply with emissions standards for a number of pollutants. However, without aggregate emissions caps and/or requirements for a percentage of the energy to come from renewable sources that do not add to GHG emissions, the overall level of GHG emissions will continue to rise. To the degree possible, groups within the region can act as advocates in California and Nevada for these types of policies. Policy options include:
    - Policies that support and encourage investor owned utilities to provide energy from renewable sources - These sources include geothermal, hydro, solar, waste-to-energy, and wind. Policies that require a minimum percentage of these sources in the energy portfolio of each utility are one approach that is being used and could be enhanced. Another approach is to streamline the permitting processes for development and distribution of these types of renewable energy.
    - Policies that limit the aggregate level of GHG emissions - One approach that can be effective is to create an overall cap on GHG emissions and allow the current “owners” of the permitted emissions to continue to use them or sell these as a commodity. Versions of this so-called cap and trade system are being used to manage other resources, such as water rights.
- Reductions in the GHG emissions created by generating electricity outside of the Region can also be achieved by reducing the demand for that electricity within the region. There are a number of methods that can, for the most part, be implemented within the Region to reduce demand. In general terms, they include:
    - Require new buildings in the Region to be more energy efficient (i.e., use less energy) - This can be achieved by reducing demand for energy with better insulation, more appropriate building orientation, use of vegetation, etc. It can also be achieved with more efficient HVAC systems, appliances, etc. Implementation of these measures can be realized, at least partially, through better design standards and code. This is being addressed through the creation of “green building standards” for the Region as one of the Regional Plan Final Environmental Impact Statement mitigation measures. This new

code will be prepared by January 2014 and will be partially funded by the SGC Round 2 grant.

- Retrofit existing buildings to be more energy efficient – The types of improvements that can be made to existing buildings include installing higher efficiency insulation, replacement of windows with poor insulation, use of higher efficiency appliances, etc. In many cases, an energy audit will show that the savings from making one or more of these improvements will more than offset the costs through reduced utility bills. A number of approaches can be utilized to help existing building owners and occupants make these improvements including low interest loans for retrofit projects, appliance rebates, or other financial incentives.
- Local, decentralized energy generation – Solar panels and small scale wind turbines are examples of systems that can be used to generate power for a single building or group of buildings. The energy from these types of systems can be used directly, stored for later use in batteries, or distributed back into the power grid to offset energy used from the grid at a different time. These and other systems can be used provided they are consistent with local and regional standards (e.g., scenic, noise, etc.).

Transportation and Land Use

Transportation system needs are directly related to land development patterns. The combination of the transportation and land use emissions accounted for nearly 30% of the Region's total GHG emissions in 2010.

Generally, with more concentrated and higher density development there are fewer vehicle miles travelled, especially in single occupancy vehicles. This concept, along with the desire to restore environmentally sensitive lands, led to the creation of a transfer of development rights (TDR) program with incentives (i.e., bonus units) for removing development rights and development from remote and sensitive lands. The Regional Plan map (Map 1) on page 9 shows the locations and transfer ratios applicable to existing development.

The Regional Plan also has a similar map depicting the locations and transfer ratios for development rights (i.e., undeveloped parcels that could be developed. These TDR "sending areas" are where development and development rights should be reduced. These rights can be transferred to the TDR "receiving areas" shown on Map 2 (page 10). These are the higher density, mixed use centers designated in the Regional Plan.

The more remote and environmentally sensitive a "sending" parcel is, the higher the bonus unit incentive for transferring development rights from that parcel to a "receiving" parcel in a designated center (see *Development Commodities Transfer Policies Analysis* which is part of the Lake Tahoe Sustainable Communities Program Document Series for a more detailed analysis and discussion of this system).

To further reduce single occupancy vehicle travel and GHG emissions within the designated centers they are required to have a mix of land uses; greater connectivity for pedestrians, bicyclists, and transit users to get to and from these uses and to transfer between these non-auto modes of transportation; and shared parking to encourage auto users to travel within centers. The average reduction in trips that can be expected ranges from 10% to 21%, depending on the mix of uses as shown in the table on page 9.

Map 1: Ratios for Transferring Existing Development

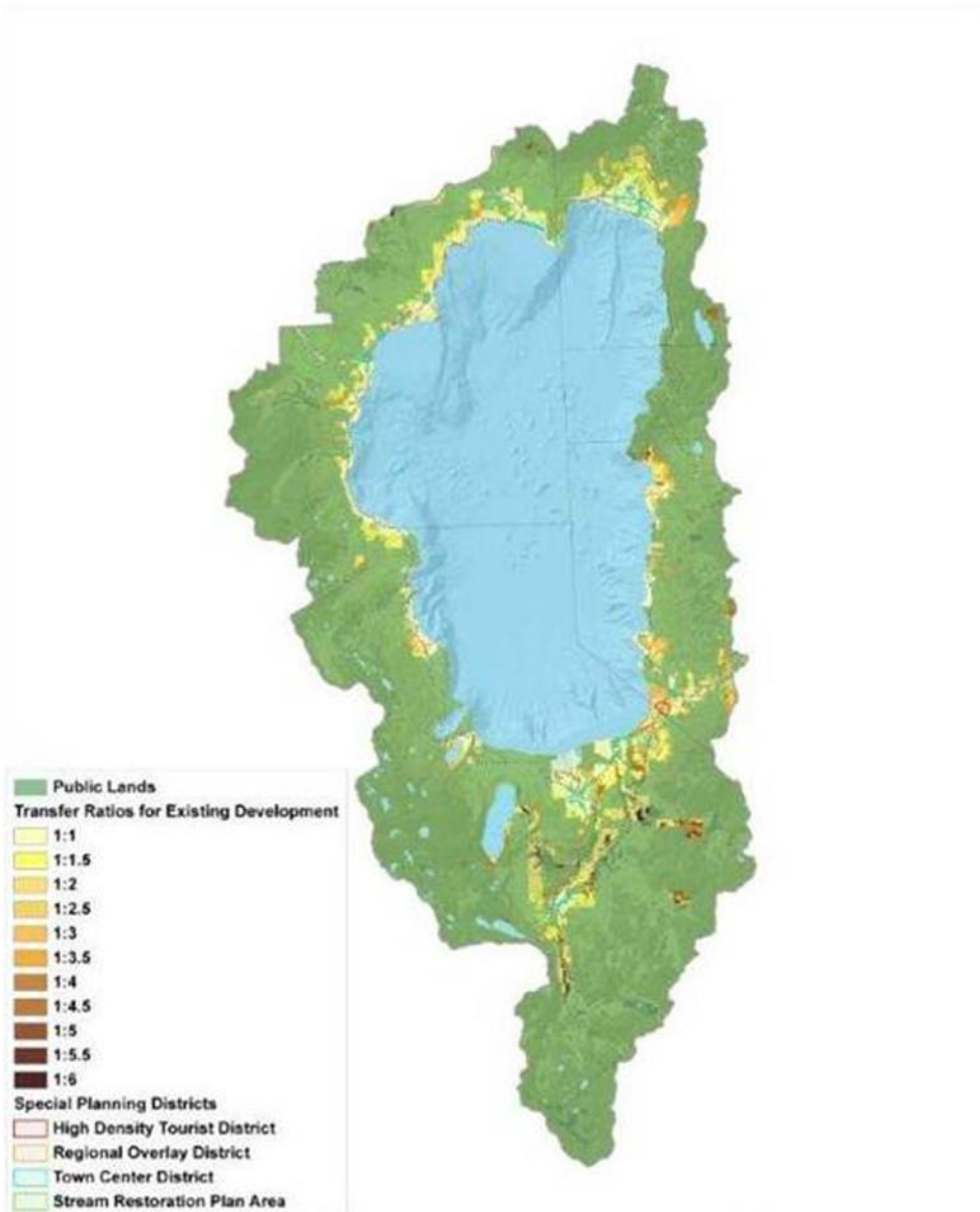
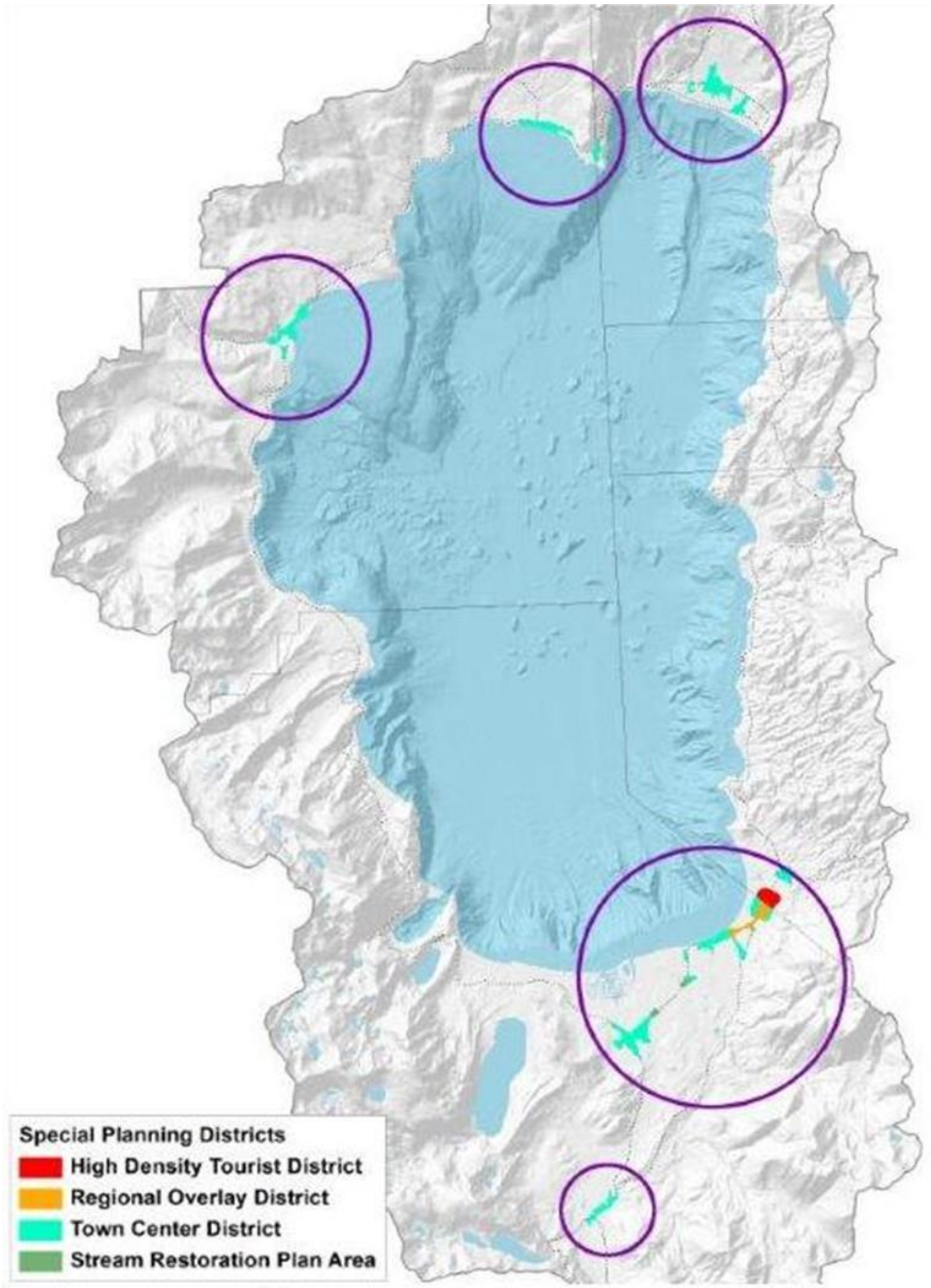


Table 2: Expected Average Percentage Trip Reduction Based on Mix of Land Uses

	Separate Uses	Office and Shopping Uses Combined	Residential, Office, and Shopping Uses Combined
Average Percent of Trips Reduced	0%	10%	21%

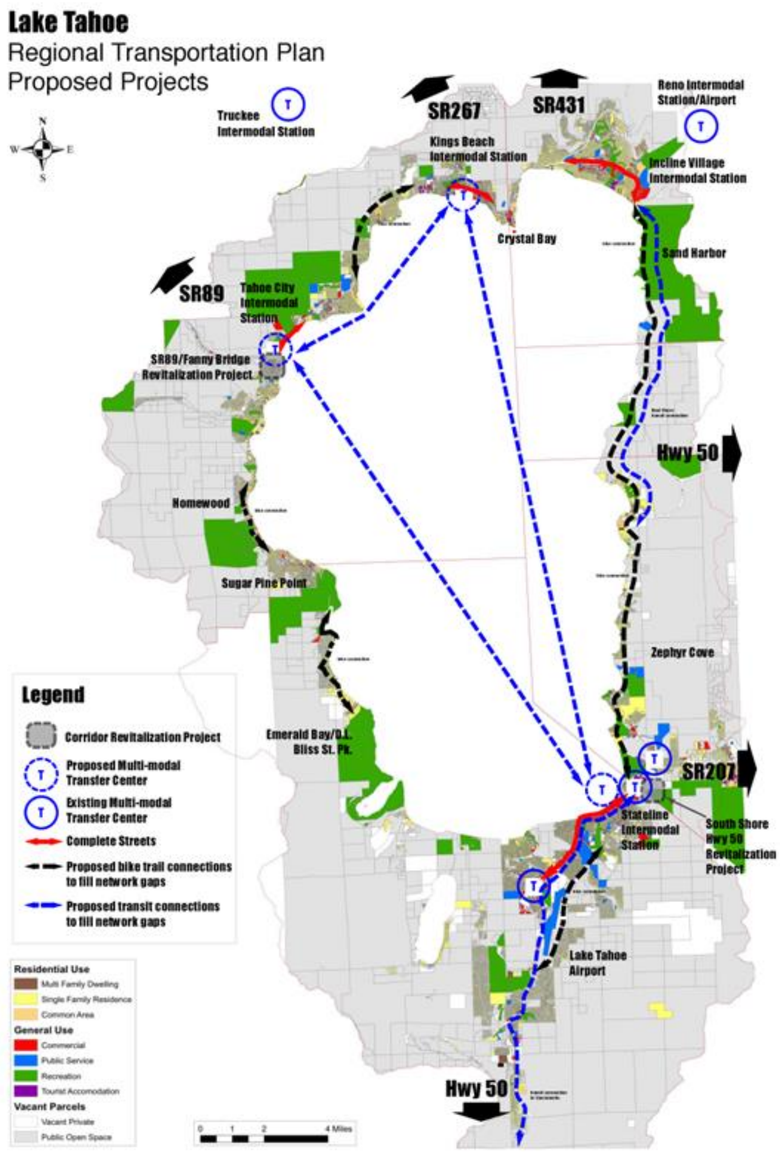
Source: Sperry, Benjamin R., Internal Trip Capture for Mixed-Use Developments, Texas A&M University, Presentation at 2007 Winter TexITE Meeting

Map 2: Receiving Areas for Transferred Development and Development Rights



Concurrently, the Regional Transportation Plan does not include projects to increase automobile capacity. Instead, the projects (Map 3 on page 11) support other modes of transportation as well as multi-modal linkages. As the demand for transportation facilities to serve remote development is reduced through the transfer of development commodities, and as alternative modes of transportation are made available in the designated centers thus reducing the need for auto-oriented transportation facilities, vehicle miles travelled and GHG emissions will also be reduced.

Map 3: Regional Transportation Plan Projects



Fuel Combustion

Fuel combustion accounted for 21% of the GHG emissions in the 2010 inventory. The vast majority of emissions from fuel combustion come from natural gas and burning wood. In 2010 natural gas comprised nearly 63% of the total, wood burning nearly 35%, and other fuels slightly over 2%. Natural gas is used in both residences and commercial establishments, while wood burning is almost exclusively used in residences.

The most effective strategies to reduce GHG emissions from fuel combustion will be to make buildings more energy efficient and to replace existing appliances. This can be achieved by reducing demand as described above in the Energy section. Implementation of these measures can be realized, as also described above, through better design standards and code, as well as by providing incentives.

Waste, Fires and Additional Strategies

The remaining 8% of GHG emissions in the 2010 inventory are attributed to waste and fires.

