Lessons Learned from the Buffalo Blizzard

Recommendations for Strengthening Preparedness and Recovery Efforts

New York University
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Report Authors & Acknowledgements

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Lessons Learned from the Buffalo Blizzard: Recommendations for Strengthening Preparedness and Recovery Efforts

Executive Summary

In December 2022, the City of Buffalo in Erie County, New York experienced a "generational storm" that claimed the lives of 31 residents and brought activity to a standstill for nearly a week. While the city is no stranger to snowstorms, several factors made this particular blizzard uniquely challenging. Hurricane-force winds of up to 80 miles per hour brought whiteout conditions and 15-foot high snowdrifts, wind chill temperatures dipped to 30 degrees below zero Fahrenheit, and the blizzard lasted longer than any prior storm below 5,000 feet of elevation in continental U.S. history.

To compound the dire situation, the blizzard hit Buffalo during the Christmas season, when many residents had travel plans and some essential workers were already away for the holidays. Employees who remained local were asked to sacrifice their holiday time to serve in extraordinary conditions that resulted in 46 deaths countywide.

Without question, the storm had serious adverse effects on the city's infrastructure, businesses, and residents. Taking a proactive approach, Buffalo Mayor Byron Brown sought expertise on how to better prepare for future blizzards of this magnitude. He commissioned the NYU Wagner School to conduct an analysis of the storm's impacts and to identify actionable solutions aimed at improving preparation and recovery, and reducing loss of life and property in the future.

A research team of nine individuals and additional advisors (a full list of study participants appears on page 2) focused on and investigated four primary areas of impact:

- **Roads**: How disastrous road conditions and insufficient snow removal resources impeded the storm response and recovery
- **Utilities**: How power losses affected residents and city operations
- **Communications**: How warnings and emergency messages were communicated to the public
- **Equity**: How the storm exacerbated existing inequities in the city of Buffalo

During the course of our study, the research team interviewed more than 30 stakeholders representing city and state government, community organizations, emergency responders, utility providers, and business owners. We collected and analyzed data and documents from a variety of sources including the City of Buffalo, National Grid, local and national media, and social media. We also reviewed the historical context of Buffalo's 1977 blizzard, the last "generational storm" with parallels to the December 2022 event. To help the city bolster its preparedness, response, and recovery efforts going forward, we identified relevant solutions and systems that have been tested and implemented elsewhere and could be considered for Buffalo.

The following key priorities emerged from our research:

· **Physical assets.** The city's emergency vehicle fleet, storage capabilities, and warming centers did not meet the demands that responding to this once-in-a-generation storm required.

· **Electrical power.** Because of failures in the electrical network, managed by National Grid, approximately 20,000 customers and key City facilities, including fire houses and the Department of Public Works facility, lost power at some point during the storm, some for up to four days.

· **Public communications.** Many people remained uninformed despite travel bans and stay-at-home orders. The city relied heavily on television and radio announcements and non-specific warnings, and not enough residents had enrolled in text message alert systems.

· **Existing equity issues.** While the snow hit all of Buffalo hard, the blizzard's impact was felt hardest in neighborhoods that endure persistent economic hardships and resource limitations. Of the 31 individuals who died within the City of Buffalo, 20 were people of color - disproportionate for the city's demographics. Some residents ventured out mid-storm for food and medicines because they were not in a financial position to stock up ahead of time.

In addition, snowstorms do not respect political boundaries. Optimal response required continual coordination between the City, County and State. This was challenging during the storm.

Despite these significant challenges, **aspects of Buffalo's response were highly successful and demonstrated resourcefulness and bravery under immense pressure**.

To address the challenges identified through our research, our team developed a set of recommendations for consideration by Mayor Brown and the City of Buffalo. These recommendations encompass changes that can be enacted as soon as next storm season (Winter 2023-24), as well as larger systemic changes aimed at upgrading preparation and recovery in the long term while minimizing the risk of loss of life, injury, and damage. We also include steps to harness the city's unique and highly successful 311 program.

Our recommendations are organized around five strategies for change (see the Recommendations and Proposed Solutions section of this report for a detailed discussion). A summary of key steps for each strategy follows.

The research team was asked to review the response to an unprecedented storm that occurred over a holiday. As such, the report should not be read as a suggestion of negligent conduct by any of the respondents or government officials, many of whom were heroic in a time of crisis. To the extent that words such as "inadequate" or "insufficient" appear in the report, the intent is the literal meaning; in other words, a given action or resource was not able to counter a particular circumstance.

We make recommendations for improving preparation, but we recognize that since resources are limited, appropriate planning must balance the costs and benefits of all preparedness actions in light of the probability that they will be needed. We do not undertake any such balancing of costs and benefits in this report.

1. **Bolstering physical assets for greater efficiency, protection, and nimble operations**
   - Build two new Department of Public Works (DPW) facilities: a replacement for the aging Broadway Barns facility as well as a Traffic Management Center, both of which are essential ingredients for responding effectively to emergencies and everyday needs.
   - Develop an Emergency Operations Center within the City of Buffalo, helmed by the new Emergency Manager, to coordinate inter-departmental efforts, situational awareness, and physical assets. Continuous training of staff for emergency management preparedness, especially through inter-governmental tabletop exercises, is key.

2. **Partnering with regional, state and federal agencies, as well as the private and non-profit sectors, to realize the City's immediate and long term needs.**
   - Strengthen partnerships to address immediate needs, such as access plans for electrical infrastructure in storms, and longer-term improvements, including upgrading housing stock.
   - Building on the success of the city's 311's outreach efforts, develop and maintain a strong network among residents, community groups, and government resources for partnership during extreme events and for meeting everyday needs.
3. **Creating and maintaining clear and consistent public communications**
   - Convey the potential dangers of the storm using all available traditional and social media channels, by deploying physical signage in high-traffic areas, and by utilizing the Wireless Emergency Alert system to ensure that emergency notifications reach the majority of Buffalonians.
4. **Addressing systemic challenges that hinder resilience, including impacts on under-resourced neighborhoods and residents and mobility-linked hindrances**
   - Evaluate aging housing stock and power infrastructure, and develop a plan to revitalize outdated infrastructure with the investment of county, state, federal and private sector resources, to help ensure that residents remain protected and warm.

In addition, Buffalo can maximize the use of data and technology for heightened situational awareness, partner coordination, and more efficient emergency response procedures. Upgraded technologies can be used to share status data and weather reports among first responder dispatchers, the Traffic Management Center, power and telecommunications providers, and 311 operators.

A true strength of the City of Buffalo is that it lives up to its nickname, "The City of Good Neighbors." Its residents are a testament to the city's resilience and caring nature. Our research team encourages the city to lean into this strength and utilize its tight-knit communities to better prepare local residents for future weather crises, and to foster even more effective mutual assistance. This report provides a roadmap for helping the city make meaningful progress.

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Introduction

The City of Buffalo, New York, experienced a devastating "generational storm" in late December, 2022.

Buffalo, a city of 276,807 people, located in Erie County, and situated on the shores of Lake Erie, is no stranger to snow; just the previous month, a Thanksgiving storm dropped five feet of snow on the city at record-high speeds, followed by another storm in mid-December. However, the Christmastime blizzard ravaged the city, killing 46 residents in Erie County – 31 of whom lived in the city of Buffalo – and ground activity to a halt for the better part of the holiday week.

Beginning on December 23rd, snow fell for three days straight, reaching 51.9 inches in depth,[1] and Buffalo's lake effect caused snowdrifts of up to 15 feet in height. While the National Weather Service (NWS) does not name winter storms, The Weather Channel named this one Winter Storm Elliott, and as a result, many people who lived through it know the storm by that name.

The snow itself was not the predominant issue, as Buffalo typically experiences several major snowstorms each winter. However, a combination of three factors made this particular storm uniquely challenging:

· **The force of the storm,** which created hurricane-force winds of up to 80 miles per hour, whiteout conditions with zero visibility, and wind chill temperatures of 30 degrees below zero Fahrenheit. Snow clearance and search and rescue activities were unable to be conducted in these conditions and driving was extremely hazardous. Rescue vehicles got stuck in the snow or frozen to the ground, rescuers became disoriented and lost, emergency vehicles couldn't get through, and motorists got stranded.

· **The duration of the storm**. Blizzard conditions lasted for 37 hours, crowning this blizzard the longest in duration to occur below 5,000 feet of elevation in continental U.S. history. Rescue attempts were impossible for most of this stretch of time (although heroic acts continued to be conducted by police, firefighters, the National Guard, and private individuals).

· **The timing of the storm**. Blizzard conditions spanned December 23rd to 26th. Because the storm occurred over the Christmas holiday, many first responders and essential workers were either out of town, had already put in for time off, or required holiday pay for coming in. Workers were pulled away from family time to serve in treacherous conditions, sometimes traveling to

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[1] Deliso, 2022

their posts along low-visibility roads and sleeping on the floors of police stations and fire houses.

Loss of life, injury, and public and private property damage were among the blizzard's most harmful effects. Many of those who perished were people who ventured outside or were stranded in their cars in the harsh elements. In some instances, the fatalities included people who had cardiac or other emergencies and were unreachable by EMS due to the extreme conditions.

The storm also had a detrimental impact on the city's infrastructure that was associated with road closures, power outages, and communication disruptions. Although every disaster presents unexpected scenarios, the Buffalo Blizzard led to a cascade of unfortunate events. To his credit, Buffalo Mayor Byron Brown recognized the importance of conducting a thorough review of the storm's effects and the city's response. In January 2023, he engaged the NYU Wagner School to conduct an analysis of impacts and to identify actionable solutions for subsequent storm seasons that could help the city improve preparation, response, and recovery while minimizing loss of life and property.

The Rudin Center for Transportation Policy and Management at NYU's Wagner School assembled a research team of nine researchers and additional advisors (a full list of study participants appears on page 2) to conduct a study focused on four primary areas of impact:
- **Roads**: How disastrous road conditions and insufficient snow removal resources impeded the storm response and recovery
- **Utilities**: How power losses affected residents and city operations
- **Communications**: How warnings and emergency messages were communicated to the public
- **Equity**: How the storm exacerbated existing inequities in the city of Buffalo

During the course of this study, the research team interviewed more than 30 stakeholders representing city and state government, community organizations, emergency responders, utility providers, and business owners. We collected and analyzed data and documents from a variety of sources including the City of Buffalo, National Grid, local and national media, and social media. We reviewed the historical context of Buffalo's 1977 blizzard, the last "generational storm" with parallels to the December 2022 event. To help the City of Buffalo bolster its preparedness, response, and recovery efforts going forward, we identified relevant solutions and systems that have been tested and implemented elsewhere and could be considered for Buffalo. We also assessed the city's unique and highly successful 311 program for its data, flexible work processes, and potential to play an expanded role in building relationships with communities and activating them to assist during future emergencies.

In the next two sections of this report, we describe the key findings from our research team's analyses and present a set of recommendations including strategies, steps, and a roadmap for consideration by Mayor Brown and the City of Buffalo. These recommendations encompass changes that can be enacted as soon as next storm season (Winter 2023-24), as well as larger systemic changes aimed at upgrading preparation and recovery in the long term.

The research team was asked to review the response to an unprecedented storm that occurred over a holiday. As such, the report should not be read as a suggestion of negligent conduct by any of the respondents or government officials, many of whom were heroic in a time of crisis. To the extent that words such as "inadequate" or "insufficient" appear in the report, the intent is the literal meaning; in other words, a given action or resource was not able to counter a particular circumstance.

We make recommendations for improving preparation, but we recognize that since resources are limited, appropriate planning must balance the costs and benefits of all preparedness actions in light of the probability that they will be needed. We do not undertake any such balancing of costs and benefits in this report.

Additional data and material appear in the report Appendices:
- Appendix A: List of Stakeholder Interviews
- Appendix B: Timeline of Events
- Appendix C: Challenges on Buffalo's Roads
- Appendix D: Business Community Needs
- Appendix E: Power Infrastructure
- Appendix F: Communications
- Appendix G: Charter Communications
- Appendix H: Equity Concerns Raised from the Blizzard's Impact and Recovery
- Appendix I: Methodology
- Appendix J: Sources Cited

Key Findings

During the course of this study, a set of challenges emerged around coordination, communication, asset management, and equity. Salient aspects of those challenges are discussed here.

Overview of Challenges

- **Physical assets.** Buffalo's emergency vehicle fleet, storage capabilities and warming centers were not sufficient to fully address December's once-in-a-generation blizzard. During the storm, fire trucks and ambulances were stuck in snow or frozen to the ground, exacerbating the emergency conditions that abounded.
  In addition, most snow removal, sanitation and salting vehicles are stored in the "Broadway Barns," an armory built before the Civil War and later converted into a Department of Public Works depot. The structure lost power and heat during the blizzard. However, it is important to note that Mayor Brown had already been working before the storm to try to secure $60 million in capital funding from New York State to build a new facility elsewhere, and has secured $10 million as of this writing.
  Finally, the electrical grid, managed by National Grid, could not withstand the blizzard conditions; approximately 20,000 customers and key City facilities, including fire houses and the Department of Public Works garage, were without power during the peak outage period of December 23 to 25. This often meant a loss of heat as well. Three substations failed due to the snow and ice; these locations were not built for extreme winter weather, and some DPW resources were dedicated to removing snow so National Grid could gain access to these locations. Addressing these challenges will require coordination with both the state and the electrical provider, National Grid.

  Progress Update: The City of Buffalo has since placed orders for additional snow removal equipment, vehicles that can traverse winter terrain, and the Common Council has approved the Mayor's proposal to hire a Fleet Manager to ensure the conscientious purchase of new vehicles. New York State has dedicated $10 million to the construction of a new DPW facility.[2,3]

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[2] Department of Administration, Finance, Policy and Urban Affairs and Division of Budget and Management
[3] McNeil, 2023a

- **Public communications.** Alerts concerning travel bans and stay-at-home orders were not sufficient to fully convey the situation's urgency. The City relied on television and radio announcements, which were ineffective for residents without those devices, and the thousands of customers who had lost power. In addition, only 16% of residents are enrolled in the City's text messaging alert system, BUFFALERT.
  Although warming centers were available during the blizzard, providing power, heat and necessities, information concerning when and how to reach the centers was inadequate.

  Progress Update: The Mayor and his staff have taken steps since the blizzard to expand the reach of emergency storm warnings through physical signage in public locations, alerting residents about upcoming weather conditions and warming center operations. In addition, City leadership, including the Office of Communications, completed NYS DHSES' "Managing Chaos" training for crisis communications in Spring 2023.

- The storm **exacerbated existing equity issues.** While the snow hit all of Buffalo hard, the blizzard's impact was felt hardest in neighborhoods that endure persistent economic hardships and resource limitations. Of the 31 individuals who died within the City of Buffalo, 20 were people of color - disproportionate for the city's demographics. Many residents who were not in a financial position to stock up ahead of time ventured out mid-storm for food and medicines. In some neighborhoods, acquiring food was even more challenging because grocery stores are not evenly distributed throughout the city. Furthermore, two of the three National Grid power substations that failed were located in Buffalo's predominantly-Black East Side, and power outages appeared to occur frequently in those neighborhoods.

  Progress Update: The City of Buffalo has secured state funding to help low-income East Buffalo homeowners become current on water, sewer and tax bills, as well as assisting with home repair costs.[4]

Additional findings related to road conditions, resource shortages, preparedness, and surmounting challenges are explored in greater depth in the sections that follow.

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[4] *Buffalo east homeowner improvement program (BEHIP)*

- **Inter-governmental coordination.** Although Buffalo comprises the majority of Erie County, it does not manage the County's Emergency Operations Center – a challenge to reach when transportation is hampered – or the 911 call system. There was a backlog of 1,100 emergency calls during the storm, but Buffalo emergency services were hampered by County dispatch software that could only view 25 calls at once (sometimes duplicative). In addition, seven people died in Erie County because of what officials have characterized as a delayed EMS response due to backlogged calls, unplowed streets, and stranded vehicles causing blockages.
It is likely that the problem of stranded vehicles was related to the timing for closing roads, a decision controlled by Erie County. Although New York's prior Governor Andrew Cuomo had historically decreed road closures through executive order during his tenure, current Governor Kathy Hochul, who took office in August 2021, has permitted greater local decision-making around road closures. This likely led to a "wait-and-see" approach leading up to the blizzard that may have contributed to belated road closures by the County, later announced by the City. Meanwhile, drivers and pedestrians still took to the streets, either unaware of or underestimating the dangers, or having been called into work before the travel ban was issued.

Progress Update: There have already been some noteworthy improvements. The Mayor and staff report that they are planning more city-based emergency management functions, weighing in on the County's plans for upgraded 911 dispatch software, and reconsidering road closure messaging. In addition, the DPW is implementing technological functions to improve tracking and alignment. New York State is studying their own response to the storm.

Road Conditions

Review of data from a range of sources revealed that:

> *Many drivers still took to the roads, either because they were not aware or underestimated the severity of the situation, leading to accidents that may have been avoided and stranded motorists.*

Although the December 2022 Blizzard Report issued by the Mayor's office documents many attempts by the Communications department, media and other government partners to spread the information regarding the potential impact of the blizzard, many drivers still took to the roads during the travel ban period. Warnings and alerts informed the public that the night of December 22nd would be the last safe time to go out until stated otherwise. Still, travel bans were either poorly communicated or were ignored. Some residents may have chosen to drive despite warnings, while others may have been returning from work because they had left home for work shifts before the travel ban was put into effect.

Traffic data show that individuals were driving before the ban was lifted on December 29.[5] This led to a higher rate of road incidents (a total of 282) and major accidents (a total of 270) during the blizzard period of December 23 to 30, 2022 compared to weeks without storm conditions (see Appendix C).[6,7]

Resource Shortages for Mitigating the Blizzard's Effects

The city's equipment and storage facilities did not meet the needs of this storm, which led to a slower and weaker response. The City's December 2022 Blizzard

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[5] Waze traffic data and INRIX traffic data were obtained through NYSDOT/C2SMART partnership from Statewide Open Source Advanced Traffic Management System (ATMS) Software Research and Pilot and DWICE tool developed by C2SMART under the Coordinated Intelligent Transportation Systems Deployment In New York City (CIDNY) Program and NYU/Waze partnership from Waze Partner Hub.

[6] December 2022 Blizzard Report, p.4

[7] Waze Traffic Data

Report indicates that there were 41 plow trucks and 19 high lifts in Buffalo's DPW.[8] The blizzard ultimately required 600 snow removal vehicles for 52 inches, in large part because the reduced visibility decreased the vehicles' range of activity. For context, the November 2022 storm required 500 snow removal vehicles for 80 inches of snow.[9]

In both cases, additional vehicles and crews were contracted from nearby communities, as local resources were insufficient. Mutual aid assistance is vital during unexpected weather events. However, even with mutual aid assistance, the number of snow removal vehicles was still not sufficient to clear the roads throughout Buffalo for the better part of a week. Mayor Brown recently announced a commitment to purchase more snow removal equipment, as well as a device to move stranded vehicles.[10]

Interviews with the Buffalo Police Department (BPD) and Buffalo Fire Department (BFD) indicated that there were not enough snowmobiles or other all-terrain vehicles to traverse the snow effectively. These interviews indicate that the BPD put out a call for groups of snowmobile owners for assistance. In the case of this storm's severe impact, that lack of snow-agile equipment, such as snowmobiles or all-terrain vehicles, left both the BPD and BFD without the resources they needed. Mayor Brown also recently announced a commitment to purchasing new Fire Department equipment.[11]

In addition, representatives of the Police and Fire departments reported housing stranded residents in Buffalo's police stations and fire houses. However, many were not equipped with cots or meals to provide for these residents.

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[8] December 2022 Blizzard Report, p.6
[9] Ajasa, A. The Washington Post.
[10] *Mayor Byron W. Brown's 2023 State of the City Address*, 2023
[11] *Mayor Byron W. Brown's 2023 State of the City Address*, 2023

Preparedness Challenges

> *The entire overnight shift was dedicated to continuing to work with fire and police, while also rescuing DPW crew stranded in snow in the plow trucks. At this time, all high-lift plows were converted to bucket-high lifts. This adjustment was made because of the height of the snow, bucket-high lifts are used when snow can no longer be plowed but must be scooped and removed from the roadway. High lift trucks have higher axles to operate in greater depths of snowfall and to allow greater maneuverability on narrow city roads." - City of Buffalo December 2022 Blizzard Report*

Despite advanced knowledge about the snow forecast, the city needed to make course corrections to tackle the effects of the storm. Some snow removal crew members had to be rescued themselves, and snow clearing methods had to be adjusted. Interview findings suggest that the city snow plan for this blizzard was not substantially different from that for a typical, standard snow event.

Arrangements for warming centers also did not meet the full need – the number and geographic distribution of warming centers were insufficient. A few facilities lacked working generators, which the city has begun to address since the blizzard. Guidance about timing and methods of transportation to warming centers was unavailable.

Equity Concerns

As noted previously, approximately two-thirds of the city's residents who perished in the blizzard were Black, as were over half of those who died countywide. Yet Black residents make up only 33% of Buffalo's and 14% of Erie County's population.[12,13] According to 2021 American Community Survey (ACS) Estimates, 27.6% of Buffalo residents live in poverty, so many may not have had the financial resources to stockpile food and supplies in advance of the storm. In addition, some

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[12] U.S. Census Bureau, 2022
[13] Samaha, 2023

neighborhoods in Buffalo lack a grocery store within a one-mile radius and are considered food deserts.

While explicit snow plowing priorities may not have varied across the city, (arterials followed by secondary roads), the effect of unplowed streets was felt most strongly in low-income areas. Community leaders claimed that districts with more poor and Black residents were the last to receive plowing services, and shared photos and personal accounts that they viewed as supporting this claim.[14] 311 data revealed that residents on the predominantly-Black East Side of Buffalo called more frequently and over more days to request street plowing than elsewhere in the city.

The highest number of 911 calls came from District E on Buffalo's East Side, and throughout the entire storm, calls from District E had longer response times.

Surmounting Challenges against the Odds

Despite the significant challenges wrought by the blizzard, several aspects of Buffalo's response were remarkably successful and demonstrated resourcefulness and heroic conduct under immense pressure.

Ingenuity in Rescue Operations

Throughout the City of Buffalo, emergency responders showed ingenuity in their rescue operations, finding creative solutions to seemingly insurmountable odds.

Buffalo's workers in the fire and police departments, as well as first responders at the airports, trudged through whiteout conditions, often on foot, to conduct search and rescue operations, and creatively stood up impromptu shelters throughout the city. They housed numerous stranded pedestrians and motorists, and remained at their police stations and fire houses well beyond their assigned shifts. Niagara Frontier

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[14] Sacks, 2022.

Transit Authority (NFTA) workers, who manage the Buffalo Airport, housed 144 people, including 16 staff members, in the airport and the facility's police and fire stations for up to three days. They rescued frozen, stranded motorists, marking their paths through the whiteout conditions using a series of flares. When flares ran out, rescuers used police tape. They were able to feed residents using airport restaurant facilities and supplies, and volunteers assumed cooking responsibilities. They even created a Christmas scene for a stranded family.

The Buffalo Police Department made use of unconventional resources. They employed scuba gear to venture outdoors, as the material is more weather-resistant than typical police apparel. BPD's Chief of Detectives had trained in the military for winter conditions, and used his specialized knowledge to help orchestrate search and rescue operations. The Department expanded their scope to include recovering and storing bodies.

The Buffalo Fire Department (BFD) orchestrated fire response operations despite most of their vehicles becoming stuck in ice and snow at some point during the blizzard. They were able to maintain full staffing at the firehouses due to a well-developed reserve plan, and to transport residents to essential medical services, like dialysis appointments.

DPW coordinated strike teams, leading emergency vehicles behind snow removal equipment so that National Grid, BPD, and BFD could reach essential locations. They coordinated 600 snow removal vehicles with the County and State to get city streets reopened, using newly implemented GPS tools to facilitate tracking and quality management. DPW continues to improve on its operations, exploring new ways to serve the City of Buffalo effectively and efficiently using new technologies and processes.

Finally, all departments transitioned with ease to virtual coordination, greatly benefiting response and rescue operations. Having moved to Microsoft Teams and similar video conferencing tools when the COVID-19 pandemic hit in 2020 allowed for a simplified transition to online coordination. Had this storm occurred in 2019, coordination could have been far more difficult.[15]

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[15] *NFTA Board Meeting*, January 26, 2023.

311 and Public Engagement

Like many cities across the United States, Buffalo manages a 311 phone system, which residents may call for non-emergency city service requests. While most cities use the system to intake requests concerning quality-of-life issues – like trash collection, streetlight outages and rodents – Buffalo's unique approach uses 311 not only for information collection and response, but as a tool for public engagement.

Buffalo 311 has performed significant outreach to residents across the city, especially in "deserts" where the number of calls from residents is lower than expected. The 311 team has developed relationships with block clubs and community organizations, allowing the city to remain aware of ongoing challenges and local needs. The 311 team also runs the city's Operation Clean Sweep Initiative, which goes out into neighborhoods once or twice per week seasonally to solve problems in real-time in order to eliminate blight, provide social services and reduce crime.[16] This innovative program has helped the 311 team establish trust and build relationships.

During the blizzard, the 311 team was able to rely on and activate those community relationships to identify local emergencies and urgent needs. In addition, the 311 team was able to maintain operations by remaining nimble. It equipped operators with remote calling equipment so that nine operators could be online at all times. The operators successfully fielded 4,190 calls during the duration of the storm, primarily concerning downed trees, snow removal needs, and power outages. Without this flexible setup, the call center would not have remained online, limiting residents' access to essential services. In the future, the team aims to mobilize neighborhood-level volunteers to check-in on vulnerable residents, distribute supplies and help as needed.

City of Good Neighbors

Buffalo's moniker, the "City of Good Neighbors," rang true throughout the storm event. Ordinary residents helped stranded motorists, checked on neighbors, and

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[16] *Clean Sweep | Buffalo, NY*

shared food and other necessities. Countless other acts of everyday heroism occurred and highlight the power of neighbors and local businesses helping one another.

● Sha'Kyra Aughtry brought a stranded, frostbitten, developmentally disabled man into her home, seeking medical advice for him by videoconference, and arranging for hospital transport by neighbors when 911 rescue operations were unavailable.[17]

● Jay Withey Jr. broke into a school building to create a temporary shelter for himself and 24 others who had been stranded outdoors or in cars in the frozen conditions. It is likely that he helped save multiple lives.[18]

● Several snowmobile clubs traversed the city delivering food and other necessities to homebound residents.[19]

● Two business owners kept their businesses open to serve as impromptu warming shelters for their communities, helping people who needed shelter, food, and a place to charge their phones and get information. Another business opened its doors for emergency personnel to eat, warm up, and regroup during recovery operations.[20]

● Members of Buffalo's African American and Bangladeshi communities collaborated to provide food, shelter and wellness checks to hundreds of individuals.[21]

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[17] Becker , 2022
[18] Epstein, 2022
[19] Tsujimoto, 2023
[20] Personal communications, March 2023
[21] Eure, 2022

Recommendations and Proposed Solutions

As Buffalo continues to rebuild businesses and repair damage from the blizzard of December 2022, a generational storm that may or may not recur at that scale again soon, the city must still prepare for the coming storm season.

To help guide the city's efforts to enhance storm response and recovery capacities, the research team identified wide-ranging improvements for consideration by Mayor Brown and other officials. To minimize the risk of loss of life, injury, and damage, we prioritized five strategies for change:
- Bolstering physical assets for greater efficiency, protection and nimble operations
- Aligning coordination among government agencies and private and non-profit partners
- Maximizing the use of data and technology for heightened situational awareness, partner coordination and more efficient emergency response procedures
- Creating and maintaining clear and consistent public communications
- Addressing systemic challenges that hinder resilience, including racially-skewed impacts and mobility-linked hindrances

In this section, we present recommendations and a roadmap with specific steps and solutions, which are intended to help Buffalo prepare and recover after future storms, and should be incorporated into disaster plans going forward. Many of the proposed actions are applicable to all hazards, not just blizzards. Additional recommendations specific to transportation problems, business community needs, and improving communication are summarized below and discussed in greater detail in Appendices C to H.

We make recommendations for improving preparation, but we recognize that since resources are limited, appropriate planning must balance the costs and benefits of all preparedness actions in light of the probability that they will be needed. We do not undertake any such balancing of costs and benefits in this report.

The December blizzard, which hit Buffalo the hardest in the region, cost the city $10.2 million in operations and recovery.[22] In order to accomplish several of the

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[22] Plants, 2023

recommendations below, Buffalo will need to partner with regional, state, federal and private sector entities to acquire resources.

The research team used an emergency preparedness cycle (see Figure 1) to organize recommendations and categorize them into timeframes.[23] Some of the recommendations can be enacted as soon as the next storm season (Winter 2023-24). Others are larger systemic changes aimed at upgrading preparation and recovery in the long term:

- **Prevention:** Steps taken well before the storm season (We are here)
- **Protection**: Specific planning in the days leading up to an expected storm
- **Response:** Actions taken during and immediately following the storm
- **Recovery:** Rebuilding in the days and weeks following the storm
- **Resilience:** Planning for long-term, systemic changes

Currently, Buffalo is in the "Prevention stage" of the preparedness cycle.

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[23] The framing of this section is based on the work of crisis management expert Juliette Kayyem.

Resilience
Planning for long-term, systemic changes

Prevention
Steps taken before the storm season

Buffalo Blizzard Preparedness and Response

Protection
Days leading up to storm

Recovery
Days and weeks following the blizzard

Response
During and immediately following the storm

Figure 1. Emergency preparedness cycle

WHAT TO START NOW

What are the most crucial priorities for the City of Buffalo to undertake as soon as possible? Here are the top five, which are explained in more detail below.

1. Secure remaining funding for new Department of Public Works facility, and begin construction.
2. Identify at least one warming shelter per council district, and develop a plan for equipping, staffing and communicating.
3. Invest in print, digital and in-person marketing to expand enrollment in BUFFALERT.
4. Develop an extreme event plan for large snow events where transportation is unavailable.
5. Develop a plan to upgrade aging East Side housing stock and continue to secure funding.

Prevention of loss of life and property

To bolster its systems, the city should consider implementing the following steps in advance of the 2023-2024 winter season:

- Planning
  - Develop and maintain an extreme event management plan, beyond the existing snow plan, along with an active training/retraining program.
    - Buffalo would benefit from an all-hazards approach to emergency preparedness, using lessons from this storm to improve communications and coordination in unrelated emergency situations.
  - Conduct tabletop exercises that include scenarios where transportation is severely restricted, or entirely unavailable, for a substantial period of time.
  - Shape a fundamental policy that focuses on what level of risk is tolerable under extreme events, to be used to prioritize snow removal routes and access to conduct electrical substation repairs.
- Asset Management
  - Secure the funding for the new Department of Public Works campus, and begin construction. This is an essential ingredient to respond effectively to both storms and everyday needs in a coordinated effort. (The City has recently secured $10 million from New York State.)
  - Secure funding for and purchase all-terrain emergency vehicles, to be used for navigation in high snow and ambulance functions, and develop a plan for replacing old apparatus on a regular cycle. (Already in progress[24,25])
  - Establish and fully staff a Traffic Management Center that can be used for both everyday operations and extreme event situations.
  - Conduct regular review of generators and supplies at city facilities.
  - Implement an asset tracking system for physical and workforce resources (from Department of Public Works, National Grid, Police, Fire and others), both within and outside Buffalo.

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[24] Tan & Williams, 2023

[25] Department of Administration, Finance, Policy and Urban Affairs and Division of Budget and Management

- Communications
  - Expand the reach of BUFFALERT to ensure that emergency notifications reach a majority of Buffalonians, and align with FEMA's emergency alert push notification program through New York State.
    - Coordinate with Erie County's ReadyErie Preparedness app for resident information and two-way communications during emergencies.
  - Establish communications outreach subcategories for specialized official notifications, including small business owners and healthcare professionals.
- Community Engagement
  - Strengthen the network among residents, community groups, and government resources for partnership during both extreme events and everyday needs.
  - Proactively partner with community-based organizations to assist with communications and outreach efforts, especially communicating essential information in multiple languages.
  - Provide emergency response training to community groups, tapping into New York State's Citizen Preparedness Corps and FEMA programs.
  - Partner with refugee service agencies to develop culturally-responsive materials for preparing for and responding to emergencies.
- Data and Technology
  - Work with Erie County to optimize their new 911 CAD system for Buffalo's emergency responders' needs. (Already underway)
    - Research new technologies for Buffalo's first responders to integrate with the County's 911 dispatch system to streamline calls and responses. (Already underway)
  - Adopt data-driven approaches for decision-making, especially pertaining to snow removal patterns and asset tracking.
- Coordination
  - Bolster an Emergency Operations Center within the City of Buffalo to assist in inter-departmental efforts, situational awareness and tracking.
  - Establish a new full-time Emergency Manager role for the City to coordinate assets and workforce resources. (Already underway)
  - Provide guidance on what constitutes "essential workers" for different emergency categories to guide local businesses on avoiding unnecessary employee travel.
  - Continue to establish mutual aid request procedures among Buffalo and surrounding areas.

Protection: Putting plans, systems, assets, and workforce into position

When a large storm is predicted, we recommend that Buffalo take these steps to protect residents, infrastructure and property in the days and hours prior to the event.

- Planning:
  - Establish a "trigger event," such as rate of snowfall per hour or wind chill factor, to set emergency plans into motion, including coordinated public notifications, pre-positioning equipment and requesting mutual aid.
- Asset Management:
  - Pre-position snowplows, drivers, emergency vehicles, and other relevant equipment in protected parking locations throughout the city.
  - Identify warming shelters throughout the City, particularly buildings with independent power – including schools, churches, and hospitals.
    - Develop an emergency plan with each warming shelter, particularly in terms of opening hours, means of transportation to the shelter, stockpiles of food and supplies, staffing, security and the assured availability of backup power.
      - Ensure warming centers are available particularly in neighborhoods with a higher risk of power outages.
    - Consider partnering with private sector mobility providers, who can offer transportation to warming shelters for residents in need.
  - Ensure National Grid has taken steps to protect power substations with concrete blankets and pre-positioned heating equipment.
    - Plan for snow removal paths to substations to ensure minimal power disruptions.
  - Promote and maintain flexibility in the deployment of equipment and workforce resources to confront uncertainties.
  - Prepare firehouses and police stations for the expectation that emergency workers will be stranded, equipping them with food, supplies, cots, blankets, and fuel in generators.
- Communications:

- Establish a "battle rhythm," where warnings and information are communicated to the public on a regular basis, such as twice daily, with supplemental updates as needed.
- Coordinate public communications plans among City, County and State entities, as well as utilities, to ensure uniform messaging.
- Convey the potential dangers of the storm, using all available traditional and media channels and physical signage in popular areas, and actionable language.
- Announce travel bans (for cars and pedestrians) several hours in advance of their implementation, in coordination with Erie County and New York State.
- Continue marketing DPW's new parking regulations social media accounts to ensure wide reach, to help mitigate the challenge of parked vehicles blocking access for plows or emergency vehicles.
- Clearly communicate safe times and means to travel to the warming shelters.
- Community Engagement:
  - Mobilize senior services providers, as well as services for other vulnerable populations, to develop and maintain contact with elderly, housebound, and disabled individuals.
  - Distribute storm boxes with food and emergency supplies at neighborhood community centers.
- Data and Technology:
  - Use technology to share status information, improving situational awareness of first responders, dispatchers, and 311 operators.
  - Collect and share machine-readable data between government agencies that will improve situational awareness of weather data and transportation resources during and after the extreme weather event.
    - Organize the National Weather Service and other weather information into actionable data to define the severity and trajectory of the storm for decision-making.
  - Use a continuous asset tracking system to prioritize response and manage ongoing challenges and activities. In particular, use GIS to monitor activities like plows and rescue operations, and sharing information between departments.
- Coordination:
  - Coordinate with the County and State to finalize the plan for declaration and timing of the travel ban.

- Identify the staffing plan for the Emergency Operations Center within Buffalo.
    - Provide a clear decision-making tree with requirements for digital and verbal coordination with state, regional, and municipal offices, and update annually.
    - Clarify and/or practice roles and responsibilities for Buffalo's Emergency Operations Center, including protocols for clearing, orienting, and introducing representatives as they arrive.
- Coordinate with New York State National Guard to optimize positioning of employees and equipment.
- Establish clear protocols for videoconferencing to promote coordination and communication.

Response: Prioritizing search and recovery efforts, and containing physical damage, during and immediately after the storm

After the storm has begun, the City must take steps to locate and rescue individuals who need assistance, assist in recovering power outages, and continue regular communications with the public.

- Communications:
    - Public communications should follow a "battle rhythm" - that is, announcements from City Hall should occur at regular intervals, so the public knows when to expect more information and how to access it.
        - Information should be posted throughout traditional media, social media, and physical signage in populated areas.
        - Information should be presented in multiple languages, including American Sign Language for videos.
    - Expand the City's social media presence to provide information and counter misinformation.
    - Maintain publicly-accessible traffic cameras trained on popular locations and intersections, for a basis of familiarity, to help residents comprehend the extent of the storm conditions.
    - Clarify public information about snow plow routes, particularly which routes are being prioritized and for what reasons, to help residents

know when to expect their streets to be cleared, especially if the storm requires the city to change course.

