Regional Leaf Blower Working Group
Final Report

Village of Deerfield

Deerfield Park District

City of Highland Park

Village of Glencoe

Village of Glenview

Go Green Wilmette

Illinois Landscape Contractors Association

Village of Kenilworth

Village of Lake Bluff

City of Lake Forest

Mariani Landscaping

Village of Lincolnshire

Village of Northbrook

Scopelliti Landscaping

Village of Wilmette

Village of Winnetka

Submitted October 2022

Purpose

The Regional Leaf Blower Working Group (referred to as the "Working Group") was formed in late 2021 to evaluate the need and impact of leaf-blower regulations to be considered by each participating municipality. The Working Group was tasked with studying the impacts of gas-powered leaf blowers, alternative technologies and how communities could mitigate the impacts of these devices.

The Working Group recognizes that the circumstances of participating municipalities are different and thus this report does not indicate whether a community should or should not prohibit the use of gas-powered leaf blowers. Instead, the report identifies best practices to consider should it be determined that gas-powered leaf blower regulations are appropriate in a particular community.

The information in this report has been compiled to assist each community's discussions and consideration of leaf-blower regulations. Municipalities which determine that new or expanded leaf blower regulations are appropriate for their community are encouraged to work together on drafting of ordinances to ensure uniformity of regulations throughout the North Shore. Because landscapers work across municipal boundaries, such cooperation will greatly enhance the effectiveness of any policy.

Working Group Composition

To ensure a balanced and thoughtful report, the Working Group is comprised of:

- Elected officials
- Appointed officials (i.e. Sustainability Commission members)
- Professional municipal staff (Municipalities and Park Districts)
- Representatives of the landscape industry

The Working Group utilized consultants, the American Green Zone Alliance & Quiet Communities, to assist with technical components of the report and to review a draft of the final report.

The Working Group created three subcommittees to conduct research and consider various policy components which have informed this report. The subcommittees include:

- Municipal Research and Best Practices
- Impact of Gas-Powered Leaf Blowers
- Alternative Equipment/Technology

A complete list of Working Group members can be found in Appendix A.

Executive Policy Summary-

Reasonable Policy Options for Consideration

For communities with existing gas-powered leaf blower regulations which are considering expanding such policies, as well as those considering new regulations, the following three policy options are presented:

- A seasonal gas-powered leaf blower ban from May 15 through September 30
  - This is the most common timeframe for regional municipalities, including Working Group participants, who currently have gas-powered leaf blower regulations.

- An 8-week window during the fall clean-up season and 4-week window during the spring clean-up season when gas-powered leaf blowers may be utilized
  - Gas-powered leaf blowers would be banned during the summer and winter months when their efficacy is less needed to meet customer expectations.

- A 10-month gas-powered leaf blower ban from December through September
  - This policy would prohibit the use of gas-powered leaf blowers during the annual spring clean-up season.
  - None of the Working Group members, nor any nearby communities, have experience prohibiting the use of gas-powered leaf blowers during spring clean-up and the impact on spring operations is unknown at this time.
  - Depending on customer expectations, use of battery-operated technology during spring clean-up may not be economically viable for landscapers

The American Green Zone Alliance (https://agza.net/) does not recommend 12-month gas-powered leaf blower bans for communities along the North Shore due to the robust tree canopy and need for high-powered equipment to adequately complete fall clean-up. As of the date of this report, there are no electric or battery alternatives which can provide the efficacy of gas required during fall clean-up nor are these alternatives economically viable for landscapers during the fall season. Alternatively, the Working Group recommends three scenarios for consideration:

Recommended Best Practices-

Policy Implementation, Enforcement & Public Education

Policy Implementation

Whether a community is considering implementing gas-powered leaf blower regulations for the first time, or extending a seasonal ban to a 10-month ban, phasing of the regulations is important for the following reasons:

- Allows additional time for technology advancements as blower strength and battery power continues to improve for alternative equipment
- Reduces the economic impact on service providers and customers
- Provides sufficient time for public education

Examples of phasing timelines include:

- 5-year phase out (recommended by the Illinois Landscape Contractors Association)
- 3-year phase out
- 1-year phase out

The appropriate phase out period may vary by each community's circumstances. For example, a community with a 6-month ban currently in place may require a shorter phase out period than a community without any current regulations.

Enforcement

Enforcement of leaf blower regulations can be challenging for the municipality and frustrating to homeowners who encounter violations of leaf blower ordinances. Regulations limiting noise to specific decibel thresholds can be particularly difficult to enforce as compared to blanket prohibitions. Consideration as to how municipalities will enforce any such regulations is essential when contemplating new or expanded policies.

Enforcement approaches vary by community and the following are best practices which have been recommended by individual Working Group participants based on experience:

- When staffing allows, proactively enforce the ordinance with a dedicated employee(s) rather than respond reactively to complaints
- Seek compliance prior to issuing citations
    - Issue citations after failing to comply to warnings
    - Revoke citations if a landscaper provides evidence they have purchased an electric or battery operated leaf blower
- Issue citations to the landscaping companies, not the individual employees or homeowners

- Require landscapers to be licensed in order to communicate regulations and provide the ability to revoke a license for continued violation of ordinances
- Require signage on landscaping vehicles to assist with enforcement

Public Education

Public education is critical to the success of any leaf blower regulation and to ensure native habitats are properly maintained. Residents play an important role in reducing the impacts of gas-powered leaf blowers in the community and in making transitions to alternative equipment more economically viable for landscapers. Understanding the problems associated with gas-powered leaf blowers, impacts of any type of blowing/disturbance to the natural environment, and then using that knowledge to educate landscapers and homeowners is essential to the success of leaf blower regulations.

Go Green has provided template communications with information that can be tailored to specific municipal regulations and for different audiences such as residents or landscapers (see Appendix B).

The Working Group recommends that communications utilize accessible, understandable language to reach the broadest possible audience.

Workforce Education and Training

Workforce education and training are critical to equitably and adequately resourcing leaf blower regulations. Battery electric technology is a different technology platform with its own operational and safety issues. It is essential to ensure electric tools are operated, handled, stored, and charged properly and safely, and that batteries are repurposed or recycled at the end of their useful lives. Safe and proper use of tools, batteries, and chargers also extend product life and optimize return on investment.

Environmental, Technology, Cost, & Other Considerations

The Working Group's best practices are based on an extensive review of the environmental impacts of gas-powered leaf blowers, current technology for alternative equipment and the cost to transition to more sustainable equipment.

Environmental Considerations

The issue of noise is the most common complaint received from community members regarding gas-powered leaf blower usage. When measured at 50 feet away (the American National Standards Institute (ANSI) standard for measuring noise)):

- Average battery-operated blowers range from 52 - 65 dB
- Average gas-powered leaf blowers range from 75 - 83 dB

For reference, each 10 dB increase in sound is twice as loud as heard by the human ear.

A study commissioned by the city of Washington D.C. in 2018 and conducted by acoustic engineers from Arup, an international engineering firm, and Quiet Communities, found that for the commercial blowers that were tested:

- *The sound from the gas leaf blowers has a strong low frequency sound component absent from battery operated leaf blowers;*
- *The low frequency component of the gas leaf blower sounds carries loud sound over longer distances resulting in a greater noise impact on the surrounding community;*
- *The low frequency component of gas leaf blower sound enables it to more easily penetrate through home windows and glass doors.*

The report from Arup can be found in Appendix C.

Appendix D is a report from the US Environmental Protection Agency and Quiet Communities titled “National Emissions from Lawn and Garden Equipment”. The report finds that:

- *Commercial gas landscape maintenance equipment (GLME) is a source of high levels of localized emissions that includes hazardous air pollutants, criteria pollutants, and carbon dioxide (CO2)*
- *Routine use of GLME in the vicinity of residential neighborhoods, schools, parks, and other public spaces may be exposing the public to unnecessary and preventable health risks.*
- *Communities and environmental, public health, and other government agencies should create policies and programs to protect the public from Gasoline-powered lawn and garden equipment air pollutants and promote non-polluting alternatives.*

Reducing the usage of leaf blowing in general (gas or battery), through public education and commercial education, is the most sustainable solution to protect native habitats and reduce noise pollution.

Technology Considerations

Gas-powered leaf blowers are significantly more powerful than electric blowers. The most common way to measure the power of a leaf blower is to determine its Cubic Feet per Minute (CFM) and Miles per Hour (MPH).

CFM measures the volume of air leaving the blower. MPH measures the speed of air leaving the blower. CFM moves *more* debris while higher MPH moves heavier, wet debris.

The following table compares the operational capabilities of battery and gas-powered commercial equipment:

Maximum Outputs	**Industry Leading Battery-Operated Leaf Blower**	**Industry Leading Gas-Powered Leaf Blower**
CFM	600	941 CFM
MPH	142 - 170	206

For industry leading battery-operated equipment, with battery backpack, the tool will generally operate for up to one hour and ten minutes on maximum power (setting most likely used during fall leaf clean-up). This requires a substantial back-up battery supply for each blower in use by a landscape company.

Cost Considerations

Per AGZA and Quiet Communities, the cost to replace gas-powered leaf blowers with battery electric technology is dependent on the intensity of leaf blower usage which is directly correlated with the expectations of customers.

The table below compares the upfront cost for a landscape business to purchase two leaf blowers:

Conventional Use (Highly manicured lawn)		**Transitional Use (Less formal aesthetic)**		**Ecological (Ecological aesthetic)**	
Battery	**Gas**	**Battery**	**Gas**	**Battery**	**Gas**
$11,225	$1,125	$7,825	$1,125	$4,350	$1,125
Requires 6 backpack batteries (3 per tool)		Requires 4 backpack batteries (2 per tool)		Requires 2 backpack batteries (1 per tool)	

*The above figures do not include the additional cost for safe and adequate battery charging infrastructure which can range from $600 for a four plug system to $1,400 for an eight plug system.

Per AGZA and Quiet Communities, aesthetic expectations appear to be the most important driver of investment required in battery electric equipment. Relaxing customer aesthetic expectations (through public education) and modifying landscape company practices can result in a more efficient ROI for battery electric equipment. So long as customers seek a highly manicured aesthetic, a substantial upfront investment in batteries and chargers is required which is likely to be passed onto customers in the form of higher service prices.

Other Considerations

Exemptions

The Working Group reviewed exemptions to existing gas-powered leaf blower bans which include:

- Municipal property
- Golf courses and/or large properties over a certain size
- Homeowners conducting maintenance on their own property
- Roof gutter cleaning

The Working Group recommends that municipalities considering new or amended leaf blower regulations consult their maintenance staff, Park Districts (if applicable), and other large landowners such as private golf courses to determine whether exemptions are appropriate or necessary.

Battery Recycling and Safety

While battery-powered leaf blowers are preferable over gas-powered leaf blowers, there are environmental and safety concerns associated with large-scale adoption of battery-operated landscaping equipment. The Working Group recommends municipalities consider partnering with professional recycling firms to coordinate safe and proper disposal of lithium batteries. The Working Group has local resources available to municipalities interested in hosting lithium battery recycling programs.

While fires stemming from battery devices are rare, they have occurred, and Fire Departments and businesses should be familiar with lithium battery fire prevention and extinguishing lithium battery fires.

Financial Incentives

Under current market conditions, the upfront cost of battery-operated blowers compared to gas-powered equipment may create a disproportionate burden on low-income residents and small landscaping businesses. For this reason, buy-back programs and other financial incentives could become crucial strategies to advance the goal of phasing out gas-powered lawncare products.

The Working Group investigated rebate programs from varying governmental organizations across the country. Items for consideration include:

1) Funding mechanisms

- Regional rebate programs have used grant monies in the past to facilitate trade-in of similar types of lawncare equipment (such as the EPA grant for the Diesel Emissions Reductions Act, awarded to the Metropolitan Mayors Caucus in early 2000s to administer sub-grants to12 Chicagoland municipalities).
- In the absence of regional grants, municipalities could allocate money to rebate programs their jurisdiction or through regional partnerships.

2) Eligible equipment

- A “best practice” observed from existing rebate programs requires evidence that new equipment meets the most recently updated EPA standards for allowable air and noise emissions levels.
- Some existing programs partner with garden centers or hardware stores to provide vouchers to purchase alternative equipment at lower cost.
- Equipment eligible for rebates can vary from leaf blowers only to various types of gas-powered lawn equipment such as lawnmowers, blowers, chainsaws, string trimmers, brush cutters, leaf vacuums, as well as accessories for alternative technology such as additional batteries and chargers.

3) Eligible rebate participants

- Consider preference to minority-owned businesses and/or low-income individuals to promote equitable adoption of alternative equipment. For example, a program run through Montgomery County, Maryland includes a statement that preference will be given to minority-owned businesses and/or low-income residents. In California, the South Coast Air Quality Management District provided funding for outreach and education of small minority-owned businesses, and for substantial subsidies (70% of retail price) to offset the upfront cost of commercial battery electric toolkits (tool plus 2 – 3 batteries and chargers per tool).

- While some programs are for residential equipment replacements only, others provide incentives to landscaping companies who are either based in the community or do business in the community.

4) Retired equipment turn-in required

- A "best practice" is to require the retirement of gas-powered equipment with proof of destruction or by facilitating a turn-in program to ensure such equipment is not repurposed.

Future Study & Analysis

Given the rapidly changing technology for battery-operated leaf blowers, municipalities participating in this study should consider reconstituting The Working Group over time to review technology advancements and the impact such advancements may have on leaf blower regulations.