GHG emissions from waste come from different stage in life cycle of product: manufacture, distribution, storage and disposal. The general strategy is to reduce emissions at each stage of lifecycle. Locally produced products (e.g., food) can eliminate emissions related to distribution and storage. Recycling reduces GHG emissions by lessening the need for manufacture and distribution of products, plus it reduces waste. Composting can support local food production and eliminate disposal. Actions that foster these approaches to dealing with waste include revising development regulations to allow community gardens and greenhouses, encouraging and/or establishing farmers markets, require waste management entities to separate municipal waste streams for recycling, composting, etc.

There are two types of fires that generate GHG emissions: wildfires and prescribed burns. Emissions from these fires will depend on fuel type. The strategy to reduce emissions is to focus on prescribed burns. Both the timing and fuel type, hence the emissions, can be managed with prescribed burns. Prescribed burns also address safety concerns and reduce wildfires with potentially greater emissions.

Additional sustainability strategies, while not necessarily reducing GHG emissions, may also be included in the Sustainability Action Plan.

Appendix

A. **Draft Final Report *Development of a Regional Greenhouse Gas Emissions Inventory for the Lake Tahoe Basin***

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Sonoma Technology, Inc.
Air Quality Research and Innovative Solutions

Development of a Regional Greenhouse Gas Emissions Inventory for the Lake Tahoe Basin

Draft Final Report

Prepared for

The California Tahoe Conservancy
South Lake Tahoe, CA

May 2012

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Development of a Regional Greenhouse Gas Emissions Inventory for the Lake Tahoe Basin

Draft Final Report
STI-911006-5371-DFR

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Cover graphic illustrates the Lake Tahoe shoreline.

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1. Introduction

This report documents the methods used to develop baseline and future-year regional greenhouse gas (GHG) emissions inventories for the Lake Tahoe Basin. This work was funded and managed by the California Tahoe Conservancy (CTC), and GHG emissions estimates were developed by Sonoma Technology, Inc. (STI) under subcontract to the University of California at Davis (UCD).

1.1 Background

In 1987, the Tahoe Regional Planning Agency (TRPA), a bi-state environmental planning agency that oversees development at Lake Tahoe, adopted a Regional Plan for achieving environmental quality standards (or thresholds) previously established by the TRPA Governing Board. These thresholds define goals for the Lake Tahoe Basin (the Basin) with regard to water quality, soil conservation, air quality, vegetation, and other environmental concerns.

In 1997, the Lake Tahoe Environmental Improvement Program (EIP) was created to better implement the Regional Plan by identifying hundreds of projects and programs designed to achieve and maintain the Basin's environmental thresholds. Recently, EIP stakeholders and partners identified a fundamental knowledge gap regarding the direct and indirect[1] emissions of GHGs in the Lake Tahoe region. To address this gap, the CTC, an EIP partner agency, funded the development of a regional GHG emissions inventory designed to establish a baseline of information on current and forecasted GHG emissions by source sector so planning agencies can set emissions reduction targets, develop mitigation strategies, and establish incentive programs within the regional planning process.

In addition, the results of the GHG inventory project will provide essential information to EIP agencies and stakeholders as they participate in initiatives originating from California Assembly Bill 32 (AB 32, or the Global Warming Solutions Act), which requires statewide GHG emissions to return to 1990 levels by 2020. For example, Tahoe planning agencies are required to meet regional GHG reduction targets through integrated land use and transportation planning as part of Senate Bill 375 (SB 375), the Sustainable Communities and Climate Protection Act.

1.2 Technical Issues

1.2.1 Overview

The greenhouse effect is a natural process that traps radiant heat in the Earth's lower atmosphere, making the planet habitable. The Earth's surface absorbs sunlight and emits infrared radiation (heat) to the atmosphere, a portion of which is absorbed and re-emitted by

[1] Direct emissions are emitted by sources located within the region of interest, while indirect emissions are emitted by sources outside the region of interest but result from activities occurring within the region (e.g., electricity consumption).

GHGs such as carbon dioxide (CO_2),[2] capturing heat that would otherwise escape into space. Over time, human activities have added to the naturally occurring levels of GHGs in the atmosphere, thereby enhancing the greenhouse effect.

A GHG emissions inventory provides a detailed estimate of the amount of GHGs emitted into the atmosphere annually by various emissions sources across a given geographic area. This quantification of GHG emissions from various source sectors is the first step toward developing strategies for reducing such emissions over time.

In general, GHG emissions are calculated by quantifying the intensity of emissions- producing activities and then applying appropriate emission factors to the activity data. Emission factors represent the amount of a given pollutant emitted per unit of activity, and for CO_2, emission factors are generally derived from the characteristics of the fuel combusted. For a given fuel, a CO_2 emission factor is calculated using the fuel's carbon coefficient and heat content and an oxidation factor that accounts for the fraction of carbon that may not be oxidized during combustion, as shown in **Equation 1** (California Climate Action Registry, 2009):

$$EF = \text{Heat Content} \times \text{Carbon Coefficient} \times \text{Oxidation Factor} \times 44/12 \quad \textbf{(1)}$$

Where:

EF = CO_2 emission factor (kg CO_2/gallon)
Heat Content = energy per unit volume (BTU/gallon)
Carbon Coefficient = mass of carbon (C) per energy unit (kg C/BTU)
Oxidation Factor = fraction of carbon oxidized (default = 1.0)
44/12 = ratio of the molecular weight of CO_2 to that of carbon

GHG emissions inventory methods and protocols providing guidance on activity data and emission factors have been established by the Intergovernmental Panel on Climate Change (2006), the California Climate Action Registry (2009), the U.S. Energy Information Administration (2008), and the U.S. Environmental Protection Agency (2009). STI based the inventory methodologies for this project on these established protocols.

1.2.2 Key Inventory Steps

In keeping with established methods and protocols, the inventory development process involved a number of key decisions and steps:

- **Engaging project stakeholders** – At the outset of the project, CTC and STI convened a GHG inventory work group consisting of staff from local planning agencies and research institutions (see Acknowledgements). The work group provided guidance in selecting inventory years, identifying available data, and coordinating the project with other planning efforts for the Basin.

[2] The six "Kyoto" GHGs are CO_2, methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6).

- **Establishing inventory boundaries** – The geographic scope of this inventory is defined by TRPA's jurisdictional boundaries, which lie within the borders of both California and Nevada. The California side of the Basin includes portions of Placer and El Dorado counties, while the Nevada side includes portions of Douglas County, Washoe County, and Carson City (see **Figure 1-1**). Because of the multiple entities present within the Basin, the GHG emissions estimates developed during the project were geographically disaggregated so the contributions of individual counties and cities could be assessed.
- **Selecting inventory years** – In consultation with the GHG inventory work group, CTC selected 2005 as the baseline inventory year on the basis of data availability and the compatibility of 2005 with other planning efforts (e.g., 2005 is also the baseline year for regional GHG reduction targets being developed for the Basin in response to SB 375). CTC also requested that emission estimates be prepared for 2010 to quantify the impact of the recent economic downturn on GHG emissions in the Basin. Future-year emissions estimates were prepared for 2020 and 2035, which also align with SB 375 target years and other regional planning efforts.
- **Identifying emissions sources** – STI worked with CTC and the GHG inventory work group to identify the emissions sources to be included in the inventories (see **Table 1-1**). The Tahoe Basin includes source categories that are typically not of concern in municipal GHG inventories (e.g., forestry, wildfires, and recreational boats), and also lacks industrial facilities that would normally be included in GHG inventories (e.g., cement production and iron and steel manufacturing).
- **Collecting activity data** – STI worked with CTC and the GHG inventory work group to identify and review available data for characterizing baseline and future-year GHG emissions in the Basin. On the basis of this review, STI compiled a list of primary data sources recommended for GHG emissions estimation, as well as secondary sources of data that could be used if primary data were not available for years of interest (Reid et al., 2011). Data sets used to estimate and forecast emissions for specific source categories are documented in Section 2 of this report.
- **Prioritizing source sectors** – To allocate available resources appropriately, STI made an initial estimate of GHG emissions associated with key source sectors and with source sectors that are not well-characterized in existing emissions inventories for the Basin. On the basis of this analysis, STI prioritized several source categories (e.g., on-road motor vehicles, electricity usage, residential wood combustion, and recreational boats) and determined that other source categories were unlikely to be significant sources of GHG emissions in the Basin (e.g., construction equipment and lawn and garden equipment) and could therefore be addressed with readily available data.

More detailed information about the data and methods used to estimate GHG emissions for the Tahoe Basin is provided in Section 2 of this report.

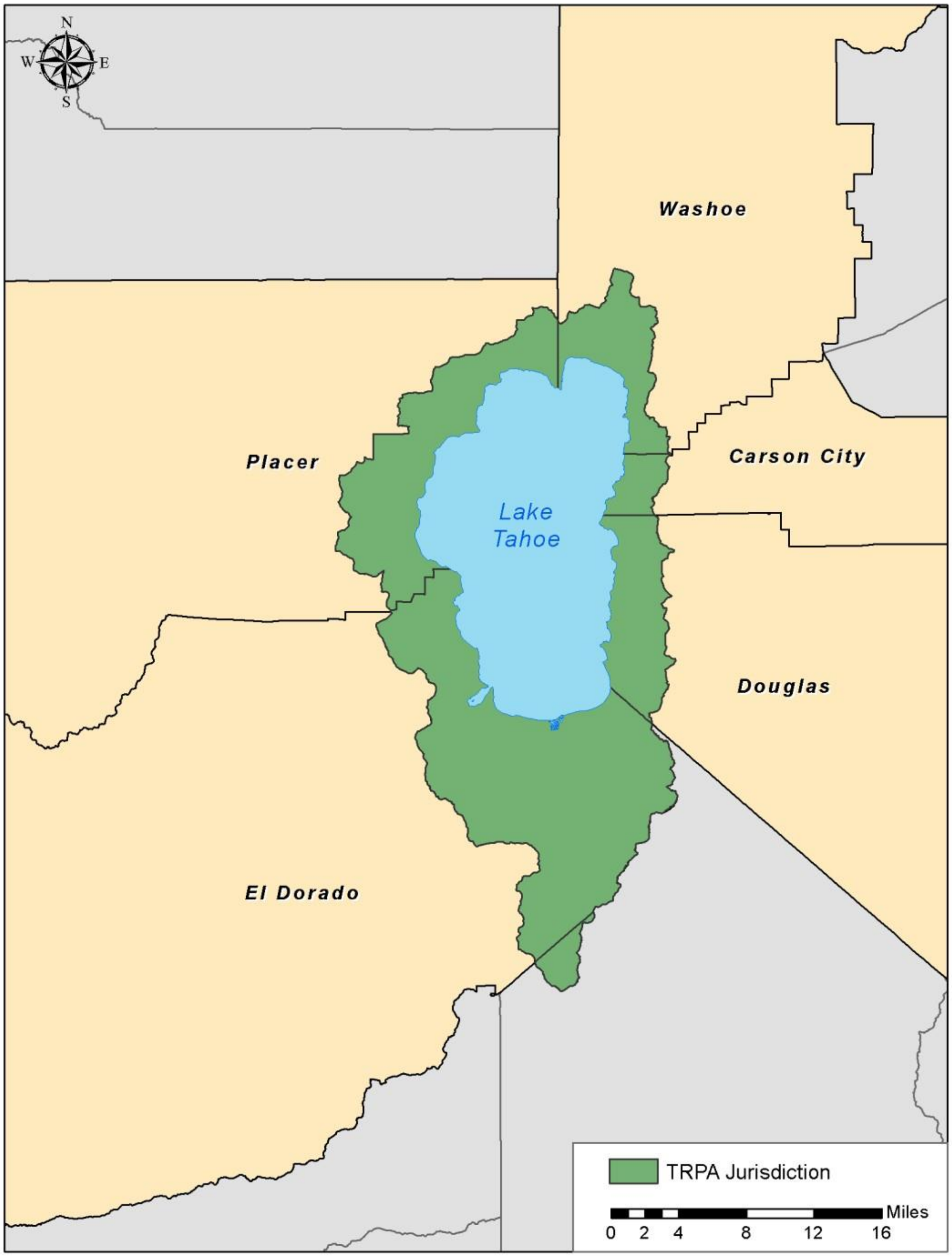

Figure 1-1. Map of TRPA's jurisdictional boundaries around Lake Tahoe Basin.

Table 1-1. Source categories included in the GHG emissions inventories for the Lake Tahoe Basin.

Emissions Type	Source Sector	Source Category
Direct	Transportation	On-road mobile sources (motor vehicles: passenger cars, trucks, buses)
		Off-road vehicles (boats, snowmobiles, lawn and garden equipment, etc.)
		Wood combustion (campfires, fireplaces, stoves)
	Fuel combustion	Natural gas combustion (residential and commercial)
		Other fuel combustion
		On-road mobile sources (motor vehicles: passenger cars, trucks, buses)
	Fires	Wildfires and prescribed burns
	Land use	Livestock
		Forestry carbon stock
	Waste	Wastewater treatment
Indirect	Energy	Electricity consumption
		Wastewater treatment
	Transportation	Aircraft
	Waste	Municipal solid waste

1.3 Emissions Summary

The Lake Tahoe Basin generated approximately 1,313,511 metric tons of CO_2-equivalent[3] (CO_2e) emissions in 2005 and approximately 1,392,737 metric tons of CO_2e emissions in 2010. Electricity generation represents the largest source of emissions, producing 487,553 metric tons of CO_2e in 2005 and 562,543 metric tons of CO_2e in 2010 (see **Table 1-2**). These emission levels represent over 38% the total CO_2e emissions in each year, as shown in **Figure 1-2**). The transportation sector was the next largest source, accounting for 31% of total of total CO_2e emissions in 2005 and 29% of total CO_2e emissions in 2010. The third largest source is fuel combustion, which includes wood, natural gas, and other fuel combustion sources. Fuel combustion in the Basin accounts for over 20% of total CO_2e emissions in 2005 and 2010. The other source sectors (fires, land use, and waste) account for only about 8% of the total CO_2e emissions in 2005 and 2010.

[3] Emissions for non-CO_2 GHGs are converted to CO_2-equivalent values based on each GHG's global warming potential (GWP). GWP is an index that quantifies the radiative forcing effects of a given GHG using CO_2 as the reference gas (California Climate Action Registry, 2009).

Table 1-2. Basin-wide CO_2e emissions by source sector and category (metric tons/year).

Type	Source Sector	Source Category	2005	2010
Direct	Transportation	On-road mobile sources	331,476	319,106
		Recreational boats	22,403	15,994
		Other off-road equipment	53,860	58,751
	Fuel combustion	Wood combustion	97,700	104,297
		Natural gas combustion	179,885	187,755
		Other fuel combustion	5,858	6,161
	Fires	Wildfires and prescribed burns	4,284	91,652
	Land use	Livestock	12,734	12,734
Indirect	Energy	Electricity consumption	487,553	562,543
		Wastewater treatment	2,115	2,300
	Transportation	Aircraft	5,131	4,739
	Waste	Municipal solid waste	110,512	26,704
Total Emissions			**1,313,511**	**1,392,737**

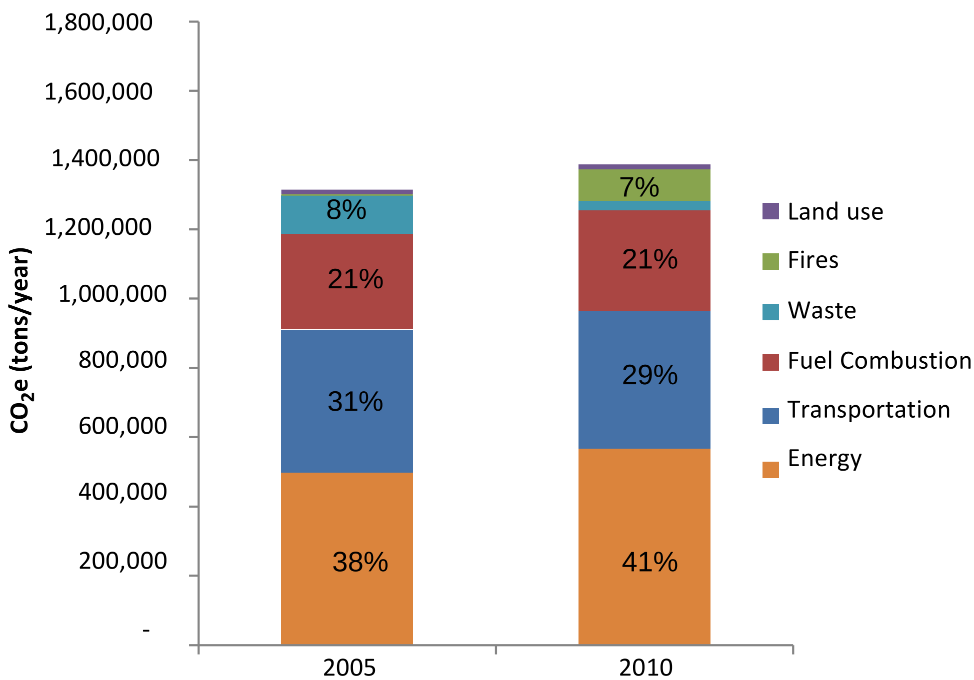

Figure 1-2. Basin-wide CO_2e emissions breakdown by source sector for 2005 and 2010.