- ○ Ensure communications reach the City's most vulnerable residents and address their needs, tapping into neighborhood networks and physical signage.
- Community Engagement:
    - ○ Develop a feedback loop between community groups and the City to help ensure City Hall's situational awareness - in other words, knowledge of ongoing issues throughout the city - as well as to support community groups' ability to assist neighbors in need. This could be built upon the existing relationships between these groups and 311.
- Coordination:
    - ○ Directly incorporate interconnections between electric power repairs and other activities, such as city facilities that rely on National Grid's power system.
    - ○ Prioritize snow removal on public transportation routes following the storm, especially on routes serving grocery stores and food pantries.

Recovery: In the days and weeks following the storm, focus on repairing damage and seeking financial assistance for costs incurred.

- Communications:
    - ○ Share information with residents and business owners about reimbursement programs for financial losses incurred as a result of lost wages, power outages, and business interruptions.
- Community Engagement:
    - ○ Lean in to Buffalo's "good neighbor" network to assess community status and needs.
    - ○ Equip neighborhood hubs with resources and information to distribute for community assistance in the aftermath of the storm.

Resiliency: Once the storm and its impacts have passed, Buffalo has an opportunity to address large-scale challenges.

To counter large-scale challenges that exacerbated the impacts of the December blizzard, the City of Buffalo should take the following steps:

- Evaluate aging housing stock and develop a plan to revitalize outdated infrastructure to help ensure that residents remain warm, with the assistance of County, State and private sector investments.
- Abandoned cars, stranded motorists, and blocked roadways were all symptoms of Buffalonians' reliance on cars. The City and State should collaborate to expand the transit system's reach, as buses can more easily traverse snowy streets than typical passenger vehicles.

The State of New York should take the following steps:
- Coordinate with the County to determine decision-making controls for road closures for the region, based on storm conditions and ability to provide mutual aid.
- Appoint City-nominated members to the Niagara Frontier Transportation Authority, which is state-run, to advance cooperation. Limiting the city's access to decision-making at NFTA hinders coordination between the city and its transit operator.
- Study and implement statewide maintenance decision support systems (MDSS), which are computer-based, customizable tools that provide winter maintenance personnel with route-specific weather forecast information and treatment recommendations, allowing for reduced resource requirements (see Appendix C).
- Acknowledge the individuals who died in the blizzard with a Day of Remembrance, to serve as closure to the community.

The federal government, specifically FEMA, should reconsider its eligibility guidelines for funding generators. During storms in which power outages cause dangerously cold conditions, generators provide life-saving power at non-traditional facilities, including warming shelters.

In addition, FEMA provides essential notification systems through push notifications to mobile phones based on location. While this service is key to ensuring safety messaging is released, the system is limited to 360 characters, two languages, and only text. The Federal Communications Commission is currently proposing improvements to these challenges.[26]

Conclusion

The Buffalo Blizzard was a ferocious storm with devastating effects. Although every disaster presents unexpected scenarios, Mayor Byron Brown recognized early that the city's response to this storm should be studied and improved. Our report aims to help the city move forward and make meaningful progress. Its recommendations should help place Buffalo in a better position to prepare, respond, and recover from major storms ahead.

While this report has pinpointed several areas for improvement, Buffalo is truly "the city of good neighbors." It is clear that Buffalonians take care of one another, taking in strangers, checking on their community members, and aiding anyone in need. The City should lean into those strong relationships as a way to lift up all communities during and after disasters. In future crises, these neighborhood networks are a key asset to helping residents stay safe, healthy, and connected.

[26]Federal Communications Commission, 2023

Summary of Topic-Specific Recommendations

Addressing Transportation-Related Problems

Based on the research team's experience and knowledge of projects that have deployed intelligent transportation system (ITS) technologies, we recommend four strategies for consideration. Example solutions and best practices for each of these strategies are discussed in Appendix C.

1. **Convey the importance of not driving and the potential impact of traveling during the storm** before it makes landing.
2. **Improve the city's DPW facilities, snow removal and emergency fleets**, and provide additional funding to consolidate operations such as snow removal, emergency response, and DPW functions.
3. **Adopt data-driven approaches for decision-making** at every stage of traffic management in response to major weather events.
4. **Use automated systems** to improve the cost-effectiveness of weather-responsive traffic management and reduce safety risks during operations. These systems can lessen traveler delay and labor costs, and improve resource allocation.

Supporting the Business Community

Buffalo's Small Business Development Center (SBDC), which spearheads local business initiatives, should be equipped to assist small businesses with disaster preparation and recovery. Further discussion is found in Appendix D.

1. **Provide employers with clear guidance in disasters**. Businesses in Buffalo, both large and small, deserve clear information from the City and County to make the best decisions possible for the safety of their employees and the continuity of their businesses. Employers should be informed through an emergency alert system that provides clear guidelines for closure expectations, and warnings about driving bans and potential state of emergency. This could be an additional notification sent

through BUFFALERT, with the creation of a business-specific sub-category in the notification system.

2. **Develop clear definitions for emergency, essential, and non-essential personnel.** Revisiting previous guidelines for the COVID-19 pandemic concerning essential and non-essential employees, the City and County should develop clear definitions for what that distinction means in different emergency scenarios (i.e. pandemic versus weather events). A clearer, event-based definition can help employers and businesses make safer choices and better prepare for an emergency.

3. **Create an information line for employers.** Business information lines should provide information about accessing funds for the small business loans that can cover the costs or losses incurred during a disaster event. Reassuring business owners before, during, and after a disaster event will help alleviate the pressure to call employees in during hazardous conditions.

4. **Provide support to businesses and organizations to create their own emergency plans**. Interviews with local businesses and organizations showed that many do not have emergency plans in place. The City and County have an opportunity to support employers in creating these emergency plans, and to coordinate their efforts with those of the City's new emergency manager and the County's Emergency Operations Center (EOC). This effort could start with pointing businesses towards existing resources (such as the SBA)[27] or guiding non-profits to literature on developing emergency plans. These plans should include expectations for preparing for emergencies and caring for essential employees during them – including stocking emergency supplies such as food, water, blankets, and flashlights if employees need to stay overnight or for several days.

Improving Power Infrastructure Performance

Although power infrastructure is managed by National Grid, and not the City of Buffalo, the City allocated resources during the blizzard to help National Grid reach impacted infrastructure, as up to 20,000 customers found themselves without power, including several key City facilities.

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[27] United States Small Business Administration, n.d.

1. **Directly incorporate interconnections between electric power and other utilities and operations into planning** to account for needs in intersectional areas, including communications, transportation and key facilities.
2. **Shape a fundamental policy to incorporate the planning, design, operation, and maintenance of electric power in the context of Buffalo's other needs**, with a focus on what level of risk is tolerable under extreme events.
3. **Work with National Grid to develop plans to use innovative power distribution system design for protection**, which can control how power lines fall to reduce the impact. This approach involves having failures occur at specific points to prevent them spreading to adjacent poles, causing cascading effects.

Further analysis and recommendations are found in Appendix E.

Improving Communications

The City of Buffalo's communications played a large role in how the public experienced the December 2022 blizzard. To promote better outcomes in the future, the city and its agencies should:

1. **Communicate early and frequently, providing supplemental updates regularly.** During a weather event, city officials should provide frequent regular updates, information, and guidance throughout the day on all public platforms. Moreover, they should include a note about when to expect updated information.
2. **Messaging should be comprehensive and tailored to the city's demographics, needs, and concerns**. Terms that have decision-making significance should be clearly defined, including "essential worker" and weather-related terminology, so that residents understand and become familiar with how to respond.
3. **The City should more thoroughly coordinate communications plans with Erie County and NY State agencies, especially about transportation-related guidelines or mandates such as travel bans**. Messaging should be consistent and distributed in a timely manner.
4. **Communications should reach and address the needs of the most vulnerable residents**. Methods and messaging should be tailored to reach vulnerable audiences, including home-bound seniors, residents who rely on public transit, and paratransit users, who are largely left out by communications that focus on drivers.

5. **Expand City social media presence, well before storm events, to provide information and counter misinformation**. On all platforms, the City should regularly deploy easy-to-digest information in addition to full-length videos of press events.

6. **Use technology to improve emergency response capacity and transparency.** The BPD dispatch system should be improved in collaboration with Erie County to avoid duplicative calls (already underway at the Buffalo Police Department). Increase the transparency of the city's response efforts by providing live information to the public using the Open Data portal.

7. **Expand BUFFALERT reach, issue more alerts, and consider other notification systems.** The city should invest in print, digital and in-person marketing year-round to expand enrollment in BUFFALERT, and use carrier-based emergency notifications that do not require opting in by obtaining certification from New York State to utilize FEMA's Wireless Emergency Alert system with Erie County (already an approved alerting authority).[28] In addition, Buffalo's public-facing announcements, as well as 311 operators, should point residents to BUFFALERT as the verified source of up-to-date information to ensure consistent messaging.

8. **Proactively partner with community-based organizations to assist with communications**. Throughout the year, the City should build connections with existing community organizations that can reach specific groups of residents and match volunteers, resources, and services with those who need them.

Examples of solutions and best practices for these communications strategies are discussed in Appendix F.

Addressing Equity-Based Challenges

Although equity concerns are long-standing and require systematic investments on local, statewide, and national levels, the City of Buffalo can help to alleviate the challenges faced by Buffalo's lowest-income communities:

1. **Provide storm boxes with emergency supplies and food to those who need it in the days prior to the storm.** While it is crucial to continue messaging the need for emergency supplies and extra food, for those who live paycheck to

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[28]Federal Emergency Management Agency, 2023

paycheck, gathering a multi-day supply of necessities just a few days before a storm can be challenging. By providing emergency food distribution and emergency kits to those in need, Buffalo can help people to avoid leaving their homes during the next emergency weather event. Block associations, mutual aid groups, food pantries, and social service providers can work to distribute emergency supplies to reach those most in need or schedule public pick-up events at schools and community centers. The City can partner with the Red Cross or other aid agencies to identify appropriate supplies and with FeedMore WNY to coordinate providing food, as well as seeking emergency assistance from FEMA, New York State, and Erie County.

2. **Prioritize restoring public transportation after a storm, especially routes that serve grocery stores and food pantries.** The city should collaborate with the transit body to prioritize a shuttle service to nearby grocery stores as soon as it is safe to do so, as has been done in past crises.

3. **Make more warming shelters available during weather events in all neighborhoods with known power outages, and develop an emergency plan with each warming shelter.** Community centers, senior centers, faith-based organizations, and schools are all community-based buildings that have the capacity to be turned into warming/cooling centers quickly. Pre-stock non-perishable supplies, including cots, blankets, flashlights, food, and water, in each location that can be safely stored and quickly accessed. Identify locations in advance and ensure that each one has staff, security, transportation to the center, and a working generator that automatically can kick in if the power goes out. This is something that Buffalo has already begun to implement in subsequent cold weather after the blizzard, and the research team encourages the practice to continue.

Further discussion and recommendations are found in Appendix H.

Appendix A: List of Stakeholder Interviews

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The following individuals and organizations were interviewed as part of this project from January through May, 2023:

1. Mayor Byron Brown
2. Deputy Mayor and Chief of Staff Crystal Rodriguez-Dabney, Esq.
3. Buffalo Fire Department
4. Buffalo Police Department
5. Buffalo Department of Community Services
6. City of Buffalo: 311 & Department of Citizen Services
7. City of Buffalo: Department of Public Works
8. New York State Division of Homeland Security and Emergency Services
9. Jessica Bauer-Walker, ANCHOR coalition
10. Ryan Caughill, Emergency Management Expert
11. Craig Elaston, Barber
12. Colleen Heidinger, 43 North
13. Ken Kujawa, National Grid
14. Mark A. Meyerhofer, Charter Communications
15. Karen Andolina Scott, Journey's End Refugee Services
16. Dawn Vanderkooi, 211 WNY
17. Vincent Ventresca, Local 282 Firefighters Union

Some additional interviews were conducted off the record.

Appendix B: Timeline of Events

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How and when roads, transit, airport, power, communications, sanitation, and sewers were affected.

Figure 2. Storm Timeline:

12/22 — NWS Buffalo predicted a "once-in-a-generation storm"

12/23 — Snow: 22.3", a daily record / Wind speeds up to 45 mph / Temperature: Low of 5°F / Visibility: near zero beginning around 9:00 a.m.

12/24 — Snow: 52" / Snowdrifts up to 15 feet / Winds: Speeds up to 38 mph / Temperature: Low of 4°F / Visibility: Near zero - whiteout conditions

12/25 — Storm shifted south / Snow: 8-12 inches / Winds: Speeds up to 28 mph / Temperature: Low of 15°F / Visibility began to clear at 1:00 a.m

12/26 — Snow: Several inches / Winds: Speeds up to 20 mph and gusts up to 25 mph / Temperature: Low of 15°F

Monday, December 19, 2022

- National Weather Service (NWS) Buffalo predicted a major storm beginning Thursday and occurring through the holiday weekend.
- Mayor Byron Brown's office continued storm preparation talks that had begun the week prior, coordinating with city departments as well as county and state partners.

Tuesday, December 20, 2022

- NWS Buffalo honed its predictions for the storm, anticipating "very strong winds" and "near zero visibility," and issued a Winter Storm Watch and a High Wind Watch.

- The Buffalo Department of Public Works (DPW) met to discuss storm preparation plans.
- National Grid updated Erie County officials with their preparations, including securing additional field crews and distributing dry ice (for refrigeration during power outages).

Wednesday, December 21, 2022

- NWS Buffalo predicted a "once-in-a-generation storm" starting Thursday night during a WGRZ (Channel 2) interview. This is announced on other mainstream local (Buffalo News, WIVB, WKBW) and national (Fox News, CNN, CBS, etc.) news outlets.
- The city announced a Winter Storm Watch on the Mayor's Facebook and Twitter accounts, encouraging residents to finish errands by 12/22. Waterfront park closings were also announced.
- Division of Community Services (DCS) announced on Facebook that garbage and recycling pickup would be suspended beginning on 12/23.
- Buffalo DPW met to discuss storm preparation plans.

Thursday, December 22, 2022

- Weather Events:
  - Precipitation began.
- NWS Buffalo upgraded its Winter Storm Watch to a Blizzard Warning for the Buffalo metro area and nearby counties.[29]
- 12:30 p.m.: Mayor Brown held a press conference about the impending storm, in which he declared a State of Emergency beginning 12/23 at 7:00 a.m.
  - A State of Emergency does not include a County-declared travel ban.
  - Mayor Brown also announced that garbage and recycling would be suspended beginning on 12/23.
- 4:30 - 6:00 p.m.: Niagara Frontier Transportation Authority (NFTA) announced via its website, social media accounts, and news media that Buffalo Metro services will be suspended starting 2:00 a.m. on December 23.
- 8:15 p.m.: Erie County Commissioner Mark Poloncarz announced a travel advisory (recommending against but not banning driving).
- Throughout the day:
  - The Buffalo Sewer Authority prepared in the days before the storm by stocking treatment chemicals to the maximum and communicating to

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[29] The original version of this report had incorrectly stated "NWS Buffalo upgraded its Winter Storm Watch to a Blizzard Watch," and has been corrected to Blizzard Warning (June 12, 2023).

waste hauling companies to pause hauling from island treatment plans during the storm.
- ○ Governor Hochul announced a full commercial travel ban on routes overseen by NY State Department of Transportation (NYSDOT), including I-190 or Route 400, as well as a commercial vehicle ban on I-90 (Thruway), beginning at 6 a.m. on Dec. 23. Utilities had exemptions from travel bans in order to manage their facilities.

Friday, December 23, 2022

- Weather Events:
  - ○ Snow: 22.3 inches at Buffalo Airport, a daily record.
  - ○ Wind: Speeds up to 45 mph and gusts up to 69 mph.
  - ○ Temperature: Low of 5°F.
  - ○ Visibility: Near zero beginning around 9:00 a.m.
- 2:00/5:00 a.m.: NFTA Buffalo Metro services (rail, bus, paratransit) suspended.[30]
  - ○ Volunteer personnel stage for community and facility support.
- 5:00 a.m.: Pre-salting by DPW began.
- 6:00 a.m.: State routes overseen by NYSDOT (e.g. I-190, Route 400) closed, though gates remained open until 9 a.m.
  - ○ I-90 (State Thruway) closed to commercial traffic at the same time.
- 7:00 a.m.: State of Emergency declared by Erie County Commissioner.
- 7:00 a.m.: Travel advisory in effect in Erie County.
- 7:00 a.m.: Emergency Operations Center (EOC) activated.
- 8:00 a.m.: Snow began as temperatures fell below freezing.
- 8:40 a.m.: NFTA reported blizzard conditions at Buffalo Airport (BUF).
- 8:37 a.m.: Blizzard Warning announced via BUFFALERT, the city's emergency alert system.
- 8:45 a.m.: Erie County travel ban announced by Commissioner Poloncarz and communicated on social media and local news, including WKBW.
- 8:47 a.m.: Blizzard Warning announced via BUFFALERT (second warning).
- 9:00 a.m.: Gates on state routes overseen by NYSDOT (e.g. I-190, Route 400) closed.
- 9:14 a.m.: Buffalo Common Council posted announcements about Erie County travel ban on Facebook and Twitter, mentioning that it applies to Buffalo.
- 9:30 a.m.: Travel ban went into effect in Erie County.

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[30] Announcements on local news and social media gave 2:00 a.m. as the time, while a post-storm presentation by the NFTA stated that 5:00 a.m. was the beginning of the suspension.

- - NFTA closed BUF airfield, lost power to airport garage and field office.
  - DPW began critical plowing when visibility permitted.
  - The travel ban was announced on the Buffalo government website at a later time.
- 9:43 a.m.: DCS announced on Facebook that Buffalo Public Schools would be closed 12/23.
- 9:45 a.m.: Buffalo Common Council posted announcements about the travel ban on Facebook.
- 9:47 a.m.: Buffalo Police Department (BPD) announced the travel ban in Buffalo on Twitter.
- 9:58 a.m.: Travel ban announced via BUFFALERT.
- 10:00 a.m.: 3,177 Buffalo National Grid customers were without power.
- 10:12 a.m.: Travel ban shared by Mayor Brown and by 311 on Facebook.
- 10:15 a.m.: Travel ban shared by DCS on Facebook.
- 10:23 a.m.: Travel ban shared by Mayor Brown on Twitter.
- 11:00 a.m.: Mayor Brown held a Zoom press conference about the storm. NY State began pre-planned assistance of DPW snow plowing on north Erie routes.
- 12:00 p.m.: 3,524 Buffalo National Grid customers were without power.
- 12:38 p.m.: NFTA began rescue operations at airports.
- 1:00 p.m.: 6,280 Buffalo National Grid customers were without power.
- 2:00 p.m.: I-90 (Thruway) closed to non-commercial traffic.
- 3:00 p.m.: Whiteout conditions began in Buffalo, stopping roadway operations.
  - Emergency services were overwhelmed with stranded individuals and motorists.
- 3:00 p.m.: 11,954 Buffalo National Grid customers were without power.
  - Warming Centers at 10 Quincy Street and 10 Ludington Street lost power.
- 4:00 p.m.: 14,312 Buffalo National Grid customers were without power.
- 5:00 p.m.: Mayor Brown held a Zoom press conference about the storm.
- 6:00 p.m.: 20,890 Buffalo National Grid customers were without power.
- 8:00 p.m.: 19,570 Buffalo National Grid customers were without power.
- 10:00 p.m.: 19,934 Buffalo National Grid customers were without power.
- Night: DPW converted high lift plows to bucket high lifts due to snow height.
- "Life and Safety" response plan went into effect for DPW, BPD, and Buffalo Fire Department (BFD), as directed by the Mayor.
  - BPD and BFD conducted rescue missions using DPW equipment.

- ○ DPW high lifts were also used during this period for National Grid power restoration, hospital clearing, Charter/Spectrum communications operations, and FeedMore WNY operations.
- Throughout the day:
  - ○ Emergency shelter in Buffalo Airport opened.
  - ○ Commercial and cargo flights were suspended at Buffalo Airport.
  - ○ BPD triggered their comprehensive emergency management plan.
  - ○ BPD, partnering with DPW, rescued 65 people stuck in the storm using high-lifts before blizzard conditions made operations infeasible.
  - ○ BFD responded to home fires and conducted rescue operations, power restoration, and other missions.
  - ○ Parks & Recreation coordinated with DPW to clear streets/houses of downed trees.
  - ○ DCS housed 65 people from 12/23 to 12/28.
  - ○ Many Buffalo Sewer Authority staff remained on site, some until 12/26, to stay safe and keep facilities in operation. Boiler staff kept the site in operation.

Saturday, December 24, 2022

- Weather Events:
  - ○ Snow: 52 total inches of snow at Buffalo Airport, 2-3 feet of snow in Buffalo metro area with snowdrifts of up to 15 feet.
  - ○ Winds: Speeds up to 38 mph and gusts up to 55 mph.
  - ○ Temperature: Low of 4°F.
  - ○ Visibility: Near zero in Buffalo - whiteout conditions.
- 7:00 a.m.: DPW attempted to keep evacuation routes clear using teams of snow plows.
- 8:00 a.m.: 19,262 Buffalo National Grid customers were without power.
- 10:00 a.m.: 19,352 Buffalo National Grid customers were without power.
- 12:00 p.m.: 19,956 Buffalo National Grid customers were without power.
- 2:00 p.m.: 20,027 Buffalo National Grid customers were without power.
- 4:00 p.m.: 20,096 Buffalo National Grid customers were without power.
- 6:00 p.m.: 20,056 Buffalo National Grid customers were without power.
- 8:00 p.m.: 20,108 Buffalo National Grid customers were without power.
- 10:00 p.m.: 19,835 Buffalo National Grid customers were without power.
- "Life and Safety" response plan remained in effect for DPW, BPD, and BFD.
- Throughout the day:
  - ○ Emergency services were unavailable across parts of Erie County due to inability to drive in zero visibility.

- ○ Power restoration was also halted due to blizzard conditions.
- ○ At least 2 storm-related deaths were confirmed.
- ○ DPW attempted to clear snow where possible, prioritizing primary streets.
- ○ BPD continued emergency operations.
- ○ BFD continued fire response.
- ○ At Buffalo Airport and in the nearby area, rescue personnel have rescued 190 people (including civilians and employees).
  - ■ Includes rescues by Airport Rescue Fire Fighting (ARFF), which set up emergency shelter, and Transit Authority Police Department (TAPD).
- ○ Stranded airport employees moved to the terminal.
- ○ The National Guard deployed in Buffalo, coordinating with BFD.
- ○ TAPD set up shelters at Metropolitan Transportation Center, 1404 Main (TAPD HQ), and Utica Station.
- ○ Division of Community Services housed 74 people at Tosh Collins Center between 12/24 and 12/27.
- ○ Charter Communications (telecommunication services to much of the City of Buffalo) alerted the City that one of its two hubs servicing most of the city was relying on backup power, but that trucks were unable to reach the facility for refueling. Ultimately, National Grid provided the power.

Sunday, December 25, 2022

- Weather Events
  - ○ Storm shifted south.
  - ○ Snow: 8-12 inches.
  - ○ Winds: Speeds up to 28 mph and gusts up to 39 mph.
  - ○ Temperature: Low of 15°F.
  - ○ Visibility: Began to clear at 1:00 a.m. in Buffalo.
- Early morning: DPW deployed equipment to open streets for National Grid to restore power.
- 7:00 a.m.: DPW plowed primary streets to allow National Grid to repair damaged substations. Two DPW contractors worked directly with National Grid.
- 9:00 a.m.: 19,821 Buffalo National Grid customers were without power.
- 11:00 a.m.: 18,782 Buffalo National Grid customers were without power.
- 12:00 p.m.: National Grid began utility restoration in the Buffalo region.
- 1:00 p.m.: 18,912 Buffalo National Grid customers were without power.

- 1:15 p.m.: Niagara Falls Airport (IAG) air traffic control tower and one runway reopened.
- 2:00 p.m.: IAG general aviation flights began arriving.
- 3:00 p.m.: DPW plowed primary streets, including the medical corridor, with 4 teams.
- 3:00 p.m.: 17,083 Buffalo National Grid customers were without power.
- 5:00 p.m.: 15,271 Buffalo National Grid customers were without power.
- 8:00 p.m.: 10,971 Buffalo National Grid customers were without power.
- 10:00 p.m.: NWS Buffalo reduced Erie County Blizzard Warning to Winter Storm Warning.
- "Life and Safety" response plan remained in effect for DPW, BPD, and BFD.
- Throughout the day:
    - BPD continued emergency operations, transport.
    - BFD began resupply, restaffing, and civilian transport missions.
    - Metro rail clean-up efforts began.
    - Snow removal at both airports began.
    - Regulations for parking on side streets remained suspended.

Monday, December 26, 2022

- Weather Events:
    - Snow: Several inches.
    - Winds: Speeds up to 20 mph and gusts up to 25 mph.
    - Temperature: Low of 15°F.
- 12:00 a.m.: 9,302 Buffalo National Grid customers were without power.
- 10:00 a.m.: 9,199 Buffalo National Grid customers were without power.
- 4:00 p.m.: 8,424 Buffalo National Grid customers were without power.
- 7:00 p.m.: 5,143 Buffalo National Grid customers were without power.
- 11:00 p.m.: 4,104 Buffalo National Grid customers were without power.
- "Life and Safety" response plan ended. "Snow Clearing" response plan began for DPW, BPD, and BFD.
    - DPW, BPD, and BFD continued search-and-rescue missions.
    - DPW snow clearing efforts ramped up.
        - DPW was assisted by private contractors, state public and private resources, and county-hired private resources (South Buffalo only).
        - DPW cleared personal vehicles, with the Division of Parking Enforcement, to allow emergency access for equipment and utility crews.
- Throughout the day:

- - Metro staff reported for emergency and recovery services, despite service remaining suspended.
  - DCS opened Delavan Grider Community Center after power was restored. 26 individuals stayed over the following 3 nights.
  - BFD continued EMS missions.
  - IAG restarted commercial air traffic operations.
  - At least 25 storm-related deaths were confirmed by the Erie County Department of Health.

Tuesday, December 27, 2022

- Weather events:
  - Snow: 2-3 inches of snow.
- 8:00 a.m.: 3,922 Buffalo National Grid customers were without power.
- 12:00 p.m.: NFTA resumed limited Metro service (11 bus routes and Metro Rail).
  - One to two vehicles on each bus route.
  - Bus supervisors inspected routes to determine if service is operable.
- 8:00 p.m.: 968 Buffalo National Grid customers were without power.
- 10:00 p.m.: 485 Buffalo National Grid customers were without power.
- Throughout the day:
  - "Snow Clearing" response plan was in effect for DPW, BPD, and BFD.
  - BPD received and responded to over 2,296 calls since 12/23
    - Most were welfare checks or stranded motorist calls.
    - Others included rescue calls or reports of abandoned vehicles or deaths.
    - Anti-Looting Task Force announced they had arrested 10 people.
      - The tally later reached 22 people as investigations proceeded.
  - BFD assisted with moving people and resources to shelters.

Wednesday, December 28, 2022

- 8:00 a.m.: 491 Buffalo National Grid customers were without power.
- 12:00 p.m.: 700 Buffalo National Grid customers were without power.
  - Increase in outages was due to NG de-energizing some locations for safe repair
- 3:00 p.m.: 526 Buffalo National Grid customers were without power.
- 5:00 p.m.: 117 Buffalo National Grid customers were without power.
- 6:00 p.m.: 59 Buffalo National Grid customers were without power.
- 8:00 p.m.: 4 Buffalo National Grid customers were without power.

- 11:30 p.m.: Power was fully restored in the Buffalo region for National Grid customers.
- "Snow Clearing" response plan in effect for DPW, BPD, and BFD.
  - By end of day, DPW had taken at least one pass at clearing every city street.
- Throughout the day:
  - Death toll of storm confirmed to be at least 37 people.
  - BFD responded to 11 structural fires and continued support for National Grid.

Thursday, December 29, 2022

- 12:01 a.m.: Travel ban was lifted and replaced with travel advisory.
- 11:00 a.m.: Buffalo Airport airfield reopened; commercial and cargo flights resumed gradually.
- Throughout the day:
  - "Snow Clearing" response plan in effect for DPW, BPD, and BFD.
  - NFTA paratransit service resumed.
  - City Hall reopened.

Friday, December 30, 2022

- 12:00 p.m.: NFTA resumed regular Metro service, with some detours.
- Throughout the day:
  - "Snow Clearing" response plan in effect for DPW, BPD, and BFD.
    - Division of Parking Enforcement had towed 324 vehicles since the beginning of the storm as of this date, many of which were blocking access to utilities or preventing clearance.
  - Garbage pickup resumed.
  - Local chapter of the American Red Cross distributed shovels, gloves, bottled water, and other supplies to volunteers and residents in need.

Monday, January 2, 2023

- Parking regulations on side streets resumed.
- Recycling pickup resumed.

January 19, 2023

- 47 people in Western New York are confirmed to have died in the storm.

January 27, 2023

- National Grid submitted its required ScoreCard to the New York State Public Service Commission.

February 27, 2023

- National Grid submitted its storm report, an after-action report to the New York State Public Service Commission.

Appendix C: Challenges on Buffalo's Roads

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Although the December 2022 Blizzard Report issued by the Mayor's office documents many attempts by the Communications department, media, and other government partners to spread the information regarding the potential impact of the blizzard, many drivers still took to the roads during the travel ban period. Warnings and alerts by the Mayor's Office informed the public that the night of December 22nd would be the last safe time to go out until stated otherwise. Still, travel bans were either poorly communicated or were ignored. Some residents may have chosen to drive despite warnings, while others may have been returning from work because they had left home for work shifts before the travel ban was put into effect.

Analysis

Continued Driving Activities During Travel Ban:

The following table contains all the incidents recorded in the Waze traffic data from Erie County during the winter storm period, which is designated in the December 2022 Blizzard Report as being between December 23-30.[31] The Waze data contains crowdsourced information specifying attributes such as the location, type and duration of the alerts/incidents. The data has been filtered for Erie County and separated into single-day instances to observe how the incidents were spread during the storm period.

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[31] Office of the Mayor of Buffalo, 2023, p.4

Table 1: Daily Distribution of Incidents for the Storm Period in Erie County Between 23-30 December[32]

	23-Dec	24-Dec	25-Dec	26-Dec	27-Dec	28-Dec	29-Dec	30-Dec	Total
Animal Struck	0	0	0	0	0	1	2	2	5
Collision	6	0	0	3	4	9	7	8	37
Disabled Vehicle	2	2	9	10	13	15	19	17	87
Flood	1	0	0	0	1	0	0	3	5
Foggy Conditions	6	0	0	0	0	0	0	0	6
Icy Conditions	3	0	0	3	4	0	0	1	11
Incident	19	0	1	1	1	4	2	8	36
Obstructions	8	0	0	0	3	14	21	16	62
Traffic Signal Not Working	0	0	0	0	2	1	4	0	7
Weather Condition	3	0	2	0	1	8	3	9	26
Grand Total	**48**	**2**	**12**	**17**	**29**	**52**	**58**	**64**	**282**

The Waze incident data indicates that there were newly disabled vehicles reported on the Waze traffic report every day of the storm period. The daily distribution of these incidents is shown in the figure below. The green area represents the city of Buffalo, the surrounding borders represent Erie County, and the points represent the location in which the individual Waze incident was recorded.

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[32] Waze, 2023

Figure 3: Daily Distribution of Traffic Incidents on (a) December 23, 2022, (b) December 24, 2022, (c) December 25, 2022, (d) December 26, 2022, (e) December 27, 2022, (f) December 28, 2022, (g) December 29, 2022, (h) December 30, 2022[33]
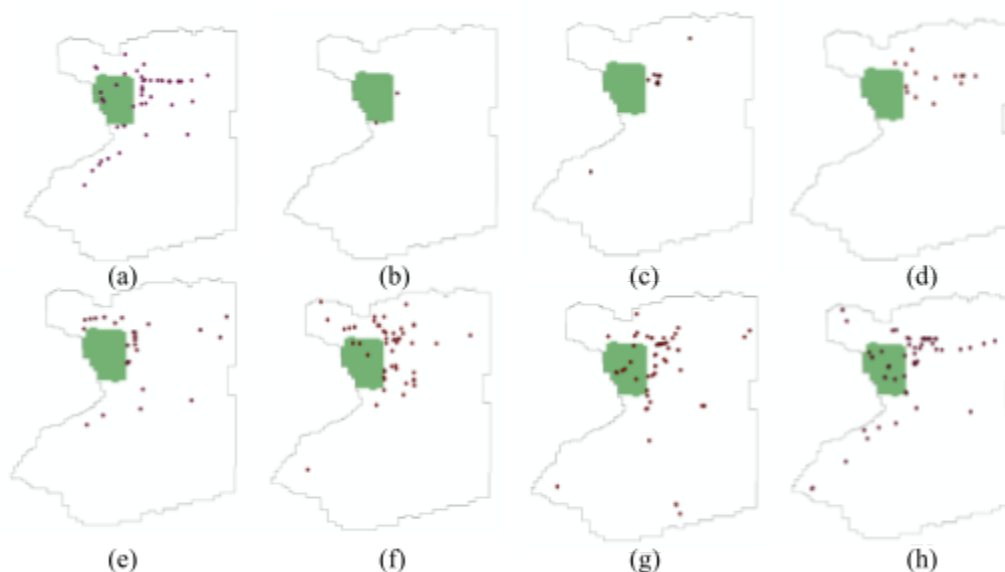
The Waze data suggests that there were still people driving despite the driving ban in place in Buffalo and Erie County, which was lifted on December 29th, leading to a higher rate of major accidents during the blizzard period compared to weeks without storm conditions. While the decrease in the total number of incidents is due to lower traffic volumes during the storm, the major accident rate increased compared to other time periods without blizzard conditions. It should be noted that the major/minor accident categories are predefined on the Waze data under the Agency-specific Subtype column. The increase in the rate of major accidents during the storm period has also been displayed in the table below:

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[33] Waze, 2023

Table 2: Major/Minor Accident Distribution Per 1000 Accidents Recorded in Erie County[34]

Dates:	23-30 Dec (Blizzard dates)	9-16 Dec	6-13 Jan	13-20 Jan	20-27 Jan	23-30 Jan
Accident Major	270	175	197	180	193	137
Accident Minor	730	825	803	820	807	863
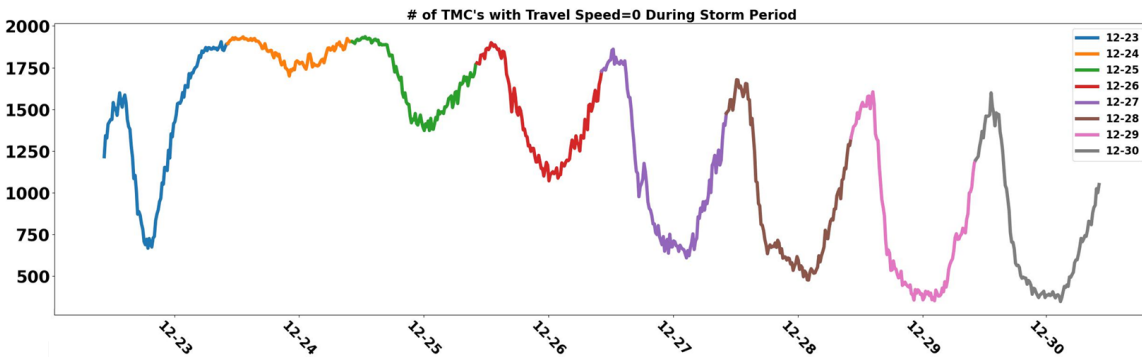
Figure 4: Daily Distribution of Number of TMCs with Travel Speed Equal to Zero[35]

Furthermore, the analysis of the INRIX traffic data suggests that after the institution of the driving ban, there was a significant increase in the number of Traffic Message Channels (TMCs) that recorded the aggregate travel speed as zero, indicating that the initial reaction from the public was to avoid going out. It is worth mentioning that INRIX uses probe vehicles to calculate aggregated link travel times, where each link is referred to as a TMC. Thus, when a TMC travel time is recorded as zero, it is safe to assume that there were no probe vehicles in traffic, which can be an indication of few or no vehicles traveling. However, after December 24th, the TMCs that record non-zero travel speed gradually started decreasing, implying that people had started using their vehicles even though the driving ban was not lifted until December 29th.

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[34] Waze, 2023
[35] INRIX, 2023

As a result, although there were warnings and alerts by the Mayor's Office, media and government partners informing the public that the night of December 22nd would be the last safe time to go out until stated otherwise, the messages were not communicated effectively, or were ignored. This is evidenced by the results shared above, leading to some people getting stranded in their disabled vehicles because of the storm conditions, and having a higher risk of getting into a major traffic accident. In addition, some residents may have chosen to drive despite warnings, while others may have been returning from work because they may have departed for work shifts before the travel ban was put into effect.