Appendices

Appendix A- Working Group Members

Appendix B- Public Education Materials

Appendix C- Arup Report on Leaf Blower Noise dated July 16, 2018

Appendix D- US Environmental Protection Agency and Quiet Communities report on air pollution titled "National Emissions from Lawn and Garden Equipment".

Appendix E- Municipal Research and Resources

Leaf Blower Regulations Regional Working Group

Members

7 January 2022

1. Co-Chair Phil Kiraly, Glencoe Village Manager
2. Co-Chair Ghida Neukirch, Highland Park City Manager
3. Co-Chair Mike Braiman, Wilmette Village Manager
4. City of Highland Park, Councilmember Anthony Blumberg
5. City of Lake Forest, Superintendent of Parks and Forestry Chuck Myers
6. Deerfield Park District, Executive Director Jeff Nehila
7. Go Green Wilmette, Beth Drucker
8. Illinois Landscape Contractors Association, Executive Director Scott Grams
9. Mariani Landscape, Fred Wacker
10. Scopelliti Landscaping, Guy Scopelliti
11. Village of Deerfield, Justin Keenan, Assistant to the City Manager
12. Village of Glencoe, Hall Healy, Sustainability Task Force
13. Village of Glenview, Joe Kenney, Deputy Director of Public Works
14. Village of Kenilworth, Trustee Alison Winslow
15. Village of Lake Bluff, Sustainability and Community Enhancement Ad Hoc Committee Co-Chair Brian Render
16. Village of Lake Bluff, Village Administrator Drew Irvin
17. Village of Lincolnshire, Management Analyst Sam Barghi
18. Village of Northbrook, Trustee Heather Ross
19. Village of Northbrook, Sustainability Coordinator Tessa Murray
20. Village of Wilmette, Environmental & Energy Commissioner Karen Glennemeier
21. Village of Winnetka, Former Village Trustee and Go Green Winnetka Member King Poor
22. Village of Winnetka, Police Chief Marc Hornstein

Go Green Wilmette

Gas-powered leaf blower
awareness and education campaign

June 26, 2022

Door Hangers (2-sided)

ENFORCE

NOTICE

Gas-Powered Leaf Blower Violation

Gas-powered leaf blowers are prohibited from
(date) ________ **to** (date) ________
in this area. Your lawn care service has been observed violating this ban at
(address) ________

Violators may be ticketed and fined by Police or Village Code Officers:

1st ticket: $75 | 2nd ticket: $150

(Village or Police Department logo)

NOTICE

Gas-Powered Leaf Blower Violation

Please obey the law and be a good neighbor to limit noise and air pollution.

Report violations to Non-Emergency number:
____

(Variable copy area for Village code info)

(Village or Police Department logo)

EDUCATE

Did you know?

Gas-powered leaf blowers produce dangerous levels of noise and air pollution, harmful to users of the equipment, residents and wildlife.

The noise is equal to a jackhammer, or a jet engine during take-off[1]

The pollutants are worse than a car - using a gas-powered leaf blower for a half hour is the same as driving a Ford F-150 pickup from Chicago to San Francisco AND back[1]

All leaf blowers blast insects, habitat and soil at speeds of up to 200 mph, affecting populations of beneficial insects, butterflies and birds

Brought to you by
Go Green Wilmette and your Township

Did you know?

Obey the law and be a good neighbor to all. Gas-powered leaf blowers are prohibited in this area from
(date) ________ **to** (date) ________

Please help get the word out to your lawn crew and any you see in your area. Violations can be reported to this non-emergency number:
(phone) ________

Variable area for Village or Police Dept. logo

[1] Gas Powered Leaf Blower Noise and Emissions Factsheet, Quiet Clean PDX, 11/12/2019

Brought to you by
Go Green Wilmette and your Township

Flyers (1-sided)

YARD CREWS

REMINDER

Gas powered leaf blower ban

Gas-powered leaf blowers are prohibited from ______(date)______ to ______(date)______ in this area. Violators may be ticketed and fined or have to appear in court. Please obey the law to limit noise and air pollution.

(Village Code info)

Variable area for Village seal

AVISO IMPORTANTE

(need spanish translation)

El uso de sopladores de hojas de gasolina está prohibido en this area entre ______(date)______ to ______(date)______. Aquel que falte a esta ley será multado por la policia.

RESIDENTS

Did you know?

There are so many good reasons to go electric, use a rake, or let leaves lay.

Variable area for Village seal

Gas-powered leaf blowers produce dangerous levels of noise and air pollution, harmful to users of the equipment, residents and wildlife.

The pollutants are worse than a car: using a gas-powered leaf blower for a half hour is the same as driving a Ford F-150 pickup from Chicago to San Francisco AND back[1]

The noise is equal to a jackhammer, or a jet engine during take-off[1]

All leaf blowers blast insects, habitat and soil at speeds of up to 200 mph, affecting populations of beneficial insects, butterflies and birds

Obey the law and be a good neighbor to all. Gas-powered leaf blowers are prohibited in this area from ______(date)______ to ______(date)______

Please help get the word out to your lawn crew and any you see in your area. Violations can be reported to this non-emergency number: ______(phone)______

If you do use a leaf blower, consider using it less often and on a lower setting.

[1] Gas Powered Leaf Blower Noise and Emissions Factsheet, Quiet Clean PDX, 11/12/2019

Brought to you by Go Green Wilmette and your Township

Social Media Posts

Technical Note

ARUP

1120 Connecticut Avenue NW
Washington DC 20036
United States of America
www.arup.com

Project title	Leaf Blower Noise	Job number	261937-00
cc	D.C. Council's Committee of the Whole	File reference	
Prepared by	Chris Pollock, PE, LEED AP, WELL Advisor Geoffrey Sparks	Date	July 16, 2018
Subject	**Bill No. B22.234, the Leaf Blower Regulation Amendment Act of 2017 - Written Statement by Arup**		

1 Executive Summary

Arup tested 7 commonly used leaf blowers, 3 gas and 4 battery powered, to help answer the question of what makes which type have more noise impact. The following written statement summarizes the testing procedure, results, and oral testimony presented by Arup to the D.C. Council's Committee of the Whole on July 2, 2018.

In summary Arup's testing indicates:

- The sound characteristics of gas leaf blowers measured have a significantly greater low frequency sound component in comparison to battery leaf blowers measured
- The low frequency sound energy of the gas leaf blowers measured transmits more readily over longer distances making them more readily audible and of greater noise impact to the community
- The low frequency sound energy of gas leaf blowers measured transmits more easily through home windows and glass doors, meaning they sound louder indoors than the battery leaf blowers measured

2 Sound Testing Methodology

2.1 Gas and Battery Leaf Blowers

The big question Arup was asked to help answer in this testing is what makes which type have a greater noise impact? This study did not investigate the noise level at the operator ears relative to exposure, but rather the impact on people and the community surrounding the leaf blowers as they are being used. Leaf blowers are often rated based on air flow rate, or the amount of air being pushed or blown per minute. The grouping of leaf blowers used aimed to capture commercial leaf blowers used in the industry, with a specific focus on commercially used similar flow rate units for both gas and battery powered blowers.

2.2 Testing

In order to answer the question above, a set of tests were designed to allow the capture of side by side noise levels for various leaf blower types. It was arranged for 7 commonly used blowers to be used, all were either new or in a well maintained working order with 3 being gas leaf blowers and 4 being battery leaf blowers.

Table 1: Leaf blowers used for testing

Manufacturer	Model	Power Source
Greenworks	GBB 700	Battery
Greenworks	GBB 600	Battery
Stihl	BGA 100	Battery
Ego	600 Chevron	Battery
Redmax	EBZ8500	Gas
Stihl	BR 700X	Gas
Echo	PB760LN	Gas

On the morning of June 17, 2018, in Lincoln, Massachusetts, the leaf blowers were set up in an open driveway entrance road, and parking lot of the Lincoln Department of Public works. This is a quiet location without close proximity to sound reflecting surfaces, where noise measurement locations were marked off at 5, 50, 100, 200 and 400 feet from the location where each of the 7 leaf blowers were operated. To simulate measurements at a greater distance we also measured at 800 feet, which was located across another street in an Audubon park.

Each blower was operated for at least 30 seconds for every measurement at full throttle and the nozzle at least 2 inches (50 mm) above the ground. At the 50 foot distance, measurements at 8 locations (at 45 degree increments) around each blower were measured as outlined in American National Standards Institute for Outdoor Power Equipment – Internal Combustion Engine-Powered Handheld and Backpack Blowers and Blower Vacuums – Safety Requirements and Performance Testing Procedures/OPEI B175.2-2012.

Measurements were made with a calibrated type 1 sound level meter with a wind screen installed and mounted on a tripod at 5 feet (1.5 meters) above the ground. The sound level meter was a Brüel & Kjaer 2250, as is common for advanced sound measurements in the acoustics industry. This meter captures one-third octave band sound levels in real time, and provides statistical time based averaging for L_{90}, L_{EQ}, L_{10} and other filtered results to best ensure that extraneous noise from the community was not a significant impact on the results. The L_{90} measurements are used for purposes of discussion and review as that metric captures the steady state noise level of the leaf blower in use while also filtering out other extraneous site noise events including intermittent traffic. This is a conservative approach in reviewing the data and a method that is widely accepted within the acoustic consulting industry. Other metrics that are commonly used including the L_{EQ} and L_{50}, will indicate higher noise values than the data presented here as L_{90} values. See the Appendix at the end of this note for definitions of L_{EQ}, L_{50}, and L_{90}

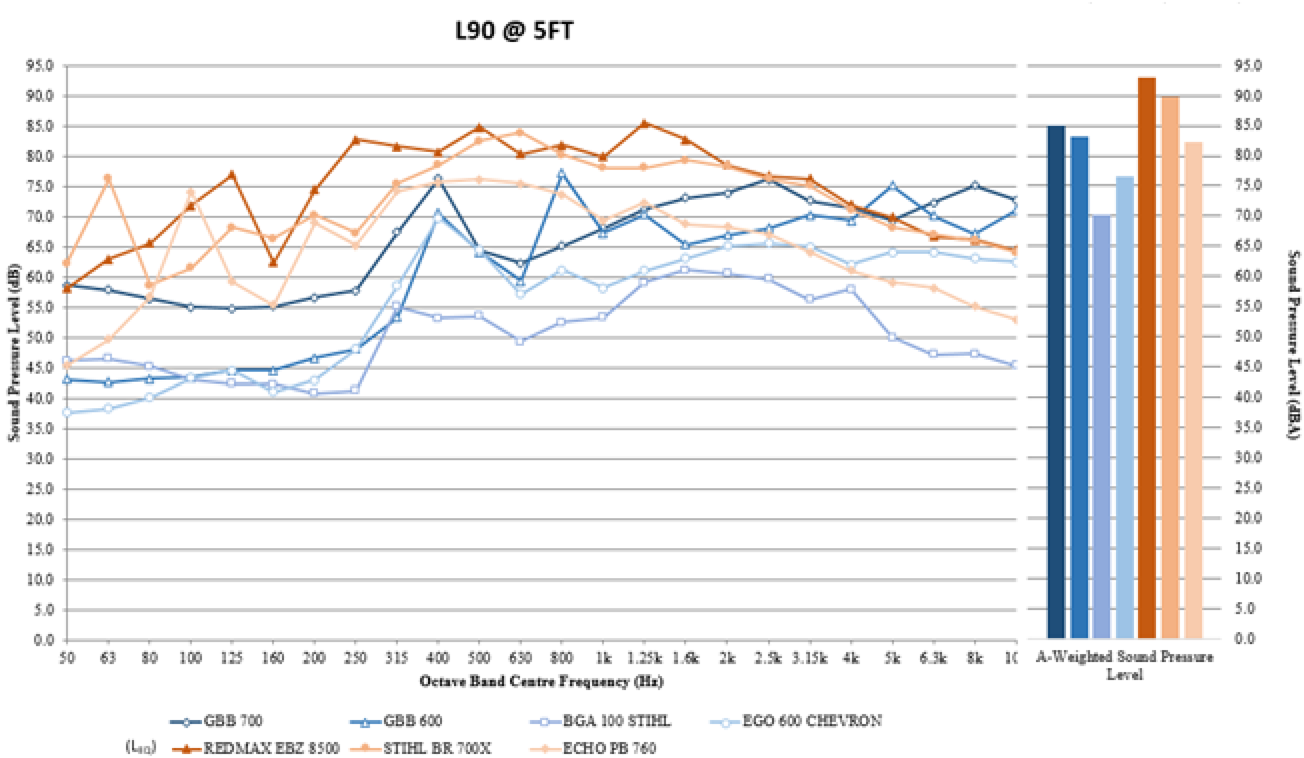
Sound levels are variations in sound pressure. The decibel scale (dB) is the commonly used metric for sound pressure levels, which is a log scale because the number value of sound pressure varies very widely. For the purposes of the data analysis, dB levels of 20-30 are a quiet bedroom or whisper, dB levels in the 40-60 range are a normal conversation, dB levels above 70 are a loud voice or busy street traffic, and sound levels above 80-90 dB would be loud music. Human hearing filters sound in a specific way, meaning that we are very attuned to voice frequencies and less attuned to low frequency sounds. For this reason, we often us an ‘A’ weighting scale, as a single number for the perceived overall loudness of a sound. These values are shown as dB(A) sound pressure levels.

