Queen's University
Enhanced Pathway Standard & Recommendations

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The Project Team

This project was collaboratively prepared by a group of six Master of Planning (M.Pl) Students from Queen's University. The team was tasked with creating campus-wide standards for the internal pathways, as well as providing additional recommendations to support a strong pedestrian realm. The team worked under the supervision of Professor Ajay Agarwal, Tony Gkotsis (Director, Campus Planning and Real Estate at Queen's University) and Nathan Splinter (Manager, Energy and Sustainability at Queen's University). This report was completed for academic credit.

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Executive Summary

Introduction & Background

The Queen's University Enhanced Pathway Standards and Recommendations project was created to support the University's desire to excel in sustainability, accessibility, and pedestrian-friendliness. As a historically renowned campus, Queen's has grown and changed significantly since the mid-nineteenth century, resulting in a need for up-to-date infrastructure campus wide. To support the University's desired open space and pathway network outcomes, improvements to the campus pathway infrastructure should be considered. As such, this project delivered a set of campus wide pathway standards and recommendations that intend to create consistency across campus, increase sustainability by reducing hardscaping where appropriate, and ensuring campus is accessible for people of all abilities.

The site area for the project is bound by Union Street to the north, Arch Street to the east, Stuart Street to the south, and University Avenue to the west. This area is part of the historic core of Queen's campus and is main area for pedestrian traffic connecting areas of campus in all four directions. This study area was used to gather data, apply research, and ultimately assess areas for improvement and application of the standard and recommendations. While the standard is intended to be applicable campus wide, the project only addresses redevelopment in the study area.

Guiding Information & Resources

Case Studies

Case studies from academic institutions of similar size and geographic context to Queen's University were analyzed to gain a better understanding of best practices for sustainable and accessible university campuses. The first portion of the case study analysis involved a vigorous review of university building standards, master plans, landscape design guidelines, and other relevant documents from eleven different academic institutions across Canada and the United States. The information gathered from this review was used to create a case study evaluation chart, which assesses universities on various metrics pertaining to pathway sustainability and accessibility. From there, five universities were selected to undergo a more comprehensive review including: (1) the University of British Columbia, (2) Dalhousie University, (3) the University of Ottawa, (4) Western University, and (5) the University of Saskatchewan. The policies and guidelines from these institutions

demonstrated best practices for sustainable and accessible university campuses and like Queen's University, they are all a part of the U15 Group of Canadian Research Universities. This was an especially pertinent consideration because for Queen's University to be the leading institution it strives to be, it must match if not exceed the practices of competitor universities.

Literature Review

An in-depth literature review of university campus sustainability and hardscape removal was conducted to direct the work of this study. Sustainable practices, materials, and operations on university campuses were examined and incorporated into the project's recommendations. Research highlighted the importance of interdisciplinary collaboration in designing campus sustainability programs, incorporating collaborative work and knowledge from designers, planners, engineers, architects, landscape architects, and scientists. Methods of reducing concrete use, recycling concrete, and concrete alternative were also explored and incorporated into the study considerations and recommendations. Findings highlighted the importance of adopting a life-cycle approach to development and analysis of alternative practices.

Pathway accessibility research was conducted to ensure all proposed pathways meet advanced accessibility standards. National design standards and an academic review of accessible university design were reviewed and incorporated into the project's recommendations. Research highlighted that the minimum application of accessibility standards does not guarantee equitable use for people with disabilities on campus, as well as the need to consider a wider range of accessibility needs for a sustainable and supportive campus experience for all.

Data Collection & Analysis

Quantitative and qualitative data was utilized to supplement the research of precedent case studies and academic literature undertaken as part of this report. The data collection and analysis results provide insight into how the Queen's University pathway network is being used, by whom, at what times of day, and if the existing pathway dimensions and design are congruent with the observed volumes and travel mode. This data was used to support the development and affirmation of the proposed pathway width standard, and in classifying the pathways within the designated study area based on the proposed standard.

Quantitative data collection was conducted through pathway user counts, assessing on- and off-peak user volumes, travel direction, and travel mode at a variety of locations within the study area. Qualitative data collection was conducted through site visits whereby pathway use characteristics, material condition, consistency, and width were recorded. Analysis of the collected quantitative data was undertaken to provide summary statistics of pathway use characteristics, as well as user flow rates and volume/capacity ratios to identify inappropriately sized pathways within the study area network. Additionally, analysis was undertaken to identify appropriate widths for each of the observed pathways within the study area, based upon their observed user flow rates and a prescribed pathway flow capacity.

The collection and analysis of pathway data within the study area highlighted relatively low user volumes and a low user mix, primarily consisting of pedestrians and occasional wheeled mobility. Thus, many pathways within the network were identified as candidates for width reductions to better align with their observed and projected user volumes and travel mode splits. Furthermore, the collected qualitative data denoted generally inconsistent pathway materials within the study area, as well as many locations of poor material quality and maintenance. These findings present concerns for safety and accessibility considerations and contribute towards a diminishing of the campus landscape quality. Through the collection and analysis of quantitative and qualitative data, opportunities were identified to improve the campus-wide and study-area-specific pathway networks through the provision of a pathway width standard and supporting recommendations.

Campus-Wide Standard & Recommendations

Through the review of relevant literature, applicable case studies, and collected study-area data, a proposed campus width pathway width standard has been developed that serves to align appropriate path widths with observed user volumes and travel modes. The proposed width standard is as follows:

- Shared Streets: 4 m – 4.5 m
- Major Pathways: 3 m – 3.5 m
- Intermediate Pathways: 2 m – 2.5 m
- Minor Pathways: 1.6 m – 1.8 m

To support the implementation of the proposed pathway width standard, and to further promote an enhanced pathway realm, implementation recommendations and supplemental recommendations have been provided, as follows:

Implementation Recommendations

Hardscaping Optimization

a) Intersections of pathways are encouraged to be designed to optimize the amount of hardscaping required to manage user flows safely and efficiently. Excess space within intersections should be considered opportunities for landscaping, greenery, and amenity spaces.
b) Pathway classification and candidate pathways for hardscaping reduction or removal should be considered based on observed and anticipated user volumes and use functions
c) Pathway removal should be considered an appropriate alternative to width reduction when there is an observed duplicity of pathways, or where the observed volume of users is sufficiently low so as to not cause disruption in typical travel patterns.
d) Opportunities should be explored to implement driveable green spaces whereby service vehicle and fire access can be accommodated, when necessary, while deterring all other vehicles through reduced pathway widths.

Pathway Greening

a) Appropriate landscaping should be located to mitigate the creation of informal pathways on campus.
b) Hardscaping removal should be considered an opportunity to improve campus sustainability through the installation of appropriate landscaping.

Vehicle Segregation

a) Pathways restricting vehicle access should be clearly distinguishable from those permitting vehicle use.
b) Vehicles should be deterred from utilizing pathways unintended for motor vehicles through the implementation of appropriate barriers, while adhering to AODA requirements to allow space for users with mobility aids.
c) Intersections between pathways and shared streets should prioritize pedestrians and wheeled mobility users rather than vehicles.

Supplemental Recommendations

Accessibility

a) All pathways should be AODA compliant and facilitate safe use for people of all abilities. Pedestrians should be able to comfortably use any mobility aid, assistive device or personal assistance to navigate through campus
b) Obstructions to pathways should avoided whenever possible and gradient changes, ramps, and stairs should be clearly marked regardless of the time of day or weather.

Pathway Materials

a) Pathway materials should be consistent across campus and should be derived from local and/or recycled sources when possible.

Signage, Lighting & Wayfinding

a) Adequate lighting should be placed at high-traffic areas and points of interest across campus such as pedestrian pathways, points of intersection between pathways and vehicular routes, parking areas, building entrances, stairs, ramps, and rest areas.
b) Wayfinding elements should direct users to buildings, transportation hubs, gateways, and major pathways across campus. These elements should provide information in multiple modes (visual, auditory, and tactile) to accommodate the diverse needs of pathway users.
c) Wayfinding signage should be consistent and have a cohesive design that reflects the character of Queen's University.

Rest Areas, Furniture & Gathering Areas

a) Rest areas should be connected to pathways and located proximal to greenery and natural open spaces.
b) Street furniture should be placed consistently along pathways and open spaces to provide resting areas and improve accessibility.

Study-Area Classification & Recommendations

To demonstrate the application of the proposed width standard to the campus pathway network, all paths within the study area were classified according to the proposed standard, as demonstrated in Figure E-1, to the right.

In addition to the proposed pathway classifications, study-area-specific recommendations have been provided, along with additional areas of opportunity for consideration by the client. These recommendations are as follows:

Hardscaping Optimization

Areas for Hardscaping Reduction

- **Behind Ontario Hall:** Proposed width reduction from 7.35 m to 4.0 m – 4.5 m or 1.6 m -1.8 m depending on anticipated future vehicle access requirements.
- **Between Clark Hall and Fleming Hall:** Proposed width reduction from 6.47 m to 4.0 m – 4.5 m or 1.6 m -1.8 m depending on anticipated future vehicle access requirements.
- **Between Jackson Hall and Old Medical Building:** Proposed width reduction from 10.13 m to 1.6 m – 1.8 m to restrict vehicle access.
- **5th Field Company Lane:** Proposed width reduction of the roadway from 6.68 m to 4.0 m – 4.5 m, and an increase in sidewalk width to 2.0 m – 2.5 m to better support active travel.
- **Between Ontario Hall and Grant Hall:** Proposed width reduction from 6.02 m to 2.0 m – 2.5 m to restrict vehicle access and reduce unnecessary hardscaping.

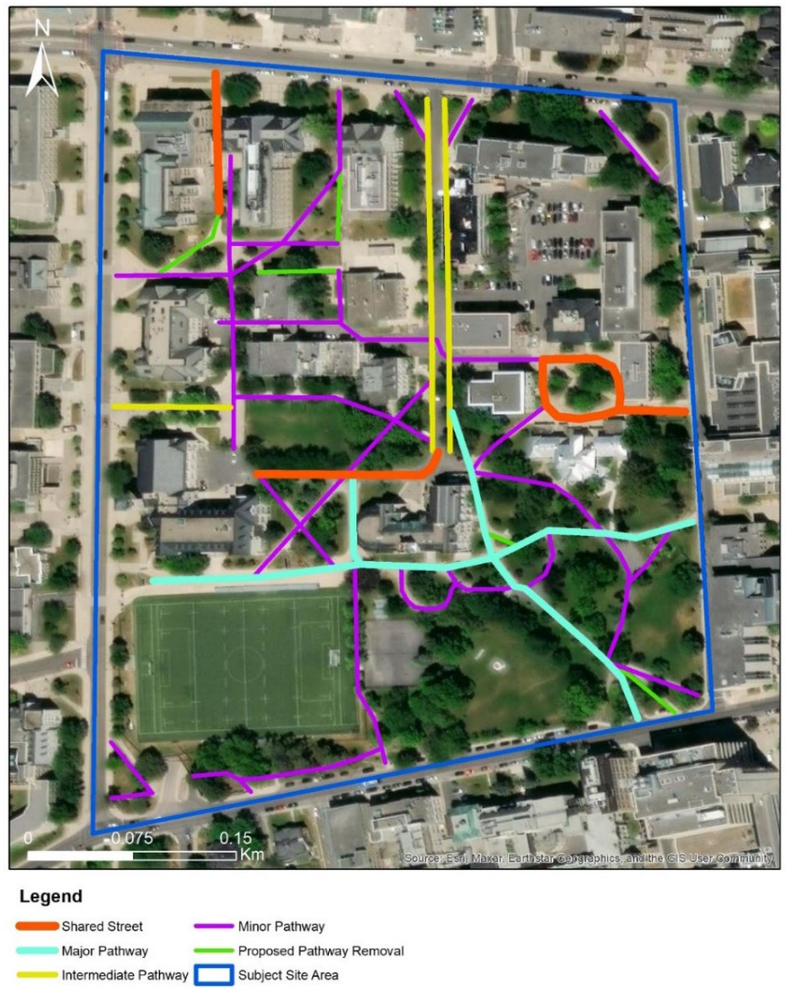

Figure E-1 Study area pathway classifications.

Areas for Hardscape Removal

- **Between Douglas Library and Ontario Hall:** Proposed removal of northeast/southwest pathway to eliminate redundancy and reduce hardscaping.
- **Between Gordon Hall and Nicol Hall:** Proposed removal of underutilized pathway to increase open green space and eliminate poor material quality.
- **North of Fleming Annex:** Proposed removal of underutilized and redundant pathway, provides opportunities for improved campus greening through hardscape reduction.
- **Pathway at corner of Arch Street and Stuart Street:** Proposed pathway removal to eliminate redundancy and unnecessary hardscaping.
- **East of Theological Hall:** Proposed removal of an unnecessary pathway cut-through, providing potential for increased greenery.

Additional Opportunity Areas

- **Miller Hall Parking Lot, 5th Field Company Lane, and Quadrangle Area:** Proposed removal of Miller Hall parking lot entrances from 5th Field Company Lane and the Quadrangle and redesigning Arch Street parking lot entrance. This will reduce vehicle ingress and provide opportunities for hardscaping removal.
- **Pathway Network south of Nixon Field:** Proposed redesign of pathway network south of Nixon Field to improve user safety, accessibility, and provide appropriately sized pathways for observed user volumes in this area.

Additional Considerations

During the course of this project, there were multiple associated factors identified to be outside the project scope that are important to the adoption and integration of the proposed pathway width standard. The consideration section briefly explores each consideration, highlighting further work to be done. Evaluating the potential carbon sequestration for landscape converted from concrete to grass has potential value in determining the best approach for removing excess hardscaping and limiting future pathway construction. The potential for grasses to act as a carbon sink is dependant on a series of factors including soil type and health, plan species, and maintenance regimes. A comprehensive study of best practices for low-input lawn maintenance as well as potential ground cover species is recommended to estimate the carbon capture potential. To further sustainable building practices on Queen's campus it is recommended that any removed concrete be recycled and reused on campus in future development. While a wide range of concrete can be recycled, the local capacity to do so is unknown and is therefore recommended for further study. Additionally, a life-cycle cost assessment is recommended to evaluate the complete costs associated with installing and maintaining concrete pathways versus natural landscaping, taking into consideration seasonal operations costs, different ground cover plant species, and low-input maintenance.

Although operations and maintenance were considered during the development of the pathway width standard and recommendations, a complete analysis of changes to maintenance practices such as snow removal and garbage collection is advised. While all pathways can accommodate vehicles used for snow removal, existing routes may need to be altered should the width standard be applied to campus pathways. Finally, a complete assessment of fire routes on campus, particularly in the study area is recommended to evaluate the potential to remove hardscaping from areas designated for emergency vehicle access; research identified a potential to use permeable paving stones rather than concrete panels for these areas. Additionally, some pathways in the study area were identified as minor or intermediate paths, which would not regularly permit vehicle access, however, due to the existing fire routes a higher classification was recommended. There is a potential to use removable or locking bollards on these paths to prevent regular vehicle access while allowing emergency and maintenance vehicle access when required.

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1 Introduction

As a leading Canadian academic institution, Queen's University in Kingston, Ontario aspires to grow as a defining example of national and international sustainability in practice. This is evidenced by its commitment to the United Nations (UN) Sustainable Development Goals (SDGs) through the 2016 *Climate Action Plan: Building a Sustainable Future* and its emphasis on advancing social impact, both locally and beyond. Over the past two years, Queen's has ranked among the top 10 universities internationally in the Times Higher Education Impact Rankings, which assess academic institutions' contributions to advancing the UN SDGs. Furthermore, the Queen's *Campus Master Plan*, introduced in 2014, provides robust objectives towards advancing campus sustainability and enhancing the quality of the campus experience for current and prospective students, faculty, staff, and visitors. A significant component of these commitments is the quality of the campus' open space and pathway network, which has been identified as an area of opportunity requiring increased attention as a sustainability resource. This report addresses the future of the institution's pathway network across the campuses, advancing the University's sustainability objectives as a resource for the Queen's University Campus Planning and Real Estate and Facilities teams.

1.1 Project Definition & Deliverables

Queen's University currently lacks consistent guidelines and standards for the design, dimensioning, implementation, and modal split on internal pathways across its campuses. This has resulted in inconsistent pathway design and material composition, potentially excessive widths, inappropriate pathway locations or redundancies, and potential conflicts between users. As such, the current internal path network is underperforming with regards to sustainability, efficiency, and safety. These outcomes are inconsistent with the objectives stated in the University's Campus Master Plan and diminish the quality of the user experience for students, faculty, staff, and visitors.

This report presents a tangible, actionable pathway width standard to be applied across all internal pathways associated with Queen's campuses, as well as supporting recommendations intended to enhance the implementation of the standard. As a demonstration of the width standard's application to the pathway network, a study area was selected whereby each pathway is classified and the proposed standard is applied. Additionally, recommendations specific to the study area pathways are provided to support the application of the standard and the objectives of the *Campus Master Plan* and *Climate Action Plan*.

1.2 Project Scope

This report is intended for consideration by the Queen's University Campus Planning and Real Estate and Facilities departments and is comprised of three categories of deliverables: a campus-wide pathway width standard, campus-wide recommendations to support the proposed standard, and a block-level application of the proposed standard as a demonstration of its implementation within a prescribed study area. The development of these deliverables was informed through a review of relevant contemporary literature, the examination of contextually relevant academic institutions, and the collection and analysis of pathway user data within the prescribed study area. Notably, the deliverables target the use of the pathway network by pedestrians and active mobility users. While consideration was given to fire routes, campus servicing requirements, parking, and vehicle access, specific recommendations are not presented for proposed changes to these functions.

Regarding the contents of the deliverables, the proposed standard pertains specifically to the systematic classification of pathways and assignment of standardized widths through consideration of their key attributes. The standard does not address requirements for material usage, pathway location, or associated amenities. The campus-wide recommendations pertain specifically to the pathway classification approach and implementation of the width standard. These recommendations primarily address functional pathway capacities, sustainable pathway practices, AODA considerations, and broad pathway typologies. While design and material considerations are addressed within these recommendations, they are not intended to be prescriptive design guidelines. The study area width standard provides recommended classifications for all pathways within the study area, bound by Union Street, Arch Street, Stuart Street, and University Avenue; as well as targeted recommendations pertaining to pathway use, hardscaping removal, and additional opportunity areas. The study area-specific recommendations do not address detailed design considerations for each pathway, but rather provide area-wide recommendations that may guide further investigation into their specific content.

2 Background

2.1 Site Overview

The findings and recommendations in this project are proposed to be applied across Queen's campuses to ensure consistency amongst the pathways and improve sustainability. To accomplish this, the report analyzes a specific site on the Queen's main campus as a baseline for the pathway standard. The study area that will be used throughout this report is the Queen's campus area bounded by Union Street, Arch Street, Stuart Street, and University Ave, as shown in Figure 2-1. As the main historic block on campus and a highly used area, the study area is particularly valuable to assess. This block has a multitude of pathways of varying widths, materials and uses; pedestrians, active mobility users, and vehicles are all present in this area. The recommended pathway standard aims to make the pathways safe and accessible for all pedestrians and active mobility users while accommodating vehicle use where it is required. Analysis of the study area was used to determine appropriate pathway classifications and establish a standard that can then be used as precedent for the rest of Queen's' campuses.

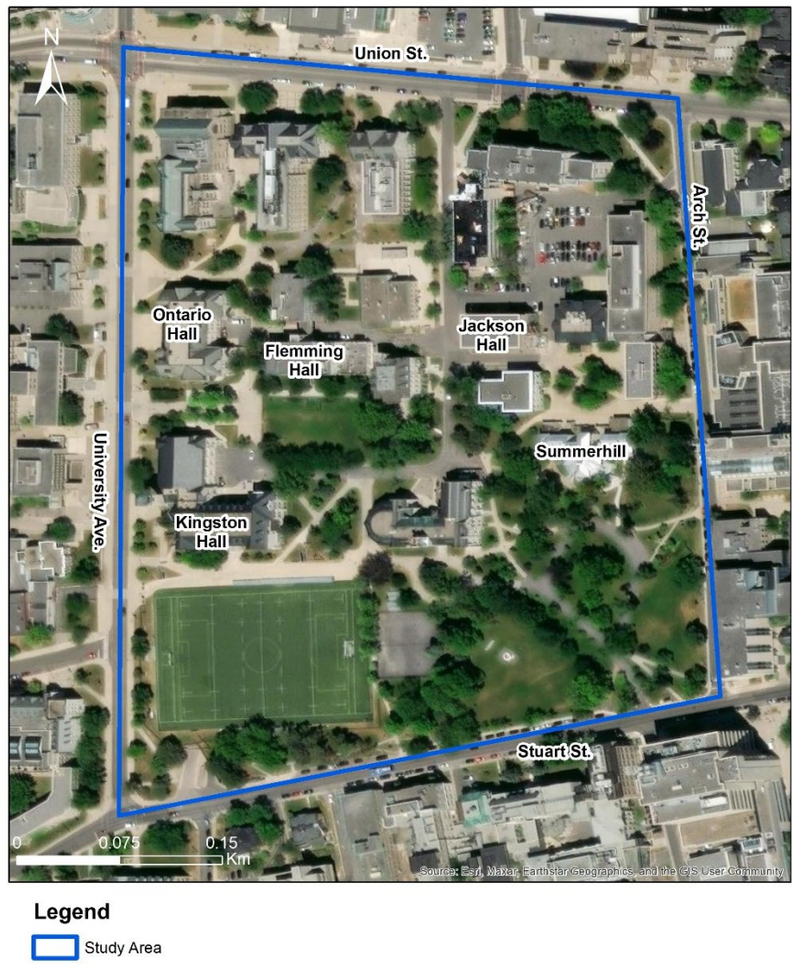

Figure 2-1 Map of the study area.

2.2 Sustainability

Queen University's main campus expands across approximately 100 acres of land on the southwestern edge of downtown Kingston. Being a dense, pedestrian-friendly campus, there are a variety of pathway networks that connect each university building with campus resources, hospital buildings and residences all within walking or cycling distance from each other. The network of pathways is a crucial component of Queen's built environment, impacting the student, faculty, staff, and visitor experience. There were three main issues identified with the pathway network. First, there is a lack of consistency across all pathways; pathway widths, material usage and pathway amenities vary significantly. Secondly, several pathways permit vehicle travel within the internal network, creating a significant safety hazard and decreasing sustainability measures. Lastly, pathway size throughout the campus does not align with pathway use, preventing potential for enhancing the pathway network, and better connecting destinations. Despite the issues presented, there is opportunity for pathway optimization to create a more friendly and sustainable campus.

Queen's University has ongoing commitments to incorporate sustainability measures across the campuses; in 2010 Queen's joined the University and College Presidents' Climate Change Statement of Action for Canada and has been developing internal strategies and goals since. The main premise of the Climate Change Statement of Action is to reduce greenhouse gas (GHG) emissions but encompasses a variety of programs that enact social, economic,

cultural, and environmental sustainability. With a commitment to become carbon neutral by 2040 and reach milestone targets in 2030, Queen's scope 3 emission goals aim to reduce emissions from student, staff and faculty commuting patterns to and from the University. With this in mind, significant infrastructure investments must be explored, including upgrades to the Queen's pathway network. The pathway network plays a crucial role in achieving sustainability both in promoting transformative social options for commuting, and through the reduction of vehicles on campus on a local scale. Additionally, these changes align with Queen's 'Living Green' campus life goal of increasing walking and biking as preferred modes of travel.

2.3 United Nations Sustainable Development Goals

The United Nations (UN) has established 17 sustainable development goals (SDG) to address issues such as climate change, inequality, health and education, and economic growth. These goals are part of the UN's global partnership to address sustainable growth, which Queen's University is contributing to. Queen's as a whole is actively contributing to all 17 goals set by the UN and has outlined for each what is being done for research and innovation, teaching and student life, community impact, global reach, and administration and operations.

The pathway standard that is being proposed is in alignment with the UN SDGs. This project specifically aligns with the following goals: good health and wellbeing; affordable and green energy; industry, innovation, and infrastructure; reduced inequalities; sustainable cities and communities; and climate action.

