Report on Initial Town of Mamaroneck Greenhouse Gas Emissions Inventory

EXECUTIVE SUMMARY

The Town of Mamaroneck (ToM), NY is developing a Sustainability Initiative program, recognizing the benefits of and concern for sustainability. Part of this effort is the development of an inventory of greenhouse gas (GHG) emissions from ToM-controlled activities, as GHG emissions have been linked to Climate Change. ToM prepared this initial GHG emissions inventory using internationally-approved procedures. Also known as a "carbon footprint", this initial inventory is composed of GHG emissions during a baseline year (2007) and during recent years (2011 and 2012).

ToM retained Climate Change & Environmental Services, LLC (CCES) to prepare the initial GHG emissions inventory and to develop initial general strategies to prudently minimize future energy usage and GHG emissions.

For this effort, GHG emissions were calculated from sources under ToM's control, including direct emissions from fuel combustion of both stationary and mobile (fleet) sources and indirect emissions from electricity usage. Compiled by ToM management, CCES reviewed fuel and electricity data from all ToM buildings, fleets, and operations. This data was used to calculate GHG emissions using published emission factors from The Climate Registry, considered the premier source of Climate Change procedures. Emissions in metric tons of CO_2 equivalents (CO_2e) were calculated in absolute terms.

ToM baseline (2007) GHG emissions totaled 2,583 metric tons of CO_2e. In 2011, ToM GHG emissions were calculated to be 2,324 metric tons of CO_2e. In 2012, ToM GHG emissions totaled 2,136 metric tons of CO_2e, a decrease of about 17% from the baseline year. ToM's main sources of energy usage and GHG emissions were electricity and their fleet. While some of the 17% reduction was due to comparatively mild weather reducing the fuel needed to heat some buildings, there were also tangible reductions in fuel use by the Sanitation and Police Departments causing a reduction in GHG emissions from ToM's fleet.

Given this information, this report contains general recommendations for the ToM to reduce energy usage and GHG emissions in the future in a smart, cost-effective manner without risking service for the public.

SPECIAL ACKNOWLEDGEMENT

A special acknowledgement is given to Ms. Andrea Grenadier of the Town of Mamaroneck office who gathered data from diverse groups and departments necessary to conduct this GHG emissions inventory. Her tireless efforts are appreciated. Special acknowledgement also goes out to Ms. Bridget Owusu, who reviewed data and inputted it into appropriate Excel spreadsheets.

INTRODUCTION

The Town of Mamaroneck (ToM), NY performed an initial greenhouse gas (GHG) emissions inventory as part of their Sustainability program, and retained Climate Change & Environmental Services, LLC (CCES), an experienced firm in these areas, to lead the effort. ToM understands that Climate Change puts the Town and its residents at risk, and therefore, needs to be addressed. It is also understood that emissions of GHGs contribute to Climate Change and that energy usage leads to GHG emissions. Reducing energy usage not only reduces GHG emissions, but at the same time, reduces costs. A GHG emissions inventory – or carbon footprint – is performed by many entities as a first step to determine their energy usage profile and as a measure of progress in sustainability efforts.

This study determined GHG emissions from activities directly controlled by and under the responsibility of the ToM municipality. Therefore, GHG emissions from activities of individual residents and businesses were not determined. The "boundary" for ToM's initial GHG emissions inventory included:

- Direct GHG emissions from boilers (fuel combustion) at ToM facilities,
- Direct GHG emissions from ToM-owned mobile sources,
- Direct GHG emissions from replacement of refrigerants, and
- Indirect GHG emissions from electricity usage of ToM-owned or -controlled operations, such as buildings, street lights, etc.

These sources of GHG emissions are considered "Scope 1" and "Scope 2" sources, according to the World Resources Institute/World Business Council for Sustainable Development (WRI/WBCSD) "The GHG Protocol." This inventory used internationally-accepted procedures from WRI/WBCSD and The Climate Registry to gather information and perform the GHG emission calculations.

CCES provided guidelines to ToM officials to gather the data necessary to perform this GHG emissions inventory. Data from such activities were gathered for three calendar years: for 2007, the "baseline" year, and two most recent complete years,

2011 and 2012. CCES reviewed data provided by ToM and requested adjustments as necessary before data was considered final and meeting the standards of the internationally-accepted procedures. CCES then determined GHG emissions for the years using emission factors for such operations published and accepted as correct. CCES evaluated trends. This document is the summary of the initial GHG emissions inventory for ToM.

ToM joined the International Council of Local Environmental Initiatives (ICLEI), a global group of municipalities concerned about climate change. The GHG emissions inventory and Sustainability Initiative are part of ToM's commitment to ICLEI.

OVERVIEW OF THE ToM SUSTAINABILITY INITIATIVE

Sustainability is a major issue of acute and growing interest worldwide, as it is understood that governments and other entities must function effectively, yet not do so by depleting natural resources nor cause damage to the environment that may affect future generations. The Town of Mamaroneck (ToM), NY has begun a Sustainability Initiative to lessen its impacts. Part of such a program is minimizing emissions of greenhouse gases (GHGs), believed by the world's scientific community to contribute to the problem. Climate Change has been associated with many physical effects, such as overall warming of the planet and the increase in severity of storms, which would affect the capabilities of municipalities to perform basic services for its citizens. Climate Change is, in part, caused by the buildup of GHGs in the atmosphere that absorb certain radiation, trapping heat in our atmosphere that would normally pass through. The worldwide effort to reduce GHG emissions has become a measuring stick for an entity's environmental and sustainability program.