Insufficiency of Resources to Mitigate the Effects of the Blizzard:

Another problem identified from the review of background documents about the storm was the city not having the needed resources to mitigate the effects of the blizzard. This impaired its response to the storm. The December 2022 Blizzard Report indicates that there were 41 plow trucks and 19 high lifts in Buffalo's Department of Public Works (DPW), which was insufficient when it came to dealing with the size of this blizzard and its widespread impact.[36] For context, the November 2022 storm required 500 snow removal vehicles for 80 inches of snow.[37] The December blizzard, on the other hand, required 600 snow removal vehicles for 52 inches, in large part because the reduced visibility decreased the vehicles' range of activity. In both cases, the vehicles and crews needed to be contracted from nearby communities, as local resources were fully tapped; even with mutual aid assistance, the number of snow removal vehicles was still not sufficient to clear the roads throughout Buffalo. In addition, Buffalo's narrower streets present challenges to large snow removal equipment.

The interviews with the Buffalo Police Department (BPD) and Buffalo Fire Department (BFD) imply that there were not enough snowmobiles or other all-terrain vehicles to traverse the snow effectively. These interviews indicate that the BPD put out a call for groups of snowmobile owners, and they go on to say that they feel the state doesn't consider snowmobiles to be an important investment, as they will only be useful two weeks out of the year.[38] In the case of this storm's severe

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[36] Office of the Mayor of Buffalo, 2023, p.6
[37] Ajasa, 2022
[38] Buffalo Police Department, personal communication, p.7

impact, that lack of snow-agile equipment, such as snowmobiles or all-terrain vehicles, left both the BPD and BFD without the resources they needed.

The 311 data, which contains information about the reported fallen trees and snowplow requests, was also analyzed by the NYU team. The analysis indicates that there was an abnormally high volume of snowplow requests and an increased number of fallen tree reports via 311 during the period of the blizzard. Even though this is to be expected, the 311 data indicates that the average times to resolve the snowplow requests took approximately 1.8 times longer compared to the rest of the requests made in December 2022, and 3.6 times longer compared to January 2023's 311 reports. Similarly, the 311 data indicates that for fallen tree reports, it took approximately 4 times longer to resolve the 311 reports during the storm period compared to the rest of the reports in December 2022 and 3 times longer compared to the reports in January 2023. Although some increase in these times is to be expected because of the harsh conditions, the time it took to resolve the reports during the blizzard period is significantly high compared to non-blizzard values. The values and locations obtained from the 311 data are shown in the table and figures below. (It should be noted that the average resolution time of the 311 request was assumed to be the difference between the "Open Date" and "Close Date" and these values are subject to human error.) While delays are expected, they point to downstream effects of insufficient numbers of snow removal equipment.

Table 3: Summary for Snowplow and Fallen Tree Reports Based on 311 Data [39]

Dates:	Dec 23-30 (Blizzard dates)	Rest of December 2022	January 2023
Number of 311 Snowplow Request Reports	3,401	205	293
Average Time to Close 311 Snowplow Request Report (Hours)	225	125	63
Number of 311 Fallen Tree Reports	260	27	119
Average Time to Close 311 Fallen Tree Report (Hours)	139	35	46

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[39] Open Data Buffalo, 2023

Figure 5: Distribution of 311 Snowplow Reports for (a) December 23-30, (b) rest of December 2022, (c) January 2023.
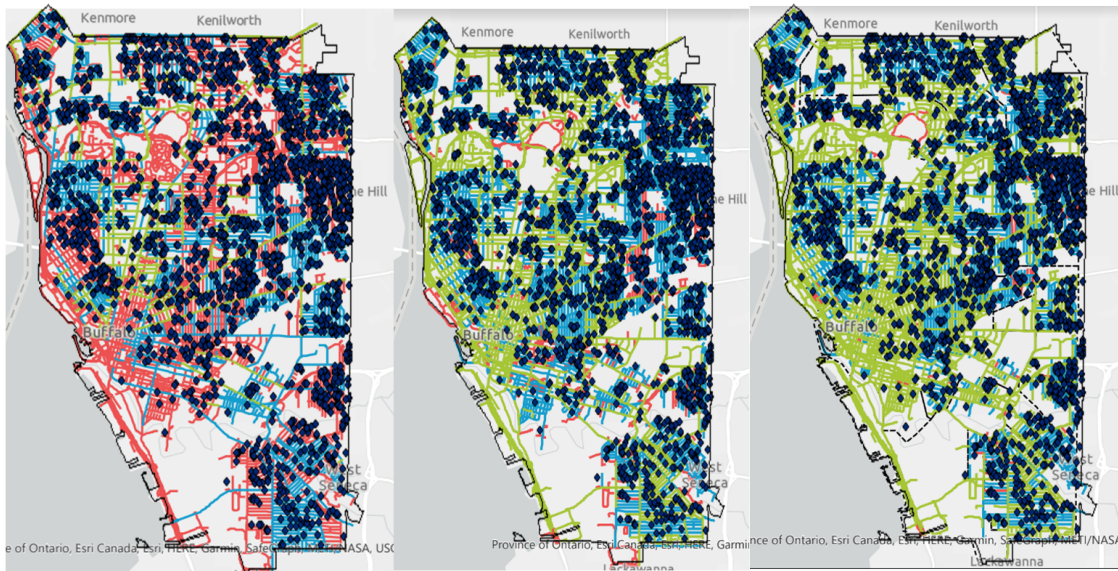
Figure 6: Distribution of 311 Snowplow Reports between December 23-30 on Snowplow Maps Dated (a) December 27 (b) December 28 (c) December 29

Based on the above brief discussion, we can conclude that the City did not have enough resources to tackle the problems that it faced during this major blizzard. As a result, the City was not able to effectively open roads blocked by heavy snow accumulation and fallen trees. Compared to normal conditions, there were major delays in clearing them.

A Need for A More Robust Blizzard Plan:

Planning and preparation for such a major snowstorm is another area underscored by this storm event. The following quote has been taken from the December 2022 Blizzard Report:

"The entire overnight shift was dedicated to continuing to work with fire and police, while also rescuing DPW crew stranded in snow in the plow trucks. At this time, all high lift plows were converted to bucket high lifts. This adjustment was made because of the height of the snow, bucket high lifts are used when snow can no longer be plowed but must be scooped and removed from the roadway. High lift trucks have higher axles to operate in greater depths of snow fall and to allow greater maneuverability on narrow city roads."[40]

The quote above suggests that the City was required to change course to tackle the effects of the storm. Despite the City knowing about the forecasted snow amount, crew members tasked with clearing the snow had to be rescued themselves, and snow clearing methods had to be adjusted during the storm. The 311 data displayed above also suggests the need for better preparation and more resources to clear incidents in an effective and efficient manner. In addition, the City of Buffalo lacked a traffic management center (TMC) to be used as a command and control center for both everyday and emergency operations – a resource that could have improved the effectiveness of response operations during the storm. The snow plan was similar to that for a typical standard snow event, indicating a need in the future for a more robust blizzard plan, or at least further information and guidance, that accounts for seriously impaired travel.[41,42,43]

Recommendations and Proposed Solutions

Below we suggest possible solutions for the major transportation-related problems identified above. These solutions are mainly based on our team's experience as well as previous ITS projects/deployments conducted at other locations, to ensure that

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[40] Office of the Mayor of Buffalo, 2023, p.4

[41] From the DPW interview: "This is an area where we need a supplemental; less a plan and more a 'here's the resources available in a normal event, here's what you have to add from in a major "once-in-a-lifetime" kind of event.'"

[42] A BPD interviewee recommended conducting tabletop exercises around circumstances where transportation is immobilized.

[43] The City of Buffalo Common Council, 2022.

their feasibility has been tested before. We make extensive use of previous work to provide meaningful examples of actual studies and real-world projects.

1. **Convey the importance of not driving and the potential impact of traveling during the storm** before it makes landing. The interview with the Mayor's Office contains the information that the city had utilized digital message boards along roads with messaging during the cold front a few weeks following the December 2022 storm. Increasing the number of physical signs and message boards on highways and popular locations would be helpful for effective information dissemination prior to a potential storm.

Another consideration is the use of ITS technologies such as Dynamic Message Signs (DMS) displaying advisory messages triggered by roadside pavement sensors.[44] This technology was field-tested on US Route 12 in Minnesota during the 2020-2021 winter season. The results demonstrated that DMS displaying weather alerts based on roadside pavement sensors were effective in reducing the average speed by 1.5 miles per hour and the 85th-percentile speed by 2.0 miles per hour, thereby reducing the risk of potential crashes. This technology helps drivers on a stretch of road become aware of the conditions ahead as the storm ramps up.

The State of New York and City of Buffalo can also look to other states for examples of preparedness measures. States' practices for winter maintenance fleet activation during storms, for example, show that most agencies summon half or more of their workforce before a storm arrives. Regarding weather forecasting, it costs about $140,000 per year to operate and maintain the Utah DOT's Travel Information Weather Program, which is based on human-powered weather forecasting using in-house meteorologists. This provides high-quality, road-specific forecasts, and timely road condition observations during and after events to help travelers to make safe travel choices[45]. Using AI-based forecasting to predict road conditions is a potential lower-cost option; one good example is the approach developed by the Iowa DOT to leverage data already collected from assets and vehicles to predict winter road conditions.[46] This effort can be further developed through a collaboration between the City of Buffalo and New York State, in collaboration with University at Albany's NY-Mesonet.[47]

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[44] Knickerbocker, 2021
[45] Federal Highway Administration, 2012
[46] Stolle, 2018
[47] NYS Mesonet, http://www.nysmesonet.org/ (n.d.)

In addition, to facilitate two-way communication with residents during extreme events, Buffalo can collaborate with Erie County's ReadyErie Preparedness app,[48] which will help offer situational information to Buffalo's Emergency manager and communicate with residents.

2. **Improve the Department of Public Works (DPW) facilities and provide additional funding to coordinate operations such as snow removal, emergency response, and DPW functions.** The resources currently managed by the DPW were not able to handle the December 2022 blizzard. This can be observed from the data analyzed in previous sections and stated in interviews with various departments including the DPW itself, which underscore that there is a real need for a new facility as well as a new fleet of snow removal vehicles.[49] Most snow removal, sanitation, and salting vehicles are stored in the "Broadway Barns," an armory built before the Civil War and later converted into a Public Works depot. The structure lost power and heat during the blizzard.

In addition to standard snow removal vehicles, smaller-form sidewalk plows can help to clear Buffalo's narrow streets and highly-used sidewalk areas. These plows, currently in use in Rochester, New York,[50] are likely insufficient for a first pass at five-foot-deep snow, but can be used for subsequent removals. These vehicles can be requested in future mutual aid packages, and/or developed in a fashion similar to the city of Cloquet, Minnesota, which uses "tractors that are converted from grass mowers in the summer months to snow clearing tractors with 5' wide broom attachments. This helped Cloquet launch its sidewalk clearing program with a very small initial investment and no need for additional staff."[51] According to the Federal Highway Administration, municipalities that manage sidewalk clearing report prioritizing "areas near schools, transit stops and business districts."[52]

Furthermore, the City needs pre-event planning and regular pre-event training of response personnel for maintenance and management of resources, to streamline the response to a major weather event. A full-time Emergency Manager should also be placed at the City of Buffalo; this is a position that would manage rapidly evolving crises, and was recommended in several interviews conducted with the various

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[48] *Get the ReadyErie Preparedness App*
[49] Buffalo Department of Public Works, personal communication, p.23
[50] *Sidewalk Snow Removal*
[51] *Minnesota Walks: Sidewalk Snow Clearing Guide,* 2018
[52] Huber et al., 2013

departments and individuals that experienced the December 2022 blizzard. The Common Council approved this role, along with a new Fleet Manager, in February.[53] With the use of various data sources and studies, questions such as where to place the resources and how much specific equipment to locate can be better answered before an event takes place.

Historical data can also be employed to improve pre-event planning for extreme severe weather management – consider the robust resource prediction models that were created to predict salt usage for the New Jersey Turnpike in the event of a snowstorm.[54] One way that similar models could be developed for Buffalo would be to use existing 311 snowplow request data to determine which parts of the city were heavily requesting the snow removal service, and then pre-positioning the equipment in garages or other covered locations in those areas, along with identifying nearby qualified workers to operate the machinery. Using an efficient inventory control model in emergency or disruption conditions also plays a crucial role in maintaining a reliable flow of supplies on a real-time need basis. The City may consider a system that offers both efficient usage and distribution of supplies but also considers integration with ITS technologies such as Radio Frequency Identification Devices (RFIDs) and GIS for commodity tracking and logistics. These tools would help the DPW map out hotspot areas for snow removal and distribute that information to inspectors and operators in the field, a feature DPW stated would be helpful in future storms.[55]

It is also important to note that the proper installation, care, and maintenance of Intelligent Transportation System (ITS) technologies will improve the transportation system's operations and safety while conserving the public's investment and ensuring that the system presents maximum benefits. Therefore, ITS technologies that will be especially crucial in responding to extreme weather events should be maintained appropriately following proper guidelines. For an out-of-state example, the New Jersey Department of Transportation (NJDOT), which did not have a clear set of guidelines to maintain their extensive state-wide ITS equipment, decided to initiate a research project to develop an ITS inspection and maintenance manual which was implemented as a software tool. The usefulness of the tool has received positive and encouraging feedback from ITS engineers after using the software[56]. A similar tool can be developed and deployed by NYSDOT and Erie County to ensure

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[53] The Buffalo Common Council, 2023
[54] Xie et al, 2017
[55] Ozguven and Ozbay, 2013
[56] Ozbay et al, 2009

proper inspection and maintenance of storm-related equipment and ITS technologies.

3. **Adopt data-driven approaches for decision-making**. Data-informed decisions should be considered at every stage of traffic management in response to major weather events. For example, operations and maintenance of fleet activation and deactivation procedures rely heavily on both current and forecasted data, making the real-time availability and usage of that data a critical factor. The City can consider the use of crowdsourced data, and research how to use this data type through the multiple studies that exist on the subject. [57,58] Snowplow dashboard images (once whiteout conditions have subsided), plus a combination of crowdsourcing and connected vehicle data can also be used to improve agency efficiency in monitoring winter road maintenance operations. A study that used connected vehicle speed data in Wyoming, for example, compared before-plow and after-plow speeds to find the best timing and conditions for plows to run and noted that snowplows improved minimum driving speeds by up to 19 miles per hour in inclement weather conditions.[59] It is recommended that Buffalo continue its partnership with Niagara International Transportation Technology Coalition (NITTEC) to help develop and source funding for this and related transportation technologies.

In addition, Buffalo should develop and maintain a long-term extreme event management plan for transportation facilities along with an active training and retraining program in concert with the New York State Division of Homeland Security and Emergency Services. It can implement the recommendations of this plan in terms of resource and information dissemination needs. This plan should also secure the financial resources needed to achieve basic goals in extreme event preparation and response.

4. **Use automated systems to improve the cost-effectiveness of weather-responsive traffic management and reduce safety risks during operations.** The benefits of these systems can result in lessened traveler delay and labor costs, and better resource allocation. Examples of their effectiveness are extensive. To name a few, the implementation of an automated weather responsive traveler information system (Wx-TINFO) in Michigan resulted in 25

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[57] North/West Passage, 2016
[58] Federal Highway Administration, 2019
[59] Li et al, 2016

to 67 percent user delay cost savings. Adoption of a web-based management tool (Salt Dashboard) saved the Iowa DOT $2.7 million per year. Adding a weather event visualization and report auto-generating system (WeatherEVANT) in New Jersey enabled coordination of weather-related operations and the potential for minimizing response times and improving resource allocation (Figure 7). Finally, integrating a mobile observations (IMO) smartphone app saved the Michigan DOT an estimated $680,000 annually through automation and reduced staff time.[60,61] Although these systems are state-based, they offer opportunities for Buffalo to recommend and request from New York State for managing extreme weather conditions.

Automated systems can also play a critical role in minimizing safety risks during and after extreme weather events, as they reduce the need for field human interaction. For post-event evaluation, autonomous drones and pre-installed cameras can aid in after-storm situational assessments,[62,63] while robotic vehicles can be deployed for hazardous snow removal and rescue operations.[64]

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[60] Demiroluk. et al, 2017
[61] Intelligent Transportation Systems Joint Program Office, 2020
[62] Erdelj & Natalizio, 2016
[63] Iqbal et al, 2021
[64] Das et al, 2017

Figure 7. User interface of the WeatherEVANT software developed by the NYU C2SMART team used by the NJ Turnpike Authority for some winter operations[65]
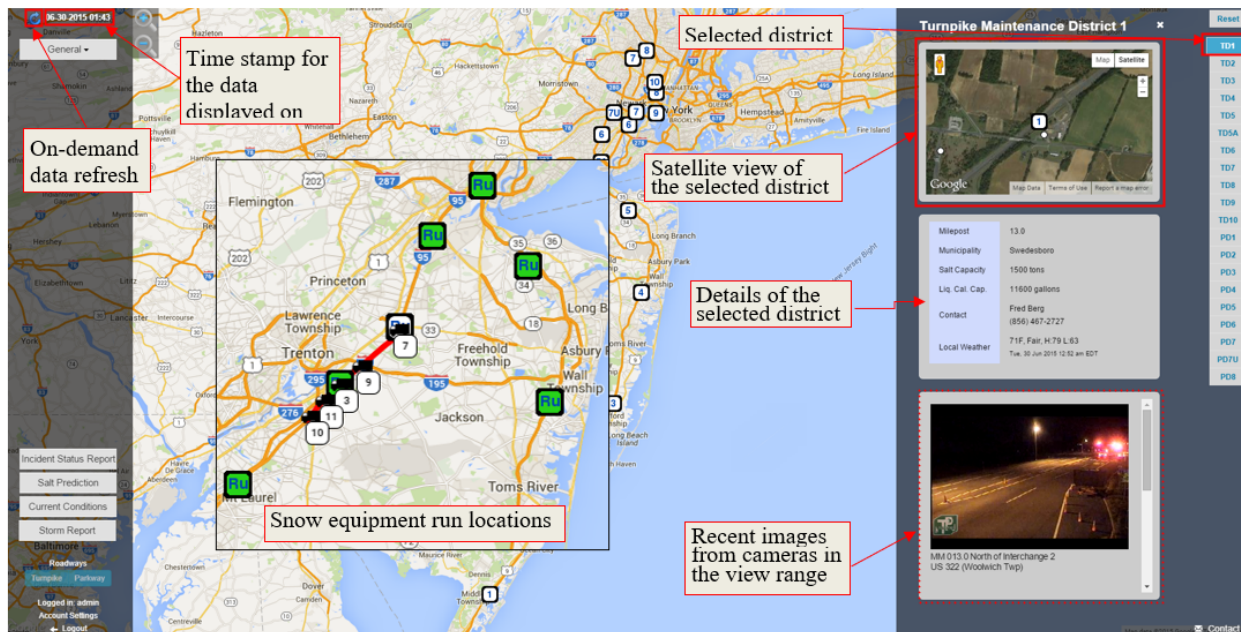
5. **Establish and fully staff a Traffic Management Center that can be used for both everyday operations and extreme event situations.** While DPW has a camera room, team members expressed a need for real-time video feeds for detection and monitoring of events, as well as more technology in the field for tracking.

The City can implement decision support systems to self-evaluate and integrate planning processes to create wider awareness of the benefits of weather integration to improve operations.[66]

Resources that focus on the best practices of maintenance decision support systems (MDSS) – computer-based, customizable tools that provide winter maintenance personnel with route-specific weather forecast information and treatment

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[65] Demiroluk et al, 2017
[66] Intelligent Transportation Systems Joint Program Office, 2011

recommendations – should be studied and implemented in partnership with New York State.[67]

For example, the Minnesota DOT reported that the use of mobile Road Weather Information System (RWIS) and MDSS in 11 winter events in 2010 enabled it to achieve an average of 53 percent reduction in salt usage, and cost savings of $2,308,866. RWIS typically consists of field-based Environmental Sensor Stations (ESS), a data transfer communication system, and central systems that gather data from multiple ESS. The Michigan DOT stated that the forecast from their MDSS enabled them to identify humanpower for upcoming storms. MDSS can be integrated with other ITS technologies such as mobile RWIS – districts that used mobile RWIS at the Colorado DOT reported an approximate 20 percent reduction in material usage. Moreover, NYSDOT is currently piloting a traffic management software for Active Traffic Management System (ATMS), named ActiveITS, for New York State's Region 1 under a research contract given to NYU's C2SMART Center.[68,69] Integrating weather data into such a software tool and enabling weather impact warnings would augment existing real-time traffic and road condition monitoring capabilities, thereby facilitating the management of winter maintenance operations. These statewide initiatives present opportunities for Buffalo to tap into intelligent decision support systems that will ideally be implemented across New York State.

Another consideration is the tracking of winter maintenance performance metrics via decision support systems in TMCs, such as response times and the time it takes to return to normal conditions, to identify best practices and future directions.[70] Using TMCs to operate as the hub of the surface transportation system and utilizing the state of the art ITS technology – including data collection, command and control of ITS devices, incident response, and communication for transportation networks – greater situational awareness for roadway networks can be enabled.[71] Examples of studies on the use of Next Generation Transportation Management Centers include those enacted in cities such as Austin, Texas, which underwent a recent TMC expansion project that resulted in a benefit-cost ratio of 2.4 in 2019; and state transportation departments such as the Virginia Department of Transportation, which conducted a study that suggests the use of non-traditional messages on highway message boards as they are more effective at changing driver behavior.

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[67] Federal Highway Administration, 2012
[68] Southwest Research Institute, n.d.
[69] C2SMART, 2023
[70] Otto, 2014
[71] Intelligent Transportation Systems Joint Program Office, December 2021

By exploring new advanced technologies to collect traffic and resource data, Buffalo's situational awareness around transportation facilities during and after the extreme weather event will be improved. The focus should be on technologies that keep humans out of harm's way, like autonomous drones instrumented with a camera and other autonomous land vehicles that can travel immediately following dangerous weather conditions. Exploring new technologies can be conducted with partners in the region, such as NITTEC, New York State, and federal grants promoting road safety.

In addition to the suggestions above, comprehensive reports on winter maintenance practices can be studied for further information about the details and lessons learned through the use of these real-time online systems. Two examples of these reports are provided as references.[72,73]

Table 4: Data Systems and Their Applications in Extreme Weather Events

Recommendation	Data Suggestions	Description:	Related Work
1	(a) Performance Metrics	Measures such as response times, time to return to specified conditions, travel speeds to monitor the effectiveness of performed activities.	• Making Winter Driving Safer - Establishing Performance Standards for Winter Maintenance • Manual of guidelines for inspection and maintenance of intelligent transportation systems

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[72] CTC & Associates LLC, 2018
[73] Papers related to winter maintenance from the 2017 TRB annual meeting, 2017

	(b) Real-Time Data	Data that is obtained as soon as it is collected or created, such as live weather conditions, traffic, inventory, road condition, safety, speed, etc.	• [ActiveITS Advanced Traffic Management System | Southwest Research Institute](#) • [Statewide Open Source Advanced Traffic Management System (ATMS) Software Research and Pilot](#) • [Next Generation Transportation Management Centers](#)
	(c) Road Weather Information System (RWIS) Data	Data collected from sensors such as atmospheric data, pavement data, and water level data to understand the road and weather conditions at different locations.	• [Evaluating the Benefits of Implementing Mobile Road Weather Information Sensors](#) • [Connected Vehicle Weather Data for Operation of Rural Variable Speed Limit Corridors](#)
2	(a) Historical Data	Data collected in past events and circumstances pertaining to a particular subject which could include information like GPS location, plow position, spreading rate and type, truck speed and direction in a snowplow optimization task or storm characteristics	• [Modeling salt usage during snowstorms: Application of hierarchical linear models with varying dispersion](#) • [Iowa DOT Office of Maintenance Snowplow Optimization](#)

		and salt usage in the development of a salt usage model.	
	(b) Real-Time Data	Data that is obtained as soon as it is collected or created, such as live weather conditions, traffic, inventory, road condition, safety, speed, etc.	• [A secure and efficient inventory management system for disasters](#)
3	(a) Crowdsourced Data	Data generated by a large group of people, which could include information such as traffic, road hazards, road conditions, weather, traveler information, etc.	• [Crowdsourcing for Operations](#) • [Evaluate the Effectiveness of Citizen Reporting](#)
4	(a) Connected Vehicle Data	Data generated by vehicles that have the ability to connect to the internet. This data can include information such as location, speed, acceleration, fuel efficiency, engine performance, and other operational	• [Leveraging Snow Plow Dashboards Cams and Connected Vehicle Speed Data to Improve Winter Operations Performance Measures](#) • [Connected Vehicle Weather Data for Operation of Rural Variable Speed Limit Corridors](#)

		parameters of the connected vehicle.	
	(b) Crowdsourced Data	Data generated by a large group of people, which could include information such as traffic, road hazards, road conditions, weather, traveler information, etc.	• [Considerations of Current and Emerging Transportation Management Center Data](#)
	(c) Historical Data	Data collected in past events and circumstances pertaining to a particular subject, which could include information such as road condition and road-weather information station data in a decision tree model.	• [Can A.I. Take Over Winter Road Condition Reporting?](#)
	(d) Real-Time Data	Data that is obtained as soon as it is collected or created, such as live weather conditions, traffic, inventory, road condition, safety, speed, etc.	• [WeatherEVANT: Real-time Weather Related Event Visualization and Analytics Tool](#) • [Next Generation Transportation Management Centers](#)

Appendix D: Business Community Needs

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Interviews with business owners, employees, and non-profit staff revealed the need for more coherent messaging for the blizzard and what it meant to business operations. While one sizable regional employer was aware of, tracking, and making plans for the storm, others were unaware and caught unprepared. The confluence of the Christmas holiday and the underestimation of the storm's severity meant that many employers approached the storm with a business-as-usual attitude, preparing for the holiday and juggling staff calendars, and not expecting the blizzard to hit until the afternoon of December 23rd. As mentioned previously, the storm arrived in Buffalo earlier than expected. Still, when the County announced the driving ban at 9:30 am on December 23rd, some employees were already at work, or on their way to work, and did not hear about it until later in the day.

While some employers made arrangements in advance to have their staff work from home or to send them home early, others were unable to do so, and went in themselves or required employees to come in. Some companies and organizations informed customers and clients beforehand that they would be closed that day, and canceled appointments. Others did not. With no driving ban yet in place, the decision was left to employers to decide how they would respond to the storm. Even once the driving ban was in place, employers were forced to determine for themselves if their work was considered "emergency" or "essential," and thus not restricted by the driving ban.

As deemed by the City, emergency personnel are uniformed workers required to come in for emergency services, such as Police, Fire, paramedics, medical personnel, and utility crews. But the city does not provide guidance on what constitutes essential workers for non-city employees (such as hospital staff and small business owners), and in advance of the 2022 blizzard the County pointed to CDC guidelines that defined essential workers in 2020 in the context of the COVID-19 pandemic.[74] Peter Anderson, press secretary for the Erie County Executive, defined essential workers as "Health care workers, hospital workers, personal care/nursing home

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[74] Centers for Disease Control and Prevention, 2021

personnel, utility workers, food service/grocery personnel, governmental agencies, people whose jobs are essential to the overall function of the community are considered essential personnel."[75] While the expectation for emergency and essential personnel was that they were only those necessary for the blizzard, some questions remained about who is considered essential. Employees at a large hospital reported feeling that there was no emergency plan for them and no preparations made for the storm, like the cancellation of non-essential procedures. Even among essential workers as they had been defined by the County, some interviewees noted that service providers (specifically, hospitals) should have adjusted schedules and staffing so that ancillary staff did not have to travel during the worst storm conditions.

Erie County Executive Mark Poloncarz issued a reminder via Twitter on December 23rd that it is illegal for employers to require employees to come to work during a travel ban. This includes employees living in a travel ban area, even if their workplace location is not under a travel ban.[76]

However, people who work hourly shifts and have fewer economic resources are especially vulnerable to losing out on wages when hit by a storm. Quoted in an article in Forbes about Hurricane Sandy in 2012, the vice president of the Economic Policy Institute said, "If the business closes because of the storm, employers don't have to pay non-salaried workers for lost wages. And if the business is open, but the worker can't make it into work, employers are also not required to pay for lost wages."[77]

Two business owners we interviewed remained in their businesses and served as impromptu warming shelters for their communities. As some neighbors lost power, these businesses maintained power and opened their doors to people who needed shelter, food, and a place to charge their phones and get information. Another business opened its doors for emergency personnel to eat, warm up, and regroup during recovery operations.

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[75] Anderson, 2022.
[76] Nice, 2022.
[77] Shapiro, Hindman, & Knafo, 2012. Sharf, 2016.

Recommendations:

Buffalo's Small Business Development Center (SBDC), which spearheads local business initiatives, should be equipped to assist small businesses with disaster preparation and recovery. Specifically:

1. Provide employers with clear guidance in disasters. Businesses in Buffalo, both large and small, deserve clear information from the City and County to make the best decisions possible for the safety of their employees and the continuity of their businesses. Employers should be informed through an emergency alert system that provides clear guidelines for closure expectations, and warnings about driving bans and potential state of emergency. This could be an additional notification sent through BUFFALERT, with the creation of a business-specific sub-category in the notification system.

An employer alert system is a feature Mayor Brown expressed interest in implementing in a recent interview.[78]

2. Develop clear definitions for emergency, essential, and non-essential personnel. Revisiting previous guidelines for the COVID-19 pandemic concerning essential and non-essential employees, the City and County should develop clear definitions for what that distinction means in different emergency scenarios (i.e. pandemic versus weather events). A clearer, event-based definition can help employers and businesses make safer choices and better prepare for an emergency.

3. Create an information line for employers. Business information lines should provide information about accessing funds for the small business loans that can cover the costs or losses incurred during a disaster event. Reassuring business owners before, during, and after a disaster event will help alleviate the pressure to call employees in during hazardous conditions.

Provide support to businesses and organizations to create their own emergency plans. Interviews with local businesses and organizations showed that many do not have emergency plans in place. The City and County have an opportunity to support

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[78] McNeil, 2023b

employers in creating these emergency plans, and to coordinate their efforts with those of the City's new emergency manager and the County's Emergency Operations Center (EOC). This effort could start with pointing businesses towards existing resources (such as the SBA)[79] or guiding non-profits to literature on developing emergency plans. These plans should include expectations for preparing for emergencies and caring for essential employees during them – including stocking emergency supplies such as food, water, blankets, and flashlights if employees need to stay overnight or for several days.

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[79] United States Small Business Administration, n.d.

Appendix E: Power Infrastructure
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This section provides context for the extent of vulnerability of electric power systems to weather and other natural hazard extremes, and their ability to withstand and recover from these stresses in general – with particular reference to the National Grid power system in the City of Buffalo during the blizzard of December 2022. With regard to recovery, this section looks at effects on usage or consumption and the performance of selected electric power facilities to meet electricity delivery demands. While electricity falls under the purview of National Grid, the necessity of maintaining power for residential heat, communications, and city operations intersects with the City of Buffalo's needs to maintain residents' safety. In addition, the City allocated resources during the blizzard to help National Grid reach impacted infrastructure, as up to 20,000 customers found themselves without power, including several key City facilities.

Key Findings and Recommendations:

1. Within the City of Buffalo, the number of customers experiencing power outages at a given time averaged about 20,000 at the peak of the blizzard between December 23rd and December 25th, 2022, including several City facilities.
   a. Recommendation: Directly incorporate interconnections between electric power and other utilities and operations into planning to account for needs in intersectional areas, including communications, transportation, and key facilities.

2. During the periods of highest outages, those in the City of Buffalo substantially exceeded outages elsewhere in Erie County (about 6-7,000, during that same period). Only at the very beginning and end of the storm period did the number of outages elsewhere in the county exceed the number of outages in the City of Buffalo.
   a. Recommendation: Develop and maintain a strong network among stakeholders and resources prior to an emergency so that they may be called upon at the outset of an emergency.

3. Power supplies and transmission lines endured unprecedented harsh conditions related to snow and wind: Three substations froze, and

transmission and distribution systems were impaired both below and above ground.

    a. Recommendation: Shape a fundamental policy to incorporate the planning, design, operation, and maintenance of electric power in the context of Buffalo's other needs, with a focus on what level of risk is tolerable under extreme events.

4. The combination of power facility failures produced widespread power outages, many of which were relatively long-term (up to four days) in duration.

    a. Recommendation: Implement an asset tracking system that provides continuous monitoring of resources in Buffalo to inform resource coordination and prioritization.

5. National Grid, the main provider of electricity, attributed its problems to issues in "access and mobility" to reach electric power facilities for repair.

    a. Recommendation: Work with National Grid to develop plans to use innovative power distribution system design for protection, which can control how power lines fall to reduce the impact. This approach involves having failures occur at specific points to prevent them spreading to adjacent poles, causing cascading effects.

6. According to National Grid, outages primarily occurred within the transmission and distribution systems, and apparently not with the external bulk power systems.

    a. Recommendation: Maintain ongoing robust data prior to, during, and following a storm to enable better knowledge of component failures and remediation, and in turn contribute to asset performance and user impact more effectively.

Power Infrastructure: Analysis

The City of Buffalo is the second largest city in New York State by population, and National Grid reports having 120,825 total customers there.[80] Energy consumption is expressed in several different ways for the City of Buffalo,[81] and National Grid has provided the following figures for energy delivery in 2022:

Customer Type	Energy in GWh

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[80] National Grid, personal communication, March 2023
[81] New York Power Authority, 2015

Residential	599
Commercial	1,206
Industrial	795
Total	**2,600**

Table 5. Energy delivery to electric customers by National Grid, City of Buffalo, 2022[82]

New York Power Authority (NYPA) provided additional information on the distribution of Buffalo's energy consumption by types of users for two major types of energy – electricity and natural gas in the year 2015 – and their data indicated that natural gas provided about 3 times the mmBtu (thermal units) of electricity.[83]
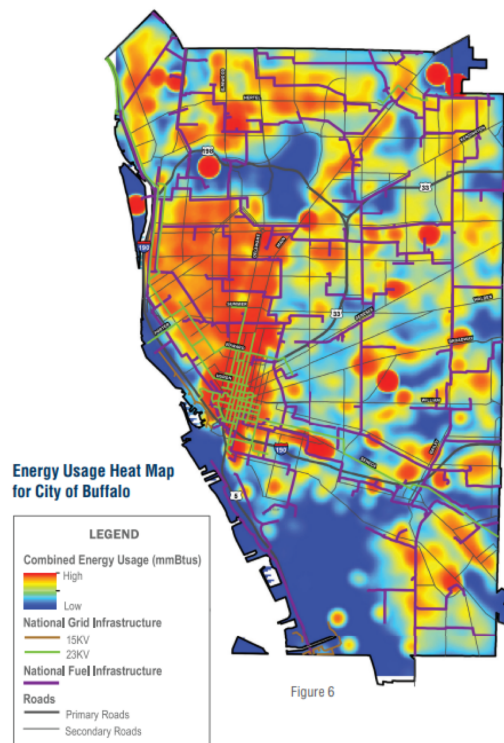
Electric power usage varies by location within Buffalo,[84] as portrayed by NYPA's heat map in Figure 8.

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[82] National Grid, personal communication, March 2023. Figures are approximate.
[83] New York Power Authority, 2015, p. 18
[84] New York Power Authority, 2015, p. 21

Figure 8. New York Power Authority Heat Map Portraying Electric Power Usage, City of Buffalo, 2015[85]

National Grid provides energy consumption data based on actual meter readings.

National Grid obtains its power externally and does not own electricity generation facilities. According to National Grid its external supply consists of energy from the following sources[86]:

- New York Independent System Operator's (NYISO) wholesale electric markets
- small independent power producers
- the New York Power Authority's (NYPA) purchase power contracts.

NYPA's largest electric power generation facility in Western New York is a hydroelectric power plant: The Niagara Power Project in Lewiston, New York. From these sources, the power is connected through the transmission system to substations where it is then connected to the distribution system in the City of Buffalo.

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[85] New York Power Authority, 2015, p. 21

[86] National Grid, personal communication, March 2023

The Buffalo Power System and Its Components

This section covers the type and extent of Buffalo's electric power system with regard to its services and facilities – with a focus on transmission, distribution, and substations. It incorporates statewide or region-wide data as well as information specific to the City of Buffalo that was provided by National Grid, which is the sole electric distributor for the City of Buffalo as well as additional parts of Erie County.[87] Gas is serviced by the National Fuel Gas Supply Corporation (NFGS)[88,89] and therefore, each customer in the City of Buffalo is served by both companies (assuming they use both electricity and gas). The two companies do not typically work together, and NFGS apparently did not experience any problems in the December 2022 blizzard as its infrastructure is underground.

According to the information shown in National Grid's service area map and its source document, National Grid provides electricity for all or portions of 43 cities, towns, villages, and hamlets within Erie County – including the City of Buffalo.[90] The other electric provider in Erie County is New York State Electric & Gas (NYSEG), which covers the southeastern portion of the country and everything east of Route 78 (also called Transit Road) including Lancaster, Orchard Park, and East Aurora.

