A GIS APPROACH TO IDENTIFYING BARRIERS TO ACTIVE TRANSPORT IN ACADIA

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UNIVERSITY OF CALGARY

Sustainable Calgary

TABLE OF CONTENTS

About the Authors

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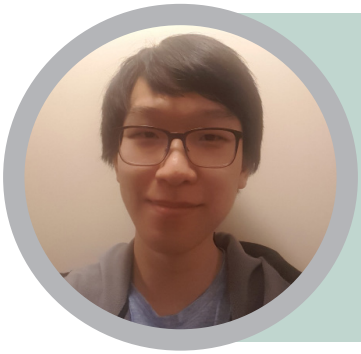
Devan Goodwin is a fourth-year Bachelor of Science Geography student at the University of Calgary. Passionate about the environment, his focus has been on studying physical geography and climate change and hopes to utilize geographic information systems in assisting environmentally friendly initiatives. In his free time, he enjoys skiing and hiking.



Jordan Jung is a fourth-year Bachelor of Science Geography student at the University of Calgary. As a geographer, he is most interested in using geographic information systems applications in urban resource management and design. Outside of school, he enjoys hockey and fishing.

INTRODUCTION

The Importance of Active Transport in Cities

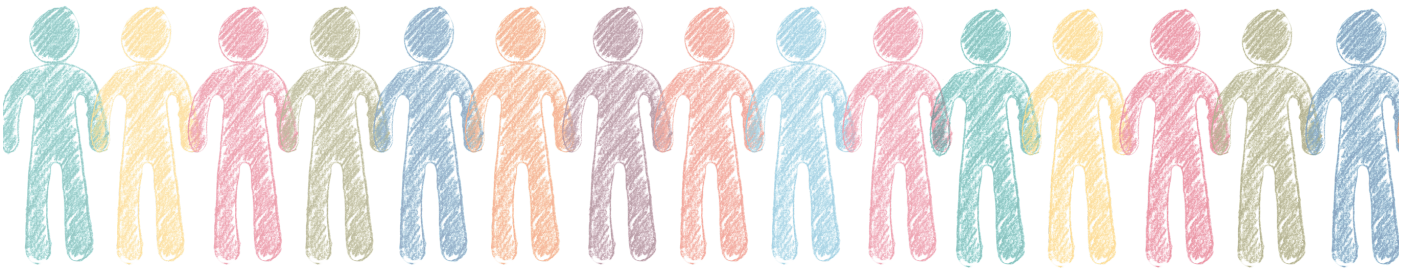
Access to active transportation options provides community residents with numerous benefits, including health, economic, environmental, and social. Neighbourhood walkability has been linked to lower rates of obesity, and lower risks of heart disease and diabetes (Creatore et al., 2016) (Frank et al., 2006) (Hankey et al., 2011).

When walking and biking are viable options, the costs associated with owning and maintaining a car can be reduced or avoided. Personal vehicle use is a major source of air and water pollution in cities, from the combustion of fuels to the runoff of oil and fluid leaks (Frank et al., 2006; D.Amato et al., 2010).

Residents of walkable neighbourhoods have been found to be more engaged in community groups, and generally report a greater feeling of belonging to their community (Glanz, 2011).

Studies have linked participation in active transport modes to the built form of a neighbourhood. Denser neighbourhoods, with mixed use development and complete streets, have been found to have higher rates of walking, biking and public transport use for commuting and daily needs (Badland & Schofield, 2005; Heath et al., 2006). This is in contrast to lower density neighbourhoods, with segregated land use patterns, and a lack of biking and walking infrastructure, where residents are more likely to meet their daily mobility needs by car.

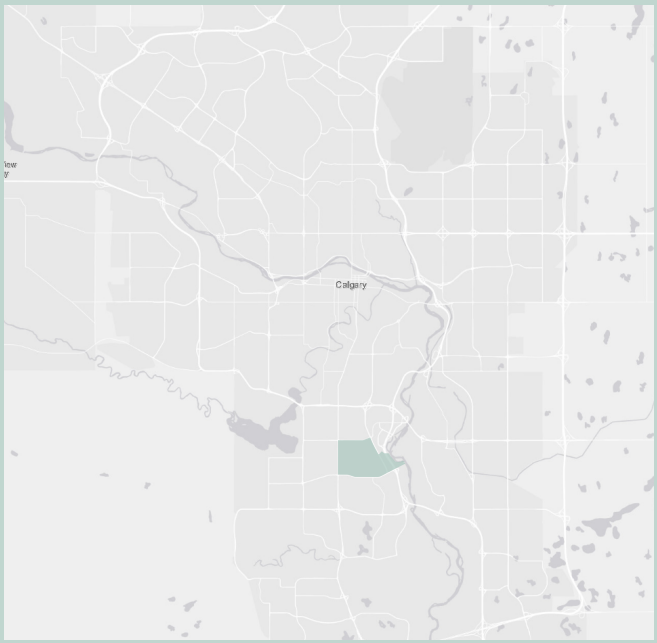
A lack of appropriate pedestrian and cycling infrastructure, particularly at intersections and crossings, reduces the feeling of safety when moving about a community. When such infrastructure does exist, if it results in round-about and indirect routes, it reduces the feeling of accessibility (Panter et al., 2008). Both safety and accessibility are vital factors in influencing an individual's commuting choices, and thus require particular attention from planners and policy makers (Ding et al., 2001; Leslie et al., 2005).



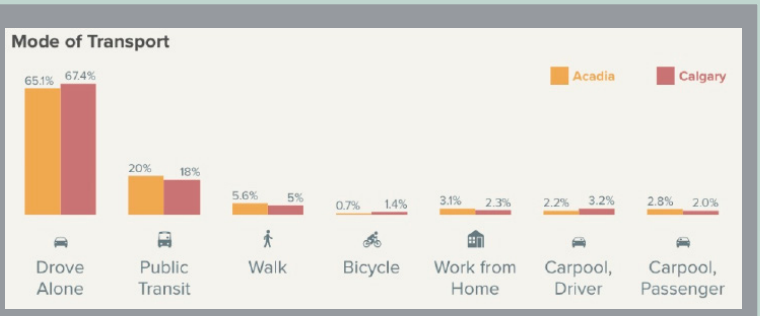
Neighbourhood Context

Acadia is a community in southeast Calgary, bounded by Heritage Drive to the north, Blackfoot Trail to the east, Southland Drive to the south, and Macleod Trail to the west. It is served by two C-Train stations, two regular bus routes, and one express crosstown route. Established in 1960, it is built on a warped-grid street network, with strict separation of residential and non-residential uses.

According to the 2017 Calgary Civic Census, 0.7% of residents commute by bike, 5.6% on foot, and 20% by transit. The citywide averages for these respective travel modes are 1.4%, 5%, and 18%, meaning Acadia residents are slightly more likely to walk or take transit than the average Calgarian, but about half as likely to bike.