In the remainder of this document, we further describe the data sources and methods used to develop GHG emissions estimates for the Lake Tahoe region for the baseline and future years. We also discuss the key findings and results of the emissions inventories for the baseline and future years, and present recommendations for improving these inventories.

2. Technical Approach

For the GHG inventory, emissions were calculated from emission factors and activity data. Emission factors represent the amount of a given pollutant emitted from a source per unit of activity (e.g., grams of CO_2 per gallon of fuel burned); for CO_2, emission factors are derived from the characteristics of the fuel combusted. For a given fuel, a CO_2 emission factor is calculated using the fuel's carbon coefficient and heat content and an oxidation factor that accounts for the fraction of carbon that may not be oxidized during combustion, information that is readily available from GHG reporting protocols (California Climate Action Registry, 2008).

Activity data represent the intensity of an emissions-producing activity or process (e.g., fuel consumption or product output). For the Tahoe Basin GHG inventory, activity data was collected for the source sectors listed in Table 1-1. Required activity data for the Basin include annual vehicle miles traveled (VMT), electricity consumption in megawatt-hours (MWh), total fuel consumption by residences and businesses (wood, natural gas, etc.), and prescribed burning acreages.

The following sections summarize the technical approach used to estimate GHG emissions for each source category in the baseline inventories, as well as the methods used to project the baseline emissions to 2020 and 2035. More detailed information on the emission factors and activity data used to estimate GHG emissions for each category is provided in **Appendix A**.

2.1 Source Categories

2.1.1 On-Road Motor Vehicles

CO_2 emissions, which represent the majority of GHG emissions from motor vehicles, are directly related to the quantity of fuel combusted. For a regional inventory, it is very difficult to convert available fuel sales data into estimates of fuel consumed within the study area. First, fuel sales are typically tracked at the state or county level and are not readily apportioned to sub-county areas like those in the Basin. Also, fuel sold within the Basin is consumed in areas outside the Basin, just as fuel sold outside the Basin is consumed within the Basin. Therefore, the preferred approach is to develop VMT estimates from available traffic counts and travel demand model outputs and convert those VMT data to fuel consumption using fuel economy estimates for vehicles in the region of interest.[4] In addition, VMT data are required to estimate CH_4 and nitrous oxide (N_2O) emissions from motor vehicles; these emissions depend on vehicle control technologies and are therefore based on vehicle characteristics and distance traveled (California Climate Action Registry, 2008).

Vehicle activity data was available from TRPA's TransCAD travel demand model (see **Figure 2-1** for network coverage). TransCAD is a geographic information system (GIS)-based traffic model for which development began in 2004. For the Basin, TransCAD was informed by

[4] For CO_2 emissions calculations, VMT data were converted to fuel consumption estimates using vehicle classifications and fuel economy data from the California Air Resources Board's (ARB's) EMFAC2011 on-road mobile source emissions model (see Appendix A).

a travel survey that collected data from over 1,200 households (Tahoe Regional Planning Agency, 2008). To calculate GHG emissions, VMT outputs from TransCAD must be classified by the following vehicle trip types:

- Internal: trips begin and end within the Basin.
- Internal-external: trips begin in the Basin and end outside the Basin, or vice versa.
- External-external: trips begin and end outside the Basin (i.e., pass-through trips).

The requirement to classify the VMT outputs is driven by SB 375, which requires local planning agencies to meet regional GHG reduction targets through integrated land use and transportation planning. According to SB 375 guidance documents, VMT totals for estimating GHG emissions in a given region should include all internal trips, half of the internal-external trips, and none of the external-external trips (Regional Targets Advisory Committee, 2009). For the base years, this formula results in GHG VMT estimates for the basin of 1,539,088 miles per day for 2005 and 1,459,299 miles per day for 2010.[5]

These VMT data were converted to fuel consumption estimates using fuel economy data derived from ARB's EMFAC2011 model. The resulting fuel consumption estimates were combined with CO_2 emission factors to estimate CO_2 emissions. For CH_4 and N_2O, VMT data were combined directly with emission factors to estimate emissions. Emissions were allocated to various jurisdictions within the Basin (i.e., counties and the City of South Lake Tahoe) based on the distribution of VMT data across TRPA's transportation network. Additional details on these calculation steps are provided in Appendix A.

[5] Total VMT for the Basin, including external-external trips, is summarized in Appendix A.

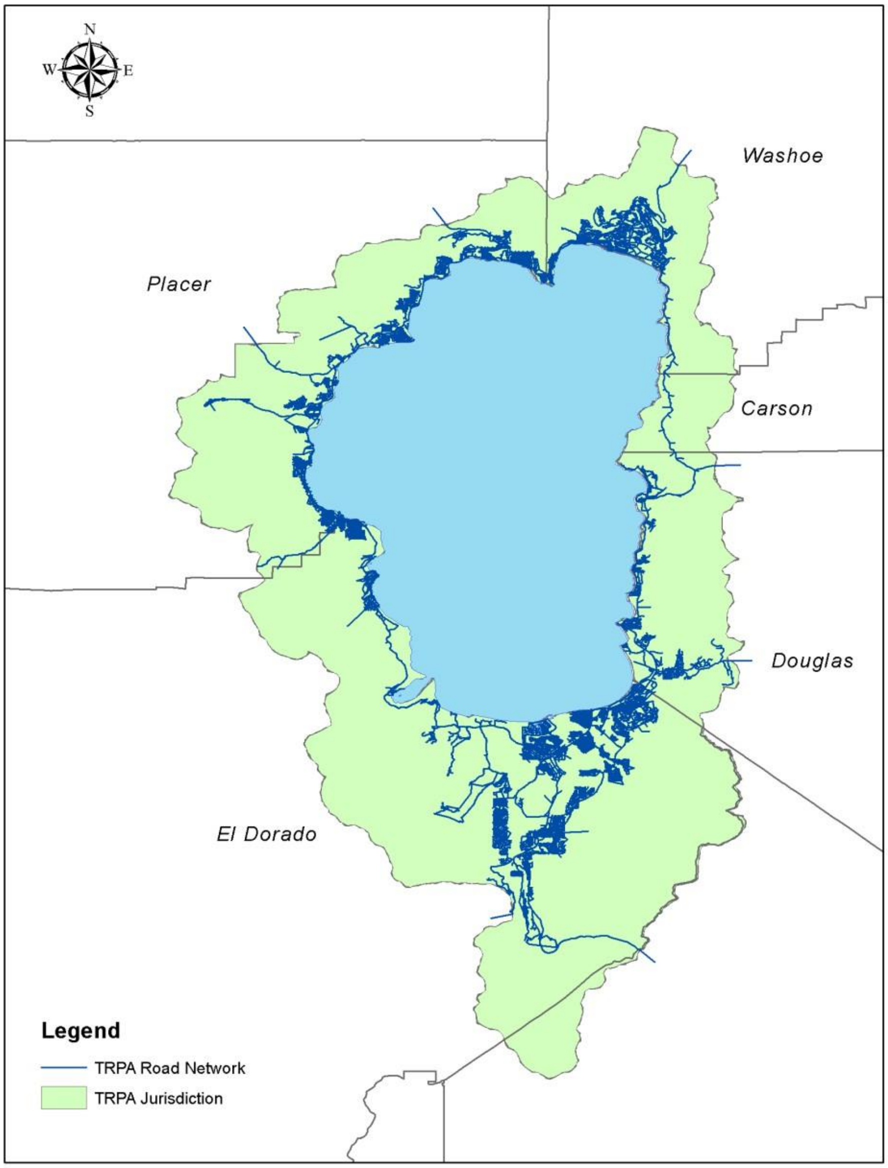

Figure 2-1. TRPA on-road network.

2.1.2 Recreational Boats

For recreational boats operating in Lake Tahoe, baseline emissions were estimated using fuel consumption activity from TRPA and relevant emission factors from the California Climate Action Registry's general reporting protocol (California Climate Action Registry, 2008). TRPA developed estimates of annual launches, fuel consumption, and emissions as part of the development of an environmental impact statement (EIS) for the Lake Tahoe Shorezone (Tahoe Regional Planning Agency, 2006). These estimates included fuel use and hours of operation estimates for recreational boats for 2004 and 2010 (2005 was estimated by interpolating between 2004 and 2010), as well as activity forecast data for various scenarios for 2014 and

2027. Fuel consumption estimates were summed by engine type and fuel type (gasoline and diesel) and then multiplied by appropriate emissions factors.

The Basin-wide emissions for recreational boats were allocated to the county level using boat launch locations provided in the Shorezone study (see **Table 2-1**). The Shoreline study provided a list of existing marinas and boat ramps in the Basin and each marina was assigned the appropriate county.

Table 2-1. County-level locations of boat launches.

<table>
<tr><th>County</th><th>% of Total Launches</th><th>Lake Area (km^2)</th><th>% of Total Area</th></tr>
<tr><td>El Dorado</td><td>10%</td><td rowspan="2">142.57</td><td rowspan="2">31%</td></tr>
<tr><td>South Lake Tahoe (SLT)</td><td>22%</td></tr>
<tr><td>Placer</td><td>36%</td><td>203.49</td><td>44%</td></tr>
<tr><td>Douglas</td><td>18%</td><td>65.53</td><td>14%</td></tr>
<tr><td>Washoe</td><td>14%</td><td>54.65</td><td>12%</td></tr>
</table>

2.1.3 Aircraft (Indirect)

Aircraft emissions were estimated for the Lake Tahoe airport using fuel data collected for 2010 and fuel combustion emissions factors from the California Climate Action Registry's general reporting protocol (California Climate Action Registry, 2008). Fuel consumption for jet fuel and aviation gasoline was provided by the airport's fuel vendor for 2009 and 2010 (Golden, 2011). In 2005, the airport used a different fuel vendor and the fuel consumption data were unavailable; therefore, 2005 fuel consumption was estimated by scaling the 2010 fuel consumption using airport traffic activity from the Federal Aviation Administration (FAA)[6].

Since the airport lies in the jurisdiction of the City of South Lake Tahoe, all emissions from the airport were geographically allocated to South Lake Tahoe/El Dorado County (see **Figure 2-2**).

[6] Airport traffic activity data available from the FAA website (http://aspm.faa.gov/main/taf.asp) .

Figure 2-2. Location of the Lake Tahoe Airport.

2.1.4 Other Off-Road Equipment

Emissions for all other off-road equipment were estimated using emissions and fuel consumption output from ARB's OFFROAD2007 model. The OFFROAD2007 model addresses a wide variety of off-road equipment types, including recreational vehicles, lawn and garden equipment, and construction equipment. The model relies on county-level equipment populations and activity data (e.g., annual hours of operation) to estimate emissions and fuel consumption. STI used the model to estimate emissions for off-road equipment in the California portion of the Basin, except for off-road sources for which more refined local estimates are available (e.g., recreational boats). In keeping with previous emissions inventory development for the Basin conducted by the Desert Research Institute (DRI) (Gertler et al., 2008), emissions for the California side were scaled up to account for the Nevada side of the Basin using the ratio of Basin-wide population for California and Nevada to the population of the California side of the Basin only.

2.1.5 Wood Combustion

Wood fuel combustion was calculated using wood burning activity estimates from a local wood burning survey, the number of Basin-wide households and visitors, and emission factors from the California Climate Action Registry's general reporting protocol (California Climate Action Registry, 2008). TRPA and researchers from the University of California, Riverside (UCR) conducted wood burning surveys in 2002, collecting information on residential wood combustion during winter months and campfire wood combustion during summer months (Fitz and Lents, 2004). UCR researchers used results of these surveys to estimate the distribution of wood-burning appliances (e.g., woodstove, fireplace with insert, fireplace without insert, and pellet stove) in the region, the type of wood burned (hardwood versus softwood), and the average quantity of wood burned per day. In 2004, the UCR results were revisited and updated by researchers at DRI as part of the development of an improved particulate matter (PM) emissions inventory for the Tahoe Region (Kuhns et al., 2004).

These updated activity data for 2004 were used to represent 2005 activity levels for wood combustion. To represent 2010 levels, the 2004 data were adjusted based on the change in total households between 2004 and 2010. The resulting emission estimates derived from these activity data were allocated to jurisdictions across the Basin using census data (U.S. Census Bureau, 2000) representing the number of households that use wood as their primary home heating source (see **Table 2-2**).

Table 2-2. Households that use wood as their primary home heating source (from the 2000 U.S. Census).

County	Households	Percentage
El Dorado County (including SLT)	503	50%
Placer	403	40%
Douglas	68	7%
Washoe	35	3%
Basin Total	**1,009**	**100%**

2.1.6 Natural Gas Fuel Combustion

Natural gas fuel combustion emissions were calculated using fuel consumption activity from local utilities and emission factors from the California Climate Action Registry's general reporting protocol (California Climate Action Registry, 2008). STI worked with CTC to acquire 2005 and 2010 activity data for total fuel consumption from the local utilities.[7]

- For most of the Basin, Southwest Gas, the primary provider of natural gas to residential and commercial customers, provided activity data for total consumption for residential and commercial gas use.
- For areas not covered by Southwest Gas data, i.e., the City of South Lake Tahoe and the unincorporated portion of El Dorado County, residential natural gas consumption rates derived from the Southwest Gas data were applied to the number of households in these areas to estimate residential fuel usage.
- Commercial fuel use was derived based on the ratio of residential to commercial usage from the data provide by Southwest Gas. This step was required because PG&E did not provide activity data in time for use in this inventory.

Figure 2-3 provides a summary of natural gas usage (in million British Thermal Units [MMBtu]) for 2005 and 2010 for the Basin.

[7] Southwest Gas provides service to Placer, Washoe, and Douglas counties. Pacific Gas and Electric (PG&E) serves El Dorado County.

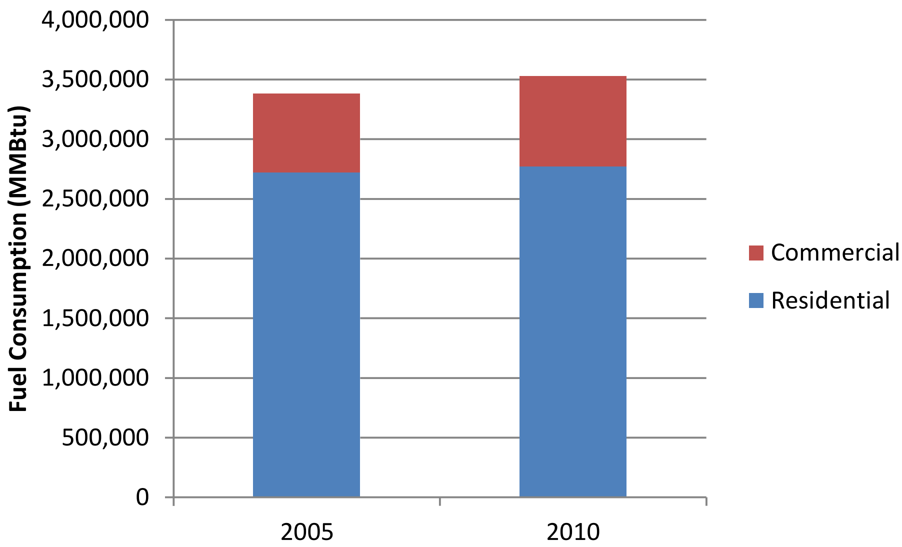

Figure 2-3. Basin-wide natural gas usage for residential and commercial use.