2.3.1 Good Health and Wellbeing

An important aspect of Good Health and Wellbeing, the third SDG, is the campus wellness program. This program focuses on principles that promote health and wellbeing amongst the Queen's student community. The pathway standard supports this goal by encouraging active transportation on campus and creating pathway widths that accommodate cycling, other forms of active mobility, and pedestrians.

2.3.2 Affordable and Green Energy

Queen's University has a pledge for carbon neutrality, as well as a goal for a green campus. There is a significant focus on developing design standards to ensure that new construction is energy efficient, and the overall process is as carbon neutral as possible. This project's pathway design standard adds another element to help Queen's University reach their goal of carbon neutrality and a green campus by reducing unnecessary hardscaping.

2.3.3 Industry, Innovation, and Infrastructure

The ninth UN SDG is Industry, Innovation, and Infrastructure. The *Campus Master Plan* plays a big role in this goal by requiring any new buildings to have minimal environmental impacts, and for the design to be flexible and adaptable. The pathway standard that is being proposed has environmental concerns at the forefront, with flexibility in width for each classification.

2.3.4 Reduced Inequalities

Prioritizing equitable access for students, staff, and visitors with disabilities is one of the main pillars in Queen's goal to reduce inequalities. It is critical that the pathway standard is designed with accessibility in mind to ensure everyone can safely travel across campus.

2.3.5 Sustainable Cities and Communities

Queen's University has a focus on sustainable commuting, not only on Queen's campus but also at a city scale in order to reduce their environmental impact. The pathway standard is accommodating to all active mobility, including but not limited to pedestrians, cyclists, and skateboarders.

2.3.6 Responsible Consumption and Production

Responsible Consumption and Production is the twelfth SDG and relates significantly to the proposed pathway standard. By right-sizing existing pathways, preventing excessive hardscaping and adoption of environmentally conscious development and maintenance regimes, Queen's University can practice responsible consumption.

2.3.7 Climate Action

The thirteenth SGD is Climate Action. This goal goes hand in hand with many of the other goals with a focus on carbon neutrality, environmental sustainability, and reducing greenhouse gasses. Sustainable development is also a key aspect of this goal which is supported by the proposed pathway standard in ensuring minimal hardscape addition.

2.4 Policy Context

2.4.1 Campus Master Plan

"The Campus Master Plan establishes a vision and framework to guide how the university will physically change over the next 10 to 15 years to accommodate Queen's evolving programs and activities" (Queen's University, n.d.). The proposed recommendations outlined in this report aligns with the Campus Master Plan (2014) in several key areas, with specific recommendations and standards that enhance the existing plan's recommendations. The goal is to create a campus vision through updated recommendations that ensures the Queen's University landscape evolves into a more sustainable, resilient, and active campus that provides a positive campus experience for students, faculty, staff, and guests. Table 2-1 below outlines the specific sections and recommendations in which the proposed recommendations fit or enhance. Appendix A further specifies the specific recommendations that align with this report.

Table 2-1 Relevance of proposed width standard to the Campus Master Plan.

Section	Recommendation (current)	Relevance
Campus Vision	*Planning Principle 2: Enhance the campus experience*	The proposed pathway width standards have been developed in accordance with AODA requirements. The minimum proposed pathway width of 1.6m is the minimum requirement to allow two mobility aids to travel side by side. Additionally, the proposed pathway width standard classifies pathways as either minor, intermediate, major, or shared streets. Each of these classifications are designed for pedestrian and active mobility safety, based on if vehicles can access the path, and if there is enough room for active mobility on the major pathways.
	Planning Principle 3: Promote good facilities management	By standardizing the pathway widths, opportunities may arise to reduce or remove hardscaping associated with pathways and replace with grasses or other planting to better the land.
	Planning Principle 4: Foster a more sustainable campus	The proposed pathway width standards are in alignment with the CMP proposed cycling trails, as well as the major pathways and shared streets having enough space for active mobility to travel alongside pedestrians. Additionally, the proposed pathway width standard will support a high-quality landscape that is consistent in appearance and function over time.
	Planning Principle 6: Create a campus that supports health and wellness	The proposed pathway width standard will support a high-quality landscape that is consistent in appearance and function over time.

Section	Recommendation (current)	Relevance
Campus at the City Scale	*4.3 Cycling Network*	The proposed pathway width standard is in alignment with the CMP proposed cycling trails, as well as major pathways and shared streets are wide enough to support both active mobility and pedestrian traffic.
Main Campus/West Campus Master Plans	*5.1 Land Use and Social Infrastructure*	Through our data collection and analysis, it has been determined which pathways require a greater width to support more pedestrians, and even gathering of pedestrians.
	5.4 Open Space Network	The proposed pathway width standards along with the removal of hardscaping promote the campus image and character by reducing concrete and increasing greenery. Additionally, the proposed minimum pathway width of 1.6m is the minimum width required for two wheeled mobility aids to pass each other and aligns with Queen's Accessibility Guidelines.
	5.4.1 Picturesque Landscapes	The proposed pathway width standards are intended to improve cohesion and consistency for all pathways across Queen's campuses.
	Queen's Quadrangle Enhancements	All proposed pathway widths are narrower than Professor's walk.
	5.4.2 Formal Linear Landscapes	The goal of the proposed pathway width standard is to introduce consistency across all pathways on Queen's campuses.
	Fifth Field Company Lane Improvements	A main aspect of the pathway width standards is safety for pedestrians. The proposed width standard for shared streets intends to reduce vehicular use, increasing priority for pedestrians and cyclists.
	5.5.1 Pedestrian Network	The pathway width standards classify different pathways as minor, intermediate, major, or shared streets based on use volumes and user modes. This ensures that there is adequate space on the pathways for safe travel. Additionally, the proposed pathway width standards emphasize accessibility as a top priority. The proposed minimum width aligns with Queen's Accessibility Guidelines and allows for two wheeled mobility aids to pass each other on the path.
	5.5.5 Servicing Network	Shared streets are designed to allow vehicle access when necessary, such as campus facility vehicles. They will maintain access to required buildings and share the path with pedestrians. Additionally, the goal for the pathway width standard is to discourage unnecessary vehicular traffic, while maintaining vehicle access, where required. The width shared streets allow vehicle travel while emphasizing priority towards pedestrians and active mobility users.
Building Design Guidelines	*7.1.7 Parking*	The pathway width standards that are being recommended prioritize pedestrians over vehicular traffic, but in cases where they interact on shared streets it is designed so there is enough space for each to travel safely.

2.4.2 Queen's University Building Design Standard

The *Queen's Building Design Standard* provides aid to "consultants and contractors during the planning, design and construction phases of the University's maintenance, renovations and new capital project" (Queen's Building Design Standards, n.d.). The proposed recommendations outlined in this report align with several sections of the Building Design Standard, enhancing recommendations to better suit the sustainable development of pathways within the Queen's pathway network. Table 2-2 below outlines the specific sections, and subsections in which the proposed recommendations fit or provide enhanced recommendation alternatives. Appendix B further specifies the specific design standard's that align with this report.

Table 2-2 Relevance of the proposed pathway width standard to Queen's Building Design Standard.

Section	Subsection	Relevance
32 14 00 Unit Paving	-	Proposed recommendation provides alternative pathway material recommendations, with respect to sustainability measures.
32 16 00 Concrete Walks and Curbs	*32 16 13 Curbs*	Proposed recommendations provide design detail on pathway curb material, and width.
	32 16 23 Sidewalks	Proposed recommendations enhance and align with sidewalk and pathway width standards, as well as pathway materials.
32 33 00 Site Furnishings	*32 33 13 Bicycle Racks*	Proposed recommendations augments bicycle equipment availability throughout the campus.
	32 33 43 Benches	Proposed recommendations provide enhanced bench recommendations with respect to the campus experience and pathway alignment.
	32 39 00 Manufactured Site Specialties	Proposed recommendations align with section through bollard installment on shared streets.
32 91 00 Planting Preparation	*32 91 19 Landscape Grading*	Proposed recommendations enhance the natural environment throughout Queen's campus, with landscape specific recommendations.

3 Case Study & Literature Review

3.1 Case Studies

To guide research on best practices for sustainable and accessible university campuses, a broad approach for case study data collection was taken. Case studies of universities of similar size and geographic context to Queen's University were used to inform current best practices. Information was collected from the university's building standards, master plans, landscape design guidelines, and other documents that provided beneficial content. In order to better summarize and compare this information, the below chart (Table 3-1) was created. The case study evaluation chart considered a wide range of themes that were found to be indicative of sustainable and accessible campus pathway systems. Each university selected had information available to the public on their pedestrian pathway systems, standards, and overall campus vision. From these documents, the most popular themes were selected for in-depth analysis. Each university was scanned for each theme on the criteria of explicitly stated, indirectly stated, or absent. This ranking is showcased in table 3-1 below. In total, 11 universities were analyzed, with a subset of them being chosen to be further examined as outlined further in this section.

Queen's University is part of the U15 Group of Canadian Research Universities, a prestigious selection of Canadian post-secondary institutions. This group of institutions is highlighted as undertaking 80 percent of all competitive research in Canada and thus being leaders not only in Canada, but in the global research arena. When looking at potential case studies to guide best practices for the Queen's University Pathway Recommendations Project, a subset of the U15 schools were used. For Queen's to be the leading institution it strives to be, it is important to match if not exceed practices at its competitor universities. A select group of U15 schools are discussed in further detail below, with Table 3-2 providing a summary of width standards found from some of these institutions.

Table 3-1 Summary of case study findings.

Case Study	Theme														
	Shared Modality Streets	Vehicle Free Core Campus	Conflict Reduction Between Modality Types	Traffic Calming	Adequate Wayfinding and Signage	Prioritize Pedestrian Environment	Implement Universal Design Concepts	Delineate Primary Pathways for Servicing	Adequate Lighting	Site Furnishings and Seating	Integrated Stormwater Management Plan	Maintenance Regime for Snow Removal	Sustainable Materials	Active Transportation Focus	Reduction of Hardscapes
University of British Columbia	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟡	🟢	🟢	🟢
University of Calgary	🟢	🟡	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🔴	🟡	🔴
Dalhousie University	🟢	🟡	🟢	🟢	🟢	🟢	🟢	🟡	🟢	🟢	🟢	🟡	🟢	🟢	🟢
McMaster University	🟢	🟢	🟢	🟢	🟢	🟢	🟡	🟡	🟢	🟢	🟢	🟡	🟡	🟢	🟡
University of Ottawa	🟢	🟢	🟢	🟡	🟢	🟢	🟡	🟡	🟢	🟢	🟢	🟢	🟡	🟢	🟡
University of Saskatchewan	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟡
Western University	🟢	🟢	🟢	🟢	🟢	🟢	🟡	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🔴
University of California, Berkeley	🟢	🟡	🟡	🔴	🟢	🟢	🟢	🔴	🟢	🟢	🟢	🔴	🟡	🟢	🟢
University of Regina	🟢	🟢	🟢	🟢	🟢	🟢	🟡	🟡	🟢	🟡	🟢	🟢	🟡	🟢	🟡
Northeastern University	🟢	🔴	🟢	🟢	🟢	🟢	🟡	🟢	🟢	🟡	🟡	🟢	🔴	🟢	🟡
Brandon University	🟢	🟢	🟢	🟢	🟢	🟢	🟡	🟢	🟢	🟡	🟢	🟢	🟡	🟢	🟡

🟢 Explicitly stated in policy or guideline

🟡 Not explicitly part of policy or guideline, but concept mentioned

🔴 Absent

Table 3-2 Existing pathway width standards from contextually similar U15 schools to Queen's University.

	Institution Pathway Width Standards (m)					
Classification	**Queen's (Existing)**	**University of Ottawa**	**University of British Columbia**	**Western University**	**Dalhousie University**	**University of Saskatchewan**
Multi-Use Pathway/Shared Streets	-	3	-	4.3	3	-
Major Pathway	4.5 – 6	3	-	3[1]	5[3]	2.5[4]
Intermediate Pathway	2.8	2.5	1.8 +	2 – 2.4 +[2]	1.8 +	1.5 +
Minor Pathway	1.8	-	1.8	-	1.8	1.5
Internal Streets	-	-	-	-	-	6 +
Bicycle Lanes	-	-	-	3	-	1.5[5]

Notes:

[1]Pathway widths considered in designated open space areas

[2]Widths associated with pathways along major roadways, contextually dependent appropriate widths

[3]Width associated with the major pedestrian spine through campus, not transferrable across all pathways

[4]Widths associated with sidewalks along major roadways

[5]Unidirectional bicycle lane width

3.1.1 University of British Columbia

The University of British Columbia (UBC) is a large institution of over 70,000 students with campuses in Vancouver and Kelowna, British Colombia. UBC is known internationally for its research and innovation, as well as its focus on sustainability. While the geographical context and size differ from Queen's, UBC provides strong sustainability standards and a pedestrian focus that can provide best practices for Queen's to emulate. The following elements from UBC's *Campus Wide Design Guidelines* provide best practices for various elements to guide the new Queen's *Campus-Wide Pathway Standard*.

Pedestrian pathway design standards are set out by UBC such that all exterior circulation routes meet minimum standards. These include walkways being at least 1.8m in width and free of any obstructions and must include streets to maintain campus character (UBC, 2020). No other pathway dimensions were available from the design guidelines. Pedestrian walkways are said to be designed to follow the desired lines of people crossing the campus, and thus may change over time as enrolment increases and buildings are added.

Section 2.2 of UBC's *Design Guidelines* outlines universal accessibility requirements that meet and exceed the BC Building Code. The seven universal design principles must be followed at a minimum, with additional elements as well. Exterior pathway accessibility standards are integrated with the universal design principles to ensure an interconnected indoor and outdoor public realm that is accessible for all. Additional accessibility elements include suitable surface treatment of pedestrian routes, covered rest areas, visual and wayfinding support features, parking and drop-off facilities, and pathway gradient guidelines (UBC, 2020).

The guidelines outline intersection treatments that are required for areas where pedestrian pathways meet roads. These treatments must include tactile warning pads comprised of vitrified polymer composite (VPC) tiles.

Section 2.5 of UBC's *Design Guidelines* outline surface infrastructure requirements. Specific paving requirements are outlined for different areas of campus, highlighting that paving across campus provides differentiation of pedestrian and cyclist friendly areas, shared streets, and vehicular streets. The Campus Core Area 1 is to be created out of sandblasted concrete pavers, the Campus Core Area 2 is to be paved with natural grey concrete, and the pedestrian paths are to be made of asphalt, with some minor pathways to be surfaced in gravel (if other accessible routes are available) (UBC, 2020).
Section 2.5.2 outlines the lighting guidelines for the campus, which aim to accentuate gateways, reinforce the hierarchy of all corridors and commons, accentuate special places, connect all residential areas safely to the core campus facilities, appropriately light all building entries and circulation and accentuate campus character, beauty, and sense of place, all within the highest standards of sustainability (UBC, 2020).

Section 2.6.6 describes wayfinding and signage requirements on campus, stating that the signage must be consistent with the *UBC Wayfinding Exterior Signage Standards and Guidelines,* a policy that is amended from time to time (UBC, 2020).

While UBC has detailed sustainability guidelines in the design guidelines, they do not explicitly mention how these guidelines are applied to pathways on campus and are more so focused on buildings and general development.

3.1.2 Dalhousie University

Dalhousie University is in Halifax, Nova Scotia, and is an institution of roughly 20,000 students. Dalhousie is well-known for its focus on environmental research and sustainability in all areas. While slightly dated, the Dalhousie *Natural Environment and Landscape Policy and Guidelines* (2013) outlines the institutions policies on many aspects that which help inform best practices for Queen's University. Further, the Dalhousie *Campus Master Plan* (2010) highlights the open space network and movement systems, which provides valuable detail on the pedestrian-oriented campus.

The *Campus Master Plan* outlines appropriate campus-wide standards for pathway widths, with a minor pathway being 1.8m wide and an intermediate pathway being above 1.8m. The main pedestrian spine through campus is 4.5m, though this is not transferrable across all major pathways, which are 3.0m.

Dalhousie follows the seven principles of universal design to ensure the campus is accessible to people of all abilities. Beyond this, the Plan does not explicitly state accessibility requirements for its pedestrian realm. However, Dalhousie incorporates the principles of Crime Prevention Through Environmental Design (CPTED). These principles can provide improved safety and reduction in fear of crime, leading to a better sense of overall wellbeing on campus (Dalhousie, 2010).

In the Plan's description of active transportation networks, it identifies the importance of providing safe intersections in areas where vehicular traffic meets pedestrians and cyclists (Dalhousie, 2010). This is accomplished through paved two-way intersections at road crossings. The Plan also suggests widening the pedestrian area at intersections and directing vehicles to slow down with signage.

The Dalhousie *Natural Environment and Landscape Policy and Guidelines* outline materials to be used for campus open space and pathways. In central open spaces and special areas of campus natural stone paving is to be used in combination with concrete (Dalhousie, 2013). Guidelines for natural materials state that it should be available in suitable quantities, over an extended period, and sourced locally. Asphalt is only to be used in temporary instances for pedestrian pathways and is not to be used as a permanent material (Dalhousie, 2013). To increase sustainability and protect water sources, paving stones and porous paving should be integrated into the pathways where applicable, aiding in groundwater regeneration and stormwater management (Dalhousie, 2013).

Dalhousie's main priority when it comes to pathway greening is the introduction of both native and non-native plant species that are resilient and resistant to drought and salt (Dalhousie, 2010). The University recommends site-specific landscaping plans for different open spaces on campus but highlights the importance of a cohesive look and feel across campus and between campuses.

The Plan describes a clear campus-wide signage and wayfinding design to increase cohesiveness and clarity both inside buildings and in outdoor spaces. For ease of movement and clear wayfinding, the Plan suggests there be campus maps at pedestrian intersections on pathways, accompanied by adequate furnishings and lighting (Dalhousie, 2010).

3.1.3 University of Ottawa

The University of Ottawa is a public research university located northeast of downtown Ottawa, Ontario. The University has a total enrollment of approximately 44,600 students. It was selected as a case study as the University of Ottawa and Queen's University are similar in size, geographic location (situated in Eastern Ontario), and proximity to the downtown core. As such, it is valuable to establish an understanding of pathway standards from the University of Ottawa as they could be applicable to Queen's University.

The standards for the University of Ottawa were outlined in the University of Ottawa *Campus Master Plan* (2015). Section 4.6 of the Plan, entitled 'Open Space and Streetscapes' established a set of standards for pathway widths, amenities, greening, and location considerations. The plan identified width standards for shared streets (3m), major pathways (3m), and intermediate pathways (2.5m), but did not include standards for minor pathways, internal streets, or bicycle lanes (University of Ottawa, 2015).

The plan recommends the addition of various amenities to enhance the pathways, including street furniture, lighting, signage, and other wayfinding elements. These elements are intended to improve perceptions of safety, ease of navigation, and contribute to a more welcoming campus overall (University of Ottawa, 2015). Pathway amenities should complement surrounding architecture and landscaping features to promote uniform design and seamless transitions between distinct places on campus. The plan has a significant focus on placing these amenities in high trafficked areas such as key intersections, campus entry points, and major open spaces (University of Ottawa, 2015).

In terms of pathway greening, the plan aims to ensure that sites where future open space improvements are proposed be appropriately planned to ensure that trees and other greenery will thrive over their life cycle. Sustainability features such as stormwater capture systems are recommended for all landscape improvement projects on the University of Ottawa campus. The plan features eleven major open space initiatives intended to increase the amount of open space, reduce the number of cars in the campus core, improve active transportation conditions, and optimize connections to public transit. To accomplish this, the plan proposes to eliminate vehicular access to certain areas on campus, repurpose parking lots into usable open space, introduce new landscaping features and pathway amenities, revitalize existing streets to create more favourable conditions for pedestrians and cyclists, develop a system of linked open spaces, and to improve access to the light-rail transit network (University of Ottawa, 2015). These initiatives were included based on their potential to support the university's sustainability objectives and shaping the identity and experience of the campus itself (University of Ottawa, 2015).

3.1.4 Western University

Western University is a public research university in London, Ontario with roughly 32,000 students. Western University was selected as a case study as it is similar in nature to Queen's University and features valuable standards for pathways and open spaces that can be used to inform the creation of new standards at Queen's University.

The standards for Western University were established in the Western University *Open Space Strategy* (2018). Chapter 5.B of the strategy focuses on recommendations for corridors on campus. In this section, Western University recommends 4.3m for a shared street, 3m for a major pathway, between 2-2.4m for an intermediate pathway, and 3m for bicycle lanes (Western University, 2018).

The strategy provides a comprehensive series of recommendations to improve the quality and user experience of campus pathways and open spaces. Common themes across these recommendations include the need to improve pedestrian safety, create signature public spaces that are accessible to everyone, and to integrate sustainability features across the campus. In terms of pedestrian safety, one of the most significant interventions in the strategy is eliminating private vehicle access to the campus core. This would reduce the volume of cut-through traffic and relieve tension between pedestrians and drivers in turn, contributing to a safer and more desirable pedestrian environment. Despite not being intended for vehicle use, the paving depths would be suitable to accommodate periodic use by service

and emergency vehicles as needed. To further improve perceptions of safety for pedestrians, the strategy recommends consistent use of wayfinding materials, signage, and adequate lighting in places of interest across campus (Western University, 2018).

With regards to open spaces, the strategy places a significant emphasis on the creation of dynamic environments and signature public spaces that contribute to campus identity. To accomplish this, it recommends that curbs be removed on pedestrian routes that accommodate vehicle use and that spaces should integrate unique paint schemes and/or textured paving materials to leave a lasting impression on the visitor. Places intended for pedestrian congregation, such as courtyards and gardens, should provide pedestrians with a variety of seating options that cater to people of all abilities and user preference. There should be a mix of benches, moveable chairs, and clustered tables to provide sufficient seating options and provide users with the opportunity to manipulate space. In addition, the strategy recommends that 25 percent of all seating within these areas be barrier-free and provide adequate space to maneuver mobility devices (Western University, 2018).

To contribute to a more sustainable campus, Western University proposed various pathway greening initiatives including preservation of existing tree plantings, providing new trees in areas where there are gaps in canopy coverage, and increasing landscaping near pathways and in open spaces. It is recommended that pathways should be framed with deciduous tree plantings to supplement the aforementioned pathway amenities, as well as in areas beyond the pathways where there is adequate soil volume. The strategy reinforced the importance of taking a sustainable approach to planting and paving by recommending the use of materials such as permeable pavers and bio-dynamic plantings (Western University, 2018).

Figure 3-1 Examples of pathways with desirable characteristics from Western University's (2018) Open Space Strategy.

3.1.5 University of Saskatchewan

The University of Saskatchewan is a public research university in Saskatoon, Saskatchewan and is comprised of almost 21,000 students. The University was selected as a case study location because of its vigorous pathway standards, which can be used as precedents in the development of pathway standards for Queen's University.

The University of Saskatchewan's standards were included in the University of Saskatchewan *College Quarter Master Plan* (2010). The plan proposes a width of 2.5 m for major pathways, 1.5+m for intermediate pathways, 1.5 m for minor pathways, 6+m for internal streets, and 1.5m for bicycle lanes (University of Saskatchewan, 2010).

Section 3 of the plan provides an overview of the University's performance standards, which aim to ensure that the design of new campus spaces contribute to a cohesive, high-quality campus image. The relevant performance standards can be divided into three categories: (1) pathway amenities, (2) open spaces, and (3) sustainability features. With regards to pathway amenities, the plan focuses greatly on incorporating features that improve pedestrian safety. Performance Standard 9 (Pedestrian-Oriented Development) and 10 (Pedestrian Street) speak to the importance of improving pedestrian safety across campus. To achieve this, vehicle use should be limited to service and emergency vehicles and pathways should incorporate public amenities, pedestrian lighting, and wayfinding elements. To ensure pathways are accessible for people of all abilities, Performance Standard 12 (Pathways) indicates that longitudinal grades should not exceed five percent and steps should not be built without a convenient and accessible alternative (University of Saskatchewan, 2010).

Figure 3-2 A rendering of the currently under development "Greenway" from the University of Saskatchewan's (2010) College Quarter Master Plan.

Performance Standard 14 (Open Spaces) proposes the creation of an interconnected system of outdoor spaces that define travel patterns within the campus. These spaces should be accessible to the public, promote use during all seasons, and should connect to a concept or theme that is meaningful to campus culture (University of Saskatchewan, 2010).

