Hamburg Active Mobility Action Plan
August 2023

GObike

HAMBURG MOVES

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Executive Summary

After successful and transformative projects to enhance the pedestrian environment in the Village of Hamburg, the Town of Hamburg passed a resolution to create the Hamburg Moves Committee to explore ways to extend the successes of the VIllage throughout the rest of the Town. In Fall 2022, the Town invited GObike Buffalo to work with Hamburg Moves to develop an Active Mobility Action Plan, with the goals of identifying priority areas for infrastructure investment to improve bike and pedestrian access, improving bike and pedestrian connectivity to amenities and services, and provide recommendations for action steps to transform those areas in the near and long-term future.

The planning process included monthly meetings with Hamburg Moves, a community-wide survey which asked about transportation behavior and preferences, a bike rodeo for children to learn about biking safely, and multiple walk audits which collected field data on the pedestrian experience in priority roadways and intersections in the Town.

Combined with demographic and transportation data, all of these engagements provided insights that enabled GObike to identify several priority areas for investment, where safety improvements could have the largest potential positive impact on active mobility in the Town. Additionally, the engagement process revealed common themes among residents about active mobility in the Town:

1. Residents desire safe, well-maintained bike paths in their neighborhoods to create more opportunities for active mobility. Residents would like to pursue a more active lifestyle and to travel by means other than a vehicle, but do not currently do so, due to a lack of safe bike path connectivity.
2. Fear of traffic violence caused by vehicles speeding, and disregarding the safety of other roadway users - namely on roadways like Clark Street, Route 20 (Southwestern Blvd.), and McKinley Parkway - is a major factor preventing residents from walking and riding bikes in Hamburg.
3. A desire for better connectivity to the Village from isolated neighborhoods like Armor Duells, and improved access to destinations like the McKinley Mall shopping district and Town Hall Plaza.

Priority areas include specific intersections and corridors that are ripe for improvements to provide the desired safety improvements and create greater connectivity to important destinations in the Town. The report offers potential design options and general recommendations for these priority areas, such as reconfigurations of signalized intersections into roundabouts, bike lanes, and pedestrian focused infrastructure like crosswalks, signals, and signage. This plan also proposes a potential pilot project intervention at the intersection of Rogers Road and Pleasant Avenue, which is dependent upon further discussions with Erie County.

Beyond immediate design changes, the Town can also make policy updates such as passing a Complete Streets Policy, completing a Sidewalk Master Plan and Bicycle Master Plan, and updating zoning code to create a framework for future improvements.

Project Background

The Village of Hamburg set a precedent for rural villages across New York State with the transformation of Route 62 from a hazardous shipping route, into a pedestrian-oriented center for local business. That task was accomplished by the Town's willingness to transform their residents' demand for a more connected community into bold and lasting infrastructure changes.

This success led to continued demand from residents for a more walkable and bikeable town, connecting neighbors to neighborhoods, and people to destinations.

A resolution to create the Hamburg Moves Committee was drafted in 2019 in response to this demand; started as a hybrid group of citizens and town employees, Hamburg Moves was established to identify focus points for connectivity improvements in the Town of Hamburg & the Village of Blasdell.

The Hamburg Moves Committee's activity fell dormant during the COVID-19 pandemic, however, and wasn't revived until fall 2022, when the Town of Hamburg teamed up with GObike Buffalo to begin a planning process to develop an Active Mobility Action Plan. One unique component of this partnership is GObike's stewardship of the existing Hamburg Moves Committee, in order to organize the group's goals, projects, and emerging leaders, and to involve them throughout the process.

Through monthly meetings, virtual and in-person surveying, a bike rodeo, and community outreach performed throughout winter 2023, GObike and the Hamburg Moves Committee worked to identify four primary roadways/intersections of concern within the Town of Hamburg. Those areas of concern - all of which include, at least in part, some portion of a county roadway - became the focus of this Active Mobility Action Plan.

Hamburg Moves Mission Statement

"The Hamburg Moves committee's mission is to implement the initiatives laid-out in the Hamburg Multimodal Trails Master Plan and additionally explore, promote, identify, and develop a safe system of multimodal recreational trails on-street and off-street, within and connected with all of Hamburg proper to enhance the economic development, safety, conservation, tourism and quality of life and place during all seasons. The committee will pursue available grant funding from various levels of government and from other entities who share common goals with Hamburg Moves".

Project Background

Project Background

Active Mobility Actions Plans Goals

Project goals were developed and agreed upon through cooperation between GObike and the Hamburg Moves Committee. Goals were developed with two primary needs in mind: how to better connect neighbors to neighborhoods, and people to the places they wish to visit. Primary goals established by the group included:

- Make roadways for people, not for cars; if streets aren't accessible to children, the elderly, and people with disabilities, they are not truly for everyone.
- Examine routes and options for safe, improved access between the Village of Hamburg and outlying areas within the Town, like the Armor Duells neighborhood.
- Develop a safe route connecting the Village of Hamburg and amenities like Lake Erie.
- Create streets safe enough for children to walk or bike to school, as most children live within a mile of their school but are forced to bus due to busy roadways and lack of alternative mode options, particularly in Forest Glen and Armor neighborhoods.
- Build on the good things Hamburg already has, such as existing bike and pedestrian infrastructure and roundabouts.
- Develop solutions for "sidewalks to nowhere" abundant throughout town.

Focus On Vulnerable Residents

In April 2023, GObike received additional funding through the Health Foundation for Western & Central New York's Age-Friendly: Go Local program to examine ways to improve livability for seniors in the Village of Blasdell. This project supplemented the efforts in other areas of the Town of Hamburg with a specific emphasis on improving the safety and accessibility of streets near Our Mother-Good Counsel Senior apartments on Lake Avenue.

Older adults have much to gain from built environments that support safe active mobility. Regular physical activity reduces obesity and blood pressure, helps maintain cardiovascular and joint health, improves mood (and socialization opportunities) and may delay functional decline. The U.S. Surgeon General recommends a minimum of 30 minutes of activity daily to maintain health: designing safe complete streets therefore emerges as a highly effective strategy for improving overall community health. Safe, accessible infrastructure can encourage people to adopt healthier behaviors as part of their daily routines – from walking to the store to biking to a social gathering. Beyond the physical benefits, walking or biking for transportation can also support financial and personal independence: the average annual cost of owning and operating a car is $10,728 (AAA, 2022). This cost can place a significant burden on low-income households, including older adults on a fixed income.

Project Background

While aging populations may see some of the greatest benefits from a safe, accessible, built environment, they also experience some of the greatest risks related to the current transportation system. While the COVID pandemic upended many aspects of daily life, including how people get around, one terrible trend remained unchanged: the alarming increase in people being struck and killed while walking – which is at a 40 year high – disproportionately impacts older adults and those living in low-income communities of color. (2022, Smart Growth America, Dangerous By Design)

Between 2017 and 2021, New York State Department of Transportation recorded 121,807 reported automobile-involved crashes, or an average of 67 crashes per day in Erie and Niagara counties, with 64 people dying each year. Despite being involved in a far smaller proportion of total crashes (2.9%), one in four fatal crashes resulted in the death of a person walking or bicycling (25.7%). The New York State Department of Health recognizes traffic deaths and injuries as a major preventable public health problem, yet crashes remain the leading cause of injury-related death, second-leading cause of injury-related hospitalizations and third-leading cause for injury-related emergency department visits in the state.

Implementing Complete Streets, which design roads to give equal consideration to all modes when a road is designed, is essential to making roads safe. Traffic-calming measures such as narrower lanes, trees, intersection bumpouts and bike lanes save lives: a pedestrian struck by a vehicle traveling at 40mph has a 15% chance of survival, while the survival rate for a crash at 20mph jumps to 95%. Recent data from NYC DOT published in Governing Magazine has shown simple changes such as road diets (converting a 4 lane street to a 3 lane one), bicycle lanes, curb extensions and turn calming can reduce the number of people killed or seriously injured on streets from 15% - 30%.

Complete Streets therefore become a vital component of creating liveable communities where people can safely access their public spaces to work, recreate, and access basic needs. The Village of Blasdell is one such community that would benefit from traffic calming measures. Several high-traffic, high-speed roads run through the village, which has a 25.8% old age dependency ratio and several senior housing locations.

Project Background

Past Planning Efforts

Several efforts within the last decade have taken place to enhance active mobility in the Town of Hamburg and across the region. This Active Mobility Action Plan builds on that existing work and is not meant to replace the priorities identified in these other plans. Rather, this plan offers supplemental recommendations that reflect updated resident priorities, and further the existing priorities identified in past plans.

Hamburg Multimodal Trails Master Plan (2017)

The Hamburg Multimodal Trails Master Plan was created to provide a planning tool that incorporates several proposed trail components into one comprehensive trail system. These trails would create connections between communities, recreational locations, shopping centers, sporting venues/fields, parkland, waterways, and existing trails located in municipalities adjacent to the Village and Town of Hamburg. The report identifies priority corridors, both on and off-road, where investments in multimodal infrastructure would improve active mobility options for residents and visitors. Two projects identified in the Multimodal Trails Master Plan, [TC-3]: Village of Hamburg to New Era Field Trail and [TC-4}: Village of Hamburg to Lake Erie Trail, aligned closely with the focus areas identified in this Action Plan. Specifically, Pleasant Ave is recognized as an important connector to the Lake, and the intersection of Clark-Armor Duells-Bayview-Abbott is identified as an unsafe barrier along the route from the Village of Hamburg to Armor and points beyond.

Bike Buffalo Niagara: Regional Bike Master Plan (2020)

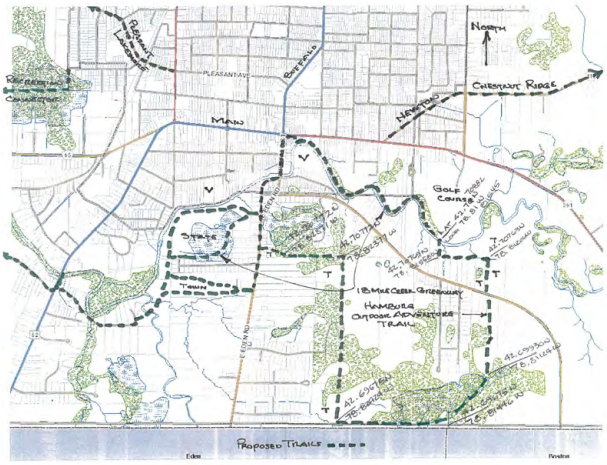
Greater Buffalo Niagara Regional Transportation Council (GBNRTC) developed the Regional Bike Master Plan to guide the development of a comprehensive network of on-street and off-street pathways, bike lanes, greenway trails, and other facilities that safely connect neighborhoods to key destinations. In a sense, the Hamburg Active Mobility Action Plan is a continuation of this work at a granular level. The Regional Bike Master Plan identified gaps in the regional network of on- and off-road bike infrastructure, inventoried existing right-of-way (ROW) by their capacity for multi-modal adaptation, and proposed new connections categorized by tiered treatment levels of bike infrastructure.

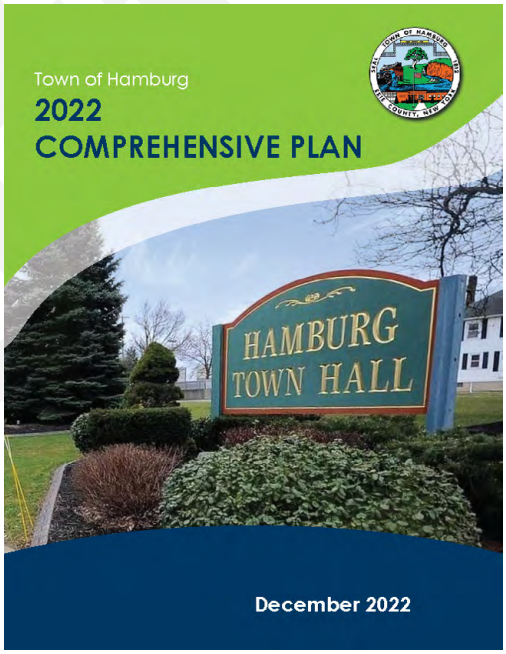
Some of the focus areas in the Active Mobility Action Plan correspond to recommendations proposed in the Regional Bike Master Plan. Namely, the regional plan identifies Lake Ave in Blasdell as a proposed Tier II (on-road bikeway) facility, and Clark St. as a proposed Tier III (on-road bikeway with minimal visual separation) facility. This plan further supports these bikeways by focusing on other design and investment recommendations that facilitate the proposed bikeways on these corridors. Other areas focused on in the Active Mobility Action Plan, such as Pleasant Ave, are not currently listed on the Regional Bike Master Plan, but could be added to the regional plan in future updates.

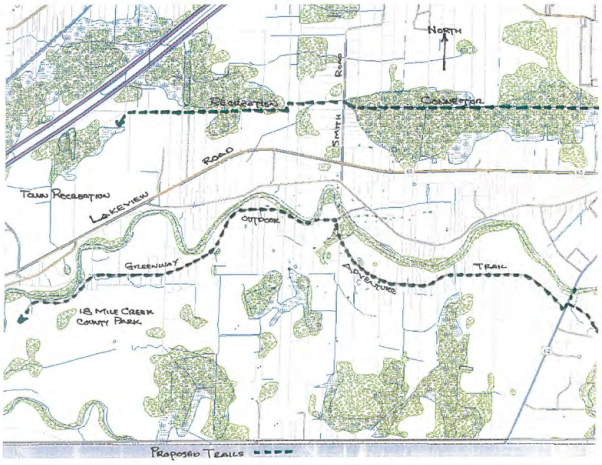
Project Background

Town of Hamburg Comprehensive Plan (2022)

The most recent update to the Town's Comprehensive Plan in 2022 builds off of foundational guiding principles, including "Maintain and revitalize our infrastructure where necessary." Within that guiding principle, the plan outlines specific goals related to transportation that were distilled from community engagements throughout the planning process. Goals include creating stronger connectivity to the waterfront, building more sustainable infrastructure, and increasing multimodal opportunities. The Plan recommends further study of how to make neighborhoods in the Town more walkable and bikeable, as well as working with other jurisdictions, such as NYS Department of Transportation (NYSDOT), Erie County, and Greater Buffalo Niagara Regional Transportation Council, to explore infrastructure improvements to make specific corridors safer and more accessible for bicyclists and pedestrians.







Source: CBNRTC, Town of Hamburg Comprehensive plan (2020) , & Hamburg Multimodel Traild master Plan (2017)

Project Background

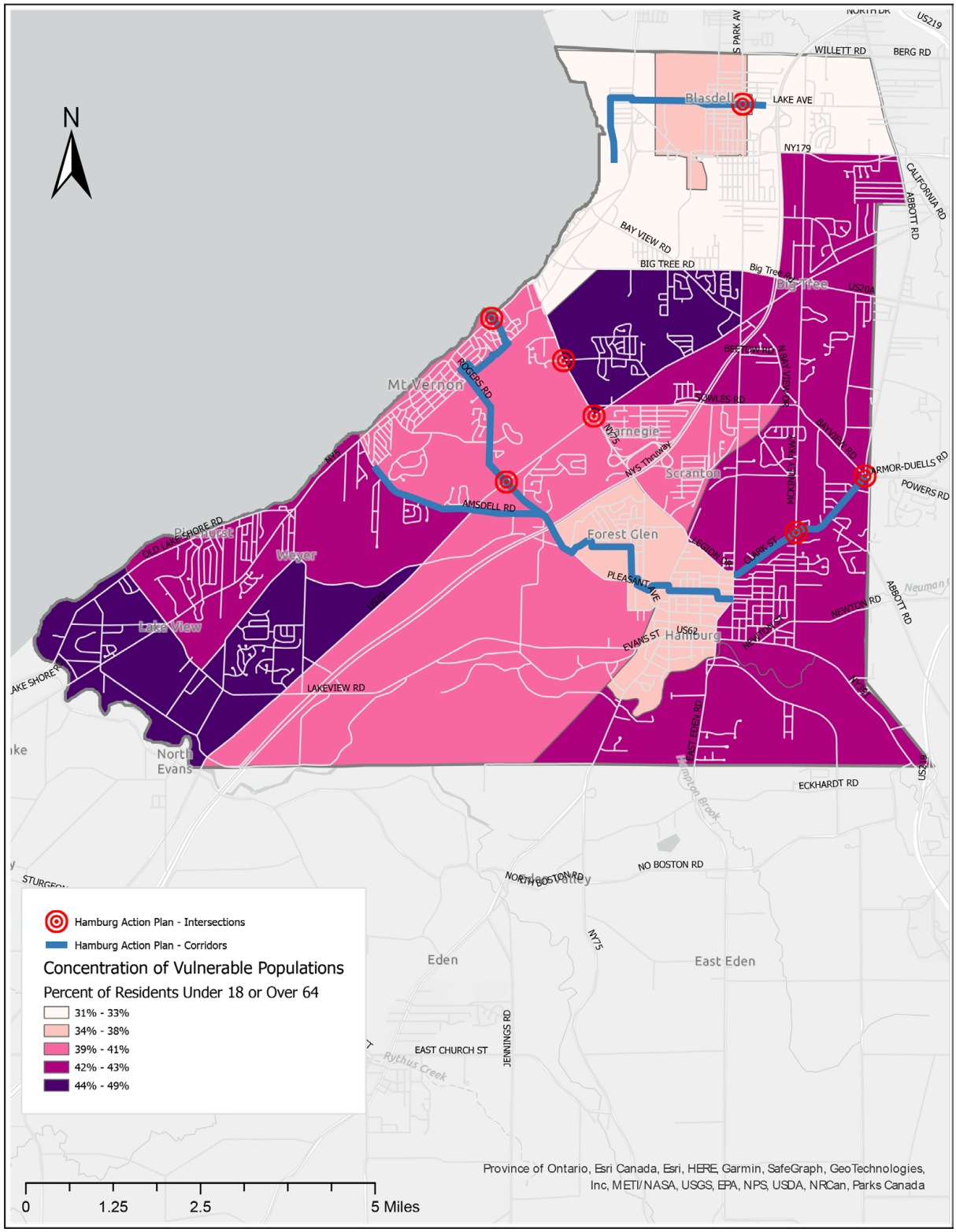
Existing Transportation Conditions

Percentage of population under 18 and over 64 years old

Concentrations of children and seniors in the Town are not too significant, but are higher near Lakeview and the neighborhoods southwest of the intersection of South Park Ave and Big Tree Rd.Children and seniors are among the most vulnerable road users. Children are smaller and less visible, have less experience with navigating dangerous environments, and may not have as much situational awareness as an adult. Seniors, on the other hand, are more likely to experience mobility challenges that limit the speed at which they can traverse roadways by foot or by bike; other challenging factors could include sensory limitations such as poor eyesight or hearing. Seniors may also need to use wheelchairs and other mobility assistive devices that are difficult to use along roadways with poor or no sidewalks, crossings, and signals. Overall, about 1 in 5 residents is under the age of 18 and 1 in 5 residents is 65 or older. These vulnerable populations make up 40% of the total population of the Town of Hamburg. When considering the tract level near the study area, specifically the village of Blasdell, vulnerable populations constitute 38% of the total population. Although this figure is lower than the town's average, it remains relatively high and demands significant attention. Conversely, in the Mckinley Pkwy and Clark Street area, the percentage rises to 43% of the total population. Among this group, 22% are elderly individuals aged 65 and older, who may face mobility limitations.

Concentration of Vulnerable Population

Percent of Residents 18 and over 64

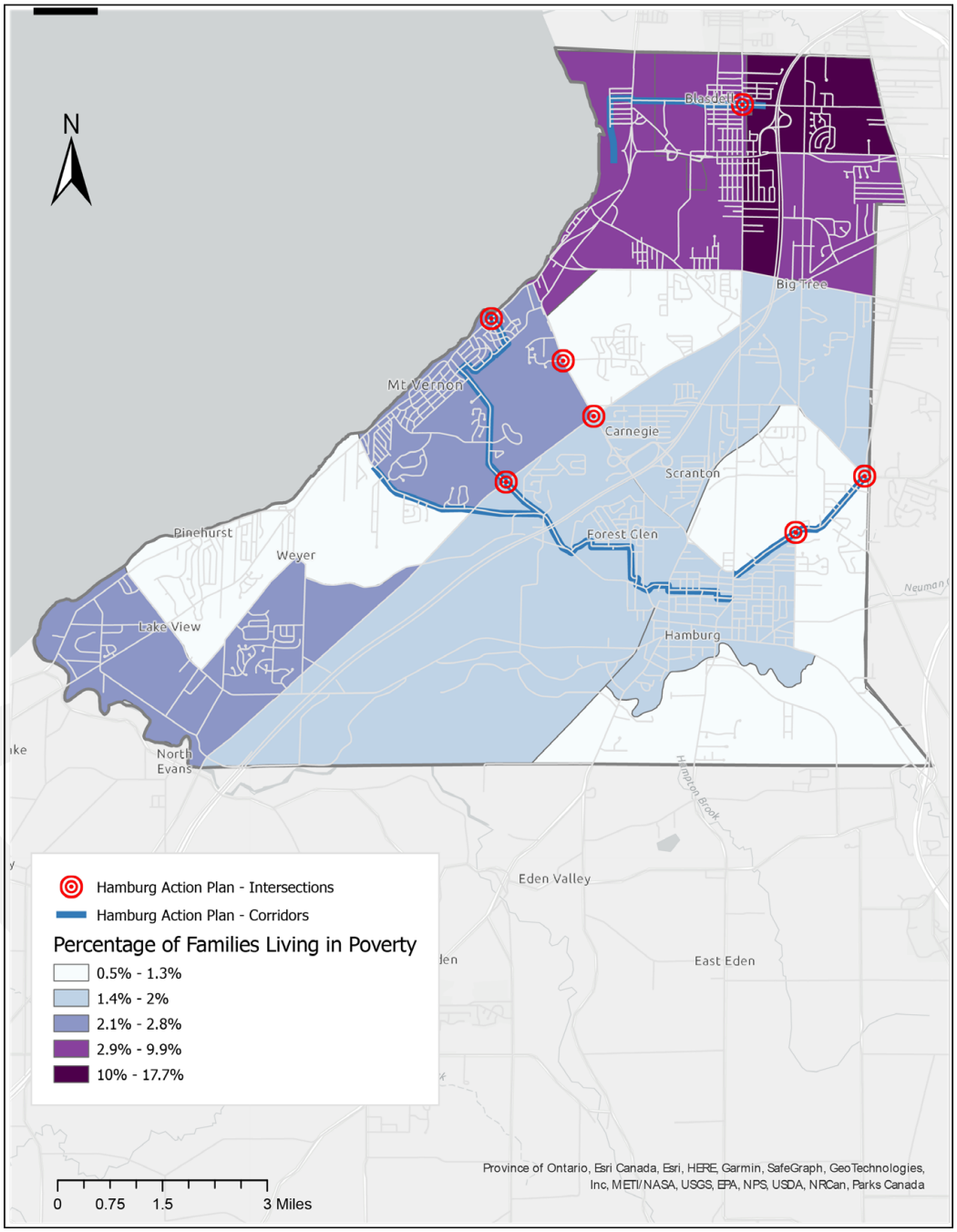


Source: GObike staff analysis of ACS 2021 5 years estimates

Project Background

Percentage of Families living in Poeverty

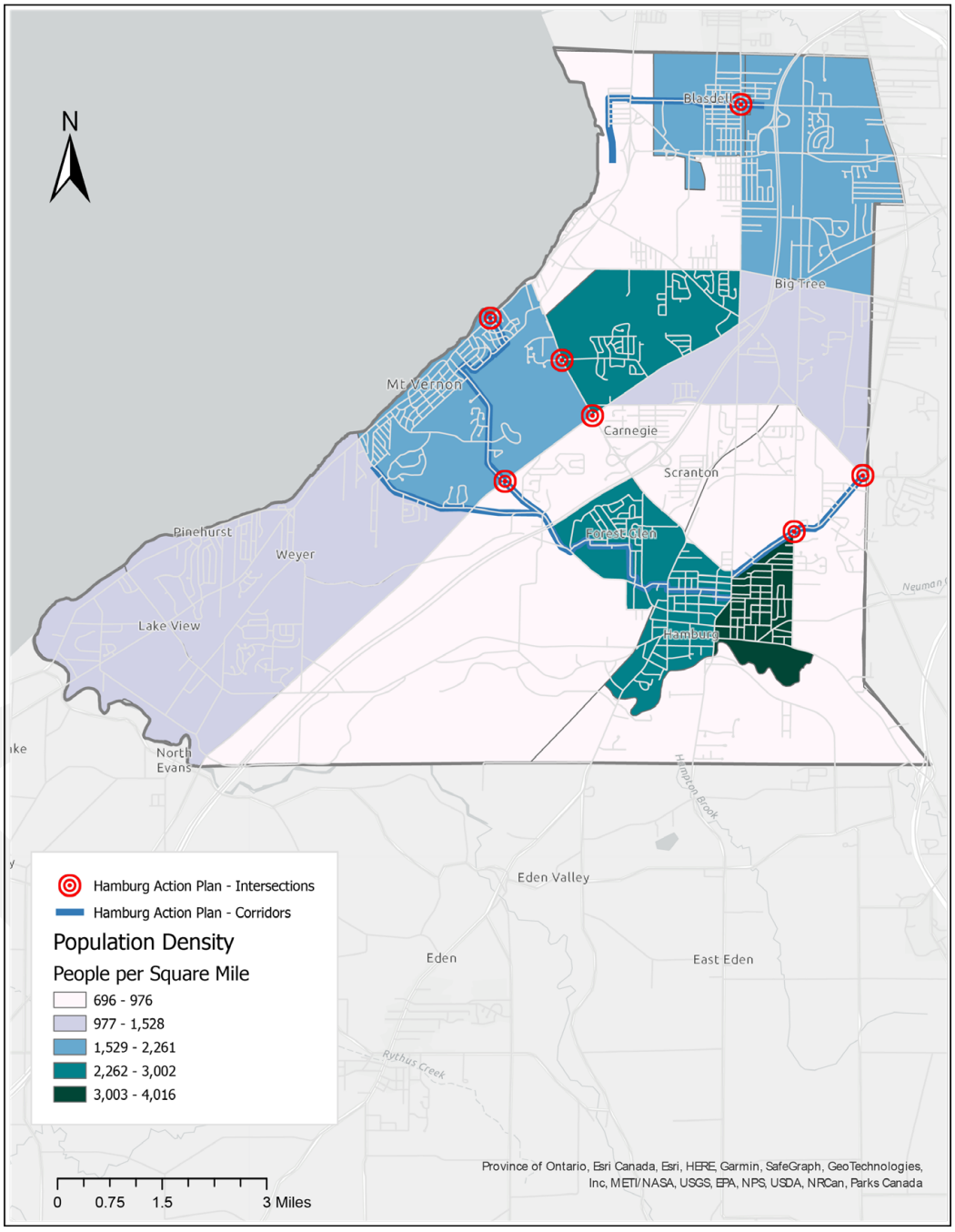
Generally, families in the Town of Hamburg live above the poverty level, with only 4% of families having incomes below that threshold, and 14% of families living below 200% of poverty level. However, families in poverty are concentrated primarily in Blasdell and nearby neighborhoods, such as those north of the McKinley Mall, where nearly 10% of families within the total population live below the poverty level.



Source: GObike staff analysis of ACS 2021 5 years estimates

Population Density

Residents of Hamburg are concentrated in the Villages of Hamburg and Blasdell, and in newer suburban developments southwest of Big Tree Rd. and Southwestern Blvd. Corridors and intersections examined in this plan create safer connectivity between these pockets of concentrated residential density.

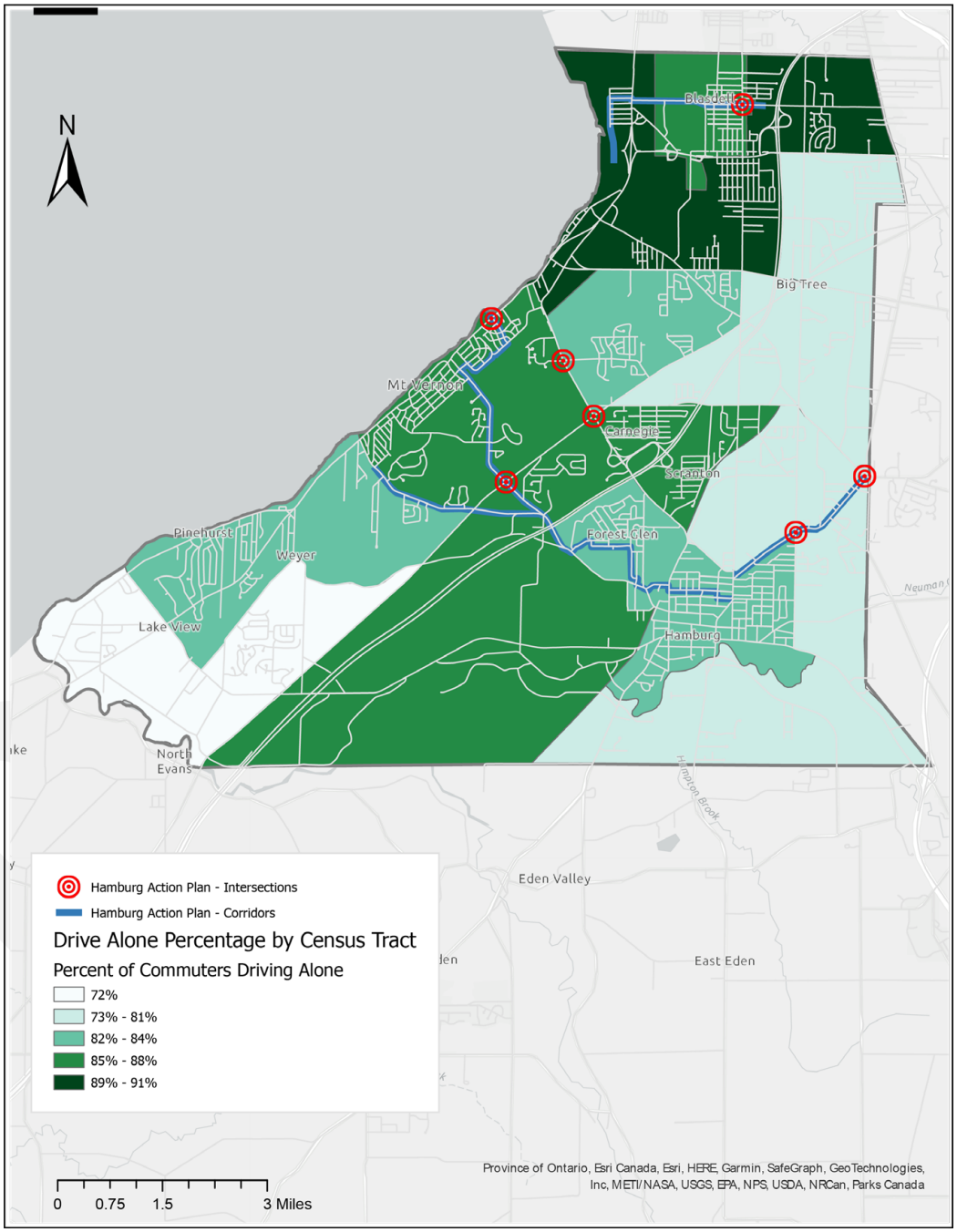


Source: GObike staff analysis of ACS 2021 5 years estimates

Project Background

Percentage of Commuters Driving Alone

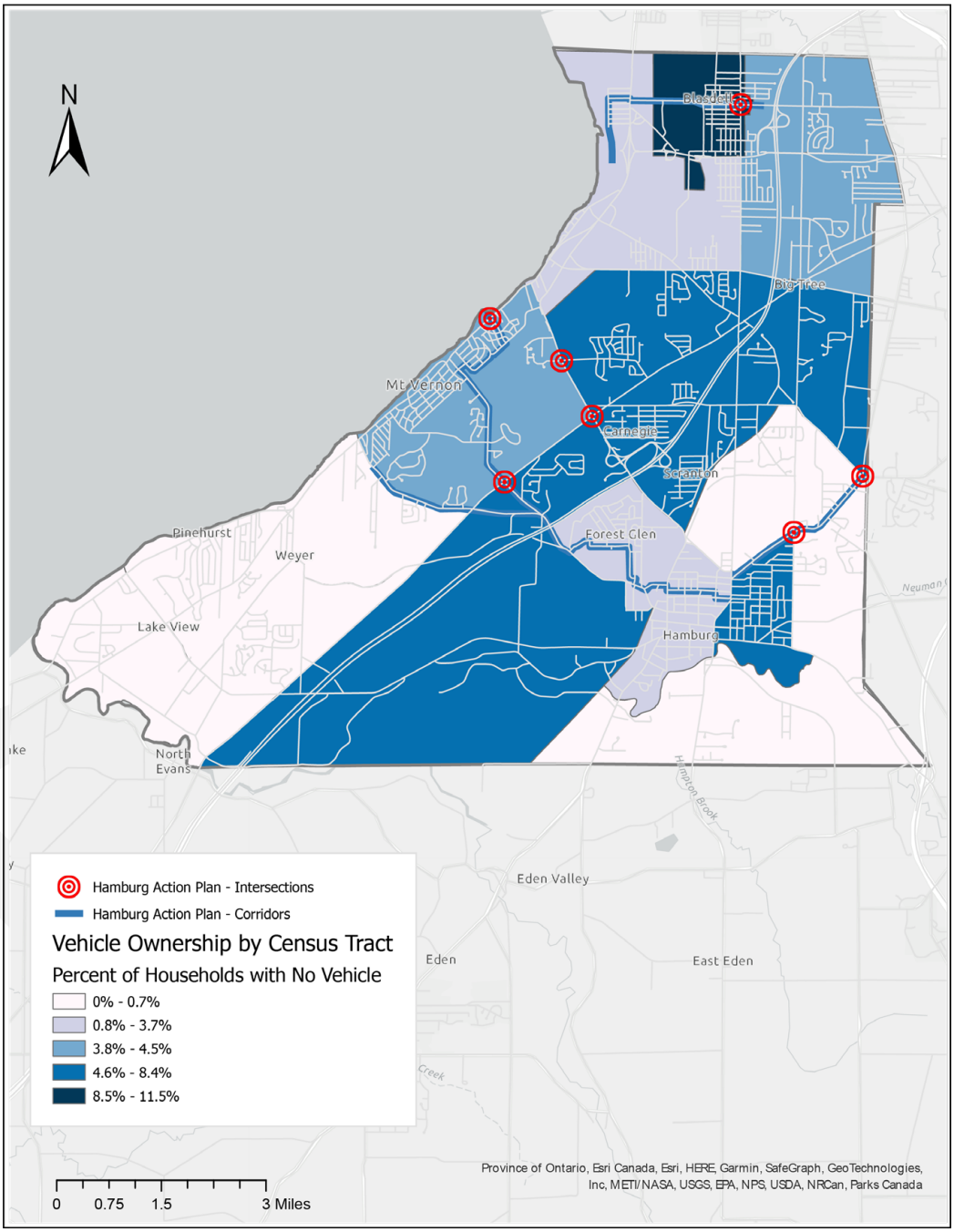
Most workers in the Town of Hamburg commute by driving alone to work, with 84% of using this mode. The most recent data on commuting is from 2021, and therefore the percentage of people working from home (9%) is likely slightly higher than it is today, as there has The most recent data on commuting is from 2021, and therefore the percentage of people working from home (9%) is likely slightly higher than it is today due to the lingering affects of the COVID-19 pandemic at the time. Since then, there has been a general shift nationwide toward hybrid or in-person work schedules. Concentrations of drive-alone commuters are in the northern end of the Town near Blasdell, in areas that are similar to those with higher percentages of families living in poverty. This correlation may be a result of the fact that many lower-wage jobs are those that do not offer the opportunity to work from home, and therefore require more residents to drive to access jobs outside of walking, biking, or transit distance.