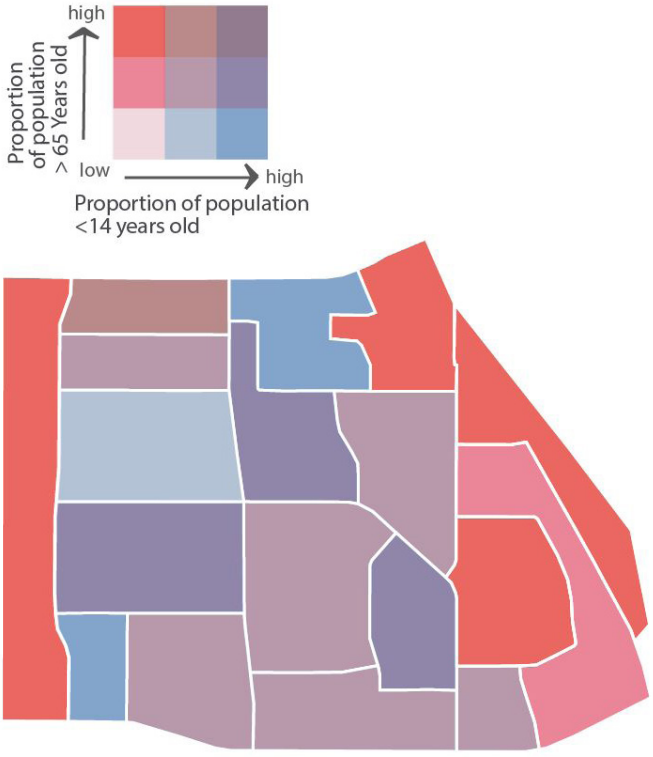
Acadia within the City of Calgary



From the Sustainable Calgary Community Report

This project will focus on the accessibility of public transportation within the community of Acadia as well as the individual's experience moving through the neighbourhood.

We are approaching public transit as a means of connecting residents to the surrounding communities. If an individual has access to public transit, they have access to the city.



Census map of vulnerable age demographics in Acadia. Proportions are normalized with total population. Data from the Stats Canada 2015.

Acadia faces a challenge common to many Calgary communities of the same era: to promote active transportation modes over private vehicles, in an area where the design was oriented primarily towards automobile use.

Our Goals

1. **Use a GIS-based approach to identify locations within Acadia, and in surrounding areas, that discourage walking and cycling as a means of transportation.**

2. **Compare the locations from our analysis to locations identified by residents during earlier consultations with Sustainable Calgary.**

3. **Identify friction points in and around the neighbourhood to assist professionals with proposing solutions for the space that will help more people leave their cars behind.**

NETWORK ANALYSIS & WALKSHEDS

Network Analysis and Walksheds

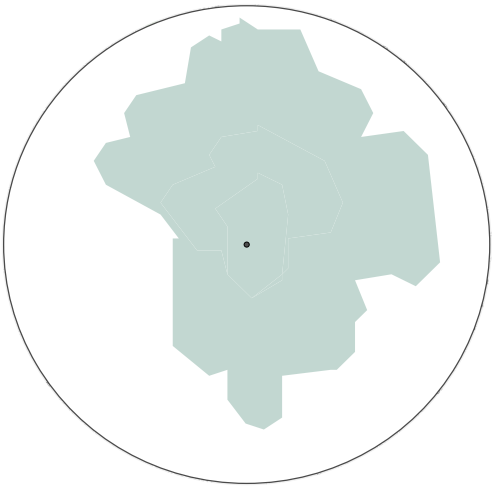
Calculating walksheds with a network analysis allowed us to assess the level of sidewalk and pathway connectivity in the community as well as indicate where this infrastructure may be lacking. A walkshed shows the area accessible from a point within a certain walk time or distance. Unlike using a simple circular buffer around a point, the walkshed factors in the street and/or pathway network to determine the area actually accessible to a pedestrian within a given time or distance.

The majority of walksheds created during analysis were focused on transit stops and stations that serve the community, as public transit accessibility is essential to the use of active transport to travel within the city at a regional scale. The quality and length of the trip to and from transit services, or the 'first and last mile' is incredibly important to the transit user experience, and often has an influence on ridership (Walker, 2018). A service range of 400m was used for each bus stop serving the community, as that is the maximum distance Calgary transit expects a user to walk in order to access bus services (Calgary Transit, 2006). However, a larger service range of 1000m was used for the Light Rail Transit (LRT) and Bus Rapid Transit (BRT) stations that serve the community, as it is generally assumed in transit planning that riders will be willing to travel further in order to access rapid transit service (Walker, 2011). A 1000m service area was also used for the additional points of interest within the neighbourhood that were investigated.

Bus stop amenities were evaluated for the presence of benches and shelters using Google Streetview. We worked under the assumption that the lack of one or both of these amenities may discourage the use of public transport, particularly by seniors or children.

Methodology

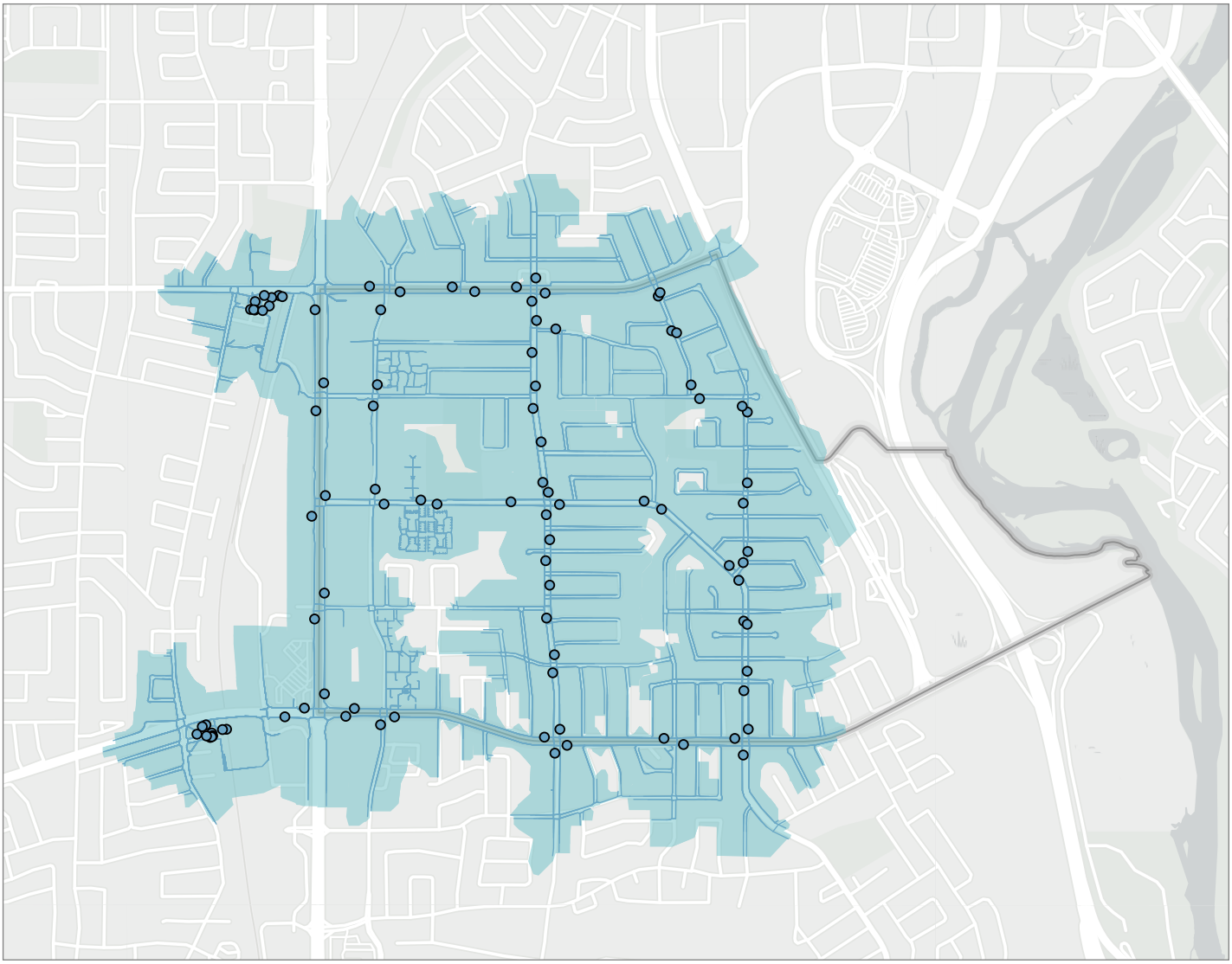
For the network analysis, we used the Service Area tool in ArcGIS Pro, and a feature layer that we created consisting of the sidewalks and pathways in Acadia. From each destination, the areas accessible within 250, 500, and 1000 metres along the sidewalk network were calculated.