The pathways and open spaces should be supplemented by sustainability features; Performance Standard 10 (Pedestrian Street) and Performance Standard 15 (Landscaping) indicate that pathways should be surrounded by trees to provide a level of weather protection, along with a connection to nearby open spaces. Landscape treatments should be integrated into the design of open spaces to provide a comfortable, safe, and attractive campus environment in all seasons (University of Saskatchewan, 2010).

3.2 Sustainability Research

As noted in the previous sections, sustainability is one of the foremost principles of the pathway standard project and a priority for Queen's University. Research was conducted into sustainable practices, materials, and operations on university campuses and incorporated into the project's recommendations (see Section 5.0). Bakos and Schiano-Phan (2021) propose a 'circular university campus' approach to sustainability, adopting best practices to reduce waste through a circular construction industry model. While the study focused on the construction of campus buildings and regenerative design, their findings are valuable to inform the pathway standard proposal, in particular their approach to whole-life carbon analysis. Way, Matthews, Rottle, and Toland (2012) propose that through sustainable campus landscape design universities can be environmental and educational leaders. They highlight the importance of interdisciplinary collaboration between designers, planners, engineers, architects, landscape architects, and scientists to create a vision for university campuses that reduce their environmental impact and carbon footprints. Case studies on four American universities highlight the value of localized strategies for creating a sustainable landscape; local conditions, capacity and campus elements are all factors in campus greening (Way et al., 2012).

Research into concrete alternatives and reuse was conducted to inform the recommendations and considerations of this project. Producing concrete is a highly energy intensive and GHG emitting process; alternative materials and processes of production were explored to evaluate potential areas for reduced material and energy use. First and foremost, reducing demand for new material is the principal method to decrease environmental impact; sourcing materials locally further decreases the carbon footprint of a development project (Davidsen & Green, n.d.). Using permeable materials such a porous concrete or asphalt "allow water to

infiltrate and recharge aquifers, instead of being sent to combined stormwater and sewer systems," further improving the environmental performance of a built landscape (Davidsen & Green, n.d.). Incorporating recycled materials such as concrete with recycled components (fly ash, crushed glass, wood chips) and recycled concrete into development practices reduces material waste, extending its life-cycle.

3.3 Accessibility Research

Academic research and institutional standards and guidelines were reviewed to inform the proposed pathway standard and guide our recommendations. The *Accessible Design for the Built Environment* guide (2004) by the Standards Council of Canada and National Capital Commission's *Barrier Free Site Design Manual* (1995) were reviewed to identify components of pathway design that support equitable and accessible use. Standards for width, material, edge treatment, lighting, and shared route use were incorporated into the following proposed pathway standard. Development on Queen's University adheres to the *Accessibility for Ontarians with Disabilities Act* (AODA) and *Ontario Regulation 332/12: Building Code* to provide students, faculty, staff, and visitors with a safe and accessible campus environment. However, as Dinç Uyaroğlu (2016) highlights, the minimum application of accessibility standards does not guarantee equitable use for people with disabilities on campus; design should consider collective use, be inclusive of all abilities and support the most 'extreme' needs to the fullest extent. The proposed pathway standard and recommendations aim to exceed AODA standards.

Academic research into accessible pathways and outdoor environments on university campuses were also reviewed to gain a greater understanding of best practices for creating a more sustainable and supportive campus experience for all. Dwyer et al. (2022) argue that it is increasingly important to create neurodiversity-inclusive campuses; they explore methods to identify and decrease sensory distress, discomfort, distraction, and overload in the campus environment to support neurodiverse students, staff, and faculty by providing what sensory refuge areas outdoors. They also propose that sensory accessibility be considered during construction on campus. Agrawal and Yadav (2021) note that on average students spend approximately one fifth of their time in the classroom; they argue that a university campus's natural landscape should be considered a learning resource for students. Investing in the natural landscape through thoughtful design, wayfinding, placemaking, and amenities such as outdoor furniture and art can be contribute to an interactive and engaging campus that support student learning and wellbeing.

4 Data Collection & Analysis

Collection and analysis of data related to pathway use and users was identified as an opportunity to understand existing use characteristics within the study area. The results of the observational data collection and analysis supplement the research of precedent case studies and academic literature undertaken as part of this report as outlined in the previous section. The results provide insight into how the internal pathways are being used, by whom, at what times of day, and if the existing pathway dimensions and design are congruent with the observed volumes and mode uses. The application of this data is twofold: firstly, in supporting the development and affirmation of the proposed pathway width standard, and secondly, in classifying the pathways within the designated study area based on the proposed standard.

4.1 Data Collection

4.1.1 Quantitative Data Collection

Quantitative data collection was conducted to gain insights into the user volumes and use characteristics of various pathways within the designated study area. The process of data collection and subsequent results are discussed below.

4.1.1.1 Process

The quantitative data collection process was derived from standard approaches identified by Portland State University's Transportation Research and Education Center (2014), the Pedestrian and Bicycle Information Center (2018), and the U.S. Department of Transportation (2016), and adapted to suit the requirements of this project. Modifications to the above standard approaches include:

- The adjustment of typical count period lengths from 3 hours to 75 minutes to align with class start and end times and optimize time burden
- The omission of weekend counts to align with typical heightened campus activity levels
- The omission of counting at the same location across multiple days to maximize time efficiency and the reach of data collection
- The omission of adjustment factors due to the absence of permanent count data at the identified locations

These adjustments culminated in the following data collection process, which is summarized below and outlined in greater detail in Appendix C.

- All pathway segments within the study area were allocated unique numerical codes through the labelling of all intersections with a numerical value, as shown in Figure 4-1.
- Segments of interest were identified through site visits and discussions with the client.
- Pathway user counts were undertaken during typical school days, namely Monday through Thursday, excluding Friday due to its potentially lower activity levels given the nature of class scheduling, increased likelihood of student absenteeism, and holidays.
- Pathway user counts were conducted over three 75-minute periods that correspond to two 15-minute peak usage periods in between classes and a 45-minute off-peak period during typical class times. These periods were distributed across typical class hours and included the following time slots:
    - 8:15 am – 9:30 am
    - 12:15 pm – 1:30 pm
    - 3:15 pm – 4:30 pm
- Pathway users were tracked via three parameters:
    - Peak- or off-peak usage
    - Direction of travel
    - Mode of travel
- Qualitative notes regarding movement patterns, vehicle use, pathway condition, and notable existing pathway design features were recorded when time permitted, typically during the off-peak periods.

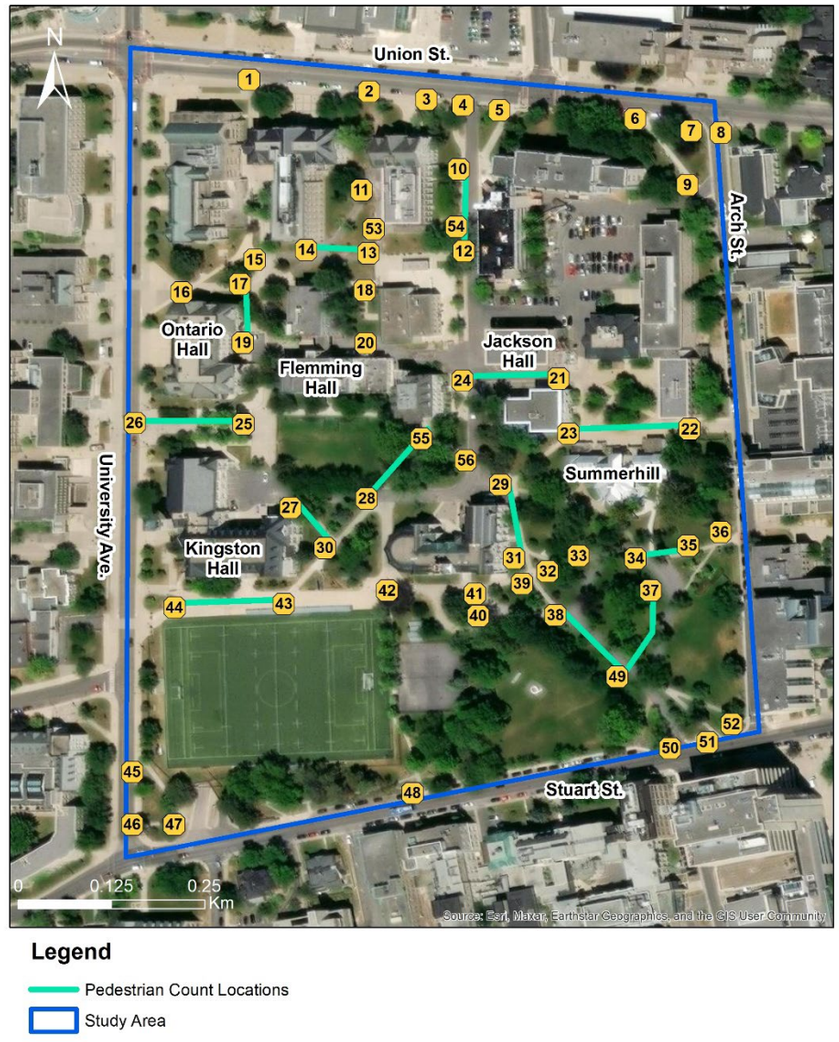

Figure 4-1 Map of intersection nodes and pedestrian count locations.

4.1.1.2 Pathway User Counts

Pathway user counts were found to vary widely across the observed locations. Generally, pathways that provide direct connections to significant campus destinations were observed to incur the largest volumes of users throughout the observation periods. Conversely, the locations that did not provide direct connections were generally found to incur lower user volumes. While these initial findings appear intuitive, they provide valuable affirmation as to the required characteristics of the pathways within the study area. The entirety of collected user data for the observed study area pathways can be found in Appendix D.

4.1.1.3 Pathway Measurements

The widths of pathways identified as candidates for observation were measured to provide current dimensions to be used as part of the data analysis, discussed below. The following pathway measurements were obtained for the selected pathway segments, provided in Table 4-1, to the right.

Table 4-1 Table of path widths.

Segment	Path Width (m)
27-30	2.40
43-44	9.07
38-49	4.65
29-31	2.11
37-49	3.66
34-35	1.84
28-55	2.41
21-24	10.13
22-23	7.52
10-53	10.21
13-14	2.79
17-19	7.35
25-26	6.02

4.1.2 Qualitative Data Collection

Qualitative data collection was conducted to characterize the existing pathway network within the study area and provide insights into existing strengths, weaknesses, opportunities, and constraints to implementing the standard and providing subsequent recommendations.

4.1.2.1 Qualitative Data Collection Process

Study area site visits were conducted whereby detailed notes and images were taken to gather a detailed depiction of the current condition and configuration of the existing pathway network, and in part guided the direction and development of the recommendations.

4.1.2.2 Existing Materials

Pathways within the study area were observed and noted for the condition and consistency of their existing materials. Generally, pathways were found to utilize inconsistent materials which diminished the visual cohesion of the path network, and in some instances present accessibility concerns. Figure 4-2 and Figure 4-3, below, demonstrate pathway material inconsistencies found within the study area.

Figure 4-2 (Left): Poor material quality along the Summerhill driveway. (Middle): Inconsistent pathway materials present between Summerhill and Theological Hall. (Right): Poor material quality and selection along the pathway west of Nicol Hall.

The Summerhill driveway is currently a paved asphalt surface and is inconsistent with other pathway materials in the area. Furthermore, its deteriorating condition was noted as both aesthetically unpleasant and a potential safety hazard. Opportunities exist to improve upon this location with enhanced material selection. Similarly, the pathway west of Nicol Hall was noted for its inconsistent materials and poor material quality.

Figure 4-3 (Left): Inconsistent pathway material selection and typology south of Douglas Library. (Middle): Inconsistent pathway material leading from Professor's Walk to the Summerhill driveway. (Right): Inconsistent pathway buffer material behind Douglas Library.

The pathways south of Douglas Library, as demonstrated in Figure 4-3, are inconsistent in material and typology. The pathway to the left utilizes a different shade of concrete, cuts through the pathway to the right, and the use of appropriate buffer materials is omitted. Professor's Walk at Summerhill also demonstrates inconsistent material usage and may pose accessibility concerns due to its slope approaching Arch Street. As noted in the Campus Master Plan (2021), Professor's Walk is intended to be consistent across its length. The inconsistent use of buffer materials was noted behind Douglas Library, whereby both cobblestones and smaller stones are implemented. Inconsistencies such as this may be remedied through the future redesign of this area.

4.1.2.3 Notable Pathways

Within the study area, select pathways were noted for various characteristics that highlighted them as candidates for special consideration. These characteristics include design elements misaligned with their observed function, perceived excess, or insufficient width to suit user volumes, their location and function within the network, or their position relative to destinations and buildings within the study area, among others. Figure 4-4, to the right, depicts notable pathways within the study area that are of interest for further consideration.

5th Field Company Lane from Theological Hall to Kingston Hall was noted for its decommissioned parking spaces and its limited vehicle access requirements. Opportunities exist to better orient this area towards active travel modes. The pathway behind Ontario Hall was found to be too wide for its observed user volumes, and its future vehicle access requirements are diminished due to the relocation of Postal Services and Campus Security from Fleming Hall to 355 King Street East. Extensive hardscape reduction may be appropriate at this location. Similarly, the roadway between Jackson Hall and the Old Medical Building provides unnecessary vehicle access and may benefit from redesigned features that prevent vehicle use. Lastly, Professor's Walk at Summerhill was found to be too narrow to accommodate its observed volumes. Hardscaping expansion is thus likely required.

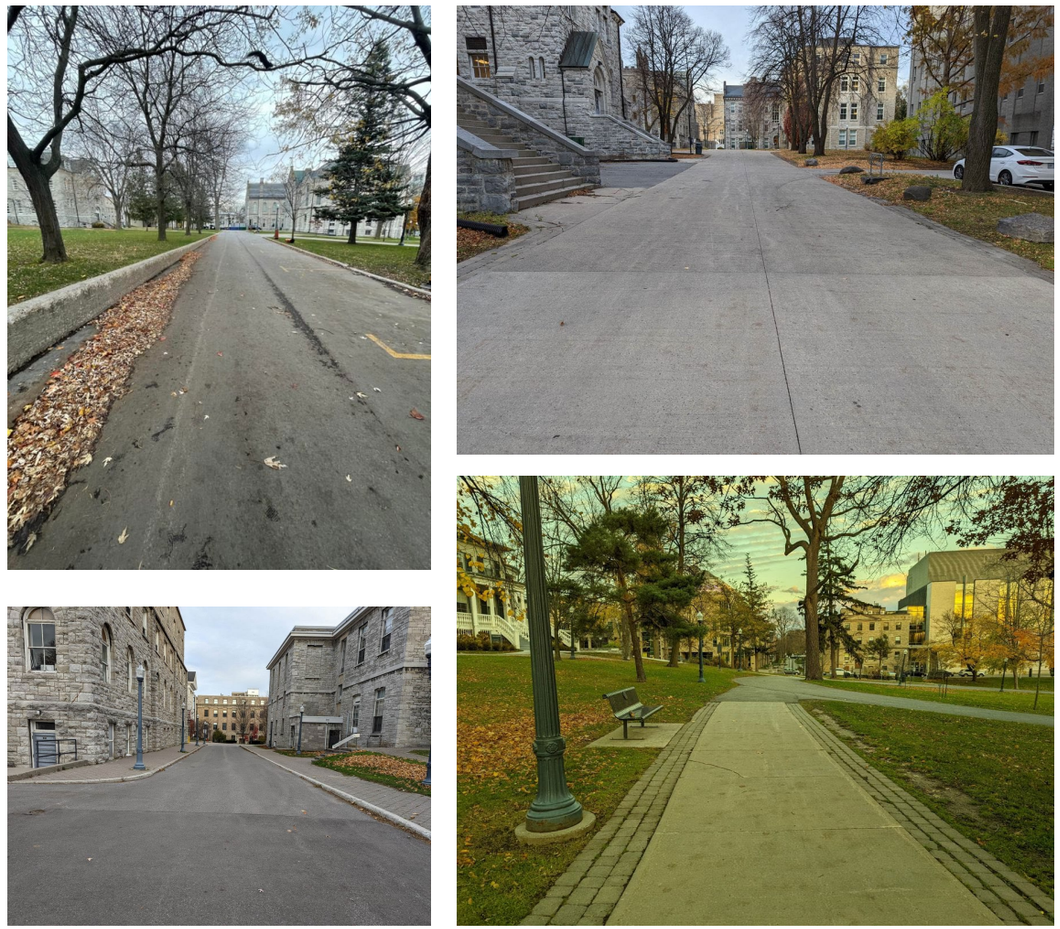

Figure 4-4 (Top left): 5th Field Company Lane behind Kingston Hall. (Top right): Path on the east side of Ontario Hall. (Bottom right): View of Professors walk in front of Summerhill, facing east. (Bottom left): Path between Jackson Hall and Old Medical Building, facing east.

4.1.2.4 Informal Pathways

The presence of informal pathways was noted at numerous locations throughout the study area. Informal pathways are those that are worn into the earth by frequent travel by users, often as a cut-through or shortcut to reduce the length of a given trip. These informal paths provide insight into the travel behaviours of users and exemplify existing deficiencies in the pathway network. Figure 4-5 shows informal pathways identified within the study area.

Informal pathways were generally found to be created in areas where users identified a more direct route to their destination. The creation of these pathways may suggest that adjustments to the path network be considered, mitigation infrastructure be implemented, or increased pathway capacity may be required. Notably, the informal pathway between Gordon and Fleming Halls was found to be used in lieu of the formal adjacent pathway, as it provided a more direct route to key destinations such as Bemish-Munro Hall, Miller Hall, and Union Street more broadly. Alternatively, informal pathways at the Arch Street gates were found to derive from the path's relatively limited capacity compared to its observed user volumes.

Figure 4-5 Top left): Informal path between Gordon Hall and Fleming Hall. (Top middle): Informal path on the north edge of the Arch St. gates. (Top right): West-facing view of the informal path leading up to the Arch St. gates. (Bottom right): Informal path veering towards Kingston General Hospital from the Summerhill driveway. (Bottom left): Informal pathway east of Nicol Hall leading to Miller Hall's Bruce Wing.

4.1.2.5 Pathway Barriers

Pathway barriers are specific features that inhibit the efficient and safe use of the network by those utilizing mobility aids. Barriers may include poor pathway conditions, insufficient travel space due to barricades such as planters, excessive grades, steps and curbs. Barriers were noted as conflict zones and aided in guiding the conducted research and development of the recommendations contained herein. Figure 4-6, to the right, shows examples of barriers identified within the study area.

Figure 4-6 (Left): Bollard in the middle of a path intersection, facing Summerhill. (Right): Stairs along the pathway west of Nicol Hall, leading to the Campus Bookstore.

Barriers identified within the study area pose potential challenges to users and may conflict with AODA requirements. Where possible, the use of infrastructure possibly creating barriers for users should be mitigated to only those locations where it is necessary, and in these events the implementation of convenient alternative routes should be strongly considered.

4.1.2.6 Pedestrian Flows

During site visits and pathway user count observations, broad pathway use trends were noted and recorded. This information is depicted in Figure 4-7 provides valuable insight into the general mobility choices of pathway users and can provide insight towards the most highly travelled routes within the study area.

Generally, few routes within the study area were found to possess frequent high volumes of users. The pathways carrying the highest volumes of users were found to be Professor's Walk, the north-south segment of 5th Field Company Lane, and the pathway south of Ontario Hall. These locations are considered major ingress points and lead to a variety of additional pathways and destinations. Other routes were noted for their unique or interesting characteristics. For example, cyclists entering the study area from the corner of Arch Street and Stuart Street utilized the pathway east of Theological Hall more than anticipated, and the path behind Ontario Hall was generally underused relative to its large size.

It should be noted that the circulation trends provided are anecdotal to the select count periods and site visits conducted by the project team. Investment into a broader campus-wide circulation study may be beneficial and would provide greater insights into the movement patterns of pathway users on Queen's' campuses.

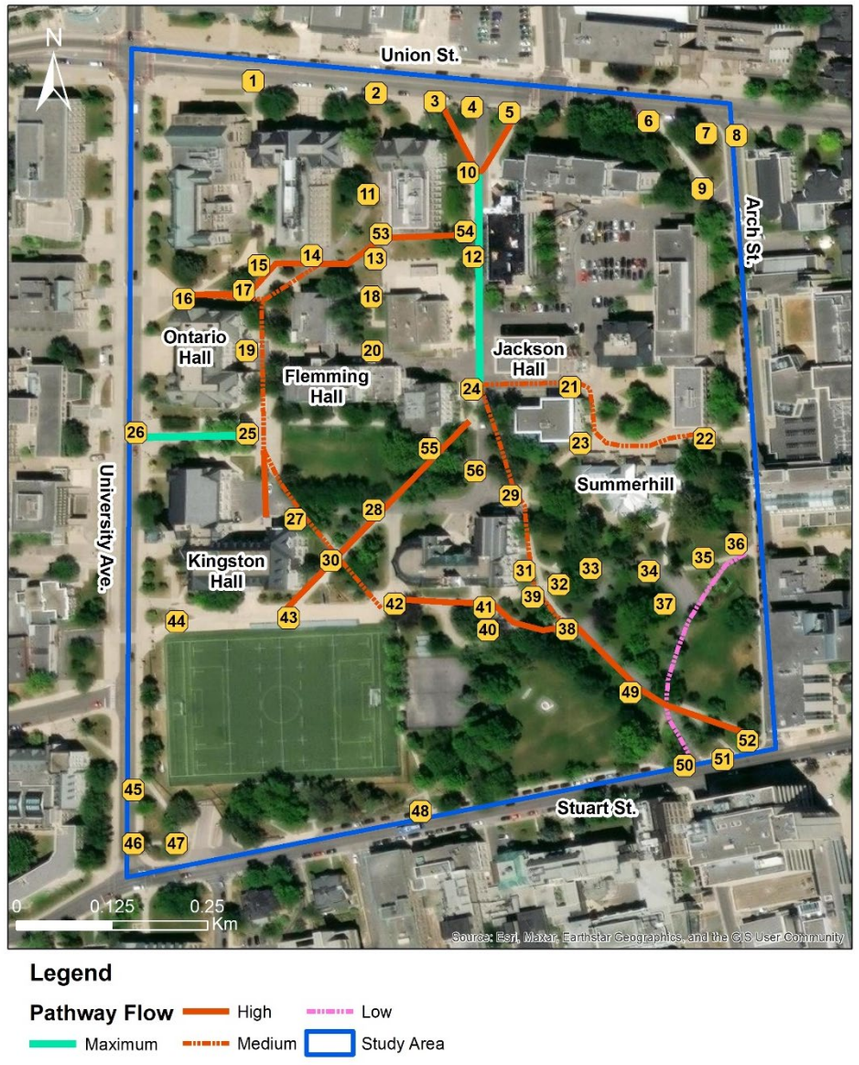

Figure 4-7 Pedestrian flow map depicting broad circulation trends noted during counts and site visits.

4.2 Data Analysis

Volume and mode data collected for the identified pathways within the study area were analyzed to provide greater insights into their existing use characteristics and to identify strengths, deficiencies, and potential areas of improvement. Additionally, the initial analysis aided in the production of path scenario forecasting, whereby the impacts of potential width adjustments were determined.

4.2.1 Data Analysis Process

Data analysis was conducted in three stages, the development of summary statistics for the measured pathways, pedestrian flow rate and volume/capacity, and flow rate and volume/capacity (V/C) scenario forecasting. Summary statistics for pathway use include total mode split, total pathway volume, and bi-directional user volume split. Pedestrian flow rate was calculated using the following formula derived from the *Highway Capacity Manual* (2000):

$$V_p = \frac{V_{15}}{15 * W_E}$$

Where V_p is the pedestrian unit flow rate (persons/minute/metre), V_{15} is the peak 15-minute flow rate (persons/15-minutes) obtained from one of six observed peak periods at each location, and W_E is the effective pathway width (metres) obtained using the standard obstacle buffer values provided in the *Highway Capacity Manual*. Volume/capacity values were determined using the following formula, derived from the *Highway Capacity Manual* (2000):

$$V/C = \frac{V_p}{V_c}$$

Where V/C is the ratio of user volume to pathway capacity, V_p is the pedestrian unit flow rate, and V_c is the pathway flow capacity (persons/minute/metre). The *Highway Capacity Manual* identifies a capacity flow value of 75 persons/minute/metre; however, this corresponds to extreme conditions that are unsuitable for typical pathway usage. For this project, a capacity flow value of 11 persons/minute/metre was utilized to represent the maximum desirable unit flow rate of users along the

pathway at any given peak period. This unit flow rate was obtained from the Transport for London (2019) *Pedestrian Comfort Guidance for London* document, which recommends that public walking areas be designed from a maximum flow rate of 11 persons/minute/metre. The guidance document specifically states that this flow rate, "provides enough walking space for normal walking speed and some choice in routes taken" (p. 13).