2.1.7 Other Fuel Combustion

Emissions from the combustion of propane (liquefied petroleum gas [LPG]) and distillate oil were calculated based on (1) number of households using these fuels for home heating and (2) emission factors from the California Climate Action Registry's general reporting protocol (California Climate Action Registry, 2008). Since propane is an unregulated fuel in California, no data are collected on sales or usage. In a guidance document for regional GHG inventories, EPA recommends that, in the absence of detailed consumption data, consumption be estimated based on the number of heating degree days (HDDs)[8] in the region for the year of interest, the number of households using LPG as heating fuel, and an average household consumption rate of 11,647 British Thermal Units (Btu per HDD (U.S. Environmental Protection Agency, 2009). We applied this methodology using census data on home heating fuels and annual average heating degree day values for 2005 and 2010 from the Western Regional Climate Center (Western Regional Climate Center, 2012).

Resulting emissions estimates were assigned to geographic jurisdictions based on census-tract-level information on the number of households using propane or distillate oil as their primary home heating fuel (see Appendix A).

2.1.8 Wildfires and Prescribed Burns

Emissions from wildfires and prescribed burns are a function of the type and amount of vegetation consumed by each fire event. Previously, STI generated a national inventory of CO_2 emissions from fires using the BlueSky Smoke Modeling Framework, a system developed by STI and the USDA Forest Service (Raffuse et al., 2008). The BlueSky system reconciles

[8] HDDs provide a representation of how cold a region's average temperature was over some period of interest and are calculated as the difference between a day's average temperature and some base temperature (e.g., 65° F).

satellite fire detections with ground-based reports to estimate the area burned by each fire event, then uses detailed land cover data, fuel consumption algorithms, and emission factors to calculate the type and amount of vegetation burned and the resulting emissions. The BlueSky system includes the SmartFire model (Raffuse et al., 2009), a geospatial processing tool that aggregates and reconciles information about when and where fires occur.

In addition, the California Department of Forestry and Fire Protection (CalFire) maintains a GIS database of fire history as part of its Fire and Resource Assessment Program (FRAP). The CalFire data is available for years back to 1990 and were used to verify BlueSky data and evaluate fire trends.

The BlueSky/SmartFire system was used to develop activity data for 2005 and 2010 for major wildfires and large prescribed burns. For smaller prescribed fires (e.g., pile burns) that are not captured by SmartFire, activity data were derived from the Lake Tahoe Fuel Reduction Plan (USDA Forest Service, 2007) and other sources that describe forest management and fire activities in the Basin. Those sources include the Lake Tahoe Basin Management Unit of the United States Department of Agriculture (USDA) Forest Service website (USDA Forest Service, 2012) and local newspaper articles (Osborn, 2012).

These data indicate that wildfire and prescribed burning activities vary greatly from year to year within the Basin, as shown in **Figure 2-4**. Between 2001 and 2010, according to CalFire, all prescribed burning activities occurred in 2006, while wildfires predominantly occurred in 2007. For 2005, activity data was low since there were no wildfires and less prescribed burning. For 2010, fire activity was higher since there was a recorded wildfire and increased prescribed burning.

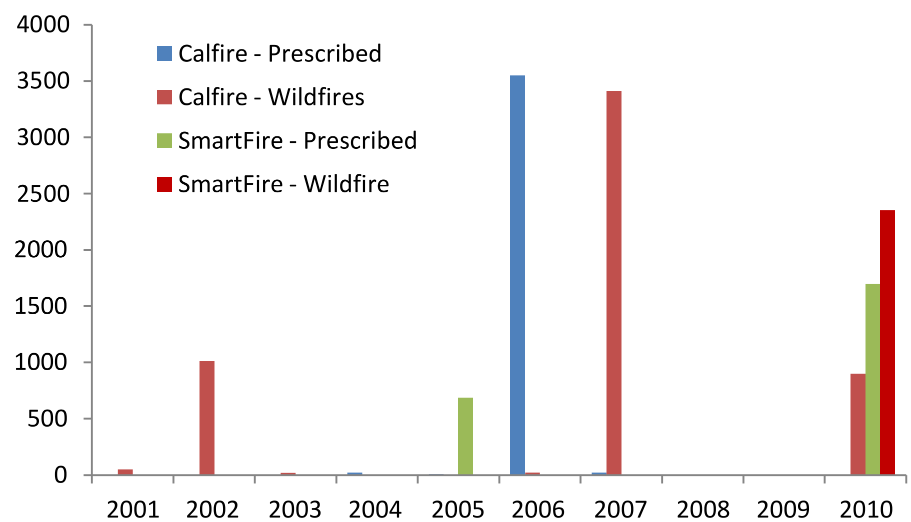

Figure 2-4. Summary of acres burned by wildfire and prescribed burns in the Lake Tahoe Basin, 2001–2010.

2.1.9 Livestock

Emissions from livestock were based on ARB estimates of animal populations in the Basin and emission factors for each animal type from EPA GHG guidance documents (U.S. Environmental Protection Agency, 2009). ARB produces refined livestock population estimates by county and air basin (Reid et al., 2008). These estimates combine statewide summaries of livestock populations from the annual Agricultural Resource Directory for dairy and beef cows published by the California Department of Food and Agriculture and the Agricultural Census developed by the USDA, providing populations for other animal types (e.g., swine, sheep, horses, and goats). The most recent population numbers (which are from 2003) were downloaded from ARB's website. These numbers were held as being constant for 2005 and 2010.

2.1.10 Solid Waste (Indirect)

GHG emissions from solid waste are a result of methane generation from the anaerobic decomposition of organic wastes deposited in a landfill. Because of this process, emission rates are a function of the amount of waste generated and type of waste generated (e.g., paper products, food waste, plant debris, wood/textiles) within the region of interest. In addition, methane recovery systems at regional landfills must be taken into account where applicable.

Because emissions from landfills continue for many years after waste disposal, two methods exist for estimating GHG emissions from this source. The Waste-in-Place method quantifies the annual amount of methane emitted by a given landfill, regardless of when the waste was disposed. The Methane Commitment method calculates emissions resulting from waste disposed in a given year, regardless of when the emissions occur. The former method requires historical waste disposal information and is not sensitive to source reduction or recycling activities. Moreover, waste from the Tahoe Basin is sent to Lockwood Regional Landfill in Storey County, Nevada, so the actual methane emissions are occurring outside the Basin at a facility that Basin agencies have no direct control over. Therefore, the Methane Commitment method was used to estimate emissions for waste generated in the Basin during 2005 and 2010, and these emissions are treated as an indirect source in the inventory.

Emissions estimates for solid waste were calculated using data on solid waste generation from local utilities (South Tahoe Refuse and Tahoe Truckee Sierra Disposal) and the solid waste module in the International Council for Local Environmental Initiative's (ICLEI) Clean Air and Climate Protection (CACP) software. The CACP solid waste module is based on EPA's Waste Reduction Model (WARM); it calculates methane emissions based on the amount and type of waste generated in a given year and the capture efficiency of the methane recovery system at the landfill in question.

For the Basin, 165,460 tons of solid waste were generated in 2005 and 159,915 tons were generated in 2010. These totals were broken down into waste types (e.g., paper, food, etc.) using waste composition percentages developed by the California Integrated Waste Management Board (CalRecycle) (Cascadia Consulting Group, 2009). Because Lockwood Landfill did not have a methane recovery system prior to 2009 (Ling-Barnes, 2010), emissions estimates for 2005 (110,512 tons of CO_2e) are much higher than for 2010 (26,704 tons of CO_2e) (see **Figure 2-5**).

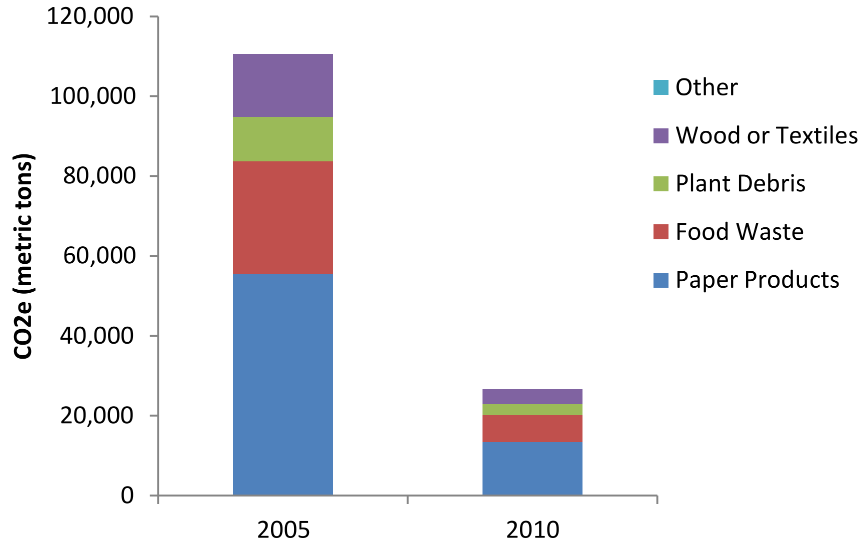

Figure 2-5. CO_2e emissions by type of waste for 2005 and 2010.

2.1.11 Wastewater Treatment

Three wastewater treatment plants currently operate in the Basin. They are managed by the South Lake Tahoe Public Utilities District, Douglas County Sewer Improvement District #1, and Incline Village General Improvement District (see **Figure 2-6**). In addition, a portion of the wastewater from Tahoe's north shore is sent to a treatment plant in Truckee operated by the Tahoe-Truckee Sanitation Agency.STI contacted these facilities and gathered information on annual wastewater throughput, wastewater treatment methods, and any control systems for methane that may be in use.

The wastewater treatment method is an important consideration, as anaerobic methods rely on bacterial processes that are carried out in the absence of oxygen and produce methane emissions. On the other hand, aerobic treatment systems, which are generally used at smaller- scale facilities, do not produce methane emissions. We found that all four facilities identified above treat their wastewater aerobically; therefore no methane emissions are produced at these facilities. However, electricity consumption at the Truckee facility was obtained from staff at that facility and treated as an indirect source in the inventory.

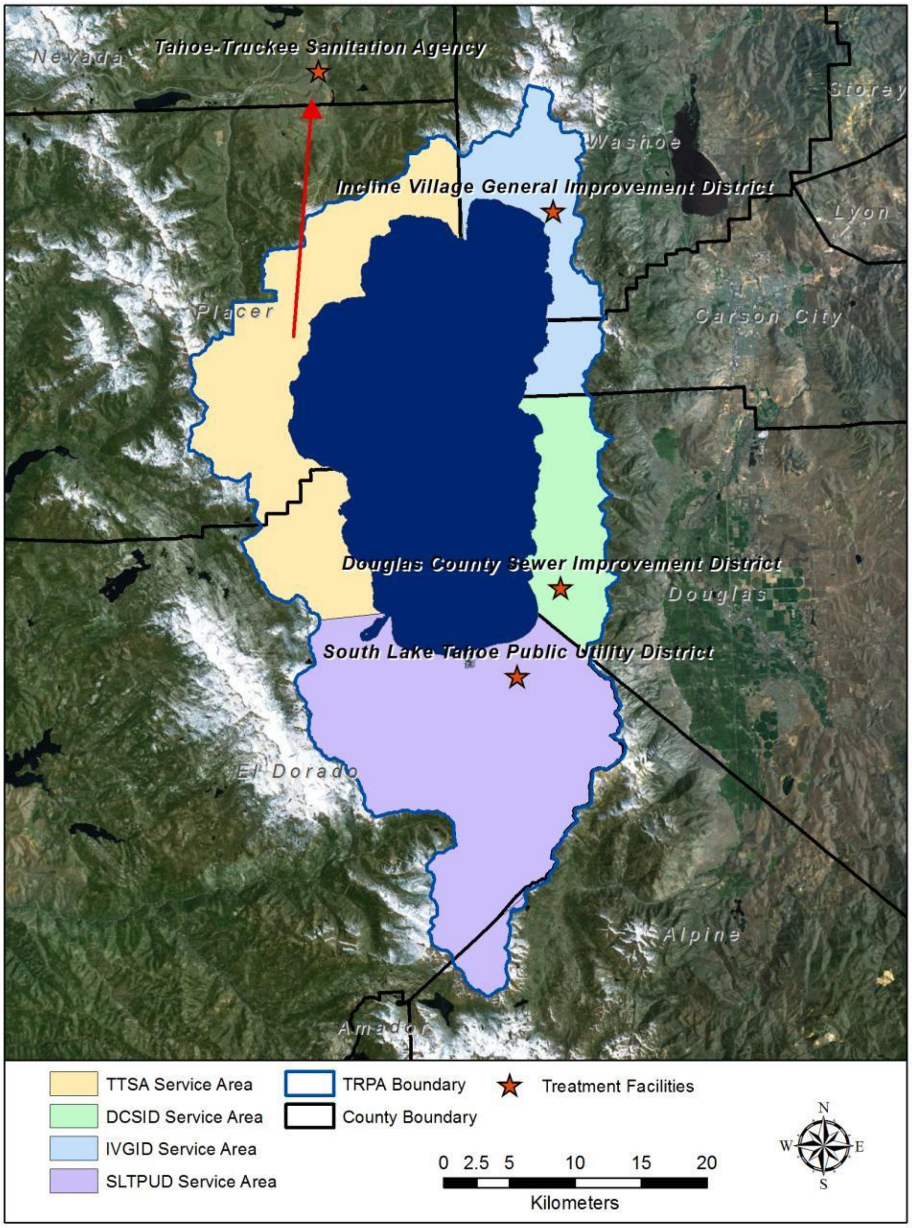

Figure 2-6. Locations of waste water treatment plants that service the Basin.

2.1.12 Electricity Consumption (Indirect)

Emissions from electricity consumption were calculated using activity information from local utilities (Nevada Energy and Liberty Energy) and emission factors from local utilities and the California Climate Action Registry's general reporting protocol (California Climate Action Registry, 2008). STI worked with CTC to acquire electricity consumption (in megawatt-hours [MWh]) for commercial, government, and residential activity from Liberty Energy, which services the California side of the Basin, and residential and commercial activity from Nevada Energy, which services the Nevada side of the Basin. **Figure 2-7** summarizes the total energy consumption by county and type. To reflect the mix of fuels used to generate the electricity, the utilities provided emission factors for 2005 and 2010 for CO_2. For methane and nitrous oxide, emissions factors from the California protocol were used.

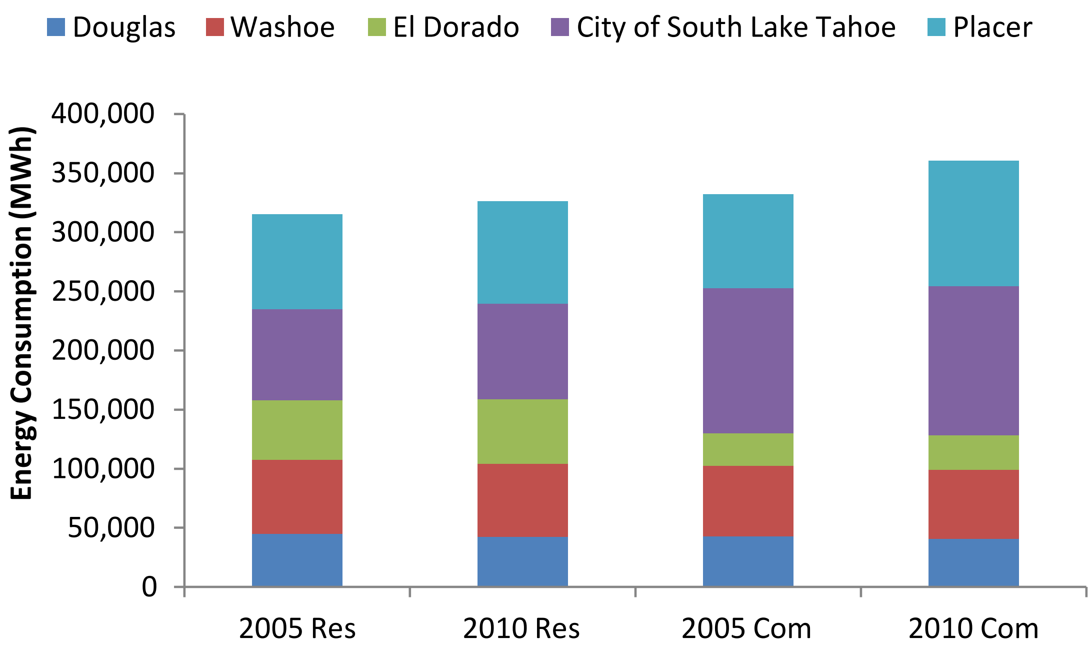

Figure 2-7. 2005 and 2010 commercial and residential energy consumption (MWh) for the Basin provided by Liberty Energy and Nevada Energy.