Collision Density Heatmap

A pedestrian-vehicle collision density map was constructed using kernel density clustering. The data used for this analysis was from the City of Calgary Open Data Portal, and showed all pedestrian-vehicle collisions from 2008 to 2017. This dataset was specific for Acadia, as the City of Calgary constructed detailed pedestrian collision reports for 10 neighbourhoods within the city.

Bus Stop Walksheds



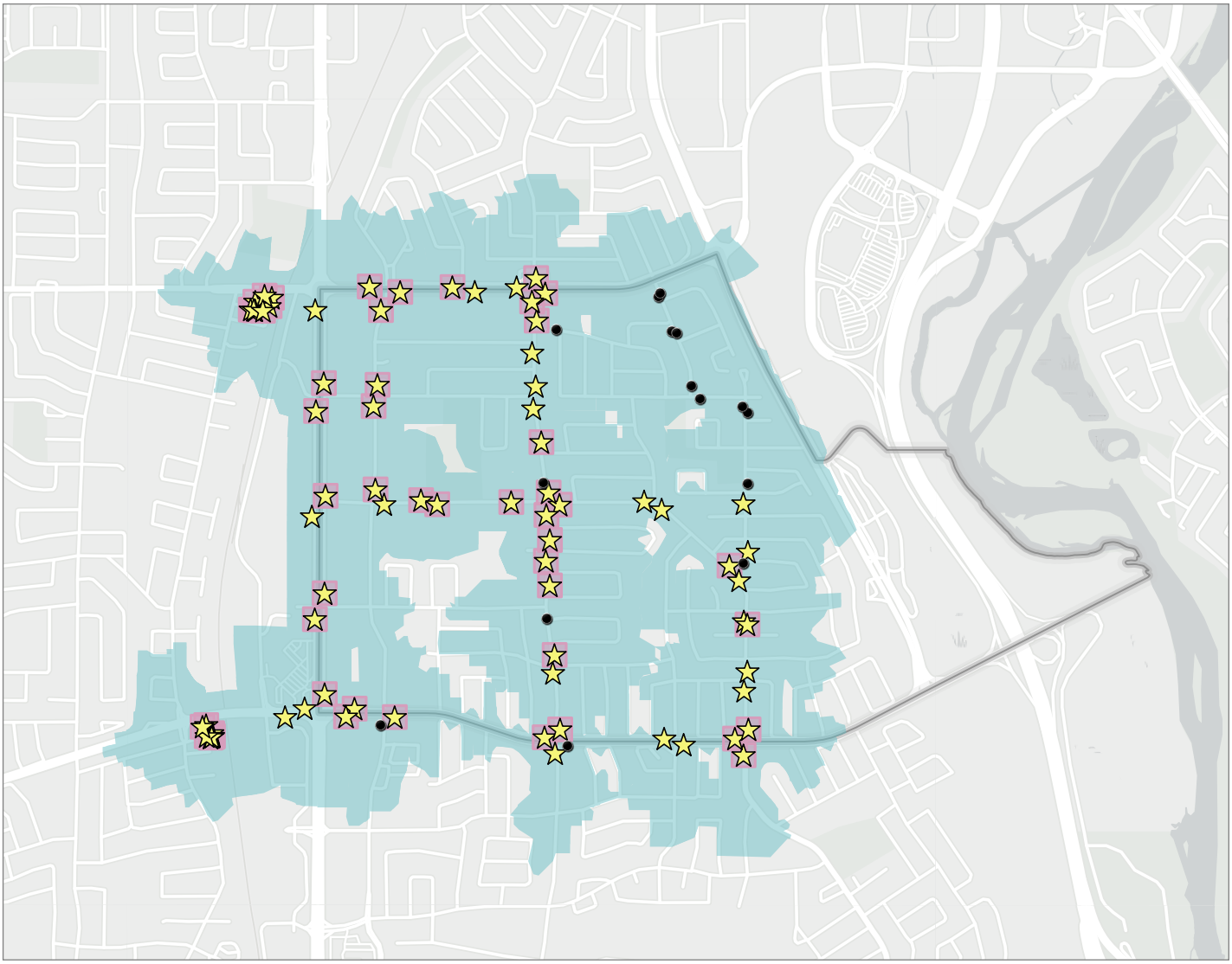
Legend

- Bus Stop