Several other drivers make such a sustainability initiative potentially economically and socially beneficial to ToM:

- **Economic and Fuel Reduction Incentives:** A robust program reducing GHG emissions can result in direct economic benefits. Most GHG emissions derive from combustion of fossil fuels. Reducing the rate of such direct combustion and electricity use is not only an effective way to reduce GHG emissions, but will also result in significant operating cost savings, given the high cost of energy. In addition, by reducing or changing routine fuel use, ToM operations would reduce its risk of potential future shortages, a critical concern.

- **Please Your Residents and Businesses:** A growing number of people are demanding to know GHG emissions ("carbon footprint") information about

items as diverse as the products they buy to the institutions that serve them. Having a carbon footprint for the Town can provide the citizens with such information and is a reliable measuring stick of efficiency and progress.

- **Improve Your Image and Develop New Business Opportunities:** Climate Change has a recognized metric: GHG emissions. ToM successfully reducing GHG emissions would be undeniable proof of progress. A robust sustainability initiative with such success can also be a positive part of what ToM is and what it is to live and own a business there, can be highlighted on your website, and can improve your image to critical stake-holders. Should ToM be successful in reducing its GHG emissions markedly, the Town can develop a reputation as a "green" town, which can itself raise property values and attract more businesses and citizens to the Town.

METHODOLOGY FOR INITIAL ToM GHG EMISSIONS INVENTORY

Any GHG emissions inventory must focus on the unique activities that result in GHG emissions. An inventory "boundary" must be developed of operations that potentially emit GHGs. This initial GHG emissions inventory will focus on GHG-emitting operations for which ToM has operational control, which would include the following:

- Direct emissions from combustion of fuel in boilers and related stationary combustion equipment to supply heat or hot water to ToM buildings;
- Direct emissions from leakage of refrigerants used in air conditioning systems;
- Direct emissions from use of ToM-owned mobile sources, such as trucks, ambulances, automobile fleets, etc.; and
- Indirect emissions from use of purchased electricity and steam. These emissions are indirect as GHGs are not directly emitted from a ToM facility, but instead from a power plant combusting a fossil fuel to meet the need.

These sources represent Scope 1 (direct) and Scope 2 (indirect) sources of GHG emissions, as defined in "The GHG Protocol", published by the World Resources Institute and World Business Council for Sustainable Development (WRI/WBCSD). Scope 3 sources include other GHG emitting operations, such as outsourced activities, business travel, and employee commutation. Scope 3 sources are commonly not included in GHG emission inventories and are not included in this one.

Like most municipalities, ToM performs necessary operations, some of which result in GHG emissions, such as combusting fuel for heat and hot water in Town-owned buildings; electricity for such buildings, as well as other needed sources, such as

street and traffic lights; gasoline or diesel fuel to operate diverse mobile sources, such as police and other automobiles, fire, garbage and repair trucks, plows, and ambulances. ToM operates a number of buildings for which fuel for heating is necessary, such as:

- Town Center
- Hommocks Ice Rink
- VFW Building
- Fire Headquarters
- Highway Garage
- Ambulance Corp Building and
- Memorial Park Utility Building

ToM is unique in that it operates an ice rink, something that very few municipalities do. In addition to those buildings, ToM uses (and pays for) electricity for two pump stations, Lot #3, and Monroe St. School. Electricity is supplied to ToM by the New York Power Authority through a special arrangement and discounted cost program.

ToM operates a variety of transportation sources for critical operations, such as:

- A-Fund: 2 6-cylinder SUV's, 1 6-cylinder Van, and 1 6-cylinder sedan
- B-Fund: 1 6-cylinder sedan and 2 4-cylinder sedans
- Police
- Fire
- Highway
- Sanitation
- Ambulance Corps 4 ambulances and 2 paramedic vehicles.

ToM tracks electricity and fuel usage from billing records provided to the appropriate departments, facilities, and operations controlled. Such data was available to calculate GHG emissions from these categories. 2007 was designated to be the baseline year, representing a year against which future changes can be compared and a year of fairly typical operations. Data was also collected and GHG emission calculations performed for 2011 and 2012, recent years of operation to determine patterns of emission growth or reduction. ToM believes that the data collected for these three years is overall of high quality. The goal of this project is to compute total GHG emissions, to compare emissions in 2007 and 2011 and 2012 in order to benchmark the facilities and operations to determine common-sense and economical strategies to reduce future GHG emissions and properly manage a future ToM GHG emission reduction program.

ToM GHG emissions were estimated based on measured activity data (i.e., electricity demand, fuel usage, etc.) and appropriate published emission factors, as follows:

- Fuel combustion in stationary sources – Tables 12.1, 12.9 in The Climate Registry General Reporting Protocol, version 2.0, March 2013;
- Fuel combustion in mobile sources – Tables 13.1 in The Climate Registry General Reporting Protocol, version 2.0, Mar. 2013;
- Electricity usage - Table 14.1 in The Climate Registry General Reporting Protocol, version 2.0, Mar. 2013, taken from latest USEPA eGRID (2007) data.
- Refrigerant losses – actual replacement quantities of refrigerants recognized as GHGs, assigned to the year replacement occurred.