2.1.13 Forestry Carbon Stocks

Removal of CO_2 from the atmosphere by forests can represent a significant emissions sink for heavily-forested regions like the Tahoe Basin. According to EPA estimates, forests sequestered the equivalent of 10.6% of nationwide GHG emissions in 2006; however, the amount of carbon sequestered by forests at a regional level can vary greatly depending on the mix of tree species in the region (U.S. Environmental Protection Agency, 2009). In addition, protocols have been developed for assessing the impact of forestry projects (e.g., reforestation, improved forest management) on net GHG emissions. Recommended methods include procedures for assessing the risk that carbon sequestered by a project may be released back into the atmosphere within a defined timeframe (Climate Action Reserve, 2010).

Because the Lake Tahoe region is heavily forested, we developed estimates of baseline carbon stocks associated with forested lands. These baseline values can be used to develop future carbon sequestration estimates associated with any changes to forest management practices in the region. To develop these baseline estimates, we relied on the Carbon Online Estimator v2 (COLE2) database, which is maintained by the Forest Inventory and Analysis (FIA) program as a record of the health of forests in the United States.

The number and size of the trees in various forests are recorded into the COLE2 database by manual surveys of the forests. Due to resource limitations, these plots are usually subdivided and only a portion of the plot is surveyed during a select year; then the data for that parcel are used to estimate the carbon stock of rest of the plot. For the next year, another portion of the plot may be estimated and those results are used to make a new estimate of the carbon stock for the plot (which could vary significantly from the previous year due to fires or other activity in the plot).

Because of this process, the tree carbon data for plots in the Basin obtained from the COLE2 database were averaged over a 10-year period to create a single baseline scenario. The tree carbon data were converted to CO_2 stock in metric tons by multiplying total carbon by 3.76, which is the ratio of the molar weight of CO_2 to the molar weigh of carbon. **Table 2-3** summarizes the 10-year average tree carbon (metric tons) and resulting CO_2 (metric tons) for the Basin by geographical jurisdictions.

Table 2-3. 10-year average tree carbon (metric tons) and CO_2 (metric tons) for the Basin.

Region	Tree Carbon	10-Year Average
Carson	32,777	123,242
Douglas	117,240	440,822
Washoe	2,422	9,107
El Dorado (unincorporated)	392,749	1,476,736
South Lake Tahoe	-	-
Placer	138,246	519,805
Nevada Total	152,439	573,171
California Total	530,995	1,996,541
Basin Total	**683,434**	**2,569,712**

2.2 Forecasting GHG Emissions

GHG emissions inventories for 2020 and 2035 were developed using the Tahoe Metropolitan Planning Organization (TMPO) alternative growth scenarios for the Basin from the draft Regional Transportation Plan (RTP) 2035 (Tahoe Metropolitan Planning Organization,2012a) and draft Environmental Impact Report/Statement (EIS) for 2035 (Tahoe Metropolitan Planning Organization, 2012b). The RTP integrates land use and transportation strategies to allow the Basin to achieve targets for reducing GHG emissions by 2035. The alternative growth scenarios presented in these reports are preliminary since they are currently in a 60-day public comment period and are subject to be changed. The TMPO draft report provides preliminary 2020 and 2035 Basin/state-wide population (see **Table 2-4**) and VMT (see **Table 2-5**) totals for each of the following five alternatives:

- Alternative 1 – No Project, which represents the business-as-usual (BAU) case
- Alternative 2 – Low Development, Increased Regulation
- Alternative 3 – Low Development, Highly Incentivized Redevelopment
- Alternative 4 – Reduced Development, Incentivized Redevelopment
- Alternative 5 –Rate of Development and Regulatory Structure Similar to 1987 Regional Plan

Table 2-4. Population by TMPO alternative growth scenario for 2020 and 2035.

Region	2020					2035				
	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
California	41,709	42,735	43,934	43,737	44,277	42,005	44,102	45,468	45,950	44,227
Nevada	13,423	13,475	14,115	13,582	13,619	13,682	13,711	14,897	13,823	15,725
Total	**55,132**	**56,210**	**58,049**	**57,319**	**57,896**	**55,687**	**57,813**	**60,365**	**59,773**	**59,952**

Table 2-5. VMT to calculate GHG emissions[9] and total Basin VMT by TMPO alternative growth scenario for 2020 and 2035.

Region	2020				
	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
California	928,908	944,010	925,150	963,786	981,457
Nevada	448,828	443,676	450,370	463,344	472,743
GHG Total	**1,377,736**	**1,387,686**	**1,375,520**	**1,427,130**	**1,454,200**
Basin Total	2,015,976	1,990,698	2,033,362	2,095,270	2,117,242
	2035				
California	989,899	1,004,890	1,017,955	1,068,686	1,095,393
Nevada	580,555	547,780	567,380	581,888	604,996
GHG Total	**1,570,454**	**1,552,670**	**1,585,335**	**1,650,574**	**1,700,389**
Basin Total	2,141,100	2,094,300	2,131,000	2,244,800	2,321,100

In order to estimate future-year emissions, some source category activity data or emissions are forecasted using other socioeconomic categories (households, employment, and visitors). The socioeconomic categories were developed from the 2005 baseline estimates and were grown to future-year estimates using population growth rates for each of the five alternatives (see **Tables 2-6 to 2-8**).

[9] VMT used to calculate GHG emissions only include VMT from internal-internal trips and half of the internal-external trips.

Table 2-6. Households by TMPO alternative growth scenario for 2020 and 2035.

Region	2020					2035				
	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
California	16,204	16,521	17,062	16,847	17,017	16,367	16,992	17,742	17,568	17,621
Nevada	6,033	6,151	6,353	6,273	6,336	6,094	6,327	6,606	6,541	6,561
Total	**22,238**	**22,673**	**23,414**	**23,120**	**23,353**	**22,462**	**23,319**	**24,348**	**24,110**	**24,182**

Table 2-7. Number of visitors by TMPO alternative growth scenario for 2020 and 2035.

Region	2020					2035				
	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
California	41,728	42,544	43,936	43,383	43,820	42,148	43,757	45,689	45,240	45,376
Nevada	15,948	16,259	16,791	16,580	16,747	16,108	16,723	17,461	17,290	17,342
Total	**57,675**	**58,803**	**60,727**	**59,963**	**60,567**	**58,256**	**60,480**	**63,150**	**62,531**	**62,718**

Table 2-8. Employment by TMPO alternative growth scenario for 2020 and 2035.

Region	2020					2035				
	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
California	12,568	12,813	13,233	13,066	13,198	12,694	13,179	13,760	13,626	13,666
Nevada	18,601	18,965	19,585	19,339	19,534	18,788	19,506	20,367	20,167	20,227
Total	**31,169**	**31,778**	**32,818**	**32,405**	**32,731**	**31,482**	**32,684**	**34,127**	**33,792**	**33,894**

For most of the source sectors, TMPO-based socioeconomic data were used to forecast the activity data or emissions to 2020 and 2035. However, future-year emissions from aircraft and recreational boats were estimated using other sources of forecast data. For aircraft, the FAA provides estimates of future-year airport operations (number of flights) and this data was used to scale 2005 baseline emissions to 2020 and 2035. For recreational boating, the Lake Tahoe Shorezone study (Tahoe Regional Planning Agency, 2006) included boat trips and fuel consumption forecast for various Shorezone buildout alternatives for 2014. During discussions with the work group, it was decided to use the “no build” scenario, which uses existing Shorezone ordinances (adopted in 1987) and prohibits construction of Shorezone structures in prime fish habitat areas. The Shorezone study provided fuel use for 2004 and estimates for 2027. Fuel estimates were interpolated between these two years to provide estimates for 2020 and 2035, which were then used to estimate the emissions from recreational boating. **Table 2-9** lists each source category and corresponding growth activity used to develop the future-year emissions inventories.

Table 2-9. Growth activity for each of the source sectors in the inventory.

Sector	Source Category	Growth Activity
Transportation	On-road mobile sources	TMPO VMT
	Recreational boats	Forecasted fuel use from the Shorezone study
	Other off-road equipment	Population and employment
	Aircraft	FAA forecast activity Wood
Fuel combustion	combustion	Household and visitor
	Natural gas combustion	Household and employment
	Other combustion	Household
Fires	Wildfires and prescribed burns	Average annual activity
Land use	Livestock	Held constant
Waste	Municipal solid waste	Population
Energy	Electricity consumption	Household and employment
	Wastewater treatment	Population

3. Summary of Results

Greenhouse gas emissions inventory estimates were produced for the Lake Tahoe Basin for the base years of 2005 and 2010 and the future years of 2020 and 2035 (BAU and four additional growth scenarios). The results of the emissions inventories are presented by Basin, state, and geographic jurisdiction. Emissions totals for CO_2e are presented below and emission totals for CH_4 and N_2O are presented in **Appendix B**.

3.1 Baseline Basin-Wide Emissions

Basin-wide CO_2e totals by year and source sectors are shown in **Figure 3-1** and **Table 3-1**. In 2005, the direct and indirect emissions from the Basin amounted to approximately 1,313,000 metric tons of CO_2e, and total CO_2e emissions increased by about 5% in 2010 to 1,392,000 metric tons. For both years, the energy sector is the largest source of CO_2e emissions, accounting for 37% of total emissions in 2005 and 41% in 2010.

In addition, the top three source sectors (energy, transportation, and fuel consumption) account for 90% and 91% of total CO_2e emissions for 2005 and 2010, respectively. Transportation-related emissions decreased about 4% from 2005 to 2010 due to a decrease in Basin-wide VMT, while emissions from solid waste decreased by 76% over that timeframe due to the implementation of a methane recovery system at Lockwood Landfill in 2009. Due to an increased amount of prescribed burning and wildfires occurring in the Basin, emissions from fires increased by 21% between 2005 and 2010. As shown in Table 3-1, the California side of the Basin produces the majority of the GHG emissions, with 68% and 71% of the emissions for 2005 and 2010 respectively.

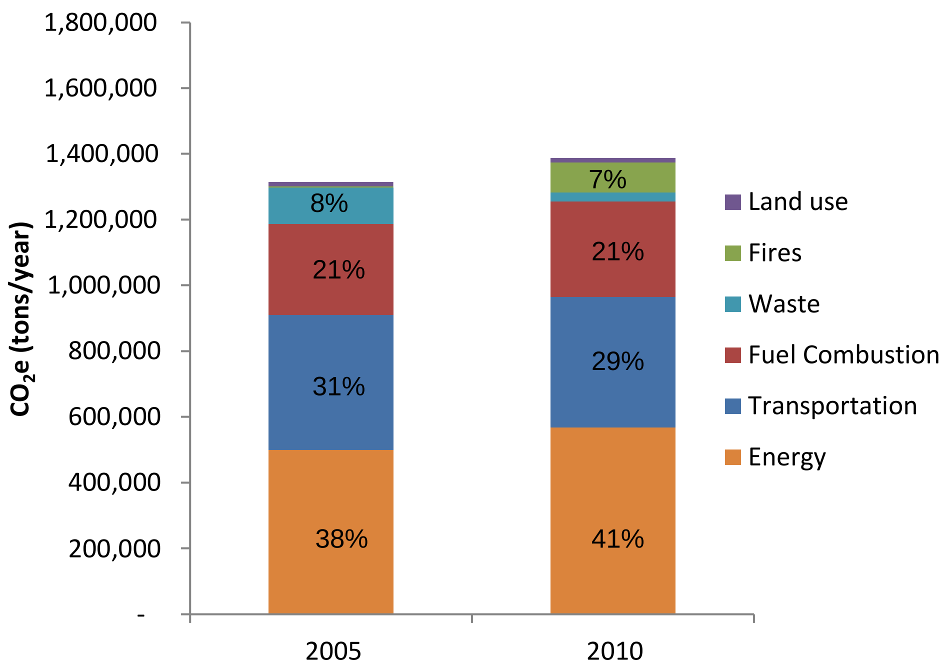

Figure 3-1. Baseline Basin-wide CO_2e emissions by source sector.

Table 3-1. Baseline CO_2e emissions (metric tons/year) by state and Basin-wide.

Type	Source Sector	Source Category	2005			2010		
			CA	NV	Basin	CA	NV	Basin
Direct	Transportation	On-road mobile sources	204,549	126,927	331,476	198,811	120,295	319,106
		Recreational boats	15,151	7,251	22,403	10,817	5,177	15,994
		Other off-road equipment	40,803	13,057	53,860	44,509	14,243	58,751
	Fuel combustion	Wood combustion	87,726	9,973	97,700	93,651	10,647	104,297
		Natural gas combustion	115,088	64,797	179,885	125,936	61,819	187,755
		Other combustion	3,970	1,888	5,858	4,317	1,844	6,161
	Fires	Wildfires and prescribed burns	3,083	1,201	4,284	79,650	12,002	91,652
	Land use	Livestock	12,734	-	12,734	12,734	-	12,734
	Waste	Wastewater treatment	-	-	-	-	-	-
Indirect	Energy	Electricity consumption	329,627	157,926	487,553	395,998	166,545	562,543
		Wastewater treatment	2,115	-	2,115	2,300	-	2,300
	Transportation	Aircraft	5,131	-	5,131	4,739	-	4,739
	Waste	Municipal solid waste	71,595	38,917	110,512	19,956	6,748	26,704
	Total		**891,573**	**421,939**	**1,313,511**	**993,418**	**399,319**	**1,392,737**

3.2 Baseline Emissions by Geographic Jurisdiction

GHG emissions were estimated for the portion of the five counties (Placer, El Dorado, Washoe, Douglas, and Carson) that lie inside the TRPA jurisdiction, as well as the City of South Lake Tahoe. **Figures 3-2 and 3-3** and **Tables 3-2 and 3-3** show baseline emissions by source sector for each geographic jurisdiction. Jurisdiction total emissions are also shown proportionally to each other, with the size of the "pie" representing the magnitude of emissions for a given area. For both years, the City of South Lake Tahoe accounts for about 27% of total emissions, followed closely by Placer County, which contributes about 26% to the overall inventory in both 2005 and 2010. Contributions to the baseline GHG inventories from unincorporated El Dorado County and Nevada counties range from 1% to 17%.

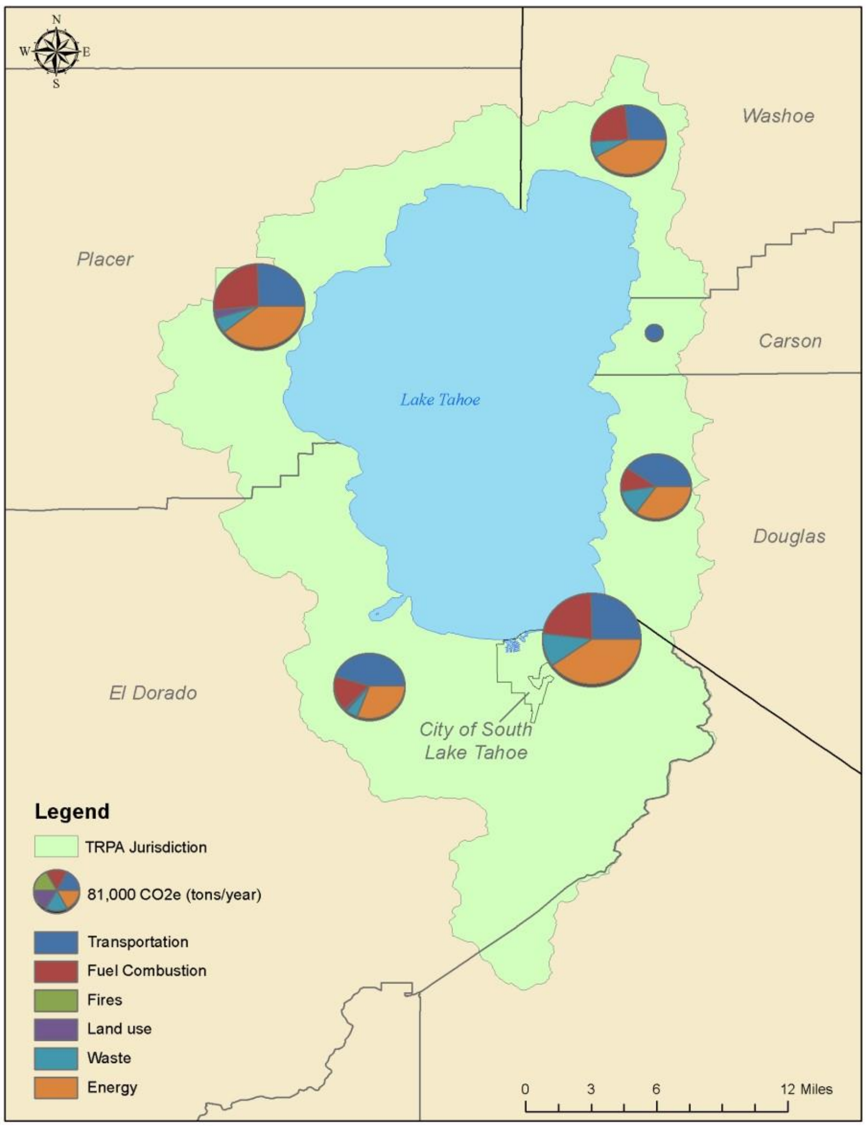

Figure 3-2. 2005 baseline CO_2e emissions by source sector and geographic jurisdiction.