3 Results

3.1 Graphs

The following graphs summarize the measured data of the 7 leaf blowers. Battery powered leaf blowers are shaded in blue and gas-powered leaf blowers are shaded in orange. The horizontal axis of the chart shows frequency, with the left side being very low frequency 'rumble' sounds, and the right side being high frequency 'hissing' sounds. The vertical axis shows increasing sound pressure level as you go up the chart. Most outdoor measurements of noise, in locations with any distant traffic will have more low frequency than high frequency noise, and the ambient sound in this case of this character also.

Figure 1: Sound Pressure Levels measured at 5 feet



Note: the L_{EQ} reading was used for the Redmax EBZ 8500 due to an elongated measurement period with the blower idling which influence the L_{90} result.

Figure 2: Sound Pressure Levels measured at 50 feet

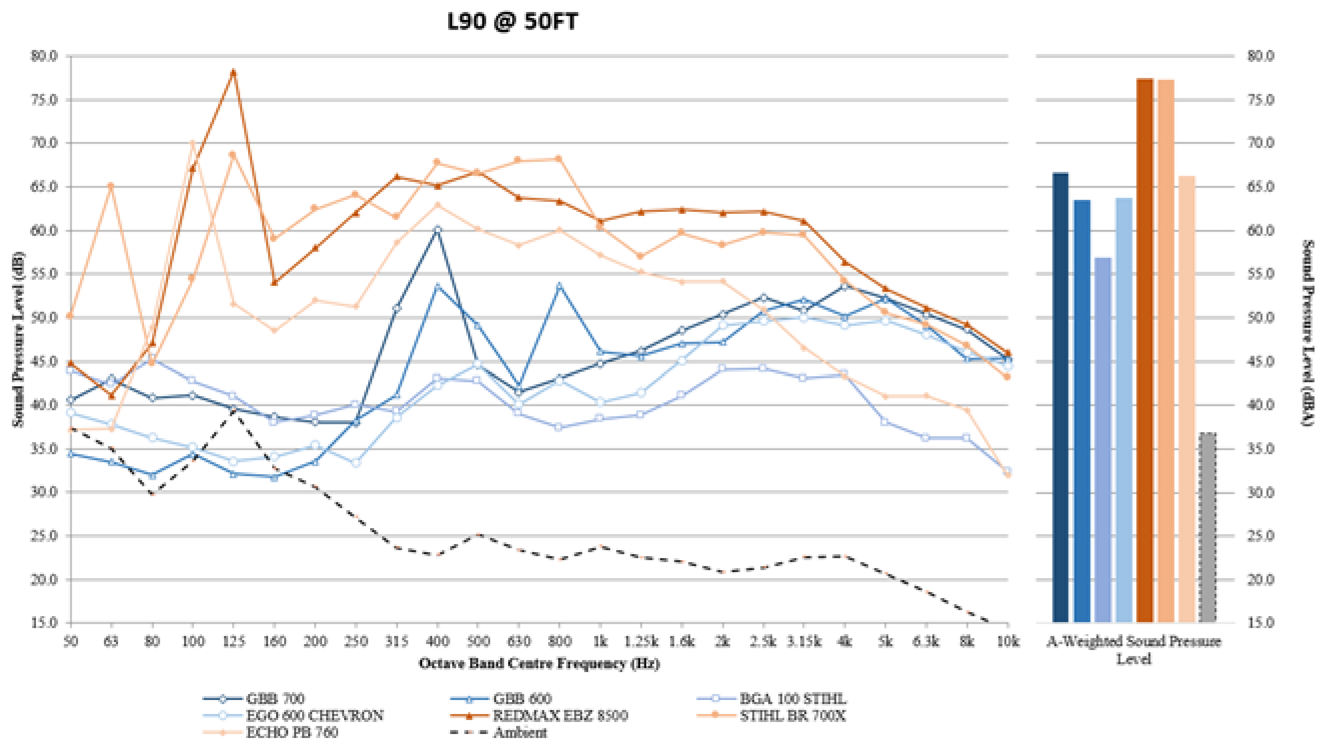
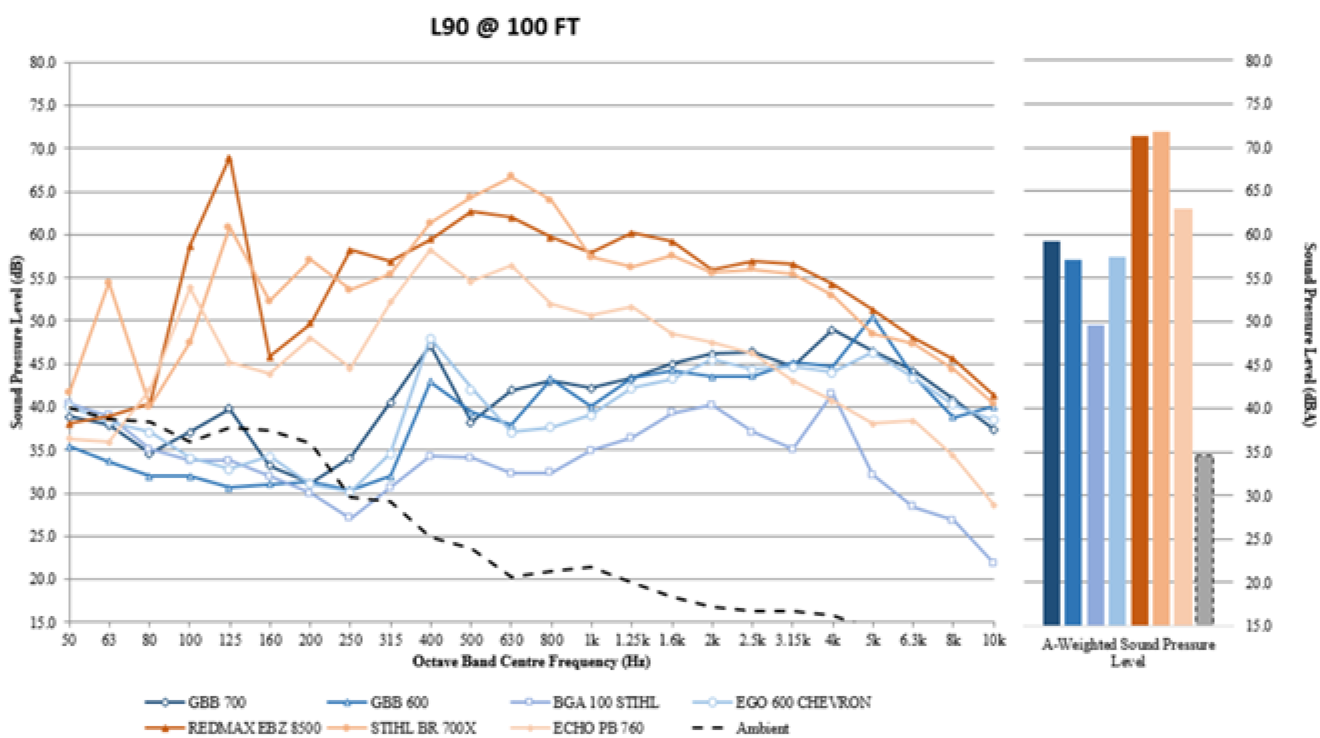