Emissions of the three major GHGs (i.e., CO_2, CH_4, and N_2O) were calculated if factors were available. GHG emissions were converted to CO_2 equivalents (CO_2e), using Global Warming Potential (GWP) factors obtained from The Climate Registry. For example, methane (CH_4) has a GWP of 21; one lb. of CH_4 has the same potency to trap heat as 21 lb. of CO_2. Therefore, the emissions of CH_4 would be multiplied by 21 to compute equivalent CO_2 emissions. For N_2O, the GWP is 310.

Raw activity data received from ToM was reviewed and some were flagged for clarification of potential flaws or misunderstandings. In such cases, ToM managers were contacted directly with concerns about any missing or questionable data. All issues were addressed. In-person audits to verify data were not conducted. Data used to calculate GHG emissions was considered of proper quality.

GHG emissions were totaled and estimated on a mass basis for each facility or category (in metric tons), as well as for each specific functional process. To enable a better comparison of emissions, GHG emissions data was also normalized to production parameters (i.e., lb CO_2e emitted per ?????????????).

GHG EMISSIONS INVENTORY RESULTS

In summary, GHG emissions are presented in table below.

(subject to slight change as numbers are finalized)

Total ToM GHG Emissions (in metric tons CO_2e)

GHG Emissions	2007	2011	2012
Electricity	893	897	869
Natural Gas	521	475	343
Heating Fuel (No. 2 Fuel Oil)	146	180	120
Mobile Sources (Fleet)	810	699	674
Refrigerants	0	60	54
Total (absolute emissions):	**2,370**	**2,312**	**2,060**

The following table shows a breakdown of each year's GHG emissions by source:

Year	Electricity	Natural Gas	Heating Fuel	Fleet	Refrigerants
2007	38%	22%	6%	34%	0%
2011	39%	21%	8%	30%	3%
2012	42%	17%	6%	33%	3%

The following table shows a breakdown of percent of total ToM GHG emissions by major activity/building:

Year	Ice Rink (elec.)	Traf./Str. Lights	Town Ctr	Fleet	Ice Rink (gas)
2007	14%	10%	7.5%	34%	11%
2011	14%	9.4%	7.6%	30%	11%
2012	16%	10%	7.8%	33%	10%

The following table shows a breakdown of % of GHG emissions from total ToM Fleet:

Year	Sanitation	Police	Highway	Fire	Town	Ambulance
2007	37%	23%	23%	6.5%	6.0%	5.0%
2011	24%	21%	32%	9.9%	7.6%	5.7%
2012	26%	21%	29%	10%	8.0%	5.7%

EVALUATION OF GHG EMISSIONS INVENTORY

Appropriate data was collected and GHG emissions were calculated for a baseline year (2007) and two recent years (2011 and 2012) for comparison purposes. Because the activities resulting in GHG emissions were also energy-related, this inventory also serves as an energy usage evaluation for ToM. Cost data was not available to be collected for all activities and all years. Therefore, a determination of accurate cost savings or growth in the energy area could not be made.

The data in the previous section shows a small reduction in GHG emissions from the baseline year to 2012. **2012 GHG emissions were almost 13% lower than the baseline year and 10.5% lower than even the previous year.**

Changes in GHG emissions and energy usage can be caused by a number of actions, and sometimes will occur because of conditions that cannot be controlled. One example of the latter is the weather. A colder winter day will necessitate the combustion of additional oil or natural gas beyond what may have been combusted during a milder day during the baseline year. Likewise, a hotter summer day will likely necessitate greater electricity use to cool given ToM areas. Below is a comparison of average temperature data for the years in question in Central Park, New York City, provided by the National Weather Service.

Average Monthly and Annual Temperatures in Central Park, New York City

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Annual
2007	37.5	28.2	42.2	50.3	65.2	71.4	75.0	74.0	70.3	63.6	45.4	37.0	55.0
2011	29.7	36.0	42.3	54.3	64.5	72.3	80.2	75.3	70.0	57.1	51.9	43.3	56.4
2012	37.3	40.9	50.9	54.8	65.1	71.0	78.8	76.7	68.8	58.0	43.9	41.5	57.3

While the ToM used much less natural gas and fuel oil in 2012 compared to the baseline year of 2007, it can be observed that the peak heating season months of December, February, and March were warmer in 2012 than during the baseline year, meaning that less fuel was needed in 2012 to be combusted for warmth. The weather was undoubtedly not the only factor that led to a ___% reduction in GHGs from electricity in 2012 versus 2007, but would explain part of the reduction. Anecdotally, one may recall that in March 2012, the area had 8 days during which the high temperature exceeded 70°F; in March 2011, there was only one such day; in the most recent severe winter (March 2013), there was not a single day where the high temperature exceeded 60°F. For heating offices used almost exclusively during the daytime, this is a critical statistic. At this time, a 2013 GHG emissions inventory

cannot be completed, but surely a rise in natural gas and fuel oil use will occur in order to heat ToM buildings due to the recent severe winter.