The City of Buffalo is located within the NY-West region; within that region it is located in "Frontier," which consists of both Erie and Niagara counties. National Grid serves 11 counties.

Transmission and Distribution

According to National Grid, its electric system includes transmission, sub-transmission, and distribution assets located throughout the City of Buffalo that consist of:
- Eight transmission lines, spanning over 20 miles
- Over 470 distribution lines, spanning more than 890 miles
- 52 substations
- Over 76,000 sub-transmission, distribution, and street lighting poles (some poles are jointly owned with other utilities)

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[87] New York Power Authority, 2015, p. 18
[88] New York Power Authority, 2015, p. 18
[89] National Fuel Gas Supply Corporation, 2023
[90] National Grid, 2023a.

- Over 10,800 pole-top and padmount distribution transformers
- Over 82,600 services points to overhead and underground customer premises/facilities[91]

Buffalo's transmission and distribution networks, along with the intermediate nodes or substations, constitute the electric power infrastructures that can be the most vulnerable to outages. While distribution networks in general consist largely of overhead poles, the downtown area of the City of Buffalo includes underground lines,[92] and as National Grid points out, both of these lines are among the service points to customers. Overhead lines are more susceptible than underground lines to wind, snow, and impingement by trees.

Substations

Substations are critical nodes that perform many different functions connecting transmission and distribution, and as a result, many different types of substations exist.[93]

According to National Grid, the underground lines are interconnected with a network of 43 indoor substations, and according to the National Grid report, the indoor substations are among the "longest serving assets in the company's system."[94] In response to the blizzard's impact, National Grid undertook an extensive repair of its underground system primarily through contracted services.

According to National Grid,[95] the substations that were affected by the blizzard are brick structures, constructed on three sides with brick walls with the fourth side open, but which are then fenced in to prevent intrusions and to keep animals and debris out. The transformer bays were left open on one side by design to keep them cool and elevated. All of the equipment is airtight to protect it from weather impacts.

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[91] National Grid, personal communication, March 2023

[92] New York Power Authority, 2015, p. 18

[93] Occupational Safety and Health Administration, n.d.

[94] National Grid, February 27, 2023, p. 29

[95] National Grid, personal Communication, March 2023

Outage Patterns and Trends During the Blizzard

The City of Buffalo has experienced numerous major snow events, but the blizzard of 2022 was of a magnitude that the state and the utility had not experienced before. Given its proximity to Lake Erie, Buffalo's vulnerability to lake effect snow – which can enhance the total amount of snow that accumulates – amplifies the impact of any winter storm. According to National Grid's account, the blizzard that was colloquially named "Winter Storm Elliott" lasted from December 23rd through December 27th, with blizzard conditions diminishing beginning December 25th.[96] Still, conditions resulting from lake effect snow continued through December 27th. Many considered it to be the worst blizzard in the City of Buffalo's history, due to its five-day duration, "the combination of heavy snow, extreme winds, blizzard conditions, and bitter cold temperatures," snow accumulation of 56 inches over 37 hours constituting "the longest blizzard duration in the region's history," and lengthy and intense wind gusts that were recorded at nearly 80 mph.[97]

These conditions created extreme impacts on the power grid and its components, as well as on other infrastructure upon which electric power and its users depended. Most notably, substations froze, which had never occurred before, and transmission and distribution systems were impaired both below and above ground. Ultimately, the combination of these failures produced widespread power outages, many of which were relatively long-term in duration. To make matters worse, the widespread nature of the storm limited access to resources that had been established to deal with such emergencies, and as noted previously, National Grid viewed its problems in terms of "access and mobility." Given the reduced visibility spurred by the storm's intensity, conventional snow plows had to be replaced by slower front-end loaders. As a result, a gap existed between what the power system was designed to withstand and what the blizzard conditions presented.[98]

Energy System Performance Measures

Several sets of criteria were used to characterize the severity of the blizzard, and its impact on the power grid, in terms of outages and the assessment of performance.
- One important set of criteria is the definition of a blizzard, which the City of Buffalo included in its final report: "Three conditions must be met for a storm

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[96] National Grid, February 27, 2023, p. 3
[97] National Grid, February 27, 2023, pp. 3-4
[98] Bragg, March 3, 2023

to be considered a blizzard: sustained winds or frequent gusts 35 mph or greater, falling and/or blowing snow reducing visibility frequently below 1/4 mile, and these two conditions must persist for at least three continuous hours."[99] The event exceeded all of these conditions.

- The second set of criteria is set by the NYS Public Service Commission (NYPSC) for the reporting responsibilities of extended outages by utilities in the form of an official ScoreCard. This is primarily in terms of the duration of an outage. National Grid submitted the ScoreCard report on January 27, 2023 as required under the NYS Department of Public Service (NYSDPS) order.[100] The NYSDPS guidance states these criteria for preparing a scorecard: "The proposed Scorecard would be applicable to events where the restoration of service requires three days or more."[101]

- A third set of criteria pertains to restoration of power under Section 17.3 of the Electric Emergency Response Plan, and repeated in the National Grid self-assessment report.[102]

National Grid produced an assessment of its assets including those in Buffalo, and in it the company explained its plan for monitoring and remediation of problems. This emergency plan provides thresholds or criteria for invoking actions, as well as for meeting reporting requirements.

Under non-weather conditions, the electric power industry in general – and National Grid in particular – use the following metrics:

"CAIDI for a base year (hr/int) is the baseline (i.e., pre-project) Customer Average Interruption Duration Index. It represents the average time to restore service, excluding major storms. SAIFI in a base year (int/cust/yr) is the baseline (i.e., pre-project) System Average Interruption Frequency Index. It represents the average number of times that a customer experiences an outage per year, excluding major storms."[103]

Performance metrics during the storm included measures like response times when wires or other components of the electric power system were downed.[104,105] During

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[99] Office of the Mayor of Buffalo, 2023, p. 2

[100] New York State Public Service Commission, 2013

[101] New York State Public Service Commission, 2013, p. 8

[102] National Grid, February 27, 2023, pp. 50-51

[103] National Grid, 2020, p. 55

[104] National Grid, February 27, 2023, p. 18

[105] National Grid, January 27, 2023, Appendix 4.1

the blizzard, estimates were given for response times along with outage estimates that in some cases were indicated as uncertain.

Several things are generally considered in interpreting outage trends, which can differ for different utilities and over time. First, "customers" is not equivalent to people, or even households or housing units. The term signifies the number of service connections. Second, outage counts can include instances of the same person or household calling in multiple times, making it appear that there were more outages than there actually were.[106] Multiple calls can also signify an individual customer's electric power being restored but then going out again, necessitating another call. Third, during an outage event, outage numbers can increase when the utility intentionally takes parts of the system offline for repairs.[107]

Citywide Patterns and Trends

Outage patterns and trends are shown in Figure 9 over the course of the blizzard for the City of Buffalo and Erie County.

The numbers were drawn from the National ScoreCard data reported by National Grid with the New York Public Service Commission (NYPSC).[108] The data was collected in the form of screenshots and was extracted into a Microsoft Excel format. More detailed information about outages from archived maps and lists was not available.

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[106] National Grid, February 27, 2023, p. 23
[107] National Grid, January 27, 2023
[108] National Grid, January 27, 2023

Figure 9. Customers Experiencing Electric Power Outages During the December 2022 Blizzard, City of Buffalo and Erie County, December 23-28, 2022[109]
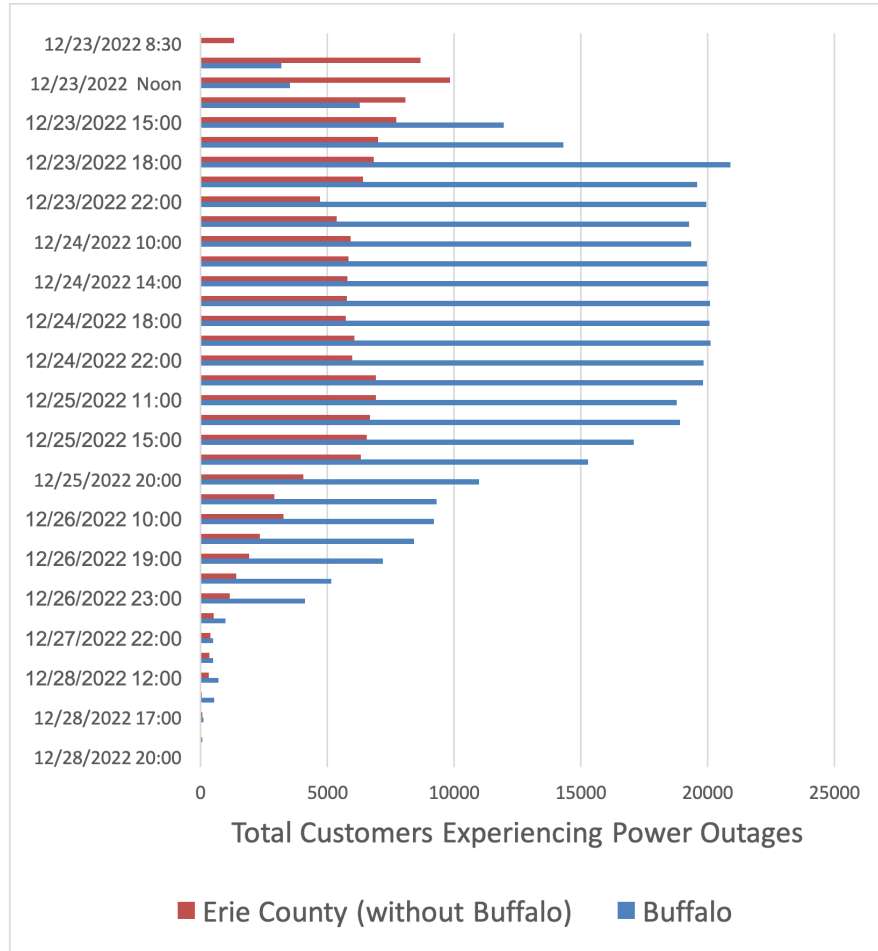
Given the total number of National Grid customers of 120,825, for any given time period, based on the information in Figure 9, the number of outages at the peak of 20,000 was about 17 percent.

Several findings are apparent from the City's outage data provided in the ScoreCard.

As shown in Figure 9, the number of outages remained relatively flat between December 23rd 18:00 through the afternoon of December 25th. Within that time period, there were several slightly separate peaks, according to data in the ScoreCard, App. 1.3:

- The highest peak represented 20,890 customers without power, and occurred during the first evening of the storm on December 23rd at 6:00pm.
- In the second peak, 20,027 outages were recorded on December 24th at 2:00pm.
- The third peak occurred later on December 24th at 8:00pm, with 20,108 outages.

At the outset of the storm on December 23rd there were very few outages, i.e. 34 at 8:30am (too small to appear on the bar chart).

Patterns and Trends in the City of Buffalo Relative to Erie County

During the periods of highest outages, the City of Buffalo's outages substantially exceeded those in the rest of the county, as indicated in Figure 9. But the details are a bit more complicated. From the late morning of December 23rd through the latter part of the storm, Buffalo ranked highest among cities in Erie County for power outages, and substantially exceeded county averages.

But early in the blizzard, on the morning of December 23rd, the City of Buffalo ranked behind a few other Erie County cities in the number of outages. According to the records, at 8:23 am Buffalo ranked behind Amherst, Evans, Lackawanna, Eden, and Cheektowaga in the total number of customers with power outages.[110] By 10am it ranked only behind Amherst.[111] After that, Buffalo led all of the other areas in Erie County in terms of customers with outages.

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[110] National Grid, January 27 2023, Appendix, p. 135
[111] National Grid, January 27 2023, Appendix, p. 133

Spatial Patterns and Trends in Selected Areas Within the City

Specific areas within Buffalo experienced higher numbers of outages, although a limited amount of information was available for these specific outages by subarea.[112] Using the information available, we can assess that the selected subareas were indicated as experiencing the most outages:

- Grider/MLK area – 3,844 customers
- Cold Springs area – 2,996 customers
- Lovejoy area – 1,823 customers
- First Ward area – 1,082 customers
- South Buffalo – 757 customers
- Kensington/Bailey area – 598 customers
- Westside area – 2 outages, one with 549 and one with 656 customers
- Elmwood Village area – 510 customers

These subareas constitute about two-thirds of the total peak outages of 20,000. Outage data during the blizzard was available at sub-city levels in real time, but that data was not archived. Keeping such data after the fact would be valuable to strategize for the future.

The outages for these sub-areas were superimposed upon the heat map from Figure 8, and Figure 10 provides the overlay. Taking into account the limited nature of the sub-area data, the highest volumes of outages seemed to occur outside of the areas with the highest energy usage. This initially looks counterintuitive. One possible explanation is that the higher-density areas where the outages were lowest are served by underground systems. If this is in fact the case, then in order to lower the vulnerability to outages from storms in these areas, local and state authorities should consider more undergrounding of utility lines in these outer locations even though their lower population densities may make this a more expensive option than on overhead lines. Alternatives to undergrounding, however, have been under study by the Electric Power Research Institute (EPRI).[113]

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[112] National Grid, Email at 11:53 a.m., December 24, 2022
[113] Electric Power Research Institute, 2015

Figure 10. Overlay of power outages for selected Buffalo sub-areas on the City of Buffalo Energy Usage Heat Map
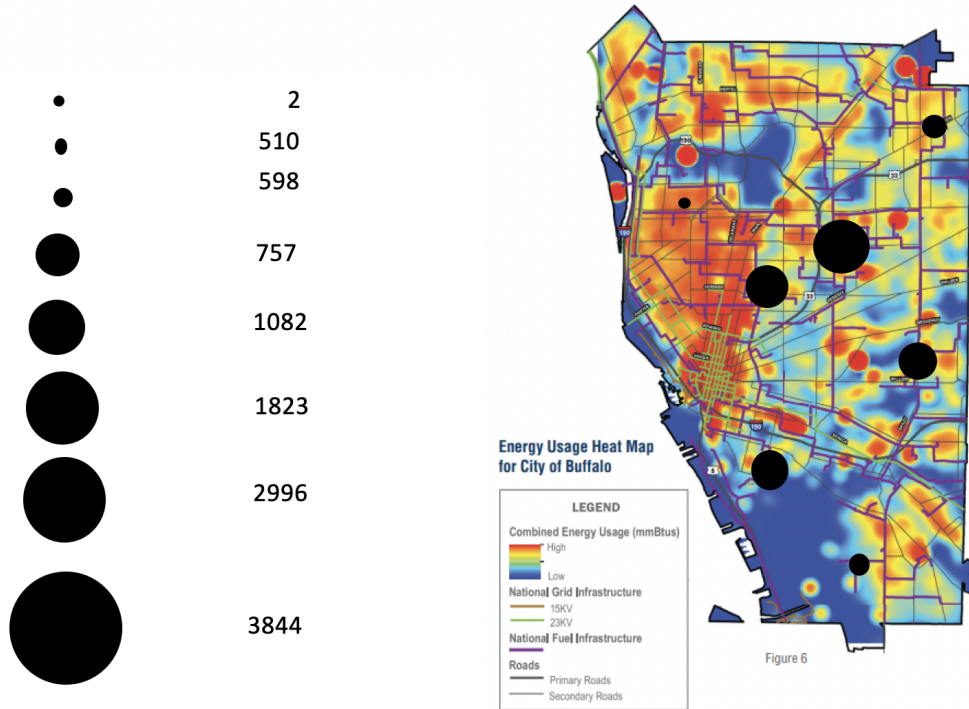
To determine outage spatial patterns of outages relative to population characteristics, certain outage information was superimposed on selected demographic information. While outages were widespread, the ones listed above were located to a somewhat greater extent in areas with lower income and higher percentages of racial minorities. Similarly, plowing priorities for the substations were also mapped against median household income and race, as shown below. The need to incorporate socioeconomic data along with engineering data is vital to electric power planning for disasters.[114]

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[114] Jusiūnas et al, 2021

Number of Customers Affected by National Grid Power Outages Compared to Median Household Income by Census Tract

Number of Customers Affected by National Grid Power Outages Compared to Most Populous Race by Census Tract
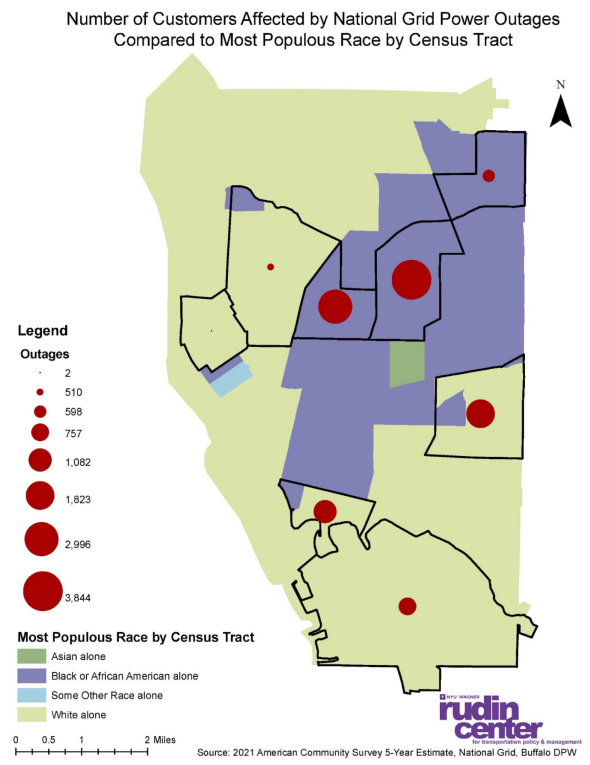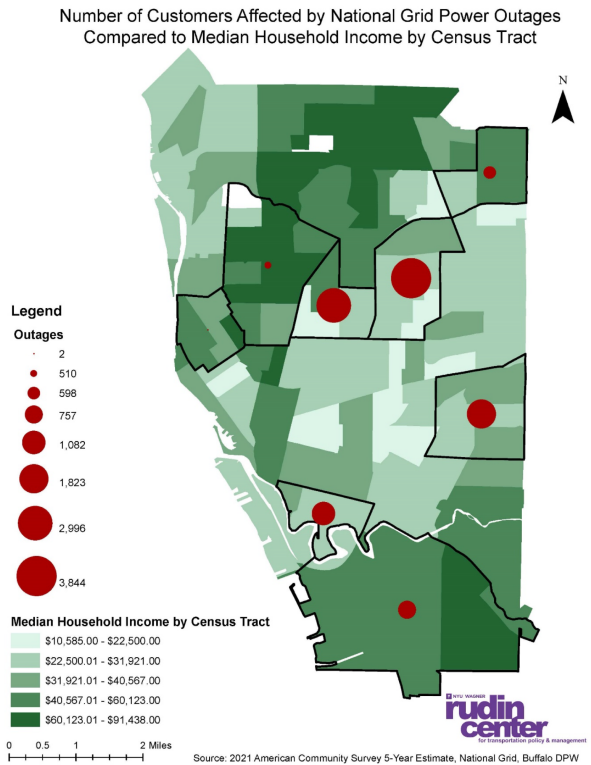
Figure 11. Map of power outages overlaid onto median household income data by census tract

Figure 12. Map of power outages overlaid onto most populous race in each census tract

Damage to Selected Electric Power Components and Response

Damage to electric power components was generally defined as "downed limbs and fallen trees, downed wires, broken poles, and damaged transformers." The specific numbers of components replaced in both the NY-Western and NY-Central regions or divisions, inclusive of Buffalo, were reported by National Grid to add up to "256 broken poles and 102 damaged transformers."[115] In the smaller region, the New York – West Frontier region, which includes the City of Buffalo and other nearby areas, National Grid reported the following damaged facilities:

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[115] National Grid, February 27, 2023, p. 5

- 82 Broken poles
- 25 Transformers
- 300 Feeders
- 88 Feeder lockouts
- 0 Transmission circuits
- 16 Sub-Transmission circuits[116]

Figure 13. Substations prioritized for plowing by National Grid overlaid onto household median income by census tract

Substations Prioritized for Plowing by National Grid

Legend

National Grid Substations Prioritized for Plowing

Median Household Income by Census Tract

$10,585.00 - $22,500.00
$22,500.01 - $31,921.00
$31,921.01 - $40,567.00
$40,567.01 - $60,123.00
$60,123.01 - $91,438.00

0   0.5   1   2 Miles

Source: 2021 American Community Survey 5-Year Estimate, National Grid to City of Buffalo DPW on 12/24/22

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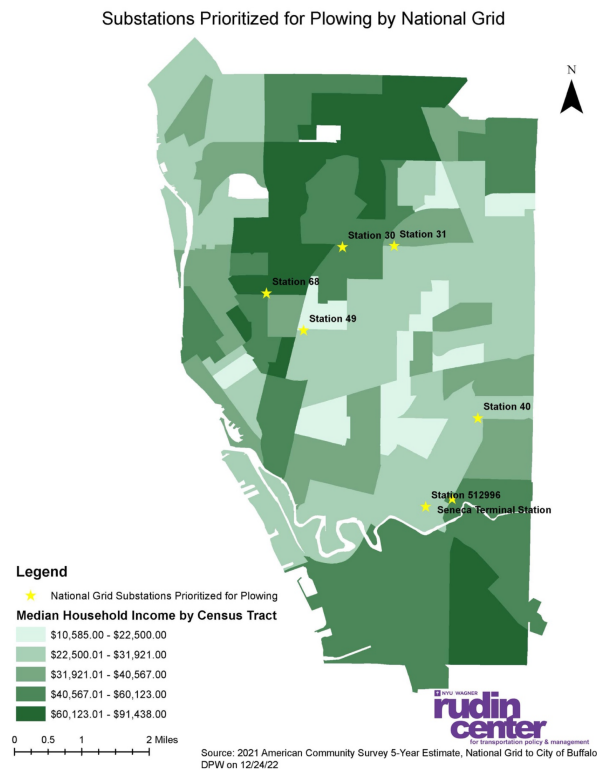
[116] National Grid, February 27, 2023, p. 26

Figure 14. Substations prioritized for plowing by National Grid overlaid onto most populous race by census tract

Substations Prioritized for Plowing by National Grid

N

Station 30 Station 31

Station 68

Station 49

Station 40

Station 512996
Seneca Terminal Station

Legend
★ National Grid Substations Prioritized for Plowing
Most Populous Race by Census Tract
■ Asian alone
■ Black or African American alone
■ Some Other Race alone
■ White alone

0   0.5   1   2 Miles

rudin center
for transportation policy & management

Source: 2021 American Community Survey 5-Year Estimate, National Grid to City of Buffalo DPW on 12/24/22

Substations

Out of the City of Buffalo's 43 substations, three experienced snow-related problems during the December blizzard. (A fourth 23 kV substation was offline due to cable problems; it was not impacted by the amount of snow in the station.) Of the three affected substations, two were in East Buffalo and one in South Buffalo.[117] The three substations combined serviced about 10,000 customers, all of whom were subsequently impacted by the blizzard.[118] Given that out of 20,000 customers impacted on those days from the blizzard, 10,000 of them were the customers of just three substations, it seems that there was a considerable concentration of electric power coverage in just a few substations. Distributing energy across more substations would likely decrease this vulnerability in the future. Decentralizing vital infrastructure components to support flexibility is a key consideration in resiliency that is especially relevant for electric power infrastructure to avoid the impact of outages. In addition, deploying sensor systems, especially in concentrated areas, is vital to detecting problems at the outset of disruption events.

During the blizzard, due to high winds and the amount of snow, snow entered the transformer bays in three of the substations. The snow did not enter through the roof, but through the side fences. Why these three substations were affected and not others is unclear. National Grid indicated they had never experienced a situation like this where substations froze. Figures 15, 16, and 17 depict the extent of snow inundation occurring at the substation facilities. Analogous to the substation problem with snow entry was snow inundation into transportation engines necessary to clear the roadways.[119]

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[117] National Grid, personal communication, March 2023

[118] National Grid, February 27, 2023, p. 29

[119] National Grid, February 27, 2023, p. 14

Figures 15, 16, and 17. Substation Components Immersed in Snow During the December 2022 Blizzard, Buffalo, New York[120]

National Grid worked on the three substations and transformers beginning on the day of December 24th, and on December 25th at 9pm National Grid reported that "customers affected by these substation-related outages were returned to service."[121]

National Grid described the process to unfreeze the three substations in the following way: they used "'concrete blankets' (special blankets or tarps that lock heat in while keeping the cold out, used in construction to prevent water from freezing during the curing of concrete) along with regular tarps and torpedo heaters (another device used in the construction industry to provide temporary heat) to blow hot air into the impacted transformer bays to melt the ice and snow from equipment."[122]

Once repairs could be made, the stations were reenergized, and power was restored to customers gradually to avoid overload and damage to the equipment.[123] This was also reported in the media based on discussions with National Grid.[124,125]

National Grid indicated that they had the heaters and concrete blankets on hand, since the equipment was there for other purposes. The heaters were used to keep underground voltage equipment warm.

As the blizzard began, National Grid identified the following substations as high priority for clearance on December 24th:
- 50 Spillman Place: Station 30
- 454 East Delavan: Station 31
- 628 Elk Street: Station 51 (As Jonathan Epstein reported in The Buffalo News: "A station on Elk Street had the biggest challenge – snow drifts 12 to 15 feet high."[126])
- 447 Bailey Ave: Seneca Terminal Station
- 1494 William Street: Station 40
- 538 Elmwood Ave.: Station 68
- 45 Best Street: Station 49[127]

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[121] National Grid, February 27, 2023, p. 29

[122] National Grid, February 27, 2023, p. 29

[123] National Grid, February 27, 2023, p. 29

[124] Plants, 2023

[125] Watson et al, 2023

[126] Epstein, 2022

[127] National Grid, Email at 11:53 a.m., December 24, 2022

Epstein reported that "Only after the storm let up could the utility finally start repairs Saturday night. Five substations in the city were flat, after the heavy wet snow effectively short-circuited the equipment, triggering shutdowns," and "those affected large swaths of neighborhoods in five areas – from North Buffalo and the Elmwood Village to the Old First Ward and East Buffalo."[128]

Transmission and Distribution

Overhead Lines

As indicated above, while a large portion of the City of Buffalo is served by underground power lines, overhead lines are the most common transmission lines.

These overhead power lines are vulnerable to threats from the direct hit of a storm, in the form of the weight of water or snow, flying debris, and falling trees.

Two data sources exist to estimate the extent of damage to electrical lines from fallen trees in the December 2022 blizzard: the city's Forestry Service records and the 311 call log.

The Forestry Service records tree falls, including those that hit power lines. Of the 308 records that were collected over the course of the blizzard, 18 explicitly referred to trees or limbs that hit power lines or power wires. Some records that only listed road damages may also have included power line damage, but it is not possible to tell from the descriptions.

The 311 call log records do not include effects on power lines – only inspection, blocking of a right of way, or other condition.

Underground Structures

As part of its ScoreCard reporting, National Grid tabulated activity with respect to underground facilities, in terms of when they were dug and whether these actions were routine or for emergencies. The tabulation of underground facility work is part

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[128] Epstein, 2022

of a "Dig Safe" program that prevents utilities from disrupting others when they dig underground. National Grid indicated that the Dig Safe calls during the week of the blizzard were done because crews had to dig around broken poles to replace or plant them.[129]

The City of Buffalo accounted for 39 Dig Safe records between December 23 and December 28 2022, of which 5 were classified as "regular" and the rest as "emergency." The entire Dig Safe record for the storm consisted of 408 records across New York State.[130]

The natural gas system seems to rely primarily on underground infrastructure. A separate emergency plan exists for the gas system,[131] and as mentioned earlier is not covered here.

Preparedness and Response for Snow Emergencies

Preparedness in advance of a major hazard is a key component of emergency management plans. In the case of the December 2022 blizzard as well as other weather-related situations, National Grid's policy is to follow a series of practices in its own emergency plan – to be enacted before, during, and after the storm – and those set forth in federal guidelines, such as in the National Incident Management System (NIMS).[132] These procedures encompass extensive information about the development of a weather event from multiple weather sources, resource deployment, and a network of partnerships ranging from within its own organization as well as local, state, and national agencies, and private organizations.

Weather Information and Communication

National Weather Service (NWS) observations and forecasts were communicated and documented in the ScoreCard posted by National Grid, with the NYPSC

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[129] According to National Grid, Dig Safe is New York State policy (and was recently renamed to UDig NY). It involves notifications by calling 811 where gas, water, sewer, telecom could be impacted by digging. NYS Code Rule 753 covers this action. NYC Department of Design and Construction, 2019.
[130] National Grid, 2023b
[131] National Grid, January 2021.
[132] Federal Emergency Management Agency, 2023

reflecting very extensive winter weather indicators that the NWS typically uses and translates into watches, warnings, and advisories.[133] These were followed and documented over the course of the storm, as well as prior to it and in the days following. The NWS indicators documented an extensive set of winter weather conditions: peak, average, and sustained winds and gusts; the consistency (wet vs. dry) and accumulation of snow and white-out conditions; and "ice, rain, flooding, temperature, and thunderstorms."[134] In addition, National Grid indicated that it had used other sources of weather information as well, such as the University at Albany's NY-Mesonet system and a third party weather service, but that it used a conservative approach in using these forecasts as a basis for its actions.[135]

Resource Deployment

National Grid defines four types of resources that it has at its disposal for disaster preparedness and weather events: equipment, workforce, logistics, and technology. Its resource deployment for the 2022 blizzard began about five days in advance of the storm and consisted of:

- prepositioned workers and equipment
- a systematic approach for removal of downed wires
- identification of and plans for critical facilities
- communications to support these efforts

National Grid also used estimation methods for these resources, based on similar events external to the service area, estimated for the 2022 blizzard at double what the numbers would be in less extreme circumstances.[136] According to National Grid, the resources were flexible enough to be expanded incrementally during the storm by relying upon external resources to fill the gaps – some of which were part of extensive pre-event planning such as mutual assistance agreements.[137] Issues that arose with respect to resource effectiveness in light of the weather conditions and actions taken for support were in the words of National Grid related to "accessibility and mobility." The media also raised preparedness and response issues such as the timing of response specifically in terms of arrangements for reaching the impaired facilities,[138] which National Grid revisited in its after-action report.[139]

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[133] National Grid, January 27, 2023

[134] National Grid, February 27, 2023, p. 8

[135] National Grid, February 27, 2023, p. 8

[136] National Grid, February 27, 2023, p. 6

[137] National Grid, February 27, 2023, pp. 10-11

[138] Watson et al, 2023

[139] National Grid, February 27, 2023

Per above, National Grid utilizes four types of resources – equipment, the workforce, the logistics that integrate them, and technology. Though equipment and workforce characteristics are addressed separately, they are highly interrelated; for example, National Grid ensured that equipment and crews were co-located. This has been a problem in snowstorms in other areas, like in the December 2010 snowstorm in the New York City area where response was weakened by the fact that equipment and personnel were in different locations.[140]

Equipment

Equipment-related resource issues included the ability to access more resources for snow removal, the nature and timing of the travel bans that affected the effectiveness of the movement and operation of the equipment, and the use of the most effective snow removal equipment – e.g., high-lifts, front loaders, or bucket loaders that "are much slower than plows."[141] Moreover, removal of vehicles was complex.[142] Also to quote the Buffalo DPW, "in Buffalo, it took until the night of December 28th for plows and other trucks to make at least one pass through every street."[143] In short, one of the primary equipment-related issues was that the most effective equipment was not the fastest.

Another issue is that backup power is often relied upon to at least temporarily reduce the risks of power outages. National Grid indicated they do not provide or support any such backup systems.[144]

Workforce

National Grid relied upon internal crews both locally and regionally, external electrical and tree contract workers, and others outside of its own organization from other utility companies, electric power associations, and government agencies. Accessing and coordinating all of those resources was challenging due to the numbers and scale, and the extent of preparation and training required for such a large workforce. National Grid indicated that those under direct control were

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[140] Metropolitan Transportation Authority, 2011

[141] Watson et al, 2023

[142] Watson et al, 2023

[143] Watson et al, 2023

[144] National Grid, personal communication, March 2023

pre-positioned at the outset of the blizzard,[145] that many had been trained prior to the storm, and that their work was supported by an extensive system of preparations and communications.[146] The company was able to draw upon and move around many of the members of its own workforce from other parts of New York State as well as other states, such as Massachusetts, and they estimated that about 3,800 personnel in total were involved in restoration in Erie County .[147]

Logistics

The emergency plans by National Grid, as well as those from the City, State and federal governments, devoted substantial effort to managing and coordinating resources for the December blizzard and putting in place a communication system that would support such processes and procedures. Snow removal and the various functions enabling it, for example, required complex logistics in the storm. An important element of snow removal was enabling the transportation system to allow electric power crews to access not only the facilities needing repair, but also getting electric power to pre-designated critical facilities and the people in them. National Grid indicated that its workforce was exempt from road closures and other restrictions where access was otherwise subject to approval from local authorities.

In addition, an important logistical consideration was the specification of plowing priorities. According to a National Grid representative, they provided high priority locations to the Department of Public Works, which the DPW had to balance with other plowing needs external to National Grid.[148] The first plowing priority area was specified as East Buffalo,[149] where one of the impacted substations was located, and was also included as a restoration priority. Although National Grid had set up arrangements and communications with key agencies before the storm, as the storm developed the number of entities in need of snow removal expanded substantially. National Grid reported interacting with the following agencies to establish plowing priorities: the New York State Police, New York State Department of Homeland Security and Emergency Services, New York State Department of Transportation, City of Buffalo Department of Public Works, City of Buffalo Police Department, and City of Buffalo Fire Department. Initially, National Grid relied heavily

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[145] National Grid, February 27, 2023 p. 11

[146] National Grid, February 27, 2023, pp. 9-11

[147] National Grid, personal communication, March 2023

[148] National Grid, personal communication, March 27, 2023

[149] National Grid, February 27, 2023, p. 28

upon the Department of Public Works for snow removal priorities, but this reliance later moved to the Police Department.[150]

Routes to the substations were given a high priority for snow removal in order to gain access to them for repair. But whiteout conditions, significant snowfall, and parked and stranded vehicles were a major impediment for utility crews, according to National Grid spokesman David Bertola in The Buffalo News: "power restoration began on the first day of the storm, but whiteout conditions and impassable roads impeded crews' ability to reach areas where restoration work was needed."[151] As a result, debris removal was a large part of the recovery and restoration process.[152]

Technological Approaches for Frozen Substations

National Grid drew upon both conventional and innovative technologies to restore electric power. Technologies for thawing out and reenergizing the substations were borrowed from those it already had on hand for other purposes as described above.[153] The company has indicated that to be proactive and prepare for future storms, it will now put station kits at every indoor substation. In addition, National Grid will send crews out in advance and tarp off transformer bays using concrete blankets to block them from snow.

Restoration time

One of the most common central issues for electricity users during a major storm is the stability of the electric power supply. The severity of these issues is rooted in various aspects of power restoration, such as the likelihood of an outage in the first place, the amount of time it takes to restore power (including reducing outage duration), short-term options for interim electric power while an outage is occurring, and longer-term considerations that reduce reliance on the grid.

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[150] National Grid, personal communication, March 27, 2023

[151] Watson et al, 2023

[152] Plowing priorities pre-storm and for this particular blizzard are reflected in both National Grid's electric emergency response plan published in December 2018 and updated (Chapter 28) effective 2022 and the City's Snow removal plan.

[153] National Grid, February 27, 2023, p. 29

Restoration times are a central function specified in National Grid's NY Electric Emergency Response Plan of May 12th, 2022, Section 15.2.[154] The calculation of power restoration times for the December 2022 blizzard were described in the February 27th, 2023 report,[155] including how start and completion times are determined. Specifically, the utility begins to enact restoration operations when "the severe weather will impact an area over several hours and within 8 – 12 hours of being impacted by the storm and incurring physical damage to the electric infrastructure serving customers".[156] National Grid estimated based on the severity of the storm at its outset that restoration would be "greater than 48 hours in duration for 90 percent of the affected customers."[157] Moreover, National Grid's emergency protocol to estimate restoration times is activated when "when more than 5,000 customers are out of service in a Division or more than 20,000 customers are out of service company-wide for more than 30 minutes," which was met in their service area.[158]

Advancing Power Stability

Likelihood of outages. The extent to which the outages could have been prevented, or at least reduced – and thus restoration time reduced – is reliant on a large number of factors that range from hardening the infrastructure and improving its performance to reliance on other power sources. The Buffalo News' Editorial Board, citing New York State's Climate Action Council, lists a number of prevention tactics aimed at improving the resistance of the infrastructure, changing its location, and relying on renewable energy sources.[159] After Hurricane Sandy, power company Con Edison produced a report with an extensive set of technological improvements for its service areas that may be relevant to Buffalo and National Grid.[160]

Short-term options. One of the shorter-term options for power stability is to lean on backup power supplies. Some larger establishments have their own backup supply, such as the telecommunications company, Charter; individual homeowners may have relied on this option also. As indicated above, National Grid does not provide

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[154] National Grid, May 12, 2022
[155] National Grid, February 27, 2023, p. 22
[156] National Grid, February 27, 2023, p. 22
[157] National Grid, February 27, 2023, p. 32
[158] National Grid, February 27, 2023, p. 32-33
[159] Buffalo News Editorial Board, 2023
[160] Consolidated Edison Company of New York, 2013

backup power, and thus any such sources would be private and not easily documented.