Source: GObike staff analysis of ACS 2021 5 years estimates

Percentage of Households with No Vehicle

Nearly all households (95%) in the Town of Hamburg have at least one vehicle. However, the Village of Blasdell has a significantly higher percentage of households with no vehicles compared to the rest of the town, at 11.5%. While it is difficult to be sure why this is, it could be a factor of lower-incomes, access to public transit, and higher density development with a mixture of uses While it is difficult to be sure why this is, it could be a factor of lower-incomes, access to public transit, and higher-density development with a mixture of uses within close proximity of each other, reducing vehicle reliance and use.



Source: GObike staff analysis of ACS 2021 5 years estimates

Project Background

The Town of Hamburg is served by five NFTA Metro bus routes:

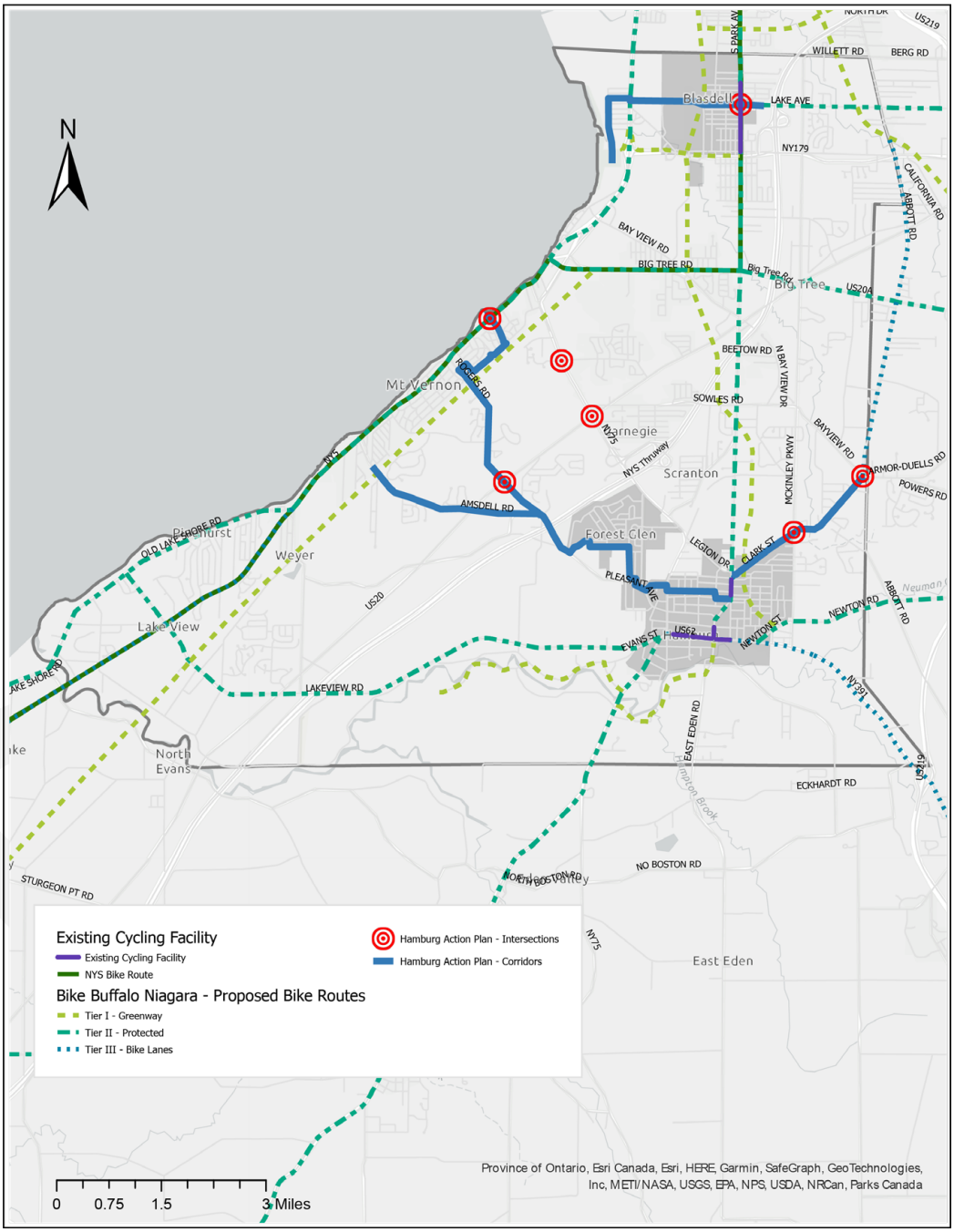
Route #	Route Name	Service Schedule (frequency varies within schedule)	Destinations
14	Abbott	Weekdays (5am - 11pm) Weekends (6am - 9:45pm)	Downtown Buffalo - McKinley Mall
16	South Park	Weekday (5:15am-11:30pm) Weekend (6:30am - 11:15pm)	Buffalo Niagara Medical Campus - McKinley Mall / Village of Hamburg
74	Hamburg Express	Weekdays - morning and evening peak hours	Downtown Buffalo - Village of Hamburg
76	Lakeshore Express	Weekdays - morning and evening peak hours	Downtown Buffalo - Irving
106	South-Suburban	School Days Only - morning and evening peak hours	Downtown Buffalo - St. Francis High School

Public transit itself is not typically considered "active mobility". However, many transit riders rely on walking or biking to get to their bus stop, or to their final destination after getting off the bus. Public transit is an important connecting piece of the greater network of mobility options and should be considered when examining the safety and accessibility of corridors on which bus stops exist. Most of the bus routes that travel through the Town of Hamburg have bus stops on corridors and intersections that have been identified as an active mobility area of concern, and on which crashes with pedestrians and bicyclists are historically concentrated. Creating safer and more accessible corridors for pedestrians and bicyclists has the added benefit of making public transit more accessible.

Source: NFTA-Metro

Existing Bicycle Routes and Proposed Bike Routes by Regional Bike Master Plan (RBMP)

Very little existing bicycle infrastructure exists across the Town of Hamburg, with the exception of on-street painted bike lanes in the Village of Hamburg along Main St and Buffalo St, and in the Village of Blasdell along South Park Ave. The RBMP proposes a network of facilities that would connect Hamburg to the larger regional network of bicycle infrastructure. The proposed facilities in the RBMP include off-road trails and greenways, and on-road separated bike lanes and widened shoulders. The focus corridors of the Active Mobility Action Plan complement the RBMP by creating additional east-west connectivity between activity centers in the town and the proposed facilities in the RBMP.

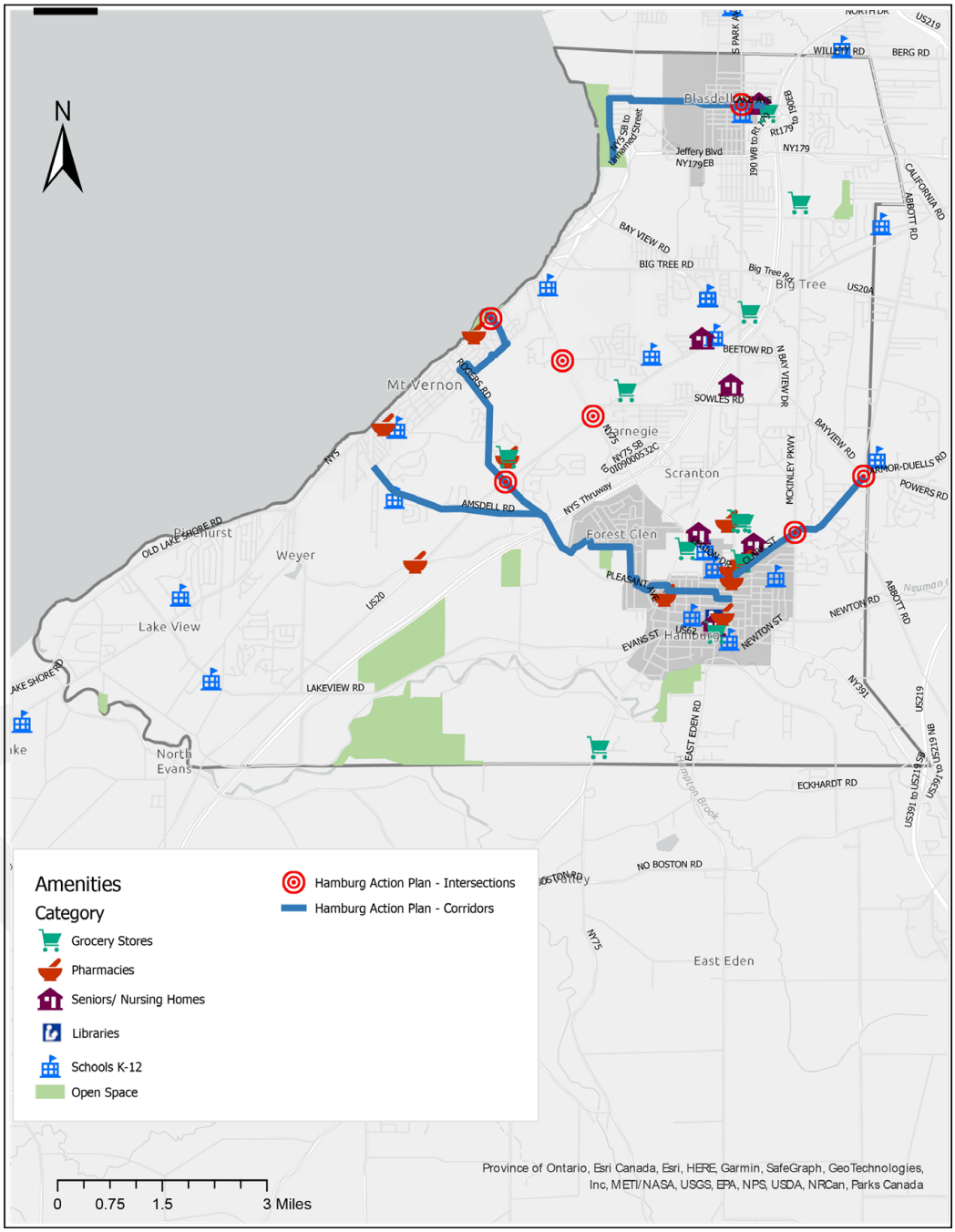


Source: GObike staff analysis of Regional Bike Master Plan (RBMP)

Project Background

Frequently Visited Destination by a Vulnerable User Group

Community amenities such as grocery stores, pharmacies, schools, libraries, parks, and senior/ nursing homes represent locations where people travel frequently, or where users are likely to come from a vulnerable user group such as children or seniors. This map demonstrates a large concentration of these types of amenities in and around the Village of Hamburg, in the Village of Blasdell, and along or at the end of the focus corridors. The recommendations of the Active Mobility Action Plan aim to facilitate easier and safer access to these priority locations for residents of the Town.



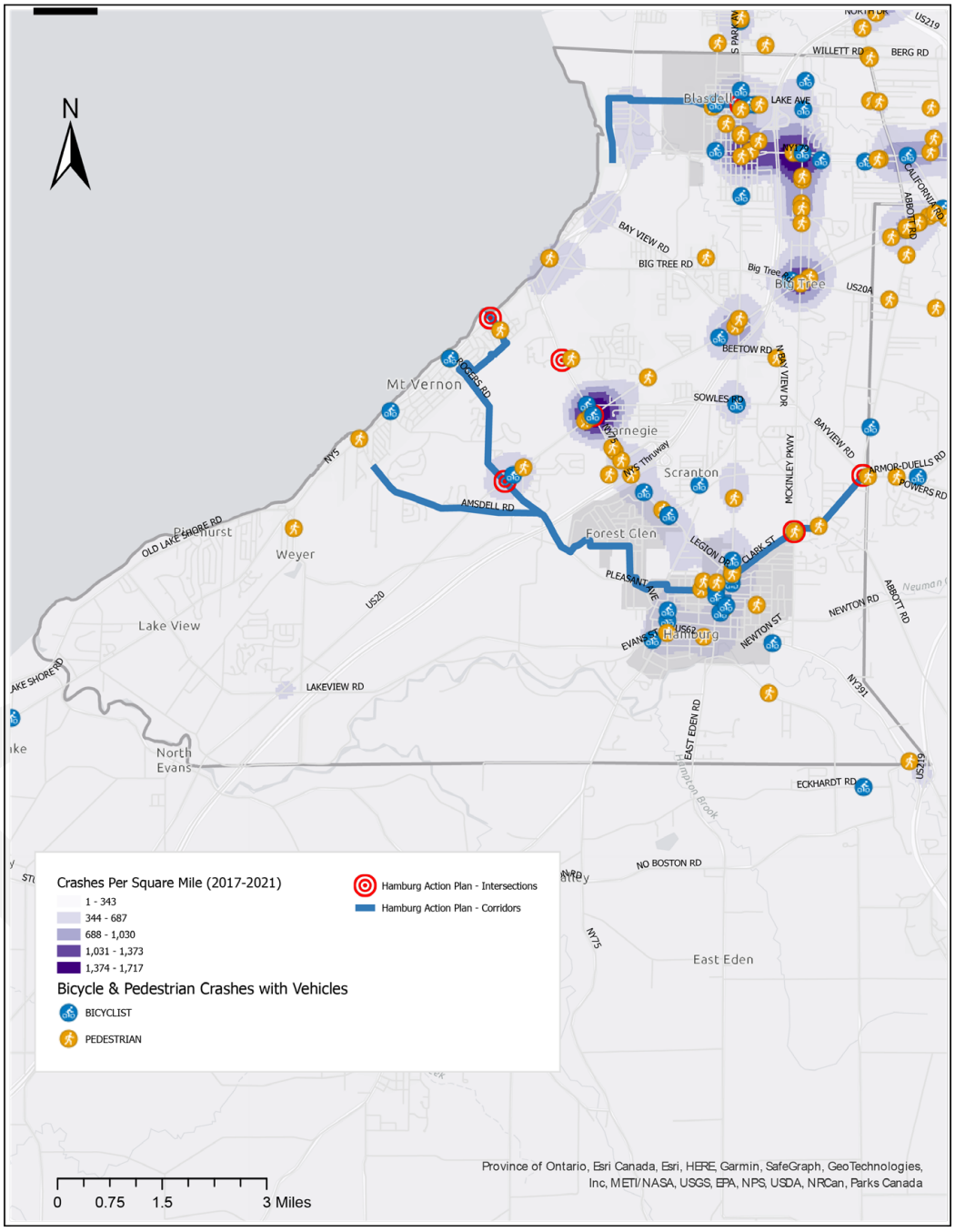
Source: GOBike

Project Background

Analysis of Vehicle Crashes (2017-2021) in Town of Hamburg

NYSDOT data show vehicle crashes between 2017 and 2021 are concentrated in areas with large intersections between major roadways, such as Camp Rd. and Southwestern Blvd.; Southwestern Blvd. and McKinley Pkwy.; and along Milestrip Rd. near McKinley Pkwy. and South Park Ave.

Between 2017 and 2021, there were about 6,600 crashes in the Town of Hamburg; 39 involved a bicyclist, 58 involved a pedestrian. Among the crashes between a motor vehicle and a bicyclist or pedestrian, there were 4 fatalities and 71 injuries. Crashes involving bicyclists and pedestrians typically occurred in the Village of Hamburg, or along Camp Rd, McKinley Pkwy., or South Park Ave.



Source: GObike staff analysis of NYSDOT data of vehicle crashes between 2017 and 2021

Community Engagement

GObike and the Hamburg Moves Committee share a mission of empowering average citizens to be leaders for positive change within their communities. That shared mission shaped the approach both groups took in their community engagement efforts, ensuring that Hamburg residents' input directly informed the action plan and resulting strategies.

GObike and the Hamburg Moves Committee united in an effort to educate citizens on the project and its goals, and sought ways to reach diverse audiences. The following methods were employed by GObike to engage Committee members and Hamburg residents alike:

- **October 2022 - June 2023.** GObike has hosted monthly meetings with Hamburg leadership and the Hamburg Moves Committee members, in order to set goals and priorities for the group. These meetings were typically attended by 15-25 people per session.

- **January 2023 - March 2023.** A community survey was developed in an effort to obtain feedback on current travel modes and areas of concern from those who live or work in the Town of Hamburg. **The Hamburg Moves Healthy Streets Initiative Survey** gauged residents' current perception of safety while traversing the region, inquired about common challenges they face when doing so, and asked about destinations they'd like to more safely visit through active means.

    ◊ Efforts were made to reach residents through survey promotion on Hamburg's **Parks & Recreation social media,** on **GObike's social media,** and through public tabling at the **Lake Shore Public Library, Hamburg Town Ice Rink,** and **Hamburg Senior Center**. A month-long **survey station** was also posted at the front desk of the **Lake Shore Public Library**, wherein patrons were entered to win a bike helmet and accessories from GObike exchange for taking a survey, and **Hamburg Moves members distributed project posters** to businesses around the Village of Hamburg.

- **May 2023**. The two groups hosted a **Hamburg Kids Bike Rodeo** in the parking lot of Hamburg Middle School, inviting area residents and their children to participate. 29 kids and their families attended.

- **June 2023.** GObike Engineer, Jim Jones, and Complete Streets Planner, Cindy Wood, led Committee members on **AARP walk audits** of two problematic roadways in Hamburg and Blasdell: **Clark Street** and **Lake Avenue.**

Key Findings.

Through community engagement and survey results, the following key findings emerged:

1. There is a **strong desire amongst Hamburg residents to have safe, well-maintained bike paths available in their neighborhoods,** in order to create more opportunities for active mobility. Many residents would like to pursue a more active lifestyle and to travel by means other than a vehicle, but do not currently do so, due to a lack of safe bike path connectivity.

2. Fear of traffic violence caused by vehicles speeding, and disregarding the safety of other roadway users - namely on roadways like **Clark Street, Route 20 (Southwestern Blvd.)**, and **McKinley Parkway** - is a major factor preventing residents from walking and riding bikes in Hamburg.

3. A desire for **better connectivity to the Village** from isolated neighborhoods like **Armor Duells**, and **improved access** to destinations like the **McKinley Mall** shopping district and **Town Hall Plaza.**

Community Engagement

Public Survey Results

124 residents responded to the Hamburg Moves Healthy Streets Initiative Survey, with most people expressing an overtly positive reaction to the proposition of bike facility improvements for the Town of Hamburg, citing a need for improved connectivity between key locations in Blasdell and Hamburg.

Respondents also noted the disparities faced by residents in more remote sections of town, like the Armor-Duells neighborhood, when compared to more robust bicycle and pedestrian facilities within the Village of Hamburg. Major concerns surrounding the topic of personal safety in Hamburg, in addition to apprehension caused by dangerous driving and high speeds on nearby roadways, were also addressed.

Primary Desires
• Improved **connectivity** between the Village of Hamburg and more remote surrounding neighborhoods, like Armor Duells. • Improved **bike/pedestrian facilities** and **crosswalks** on major roadways like **McKinley Parkway, Camp Road, and South Park Avenue.** • Improved connectivity to surrounding **trail systems,** like **18 Mile Creek Trail** and the **Shoreline Trail.**
Primary Concerns
• **High speed limits,** and **poor enforcement of those limits** by police on busy roadways. • **Lack of connectivity to shopping destinations**, like the **McKinley Mall/Wegmans** area, and **Tops** and **Town Hall Plaza** on South Park Avenue, creates barriers for those without cars or the ability to drive
Neutral Findings
• **Most residents are extremely proud of the amenities Hamburg has to offer**, and are supportive of the efforts to improve safety and connectivity through the installation of bike facilities and round-abouts at key junctures in the Town.

Demographics & Characteristics.

The vast majority of survey respondents were indeed Hamburg residents; 76.2% people surveyed identified themselves as residents of the 14075 ZIP code, in which much of Hamburg and North Boston are located. The **second-most frequent ZIP Code was the 14085 area, representing 10.3% of responses,** in which Lake View is located.

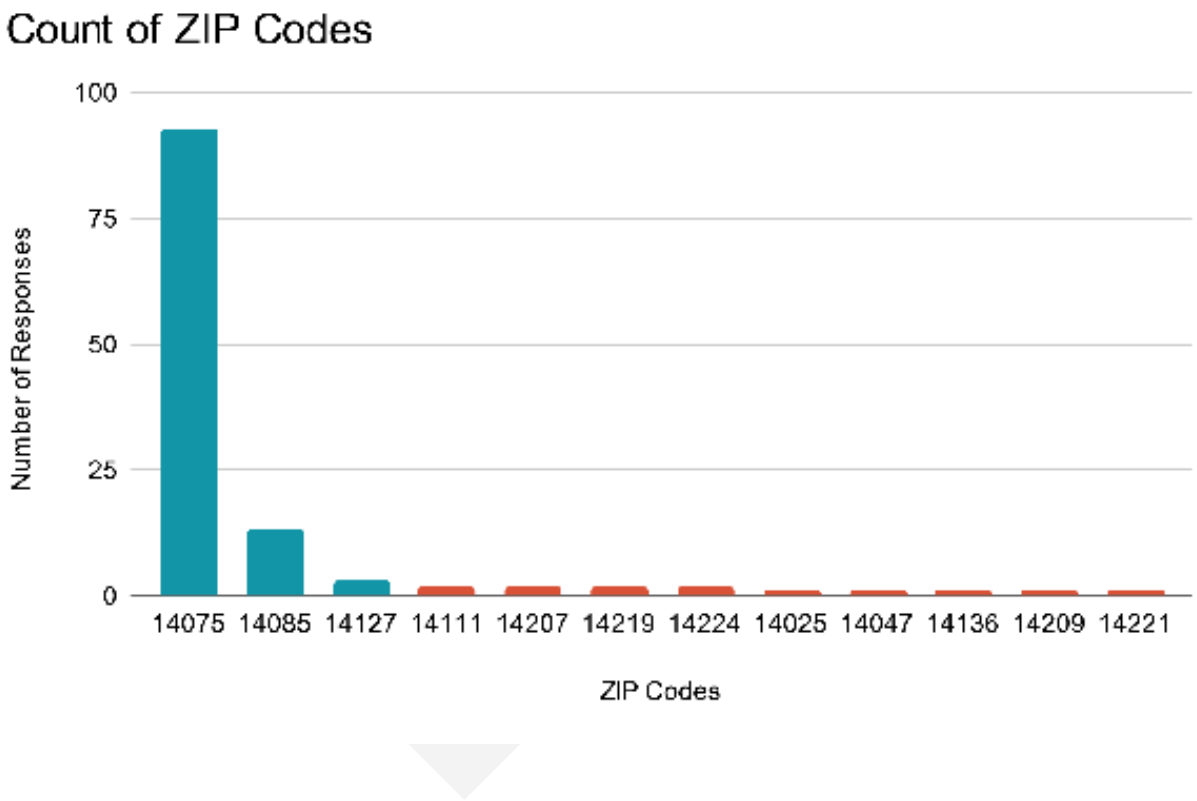


Chart 1: In what ZIP code is your home located?

Community Engagement

While a substantial percentage of survey respondents reported being residents of the Hamburg area (78.8%), the **most common answer of people surveyed visit Hamburg to shop and run errands (81.3%).**

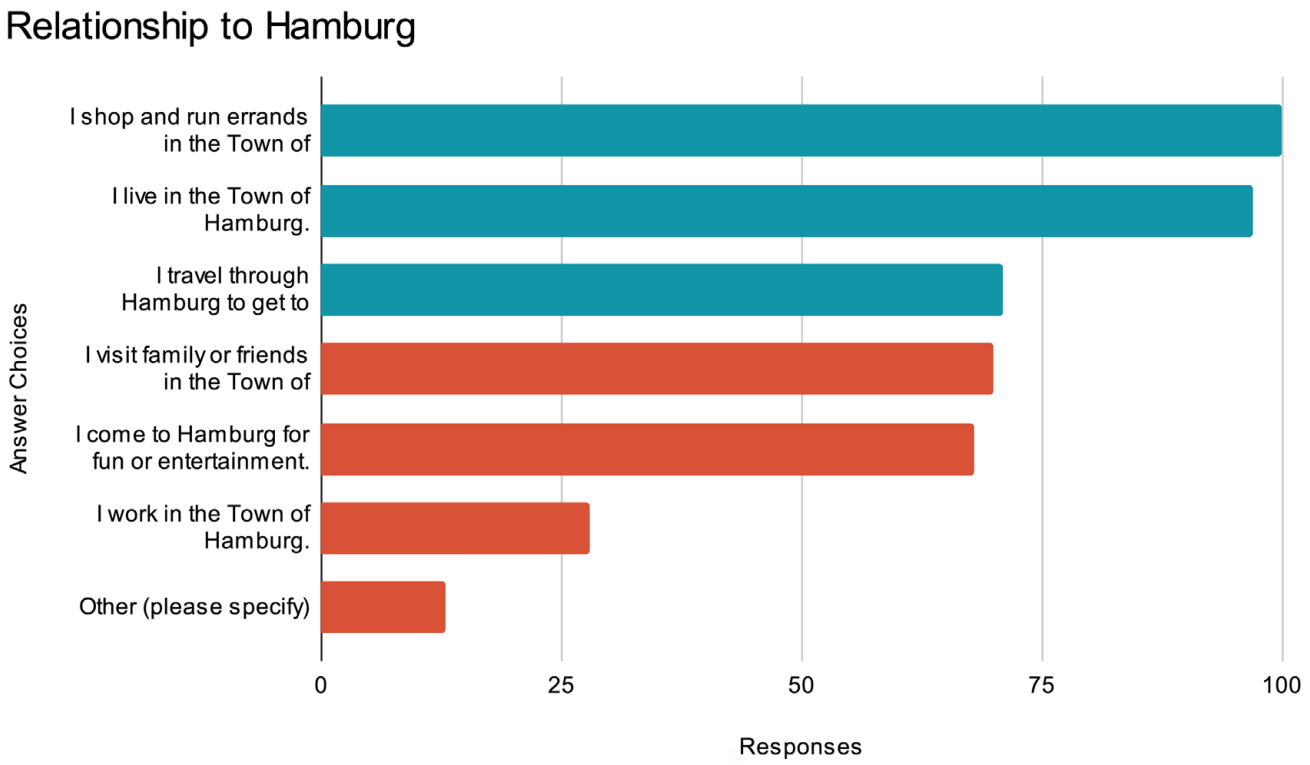


Chart 2: Check any that apply to your relationship to the Town of Hamburg

The majority of those surveyed identified as **female (43.9%),** and the greatest concentration of responses came from those in the **55-64 age range (23.26%)**. The vast majority **(92.5%) described their racial or ethnic background as "white."**

Travel Modes & Comfort.

Most of the individuals surveyed **(82.7%) claim their primary means of transportation is to "drive alone,"** indicating a heavy local reliance on single-occupancy automobiles. The next most popular selection, at just **5.75% of respondents, was "bicycle."**

Although only five people identified bicycling as their primary means of transportation, there is nevertheless strong evidence of existing reliance upon bikes for transportation and recreation in the Town of Hamburg; **36.7% reported biking 1-5 times per month. 39.08% biking six or more times per month. Only 24.2% reported not biking at all. Even fewer people use transit each month; 90.8% of those surveyed do not use transit at all each month**, further demonstrating the outsized reliance on vehicles in the Town of Hamburg.

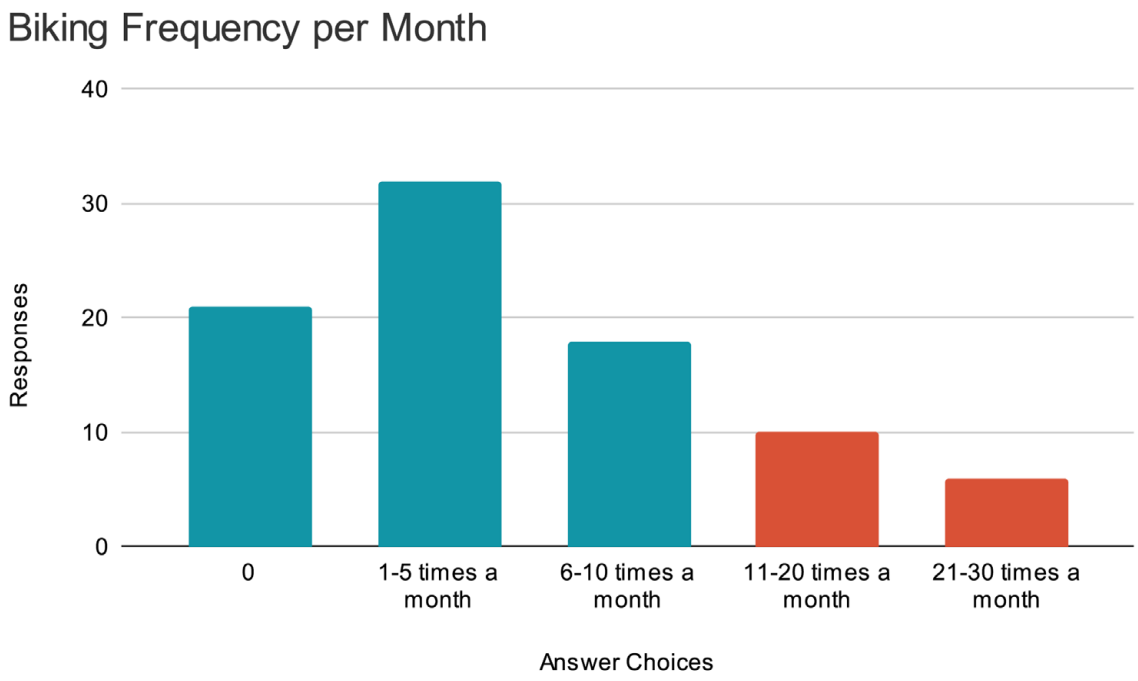


Chart 3: How often do you bike per month?

While vehicular travel is a clearly demonstrated preference in the Hamburg area, that may be due to peoples' perceptions of safety and connectivity when attempting to travel to destinations.