Electricity usage was the highest percentage of ToM sources of GHG emissions. Electricity usage and thus GHG emissions from electricity were essentially unchanged in the three years studied (decreased 2.8% in 2012 compared to the baseline year of 2007). The weather data above shows that the summer of 2011 was a little warmer than 2007 and 2012, but not by much, necessitating an insignificant additional usage of electricity for cooling. The biggest user of electricity in ToM's inventory is the Hommocks Ice Rink, which in 2012 accounted for about 39% of all of ToM's electricity usage. Electricity usage at the Ice Rink rose about 5% in 2012 compared to the baseline year of 2007. The second largest usage of electricity by ToM is street and traffic lights, which in 2012 accounted for about 25% of all ToM electricity usage. Street and traffic light electricity usage decreased by about 11% in 2012 compared to 2007. Finally, the third largest user of electricity is the Town Center, accounting for about 19% of all ToM electricity usage. Town Center electricity usage decreased by about 8.5% in 2012 compared to 2007.

The two areas where there were significant reductions in GHG emissions between 2007 and 2012 is in the leakage of refrigerants and the operation of the ToM fleet of vehicles. Many commercial refrigerants are GHGs. When equipment is inspected (generally, annually) and the refrigerant level is low and must be replaced, that is considered equal to the quantity that has leaked and entered the atmosphere. Leaks can be small and gradual or larger and caused by a distinct problem. Such a repair can cause a reduction in leakage. This appeared to be the case for ToM. In 2007, the quantity of GHG emissions from refrigeration was much greater than in 2011 and 2012. Although there appears to be no records on exact repairs, it is probable that repairs or replacement of lines occurred to reduce the reduction rate.

ToM fleet includes Sanitation trucks, Police cars, Highway Dept cars/trucks, Fire cars/trucks, Ambulance and Paramedic cars and ambulances, and others. Fleet represents the second highest source of ToM's energy usage (gasoline and diesel fuel) and of GHG emissions. For Fleet, overall ToM fuel usage and GHG emissions decreased by about 17% between 2007 and 2012. The biggest declines were in Sanitation (about 40%) and Police (about 20%). The 2012 reduction in fleet fuel usage would result in a roughly 5% decrease in total ToM GHG emissions compared to the 2007 baseline.

FUTURE OF YOUR SUSTAINABILITY INITIATIVE

Establishing a Successful Program

The first step in establishing a successful, effective Sustainability Initiative is to establish an infrastructure. A successful Sustainability Initiative requires leadership from the top, from the Town Supervisor. While Sustainability does not need a formal department of its own, successful programs have at least an established committee with roles and responsibilities articulated. It is also critical to have active participation by members of diverse ToM groups impacted by sustainability, such as equivalent of Administrative, Engineering, Purchasing, Financial, Legal, and IT.

Sustainability initiatives have a greater chance of successfully meeting goals if serious planning occurs. Discussions about the short- and long-term goals of such a program are critical, as well as anticipating potential barriers that may delay or prevent success. ToM participated in a diagnostic study about sustainability, with key personnel learning more about its concepts and exploring the steps involved in moving forward and anticipating unique potential “roadblocks” down the road. Participants began to understand what the Sustainability Initiative consists of and what areas ToM may currently be weakest in. During the exercise, the group identified managing energy use as their weakest current position. This report should begin the effort for ToM to better understand and smartly reduce energy usage.

Data Management

ToM has completed its initial baseline GHG emissions inventory covering 2007 as a baseline year and 2011 and 2012. ToM plans to continue the effort to collect future relevant data from the facilities and activities and continue to calculate GHG emissions using the current tools. It is recommended that such an effort be conducted at least every second year, if not on an annual basis. This will help ToM determine future changes in GHG emissions over time (trending), particularly after energy-reducing strategies are implemented. ToM will also track costs involved and potential cost savings over time. Developing a system to track actual monthly electricity and natural gas usage of each applicable building or activity, heating oil and fleet fuel purchases will make the effort for ToM easier.

While calculating and managing such data on an Excel spreadsheet is quite reliable, it may be necessary given the growth to a very large quantity of data (i.e., usages of fuel for fleets and for buildings, electricity, etc. and the GHG emissions and trending for many years) to research specific commercially-available information management software that can dovetail with other specific software the Town has or will use to

better manage the program long-term. Such specific software should dovetail with existing or future ToM software used for budgetary and other purposes.

General Discussion of Strategies To Reduce Energy Usage, GHG Emissions

ToM's overall goal in their Sustainability Initiative is to demonstrate reductions of GHG emissions, achieved in a sound and cost-effective manner. GHGs, derived primarily from fossil fuel combustion, can be most effectively reduced in two ways:

- institute an energy conservation program. In other words, ToM should perform the same services as always using less fuel or electricity; and/or
- use energy derived from less carbon-intensive sources, such as renewable sources.

This section will address these strategies in a general sense. Site- and strategy-specific evaluations of ToM operations would need to be performed to determine the feasibility of the listed strategies and costs, energy saved, and GHGs reduced. Therefore, this report presents general strategies that could be feasible and effective.

A discussion pertaining to the main sources of energy usage and GHG emissions discussed earlier is provided.

Electricity

Electricity usage was determined to be the greatest contributor to ToM's overall GHG emissions profile (about 42% of the total in 2012). While each building is not directly emitting GHGs when using electricity, it is an indirect source because it requires a power plant to produce the electricity, likely by fuel combustion. Thus, minimizing electricity usage in a smart way reduces GHG emissions (as well as costs), and ToM can take credit for this.