4.2.2 Data Analysis Results

The summary statistics derived from the collected quantitative pathway data are provided in Table 4-2, below. Provided statistics include mode split, consisting of pedestrian travel, bicycles, and other wheeled active mobility; total observed volume of pathway users encompassing all travel modes; and directional volume split, demonstrating the relative percentage of users travelling along the pathway in a given direction.

Table 4-2 Pathway observation summary statistics.

Date (2022)	Segment	Mode Split			Total Volume	Directional Volume Split			
		Pedestrian	*Bike*	*Other*		*North*	*South*	*East*	*West*
Mon, Sept 19[1]	28-55	98.3%	1.5%	0.2%	465	71%	29%	-	-
	43-44	97.8%	1.6%	0.7%	1,215	-	-	54%	46%
Tues, Sept 20	37-49	100.0%	0.0%	0.0%	198	51%	49%	-	-
Wed, Sept 21	38-49	95.7%	3.8%	0.5%	833	54%	46%	-	-
Thurs, Sept 22	27-30	96.6%	2.2%	1.2%	416	39%	61%	-	-
Mon, Sept 26	10-53	97.0%	2.5%	0.6%	1,589	40%	60%	-	-
	22-23	99.6%	0.2%	0.2%	473	-	-	38%	62%
Tues, Sept 27	21-24	96.4%	2.2%	1.5%	411	-	-	53%	47%
	29-31	97.0%	2.4%	0.6%	468	56%	44%	-	-
Wed, Sept 28	13-14	97.2%	2.0%	0.8%	598	-	-	39%	61%
	25-26	96.8%	2.1%	1.1%	1,310	-	-	51%	49%
Thurs, Sept 29	17-19	95.3%	2.3%	2.4%	836	49.5%	50.5%	-	-
	34-35	98.5%	1.3%	0.2%	1,492	-	-	57%	43%

Notes:

[1]Counts on Monday, September 19th did not include the 12:15 pm – 1:30 pm time slot due to inclement weather.

The summary statistics for the collected data suggest that pedestrians are the primary users of the pathways within the study area, followed by bicycles, and other wheeled mobility. This result is significant, confirming observed use characteristics across pathways within the study area. Furthermore, the bi-directional volume splits suggest that most observed pathways receive comparable usage in both directions. This is expected, as all buildings within the study area act as origins and destinations for trips, depending on the time of day. Finally, the total observed volumes provide broad indications as to relative popularity of routes used within the study area. However, it should be noted that variations in class times, day of week, weather, and time of observation influence the observed volumes; therefore, only broad trends of relative volume were derived from this data. Flow rate and volume/capacity results are provided Table 4-3 below:

Table 4-3 Flow rate and volume/capacity result table.

Date (2022)	Segment	Flow Rate (p/m/m)					V/C				
		N	S	E	W	Total	N	S	E	W	Total
Mon, Sept 19	28-55	3.29	0.94	-	-	4.23	0.299	0.086	-	-	0.385
	43-44	-	-	1.09	1.19	2.28	-	-	0.099	0.108	0.207
Tues, Sept 20	37-49	0.18	0.16	-	-	0.35	0.017	0.015	-	-	0.031
Wed, Sept 21	38-49	0.65	0.59	-	-	1.23	0.059	0.053	-	-	0.112
Thurs, Sept 22	27-30	0.67	0.78	-	-	1.44	0.061	0.071	-	-	0.131
Mon, Sept 26	10-53	0.61	0.95	-	-	1.56	0.055	0.087	-	-	0.142
	22-23	-	-	0.31	0.62	0.93	-	-	0.028	0.056	0.085
Tues, Sept 27	21-24	-	-	0.28	0.25	0.53	-	-	0.026	0.023	0.048
	29-31	0.82	1.20	-	-	2.02	0.075	0.109	-	-	0.184
Wed, Sept 28	13-14	-	-	0.72	1.98	2.70	-	-	0.065	0.18	0.245
	25-26	-	-	1.36	1.44	2.80	-	-	0.124	0.131	0.255
Thurs, Sept 29	17-19	0.45	0.42	-	-	0.87	0.041	0.038	-	-	0.079
	34-35	-	-	6.05	4.60	10.65	-	-	0.55	0.418	0.968

The pathway flow rates provided above suggest that many observed paths within the study area operate at relatively low flows, often around or below 1 person/minute/metre. To provide further insight, the volume/capacity values indicate that many paths are operating well below the maximum desired flow of 11 persons/minute/metre. This suggests that there are opportunities to reduce path widths at certain locations within the study area. However, the flow and volume/capacity values for Professor's Walk at Summerhill (segment 34-35) was identified as approaching the target maximum flow of 11 persons/minute/metre.

4.3 Pathway Width Optimization

To determine the pathway widths that would be required to accommodate the observed use levels within the study area, a pathway width optimization exercise was undertaken with the objective of improving campus sustainability through right-sizing pathway widths and reduced hardscaping where possible. The results of this optimization informed the classification of pathways within the study area, and in part guided the proposed campus-wide pathway width standard.

4.3.1 Pathway Width Optimization Process

The pathway width optimization exercise was conducted using an adaptation of the pedestrian flow rate and volume/capacity equations provided above. Firstly, the volume/capacity equation was rearranged to isolate V_p and was inserted into the unit flow rate equation, which was rearranged to isolate W_E. The resulting equation is shown below:

$$W_E = \frac{v_{15}}{15 * (V/C * V_c)}$$

This equation provided opportunities to determine the required pathway width to accommodate the observed peak pedestrian flow rates at a selected volume/capacity ratio. For the purposes of this exercise, a ratio of 0.65 was selected, to account for potential future increases to pathway user volumes and lack of longitudinal data gathered through the data collection process. As with the volume/capacity calculations provided above, the pathway flow capacity was set to 11 persons/minute/metre. To determine the effective width required for each observed pathway, the peak 15-minute pedestrian flows were determined for both measured directions (i.e. north and south or east and west). The effective width was then calculated for each direction and summed to determine the total required effective width. These values were then compared to the minimum width requirement of 1.6m for accessibility considerations and adjusted accordingly. Finally, the effective widths for each pathway were classified as one of either major, intermediate, or minor, to suit the proposed pathway width standard.

4.3.2 Pathway Width Optimization Results

The pathway width optimization exercise provided insight into the effective widths required to accommodate the recorded user volumes at the observed pathways. These effective widths allowed each observed pathway to be assigned a classification from the proposed pathway width standard. Furthermore, pathways that were

not observed for user volumes within the study were able to be classified by comparing their location and characteristics with that of the observed pathways. The pathway width optimization results are provided in Table 4-4, below.

Table 4-4 Pathway width optimization results.

Segment	Existing Width (m)	V_{15}		V/C Target	W_E		W_E Total	
		N/E	S/W		N/E	S/W		
28-55	2.41	119	34	0.65	1.110	0.317	1.43	1.60
43-44	9.07	148	162	0.65	1.380	1.510	2.89	2.89
37-49	3.66	10	9	0.65	0.093	0.084	0.18	1.60
38-49	4.65	45	41	0.65	0.420	0.382	0.80	1.60
27-30	2.4	24	28	0.65	0.224	0.261	0.48	1.60
10-53	10.21	93	146	0.65	0.867	1.361	2.23	2.23
22-23	7.52	35	70	0.65	0.326	0.653	0.98	1.60
21-24	10.13	43	38	0.65	0.401	0.354	0.76	1.60
29-31	2.11	26	38	0.65	0.242	0.354	0.60	1.60
13-14	2.79	30	83	0.65	0.280	0.774	1.05	1.60
25-26	6.02	123	130	0.65	1.147	1.212	2.36	2.36
17-19	7.35	50	46	0.65	0.466	0.429	0.90	1.60
34-35	1.84	167	127	0.65	1.557	1.184	2.74	2.74

The above width optimization results indicate that many of the recorded user volumes on the observed pathways can be accommodated by widths that are below the minimum 1.6m required for accessible use and snow removal. Only two pathways were found to require classification as intermediate and two others classification as major pathways. While this exercise guided the classification of pathways within the study area, other considerations were included as well, such as the anticipated use function of the pathways within the broader network, vehicular access requirements, fire routes, and the inclusion of pathways as proposed cycling trails within the Queen's Campus Master Plan.

5 Pathway Width Standard & Campus-Wide Recommendations

5.1 Pathway Standard & Characteristic Summary

Through an integrated process of a literature review, case study analysis, and primary data collection, a pathway width standard has been developed that classifies pathways through their observed and anticipated user volumes, use function, and position and role within the campus pathway network. Each classification is assigned an appropriate width range that is suitable for these characteristics, as well as potential operational and maintenance ramifications. Table 5-1, below, provides the pathway width standard classifications, width ranges, and summary notes regarding the defining pathway characteristics.

Table 5-1 Pathway width standard, classifications, and summary notes.

Pathway Classification	Width Range (m)	Use Functions	User types	Additional Notes

Shared Streets	4 – 4.5	• Multimodal travel route
		• Permit limited vehicle access
		  ○ Service vehicles
		  ○ Accessible parking
		  ○ Fire access
			• Pedestrians
			• Bicycles
			• Micro-mobility
			• E-mobility
			• Automobiles
				• Major corridor on campus
				• Range of user volumes, variable given location and context of pathway

Major	3 – 3.5	• High volume active travel route for pedestrians and wheeled mobility • Occasional and limited service vehicle access under special circumstances	• Pedestrians • Bicycles • Micro-mobility • E-mobility	• Regularly accommodate highest volumes of users
Intermediate	2 – 2.5	• Pedestrian-oriented travel route • Accommodate a range of user volumes	• Pedestrians • Occasional wheeled mobility	• Not designed to accommodate vehicle use under any circumstances • Provide a variety of connections
Minor	1.6 – 1.8	• Pedestrian-oriented travel route • Intended to accommodate low user volumes	• Pedestrians • Occasional wheeled mobility at off-peak times	• Not designed to accommodate vehicle use under any circumstances

5.2 Pathway Recommendations

5.2.1 Pathway Classification Characteristics

Pathway classification characteristics are intended to support and guide the application of the proposed pathway width standard to existing and proposed pathways across Queen's campuses. Through the pathway classification characteristics, consideration is given to the pathway function, the desired travel modes, the observed and anticipated user volumes, and the pathway location and context. Notably, the provided characteristics are not prerequisites for pathway classification, but rather should serve as a guidance tool to utilize when undergoing the process of classifying pathways on Queen's campuses.

Figure 5-1 Overlooking Nixon Field, Theological Hall, and Kingston Hall/Grant Hall on Queen's Main Campus.

5.2.1.1 Shared Streets

Shared streets are intended to function as a multimodal, multifunctional route on campus that prioritizes pedestrian and active mobility users while maintaining vehicle access required for specific university functions. Vehicle access is intended to be oriented towards required services (e.g., waste collection, snow removal access, required PPS operations), vehicles permitted to utilize accessible on-campus parking near specific buildings, and fire access. Shared modality pathways are intended to integrate all forms of mobility, providing flexible travel corridors on campus. Through locational and use contexts, shared modality paths may be expected to accommodate a wide variety of user volumes and mode splits. Figure 5-2, to the right, provides a typical cross section for shared streets demonstrating the designated width range. Notably, the buffer width is anticipated to conform to the requirements for pathways exceeding 3 m stated within the Queen's Building Design Standard (2022), resulting in a width of 750 mm.

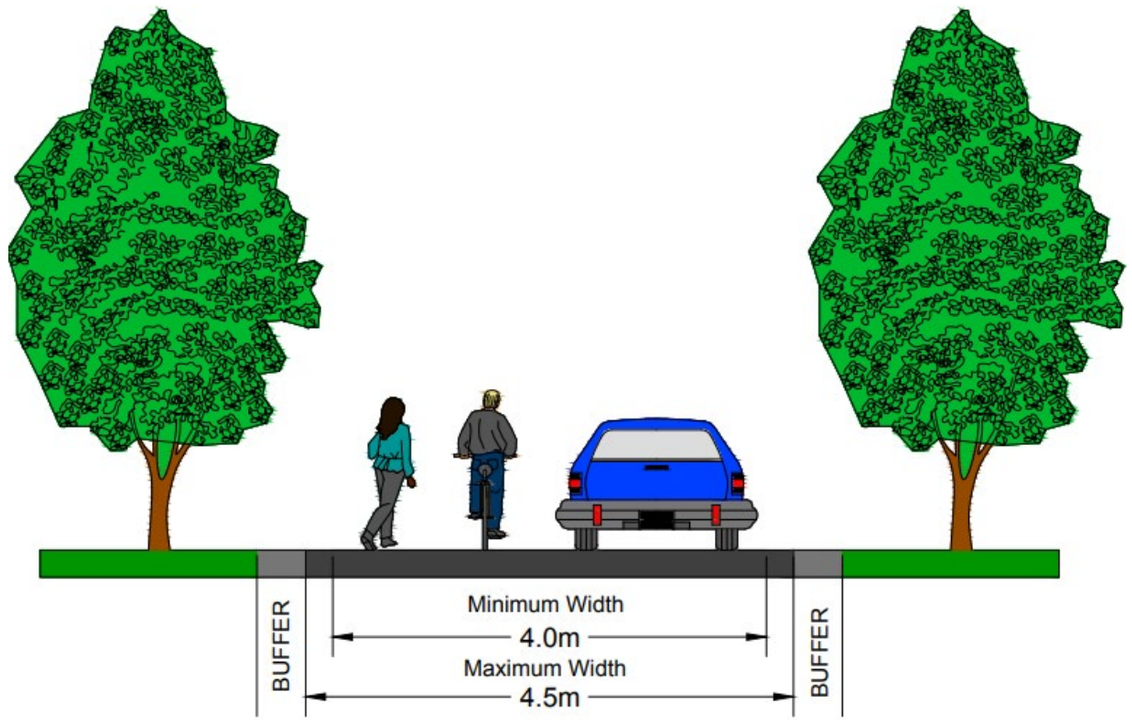

Figure 5-2 Cross-section demonstrating typical dimensions and configuration of a shared streets pathway.

The shared street pathway classification should be assigned where a route or corridor has been identified as requiring continued occasional vehicle access due to servicing or accessibility requirements but is best suited to serve the daily needs of active transportation users, rather than vehicles. The implementation of shared modality pathways may be appropriate where adequate servicing for multiple buildings can be achieved through a single path, or where vehicle access is deemed necessary for accessible parking requirements.

5.2.1.2 Major Pathways

Major pathways are intended to function as major multimodal travel routes on campus, regularly accommodating high volumes of pedestrians at peak times and thoughtfully integrating active mobility where applicable. Given their proposed widths and prominence as significant routes on campus, major pathways may be subject to occasional and limited service vehicle access under special circumstances such as campus events. Figure 5-3, to the right, provides a depiction of a typical major pathway cross section demonstrating its typical dimensioning range. Notably, the buffer width is anticipated to conform to the requirements for pathways exceeding 3 m stated within the Queen's Building Design Standard (2022), resulting in a width of 750 mm.

The major pathway classification should be assigned where a route has been identified as regularly accommodating high volumes of users at peak periods, or where a pathway has been denoted as a cycling trail within the Campus Master Plan (2021). Additionally, major pathways should be considered along pathways near entrances to campus destinations with high trip generation rates, such as cafeterias, libraries, student services and amenities, residences, and large academic buildings.

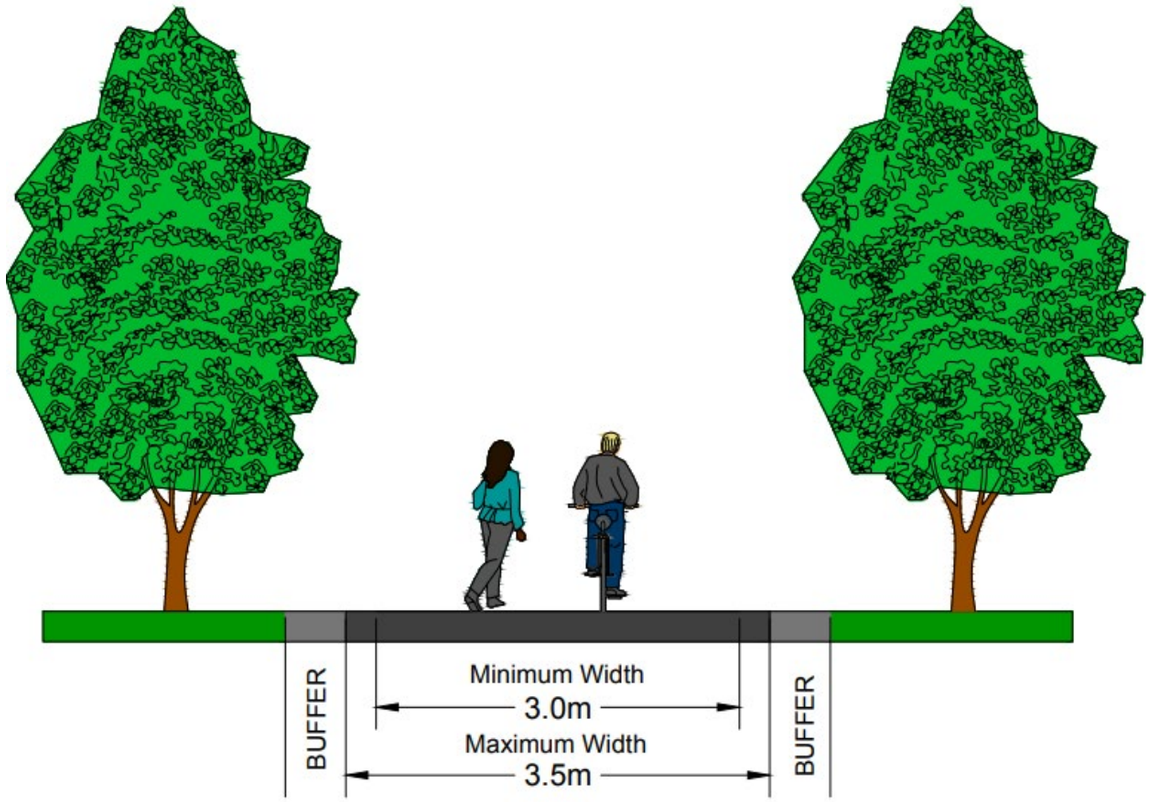

Figure 5-3 Cross-section depicting typical dimensions and configuration of the major pathway classification.

5.2.1.3 Intermediate Pathways

Intermediate pathways are intended to function as pedestrian-oriented travel routes that can accommodate a range of user volumes dependent on locational context. Intermediate pathways are also capable of accommodating occasional wheeled mobility users; however, should not be expected to regularly manage these modes. Vehicles should be restricted from accessing intermediate pathways under all circumstances to reinforce their orientation towards pedestrians. Figure 5-4, below, provides a typical cross section for intermediate pathways, providing the appropriate dimensioning range. Notably, the buffer width is anticipated to conform to the requirements for pathways under 3 m stated within the Queen's Building Design Standard (2022), resulting in a width of 450 mm.

The intermediate pathway classification should be assigned where a route typically accommodates moderate user volumes but may occasionally experience high volumes.

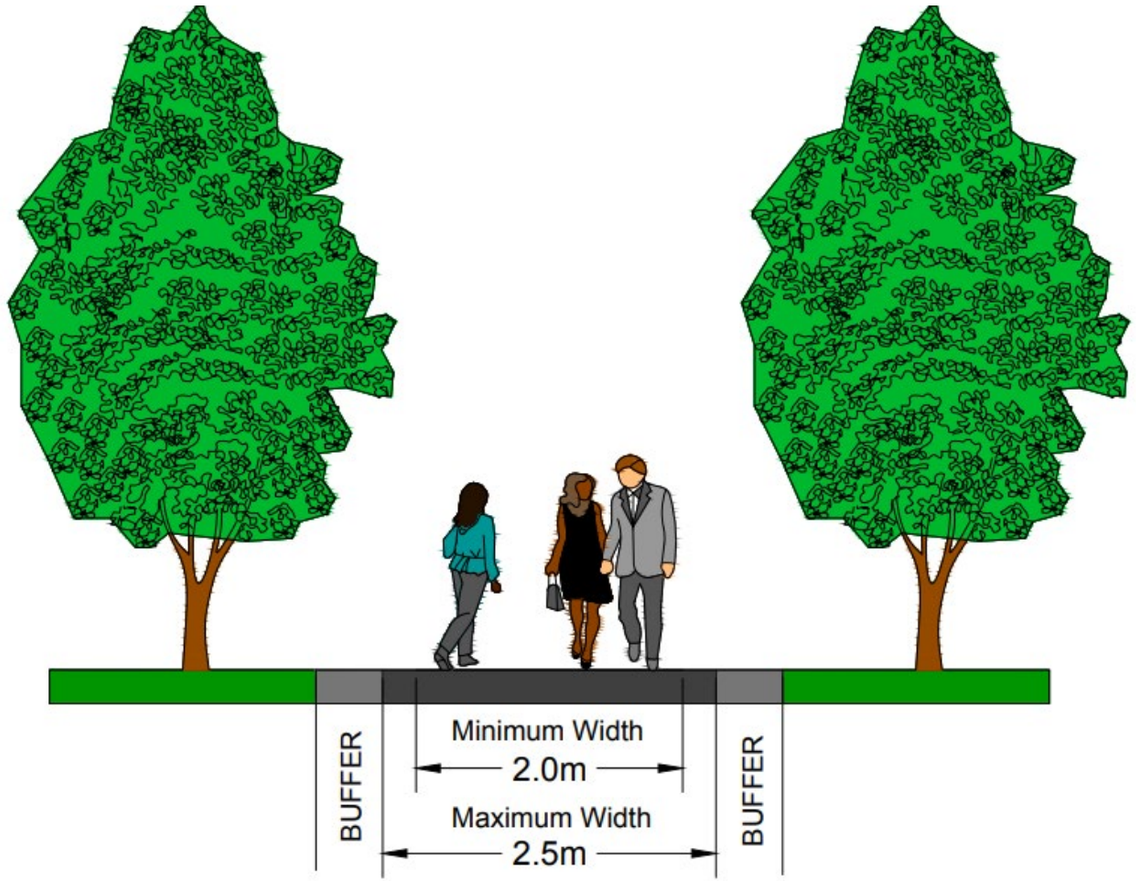

Figure 5-4 Cross-section depicting typical dimensions and configuration of the intermediate pathway classification.

5.2.1.4 Minor Pathways

Minor pathways are intended to function as pedestrian-oriented travel routes that experience the lowest user volumes on campus. These pathways should not be expected to accommodate wheeled mobility users but may be capable of such during off-peak times. Like intermediate pathways, vehicle access should be restricted along minor pathways under all circumstances to reinforce their orientation towards pedestrians. Notably, the minimum proposed minor pathway width 1.6 metres is the minimum requirement to provide sufficient space to allow two mobility aids to safely pass one another. Figure 5-5, below, provides a typical cross section for minor pathways, demonstrating the appropriate dimensioning range. Notably, the buffer width is anticipated to conform to the requirements for pathways under 3 m stated within the Queen's Building Design Standard (2022), resulting in a width of 450 mm.

The minor pathway classification should be assigned where a route typically accommodates low user volumes and is not subject to frequent wheeled mobility user travel.

Figure 5-5 Cross-section depicting typical dimensions and configuration of the minor pathway classification.