Figure 3: Sound Pressure Levels measured at 100 feet



Technical Note

261937-00 July 16, 2018

Figure 4: Sound Pressure Levels measured at 200 feet

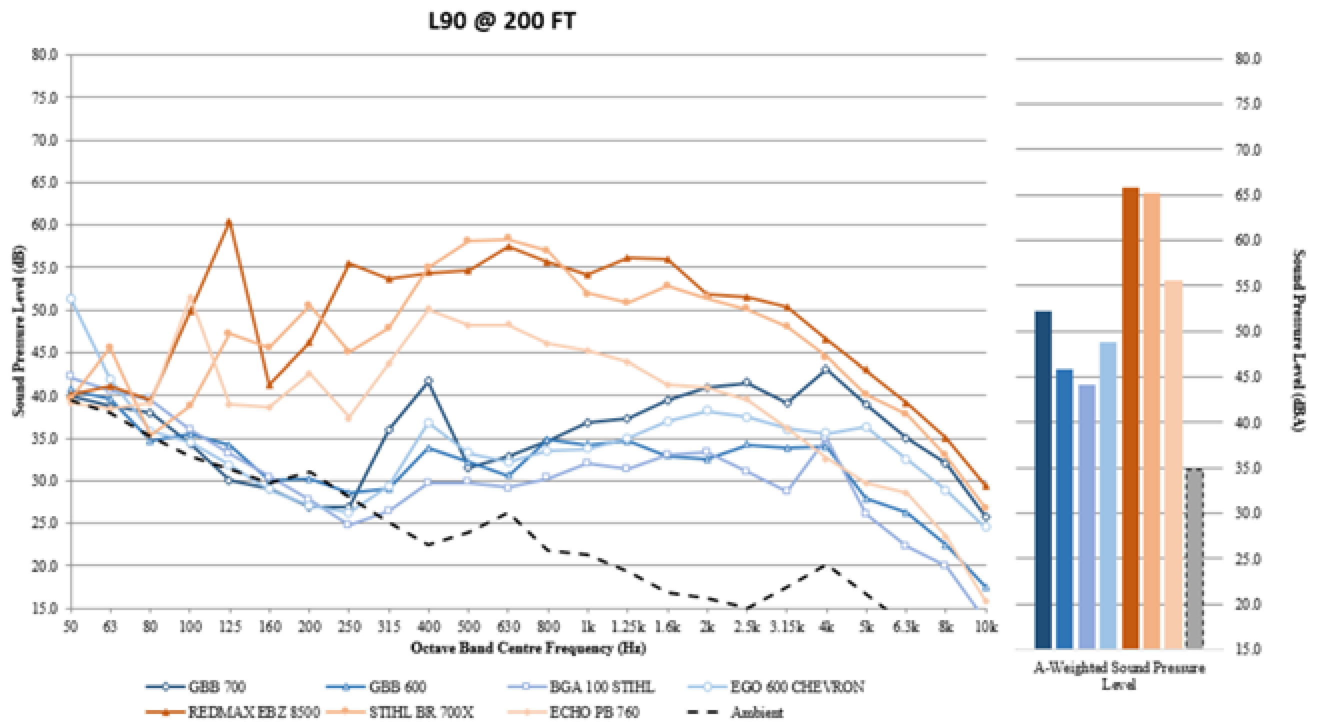


Figure 5: Sound Pressure Levels measured at 400 feet

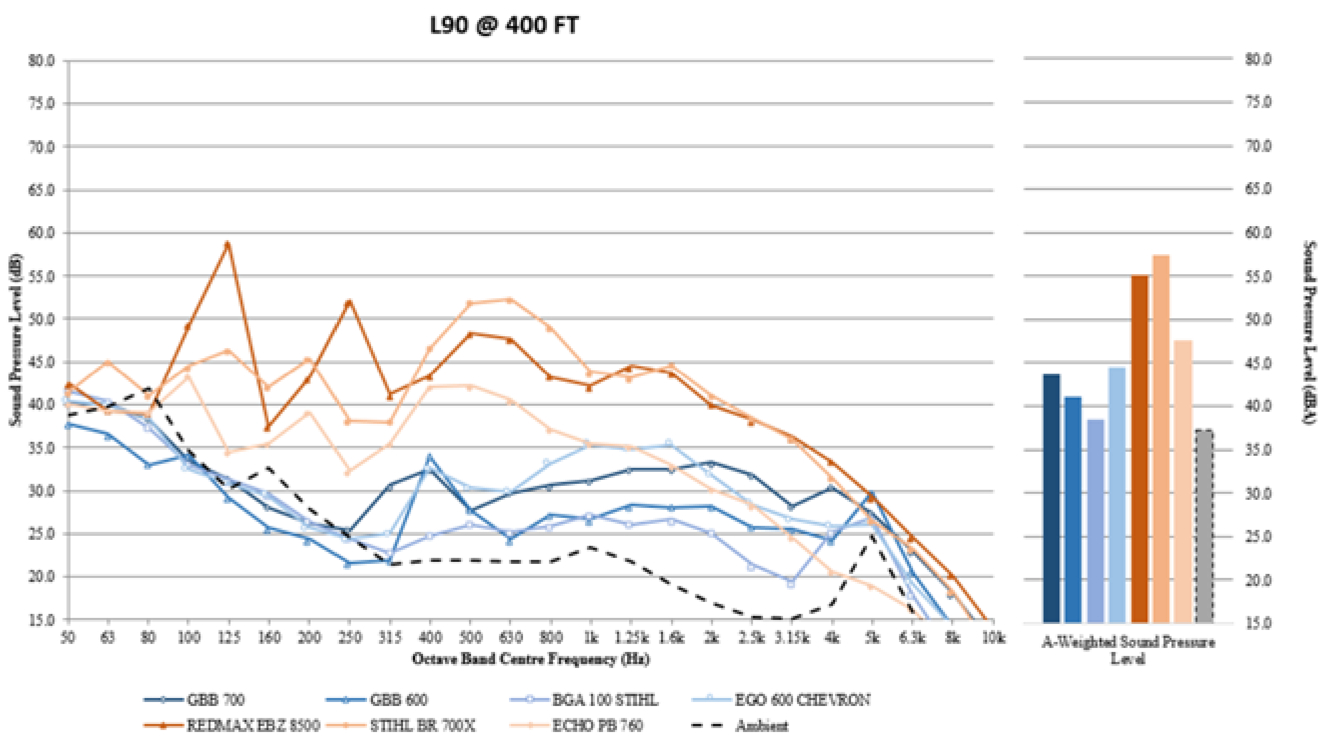


Figure 6: Sound Pressure Levels measured at 800 feet

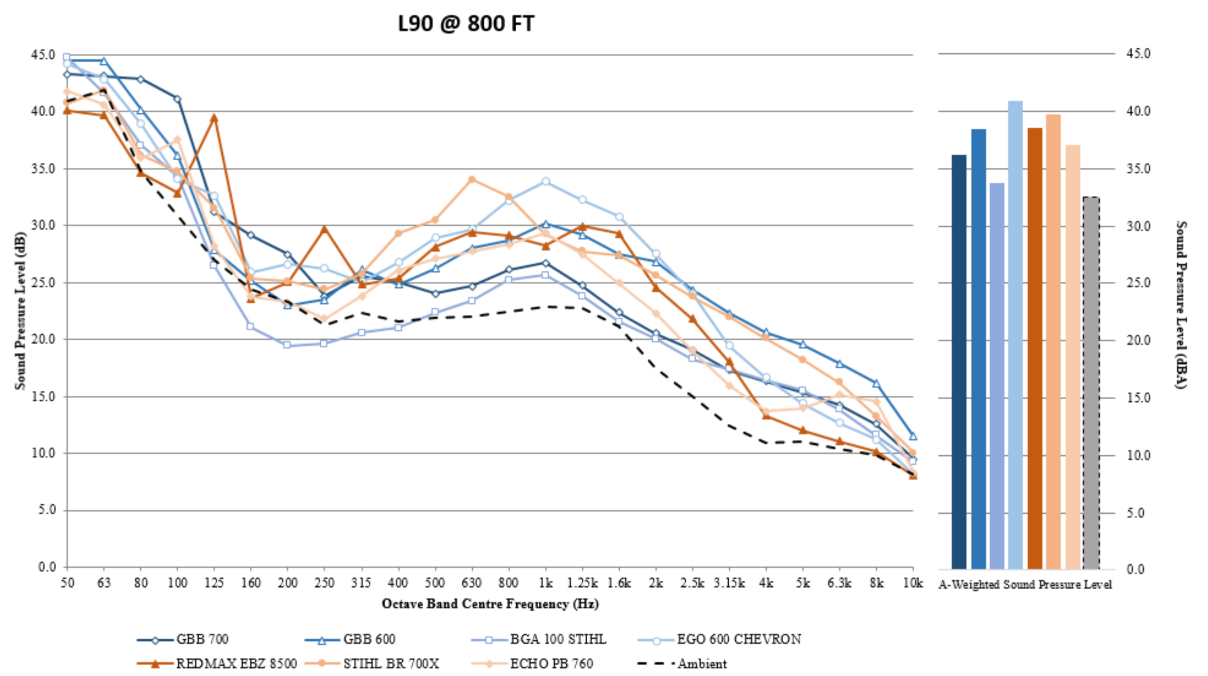
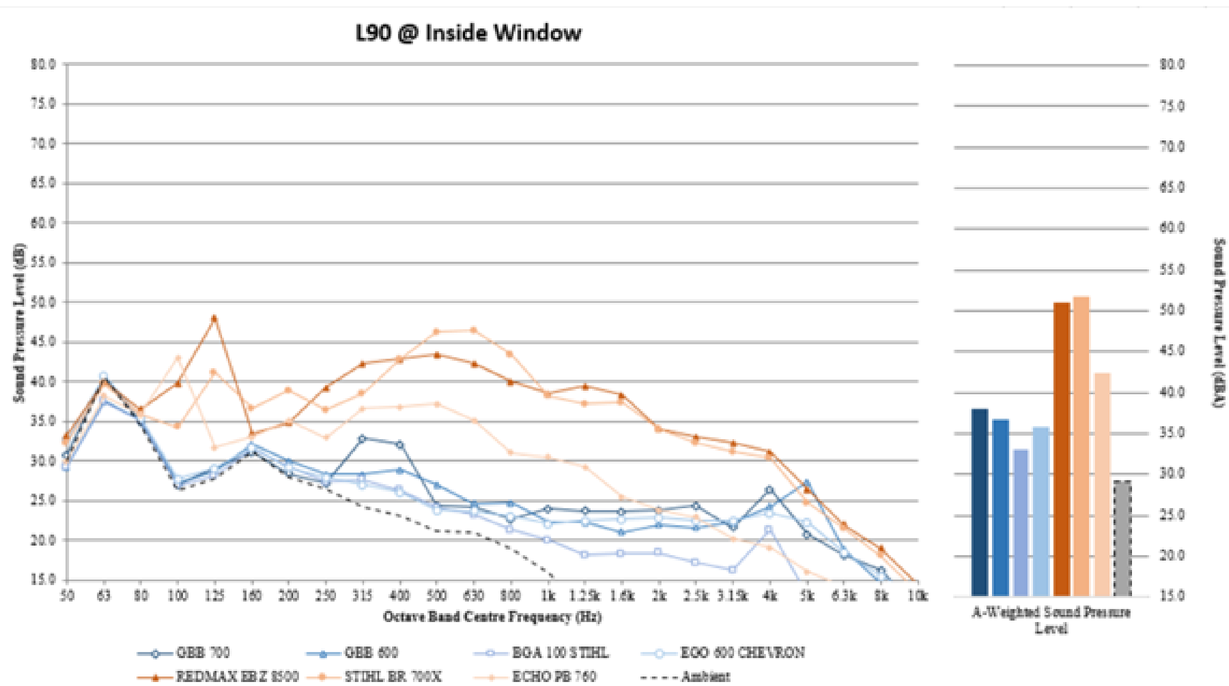


Figure 7: Sound Pressure Level measured inside a residence with leaf blowers 50 feet from the window



3.2 Discussion

From the measured data graphed above, it is observed clearly that the group of gas leaf blowers (shaded in orange) all exhibit a much higher level of sound energy in the low frequency bands at all distances. In a number of cases, this engine noise is a peak at 100 to 125 Hz. This low frequency energy is quite distinctly different for the gas leaf blowers than the battery powered leaf blowers.

Audibility over larger distances: The chart above shows that at only the peaks of low frequency engine sound were prominently above the ambient noise measured. Based on the experience of measuring sound, Arup witnessed that the three gas powered leaf blowers at an 800 foot distance were audible, two being clearly audible and the third being noticeable, while all of the battery powered leaf blowers were not distinguishable above the ambient community sound levels at that distance. Since these peaks on the chart do not occur with the battery powered leaf blowers it can be concluded that this is the character of the sound that travels over greater distances and is more audible throughout a community.

Audibility within Houses: One of the challenges with low frequency noise is that it requires heavy construction or materials to stop the sound transmitting. This is very clear when it comes to windows and glass doors in houses. The heavy drywall or brick walls of a house may do a very good job at blocking noise from outside, but any low frequency sound transmits easily through the lighter weight windows. This is a common issue with the drone of road traffic or aircraft overhead, and a number of states and federal programs provide funding to upgrade housing in impacted areas. With leaf blowers, the low frequency components of the gas leaf blowers are what is most easily transmitted, and this is clearly seen in Figure 7 at 100-125 Hz as well as in the air ‘whooshing’ frequencies up to around 500 Hz which also transmits into the house very easily. These sound levels of gas powered leaf blowers as measured inside the house, are significantly above those of the battery powered leaf blowers.

4 Audio Demonstrations

During the oral testimony of Chris Pollock on July 2, 2018, calibrated audio demonstrations of gas and battery powered leaf blowers were presented. It is important to note that the audio was played to replicate the level of the sound at the listening positions of Chairman Mendelson and Councilmember Cheh. The demonstrations were audible to members of the audience in the room and on the internet; however, the experience and levels perceived by the audience was not calibrated for their listening position.

The following three scenarios were experienced by Chairman Mendelson and Councilmember Cheh:

4.1 Demonstration 1

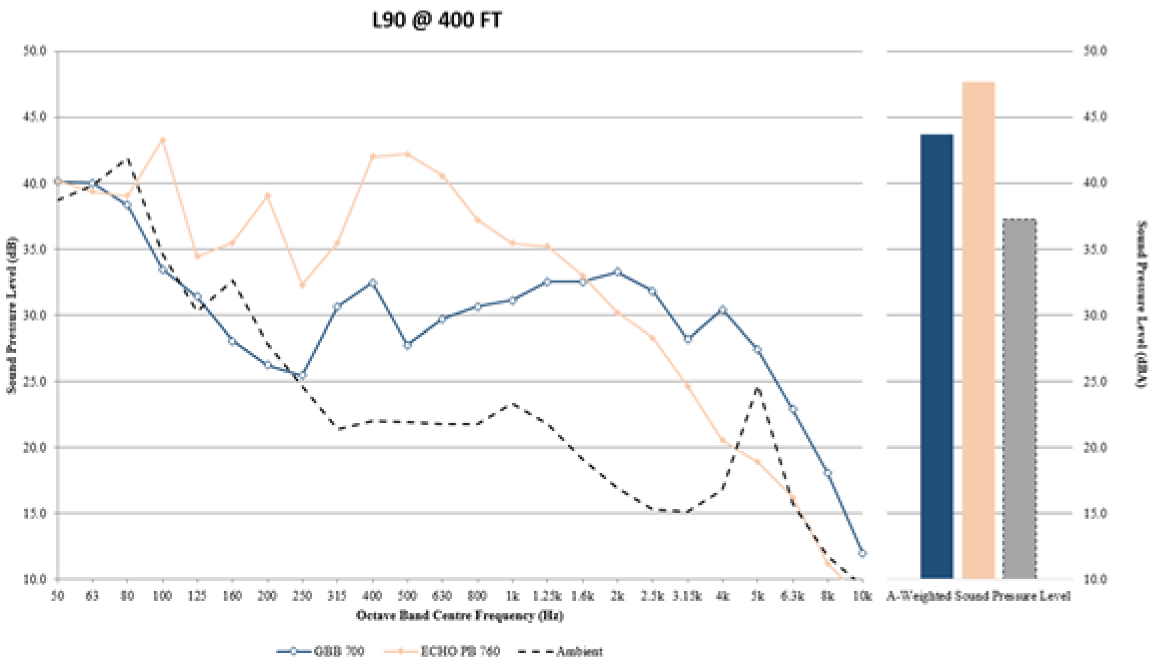
The first sample was a comparison of a gas and a battery blower with the same dB(A) from the manufacturers standardized testing. The important comparison is that while the overall loudness may be the same, the acoustic qualities of each and the character of the sound are totally different – the gas leaf blower generating much more low frequency noise.

Figure 8: Audio demonstration 1 – equivalent gas and battery leaf blowers at 50 feet

4.2 Demonstration 2

The second demonstration presented in the proceedings was relative to the same two equally noise rated blowers, one gas (Echo PB 760) and one battery (Greenworks GBB 700) at 50 feet. This demonstration indicates that while rated the same overall noise level at 50 feet, the same gas blower has a significantly greater noise impact at 400 feet because the low frequency content of its noise transmits more easily over the 400 foot distance. This demonstration indicates what the community hears around operating blowers, highlighting that the low frequency components of the gas engines is part of the increased impact of gas blowers.

Figure 9: Audio demonstration 2 – equivalent gas and battery leaf blowers at 400 feet



4.3 Demonstration 3

Our third and final demonstration is three leaf blowers as measured inside an adjacent house (Greenworks GBB 700, Echo PB 760 and the Redmax EBZ 8500), with the leaf blowers operating at 50 feet from the windows, behind a typical insulated glass window. The audio results indicated that the two gas leaf blowers, the two orange lines in the graph below, were significantly above the battery blower in almost all frequency bands.

Figure 10: Audio demonstration 3 – gas and battery leaf blowers inside a house

5 Conclusions

Based on our measurements we conclude the following key points from our review of the results:

- The gas powered leaf blowers tested all generated more low frequency noise than the battery powered leaf blowers tested
- The low frequency noise of the gas leaf blowers transmitted over greater distances and was more readily audible over the longer 400 and 800 foot measurement distances
- The low frequency noise of the gas leaf blowers transmitted into a residential house more easily and were louder inside than the battery leaf blowers tested

6 Technical Glossary

L_{10}- The level of sound in deciBels that, for a given time period of interest, is exceeded 10 % of the time.

L_{EQ} – The equivalent continuous sound level. The preferred method to describe sound levels that vary over time, resulting in a single deciBel value which takes into account the total sound energy over the period of time of interest.

L_{50} - The level of sound in deciBels that, for a given time period of interest, is exceeded 50 % of the time.

L_{90} - The level of sound in deciBels that, for a given time period of interest, is exceeded 90 % of the time.

7 About Chris Pollock, PE

Chris Pollock, PE is an acoustical consultant with Arup with 20 years of experience measuring noise and designing buildings and spaces for acoustics on projects in the USA and around the world. He has an Honors degree in Mechanical Engineering from the University of Canterbury an is a Professional Engineer in the Commonwealth of Virginia. Chris has been published in articles in the field of acoustics in Architectural Record, contributed to the Architectural Graphic Standards and has been interviewed by various media outlets regarding acoustics and noise and serve on a number of panels and committee on topics related to acoustics and noise.