Ice Rink, Unique ToM Function. While most municipalities have common responsibilities, such as police, sanitation, ambulance, road repair, etc., ToM has a unique responsibility that few other towns perform. ToM operates an ice rink, a very energy-intensive activity. The Hommocks Ice Rink contains a large amount of space that must be conditioned (heated or cooled) for the comfort of participants and observers. In addition, ice surface maintenance is energy-intensive. The building is used for a large number of hours daily and used nearly all year for activities.

According to the GHG emissions inventory, the Hommocks Ice Rink itself uses about 39% of the total Town electricity, the largest single source. Therefore, a program to

reduce overall electricity use of ToM functions should begin and focus on the ice rink. ToM is currently in the process of hiring an energy advisor to perform a thorough energy audit of the ice rink and determine potential energy efficiency strategies.

Lighting.

Street and traffic lights. Another major component of electricity usage is lighting. ToM operates street and traffic lights (about 25% of all electricity), as well as having to light its offices. In the last 5 years there has been quite literally a revolution in lighting capabilities, as light emitting diodes (LEDs) can function quite well in place of traditional street lights (metal halides) while using much less electricity (up to 80% less). Besides the reduction in kilowatt-hours used and electricity costs, these lights typically last much longer than traditional bulbs, meaning less hours for ToM Maintenance replacing bulbs, allowing the Town to utilize these workers in other areas. Another benefit of such a changeover is a lower insurance risk for ToM as there would be fewer trips up and down "the ladder" for bulb changes. While more expensive upfront, these new technologies generally pay back the extra cost through electricity savings in a very reasonable time.

There is growing evidence of municipalities switching to LEDs in street and traffic lighting, and achieving significant and quick cost savings. A recent published example is the City of Las Vegas: http://www.energymanagertoday.com/led-street-lights-save-las-vegas-2-million-per-year-095235/. While such savings should not be expected for ToM, this is but another example of a municipality that has successfully switched and is saving them costs. One cautionary note about using LEDs: they are so energy efficient that they give off very little heat during operation. That could be a problem after a snow storm. Conventional traffic lights give off heat, melting snow that has piled up next to it, allowing the green, yellow, or red lights to be seen. There have been rare instances in extremely cold days where LED traffic lights are obscured by piling snow. A properly designed light fixture where snow does not accumulate or basic brushing during the rare high piling would alleviate this problem. Another concern is quality. The U.S. has no formal standards for LEDs, and there may be differences in the quality of some vendors' LEDs (serviceable length of time or quality of light). It is a good idea to retain a lighting expert who can recommend the right vendors to supply LEDs from historically reliable sources.

Office/Building Efficient Lighting. Another conversion to consider in ToM buildings is of fluorescent fixtures called T-12s and T-8s (the number refers to the bulb's thickness; T-8s are thinner than T-12s) to LEDs. While many offices have converted from T-12s to T-8s, it may make economic sense to switch again to LEDs as they use much less electricity for the same amount of light than even T-8s. In addition, recent

research shows that LED light usage in an office setting can result in less strain and better acuity of what is on a screen or reading material than other forms of light sources. While LEDs are currently a little more expensive, again, the energy cost savings are significant and there is usually a relatively short payback.

While this may vary from entity to entity, according to a major study performed by the McKinsey Group in 2009, a lighting upgrade is the most cost-effective strategy for reducing GHG emissions. (http://www.mckinsey.com/client_service/sustainability/latest_thinking/greenhouse_gas_abatement_cost_curves)

Use of Natural Lighting and Focused Lighting. In addition to optimizing light fixtures, other factors influence electricity usage from lighting. One is building design. Buildings that allow natural light to enter the internal space, such as through windows and sun roofs, can significantly reduce the amount of artificial light needed and electricity used. Encouraging workers to open shades will allow natural light to come into their workplace.

Lighting can also be reconfigured to direct more light at the areas where activities are being performed (desks, work benches, machinery, etc.) and less in less critical areas (yet sufficient for safe activities or movement to occur). Such lighting reconfiguration should be considered by ToM, particularly during any renovations.

End Wasteful Lighting. Even when installing more efficient lighting, a building can still waste light and therefore energy and costs by having lights on when a room or work area is not being occupied or used. Therefore, another successful strategy to reduce electricity usage from lighting is the use of occupancy sensors, which turn off lights either when natural light is sufficient or when the room is unoccupied. This is a particular problem in offices, as workers may forget to turn off the lights, leaving them on in unused space for many hours. Historically, campaigns to encourage workers to turn off lights in areas not being used and at the end of the work day have not been very successful. Fewer light fixtures in full operation when not needed would significantly reduce electricity usage, your costs, and GHG emissions. In general, occupancy sensors are relatively inexpensive to purchase and install.

Electricity-efficient equipment purchasing policy. Another significant contributor to electricity usage in an office setting is the day-to-day use and efficiency of necessary equipment, such as computers, window air conditioners, refrigerators, and printers/faxes. These are critical and are often “ON” for long periods, using electricity.

First, ToM should always ensure that equipment to be purchased is truly needed and is sized properly for its function. For example, a refrigerator too large for its contents results in much unneeded space being cooled 24 hours a day for many years.

Another important concept is that different models of the same type of item can use significantly different quantities of electricity to perform its functions. Selecting one that is reliable and also uses the least amount of electricity is ideal. Energy Star, a joint program of the federal EPA and DOE, tests and rates different equipment for electricity usage. See www.EnergyStar.gov for more information about the program. Energy Star-labeled models often use over 20% less electricity than similarly-sized, equivalent models for the same function. For example, Energy Star-labeled personal computers have advanced systems to maximize the low energy "Sleep" mode.