5.2.2 Pathway Implementation Recommendations

The following recommendations are intended to support the implementation of the proposed pathway width standards across Queen's campuses. Broadly, consideration is given to the appropriate and efficient use of hardscaping across the pathway network, opportunities to support a high quality sustainable open space network, and the interaction between pathway users and modes.

5.2.2.1 Hardscaping Optimization

a) **Intersections of pathways are encouraged to be designed to optimize the amount of hardscaping required to manage user flows safely and efficiently. Excess space within intersections should be considered opportunities for landscaping, greenery, and amenity spaces.**
   The intersection of pathways present potential conflict zones between users travelling in different directions and along different paths. Thus, it is not uncommon to mitigate this conflict through excessive hardscaping, providing abundant space for user movement. Pathway intersections may be considered more easily managed from an operations and maintenance perspective when greater quantities of hardscaping are present. For example, ease of movement for snow clearing equipment or increased turning radii to allow vehicles and equipment to make turns without leaving the path. However, this may contribute to environments that are unpleasant for users, non-contributory to environmental wellbeing, and do not support the objectives of the Campus Master Plan. Thus, pathway intersections should not be arbitrarily hardscaped, but should be thoughtfully designed to support sustainability and public realm improvements on campus.

b) **Pathway classification and candidate pathways for hardscaping reduction or removal should be considered based on observed and anticipated user volumes and use functions**
   It has been noted that in various circumstances the width of existing pathways at Queen's were determined without thorough consideration for their functional requirements, both in their immediate vicinity and within the broader network. Instances have been identified where the addition of new pathways has not coincided with the consideration for network-wide impacts, leading to redundancies within the network and excessive hardscaping. In tandem, these observations contribute to the possibility of inappropriately located or sized pathways that do not align with the function of the broader network. Thus, the classification of pathways across Queen's, and identifying candidate paths for reduction, removal, or expansion, should be rooted in rigid considerations outlined by the institution to ensure a consistent approach towards future changes to the network.

c) **Pathway removal should be considered an appropriate alternative to width reduction when there is an observed duplicity of pathways, or where the observed volume of users is sufficiently low so as to not cause disruption in typical travel patterns.**

It has been noted that the current process of assessing the need for pathways and their subsequent implementation has omitted the potential for simultaneous pathway removal under appropriate circumstances. This process is apparent where former informal pathways have been hardscaped in effort to mitigate damage to grass and landscaping; however, the resultant of this process is a duplicity of paths and excessive hardscaping. Furthermore, sections of rarely used pathways have been identified as unnecessary for the function of the network, and therefore their presence provides minimal benefit. These circumstances, among others, provide opportunities to reduce hardscaping through the removal of redundant or underutilized infrastructure, thus contributing to enhancing the pathway network.

d) **Opportunities should be explored to implement driveable green spaces whereby service vehicle and fire access can be accommodated, when necessary, while deterring all other vehicles through reduced pathway widths.**

Instances currently exist on Queen's campuses whereby pathways possess excessive width and hardscaping due to their classification as a fire route. In many cases, these pathways are not subject to frequent vehicle traffic, or do not provide substantial benefit as a vehicle route over the existing vehicle network on campus. These pathways may be currently designed as roadways, with curb cuts and sidewalks, or as excessively wide pathways using concrete pavers. Regardless of material and design composition, the existing infrastructure was deemed unsuitable relative to the observed use functions. Thus, opportunities exist to reduce hardscaping along these path segments, while maintaining required vehicle access for fire routes and occasional service vehicle use through the implementation of driveable greening technologies. In many instances, these technologies contribute to improving campus sustainability while providing the required structural integrity to allow vehicles to travel safely and conveniently. Notably, specific details pertaining to technical considerations for implementing driveable green spaces are explored further in Section 7 of this report.

5.2.2.2 Pathway Greening

a) **Appropriate landscaping should be located to mitigate the creation of informal pathways on campus.**

Informal pathways were noted at various locations across the study area and are often developed as a short cut for users travelling across campus. Frequent travel along these informal pathways damages the vegetation and underlying soil, resulting in hard-packed trails that diminish water infiltration and prevent the growth of grass or other greenery at these locations. Cumulatively, these pathways negatively reflect on the visual appeal of the campus' open space and path networks, as well as campus sustainability. In some instances, informal pathways may be utilized to understand user route selection and behaviours and can indicate potential locations for new pathways. Alternatively, informal pathways may be created parallel to existing paths due to insufficient hardscaping and a resulting overflow of users onto adjacent grass. Under the aforementioned circumstances, appropriate hardscaping may be considered as a potential solution; however, instances were observed whereby the creation of informal pathways may be more appropriately deterred through the installation of mitigating features, such as landscaping or public amenities.

b) **Hardscaping removal should be considered an opportunity to improve campus sustainability through the installation of appropriate landscaping.**

Excessive hardscaping is a frequently observed theme throughout the study area and across Queen's campuses. This presents various challenges towards cultivating a sustainable campus by diminishing opportunities for carbon sequestration and water infiltration and necessitating potentially heightened maintenance requirements. Broadly, this report recommends appropriately sizing pathways, reducing hardscaping where possible through the adoption of a pathway width standard that assigns appropriately sized pathways across campus. However, potential reductions to hardscaping should not be undertaken without consideration for opportunities to simultaneously implement infrastructure that supports sustainability objectives. Such infrastructure may include appropriately located landscaping, public amenities such as seating and resting areas, or for contextually appropriate locations, the introduction of rain gardens/bioswales to support water infiltration.

5.2.2.3 Vehicle Segregation

a) **Pathways restricting vehicle access should be clearly distinguishable from those permitting vehicle use.**
Observations made during site visits to the study area suggested that there is prevalent use of the existing pathway network by vehicles. In certain instances, this was along internal streets or pathways that permit vehicle use, while in others it was observed to occur on pathways that are not intended for vehicle use, the latter of which present concerns of pathway user safety due to incompatible use of the network. To support the appropriate use of pathways, those which are intended for and supportive of vehicles should be clearly distinguishable through design. Examples of this may include distinctions in materials, edge treatments, and barriers to pathway entry points that deter vehicle entry.

b) **Vehicles should be deterred from utilizing pathways unintended for motor vehicles through the implementation of appropriate barriers, while adhering to AODA requirements to allow space for users with mobility aids.**
As noted above, vehicle travel along pathways primarily intended for pedestrians, cyclists, and active mobility users was commonly observed within the study area. In addition to the recommendations provided above regarding clearly distinguishing pathways intended for vehicles and active users, some circumstances of vehicle segregation may warrant increased measures to deter vehicle use of the pathways. Such circumstances may include for particularly wide or busy paths, those which are adjacent to or connecting to shared streets, or those which may provide a short cut for vehicles travelling on campus, among others. Where the requirement for enhanced vehicle restriction has been identified, appropriate barriers should be considered, such as strategically placed flexible or removable bollards, planters, benches, etc., that will physically restrict the entry of vehicles. Notably, these proposed barriers are not considered appropriate for pathways identified along the campus fire routes. Instead, opportunities for driveable greening, as discussed above, may be considered an appropriate deterrent for these locations.

c) **Intersections between pathways and shared streets should prioritize pedestrians and wheeled mobility users rather than vehicles.**

As a campus oriented primarily towards pedestrians and active mobility users, pathway users were found to frequently interact with and cross pathways and internal streets that permit vehicle use. These specific interactions – where pedestrians are crossing the potential path of vehicles – are potential conflict zones that pose heightened safety risks for pathway users. As such, pedestrian and active mobility user safety and accessibility should be prioritized at locations where pathways intersect with shared streets through design. Such features may include:

- Raised crosswalks, such as ramped speed tables, utilized to slow vehicles and orient the crossing to the user
- Features that increase pathway user visibility such as set back vegetation and amenities or pedestrian bump-outs
- Strategically utilized materials that demarcate the crossing

The inclusion of such features will simultaneously improve pathway user safety and accessibility relative to necessary vehicle ingress and reiterate the prioritization of pedestrians and active mobility users as the preferred travel modes on Queen's campuses.

5.2.3 Supplemental Recommendations

5.2.3.1 Accessibility

a) **All pathways should be AODA compliant and facilitate safe use for people of all abilities. Pedestrians should be able to comfortably use any mobility aid, assistive device or personal assistance to navigate through campus**

Pathway accessibility recommendations aim to surpass the standards outlined in the AODA, creating a campus-wide network of pathways where people of all abilities can use the pathways to the fullest extent possible, year-round, and without any significant divergence from the broader campus community. Observations from the site visit revealed that the condition of certain pathways was not suitable for people with mobility challenges or that may require a mobility aid. Some paths were found to uneven or sunken in, while others had loose materials. This poses a significant safety risk to users and may impede their ability to travel certain routes. Pathways should be designed in accordance with AODA standards and should be subject to regular maintenance to prevent barriers to accessibility from developing.

b) **Obstructions to pathways should avoided whenever possible and gradient changes, ramps, and stairs should be clearly marked regardless of the time of day or weather.**

Bollards, planters, and other street furniture are attractive pathway amenities, but when placed in the right-of-way, may impede one's ability to navigate a space. These elements should only be placed on pathways when necessary and under the condition that there is sufficient room around them to accommodate the volume of traffic flow (which may include varying combinations of pedestrians, wheeled active transportation users, and people using mobility devices). Permanent hardscaping features, such as stairs, can be perceived as barriers to accessibility. Stairs should not be built unless there is a convenient and accessible alternative available. Any gradient change, whether that is stairs or a ramp, must be clearly marked in a manner that can be understood at all times of the day and in any season.

5.2.3.2 Pathway Materials

a) **Pathway materials should be consistent across campus and should be derived from local and/or recycled sources when possible.**

Pathways will continue to be constructed using concreate pads. Site observations revealed differences in pathway appearances across campus. By standardizing the materials, it will create a more uniform look and improve the connection between distinct spaces. In addition to being easily passable by pedestrians and active transportation users, concrete will support service and emergency vehicle use as needed. While the pathway materials will remain unchanged, opportunities to use local and/or recycled sources should be considered. Using recycled materials from former pathways or other campus construction projects will be cost-effective and contribute to a more sustainable building process.

5.2.3.3 Pathway Environment & Amenities

5.2.3.3.1 Signage, Lighting & Wayfinding

a) **Adequate lighting should be placed at high-traffic areas and points of interest across campus such as pedestrian pathways, points of intersection between pathways and vehicular routes, parking areas, building entrances, stairs, ramps, and rest areas.**
Lighting should be AODA compliant to ensure there is sufficient sources of light in high-traffic areas and points of interest across campus. Lighting on main pathways should be continuous and regularly maintained to prevent dark or shadowed areas and outages, which is a barrier to accessibility and may hinder perceptions of safety among pathway users. Light fixtures should be set back from the path to mitigate disruptions to pathway traffic or pose accessibility risks. In addition to improving accessibility and perceptions of safety, outdoor lighting can be incorporated into landscape design to elevate the look of the space and improve the overall campus image.

b) **Wayfinding elements should direct users to buildings, transportation hubs, gateways, and major pathways across campus. These elements should provide information in multiple modes (visual, auditory, and tactile) to accommodate the diverse needs of pathway users.**
Wayfinding elements should be included to direct users to popular destinations on campus. These elements should be clear and easily identified to promote ease of navigation across campus. During site observations, wayfinding signage was observed. Queen's University uses white writing and a dark background for maximum contrast on their wayfinding signage. While this is beneficial, visual wayfinding elements do not accommodate all users. Queen's University should aim to include consistent auditory and tactile wayfinding across its campus to accommodate people of all abilities.

c) **Wayfinding signage should be consistent and have a cohesive design that reflects the character of Queen's University.**
The design and placement of wayfinding signage should be carefully considered to mitigate the risk of confusion among pathway users. Wayfinding signage should be clear, easily identifiable, and located at a convenient height and location that can be seen from all directions. The design of wayfinding signage should reflect the character of Queen's University, which could be accomplished by using fonts, logos, and design elements that represent or are often associated with the university. Wayfinding signage could also reflect the history or character of the specific location where it is posted whether that is a building, open space, or pathway. This signage presents a unique opportunity to connect distinct places across campus, while also paying homage to campus history and identity.

5.2.3.3.2 Rest Areas, Furniture & Gathering Areas

a) **Rest areas should be connected to pathways and located proximal to greenery and natural open spaces.**
Open spaces intended for resting and gathering should be located along or within a close proximity to a pathway to ensure it is accessible to pathway users. In doing so, Queen's University could create a connected network of open spaces, which would contribute to ease of travel between different locations and encourage further use. Resting and gathering areas should either feature natural elements or be located proximal to greenery and natural open spaces. Some areas may have designated applications, while others may be left as an open lawn to accommodate a larger range of uses. To encourage gathering, furniture such as benches and picnic tables should be placed throughout the space. Where possible, Queen's University should focus on integrating accessibility elements into the design of these spaces. This can be accomplished by providing a paved connection to these areas, as well as providing types of activities and seating that accommodates people of all abilities.

b) **Street furniture should be placed consistently along pathways and open spaces to provide resting areas and improve accessibility.**
It is important that there is sufficient street furniture located along pathways and open spaces. Ideally, the user should always be able to see the next available bench from where they are currently situated. For pathways, benches and other street furniture should be appropriately set back to prevent interferences with the flow of traffic. For resting and gathering areas, it is important to provide the user with various types of street furniture to ensure they have sufficient options. The furniture should be comprised of moveable chairs and tables to provide users with the opportunity to manipulate the space as necessary. Furthermore, a standard should be established to quantify the requirements for barrier-free seating options in these spaces. For example. Western University recommends that 25 percent of all seating should be barrier-free and provide ample space to maneuver mobility devices (Western University, 2018). Queen's University could adopt a similar standard to ensure that public spaces across campus can be enjoyed by people of all abilities.

6 Old Queen's Campus Block Pathway Recommendations

6.1 Pathway Classification Recommendations

Targeted recommendations will be provided to the study area through application of the campus-wide pathway standards and recommendations and the collected and analyzed data.

The Old Queen's Campus Block is the area bounded by Arch Street, Stuart Street, University Avenue, and Union Street. Within this area is a multitude of pathways varying in size and use. Each pathway in this area has been classified based on the pathway standard which is described in the previous section. These classifications are based on pedestrian and active mobility counts that took place in the study area, as described in Chapter 4 of this report. In addition to data analysis leading to these classifications, current infrastructure, fire routes, bike networks, service access, and other qualitative measures were also considered. Figure 6-1, below, provides a summary of the proposed pathway classifications within the study area.

By classifying all paths in the study area, it allows for the proper standard to be implemented when maintenance is needed in the future. It ensures that the amount of hardscaping is appropriate for both the flow of pedestrian traffic and the use. Pathways where lower pedestrian counts were observed were classified as minor pathways and have a smaller width than intermediate pathways and major pathways. All pathway classifications have a priority for pedestrian traffic, but also accommodate active mobility, and in some cases vehicles. Areas that are fire routes or where services are needed are classified as shared streets, which does still accommodate pedestrians and active mobility, but also accommodates vehicles. Each of these paths in the study area have been carefully classified with these considerations in mind to ensure the efficiency of hardscaping on campus.

There are myriad benefits that come from implementing a pathway standard for Queen's campuses. One of the benefits of these recommendations is that the standard supports the University's and the UN's sustainable development goals. By optimizing hardscaping, we are ensuring there is not excess concrete on the campus where it would not be appropriate. This also aligns with increasing campus greenery by encouraging more grass and vegetation be added in lieu of some pathways deemed unnecessary. By making the pathway standard consistent across all campuses, it enhances the campus experience, improves visual coherence, and increases campus safety through design. Not only will every visitor have the same experience on the pathways, but they will also know that every pathway across any Queen's campus will be accessible for everyone. There is also a potential for operational and maintenance cost reductions with there being only four different pathway classifications as well as proposed pathway removals. This will be beneficial when it comes to the cost and process of snow removal, but also for the lifecycle cost analysis. Figure 6-1 provides the proposed pathway classifications within the study area.

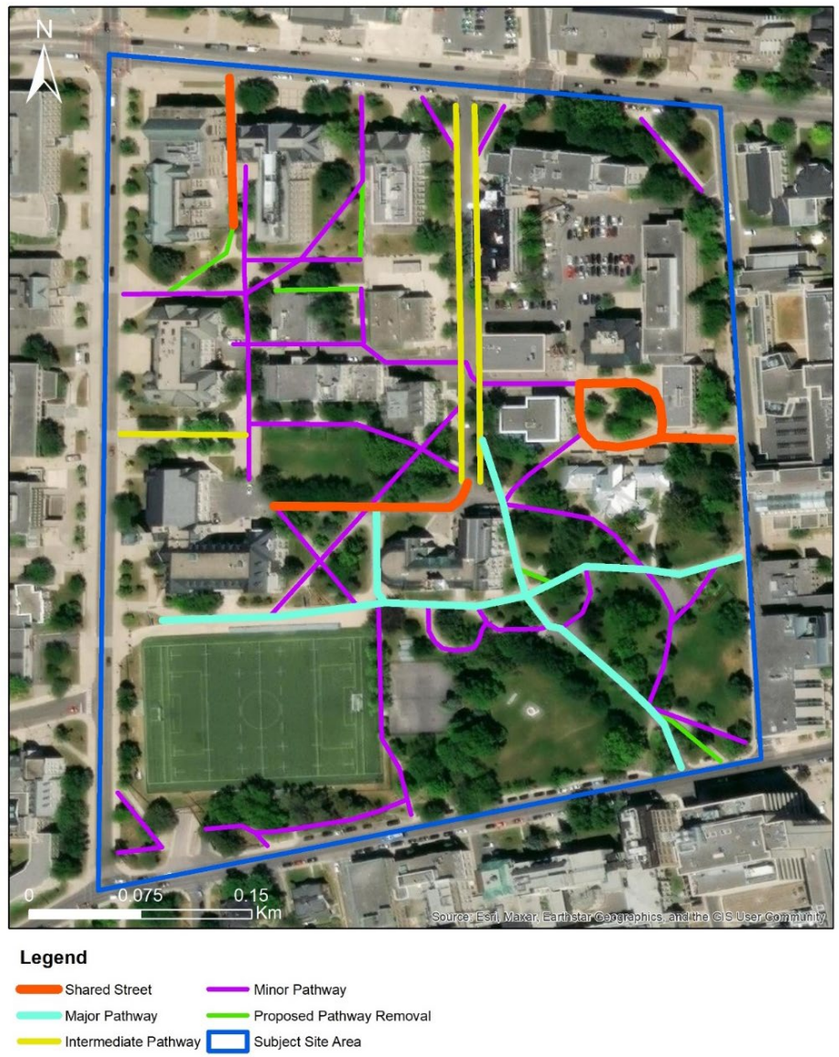

Figure 6-1 Proposed pathway classifications for the study area path network.

6.2 Hardscaping Optimization Recommendations

6.2.1 Areas for Hardscaping Reduction

To support the implementation of the pathway standard, several locations in the study area have been highlighted as spaces where there is excessive hardscaping. These locations were carefully selected based on data analysis, demonstrating low flow rates and/or incompatible infrastructure for observed or perceived usage.

6.2.1.1 Behind Ontario Hall

The area behind Ontario Hall has significant opportunity for hardscaping reduction. This area is currently 7.35m wide and is used by all forms of transportation. While the area has previously been needed for service vehicle access to Fleming Hall for Campus Security and Postal Services, these facilities are no longer located in this building. Two different widths are proposed for this area, based on the observed behaviour of pedestrians and vehicles in this space. Since this location is a fire route, both proposed widths can accommodate a fire truck in the event of an emergency. First, if the area were to continue allowing vehicular traffic, a width of 4.0 - 4.5 m is suggested. This is in alignment with the shared streets pathway standard. While still allowing vehicle access, this width reduction of ~2.85 m would significantly decrease the amount of hardscaping and provide opportunities for increased greenery. Second, if the area were to be converted into a no-vehicle access zone, a proposed with of 1.6 - 1.8 m is suggested, in alignment with the minor pathway campus standard. To accommodate the continued fire route requirements, driveable greening could be implemented on either side of the pathway. This significant reduction in pathway width would ensure that only pedestrians and other modes of active transportation can utilize the path, providing a better sense of pedestrian realm and campus community. Figure 6-2, below, provides both the existing and proposed condition for the pathway behind Ontario Hall, including both width proposals depending on the anticipated future vehicle use requirements.

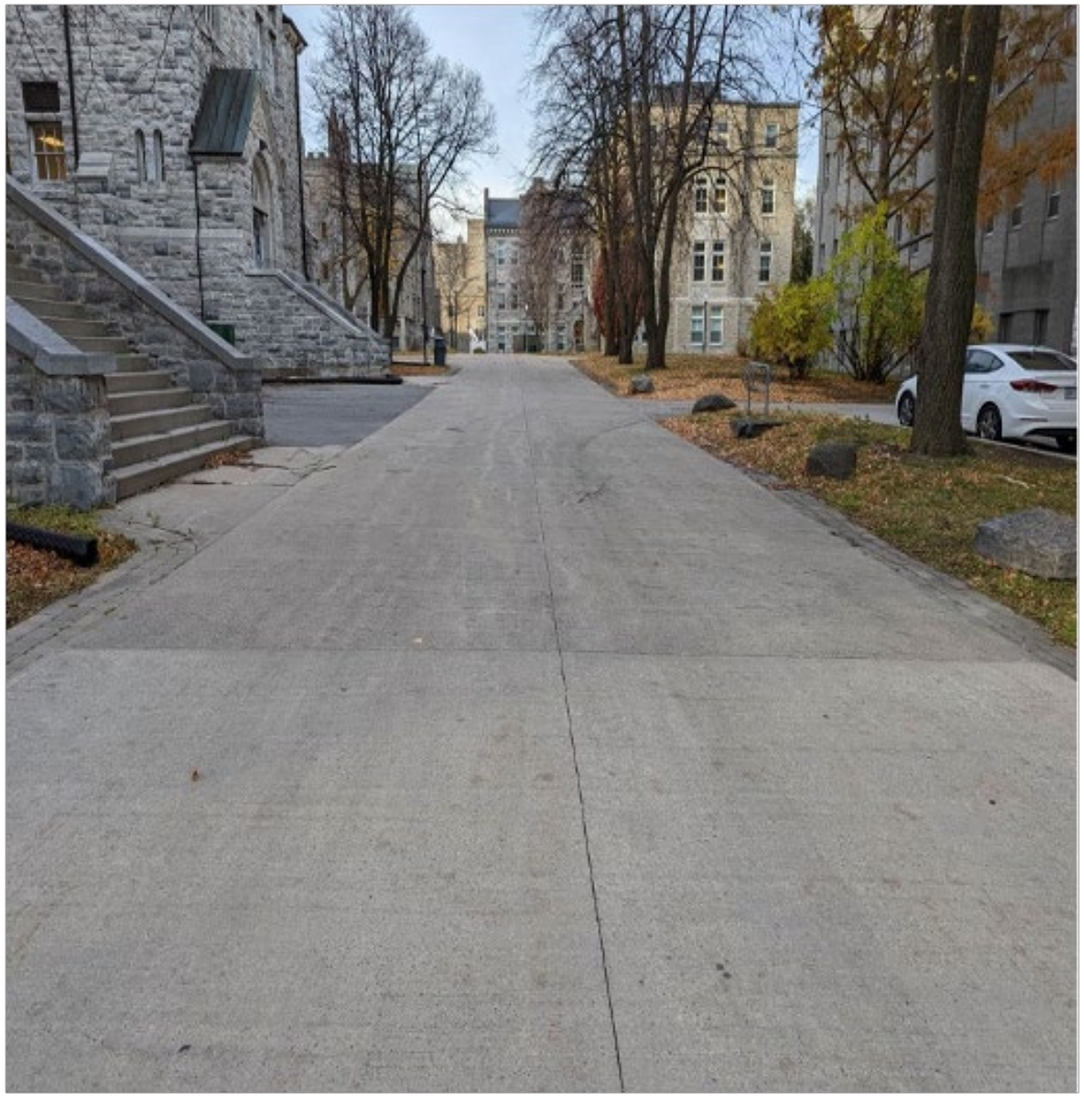

Figure 6-2 (Left): Existing condition of pathway behind Ontario Hall. (Top right): Proposed condition utilizing shared streets pathway classification. (Bottom right): Proposed condition using minor pathway classification.