End of Written Statement

National Emissions from Lawn and Garden Equipment

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Abstract

Background: The contribution of gasoline-powered lawn and garden equipment (GLGE) to air pollutant emissions in the United States has not been extensively studied. Goal: Our goal is to provide annual US and state-level emissions estimates of volatile organic compounds (VOC): criteria pollutants (carbon monoxide [CO], nitrogen oxides [NOx], particulate matter [PM] <10 microns, including PM < 2.5 microns [PM 10, PM2.5]; and carbon dioxide (CO2) from GLGE, with a focus on 2-stroke engines. Methods: Pollutant emissions data were extracted from the Environmental Protection Agency's (EPA) 2011 and 2018 modeling platform (version 6), for GLGE (Source Code Classifications 2260004021−2265004071), and equipment population data were obtained from the EPA's nonroad model. Data were sorted by equipment type and characteristics. Aggregate and equipment-specific emissions were calculated and compared with emissions from all gasoline-fueled nonroad equipment. Results are presented as descriptive statistics. Results: In 2011, approximately 26.7 million tons of pollutants were emitted by GLGE (VOC=461,800; CO=5,793,200; NOx=68,500, PM10=20,700; CO2=20,382,400), accounting for 24%−45% of all nonroad gasoline emissions. Gasoline-powered landscape maintenance equipment (GLME; leaf blowers/vacuums, and trimmers, edgers, brush cutters) accounted for 43% of VOCs and around 50% of fine PM. Two-stroke engines were responsible for the vast majority of fine PM from GLME. State data (California, New York, Texas, Illinois, and Florida), 2018 projections, and additional comparisons are presented. Methodological issues are discussed. Conclusions: GLGE accounts for a major portion of US nonroad gasoline emissions. Two-stroke engines are an important source of VOCs and criteria pollutants.

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INTRODUCTION

Gasoline-powered lawn and garden equipment (GLGE) ranging from string trimmers to stump grinders and tractors is a source of high levels of localized emissions that includes hazardous air pollutants, criteria pollutants, and carbon dioxide (CO2).[1-4] Workers using commercial equipment are exposed when they are close to the emitting sources several hours each day, several days a week in seasons of use. Other members of the public, including children, may also be exposed to high levels of emissions from commercial landscape maintenance equipment (GLME) such as leaf blowers, trimmers, and mowers, used routinely around residential neighborhoods, schools, parks, and other public spaces. The commercial landscape maintenance industry has experienced strong growth over the last 15 years and depends largely on gasoline-powered equipment for most tasks once performed manually. These factors are raising concerns about the health impacts of GLGE emissions on workers and the public.

Extensive evidence exists on the adverse health effects of exhaust emissions and other fine particulates which include cardiovascular disease, stroke, respiratory disease, cancer, neurological conditions, premature death, and effects on prenatal development.[5-13] Short term and long term exposures are implicated. However, GLGE as a source of these emissions has received little attention. Understanding the characteristics of GLGE and GLME emissions can help estimate potential health impacts of these close-to-the-source emissions.

The goal of this study was to characterize annual emissions from GLGE at the national level and in selected states and to estimate the contribution of GLME to those emissions. Special attention is paid to 2-stroke GLME engines. The emissions contributions from the four of the five most populated states are derived from the NEI, and for California, from the emissions inventory of the California Air Resources Board (CARB).

METHODS

Study Design

The GLGE emissions analyzed are total volatile organic compounds (VOC) and individual VOCs (benzene, 1,3 butadiene, acetaldehyde, formaldehyde); criteria pollutants (carbon monoxide [CO], nitrogen oxides [NOx], particulate matter [PM] <10 microns, including PM < 2.5 microns [PM 10, PM2.5]); and carbon dioxide (CO2). Equipment pollutant data were extracted from SCC summary reports from the EPA's 2011 and 2018 modeling platform (version 6), and equipment population data were obtained from the Nonroad model. GLGE included the equipment in **TABLE 1** and identified by Source Code Classifications 2260004021−2265004071. The GLME subset is defined as leaf blowers/vacuums; trimmers/edgers/brush cutters; and mowers. Groupings of equipment, eg, leaf blowers/vacuums, were predefined by the NEI.

"All Emissions" are defined as all emissions from stationary and mobile sources, excluding biogenic and naturally occurring emissions. "All Nonroad Emissions" are defined as all emissions from the equipment types accounted for within the Nonroad model; note that this does not include emissions from commercial marine, rail, and aircraft sources. "Gasoline Nonroad Emissions" are defined as emissions from gasoline fueled equipment accounted for within the Nonroad model. National emissions were analyzed by type of equipment and engine configuration as shown in **TABLE 1**. All results are presented as descriptive statistics.

Table 1. Categorization scheme for analysis of GLGE emissions

Type of Equipment	Engine Configuration
GLME	
Leaf Blowers/Vacuums	2 stroke, 4 stroke
Trimmers/Edgers/Cutters	2 stroke, 4 stroke
Mowers	4 stroke
Other GLGE	
Chain Saws	2 stroke, 4 stroke
Rotary Tillers	2 stroke, 4 stroke
Snowblowers	2 stroke, 4 stroke
Turf Equipment	2 stroke, 4 stroke
Chippers/stump grinders	4 stroke
Tractors	4 stroke
Shredders	4 stroke
Other	4 stroke

Analyses

All analyses except for the 2018 projections represent 2011 estimates.

Equipment Populations

The national populations of all types of GLGE were obtained from the Nonroad model. The contribution of each type to the whole population was determined.

Contributions of All Nonroad and GLGE Sources

All Nonroad Emissions were compared to All Emissions. GLGE emissions were then calculated and compared with All Nonroad Emissions and All Emissions.

Contribution of Landscape Maintenance Equipment to GLGE Emissions

GLME emissions and their contribution to GLGE and All Nonroad Emissions were analyzed. Additional analyses were conducted to examine the relative contributions of 2-stroke GLME engine emissions.

Projected Growth of GLGE Emissions: 2011−2018

GLGE emissions projected for 2018 were obtained from the EPA's 2018 modeling platform, version 6, and compared with 2011 emissions.

GLGE Emissions in the Five Largest States

State level emissions data from the five most populated states (US Census) – California, Florida, Illinois, New York, and Texas – were extracted and analyzed. Estimates of GLGE emissions for Florida, Illinois, New York, and Texas were based on 2011 data from the EPA's 2011 modeling platform, version 6. Estimates of GLGE emission for California were based on data from the CARB's OFFROAD2007 Model and estimated for 2012. No adjustments were made for potential differences in annual emissions between 2011 and 2012 California data. The program structure of the OFFROAD2007 Model provides a general overview of the methodology used to estimate emissions from off-road sources (http://www.arb.ca.gov/msei/offroad/pubs/offroad_overview.pdf).

Each state's contribution to national GLGE Emissions was calculated and compared with its contributions to the US landscape maintenance labor force and the US population. Labor force statistics were sourced from the Bureau of Labor Statistics, May 2013 reports (www.bls.oes) and population data from the 2011 US Census.

Nonroad Air Emissions Model

EPA developed a nonroad air emissions model in the 1990s to provide estimates of emissions from most types of nonroad equipment, including construction equipment, recreational marine vessels, and lawn and garden equipment (LGE). The model is referred to simply as the "Nonroad" model, and it has been updated a number of times since its creation. Documentation for the model exists as a number of technical reports available on EPA's website (http://www.epa.gov/otaq/nonrdmdl.htm). Total emissions are determined by summing the exhaust and evaporative emission components.[14, 15] The preponderance of emissions from Nonroad equipment occurs as exhaust emissions due to the combustion of fuel. The methodologies for determining exhaust emissions are summarized below.

<u>Exhaust Emissions from Nonroad Engines</u>

The Nonroad model uses the following equation to calculate exhaust emissions from nonroad engines (ref: Median):

Emissions = (Pop) x (Power) x (LF) x (A) x (EF)

Where Pop = Engine population

Power = Average Power (hp)

LF = Load factor (fraction of available power)

A = Activity (hrs/yr)

EF = Emission factor (g/hp-hr)

The derivation of the default model data for each factor from the above equation is discussed below.

a. Equipment populations and average power (horsepower)

The technical report titled "Nonroad Engine Population Estimates"[16] indicates that equipment population data for most types of equipment were obtained from Power Systems Research, an independent marketing research firm, although in some instances other data source were used. Of interest for this analysis, for many LGE categories EPA used sales data obtained from equipment manufacturers during the development of its Phase 1 emission standards for small (less than 25 hp) gasoline fueled nonroad engines. This was done for the following LGE categories: lawn mowers, trimmers/edgers/brush cutters, leaf blowers/vacuums, and chainsaws. The report notes that an equipment population base year of either 1996 or 1998 was used for the LGE types.

Once estimates of equipment populations were derived, information obtained by the state of California was used to divide the equipment between the residential and commercial sectors. This step was needed because of the large difference in usage patterns between these two sectors. **TABLE 2** below contains an extract of data from Table 3 of the Nonroad Engine Population report mentioned above, and illustrates how the split between residential and commercial equipment was apportioned for a number of LGE types.

Table 2. Percentage split between residential and commercial equipment

SCC code	Application	Horsepower categories	Residential (% of equipment population)	Commercial (% of equipment population)
22xx004010 22xx004011	Lawn mowers	All	96.3	3.7
22xx004025 22xx004026	Trimmers/edgers/cutters	0-1 hp	100	0
		1-3 hp	85.3	14.7
		> 3 hp	0	100
22xx004020 22xx004021	Chainsaws	0-1 hp	100	0
		1-3 hp	97.0	3
		> 3 hp	0	100
22xx004030 22xx004031	Leaf blowers/vacuums	0-1 hp	100	0
		1-3 hp	92.5	7.5
		> 3 hp	0	100

i. Geographic allocation of residential LGE Populations (except snowblowers)

The Nonroad model uses US Census data on one and two unit housing to allocate national equipment populations to the county level. The population documentation report mentioned above notes that other variables are likely to also affect the distribution of LGE population, such as average yard size. However, no consistent, reliable data surrogates could be found to apportion the national level equipment populations based on these alternative factors, and so the model relies solely upon US Census data on one and two unit housing to allocate national LGE population data to the county level.

ii. Geographic allocation of commercial L&G Equipment Populations (except snowblowers)

The Nonroad model uses the number of employees in the landscaping services industry to dis-aggregate national level LGE population data to the county level. This was accomplished using data from the North American Industry Classification System (NAICS); specifically, for NAICS code 561730, landscaping services.

iii. Equipment population projections

The Nonroad model enables the user to obtain estimates of emissions for years other than the base year used for equipment populations. This is accomplished by the development of processes to handle the growth in equipment populations due to the purchase of new equipment as years pass, and adjustments made to account for the scrappage of old equipment. The reader is referred to the EPA technical reports “Nonroad Engine Growth Estimates,”[17] and “Calculation of Age Distributions in the Nonroad Model – Growth and Scrappage”[18] for further information on these topics. Both of these reports are available on the EPA website (http://www.epa.gov/otaq/nonrdmdl.htm).

b. Activity levels and load factors.

Equipment populations and horsepower levels alone are not sufficient for determining emissions from nonroad equipment; assumptions about frequency and patterns of use must also be made. The EPA report, “Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling”[19] describes how the Nonroad model assigns default activity levels, in hours per year, and load factors in performing its calculations. Load factors are needed to account for the fact that equipment is not typically used at full power 100% of the time; load factors reflect that and are presented in terms of average percent of full power for the equipment as it is used. The activity levels and load factors for small (< or = to 25 hp) spark-ignition engines for many LGE types was taken from data supplied to EPA during the comment period for the regulation of these engines. **TABLE 3** below contains an extract of the default activity data, in annual hours of equipment use, and load factor data, expressed as fraction of full power, taken from Table 6 of the above mentioned report.

Table 3. Example default activity levels and load factors for LGE

Equipment type	Use	Activity level (Annual hours)	Load factor (fraction of full power)
Lawn mowers	Residential	25	0.33
	Commercial	406	0.33
Trimmers/Edgers/Cutters	Residential	9	0.91
	Commercial	137	0.91
Leaf blowers\Vacuums	Residential	10	0.94
	Commercial	282	0.94
Chainsaws	Residential	13	0.70
	Commercial	303	0.70

c. Emission factors

EPA's documentation for the source of the emission factors used within the Nonroad model are contained in the following two reports: "Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling: Compression-Ignition"[20] and "Exhaust Emission Factors for Nonroad Engine Modeling: Spark-Ignition." [21] Information pertaining to LGE contained in the latter report is discussed below.

Emission factors for spark-ignition engines rated at less than 25 hp were segregated into 5 engine classes based on primary use of the engine (handheld vs. non-handheld), and engine size according to engine displacement. Beginning in 1997, engines designed for both handheld and non-handheld applications became subject to several phases of regulation geared towards reducing fuel consumption (expressed in terms of brake-specific fuel consumption [BSFC]) and producing fewer air emissions in the combustion process. **TABLE 4** below contains an extract of information from Table 1 of the Exhaust Emissions 2010 report, and shows the impact of EPA's regulation on one such class of engines: small, hand-held, gasoline fueled two-stroke engines.

Table 4: Impact of regulation on small*, hand-held, gasoline fueled two stroke engines

Engine Tech Type	HC (g/hp-hr)	CO (g/hp-hr)	NOx (g/hp-hr)	PM (g/hp-hr)	BSFC (lb/hp-hr)
Baseline	261.00	718,87	0.97	7.7	1.365
Phase 1	219.99	480.31	0.78	7.7	1.184
Phase 2 (with catalyst)	26.87	141.69	1.49	7.7	0.822

BSFC: Brake-specific fuel consumption; CO: carbon monoxide; HC: hydrocarbon; NOx: nitrogen oxides; PM: particulate matter
* These emission factors are for engines sized from 0 to 1 hp.