Longer-term energy options. The development of renewable energy sources has been considered an important priority for stabilizing and supplementing the energy supply. New York State has embarked on an extensive effort in its statewide energy master plan to promote renewable sources, and National Grid has taken part in this effort. The plan has identified renewable energy efforts in different regions of the state.

Interorganizational Management

Partnerships

In addition to internal resources, National Grid sought a variety of partnerships and arrangements with other organizations. The company was given a very high priority for resource support from the City at the outset, according to the Mayor's final report. This has also been supported by Mutual Assistance Agreements that National Grid has described extensively.[161]

The Edison Electric Institute's (EEI) Mutual Assistance Process was tapped for coordination with other municipal assistance groups. These agreements appeared to be organized hierarchically, relying first upon North Atlantic Mutual Assistance Group ("NAMAG") and then tapping Regional Mutual Assistance Groups ("RMAG") where NAMAG resources were not available.[162] National Grid, however, reported that pre-storm commitments were not obtained from them at the outset of the storm due to the lack of availability of resources. Instead, they were received on December 26th through NAMAG.[163] This was in part due to needs of other areas.

National Grid's territory covers a large area outside of the City of Buffalo. This means the company potentially could and did provide resources from other locations. Inevitably, in the case of a widespread storm such as this one, there will be competition for resources, and that usually necessitates drawing upon resources from longer distances away from the storm area.

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[161] National Grid, February 27, 2023, pp. 21-22
[162] National Grid, February 27, 2023, p. 11
[163] National Grid, February 27, 2023, p. 22

Learning from Previous Events

The 2014 "Wall of Snow" event, plus the November and December 2022 storms that preceded the December blizzard, were important prior events for lessons in response and recovery. Several issues in particular stood out. Among them were the interface between transportation and electric power restoration; which organizations can issue a travel ban and who they coordinate with in doing so about the timing of closures; how the authority changes in normal vs. emergency conditions; and how priorities can be set based on critical needs, including electric power outages.

Community Relations

Developing community relations takes place over a long time period to generate trust, adequate communication, and integration mechanisms and venues. This process can take many different forms, and ideally predates the onset of any emergency situation or other issue to be most effective.[164,165,166,167] National Grid and the City of Buffalo identified a wide range of organizations and groups with whom they interacted over the course of the storm. National Grid reported that it had used relatively standard ways of enabling affected customers to communicate with them, in addition to its emergency call lines.

Some conflicts arose that may have been unexpected at the time of the blizzard and would be important to include in a future preparedness plan. Apparently, when the City was trying to assist National Grid in snow removal, in some neighborhoods it was met with hostility from residents expressing concerns about National Grid. In order to not let this delay response, National Grid's immediate strategy to address these issues during the blizzard was to coordinate with the NYS Police if crews were being threatened. The police stayed with the crews.[168]

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[164] Crane, 2018

[165] Ianniello et al, 2019

[166] Lange et al, 2021

[167] Zimmerman, 2022

[168] National Grid, personal communication from Buffalo Police Chief Gramaglia to Mayor Brown, December 25, 2022 (appears in ScoreCard)

Interrelationships Between Electric Power and Other Infrastructure

Emergency conditions underscore the extent to which different utilities rely on each other in order to keep all their systems functioning. It was well established that the ability of electric power infrastructure to be restored depended on transportation to key locations. In turn, numerous functions depend upon electric power to function and recover. Key communication hubs, for example, depended on electric power; though they had backup power, it was finite.[169] An email from Charter Communications to DPW and National Grid stated:

"I already alerted some of you to our situation at our Chicago Street hub at 355 Chicago Street, which serves a large part of the city. This hub has been on backup power and the generator has possibly 12-16 hours left, as it runs on diesel and our crews have been unable to maintain it. We are working with National Grid to restore power, but as everyone knows, it has been near impossible to travel on roads. I understand the priority may be for recovery of city residents, plows and emergency vehicles, but I wanted to make sure everyone is aware of this situation and hope Public Works are able to plow the roads near the Chicago Street hub so National Grid crews can restore power."

National Grid ultimately restored the power to the hub, avoiding telecommunication outages.

Recommendations:

Conditions presented by the December blizzard were unprecedented, particularly in the realm of power infrastructure. In order to prepare for future storm events, we recommend that National Grid, and other entities that are part of ensuring the robustness of the electric power system, take the following steps, working with the City of Buffalo where appropriate:

1. **Implement a coordinated asset tracking system:** Given the larger share of outages experienced by the City of Buffalo compared to

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[169] Charter Communications, personal communication to DPW and National Grid, December 24, 2022, 5:30 p.m.

surrounding areas, a tracking system to identify resources from National Grid and others outside of the City, which can contribute to and benefit from City resources, will be necessary for successful response, as an event like the blizzard can affect multiple areas at the same time that all from the same pool of resources (including both physical facilities and workforce), requiring a distribution of resources.

2. **Provide an essential continuous tracking system:** Tracking information over time is critical for gauging the performance of response and recovery efforts. This step will help to prioritize responses and manage ongoing challenges. One source of such information is the outage data, which is provided in both list and mapped formats very frequently while an event is occurring. A means of archiving that data, which was notably lacking in the wake of the December 2022 blizzard, is important for a tracking system. The amalgamation of data will help inform National Grid and local governments about what steps to take to mitigate issues for upcoming storm and emergency events.

3. **Promote and maintain flexibility in the deployment of equipment and workforce resources:** This will be necessary to confront the many uncertainties that arise in extreme events, which National Grid was in part able to do with the resources under its direct control.

4. **Develop and maintain a strong network prior to an emergency:** This will need to be done with both stakeholders and resources that can be brought into play. This will ensure operations can be enacted more effectively than if such networks needed to be called upon at the outset of an emergency.

5. **Shape a fundamental outage policy:** This policy will need to incorporate the planning, design, operation and maintenance of electric power and related infrastructure across all functions, with a focus on what level of risk is tolerable under extreme events.

6. **Directly incorporate interconnections between electric power and other utilities and operations into planning:** This is an essential part of actions across the time period well prior to the event in the form of preparedness, and afterwards for mitigation and future planning. An important aspect of such interconnections is one already recognized in identifying critical facilities dependent upon electric power (see Appendix E1: Critical Facilities). Another that should be at the forefront is to determine what electric power depends upon, such as the ability of

transportation systems to provide support for access and mobility. [170] A third is the need to maintain a robust communication system, which is often dependent upon electric power.

7. **Maintain ongoing robust data systems prior to, during and following a storm:** National Grid, the main electricity provider, made extensive data available to the project, primarily the data required under NYPSC posting requirements as a ScoreCard. This was primarily aggregated by the larger geographic areas that encompass Buffalo, and the lack of availability of comprehensive sub-city data on outages inhibited some important analysis. Such finer levels of data – including, for example, where vegetation and electric power infrastructure intersect – can enable better knowledge of component failures and remediation, and in turn contribute to asset performance and user impact more effectively.[171]

8. **Use innovative distribution system design for protection:** This includes controlling how power lines fall to reduce the impact, and if that is not possible, to shift the strategy to improving recovery.[172] This approach involves having failures occur at specific points to prevent them spreading to adjacent poles, causing cascading effects. EPRI estimates that this strategy can cut recovery time down to a tenth of what it might otherwise be.[173] Relatedly, the Center for Climate and Energy Solutions also proposes a strategy of identifying the most vulnerable sectors and isolating them.[174] A strong communication system with digital and human elements that interact will be necessary to accomplish this.

Extreme events have the capacity to wreak catastrophic conditions and disrupt the social and economic fabric of society. And they are becoming more frequent. As National Grid repeatedly said in its after-action report, many conditions in the December 2022 blizzard were unprecedented – the intensity and persistence of the snow combined with wind, the way in which electric power facilities became immobilized, and the delay in restoration. The anticipation of such extremes is a challenge for both withstanding and recovering the electric power system, which in turn many other functions are dependent upon.

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[170] Li et al, 2022

[171] Electric Power Research Institute, 2015

[172] Brown, 2021

[173] Electric Power Research Institute, 2015

[174] Center for Climate and Energy Solutions, 2018

Appendix E1: Critical Facilities from the National Grid Electric Emergency Response Plan

Critical Facilities from the National Grid Electric Emergency Response Plan (National Grid May 12, 2022:190) and again in the after action report (National Grid February 27, 2023: 50-51).

"Critical Facility Level 1: Those facilities critical to public health and safety. These include:
a) Hospitals and Emergency Medical Facilities
b) Emergency Shelters and Cooling Centers
c) Fire, Police, Paramedics, and Rescue Facilities
d) Emergency Management Offices
e) Water and Wastewater
f) Critical Utility and Communications Facilities
g) Fuel Transfer and Fuel Loading Facilities (ports)
h) Mass Transit (tunnels, bridges, ferry terminals, major rail facilities)
i) Airports
j) Military Bases
k) Critical Flood Control Structures

Critical Facility Level 2: May include some of the same types of facilities described for Level 1 depending on the event type. These facilities provide significant public services but are considered to some extent less critical by government agencies. These include:
a) Nursing Homes and Dialysis Centers
b) Facilities to support other critical government functions
c) Prisons and Correctional Facilities
d) Communications (radio, TV, etc.)

Critical Facility Level 3: Facilities provide public services but are considered to some extent less critical than Level 2 by government agencies. These include:
a) Event Specific Concerns
b) High-Rise Residential Buildings
c) Customers providing key products and services (food warehouse)

d) Managed Accounts, Large Employers, and Other Key Customers
e) Other Government Buildings, Schools, and Colleges
f) Residential developments with large elderly populations or other similarly vulnerable establishments"

Appendix E2: Aggregated Distribution of Transmission System Lines for National Grid Western, Central, and Eastern Regions, New York ISO, 2022

New York ISO (2022: 138, Table VI-2) provides in aggregate a description of the western, central and eastern regions of National Grid's transmission system that encompasses but is larger than the City of Buffalo. The NYS system totals 5,111.5 circuit miles including both overhead and underground lines.

Table 6: National Grid Transmission System by Size or Type of Line, NYISO (2022)*

Type/Size	Overhead	Underground	Total OH and UG
115kV	4,037.4	22.9	4,060.30
138kV	0.0	0.0	0.00
230kV	426.4	20.2	446.60
345kV	604.3	0.4	604.70
500kV	0.0	0.0	0.00
750kV	0.0	0.0	0.00
Total	5068.1	43.5	5,111.60

* Numbers represent circuit miles. Definition of circuit miles: "Circuit-mile: The total length in miles of separate circuits regardless of the number of conductors used per circuit."[175]

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[175] U.S. EIA undated Glossary:
https://www.eia.gov/tools/glossary/index.php?id=finance#:~:text=Circuit%2Dmile%3A%20The%20total%20length,of%20conductors%20used%20per%20circuit.

Appendix F: Communications

The City of Buffalo's communications played a large role in how the public experienced the December 2022 blizzard. This section focuses on how the City and its agencies communicated to Buffalo residents during the storm, and provides recommendations for improving communications to create better outcomes in the future. Areas of focus include the timeliness, frequency, and content of storm warnings and guidelines; the relevance of messaging to residents' needs and concerns; the capacity of emergency responders; and the reach of BUFFALERT, the city's emergency alert system.

Key Findings and Recommendations

1. Storm warnings began later than many residents needed to be able to fully prepare for the storm. Though communications then escalated rapidly, the time frame for preparation was too narrow for many residents in the first place..

    a. **Recommendation: Communicate early and frequently, providing supplemental updates regularly.** During a weather event, city officials should provide frequent regular updates, information, and guidance throughout the day on all public platforms, offering information about City services and other local context. Moreover, they should include a note about when to expect updated information.

2. Public messaging did not fully address residents' questions and concerns, relying on undefined terminology, incomplete instructions to residents, and unanswered questions.

    a. **Recommendation: Messaging should be comprehensive and tailored to the city's demographics, needs, and concerns**. Terms that have decision-making significance should be clearly explained, including "essential worker" and weather-related terminology, so that residents understand and become familiar with how to respond.

3. Road closure and driving ban communications did not appear to be coordinated with the County and State; announcements from different levels of government were sent at different times.

    a. **Recommendation: The City should more thoroughly coordinate communications plans with Erie County and NY State agencies, especially about transportation-related guidelines or mandates such as travel bans**. Messaging should be consistent and distributed in a timely manner, and refer recipients to a primary source of information.

4. City communications focused on car-based transportation, rather than public transit, walking, paratransit, and other modes of transportation.
   a. **Recommendation: Communications should reach and address the needs of the most vulnerable residents.** Methods of communication and messaging should be tailored to reach vulnerable audiences, including home-bound seniors, residents who rely on public transit, and paratransit users, who are largely left out by communications that focus on drivers.
5. City social media posts lacked regular frequency and content. While Mayor Brown's and city agencies' social media accounts (such as 311 and DCS) were active before and during the storm, this was often not in the form of official announcements that can mitigate confusion and curb the spread of misinformation.
   a. **Recommendation: Expand City social media presence, well before storm events, to provide information and counter misinformation.** On all platforms, the City should regularly deploy easy-to-digest information instead of full-length videos of press events.
6. Emergency and non-emergency numbers needed more resources. During the storm, Buffalo's first responders were overwhelmed; in Erie County's 911 dispatch, roughly 1,200 active calls were handled per day during the first few days of the storm.
   a. **Recommendation: Use technology to improve emergency response capacity and transparency.** The BPD dispatch system should be improved in collaboration with Erie County to avoid future issues like duplicative calls (already underway). The transparency of the city's emergency response efforts can be increased by providing live information to the public using the Open Data portal.
7. Only 16% of residents are enrolled in the City's messaging alert system, BUFFALERT, limiting the city's ability to spread urgent safety-related information.
   a. **Recommendation: Expand BUFFALERT reach, issue more alerts, and consider other notification systems.** The city should invest in print and digital marketing, as well as tabling at community events, year-round to expand enrollment in BUFFALERT. In addition, Buffalo can send carrier-based emergency notifications that do not require opting in by obtaining certification from New York State to utilize FEMA's Wireless

Emergency Alert program, and partnering with Erie County, which is already an authorized alerting body, to send localized notifications[176,177].

8. The city shared updates with the press, but public reach was unclear due to city demographics. While the Mayor held press events before, during, and after the storm as his main form of public communication, the exact reach of these press events and news reports within Buffalo is unclear – especially when considering the widespread loss of power, lack of access to television or internet, and other demographic factors affecting the reach of traditional media in Buffalo.

   a. **Recommendation: Proactively partner with community-based organizations to assist with communications.** Throughout the year, the City should build connections with existing community organizations that can reach specific groups of residents and match volunteers, resources, and services to those who need them.

How was the Storm Communicated to the Public? An Analysis

1. Storm warnings began late, then escalated rapidly-- likely sending mixed messages.

As early as December 19th, 2022, National Weather Service Buffalo was forecasting a "powerful storm" that would impact Buffalo.[178] By December 20th, the NWS had declared a Winter Storm Watch.[179] While city agencies and officials had internally begun to prepare for the storm, initial warnings to the public did not convey a significant urgency to match the forecasts. For example, Mayor Brown's social media posts on December 21st "encourage[d]" people to finish "holiday and personal errands" by December 22nd (Figure 18).[180]

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[176] FEMA. *Wireless Emergency Alerts*.
[177] Federal Emergency Management Agency, May 17, 2023
[178] National Weather Service Buffalo, December 19, 2022.
[179] National Weather Service Buffalo, December 20, 2022.
[180] Brown, December 21, 2022.

Figure 18. A Facebook post from December 21st, 2022 from Mayor Brown warning residents about the storm. It was among the first of the City's social media posts about the storm, and came on the same day NWS Buffalo predicted a "once-in-a-generation storm."[181]

Those were the first mentions of the storm on the Mayor's social media platforms, even though as of that morning the NWS was already predicting a "once-in-a-generation storm" that would bring gusts over 65 mph and likely cause power outages.[182] The next day (December 22nd), the Mayor issued more urgent

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[181] Brown, December 21, 2022
[182] National Weather Service Buffalo, December 21, 2022

warnings about the storm at a press conference, and declared a State of Emergency beginning December 23rd.[183] Finally, once the storm began on December 23rd, city officials declared further emergency measures, including sharing the travel ban.

The late start to official warnings, plus the rapid but still delayed escalation of restrictions, are likely part of the reason many people were not fully prepared for the storm. The official messaging trailed forecasts by a day or more, and the quick ramp-up to more urgent declarations may have sent mixed messages to those who were still planning to travel based on more moderate messaging that they had recently received. Generally speaking, individuals and businesses need enough time to decide in advance to change travel routines or plans, especially shift workers and those planning to travel for a major holiday like Christmas. The 72-hour transition from a recommendation against travel, to a de facto travel restriction (except for a vaguely-defined group of "essential workers"), to a de jure travel ban, meant that many people who regularly leave home for work or other purposes had to quickly decide whether they qualified to stay home on December 23rd. Some businesses opened that Friday morning and required employees to report to work in-person.

This lack of clarity was compounded by the fact that the City did not announce the travel ban on December 23rd until well after peak morning commuting hours on that day. Although the travel ban was announced by Erie County at 8:45am to go into effect at 9:30am, on many first- and third-party platforms (Facebook, Twitter, BUFFALERT, traditional news sites), Buffalo announced the travel ban at 9:58am,[184] and on other platforms like Instagram, it was not posted at all. City warnings prior to the storm (discussed above) discouraged some travel, but did not prevent all of it, as seen by the Waze data described in the roadway section and the high number of vehicles stranded during the storm. It's clear that those earlier, less urgent warnings do not fully justify the delayed ban announcement. Several people ventured outside because of work or to obtain necessities. At least some would likely have stayed inside if the travel ban had been announced further in advance and with more urgency. In addition, an earlier announcement could have better signaled the severity of the storm to residents as they made preparations. City officials also sent announcements to City agencies and stakeholders such as the Buffalo Common Council and Block Clubs, but earlier coordination could have allowed them to spread messaging sooner.

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[183] WGRZ Staff, 2022.
[184] BUFFALERT, December 23, 2022, 9:58 a.m.

2. Public messaging did not fully address residents' questions and concerns.

Across all channels of official public communications (BUFFALERT, social media, press events, etc.), several messaging problems hindered residents from getting all of the information they needed to make safe, informed decisions during the storm.

First, citywide messaging was not always clear about the meaning of emergency declarations and terms that could be ambiguous for the average resident. For example, BUFFALERTs about "essential personnel" being allowed on the roads did not define what was meant by "essential."[185] Similarly, declarations like "blizzard warning" and "winter storm warning" on the city's public-facing messaging did not explicitly offer instructions to stay home.[186] While some of these terms may seem self-explanatory, the amount of ambiguity likely led to confusion and reduced conformity. Although instructions about staying indoors were shared by Erie County, they were not shared on BUFFALERT or Buffalo's social media until later in the storm, which would have helped city residents grasp the severity of the situation earlier.

Second, in the complex storm situation, the City's messaging often took the form of basic orders about what not to do, alongside incomplete information about resources. The resulting messaging was difficult for some residents to follow, given their needs and resources. For example, information about warming centers not only generally lacked transportation guidance, specifically about when and how to travel to the centers, but it also seemed to contradict orders to stay indoors amid the travel ban (Figure 19).[187]

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[185] BUFFALERT, December 23, 2022, 8:55 p.m.

[186] BUFFALERT, December 23, 2022, 8:37 a.m.
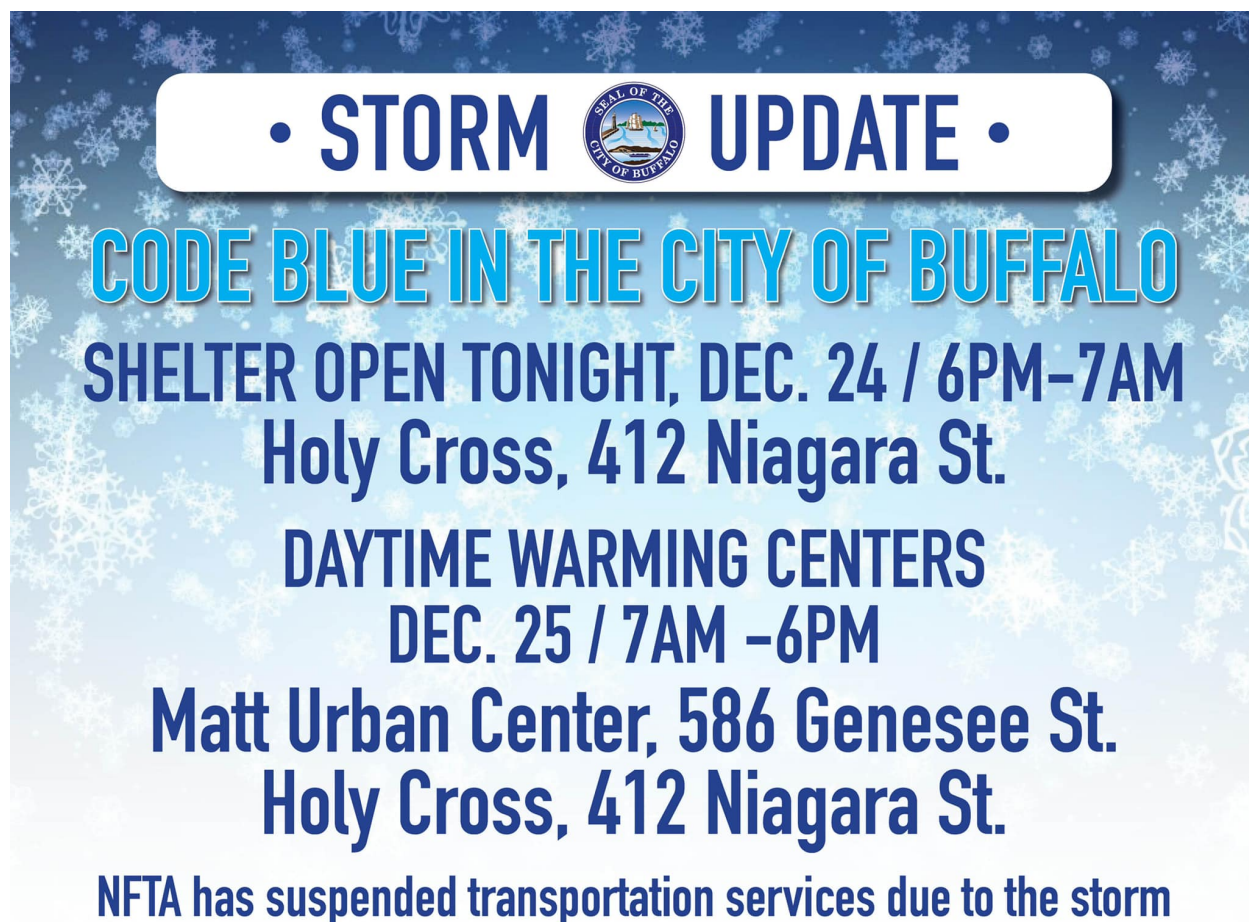
[187] Brown, December 24, 2022.

Figure 19. Example of a graphic providing warming center and shelter information that does not describe how a resident could access it in storm conditions or without a vehicle.[188]

In other words, a resident (with or without a car) would seem to be violating the travel ban in order to reach the warming center. While there may have been no easy answers for city officials to give, the lack of a comprehensive approach to communicating related mandates and resources likely hindered residents' ability to make better-informed, potentially life-saving decisions.

Third, messaging from City sources did not seem to respond to common concerns or questions that were being received (such as via social media comments). In the above example of the warming centers, residents posted Facebook comments on the Mayor's account asking how to reach warming centers when there was a travel

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[188] Brown, December 24, 2022.

ban in place and NFTA services were suspended.[189] This question was neither addressed through direct replies nor by subsequent announcements, leaving residents' questions unanswered by official sources. Another common question concerned the status of plowing in specific locations. While DPW and other City agencies, as well as Erie County agencies, were prioritizing life and safety rescue and power outages during earlier stages of the storm, the messaging about this prioritization could seem dismissive even when it reflected sound policies. For example, on December 26th the Mayor's Twitter account tweeted that "The focus of the City's operation has been on life safety. We are plowing to get to motorists that have been stranded in vehicles."[190] The lack of two-way engagement likely contributed to some residents' frustration.

3. Road closure and driving ban communications did not appear coordinated.

County and State officials announced and implemented road closures at different times for the roads they each oversee. The closure of state DOT routes like I-190, which started at 6:00am on December 23rd, was announced on December 22nd, alongside an announcement that I-90 would be closed to commercial traffic at the same time. Meanwhile, on December 23rd, Erie County announced at 8:45am that it would be banning travel starting at 9:30am. The City of Buffalo announced the travel ban on BUFFALERT at 9:58am and Facebook at 10:12am. Lastly, the state Thruway Authority closed I-90 to all traffic at 2:00pm that day.[191] Staggered closures can be necessary to avoid stranding vehicles that were already on the road; however, these closures and travel bans seem to have been announced haphazardly. Offering uniform, synchronized announcements benefits residents receiving information from different channels to have the same information.

These announcement timings were likely due to Buffalo and Erie County officials waiting for the State's decision, having grown accustomed to the previous New York State Governor's common executive orders closing local roads, which he did 14 times. [192] During this storm, Governor Hochul left road closures to local authorities, while the Erie County Executive expressed concerns about starting the ban too early.[193]

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[189] Silke, 2022.

[190] Brown, December 26, 2022.

[191] Bragg, 2023.

[192] Bragg, 2023.

[193] Buffalo News Editorial Board, 2023.

4. City communications focused on car-based transportation. Communications about public transit, walking, paratransit, and other modes were generally absent.

Communications from the City of Buffalo about transportation during the storm focused on the use of personal vehicles. Communications about public transit, walking, paratransit, and other modes were generally absent. Even though the State-run NFTA operates the transit system, the City could have better tailored messaging to reach its approximately 57,000 residents who use public transportation daily.[194] While the NFTA's suspension of services from December 23rd to 26th likely kept most transit riders indoors, the lack of messaging targeted at the 21% of households who do not own a vehicle (who are also disproportionately lower-income) meant that those households were less prepared and informed about what to do. For example, information about warming centers was often shared without guidance about whether, when, or how they were accessible for those unable to drive to them. Some bodies of government (such as the Buffalo Common Council) shared instructions about how individuals could be shuttled to warming centers from bus stops, but such information was broadly missing from city agency and mayoral communications.[195] Besides contributing to a feeling of being ignored, these omissions could have created life-threatening situations for individuals without cars who may have risked leaving their homes on foot to reach heat or other necessities, as well as for paratransit customers who may have been stranded.

5. City social media posts lacked effective frequency and content.

While Mayor Brown's and city agencies' social media accounts (such as 311 and DCS) were active before and during the storm, both the frequency and content of the posts were insufficient for the severity of the storm. Residents can supplement official announcements with news from other sources, but a dearth of official announcements likely contributed to confusion and the spread of misinformation.

The issue of frequency is related to the timing of warnings described in section 1 above. The infrequency of announcements through social media meant not only that each post was more likely to be "buried" and not seen on residents' feeds, but also that each one carried more "weight" than it would have if more frequent updates were being made. The Mayor's storm-related post on December 22nd, for example, needed to inform people that the storm was going to be severe and that

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[194] McCarthy, 2022
[195] Buffalo Common Council, December 23, 2022

they should not go outside the next day, because the prior post on December 21st had only "encouraged" people not to travel (Figure 18).[196] While posting more is not always better, one post per day about the storm prior to December 23rd was likely not enough. By contrast, Erie County Commissioner Mark Poloncarz's Twitter account posted around 30 tweets on December 22nd, with a mix of weather updates, infographics, and County-related updates (such as school closures and information about the EOC).[197]

In addition to lacking frequency, some social media posts from City-related accounts before and during the storm did not take the form of media that would be most easily digestible by many residents . The aforementioned crucial update on December 22nd took the form of a 22-minute livestream (and subsequent video recording) of an in-person press conference, posted on Facebook (Figure 20).[198]

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[196] Brown, December 21, 2022
[197] Poloncarz, n.d.
[198] Brown, December 22, 2022

Figure 20. A Facebook post with a recorded press conference livestream. The post does not include text describing the key points of the press conference (such as the State of Emergency starting on December 23/22), so audiences would need to watch the 22-minute video, reducing the post's effectiveness. [199]

The description reads "December 22 Storm Update." The post has 6,100 views as of this writing, but it is unclear how many people watched enough of the video to learn that a State of Emergency was being declared for the next day. Key announcements from the press conference were not summarized for social media, either in the same post or in a separate one. The long video without description, and the fact that it was not shared on Twitter, Instagram, or other social media platforms beyond Facebook, likely reduced the reach of its crucial messages. While the information was conveyed through third-party sources, such as TV news channels and their websites, those are not perfect substitutes for first-party platforms. Furthermore, while some of the Mayor's other posts used more easily digestible infographics, these lacked alt text for accessibility. Lastly, the City's social media posts were in English only, despite 8% of residents having limited English proficiency.

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[199] Brown, December 22, 2022

While Buffalo residents were likely also receiving messaging from the County, State, and other news sources, they were also seeing popular posts by residents, local businesses, and organizations. While these posts served as ad-hoc methods of spreading helpful information, some also spread misinformation. For example, some residents were misled to call the Erie County SNOW hotline for National Guard emergencies, to report power outages, or to request food delivery, even though that number was reserved for serious but non-life-threatening emergencies and could not assist with those matters.[200] Other posts that were not misinformation per se contributed to "noise" on social media that may have buried more important communications. Posts requesting urgent help, posts about less urgent needs, or distressing posts showing bodies, for example, all competed for attention on social media platforms. More frequent and social-media-friendly content from City-run social media accounts likely would have helped spread accurate, potentially life-saving information, and built trust with residents.

6. Emergency and non-emergency numbers faced insufficient capacity and unclear messaging.

During the storm, Erie County's 911 dispatchers were overwhelmed with callers, with roughly 1,200 active calls being handled per day during the first few days of the storm. Several factors contributed: a limited number of dispatchers (even with the number doubled to 6 for the storm), a County-run dispatch system that can only show 25 calls at a time to the dispatcher, and repeat calls.[201] 858-SNOW, a County-run line for serious but not life-threatening needs for help, was also overwhelmed with callers. The Western New York health and human services line, 211, received 2,500 calls from December 23rd to December 27th, a 144% increase from the same period in 2021.[202] Each of these numbers faced a common issue: callers would take up bandwidth with matters that were either not handled by that particular number, were duplicative, or were not being prioritized at the current stage of storm response (such as the plowing of residential streets when the top priority was life and safety rescue). Erie County Executive Mark Poloncarz tweeted on December 23rd: "According to @ErieCountyESU Commissioner Neaverth, we need to "weed out" about 90% of calls that are coming into the 911 call center. 911 is for true life and death emergencies.".[203]

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[200] Poloncarz, December 24, 2022
[201] Buffalo Police Department, personal communication, February 6, 2023
[202] 211 WNY, personal communication, March 1, 2023
[203] Poloncarz, December 23, 2022

The first issue seems to reflect some residents' reporting that the numbers to call for various situations were not clearly communicated by the City or County. While operators staffing the lines attempted to redirect callers or provide resources, they also reported facing a lack of information themselves that stemmed from lack of direct coordination between the various entities; for example, 211 operators had to call warming centers to verify if they were truly open, and had to ask the SNOW line for transportation information. Ideally, these data points would have been communicated automatically to all external communications needs. These numbers were especially crucial for disabled and senior residents without internet or power, who had no other way to obtain information.

The 311 line, run by Buffalo's Division of Citizen Services, also faced issues of repeat callers as well as calls about issues that were not feasible to address at the moment. [204] Notably, 311 had been conducting outreach to underserved communities in Buffalo beginning prior to the storm. This served that department's situational awareness well, as that team remained tuned in to neighborhood needs throughout the storm event.

On Saturday, December 24th, BPD's tweet stating that "EMS service is very limited" due to the whiteout conditions and impassable roads, along with 1,000 calls to 911 that went unanswered over several days, caused fear among residents.[205,206] Since rescue operations during the worst of the storm were indeed impossible, this is a scenario that should be addressed in planning communications for future storms, as well as plans to update the public on when emergency services would likely become available again. This would have built trust with residents and ensured that the most vulnerable residents would be prepared for a lack of immediate emergency assistance.

7. BUFFALERTs did not reach a majority of residents, and were late in some cases.

BUFFALERT, Buffalo's emergency alert system, reaches residents through text messages, emails, and voicemails. Eighteen storm-related BUFFALERTs were sent to the general public between December 22nd and 30th. The last alert on December 30th reached 44,292 subscribers. The first storm-related alert, sent on December

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[204] Buffalo Department of Citizen Services, personal communication, February 6, 2023
[205] Buffalo Police Department, December 24, 2022
[206] Kilgannon et al., 2022

22nd, reached 43,748 subscribers, so there was a net gain of 544 subscribers (+1.2%) during the storm period. This suggests that the City's efforts to encourage sign-ups to BUFFALERT had some success.[207] Still, out of 276,807 Buffalo residents, the 44,292 subscribers represent only 16% of residents. Since multi-person households can share information from one subscriber, it may be more accurate to say that up to 38% of households (out of 118,071 total) are subscribed to BUFFALERT, though the percentage is likely lower due to households that have more than one BUFFALERT subscriber.[208] That said, BUFFALERT's ability to reach subscribers directly through multiple means (text message, email, and voicemail) contributed to its reach exceeding that of most of the city's social media posts – and possibly other communications methods, such as press conferences, as well.

Despite its potential to share updates with residents more promptly than other channels, BUFFALERT suffered from the same issue of lateness described in section 1 above. For example, the travel ban was sent as an alert at 9:58am on December 23rd, before the City's social media accounts but still after the ban went into effect at 9:30am.[209]

Unlike many other cities, Buffalo does not partner with FEMA, New York State, or telecommunications providers to push emergency alerts to all mobile phones in a given emergency area. These alerts, which are categorized by FEMA as "Imminent Threat Alerts" for extreme weather, are particularly helpful for shelter-in-place orders. [210] Without these partnerships, Buffalo continues to rely on opt-in emergency messaging that only reaches a small number of residents. Erie County is approved as a sender of these alerts, presenting an opportunity for the Buffalo government to utilize this system when communicating with residents in future emergency situations

8. The city shared updates with the media, but public reach was unclear due to city demographics.

The Mayor held press events before, during, and after the storm as his main form of public communication. While important, it is unclear how effectively these reached the general public. Some press events (either in-person or on Zoom) were posted on the City's online media platforms, but could have been done so more effectively, as

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[207] BUFFALERT, 2022

[208] United States Census Bureau, 2021b

[209] BUFFALERT, December 22, 2022, 9:58 a.m.

[210] FEMA. *Emergency Wireless Alerts*.

discussed in the section above about social media. Press events were also disseminated through TV and radio news outlets, news websites, and reporters' social media platforms. Mayor Brown also made direct appearances on local news (WGRZ, WKBW, WIVB, WUTV, Spectrum, FOX, WBEN, Buffalo News, NPR and The Government Channel) as well as national TV.[211]

However, the exact reach of these press events and news reports within Buffalo is unclear – especially when considering the widespread loss of power, lack of access to television or internet, and other demographic factors affecting the reach of traditional media in Buffalo. Not all households have access to television, and those that do can lose it during power outages or severe weather. Unhoused Buffalonians, which some estimates put at around 900 on any given night across Erie County and four of whom died during the blizzard, are also less likely to have access to TV or radio.[212] Modes of communication other than traditional press briefings or conferences disseminated to TV and radio are therefore important.

Buffalo's neighborhoods vary in terms of internet access. Figure 20 shows U.S. Census tracts in which over 25% of households lack internet access. These areas also have high percentages of households without high-speed broadband (defined as at least 25/3 Megabits per second) and/or without computers, mobile phones, or tablets.[213] These tracts tend to be on the East Side, in lower-income neighborhoods, raising equity concerns about internet-based communications' ability to reach the most vulnerable residents.

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[211] Office of the Mayor of Buffalo, 2023
[212] Tokasz, 2023
[213] National Telecommunications and Information Administration, 2021

Figure 21. Buffalo Census Tracts with 25% or more households without internet access. Derived from the NTIA Indicators of Broadband Need Map, which uses data from the American Community Survey 2016-2020.[214]

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[214] National Telecommunications and Information Administration, 2021

In addition, 8% of Buffalonians qualify as Limited English Proficiency (LEP) residents according to the U.S. Census, and about 19% of residents speak a language other than English at home.[215] English-only communications do not effectively reach these residents. Partnerships with community groups can help to disseminate information in non-English languages.

