# Appendix E: Greenhouse Gas Emissions Calculator

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# Greenhouse Gas Emissions Calculator

The Greenhouse Gas Emissions Calculator was developed as part of a Basin Study of the Santa Ana River in a partnership between the Santa Ana Watershed Project Authority and The United States Department of the Interior Bureau of Reclamation. It has been used here to calculate the annual metric tons of carbon dioxide equivalent in the Upper Santa Anna River watershed produced by water agencies, including both suppliers and that providing water treatment. The spreadsheet is reliant on the population over a sixty year period, but additional regionally specific information such as the per capita water usage, the percentage of the sources of water, and the average daily flow to potable water treatment plants over a sixty year period can be added for a more accurate description of the region. Additional regionally specific information may also be added for greater accuracy.

Default data for population projections for Southern California are provided in the calculator, but population growth may also be inputted as projected population, decadal growth rate, or annual growth rate. Population data for the current, 1990, 2000, and 2010 years are the only data that are necessary to run the model. Table 1 is the calculated population levels for the Upper Santa Ana River Water IRWM Plan area. These values were used consistently throughout the model.

Table 1: Population Data

| Year | Population |
|---|---|
| 1990 | 713,269 |
| 2000 | 938,989 |
| 2010 | 1,130,102 |
| Current | 1,175,306 |

Per capita water usage, in gallons per capita per day (gaped), has a default level for Southern California set at 209 gallons per capita per day. Ideally per capita water usage should be entered for the current, 1990, 2000, and 2010 years in gallons per capita per day if available, but these values are not necessary to run the model. Projected per capita water usage can be entered if available, or a decadal or annual growth rate, to view the effects of water usage on greenhouse gas emissions. A water district average of 294 gpcd weighted by population served was used as the current per capita water usage.

Table 2: Per Capita Water Usage

| Agency | Baseline Water Use (gpcd) |
|---|---|
| East Valley Water District | 342 |
| City of Loma Linda | 255 |
| City of Redlands | 365 |
| City of San Bernardino | 249 |
| West Valley Water District | 316 |
| Yucaipa Valley Water District | 291 |
| City of Colton | 241 |
| **Weighted Average** | **294** |

Water supply percentage values for the amount of groundwater, State Water, Project water, Colorado River water, and self-supplied water should be provided. Default values for Southern California are given, but more accurate percentages should be applied if available. Self-supplied water is any water that is not imported and is only treated and distributed (recycled and surface water). If it is placed into the ground water supply, it is considered groundwater, to prevent from under or over calculation of energy usage for treatment.