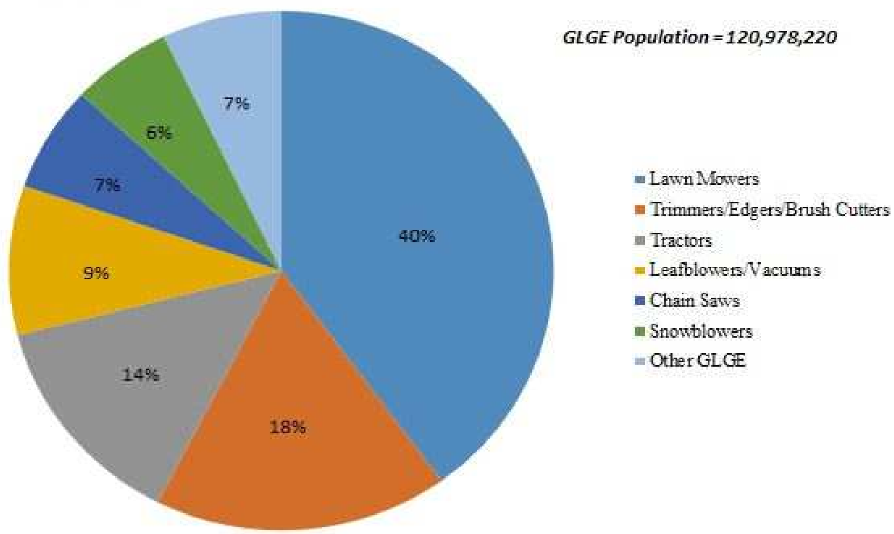
Other factors also influence the combustion related exhaust emissions from nonroad engines, such as fuel type, ambient temperature, and deterioration of equipment with age and use. The reader is referred to the EPA web-site (http://www.epa.gov/otaq/nonrdmdl.htm) for additional information on these topics.

RESULTS

Equipment Populations

Approximately 121 million pieces of GLGE are estimated to be in use in the United States (**FIGURE 1**). GLME accounts for two-thirds of all GLGE of which lawn mowers are the most numerous, followed by trimmers/edgers/ brush cutters, and then leaf blowers/vacuums. Projections from 2011 indicate a 13% increase across all equipment types after the combined effect of new equipment purchases and scrappage of old equipment are evaluated, resulting in an estimated 136 million pieces of GLGE in use by 2018.

Figure 1. GLGE population, US, 2011



Contribution of Nonroad Emissions to All Emissions

All Nonroad sources account for approximately 242 million tons of pollutants each year, accounting for 17% of all VOC emissions, 12% of NOx emissions, 29% of CO emissions, 4% of CO2 emissions, 2% of PM10 emissions, and 5% of PM2.5 emissions.

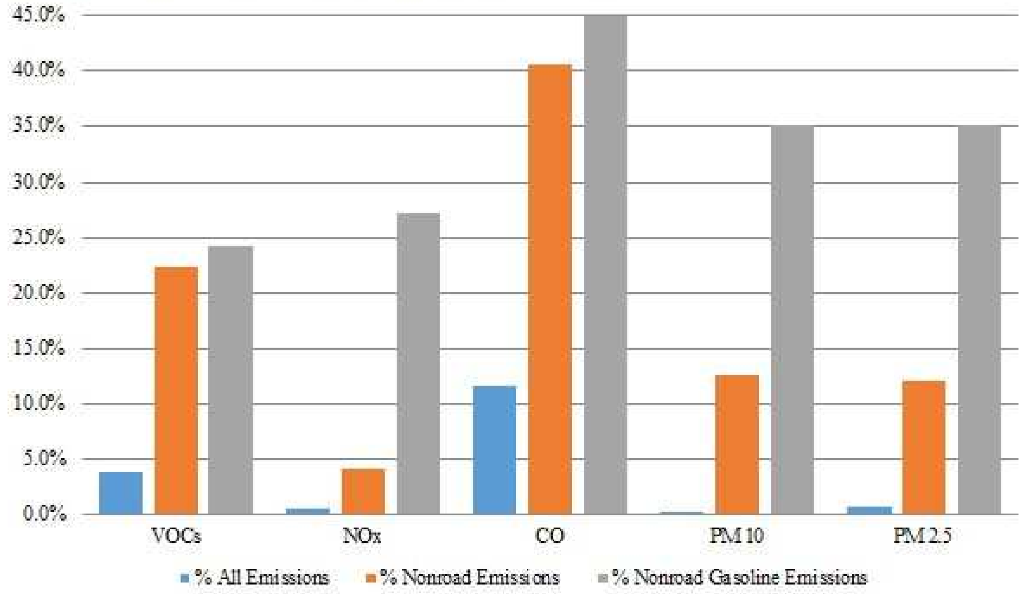
All Nonroad Emissions account for a substantial percentage of All Emissions of benzene (25%), 1,3 butadiene (22%), CO (29%), PM10 (2%), and PM2.5 (5%). Because of the relatively small contribution of GLGE CO2 to All Emissions (0.3%), it is not further considered in this report.

Contribution of GLGE to All Emissions and Nonroad Emissions

GLGE emitted approximately 6.3 million tons of VOCs (461,800) and criteria pollutants (CO=5,793,200; NOx=68,500, PM10=20,700 [19,000 of which is PM2.5]), and 20.4 million tons of CO2 in 2011. GLGE represented nearly 4% of All Emissions of VOCs and 12% of All Emissions of CO

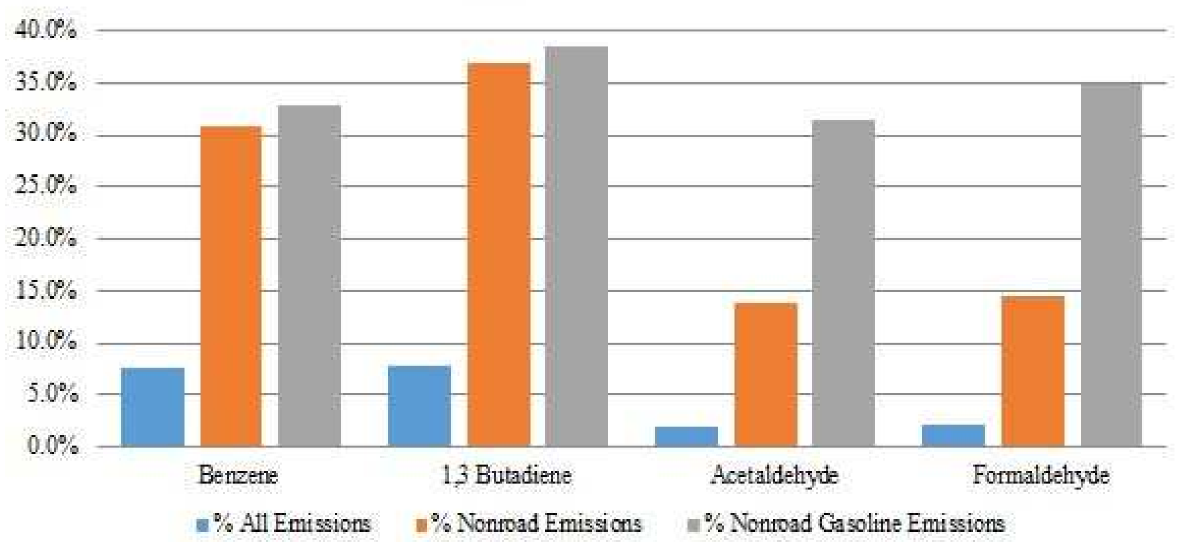
(**FIGURE 2**). GLGE fine PM emissions constitute a fraction of a percent of All Emissions of fine PM, but is a major Nonroad source, accounting for nearly 13% of All Nonroad Emissions of fine PM and more than one-third of Gasoline Nonroad Emissions of fine PM.

Figure 2. Contribution of GLGE emissions, US, 2011



Analysis of individual VOC emissions shows that GLGE contributes nearly 8% of All Emissions of both benzene and 1,3 butadiene (**FIGURE 3**). Within All Nonroad Emissions and Gasoline Nonroad Emissions, GLGE accounts for nearly one-third or more of benzene and 1,3 butadiene emissions, and also becomes a major source of aldehyde and formaldehyde emissions from Gasoline Nonroad sources.

Figure 3. Contribution of individual VOC emissions from GLGE, US, 2011



Contribution of GLME to GLGE Emissions

Compared with the GLGE contributions of Nonroad Gasoline Emissions shown in **FIGURE 2**, contributions of VOCs and fine PM emissions from GLME are disproportionately high, and for NOx and CO, are disproportionately low (**FIGURE 4**). Small GLME engines account for more than 40% of VOC emissions and one-half of PM10 and PM2.5 emissions from GLGE. Close to 90% of fine PM emissions from GLME come from 2-stroke engines (**FIGURE 5**).

Figure 4. Contribution of GLME to GLGE emissions, US, 2011

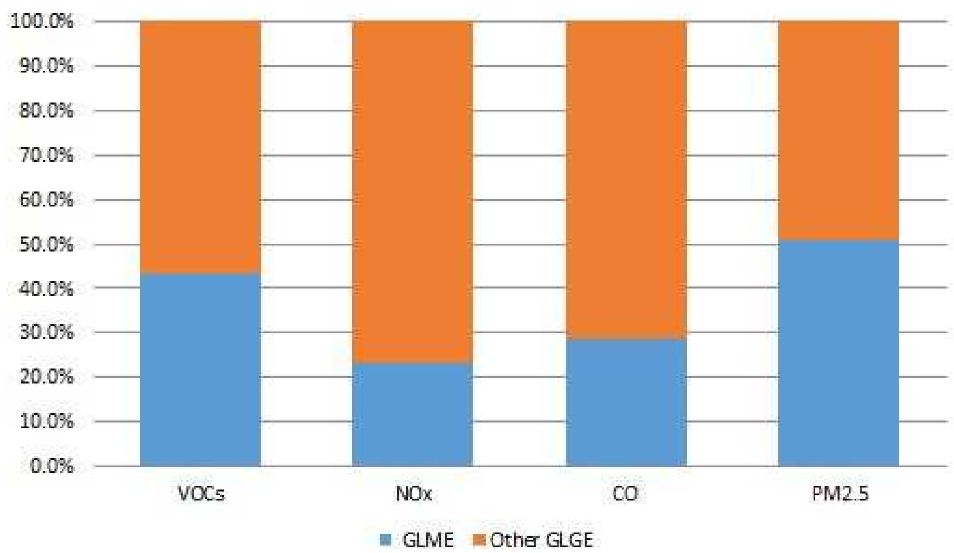
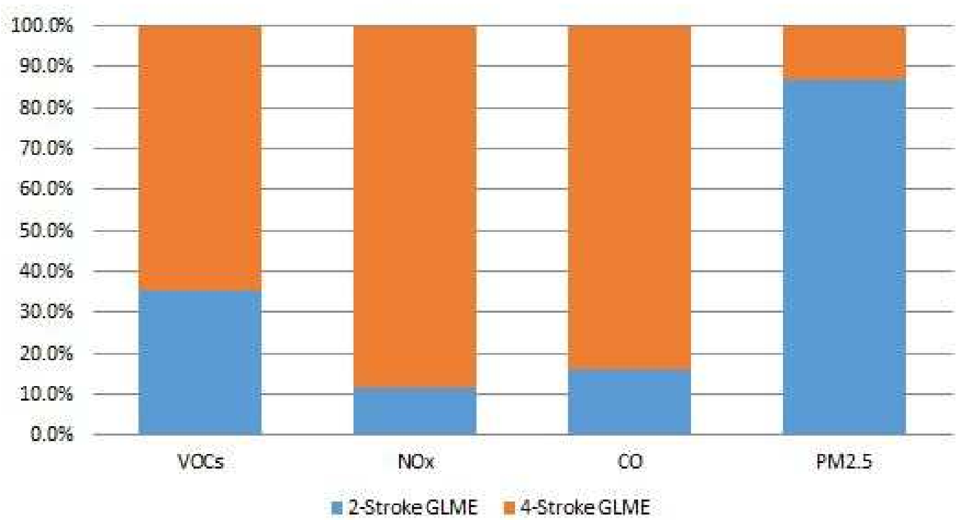


Figure 5. Contribution of 2-stroke engines to GLME emissions, US, 2011



Projected Growth of GLGE Emissions: 2011−2018

By 2018, the annual tonnage of ozone precursors, VOCs and NOx, emitted by GLGE is projected to decrease substantially from 2011, as more of the in-use fleet becomes represented by equipment built to meet EPA nonroad emission standards. CO emissions remain comparable to 2011 levels, while CO2 and fine PM emissions are projected to increase modestly.