6.2.1.2 Between Clark Hall and Fleming Hall

The area between Clark Hall and Fleming Hall poses similar opportunity for hardscaping reduction that the area behind Ontario Hall does. Currently, this area is 6.47 m wide, accommodating all modes of transportation. Figure 6-3 demonstrates the existing conditions of the area between Clark Hall and Fleming Hall. With the removal of Campus Security and Postal Services from Fleming Hall, the area no longer needs to support vehicular access and parking. Two different widths are proposed for this area, based on the reduction of need for vehicular parking and access. First, if the area were to be continuing to allow vehicular traffic for any reason such as accessibility, a width of 4.0 – 4.5 m is suggested. This is in alignment with the shared streets pathway standard, and still provides a width reduction of ~2.0 m. Second, if the area were to eliminate the need for vehicular access, a proposed width of 1.6 –1.8 m is suggested, in alignment with the minor pathway campus standard. This significant reduction in pathway width would ensure that only pedestrians and other modes of active transportation can utilize the path, providing a better sense of pedestrian realm and campus community. Increased opportunities for pathway greening and amenities would also be available.

Figure 6-3 Existing condition of area between Clark Hall and Fleming Hall.

6.2.1.3 Between Jackson Hall and Old Medical Building

The area between Jackson Hall and the Old Medical building has the largest potential for removal of significant hardscapes. This area is currently 10.13 m wide, consisting of a vehicle thruway and a pedestrian path on either side. During data collection and site visits, it was apparent that this area is very rarely accessed by vehicles and should therefore be converted into a pedestrian-oriented pathway. The recommended pathway width for this area is 1.6 - 1.8 m, consistent with the proposed minor pathway standard. To accommodate the existing fire route in this area, driveable greening is recommending on either side of the minor pathway. This width reduction of ~8.33 m would dramatically reduce the impermeable surface and allow for increased greening and a pedestrian focused environment. Figure 6-4 provides both the existing and proposed conditions for the roadway between Jackson Hall and the Old Medical Building.

Figure 6-4 (Left): Existing condition of roadway between Jackson Hall and the Old Medical Building. (Right): Proposed condition utilizing minor pathway classification.

6.2.1.4 5th Field Company Lane

5th Field Company Lane is currently 10.21 m wide and is designed as a wide roadway with narrow sidewalks. Figure 6-5, to the right, demonstrates the existing condition of 5th Field Company Lane. This area favours vehicles and is not pedestrian friendly, given the excessive road width, inconsistent presence of sidewalks, and excessive hardscaping. The desire is to keep this area as a roadway, but to increase its safety and accessibility to pedestrians by narrowing the roadway and creating wider pedestrian paths on either side. This will allow for a proposed width of 4.0 - 4.5 m, consistent with the shared streets pathway classification and sidewalks that are 2.0 – 2.5 m, consistent with the intermediate pathway classification. In addition to creating a more pedestrian focused space, increased green space and other design features can be incorporated to better separate the pedestrian space from vehicles. The Civil Engineering 2021 Capstone Project concerning the proposed redevelopment of 5th Field Company Lane should be used to guide the future enhancement of this area.

Figure 6-5 Existing condition of 5th Field Company Lane, facing north.

6.2.1.5 Between Ontario Hall and Grant Hall

The area between Ontario Hall and Grant Hall is designed as a wide courtyard/ pathway with large tree boxes that gives the feeling of separate pathways. The total pathway width is 18 m, with the centre path measuring 6.02 m. Data collection and observations showed that there was very low usage and thus, excessive hardscaping. For this area there is a proposed width of 2.0 – 2.5 m, consistent with the intermediate pathway standard. This proposed width would support the usage flow observed in the area and provide opportunity to implement urban design and greening features for increased sustainability. Figure 6-6, below, provides both the existing and proposed condition for the pathway between Ontario Hall and Grant Hall.

Figure 6-6 (Left): Existing condition of pathway between Ontario Hall and Grant Hall. (Right): Proposed condition utilizing intermediate pathway classification and increased greenery.

6.2.2 Areas for Pathway Removal

6.2.2.1 Between Douglas Library and Ontario Hall

The area between Douglas Library and Ontario Hall consists of two diverging pedestrian pathways directed East-West. One of the pathways is angled slightly north, as demonstrated in Figure 6-7. These pathways are similar in width and have the same intended usage as primarily pedestrian. Throughout both quantitative and qualitative data collection, it was evident that the pathway that is directed slightly north is redundant. It is suggested that one pathway in this area would be sufficient to maintain the currently observed and anticipated user flows in this area. Since the pathways lead in the same direction, removing the northern pathway would not results in significant changes to pedestrian travel. Further, removing this pathway would create opportunities for increased greening such as grass, planting boxes, or trees.

Figure 6-7 Existing condition of pathway network south of Douglas Library.

6.2.2.2 Between Gordon Hall and Nicol Hall

The pathway between Gordon Hall and Nicol Hall is recommended to be removed, as the data collected showed extremely low usage of this pathway. Removing this pathway would result in hardscape reduction and opportunities for increased greening. Since the pathway is near grass, outdoor furniture could be implemented to create a better sense of place and increase the feeling of campus community. The existing condition of the pathway between Gordon Hall and Nicol Hall is provided in Figure 6-8, which demonstrates poor material quality.

Figure 6-8 Existing condition of pathway west of Nicol Hall.

6.2.2.3 North of Fleming Annex

The pathway North of Fleming Annex is directed east-west and it has no clear destination. At the end of the pathway there is a short set of stairs that create a barrier for use by those utilizing mobility devices. The lack of a clear destination in addition to being close to other pathways of similar size resulted in low observed usage. Therefore, it is recommended that this pathway be removed. By removing this pathway there is opportunity for increased greening, as well as providing a more accessible space without the presence of stairs. Figure 6-9 depicts the existing condition of the pathway north of Fleming Annex, facing east.

Figure 6-9 Existing condition of pathway north of Fleming Annex.

6.2.2.4 Pathway at corner of Arch Street and Stuart Street

The pathway leading from core campus to Botterell Hall begins as one wider path and forks into to more narrow pathways. The destination of each of these pathways is very close, resulting in the need for two pathways to be redundant. It is recommended that the pathway on the right side (see Figure 6-10) be removed. Based on observations, this pathway is sufficient to support the pedestrian usage on its own and does not provide a large enough variation in destination to justify the additional hardscaping currently present.

Figure 6-10 Existing condition of pathways leading from Summerhill driveway to Botterell Hall.

6.2.2.5 East of Theological Hall

Professor's Walk east of Theological Hall is part of a high-volume east-west corridor on campus. However, this specific area has an unnecessary cut-through that does not serve a significant purpose and results in unnecessary and excessive hardscaping. It is recommended that this cut-through path be removed, allowing the remaining paths to support the pedestrian flow. Removal of the cut-through provides opportunity for increased greening such as garden boxes, which contribute to campus sustainability and a quality landscape. Furthermore, appropriate landscaping may help deter the potential creation of undesired informal pathways at this location after pathway removal. Figure 6-11, to the right, depicts the existing cut-through proposed for removal.

Figure 6-11 Existing condition of pathway cut-through east of Theological Hall.

6.3 Additional Opportunity Areas

Additional opportunity areas have been identified in order to further reduce hardscaping and improve pathway use compatibility. These locations are outside the scope of this project, but are identified are future areas of consideration, as changes would be beneficial to the study area. Figure 6-12, to the right, provides the location of the two additional opportunity areas identified by the project team.

The recommendations provided within this section may be used as a starting point for advancing discussions pertaining to broader improvements to the study area landscape, user experience, and sustainability function. It should be noted that these recommendations are not exhaustive of the potential improvements that may be made to the pathway network within the study area, but rather represent the areas identified by the project team as being most pressing towards fulfilling the objects guiding this project. It is suggested that closer examination be made into other areas, in addition to those presented here, whereby prospective redesigns of the pathway network may further advance the objectives of this project, both within the study area and across all Queen's campuses.

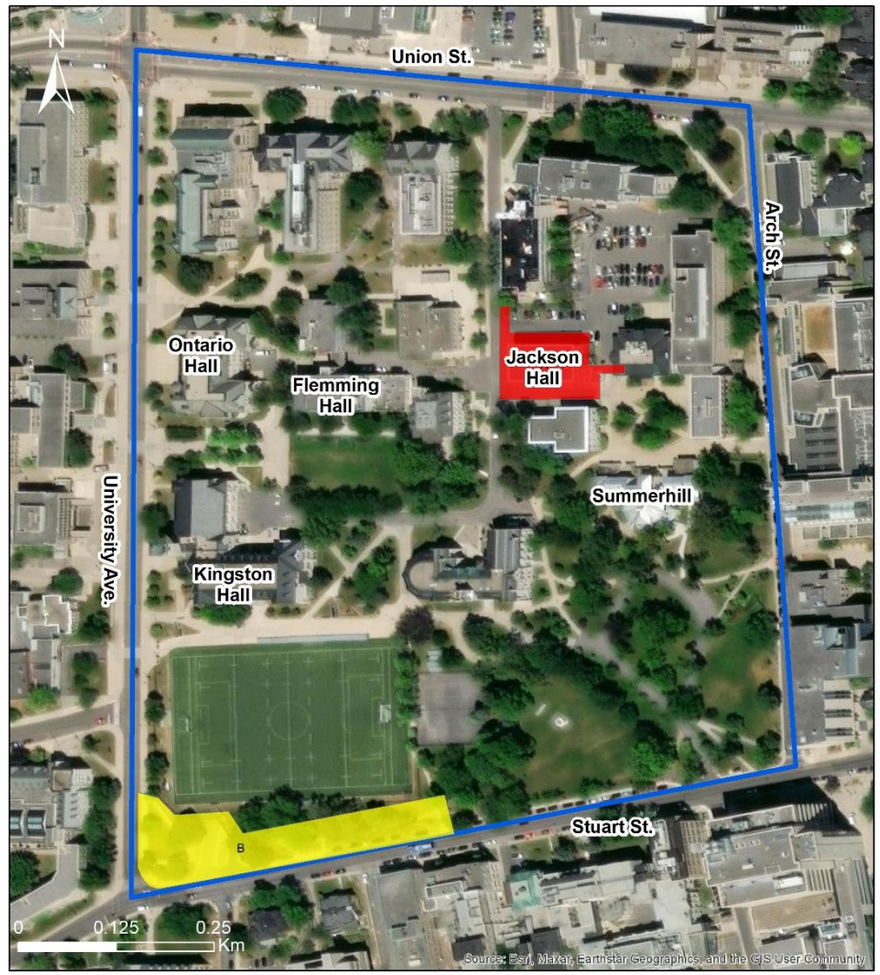

Figure 6-12 Additional opportunity areas identified for future consideration.

6.3.1 Opportunity Area "A" - Miller Hall Parking Lot, 5th Field Company Lane, & Quadrangle Area

The first area for opportunity is the entrance to Miller Parking Lot off 5th Field Company Lane and the Quadrangle. Both entrances to Miller Hall Parking Lot consist of excessive hardscaping and encourage vehicle traffic into the area. It is recommended that hardscaping be removed from both entrances and replaced with a minor walking path accompanied by greenery and landscaping. To maintain required fire routes in the area, implementing driveable greening in these areas is recommended. As intended, the Miller Hall Parking Lot will not be accessible from 5th Field Company Lane or the Quadrangle. To better support both vehicle ingress and egress at the parking lot, a redesign and widening of the parking lot entrance off Arch Street is recommended. Figure 6-13, below, demonstrates the existing conditions at the entrances to the Miller Hall parking lot from both 5th Field Company Lane and the Quadrangle.

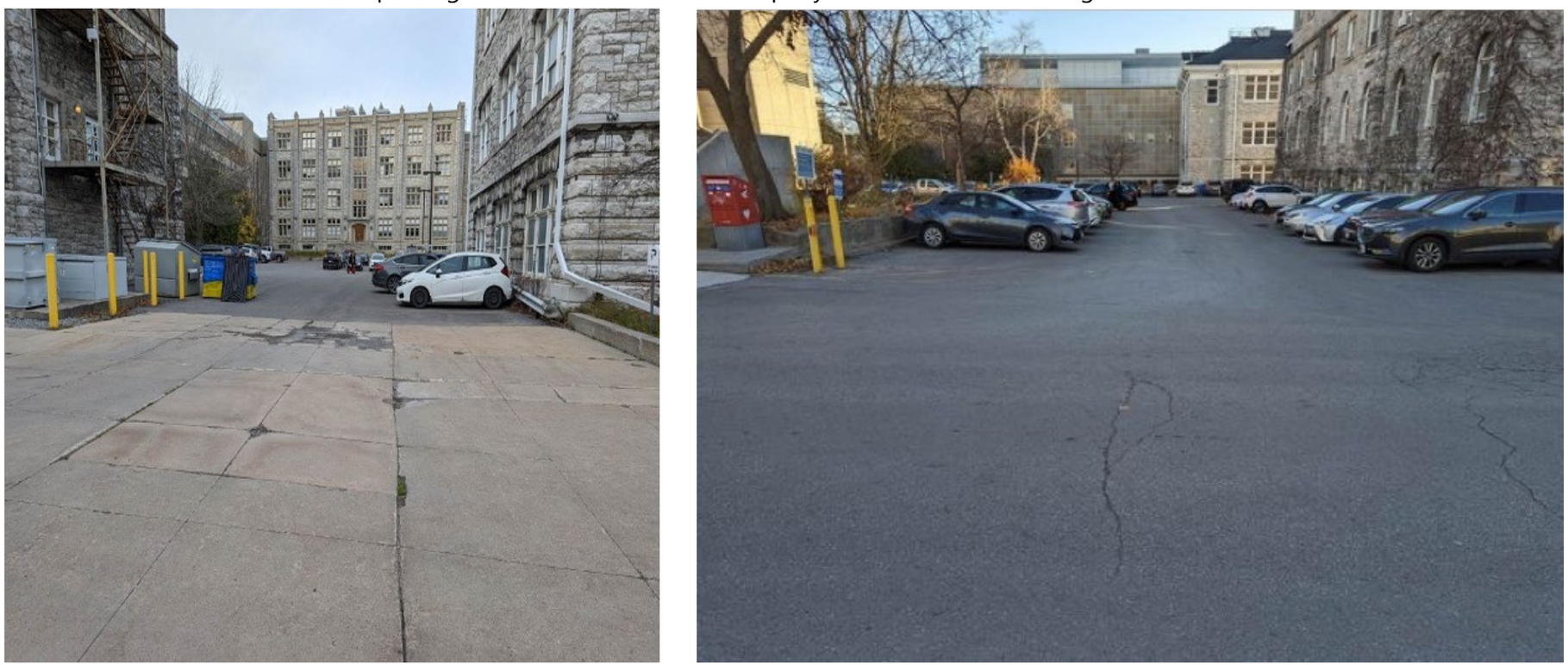

Figure 6-13 (Left): Existing access to the Miller Hall parking lot from the Quadrangle. (Right): Existing access to the Miller Hall parking lot from 5th Field Company Lane.

6.3.2 Opportunity Area "B" – South of Nixon Field

The area south of Nixon Field consists of a broken sidewalk and pathway, which lead both north-south and east-west. The pathways connect to both the underground parking garage and lead to Kingston General Hospital (KGH). While at the edge of the study area, this section of campus sees high traffic of pedestrians both from the Queen's community and individuals accessing KGH. Figure 6-14, below, provides a demonstration of the existing conditions of the pathway network south of Nixon Field. It is recommended that this area is reconfigured and redesigned to improve the user experience, enhance accessibility, and mitigate conflict between pedestrians, cyclists, vehicles and public transit. The redesign should also include improved materials that will maintain quality over time and seasonal conditions.

Figure 6-14 (Left): Existing paths leading from Stuart Street to University Avenue south of Nixon Field. (Right): Existing pathway running parallel to Stuart Street south of Nixon Field.

7 Considerations

Research conducted for the pathway standard recommendations uncovered associated factors that could not be fully explored within the scope of this project. This section outlines some considerations for further study, identifying the value of this research, applicability to sustainability commitments made by the university and application to the pathway recommendations.

7.1. Hardscaping Reduction Benefit Metrics

The reduction of hardscaping across Queen's campuses presents opportunities to improve the environmental, economic, and social value of the University's open space and pathway networks. To characterize and quantify these potential benefits, various considerations will be presented that may be utilized to guide further study and develop performance indicators or business case metrics.

7.1.1. Carbon Sequestration

By adopting the proposed pathway standard across campus, areas recommended for hardscape removal can be converted from concrete to organic ground cover such as grass and excess hardscaping in new development can be prevented.

Grass can act as a carbon sink, fixing carbon in the soil, and has been found to be able to sequester more carbon than it emits under certain conditions. Healthy soils with higher rates of carbon capture also contribute to reducing runoff pollution and improved stormwater management (Freeborn, 2011). Selecting low input grass species, reducing synthetic fertilizer and pesticide use, and adopting sustainable management practices such as reduced watering regimes contribute to grass sequestering rather than emitting carbon (Hostetler & Escobedo, 2008). Zirkle et al. (2011) determined a series of lawn carbon sequestration ranges for different lawn types and management practices; low management lawns with minimal input were found to have a sequestration rate of 25.4 to 114.2 g C/m^2/year whereas using industry and academic best practices produces a sequestration rate from 51.7 to 204.3 g C/m^2/year (Zirkle et al., 2011).

There is however a set carrying capacity of soil to sequester carbon, after which the lawn can become a carbon emitter rather than sink. The time period that grass can be a carbon sink varies significantly depending on cover type, operations, and management practices. As such, further study into plant species and sustainable management practices for lawns on Queen's University campuses is recommended to evaluate the existing soil conditions, potential for carbon sequestration and stormwater management, and lifecycle cost benefits.

7.1.2. Concrete Carbon Emission

Replacing concrete with grass has the added benefit of reducing campus-wide demand for new concrete. Globally, over 4 billion tonnes of cement are produced annually, generating 6-8% of all anthropogenic CO_2 emissions and consuming 2–3% of total global energy use (Lehne & Preston, 2018; Monteiro, Miller, & Horvath, 2017; Mehta & Meryman, 2009). As one of the most widely used construction materials in the world, reducing overall use and emissions from concrete production has a high potential to contribute to global greenhouse gas (GHG) reduction. While there are global initiatives as well as academic and industry research into reducing CO_2 emissions from cement and concrete production, the research has not been widely adopted in the industry; reducing the overall demand for concrete is the best way to reduce emissions. Research suggests that by using less concrete overall and reducing the amount of cement used in concrete, global concrete consumption could be decreased by 30% (Mehta, 2010). Minimizing the demand for concrete on Queen's campus and replacing concrete with more sustainable alternatives overtime is the most sustainable solution. Removing excessive hardscape on campus by right-sizing pathways will reduce the long-term use of concrete while further study into concrete alternatives can be conducted for future development plans. We recommend further study be conducted into the use of recycled concrete and carbon capturing, high performance concrete (Dixit, Du, & Dai Pang, 2021; Park & Choi, 2021; Monteiro, Miller, & Horvath, 2017).

Decreasing the reliance on carbon-intensive materials will further Queen's sustainability goals outlined in the campus Climate Action Plan (2016). While industry has been slow to adopt concrete alternatives, there are advances being made and opportunity for Queen's University to incorporate sustainable practices in development across campus. Incorporating the central principles of sustainability, to reduce, reuse and recycle, in campus development and extending the lifecycle of products such as pathway concrete will contribute to minimizing the use of finite resources. Research into the viability of recycled and high-performance concrete for use in pathway and building construction is recommended to further the findings of this study.

7.1.3. Operational and Maintenance Cost Considerations

Viewing the campus open space landscape as an asset which contributes to environmental and social health, operational and maintenance regimes should be evaluated to identify best practices and areas for transition. Reducing hardscape across campus, through both pathway width reductions and pathway removals, presents opportunities to reduce the operational and maintenance costs associated with the existing network. While operational and maintenance costs are typically quite dynamic, consideration of relativistic cost changes due to the removal of hardscaping depicts the potential benefits in the absence of specific cost values.

The life-cycle costs of concrete pathway installation, maintenance, repair, and replacement across campus is important to evaluate to develop a complete understanding of the true cost of the pedestrian network. The tendency to cap open spaces with concrete is apparent across campus; replacing greenspace with hardscape has enabled more efficient snow removal and decreased operations costs in lawn maintenance. Understandably, concerns over increased operational requirements from introducing increased green space are to be expected. However, the current project identifies a gap in information; a detailed cost analysis comparing life-cycle costs for hardscape and sustainably managed open space is needed to identify the financial commitment of each type.

While the initial cost of removing hardscape and converting an organic groundcover can be high, investing in resilience plant species and adopting sustainable (low input) management practices is expected to decrease costs overtime. Concrete removal is estimated to cost between $2-$8 per sq foot depending on the pathway design, reinforcement, and thickness and there are additional costs for concrete disposal (RKS Service Group, n.d.). However, methods of recycling concrete and opportunities to use urbanite (the term for broken pieces of concrete leftover from demolition) in landscaping on campus can eliminate the disposal costs. While concrete is relatively inert and not considered a hazard in landfills, as the availability of space in landfills declines, the cost of landfilling construction debris will rise; diverting waste to be reused as much as possible will reduce costs and increase a projects sustainability. Removed concrete can be crushed and used as an aggregate in new concrete, as a structural layer or sub-base layer. Another advantage of concrete recycling is that there are no restrictions to what type of concrete can be recycled; continuously reinforced pavement, jointed plain pavement, and jointed reinforced pavement have all been successfully and economically recycled (Concrete Network, n.d.). Urbanite can be reused across campus in landscaping features such as flower beds, retaining walls and to line pathways.

Conducting a detailed lifecycle cost analysis of constructing pathways, concrete removal, and transitioning a landscape to organic groundcover such as grass (or more sustainable alternatives) will help inform decision making and expense planning for operations/facilities staff. As noted above, there are range of cost factors

to consider for concrete pathways and lawns including installation, replacement and repair, snow removal, and maintenance which are difficult to predict without a full cost evaluation. Opportunities to reduce costs of concrete removal such as recycling into aggregate should be considered when conducting a cost analysis. The lifecycle cost analysis could be used to assist with financial and operational planning, allocating resources to prioritizing deteriorating pathways and areas identified for hardscape removal in this study.

7.2. Operational Limitations

It is recognized that changes to the campus pedestrian network must consider a range of factors beyond pedestrian experience and sustainability. Operational and safety requirements are imperative to consider in any design process and have been incorporated throughout the pathway standard development process.

Changes to facilities operations such as snow removal are expected should the proposed standard be adopted. The snow removal routes may need to be adapted to changes in path widths and a reassessment of where removed snow will be stored should the current areas be impacted. Following discussion with facilities staff who outlined the snow removal process and machinery used on campus, it was found that no pathway would be too narrow for the plows currently used. Mowers with attached snowplows that are used for narrow pathways are 1.5m wide, less that the proposed minor pathway standard (1.6 - 1.8m) and would be sufficient to clear those routes. Three-quarter ton trucks used for larger pathways and parking lots are approximately 3m wide which is sufficient to clear major pathways (3m – 3.5m) and shared streets (4m – 4.5m). Should the proposed standards be implemented, the most significant foreseeable changes would be to clearing intermediate pathways (2m – 2.5m), which would require multiple passes with a mower rather than a truck, and any pathways reduced from major to minor pathway widths.

Similarly, depending on the application of the recommended pathway standard, the siting of dumpsters and garbage collection routes may need to be reassessed to respond to changes in pathway vehicle access. Within the Old Campus Block there are currently dumpsters behind each building, requiring access for a garbage truck. However, this is not necessarily the most efficient approach or means of waste collection. Identifying specific sites to collect waste from multiple buildings that are easier to access from main roadways would decrease the need for wide vehicle routes within the central block and further the potential for hardscape removal. In both instances, there is an opportunity to optimize facilities operations for more efficient and cost-effective servicing.