Table 3: Water Supply Portfolio for the Upper Santa Ana River Wash

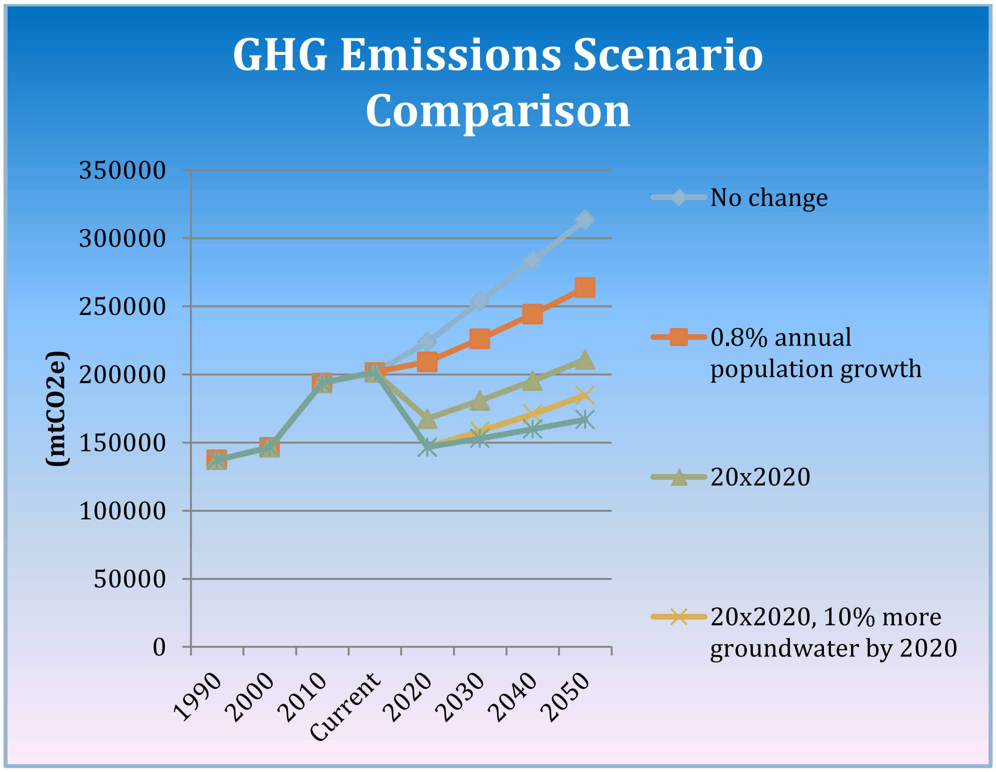
| Type of Water | Percentage |
|---|---|
| Groundwater | 57% |
| State Water Project | 24% |
| Colorado River | 0% |
| Self-Supplied | 19% |

Potable water treatment data should be entered if available for current, 1990, 2000, and 2010 in million gallons per day (MGD). Default data is provided at 20 MGD if specific data is not available. If projected data, decadal growth, or annual growth of potable water treatment is available, it can be used to adjust scenarios. The default data was used to run the model.

Additional specific information, such as monthly or annual State Water Project data for 1990-2011, monthly or annual Colorado River water data for 1990-2011, monthly or annual potable water treatment flow data and energy data for 1990-2011 for each agency, and monthly or annual groundwater flow data and energy data for 1990 to 2011 can also be applied for greater accuracy. State water project monthly deliveries for the time frame were applied to the calculations.

Scenarios can be created and then exported for comparison. These scenarios can be used to show which of the above characteristics has the greatest effect on emissions levels. Below is an example of a scenario comparison that is relevant to the Upper Santa Ana River Watershed. It is important to note that when using the State Water Project as a default baseline for comparison that comparison is made based on current energy use. Changes in operational efficiency are not included; however it is likely that energy use to wheel water in California will decrease in the future. The model does not also include assumptions showing an increase in renewable energy used to wheel and treat water in the future.

Figure 1: Scenario Comparison




The first scenario demonstrates the trend of greenhouse gas emissions without any conservation efforts by using Southern California population projections provided by the model. If no reduction changes are made, the amount of carbon dioxide equivalent will more than double over the sixty year period based on given assumptions.

The second scenario uses and 0.8% annual growth rate for population instead of the provided Southern California projections. This growth rate is the projected growth rate for San Bernardino County and therefore is a more accurate representation of population growth for the region. This population growth is slower than Southern California population projections and therefore has a slower increasing rate for greenhouse gas emissions. This population growth will be used in the rest of the scenarios.

The 20x2020 conservation plan effort is shown in the third scenario, where the per capita usage for the area will be reduced by twenty percent by the year 2020. This method of conservation will decrease the amount of greenhouse gas emission by approximately 34,000 mtCO2e between the current year and 2020.

The fourth scenario continues the 20x2020 goals as well as increases the amount of groundwater in the region by ten percent by 2020. This increase in ground water will help to cover the increasing water supply demands caused by a growing population.

The fifth scenario continues the trends of the fourth scenario, but decreases the per capita usage by another ten percent between the years 2020 and 2050. This further per capita decrease in usage helps to lower the emissions level to 30,000 mtCO2e more than the 1990 level in 2050. This is a relatively decent number knowing that the population is expected to grow by approximately 48% between 1990 and 2050.