When asked to reflect upon the speed of vehicles in the Town of Hamburg, residents were generally satisfied; **69.2% said that speeds were "about right," whereas 25.9% claimed that they're "too fast," and only 4.8% maintained they are "too slow."**

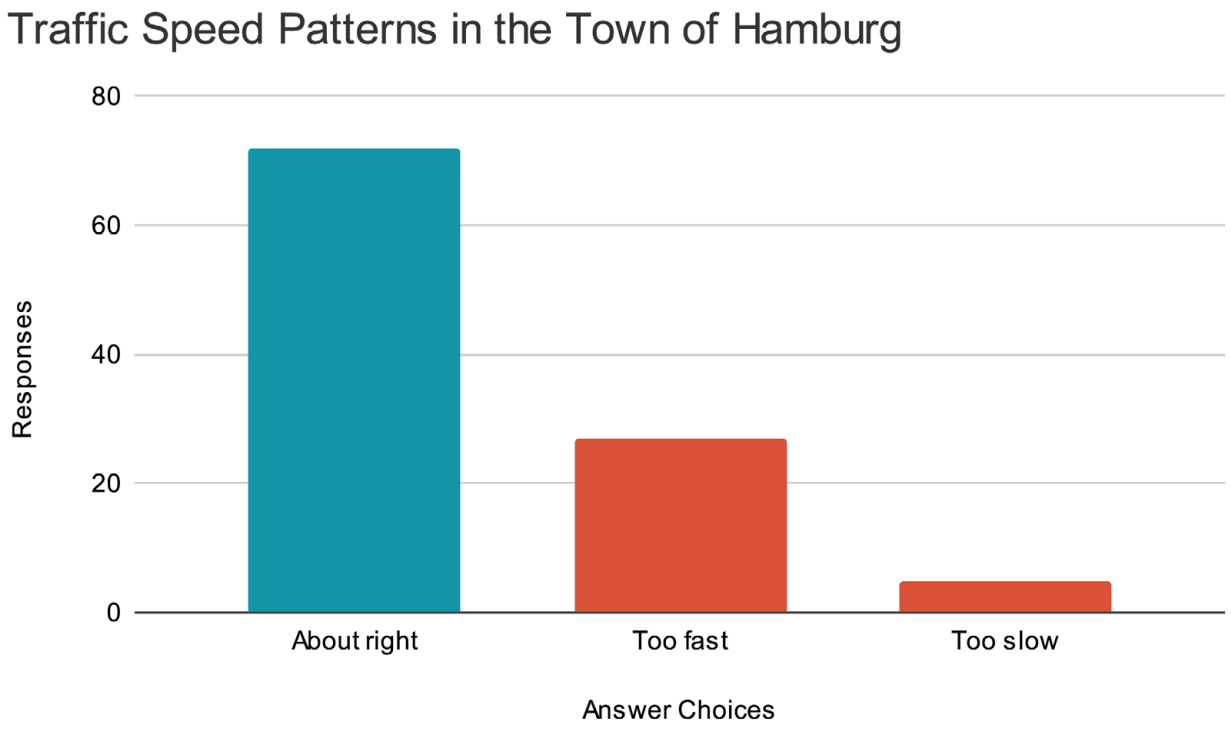


Chart 4: Traffic speed in the Town of Hamburg tends to be...

When asked whether current crosswalks, crossing signals, and signage made them feel comfortable using active mobility (walking, biking, and rolling) to certain destinations like grocery stores and local parks, **46.1% of respondents replied "none," indicating that current infrastructure in Hamburg does not empower residents to feel safe when pursuing active mobility options.**

Most notably, only **12.5% felt safe traveling to adjacent towns and villages**, highlighting the lack of safe connectivity between neighboring towns and regions.

Table 2: Current crosswalks, crossing signals, and signage in the Town of Hamburg make it comfortable to walk, ride a bike, or take the bus to the following destinations (please check all that apply)

Answer Choices	Responses	Percentages
Work	9	8.65%
Grocery store and/or shopping	36	34.62%
Historical Sites and Landmarks	15	14.42%
Local Library and/or community centers	38	36.54%
Local parks, playgrounds, or other recreation sites	38	36.54%
Dining and/or entertainment	42	40.38%
Destinations within my town/city/ village	36	34.62%
Destinations in an adjacent town/ city/village	13	12.50%
None of the above	48	46.15%
Answered	**104**	
Skipped	**19**	

When asked whether "current street lighting and lighting fixtures in the Town of Hamburg make it comfortable to walk, ride a bike or take the bus," respondents had similar answers; the exact same percentage of people **(46.1%) replied "none of the above,**" whereas the places they felt safest were destinations typically located within the village center, like **dining and entertainment (40.3%), libraries (36.5%), and playgrounds (36.5%)**, lending further credence to the idea that residents' discomfort increases the further away they travel from the Village of Hamburg's core business district.

Trail Use and Preferences

While the popularity of biking in the Town of Hamburg has already been established, survey respondents also demonstrated a high use of local bike trails; **54% currently utilize local multi-use trails in Western New York.**

When asked to rank their priorities in new trail development, **safety was the highest ranking priority for respondents; 87.5%** said that "new facilities should be focused on improving safety. Crash statistics and speed data analysis will be used to identify priority locations."

The second-highest ranked priority was gap closure, with 59% supporting a "focus on closing gaps, like spaces between trail links and "sidewalks to nowhere." **44.3% supported prioritizing connectivity,** lending even more credence to the fact that connecting people to their destinations is a major desire for area residents.

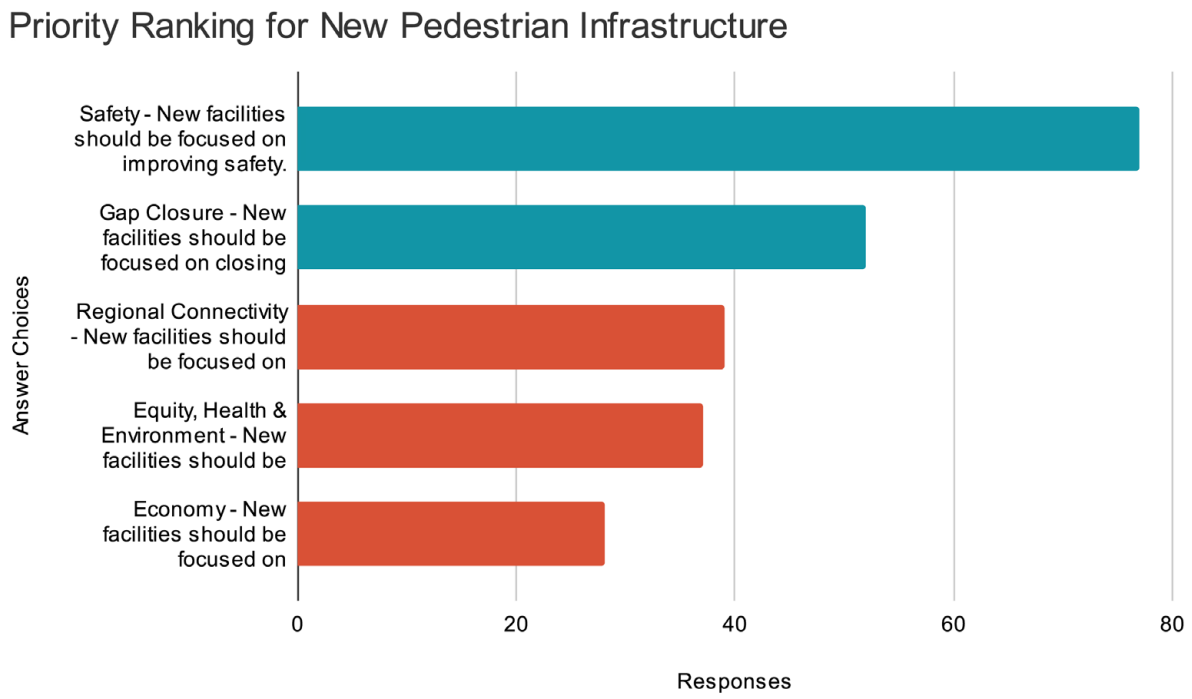


Chart 5: When implementing new crosswalks, sidewalks, paths and trails, which of the following do you feel should be prioritized? Please check your top three (3) priorities:

Respondents identified multiple aspects of their community they were proud of, and wished to have featured as a destination on any future bike trails; when asked for their preferred destinations in an open-comment question, **36.7% identified the Village as their ideal destination. 11.3% desired connection to businesses, and 10.3% wanted to reach both Lake Erie and parks/playgrounds.**

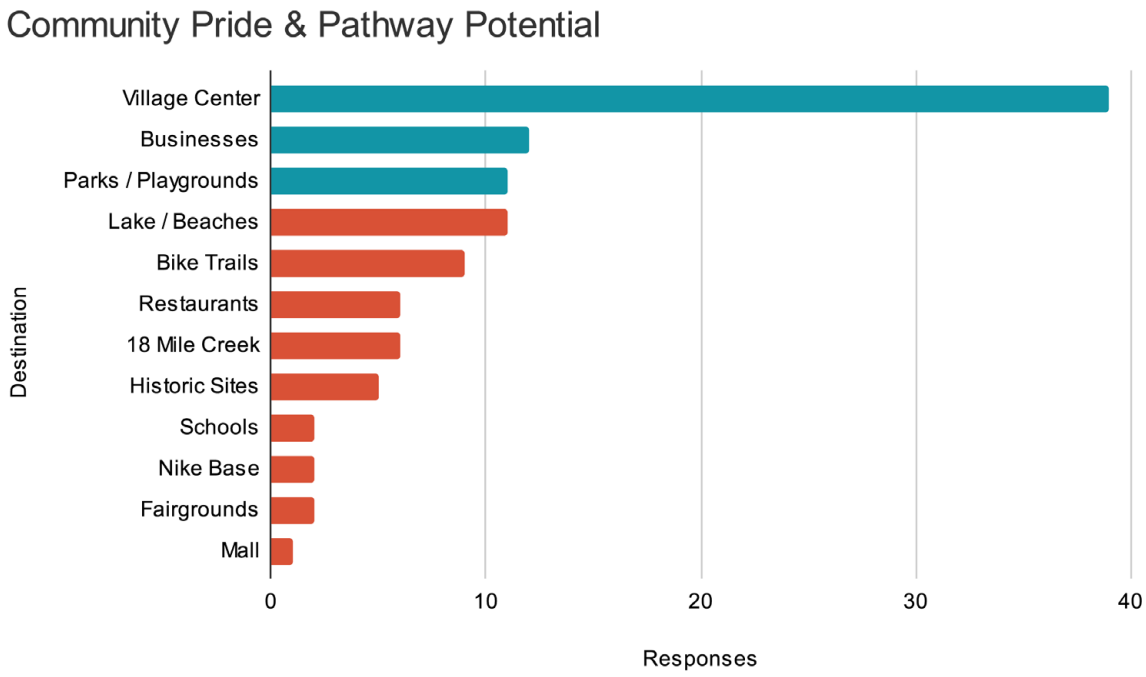


Chart 6: What are you proud of in your community? What elements of your community should improved walking or bicycling paths celebrate or highlight, if it is most successful? (Ex. historic main street or buildings, scenic areas or parks, community or cultural centers):

Community Engagement

What we heard in comments to this question:

"The Hamburg Fitness Trail, Memorial Park, Peace Park, Hamburg Youth Center, Tree Grove Park."
"There's so much more green space & trees in the southtowns, it would be wonderful if bike paths could take you to some parks like Chestnut Ridge, Spraguebrook, etc. to encourage people to enjoy the scenery and nature and to enjoy the RIDE there. Just get out to see the older houses, the churches, visit the businesses, slow down and appreciate the scenery in this area of Erie County."
"Village is great. Blasdell is improving. We need safe options to bike and walk to those areas, as well as Wegmans area, and most importantly along Route 5 and the Mount Vernon area where sidewalks are intermittent."
"The route 62 project which brought the roundabouts and improvements to streets and general walkability within the village of Hamburg. The effort that goes into landscaping and planters around the village, the improvements to the exterior of many village buildings including the plaza."
"The Village of Hamburg Main Street bike path is amazing although it needs to be repainted and repaired. It would be amazing to connect the town of Hamburg to the City (of Buffalo) by bike on Rt 5 or some other route, would be amazing to see what they did on Niagara St in Buffalo with bike lights happening in Hamburg! Create bike paths to Woodlawn beach and all the beaches and water."
"The eighteen mile creek has a wonderful walking path but it is falling into disrepair. I love the history kiosks and placards around the village. Glad there's much improvement around Pleasant Ave. and Scott Street."

Similar to identifying what they're most proud of in their community, residents were also asked to **"identify up to three (3) roadways/intersections in the Town of Hamburg where you wish you felt safer when walking, riding, or rolling."** 192 responses were received, the top eight of which were then bucketed into the following table:

Table 3: Think about your daily life and transportation patterns. Please identify up to three (3) roadways/intersections in the Town of Hamburg where you wish you felt safer when walking, riding, or rolling

Buckets	Count of Buckets
Amsdell Road / Pleasant Avenue	15
Bayview Road	7
Camp Road	9
Clark Street	37
McKinley	52
Main Street	14
Rt. 20	30
South Park	23

Concerns & Open-Comment.

Residents were asked to share "any other concerns or experiences with mobility or transportation in the Town of Hamburg," in an open-comment forum; 38 individuals submitted responses, generating approximately 112 pieces of feedback, **a quantified summary of which revealed that 25% of responses had to do with roadway connectivity.** Similarly, **9.82% of overall responses dealt specifically with sidewalk connectivity and maintenance,** like snow removal and concrete repair.

Two other intersectional categories of concern dealt with the topic speed; **16% cited a fear of speeding and reckless drivers on shared roadways, and 3.5% of responses discussed poor enforcement of speed limits on local roadways.** Some roadways identified as particularly hostile to cyclists and walkers in comments included **McKinley Parkway, Lake Shore Road, and Camp Road.**

What we heard in comments to this question:

"I enjoy riding however I am not comfortable riding outside of the village on any road other than a protected bike path. People drive too fast, are aggressive and distracted. Drivers do not safely share the road. They will purposely drive too close to you to scare you."
"I would like to see better awareness of the cycling community, laws that are applicable regarding sharing the road and even utilizing roadways as designated bike routes to key locations through town designated to raise awareness of bike traffic and possibly calming measures."

"Improved sidewalk connectivity, crosswalks, and bus routes/stops to serve the community better would benefit EVERYONE, not just those who live here."
"This could also be placed under "underrepresented demographic" for those who do not drive. It makes it nearly impossible to access Tops Markets from my location, having to walk alongside
McKinley in unkempt growth while walking carefully over a ravine to finally access a side walk "to no where" finally appears. This would include the entire stretch from the Fairgrounds to Milestrip. Many people walk along the side of the road on the shoulder to avoid walking through brush. Removing the grassy medians, replacing with a median turning lane could help to make it easier to access the side roads and neighborhoods along McKinley, and allow for sidewalks to be introduced along each side."

Two additional open-comment questions centered on the **lived experience of under-represented groups;** one question was intended for those whose mobility is affected by a disability, and the other was directed toward those belonging to an underrepresented demographic, such as women, underrepresented genders, and communities of color.

Community Engagement

Twelve individuals responded to the question asking for feedback from those living with a disability and/or caring for a family member or community member with a disability, generating approximately 21 pieces of quantifiable feedback. **47.6% of their concerns had to do with the lack of accessible routes for people with disabilities and their caretakers to accomplish daily tasks. Similarly, a lack of accessible greenspace and recreation for people with disabilities was expressed in 19% of responses.**

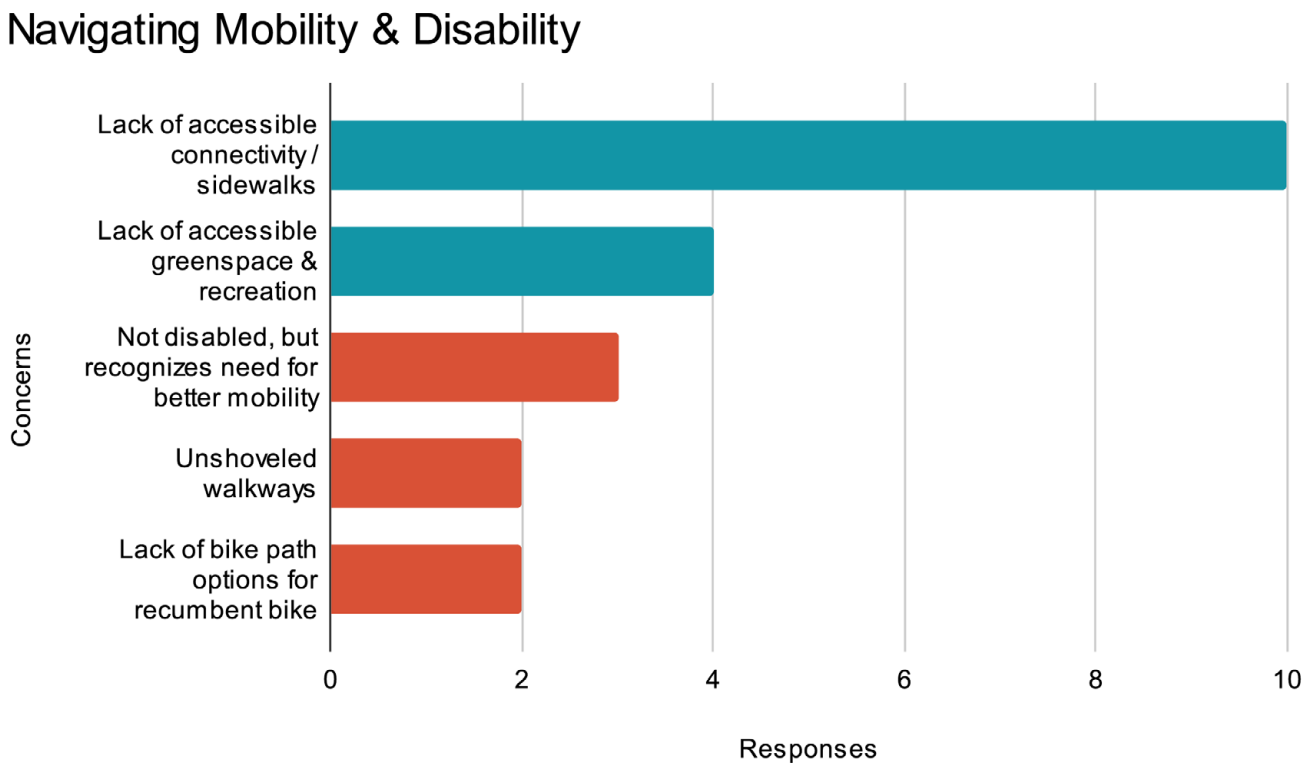


Chart 7. If applicable, please tell us about your lived experience with mobility and disability (i.e. living with a disability and/or caring for a family member or community member with a disability).

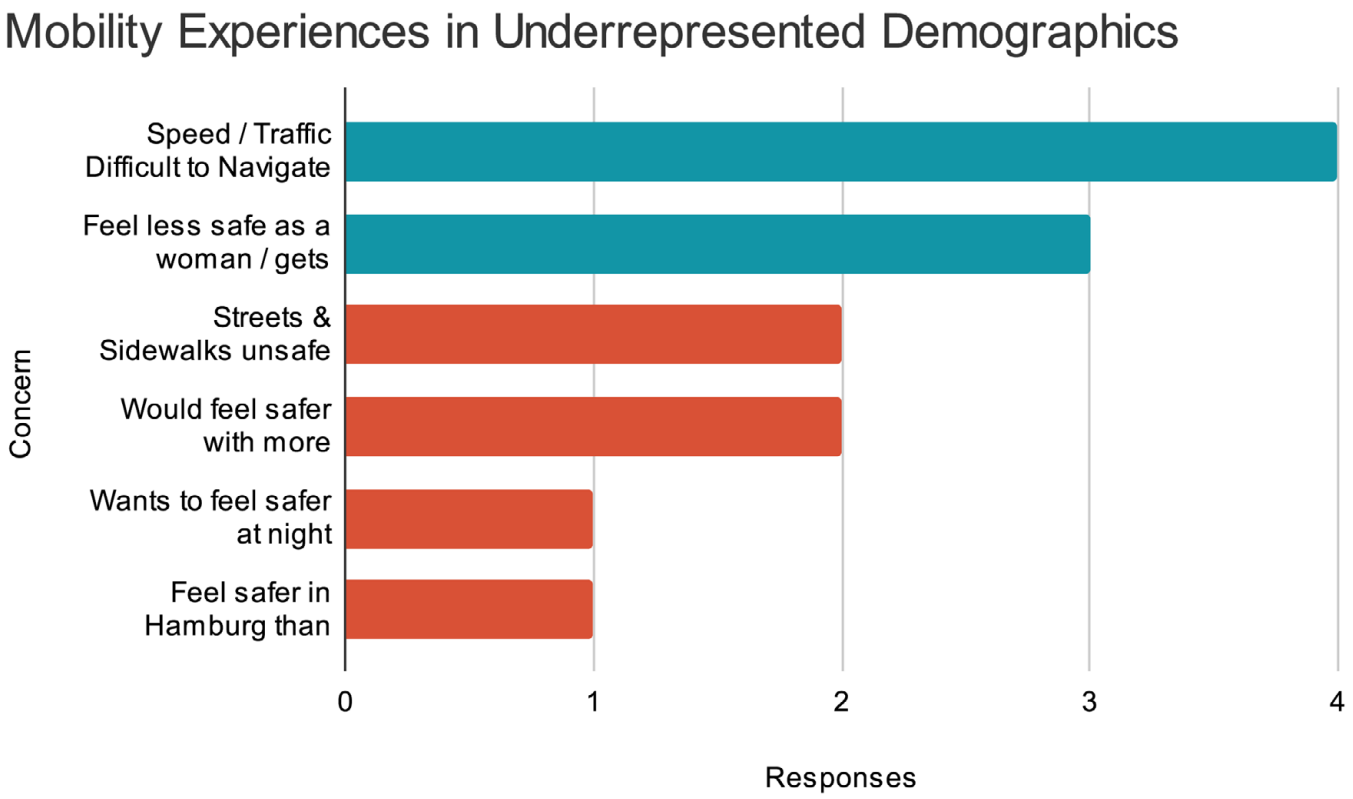


Chart 8. If applicable, please tell us about your lived experience with mobility as a member of an underrepresented demographic (i.e. women, underrepresented genders, communities of color).

Community Engagement

Clark Street & Lake Avenue Walk Audits

Throughout the meeting and survey process, GObike and the Hamburg Moves Committee were tasked with identifying the most problematic roadways and intersections within the town; collective feedback was narrowed down to three focus areas: Clark Street (namely the Clark/McKinley intersection), Lake Avenue in front of the Our Mother of Good Counsel Apartment Complex in Blasdell, and Pleasant Avenue leading to Amsdell Road as a connector between the Village of Hamburg and Lake Erie.

Lake Avenue was also selected due to the April 4, 2023 death of Our Mother of Good Counsel resident Sandra Burczynski, who was killed when crossing Lake Avenue in front of the apartments. Residents approached Supervisor Hoak with pleas for improvements on the roadway.

Since both Lake Avenue and Clark Street fall under Erie County Department of Public Works jurisdiction, and thus fall outside the purview of the Town of Hamburg, it was determined that AARP road audits would be a great tool for involving Hamburg Moves Committee Members in examining conditions of the sidewalk and pedestrian experience, and report their findings to the Erie County DPW.

19 participants attended the Clark Street walk audit, and 16 attended the Lake Avenue Walk Audit, including 7 residents of the Our Mother of Good Counsel Senior Apartments.

Sidewalks, Streets and Crossings (Clark St. / Mckinley Parkway)

The sidewalk: The audit results indicate that there are several issues with the condition and accessibility of the sidewalk. The majority of volunteers reported that sidewalks lacked proper separation from the street, had rough surface material, and were in poor condition. These factors often made them feel uneasy within the location.

While utilizing the sidewalk, obstacles such as hydrants and utility poles were present on some sections. Volunteers also reported concerns about the continuity, as "sidewalks to nowhere" were frequent, and some sections of the road lacked any sidewalk at all, preventing pedestrians from utilizing it.

Another major issue reported by volunteers was inadequate sidewalk width; substantial sections of sidewalk were not wide enough for more than one pedestrian to utilize the walkway. Often, the sidewalk becomes uncomfortably narrow, posing a safety concern. One of the volunteers stated, "... There is no sidewalk for a person to even stand in, especially at McKinley turning Clark St. going to Armor."

The sidewalks also fail to cater to people with disabilities and vision-impaired pedestrians by lacking tactile indicators at intersection corners, the lack of which poses a hazardous situation for visually impaired pedestrians as they cannot easily predict where and when the sidewalk ends. Uneven sidewalks also prevent people with wheelchairs or strollers to traverse easily.

The street: Similar to the sidewalk condition, the street is also in relatively poor condition. The audit responses from volunteers highlight significant deficiencies in pedestrian safety features and infrastructure on the street, like crosswalks, signage alerting drivers to pedestrians, or designated bicycle lanes.

Some of the major issues with this street are a lack of pedestrian safety features, visibility issues, and inadequate infrastructure. This indicates a safety concern for both pedestrians and cyclists, as without proper signage, drivers might be unaware that they are entering a zone shared with other kinds of users. Furthermore, while the majority of volunteers reported that there is a visible traffic light, it lacks a pedestrian push button, and is therefore not useful for pedestrians and cyclists to utilize it, as it only caters to motor vehicles. Not having a pedestrian-friendly traffic light is a safety issue.

Pedestrian signals: All of the volunteers reported that there are no crossing signals or signage for pedestrians to utilize. There is also no marking to indicate where pedestrians can cross the street. This is a serious issue as it poses a safety hazard for everyone on the street.

Street Safety and Appeal : After completing the sidewalks, streets, and crossings walking audit, volunteers were asked to assess street safety and appeal. In this section, the volunteers examined the amenities available at the location.

The data indicated numerous deficiencies at this location, as it does not offer any amenities that cater to pedestrians and the public, such as public seating areas, water fountains, weather shelters, or public restrooms. This lack of facilities creates an unwelcoming environment for pedestrians. The location also has no access to the public transit system. Another major issue is the absence of proper signage and pedestrian-friendly lighting, which poses a serious safety hazard for pedestrians and anyone else using this location. Additionally, there is a failure to control the speed limit of motor vehicles, as drivers frequently exceed the speed limit, increasing the risk of fatal injuries. However, there are some positive aspects to this location. The houses in this area appear to be in good shape, and the road provides plenty of shading from the trees along the side.

General Impressions: The location failed to make the volunteers feel safe. According to audit data, there are several safety concerns, ranging from pedestrian safety to crimes and overall safety for various demographic groups. The volunteers also expressed differing opinions. While the majority of the volunteers expressed concern about the safety of the location, some found the place to be generally safe.

Building a better Block: After completing the walk audit, the volunteers were asked to provide potential suggestions for street improvements. The volunteers pointed out many valuable potential improvements. The top five improvements that almost all volunteers agreed upon are as follows:

1. Sidewalk improvement and addition
2. Implementation of crosswalks
3. Pedestrian bulb-outs
4. Pedestrian islands
5. Pedestrian-friendly lighting.

The table also indicates that the volunteers primarily focused on improving the safety and attractiveness of the location.

Community Engagement

Source: GObike

Sidewalks, Streets and Crossings (Lake Avenue, Blasdell)

The sidewalk: After conducting a walking audit, it is clear that the sidewalk condition is not optimal for pedestrians to utilize. The sidewalk exhibits several deficiencies and lacks proper safety measures.

Notably, the majority of volunteers stated that the sidewalk does not have a separated space from the street and lacks a smooth surface, which is a major concern considering that many of the people walking along this roadway are senior residents from OMGC. The residents rely on walkers and wheelchairs, and the current sidewalk condition poses a dangerous situation for them when attempting to reach destinations like the nearby post office, CVS pharmacy, and Dollar General plaza.

Volunteers also noted that the sidewalk has numerous obstacles, causing foot traffic to slow down and preventing users from freely utilizing the sidewalk. There is also a continuity issue as segments of the sidewalk are missing, and in some areas, there is no sidewalk at all, which poses a serious problem for pedestrians. Another significant issue is that the sidewalk is too narrow to accommodate more than one person, forcing the second person to share the road with oncoming traffic. Furthermore, the sidewalk lacks a tactile surface for vision-impaired individuals, making it hazardous and preventing them from navigating the area safely.

The street: The audit report revealed a mixed opinion on street conditions. Similar to the condition of the sidewalk, the volunteers expressed concerns about the existing state of the street. They observed the presence of traffic lights at this location, though opinions varied regarding their visibility. Some volunteers stated that they could not clearly see the traffic lights. The audit reports indicate that a crosswalk is present in this area; however, the markings and visibility for both pedestrians and drivers are not clear. Moreover, there is a lack of sufficient signage, which poses a safety issue.

The street also does not cater to bicyclists as there is no designated bicycle lane, discouraging cyclists from using the street, despite its designation in the Bike Buffalo Niagara Regional Bicycle Master Plan as a class Tier 2 bicycle facility. Tier 2 facilities are noted in the plan as being "on-road bikeway with generous visual separation from traffic."

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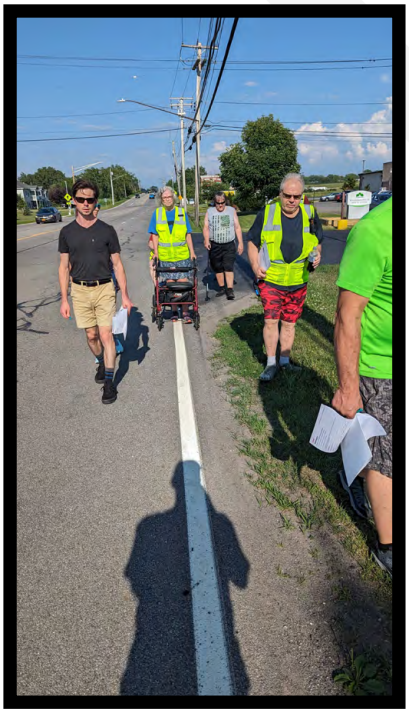
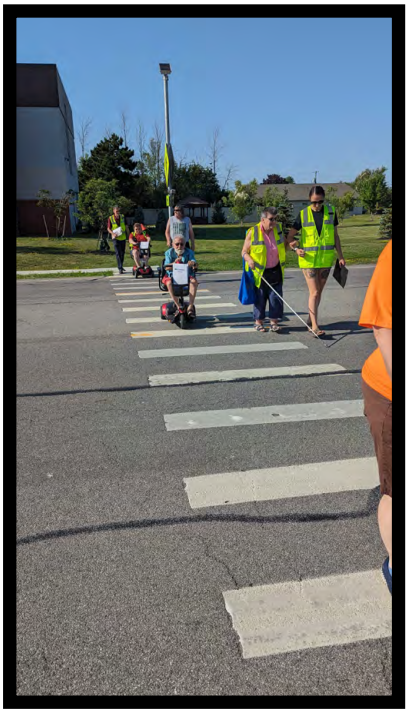
Pedestrian signals: The audit indicates that the majority of the volunteers have noted that the crossing signals are working. However, they have shown a mixed opinion regarding the "push-to-walk" mechanism. Some of the volunteers stated that it is working, while others said it was non-functional. The majority of the volunteers showed concern for the placement of the signals and the limited amount of time they had to cross the street. They did not feel safe and comfortable while crossing the street at the signal. The volunteers also expressed concerns that the signal does not welcome pedestrians to cross the street, posing a safety concern for aging adults.

Street Safety and Appeal: The location does not offer a sufficient amount of facilities for pedestrians. The responses received from the volunteers were mixed regarding the present amenities at this location; however, the majority of them expressed that the location is lacking in many areas. Seating availability presented varied responses, with some volunteers stating that there are some seating arrangements like benches on the sidewalk, while others stated that the location does not provide sufficient seating arrangements. The volunteers also mentioned that the place is not well shaded and lacks greenery upkeep, which poses discomfort while utilizing the area. However, the buildings and homes in this location are well maintained, which is a positive aspect contributing to the area's appeal. The area also lacks many other proper safety facilities, such as proper signage, streetscapes, and pedestrian-friendly lighting. These are also vital safety measures.

General Impressions: After the walking audit, the volunteers were asked to express their impressions about the area. They unveiled valuable insights about the area. Notably, the majority of the volunteers expressed discomfort about this area. They did not feel safe around this location, especially for the elderly. Almost everyone stated that it is not safe for them. Some of the volunteers also felt unsafe from crime and harassment, while others felt the area was rather safe. However, the overall safety of this area is still in a concerning state.

Building a better Block: The volunteers were asked to provide suggestions for improvements they would like to see in this location. They offered many important and valuable ideas for improvement. The top five improvements they identified are as follows: sidewalk enhancements, pedestrian-friendly lighting, street trees and landscaping, proper signage, and trash receptacles. By implementing and adding these features, it will ensure the safety and attractiveness of this location.





Community Engagement

Hamburg Bike Rodeo

The Hamburg Bike Rodeo was held on Thursday, May 11, 2023, in the parking lot of Hamburg Middle School, and was organized in partnership between the Hamburg Moves Committee and the GObike team. Committee member Brooke DeLucia helped to secure the Rodeo's location at Hamburg Middle School, and worked with other Hamburg Moves members to promote the Rodeo both on social media and around the Village of Hamburg.

GObike Deputy Director, Ashley Smith, and Development Director, Sarah Omicioli were on hand to answer questions about active mobility in the Town of Hamburg, and to present maps of preliminary design plans for connectivity enhancements between the Village of Hamburg and the shores of Lake Erie, welcoming visitor feedback.