Fire route access is vital to plan for during the pathway optimization process; existing fire route plans were assessed and incorporated in the design. Through discussion with the client, some potential for adjustment to the fire plan was identified; however, specific location, changes, and the implication for the study area recommendations are required to be discussed with officials from the Kingston Fire Department. Pathways that have been classified to not permit regular vehicle use but that are designated fire lanes may be delineated using removeable bollards. Bollard systems have been identified that utilize a locking mechanism to keep them upright but can be unlocked and removed to allow vehicles to pass. Provided a key to the bollard system is given to the fire department, this was identified as a potential solution to accommodate fire trucks and service vehicles while prioritizing pedestrian safety. There are a significant number of pathways and lots behind buildings within the Old Campus Block with excessive hardscape reserved solely for fire truck access; research and discussion with facilities and operations staff raised the possibility of replacing the hardscape with loadbearing permeable paving stones or grass reinforcement systems such as permeable grass pavers (see demonstrations provided below in Figure 7-1 and Figure 7-2) (Hall, 2015; ABG Geosynthetics, n.d). Replacing concrete slabs with permeable blocks allows for significant improvement in ground water absorption and reduced runoff. Should the fire lanes be considered for hardscape conversion there are numerous operational factors to assess namely changes to snow removal, maintenance, and life-cycle costs.

Figure 7-1 Examples of possible driveable greening infrastructure that integrates vegetation and concrete pavers at grade.

Figure 7-2 Examples of possible driveable greening infrastructure that utilizes structural load bearing components below grade, allowing vegetation to grow unobstructed at the surface.

The challenges and considerations outlined above were identified during the pathways standards project and have been factored into the recommendations to the fullest extent possible within the scope of study. Detailed planning and accommodation for each of these factors are outside the scope of the study and further work is required to align operations and servicing regimes with the proposed standards. Since changes to pathway widths and hardscape removal will be a gradual process, there is sufficient time to re-evaluate servicing requirements and routes.

8 Conclusion

This report presented a proposed pathway width standard for Queen's University. The standard aims to contribute to the sustainability objectives of the institution by appropriately classifying all pathways based on their user volumes and use function and assigning a corresponding width range that is deemed appropriate for these considerations. Additionally, various recommendations were provided in efforts to support the implementation of the pathway standard across the Queen's campuses and within the designated study area.

The development of the pathway width standard was conducted through an integrated process that considered findings from relevant literature, case studies of contextually relevant U15 Canadian universities, and pathway user information that was collected and analyzed to identify informative use trends. The resulting standard is comprised of four pathway classifications each with a respective width range; these widths were derived from existing precedents found within the case studies, the observed user volumes within the study area, and operational width requirements. The classifications and their associated widths are as follows:

- Shared streets: 4 m – 4.5 m
- Major pathways: 3 m – 3.5 m
- Intermediate pathways: 2 m – 2.5 m
- Minor pathways: 1.6 m – 1.8 m

To support each classification, specific distinguishing characteristics have been provided as a guidance tool for the classification of pathways across the Queen's campuses. These classification characteristics pertain to the suitable use functions, relative user volumes, and pathway position within the broader network. Accompanying the width standard, campus-wide recommendations were provided to support the implementation of the standard, and to provide further guidance regarding elements associated with the pathway network, such as lighting, wayfinding, and appropriate greening, among others.

To exemplify the application of the width standard to the existing path network, all pathways within a defined study area were classified. Through client recommendation, the study area was identified as the campus block bound by Union Street, Arch Street, Stuart Street, and University Avenue. The classification of

pathways were conducted through consideration for existing and anticipated use functions, relative user volumes, and any special path designation within the Campus Master Plan, such as potential inclusion as a designated cycling trail. The resulting pathway classifications are intended to serve as both an exemplification exercise as well as a point of consideration for how this standard may be applied to the path network and the necessary variables for consideration. In addition to the study area pathway classification, area-specific recommendations were provided to enhance the network's user experience and sustainability contributions. These recommendations generally pertain to the areas recommended for significant hardscaping reduction or removal. Furthermore, two key opportunity areas were identified through the investigation of the study area pathway network – these areas included the lands surrounding Jackson Hall and the pathway segments south of Nixon Hall. The recommendations provided for these areas are noted as outside of the scope of this project but may nonetheless contribute to enhancing the pathway network.

In addition to the proposed pathway width standard and associate recommendations, items for further consideration were addressed and discussed as they relate to the project. In efforts to advance the quantitative assessment of the standard's potential sustainability impacts, carbon sequestration comparisons and the lifecycle carbon emissions of concrete were briefly addressed and identified as an area requiring further assessment. Additionally, potential operational impacts and cost considerations were discussed from the perspective of the pathway width standard's implementation in the study area. These were also identified as areas requiring further consideration from multiple stakeholders.

The key deliverables provided within this report serve to support and advance the sustainable develop goals identified by Queen's University while encouraging an efficient, attractive, and enduring pathway network that may be enjoyed by faculty, staff, students, and visitors alike.

8.1 Limitations

Various limitations have been identified that may have influenced the development of the proposed pathway width standard and accompanying recommendations. These limitations and their potential impact are briefly discussed below.

8.1.1. Time Constraints

The project's timeframe for completion was identified as a limiting factor that influenced both the targeted deliverables as well as the ability to conduct the necessary actions to satisfy these deliverables.

Firstly, the project's scope was inherently limited given this time constraint and did not permit the detailed consideration of external factors that may influence the requirements of a campus-wide pathway width standard. For example, the holistic improvement of the Queen's campus pathway network requires the consideration of a variety of aspects, including appropriate pathway width, material, amenity, location, greening, among others. While recommendations are broadly provided to address a plethora of these considerations, the developed standard was limited to only appropriate pathway widths. This will require future action towards providing stronger guidance towards the aspects of pathway improvement that were not included in this standard.

Secondly, time constraints limited the inclusion of a greater breadth of stakeholders into the project, some of whom may have provided valuable insight towards the pathway standard development and subsequent recommendations. For example, a shift in future use of internal campus pathways by motorized vehicles, whether permitted or otherwise, requires a detailed process of communication and planning across numerous stakeholders within the institution and the City of Kingston. Thus, considerations such as waste collection, which may have substantial impact on the future use of internal pathways on campus, were only marginally addressed within this project. Furthermore, the potential consolidation of collection locations, which may present substantial benefit towards reducing required vehicle access to pathways, was not discussed in depth.

8.1.2. Available Resources

Through the process of procuring and analyzing relevant case studies, it was determined that publicly available resources providing quality information pertaining to the content and context of this project were limited. Specifically, it was found that many U15 institutions included in this study either do not possess or do not publicly disclose their pathway width standards. As such, information was typically obtained through an analysis of master plan documents, which generally provided inconsistent information. This resulted in a greater need to infer and interpret information found within the case studies and literature to develop the standard and accompanying recommendations, possibly resulting in some gaps in the recommendations that may require further examination.

There were also noted instances where information pertaining to the study area's pathways was unavailable, limiting the ability to consider all potential stakeholders within the proposed study area pathway classification. For example, explicit information regarding the pathway network's anticipated future vehicle access requirements is not currently available given the extensive communication and planning required to be undertaken across numerous stakeholders. This potentially limits the ability to provide accurate and anticipatory pathway classification recommendations within the study area, and in some instances has resulted in providing multiple scenarios that accommodate potentially differing vehicle access requirements.

8.1.3. Data Gathering

Data gathering was an important contributory component of this project, providing valuable insight into the use patterns of the existing pathways within the study area. Furthermore, the collected data aided in the development of the pathway standard as well as the classification of pathways within the study area and their associated recommendations. However, the data gathering process was limited due to time and resource restrictions that inhibited the amount and quality of data that was able to be collected.

Firstly, the project's time constraints only permitted a short window of opportunity for data collection – eight collection days over two consecutive weeks at a total of 13 collection locations. Data was collected at each of these locations for one day each, resulting in a limited sample from which to analyze and draw conclusions from. The selected locations were identified through site visits and discussions with the client in efforts to select both representative and unique locations; however, not all pathways within the study area were able to be assessed. As a result, many of the recommended pathway classifications within the study area have been

provided on the basis of anticipated uses and volumes relative to those that were observed at the count locations. Furthermore, the lack of longitudinal data at each location heightens potential for recommendations biased towards the singular observed volumes on each day of the counts. To combat this, conservative assumptions and projections were presented to potentially offset volumes exceeding those observed during the counts.

Secondly, the pathway user count process was limited by the available resources allotted for this project. Specifically, manual user counts were required to be conducted rather than continuous counts using cameras as these technologies were not an available resource. As a result, there is potential for actual user volumes to exceed those observed during the counts, potentially culminating in the analysis of inaccurate data. While continuous counts using camera technologies are preferred for capturing the most accurate representation of user volumes, the developed user count process likely captured an adequate representation of the actual user volumes such that slight inaccuracies of the data would not greatly impact the resulting classifications and recommendations.

8.2 Next steps

This project provides an appropriate and progressive pathway width standard, accompanied by targeted recommendations and additional considerations for future investigation related to this work. Specifically, seven next steps have been identified that will help advance the deliverables of this project and further contribute to enhancing the Queen's campus pathway network.

Endorse the proposed pathway width standard

As an initial step towards advancing the deliverables of this project, and more broadly the sustainability efforts towards Queen's pathway network, the pathway width standard presented in this report should be endorsed and adopted. This will initiate the process of critically examining the existing and future pathways on Queen's campuses, identifying areas where excessive or insufficient hardscaping are negatively impacting both the network's efficiency and sustainability.

Present report contents to variety of stakeholders

The recommendations contained within this report, while specifically targeted towards the implementation of the proposed pathway width standard, require consideration from a variety of stakeholders prior to being actionable. Thus, the contents of this report should be distributed to those who may influence or be influenced by these recommendations. This process will provide valuable insight and will begin a dialogue that considers the future use of pathways both within the study area and across campus.

Continue to engage in pathway user count program long-term

To continue gathering information on pathway users, a count program should be established whereby counts are conducted at various locations at designated intervals (e.g., quarterly, semi-annually, etc.). Creating and executing such a program will develop a catalogue of pathway information that can be utilized to inform future projects, amenities, and classifications. Furthermore, to reduce the commitment of manual labour required to conduct counts, opportunities to install designated cameras in strategic locations that collect data to be analyzed by a third-party may be investigated. This would provide opportunities to increase the frequency of data collection while simultaneously reducing burdens to employees.

Classify all pathways across Queen's campuses

Upon adoption of the width standard, a process should be initiated whereby all pathways on all of Queen's campuses are classified in conformance with the provided standard. This will provide opportunities to identify locations that currently do not conform to the standard and will provide guidance for future projects that will necessitate the removal or replacement of existing pathways. Furthermore, the classification of pathways should be revisited occasionally to ensure that shifting travel patterns continue to align with the assigned classification.

Investigate opportunities to collect mass-level campus travel information through the application of voluntary tracking technologies

To further develop an understanding of existing and evolving pathway travel behaviours across Queen's campuses, it is recommended that opportunities to collect mass-level campus travel information be explored. As the key area of interest for this project is the specific pathways that are being utilized, the use of voluntary tracking technologies is likely the most suitable approach. Such technologies have been used in the past by institutions undertaking mobility studies and provide substantial opportunity to accurately gauge the circulation of users across campus. This information may aid in guiding the future installation or removal of pathways within the network and will provide pathway user information with increased granularity.

Review existing fire routes and make adjustments accordingly to reduce unnecessary hardscaping

The extent of the existing fire routes within the designated study area have been identified as a potential contributor to excess observed hardscaping. It has been noted that in some instances the existing routes are not considered to reflect the path anticipated to be taken by the Kingston Fire Department in the event of an emergency and are rather contingency routes or opportunities for vehicle turnaround. As such, opportunities may exist to re-evaluate the existing fire routes within the study area, and across campus, to optimize their locations to reduce otherwise unnecessary hardscaping.

Investigate the potential to address opportunity areas identified within this report

The opportunity areas provided within this report offer initial considerations for potential future projects that may contribute to supporting the implementation of the pathway width standard while enhancing the campus user experience. The discussion surrounding these identified opportunities should be used as an initiation towards further investigating and addressing their respective issues in the coming years.

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Appendix A: Queen's Campus Master Plan

Updated in 2021, Queen's University Campus Master Plan (CMP) acts as a guide for the future growth of the University. The CMP outlines the Universities vision, goals, and objectives through a set of recommendations applied to the physical campus environment. The recommendations highlighted in this report are designed to align and enhance the recommendations set in the CMP. The following recommendations are pulled from the Queen's CMP official document and highlight areas where the recommendations proposed in this report fit best.

- Campus Vision
  - **Planning Principle 2: Enhance the campus experience**
    - 2.2 Ensure the campus is accessible, adhering to existing campus policy and guidelines regarding universal design.
  - **Planning Principle 3: Promote good facilities management**
    - 3.1 Act as stewards of our land and consider the best use of that land over time.
  - **Planning Principle 4: Foster a more sustainable campus**
    - 4.2 Improve active transportation infrastructure, including cycling routes and pedestrian pathways.
    - 4.3 Invest in buildings and landscapes of enduring quality
  - **Planning Principle 6: Create a campus that supports health and wellness**
    - 6.4 Enhance infrastructure and services to promote active transportation such as walking and biking.
- Campus at the City Scale
  - **4.3 Cycling Network**
    - 4.3.1 (2) Consider design features to mitigate conflict between cyclists and pedestrians in the design of Walks and Pathways indicated as Proposed Cycling Trails on Figure 4-3

- Main Campus/West Campus Master Plans
    - **5.1 Land Use and Social Infrastructure**
        - Recommendation 5: Areas with a high concentration of social infrastructure should be considered priority areas for public realm improvements that incorporate infrastructure for gathering and socializing, such as outdoor patios, public seating (including Indigenous seating circles), and attractive landscaping
    - **5.4 Open Space Network**
        - Recommendation 2: New landscape projects will reinforce the established character, image and the spatial structure of the campus. Individual landscape projects should be planned and designed to contribute to the sense of a whole campus as well as meeting particular site and program requirements.
        - Recommendation 12: The design and retrofit of all landscapes, existing and proposed, should comply with Queen's Accessibility Guidelines
    - **5.4.1 Picturesque Landscapes**
        - Recommendation 2: Landscape plans should be developed for each picturesque landscape, including provisions for pathway re-treating or realignments, new plantings, and guidelines for adjacent buildings.
    - **Queen's Quadrangle Enhancements**
        - Recommendation 3: All other walking paths should be narrower than Professor's walk and be of a consistent paving treatment.
    - **5.4.2 Formal Linear Landscapes**
        - Recommendation 1: The design and treatment of paving should be consistent throughout all pathways to provide legibility.
    - **Fifth Field Company Lane Improvements**
        - Recommendation 1: Re-design Fifth Field Company Lane to signify it as a pedestrian-priority street. This may include special paving or rolled curbs.
    - **5.5.1 Pedestrian Network**
        - Recommendation 1: The continued maintenance and enhancement to the pedestrian network should be considered a priority in order to ensure a continued safe, walkable, and accessible Main Campus. Enhancements should aim to create protected and inviting routes. Design considerations should include: Continuous, identifiable paving, Framing and protective elements such as trees or planting, The incorporation of street furniture such as benches to provide places to rest. These should be located on either side of the path but should not obstruct the pedestrian right of-way , Regard for Design for Crime Prevention through Environmental Design (CPTED) principles
        - Recommendation 2: Pedestrian activity should remain at grade and be designed in accordance with Queen's Accessibility Guidelines to accommodate those with mobility-related disabilities.

- **5.5.5 Servicing Network**
  - Recommendation 2: Consolidated service routes should be designed to ensure appropriate service and truck access to campus facilities.
  - Recommendation 3: Where service routes overlap the pedestrian network, they should be designed as high-quality pedestrian spaces to discourage unsafe vehicular behaviour and reinforce the pedestrian nature of campus.

- Building Design Guidelines
  - **7.1.7 Parking**
    - Recommendation 3: Driveways and access points for surface parking lots, structured parking facilities, pick-up and drop-off areas, and building servicing facilities should be carefully designed to minimize visual impacts and reduce the potential for pedestrian and vehicular conflicts

Appendix B: Queen's Building Design Standard

Queen's University provides a set of design standards that allows for consultants and contractors to have detailed guidance when working on campus renovations, new projects, and physical campus maintenance. The standard highlighted in this report are designed to align and enhance Queen's Building Design Standard. The following standards are pulled from the Queen's University Building Design Standard official document and highlight areas where the standard proposed in this report fit best.

- 32 14 00 Unit Paving
    - 1 Unit paving should be unified by set dimensions and colours for field paving, borders, banding and accents. Variety can be achieved by varying the pattern at specific locations in response to the setting. The perimeter of unit paving areas should be defined by walls, curbs, and paver edging system and banding material, as appropriate for the location. Unit paver for field paving shall be 200 x 200 mm size in dark grey colour, and for borders and banding shall be 100 x 100 mm grid size, textured, natural (light grey) colour. Pavers shall be laid in stack bond pattern, flush with adjacent paving. The standard widths for unit paver border and banding shall be 600 mm and 400 mm respectively. The University shall approve paver size, colour and pattern for non-standard field, banding and accents.
    - 2 Unit pavers approved for use at walkways shall be of colour and pattern consistent with the predominant precedent in the streetscape and vicinity. Finish and detailing should be durable, attractive, low maintenance, slip resistant, wheelchair accessible and convenient for snow removal
- 32 16 00 Concrete Walks and Curbs
    - 32 16 13 Curbs
        - 1 Concrete curbs at sidewalks shall be flush with sidewalk. Concrete curbs defining shrub beds and turf areas shall be raised a minimum of 100 mm above finish grade of adjacent paving.
        - 2 Exposed edges of concrete curbs shall be rounded or chamfered to prevent chipping and damage from maintenance equipment. Sharp edges and corners shall be avoided.
        - 3 The dimension, finish and detailing of concrete curbs should be compatible with the predominant precedent in the vicinity, and should be durable, attractive, and low maintenance

- 4 Curbs adjacent to hard surfaces shall be fitted with skateboard deterrent devices that are tamper-proof, safe, attractive, designed to minimize liability and blend in with the character of the site.

- 32 16 23 Sidewalks
  - 1 Walkway construction in a project should take into consideration the specific character of the site and the campus precinct, recognize the unique purpose of the project, ensure the continuity of design in the pedestrian circulation network, and effect economies in the long-term maintenance of that network. Walkway layout and dimension should follow desired line of pedestrian movement and adequately accommodate pedestrian traffic. Walkway detailing should signify pedestrian priority, indicate changes in use (e.g., city sidewalk, sidewalk widening, transition space and linkages), and provide clear separation between pedestrians and vehicles at high use zones.
  - 2 Major sidewalk shall be poured-in-place concrete. Width shall be 4.5 m and may be modified if justified by use and site conditions. Where city sidewalks need to be widened to accommodate pedestrian needs, sidewalk widening of l m or wider than the standard city sidewalk shall have a unit paver border at the back of the city sidewalk. The standard unit paver border shall be 600 mm wide, unless approved by the University. Unit paver shall be 100 x 100 mm grid size, textured, natural (light grey) colour, laid in stack bond pattern, flush with adjacent paving.
  - 3 Standard sidewalk shall be poured-in-place concrete, natural (light grey) colour, 2.8 m wide. Standard unit paver border at the back of the curb shall be determined on a project by-project basis, depending on local conditions.
  - 4 Major walkways shall be 4.5 m to 6 m wide. Standard walkways shall be 2.8 m wide. Major and standard walkways shall be poured-in-place concrete, natural (light grey) colour, with unit paver border along both edges. The width of the border shall be approximately 750 mm (5 courses) wide for walkways 3 m or wider, and approximately 450 mm (3 courses) wide for walkways less than 3 m wide. The University shall approve variances in border width that are required to suit site and walkway proportion. Border shall be tumbled concrete unit paver 150 x 150 mm size, dark grey colour, laid in stack bond pattern. Walkway and border surfaces should finish flush.
  - 5 Minor walkway shall be a minimum 1.8 m wide poured-in-place concrete, natural (light grey) colour. If a minor walkway is not the sole accessible route to a facility, alternate materials may be accepted subject to University approval. Alternate materials should be durable, attractive, low maintenance, slip resistant, wheelchair accessible and convenient for snow removal.
  - 6 Concrete walkway configuration, finish and detailing should be compatible with the established design on campus, be appropriate for the intended use and maintenance equipment, and should be durable, attractive, low maintenance, slip resistant, wheelchair accessible and convenient for snow removal. Concrete shall be broom finish, in straight lines perpendicular to the primary direction of travel. Paving patterns

may be adapted in response to setting but should ensure continuity with the established walkway design on campus. Unnecessary grade changes and steps should be avoided, and if present, alternate and convenient accessible routes should be provided.

- 7 Patios and courts along major pedestrian routes shall be poured-in-place concrete to provide ease of wheelchair access. Field paving materials other than poured-in- place concrete is subject to university approval. The use of unit pavers shall be limited to borders, banding and accents
- 8 Poured-in-place concrete shall meet the appearance and performance criteria specified in these standards. Unit paver for border and banding shall be 100 x100 grid size, textured, natural (light grey) colour, laid in stack bond pattern, flush with adjacent paving. The standard widths for unit paver border and banding shall be 600 mm and 400 mm respectively, unless approved by the University.

- 32 33 00 Site Furnishings
  - 32 33 13 Bicycle Racks
    - 1 Bicycle racks should be in well-lit and convenient locations to meet the needs of potential users. Locations that allow casual supervision from building occupants and passers-by may provide additional safeguard against theft.
    - 2 Bicycle rack should allow the frame and one wheel to be locked to the rack with a high security, U-shaped shackle lock if both wheels are left on the bicycle.
    - 3 Bicycle rack shall be bolted to pavement. Placement of racks should allow for parking perpendicular to the rack on both sides. A minimum clearance of 2 m between parked bicycles is required for snow removal.
    - 4 Racks should be catalogue item rather than custom made. The preferred product is the Ring Rack by Bikeup Bicycle Parking Systems Inc
  - 32 33 43 Benches
    - Benches should be conveniently located in areas of frequent use. A variety of seating arrangements for different social patterns and for choices in sun and shade should be provided. Seating arrangements can also help define a space.
    - 2 Bench should be catalogue item rather than custom made. The design should be comfortable, durable, attractive, and low maintenance.
    - 3 Freestanding benches shall have back with no arm rests. The base plate shall be anchored to a concrete pad or footing with tamper-proof hardware.
    - 4 Where the bench is built-in such as a seat wall, refer to Cast-in- Place Concrete Planter and Seat Walls, for requirements.
    - 5 Free-standing bench shall be Victory Stanley model NRB-6, 6 ft. length, surface mount base, powder coat finish RAL 7024 graphite grey semi-gloss.

- 32 39 00 Manufactured Site Specialties
  - Rigid and collapsible bollards are used to prevent access by unauthorized vehicles to walkways and fire lanes, but do not interfere with pedestrians. A special tool allows the collapsible bollard to be lowered to the ground, remaining attached to a hinge, and then replaced in the upright position.
  - .2 Bollards shall be Maxi force 1 collapsible style bollard Model MF and rigid type bollard Model MF, supplied by G. Reale Enterprises, Inc., 3444 Marshall Road, Drexel Hill, PA 19026, Tel. 610-623-2611. Standard dimensions of extruded steel tubing are 6 in. x 3 in., above ground height is 32 in. Bollards shall have powder coat finish, RAL 7024 graphite grey semi-gloss. Apply reflective tape as specified. Installation shall be per manufacturer's specifications.
- 32 91 00 Planting Preparation
  - 32 91 19 Landscape Grading
    - .1 Subgrade preparation is required under all areas designated to receive landscaping as shown on drawings.
    - 2 Subgrade should be free of rocks, weeds, roots, and other debris. Foreign material shall not be buried beneath areas to be landscaped.
    - 3 Completed subgrade should be even and have positive drainage. Subgrade should be scarified to a minimum 100 mm (4 in.) depth. Subgrade shall be approved by project manager before topsoil placement begins.
    - 4 Topsoil mixture shall be 3 parts Grade 1 topsoil, 1-part sterilized mushroom compost, 1- part peat moss. Mixture should avoid being excessively wet and should be free of weeds, roots, rocks, and other debris.
    - 5 Place topsoil in dry weather, on dry unfrozen grade to obtain minimum depth after settlement of 100 mm (4 in.) or depth specified in planting details. Allow settling to occur for 1 week or roll to facilitate settling. Top layer should be loosely raked to allow for rooting of seed or sod. Surface should be smooth, uniform and sufficiently firm to prevent sinkage pockets when irrigated. Surface should fall smoothly to catch basin rim and finish flush and ensure positive drainage away from building and sidewalks.
    - 6 Project manager should be present for inspection at all stages of grading.