- Sidewalk
- 0 - 400m
- Community Boundary

N

1.5km

Bus Stop Amenities



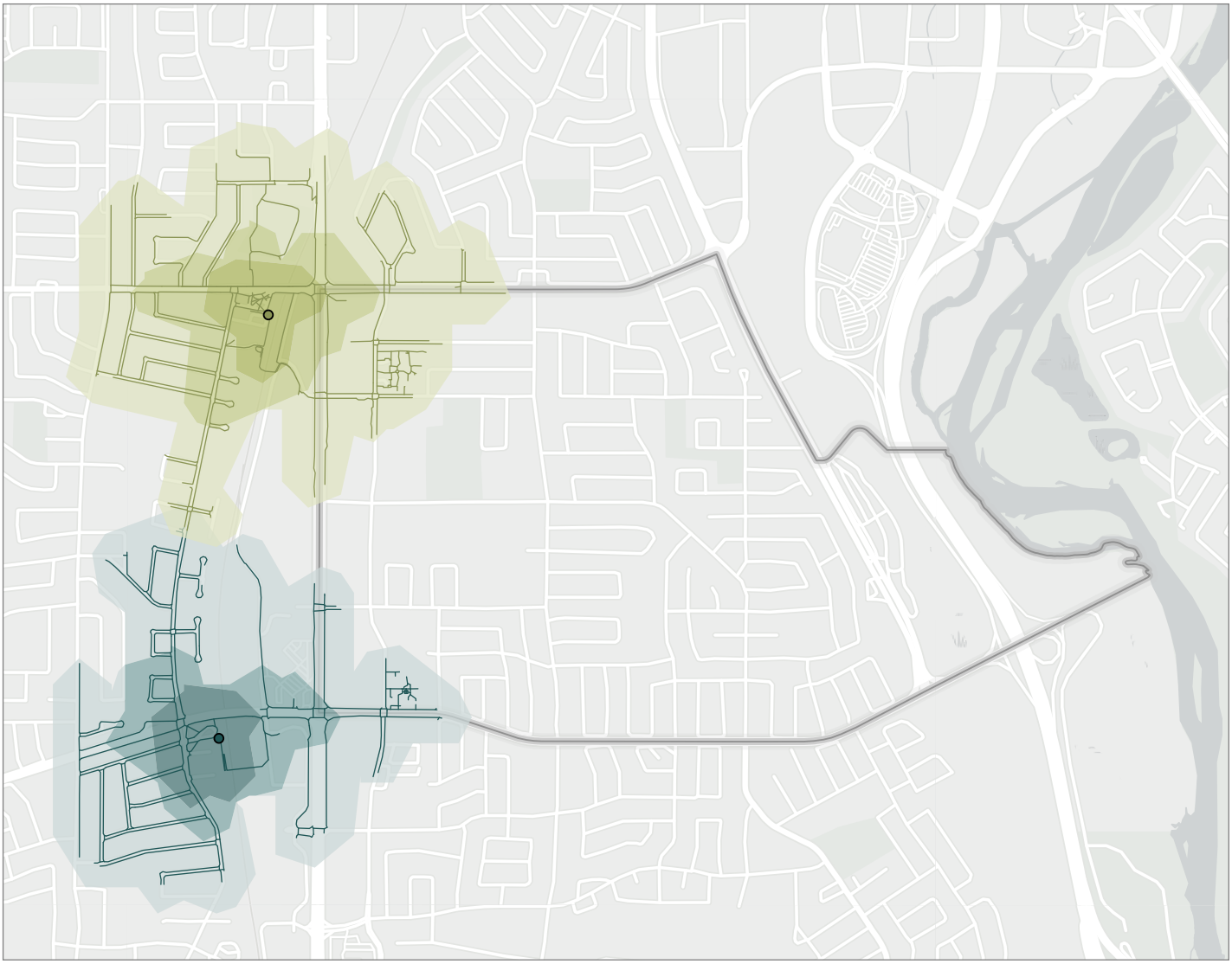
Legend

- Sidewalk
- 0 - 400m
- Benches Present
- Shelter Present
- No Bench/Shelter Present
- Community Boundary

N

1.5km

LRT Walksheds - Distance



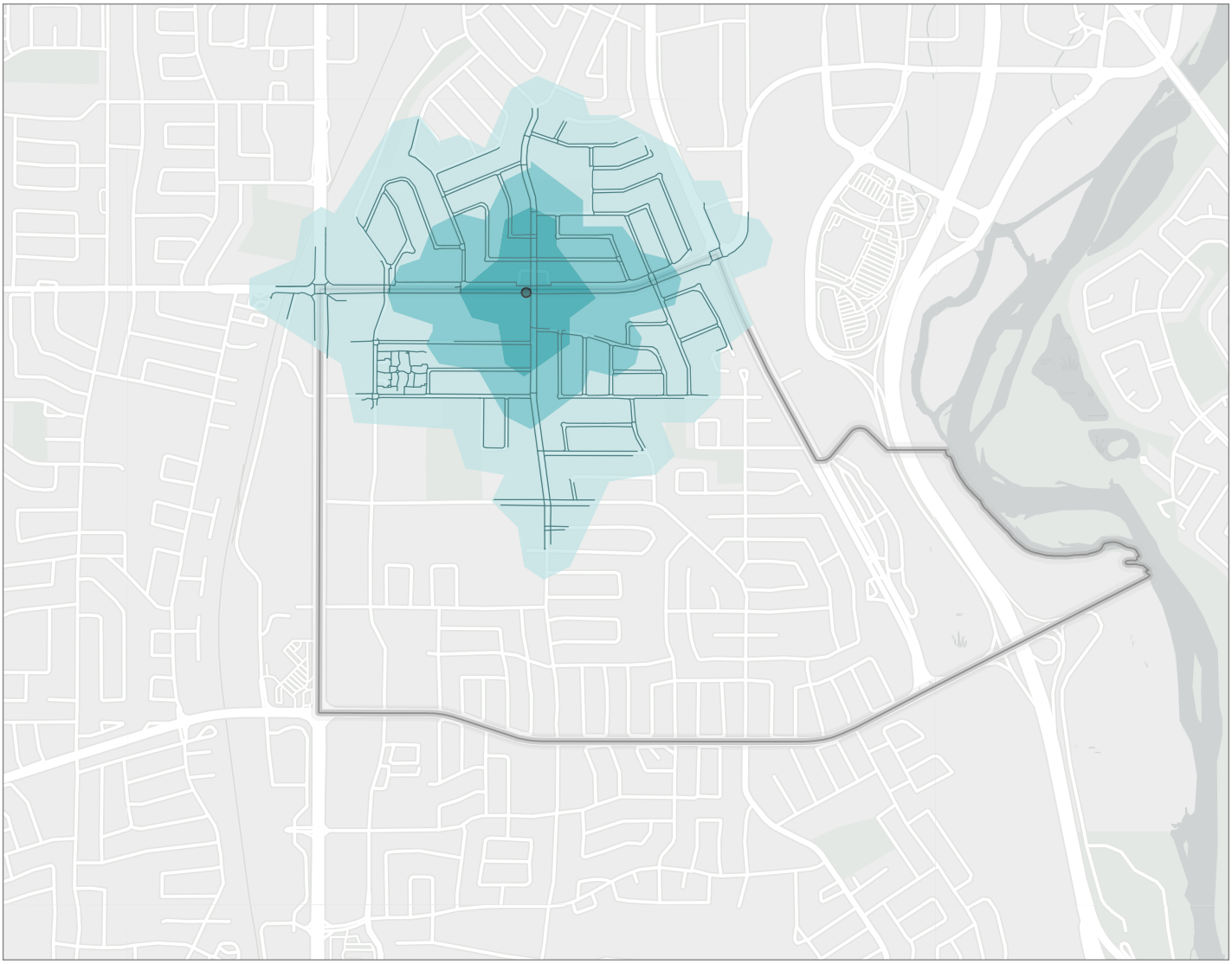
Legend

- Heritage LRT Station
- Sidewalk
- 0 - 250m
- 250 - 500m
- 500 - 1000m
- Community Boundary
- Southland LRT Station
- Sidewalk
- 0 - 250m
- 250 - 500m
- 500 - 1000m