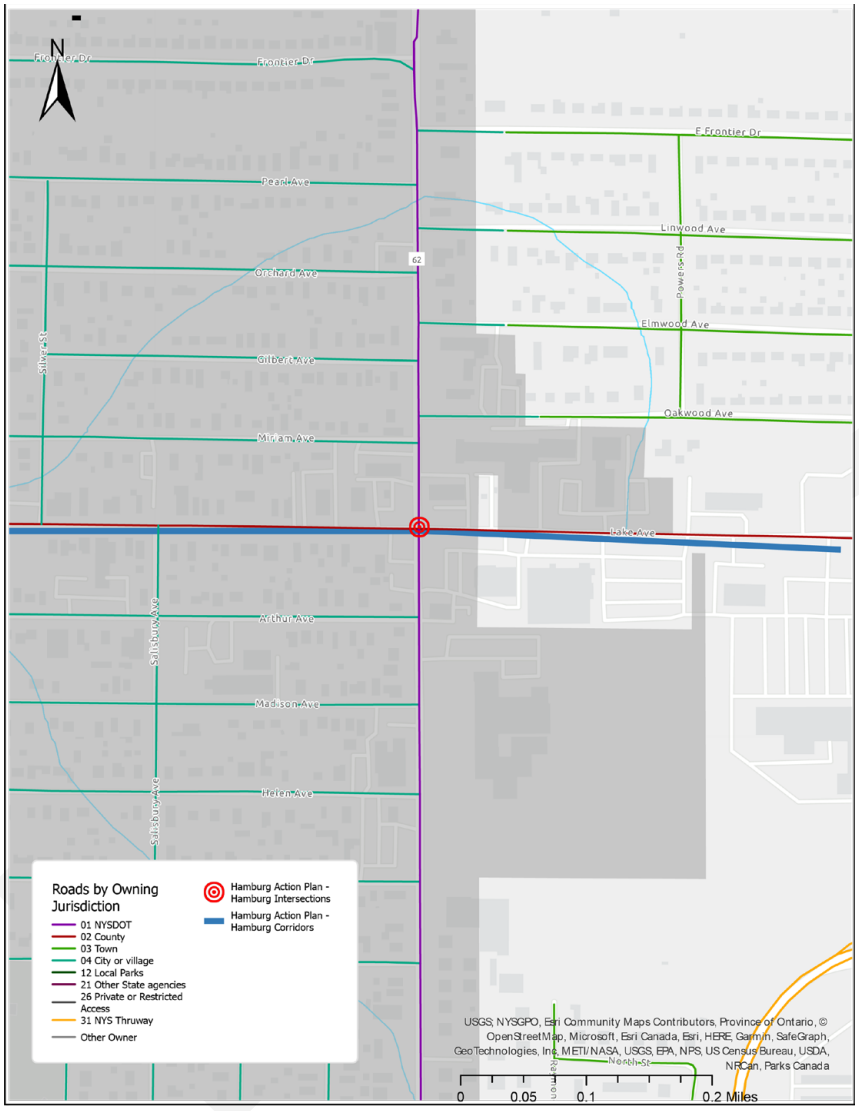
Tabling alongside GObike, and helping to assist with the Rodeo, were additional volunteers from the Hamburg Moves Committee: Tom Nemmer, Kaitlin Chmura, Dan Rosetti and Hamburg Traffic Safety Coordinator Paul McQuillen. Also on-hand for the event were Hamburg Town Supervisor, Randy Hoak, and Assistant Planner for the Town of Hamburg, Annalyse Paulson, in addition to several members of the Hamburg Village Police Department.

GObike Education Manager, Dave Meyers, and Community Engagement Manager, Kaden Shea, teamed up with several Hamburg Moves Committee members to create a bike obstacle course on the surface lot, and led 29 children in safety and skill development exercises. Each participating child received a certificate of course completion, along with bike light sets and other safety resources. It proved to be a fun and educational event for all, and was a great starting point for the Hamburg Moves Committee progressing toward their own autonomy as an independent group, presenting on topics of mobility justice in Hamburg.


POLICE

Priority Areas of Focus

Lake Ave & South Park Ave: Village of Blasdell



GObike conducted a speed study using a StealthStat radar unit along Lake Avenue at 4233 Lake Ave, looking west toward the intersection of South Park and Lake. The results are summarized below, and the full study is included in the appendix:

Table 4: Speed Study Results: Lake Avenue (4233 Lake Ave) with Focus on Westward View towards South Park and Lake Intersection

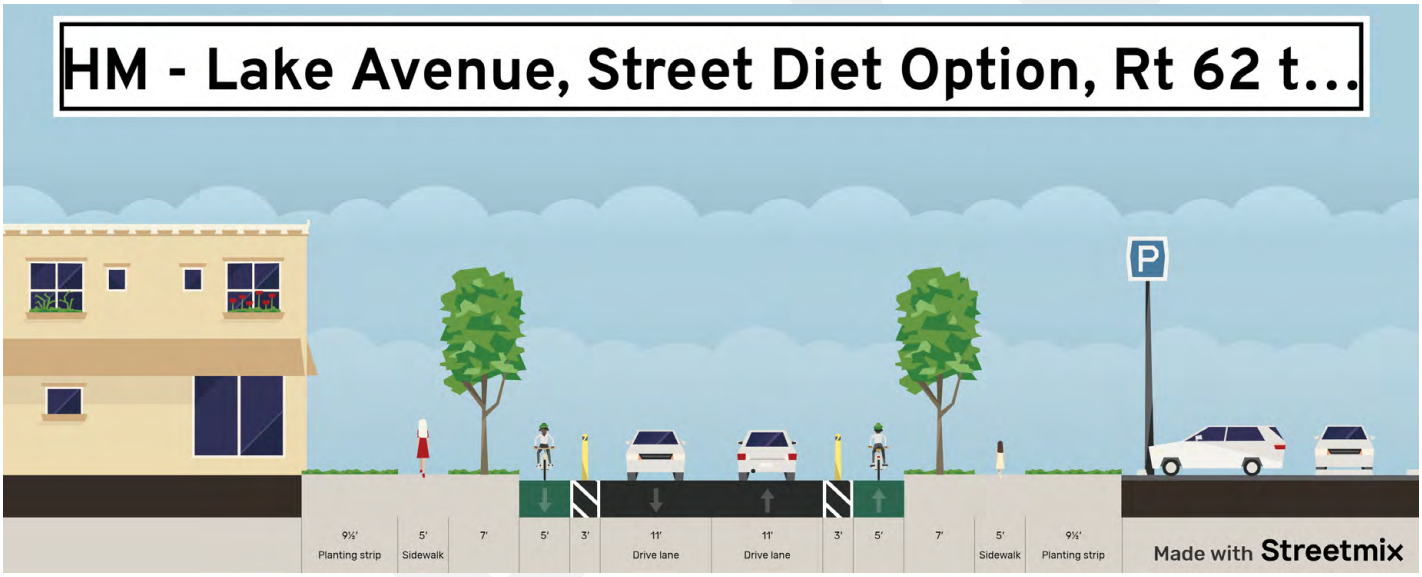
Study Title	Lake Avenue Speed Study - July 2023	
Study Run Dates	2023/07/08 12:02:48 to 2023/07/13 17:00:00	
Total Study Time	5 Days 4 Hours 57 Minutes	
Study Download Time	2023/07/13 17:24:31	
Study Location		
Study GPS Location	Unknown	
Study Timing Interval	5 minute blocks	
Study Total # of Vehicles	32303	
Study Posted Speed Limits	40 mph	
Study Total # of Speeds	3482	
Approaching Traffic	# of Vehicles	15608
	# of Speeders	611
	Maximum Speed	54 mph
	Average Speed	31 mph
	Median Speed	33 mph
	85th Pecentile Speed	37 mph
	10 mph Pace	31 - 40 mph
Receding Traffic	# of Vehicles	16695
	# of Speeders	2871
	Maximum Speed	70 mph
	Average Speed	35 mph
	Median Speed	36 mph
	85th Pecentile Speed	40 mph
	10 mph Pace	31 - 40 mph

About 11% of vehicles were driving above the posted speed limit of 40 mph, though the maximum speed recorded was 70 mph. Eighty five percent of receding vehicles were traveling 40 mph or less, and 85% of approaching vehicles were traveling 37 mph or less; this indicates that the vast majority of vehicles at this point on Lake Avenue were obeying the speed limit. Average speeds for both directions were also well under the 40mph limit.

Priority Areas of Focus

In response to the Lake Avenue concerns, GObike developed three design alternatives between South Park Avenue (RT-62) and McKinley Avenue.

1. Lake Avenue, Street Diet Option. This option reduces the pavement width to consist of two 11 foot wide travel lanes, two 5 foot wide bicycle lanes each with 3 foot wide buffers. Sidewalks would be expanded to 5 foot widths at a minimum to better meet ADA requirements and trees would be added.Six foot wide sidewalks provide greater walking comfort in general. Street trees should be added in any alternative selected for their numerous benefits. It is recommended that the speed limit be reduced to 30 MPH should this option be constructed. Consideration should be made to provide protected bikeways instead of buffered bikeways as a phased approach.



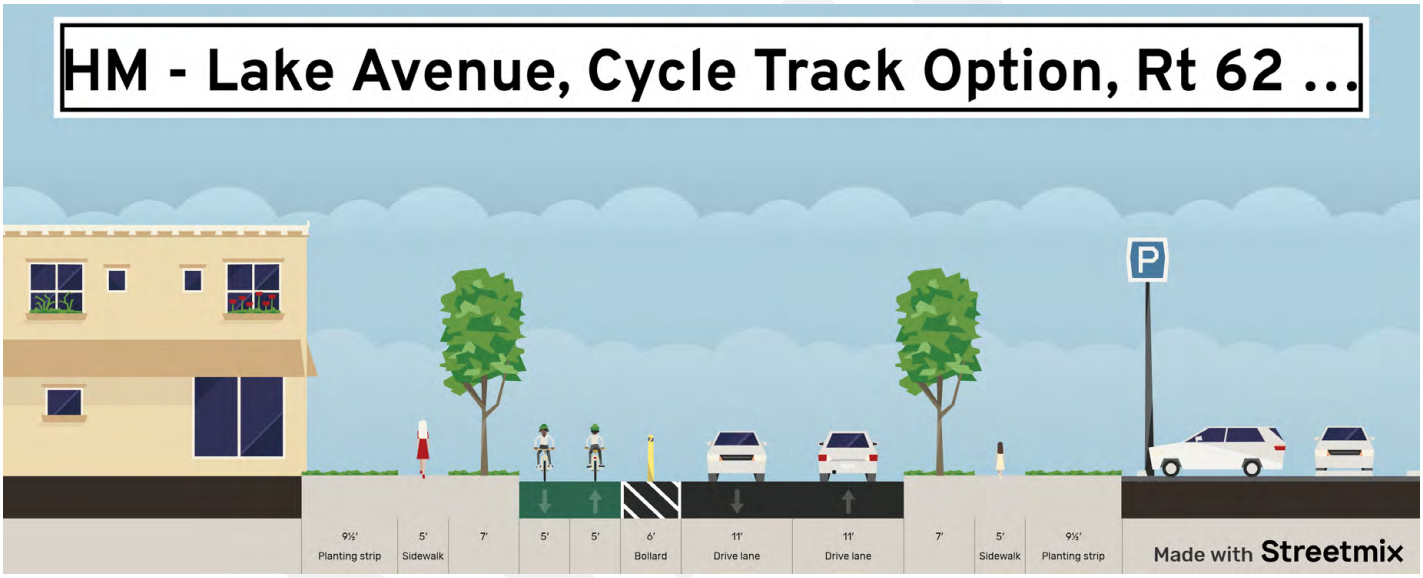
Typical Section, Street Diet

Aerial view of Lake Avenue at South Park Avenue, Street Diet Option

Aerial view of Lake Avenue at McKinley Avenue, Street Diet Option

A full set of corridor views for the Street Diet Option can be found in the appendix

2. Lake Avenue, Cycle Track, North Side. This option includes a two-way cycle track along the north side of Lake Avenue separated by a 6 foot wide buffer and again two 11 foot wide travel lanes and Sidewalks would be expanded to 5 foot widths to better meet ADA requirements and trees would be added. Six foot wide sidewalks provide greater walking comfort in general. Street trees should be added in any alternative selected for their numerous benefits. Consideration should be made to provide protected bikeways instead of buffered bikeways as a phased approach. It is recommended that the speed limit be reduced to 30 MPH should this option be constructed.



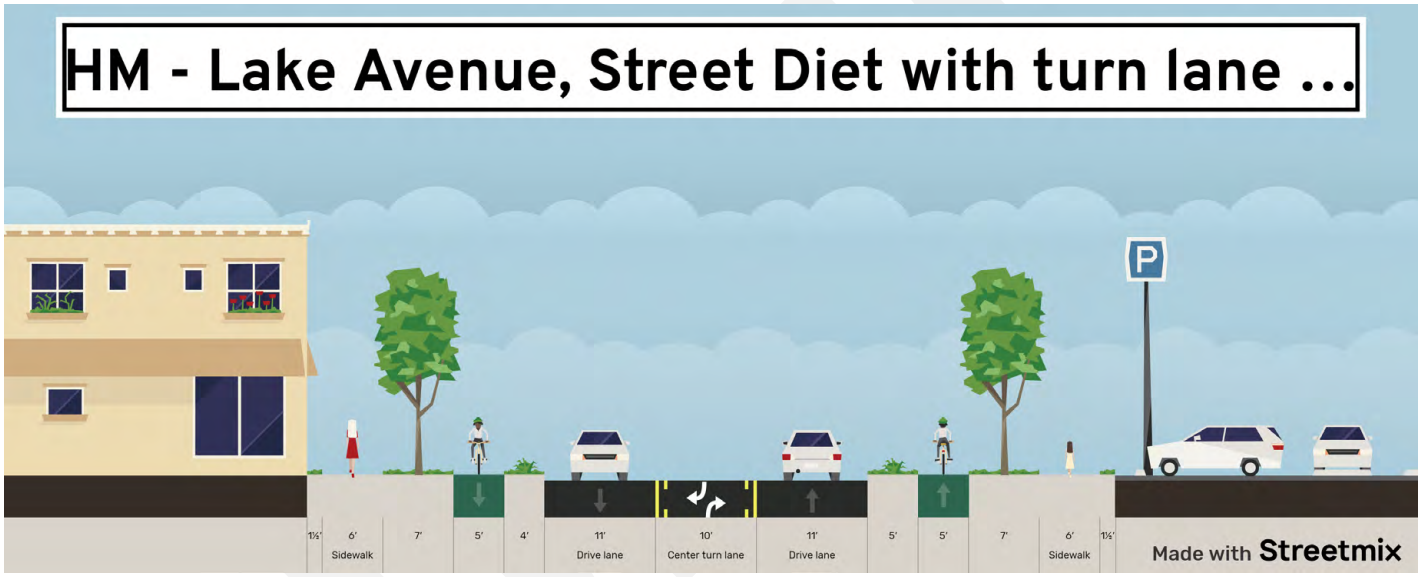
Typical Section, Cycle Track

Aerial view of Lake Avenue at South Park Avenue, Cycle Track Option

Aerial view of Lake Avenue at McKinley, Cycle Track Option

A full set of corridor views for the Cycle Track Option can be found in the appendix

3. A third option would be to include a center two way turn lane and sidewalk level bikeways. This option provides better protection to both bicyclists and pedestrians and the flexibility of the center lane. Six foot wide sidewalks provide greater walking comfort in general. Street trees should be added in any alternative selected for their numerous benefits. It is recommended that the speed limit be reduced to 30 MPH should this option be constructed. Consideration should be made to provide protected bikeways instead of buffered bikeways as a phased approach.



Typical Section of Lake Ave with sidewalk level bikeways and center two way turn lane

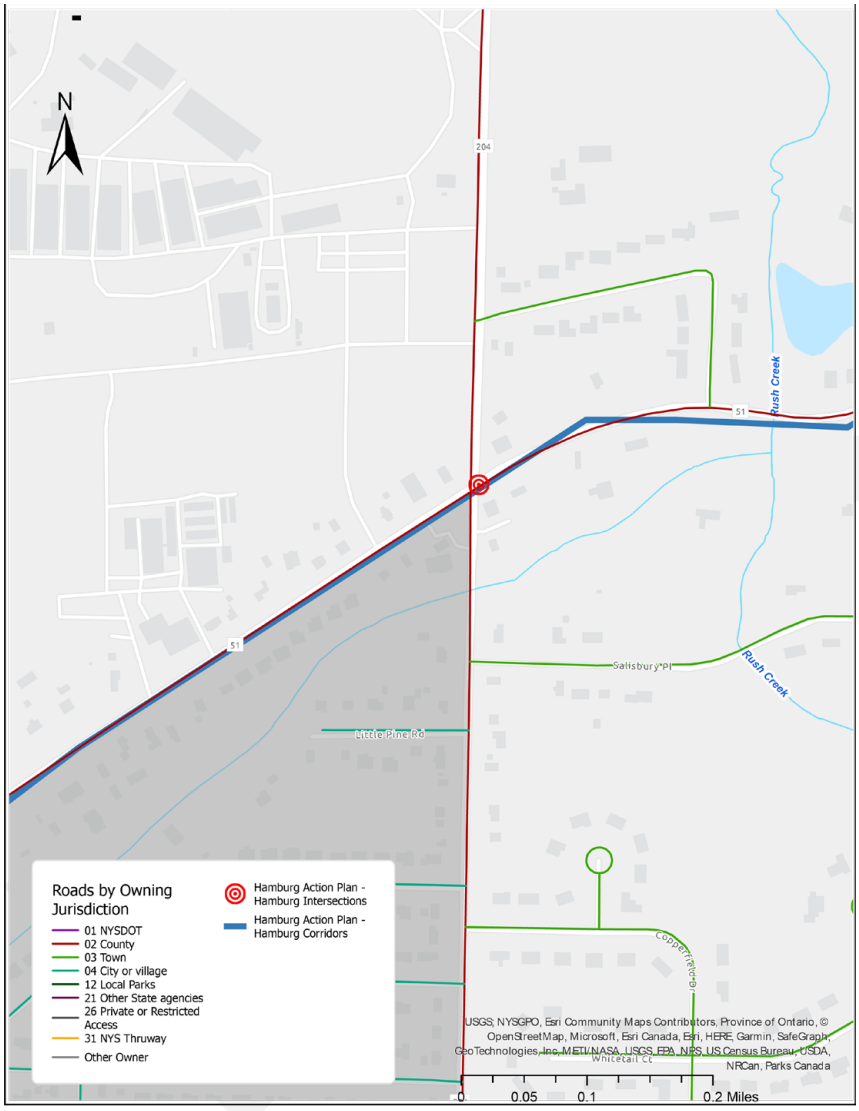
Aerial view of Lake Avenue at South Park Ave, TWCTL & Road Diet Option

Aerial view of Lake Avenue at McKinley, TWCTL & Road Diet Option

A full set of corridor views for the Cycle Track Option can be found in the appendix

Priority Areas of Focus

Clark St. & McKinley Pkwy.: Town of Hamburg



GObike conducted a speed study using a StealthStat radar unit along Clark St. just east of the intersection of Clark St. and McKinley Pkwy. The results are summarized below, and the full study is included in the appendix:

Table 5: Speed Study Results: Clark St. East of Clark St. and McKinley Pkwy Intersection

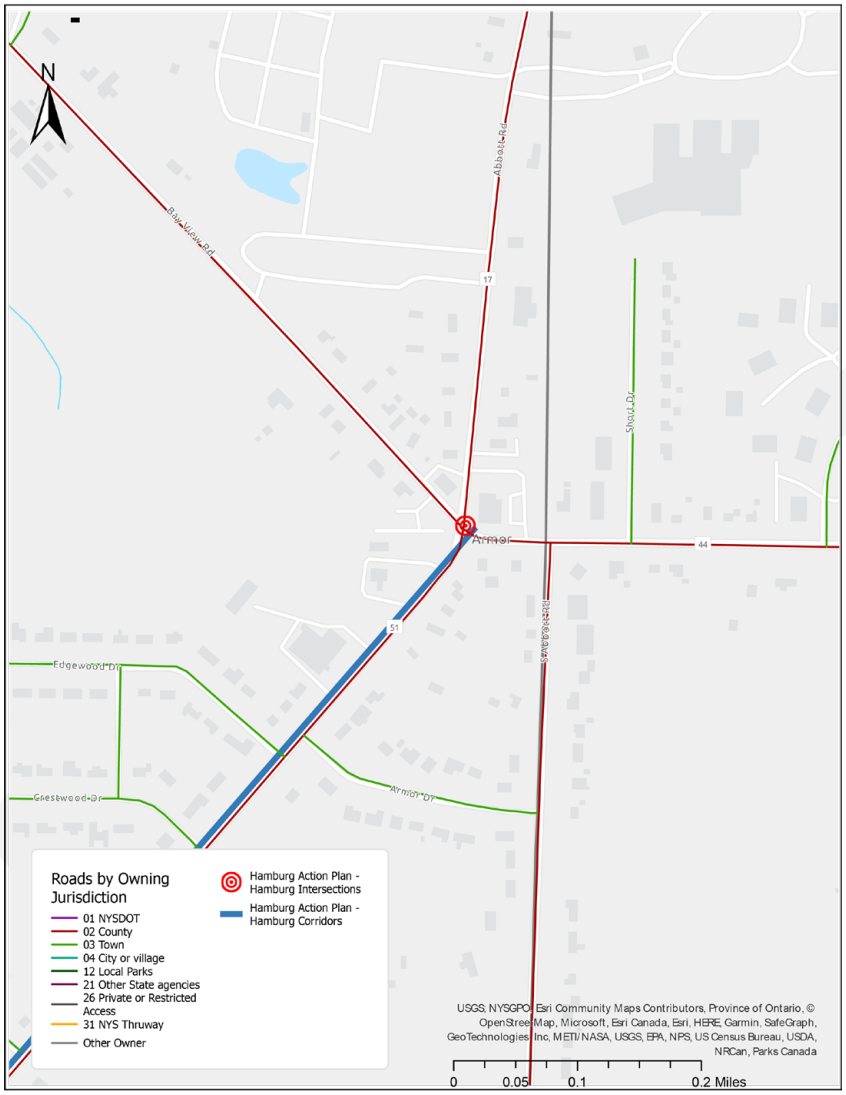
Study Title	Clark Street Speed Study - Hamburg NY, July 2023	
Study Run Dates	2023/07/08 11:53:43 to 2023/07/22 14:20:00	
Total Study Time	4 Days 2 Hours 26 Minutes	
Study Download Time	2023/07/24 13:27:54	
Study Location		
Study GPS Location	Unknown	
Study Timing Interval	5 minute blocks	
Study Total # of Vehicles	31791	
Study Posted Speed Limits	30 mph	
Study Total # of Speeds	25157	
Approaching Traffic	# of Vehicles	15715
	# of Speeders	12728
	Maximum Speed	70 mph
	Average Speed	33 mph
	Median Speed	33 mph
	85th Pecentile Speed	37 mph
	10 mph Pace	31 - 40 mph
Receding Traffic	# of Vehicles	16076
	# of Speeders	12429
	Maximum Speed	77 mph
	Average Speed	32 mph
	Median Speed	33 mph
	85th Pecentile Speed	36 mph
	10 mph Pace	31 - 40 mph

Priority Areas of Focus

Note that the unit was aimed in the westerly direction on the utility pole in front of 4681 Clark Street. Of interest is that 79.1% of vehicles exceed the posted speed limit, the maximum speed recorded was 77 mph (47 mph above the posted limit), and the 85th percentile speed is 6 to 7 miles above the posted limit.

This intersection is currently being examined through a separate process with the Town of Hamburg, under the guidance of Blue Zones and Dan Burden, one of the world's foremost experts in developing walkable and bikeable places. The survey conducted by GObike identified Clark St and McKinley Pkwy as key areas for connecting the Village of Hamburg with Armor and other amenities such as the Hamburg Fairgrounds. The need to address safety and connectivity at this intersection, and along Clark St., is reinforced by similar goals laid out in past planning efforts. In staying consistent with other intersection improvements in the Village, the Town is exploring a roundabout as a potential alternative to the existing signalized intersection. As such, this report did not focus on offering recommendations for this intersection.

Clark, Armor-Duells, Bayview, Abbott: Town of Hamburg



This signalized intersection was identified for potential improvements due to nearby amenities and its existing complex geometry. One crosswalk exists across the west leg which is serviced by a limited sidewalk segment between the municipal parking lot in the southwest corner and the two story building at 5390 Abbott Rd. The latest Turning Movement Count (TMC) by the GBNRTC is from August 2011 [please see the appendix for details] and indicates the eastbound and northbound left turn movements are significant during the morning and afternoon peak periods. Truck movements are typically between 3 to 5 %. The signal has a left phase for westbound traffic however that appears inconsistent with the 2011 TMC and may affect intersection performance. It is recommended that Hamburg request updated traffic data for this intersection.

Priority Areas of Focus

In general, except as previously noted, there are no sidewalks in this area. Should the intersection be reconstructed in the future, two configurations could be considered.

1. Roundabouts are considered as proven safety countermeasures by the Federal Highway Administration and are also required to be considered as an alternative by the NYSDOT when reconfiguring intersections for safety and performance. Given the generally low volume of traffic along with complicated adjacent land use and right-of-way (ROW) configurations, a mini roundabout should be considered as an alternative intersection design. Such a configuration could look as shown below.

This configuration would require adjusting street centerlines and would also require ROW acquisitions on the west side where the municipal parking lot exists. Due to the intersection's close proximity to the Armor Duells and S. Abbott Rd intersection, it is recommended that that intersection be included for reconstruction consideration .

Mini roundabouts have been used successfully on Parker Boulevard in the Town of Tonawanda which carry similar traffic loadings and 2 of their key features include a traversable dome by larger vehicles during turning movements and are more compact for areas with ROW limitations. Entries to the roundabout are configured to reduce traffic speeds to 15 MPH to improve safety and efficiency.

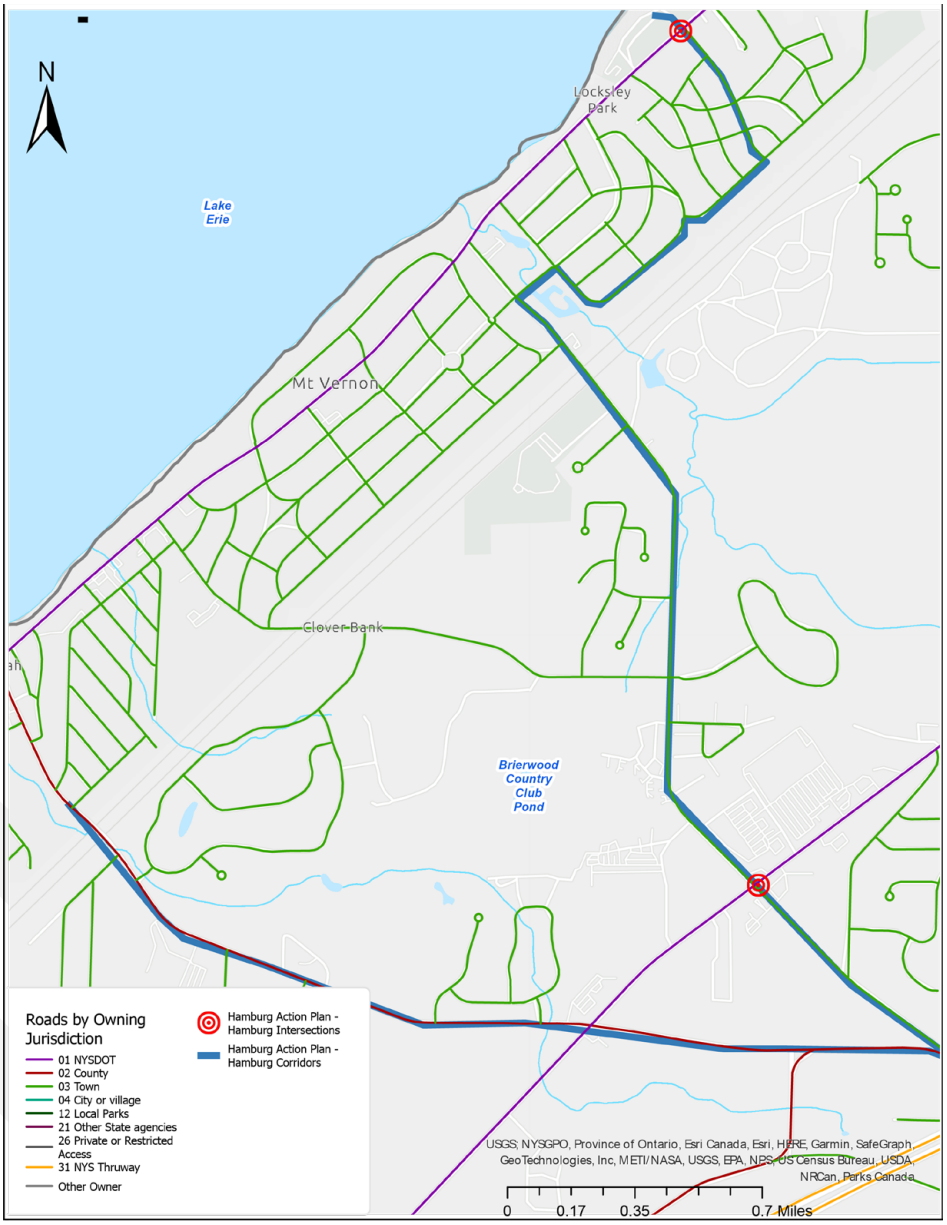
2. A second option as a more traditional signalized intersection would also require adjusting street centerlines and would also require ROW acquisitions on the west side where the municipal parking lot exists. Updated signal equipment would include signal mast arms, signal heads, LED signal faces, pedestrian poles, pedestrian countdown timers, accessible pedestrian signal actuation, camera detection, adaptive signal timing and phasing logic, cellular data connectivity, generator transfer switching and signal cabinet and controller equipment. The 2011 TMC indicates that eastbound and northbound left turn lanes and signal phasing may be warranted.

   Due to the intersection's close proximity to the Armor Duells and S. Abbott Rd intersection, it is recommended that that intersection be included for reconstruction consideration . The addition of sidewalks, trees and potentially bicycle lanes should also be considered as Hamburg moves towards the adoption of Complete Streets and expansion of their pedestrian and bicycle networks. Compliant accessible pedestrian circulation and access routes should be included as a minimum. Such an intersection reconfiguration could look like the following figure.