Appendix C: Pedestrian Count Process & Worksheet

1. Identify segment of path to be counted
    a. Refer to Pathway Identification Key PDF to determine which segment is being observed
    b. Naming convention for segments is as follows: Intersection X-Intersection Y (i.e. 10-53, which is along 5th Field Company Lane)
2. Populate count worksheet with required information
    a. Date
    b. Study Period
    c. Mode
    d. Location (mark location on map & add segment name)
    e. Peak periods
    f. Name
    g. Weather
3. Confirm study period for observation
    a. 75-minute period to capture two peak periods (e.g. 8:15 am – 9:30 am)
    b. Study period is split into peak and off-peak segments
        i. 15-minute peak period prior to start of class (e.g. 8:15 am – 8:30 am)
        ii. 45-minute off-peak period during class (e.g. 8:30 am – 9:15 am)
        iii. 15-minute peak period between classes (e.g. 9:15 am – 9:30 am)
    c. Study periods include:
        i. **8:15 am – 9:30 am**
        ii. **12:15 pm – 1:30 pm**
        iii. **3:15 pm – 4:30 pm**
4. Position counters to accurately track passers-by
    a. Typically, two counters per path segment

    b. One observing each direction
    c. Click hand counter once per passer-by
5. At the end of each segment, record the total clicks on the hand counter – DO NOT RESET HAND COUNTER BETWEEN SEGMENTS
    a. The net number of pedestrians, cyclists, etc. will be determined through subtraction
6. During off peak periods, record qualitative observations about use behaviours as necessary
    a. Examples of observations may include the following:
        i. Frequent overflow of path users onto grass/roadway
        ii. Common turning movements along path (e.g. everyone turning left at a path intersection)
        iii. Common issues, conflicts arising (e.g. benches, gates, planters impeding pedestrian/AT flow; pedestrian slow downs from bottlenecking, etc.)

SURP 826 Project Course Counter Worksheet

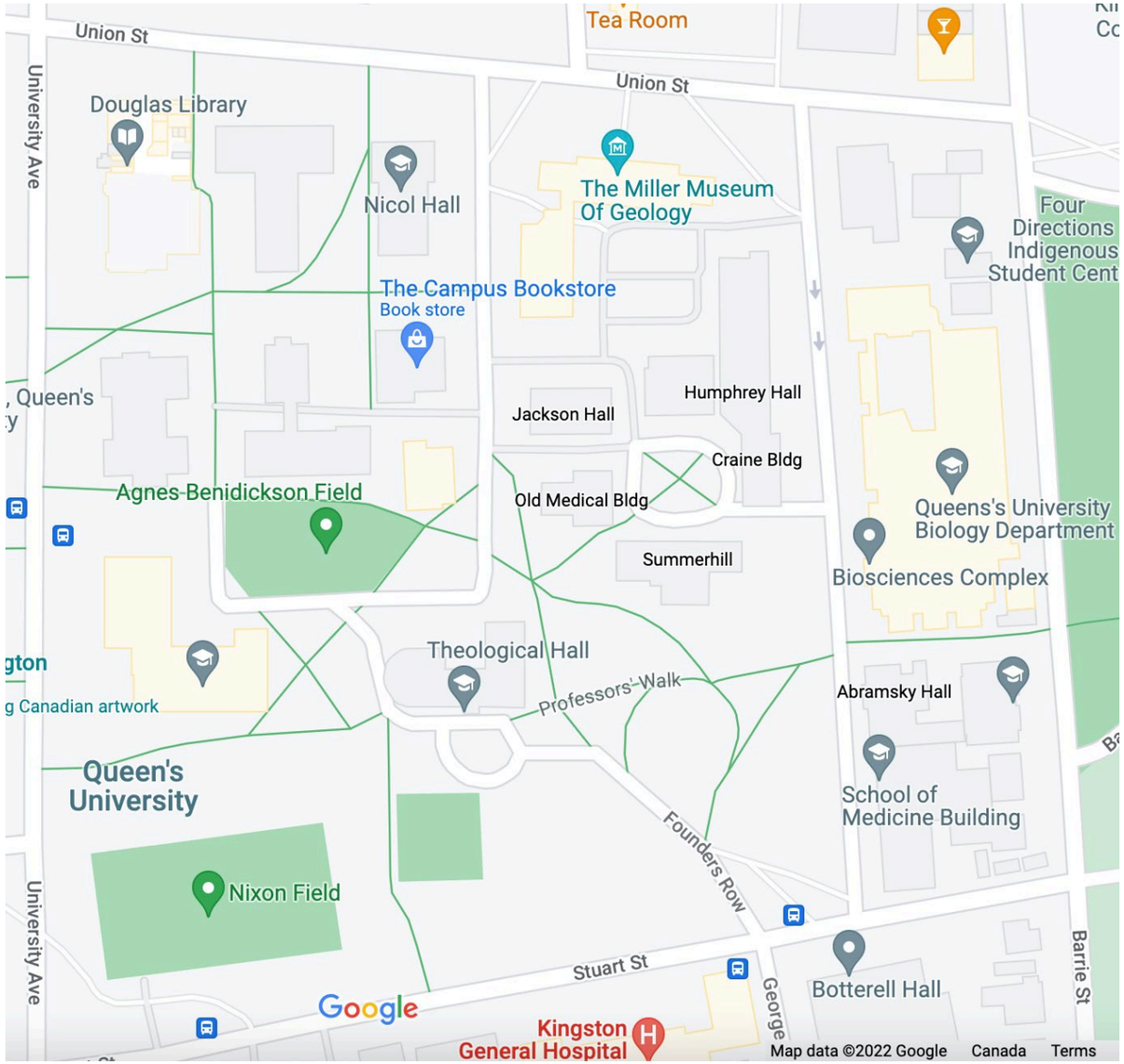
Date: _____ Name: _____ Location: _____

Study Period: _____ Peak Period: _____ Mode: _____

Weather: _____

Peak time: Total: _____	*Notes:*
Off-peak time: Total: _____	*Notes:*
Peak time: Total: _____	*Notes:*

Study Area Map – *kindly mark on the study area map where you are positioned for the count.*



APPENDIX D: DATA COLLECTION

Location	28-55			43-44			37-49		
Date	Mon Sept 19, 2022			Mon Sept 19, 2022			Tues Sept 20, 2022		
Time Slot	8:15 am - 8:30 am			8:15 am - 8:30 am			8:15 am - 8:30 am		
Weather	Partly sunny/overcast			Partly cloudy/overcast/wet			Cloudy		
		N	**S**		**E**	**W**		**N**	**S**
8:15 - 8:30	Ped.	6	19	Ped.	148	44	Ped.	7	8
	Bike	1	1	Bike	1	1	Bike	0	0
	Other	0	0	Other	0	0	Other	0	0
8:30 - 9:15	Ped.	7	7	Ped.	82	23	Ped.	10	24
	Bike	0	0	Bike	3	1	Bike	0	0
	Other	0	0	Other	0	0	Other	0	0
9:15 - 9:30	Ped.	65	5	Ped.	83	108	Ped.	7	5
	Bike	0	1	Bike	1	1	Bike	0	0
	Other	1	0	Other	0	1	Other	0	0
Total	Ped.	78	31	Ped.	313	175	Ped.	24	37
	Bike	1	2	Bike	5	3	Bike	0	0
	Other	1	0	Other	0	1	Other	0	0
Time Slot	12:15 pm - 1:30 pm			12:15 pm - 1:30 pm			12:15 pm - 1:30 pm		
Weather	COUNTS CANCELLED			COUNTS CANCELLED			Cloudy		
		N	**S**		**E**	**W**		**N**	**S**
12:15 - 12:30	Ped.			Ped.			Ped.	3	7
	Bike			Bike			Bike	0	0
	Other			Other			Other	0	0
12:30 - 1:15	Ped.			Ped.			Ped.	22	29
	Bike			Bike			Bike	0	0
	Other			Other			Other	0	0
1:15 - 1:30	Ped.			Ped.			Ped.	8	9
	Bike			Bike			Bike	0	0
	Other			Other			Other	0	0

Total	Ped.	0	0	Ped.	0	0	Ped.	33	45
	Bike	0	0	Bike	0	0	Bike	0	0
	Other	0	0	Other	0	0	Other	0	0
Time Slot	3:15 pm - 4:30 pm			3:15 pm - 4:30 pm			3:15 pm - 4:30 pm		
Weather	Cloudy/overcast			Cloudy/overcast			Overcast		
		N	**S**		**E**	**W**		**N**	**S**
3:15 - 3:30	Ped.	119	34	Ped.	80	162	Ped.	10	6
	Bike	2	0	Bike	2	2	Bike	0	0
	Other	0	0	Other	0	0	Other	0	0
3:30 - 4:15	Ped.	43	38	Ped.	108	130	Ped.	28	5
	Bike	1	0	Bike	3	1	Bike	0	0
	Other	0	0	Other	0	3	Other	0	0
4:15 - 4:30	Ped.	85	29	Ped.	139	81	Ped.	6	4
	Bike	1	0	Bike	3	0	Bike	0	0
	Other	0	0	Other	2	2	Other	0	0
Total	Ped.	247	101	Ped.	327	373	Ped.	44	15
	Bike	4	0	Bike	8	3	Bike	0	0
	Other	0	0	Other	2	5	Other	0	0

Location	38-49			27-30			10-53			22-23		
Date	Wed Sept 21, 2022			Thurs Sept 22, 2022			Mon Sept 26, 2022			Mon Sept 26, 2022		
Time Slot	8:15 am - 8:30 am			8:15 am - 8:30 am			8:15 am - 8:30 am			8:15 am - 8:30 am		
Weather	Cloudy			Sunny						Overcast/rain		
		N	**S**		**N**	**S**		**N**	**S**		**E**	**W**
8:15 - 8:30	Ped.	41	41	Ped.	11	28	Ped.	12	146	Ped.	21	4
	Bike	0	0	Bike	0	3	Bike	0	7	Bike	0	0
	Other	0	0	Other	0	0	Other	0	1	Other	0	0
8:30 - 9:15	Ped.	20	29	Ped.	4	16	Ped.	13	73	Ped.	12	12
	Bike	1	7	Bike	1	0	Bike	0	2	Bike	0	0
	Other	0	0	Other	0	0	Other	0	0	Other	0	0
9:15 - 9:30	Ped.	18	32	Ped.	7	10	Ped.	46	70	Ped.	21	41
	Bike	3	1	Bike	0	0	Bike	1	4	Bike	0	0

	Other	0	0	Other	0	0	Other	0	1	Other	0	0
Total	Ped.	79	102	Ped.	22	54	Ped.	71	289	Ped.	54	57
	Bike	4	8	Bike	1	3	Bike	1	13	Bike	0	0
	Other	0	0	Other	0	0	Other	0	2	Other	0	0
Time Slot	12:15 pm - 1:30 pm			12:15 pm - 1:30 pm			12:15 pm - 1:30 pm			12:15 pm - 1:30 pm		
Weather	Sunny			Rainy/cloudy			Overcast			Overcast/Rainy		
		N	**S**		**N**	**S**		**N**	**S**		**E**	**W**
12:15 - 12:30	Ped.	45	33	Ped.	23	11	Ped.	77	66	Ped.	22	70
	Bike	2	0	Bike	0	0	Bike	2	1	Bike	0	1
	Other	0	0	Other	0	1	Other	1	0	Other	0	0
12:30 - 1:15	Ped.	103	122	Ped.	17	66	Ped.	122	129	Ped.	10	36
	Bike	6	1	Bike	0	1	Bike	0	2	Bike	0	0
	Other	0	1	Other	0	0	Other	1	1	Other	0	0
1:15 - 1:30	Ped.	20	19	Ped.	15	19	Ped.	48	134	Ped.	35	44
	Bike	1	0	Bike	0	0	Bike	2	2	Bike	0	0
	Other	0	0	Other	0	0	Other	0	0	Other	0	0
Total	Ped.	168	174	Ped.	55	96	Ped.	247	329	Ped.	67	150
	Bike	9	1	Bike	0	1	Bike	4	5	Bike	0	1
	Other	0	1	Other	0	1	Other	2	1	Other	0	0
Time Slot	3:15 pm - 4:30 pm			3:15 pm - 4:30 pm			3:15 pm - 4:30 pm			3:15 pm - 4:30 pm		
Weather	Overcast			Sun and cloud mix			Sunny and windy			Partly sunny		
		N	**S**		**N**	**S**		**N**	**S**		**E**	**W**
3:15 - 3:30	Ped.	45	10	Ped.	24	16	Ped.	82	86	Ped.	13	28
	Bike	1	1	Bike	0	0	Bike	2	2	Bike	0	0
	Other	0	0	Other	1	1	Other	0	0	Other	0	0
3:30 - 4:15	Ped.	110	56	Ped.	41	71	Ped.	128	137	Ped.	39	45
	Bike	5	1	Bike	3	1	Bike	4	2	Bike	0	0
	Other	0	1	Other	0	0	Other	0	2	Other	0	0
4:15 - 4:30	Ped.	26	27	Ped.	12	11	Ped.	93	79	Ped.	6	12
	Bike	1	1	Bike	0	0	Bike	4	2	Bike	0	0
	Other	1	1	Other	2	0	Other	2	0	Other	1	0
Total	Ped.	181	93	Ped.	77	98	Ped.	303	302	Ped.	58	85

	Bike	7	3	Bike	3	1	Bike	10	6	Bike	0	0
	Other	1	2	Other	3	1	Other	2	2	Other	1	0

Location	21-24			29-31			13 - 14			25-26		
Date	Tues Sept 27, 2022			Tues Sept 27, 2022			Wed Sept 28, 2022			Wed Sept 28, 2022		
Time Slot	8:15 am - 8:30 am			8:15 am - 8:30 am			8:15 am - 8:30 am			8:15 am - 8:30 am		
Weather	Sunny progressing to overcast			Mix of sun and cloud			Cloudy & Windy 11ºC			Overcast/chilly		
		E	**W**		**N**	**S**		**E**	**W**		**E**	**W**
8:15 - 8:30	Ped.	18	8	Ped.	19	38	Ped.	7	35	Ped.	123	5
	Bike	1	0	Bike	0	1	Bike			Bike	2	
	Other	1	0	Other	0	0	Other		1	Other	0	1
8:30 - 9:15	Ped.	9	4	Ped.	14	19	Ped.	15	21	Ped.	50	15
	Bike	0	0	Bike	2	1	Bike	1	1	Bike	4	1
	Other	0	0	Other	0	1	Other			Other	1	
9:15 - 9:30	Ped.	24	16	Ped.	26	7	Ped.	28	45	Ped.	20	31
	Bike	0	0	Bike	0	1	Bike	1	2	Bike	0	
	Other	0	0	Other	1	0	Other	1	2	Other	0	1
Total	Ped.	51	28	Ped.	59	64	Ped.	50	101	Ped.	193	51
	Bike	1	0	Bike	2	3	Bike	2	3	Bike	6	1
	Other	1	0	Other	1	1	Other	1	3	Other	1	2
Time Slot	12:15 pm - 1:30 pm			12:15 pm - 1:30 pm			12:15 pm - 1:30 pm			12:15 pm - 1:30 pm		
Weather	Sunny			Sunny			Cloudy & weather 14ºC			Overcast/chilly		
		E	**W**		**N**	**S**		**E**	**W**		**E**	**W**
12:15 - 12:30	Ped.	43	33	Ped.	18		Ped.	25	83	Ped.	83	83
	Bike	1	1	Bike	1		Bike		1	Bike	0	1
	Other	2	1	Other	0		Other			Other	1	1
12:30 - 1:15	Ped.	21	28	Ped.	57		Ped.	56	59	Ped.	145	94
	Bike	1	0	Bike	0		Bike	2	1	Bike	4	2
	Other	0	0	Other	1		Other			Other	0	1
1:15 - 1:30	Ped.	29	20	Ped.	22		Ped.	30	48	Ped.	54	130

	Bike	2	0	Bike	0		Bike		1	Bike	2	2
	Other	0	0	Other	0		Other			Other	1	
Total	Ped.	93	81	Ped.	97	0	Ped.	111	190	Ped.	282	307
	Bike	4	1	Bike	1	0	Bike	2	3	Bike	6	5
	Other	2	1	Other	1	0	Other	0	0	Other	2	2
Time Slot	3:15 pm - 4:30 pm			3:15 pm - 4:30 pm			3:15 pm - 4:30 pm			3:15 pm - 4:30 pm		
Weather	Cloudy, partial rain			Rainy			Overcast			Overcast/chilly		
		E	**W**		**N**	**S**		**E**	**W**		**E**	**W**
3:15 - 3:30	Ped.	19	38	Ped.	23	11	Ped.	12	20	Ped.	79	85
	Bike			Bike	1	0	Bike	1		Bike	3	
	Other		2	Other	0	0	Other	0		Other	2	
3:30 - 4:15	Ped.	31	20	Ped.	52	31	Ped.	33	31	Ped.	36	135
	Bike	2	1	Bike	1	0	Bike	0		Bike	1	2
	Other			Other	0	0	Other	1		Other	2	2
4:15 - 4:30	Ped.	13	22	Ped.	23	12	Ped.	18	15	Ped.	52	48
	Bike			Bike	1	0	Bike	1		Bike	2	2
	Other			Other	0	0	Other	0		Other	0	1
Total	Ped.	63	80	Ped.	98	54	Ped.	63	66	Ped.	167	268
	Bike	2	1	Bike	3	0	Bike	2	0	Bike	6	4
	Other	0	2	Other	0	0	Other	1	0	Other	4	3

Location	17-19			34-35		
Date	Thurs Sept 29, 2022			Thurs Sept 29, 2022		
Time Slot	8:15 am - 8:30 am			8:15 am - 8:30 am		
Weather	Chilly, Sunny			Sunny/Chilly		
		N	**S**		**E**	**W**
8:15 - 8:30	Ped.	22	46	Ped.	103	60
	Bike	0	2	Bike	1	0
	Other	0	1	Other		1
8:30 - 9:15	Ped.	12	27	Ped.	61	20

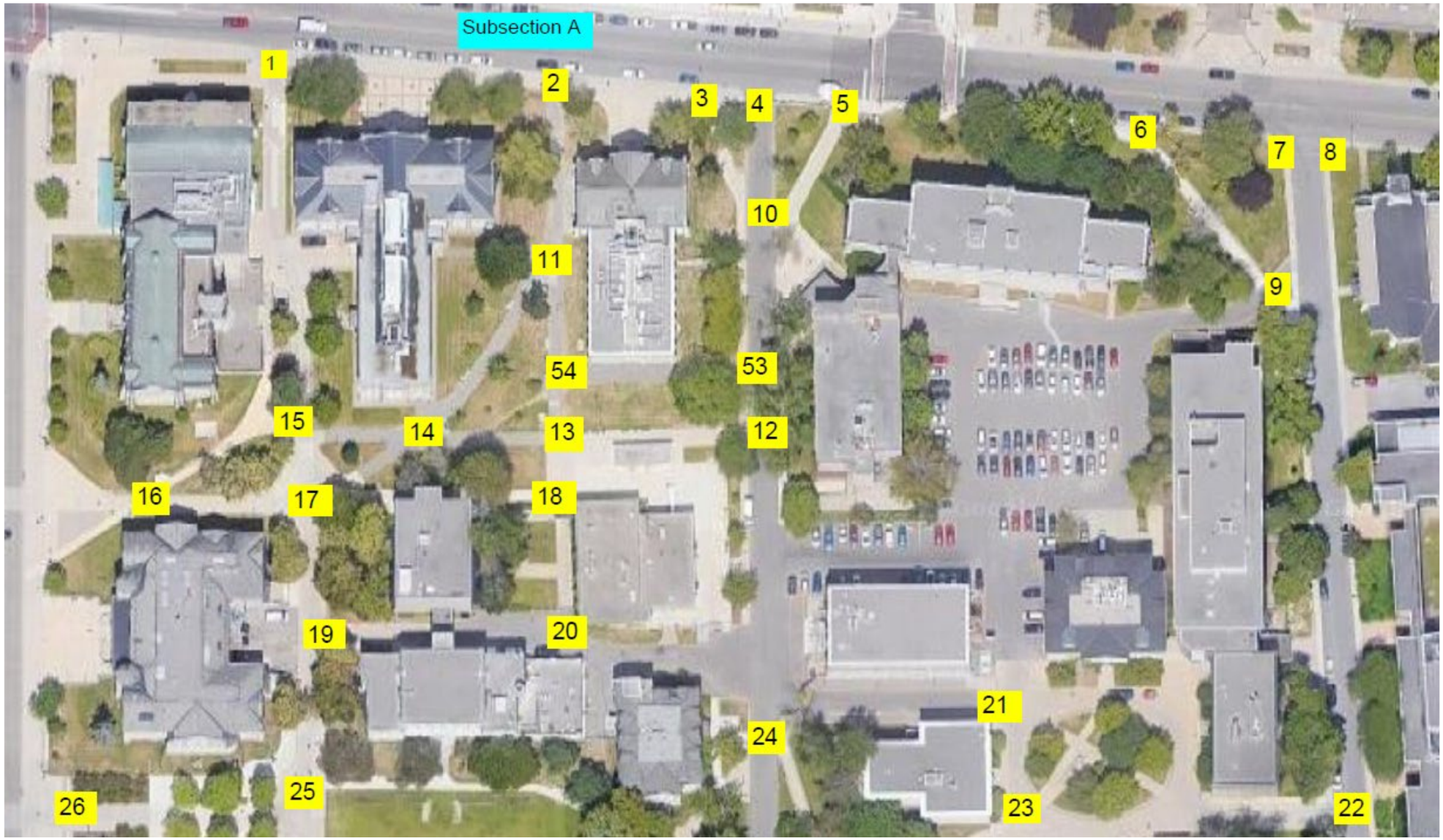
	Bike	0	3	Bike	2	1
	Other	0	3	Other		0
9:15 - 9:30	Ped.	50	22	Ped.	100	94
	Bike	0	1	Bike	1	0
	Other	1	2	Other		0
Total	Ped.	84	95	Ped.	264	174
	Bike	0	6	Bike	4	1
	Other	1	6	Other	0	1
Time Slot	12:15 pm - 1:30 pm			12:15 pm - 1:30 pm		
Weather	Sunny			Sunny		
		N	**S**		**E**	**W**
12:15 - 12:30	Ped.	48	34	Ped.	167	36
	Bike	1	3	Bike	1	4
	Other	0	2	Other		0
12:30 - 1:15	Ped.	91	105	Ped.	94	62
	Bike	0		Bike	3	1
	Other	3	4	Other		0
1:15 - 1:30	Ped.	47	39	Ped.	144	82
	Bike	1	2	Bike		1
	Other	0	1	Other		0
Total	Ped.	186	178	Ped.	405	180
	Bike	2	5	Bike	4	6
	Other	3	7	Other	0	0
Time Slot	3:15 pm - 4:30 pm			3:15 pm - 4:30 pm		
Weather	Sunny			Mostly sunny		
		N	**S**		**E**	**W**
3:15 - 3:30	Ped.	29	35	Ped.	75	127
	Bike	1	1	Bike	0	0
	Other			Other	0	1
3:30 - 4:15	Ped.	85	65	Ped.	53	49
	Bike	3	1	Bike	1	2

	Other		2	Other	0	0
4:15 - 4:30	Ped.	19	21	Ped.	47	96
	Bike			Bike	0	1
	Other	1		Other	1	0
Total	Ped.	133	121	Ped.	175	272
	Bike	4	2	Bike	1	3
	Other	1	2	Other	1	1

Appendix E: Study Area Pathway Identification Key

Pathway Segment Naming Convention

- Pathway segments are identified by their adjacent, coded intersections
- Segments being observed should align with the following naming convention:
  - Intersection X-Intersection Y
  - Smaller number should always go first, followed by larger number
  - E.g. ***10-53*** for the segment near the north end of 5th Field Company Lane


Subsection A
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Subsection B
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