Recommendations for Future Winter Storm Communications

1. Communicate early and frequently, providing supplemental updates regularly.

Buffalo should plan to provide timelier and more frequent communications about serious weather events immediately following weather experts' predictions. Once NWS Buffalo declares a Winter Storm Watch, Blizzard Watch, or other substantial forecast, standard procedures should be in place to publicly communicate not only the severity of the forecast but also how residents and businesses should prepare. These procedures should convey the information within hours, not days. In particular, mandates such as travel bans or information about parking garages for off-street car storage need to be communicated further in advance. Early communications should also target employers, whose decisions to open for business can affect many residents' travel decisions.

Best practices in crisis communications indicate that regular, frank information updates, with a timeframe for the next status report, provides a consistent source of verified information and reassurance in leadership during an unpredictable time.[216,217] In addition, research demonstrates that longer, more informative communications produce a briefer delay in response.[218]

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[215] United States Census Bureau, 2021a

[216] Kayyem, p. 74.

[217] Schacht, 2020

[218] Wood, et al, 2018.

During a weather event, city officials should provide frequent regular updates, information, and guidance throughout the day on all public platforms. Moreover, they should include a note about when to expect updated information.

2. Messaging should be comprehensive and tailored to the city's demographics, needs, and concerns.

Messaging should clearly define terms that have decision-making significance. For example, it should define the category of "essential" workers during a winter storm and use said category to issue guidelines to employers prior to storms. Use weather-related terminology (for example, "blizzard warning") in proper contexts and explain its implications in plain language (for example, "Do not go outside to shovel or run errands; weather is deadly"), so that residents become familiar with how to respond rather than ignoring the terminology as jargon.

Messaging should comprehensively address the range of situations that residents may find themselves in, rather than taking a one-size-fits-all approach. For example, notice of warming center openings could be followed by information about how residents who need to get to a warming center can do so safely (before storm conditions/travel ban sets in), with additional guidance for those who do not own cars.

Messaging should respond to residents' concerns that come up repeatedly, even if those concerns are not able to be fully addressed at that moment. For example, questions about plowing on residential side streets could be answered with information about the different stages of emergency operations and with regular follow-ups about the status of plowing. The City should make every effort to respond to essential questions posted on social media.

3. The City should more thoroughly coordinate communications plans with Erie County and NY State agencies, especially about transportation-related guidelines or mandates such as travel bans.

While the City and County talked hourly through the weather event, and there were efforts to coordinate messaging, these were not sufficient to project a fully coordinated communications response. The City of Buffalo should more thoroughly coordinate communications timelines and content with Erie County and NY State agencies (such as the Thruway Authority), especially about transportation-related guidelines or mandates such as travel bans, which were distributed at various times,

or the status of EMS response. The goal should be that consistent messaging can be distributed in a timely manner. Government entities should agree on a plan for announcing right-of-way closures, simultaneously laying out all changes regardless of jurisdiction, rather than the current system in which separate announcements are made about different (but intersecting) road networks. While staggered closures may be required to avoid stranding drivers, they should be pre-planned and clearly communicated with the public, and the various parties can amplify each other's messaging to ensure better reach. The coordinated announcement, implementation, and enforcement of closures and other right-of-way modifications can prevent confusion and ensure compliance. Buffalo should ensure that it works with Erie County in developing emergency alert plans for future storms.

4. Communications should reach and address the needs of the most vulnerable residents.

Methods of communication and messaging should be tailored to reach vulnerable audiences like home-bound seniors, who under a loss of power may need to be reached by landline phone, and for whom transportation and wheelchair access to warming centers could be essential. Other vulnerable groups include residents who rely on public transit, including paratransit users, who are largely left out by communications that focus on drivers. Even though the state-run NFTA operates transit services, the City can amplify its messaging and coordinate with the agency to help serve residents who use public transit or do not have cars, rather than merely noting that the NFTA has suspended services.

Buffalo should continue to support language access, as outlined in the equity section below, to ensure that all residents receive time-sensitive updates. Identifying and partnering with community groups to help disseminate information in non-English languages can help with language access needs.

Digital communications should be accessible to people of all abilities. Ensure images have alt text to reach people who may have vision impairments, which is typically a quick addition to a website or social media post, using the text already in the image. Coordinate with disability-related agencies and groups to ensure that accessibility is considered when communicating about emergency services.

The city should not only post across traditional and social media, but also on physical display signage throughout the city, particularly at populated and high-traffic locations like shopping centers, major intersections, and community centers. By

posting information for passers-by, the city can help to ensure that messaging reaches a wider swath of the population, including those without power or internet access.

5. Expand City social media presence to provide information and counter misinformation.

The City should expand its social media audiences well before storm events through marketing and creative content, and consider expanding to other platforms like TikTok to reach audiences where they are.

On all platforms, the City should provide easy-to-digest information instead of full-length videos of press events, while keeping visual accessibility of images or infographics in mind (using alt text and captions for low vision individuals). In addition, documents such as the Snow Plan should be machine-readable, permitting their use by screen readers and adding the option to plug the data into additional websites.

Official social media communications should be rapidly and regularly deployed to keep up with the pace of social media posts and mitigate potential misinformation from the public.[219] This means increasing the frequency of updates. During an event, information should travel both from agencies to the public and from the public to the agencies.

As many social media platforms have moved away from chronological feeds toward algorithmic feeds, it is even more important to post frequent and well-crafted updates as the urgency of a storm increases, to reach people who are not following every post of government accounts. Use of paid promotion may also be useful for increasing reach as urgency increases.

6. Use technology to improve emergency response capacity and transparency.

The Buffalo Police Department dispatch system should be improved in collaboration with Erie County to avoid duplicative calls (already underway at the BPD). The City should expand the use of virtual (at-home) call centers and consider upskilling other city employees for deployment as dispatchers in the event of an emergency.

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[219] Kaufman, 2013

The transparency of the city's emergency response efforts can be increased by providing live information to the public using the Open Data portal and other means. [220] Resources like the DPW's snow plowing status map should be supported and spread to increase the public's awareness of and trust in government actions by sharing the current "big picture" of the city's response.[221] These technologies can have limitations, like delays or the inability to show county or state movements. They should be used in conjunction with other mediums, such as physical signage.

7. Expand BUFFALERT reach, issue more alerts, and consider other notification systems.

BUFFALERT enrollment should be expanded significantly to reach as many Buffalonians as possible. The city should invest in print and digital marketing year-round, but also conduct more proactive (such as door-to-door) outreach to sign up tech-averse seniors, immigrants, and other underserved groups who otherwise may not be signing up. The City should aim to enroll the majority of households.

In addition to BUFFALERT, the City should use carrier-based emergency notifications that do not require opting in by obtaining certification from New York State to utilize FEMA's Wireless Emergency Alert system with Erie County (already an approved alerting authority).[222] This technology pushes calls and texts through carriers to people who haven't opted in to BUFFALERT, but who can be accessed through partnerships with telecommunications providers.

In addition, Buffalo's public-facing announcements, as well as 311 operators, should point residents to BUFFALERT as the verified source of up-to-date information to ensure consistent messaging.

8. Proactively Partner with Community-based Organizations to Assist with Communications

Throughout the year, the City should build connections with existing community organizations that can reach specific groups of residents and match volunteers, resources, and services to those who need them. The existing model of outreach

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[220] Open Data Buffalo, n.d.
[221] Buffalo Department of Public Works, 2023
[222] FEMA, 2023

used by Buffalo 311 could be expanded, further bringing proactive outreach to traditionally underserved neighborhoods and groups to inform them of resources like emergency numbers or shelters. The goal would be to build a network of representatives and leaders from different communities, and to provide them with training on how to help spread information, resources, or assistance to their neighbors during an emergency. In addition, the City can learn localized information about neighborhood conditions and needs.

Appendix G: Charter Communications

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Characteristics of Charter Communications and Its Services

Charter Communications is a cable operator that provides a wide range of internet services under the brand name Spectrum. It has a substantial presence in New York State, where it serves 3.2 million customers – about ten percent of its 32 million nationwide customers.[223] Other telecom providers in the Buffalo area include Verizon and Greenlight Networks. Verizon has some old copper lines providing DSL internet service, as well as FIOS to a limited extent.[224] Greenlight is a newer company, established in 2011, with coverage of "120,000 homes in 21 municipalities in the Rochester, Buffalo, Binghamton, and Albany areas."[225]

Charter Communications has a hybrid-fiber coaxial network in Buffalo providing service to "all business, government and residential buildings" for high-speed internet, cable TV, and phone services."[226]

Although Charter Communications' operations do not fall under the City of Buffalo's control, maintaining communications during an emergency situation is essential, and addressed here.

Emergency Planning Procedures

Charter's disaster planning procedures are drawn from its Disaster Emergency Action Plan (DEAP). It explains that the reach of its own resources in emergencies extends across seven northeastern states, as well as Ohio and North Carolina.[227] The company seems to employ typical notification procedures for its customers in the event of an outage, but no information was available on the extent of the use of these procedures.

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[223] Charter Communications / Spectrum, 2023

[224] Charter Communications, personal communication, March 17, 2023

[225] Greenlight Networks, 2023

[226] Charter Communications / Spectrum, 2023

[227] New York State Public Service Commission, 2022, p.5

Blizzard Impacts

Charter Communications estimates that 56,000 customers experienced service outages in the Western New York region (which encompasses the City of Buffalo but other areas as well) during the blizzard. One problem that arose exemplifies Charter's dependence upon other services, namely transportation and electric power (this is covered in the electric power section). One of its hubs, the Chicago Street hub at 355 Chicago Street, provides services to a large portion of Buffalo. The company had to rely upon a diesel-powered backup generator, which had to be refueled during the blizzard. The company estimated at the time that it had only 12-16 hours of fuel left.[228]

The tanker truck required for refueling was 20 miles away from the hub, and getting to it required transportation routes to be cleared. As a result, Charter relied upon the City of Buffalo's assistance, along with police escorts. The company underscored the importance of being exempted from travel bans under NYS Chapter 724. The reliance on backup power ended the evening of December 25th, with assistance from National Grid providing commercial power.

Recommendations

The use of backup power during the blizzard was important, for at least a short duration. Better proximity of a truck for refueling would improve circumstances, especially at the onset of the storm. As in the National Grid circumstance, Buffalo must incorporate the telecommunications provider's needs, such as site access, into emergency planning.

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[228] Charter Communications, personal communication, March 31, 2023

Appendix H: Equity Concerns Raised from the Blizzard's Impact and Recovery

While the snow hit all of Buffalo hard, the blizzard's impact was felt hardest in Buffalo neighborhoods that endure persistent economic hardships and resource limitations. This issue arose throughout stakeholder interviews and media coverage.[229,230,231,232]

As crisis management expert Juliette Kayyem wrote, "Disasters hold our attention because of the harm we see, but also because they hold a mirror to what we are and the society and institutions we have built. Disasters find victims as they are, not as we want them to be. They expose all that is already wrong in a society."[233] Through data analysis and interviews with community stakeholders, the NYU research team uncovered several salient points about observed inequities and opportunities for the City to address preceding future disaster responses.

Although equity concerns are long-standing and require systematic investments on local, statewide, and national levels, the City of Buffalo can help to alleviate the challenges faced by Buffalo's lowest-income communities.

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[229] Merriweather & Woods, 2023
[230] Specht, 2023
[231] Watson et al, 2023
[232] Walker & Ghirmatzion, 2023
[233] Kayyem, 2022

2021 Median Household Income by Census Tract

N

Legend

Median Household Income
- $10,585.00 - $22,500.00
- $22,500.01 - $31,921.00
- $31,921.01 - $40,567.00
- $40,567.01 - $60,123.00
- $60,123.01 - $91,438.00

0   0.5   1   2 Miles
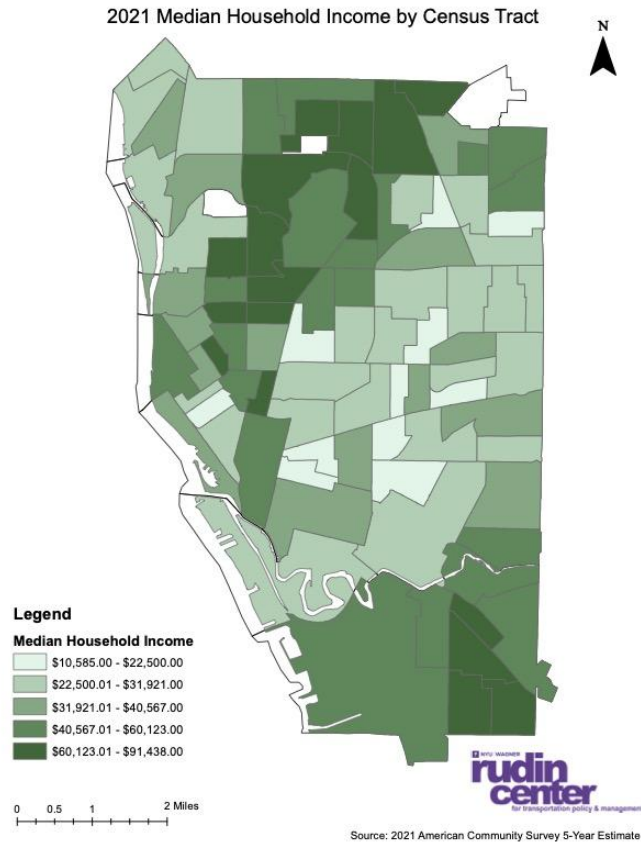
Source: 2021 American Community Survey 5-Year Estimate

Figure 22. 2021 Median household income by census tract, Buffalo[234]

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[234] United States Census Bureau, 2021f.

Most Populous Race per Census Tract

Legend

Most Populous Race by Census Tract
- Asian alone
- Black or African American alone
- Some Other Race alone
- White alone

0   0.5   1   2 Miles

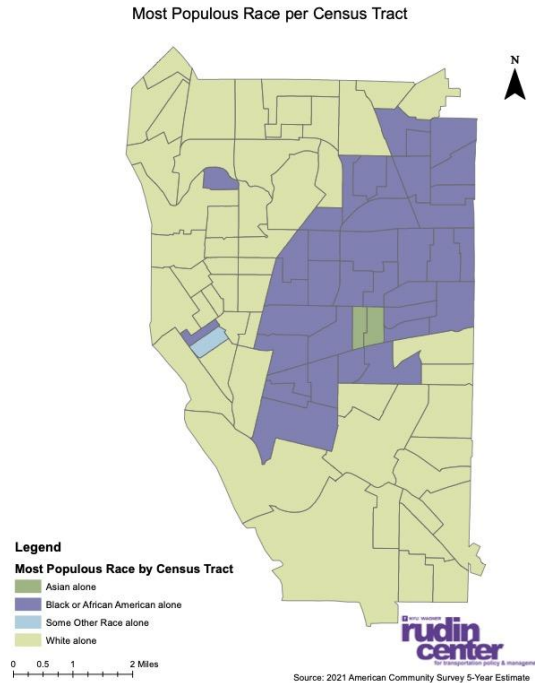Source: 2021 American Community Survey 5-Year Estimate

Figure 23. Most populous race in each census tract, Buffalo[235]

Disparate Impacts on Communities of Color

A total of 47 people died due to the effects of the Buffalo Blizzard; 31 of these deaths were in the City of Buffalo.[236] Buffalo was recently found to be the seventh most segregated city in the United States[237], and therefore, any problem that affects geographic areas differently has equity implications as well. In sum, 20 of the 31 people found in Buffalo, and 26 of the 46 people found dead in Erie County were people of color; 25 were Black and one was Hispanic.[238,239] Black residents make up only 13.8% of Erie County's population, and 33% of Buffalo's, but over 50% of the death toll in the county and nearly two-thirds of that in Buffalo.[240,241] In addition, there is

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[235] United States Census, 2021g

[236] Samaha, 2023

[237] University at Buffalo, n.d.

[238] Watson, 2023. The 47th person was in adjacent Niagara County.
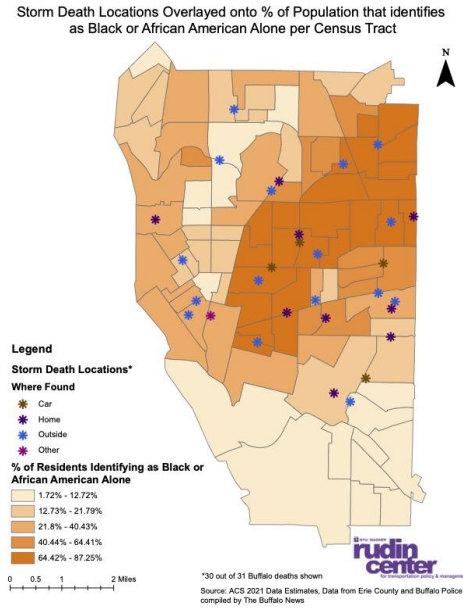
[239] Sacks, 2023

[240] United States Census Bureau, 2021a

[241] Samaha, 2023

significant income-based segregation. The deaths that occurred in predominantly white areas were often low-income areas as well.

Figure 24. Storm death locations overlaid onto to the percent of Black residents per census tract, Buffalo[242]

Storm Death Locations Overlayed onto % of Population that identifies as Black or African American Alone per Census Tract

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[242] The Buffalo News, 2023. United States Census Bureau, 2021g.

Storm Death Locations Overlayed onto Median Household Income
by Census Tract

Legend

Storm Death Locations*
Where Found

✳ Car
✳ Home
✳ Outside
✳ Other

Median Household Income by Census Tract

☐ $10,585.00 - $22,500.00
☐ $22,500.01 - $31,921.00
☐ $31,921.01 - $40,567.00
☐ $40,567.01 - $60,123.00
☐ $60,123.01 - $91,438.00

0   0.5   1   2 Miles

*30 out of 31 Buffalo deaths shown
Source: ACS Data Estimates, Data from Erie County and Buffalo Police compiled
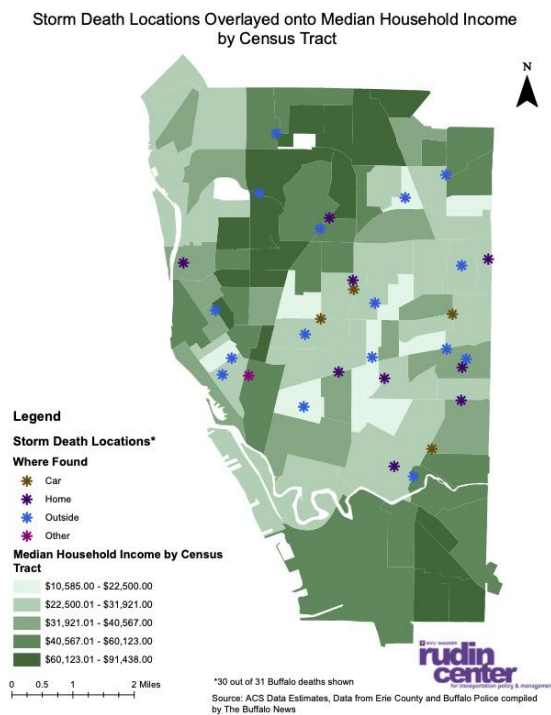by The Buffalo News

Figure 25. Storm death locations overlaid onto median household income by census tract, Buffalo[243]

Recommendation: Acknowledge the people who died in the blizzard with a Day of Remembrance, in collaboration with New York State. The Christmastime blizzard was a collective tragedy that profoundly affected the residents of Buffalo and the surrounding areas. In addition to the tragic loss of life, people also missed celebrating Christmas with loved ones, were severely isolated, and experienced the devastating effects of cold when homes lost power. The blizzard was a collective trauma that the Erie and Niagara Counties experienced, and community stakeholders have recommended that a public acknowledgment and memorial service for the people who lost their lives could serve to begin the healing process. In an article about post-disaster rituals, the author Anne Eyre states, "Both individual and collective rituals enable the expression of grief and can be therapeutic in helping communities come to terms with tragedy."[244] Community members noted that the deaths from the blizzard, combined with the tragic shooting at the Tops Grocery store in May 2022 and ongoing COVID-related grief, compounded the impact on

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[243] The Buffalo News, 2023. United States Census Bureau, 2021f.
[244] Eyre, 1999

Buffalo's Black community. Acknowledging these losses sensitively and thoughtfully with a Day of Remembrance can be a balm for the community.

Income-Based Challenges

According to 2021 American Community Survey (ACS) Estimates, 27.6% of Buffalo residents live in poverty,[245] and 28.1% of residents had received cash public assistance or SNAP benefits in the prior 12 months.[246] New York State issues food stamps within the first nine days of each month,[247] and given the timing of the blizzard at the end of December, beneficiaries of the SNAP program may have had their public assistance funds beginning to run out. Many had spent additional money for the holiday season, making them unable to stockpile necessary supplies on short notice. Furthermore, 45.5% of households are rent burdened (where the cost exceeds 35% of their monthly income), making unforeseen costs more difficult.

Stakeholder interviewees cited food access as one of the most significant concerns for residents calling local helplines like 211 and mutual aid organizations. Still, it was practically impossible to reach most residents who were requesting food, especially during the first part of the storm. While the Mayor's Office recommended that people buy additional food and supplies in the days before the storm, as noted in the communication section, many remained unaware or skeptical of the storm's severity. Coupled with the Christmas holiday and the earlier-than-expected arrival of the storm, people were attempting to shop for supplies after the County announced the driving ban. Those without cars braved the weather on foot or went without enough supplies.

Additionally, some neighborhoods in Buffalo are considered food deserts (especially in the East Side and West Side neighborhoods), defined as having no grocery store within a one-mile radius. This challenge made it difficult to stock up on supplies, because if one grocery store serves a large population it will quickly become picked over for staples. In addition, many people underestimated the blizzard's effects during initial warnings. Residents were unprepared to withstand a driving ban and emergency order that would lock them in their homes for nearly a week.

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[245] United States Census Bureau, 2021a
[246] United States Census Bureau, 2021b
[247] United States Department of Agriculture, 2021

Power outages also limit food options, so even if a household did stock up, the food may not have been edible due to spoilage, or power outages may have limited the ability to cook with electrical appliances. After the blizzard passed, it was difficult to access food, as trucks to restock grocery stores could not enter the city due to snow and the driving ban. In addition, stores could not open if employees could get there. However, food supplies did arrive in various forms. In one neighborhood with no grocery stores within a walkable area, a coffee shop became the de facto warming center and provided food to neighbors without power. The National Guard visited 3,755 households in the East Side neighborhood and delivered 278 cases of MRES—3,336 meals—and 150 cases of water.[248] World Central Kitchen, an international food relief organization, provided 8,400 meals,[249] and Goya provided 30,000 lbs of food for distribution.

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[248] Durr, 2023
[249] World Central Kitchen, 2023

Figure 26. Low-income and low access census tracts based on vehicle accessibility, as defined by USDA
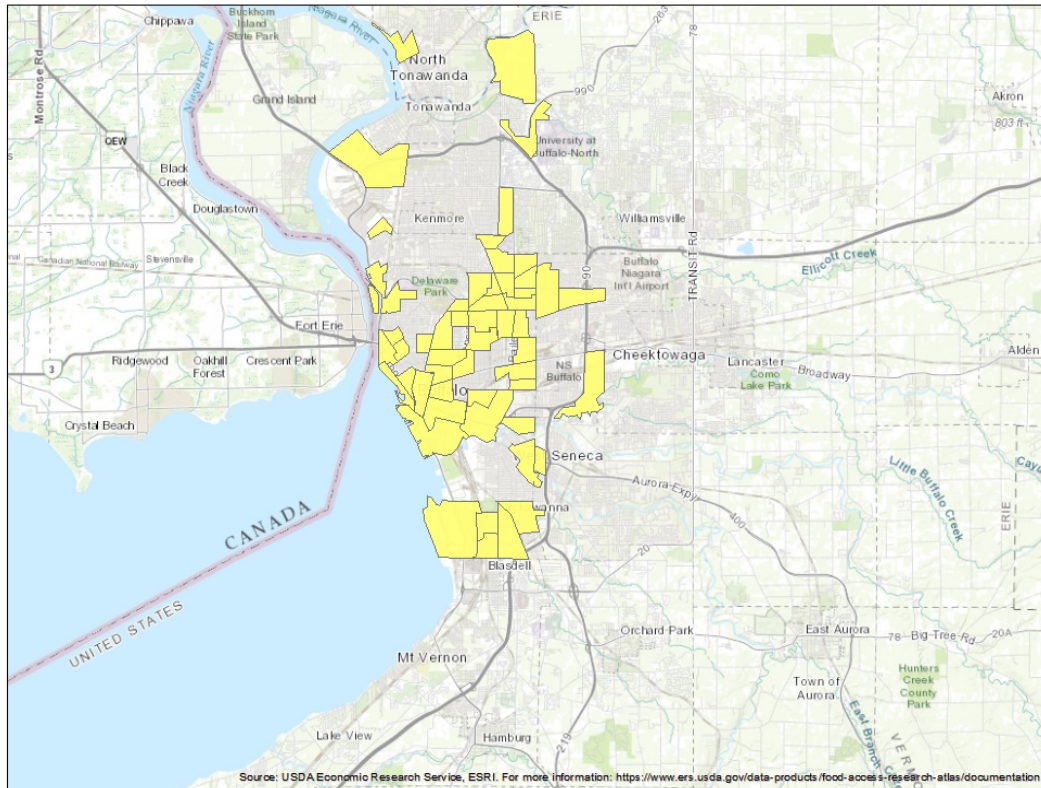

Figure 26 shows low-income census tracts where more than 100 housing units do not have a vehicle and are more than ½ mile from the nearest supermarket, or where a significant number or share of residents are more than 20 miles from the nearest supermarket.[250]

Recommendations

1. **Provide storm boxes with emergency supplies and food to those who need it in the days prior to the storm.** While it is crucial to continue messaging the need for emergency supplies and extra food, for those who live paycheck to paycheck, gathering a multi-day supply of necessities just a few days before a storm can be challenging. By providing emergency food distribution and emergency kits to those in need, Buffalo can help people to avoid leaving their

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[250] United States Department of Agriculture, 2022

homes during the next emergency weather event. Block associations, mutual aid groups, food pantries, and social service providers can work to distribute emergency supplies to reach those most in need or schedule public pick-up events at schools and community centers (which, ideally, can also serve as warming shelter locations). These boxes should contain water, non-perishable food, a flashlight, warm clothing or blankets, and other necessary supplies based on the household needs, such as diapers or insulin. The City can partner with the Red Cross or other aid agencies to identify appropriate supplies and with FeedMore WNY to coordinate providing food, as well as seeking emergency assistance from FEMA, New York State, and Erie County. There should be a clear line of communication between the City – specifically an emergency manager – and those organizations about when and how to mobilize resources.

In addition to providing food in advance of an emergency, there should also be an emphasis on providing information about how to stockpile food and emergency preparedness even for those with limited resources. Community centers and public libraries could host educational sessions and distribute educational resources with the help of local community groups.[251] Some organizations that are already addressing food access in Buffalo are FeedMore WNY and the African Heritage Food Co-Op.

2. **Prioritize restoring public transportation after a storm, especially routes that serve grocery stores and food pantries.** As the NFTA did immediately in the past,[252] the City should work with the transit body to prioritize a shuttle service to nearby grocery stores as soon as it is safe to do so. DPW should continue to ensure timely plowing of those routes that are used by buses, especially those providing access to necessities, like groceries.[253]

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[251] For example, see Andress & Harrison, n.d.
[252] WGRZ Staff, 2022
[253] McCarthy. 2022

Figure 27. 311 calls originating on Buffalo's East Side relative to the rest of Buffalo[254]
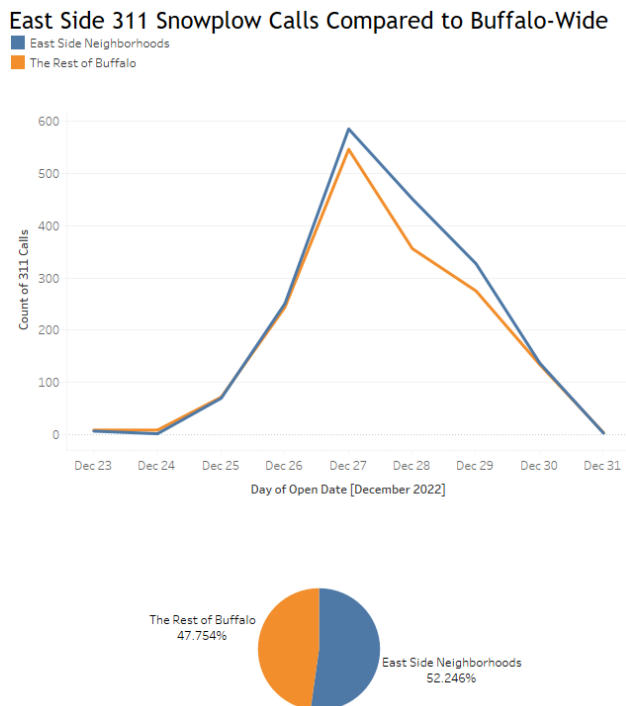
Snow Removal and Plowing

The exact timing and routes of snow removal and plowing following the blizzard are unavailable because of the DPW's reliance on many contractors that provide plowing services, and data is not retained by these companies. Still, 311 data indicated that residents on the East Side of Buffalo called more frequently and over more days to request street plowing services than the rest of the city. The 14 East Sector Neighborhoods, as defined by the City of Buffalo, made more calls than all other neighborhoods combined, especially on the days after snowfall had ceased (as shown in Figure 27).[255] One reason given for the delays in plowing some streets was that cars stranded in streets were blocking access, and DPW required a tow truck to remove them before they could plow the streets. Others reported that while concerns and complaints about plowing may have been greater in low-income areas,

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[254] Open Data Buffalo, 2023
[255] Open Data Buffalo, 2023

the order of plowing was similar (arterials followed by secondary roads) across the city.

Recommendations:
1. **Clarify public communications about plowing routes and parking procedures for facilitating plowing.** Establish "parking zones" for snow emergencies and communicate parking procedures to city residents using more channels. DPW already offers off-street parking sites for snow emergencies throughout the city; however, from community members, it is clear that snow emergency parking procedures are not clear to all Buffalo residents. Designated parking procedures, snow plowing routes, and expectations for the plowing of residential streets should be communicated in various forms, including traditional media, permanent or temporary street signs, social media, and community or block associations – and in multiple languages. DPW is currently building a more pronounced social media presence for this information dissemination, which is likely to benefit the city during the next weather event.
2. **Pre-position plows, drivers and other snow removal equipment into neighborhoods prior to future snow emergencies.** The massive amounts of snow and whiteout conditions meant that snow removal equipment and personnel could not reach all of the city's neighborhoods, and could only start after the storm. For more distributed plowing in future storms, snow removal equipment and drivers – either from the city or contracted by the city, or from the state – should be pre-positioned throughout the city. Specifically, with contractors, the city could identify plowing contractors who live in or close to the neighborhoods that have historically remained unplowed the longest and who would be able to mobilize quickly in a snow event.

Emergency Services

On Saturday, December 24th, the second day of the blizzard, the county announced that emergency services would not be able to reach people for emergencies due to the severity of the snowstorm. Seven people died because of what officials have characterized as a delayed EMS response.[256] The inability of emergency vehicles to reach many households in Buffalo was due to whiteout conditions, unplowed streets and snow pile-ups, and emergency personnel struggling to leave their homes to get to work. By 3:00pm on Friday, 911 dispatchers were overwhelmed with emergency

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[256] Watson, 2023

calls, and by the following morning, there was an 1,100-call backlog. The County announced that 911 was down and that residents should call the Erie County SNOW line instead (which is a non-emergency line for requesting medical treatment). Interviews indicate that Buffalo did not have sufficient tracking, triage, and prioritization for search and rescue, in part due to the dispatch issues from the County 911 system.[257] Emergency services would respond to a call but not close the call, sometimes because they could reach an emergency situation, but lacked equipment or personnel to resolve the issue. As a result, it was impossible to tell which calls continued to need assistance. The police, EMS, and fire did continue to mobilize throughout the storm for rescue efforts. In fact, many emergency responders and their vehicles became stranded and were unable to proceed due to the severity of the storm. 911 call logs indicate that there were 6,119 calls made for service within the Buffalo city limits from December 23rd through December 26th.[258] Some of these calls were repeat calls for services as people waited for assistance that did not reach them for days, or were multiple calls for the same incident (such as a dead body or large fire).

Buffalo is divided into five police patrol districts, as shown in the Figure 28 below.[259] Sectors C and E cover the East Side of Buffalo, including the city's majority-Black and lowest-income parts.

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[257] Buffalo Police Department, personal communication, Feb. 6
[258] 68 duplicate calls were removed from the final dataset. Duplicates were identified as calls that were listed with an identical date, time and service location.
[259] Buffalo Police Department Patrol Districts & Sectors map from the Erie County Central Police Services, in Kelly, 2021

Figure 28. Buffalo Police Department Patrol Districts and Sectors[260]

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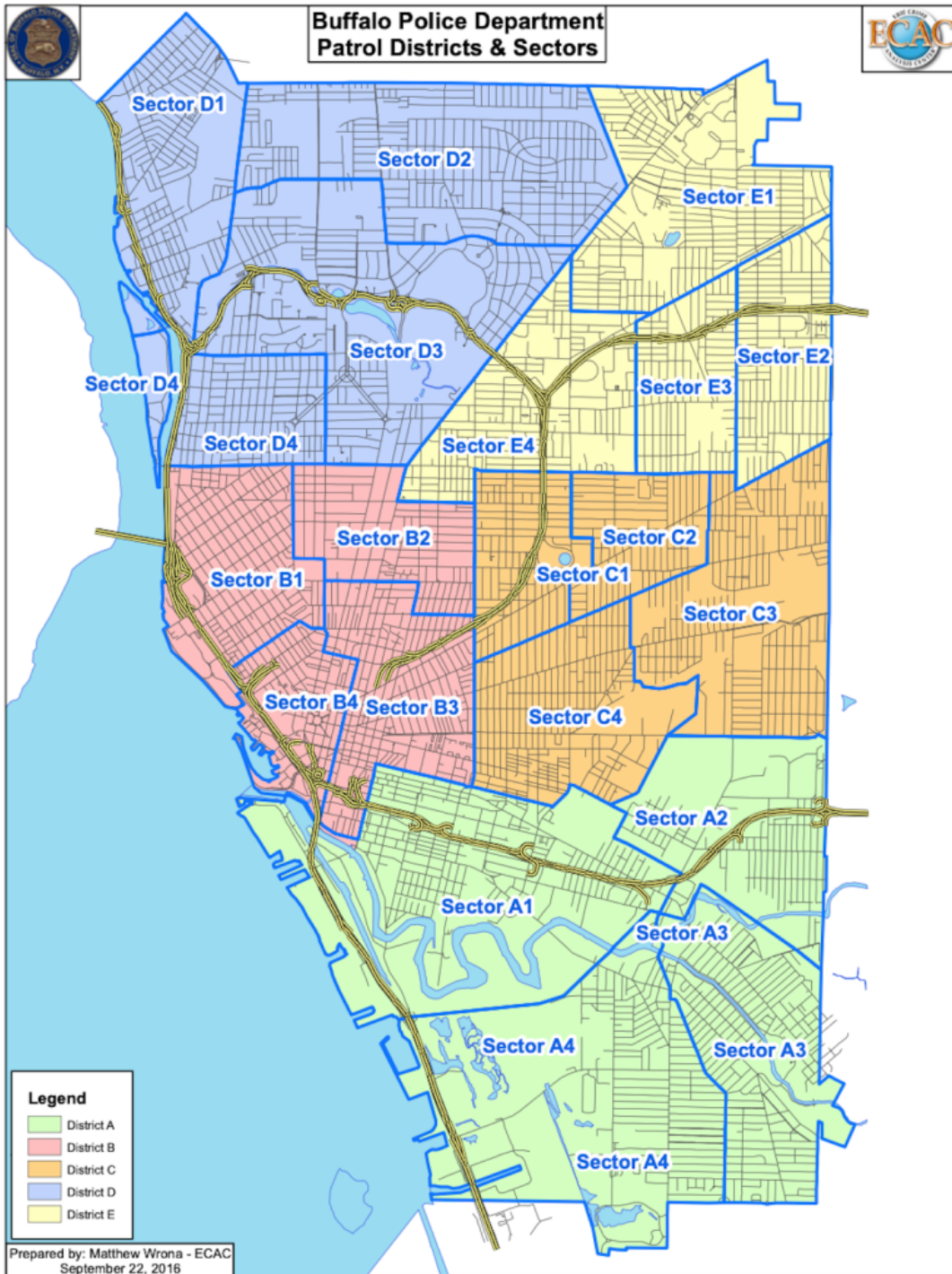
[260] Kelly, 2021

The largest number of calls came from District E (1,736 calls), and the greatest number of calls were requests for an ambulance (1,369), stranded motorists (1,158), and welfare checks (667).