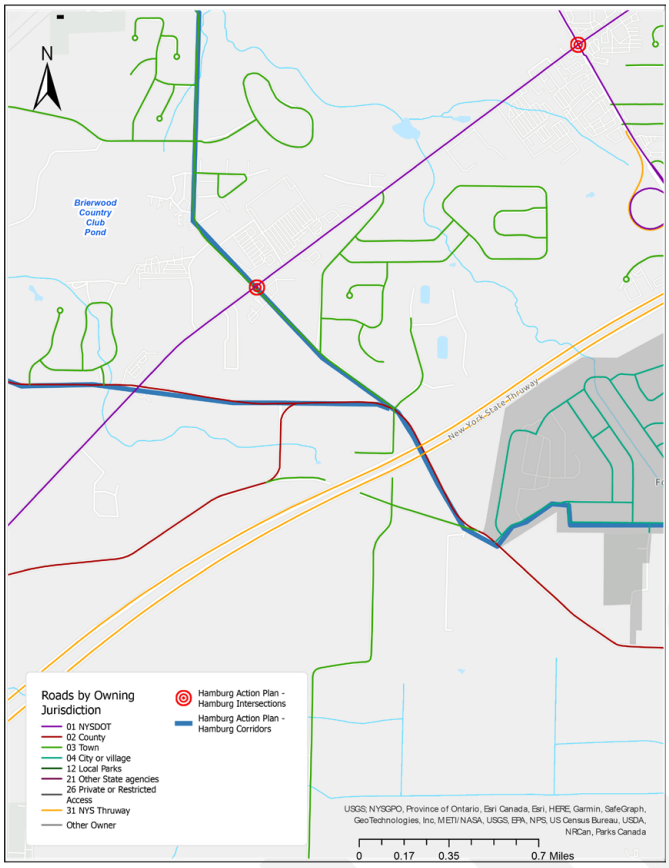
Priority Areas of Focus

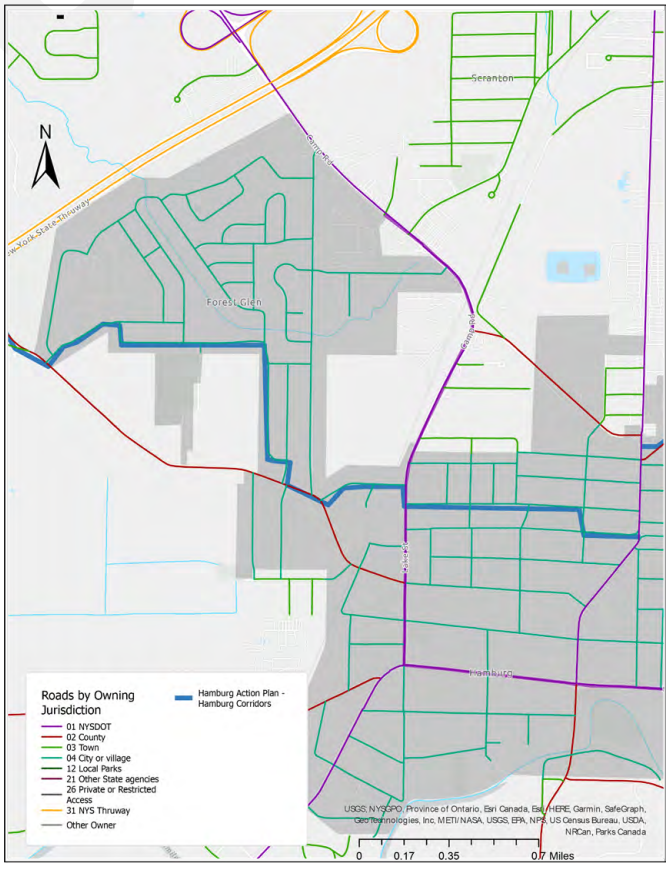
Pleasant Ave - Amsdell Rd.: Village and Town of Hamburg

Pleasant Avenue (CR 122) turns into Amsdell Road (CR 104) where the Town of Hamburg owned segment of Pleasant Avenue runs north-south. Pleasant Avenue (CR 122) resumes at Rogers Road and continues eastward into the Village of Hamburg to Buffalo Street (US 62). This corridor is considered to be a potential multimodal connection between the Lake Erie waterfront area and the Village of Hamburg. It is primarily a two lane road with 10 foot wide travel lanes and 2 to 4 foot wide paved shoulders. The street has sidewalks in the Village of Hamburg. According to the NYSDOT Traffic Data Viewer, Average Annual Daily Traffic (AADT) and other key roadway characteristics can be summarized as follows:



Priority Areas of Focus



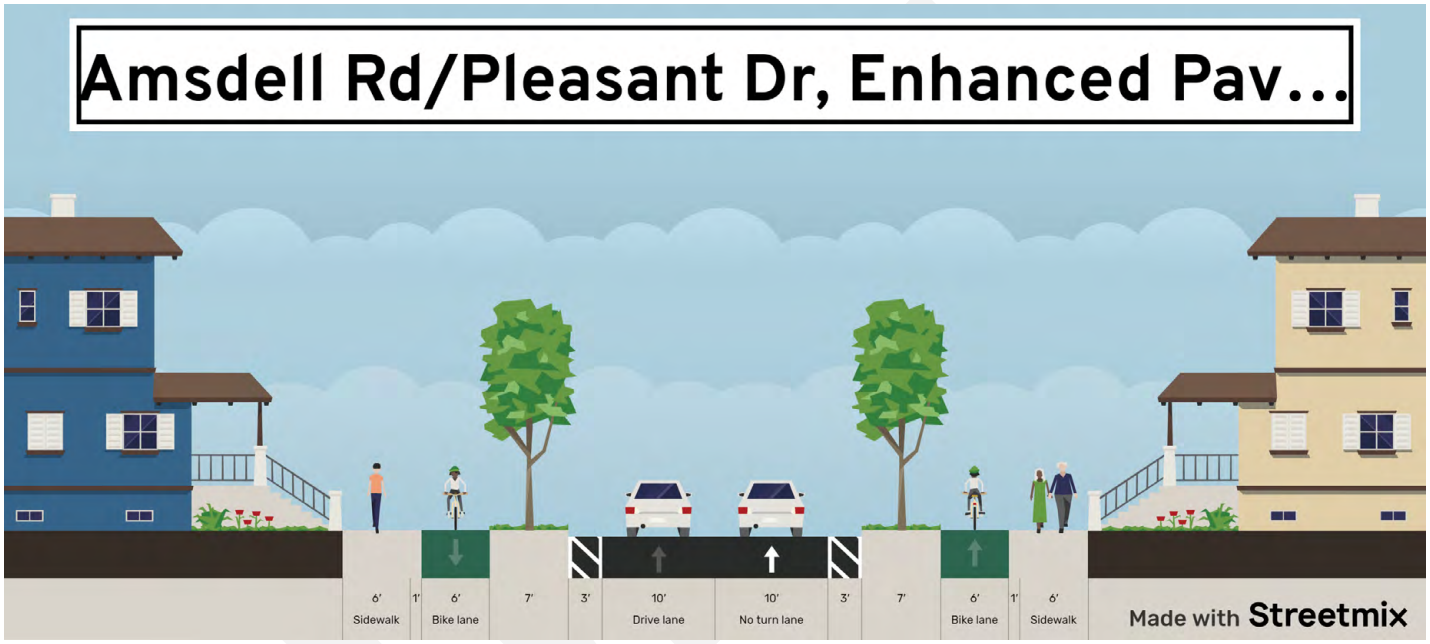


Priority Areas of Focus

Segment	From	To	Posted Speed	85th % Speed	AADT	% Trucks
Amsdell Rd *	Lake Shore Rd (SR 5)	Southwest-ern Blvd (US 20)	35 MPH	45 MPH	5122 (2019)	1%
Amsdell Rd	Southwest-ern Blvd (US 20)	Rogers Rd	35 MPH	43 MPH	1963 (2019)	2%
Pleasant Ave	Rogers Rd	E Pleasant Dr	35 MPH	44 MPH	5679 (2019)	4 %
Pleasant Ave	E Pleasant Dr	Lenora Dr	35 MPH	38 MPH	4727 (2019)	3%
Pleasant Ave	Lenora Dr **	Lake St (SR 75)	30 MPH	27 MPH	6172 (2019)	3 %
Pleasant Ave	Lake St (SR 75)	Buffalo St (US 62)	30 MPH	NA	NA	NA

*Frontier Middle School within this segment
**Village line

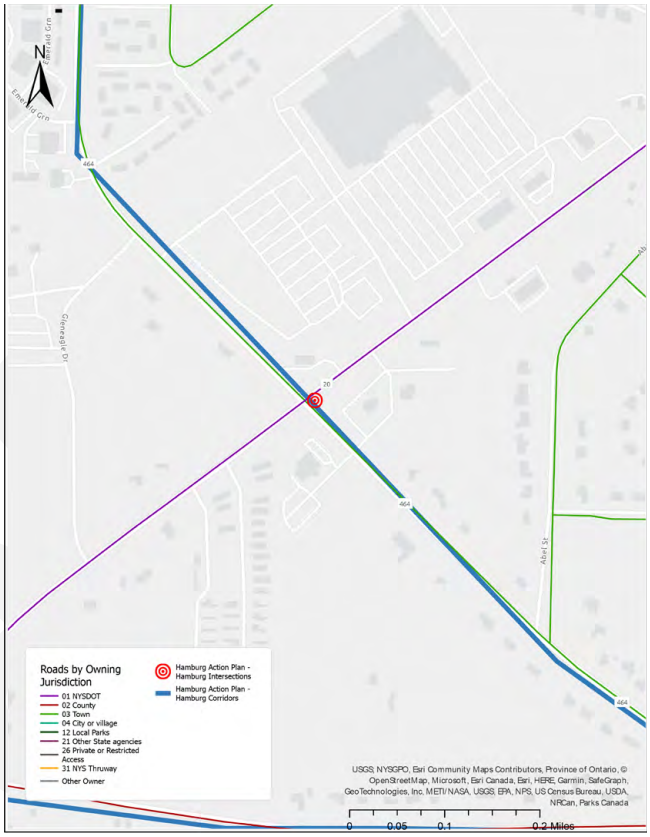
Generally, the ROW is 66 feet wide although significant constriction occurs under the Buffalo - Lake Erie District railroad bridges and where Pleasant Avenue goes over the NYS Thruway. Protected and or buffered bikeways and sidewalks should be considered to be added to the ROW in order to achieve the town's overall connectivity goals. As a minimum interim measure, 6 foot wide buffered shoulders should be added. A typical section of a recommended street reconfiguration is shown below.



Priority Areas of Focus

Rogers Rd. and Southwestern Blvd.: Town of Hamburg

Rogers Road is a 35 MPH road under the Town of Hamburg jurisdiction. Near its intersection with Southwestern Boulevard (US 20) it is generally two eleven foot wide travel lanes with 4 foot wide paved shoulders. The AADT in 2019 was 3670 west of US 20 and 3411 to the east. Approximately 68 crashes were reported between 2017 and 2021 within the influence of the intersection. Google Streets indicates that Rogers Road east of Southwestern Boulevard is bicycle friendly.



Southwestern Boulevard is a 50 MPH road under the jurisdiction of NYS and carries an AADT of 32,256. There are dedicated left turn lanes on all four approaches and the southbound approach includes a dedicated right turn lane. Sidewalks exist on both sides of the street. The approximate pedestrian exposed crossing distance is 75 feet across the south leg and 85 feet across the north leg. The traffic signal is also under the NYSDOT jurisdiction and includes a NB/SB left turn signal phase. There are pedestrian countdown signals with actuation at each crosswalk entry. Recently, the pavement markings were reestablished to the latest NYSDOT standards. The latest TMC from the GBNRTC is dated July 24, 2014 and the southbound left volume is of note and most likely the warrant for the dedicated left turn phase however the southbound right turn volumes do not appear to warrant the dedicated right turn lane. Consideration to change the paved shoulders to protected bicycle lanes, lane width reductions to 11 feet and street trees should be made on Southwestern Boulevard.

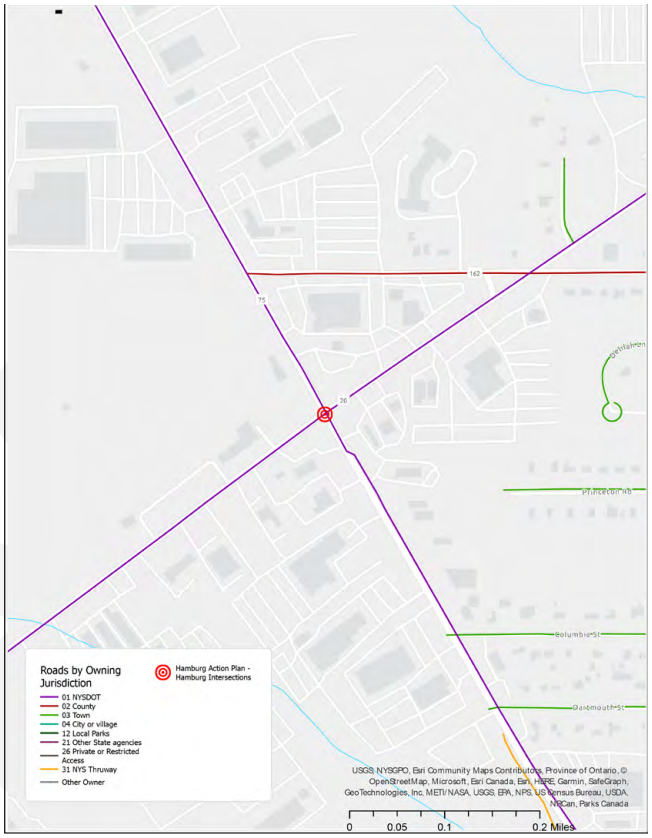
Potential pedestrian supporting actions could include the removal of the dedicated SB right turn lane and the dedicated left turn lanes in Rogers Road to lessen pedestrian exposure time and to better adjust signal timing and phasing. Video detection of traffic including bicycles and pedestrians along with the inclusion of adaptive signal timing to respond to actual traffic demand is also recommended. The intersection lighting levels should be upgraded to meet FHWA Lighting Handbook 2023 guidelines.

Camp Rd. and Southwestern Blvd.: Town of Hamburg

Camp Road (SR 75) and Southwestern Boulevard (US 62) are both under the jurisdiction of NYSDOT. Approximately 234 crashes including two crashes involving bicycles and two with pedestrians occurred between 2017 and 2021 within the influence of the intersection. US 62 is seven lanes wide and Camp Road is six lanes on the north leg and seven lanes on the south leg.

A conversion of this traditional multi-lane, signalized intersection to that of a turbo roundabout style should be considered to include a separate circulatory bikeway. Turbo roundabouts are considered to be proven safety countermeasures for higher volume multi lane intersections with significant crash history. The FHWA has guidance on turbo roundabouts which host the following benefits.

- A turbo roundabout eliminates some of the most severe conflict points on a roundabout.
- The most important feature of the turbo roundabout is the spiral lane marking to eliminate the necessity of weaving or changing lanes.
- A mountable lane divider induces traffic to keep its own lane, and this helps to prevent sideswipe collisions that can occur not only upon entering the roundabout, but also when exiting.
- As a result of the lane dividers, drivers need to choose the correct lane before they enter the roundabout.
- Turbo roundabouts require less right-of-way than a standard two-lane roundabout. At least one entry to a turbo roundabout has a second lane inserted on the central island side. Turbo roundabouts normally have radial design where entering traffic flows directly towards the center of the roundabout. These two elements together allow for a reduction in the diameter of the intersection.
- The capacity of a turbo roundabout is about 25% to 35% higher than the capacity of a conventional two-lane roundabout, depending on the balance of the traffic volumes on the approaches.
- The use of turbo roundabouts in the USA will require adjustments to allow for the larger size trucks compared with those in Europe.
- The raised lane dividers are preferable to painted lane dividers but some variation of the raised lane divider may be considered for turbo roundabouts in snowy areas.



Turbo Roundabout Design Guidelines Translated to the USA

FHWA Turbo Roundabout Informational Primer

Pilot Implementation

As part of GObike's scope of work, a demonstration project to reflect pedestrian safety and accessibility could include the addition of signage and pavement marking at the intersection of Pleasant Avenue and Rogers Road. This is an existing "Tee" intersection with unmarked crosswalks. A STOP sign exists for northbound traffic. The streets shoulders are defined as pedestrian access routes as pedestrians are to walk against the flow of traffic in the Uniform Vehicle Code §11-506c Pedestrians on highways.

An illustration of such signage and markings are shown below and enhance traffic safety and guidance of existing operations at the intersection.

Strategy Recommendations

Policy

Adopt a Complete Streets Policy

Municipalities across the region are adopting Complete Streets Policies as a way to improve active transportation opportunities for residents and visitors. Adopting a Complete Streets Policy ensures that the Town of Hamburg's commitment to ensuring safe, convenient, and accessible mobility options for all residents is codified into the Town's infrastructure planning and investments. The policy clearly identifies the Town's vision for mobility, the intent of the policy, who benefits, how the policy is implemented (and when it is not), offers a guide for context-sensitive investments in complete streets infrastructure, and establishes the metrics by which success of future projects are measured. A model complete streets policy has been included in the appendix of this plan as a starting point for the Town of Hamburg to develop its own policy.

Complete a Sidewalk Master Plan

The Town of Hamburg is in the beginning stages of developing a Sidewalk Master Plan. This plan should inventory the existing conditions, or absence, of sidewalks throughout the Town, and create a roadmap to fund and construct a network of pedestrian facilities to fill in gaps in the pedestrian network. Through the community survey and walk audits, this Active Mobility Action Plan can offer a starting point for further examination of the corridors and intersections identified by community members as unsafe for pedestrians. Additionally, Hamburg Moves, with support from GObike, can continue to act as a community liaison in leading outreach events such as informational sessions or additional walk audits, to further support the Sidewalk Master Plan's efforts.

Complete a Bicycle Master Plan

The 2022 Town of Hamburg Comprehensive Plan establishes a clear goal for making the Town more bikeable and walkable through investments in safer, multimodal infrastructure that connects residents and neighborhoods to each other and to the Town's many amenities. While the 2017 Multimodal Trails Master Plan offers a starting point for bicycle connectivity in the town, a Bicycle Master Plan would further explore the connectivity between those off-street connections to an on-road network of bicycle infrastructure. This plan would examine how to connect an enhanced local on-road bicycle network and nearby destinations to the regional network described by Regional Bike Master Plan, and serve as a guiding document for collaboration with Erie County and NYSDOT to improve roadways not under the Town's jurisdiction. A Bicycle Master Plan would define specific, prioritized strategies for bicycle infrastructure investments, establish a timeline for implementation, and identify metrics to measure the success of bicycle infrastructure.

Amend Zoning Code

Hamburg's zoning code should be updated to reflect best practices that support improved walkability, bicycling and transit use. A few of the focus areas should include but not be limited to the following:

- Eliminate parking minimums for residential and commercial land uses and incentivize bicycle parking facilities and transit usage along transit routes
- Require five foot minimum sidewalks along all new development frontages
- Require sidewalk connectivity between all building doorways and the public sidewalk. Include sidewalk circulation facilities within all parking areas
- Require all pedestrian circulation routes to conform to the US Access Board's Public Right of Way Accessibility Guidelines (PROWAG) and ADA Accessibility Guidelines (ADAAG).

Strategy Recommendations

Formalize Hamburg Moves

As an officially-recognized committee of the Town of Hamburg Board, Hamburg Moves would be given the authority to review and audit transportation infrastructure projects proposed by the Department of Engineering. While Hamburg Moves would not have the authority to force amendments to proposals, they will offer active mobility-related recommendations to the board for each project. This model is similar to the one implemented in the City of Buffalo with the Bicycle and Pedestrian Advisory Board, which is a subcommittee of the City Council and offers recommendations on proposed transportation related projects. If formalized as a committee of the Town Board, Hamburg Moves will need to establish by-laws and elect officers in accordance with Town legislation.

Investment

Focus On Priority Areas

Between the community-informed priority areas in this Active Mobility Action Plan, Hamburg Multimodal Trails Master Plan, and Regional Bike Master Plan, the Town of Hamburg has a list of key projects to focus infrastructure investments. Seek out funding opportunities that leverage existing planning work to design and implement previously identified recommendations and projects.

Capacity

Develop an Agreement with Erie County DPW

One of the major challenges of implementing changes to most of the priority corridors and intersections in this plan is that the roadways are under the ownership jurisdiction of Erie County, meaning the Town has little influence over the design and construction of those roadways. To complement the Town's future Complete Streets Policy, Hamburg should continue conversations with the Erie County Department of Public Works to establish an agreement with Erie County. The collaborative agreement should create a foundational guide for implementing Complete Streets in the Town of Hamburg, in accordance with the Complete Streets Policy, on County-owned right-of-ways. Ideally, Erie County would agree to coordinate with Hamburg's Department of Engineering to review road projects for compliance with the Town's complete streets policy.

Leverage Hamburg Moves Committee

In addition to becoming a committee of the Town Board, Hamburg Moves should be leveraged to continue engaging members of the community. Members of the committee are passionate about making Hamburg safer for all residents, no matter what mode of transportation they use. Through the Active Mobility Action Plan process, members of the committee have become more well-informed about active mobility planning and gained experience with field work such as walk audits. Members can act as ambassadors in the community for all future active mobility initiatives, including the Sidewalk Master plan. With continued guidance from GObike in the near future, Hamburg Moves can continue to be an asset for engaging residents in civic processes.

Appendices

List of Appendices

- Appendix A: Street Maps
- Appendix B: Peak Hour Data for Intersection
- Appendix C: Model Complete Streets Policy
- Appendix D: FHWA Turbo Roundabout Informational Primer
- Appendix E Turbo Roundabout Design Guidelines Translated to the USA

Appendix A
Street Maps


HM - Clark, Bayview, Armor Duells & Abbott, Intersection Improvements Option
HM - Clark, Bayview, Armor Duells & Abbott, Intersection Improvements Option
Bay View Rd
Armor Duells Rd
Clark St
50 ft
mapbox
remix
© Mapbox © OpenStreetMap

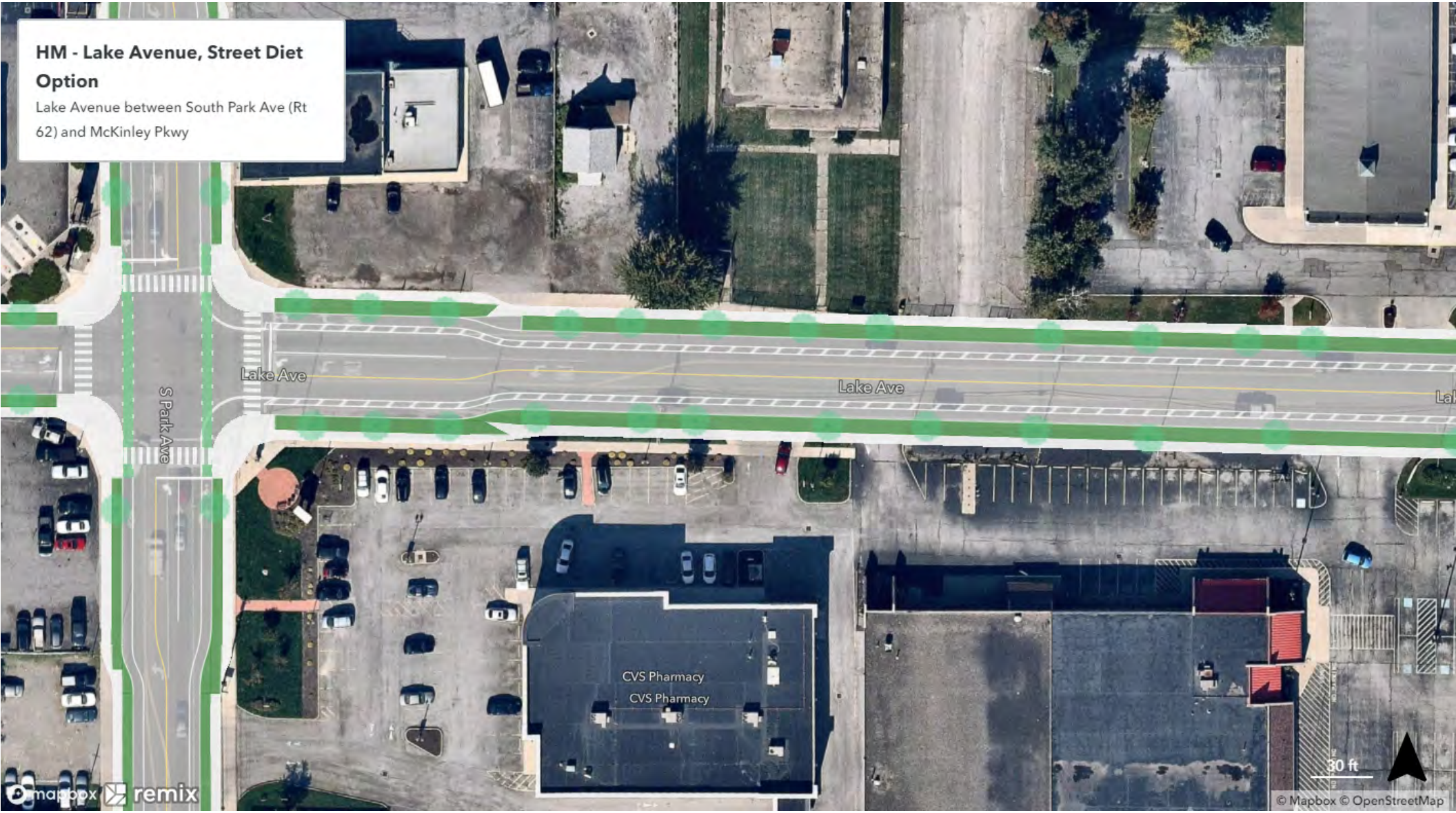

HM - Clark, Bayview, Armor Duells & Abbott, Roundabout Option
Convert existing intersection to one lane roundabout
Bay View Rd
Armor Duells Rd
Clark St
50 ft
mapbox
remix
© Mapbox © OpenStreetMap


HM - Lake Avenue, Cycle Track, North Side
Lake Avenue between South Park Ave (Rt 62) and McKinley Pkwy
Marathon
Lake Ave
S Park Ave
Lake Ave
CVS Pharmacy
CVS Pharmacy
50 ft
mapbox
remix
© Mapbox © OpenStreetMap


HM - Lake Avenue, Cycle Track, North Side
Lake Avenue between South Park Ave (Rt 62) and McKinley Pkwy
Lake Ave
Lake Ave
McKinley Pkwy
Lake Ave
50 ft
mapbox
remix
© Mapbox © OpenStreetMap


HM - Lake Avenue, Sidewalk level Bikeways and CTWTL Option
Lake Avenue between South Park Ave (Rt 62) and McKinley Pkwy
Marathon
Lake Ave
S Park Ave
Lake Ave
Lake Ave
CVS Pharmacy
CVS Pharmacy
50 ft
mapbox
remix
© Mapbox © OpenStreetMap


HM - Lake Avenue, Sidewalk level Bikeways and CTWTL Option
Lake Avenue between South Park Ave (Rt 62) and McKinley Pkwy
Lake Ave
Lake Ave
McKinley Pkwy
Lake Ave
50 ft
mapbox
remix
© Mapbox © OpenStreetMap


HM - Lake Avenue, Street Diet Option
Lake Avenue between South Park Ave (Rt 62) and McKinley Pkwy
Lake Ave
Lake Ave
S Park Ave
CVS Pharmacy
CVS Pharmacy
30 ft
mapbox
remix
© Mapbox © OpenStreetMap


HM - Lake Avenue, Street Diet Option
Lake Avenue between South Park Ave (Rt 62) and McKinley Pkwy
Lake Ave
Lake Ave
McKinley Pkwy
Lake Ave
30 ft
mapbox
remix
© Mapbox © OpenStreetMap


Rogers Road at Pleasant Dr
Pedestrian Improvement Option
Rogers Rd
Cooper Ridge
30 ft
mapbox
remix
© Mapbox © OpenStreetMap

Appendix B
Peak Hour Data for Intersection

Greater Buffalo-Niagara
Regional Transportation Council

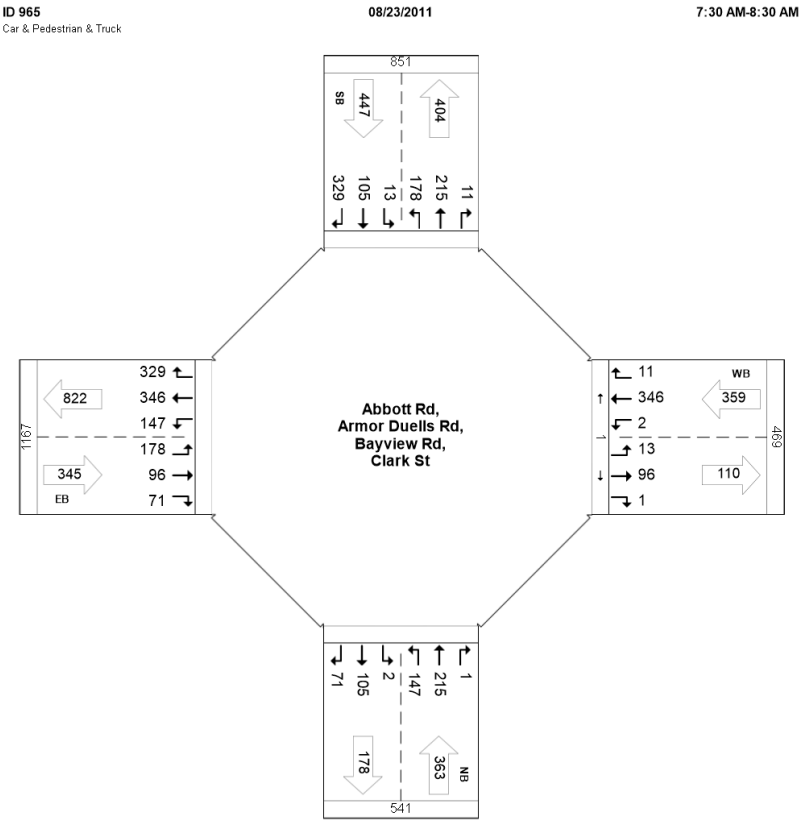
Peak Hour Data for Intersection

Int ID:	965		
Community:	Hamburg	**Zone:**	N/A
Road 1:	Abbott Rd	**Road 2:**	Bayview Rd
Road 3:	Clark St	**Road 4:**	Armor Duells Rd

AM Peak Hour (08/23/2011)

☑ Car ☑ Pedestrian ☑ Truck

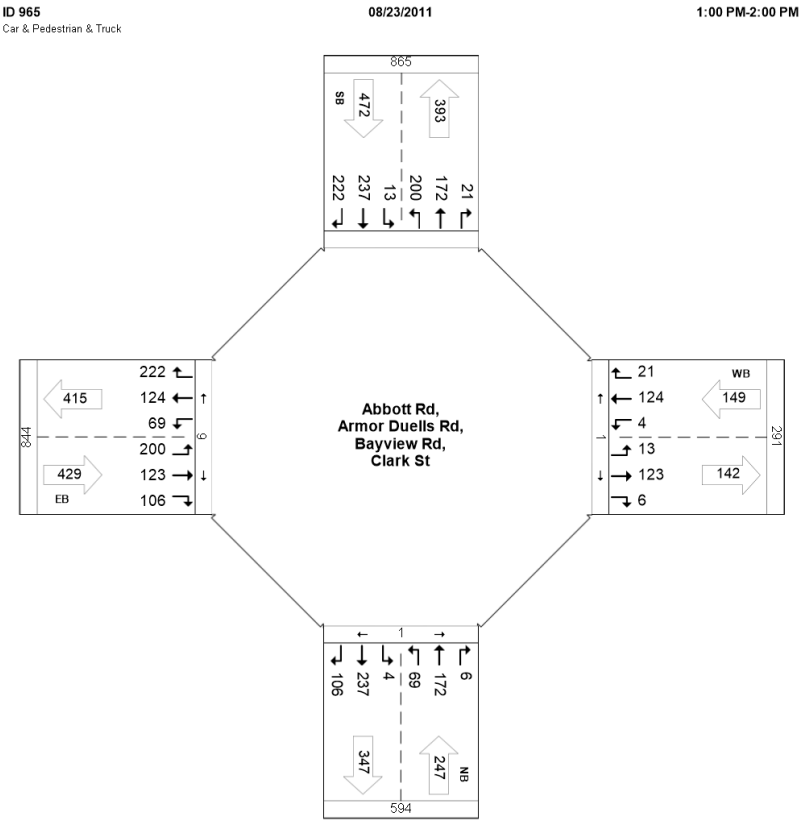
	NB					EB					SB					WB				
Start Time	**Left**	**Thru**	**Right**	**Ped***	**Total**	**Left**	**Thru**	**Right**	**Ped***	**Total**	**Left**	**Thru**	**Right**	**Ped***	**Total**	**Left**	**Thru**	**Right**	**Ped***	**Total**
7:30 AM	36	53	1	0	**90**	40	26	9	0	**75**	1	23	96	0	**120**	1	95	3	0	**99**
7:45 AM	36	51	0	0	**87**	56	25	21	0	**102**	3	22	98	0	**123**	0	101	4	0	**105**
8:00 AM	38	61	0	0	**99**	33	27	20	0	**80**	4	30	68	0	**102**	0	71	2	1	**73**
8:15 AM	37	50	0	0	**87**	49	18	21	0	**88**	5	30	67	0	**102**	1	79	2	0	**82**
Total	147	215	1	0	**363**	178	96	71	0	**345**	13	105	329	0	**447**	2	346	11	1	**359**
App %	40%	59%	0%			52%	28%	21%			3%	23%	74%			1%	96%	3%		
PHF	0.97	0.88	0.25		**0.92**	0.79	0.89	0.85		**0.85**	0.65	0.88	0.84		**0.91**	0.50	0.86	0.69		**0.85**
HV %	2%	3%			**3%**	4%	5%	4%		**4%**	8%	4%	1%		**2%**	50%	2%	9%		**3%**
Total %	10%	14%	0%		**24%**	12%	6%	5%		**23%**	1%	7%	22%		**30%**	0%	23%	1%		**24%**



Midday Peak Hour (08/23/2011)

☑ Car ☑ Pedestrian ☑ Truck

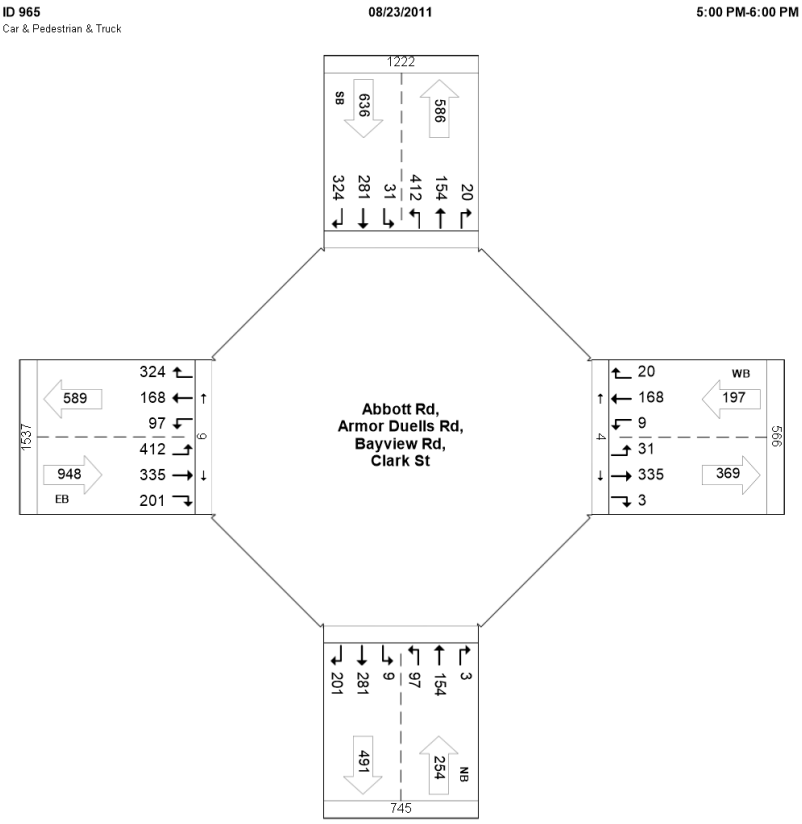
	NB					EB					SB					WB				
Start Time	Left	Thru	Right	Ped*	Total	Left	Thru	Right	Ped*	Total	Left	Thru	Right	Ped*	Total	Left	Thru	Right	Ped*	Total
1:00 PM	12	40	2	1	**54**	44	23	19	0	**86**	8	45	62	0	**115**	0	33	9	1	**42**
1:15 PM	12	43	1	0	**56**	45	28	25	1	**98**	2	59	47	0	**108**	2	27	3	0	**32**
1:30 PM	20	46	3	0	**69**	52	28	30	0	**110**	0	56	49	0	**105**	0	35	7	0	**42**
1:45 PM	25	43	0	0	**68**	59	44	32	5	**135**	3	77	64	0	**144**	2	29	2	0	**33**
Total	69	172	6	1	**247**	200	123	106	6	**429**	13	237	222	0	**472**	4	124	21	1	**149**
App %	28%	70%	2%			47%	29%	25%			3%	50%	47%			3%	83%	14%		
PHF	0.69	0.93	0.50		**0.89**	0.85	0.70	0.83		**0.79**	0.41	0.77	0.87		**0.82**	0.50	0.89	0.58		**0.89**
HV %	1%	1%			**1%**	2%	2%	1%		**2%**	15%	3%	3%		**3%**		5%	10%		**5%**
Total %	5%	13%	0%		**19%**	15%	9%	8%		**33%**	1%	18%	17%		**36%**	0%	10%	2%		**11%**