N

1.5km

BRT Walkshed - Distance



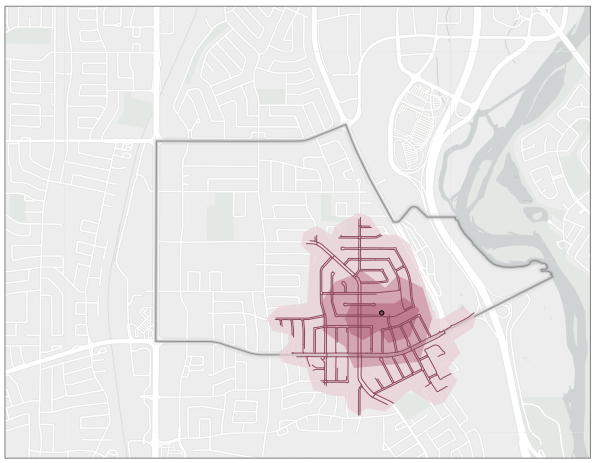
Legend

- Fairmount BRT Station
- Sidewalk
- 0 - 250m
- 250 - 500m
- 500 - 1000m
- Community Boundary

N

1.5km

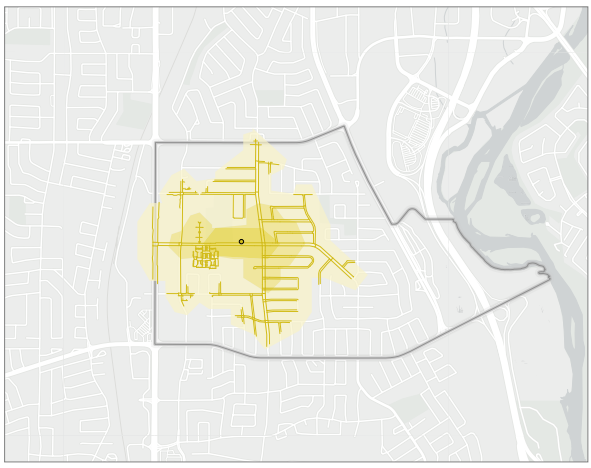
Alice M. Curtis Walkshed - Distance



Legend
- Alice M. Curtis Elementary School
- Sidewalk
- 0 - 250m
- 250 - 500m
- 500 - 1000m
- Community Boundary

N
1.5km

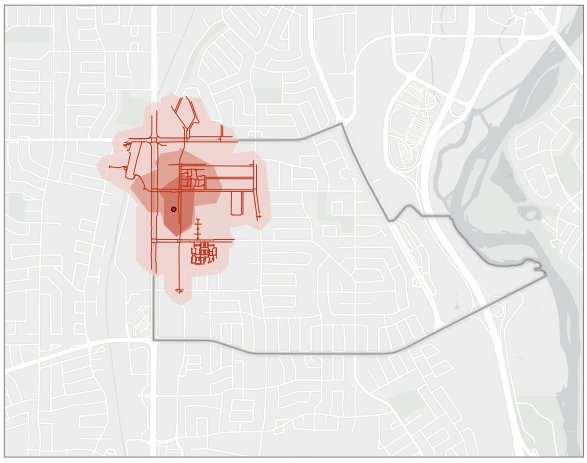
Beaverbrook Walkshed - Distance



Legend
- Lord Beaverbrook High School
- Sidewalk
- 0 - 250m
- 250 - 500m
- 500 - 1000m
- Community Boundary

N
1.5km

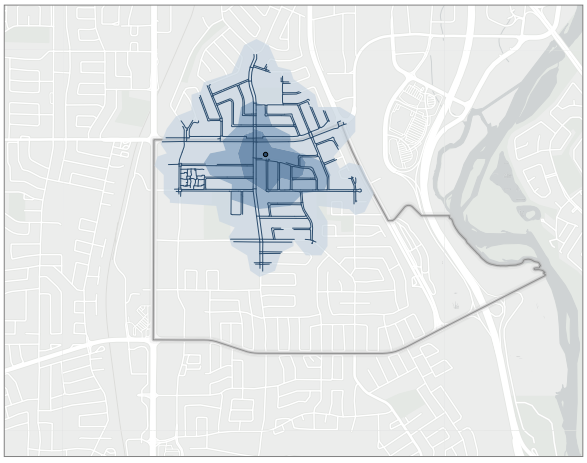
Co-op Walkshed - Distance



Legend
- Macleod Trail Co-op
- Sidewalk
- 0 - 250m
- 250 - 500m
- 500 - 1000m
- Community Boundary

N
1.5km

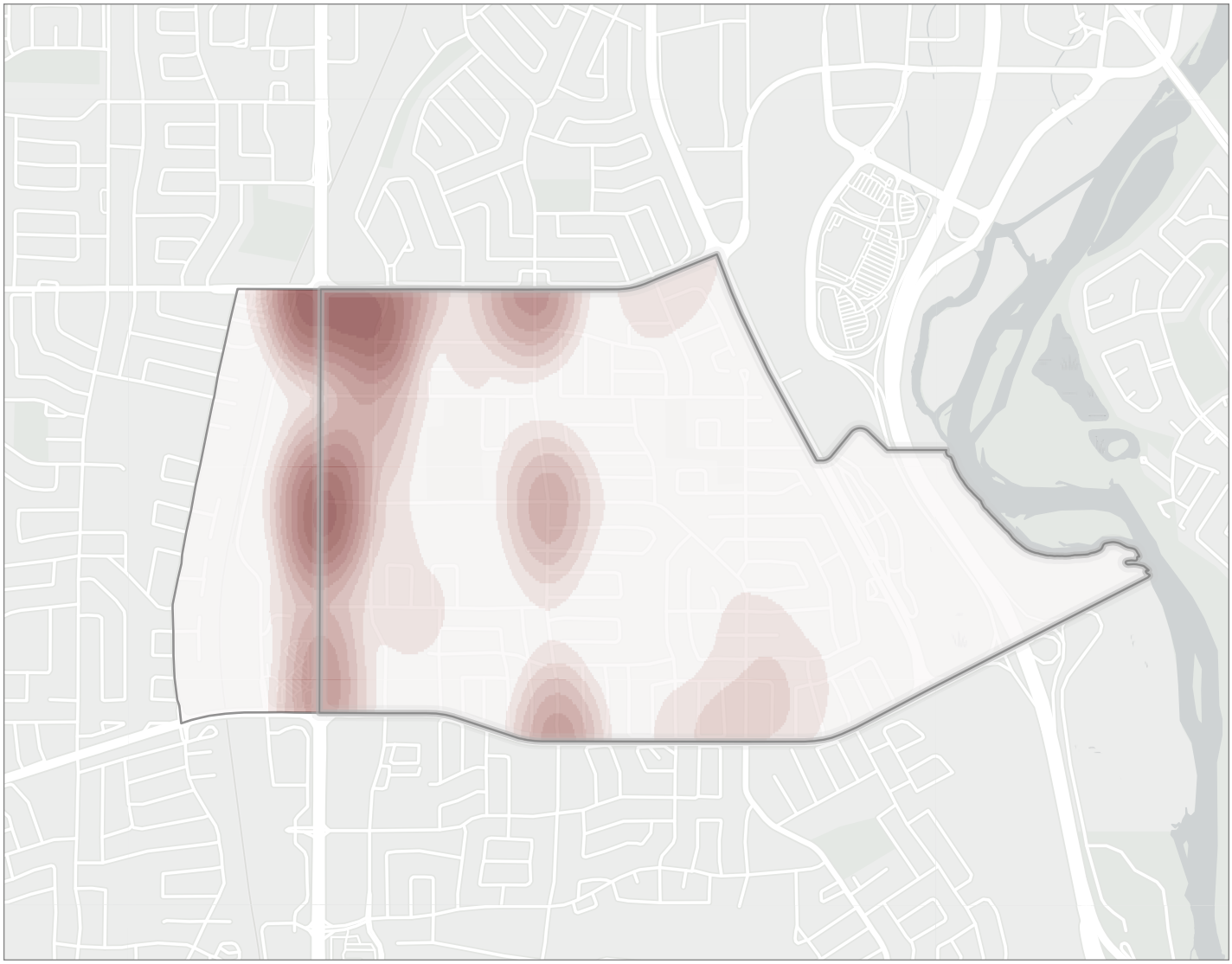
St. Matthew Walkshed - Distance



Legend
- St. Matthew School
- Sidewalk
- 0 - 250m
- 250 - 500m
- 500 - 1000m
- Community Boundary