For ToM, which may potentially purchase quantities of such equipment, the cumulative electricity savings can be significant, while not sacrificing operations.

While Energy Star-labeled products are usually more expensive than equivalent non-Energy Star-labeled products, the gap has narrowed and in some cases, prices are the same. However, buying Energy Star-labeled products is very cost-effective as the savings every month in the ToM electricity bill will pay back that extra upfront cost in a relatively short time (in many cases, less than one year). According to that McKinsey study of GHG reducing strategies referenced above, procurement of electricity-efficient equipment was the second most cost-effective strategy to reduce energy use and GHG emissions.

Therefore, it is recommended that ToM establish a purchasing policy to procure only computers, printers, faxes, etc. with the Energy Star label. Such a purchasing policy is one of the simplest and most cost-effective ways to reduce electricity usage and costs and to reduce GHG emissions.

Communicating information on electricity savings. Related to this, ToM could provide an informational program or document to its diverse employees (i.e., police, highway, etc.) regarding electricity usage practices that reduce consumption and further savings. This could include information such as reminding employees to turn off their computers and lights when they leave their work areas for a significant amount of time and to turn off electricity strips ("phantom electricity"). These tips can also be used by ToM employees to promote personal home energy saving measures, which will save them money and lead to further support of ToM and of the sustainability program.

Air Conditioning. Air conditioning (AC) is another major user of electricity. Improvements in the efficiencies of central and window AC units can save electricity and costs. Hiring a specialized firm to review, optimize, and perform maintenance on your AC systems will save significant electricity usage. In particular, the use of variable speed fans and using clean filters are two of the most effective ways to reduce electricity usage.

Another way to save electricity from AC revolves around its use. Investing in multiple programmable thermostats to control the temperature at different times and in different portions of your buildings is cost-effective. Different sections of buildings may need cooling 24 hours per day (i.e., police station), while other sections can have their air conditioning turned off after 5 pm and/or on weekends (i.e., offices). Thermostat location is critical too, preferably near where people work to better gauge comfort. Make sure there are no heat sources near a thermostat. Using air conditioning more effectively can reduce electricity usage, which would more than make up for the cost of the thermostats and also result in GHG emission reductions.

Mobile Sources (Fleet)

Operation of ToM-owned vehicles (fleet) is the second greatest contributor to ToM's energy usage and the overall GHG emissions inventory. Every mile that an automobile or truck is driven results in gasoline or diesel fuel being combusted, resulting in direct GHG emissions. The simplest methods to reduce GHG emissions from ToM mobile sources are (1) to use such equipment less frequently and/or (2) procure fleet equipment that is more fuel-efficient.

The GHG emissions inventory demonstrates a significant reduction in energy usage and GHG emissions from Fleet from the baseline year 2007 to 2012, particularly Sanitation and Police. The decline is about 18% in GHG emissions. It appears that both strategies above have been successfully used. It is understood that two Sanitation trucks switched to biofuel (used vegetable oil), thereby, no longer burning diesel fuel and burning a fuel with no net GHG emissions. It also appears that ToM police vehicles in particular are driving fewer miles in recent years compared to 2007.

Vehicle efficiency. A mobile source's miles per gallon (mpg) rating is indicative of fuel and cost savings. ToM should investigate instituting a purchasing policy that includes fuel efficiency in determining which new trucks, cars, etc. will be purchased. There are vehicles labeled as low emitting vehicles ("LEV") and as zero emitting vehicles ("ZEV"). If such a vehicle can meet the needs of the function (police car, truck, ambulance), then that would be preferable to a "gas guzzler."

Using fuels that emit less GHGs. Different fuels work satisfactorily on cars and trucks that emit different amounts of GHGs. One example is using "biodiesel" fuel, derived from a biological source, such as vegetable oil. This is considered "zero GHG emissions", as the source of the fuel is a plant, not fossil fuel. The carbon dioxide emitted is presumably replaced by carbon dioxide taken out of the air in the same area producing the new plants that produce the vegetable oil. This is an example of "renewable energy." In many cases, waste vegetable oil from a local merchant can be successfully used, often for cheap or for free. Because such an action also saves that local merchant the cost of waste oil disposal this can be a "win-win" for ToM and for the local merchant. ToM has already retrofitted garbage truck engines to combust waste vegetable oil, and is encouraged to expand the program. A cautionary note: vegetable oil used as a fuel could freeze under extreme cold conditions rendering the truck unusable during those extreme cold periods. This is unheard of in Mamaroneck's location, but has occurred in some extremely cold cities.

Drive fewer miles. Another way to reduce fuel usage and GHG emissions is to use mobile sources less; in other words, drive fewer miles. A number of corporations and municipalities have re-drawn driving routes of delivery people or police to meet goals while driving fewer miles, saving fuel. Any opportunity that ToM has to implement such an upgrade for its workers will result in fuel cost savings, not to mention a reduction in depreciation of the asset and risk of an incident occurring.