Table 7. Distribution of 911 calls from December 23rd to 26th, by Police District

		Districts					
	None	A	B	C	D	E	Total
ALARM		52	119	86	89	104	450
AMBULANCE		155	243	351	195	425	1369
ASSIST CITIZEN		44	102	121	47	175	489
BURGLARY		10	18	15	20	34	97
BURGLARY IN PROGRESS		20	22	43	35	70	190
CHECK WELFARE		85	124	139	68	251	667
DOMESTIC TROUBLE		16	12	18	17	27	90
FIRE		29	69	47	48	63	256
MOTORIST STRANDED	2	277	173	250	200	256	1158
UTILITY COMPANY NEEDED		37	49	48	39	50	223
OTHER		151	247	249	202	281	1130
Grand Total	2	876	1178	1367	960	1736	6119

Analysis shows that throughout the city, it took 22.72 hours on average for emergency services to respond to a call; unsurprisingly, responses to calls that came in on the afternoon of December 23rd or anytime on December 24th took much longer due to the whiteout conditions and massive amounts of snow. While the storm had stopped by the 25th, due to a large amount of snow and lack of cleared streets, it took emergency personnel over 18 hours to respond to calls that came in that day, and nearly 8 hours for those that came in on the 26th. During the entire storm period, calls from District E had a much longer response time, 30.21 hours, compared to the next longest response time (District C, 22.28 hours).

Table 8. 911 emergency services' average response time (in hours) by police district

	District					
	A	B	C	D	E	Total
23-Dec	21.78	15.57	34.53	16.13	40.02	27.04
24-Dec	24.33	30.27	25.59	33.12	40.33	31.93
25-Dec	15.43	17.15	16.88	14.87	22.24	18.06
26-Dec	5.59	6.13	6.73	10.16	9.81	7.90
Grand Total	18.30	18.66	22.28	18.80	30.21	22.72

Figure 29 below shows the trendline for the average response time for each district's calls that came in by the hour. Again, the data show that calls that came in on the afternoon of December 23rd had the longest average response time: 40 hours in District E and 34 hours in District C—in the other three districts, the longest response times occurred for calls that came in on the morning of December 24th, during the peak of the storm.
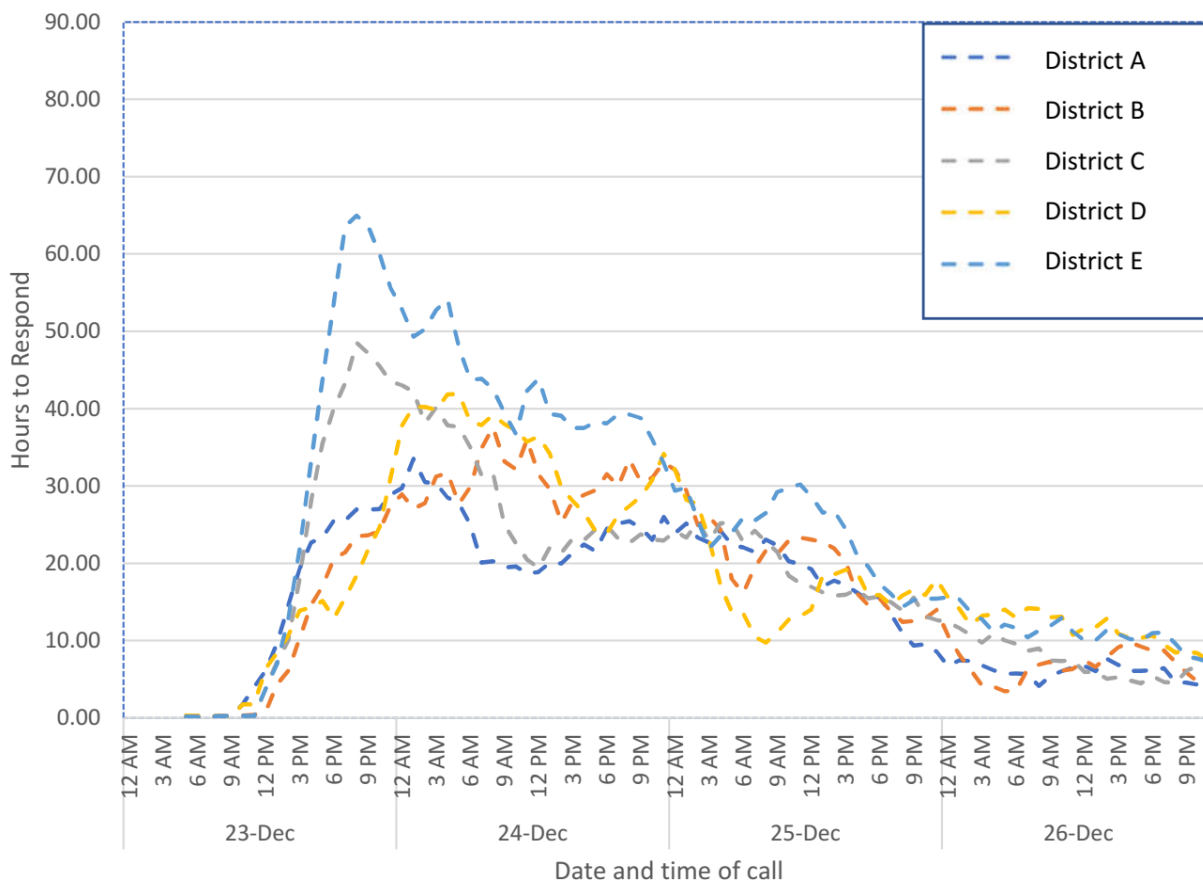

Figure 29. Trendline for average response time for 911 calls from December 23rd to 26th, by police district.

As mentioned in previous sections, the longest response times to 911 calls occurred in neighborhoods with the highest concentration of Black residents and populations with the lowest median income, at least in part due to the impassibility of most roads in the area. Still, these neighborhoods historically have the slowest emergency service response rates even in non-storm times, according to a 2021 study.[261] Community members reported feeling their needs were not being met by emergency services throughout the region, especially in those neighborhoods.

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[261] Kelly, 2021

Individuals took it upon themselves to help neighbors and family members, using Facebook (specifically the Buffalo S.T.O.R.M. Facebook group, with more than 68,000 members) to request services and offer help. People opened their doors to shelter strangers who were without power or who could not reach their homes, and community groups organized food delivery and aid. While this was a "good neighbors" effort that potentially saved countless lives, relief efforts from untrained civilians brought additional people out in the storm, who then also required rescuing, and this led to blocked emergency vehicles and even some deaths.

Recommendations:
1. **Provide emergency response training to community members.** During a large-scale disaster, the response of any community's emergency services may be delayed or overwhelmed for various reasons. This leaves the community's citizens - families, neighbors, and co-workers - to provide for their own well-being and safety until professional responders arrive. Interviews with community stakeholders indicated that they felt their community stepped up to respond to hyper-local needs during the blizzard. To address potential gaps in services, the State, County and City could train community leaders and residents through block clubs, community centers, religious groups, schools, or other community-based organizations that can mobilize an emergency response. Both the FEMA Community Emergency Response Team (CERT) program and the New York State Division of Homeland Security and Emergency Services Citizen Preparedness Corps offer members of the public opportunities to learn basic hands-on disaster response techniques and life-saving skills to utilize in their own homes and neighborhoods.

The FEMA CERT program operates in several municipalities, including Chicago, through the Office of Emergency Management.[262] After training, participants become part of the Chicago Citizen Corps and can assist professional emergency services during crises. They offer monthly training sessions for volunteers to maintain their skills and integrate them into the emergency management response. The City of Buffalo can inform residents and community groups about these courses in advance of the next storm season.

2. **Develop a feedback loop between community groups and the city. In response to the storm, local mutual aid groups, community groups, and**

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[262] Chicago Emergency Management & Communications, n.d.

individuals quickly mobilized to help one another. The people most aware of what is happening on the ground are often those who live and work directly in neighborhoods, and this expertise is always vital – especially when responding to emergencies. On the flip side, the City has resources and information typically unavailable to residents. In order to facilitate an exchange of knowledge that would help to best allocate resources, the City should develop communication protocols and relationships with community groups. A constant feedback loop between these hyper-local knowledge centers and City Hall could vastly improve emergency response in Buffalo.

The ANCHOR coalition, founded in response to the COVID-19 pandemic and mobilized during the Tops shooting and the blizzard, has already convened and met with representatives from 311 and Erie County to develop a partnership for future emergency responses. It is in the City and County's best interest to partner with ANCHOR and other key organizations and engage them in emergency planning and response. Another suggestion from community stakeholders was to enhance and expand neighborhood block clubs beyond Neighborhood Watch, by training them and providing resources for emergency response and as a source for information about neighborhoods' different needs.

3. **Support local businesses that serve as community resources.** Many small businesses in Buffalo opened their doors during and after the blizzard to help their community during or after the blizzard in various ways, to provide resources, distribute food, or organize assistance through their social media accounts. The City should recognize small businesses as linchpins of the community by supporting them through economic development programs on the local, state and federal levels, including federal assistance for small business disaster relief.[263]

Mobility

The emergency alerts issued to Buffalonians primarily concerned driving, not transit or the ability to walk, and were thereby not relevant to the 24.7% of households that do not have vehicles available for use and rely on other modes of transportation. In some census tracts, particularly those in low-income areas, lack of a vehicle is much more common than in others, including several where less than 55% of households

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[263] U. S. Small Business Administration

have access to a vehicle.[264] [265] In the city of Buffalo, 17% of Black, 14% of Hispanic, 12% of Asian, and 17% of "some other race" workers commute by transit, compared to less than 4% of workers who are white.[266] The Communications section of this report details the importance of deploying emergency alerts that are independent of travel mode.

Aging Infrastructure: Housing and Electricity

Many residents in Buffalo live in old buildings with poor insulation.[267] About 64% of Buffalo's housing units were built prior to 1940, compared to 28% across urban areas in the Northeast, and only 12.2% across the US.[268] Though many of these older buildings have likely been upgraded, older buildings tend to be less resilient to severe weather. Older buildings that lack sufficient insulation are susceptible to heat loss.

Buffalo's power system is managed by National Grid.

In interviews, stakeholders mentioned that power losses in these older homes are common, including brownouts in the summer and power outages in windstorms, so power outages during the blizzard were not unexpected.

The City announced that daytime warming shelters would be available for people who needed them during the storm. However, two of the warming centers in the Lovejoy neighborhood (Sector C on the police district map) quickly lost power along with the rest of the neighborhood. Since they did not have working generators, they could not provide essential services to people in the neighborhood. According to a community stakeholder, many homes in the Old First Ward (along the Buffalo river, Sector A1 on the Police district map) lost power, but the City had not designated a single warming shelter in the neighborhood. Shelter providers made an effort to transport people to additional CodeBlue shelters that opened their doors, but blizzard conditions made that difficult. However, as CodeBlue shelters are adult

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[264] United States Census Bureau, 2021c
[265] Magavern, 2018
[266] United States Census Bureau, 2021d
[267] Sacks, 2022
[268] United States Census Bureau, 2021c

homeless shelters, they were not necessarily appropriate for families with children who needed a place to sleep if their homes lost power. Additionally, some areas of the City lost power and lacked warming shelters nearby; people in need of shelter turned to fire stations, police departments, local businesses, and others' homes for shelter, warmth, and food.

Table 9: Number of customers affected by power outages per neighborhood [269]

Neighborhood	Number of Customers Affected
Lovejoy	1,823 customers
First Ward area	1,082 customers
South Buffalo	757 customers
Westside area	2 customers
Elmwood Village area	510 customers
Cold Springs area	2,996 customers
Grider/MLK area	3,844 customers
Kensington/Bailey area	598 customers

Recommendations:
1. **Make more warming shelters available during weather events in all neighborhoods, especially those with frequent power outages.** Community centers, senior centers, faith-based organizations, and schools are all community-based buildings that have the capacity to be turned into warming/cooling centers quickly. Pre-stock non-perishable supplies, including cots, blankets, flashlights, food, and water, in each location that can be safely stored and quickly accessed. Identify locations in advance and ensure that each one has staff, security, transportation to the center, and a working generator that automatically can kick in if the power goes out. This is something that Buffalo has already begun to implement in subsequent cold weather after the blizzard, and the research team encourages the practice to continue. Expanding this service will require additional funding from New York State and the federal government emergency assistance programs.

[269] National Grid, 2022

In advance of Hurricane Ian, Miami, Orlando, and other Florida cities worked with private mobility providers Uber and Lyft to offer thousands of residents free and discounted round trips to shelters. These rides were provided and subsidized by the private sector, at no cost to the city.[270,271] We encourage Buffalo to pursue similar arrangements with private sector partners in advance of future major weather events.

2. **Develop an emergency plan with each warming shelter.** Warming shelter plans will need to identify the appropriate level of staffing, identify which staff are available to come in if there is no transportation, create a safety plan, and identify resources to have on hand in different situations. A coordinated effort with the city to provide training to temporary warming shelter locations can ensure that each one will be ready to go in the event of an emergency.

3. **Conduct pre-season review of generators and supplies.** The City should check temporary warming shelter locations before the storm season to ensure the generators are in good working order and have restocked supplies before winter. Each site's emergency plan should be reviewed with staff, and emergency services training (CERT through FEMA) should be provided to them.

4. **Clearly communicate safe times to travel to the warming shelters.** By establishing a recommended time preceding expected whiteout conditions, the City will help reduce the number of residents who venture out when conditions are unsafe. In addition, the City can work with private mobility providers to offer more information, and potentially provider-subsidized rides, to these shelters in advance of the storm.

5. **Evaluate aging housing stock and power infrastructure, and develop a plan to revitalize outdated infrastructure** with the investment of county, state, federal and private sector resources, to help ensure that residents remain protected and warm.[272]

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[270] Fox 13 News staff, 2022
[271] Fox 35 News Staff, 2022
[272] U.S. Department of Housing and Urban Development

Vulnerable Populations

Senior Citizens

Thirteen of the 31 identified victims, or 42%, were over 65 years old.[273] Only about 13% of the Buffalo population is over 65. With advanced age comes increased vulnerability in severe weather, especially when mobility and communications are impacted, and many elderly victims died due to a lack of heat in their homes or other cold-related reasons.[274] The 211 social services call center reportedly received many calls from elderly and disabled people who were homebound during the storm and had lost power and internet, and who called 211 to get information, to talk to someone, or to obtain help submitting requests such as snow shoveling or emergency services.

Recommendation:

1. **Mobilize senior services providers prior to a weather emergency to contact elderly or housebound individuals.** While Erie County manages senior services, Buffalo can provide information for them to make adequate preparations for the storm. These individuals may need assistance with filling prescriptions through the duration of the storm, ensuring necessary medical equipment is in good working order and backups are available, having sufficient food for the duration of the event (including shelf-stable food that will not spoil if the power goes out), transportation to a warming center, and arranging for snow shoveling services before the storm. While the City of Buffalo does not manage senior services, preemptively coordinating with the County to help these needs be met can reduce the risk of these individuals needing Buffalo's emergency services during the storm.

Communications

About 75% of households in Buffalo have internet access, as discussed in the Communications Section, indicating that the remaining 25% of households possibly

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[273] McAndrew, 2023
[274] McAndrew, 2023

missed out on important information. Local aid organizations like 211 assisted people by triaging calls for the SNOW line and filling out online forms for assistance (211 reported that they filled in 284 forms on behalf of callers), connecting people with snow removal efforts by the Snow Brigade (a volunteer effort to assist snowed in neighbors), and sending referrals directly to organizations providing food (the African Heritage Co-op, World Central Kitchen, and Feed Buffalo).

According to a refugee services provider, blizzard information was only provided in English, making it difficult for immigrant and refugee communities to access and understand. Census data shows that 8% of residents in Buffalo self-identify as speaking English less than "very well."[275] The lack of translated information was a significant oversight. Luckily, the refugee and immigrant communities have strong networks that share information and provide resources and care to each other during the storm, communicating through WhatsApp and Facebook groups.

Recommendations:

1. **Provide live interpretation in multiple languages.** Nearly one-fifth of Buffalonians speak languages other than English at home; during the blizzard, they needed access to current information through the City and County press conferences and news releases, but many had to rely instead on others in their community for translation. The City should provide live interpretation in multiple languages (including ASL) during press conferences, as well as translations for press releases and other printed materials. New American organizations in the City can be consulted to identify which languages would be most important for translation, and skilled interpreters can be contracted in advance for their services during emergencies.[276] Similar strategies have been successfully deployed in numerous U.S. cities, including Seattle, Chicago and New York City, which provide materials in many different languages. In addition, Google Translate provides real-time translation, which can offer free, if imperfect, translation services of materials and events (a disclaimer can be included for users).[277] This technology continues to evolve.

2. **Partner with refugee service agencies to develop culturally-responsive materials for preparing for and responding to emergencies.** Buffalo's presumptive Emergency Manager should partner with existing refugee and

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[275] United States Census Bureau, 2021e

[276] Potential partners include International Institute of Buffalo and Journey's End Refugee Services.

[277] https://translate.google.com/about/

immigrant service agencies, as well as specific community groups representing ethnic populations in Buffalo, to develop linguistically and culturally-responsive materials for New Americans on preparing for and responding to weather emergencies, specifically winter storms. According to the U.S. Department of Health and Human Services Public Health emergency website, "An inclusive and integrated approach to disaster and emergency preparedness, response, and recovery activities ensures that culturally and linguistically diverse populations are not overlooked or misunderstood."[278] Research also shows that minority communities are more likely to recover slowly from natural disasters due to cultural barriers and receiving incomplete or inaccurate information.[279]

In addition to information in different languages, culturally-responsive planning can include identifying and distributing trusted sources of information for different cultural communities, using culturally-specific examples and adaptations for preparing for an emergency, communicating which culturally-specific grocery stores and other services are open, and identifying barriers to accessing emergency or recovery services. Drexel University has a very good online database of resources for advancing emergency preparedness for culturally diverse communities.[280] Information packets could include simple definitions of different types of weather warnings, what to do in each case, an illustrated guide for gathering emergency supplies and where to get them, how to stay warm if the power goes out, information about what warm clothing to own, and emergency services resources, especially ones with interpretation services. Refugees are also a very resilient population that can provide ideas for other community residents on how to prepare or respond to an emergency.

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[278] United States Department of Health & Human Services, n.d.
[279] Bethel, Burke, & Britt, 2013
[280] Drexel University, n.d.

Appendix I: Methodology

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This analysis is based on stakeholder interviews, data analysis, public hearings, public records, media reports, and historical context. The research team met with approximately 35 stakeholders both in person and on Zoom:

- City of Buffalo officials
- New York State officials
- Utility providers
- Community leaders
- First responders
- Business owners and representatives
- Neighborhood association representatives

A full list of interviewees is available in Appendix A.

The report team acquired extensive data from the City of Buffalo and National Grid concerning snow removal, 311 calls, power outages, and other salient information. Much of the National Grid information was publicly available from submissions to the NYS Public Service Commission. Analysis of this data is found throughout the report.

Essential coverage was found in The Buffalo News, which covered the storm and its aftermath extensively. Additional media sources, including WBFO radio, ABC News, and The Washington Post, were also incorporated. Local perspectives were gleaned from social media sources, including Twitter threads and the "Buffalo Blizzard of '22 Resource Group" on Facebook.

Finally, historical context was offered by the book Declaring Disaster: Buffalo's Blizzard of '77 and the Creation of FEMA, which offered at times uncanny parallels to the 2022 blizzard.

The research team pursued the answers to five specific questions in order to equip the City of Buffalo for next winter's storm season. The key research questions in this project were:

1. How does the timing of road closures affect storm impacts and response?
2. How might Buffalo better prepare for snow removal and homebound residents?

3. What are the best ways to communicate warnings to the public?
4. How might impacts to power and communications utilities be mitigated?
5. How can communities be cared for equitably?

Appendix J: Sources Cited

Introduction and Key Findings Sources

Becker , M. (2022, December 27). *A real-life Christmas angel saves a life and gives WNY a reason to smile. Buffalo News.* https://buffalonews.com/news/local/a-real-life-christmas-angel-saves-a-life-and-gives-wny-a-reason-to-smile/article_8f77929a-8601-11ed-b35b-af3aede6d7d8.html

Buffalo east homeowner improvement program (BEHIP). (n.d.). Homes and Community Renewal. Retrieved May 31, 2023, from https://hcr.ny.gov/buffalo-east-homeowner-improvement-program-behip

Buffalo News Staff. (2015, March 8). Proposal for a public works campus raises issues of cost, preservation. *The Buffalo News.* https://buffalonews.com/opinion/editorial/proposal-for-a-public-works-campus-raises-issues-of-cost-preservation/article_b00be28f-ceab-5b49-a18b-3b3368bee562.html

Clean sweep | Buffalo, NY. (n.d.). City of Buffalo. Retrieved May 31, 2023, from https://www.buffalony.gov/849/Clean-SweepDeliso, M. (2022, December 31). Buffalo's deadly blizzard by the numbers: What made the storm so historic. *The Buffalo News.* https://abcnews.go.com/US/buffalos-deadly-blizzard-numbers-made-storm-historic/story?id=95945684

Department of Administration, Finance, Policy and Urban Affairs & Division Of Budget and Management. (n.d.). *Recommended annual budget city of Buffalo for the fiscal year ending June 30, 2024.* https://www.buffalony.gov/DocumentCenter/View/11799/Recommended-Budget-Fiscal-Year-2023-2024

Epstein, J. D. (2022, December 29). *Kenmore mechanic heralded for saving lives by breaking into school during blizzard.* Buffalo News. https://buffalonews.com/news/local/kenmore-mechanic-heralded-for-saving-lives-by-breaking-into-school-during-blizzard/article_fd089cb8-87b5-11ed-8bab-af209a848849.html

Eure, S. (2022, December 30). *The African American and Bangladesh communities join together during storm.* WKBW 7 News Buffalo. https://www.wkbw.com/news/local-news/blizzard-of-22/the-african-american-and-bangladesh-communities-join-together-during-storm

Mayor Byron W. Brown's 2023 State of the City Address. (2023). https://www.buffalony.gov/DocumentCenter/View/11797/SOTC-Speech-2023

McNeil, H. (2023, May 1). *"We are investing in our people": Brown touts public safety, infrastructure spending plans in State of the City.* Buffalo News. https://buffalonews.com/news/local/govt-and-politics/we-are-investing-in-our-people-brown-touts-public-safety-infrastructure-spending-plans-in-state/article_0314fb98-e868-11ed-aa0e-33bd881c8f2e.html

NFTA Board Meeting. (2023, January 26). https://livestream.com/accounts/6540352/events/10753347?t=1685548654

Sacks, B. (2022, December 29). Buffalo blizzard fuels racial and class divides in polarized city. *The Washington Post.* https://www.washingtonpost.com/weather/2022/12/29/buffalo-blizzard-storm-race-class/

Samaha, A. (2023, March 7). *Abdul Sharifu was buying milk for a neighbor's baby. A snowstorm killed him.* BuzzFeed News. https://www.buzzfeednews.com/article/albertsamaha/abdul-sharifu-buffalo-blizzard-2022

Tsujimoto , B. (2023, January 21). *Gov. Kathy Hochul recognizes "ordinary" heroes from blizzard during Buffalo State visit.* Buffalo News. https://buffalonews.com/news/local/gov-kathy-hochul-recognizes-ordinary-heroes-from-blizzard-during-buffalo-state-visit/article_0c4660c2-99ca-11ed-bef3-1b2edd1f23c9.html

U. S. Census Bureau. (2022). *QuickFacts: Buffalo City, New York; Erie county, New York.* https://www.census.gov/quickfacts/fact/table/buffalocitynewyork,eriecountynewyork/PST045222

Business Community Needs Sources

Anderson, K. (2022, December 29). The question remains after the Blizzard of '22: Who is 'essential'? *Buffalo Business First.* https://www.bizjournals.com/buffalo/news/2022/12/29/what-workers-are-essential-in-a-blizzard.html

Centers for Disease Control and Prevention. (2021, March 29). *Interim list of categories of essential workers mapped to standardized industry codes and titles.* https://www.cdc.gov/vaccines/covid-19/categories-essential-workers.html#:~:text=This%20interim%20list%20identifies%20%E2%80%9Cessential,the%20United%20States%20(U.S.).

Nice, E. (2022, December 24). Can employers make staff come to work in a driving ban? *WBLK.* https://wblk.com/can-employers-make-staff-work-driving-ban/

Shapiro, L., Hindman, N., & Knafo, S. (2012, November 1). Hourly workers are hit in Hurricane Sandy aftermath. *HuffPost.*

https://www.huffpost.com/entry/hourly-workers-hurricane-sandy-aftermath_n_2060235

Sharf, S. (2016, January 22). Economics of a blizzard: Winter Storm Jonas is a win for Whole Foods but a loss for hourly workers. *Forbes.* https://www.forbes.com/sites/samanthasharf/2016/01/22/economics-of-a-blizzard-winter-storm-jonas-is-a-win-for-whole-foods-but-a-loss-for-hourly-workers/?sh=1008ebea513b

United States Small Business Administration. (n.d.). *Prepare for emergencies.* https://www.sba.gov/business-guide/manage-your-business/prepare-emergencies

Roads Sources

Ajasa, A. (2022, November 22). How Buffalo is clearing 80 inches of snow almost as fast as it fell. *The Washington Post.* https://www.washingtonpost.com/climate-environment/2022/11/22/how-buffalo-is-clearing-80-inches-snow-almost-fast-it-fell/

The City of Buffalo Common Council. (2022). *Scanlon Files Critical Resolutions in Response to Deadly Blizzard to Ensure Our Front Line Workers are Properly Equipped to Serve our Residents.* https://www.buffalony.gov/DocumentCenter/View/11295/MEDIA-RELEASE_-Scanlon-Files-Critical-Resolutions-in-Response-to-Deadly-Blizzard?bidId=

C2SMART. (2023). *Statewide open source Advanced Traffic Management System (ATMS) software research and pilot.* https://c2smart.engineering.nyu.edu/statewide-open-source-advanced-traffic-management-system-atms-software-research-and-pilot/

CTC & Associates LLC. (2018). *Effective practices for activating snow and ice personnel and equipment for winter storms.* http://clearroads.org/wp-content/uploads/dlm_uploads/CR-17-S3-Storm-Activation-Synthesis-Final.pdf

Das, R. K., Upadhyay, A., & Garg, R. K. (2017). An Unmanned Tracked Vehicle for Snow Research Applications. *Defence Science Journal*, *67*(1).

Demiroluk, S., Ozbay, K., Bartin, B., Maggio, M. D., Nassif, H., & Hesslein, D. L. (2017). *WeatherEVANT: Real-time weather related event visualization and ANalytics tool.* Transportation Research Board 96th Annual Meeting. https://trid.trb.org/view/1437134

Erdelj, M., & Natalizio, E. (2016, February). UAV-assisted disaster management: Applications and open issues. In *2016 international conference on computing, networking and communications (ICNC)* (pp. 1-5). IEEE.

Federal Highway Administration. (2012, June). *Best practices for road weather management.* https://ops.fhwa.dot.gov/publications/fhwahop12046/fhwahop12046.pdf

Get the ReadyErie preparedness app . (n.d.). Homeland Security and Emergency Services. Retrieved May 31, 2023, from https://www3.erie.gov/dhses/get-readyerie-preparedness-app

Huber, T., Luecke, K., Hintze, M., Coffman, V., Toole, Jennifer, & VanOosten, Matt . (2013). *Guide for maintaining pedestrian facilities for enhanced safety research report—Safety* (pp. 54–120). Federal Highway Administration Office of Safety . https://safety.fhwa.dot.gov/ped_bike/tools_solve/fhwasa13037/research_report/chap2d.cfm

INRIX. (2023). *Traffic data*. Extracted via the DWICE tool developed by C2SMART under the Coordinated Intelligent Transportation Systems Deployment In New York City (CIDNY) Program.

Federal Highway Administration. (2019). Crowdsourcing for Operations. In *Innovator*, *13*(73), 6–7. USDOT-FHWA. https://www.fhwa.dot.gov/innovation/innovator/issue73/issue73.pdf

Intelligent Transportation Systems Joint Program Office. (2011, August 17). *Use the self-evaluation and integration planning process to create wider awareness of the benefits of weather integration to improve TMC operations.* https://www.itskrs.its.dot.gov/its/benecost.nsf/ID/1e4c25bf2cd62649852578c4007026a5

Intelligent Transportation Systems Joint Program Office. (2020, December). *Rural Road Weather Management Systems 2020 Executive Briefing*. US Department of Transportation. https://www.itskrs.its.dot.gov/briefings/executive-briefing/rural-road-weather-management-systems

Intelligent Transportation Systems Joint Program Office. (2021, March 30). *An optimization-based algorithm can reduce deadhead distance by 13.2 percent for winter road maintenance operations in northwest Iowa.* https://www.itskrs.its.dot.gov/node/209360

Intelligent Transportation Systems Joint Program Office. (2021, December). *Next generation transportation management centers*. US Department of Transportation. https://www.itskrs.its.dot.gov/briefings/executive-briefing/next-generation-transportation-management-centers

Iqbal, U., Perez, P., & Barthelemy, J. (2021). A process-driven and need-oriented framework for review of technological contributions to disaster management. *Heliyon*, *7*(11), e08405.

Knickerbocker, S. (2021, November). *Evaluation of road weather messages on DMS based on roadside pavement sensors.* https://www.dot.state.mn.us/research/reports/2021/202125.pdf

Li, S., Bullock, Li, H., Peters, L., Banuelos, C., Zaugg, J., Sharma, A., & Bullock, D. (2016). *Leveraging snow plow dashboards cams and connected vehicle speed data to improve winter operations performance measures.*

https://docs.lib.purdue.edu/cgi/viewcontent.cgi?article=1028&context=jtrpaffdocs

McNeil, H. (2023, February 5). *Buffalo Mayor Byron Brown calls for employer alert system for future blizzards.* Buffalo News. https://buffalonews.com/news/local/buffalo-mayor-byron-brown-calls-for-employer-alert-system-for-future-blizzards/article_55069d54-a40b-11ed-8f4f-cb81f6c9947d.html

Minnesota walks: sidewalk snow clearing guide. (2018). Minnesota Department of Health. https://www.health.state.mn.us/communities/physicalactivity/docs/cleaning.pdf

North/West Passage. (2016, August). *Evaluate the effectiveness of citizen reporting.* https://www.nwpassage.info/projects/downloads/10-3-citizen-reporting-final-summary-report.pdf

Office of the Mayor of Buffalo. (2023). *December 2022 blizzard report.*

Open Data Buffalo. (2023). *311 service requests.* https://data.buffalony.gov/Quality-of-Life/311-Service-Requests/whkc-e5vr

Otto, S. (2014, November 30). Making Winter driving safer - establishing performance standards for winter maintenance. Retrieved from https://trid.trb.org/view/1399648

Ozbay, K., Ozguven, E. E., Sertel, T., Bourne, T., Aboobaker, N., Littleton, B., & Caglar, V. K. (2009). Manual of Guidelines for Inspection and Maintenance of Intelligent Transportation Systems. *Transportation Research Record: Journal of the Transportation Research Board*, *2129*(1), 90–100. https://doi.org/10.3141/2129-11

Ozguven, E. E., & Ozbay, K. (2013). A secure and efficient inventory management system for disasters. *Transportation Research Part C: Emerging Technologies*, *29*, 171–196. https://doi.org/10.1016/j.trc.2011.08.012

Papers related to winter maintenance from the 2017 TRB annual meeting. (n.d.). http://clearroads.org/download/2017-trb-annual-meeting-papers-related-to-winter-maintenance/

Sidewalk snow removal. (n.d.). City of Rochester. Retrieved May 31, 2023, from https://www.cityofrochester.gov/sidewalkplowing/

Southwest Research Institute. (n.d.) *ActiveITS advanced traffic management system.* https://www.swri.org/industry/intelligent-transportation-systems/activeits-advanced-traffic-management-system

Stolle, S. (2018, October 24). *Can A.I. take over winter road condition reporting?* [Conference presentation]. 2018 National Rural ITS Conference. https://www.nationalruralitsconference.org/wp-content/uploads/2019/01/2018-Stolle-Can-AI-Report-Road-Conditions.pdf

The Buffalo Common Council. (2023). *Common Council advocates for and creates emergency manager (homeland security coordinator) position as well as fleet manager position.* https://www.buffalony.gov/DocumentCenter/View/11440/Common-Council-Ad

vocates-For-and-Creates-Emergency-Manager-Homeland-Security-Coordinat
or-Position-as-well-as-Fleet-Manager-positiondocx?bidId=

Waze. (2023). *Waze traffic data.* Obtained through NYSDOT/C2SMART partnership
from Statewide Open Source Advanced Traffic Management System (ATMS)
Software Research and Pilot.
https://c2smart.engineering.nyu.edu/development-of-a-multi-agency-construc
tion-management-tool/

Xie, K., Ozbay, K., Zhu, Y., Demiroluk, S., Yang, H., & Nassif, H. (2017). Modeling salt
usage during snowstorms: Application of hierarchical linear models with
varying dispersion. *Transportation Research Record*, *2643*(1), 54-64.

Power Sources

Bragg, C. (2023, February 19). Buffalo's blizzard led to a patchwork of driving bans.
Could Hochul have closed local roads? *The Buffalo News.*
https://buffalonews.com/news/local/buffalos-blizzard-led-to-a-patchwork-of-dr
iving-bans-could-hochul-have-closed-local-roads/article_eddf800c-ae12-11ed-b
62a-837714191fb5.html

Bragg, C. (2023, March 3). National Grid: Substations that failed during blizzard were
not designed to withstand extreme cold and snow. *The Buffalo News.*
https://buffalonews.com/news/local/national-grid-substations-that-failed-durin
g-blizzard-were-not-designed-to-withstand-extreme-cold-and/article_800749
e4-b861-11ed-8218-23639029028c.html

Brown, D. (2021, September 5). Burying power lines isn't the only way to weatherproof
the grid. *The Washington Post.*
https://www.washingtonpost.com/technology/2021/09/04/weather-power-lines
-climate-change/

Buffalo News Editorial Board. (2023, March 3). *The Buffalo News.* Substation failures
are matters of public concern, with good reason.
https://buffalonews.com/opinion/editorial/the-editorial-board-substation-failur
es-are-matters-of-publicconcern-with-good-reason/article_aee3c4d8-b9f9-11e
d-a2b4-9bdd2f9c6890.html

Center for Climate and Energy Solutions. (2018, August). *Resilience strategies for
power outages.*
https://www.c2es.org/document/resilience-strategies-for-power-outages/

Charter Communications. (2022, December 24). Personal communication to Buffalo
Department of Public Works and National Grid at 5:30 p.m.

City of Buffalo Department of Public Works, Parks, and Streets. (2022). *Snow removal
plan 2022-2023.*
https://www.buffalony.gov/1565/Department-of-Public-Works-2022-2023-Sno

Consolidated Edison Company of New York. (2013, June 20). *Post Sandy
enhancement plan.*

https://www.coned.com/-/media/files/coned/documents/services-outages/post_sandy_enhancement_plan.pdf

Crane, B. (2018, February 20). Revisiting who, when, and why stakeholders matter: Trust and stakeholder connectedness. *Business & Society*, *59*(2): 263–286. https://doi.org/10.1177/0007650318756983

Electric Power Research Institute. (2015). *Distribution grid resiliency: prioritization of options*. https://www.epri.com/research/products/3002006668.

Epstein, J. D. (2022, December 30). National Grid: Snow and high wind overwhelmed Buffalo substations, but power now restored. *The Buffalo News*. https://buffalonews.com/business/local/national-grid-snow-and-high-wind-overwhelmed-buffalo-substations-but-power-now-restored/article_549abe50-86e6-11ed-a766-6b88f4f15987.html

Federal Emergency Management Agency. (2022). https://www.fema.gov/locations/new%20york

Federal Emergency Management Agency. (2023, March 20). National Incident Management System (NIMS). U.S. Department of Homeland Security. https://www.fema.gov/emergency-managers/nims

Fox Buffalo. (2023, January 10). City leadership open to discuss freezing power station issue post Blizzard '22. https://wutv29.com/news/local/city-leadership-open-to-discuss-freezing-power-station-issue-post-blizzard-22

Ianniello, M., Iacuzzi, S., Fedele P., & Brusati, L. (2019). Obstacles and solutions on the ladder of citizen participation: a systematic review, *Public Management Review*, 21(1): 21-46.

Jasiūnas J., Lund, P. D., Mikkola, J., & Koskela, L. (2021, May 1). Linking socio-economic aspects to power system disruption models. *Energy*, *222*:119928.

Lange, A., Ebert, S., & Vetter, A. (2021). Adaptation requires participation: Criteria and factors for successful stakeholder interactions in local climate change adaptation. In W. L. Filho, J. M. Luetz, & D. Ayal (eds), *Handbook of Climate Change Management*. Springer.