N
1.5km

Pedestrian-Vehicle Collision Density



Legend

Low Incidence — High Incidence

N

1.5km

COST PATH ANALYSIS

Cost Path Analysis

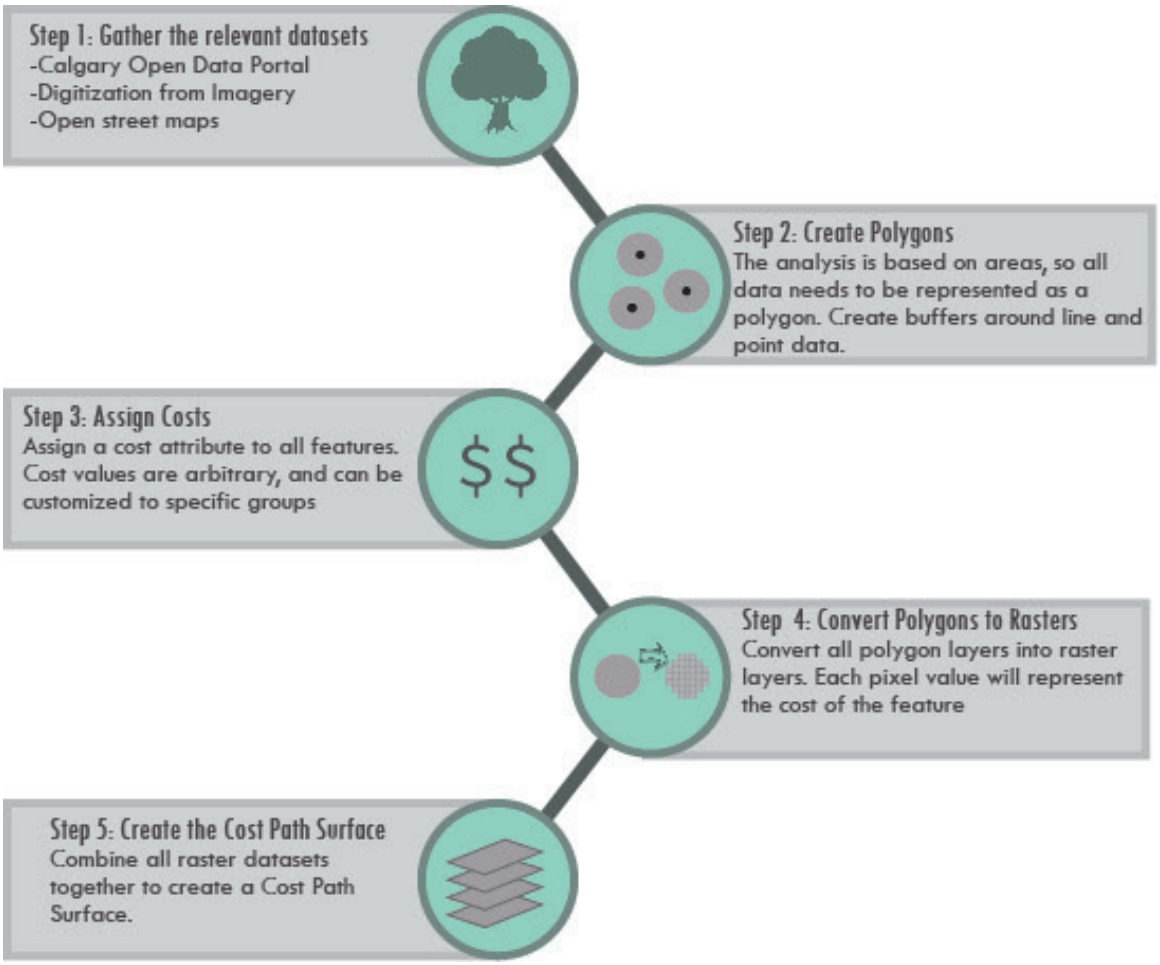
The cost path analysis complements the results of the network analysis by providing a qualitative overview of what it is like to walk in Acadia.

Attributes relevant to the quality of the pedestrian environment are given a cost score, with higher scores indicating unattractive environments, and lower scores indicating attractive ones. Some examples of the attributes we assigned scores to include: the size of street trees, speed limits on the roads, and the presence of buffer strips between sidewalks and roads. These attribute layers are then added together based on their cost scores, to create a cost-path map representing the overall quality of the pedestrian environment.

This process is highly customizable, with scores being adjustable to reflect the perspective of a specific group of individuals. This can be done through the inclusion of specific datasets, and the customization of attribute costs to reflect their impact on a specific group. For example, if the cost path map is intended for people with mobility issues, scores or attributes may differ from a map intended for the general population.

Two cost path maps were constructed or this project, one focusing on the pedestrian perspective of movement through Acadia, and the second focusing on a cyclists perspective of movement through Acadia.

Methodology



Our Analysis

Both the pedestrian and cyclist cost path maps used the same set of data, but had altered costs associated with each attribute.

The datasets can be divided into two categories: travel surfaces and qualitative features. The cost scores associated with travel surfaces are the most influential to customizing a cost path map for a specific group of people. Qualitative features, such as trees or art features, do not impact movement itself, but rather the users experience throughout their journey. For many of these qualitative features, we created a 'sphere of influence' where the presence of a specific real world feature, such as a tree, reduces the costs of a user-defined area surrounding it.

Pedestrian Cost Path Map:

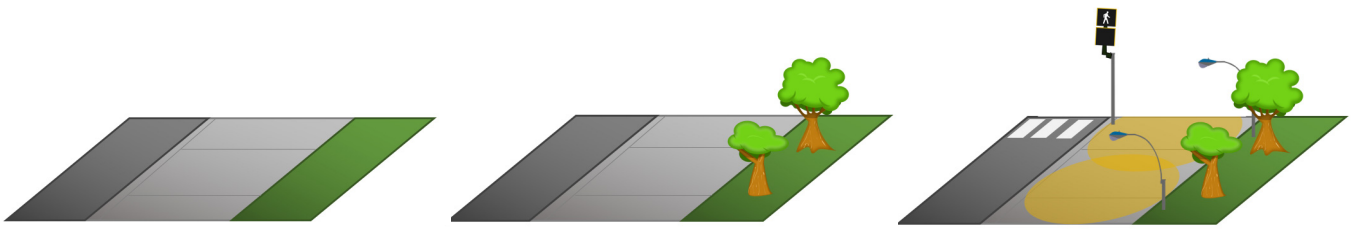
This analysis assumes that people are able and willing to walk over all surfaces, including grass, roads, and parking lots. Cost values were assigned to all surfaces based on their ease of traversal and traveling experience. Sidewalks were given the lowest cost, and roads given the highest cost, with large increases based on speed limit.