Minimize idling. Idling, keeping fleet vehicles on and combusting fuel while it is not moving or operating, is another way to waste fuel and costs. In addition, to these effects, idling causes emissions of toxic compounds low to the ground (tailpipe) that can harm the general public. In fact, excess idling is already regulated by ToM. Such rules should be enforced for vehicles operating in the Town, and operators of ToM fleet vehicles should be aware of this, as well, and turn off their vehicles when not in use, if that does not interfere with their activities.

Other mobile sources. Remember that mobile sources are more than just equipment that transport people, but also include machines that move for other functions, such as mowers, forklifts, etc. They burn fuel, too, and thus can be optimized to minimize fuel combustion, saving money and reducing GHG emissions. While there are no "mpg" standards for such equipment, research can reveal which models may be more fuel efficient. This is another example of a robust purchasing policy.

Maintenance. Finally, for all mobile sources, another key to reduce fuel usage and costs is a written active and proper maintenance program. ToM should ensure that all equipment – even mowers and forklifts – receive regular maintenance and oil

changes to ensure it is operating optimally and burning fuel efficiently. In addition, this will save ToM costs in terms of equipment replacement.

Stationary Source Combustion Fuel Usage

Fuel combustion and associated GHG emissions from boilers to warm ToM buildings was determined to be a significant source of ToM's GHG emissions, contributing by itself about 23% of the total in 2012.

The most common fuel combusted is natural gas, although several buildings use No. 2 (distillate) fuel oil as its primary fuel. Some buildings that use No. 2 oil also use natural gas for specific purposes, such as ovens or site-specific needs.

Fuel switching. Natural gas emits less GHGs per unit of heat compared to other conventional fuels (for example, about 22% less than fuel oils, according to The Climate Registry). Therefore, one way to reduce GHG emissions is to switch the fuel used in a boiler from only No. 2 (distillate) fuel oil to natural gas as a primary fuel (perhaps with No. 2 oil as a backup). As this is written, natural gas is about half the cost of No. 2 oil on a BTU (heat) basis, and the US Dept of Energy recently released a report predicting that based on projected supplies and market conditions this differential will likely be maintained for at least the next 5 years. Therefore, great long-term cost savings can be achieved in switching to natural gas. There are other benefits, as well. Natural gas generally requires less maintenance than oil (for example, gas needs no storage tanks, oil can be messy to handle). Also, natural gas is delivered through underground pipes right to the facility and boiler, while oil requires trucks to travel through the Town streets to get to the building. Eliminating oil would eliminate this specific truck traffic. Having it only as a backup fuel would reduce the number of annual truck trips through the Town. Also, reducing oil deliveries reduces the risk of a messy spill which would take a lot of time and expense to contain and clean up. This can be addressed with your insurance agent to demonstrate reducing risks. Finally, natural gas emits lower quantities of most other pollutants than fuel oils, including toxic compounds, into the local air.

One potential problem with fuel switching is that in some cases natural gas service may not be available to the building in question. In ToM, natural gas is prevalent; therefore, it is likely, at worst, a short distance to an existing line. ToM would need to pay a fee to Con Edison or NYPA to bring in a line to a building that does not have one, but it can be paid back in time, often in conjunction to future cost savings.

In order to switch to natural gas, it must be determined whether the existing boilers are capable of combusting it. ToM would need to work with the boiler manufacturer or

a qualified mechanical professional to make that determination or to implement a minor upgrade to allow the switch. It is possible that a boiler or its burner may need to be replaced in order to burn natural gas, which can be very expensive. Should a No. 2 oil-only boiler need to be replaced because of old age and a natural gas line already goes into or is near the building, then it may make sense to ensure the replacement boiler can combust natural gas.

While this option provides a potential opportunity to both save money and to reduce GHG emissions greatly, it comes down to how cost beneficial this is. If a boiler has to be replaced altogether and an additional fee must be paid to bring in a natural gas line into a building, these upfront costs may cause a long payback, rendering it not cost-effective. However, if a natural gas line already exists in the building and the existing boilers only need minor modifications to combust natural gas, then fuel switching can be a very cost-effective way to reduce costs and GHG emissions.

Temperature controls. As discussed earlier under Electricity, thermostats can also control the hot water supplied to different sections of a building to keep occupied sections at a comfortable temperature. Programmable thermostats can automatically control heat flow, saving fuel combusted, based on the use and needs of the building.

Optimize fuel-burning equipment. Another contributor to GHG emissions is fuel-burning equipment inefficiencies. A regular technical evaluation (tune-up) of your fuel burning equipment to determine whether they are being utilized most efficiently (producing and capturing the maximum amount of heat given the quantity of fuel combusted) can be cost effective. An energy assessment and regular maintenance program for all of your fuel burning equipment may demonstrate significant opportunities for upgrades to improve their efficiency and save costs.

Building envelope. Heat loss from a building represents a significant waste of fuel. Two major areas of heat loss are windows and un- or under-insulated walled areas or the roof. There is a new generation of windows which are typically double-paned and have a high resistance or R value, reducing heat loss through it compared to older models. A related potential opportunity is to reduce your window space and replace groups of windows with well-insulated walls, particularly in north facing areas. High R-value insulation under roofs or in external walls can reduce heat loss, too.

Trained assessors can estimate heat loss in a building and pinpoint areas where upgrading insulation can reduce building heat losses, resulting in less fuel to combust to keep workers comfortable. This can save ToM fuel costs and reduce GHG emissions. There may be incentive programs that ToM qualifies for to pay some of the costs for such window or insulation upgrades.