PM Peak Hour (08/23/2011)

☑ Car ☑ Pedestrian ☑ Truck

	NB					EB					SB					WB				
Start Time	Left	Thru	Right	Ped*	Total	Left	Thru	Right	Ped*	Total	Left	Thru	Right	Ped*	Total	Left	Thru	Right	Ped*	Total
5:00 PM	18	37	0	0	**55**	98	62	47	3	**207**	9	87	72	0	**168**	3	41	6	0	**50**
5:15 PM	28	48	1	0	**77**	103	106	54	1	**263**	8	66	82	0	**156**	1	42	3	0	**46**
5:30 PM	28	38	1	0	**67**	108	89	32	0	**229**	8	56	84	0	**148**	1	47	4	0	**52**
5:45 PM	23	31	1	0	**55**	103	78	68	2	**249**	6	72	86	0	**164**	4	38	7	4	**49**
Total	97	154	3	0	**254**	412	335	201	6	**948**	31	281	324	0	**636**	9	168	20	4	**197**
App %	38%	61%	1%			43%	35%	21%			5%	44%	51%			5%	85%	10%		
PHF	0.87	0.80	0.75		**0.82**	0.95	0.79	0.74		**0.90**	0.86	0.81	0.94		**0.95**	0.56	0.89	0.71		**0.95**
HV %	4%	1%			**2%**	1%	2%	0%		**1%**		1%	1%		**1%**		4%			**4%**
Total %	5%	8%	0%		**12%**	20%	16%	10%		**47%**	2%	14%	16%		**31%**	0%	8%	1%		**10%**



AllDay (08/23/2011)

☑ Car ☑ Pedestrian ☑ Truck

	NB					EB					SB					WB				
Start Time	Left	Thru	Right	Ped*	Total	Left	Thru	Right	Ped*	Total	Left	Thru	Right	Ped*	Total	Left	Thru	Right	Ped*	Total
7:00 AM	32	29	0	0	**61**	28	14	12	0	**54**	0	12	57	0	**69**	0	72	3	0	**75**
7:15 AM	38	37	1	0	**76**	33	20	16	0	**69**	1	20	86	1	**107**	0	89	4	0	**93**
7:30 AM	36	53	1	0	**90**	40	26	9	0	**75**	1	23	96	0	**120**	1	95	3	0	**99**
7:45 AM	36	51	0	0	**87**	56	25	21	0	**102**	3	22	98	0	**123**	0	101	4	0	**105**
8:00 AM	38	61	0	0	**99**	33	27	20	0	**80**	4	30	68	0	**102**	0	71	2	1	**73**
8:15 AM	37	50	0	0	**87**	49	18	21	0	**88**	5	30	67	0	**102**	1	79	2	0	**82**
8:30 AM	39	58	2	0	**99**	54	20	9	1	**83**	3	26	78	0	**107**	0	75	5	0	**80**
8:45 AM	21	57	0	0	**78**	37	20	21	0	**78**	4	29	76	0	**109**	1	65	7	1	**73**
9:00 AM	22	33	0	0	**55**	36	16	7	2	**59**	2	28	40	0	**70**	1	55	4	0	**60**
9:15 AM	26	30	2	0	**58**	32	21	25	0	**78**	0	18	49	0	**67**	0	44	5	0	**49**
9:30 AM	22	24	3	0	**49**	35	25	14	0	**74**	2	20	46	0	**68**	2	34	2	0	**38**
9:45 AM	17	33	2	0	**52**	43	16	9	0	**68**	4	40	44	0	**88**	0	28	1	2	**29**
12:00 PM	21	39	1	0	**61**	51	30	14	0	**95**	5	53	51	0	**109**	0	29	4	0	**33**
12:15 PM	19	30	0	0	**49**	57	32	29	2	**118**	8	61	51	1	**120**	0	33	4	1	**37**
12:30 PM	25	46	2	0	**73**	43	37	28	0	**108**	4	42	43	0	**89**	0	35	1	1	**36**
12:45 PM	34	38	0	0	**72**	48	30	14	0	**92**	6	49	64	1	**119**	0	26	9	1	**35**
1:00 PM	12	40	2	1	**54**	44	23	19	0	**86**	8	45	62	0	**115**	0	33	9	1	**42**
1:15 PM	12	43	1	0	**56**	45	28	25	1	**98**	2	59	47	0	**108**	2	27	3	0	**32**
1:30 PM	20	46	3	0	**69**	52	28	30	0	**110**	0	56	49	0	**105**	0	35	7	0	**42**
1:45 PM	25	43	0	0	**68**	59	44	32	5	**135**	3	77	64	0	**144**	2	29	2	0	**33**
3:00 PM	29	46	0	0	**75**	60	48	25	3	**133**	3	51	65	0	**119**	1	35	6	2	**42**
3:15 PM	33	51	1	0	**85**	73	61	29	0	**163**	10	49	59	0	**118**	0	33	6	0	**39**
3:30 PM	37	46	1	0	**84**	73	78	31	2	**182**	10	51	68	0	**129**	1	42	7	0	**50**
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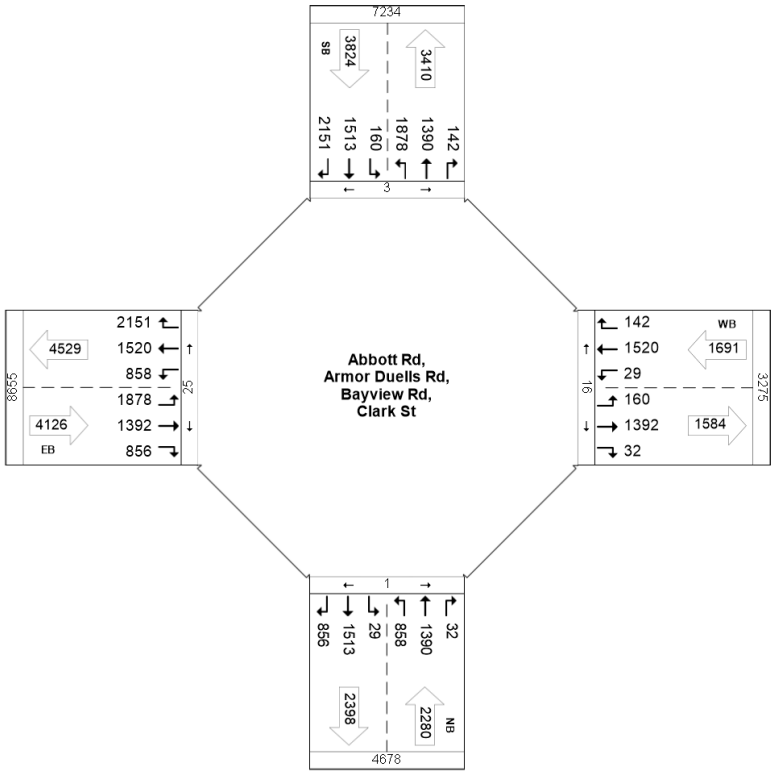
4:00 PM	25	58	2	0	**85**	81	75	30	0	**186**	13	57	82	0	**152**	0	27	2	0	**29**
4:15 PM	28	42	0	0	**70**	88	86	54	2	**228**	12	76	78	0	**166**	5	30	4	1	**39**
4:30 PM	32	51	4	0	**87**	74	70	34	0	**178**	1	79	80	0	**160**	2	44	7	1	**53**
4:45 PM	20	59	0	0	**79**	71	81	44	1	**196**	8	67	78	0	**153**	1	45	5	0	**51**
5:00 PM	18	37	0	0	**55**	98	62	47	3	**207**	9	87	72	0	**168**	3	41	6	0	**50**
5:15 PM	28	48	1	0	**77**	103	106	54	1	**263**	8	66	82	0	**156**	1	42	3	0	**46**
5:30 PM	28	38	1	0	**67**	108	89	32	0	**229**	8	56	84	0	**148**	1	47	4	0	**52**
5:45 PM	23	31	1	0	**55**	103	78	68	2	**249**	6	72	86	0	**164**	4	38	7	4	**49**
Total	858	1,390	32	1	**2,280**	1,878	1,392	856	25	**4,126**	160	1,513	2,151	3	**3,824**	29	1,520	142	16	**1,691**
App %	38%	61%	1%			46%	34%	21%			4%	40%	56%			2%	90%	8%		
PHF	0.69	0.71	0.25		**0.72**	0.54	0.41	0.39		**0.49**	0.38	0.54	0.69		**0.71**	0.18	0.47	0.49		**0.50**
HV %	2%	3%	6%		**2%**	2%	4%	2%		**3%**	9%	3%	2%		**3%**	7%	3%	5%		**3%**
Total %	7%	12%	0%		**19%**	16%	12%	7%		**35%**	1%	13%	18%		**32%**	0%	13%	1%		**14%**

ID 965: Total Count **08/23/2011** **7:00 AM-10:00 AM,12:00 PM-2:00 PM,3:00 PM-6:00 PM**
Car & Pedestrian & Truck



Appendix C
Model Complete Streets Policy

Model Complete Streets Policy

Draft Model Ordinance

The National Complete Streets Coalition promotes a comprehensive policy that addresses ten main elements for communities to adopt. These elements include an identified vision, specific direction and commitment, interpret clearly the community's desire, and establish flexibility in planning and implementation to ensure real results through good process. Provided is a description of each section and sample language for consideration.

A strong **vision** can inspire a community to follow through on its policy. Every community has its own set of challenges and desires, which has encouraged them to develop Complete Streets as an effective policy to combat them. At its core, complete streets identifies that all users upon the roadways should be safely accommodated into the planning, design, construction and operation of the transportation system.

- *Whereas; Establish (your community) as a safe and accessible community by improving bicycle and pedestrian friendliness through consistent public realm design standards to a revitalized mixed-use downtown district.*

Clarity in the **intent** of the policy makes it easy for those who are tasked with its implementation and follow through. All involved understands this new goal and can determine what changes in the current process need to occur.

- *Whereas; The (your community) shall plan for, design, construct, operate and maintain appropriate facilities for all transportation users in all new construction, retrofit and reconstruction projects.*

Complete Street policies come with an understanding that **all users and modes** shall be accommodated upon the roadway. This recognizes that our streets are for more then moving vehicles through them. Streets should also be places for those who travel by foot and bicycle for they too are deserving of safe facilities to travel upon.

- *Whereas; streets that integrate multiple transportation choices for pedestrians, bicyclists, and transit, with special consideration for children, the elderly and people with disabilities, contribute to the public life of a community, sustainable economic development and efficient movement of people and goods.*

The complete street policy should apply to all street **projects and phases**. Whether it is new construction, reconstruction, maintenance or operations all transportation improvements should be viewed as an opportunity to create safer, more accessible streets for all users.

- *Whereas; the (your community) shall, to the maximum extent practical, scope, plan, design, construct, operate and maintain all streets to provide a comprehensive and integrated network of facilities for all users of all abilities.*

There are some **exceptions** that should be in place to ensure the policy is not too onerous. However, a process to handle exceptions is needed and should not weaken the overall policy. The Federal Highway Administrations guidance on accommodating bicycle and pedestrian travel identifies when accommodations may not be necessary on corridors where specific users are prohibited, such as interstate freeways or pedestrian malls; the cost of accommodation is excessively disproportioned to the need or probable use; there is a documented absence of current or future need.

- *Whereas; Any exception to applying this Complete Streets Policy to a specific roadway project must be approved by (the Village Trustees) with documentation of the reason for the exception. Exceptions may be made when the project involves a roadway on which non-motorized use is prohibited by law. In this case, an effort shall be made to accommodate pedestrians and bicyclists elsewhere.*

Streets must be organized in an integrated **network**. Residents have many potential destinations in their daily travel. A complete street provides an interconnected network that meets this demand.

- *Whereas; This policy will create a comprehensive, integrated, connected transportation network for (your community) that balances access, mobility, health and safety needs for all residents. Planning, funding, designing, constructing, managing and maintaining a complete multi-modal network, ensures this.*

Implementing a complete street network can become difficult with multiple agencies having **jurisdiction** over the planning, design and construction of different roads. Within your community, the state and county may also have jurisdiction over some of the roadways. Additionally, new developments may be built in town and new roadways established by private developers.

- *Whereas; It is the intent of this policy to foster partnerships with the state, county, school district, citizens, businesses, interest groups and neighborhoods to implement complete streets.*

Communities should **design** their streets using the best and latest design standards available.

- *Whereas; The (your community) shall adapt, develop and adopt departmental policies, design criteria, standards and guidelines based upon recognized best practices in street design, construction and operations including but not limited to the latest editions of American Association of State Highway Transportation Officials (AASHTO) A Policy on Geometric Design of Highways and Streets; AASHTO Guide for Planning, Designing, and Operating Pedestrian Facilities; AASHTO Guide for the Development of Bicycle Facilities; Institute of Transportation Engineers (ITE) Designing Walkable Urban Thoroughfares: A Context Sensitive Approach; National Association of City Transportation Officials (NACTO) Urban Bikeway Design Guide; U.S. Access Board Public Right-of-Way Accessibility Guidelines; Highway Capacity Manual and Highway Safety Manual.*

All communities are different and it is important that each maintain their character and sense of place when designing complete streets. A **Context sensitive** approach does this by adapting roads to fit the character of the surrounding neighborhood.

- *Whereas; the implementation of this policy shall reflect the context and character of the surrounding built and natural environments while enhancing the appearance of such. In doing so, the (your community) shall consider methods of providing development flexibility within safe design parameters such as context-sensitive design solutions and shall attempt to employ all solutions consistent with and sensitive to the context of the project.*

Performance Measures help communities measure their success. The evaluation of complete streets projects can help identify this success by determining improvements in safety, economic development and changes in mode share. These can include the total number of bike lanes added, increase in building permits issued to the increase in activity levels of residents because they are now walking or biking more often.

- *Whereas; Complete Streets should be continuously evaluated for success and opportunities for improvement sought. This policy encourages the regular evaluation and reporting of implementing complete streets through the following performance measures:*
  - *Increase in the share of bicycles, pedestrians and transit users;*
  - *Crash data;*
  - *Use of new projects by mode;*
  - *Compliments and complaints;*
  - *Linear feet of pedestrian accommodations built;*
  - *Number of ADA accommodations built;*
  - *Miles of bike lanes/trails built or striped;*
  - *Number of transit accessibility accommodations built;*
  - *Number of street trees planted;*
  - *Number of building permits issued along new complete street;*
  - *Number of exemptions from this policy.*

Once a policy is passed, the work is not done. There are a number of steps that a community can take to ensure the **implementation** of complete streets. There are five key steps to follow in order to be successful, these include:

1. Restructure or revise related procedures, plans, regulations and other processes to accommodate all users.
2. Develop new design policies and guides or revise existing ones to reflect current best practices in transportation design.
3. Ensure that staff responsible for implementing the policy, as well as community leaders and the general public has opportunities to attend workshops or other training opportunities so that everyone understands how to implement the policy effectively.
4. Identify ways to evaluate and measure the performance of your new complete streets by collecting data and sharing with the general public how well the streets are serving them.

- *Whereas; The (your community) shall implement the following steps to ensure successful implementation of complete streets:*
  - *Advisory Board: the (your community) will establish an interdepartmental advisory board to oversee the implementation of this policy. The committee will included members of the village (board members, planning board, school board, highway department), county (planning department and highway department), the NYS Department of Transportation, the police department as well as representatives from bicycling, pedestrian, disabled, youth and elderly communities or any other organizations as deemed relevant.*

This committee will meet quarterly and provide a written report to the (your community's elected officials) evaluating progress and advising on implementation.

- *Inventory: The (your community) will maintain a comprehensive inventory of the pedestrian and bicycle infrastructure and will prioritize projects to eliminate gaps in the sidewalk and bikeway networks.*
- *Capital Improvement and Maintenance Project Prioritization: The (your community) will reevaluate capital improvement and maintenance project prioritization annually to encourage implementation of pedestrian and bicycle improvements.*
- *Revisions to Existing Plans and Policies: The (your community) will incorporate complete street principles into the comprehensive plan, zoning code and other plans and manual, rules, regulations and programs.*
- *Other Plans: The (your community) will prepare, implement and maintain a Bicycle and Pedestrian Transportation Plan, a Safe Routes to School Plan, an Americans with Disabilities Act Transition Plan, and a Street Tree and Landscape Plan.*
- *Storm Water Management: The (your community) will prepare and implement a plan to transition to sustainable storm water management techniques along our streets.*
- *Staff Training: The (your community) will train all pertinent staff on the content of the complete streets principles and best practices for implementing the policy.*
- *Coordination: The (your community) will utilize inter-departmental project coordination to promote the most responsible and efficient use of fiscal resources for activities that occur within the public right of way.*
- *Street Manual: The (your community) will create and adopt a Complete Streets Design Manual to support implementation of this policy.*
- *Funding: The (your community) will actively seek sources of appropriate funding to implement complete streets.*

Appendix D
FHWA Turbo Roundabout Informational Primer

Informational Primer

Turbo Roundabouts

FHWA Safety Program

Cover images by Arcadis
Turbo Roundabouts, Netherlands

U.S. Department of Transportation
Federal Highway Administration

Safe Roads for a Safer Future
Investment in roadway safety saves lives

http://safety.fhwa.dot.gov

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List of Abbreviations

CG	center point of turbo block
FHWA	Federal Highway Administration
HCM	Highway Capacity Manual
LED	Light Emitting Diode
MUTCD	Manual on Uniform Traffic Control Devices
NCHRP	National Cooperative Highway Research Program
OS/OW	oversize/overweight
Pcu/h	passenger cars per hour

Introduction

Implementing modern roundabouts saves lives and reduces serious injuries resulting from intersection and intersection-related crashes. As planned points of conflict, crashes attributed in some way to intersections contribute significantly to traffic fatality and injury numbers in the United States. Approximately half of all crashes and half of fatal and serious injury crashes occur at or near intersections. In the single year of 2018, 8,858 people were killed in intersection and intersection-related crashes.(1) In stark contrast, there were a total of 46 fatalities at roundabouts built in the United States over the nine-year period spanning 2005 to 2013, a time period in which the total number of roundabouts in the United States grew from a few hundred to a few thousand.(2) At the individual intersection level, converting a traditional at-grade signalized intersection to a modern roundabout is expected to reduce the number of injury crashes by 78 percent.(3) Converting a traditional at-grade minor-road stop control intersection to a modern roundabout is expected to reduce the number of injury crashes by 82 percent.(3)

Though most roundabouts in the United States are single-lane, multilane roundabouts have become more common. There is a tendency for some 2 x 2 multilane roundabouts[1] to experience higher than expected frequencies of sideswipe – same direction crashes.(4) Given that modern roundabout geometry reduces both the speed and angle of collisions, the sideswipe – same direction crashes in 2 x 2 multilane roundabouts tend to be low severity (i.e., crashes in which people are not injured, but where vehicles may be damaged).(4) Some other countries have implemented a modified version of a multilane roundabout, the turbo roundabout, with positive results. Characteristics of the turbo roundabout could potentially be effective at influencing driver behavior and reducing lane change conflicts in a way that would address the crash types occurring in 2 x 2 multilane roundabouts. First designed and implemented in the Netherlands in the 1990s, the turbo roundabout[2] (shown in figure 1) has the same general operating characteristics as modern roundabouts but utilizes notably different geometrics and applications of traffic control devices.(5) This informational primer seeks to describe the characteristics of turbo roundabouts, highlighting the design and traffic control features, operational capabilities, and potential safety benefits of these roundabout alternatives.

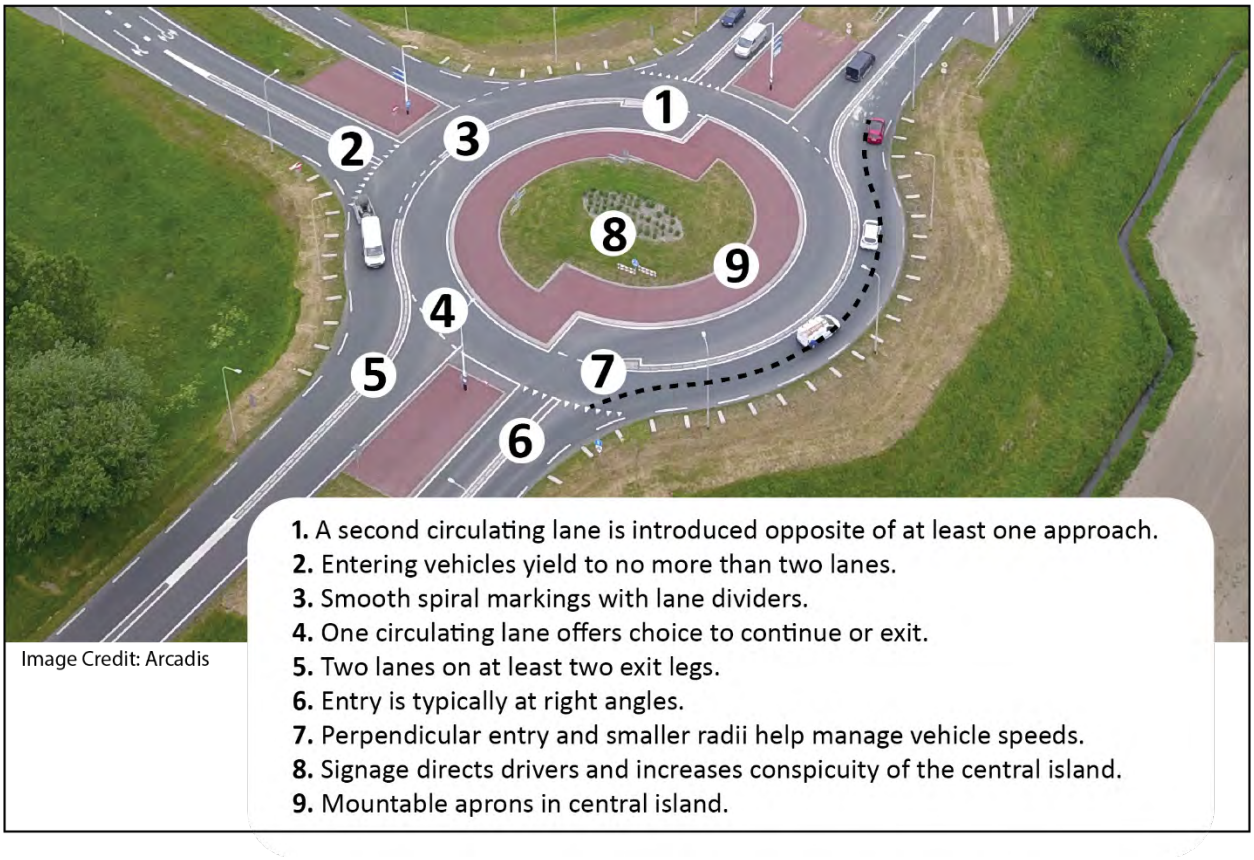
[1] A 2 x 2 roundabout is characterized by two entry lanes approaching two circulating lanes.
[2] The turbo roundabout was named by its inventor in the Netherlands in 1996. The descriptor “turbo” is meant to symbolize the geometric shape. It is not meant to convey faster vehicle speeds. In fact, its geometry was in part developed to reduce vehicle speeds below what might be observed during lower-volume hours of more traditional concentric multilane roundabouts.(6)

Figure 1. Photograph. Aerial view of turbo roundabout in Delft.[7]

Section 1: Characteristics of a Turbo Roundabout

Based on a review of international experience[8], features (illustrated in figure 2) that characterize turbo roundabouts include the following:[6]

- A second circulatory lane is inserted opposite of at least one entry lane.
- Traffic approaching the roundabout on at least one leg must yield to traffic in two, and no more than two, circulatory lanes in the roundabout.
- Smooth flow is encouraged by a spiral alignment.
- Lane dividers discourage lane changing within the roundabout. Drivers, therefore, select the proper lane prior to entering the roundabout. Internationally, options for lane separation have included raised, mountable lane dividers; flush lane dividers; or solid pavement markings.
- Each segment of the roundabout includes one circulatory lane from which drivers can choose whether to exit or continue around the roundabout.
- At least two exit legs are two-lane.
- The diameter of the roundabout is kept small to encourage lower speeds through the roundabout.
- Approach legs and entry are typically at right angles to the roundabout.
- Roundabout directional arrow signs direct drivers and increase conspicuity of the central island.
- Mountable aprons offer sufficient maneuvering space for longer vehicles.



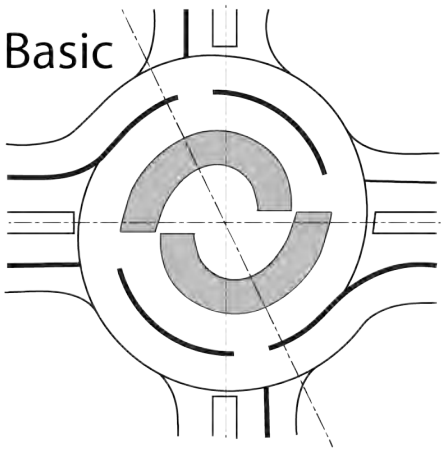
Source: FHWA.

Figure 2. Graphic. Turbo roundabout features. Image based on Fortuijn, 2009.[6]

There are different types of turbo roundabouts, including the basic, egg, knee, spiral, and rotor turbo roundabouts.[6] These options differ with respect to central island design, number of circulating lanes, and number of approach lanes, as described below:

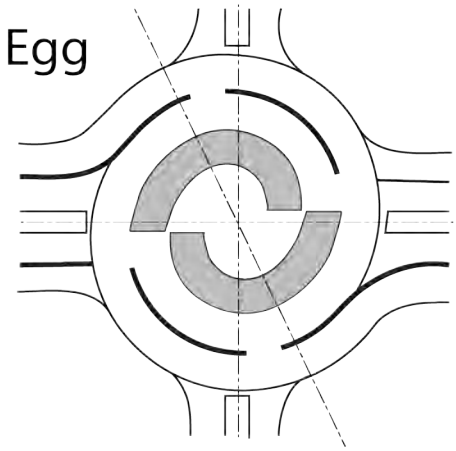
- Basic – inside lane added on major approaches, two lanes on each approach (see figure 3).
- Egg – similar to a basic turbo roundabout, but with only one approach lane on minor approaches (see figure 4).
- Knee – the inside lane is only added on one approach, two lanes on each approach (see figure 5).
- Spiral – three circulatory lanes, inside lane only added on two approaches, two approaches with three lanes and two approaches with two lanes (see figure 6).
- Rotor – three circulatory lanes, inside lane added on each approach, three lanes on each approach (see figure 7).

The variations in turbo roundabout designs differ in terms of total capacity available, so the type selected may be dictated by intersection demand. The capacity values provided in figure 3 through figure 7 represent capacity in the Netherlands and are not necessarily reflective of expected capacity values elsewhere.



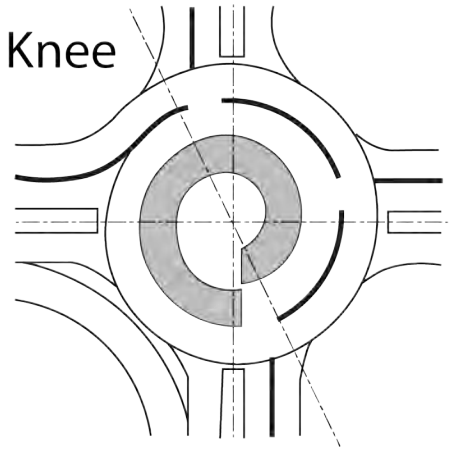
Source: FHWA.

Figure 3. Graphic. Basic turbo roundabout. Image based on Dzambas et al., 2017 with capacity value from Fortuijn, 2009.[6,9]



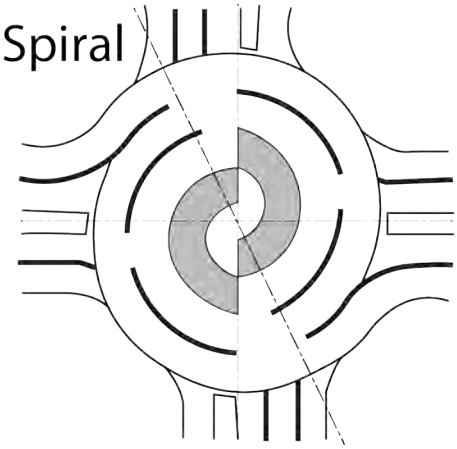
Source: FHWA.

Figure 4. Graphic. Egg turbo roundabout. Image based on Dzambas et al., 2017 with capacity value from Fortuijn, 2009.[6,9]



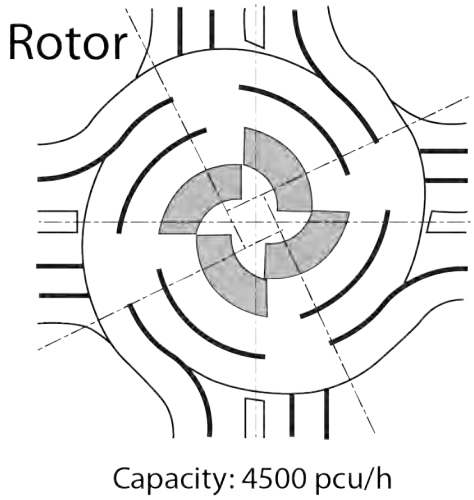
Source: FHWA.

Figure 5. Graphic. Knee turbo roundabout. Image based on Dzambas et al., 2017 with capacity value from Fortuijn, 2009.[6,9]



Source: FHWA.

Figure 6. Graphic. Spiral turbo roundabout. Image based on Dzambas et al., 2017 with capacity value from Fortuijn, 2009.[6,9]

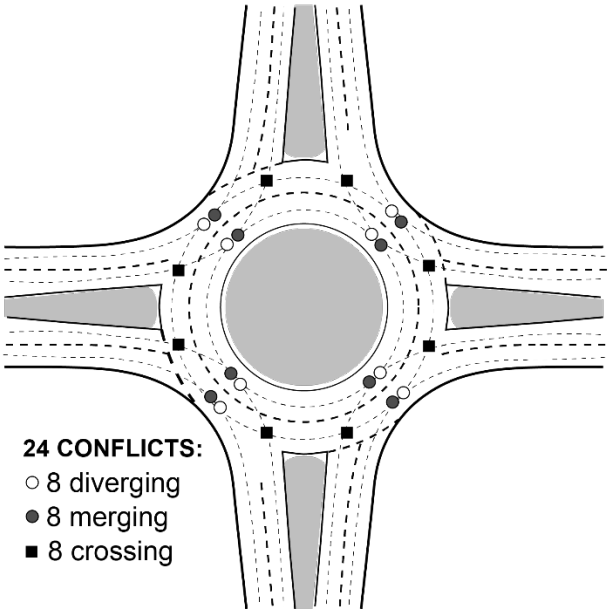


Source: FHWA.