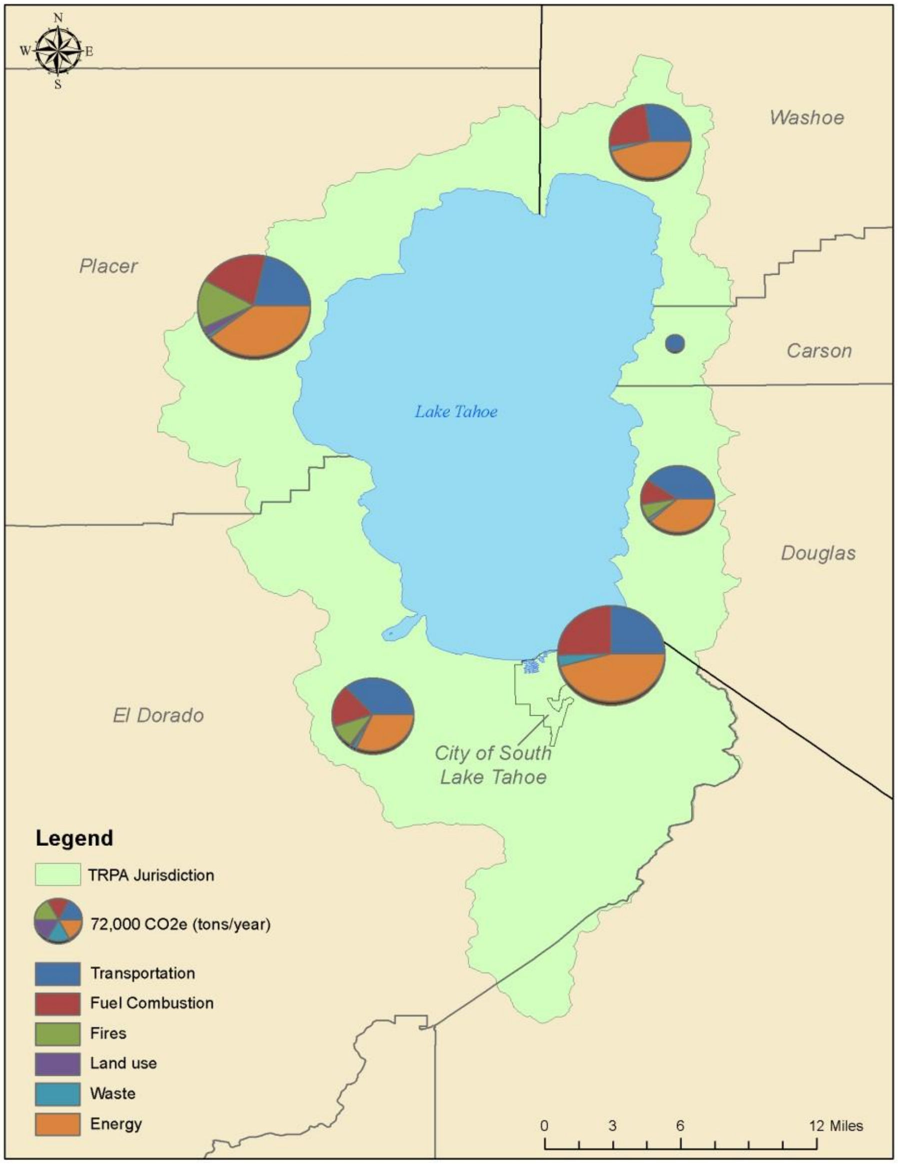

Figure 3-3. 2010 baseline CO_2e emissions by source sector and geographic jurisdiction.

Table 3-2. 2005 baseline CO_2e emissions by source sector and geographic jurisdiction.

Type	Source Sector	Source Category	Geographic Jurisdiction					
			Placer	El Dorado (unincorporated)	South Lake Tahoe	Washoe	Carson	Douglas
Direct	Transportation	On-road mobile sources	64,102	77,194	63,253	47,281	11,419	68,227
		Recreational boats	8,001	2,329	4,821	3,200	-	4,051
		Other off-road equipment	9,602	8,274	22,026	8,100	-	5,857
	Fuel combustion	Wood combustion	39,022	13,299	35,405	3,389	-	6,584
		Natural gas combustion	44,792	18,128	52,168	50,235	-	14,563
		Other combustion	1,073	747	2,150	418	-	1,470
	Fires	Wildfires and prescribed burns	1,345	1,738	-	-	-	1,201
	Land use	Livestock	9,809	2,925	-	-	-	-
	Waste	Wastewater Treatment	-	-	-	-	-	-
Indirect	Energy	Electricity consumption	120,258	58,922	150,447	91,652	-	66,274
		Wastewater treatment	2,115	-	-	-	-	-
	Transportation	Aircraft	-	-	5,131	-	-	-
	Waste	Municipal solid waste	18,251	10,838	42,506	15,397	-	23,520
Total			**318,370**	**194,395**	**377,907**	**219,673**	**11,419**	**191,747**

Table 3-3. 2010 baseline CO_2e emissions by source sector and geographic jurisdiction.

Type	Source Sector	Source Category	Geographic Jurisdiction: Placer	El Dorado (unincorporated)	South Lake Tahoe	Washoe	Carson	Douglas
Direct	Transportation	On-road mobile sources	71,892	67,882	59,038	47,301	10,145	62,849
		Recreational boats	5,712	1,663	3,442	2,285	-	2,892
		Other off-road equipment	9,571	10,365	24,649	8,375	-	5,792
	Fuel combustion	Wood combustion	41,657	15,391	36,602	3,618	-	7,029
		Natural gas combustion	46,200	22,207	57,529	49,858	-	11,961
		Other combustion	1,046	911	2,361	423	-	1,421
	Fires	Wildfires and prescribed burns	58,372	21,278	-	-	-	12,002
	Land use	Livestock	9,809	2,925	-	-	-	-
	Waste	Wastewater treatment	-	-	-	-	-	-
Indirect	Energy	Electricity consumption	157,801	68,854	169,344	98,456	-	68,089
		Wastewater treatment	2,300	-	-	-	-	-
	Transportation	Aircraft	-	-	4,739	-	-	-
	Waste	Municipal solid waste	4,446	3,374	12,136	3,890	-	2,858
Total			**408,806**	**214,849**	**369,839**	**214,205**	**10,145**	**174,893**

3.3 Future-Year Emissions

Future-year GHG emissions inventories were developed by projecting the 2005 baseline inventory using growth rates from each of the five preliminary TMPO growth alternatives for 2020 and 2035 (see **Figures 3-4 and 3-5**). For 2020, the GHG emissions inventory total CO_2e ranges from 1% to 5% higher than 2005 baseline totals; alternative 1 (BAU) projects the smallest increase in emissions and alternative 5 projects the largest increase in emissions. For 2035, the GHG emissions inventory total CO_2e ranges from 5% to 12% higher than 2005 baseline totals; as with the year 2020, alternative 1 (BAU) projects the smallest increase in emissions, with alternative 5 projecting the largest increase in emissions. The BAU scenario projects lower emissions because it extends the current plan, which relies on existing land use zoning and would authorize no additional development rights or allocations beyond those authorized in the 1987 RTP.

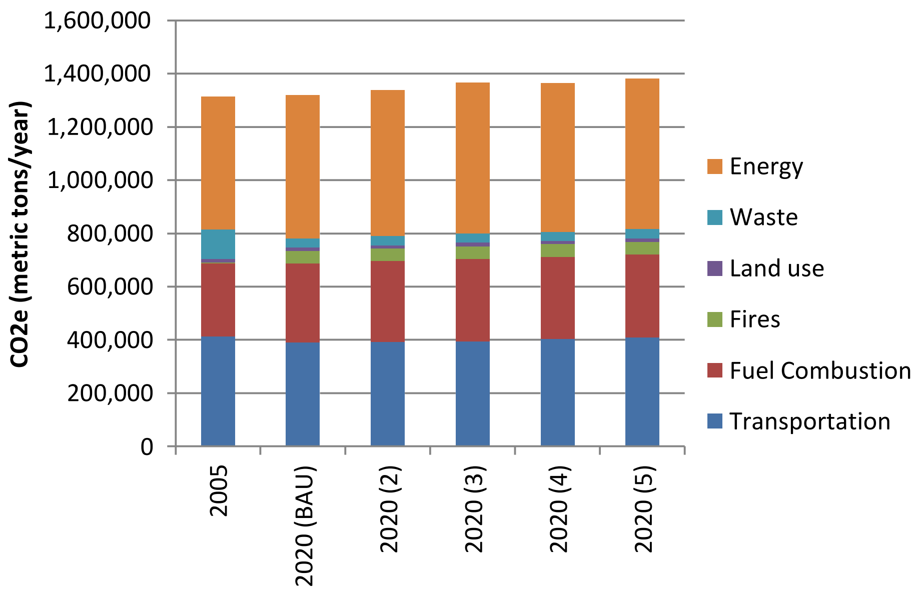

Figure 3-4. GHG CO_2e emissions by source sector for 2020 for each scenario.

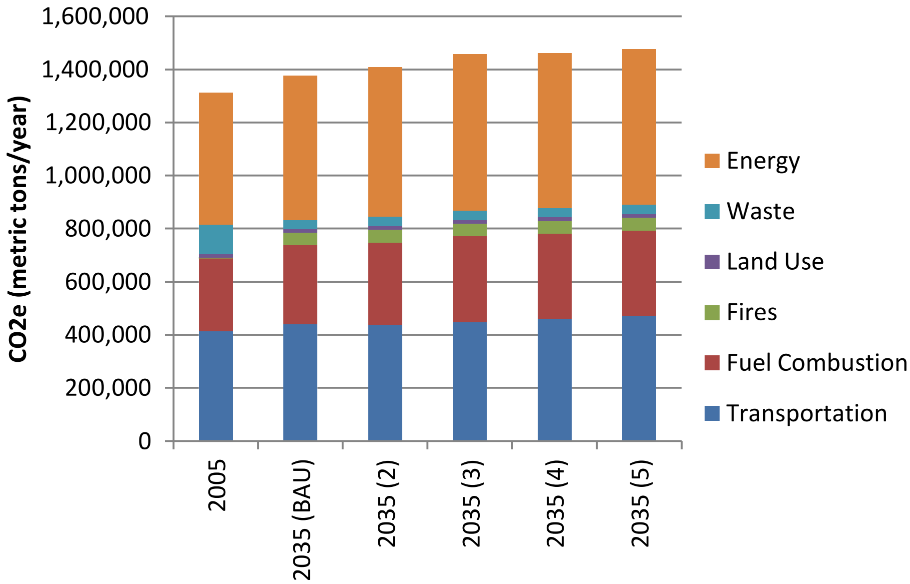

Figure 3-5. GHG CO_2e emissions by source sector for 2035 for each scenario.

Tables 3-4 and 3-5 summarize the basin-wide 2020 and 2035 GHG emissions inventories for each source category by each of the five TMPO preliminary growth alternatives. Emissions from on-road mobile sources are lower than 2005 for all five of the growth scenarios (this is due to VMT totals that are lower in 2020 than in 2005). This decrease in emissions is consistent with TMPO's draft RTP and EIS (Tahoe Metropolitan Planning Organization, 2012b, a), which note the reduction of VMT from the TransCAD model outputs. For other source categories, average growth in CO_2e emissions from 2005 is 7% for 2020 and 10% for 2035.

Table 3-4. 2020 future-year GHG emissions by source category for each TMPO alternative.

Type	Sector	Category	2005	2020				
				Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
Direct	Transportation	On-road mobile sources	331,476	296,725	298,868	296,248	307,364	313,194
		Recreational boats	22,403	29,834	29,834	29,834	29,834	29,834
		Other off-road equipment	53,860	58,122	59,259	61,197	60,428	60,860
	Fuel combustion	Wood combustion	97,700	105,431	107,397	110,752	109,420	110,522
		Natural gas combustion	179,885	194,120	197,916	204,391	201,821	203,852
		Other combustion	5,858	6,322	6,445	6,656	6,573	6,639
	Fires	Wildfires and prescribed burns	4,284	47,968	47,968	47,968	47,968	47,968
	Land use	Livestock	12,734	12,734	12,734	12,734	12,734	12,734
	Waste	Wastewater treatment	0	0	0	0	0	0
Indirect	Energy	Electricity consumption	487,553	523,852	534,095	551,569	544,633	550,115
		Wastewater treatment	2,115	2,282	2,327	2,403	2,373	2,397
		Aircraft	5,131	5,304	5,304	5,304	5,304	5,304
	Waste	Municipal solid waste	110,512	29,814	30,397	31,392	30,997	31,309
Total			**1,313,511**	**1,312,509**	**1,332,545**	**1,360,449**	**1,359,447**	**1,374,727**

Table 3-5. 2035 future-year GHG emissions by source category for each TMPO alternative.

Type	Sector	Category	2005	2035				
				Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
Direct	Transportation	On-road mobile sources	331,476	338,232	334,401	341,436	355,487	366,216
		Recreational boats	22,403	35,767	35,767	35,767	35,767	35,767
		Other off-road equipment	53,860	58,538	60,773	63,455	62,833	63,021
	Fuel combustion	Wood combustion	97,700	106,492	110,370	115,026	113,946	114,272
		Natural gas combustion	179,885	196,074	203,560	212,546	210,461	211,091
		Other combustion	5,858	5,423	6,629	6,922	6,854	6,874
	Fires	Wildfires and prescribed burns	4,284	47,968	47,968	47,968	47,968	47,968
	Land use	Livestock	12,734	12,734	12,734	12,734	12,734	12,734
	Waste	Wastewater treatment	0	0	0	0	0	0
Indirect	Energy	Electricity consumption	487,553	529,126	549,327	573,575	567,950	569,651
		Wastewater treatment	2,115	2,305	2,393	2,499	2,474	2,482
		Aircraft	5,131	6,239	6,239	6,239	6,239	6,239
	Waste	Municipal solid waste	110,512	30,114	31,264	32,644	32,324	32,421
Total			**1,313,511**	**1,369,012**	**1,401,426**	**1,450,811**	**1,455,038**	**1,468,737**

4. Conclusions and Recommendations

To address a fundamental knowledge gap regarding direct and indirect GHG emissions in the Lake Tahoe region, STI developed regional GHG inventories for baseline years of 2005 and 2010 and future years of 2020 and 2035. We worked with CTC, TRPA, and other partners to collect local activity data that could be used to estimate baseline emissions for various source sectors and forecast data that could be used to project baseline estimates to the future years of interest. Key findings from the work are summarized below:

- Basin-wide CO_2e emissions total 1,313,511 metric tons in 2005, and these emissions increased by 6% to 1,392,737 metric tons in 2010.
- The energy sector (i.e., electricity usage) is the single largest source of GHG emissions in the Basin-wide inventories, accounting for 37% of total CO_2e emissions in 2005 and 41% in 2010.
- On-road motor vehicles are the second-largest source of CO2e emissions in the Basin, accounting for 31% of total CO_2e emissions in 2005 and 29% in 2010.
- The top three sectors (energy, transportation, and fuel combustion) account for over 90% of CO_2e emissions in both 2005 and 2010.
- The California side of the Basin is responsible for 70% of the baseline emissions, with the City of South Lake Tahoe accounting for 27% of total emissions.
- Growth from 2005 to 2020 ranges from 1% to 5%, and growth from 2005 to 2035 ranges from 5% to 12%.
- The BAU scenario (alternative 1) projects the smallest increase in emissions since it extends the current plan and would rely on existing land use zoning and would authorize no additional development rights or allocations beyond those authorized in the 1987 RTP.
- On-road mobile source emissions decreased from 2005 to 2020, with a range of -1% to -10%, but increased from 2005 to 2035 with a range of 6% to 11%.