Other Ways to Reduce GHG Emissions ("Outside the Box")

The suggestions for ToM to reduce energy usage and GHG emissions discussed so far have centered on individual equipment or buildings improving efficiency; that is, functioning using less electricity, heat, or fuel. While these are all good suggestions, it is possible to take a more holistic, systematic approach for even greater reductions. These are more involved and expensive, and often have a longer payback period, but can result in significant GHG emission reductions.

CHP systems. A combined heat and power (CHP) system represents an opportunity for a building to fully use more of the heat generated by the boilers; in essence, to operate its own power plant. In general, CHP systems produce electricity for a lower price than what the local utility charges. (However, this may not be the case for ToM because of its special negotiated agreement with NYPA.) What makes CHP favorable is the opportunity to generate both steam and electricity from the same fuel. CHP systems often achieve an energy efficiency of over 80% (extract 80% of the energy of the fuel combusted), well in excess of what separate systems generating electricity and steam can achieve. Such efficiency requires less fuel to be combusted and decreases GHG emissions.

It should be understood that CHP systems do have a significant upfront capital cost and involve major construction, management, and maintenance. Payback (based on savings from reduced energy costs) often takes a number of years, and may be particularly long for ToM, since its normal electricity rates are low. However, ToM may qualify in some incentive programs for seed money and assistance encouraging such alternative sources of power.

Should ToM be interested in CHP, a multi-step feasibility study, led by experienced energy engineers, covering technical and financial issues should be conducted before a commitment is made.

Renewable sources of energy. In addition to switching to less carbon-intensive fuels, such as natural gas, there are opportunities to switch to sources which are carbon free. Such "renewable" sources of energy emit no net GHGs at all. Biodiesel, discussed earlier, is one example. These renewable sources include solar, wind, and geothermal. Technology in these areas has improved to make them feasible in many situations. However, as with CHP, a significant capital investment must be made and a payback of many years may occur. A thorough technical and economic review of different renewable sources and how it will impact ToM is necessary, especially given

its current low electricity costs. The first step is to determine whether a given building is a feasible candidate for such a technology (has the proper sunlight, wind, etc.). Only if feasible, can the economic/technical analysis be performed.

"Green" Building. The U.S. Green Building Council (USGBC) has developed certification standards for existing or planned new buildings in a program called Leadership in Energy and Environmental Design (LEED). This is an accepted standard to determine how "green" a building is. The program is comprehensive, lending itself not only to GHG emission reductions from energy conservation, efficiency and renewable sources, but also to other sustainability goals that should be important to ToM, such as water use reduction, stormwater management, waste generation minimization, indoor air quality, and recycling. New or existing buildings that incorporate the appropriate number of items can be listed as "LEED-certified" by USGBC. Such projects may range from LEED-certified to LEED-Platinum, based on the degree of achievements.

A "gap analysis" of an existing ToM facility can be performed to determine whether it may have already meet LEED certification standards and, if not, what cost-effective upgrades may be able to raise it to be LEED certified. Another potential opportunity is to examine LEED standards when a building is undergoing a major renovation.

Going through the LEED certification process is time-consuming. One can incorporate many green features and gain benefits without going through formal certification. However, if one wants recognition of such upgrades (such as, the Mamaroneck Public Library's recent upgrade), getting official LEED certification is an undeniable achievement.

In addition to investigating "green building" for ToM buildings, ToM can also be a leader and promulgate rules and codes to encourage or mandate certain "green" standards be met for new or refurbished buildings in the Town. Perhaps ToM can work with Westchester County to make these county standards. A couple of examples include requiring certain sized buildings to undergo a basic energy audit and retrocommissioning study so that the owner/operator is aware of potential upgades available and operates their equipment properly. Local Law 87 is such a rule in New York City. Another example is to require all new or substantially renovated buildings to meet recent ASHRAE energy standards.

These potential rules can encourage some minimal environmental standards be met to improve quality of life. While such a rules-based approach will have legal implications, any encouragement of buildings to use less energy, save water, collect stormwater, etc. will be positive for ToM and render it positive publicity. Grant money could be available to help research and institute such green codes and standards.

Future Steps

You are off to a good start with the ToM Sustainability Initiative. As the saying goes, "You cannot manage what you do not measure." You have baseline data to start with. Here are some critical future steps to continue the program and realize gains:

Continuation of the program. It is important to understand that while this initial analysis of your carbon footprint has resulted in meaningful data, the program must continue. You must continue to collect energy information that is accurate and of high quality and do so at least every other year, if not annually. Develop a procedure for the departments and other critical users report on a monthly or regular basis their electricity and fuel usage/purchase data.

Ways to reduce your carbon footprint. Thorough technical evaluations on some of the general strategies discussed above can be beneficial to ToM, particularly in reducing expenses which should be pleasing to the citizens of the Town.

Communications. While the gains of a program are important in and of itself, publicizing your accomplishments is an ongoing and crucial activity, as the community and other governments should understand your achievements. Such positive publicity will encourage citizens in ToM that the program is credible, be a "green" magnet for business, and be a model for your citizens and other communities in New York. It is important to be able to present your data, goals, and achievements not only from a scientific point of view (GHG emission reductions), but also to show the monetary benefits to your stakeholders.

APPENDIX A

GHG Emissions Calculation