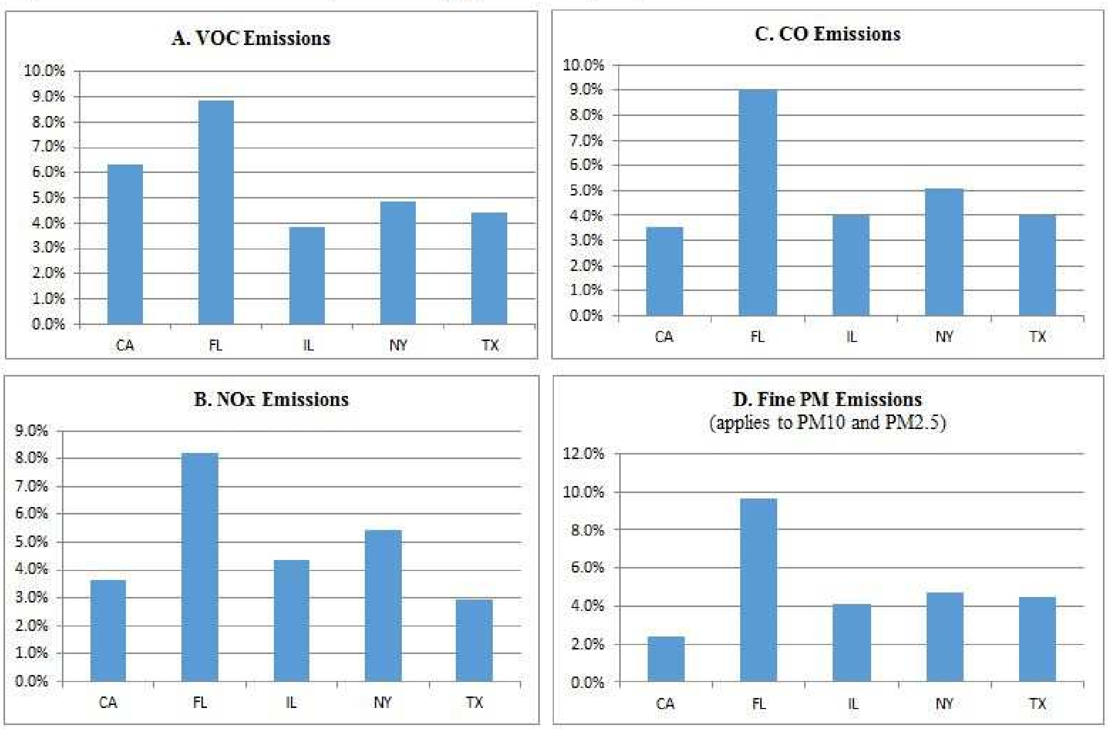
Table 5: Estimated Change in GLGE Emissions, 2018 vs 2011

Emissions	% Change
VOCs	-20.9%
NOx	-31.1%
CO	-4.9%
CO2	12.3%
PM 10	8.2%
PM 2.5	8.4%

GLGE Emissions in the Five Most Populated States

When considered together, GLGE emissions from California, Florida, Illinois, New York and Texas constitute approximately one-quarter of national GLGE emissions.

Figure 6. Emissions contributed by the 5 most populated states, US, 2011*

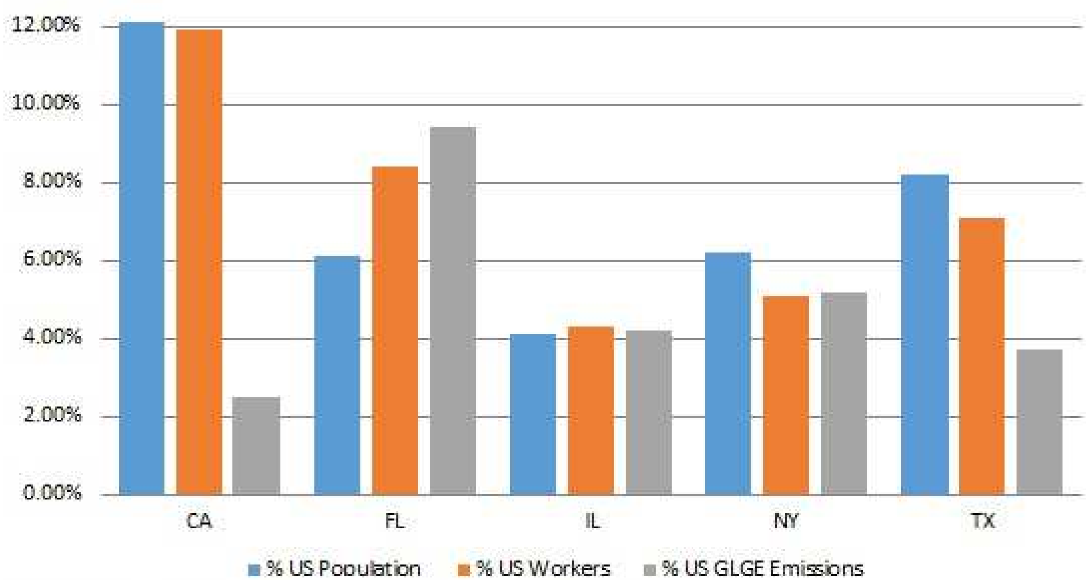


CA: California; FL: Florida; IL: Illinois; NY: New York; TX: Texas
*California data are from 2012.

Florida's GLGE emissions were 1.4 to 2.1-times higher compared with emissions in states having the next highest level of emissions in each GLGE pollutant category, and 2.2 to 4.4-times higher compared with emissions in states having the lowest level of emissions in each GLGE pollutant category (**FIGURE 6**).

For Florida, Illinois, and New York, state-specific contributions of GLGE emissions compared to the national total were relatively consistent with their contributions to the national population and the national grounds maintenance workforce. For California, its GLGE emission contribution was one-fifth that of its contribution to the national population and to the national grounds maintenance workforce. For Texas, its GLGE emission contribution was 40%−50% that of its contribution to the national population and to the national grounds maintenance workforce (**FIGURE 7**).

Figure 7. State contributions to US national population, grounds maintenance workforce, and GLGE emissions*



CA: California; FL: Florida; IL: Illinois; NY: New York; TX: Texas
*California data are from 2012 CARB estimates; all other state data are from 2011 NEI estimates.

DISCUSSION

The main findings of this study are: 1) GLGE is a prevalent source of toxic and carcinogenic emissions; 2) GLGE contributes substantially to nonroad emissions of benzene,1,3 butadiene, formaldehyde, CO, and fine PM; 3) GLME accounts for a disproportionately large share of VOC and fine PM emissions; 4) 2-stroke engines account for most fine PM emissions from GLME; 5) VOCs and NOx are projected to decrease substantially by 2018; CO emissions remain comparable to 2011 levels; and CO2 and fine PM emissions are projected to increase modestly; and 6) the GLGE emissions contributions from the the largest states are not always consistent with contributions to national population and national grounds maintenance workforce.

The large volume of emissions from GLGE found in this study is consistent with findings previously reported by the EPA[1] and from other studies.[2-4] The very substantial contribution of VOC, in particular benzene and 1,3 butadiene, deserves attention especially because of their localized nature.

While VOC emissions are expected decrease 21% on average by 2018, the rates of equipment replacement on which those projections are based are only approximated.

Adverse health effects from the GLGE emissions are well known. Benzene, 1,3 butadiene, and formaldehyde are listed among the four top ranking cancer-causing compounds.[22] They cause lymphomas, leukemias, and other types of cancer (International Agency for Research on Cancer, World Health Organization).[23, 24] Ground level ozone (formed by VOCs and NOx in the presence of sunlight) and fine PM cause or contribute to early death, heart attack, stroke, congestive heart failure, asthma, chronic obstructive pulmonary disease, and cancer.[5-11] Growing evidence suggests these pollutants also contribute to developmental and neurological disorders, including autism.[7-9, 12, 13] The mounting evidence on the dangers of short term exposure are especially concerning.[7, 9, 11]

The high levels of VOCs and fine PM from GLME are health risks for workers and other members of the public close to the emitting source. Although no studies of grounds maintenance workers were found, studies of gas station workers have shown that regular exposure to gasoline vapors can produce hematological and immunological abnormalities and elevate the risk of cancer.[25-27] In addition, children, seniors, and persons with chronic illnesses are especially vulnerable to the negative health impacts of GLME emissions.[28] Routine use of GLME in the vicinity of residential neighborhoods, schools, parks, and other public spaces may be exposing the public to unnecessary and preventable health risks. New equipment standards do not affect fine PM emissions; in fact, those emissions are expected to increase.

School buses represent another example of a close-to-emitting source in which children are subjected to increased exposure from diesel exhaust.[29] Tests of school buses found that diesel exhaust entering through the front door of the bus results in elevated levels of PM over time. When queuing, PM built up rapidly in the bus cabin when the front doors were open.

The variation in emissions levels observed among the five most populated states should be explored further. The reasons for the high emissions contribution from Florida and relatively low emissions contributions from Texas and California are not clear. Differences between CARB data and NEI data may account for some of the difference between California and other states. For example, the NEI baseline equipment population data are older compared with those of CARB. Other factors that may be involved include but are not limited to emissions estimation procedure, geographic and climate factors, regulations and their effectiveness, and efforts to promote cleaner alternatives.

This study has several limitations. Not all potentially harmful emissions were characterized; for example, polycyclic aromatic hydrocarbons. Other limitations concern the source data. Although the NEI is a comprehensive source of GLGE emissions data, the accuracy of the reported data is uncertain. Baseline equipment population data for the Nonroad model is 15−20 years old and does not account for growth of the commercial industry. This older population data supplies emission estimates to NEI, which in turn is used to create EPA's 2011 and 2018 modeling platforms. Although the residential and commercial CARB inventories and activity data are newer, they depend largely upon telephone survey data.[30, 31] Methodological weaknesses with the commercial survey data are discussed in the survey report.[31] For both data sources, the rates of replacement of older equipment by newer, cleaner equipment that meets the newer Phase 3 standards[32] can only be approximated.

CONCLUSIONS

GLGE is an important source of toxic and carcinogenic exhaust and fine particulate matter. Improved reporting and monitoring of localized GLGE emissions should be implemented. Medical and scientific organizations should increase public awareness of GLGE and GLME and identify GLGE as an important local source of dangerous air pollutants. Communities and environmental, public health, and other government agencies should create policies and programs to protect the public from GLGE air pollutants and promote non-polluting alternatives.

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LEAF BLOWER REGULATIONS
REGIONAL WORKING GROUP

MUNICIPAL RESEARCH AND BEST PRACTICES
SUBCOMMITTEE REPORT

AUGUST 16, 2022

Summary

The Leaf Blower Regulations Regional Working Group Municipal Research and Best Practices Subcommittee surveyed numerous Illinois municipalities to determine if and how they regulated leaf blowers (see *Appendix A*). It was determined that most Illinois municipalities do not have ordinances that prohibit or restrict the use of gas-powered leaf blowers. However, certain municipalities including but not limited to Evanston, Kenilworth, Winnetka, and Wilmette have adopted gas-powered leaf blower regulations to reduce noise and air pollution.

The Subcommittee also surveyed municipalities nationwide to identify successful programs, policies, and best practices for the Regional Working Group to consider. We found California has several communities with gas leaf blower regulations which are highlighted in the "Best Practices" section of this memorandum, along with other noteworthy municipal attempts to limit air pollutants and reduce noise pollution.

Importantly, our research assessed the success of various regulatory and enforcement strategies used in Illinois municipalities. We found:

- Police departments are the most common enforcer of leaf blower regulations; complaints of this nature are typically treated as low priority. Other enforcement agencies include Code Enforcement, Public Works, or, in the case of Evanston, the Health Department.

- To limit noise, many communities have noise ordinances that consequently limit the hours of use of leaf blowers without completely banning their use. The following communities have noise ordinances but do not specifically include "leaf blowers" in their regulation: Barrington, Buffalo Grove, Deerfield, Elmhurst, Glen Ellyn, Glenview, Grayslake, Lake Forest, Lake Zurich, Libertyville, Lincolnshire, Mettawa, Morton Grove, Mount Prospect, Mundelein, Northbrook, Northfield, Park Ridge, Riverwoods, Skokie, and Vernon Hills.

- The following Illinois communities have partial or full bans on leaf blowers:
  Wilmette, Evanston, Glencoe, Winnetka, Lincolnwood, Kenilworth, and Highland Park.

Illinois Municipal Regulations

Many Illinois municipalities regulate leaf blowers indirectly through the use of noise and nuisance ordinances that effectively set the acceptable hours of operation without introducing a seasonal ban. These communities, primarily on Chicago's North Shore, have engaged in more extensive regulatory efforts.

Evanston. The City of Evanston has an ordinance that prohibits gas-powered leaf blowers between May 15th and September 30th (summer) and after the first Thursday in December until March 29th (winter). Evanston will ban all gas-powered leaf blowers starting April 1, 2023 including during the seasons listed. There are no seasonal restrictions on electric-powered leaf blowers. When leaf blowers are allowed, their use is limited to Monday through Friday from 7:00 a.m. to 9:00 p.m. and on Saturday, Sunday, and holidays from 9:00 a.m. to 5:00 p.m. The Evanston Health Department enforces their regulations through progressive discipline: a written violation letter is sent upon the first offense, a $100 fine for the second offense, a $150 fine for the third offense, a $200 fine for the fourth offense, and $250 fines for the fifth and subsequent offense(s).

Glencoe. The Village of Glencoe prohibits the use of gas-powered leaf blowers between May 15th to September 15th and from December 15th to March 15th. The ordinance restricts commercial lawn maintenance equipment use from 7:00 a.m. to 7:00 p.m. on weekdays and from 9:00 a.m. to 6:00 p.m. on Saturdays, and bans use entirely on Sundays and holidays. These restrictions do not apply to property owners conducting maintenance on their property. The Glencoe Police Department enforces these restrictions by issuing $250 fines to commercial landscape companies who are in violation, starting from the first offense (e.g. no warning).

Highland Park. The City of Highland Park prohibits the use of gas-powered electric leaf blowers between May 15th and October 1st, except for golf course maintenance or roof gutter cleaning (between May 15th and June 15th). When allowed, leaf blowers can be operated between 7:00 a.m. to 7:00 p.m. on weekdays and from 9:00 a.m. to 5:00 p.m. on Saturdays. The Highland Park Police Department and Community Development Department enforce this ban with fines ranging from $200 to $500.