These findings identify the major sources of GHG emissions within the Basin and provide a starting point for setting reduction targets and identifying potential mitigation strategies that can be implemented to meet those reduction targets in the future. Going forward, we offer the following recommendations for improving these inventories:

- Emissions projections for 2020 and 2035 are based on preliminary forecast data for those years. These projections should be updated when final forecasts become available.
- As part of Mobility 2035, the Lake Tahoe Regional Transportation Plan Update, an integrated model that converts travel demand model output to EMFAC2011, is being developed. This model will produce CO_2 estimates for on-road mobile sources (Norberg, 2012). Results from this model should be compared to inventory results presented here to ensure the consistency of emission estimates for on-road mobile sources.

- For the baseline inventories, high-quality activity data for some categories were more readily available for the California side of the Basin than the Nevada side. For example, electricity consumption from Nevada Energy was only available at the regional (multi- county) level. As a result, improved Nevada data should be incorporated into inventory estimates should such data become available in the future.
- Fire activity in the Basin is highly variable from year-to-year. As a result, consideration should be given to developing a “typical year” baseline inventory that could be used for comparisons to emissions resulting from planned burning projected to occur in future years.
- Limited information is available on future-year prescribed burning plans and goals; therefore, baseline fire emissions were held constant for future years (based on the average emissions from 2005 and 2010). Better future-year estimates of fire emissions should be developed as information becomes available.

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Appendix A

Detailed Activity Data and Emissions Factors by Source Sector

This appendix provides detailed information on the activity data and emission factors that were used to calculate GHG emissions for each source category in the Tahoe Basin, as well as information on the data that were used to allocate Basin-wide emissions to individual jurisdictions (i.e., counties and the City of South Lake Tahoe).

A.1 Activity Data for Spatial Allocation

Table A-1 summarizes population, households, and employment for the Lake Tahoe Basin by geographic jurisdiction. These data were provided by TRPA for the base years of 2005 and 2010.

Table A-1. Population, households, and employment by region (provided by TRPA).

Region	Population		Households		Employment	
	2005	2010	2005	2010	2005	2010
Carson	0	0	0	0	0	0
Douglas	5,556	5,370	2,390	2,334	12,206	6,516
Washoe	7,684	7,765	3,201	3,262	5,031	3,795
El Dorado (unincorporated)	7,848	9,610	2,902	3,581	484	550
South Lake Tahoe	20,893	22,854	8,351	9,277	7,536	8,191
Placer	9,108	8,874	3,763	3,693	3,626	3,553
California	37,849	41,338	15,016	16,551	11,646	12,294
Nevada	13,240	13,135	5,591	5,596	17,237	10,311
Total	**51,089**	**54,473**	**20,607**	**22,147**	**28,883**	**22,605**

A.2 On-Road Mobile Sources

For on-road mobile sources, emissions were calculated using VMT data from TRPA's TransCAD travel demand model, fleet mix and fuel economy data from ARB's EMFAC2011 model, and emissions factors from the California Climate Action Registry's general reporting protocol (California Climate Action Registry, 2008) (see **Table A-2**). VMT data from TransCAD are not vehicle specific; therefore, output from the EMFAC2011 model was used to determine what fraction of the VMT is attributable to gasoline and diesel vehicles and also to determine the average fuel economy (miles per gallon) of gasoline and diesel vehicles.

Table A-2. Summary by year and fuel type the fleet characteristics for the Lake Tahoe Basin and corresponding emission factors.

Year	Fuel Type	Fleet Characteristics		Emission Factors		
		VMT Fraction	MPG	CO_2 (metric tons / gallon)	CH_4 (metric tons / mile)	N_2O (metric tons / mile)
2005	Gasoline	0.95	16.7	0.00881	4.55×10^{-8}	5.56×10^{-8}
	Diesel	0.05	7.5	0.01015	3.57×10^{-9}	3.56×10^{-9}
2010	Gasoline	0.93	16.0	0.00881	4.55×10^{-8}	5.56×10^{-8}
	Diesel	0.07	9.8	0.01015	3.57×10^{-9}	3.56×10^{-9}
2020	Gasoline	0.93	16.6	0.00881	4.55×10^{-8}	5.56×10^{-8}
	Diesel	0.07	8.9	0.01015	3.57×10^{-9}	3.56×10^{-9}
2035	Gasoline	0.92	16.7	0.00881	4.55×10^{-8}	5.56×10^{-8}
	Diesel	0.08	8.7	0.01015	3.57×10^{-9}	3.56×10^{-9}

Basin-wide on-road vehicle activity data (miles/day) was provided by TRPA for the base years of 2005 and 2010 (see **Table A-3**). Following SB 375 guidance on assigning VMT to various regions across California, GHG emissions from mobile sources should be estimated based on VMT from all internal-internal trips (trips that start and end in the Basin) and half of the internal-external trips (trips that start in the Basin and end outside or vice versa). VMT from all external-external trips (those that start and end outside the Basin) should be excluded (Regional Targets Advisory Committee, 2009). This formula was used to derive the GHG VMT value shown in Table A-3; **Figure A-1** shows the breakdown of VMT by trip type that was used for all calculations (Tahoe Metropolitan Planning Organization, 2012b).

Table A-3. VMT (miles/day) by region and year (provided by TRPA).

Region	2005	2010
Carson	71,265	67,192
Douglas	425,785	416,276
Washoe	295,067	313,294
El Dorado (Unincorporated)	485,974	405,581
South Lake Tahoe	398,209	352,739
Placer	403,549	429,540
Tahoe Total	2,079,849	1,984,623
GHG VMT Total	1,539,088	1,459,299

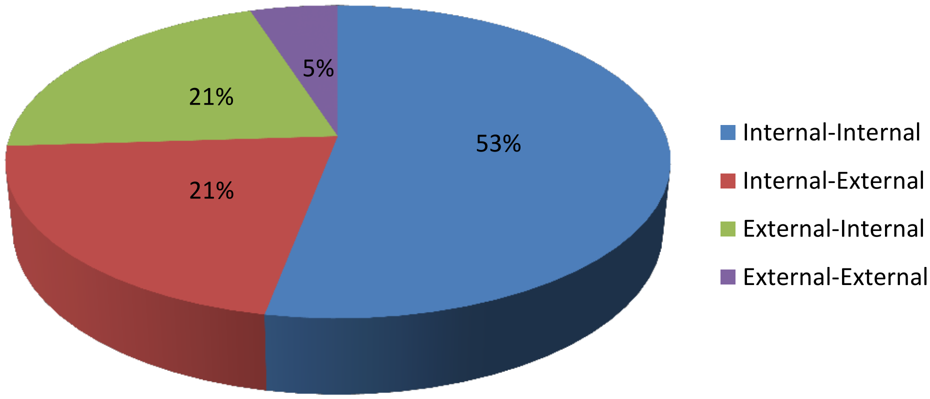

Figure A-1. Breakdown of VMT by trip type.

A.3 Recreational Boats

For recreational boats operating in Lake Tahoe, emissions were estimated using fuel consumption activity from TRPA and emission factors from the California Climate Action Registry's general reporting protocol (California Climate Action Registry, 2008) (see **Table A-4**).

Table A-4. Emission factors for ships and boats by fuel type (metric tons/gallon).

Fuel Type	CO_2	CH_4	N_2O
Gasoline	8.81×10^{-3}	6.40×10^{-7}	2.20×10^{-7}
Diesel	1.02×10^{-2}	7.40×10^{-7}	2.60×10^{-7}

Table A-5 shows the fuel estimates from a TRPA EIS for the Lake Tahoe Shorezone (Tahoe Regional Planning Agency, 2006). The EIS provided fuel use for 2004 and the future year of 2027 and hours used for 2004 and 2010. For 2010, fuel use was estimated by multiplying the hours used by the gallons/hour based on the 2004 data. Fuel use for 2005 was interpolated between 2004 and 2010.

Table A-5. Total fuel consumption in the basin by fuel types provided by TRPA (gallons).

Fuel Type	2004	2005	2010
Gasoline	2,639,068	2,509,272	1,781,440
Diesel	3,884	8,884	15,072

A.4 Aircraft

Aircraft emissions were estimated for the Lake Tahoe airport using fuel data collected for 2010 and emissions factors from the California Climate Action Registry's general reporting protocol (California Climate Action Registry, 2008) (see **Table A-6**).

Table A-6. Emission factors by fuel type (metric tons/gallon).

Fuel Type	CO_2	CH_4	N_2O
Jet Fuel	9.57×10^{-3}	2.70×10^{-4}	3.10×10^{-7}
Aviation Gasoline	8.32×10^{-3}	7.04×10^{-3}	1.10×10^{-7}

Fuel consumption for jet fuel and aviation gasoline was provided by the airport's fuel vendor for 2009 and 2010 (Golden, 2011). For 2005, the airport used a different fuel vendor and the fuel consumption data were unavailable. Therefore, 2005 fuel consumption was estimated by scaling the 2010 fuel consumption using airport traffic activity (number of flights) from the FAA.[10] According to the airport fuel vendor, 95% of the fuel sold at the airport is jet fuel. Using this breakdown, emissions were calculated for each fuel type by multiplying fuel consumption with the appropriate emissions factor and relative percentage of use. **Table A-7** summarizes the fuel consumption (gallons) for jet fuel and aviation gasoline for the Lake Tahoe airport.

Table A-7. Fuel sales data for the Lake Tahoe airport and number of flights.

Activity	2005	2010
Flights	24,662	22,777
Fuel sales (gallons)	229,279	211,754

A.5 Other Off-Road Equipment

For all other off-road equipment, ARB's OFFROAD2007 model was run for the base years of 2005 and 2010 (see **Table A-8**). Annualized emissions for off-road vehicles[11] were calculated by multiplying the daily emissions by 365. These emissions only represent the California portion of the Basin. Therefore, in keeping with previous emissions inventory development for the Basin conducted by the DRI (Gertler et al., 2008), emissions for the California side were scaled up to account for the Nevada side of the Basin using the ratio of Basin-wide population for California and Nevada to the population of the California side of the Bain only. A population scaling factor of 1.32 was calculated using population data from TRPA. Emissions were allocated to geographic jurisdiction using population estimates.

[10] Airport traffic activity data available from the FAA website (http://aspm.faa.gov/main/taf.asp).
[11] Emissions from pleasure craft were excluded since they are calculated separately.

Table A-8. Daily emission from OFFROAD2007 (metric tons/day).

Class	CO_2		CH_4		N_2O	
	2005	2010	2005	2010	2005	2010
Construction and Mining Equipment	73.18	79.33	0.01	0.01	0.00	0.00
Entertainment Equipment	0.09	0.09	0.00	0.00	0.00	0.00
Industrial Equipment	9.34	10.51	0.01	0.00	0.00	0.00
Lawn and Garden Equipment	3.41	3.74	0.01	0.01	0.00	0.00
Light Commercial Equipment	5.09	5.72	0.00	0.00	0.00	0.00
Logging Equipment	17.98	17.98	0.01	0.00	0.00	0.00
Other Portable Equipment	0.13	0.13	0.00	0.00	0.00	0.00
Railyard Operations	0.00	0.00	0.00	0.00	0.00	0.00
Recreational Equipment	2.88	3.65	0.03	0.03	0.00	0.00
Transport Refrigeration Units	7.01	8.99	0.00	0.00	0.00	0.00
Total	**119.10**	**130.13**	**0.06**	**0.06**	**0.01**	**0.01**

A.6 Wood Combustion

Wood fuel combustion was calculated using wood burning activity estimates from a local wood burning survey (Kuhns et al., 2004), data on the annual number of households and visitors, and emissions factors from the California Climate Action Registry's general reporting protocol (California Climate Action Registry, 2008).

Wood combustion emission factors for wood combustion are in kilograms per Million British Thermal Unit (kg/MMBtu). Since fire activity data is the mass of wood burned, the emission factors were converted to metric tons per Mega-gram wood (metric tons/Mg wood) for each pollutant using the default wood moisture of 12% and wood heat content of 15.38 MMBtu per ton of wood burned from the reporting protocol (see **Table A-9**).

Table A-9. Default wood moisture, heat content, and CO_2 equivalent emission factors by pollutant.

Wood Moisture	Wood Heat Content (MMBtu/ton)	Emission Factor (kg CO_2e /MMBtu)			Emission Factor (mtons CO_2e/Mg wood)		
		CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
12%	15.38	93.86	0.32	0.004	1.6	0.005	0.00006

A local study of PM source characterization in Lake Tahoe, estimates a wintertime wood burn rate of 450 Mg wood/day (120 days in winter) and a summertime wood burn rate of 29 Mg wood/day (90 days in the summer) (Kuhns et al., 2004); see **Table A-10**. It was assumed that for 2005, burn rates were similar to 2004 rates. For 2010, the amount of wood burned in 2005 was scaled using household and visitor growth rates from 2005 and 2010. Emissions from wood consumption were then allocated to geographic jurisdictions based on the number of households that use wood to primarily heat their homes, which was collected from the 2000 U.S. Census (U.S. Census Bureau, 2000); see **Table A-11**.

Table A-10. Wood consumption by fire combustion type (Mg/year).

Type	2005	2010
Residential Fires	54,000	57,577
Campfires	2,610	2,397
Total	**56,610**	**59,974**

Table A-11. Households primarily heated with wood by region.

Region	Households
Carson	-
Douglas	68
Washoe	35
El Dorado	503
Placer	403
Total	**1,009**

A.7 Natural Gas Fuel Combustion

Natural gas fuel combustion emissions were calculated using fuel consumption activity from local utilities and emissions factors from the California Climate Action Registry's general reporting protocol (California Climate Action Registry, 2008); see **Table A-12**.

Table A-12. Emission factors for natural gas combustion (metric tons/MMBtu). (California Climate Action Registry, 2008) (California Climate Action Registry, 2008) (California Climate Action Registry, 2008).

Fuel	CO_2	CH_4	N_2O
Natural Gas	53.06	0.005	0.0001

For most of the Basin, Southwest Gas is the primary provider of natural gas to residential and commercial customers. Southwest Gas (Rader, 2011)provided activity data for total consumption (therms)[12] for residential and commercial gas use for Placer, Washoe, and Douglas counties (see **Table A-13**). Residential natural gas consumption rates, derived from the Southwest Gas data, were applied to the number of households in the unincorporated

[12] 10 therms = 1MMBtu

portion of El Dorado County and the City of South Lake Tahoe to estimate residential fuel usage for that county. Commercial fuel use was derived based on the ratio of residential to commercial usage from the data provide by Southwest Gas. This step was required because PG&E, the utility serving El Dorado, did not provide activity data in time for use in this inventory.

Table A-13. Natural gas usage and customer number by region from Southwest Gas.

Region	Usage (therms/household)			
	2005		2010	
	Res.	Com.	Res.	Com.
Carson	-	-	-	-
Douglas	2,348,038	389,491	1,825,502	423,039
Washoe	7,443,001	2,000,356	7,041,221	2,331,298
El Dorado (unincorporated)	2,742,987	2,742,987	2,742,987	2,742,987
South Lake Tahoe	7,893,412	7,893,412	7,893,412	7,893,412
Placer	6,790,702	1,629,419	7,074,904	1,609,971
Nevada Total	9,791,039	2,389,847	8,866,723	2,754,337
California Total	17,427,100	12,265,817	17,711,302	12,246,369
Tahoe Total	**27,218,139**	**14,655,664**	**26,578,025**	**15,000,706**

A.8 Other Fuel Combustion

Emissions from home heating fuel combustion of propane (LPG) and distillate oil were calculated based on (1) the number of households using these fuels to heat their homes and (2) emissions factors (see **Table A-14**) from the California California Climate Action Registry's general reporting protocol (California Climate Action Registry, 2008).