Cyclist Cost Path Map:

Costs were adjusted to reflect the viewpoint of a cyclist: grass, parking lots, and sidewalks were given increased costs, while roads were given lower costs. Marked cycling routes were given the lowest cost score. Qualitative influences such as trees and street lights were included, but had reduced significance compared to the pedestrian map. The slope was more influential in this analysis as well.

Below is a table which describes the data sets used in our cost path analysis, their sources, and a description of the dataset and of any categorization within the dataset.

	VARIABLE	SOURCE	DESCRIPTION
Travel Surfaces	Sidewalks	Digitized from Imagery	Classified as separated or non-separated from the road.
	Parking lots	City of Calgary Open Data Portal	Included commercial and residential parking lots.
	Grass	City of Calgary Open Data Portal	Included city owned parks and greenspaces as well as school yards and recreational fields.
	Roads - includes Alleys and Cat Tracks	University of Calgary SANDS Library	Roads were classified based on their speed limit, alleys and cat tracks were classified separately.
	Barriers	Digitized from Imagery	All impassible barriers, such as fences, walls, buildings and residential blocks.
Qualitative Attributes	Digital Elevation Model (DEM)	University of Calgary SANDS Library	Used to find the slope at every point within Acadia.
	Stoplights and Crosswalks	City of Calgary Open Data Portal	Differentiated intersections equipped with walking signals and/or painted crosswalks present.
	Street Lights	City of Calgary Open Data Portal	Influenced a 10m radius surrounding individual street lights.
	Trees	City of Calgary Open Data Portal	Were classified into three categories, small, medium and large trees, with larger trees having higher benefits to movement. Influenced a 5 meter radius surrounding each individual tree.



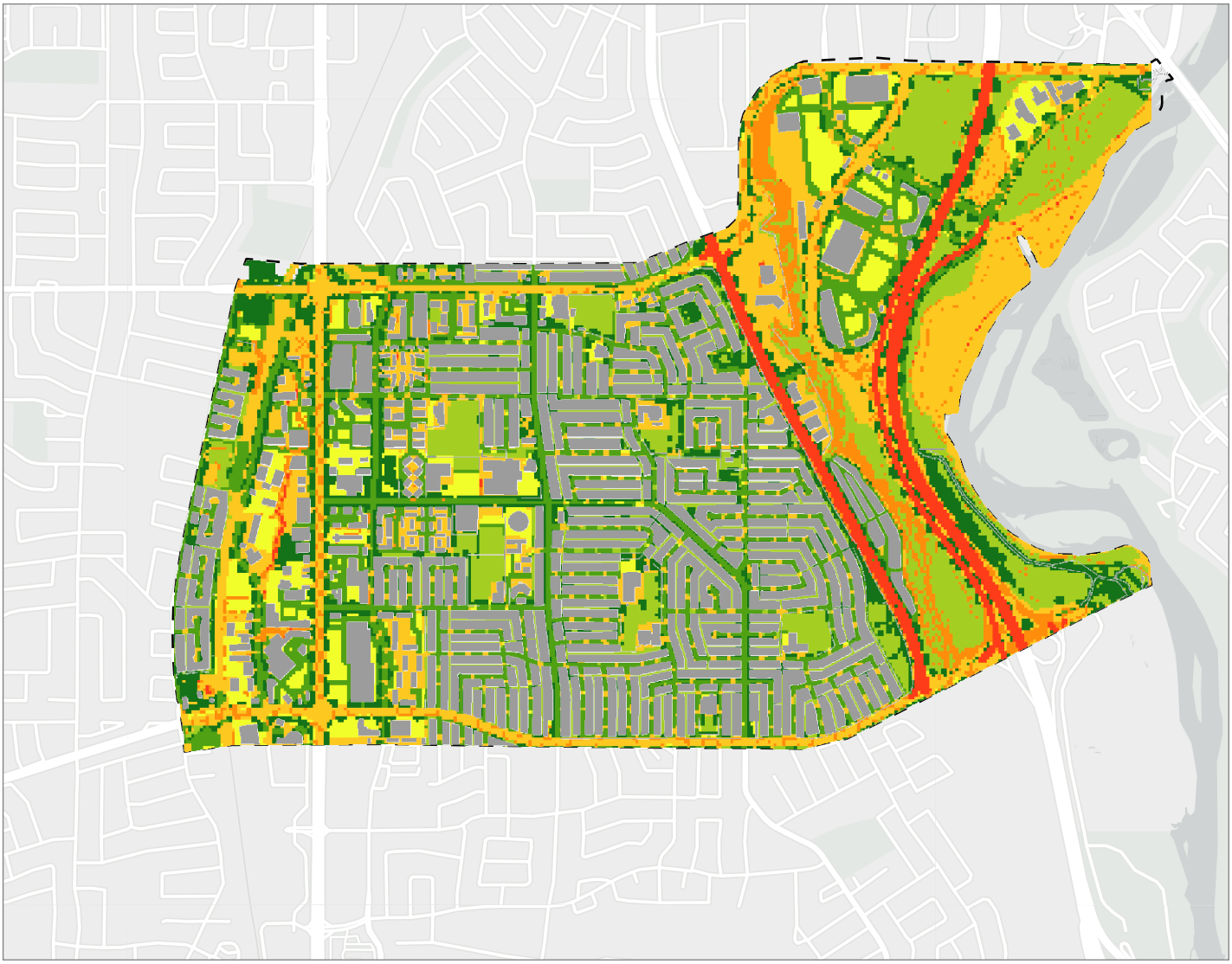
Cost Path Walkshed Analysis

Using the cost distance analysis, it is possible to determine the accumulated cost of travelling along a path on a cost surface, from a particular starting point.

We calculated the accumulated costs from the seven primary destinations used in the network analysis, and clipped the results to fit within the 1000 metre perimeter surrounding each point, creating individual "cost-sheds" for each. This allows us to represent the differences in quality of the pedestrian environment within a fixed distance from a starting point.

Since less attractive walking environments incur a higher cost, we can assume that the higher the accumulated cost at the 1000 metre cut-off, the less appealing the route. In this way we were able to identify friction points and areas that may not have been obvious from network or cost path analysis alone.