Kenilworth. The Village of Kenilworth has a noise and leaf blower ordinance that prohibits the use of gas-powered leaf blowers between May 15th and September 30th. When allowed, leaf blowers can be operated Monday through Friday from 8:00 a.m. to 6:00 p.m. and on Saturday, Sunday, and holidays from 9:00 a.m. to 5:00 p.m. Gas or electric-powered leaf blowers must never exceed 75 decibels. The Kenilworth Police Department enforces this ordinance.

Illinois Municipal Regulations (continued)

Lincolnwood. The Village of Lincolnwood prohibits the use of gas-powered leaf blowers from May 15th to September 30th. When allowed, the leaf blower ordinance restricts use from 7:00 a.m. to 6:00 p.m. Monday through Friday; 7:00 a.m. to noon on Saturday; and bans use entirely on Sundays and holidays. The Lincolnwood Police Department and a Code Enforcement Officer issues violation notices upon the first offense and a citation upon the second offense. Fines are determined in court.

Wilmette. The Village of Wilmette introduced a ban on gas-powered leaf blowers between May 15th and September 30th beginning in 2006. Between October 1 and May 14, the Village permits the use of gasoline-powered leaf blowers, however, use is limited for to no more than 30 minutes in any three-hour period on lots of one-half acre or less. The prohibition includes using an electric leaf blower powered by a portable gasoline generator, but not the use of electric leaf blowers plugged into permanently installed electrical outlets attached to a permanent structure. A dedicated code enforcement officer (not a Police Department employees) issues a fine to the landscape company, not the employee of the company using the device. The citation is voided if the company provides proof they have purchased an electric or battery operated device. Multiple violations result in fines.

Winnetka. The Village of Winnetka has a noise and leaf blower ordinance that prohibits the use of gas-powered leaf blowers between June 1st and September 30th, except for golf course maintenance. From October 1st to May 31st, the use of gas-powered leaf blowers is limited to Monday through Friday from 8:00 a.m. to 7:00 p.m. and on Saturday, Sunday, and holidays from 9:00 a.m. to 6:00 p.m. The Winnetka Police Department enforces the ordinance and issues fines starting at $100 for the first violation and increasing for repeat offenses.

National Municipal Regulations - California

California has a history of strict air quality standards that resulted in leaf blower bans as early as the late 1970s. Some municipalities have banned both gas-powered and electric leaf blowers.

Hermosa Beach. Hermosa Beach, California directly references "leaf blowers" under "Prohibited Noises" in their noise ordinance, effectively banning leaf blowers since the early 1990s. The city issues notice to first-time violators, while the Police Department can "decide to issue a citation to the person who is caught using the leaf blower", enforcing the ban that way.

Laguna Beach. Since 1993, Laguna Beach, California has banned both gasoline-powered and electric leaf blowers. Fines are issued to users starting at $100 for the first violation, $200 for the second violation, and $500 for the third violation. Code Enforcement staff issue warnings and citations if they see someone using a leaf blower.

Santa Barbara. Santa Barbara, California has banned gas-powered leaf blowers since 1997. This ordinance is enforced through a complaint system: a District Inspector monitors an online complaint website where residents can register an online complaint as an air pollution complaint. The District Inspector determines if a complaint is a violation and can issue a citation. Every hour of violation is treated as a separate incident.

Santa Monica. Santa Monica, California bans the use of both gasoline-powered and electric leaf blowers within the city. Violators can receive citations from Code Enforcement. $500 fines are usually given to the operator of the leaf blower, but management companies, landscaping companies, or property owners can be cited. A court case in 2015 limited the scope of citations as a property owner claimed that the City could not prove that the owner knew that the leaf blower was being used on his property at the time of the citation.

In addition to municipal regulations, notably, the California Air Resources Board recently (December 2021) adopted administrative regulations that will effectively halt the sale of gas-powered leaf blowers, lawn mowers, and other landscaping equipment starting in model year 2024. Equipment manufactured prior to 2024 can continue to be legally sold and used after the effective date of these regulations.

National Municipal Regulations – Outside California

Burlington, VT. Burlington, Vermont's largest city, passed a phased-in ban that required compliance by May 2022. The ordinance bans the use of gas-powered leaf blowers from Memorial Day to Labor Day. The ordinance allows for year-round use of electric-powered leaf blowers that are below 65 decibels; when allowed, gas-powered leaf blowers must operate below 65 decibels. The use of any leaf blower is limited to Monday through Friday from 7:00 a.m. to 5:00 p.m., Saturdays from 8:00 a.m. to 5:00 p.m., and prohibited on Sundays and Holidays except for property owners from 9:30 a.m. to 5:00 p.m.

East Hampton, NY. East Hampton, New York, passed an ordinance prohibiting gas and diesel-powered leaf blowers from May 20th to September 20th. When allowed, leaf blower use is restricted to Monday through Friday from 8:00 a.m. to 6:00 p.m., Saturdays from 9:00 a.m. to 5:00 p.m., and prohibited on Sundays and Holidays except for property owners from 9:00 a.m. to 3:00 p.m. The East Hampton Town Ordinance Department enforces the ban with fines between $1,000 and $5,000 depending on the offense.

Montclair, NJ. Montclair, New Jersey passed an ordinance that restricts gas-powered leaf blower use, allowing for use only between March 15th and May 15th and between October 15th and December 15th. When allowed, leaf blower use is restricted to Monday through Friday from 9:00 a.m. to 6:00 p.m., Saturdays from 10:00 a.m. to 6:00 p.m. (8:00 p.m. for property owners), and Sundays and Holidays from 10:00 a.m. to 5:00 p.m. Additionally, the ordinance requires lawn care companies to provide safety protection for their employees. A Municipal Court Judge administers fines at their discretion; first-time violations start at $100 and recurring violators can be fined up to $2,000 and risk 90 days of community service or imprisonment.

Summit, NJ. Summit, New Jersey introduced a pilot program that temporarily banned gas-powered leaf blowers from June 1st, 2021, through August 31st, 2021. The ordinance adds on to existing use restrictions: Monday through Friday from 8:00 a.m. to 6:00 p.m. (8:00 p.m. for non-commercial use), Saturdays from 9:00 a.m. to 6:00 p.m., and on Sundays and Holidays from 9:00 a.m. to 6:00 p.m. for non-commercial use. The temporary ordinance was enforced by the Summit Police Department and/or the Department of Community Services through a progressive discipline system; first-time violators receive a notice, then incur increasing fines after subsequent violations, from $100-$500. The program/ban was not extended and there are currently only temporal restrictions on use.

APPENDIX A

Survey of Municipal Leaf-Blower Regulations
(Excel Spreadsheet)

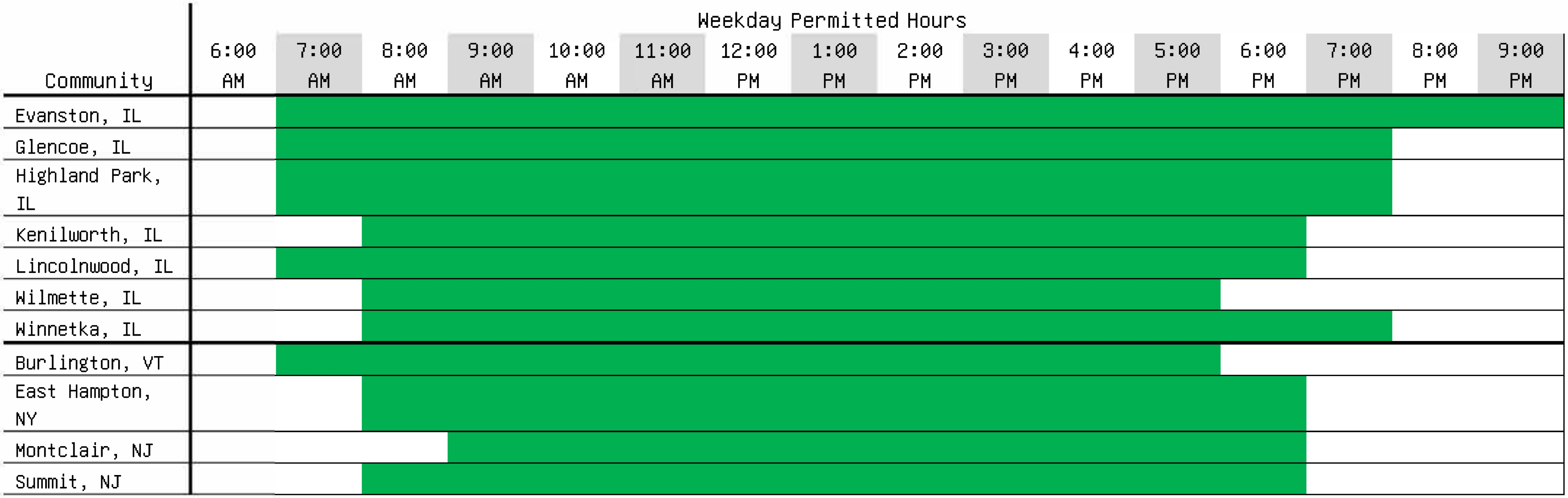
Time of Day Restrictions

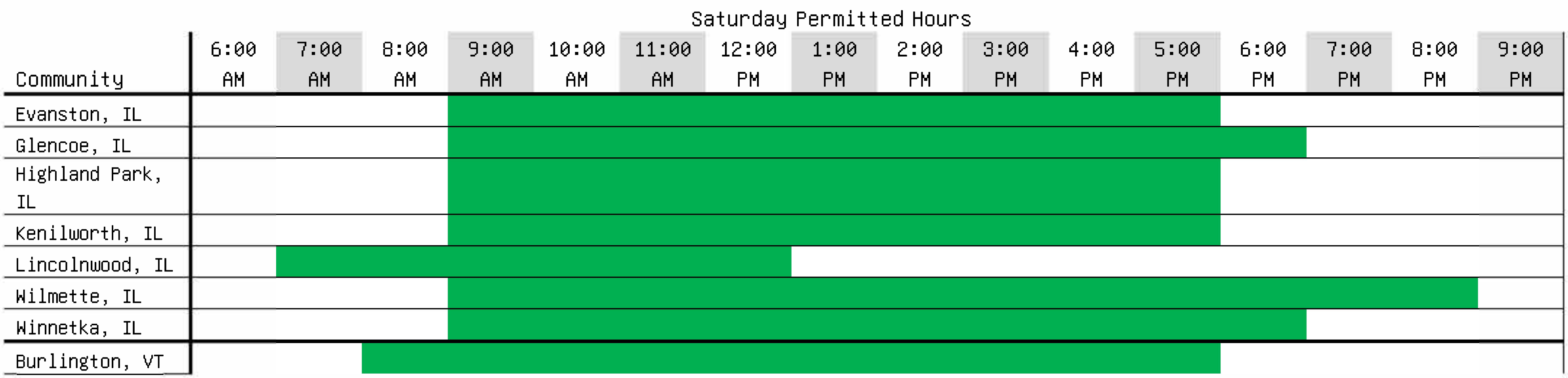
Community	Ord. Reference	When Prohibited	Enforcing Agency	First Offense	Subsequent Offense(s)
Wilmette, IL	Sec. 16-115(a) (nuisances)	May 15th - September 30th	Police	$80	$160
Evanston, IL	Title 8, Chapter 26	May 15th - September 30th, First Thursday in December - March 29th	City Health	Notice	$100, $150, $200, $250
Glencoe, IL	Sec. 24-38(c) (nuisances)	May 15th - September 15th, December 15th - March 15th	Police	Discretionary	Discretionary
Highland Park, IL	Sec. 95-001(O)(9) (nuisances)	May 15th - October 1st	Police, Community Development	$200-500	$200-500
Winnetka, IL	Sec. 9.16.020(21) (nuisances)	June 1st - September 30th	Police	$100	$100-$750
Kenilworth, IL	Sec. 135-02(23) (nuisances)	May 15th - September 30th	Police	Discretionary	Up to $750
Lincolnwood, IL	Sec. 17-2-16(H) (noise)	May 15th - September 30th	Police, Code Enforcement	Notice.	Discretionary.

Time of Day Restrictions

Community	Ord. Reference	When Prohibited	Enforcing Agency	First Offense	Subsequent Offense(s)
Hermosa Beach, CA	Sec. 8.24.020(H) (noise)	Complete ban	Code Enforcement	$100	$200, $500
Laguna Beach, CA	Sec. 7.25.070(D) (noise)	Complete ban	Code Enforcement	$100	$200, $500
Santa Monica, CA	Sec. 4.08.270 (nuisances)	Complete ban	Code Enforcement	$500	$500
Santa Barbara, CA	Sec. 9.16.050 (noise)	Complete ban	Police, Santa Barbara County Air Pollution Control District	Discretionary	Discretionary
Burlington, VT	Sec. 21-14	Memorial Day (May) - Labor Day (September)	Police	$200-$500	$300-$500
East Hampton, NJ	Chapter 155	May 20^{th} - September 20^{th}	Town Ordinance	Up to $1,000	$1,500-$5,000
Montclair, NJ	Sec. 217-6 (noise)	May 15^{th} - October 15^{th}, December 15^{th} - March 15^{th}	Police	$100	Up to $2,000; community service; 90 days in jail
Summit, NJ	Sec. 3-8.1(b)(4) (noise)	June 1^{st} - August 31^{st}	Police, Community Services	Notice	$100, $250, $500

Time of Day Restrictions





Time of Day Restrictions