Figure 7. Graphic. Rotor turbo roundabout. Image based on Dzambas et al., 2017 with capacity value from Fortuijn, 2009.[6,9]

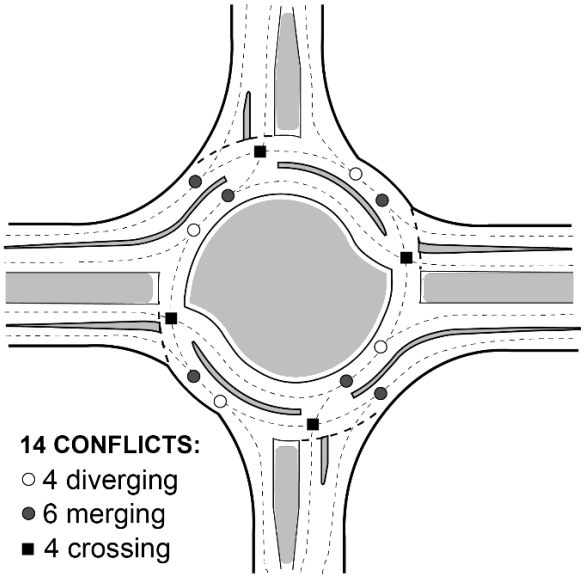
Section 2: Potential Benefits of Turbo Roundabouts

An international crash-based safety evaluation suggests conversion of an intersection from yield-control, signalized, or old-style rotary to a turbo roundabout is associated with a 76-percent reduction in injury crash frequency.[6] In addition, the geometric characteristics of the turbo roundabout result in operational outcomes that should help address lane selection, lane changing, and entering and exiting behaviors that can lead to the lower severity, multiple-vehicle crashes in 2 x 2 multilane roundabouts. The spiral road geometry and lane dividers of turbo roundabouts require drivers to choose the proper lane prior to entering the roundabout in order to leave the roundabout in the desired direction. Figure 8 and figure 9 show that the turbo roundabout eliminates some of the conflicts associated with the common crash types in modern 2 x 2 multilane roundabouts. At the two-lane exits of a turbo roundabout, drivers in the inside lane execute a "turn" to exit the roundabout, as in concentric roundabouts.[10] However, the turbo roundabout eliminates the requirement in concentric multilane roundabouts of exiting drivers in the inside lane having to first cross the outside lane. This is done by physically forcing drivers in the outside lane to exit.[6] The geometry of turbo roundabouts also helps to manage the speeds of vehicles entering, navigating, and exiting the roundabout. Operationally, the capacity of a turbo roundabout is expected to be similar to other modern multilane roundabouts.



Source: FHWA.

Figure 8. Graphic. Conflict point frequency for modern multilane roundabout. Image based on Vasconcelos et al., 2014.[11]



Source: FHWA.

Figure 9. Graphic. Conflict point frequency for turbo roundabout. Image based on Vasconcelos et al., 2014.[11]

Section 3: User Considerations

It is important to consider how various user groups are accommodated at turbo roundabouts given the intersection type's key features. Five primary user groups – motorists, pedestrians, bicyclists, motorcyclists, and freight/large vehicles – are discussed in this section.

3.1 Motorists

Turbo roundabouts rely on more direct entry geometry and enhanced delineation of lanes that can make it easier for motorists to successfully navigate them. Signage and supplemental pavement markings are provided in advance on approaches so drivers are given enough time to select their desired lane. When locating signs, designers should consider decision and stopping sight distance as well as potential queue lengths to provide drivers with adequate advance notice. At the entrance to the roundabout, drivers are required to identify acceptable gaps in no more than two conflicting lanes. A roundabout directional arrow sign placed directly in the drivers' field of view directs drivers to enter the circulatory roadway in the appropriate direction. Internationally, these signs are also recommended to increase the conspicuity of the central island and communicate to drivers the need to slow and turn into the roundabout.[6] The Roundabouts Informational Guide also recommends using landscaping to increase central island conspicuity.[12] Finally, the spiral geometry and enhanced delineation reinforce the appropriate maneuvers from each lane inside the roundabout.

One notable difference between turbo roundabouts and other modern roundabouts is the ability to complete U-turns. Modern roundabouts allow vehicles from all approaches to complete U-turn maneuvers. The lane arrangement of a turbo roundabout prohibits vehicles that enter on some approaches from completing U-turns. The approaches and lanes from which vehicles can and cannot perform U-turns vary based on the type of turbo roundabout. For instance, vehicles entering from the inside lane of the left and right approaches (the major road approaches) in figure 9 (a "Basic" turbo roundabout) can complete a U-turn; while vehicles approaching from the top and bottom approaches (the minor road approaches) cannot. As a result, it is important for analysts to consider the frequency of U-turn maneuvers at an intersection when evaluating turbo roundabouts as a potential alternative.

3.2 Pedestrians

The navigation through a turbo roundabout by a pedestrian does not differ from single-lane and multilane roundabouts. As a result, designers can follow guidance for pedestrian facilities at roundabouts proposed in the Roundabouts Informational Guide and National Cooperative Highway Research Program (NCHRP) Report 834:[12, 13]

- Keep sidewalks along the perimeter of the roundabout, separated from the edge of the circulatory roadway with a landscaped strip or buffer.
- Where crosswalks are provided, locate them for pedestrian convenience and safety, where drivers can be expected to yield the right-of-way, and where the crossing will be less likely to be blocked by queued vehicles.
- Provide a splitter island sufficiently wide to accommodate a crossing that is accessible to pedestrians with disabilities as well as wide enough for comfortable queueing.

3.3 Bicyclists

The decision of whether to provide separated bicycle facilities at turbo roundabouts depends on context, considering factors such as bicycle volume, the presence of existing bicycle facilities, motor vehicle volume, complexity of the roundabout, adjacent infrastructure and land use, and right-of-way availability. Bicycle features at turbo roundabouts are not expected to differ from traditional roundabouts, and features designers can consider to better accommodate bicyclists include:[12]

- Keeping radii small to reduce vehicle speeds, which can make bicyclists more comfortable if they ride in the roundabout.
- Terminating bicycle lanes before the edge of the circulatory roadway and crosswalks with enough length remaining for bicyclists to merge into traffic.
- Introducing bicycle lanes on exit legs downstream of crosswalks.
- If bicyclists are required to utilize the sidewalk, designing sidewalks to meet shared use path width requirements.
- If the intent is for bicyclists to cross at-grade on approaches, whether on a designated crossing or on a pedestrian crosswalk, a pavement-level cut-through of the splitter island can be provided.[14] The cut-through can be designed to include a chicane to encourage a two-stage crossing for bicyclists and provide more time for approaching drivers to identify crossing bicyclists. This is a commonly used treatment in the Netherlands.

3.4 Motorcyclists

While fatal crashes at roundabouts are much less likely than at traditional three- and four-leg intersections, motorcyclists are overrepresented in those fatal crashes. Motorcyclists were involved in 21 of the 46 fatal crashes that occurred at roundabouts in the United States between 2005 and 2013.[15] Roadway features that can have a significant impact on motorcycle safety performance at roundabouts include the presence and location of raised lane dividers and curbing, surface friction, pavement markings, drainage, sight distance (especially rider conspicuity), radii, the roadside environment, and surface conditions. Specific concerns for motorcyclists in turbo roundabouts are the truck apron and lane divider options that are raised. Sloped curbing with minimal vertical reveal can provide a more forgiving environment to motorcycles compared to vertical or rolled curbing. Designers can also provide supplemental signage alerting motorcyclists to these elements of turbo roundabouts. Potential alternatives to the raised lane dividers include striping and colorized and/or textured pavement, which are discussed in Section 7.1.4 Lane Divider.

3.5 Freight/Large Vehicles

The design of some turbo roundabout features is influenced by the physical dimensions and turning characteristics of the larger vehicles that will use the intersection. The lane widths of turbo roundabouts are determined with consideration of the design vehicle, typically the largest vehicle anticipated to regularly navigate the intersection. European turbo roundabout design guidance includes discussions on selecting lane widths so that design vehicles do not track into adjacent lanes.[9] However, the dimensions of European design vehicles are often smaller than design vehicle dimensions in the United States. Designing turbo roundabouts in the United States to prevent, for example, a WB-67 from tracking into an adjacent lane it not feasible within

a reasonably sized roundabout. However, this characteristic is not limited solely to turbo roundabouts. The Roundabouts Informational Guide states that "multilane roundabouts are designed either to allow large vehicles to track across more than one lane while entering, circulating, and exiting or to stay within their lane" [Pages 2-19].(12) This concept has also been adopted by some State departments of transportation as well. The Washington State Department of Transportation Design Manual informs designers to "assume a truck's travel path will [straddle] parts of two adjacent lanes" in multilane roundabouts [Pages 1320-18].(16) The South Carolina Department of Transportation allows large vehicles to "track across the whole width of the circulatory roadway to negotiate the roundabout" [Pages 9.7-11].(17) Given this allowance for multilane roundabouts, it is reasonable for agencies to allow design vehicles to track across multiple lanes within turbo roundabouts. In these situations, a raised lane divider is unlikely to be a sustainable option due to repeated strikes by the larger vehicles.

Starting the lane divider of a turbo roundabout as near as possible to the vehicle entry point is necessary to prevent vehicles circulating in the outside lane from changing to the inside lane at these locations. However, large vehicles entering the inside lane from an approach need a wider opening to account for their larger swept paths. Where a raised lane divider option is used, a traversable, demarcating feature can be provided at the origin of the raised divider to ease the entrance of larger vehicles.

A central truck apron is provided in turbo roundabouts to help accommodate larger vehicles that need to navigate the intersection. Aprons can also be provided on the perimeter of the roundabout to provide additional turning space for large vehicles. Finally, agencies can work with the State Oversize/Overweight (OS/OW) Load Permit Office to determine if the intersection is commonly used by OS/OW vehicles, and if so, obtain the applicable length and width requirements for those vehicles to develop strategies for accommodation.

Section 4: Location Considerations

Modern roundabouts can be among the safest feasible intersection alternatives in a wide variety of settings and contexts – low-speed urban, high-speed rural, at isolated intersections, as corridor treatments, and even at interchange ramp terminal intersections. Relevant site characteristics that can influence whether a roundabout is a feasible alternative include right-of-way limitations, intersection skew, winter maintenance needs, adjacent traffic generators or sites that require pre-emption, and downstream bottlenecks. Additional detail on roundabout applications commonly found to be feasible and advantageous can be found in the Roundabouts Informational Guide[3].(12)

Turbo roundabouts may be considered at any intersection where a roundabout is a potential alternative, particularly where traffic demand indicates the need for a multilane roundabout. Their design provides similar capacity to multilane roundabouts while reducing conflict points,

[3] At the time of publication of this informational primer, the 2nd Edition of the Roundabout Informational Guide was published under NCHRP Report 672. The 3rd Edition is being developed under NCHRP Project 03-130.

discouraging lane changes, and maintaining the speed reduction characteristics of single-lane roundabouts.

Section 5: Safety Analysis Methods and Results

Given the brief history of turbo roundabouts, international safety studies based on an analysis of crash data are limited, and not yet available in the context of a United States driving population. Dutch research analyzed crash data at seven intersections—including signalized, yield-control, and old-style rotary types—that were converted to a turbo roundabout and found a 76-percent reduction in the number of injury crashes.(6) Polish research found that turbo roundabouts with a raised lane divider experience a lower crash frequency than those with paint stripes only. However, the research observed lower severity crash outcomes in both cases. Only 7 percent of crashes on turbo roundabouts without a raised lane divider resulted in an injury, compared to 4 percent of crashes with a raised lane divider.(18) Safety surrogate measures resulting from microscopic traffic simulations or field observations (e.g., time-to-collision, vehicle speeds, vehicle conflicts, incorrect movements, and incorrect paths) have also indicated that turbo roundabouts are likely to experience less frequent and less severe crashes than multilane roundabouts due to the reduction of conflict points within the roundabout and the lower speeds required to navigate the smaller radii[4]. [See references 19, 20, 21, 22, and 23.]

Section 6: Operational Analysis

For a turbo roundabout to be successful, it is important to verify the design can accommodate the projected traffic volumes at the intersection. At modern multilane roundabouts in the United States, the capacity of one entry lane ranges from 300 to 1,100 passenger cars per hour (pc/h), depending on conflicting flow in the circulatory roadway, implying a total approach capacity ranging from approximately 600 to 2,200 pc/h for a two-lane approach.(12, 24) As with modern roundabouts, turbo roundabout capacity is measured at the approach level. Operational performance models for turbo roundabouts have not yet been developed for, or adapted to, the context of a United States driving population. International research suggests basic turbo roundabouts have similar capacities as multilane roundabouts with two entry and two circulating lanes. One such study from the Netherlands estimated a capacity for a basic turbo roundabout design of approximately 3,500 pc/h for all entries combined, assuming conflicting traffic volumes between 1,900 and 2,100 pc/h.(25) However, roundabout capacity in the Netherlands is likely to be higher than in the United States given broader driver familiarity with roundabouts.

Gap-acceptance models that consider critical headway, critical follow-up time, and conflicting traffic appear adequate for estimating turbo roundabout capacity. Research in Poland found the Highway Capacity Manual (HCM) capacity models for roundabouts produced capacity estimates for Polish turbo roundabouts that were comparable to estimates from Polish-specific turbo roundabout capacity models.(26) The roundabout capacity models of the HCM are likely to represent reasonable capacity estimates for turbo roundabout approaches with up to two lanes. As with single and multilane roundabouts, analysts would apply the HCM models to each lane of

[4] The ability to reliably link safety surrogates to crash frequency and severity remains a topic of ongoing research and debate.

each approach, given the specific characteristics of the lane and approach (e.g., number of entry lanes, number of conflicting lanes, conflicting flow).

Section 7: Design Considerations

The geometric design of a turbo roundabout is driven by the desired capacity and the desired characteristics of a design vehicle's horizontal swept path. The projected demand and cross sections on the approach roadways inform the number of lanes/lane arrangement decisions, which dictate the type of turbo roundabout to be built (see Section 1: Characteristics of a Turbo Roundabout). Once the type is selected, a horizontal swept path analysis of the design vehicle informs lane width decisions along with other lane width-related considerations (e.g., right-of-way, performance for all vehicle types and users). The turbo roundabout type and lane widths are combined to construct the turbo block, which guides the geometric design of the circulatory roadway.

7.1 Horizontal Design

7.1.1 Turbo Block

The spiral alignment of a turbo roundabout is generated from the "turbo block," a series of circular arcs with centers located at various points along a reference line known as a "translation axis." The turbo block consists of arcs that represent the inner and outer edges of each lane. The inner radius of the turbo block, which represents the radius of the central island, is selected based on the anticipated size of the turbo roundabout. The shift along the translation axis from the center is the width of the lane represented by the arc. The turbo block and angle of the translation axis differs for each turbo roundabout type. Figure 10 is a sample turbo block for a basic turbo roundabout with the major roadway oriented horizontally.

The turbo block is defined by the characteristics shown in figure 10. First is the center point (CG), which is the intersection of the approach centerlines. Second is the orientation of the translation axis, which is defined in relation to the major road approaches. Assuming the major road is oriented with the x-axis in figure 10, the right side of the translation axis is rotated 57.5 degrees around the center below the x-axis for a four-leg intersection, and the left side of the translation axis is rotated 65 degrees around the center below the x-axis for a three-leg intersection.[9,25] The angle of rotation for the translation axis can be tweaked to provide smooth, spiraled vehicle paths for all vehicle movements. Third are the radii of the circles (TR1, TR2, TR3, and TR4). TR1 defines the radius of the inside edge of the inside roadway. TR2 defines the outside edge of the inside roadway; with the difference between TR2 and TR1 equal to the width of the inside travel lane plus additional width for the edge lines delineating the raised lane divider. TR3 defines the inside edge of the outside roadway. The difference between TR2 and TR3 is the width of the lane divider. TR4 defines the outside edge of the outside roadway.

The fourth key set of dimensions defining the turbo block is the distances between the center points of the arcs. The circles corresponding to the four radii are split along the translation axis, and the resulting arcs are slid along the translation axis in opposing directions by half the distance defined as the *shift.* The shift is the distance between the centers of the arcs. The shift can differ for the TR1 centers and the TR2/3/4 centers if the inside roadway width is different than the outside roadway width. The shift for the TR1 centers ($\Delta\upsilon$ in figure 10) is equal to the

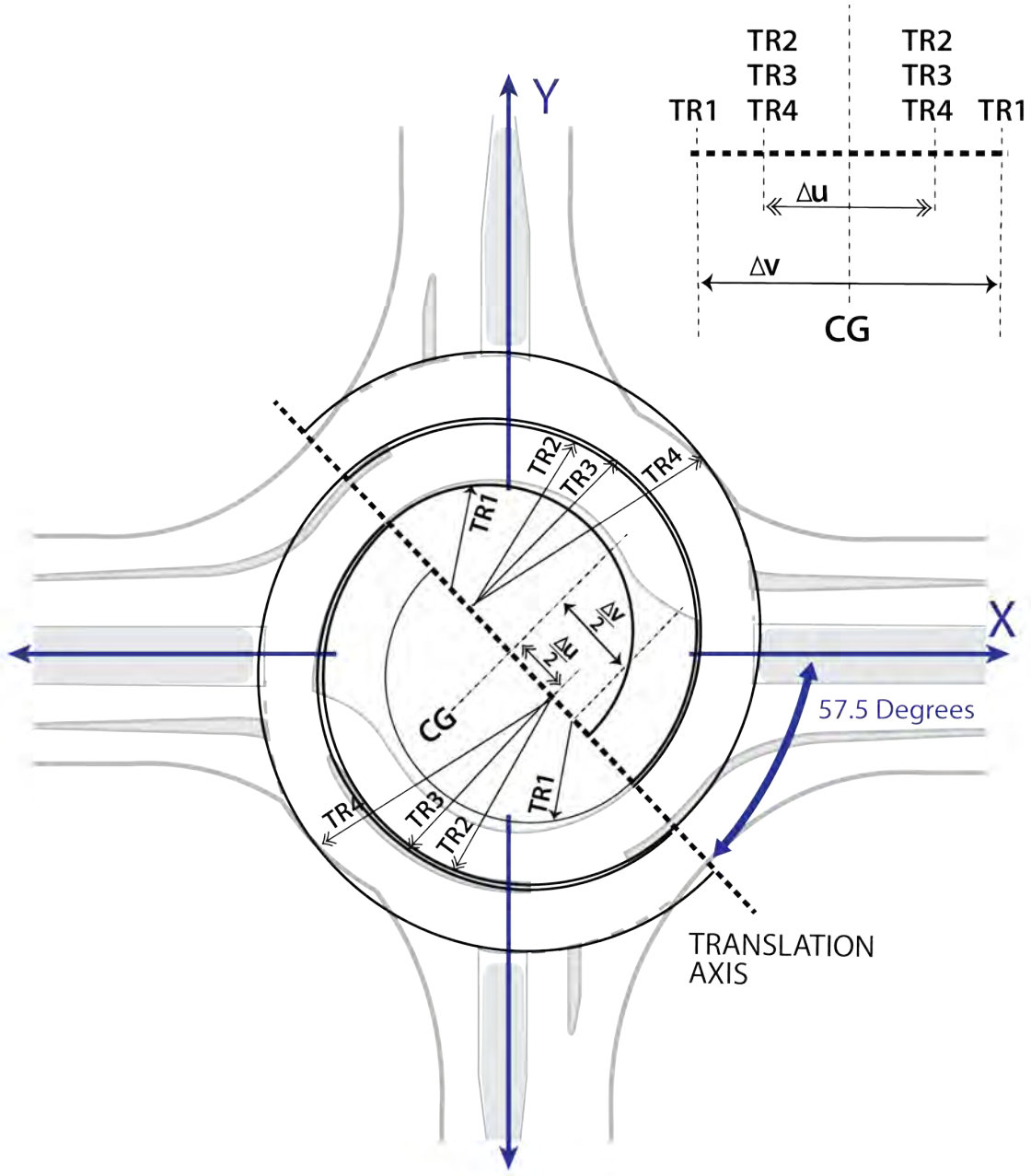
difference between the inside edge of the inside roadway and the inside edge of the outside roadway (also the difference between the values used for TR3 and TR1). The shift for the TR1 centers is achieved by sliding the two arcs defined by TR1 in opposing directions away from CG, each by $\Delta\upsilon/2$. In international practice, $\Delta\upsilon/2$ ranges from between 8.5 and 9.5 feet (for total shifts ranging between 17 and 19 feet), as shown in figure 10. The shift for the TR2/3/4 centers (Δu in figure 10) is the distance between the outside edge of the inside roadway and the outside edge of the outside roadway (also the difference between the values used for TR4 and TR2). The shift for the TR2/3/4 centers is achieved by sliding the arcs defined by TR2/3/4 in opposing directions away from CG by $\Delta u/2$, as shown in figure 10. This value ($\Delta u/2$) typically ranges from between 7.5 and 8.5 feet (for a total shift of 15 to 17 feet). If the inside and outside roadways are the same width, the shift value for all radii are the same ($\Delta\upsilon = \Delta u$).

Internationally, the radii (TR1, TR2, TR3, and TR4) for basic turbo roundabouts have ranges as follows:

- 34 to 66 feet for TR1.
- 52 to 82 feet for TR2.
- 53 to 83 feet for TR3[5].
- 70 to 100 feet for TR4.

With the offset arcs making up the turbo roundabout, the nominal diameter of the turbo roundabout is twice the value TR4 plus the width of the TR2/3/4 shift, Δu. Assuming a shift of 15 feet, the inscribed circle for basic turbo roundabouts ranges from 155 feet to 215 feet.

[5] The one-foot difference between the minimum and maximum TR2 and TR3 values implies an average width of one foot for the lane divider.



Source: FHWA.

Figure 10. Graphic. Sample turbo block. Image based on Overkamp & Van der Wijk, 2009 and Dzambas et al., 2017.[9,25]

7.1.2 Lane and Roadway Width

Determining the width of each lane of a turbo roundabout is informed by a horizontal swept path analysis of the design vehicle. The inside lane is often wider than the outside lane to compensate for the design vehicle maneuvering a smaller radius. Internationally, inside lane

width ranges from between 14 and 16 feet, while outside lane width ranges from between 13 and 14.5 feet. The inner roadway width, defined as the distance from the central island to the lane divider (TR2 minus TR1), including the inside and outside edge line pavement markings ranges from between 16 and 18 feet. The outer roadway width, defined as the distance from the lane divider to the outer edge of the roundabout (TR4 minus TR3), again including the inside and outside edge line pavement markings ranges from between 15 and 16.5 feet.[9, 25]

7.1.3 Central Island

The central island is defined by the innermost radius of the turbo block (TR1) and consists of a traversable portion (mountable apron) and a non-traversable portion. The non-traversable portion is typically used for signage, specifically a roundabout directional arrow sign. There are cutouts in the central island to introduce the inside lane of the turbo roundabout on the applicable approaches. There are two developed methods for design of these cutouts and beginning the inner lane. A curved entry, shown in figure 11, provides a smooth path for approaching vehicles, but may result in a greater chance of circulating vehicles entering the inside lane. A flat entry, shown in figure 12, helps to discourage this movement from circulating vehicles. Designers should check that objects on the central island do not restrict sight distance along the circulatory roadway.

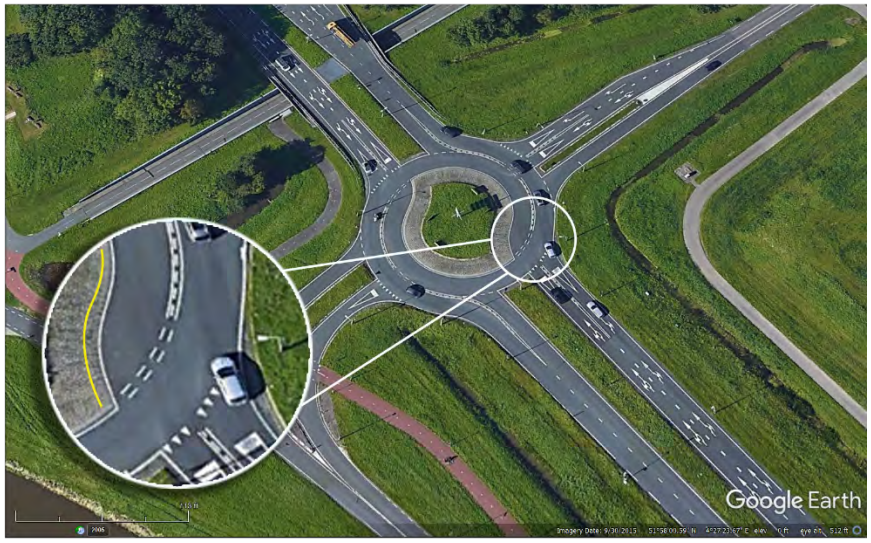


Figure 11. Photograph. Original design used in the Netherlands for introducing the inner lane.[27]

©2019 Google Earth®.

Figure 12. Photograph. Revised design used in the Netherlands for introducing the inner lane.(28)

7.1.4 Lane Divider

One important feature of the turbo roundabout is a lane divider between each circulating lane. In the Netherlands, this lane divider is raised but mountable, designed with little vertical profile and a rather flat slope to provide forgiveness for errant vehicles (as shown in figure 13). Often, the raised lane divider is introduced with a traversable, demarcating feature to allow tracking by large vehicles (see figure 14). Some countries (including Poland, Germany, and Canada) have implemented turbo roundabouts without raised lane dividers, in part due to possible challenges these dividers present to motorcyclists and snow plowing operations.(9) In the United States, a roundabout in Alta, Utah[6] has a raised, mountable lane divider separating lanes for a two-lane portion of the roundabout.

Alternatives to the raised lane divider include striping and colorized or textured pavement, as shown in figure 15 from a turbo roundabout in Canada. While these options do not provide a physical barrier to lane changing, they still communicate this message to the driver both visually, and in the case of textured pavement, through audible and tactile mediums. Other alternatives to consider include:

- Milled rumble strips or rumble stripes, which provide more intense feedback to drivers than textured pavement.
- A double solid white lane, which the Manual on Uniform Traffic Control Devices (MUTCD) describes as a standard approach when crossing the lane lines are prohibited.(29) For one example, two roundabouts in Conway, Arkansas[7] use solid wide white thermoplastic lines to separate its two lanes within the circulatory roadway.
- Raised pavement markers which can provide visual and tactile feedback and be snow-plowable where needed.

[6] Located at Latitude 40.645758 Degrees North, Longitude 111.494956 Degrees West.
[7] Located at Latitude 35.066366 Degrees North, Longitude 92.414523 Degrees West.

© 2020 Arcadis.

Figure 13. Photograph. Raised lane divider in a turbo roundabout in the Netherlands.

©2020 Google Earth®.

Figure 14. Photograph. Example introduction of the raised lane divider.[30]

©2020 Google Earth®.

Figure 15. Photograph. Lane divider for turbo roundabout at Victoria International Airport.[31]

7.1.5 Approach Geometry

Turbo roundabouts are constructed with radial approaches, which have the benefit of reducing changes to the alignment along the approach roadway and maintaining exit curvature that encourages drivers to maintain slower speeds through the exit of the roundabout. Additionally, turbo roundabouts are built with little or no flare or deflection and smaller entry radii. The angle between entering traffic and circulating traffic is therefore larger (closer to a perpendicular entry) for a turbo roundabout than for other modern multilane roundabouts. These approach features differ from modern multilane roundabouts in the United States, which typically include flare to gain some capacity increase and deflection to align entering vehicles "to the right of" the central island in the desired direction of travel. The entry geometry of a turbo roundabout generally does not channelize drivers into the circulatory roadway to the right of the central island and the splitter islands generally do not have enough curvature to block a direct path of approaching vehicles to the central island. This approach geometry is based on the premise that it will be clearer to drivers that they are approaching an intersection that should be negotiated at lower speeds.[6] Potential disadvantages include drivers errantly hitting the central island, making wrong-way left turn maneuvers to enter the roundabout, and making wrong-way exit maneuvers into entrance approach lanes.[12] International literature emphasizes the importance of a roundabout directional arrow sign, placed in the central island in the line of sight of approaching drivers, that directs drivers to turn right and increases the conspicuity of the central island (discussed in Section 7.3). It also emphasizes the need for a forgiving design of the central island and sign in the case that either is struck.

Internationally, turbo roundabout entry radii range from 39 to 50 feet.[9, 25] For comparison, modern multilane roundabouts in the United States are designed with entry radii exceeding 65 feet, and even single-lane roundabouts have entry radii ranging from 50 to 100 feet.[12]

7.2 Sight Distance and Visibility

Adequate stopping and decision sight distance should be provided for all users of the turbo roundabout. Stopping and intersection sight distance should be provided at all approaches. The Roundabouts Informational Guide provides guidelines for evaluating sight distance and visibility at roundabouts.[12]

7.3 Signage and Pavement Markings

There are a few differences in the traffic control devices within the circulatory roadway of turbo roundabouts compared to modern multilane roundabouts. For modern multilane roundabouts, lanes are separated using either a single dashed or solid white line. As discussed in section 7.1.4 Lane Divider, these are replaced with lane dividers in turbo roundabouts. Potential advantages of the lane divider compared to single dashed or solid white lines include less ambiguous and more intuitive messaging to drivers on lane selection, lane keeping, and the appropriate maneuvers from each lane.

Given the operational characteristic of prohibited lane changes within the circulatory roadway of a turbo roundabout, signage and pavement markings on the approaches, especially for lane selection, are critical for motorists to identify and select their desired lane before entering the roundabout. Chapter 2 of the MUTCD, as well as the Roundabouts Informational Guide, describe applications of lane control signage for roundabout approaches.[12, 29] Lane control signage can be supplemented using pavement marking arrows.

A version of the roundabout directional arrow sign (R6-4, R6-4a, or R6-4, as shown in figure 16) in the central island directs drivers to the right and increases the conspicuity of the central island. Signage can also direct pedestrians and bicyclists to designated facilities, drivers to their desired lanes, and communicate the presence of raised curbing, such as a raised lane divider (if one is used). If the lane divider includes grooved, textured, or brick pavements, consideration can be given to including sign W8-15 to warn road users of its presence. Pavement markings shall be used to delineate the edges of the approach and circulatory lanes. Additionally, supplemental delineation can be achieved using reflectors or light emitting diodes (LEDs) to illuminate the edges of the apron and lane dividers.[29] Finally, given the important role signage and pavement markings play for all users of turbo roundabouts, it is important that all traffic control devices are compliant with the MUTCD and for agencies to establish consistent maintenance practices that sustain the visibility and retroreflectivity of traffic control devices.

Source: FHWA.

Figure 16. Graphic. Roundabout directional arrow sign (R6-4b) for central island.[29]

7.4 Pedestrian Design Treatments

Pedestrian accommodations for turbo roundabouts do not differ from modern roundabouts. Crossings should be kept at the perimeter of the intersection, with crosswalks and splitter islands on the approaches to provide two stage crossings. All sidewalks, crosswalks, and curb ramps should be accessible to and usable by pedestrians with disabilities. The crosswalk should be placed far enough (minimum of 20 feet, or one vehicle-length) from the circulatory roadway so a motorist can exit the roundabout and then stop before reaching any potential pedestrians in the crosswalk.[12]

7.5 Bicycle Design Treatments

Bicycle guidance for turbo roundabouts is the same as for modern roundabouts. A bicyclist can either mix with motor vehicle traffic or, when available, utilize separated facilities. The decision as to which treatment is adopted is based on context, weighing factors such as bicyclist volume, motor vehicle volume, complexity of the roundabout, adjacent infrastructure and land use, and available right-of-way. In the Netherlands, separate bicycle paths outside of the roundabout are recommended where possible, including for turbo roundabouts.[25] Dutch guidance recommends adding curb cuts with chicanes in splitter islands for bicycle crossings (figure 17). The curb cuts encourage bicyclists to use the crossing, while the chicane encourages the crossing to be taken in two stages.

Figure 17. Photograph. Example of a chicane in a splitter island at a turbo roundabout in the Netherlands to provide additional time for approaching drivers to identify the bicyclist and to encourage bicyclists to perform a two-stage crossing.[32]

7.6 Vertical Design

Vertical alignment considerations are the same as other modern roundabouts. The geometry should not restrict sight distance throughout the intersection area, including decision sight distance on the approaches when selecting lanes, stopping sight distance on the approach and on the circulatory roadway, and intersection sight distance at the entrances to the circulatory roadway.

7.7 Lighting

The use of proper lighting is encouraged to improve the visibility of the middle island and raised lane divider.[25] Lighting should also be provided to give adequate visibility for pedestrian and bicycle facilities, especially crossings, though it is important that designers are careful to avoid creating negative contrast lighting and shadowing.[12]

7.8 Landscaping

Landscaping should be limited to the non-traversable portion of the central island and not hinder stopping sight distance around the circulatory roadway. If sprinklers are used to maintain landscaping, designers should consider the impacts of irrigation runoff onto the circular roadway, as unexpected wet pavement can introduce another potential risk to users of the intersection.[33]

7.9 Other Design Considerations

Other design considerations, such as bypass lanes, access management, at-grade rail crossings, evacuation routes, and bus stops, should be addressed the same as they are for modern roundabouts. Specific guidelines for these issues are available in the Roundabout Informational Guide.[12]

7.10 Comparison to United States Roundabout Design Principles

The Roundabouts Informational Guide describes six overarching principles that inform the design of roundabouts.[12] Table 1 describes the principles and the manners in which they are addressed in turbo roundabouts.

Table 1. Roundabout design principles.

Design Principles from the Roundabout Informational Guide[12]	Addressed in Turbo Roundabouts
"Provide slow entry speeds and consistent speeds through the roundabout by using deflection."	International practices of a perpendicular entry and smaller radii of the right turns on entry are intended to slow vehicle entry speeds.
"Provide the appropriate number of lanes and lane assignment to achieve adequate capacity, lane volume balance, and lane continuity."	Turbo roundabout variants are available for a range of traffic demand. International research suggests basic turbo roundabouts have similar capacities as multilane roundabouts with two entry and two circulating lanes.
"Provide smooth channelization that is intuitive to drivers and results in vehicles naturally using the intended lanes."	The spiral lane markings and lane dividers provide intuitive messaging to drivers on lane selection, lane keeping, and the appropriate maneuvers from each lane.
"Provide adequate accommodation for the design vehicles."	As with modern multilane roundabouts, lane width decisions for turbo roundabouts are informed by a horizontal swept path analysis of the design vehicle along with other lane width-related considerations (e.g., right-of-way, performance for all vehicle types and users). Additionally, aprons are provided on the central island and as necessary on the perimeter of the roundabout to provide additional space.
"Design to meet the needs of pedestrians and cyclists."	Pedestrian and bicycle accommodations for turbo roundabouts do not differ from modern multilane roundabouts.
"Provide appropriate sight distance and visibility for driver recognition of the intersection and conflicting users."	Signage is placed far enough in advance of the roundabout so road users are aware of the approaching intersection and the need to select their lane before entering the roundabout. The roundabout directional arrow sign on the central island increases driver recognition of the roundabout.