Li, Z.., Tang, W., Lian, X., Chen, X., Zhang, W., Qian, T. (2022). A resilience-oriented two-stage recovery method for power distribution system considering transportation network. *International Journal of Electrical Power & Energy Systems*, *135*(107497). https://doi.org/10.1016/j.ijepes.2021.107497

Metropolitan Transportation Authority. (2011, June 27). *MTA storm performance review*. https://new.mta.info/document/2306

National Fuel Gas Supply Corporation. (2023). *About National Fuel Gas Supply Corporation*. https://www.nationalfuel.com/pipeline-storage/national-fuel-gas-supply-corp/about-national-fuel-gas-supply-corporation/

National Grid. (2020, June 30). *Benefit cost analysis (BCA) handbook / version 3.0*. https://jointutilitiesofny.org/sites/default/files/NYSEG_RGE_2020_DSIP_BCA_Handbook.pdf

National Grid. (2021, January 28). *National Grid New York gas emergency response plan*.
https://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId={3EE07580-1654-4BB3-9801-5DA8EC650217}

National Grid. (2021, December). *New York electric emergency response plan*.

National Grid. (2022, May 12). *NY electric emergency response plan case 21-E-0567*.

National Grid. (2022, December 24). Email from Manager of Community & Customer Management to the Buffalo Department of Public Works (DPW) at 11:53 a.m.

National Grid. (2022, December 24). Email from City of Buffalo Charter Communications to DPW and National Grid.

National Grid. (2023a). *Service territory map*.
https://www9.nationalgridus.com/niagaramohawk/about_us/serviceterr_map_a.asp?county=Erie.

National Grid. (2023b). Winter Storm Elliot 122322 to 122822 - Dig Safe Excavator redactedApp9. Part of Scorecard documents submitted to the NYPSC.

National Grid. (2023, January 27). Scorecard Submission to Hon. Michelle Phillips, Secretary New York Department of Public Service, Albany, NY.

National Grid. (2023, February 27). *Winter Storm Elliott December 22, 2022 storm report*.

National Grid. (2023, March 27). Personal Communication.

New York City Department of Design and Construction. (2019). *Code Rule 753 call before you dig*.
https://www.nyc.gov/assets/ddc/downloads/publications/presentations/2019%20Code753%20Training_Final.pdf

New York Independent System Operator (ISO), Inc. (2022). *2022 Load & Capacity Data The Gold Book*.
https://www.nyiso.com/documents/20142/2226333/2022-Gold-Book-Final-Public.pdf

New York Power Authority (NYPA). (2015). *Five cities energy plan*.
https://www.nypa.gov/-/media/nypa/documents/document-library/operations/five-cities/2015-01-31-buffaloenergyplan.pdf

New York State Public Service Commission. (2013, December 23). *Order approving the scorecard for use by the Commission as a guidance document to assess electric utility response to significant outages in case 13-E-0140*.
https://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId=%7B9FFD6E37-BF89-4124-94E0-EC23BE43E71B%7D

Occupational Safety and Health Administration (OSHA). (n.d.). *Substations*.
https://www.osha.gov/etools/electric-power/illustrated-glossary/sub-station

Office of the Mayor of Buffalo. (2023). *December 2022 Blizzard Report*.

Plants, R. (2023, January 13). National Grid shows how Buffalo substations froze in blizzard, resulting in power loss for thousands. *WGRZ*.
https://www.wgrz.com/article/news/local/national-grid-buffalo-substations-froze-blizzard-power-loss-thousands/71-cd5bec0e-9527-4509-b9ff-b82b98ad3a19

U.S. Energy Information Administration (EIA). (n.d.). *Glossary*. https://www.eia.gov/tools/glossary/index.php?id=finance#:~:text=Circuit%2Dmile%3A%20The%20total%20length,of%20conductors%20used%20per%20circuit.

Watson, S. T., Tan, S., Becker, M., McCarthy, R. J., & Glynn, M. (2023, January 17). What went wrong? A generational blizzard exposed fatal flaws and generates fierce second-guessing. *The Buffalo News*. https://buffalonews.com/news/local/accident-and-incident/what-went-wrong-a-generational-blizzard-exposed-fatal-flaws-and-generates-fierce-second-guessing/article_c0a2be50-92ac-11ed-bf4f-bbb2ac27b949.html

Zimmerman, R. (2022, November 10). *The centrality of collaboration in social services for sustainability and communities*. Proceedings of the International Conference on Sustainable Development (ICSD). https://ic-sd.org/wp-content/uploads/2022/11/submission_455.pdf

Charter Communications Sources

Charter Communications. (March 17, 2023). Personal communication with Mark A. Meyerhof.

Charter Communications. (2023, March 31). Personal communication: Response to NYU inquiries.

Charter Communications / Spectrum. (2023). *Our impact in New York*. https://policy.charter.com/static/582be000e29f0d808cbdd8c6d8693c90/Charter%20New%20York%20Fact%20Sheet%20(2-15).pdf

Greenlight Networks. (2023). *About*. https://www.greenlightnetworks.com/about/

New York State Public Service Commission. (2022, May 11). *Case No. 22-M-0180 initial comments by Charter Communications and others*.

Communications Sources

Bragg, C. (2023, February 19). Buffalo's blizzard led to a patchwork of driving bans. Could Hochul have closed local roads? *The Buffalo News*. https://buffalonews.com/news/local/buffalos-blizzard-led-to-a-patchwork-of-driving-bans-could-hochul-have-closed-local-roads/article_eddf800c-ae12-11ed-b62a-837714191fb5.html

Brown, B. W. [@MayorByronBrown]. (2022, December 21). *A #WinterStormWatch has been issued for all of WNY except for Allegany County from 7am on Friday until 7am Monday*. [Thumbnail with link attached] [Tweet]. Twitter. https://twitter.com/MayorByronBrown/status/1605583778230833154

Brown, B. W. [@MayorByronBrown]. (2022, December 23). *Storm update: Mayor Brown issues driving ban for the city of Buffalo effective December 23, 2022 / 9:30AM*. [Image] [Tweet]. Twitter. https://twitter.com/MayorByronBrown/status/1606309543180439553

Brown, B. W. [@MayorByronBrown]. (2022, December 24). *Storm update: Code blue in the city of Buffalo / Shelter open tonight, Dec. 24 / 6PM - 7AM*. [Image] [Tweet]. Twitter. https://twitter.com/MayorByronBrown/status/1606833358687928321

Brown, B. W. [@MayorByronBrown]. (2022, December 26). *The focus of the City's operation have been on life safety. We are plowing to get to motorist that have been stranded in vehicles.* [Tweet]. Twitter. https://twitter.com/MayorByronBrown/status/1607435230318825474

BUFFALERT. (2022, December 22 to 30). Records provided by the Office of the Mayor of Buffalo.

Buffalo Common Council. (2022, December 23). *Code Blue shelters will be open 24 hours effective immediately. The NFTA has suspended transportation, individuals in need of shelter* [Status update]. Facebook. https://www.facebook.com/BFLOCC/posts/pfbid032sTer2C7HShu8EEu5s3yTmr aKNZBctF5S44HzK9Ht7PcBXphoRhU4YsUQtyg1SNil

Buffalo Department of Public Works. (2023). *Buffalo snow plowing status*. https://citizeninsights.geotab.com/#/buffalosnow

Buffalo News Editorial Board. (2023, February 20). Save lives by making the governor's road closing power explicit. *The Buffalo News*. https://buffalonews.com/opinion/editorial/the-editorial-board-save-lives-by-ma king-the-governors-road-closing-power-explicit/article_4b8b3208-b149-11ed-9f d4-4790c45068e9.html

Buffalo Police Department [@BPDAlerts]. (2022, December 24). *Storm latest: Blizzard conditions continue in the City of Buffalo making driving virtually impossible. People should stay off the roads*. Twitter. https://twitter.com/BPDAlerts/status/1606691043298185216

Federal Emergency Management Agency. (2023, April 6). *Integrated public alert & warning system*. https://www.fema.gov/emergency-managers/practitioners/integrated-public-al ert-warning-system

Federal Emergency Management Agency. (2023, May 17). *IPAWS Alerting Authorities - Agencies and Organizations*. https://www.fema.gov/emergency-managers/practitioners/integrated-public-al ert-warning-system/public-safety-officials/alerting-authorities/agencies-organi zations

Federal Emergency Management Agency. *Wireless Emergency Alerts*. https://www.fema.gov/emergency-managers/practitioners/integrated-public-al ert-warning-system/public/wireless-emergency-alerts

Kaufman, S. M. (2013, July-August). Social media in disaster preparation, response, and recovery. *TR News*, *287*: 26-27. https://onlinepubs.trb.org/onlinepubs/trnews/trnews287.pdf

Kilgannon, C., Fadulu, L., Meko, H., & Nir, S. M. (2022, December 29). How the buffalo
blizzard became so deadly. *The New York Times.*
https://www.nytimes.com/2022/12/29/nyregion/western-new-york-storm.html

Mayor Byron W. Brown. (2022, December 21). *A Winter Storm Watch has been issued
for all of western New York except for Allegany County from 7:00 am*
[Thumbnail with link attached] [Status update]. Facebook.
https://www.facebook.com/MayorByronBrown/posts/pfbid0ixtYNosPpjSnsXVyff
kqF52FF7BYCWU2w6xee9QKjJ8arepgfP1UC4ieWwKTfjM5l

Mayor Byron W. Brown. (2022, December 22). *12/22 storm update.* [Video attached]
[Status update]. Facebook.
https://www.facebook.com/MayorByronBrown/videos/867457434297852/

Mayor Byron W. Brown. (2022, December 23). *Storm update: Mayor Brown issues
driving ban for the city of Buffalo effective December 23, 2022 / 9:30AM.*
[Image] [Status update]. Facebook.
https://www.facebook.com/photo/?fbid=710673967084428

McCarthy, R. J. (2022, December 19). Pre-Covid ridership slowly returning to Metro
Bus and Rail. *The Buffalo News.*
https://buffalonews.com/news/local/pre-covid-ridership-slowly-returning-to-m
etro-bus-and-rail/article_e821c09e-7ca8-11ed-bed6-9b23edcba35e.html

National Telecommunications and Information Administration. (2021, November 22).
Indicators of broadband need.
https://broadbandusa.maps.arcgis.com/apps/webappviewer/index.html?id=50
c64e2c028d46a58247125e4bcdcdc8

National Weather Service Buffalo [@NWSBUFFALO]. (2022, December 19). *A powerful
storm will impact the region heading into the holiday weekend. Here's an
overveiw of the potential weather hazards* [Image attached] [Tweet]. Twitter.
https://twitter.com/NWSBUFFALO/status/1604963625378238465

National Weather Service Buffalo [@NWSBUFFALO]. (2022, December 20). *Here are
our first round of watches for a major storm system which will impact the
region beginning late Thursday* [Image attached] [Tweet]. Twitter.
https://twitter.com/NWSBUFFALO/status/1605283973898244097

National Weather Service Buffalo [@NWSBUFFALO]. (2022, December 21). *A
once-in-a-generation storm will produce high winds east of Lake Ontario
Thursday night into Friday morning, then over a larger coverage* [Image
attached] [Tweet]. Twitter.
https://twitter.com/NWSBUFFALO/status/1605542943879827458

Office of the Mayor of Buffalo. (2023). *December 2022 blizzard report.*

Open Data Buffalo. (n.d.). https://data.buffalony.gov/

Poloncarz, M [@markpoloncarz]. (n.d.) *Tweets* [Twitter profile]. Twitter. Retrieved April
28, 2023, from https://twitter.com/markpoloncarz/

Poloncarz, M [@markpoloncarz]. (2022, December 24). *Please remember, 911 is only
for life-threatening emergencies. 858-SNOW is ONLY for very serious but*

non-life-threatening emergencies. Twitter.
https://twitter.com/markpoloncarz/status/1606734118670172160?s=20

Poloncarz, M [@markpoloncarz]. (2022, December 23). *According to @ErieCountyESU Commissioner Neaverth, we need to "weed out" about 90% of calls that are coming into the 911 call center. 911 is for true life and death emergencies.* Twitter. https://twitter.com/markpoloncarz/status/1606397759522848768

Schacht, L. P. (2020, April 8). Cuomo and Trump's daily briefings in a propaganda world. *Brookings.* https://www.brookings.edu/blog/fixgov/2020/04/08/cuomo-and-trumps-daily-briefings-in-a-propaganda-world/

Silke, E. (2022, December 25). *And how are they supposed to get there without transportation, unplowed streets and a travel ban?!!!* [Comment on the Facebook post *Storm update: code blue in the city of Buffalo / Shelter open tonight*]. Facebook. https://www.facebook.com/photo/?fbid=711717460313412

Tokasz, J. (2023, February 3). *Four people believed to be homeless died in the Buffalo blizzard. How others found safety. The Buffalo News.* https://buffalonews.com/news/local/four-people-believed-to-be-homeless-died-in-the-buffalo-blizzard-how-others-found-safety/article_9c4cdba0-a0c9-11ed-8382-33612acc41a3.html

United States Census Bureau. (2021a). *American Community Survey 2016-2021 S1601 language spoken at home.* https://data.census.gov/table?q=language+in+buffalo&tid=ACSST5Y2021.S1601

United States Census Bureau. (2021b). *QuickFacts Buffalo city, New York.* https://www.census.gov/quickfacts/buffalocitynewyork

WGRZ Staff. (2022, December 22). Buffalo mayor issues State of Emergency beginning 7 a.m. Friday. *WGRZ.* https://www.wgrz.com/article/weather/severe-weather/mayor-issues-state-of-emergency-for-buffalo-beginning-7am-friday-winter-weather-blizzard-warning/71-9d076d26-2602-4003-88e4-836365b521e6

Wood, M. M., Mileti, D. S., Bean, H., Liu, B. F., Sutton, J., & Madden, S. (2018). Milling and Public Warnings. Environment and Behavior, 50(5), 535–566. https://doi.org/10.1177/0013916517709561

Equity Sources

Andress, E., & Harrison, J. (n.d.). *Preparing an emergency food supply, short term food storage.* https://www.fcs.uga.edu/extension/preparing-an-emergency-food-supply-short-term-food-storage

Bethel, J. W., Burke, S. C., & Britt, A. F. (2013, November 8). Disparity in disaster preparedness between racial/ethnic groups. *Disaster Health, 1*(2), 110-116. https://doi.org/10.4161/dish.27085

Chicago Emergency Management & Communications. (n.d.). *Community Emergency Response Team (CERT)*.
https://www.chicago.gov/city/en/depts/oem/provdrs/edu/svcs/become_a_cert_volunteer.html

Drexel University. (n.d.). *Diversity preparedness*.
https://www.diversitypreparedness.org/

Durr, E. (2023, January 3). NY National Guard mobilized 849 for deadly Buffalo Blizzard response. *U.S. Army*.
https://www.army.mil/article/263062/ny_national_guard_mobilized_849_for_deadly_buffalo_blizzard_response#:~:text=If%20people%20needed%20food%20or,Daniel%20Weimer%20told%20Spectrum%20News

Eyre, A. (1999). In remembrance: post-disaster rituals and symbols. *Australian Journal of Emergency Management*, Spring 1999.
https://knowledge.aidr.org.au/media/3836/ajem-14-03-07.pdf

Fox 13 News staff. (2022, September 26). *Hurricane Ian: Uber offering free round-trip rides to Tampa Bay area shelters*. FOX 13 News.
https://www.fox13news.com/news/hurricane-ian-uber-offering-free-round-trip-rides-to-tampa-bay-area-shelters

FOX 35 News Staff. (2022, October 3). *Lyft offers Florida residents affected by Hurricane Ian free, discounted rides*. FOX 35 Orlando.
https://www.fox35orlando.com/news/lyft-offers-florida-residents-affected-by-hurricane-ian-with-free-discounted-rides

Kayyem, J. (2022, March). *The Devil Never Sleeps: Learning to Live in an Age of Disasters*. Hachette Book Group.

Kelly, G. (2021, December 7). Where's a cop when you need one? *InvestigativePost*.
https://www.investigativepost.org/2021/12/07/wheres-a-cop-when-you-need-one/

Magavern, S. (2018, April). *Poverty in Buffalo: Causes, impacts, solutions*.
https://ppgbuffalo.org/files/documents/poverty_low_wage_work_income_inequality/truth_commission_report__poverty_in_buffalo__causes__impacts__solutions.pdf

McAndrew, M. (2022, December 29). What we know about people who died in Buffalo Niagara's blizzard. *The Buffalo News*.
https://buffalonews.com/news/local/what-we-know-about-the-people-who-died-in-buffalo-niagaras-blizzard/article_98a32b72-87aa-11ed-985e-4beeb22a08f1.html

McCarthy, R. J. (2022, December 19). Pre-Covid ridership slowly returning to Metro Bus and Rail. *The Buffalo News*.
https://buffalonews.com/news/local/pre-covid-ridership-slowly-returning-to-metro-bus-and-rail/article_e821c09e-7ca8-11ed-bed6-9b23edcba35e.html

Merriweather, D., & Woods, S. (2023, February 1). Buffalo blizzard of 2022 highlights vulnerability for one segment of Buffalo's City of "Good Neighbors". *WNY & NWPA Episcopal Partnership*.

https://episcopalpartnership.org/buffalo-blizzard-of-2022-highlights-vulnerability-for-one-segment-of-buffalos-city-of-good-neighbors/

National Grid. (2022, December 24). Email from Manager of Community & Customer Management to the Buffalo Department of Public Works (DPW) at 11:53 a.m.

Open Data Buffalo. (2018). *Disability status, age of building stock, age distribution, rent burden*. Based on American Community Survey 2017 5 Year Estimates, Erie County - Census Tract. https://data.buffalony.gov/

Open Data Buffalo. (2022, September 1). *Neighborhoods*. https://data.buffalony.gov/Economic-Neighborhood-Development/Neighborhoods/ekfg-mtu8

Open Data Buffalo. (2023). *311 service requests*. https://data.buffalony.gov/Quality-of-Life/311-Service-Requests/whkc-e5vr

Sacks, B. (2022, December 29). Buffalo blizzard fuels racial and class divides in polarized city. *The Washington Post*. https://www.washingtonpost.com/weather/2022/12/29/buffalo-blizzard-storm-race-class/

Sacks, B. (2023, January 19). Death toll in Buffalo blizzard rises; delayed emergency response cited. *The Washington Post*. https://www.washingtonpost.com/weather/2023/01/19/buffalo-blizzard-deaths-emergency-response/

Samaha, A. (2023, March 7). Abdul Sharifu was buying milk for a neighbor's baby. A snowstorm killed him. *Buzzfeed News*. https://www.buzzfeednews.com/article/albertsamaha/abdul-sharifu-buffalo-blizzard-2022

U. S. Small Business Administration. (n.d.). *Disaster assistance* . U. S. Small Business Administration. Retrieved May 31, 2023, from https://www.sba.gov/funding-programs/disaster-assistance

Specht, C. (2023, January 1). How 'cascading failure' hit some neighborhoods harder. *The Buffalo News*. https://buffalonews.com/how-cascading-failure-hit-some-neighborhoods-harder/article_62e981ec-2b71-5d90-b877-1f496fddb216.html

The Buffalo News. (2023, January 25). *2022 Buffalo blizzard deaths*. https://www.google.com/maps/d/u/0/viewer?mid=1-o8L7k9hycsuEnPsuPTdTZyxe39en7o&ll=42.873224%2C-78.81814310000001&z=13

United States Census Bureau. (2021a). *Quickfacts: Buffalo city, New York; Erie County, New York*. https://www.census.gov/quickfacts/fact/table/buffalocitynewyork,eriecountynewyork/PST045222

United States Census Bureau. (2021b). *B19058 | Public assistance income or food stamps/SNAP in the past 12 months*. American Community Survey 2021. https://data.census.gov/table?q=2021+B19058&tid=ACSDT1Y2021.B19058

United States Census Bureau. (2021c). *DP04 | Selected housing characteristics* . American Community Survey 2021 5-Year Estimates.

https://data.census.gov/table?tid=ACSDP5Y2021.DP04&g=160XX00US3611000_0 40XX00US36&hidePreview=true

United States Census Bureau. (2021d). *S0802 | Means of transportation to work by selected characteristics*. American Community Survey 2021 5-Year Estimates. https://data.census.gov/table?q=commuting+characteristics+in+buffalo&tid=A CSST5Y2021.S0802&moe=false

United States Census Bureau. (2021e). *American Community Survey 2016-2021 S1601 language spoken at home*. https://data.census.gov/table?q=language+in+buffalo&tid=ACSST5Y2021.S1601

United States Census Bureau. (2021f). *Median household income by census tract, Buffalo, NY*. American Community Survey 2016-2021 5-Year Estimates.

United States Census Bureau. (2021g). *Race by census tract, Buffalo, NY*. American Community Survey 2016-2021 5-Year Estimates.

United States Department of Agriculture. (2021, November 15). *Monthly SNAP issuance schedule for all states and territories*. https://www.fns.usda.gov/snap/monthly-issuance-schedule-all-states-and-terri tories

United States Department of Agriculture. (2022, December 9). *Food access research atlas*. https://www.ers.usda.gov/data-products/food-access-research-atlas/go-to-the-atlas/

United States Department of Health & Human Services. *Cultural and Linguistic Competency in Disaster Preparedness and Response Fact Sheet*. https://www.phe.gov/Preparedness/planning/abc/Pages/linguistic-facts.aspx

U.S. Department of Housing and Urban Development (HUD). (n.d.). *Funding opportunities*. HUD.Gov. Retrieved May 31, 2023, from https://www.hud.gov/grants

University at Buffalo. (n.d.). *East-West divide*. https://archplan.buffalo.edu/research/research-initiatives/seeitthrough/aschool anditscity/eastwestdivide.html

Walker, J. B., & Ghirmatzion, R. (2023, February 3). Another Voice: We must work together for equity and efficiency in times of crisis. *The Buffalo News*. https://buffalonews.com/opinion/another-voice-we-must-work-together-for-eq uity-and-efficiency-in-times-of-crisis/article_30f816e8-8d3d-11ed-8908-eb1a8d3 54c5c.html

Watson, S. T. (2023, January 19). Death toll in Buffalo blizzard rises to 47 people. *The Buffalo News*. https://buffalonews.com/news/local/death-toll-in-buffalo-blizzard-rises-to-47-p eople/article_04c578e0-9814-11ed-b391-dbf7d2370f3d.html

Watson, S. T., Tan, S., Becker, M., McCarthy, R. J., & Glynn, M. (2023, January 17). What went wrong? A generational blizzard exposed fatal flaws and generates fierce second-guessing. *The Buffalo News*. https://buffalonews.com/news/local/accident-and-incident/what-went-wrong-

a-generational-blizzard-exposed-fatal-flaws-and-generates-fierce-second-guessing/article_c0a2be50-92ac-11ed-bf4f-bbb2ac27b949.html

WGRZ Staff. (2022, May 16). Transportation services being offered to people who depend on Tops on Jefferson Ave. *WGRZ*. https://www.wgrz.com/article/news/local/transportation-services-being-offered-who-depended-tops-jefferson-ave-following-mass-shooting/71-c9d897b3-88dc-4fbc-9e31-93f051478737

World Central Kitchen. (2023). *Deadliest blizzard in decades hits Buffalo*. https://wck.org/relief/buffalo-winter-storm

Successes Sources

Becker, M. (2022, December 27.). A real-life Christmas angel saves a life and gives WNY a reason to smile. *The Buffalo News*. https://buffalonews.com/news/local/a-real-life-christmas-angel-saves-a-life-and-gives-wny-a-reason-to-smile/article_8f77929a-8601-11ed-b35b-af3aede6d7d8.html

City of Buffalo Division of Citizen Services. (n.d.). *Clean sweep*. https://www.buffalony.gov/849/Clean-Sweep

Epstein, J. D. (2022, December 29). Kenmore mechanic heralded for saving lives by breaking into school during blizzard. *The Buffalo News*. https://buffalonews.com/news/local/kenmore-mechanic-heralded-for-saving-lives-by-breaking-into-school-during-blizzard/article_fd089cb8-87b5-11ed-8bab-af209a848849.html

Tsujimoto, B. (2023, January 21). Gov. Kathy Hochul recognizes 'ordinary' heroes from blizzard during Buffalo State visit. *The Buffalo News*. https://buffalonews.com/news/local/gov-kathy-hochul-recognizes-ordinary-heroes-from-blizzard-during-buffalo-state-visit/article_0c4660c2-99ca-11ed-bef3-1b2edd1f23c9.html#tncms-source=login

Recommendations Sources

Department of Administration, Finance, Policy and Urban Affairs & Division Of Budget and Management. (n.d.). *Recommended annual budget city of Buffalo for the fiscal year ending June 30, 2024.* https://www.buffalony.gov/DocumentCenter/View/11799/Recommended-Budget-Fiscal-Year-2023-2024

Federal Communications Commission. (2023). Amendments to Part 11 of the Commission's Rules Regarding the Emergency Alert System. https://docs.fcc.gov/public/attachments/FCC-23-30A1.pdf

Federal Emergency Management Agency. (2023, May 17). IPAWS Alerting Authorities - Agencies and Organizations.

https://www.fema.gov/emergency-managers/practitioners/integrated-public-al
ert-warning-system/public-safety-officials/alerting-authorities/agencies-organi
zations

Plants, R. (2023, February 7). *New York makes formal request for federal funds to
help on blizzard response costs*. Wgrz.com.
https://www.wgrz.com/article/money/nys-formal-request-federal-funds-blizzar
d-response-costs/71-07a7f37a-926d-42ba-86d1-81cffb335a34

United States Small Business Administration. *Home Page*. https://www.sba.gov/.
Accessed 1 June 2023.

Tan, S., & Williams, D. (2023, January 15). The blizzard revealed a gap in coordination
efforts between the city and county. *The Buffalo News*.
https://buffalonews.com/news/local/the-blizzard-revealed-a-gap-in-coordinatio
n-efforts-between-the-city-and-county/article_19d47020-9363-11ed-b19b-73d82
141c713.html

Timeline of Events Sources

Becker, M. (2022, December 25). 17 dead, desperation grows on Buffalo blizzard Day 3:
'Not the Christmas that we wanted'. *The Buffalo News*.
https://buffalonews.com/news/local/17-dead-desperation-grows-on-buffalo-bli
zzard-day-3-not-the-christmas-that-we-wanted/article_c6420664-849b-11ed-9
e23-c3028c631897.html

Besecker, A. (2022, December 22). NFTA suspends bus, rail, paratransit service as of 2
a.m. Friday. *The Buffalo News*.
https://buffalonews.com/news/local/nfta-suspends-bus-rail-paratransit-service-
as-of-2-a-m-friday/article_776c0f4a-8247-11ed-b321-33a34b213f9a.html

Bragg, C. (2023, February 19). Buffalo's blizzard led to a patchwork of driving bans.
Could Hochul have closed local roads? *The Buffalo News*.
https://buffalonews.com/news/local/buffalos-blizzard-led-to-a-patchwork-of-dr
iving-bans-could-hochul-have-closed-local-roads/article_eddf800c-ae12-11ed-b
62a-837714191fb5.html

Brown, B. W. [@MayorByronBrown]. (2022, December 23). *Storm update: Mayor
Brown issues driving ban for the city of Buffalo effective December 23, 2022 /
9:30AM*. [Image] [Tweet]. Twitter.
https://twitter.com/MayorByronBrown/status/1606309543180439553

Brown, B. W. [@MayorByronBrown]. (2022, December 23). *Parking regulations on City
of Buffalo side streets are suspended until Monday, January 2, 2022. #Buffalo
#BuffaloBlizzard* [Image attached] [Tweet]. Twitter.
https://twitter.com/MayorByronBrown/status/1608588268693774336

Brown, B. W. [@MayorByronBrown]. (2023, January 1). *Sanitation and Recycling
collection will resume regular scheduled pick-up tomorrow, January 2nd*

[Tweet]. Twitter.
https://twitter.com/MayorByronBrown/status/1609625213674876928

Buffalo Common Council. (2022, December 23). *A Driving Ban for all of Erie County, including the City of Buffalo, will be going into effect at 9:30AM.* [Status update]. Facebook.
https://www.facebook.com/BFLOCC/posts/pfbid0xf34YcodqMdkr1wKcZ3ZpBH
WS4Up5qU7G8C14rejtSMwUi4SKTjmSEtZhMgHxwjGl

Buffalo Common Council. (2022, December 23). ⚠️ *Effective at 9:30 AM there is a travel ban for the City of Buffalo* [Status update]. Facebook.
https://www.facebook.com/photo/?fbid=502036708697181&set=a.196883672545
821

Buffalo Police Department [@BuffaloNYPolice]. (2022, December 23). *Storm latest: A travel ban is now in effect for the City of Buffalo & Erie County. Only essential personnel should be on the roads.* [Tweet]. Twitter.
https://twitter.com/BuffaloNYPolice/status/1606300487539720193

City of Buffalo. (2022, December 21). *Mayor Brown announces closings and changes in advance of forecasted Christmas weekend storm.* Press release.
https://www.buffalony.gov/CivicAlerts.aspx?AID=1187

City of Buffalo. (2022, December 23). *Mayor Brown announces driving ban in Buffalo, effective Friday, December 23 at 9:30 am.* Press release.
https://www.buffalony.gov/CivicAlerts.aspx?AID=1188

City of Buffalo Parking [@buffalo_parking]. (2022, December 25). *Storm update parking regulations on side streets are suspended until further notice* [Image attached] [Tweet]. Twitter.
https://twitter.com/buffalo_parking/status/1607093104137408512

Erbacher, A. (2022, December 29). Live updates: Western New York digs out from Blizzard of '22. *ABC7 WKBW*.
https://www.wkbw.com/weather/live-updates-preparing-for-a-christmas-week
end-blizzard-warning-in-western-new-york

Mayor Byron W. Brown. (2022, December 23). *Storm update: Mayor Brown issues driving ban for the city of Buffalo effective December 23, 2022 / 9:30AM* [Image] [Status update]. Facebook.
https://www.facebook.com/photo/?fbid=710673967084428

Mayor Byron W. Brown. (2022, December 27). *National Grid US just informed me that we are now just under 2000 residents without power in the City of Buffalo* [Status update]. Facebook.
https://www.facebook.com/MayorByronBrown/posts/pfbid02mz8tvxvntuqATPf
9wphAmH9H8ctsC4nESfGYTmJZCRy5NUFzHtsYNbMakbWedRaRl

National Grid. (2022, December 24). *Western New York: National Grid crews battling blizzard, treacherous conditions as they work to restore service to affected customers.*
https://www.nationalgridus.com/News/2022/Western-New-York-National-Grid-

Crews-Battling-Blizzard,-Treacherous-Conditions-as-they-Work-to-Restore-Service-to-Affected-Customers-/

National Grid. (2022, December 28). *National Grid to restore power today to all Western New York customers impacted by historic blizzard.* https://www.nationalgridus.com/News/2022/12/National-Grid-to-Restore-Power-Today-to-all-Western-New-York-Customers-Impacted-by-Historic-Blizzard-/

National Grid. (2023). *National Grid storm outreach tracking log.*

National Weather Service Buffalo [@NWSBUFFALO]. (2022, December 19). *A powerful storm will impact the region heading into the holiday weekend. Here's an overveiw of the potential weather hazards* [Image attached] [Tweet]. Twitter. https://twitter.com/NWSBUFFALO/status/1604963625378238465

National Weather Service Buffalo [@NWSBUFFALO]. (2022, December 20). *Here are our first round of watches for a major storm system which will impact the region beginning late Thursday* [Image attached] [Tweet]. Twitter. https://twitter.com/NWSBUFFALO/status/1605283973898244097

National Weather Service Buffalo [@NWSBUFFALO]. (2022, December 21). *A once-in-a-generation storm will produce high winds east of Lake Ontario Thursday night into Friday morning, then over a larger coverage* [Image attached] [Tweet]. Twitter. https://twitter.com/NWSBUFFALO/status/1605542943879827458

National Weather Service Buffalo [@NWSBUFFALO]. (2022, December 22). *A Blizzard Warning was issued for the Niagara Frontier, including the Buffalo Metro area. Lake effect snow, strong wind, blowing snow* [Image] [Tweet]. Twitter. https://twitter.com/NWSBUFFALO/status/1605879863935750144

National Weather Service Buffalo [@NWSBUFFALO]. (2022, December 25). *After a rough ~40 hours, wind speeds have dropped and visibilities have improved here at #BUF. Currently, winds are gusting* [Image] [Tweet]. Twitter. https://twitter.com/NWSBUFFALO/status/1606903849012580352?s=20

Niagara Frontier Transportation Authority. (2023, January 26). *Blizzard of '22* [slide deck]. https://nfta.granicus.com/DocumentViewer.php?file=nfta_cee5079361e883f99ba405795359ef45.pdf&view=1

Smith, E [@ElyseSmithWX]. (2022, December 19). *Another way to lay out the potential impacts heading our way. Wednesday will be the last "guaranteed" day for minimal travel.* [Image] [Tweet]. Twitter. https://twitter.com/ElyseSmithWX/status/1605044757163655170

Smith, E. (2023, March 16). Timeline of the Blizzard of 2022. *WGRZ*. https://www.wgrz.com/article/weather/severe-weather/timeline-of-the-wny-blizzard-of-2022-buffalo-niagara/71-31e533fe-edd2-4201-86c8-2fe678fb784e

Timmer, R [@@ReedTimmerAccu]. (2022, December 24). *Live update from downtown Buffalo looking down at trapped emergency vehicles in 15 foot snow drift with #blizzard continuing to* [Video attached] [Tweet]. Twitter. https://twitter.com/ReedTimmerAccu/status/1606728362499506176

Watson, S. T. (2023, January 19). Death toll in Buffalo blizzard rises to 47 people. *The Buffalo News*.
    https://buffalonews.com/news/local/death-toll-in-buffalo-blizzard-rises-to-47-people/article_04c578e0-9814-11ed-b391-dbf7d2370f3d.html

Weather Underground. (2023). *Cheektowaga, NY weather history*.
    https://www.wunderground.com/history/daily/us/ny/cheektowaga/KBUF/date/2022-12-23

WGRZ Staff. (2022, December 29). Garbage pickup resumes Friday in City of Buffalo. *WGRZ*.
    https://www.wgrz.com/article/weather/severe-weather/garbage-pickup-resumes-friday-city-buffalo-blizzard/71-93dd3a9a-8782-4057-8912-910acf4370f4#:~:text=Updated%3A%206%3A48%20PM%20EST%20December%2029%2C%202022%20BUFFALO%2C,added%20that%20alternate%20parking%20is%20suspended%20until%20Monday

WGRZ-TV. (2022, December 21). *Town Hall: Mike Fries discusses weekend storm* [Video]. Youtube. https://www.youtube.com/watch?v=b8umco_yfkQ

Miscellaneous Sources

Benson, N. (2023, January 17). Several blizzard-related items on Buffalo Common Council agenda Tuesday. *WGRZ*.
    https://www.wgrz.com/article/news/local/blizzard-related-items-on-buffalo-common-council-agenda-tuesday/71-37062502-81c9-4968-8e81-902d35a47657

Buffalo agencies and stakeholders. (2023, February 6 to March 5). Personal communications.

Buffalo Common Council. (2023, January 11). *Buffalo Common Council Police Oversight Committee Meeting - Wednesday, January 11, 2023* [Status update] [Video]. Facebook.   https://fb.watch/k1fw4Xaz4T/

Kayyem, J. (2022, March). *The Devil Never Sleeps: Learning to Live in an Age of Disasters*. Hachette Book Group.

Kilgannon, C., Fadulu, L., Meko, H., & Nir, S. M. (2022, December 29). How the Buffalo blizzard became so deadly. *The New York Times*.
    https://www.nytimes.com/2022/12/29/nyregion/western-new-york-storm.html

Kneeland, T. W. (2021, May). *Declaring Disaster: Buffalo's Blizzard of '77 and the creation of FEMA*. Syracuse University Press.

New York City Emergency Management. (n.d.). *After-action reporting: Best practices*.
    https://www.nyc.gov/assets/em/downloads/pdf/nyc_emergency_management_aar_hotwash_best_practices.pdf

Office of the Mayor of Buffalo. (2023). *December 2022 Blizzard Report*.

Regan, M. D., Fadulu, L., & Meko, H. (2022, December 28). In Buffalo, finger-pointing and growing complaints over storm response. *The New York Times*.

https://www.nytimes.com/2022/12/28/nyregion/buffalo-storm-response-criticism.html

Tan, S., & Williams, D. (2023, January 15). The blizzard revealed a gap in coordination efforts between the city and county. *The Buffalo News*. https://buffalonews.com/news/local/the-blizzard-revealed-a-gap-in-coordination-efforts-between-the-city-and-county/article_19d47020-9363-11ed-b19b-73d82141c713.html

WBFO. (2023, January 27). *Buffalo, what's next? | Producers' picks* [Radio broadcast]. https://www.wbfo.org/wbfo-brief-season-4-2023/2023-01-27/buffalo-whats-next-producers-picks

WGRZ. (2023, January 30). *We review the Blizzard of 22 with two Erie County commissioners* [Video]. https://www.wgrz.com/video/news/we-review-the-blizzard-of-22-with-two-erie-county-commissioners/71-797f8e0a-e9c8-4300-84cc-02202009e89f

WGRZ-TV. (2022, December 29). *Buffalo Common Council says city was unprepared for blizzard* [Video]. Youtube. https://www.youtube.com/watch?v=YHVEkd9m2qE