Decreasing the per capita usage has the greatest effect on greenhouse gas emissions. The 20x2020 plan decreased the greenhouse gas emissions by more than 40,000 metric tons of carbon dioxide from the expected value for 2020 without conservation. If a continued decrease in per capita usage were possible the greenhouse gas emissions in the region would drastically decrease.

Another effective method to decrease greenhouse gas emission would be to incorporate more groundwater resources through storm and rain water capture and recycled water. These methods decrease the necessity of State Water Project water, which may become less reliable in future years.

If ground water levels are not monitored and maintained, the volume of available local water could be insufficient to supply the increasing population. The above scenario maintains that 57% of the total water supply will be supplied by groundwater even as the population increases. This assumes that proportionally more groundwater would be used to keep up with the increased population levels water usage.

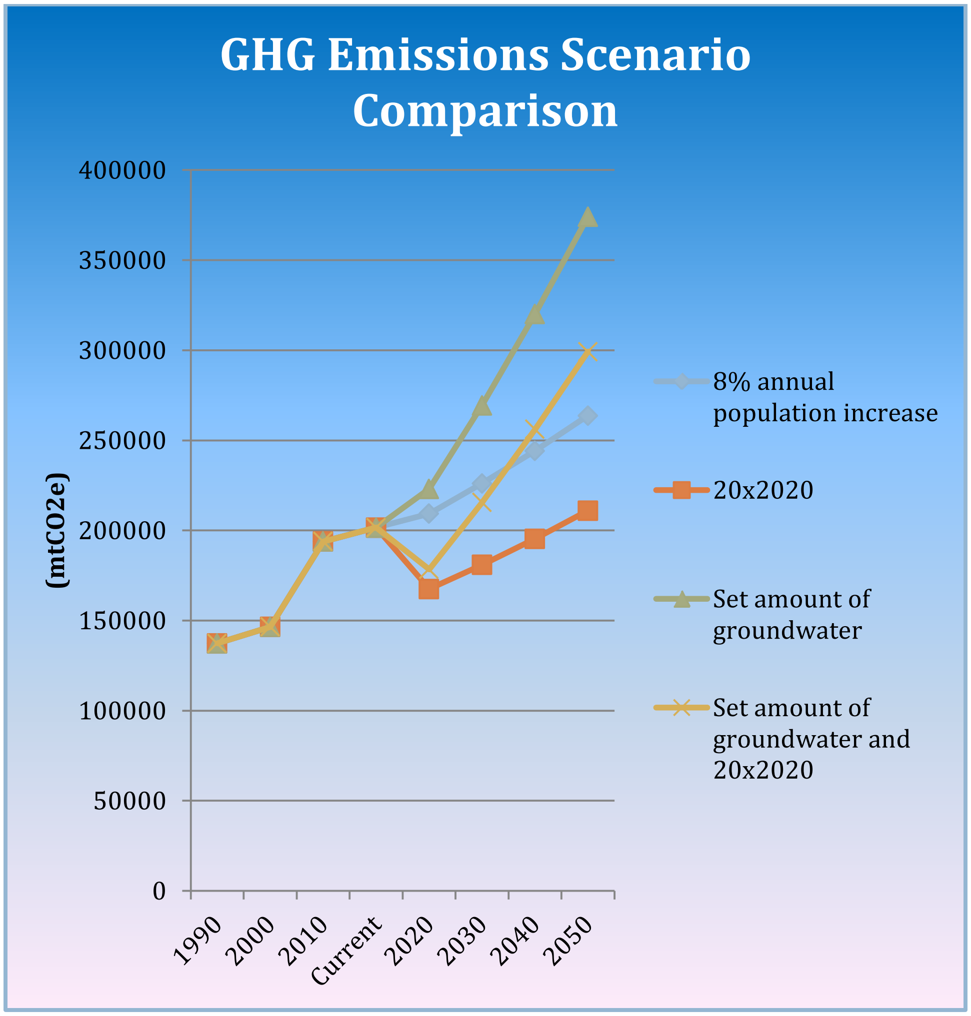
Below is a scenario that assumes that only a finite amount of water is available as groundwater in the region each year and therefore only a set number of people can receive water from groundwater each year. The increasing population levels may have to depend on increased provisions of State Water Project water if increasing levels of groundwater and self-supplied water are not available. It is assumed that only the current amount of groundwater will be available in future years. Table 4 gives shifting percentage values that were used to drive the model to demonstrate the need for an increased amount of water provided by the State Water Project.