Table A-14. Emission factors for LPG (metric tons/Btu).

Fuel Type	CO_2	CH_4	N_2O
LPG	6.3×10^{-8}	1.1×10^{-11}	6.0×10^{-13}
Distillate Oil	7.3×10^{-8}	8.0×10^{-13}	3.0×10^{-13}

In the absence of detailed consumption data, the EPA recommends that consumption can be estimated using the number of HDDs[13] in the region for the year of interest, the number of households using the fuel to heat their homes, and an average household consumption rate per HDD (U.S. Environmental Protection Agency, 2009). The number of households using LPG and distillate oil as their primary home heating source from the 2000 U.S. Census (U.S. Census

[13] HDDs provide a representation of how cold a region's average temperature was over some period of interest and are calculated as the difference between a day's average temperature and some base temperature (e.g., 65°F).

Bureau, 2000) was scaled to 2005 and 2010 using the household growth rate from 2005 to 2010 (see **Table A-15**). Heat consumption for the Basin was then calculated by multiplying the number of households using LPG and distillate oil as their primary home heating source with the Basin annual average HDD value of 7,882[14] and the average household consumption rate of 11,647 BTU/HDD.

Table A-15. Households using LPG as their primary home heating source by region.

Region	Fuel Type					
	LPG			Distillate Oil		
	2000	2005	2010	2000	2005	2010
Carson City	-	-	-	-	-	-
Douglas	191	185	178	70	68	65
Washoe	39	39	40	32	32	33
El Dorado (including SLT)	414	468	528	26	29	33
Placer	166	162	158	23	22	22
Nevada Total	230	224	218	102	100	98
California Total	580	629	686	49	52	55
Tahoe Total	**810**	**853**	**904**	**151**	**152**	**153**

A.9 Wildfires and Prescribed Burns

Emissions from wildfires and prescribed burns are a function of the type and amount of vegetation consumed by each fire event. Previously, STI generated a national inventory of CO_2 emissions from fires using the BlueSky Smoke Modeling Framework, a system developed by STI and the USDA Forest Service (Raffuse et al., 2008). The BlueSky system reconciles satellite fire detections with ground-based reports to estimate the area burned by each fire event, then uses detailed land cover data, fuel consumption algorithms, and emission factors to calculate the type and amount of vegetation burned and the resulting emissions. The BlueSky system includes the SmartFire model (Raffuse et al., 2009), a geospatial processing tool that aggregates and reconciles information about when and where fires occur.

In addition, CalFire maintains a GIS database of fire history as part of its FRAP. The CalFire data is available for historical years back to 1990 and were used to verify BlueSky data and evaluate fire trends.

The BlueSky/SmartFire system was used to develop activity data for 2005 and 2010 for major wildfires and large prescribed burns. For smaller prescribed fires (e.g., pile burns) that are not captured by SmartFire, activity data were derived from the Lake Tahoe Fuel Reduction Plans (LTFRP) (USDA Forest Service, 2012) and other sources that describe forest

[14] Annual average HHD for the Basin was calculated using a climate summary from the South Lake Tahoe airport for the years 2000 to 2008 (http://www.wrcc.dri.edu/summary/tvl.ca.html).

management and fire activities in the Basin (USDA Forest Service, 2012) and (Osborn, 2012); see **Table A-16**.

Table A-16. Acres burned and number of piles by region from SmartFire and LTFRP.

Region	2005		2010	
	SmartFire (acres burned)	LTFRP (# of piles)	SmartFire (acres burned)	LTFRP (# of piles)
Carson	-	-	-	-
Douglas	-	162	1,000	400
Washoe	-	-	-	-
El Dorado (unincorporated)	-	365	400	900
South Lake Tahoe	-	-	-	-
Placer	-	162	949	400
Nevada Total	-	162	1,000	400
California Total	-	527	1,349	1,300
Total	**-**	**689**	**2,349**	**1,700**

BlueSky only estimates CO_2 emissions; therefore, using EPA guidance (U.S. Environmental Protection Agency, 2011), the CO_2 emissions were scaled by 0.0001641 to calculate N_2O and by 0.0029813 to calculate CH_4

A.10 Livestock

Emissions from livestock were based on ARB estimates of animal populations in the Basin and emission factors for each animal type from EPA GHG guidance documents (U.S. Environmental Protection Agency, 2009) (see **Table A-17**).

ARB produces refined livestock population estimates by county and air basin (Reid et al., 2008). They combine statewide summaries of livestock populations from the annual Agricultural Resource Directory for dairy and beef cows published by the California Department of Food and Agriculture and the Agricultural Census developed by the USDA, providing populations for other animal types (e.g. swine, sheep, horses, and goats). **Table A-18** summarizes the livestock population from the 2003 ARB livestock population report[15] for the Basin; these populations were held as being constant for 2005 and 2010.

[15] Data summarized from the ARB livestock population report (http://www.arb.ca.gov/ei/areasrc/lstkpopmeth.pdf).

Table A-17. Emission factors by livestock category (metric tons/head-year).

Category		CH_4	N_2O
Dairy Cattle	Young Heifers	6.70×10^{-2}	5.96×10^{-3}
	Calves	4.50×10^{-2}	5.96×10^{-3}
Range Cattle	Beef Cows	9.40×10^{-2}	2.54×10^{-3}
	Beef Bulls	5.30×10^{-2}	2.54×10^{-3}
	Beef Heifers	5.90×10^{-2}	2.54×10^{-3}
	Beef Calves	5.90×10^{-2}	2.54×10^{-3}
	Stockers	5.80×10^{-2}	2.54×10^{-3}
Poultry	Broilers	-	2.36×10^{-4}
	Layer & Pullets	-	2.36×10^{-4}
	Turkeys	-	8.74×10^{-4}
Other	Swine	1.50×10^{-3}	3.81×10^{-6}
	Sheep	8.00×10^{-3}	-
	Horses	1.80×10^{-2}	-
	Goats	5.00×10^{-3}	-

Table A-18. 2005 livestock population by region and category (number of head).

Category		El Dorado	Placer	Total
Dairy Cattle	Young Heifers	38	184	222
	Calves	75	367	442
Range Cattle	Beef Cows	549	1,000	1,549
	Beef Bulls	25	45	70
	Beef Heifers	99	179	278
	Beef Calves	230	418	648
	Stockers	83	406	489
Poultry	Broilers	55	91	146
	Layer & Pullets	150	289	439
	Turkeys	210	11,570	11,780
Other	Swine	23	26	49
	Sheep	261	329	590
	Horses	194	237	431
	Goats	46	53	99

A.11 Solid Waste

Emission estimates for solid waste were calculated using data on solid waste generation from local utilities, waste composition percentages developed by CalRecycle (Cascadia Consulting Group, 2009), and the solid waste module in the ICLEI's CACP software. Total municipal solid waste (MSW) quantities were collected for the Basin for 2005 and 2010 from South Tahoe Refuse, which provided data on MSW produced from the City of South Lake Tahoe, El Dorado County, and Douglas County. For the northern portion of the Basin, Tahoe Truckee Sierra Disposal manages the collection of solid waste; however, they were unable to provide data in time for use in this project. Therefore, waste generation was calculated for Washoe and Placer Counties using the average per-capita waste generation rates from the counties for which data were available. **Table A-19** shows total solid waste by jurisdiction and year.

Table A-19. Solid waste generated by region (tons/year).

Region	2005	2010
Carson	-	-
Douglas	35,213	17,116
Washoe	23,051	23,295
El Dorado (unincorporated)	16,226	20,207
South Lake Tahoe	63,636	72,676
Placer	27,324	26,622
Nevada Total	58,264	40,411
California Total	107,186	119,504
Total	**165,450**	**159,915**

Table A-20 shows the waste composition percentages derived from CalRecycle data that were used in the CACP software. For the year 2005, a methane capture efficiency of zero was used in the CACP software, as Lockwood had not installed a methane recovery system at that time. For the year 2010, a methane capture efficiency of 75% was used (Ling-Barnes, 2010).

Table A-20. Waste composition percentages from CalRecycle.

CACP Waste Type	Percentage
Paper Products	17.3%
Food Waste	15.5%
Plant Debris	10.8%
Wood or Textiles	17.3%
Other	39.1%

A.12 Energy

Natural gas fuel combustion emissions were calculated using fuel consumption activity from local utilities (Liberty Energy and Nevada Energy) and emission factors from local utilities and the California Climate Action Registry's general reporting protocol (California Climate Action Registry, 2008); see **Table A-21**.

Table A-21. Emission factors (metric tons/KWh) for energy consumption.

Year	CO_2	CH_4	N_2O
2005	7.52×10^{-4}	1.36×10^{-8}	3.67×10^{-8}
2010	8.18×10^{-4}	1.28×10^{-8}	2.83×10^{-9}

Historically, electricity for the California and Nevada sides of the Basin has been provided by Sierra Pacific Power Company and Nevada Energy, respectively. However, Sierra Pacific Power was recently sold to Liberty Energy Utilities Company, and the customers previously served by Sierra Pacific are now served by a subsidiary of Liberty Energy known as California Pacific Electric Company.

To estimate GHG emissions from electricity consumption on the California side of the Basin, we obtained usage data (KWh) for commercial, government, and residential activity from Liberty Energy. These data covered the unincorporated portion of El Dorado County, the City of South Lake Tahoe, and Placer County. For the Nevada side of the Basin, electricity consumption for residential and commercial activity was obtained from Nevada Energy. However, the data represented a service area that includes most of western Nevada (they were unable to provide data at a smaller spatial geographic level). Therefore, for Douglas and Washoe counties, energy consumption was estimated using county-level population and default electricity consumption rates (KWh/person) for 2005 and 2010 from the California Energy Commission's (CEC) energy almanac[16] (see **Tables A-22 and A-23**).

In addition to residential and commercial energy use, energy consumption by waste water treatment plants was considered. There are three plants in the Basin, but their energy use is captured in the data provided by Liberty Energy. However, portions of the north shore send their waste to a treatment plant in Truckee. Energy consumption for the Truckee plant was provided by the Tahoe-Truckee Sanitation Agency (Parker, 2011), and this plant was treated as an indirect source in the inventory. Since only 35% of the waste water treated at the plant is from the Basin, the total energy consumption from the plant (7,800,000 KWh) was scaled down to represent the energy used to treat the Basin's waste water.

[16] Data from the CEC's energy almanac are available from the following website: http://www.energyalmanac.ca.gov/electricity/us_per_capita_electricity-2010.html

Table A-22. Total energy consumption in the Basin for 2005 (KWh).

Region	Waste Water Treatment	Other		
		Residential	Commercial	Total
	2005			
Carson	-	-	-	-
Douglas	-	45,032,562	42,961,768	87,994,330
Washoe	-	62,277,127	59,413,352	121,690,478
El Dorado	-	50,508,001	27,725,315	78,233,316
South Lake Tahoe	-	77,296,460	122,458,783	199,755,243
Placer	2,808,000	80,272,646	79,398,687	159,671,333
Nevada Total	-	107,309,689	102,375,119	209,684,808
California Total	2,808,000	208,077,107	229,582,785	437,659,892
Total	**2,808,000**	**315,386,795**	**331,957,905**	**647,344,700**

Table A-23. Total energy consumption in the Basin for 2010 (KWh).

Region	Waste Water Treatment	Other		
		Residential	Commercial	Total
	2010			
Carson	-	-	-	-
Douglas	-	42,539,653	40,583,493	83,123,146
Washoe	-	61,512,180	58,683,580	120,195,760
El Dorado	-	54,753,474	29,303,393	84,056,867
South Lake Tahoe	-	80,729,417	126,006,353	206,735,770
Placer	2,808,000	86,459,092	106,185,396	192,644,488
Nevada Total	-	104,051,833	99,267,074	203,318,906
California Total	2,808,000	221,941,983	261,495,142	483,437,125
Total	**2,808,000**	**325,993,815**	**360,762,215**	**686,756,031**

A.13 Forestry Carbon Stocks

To determine the quantity of forest in the Tahoe region, STI relied on the COLE2 database, which is maintained by the FIA program as a record of the health of forests in the United States. The number and size of the trees in various forests are recorded into the COLE2 database by manual surveys of the forests. Due to resource limitations, these plots are usually subdivided and only a portion of the plot is surveyed during a select year; then the data for that parcel are used to estimate the carbon stock for the rest of the plot. For the next year, another portion of the plot may be estimated and those results are used to make a new estimate of the carbon stock for the plot (which could vary significantly from the previous year due to fires or other activity in the plot).

Because of this process, the tree carbon data obtained from the COLE2 database were averaged over a 10-year period to create a single baseline scenario. The tree carbon data were converted to CO_2 stock in metric tons by multiplying total carbon by 3.76, which is the ratio of the molar weight of CO_2 to the molar weigh of carbon. **Table A-24** summarizes the 10-year average tree carbon (metric tons) for the Basin by geographical jurisdictions.

Table A-24. Total tree carbon (metric tons) by geographic jurisdiction.

Region	2005
Carson	32,777
Douglas	117,240
Washoe	2,422
El Dorado (Unincorporated)	392,749
South Lake Tahoe	0
Placer	138,246
Nevada Total	152,439
California Total	530,995
Total	**683,434**

Appendix B

Emissions Summary by Greenhouse Gas Pollutant

Each GHG differs in its ability to absorb heat in the atmosphere. Non-CO_2 emissions data are converted to CO_2e values based on each GHG's GWP.[17] N_2O has a GWP of 310 (it absorbs 310 times more heat per molecule than carbon dioxide) and CH_4 has a GWP of 21. Total CO_2e emissions are summed across all pollutants. **Tables B-1 and B-2** summarize GHG emissions by pollutant and the resulting total CO_2e for each source category.

Table B-1. 2005 baseline emissions (metric tons/year) by pollutant and CO_2e for each source category.

Type	Source Sector	Source Category	2005			
			CO_2	N_2O	CH_4	**CO_2e**
Direct	Transportation	On-road mobile sources	321,757	30	24	**331,476**
		Recreational boats	22,197	1	2	**22,403**
		Other off-road equipment	52,056	4	28	**53,860**
	Fuel combustion	Wood combustion	90,081	4	303	**97,700**
		Natural gas combustion	179,425	0	17	**179,885**
		Other combustion	5,820	0	1	**5,858**
	Fires	Wildfires and prescribed burns	3,848	1	11	**4,284**
	Land use	Livestock	-	22	280	**12,734**
	Waste	Wastewater treatment	-	-	-	**-**
Indirect	Energy	Electricity consumption	486,631	2	9	**487,553**
		Wastewater treatment	2,111	0	0	**2,115**
	Transportation	Aircraft	2,180	0	140	**5,131**
	Waste	Municipal solid waste	-	-	5,262	**110,512**
Total Emissions			**1,166,106**	**64**	**6,078**	**1,313,511**

[17] GWP is an index developed by the Intergovernmental Panel on Climate Change (IPCC) to quantify the relative radiative forcing effects of a given GHG using CO_2 as the reference gas (California Climate Action Registry, 2009).

Table B-2. 2010 baseline emissions (metric tons) by pollutant and CO_2e for each source category.

Type	Source Sector	Source Category	2010			
			CO_2	N_2O	CH_4	**CO_2e**
Direct	Transportation	On-road mobile sources	310,014	28	23	**319,106**
		Recreational boats	15,847	0	1	**15,994**
		Other off-road equipment	56,878	4	26	**58,751**
	Fuel combustion	Wood combustion	96,165	4	324	**104,297**
		Natural gas combustion	187,275	0	18	**187,755**
		Other combustion	6,120	0	1	**6,161**
	Fires	Wildfires and prescribed burns	82,312	14	245	**91,652**
	Land use	Livestock	-	22	280	**12,734**
	Waste	Wastewater treatment	-	-	-	**-**
Indirect	Energy	Electricity consumption	561,757	2	9	**562,543**
		Wastewater treatment	2,297	0	0	**2,300**
	Transportation	Aircraft	2,013	0	129	**4,739**
	Waste	Municipal solid waste	-	-	1,272	**26,704**
Total Emissions			**1,320,679**	**75**	**2,327**	**1,392,737**