Section 8: Costs

As of this writing, no turbo roundabouts have been constructed in the United States, meaning there is no local data related to turbo roundabout costs. However, turbo roundabouts are similar to multilane roundabouts, and are therefore expected to have similar types and magnitudes of costs. Turbo roundabouts may vary slightly from multilane roundabouts in required right-of-way. A radial entry with no flare and smaller entrance radii requires a larger swept path for large vehicles. The circular roadway may therefore be wider in some cases than for a comparable multilane roundabout. However, significant changes to the alignment of the approach roadway are generally unlikely given the entry geometry of the turbo roundabout.

Section 9: Education and Public Involvement

Given the unique geometry and limited knowledge of turbo roundabouts in the United States, traditional public outreach methods for roundabouts will need to be modified for educating the public about turbo roundabouts. Below is a discussion on various messages and approaches that may benefit education efforts, drawing on successful methodologies used in Europe and other roundabout strategies implemented in the United States.

9.1 Key Messages

During initial public outreach, agencies may find it helpful to place emphasis on the safety benefits of roundabouts in general, along with additional emphasis on the reduction of conflict points and the intuitive lane selection and channelization associated with turbo roundabouts. Agencies can also emphasize the key differences between multilane roundabouts and turbo roundabouts, including the lane divider and the spiral lane markings.

As the project develops, highlighting previous turbo roundabouts can be important to demonstrate the positive impact made on traffic flows and to create a greater sense of familiarity with how to navigate the roundabout. These messages can reemphasize the importance of lane selection on the approach and the principle of no lane changing in the circulatory roadway. The lack of a track record for turbo roundabouts in the United States may present challenges to convey these key messages in the short term; international success can be discussed here instead. As turbo roundabouts are opened throughout the United States, it is important to incorporate feedback from those projects into messaging on future projects. After installation, agencies can continue providing information on how specific user types are intended to navigate the turbo roundabout.

9.2 Educational Media

Real-time video or simulations are appropriate media for educating engineering audiences and the public alike at the beginning of a project, as they provide a clear depiction of how users are meant to navigate the turbo roundabout. Though video will be difficult to obtain until after early United States installations, agencies can take this form of media into consideration as more turbo roundabouts are built. Other suggested media include social media, flyers and fact sheets, slide decks, and educational guides.

9.3 Audiences

It is important for agencies to consider all relevant audiences for public involvement and education efforts, not just the general driving population. Other important target audiences include:

- New/young drivers.
- Large vehicle/freight drivers.
- Motorcyclists.
- Bicyclists and pedestrians.
- Local and State roadway personnel, including maintenance crews and land use planners.

9.4 Decision Matrix

Transportation agencies need to consider the audience's key needs and issues, the appropriate method for reaching the targeted audience, and the agency's capabilities and budget to implement the selected education/awareness approaches. A decision matrix, similar to that in table 2, can be useful for identifying audiences and developing appropriate marketing and communication materials.

Table 2. Target audience educational/awareness media.

Audience	Organization	Informational Primer	Real-time Video/Simulatio	Signage	Slide Decks	Social Media	Education Guide	Fact Sheets and Flyers	Webinars
Local and State Transportation Agencies	Roadway Designers & Engineers	X	X		X		X	X	X
	Maintenance Crews	X					X		X
	Land Use Planners	X	X		X		X	X	X
User Groups	Drivers		X	X	X	X	X	X	
	Large Vehicle/Freight Drivers		X	X	X	X	X	X	
	Motorcyclists		X	X	X	X	X	X	
	Bicyclists & Pedestrians		X	X	X	X	X	X	

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Appendix E
Turbo Roundabout Design Guidelines Translated to the USA

Turbo Roundabout Design Guidelines Translated to the USA

Bill Baranowski, President of RoundaboutsUSA, Salt Lake City, UT. Email: bbbara@msn.com.

ABSTRACT

Turbo roundabouts are multi-lane roundabouts with spiral road markings and with entry and circulating lanes separated by raised lane-dividers. The Turbo Roundabout was introduced in the Netherlands to solve capacity and safety issues that often occur in standard multi-lane roundabouts. The safety and capacity success of the Turbo Roundabout prompted the author to visit with Dutch engineers in March 2017 to help transfer this innovative intersection design to the USA. In this paper the geometric design of turbo roundabouts is compared to design vehicles and current practice in the USA. A comparison between design guidelines in the Netherlands and the USA may be helpful in promoting this new intersection design.

1. Turbo Roundabouts in the Netherlands

The turbo roundabout is an innovative arrangement of a two-lane roundabout that has revolutionized roundabout design in the Netherlands since 1998. Entering and exiting a typical two-lane roundabout can be complicated for some drivers, which may lead to crashes due to lane changing inside the roundabout. The turbo roundabout eliminates some of the most severe conflict points on a roundabout and reduces the need to change lanes (1). There are currently 435 turbo roundabouts with 324 located in the Netherlands and 111 located in other countries, mainly in Europe (2).

Essential Features

The most important feature of the turbo roundabout is the spiral lane marking to eliminate the necessity of weaving or changing lanes. This results in both an increase in safety as well as an increase in the capacity of the roundabout. The turbo roundabout does not have two lanes throughout the whole roundabout, but only over the sections where two lanes are required. At least one of the exits should have two lanes, and some exits may have only one lane (3). Figure 1 shows a typical turbo roundabout in the Netherlands at the intersection of a major street with a minor street.

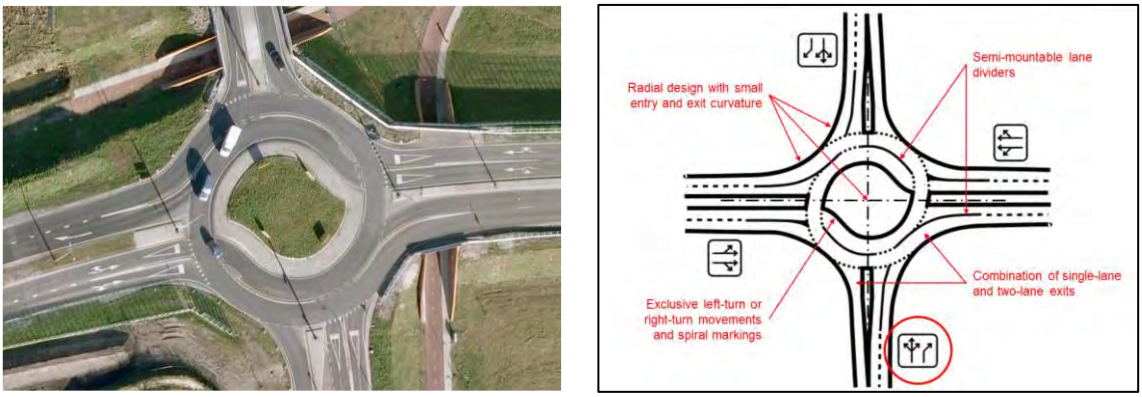

Figure 1. Typical Turbo Roundabout in the Netherlands (Weber)

When compared to a typical two-lane roundabout a turbo roundabout reduces the number of potential conflict points from 16 to 10. This is mainly the result of the elimination of the weaving conflicts (a reduction of 4 conflicts) in the roundabout. A further benefit is that traffic in the main direction, only must consider crossing one lane before entering the roundabout (a reduction of 2 conflicts) (4). Since weaving in the roundabout is no longer necessary, the lane divider can be slightly elevated (Figures 2 and 3). The mountable lane divider induces traffic to keep to its own lane, and this helps to prevent sideswipe collisions that can occur not only upon entering the roundabout, but also when exiting. Heavy and oversized vehicles can traverse the lane dividers if necessary, as shown in Figure 3.

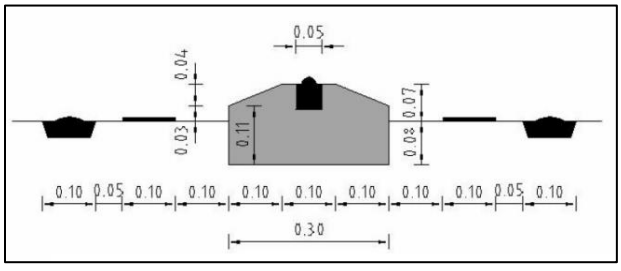

Figure 2. Turbo Roundabout Raised Lane Divider Detail (Fortuijn)

Figure 3. Turbo Roundabout Raised Lane Divider (Fortuijn)

Because of the lane dividers, drivers need to choose the correct lane before they enter the roundabout. Drivers should be assisted by clear signposting and lane marking. In the Netherlands, all turbo roundabouts have entries that are perpendicular to the circulatory roadway which is commonly called "radial design" in the USA (Figure 4). Also noteworthy, on my tour of over 50 turbo roundabouts in the Netherlands, the author was impressed by the large twin overhead lane assignment signs and at least 4 sets of large lane assignment symbols on the approaches to each of the turbo roundabouts. The capacity of a turbo roundabout is about 25% to 35% higher than the capacity of a conventional two-lane roundabout, depending on the balance of the traffic volumes on the approaches. The main reason for the higher capacity of the turbo roundabout is the reduction of conflict points for traffic entering and exiting the roundabout (3).

Figure 4. Advance Lane Assignment Signs and Legends (Fortuijn, DeBaan)

On a typical turbo roundabout there are 10 conflict points for vehicles, while on a two-lane roundabout there are 16. This represents 60% more conflict points, including four weaving conflicts and two exiting conflicts, which amount to a higher accident risk for a two-lane roundabout (Figure 5). A turbo roundabout is therefore a significantly safer option. A quantitative safety data comparison of the conversions of several 2-lane roundabouts to turbo roundabouts in the Netherlands was completed in 2015 using 3 years "before" to 3 years "after" data. The conversion from 2-lane roundabouts to turbo roundabouts resulted in a 53% reduction of injury accidents (2).

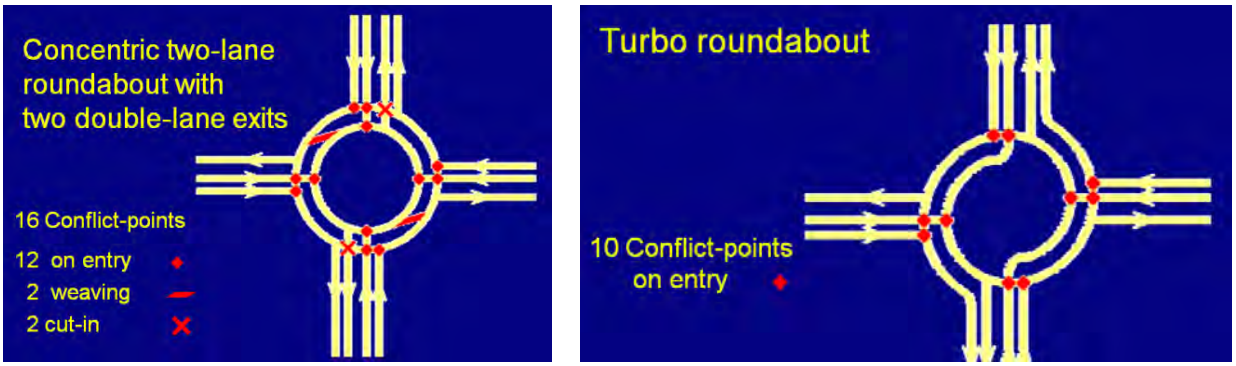

Figure 5. Conflict Points Comparison: Two-lane Roundabout vs. Turbo Roundabout (Fortuijn)

Research from the Netherlands makes a comparison between turbo roundabouts and traffic signal and yield controlled intersections. It shows that a 70% reduction of accidents resulting in serious injuries can be expected when introducing a

turbo roundabout at such an intersection. The same applies to the introduction of a one-lane roundabout, however this would result in a lower intersection capacity (5).

Reduced Right-of-Way and Second Lane Inserted into the Center Island

Turbo roundabouts require less right-of-way than a standard two-lane roundabout. At least one entry to a turbo roundabout has a second lane inserted on the central island side. Turbo roundabouts normally have radial design where entering traffic flows directly towards the center of the roundabout. These two elements together allow for a reduction in the outside diameter of the intersection.

Spiral Roundabouts vs. Turbo Roundabouts

The majority of multi-lane roundabouts constructed in the USA over the past 20 years follow "spiral striping" as developed in the UK and outlined in the FHWA guide. The current FHWA roundabout guide highlights multi-lane roundabouts with spiral lane markings and spiral transitions. The term "turbo-like roundabout" refers to the various alternative designs or a layout that does not meet all the requirements of a Dutch turbo roundabout. However, a high percentage of the 111 turbo roundabouts constructed outside of the Netherlands have been shown to have regional differences to allow for snowy weather or local preferences but are called turbo roundabouts. Figure 6 shows a common turbo roundabout layout as an alternative to an equivalent spiral roundabout (6).

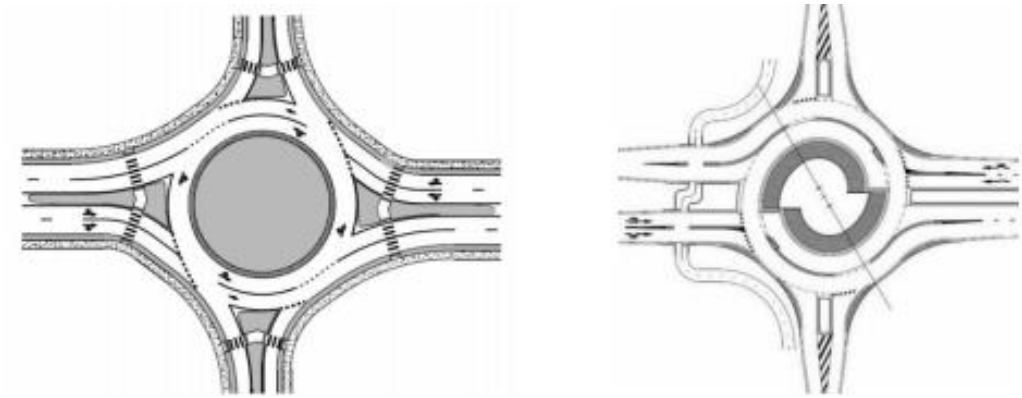

Figure 6. Spiral Striping Recommended in NCHRP-672 vs. Equivalent Turbo Striping (Homula)

Turbo Roundabout Checklist

The following is a summary of design features included in a turbo roundabout:

- ✓ Entries are usually perpendicular to the circulatory roadway (radial design);
- ✓ Mountable raised lane dividers control the traffic path and speed by keeping vehicles in their lane with a smaller roundabout Inscribed Circle Diameter (ICD);
- ✓ At least one entry has a second lane inserted on the central island side;
- ✓ Radial entry lane design;
- ✓ Traffic must choose the appropriate lane for the desired turning movement prior to entering the roundabout; and
- ✓ Spiral road markings guide traffic from inside to outside, avoiding weaving and reducing conflicts in the roundabout.

2. USA Projects with "Turbo-Like" Roundabout Features Included

The introduction of the turbo roundabout to design engineers in the USA since 2008 has resulted in the adoption of some of their features in several projects. The following examples are used to illustrate some of the Turbo Roundabout features included in recent USA projects which may be called "turbo-like".

The original roundabout at the entrance to the Utah Valley University was the first modern roundabout constructed in Utah in 1994. It performed well for 20 years but the school has since grown from 10,000 students in 1994 to over 35,000 students today and most of the students commute to school in single occupant vehicles. The original circle was only 150-ft in diameter and although it was striped for two lanes it has always functioned as a single-lane roundabout.

The reconstructed layout on top of the original layout (shown in Figure 7) includes a turbo-style entry on the northbound entry that allows two lanes at the entry and within parts of the roundabout. The small size of the circle requires the new

lane to be in the inner side of the center island. The entries are all radial design. The diameter is rather small for a two-lane roundabout and may be considered as a “turbo-like roundabout”. If it were to include raised divider islands it could be a “complete turbo roundabout”.

Figure 7. UVU Roundabout First Constructed in 1994, and Re-constructed in 2014, Orem, UT (Horrocks)

This next example on Main Street in Mesa, Arizona constructed in 2018, illustrates how the turbo shape or spiral striping was used to allow exclusive left-turn lanes at the roundabout that includes a light-rail train crossing. Raised lane dividers were evaluated to separate the left-turn lane from the through-lanes during the design but instead, Raised Pavement Markers (RPMs), were utilized (Figure 8). Raised lane dividers would not be impacted by snow plows in the warm Arizona climate but they were not included in the final design.

Figure 8. Main Street/Horne Roundabout, Mesa, AZ (Baranowski, Perrin)

The following example from Salem, Connecticut, is of a roundabout with a raised/stamped brick divider between the two entry lanes. It was constructed in 2012. The lane divider on the entry, consists of a red stamped brick pattern (Figure 9).

Figure 9. Raised Lane Dividers on Entry, Salem, CT (Britnell)

The first recognized and purpose-built turbo roundabout in North America, was constructed in 2010 at the Victoria, BC airport. The lane divider is not raised concrete, but flush-colored pavement (very similar to Salem, CT) to allow for the large airport snow plows to clear the intersection during snow storms (Figure 10).

Figure 10. Victoria Airport Turbo Roundabout, Victoria, BC (Murphy)

Poland currently has about 35 turbo roundabouts. Macioszek compared the two-year crash history of 7 turbo roundabouts in Poland with raised lane dividers to the crash history of 11 turbo roundabouts constructed with only a continuous wide painted line (solid/approx. 10-inch wide white type P-2). The turbo roundabouts with painted lane dividers were found to have a level of safety similar to that found in typical two-lane roundabouts. The number of side-swipe crashes for turbo roundabouts with raised lane dividers was considerably less than that of turbo roundabouts with painted lane dividers (7). Two types of painted lane dividers are shown in Figure 11: one with a large red stripe between two white stripes and one with the single white stripe.

Figure 11. Poznan and Chelm, Poland Turbo Roundabouts with Painted Lane Dividers (Macioszek)

3. Issues with Transferring Turbo Roundabouts to the USA

Roundabouts should always be designed for the largest vehicle that can be reasonably anticipated (the design vehicle) (8). In the USA, roundabouts on urban arterials are commonly designed to accommodate a WB-50 (WB15 metric) and sometimes a WB-67 (WB20 metric) design vehicle. Turbo roundabouts have replaced most multi-lane roundabouts in the Netherlands. Turbo roundabouts are able to keep circulating trucks in-lane through the use of wider lanes and outer truck aprons. While on a tour of Rotterdam, the author was quite amazed to see several tractor-trailer trucks commonly enter and go around turbo roundabouts side-by-side with no difficulty.

However, tractor-trailers trucks are longer and wider in the USA with a larger turning radius than those used in Europe (Figure 12). The result is that turbo roundabouts in the USA may have to be larger, with wider circulating lanes, and or they may require larger outer truck aprons. Fortunately, there are software programs that can aid the designer by checking the turning radii of various design vehicles from Buses, tractor-trailers, and oversize vehicles and adjusting for them (9).

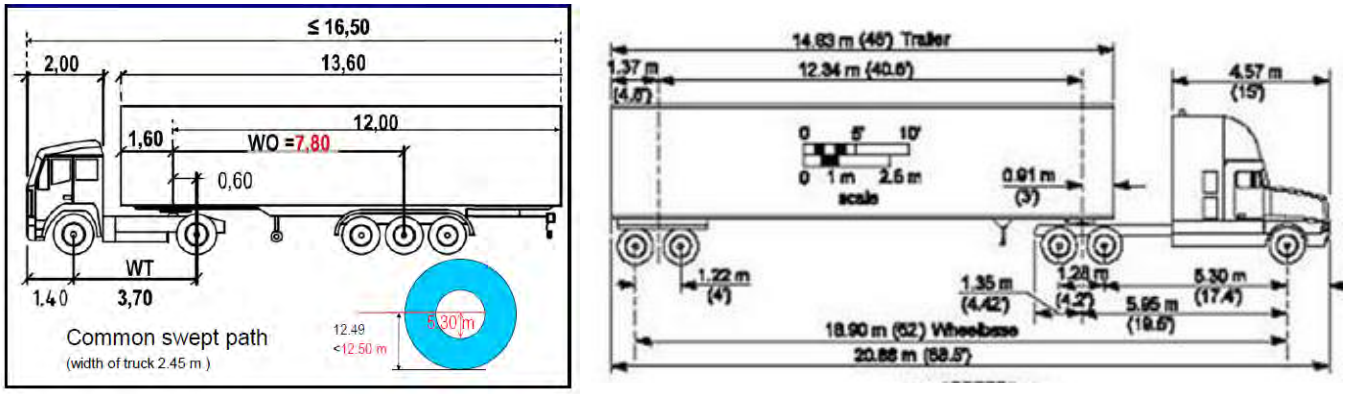

Figure 12. Common Design Vehicle Europe vs. USA (Fortuijn, AASHTO)

To aid in the translation from the Netherlands to the USA, the larger USA design vehicles have been modeled by Transoft Solutions. They followed the Dutch manual which makes the inner lane wider to accommodate the swept path. They compared the circulating lane widths for European design vehicles to USA design vehicles. They discovered a design variable not noted in the Dutch Design Manual called the "opening width". They found that the swept path influences the circulating lane widths and the opening width. The opening width decreases as the central island radius increases (Figure 13) (10).

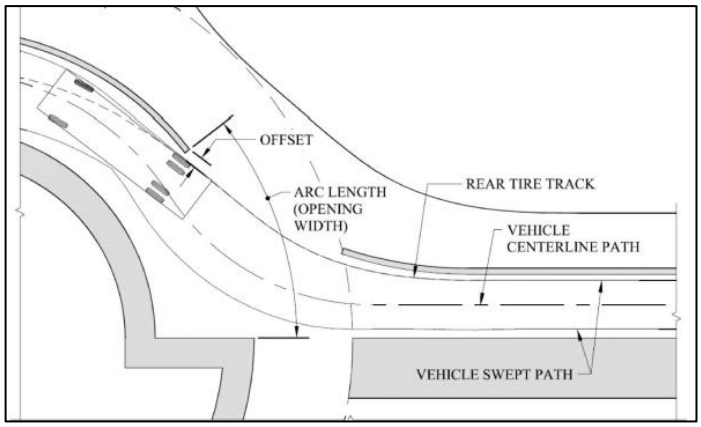

Figure 13. Opening Width of Turbo-Roundabout Spiral Lane and Vehicle Swept Path (Chan)

4. Deer Valley Roundabout – A "Turbo-like Roundabout"

The Deer Valley roundabout is included here to illustrate the successful use of a "raised lane divider" which is a key turbo roundabout design feature. The modifications shown were directly inspired by the turbo roundabouts in the Netherlands. The Deer Valley roundabout was first constructed in 2000 for the 2002 Winter Olympics in Park City, Utah. The roundabout was designed and constructed as a typical two-lane roundabout at a difficult location connecting two ski resorts and a main street shopping area with the Olympic Intermodal transit center. The ski area receives up to 300 inches of snow during the winter and was an ideal location for the Winter Olympics.

The modern roundabout made it possible for buses to directly access the intermodal center using a new improved intersection. Some of the challenges of the project included a skewed intersection, providing a new connection to the Olympic intermodal center, and providing a new section of a bicycle/pedestrian trail that required a roadway underpass (Figure 14). The author participated in the original design of the Park City Intermodal Center including the new roundabout.

The original Deer Valley roundabout performed well during the 2002 Winter Olympics. In the years following the Olympics, the PM peak-hour traffic began to back up to the east into Deer Valley as drivers were hesitant to enter the roundabout when circulating traffic volumes were high. The re-design in 2008 considered several changes to improve traffic flow at the roundabout. The most significant traffic improvement was a mountable raised lane divider installed to separate westbound to northbound right-turn traffic from heavy northbound traffic (Figure 15). The lane divider separates traffic leaving Deer Valley ski resort traffic from the circulating traffic travelling north.

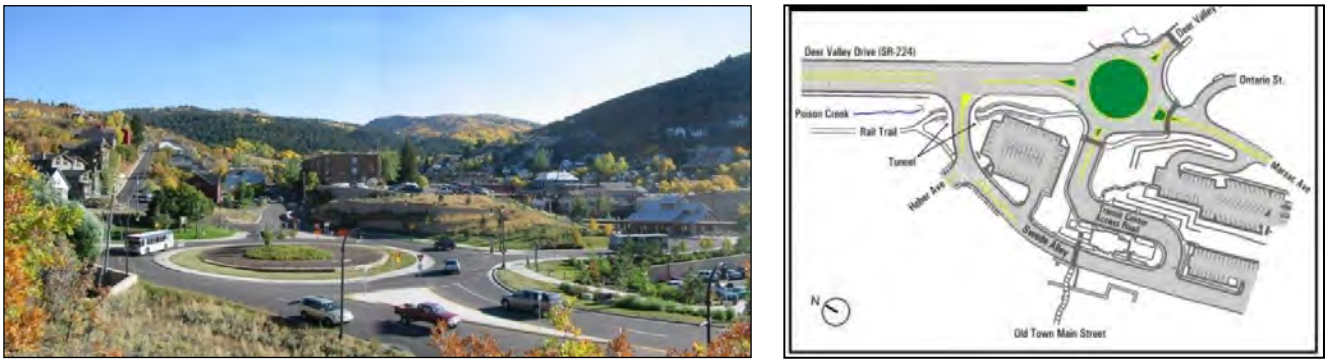

Figure 14. Deer Valley Roundabout Original Design 2000-2008 Looking South (Baranowski)

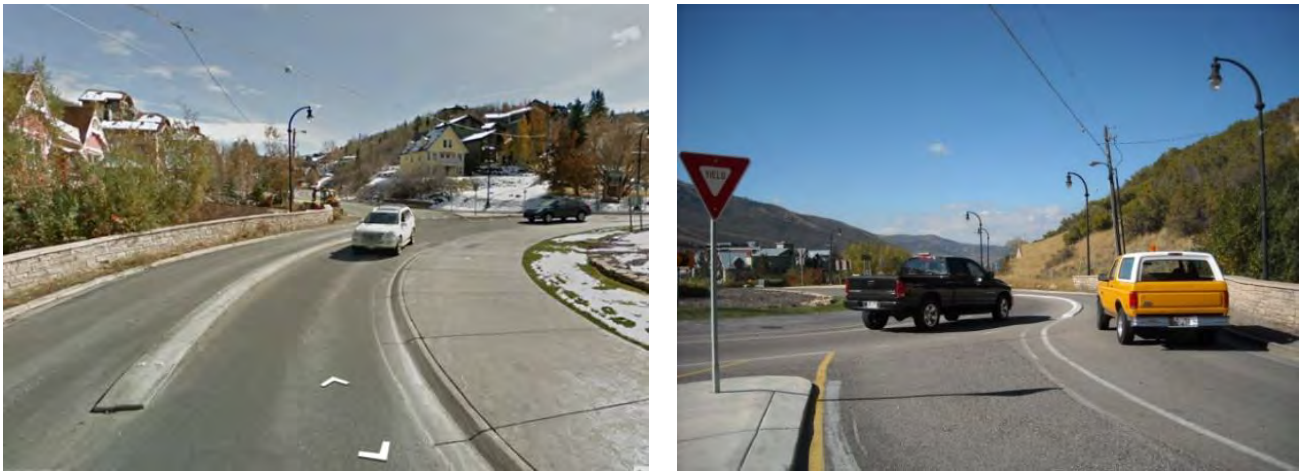

Figure 15. Deer Valley Rbt. Raised Lane Divider – looking south and north (Baranowski)

The new configuration can service over 1,000 vehicles per hour (vph) at the northbound exit lanes while the overall entering traffic is over 2,000 vph. Side swipe vehicle crashes have been reduced greatly for the years 2008-2018 and traffic capacity has improved by 30%. Peak-hour delays for westbound to northbound traffic have been greatly reduced (by approximately 60%). The mountable raised lane divider is snow-plowable and has helped to reduce the speeds of traffic at the northeast quadrant where it is located. Lane change or weaving type crashes are virtually impossible on the northbound exit of the roundabout. A detailed layout of the changes made to the Deer Valley roundabout is shown below in Figure 16. The Deer Valley roundabout would require more modifications to be considered a "complete turbo roundabout" like the changes shown in Figure 17. These modifications would include reshaping the central island and creating more raised dividers between the circulating and entering lanes.

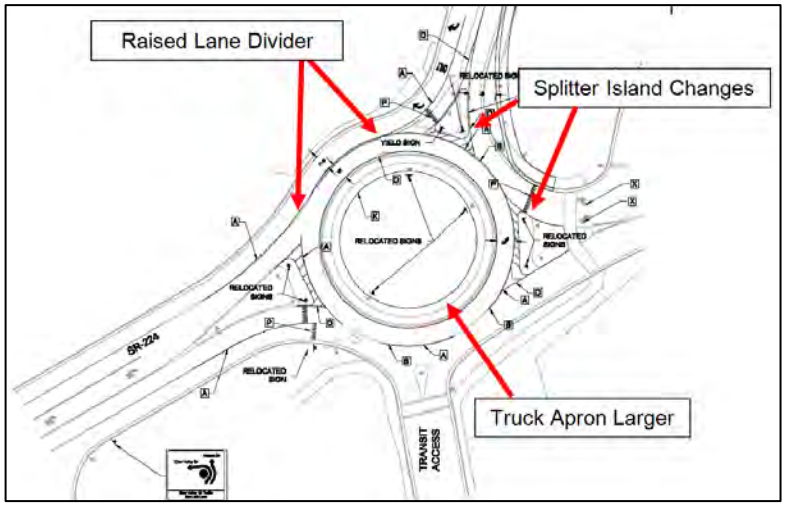

Figure 16. Deer Valley Roundabout Re-design including Raised Lane Divider, in 2008 (Baranowski)

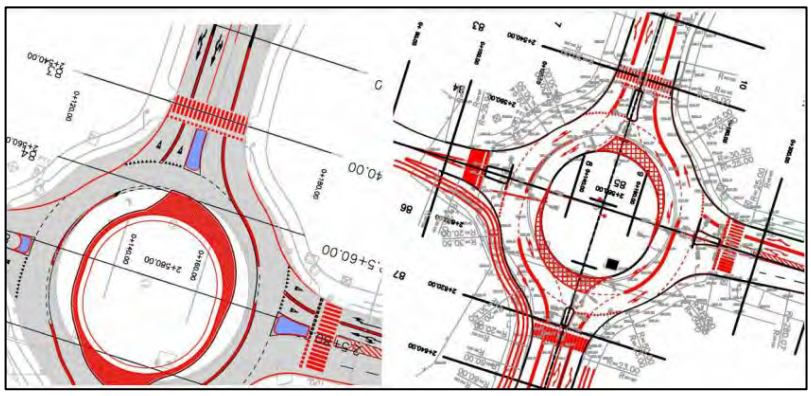

Figure 17. Modifying an Existing 2-Lane Roundabout to be a Turbo Roundabout in Slovenia (Tollazzi)

A modified raised lane divider has been used at 17 turbo-roundabouts in Slovenia which has significant snowfall in Winter. The concrete dividers are flatter than the Dutch design and some include end markers to stand out more in snowy conditions which are common in Slovenia. They also have been found to accommodate motorcycles (Figure 18) (11).

Figure 18. Flatter Raised Lane Divider in Slovenia and End Snow Markers (Tollazzi)

5. Summary

The introduction of the turbo roundabout to design engineers in North America has influenced several existing and future roundabout projects. The examples provided, help to illustrate some of the Turbo Roundabout features incorporated in recent projects and may encourage engineers and planners to include variations of Turbo Roundabouts in the future.

The following summarizes the benefits of a Turbo Roundabout and some of the challenges to consider in translating this innovative design to the USA:

- A turbo roundabout eliminates some of the most severe conflict points on a roundabout.
- The most important feature of the turbo roundabout is the spiral lane marking to eliminate the necessity of weaving or changing lanes.
- A mountable lane divider induces traffic to keep its own lane, and this helps to prevent sideswipe collisions that can occur not only upon entering the roundabout, but also when exiting.
- As a result of the lane dividers, drivers need to choose the correct lane before they enter the roundabout.
- Turbo roundabouts require less right-of-way than a standard two-lane roundabout. At least one entry to a turbo roundabout has a second lane inserted on the central island side. Turbo roundabouts normally have radial design where entering traffic flows directly towards the center of the roundabout. These two elements together allow for a reduction in the diameter of the intersection.
- The capacity of a turbo roundabout is about 25% to 35% higher than the capacity of a conventional two-lane roundabout, depending on the balance of the traffic volumes on the approaches.
- The use of turbo roundabouts in the USA will require adjustments to allow for the larger size trucks compared with those in Europe.
- The raised lane dividers are preferable to painted lane dividers but some variation of the raised lane divider may be considered for turbo roundabouts in snowy areas.

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