Table 4: Projected Water Supply Levels

| Reliance on State Water | | | |
|---|---|---|---|
| **Year** | % groundwater | % self-supplied water | % state water |
| **Current** | 57.0% | 19.0% | 24.0% |
| **2020** | 54.9% | 18.3% | 26.8% |
| **2030** | 50.8% | 16.9% | 32.2% |
| **2040** | 47.1% | 15.7% | 37.3% |
| **2050** | 43.6% | 14.5% | 41.9% |

If groundwater and self-supplied water levels decrease as population increases, reliance on State Water Project water will increase resulting in higher GHG emissions as seen below.

Figure 2: Reliance on State Water




The first scenario shows the model being run with only the 0.8% annual population growth as a factor. It still assumes that as the population increases the water supplies will all grow to meet the population demands without changing the percentage values. The second scenario also maintains the water supplies at the same percentage values, but shows the effects of the 20x2020 decrease in per capita usage. Both of these scenarios are seen in Figure 1 as well.

The third scenario introduces the idea that the amount of groundwater supplies will not increase as the population increases. It stipulates that only 669,924 people in the region can be supplied with ground water each year, as that is the current level. In order to make up for the gap in the increasing population, and assuming that self-supplied water will not increase, the amount of State Water Project water will have to increase to meet the demands of the increased population. Table 4 gives the percentage values that were used to run the third scenario, showing the proportional decrease in the percentage of groundwater and self-supplied water each year, and therefore the increase in State Water Project Water.

The increasing amount of necessary State Water Project water drives up the greenhouse gas emissions.. This water is transported approximately 200 miles to the region where it is treated and dispersed to the population. The transportation drastically increases the greenhouse gas emissions levels. In contrast, locally supplied water has a lower impact on greenhouse gas emission because long distance transportation is not required.

The fourth scenario shows the increased reliance on State Water Project water and the required compliance with 20x2020. This scenario shows that the decrease of 20x2020 can have an impact in the short term, but ultimately the increased reliance on State water drives up the emission levels.

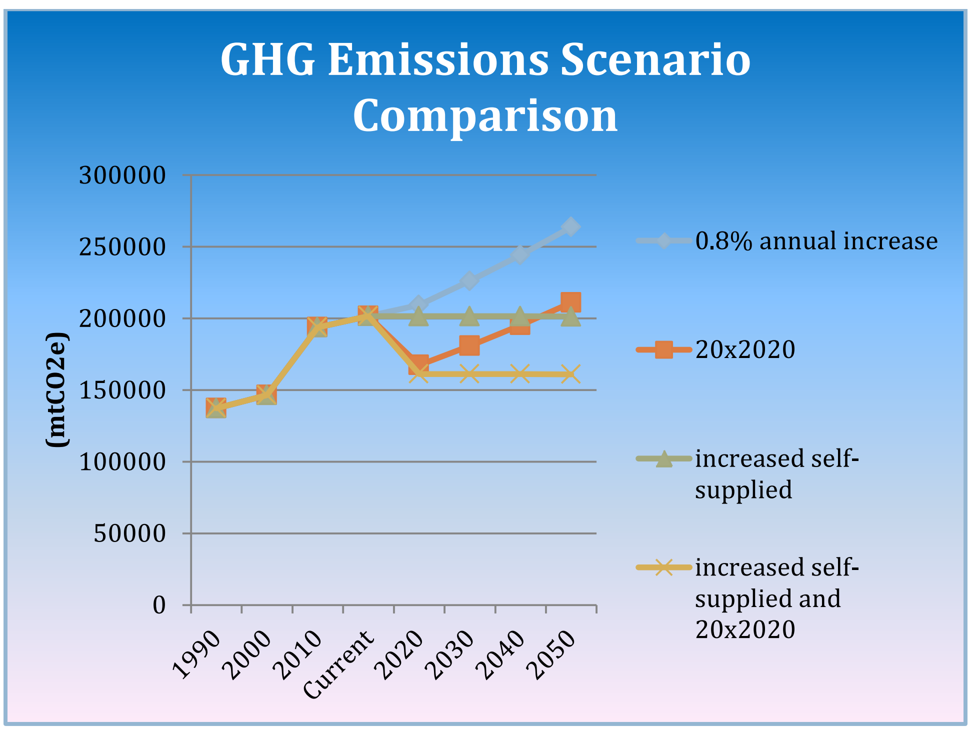
Increasing the amount of self-supplied water either through increased storm water capture or increased recycled water could greatly decrease the greenhouse gas emissions. The amount of groundwater and self-supplied water are set to finite annual levels in a similar fashion as shown above. Table 5 gives the water supply percentage values used to drive the model to provide set quantities of groundwater and State Water Project water.

Table 5: Projected Water Supply Levels

| Increased Self-Supplied Water | | | |
|---|---|---|---|
| **Year** | % groundwater | % state water | % self-supplied water |
| **Current** | 57.0% | 24.0% | 19.0% |
| **2020** | 54.9% | 23.1% | 22.0% |
| **2030** | 50.8% | 21.4% | 27.8% |
| **2040** | 47.1% | 19.8% | 33.1% |
| **2050** | 43.6% | 18.3% | 38.1% |

Figure 3 demonstrates that increasing the amount of self-supplied water to meet the demands of the population growth greatly decreases the amount of greenhouse gas emissions.

Figure 3: Increase Self-Supplied Water



The first scenario shows the model being run with only the 0.8% annual population growth as a factor. It still assumes that as the population increases the water supply will grow to meet the population demands without changing the percentage values. The second scenario also maintains the water supply at the same percentage values, but shows the effects of the 20x2020 decrease in per capita usage.

The third scenario shows the implementation of the increased amount of self-supplied water to meet the demands of the increasing population. The set amount of groundwater and State Water Project water forces the emissions to a relatively uniform level as the amount of water transported or pulled up is at a constant quantity. The fourth scenario shows the increase in self-supplied water along with 20x2020. This scenario lowers the emissions levels even further and keeps those levels at a consistently decreased level.

In general, an increased amount of self-supplied water will decrease the amount of greenhouse gas emissions due to the fact that no intermediate activity is required before it can be treated and distributed. In contrast, groundwater must be extracted and state water must be transported before treatment and distribution. . However, it is the transportation process that causes the highest emissions compared to any other activity in the water distribution system.

Rather than adopting a single mitigation method, an integrative approach using all methods would be the most effective in achieving the lowest levels of carbon dioxide equivalent. However, despite their positive outcomes some of these methods would be impractical to implement in the short term. Increasing self-supplied water involves more storm water capture and increased usage of recycled water which may become more difficult as weather patterns change. Increasing the amount of available water requires more groundwater recharge. Ultimately the greatest short term effect is conservation. Conservation efforts lower the total demand for water and thereby decrease the emissions levels.

The GHGE calculator does not account for any technological advances that may occur over the 60 year period as these changes are not predictable. These advances could potentially increase the efficiency of pumps, energy, and the water system as a whole.