Pedestrian Cost Path Surface



Legend

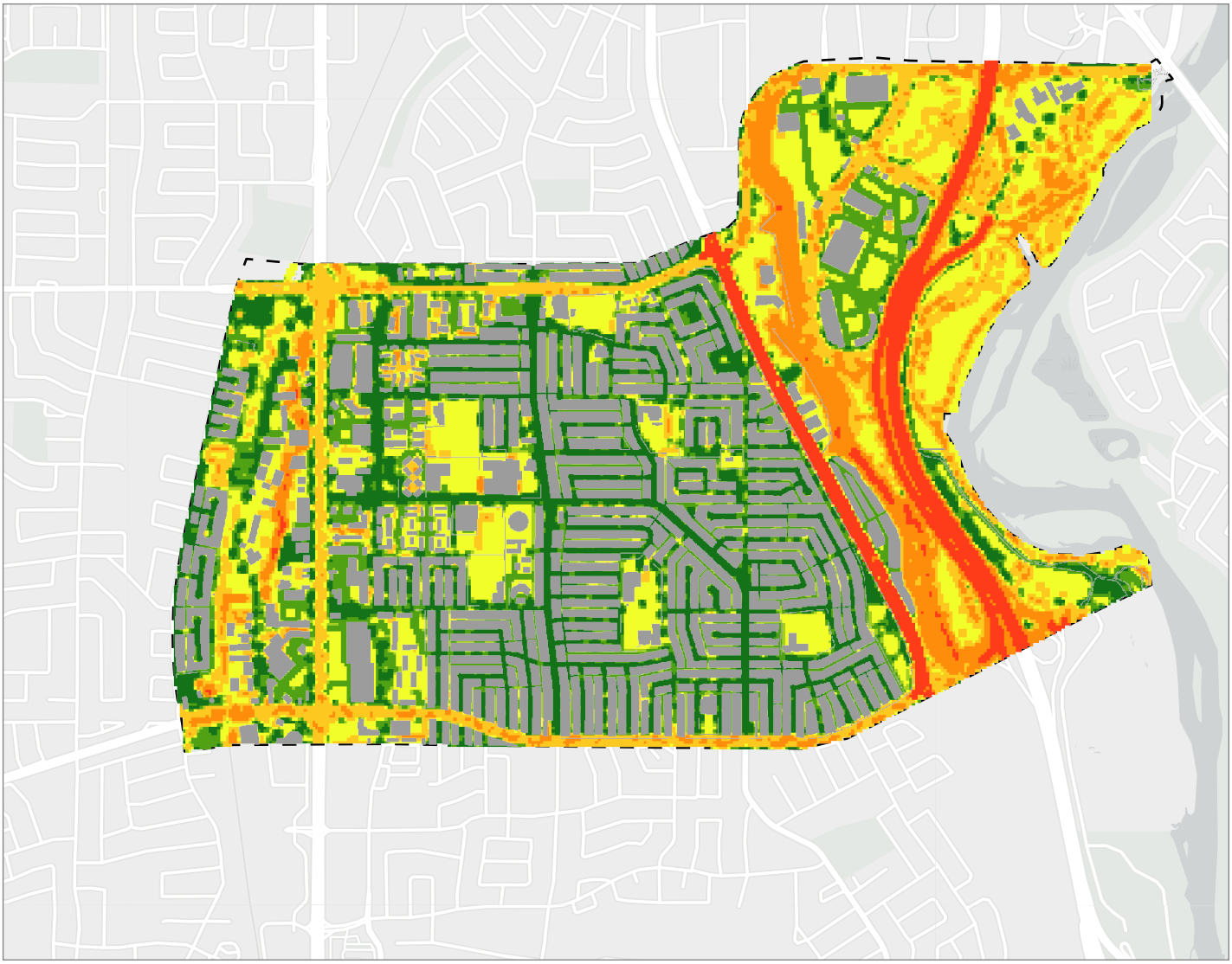
Barrier

Low Cost — High Cost

N

1.5km

Cycling Cost Path Surface



Legend

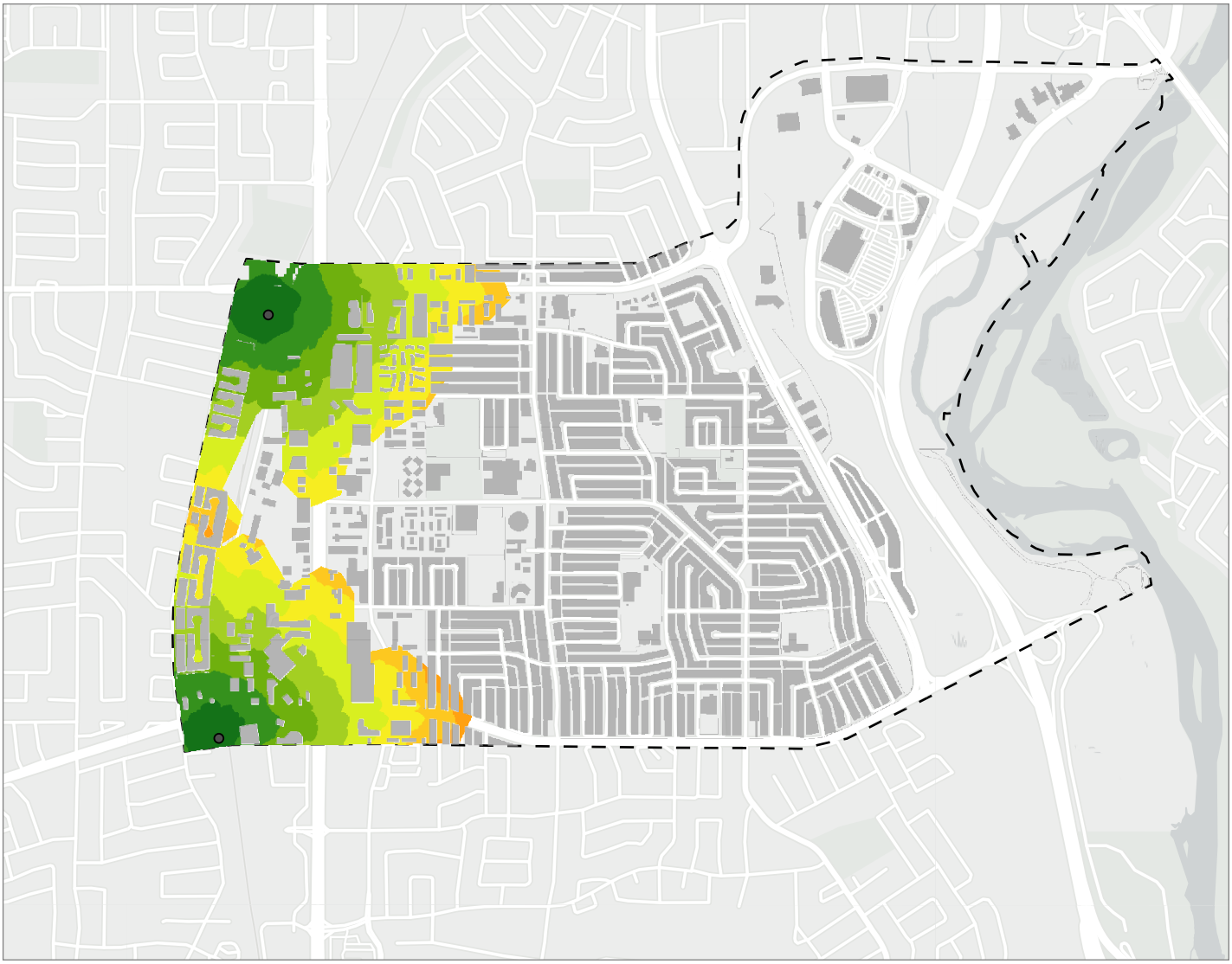
Barrier

Low Cost — High Cost

N

1.5km

LRT Cost Path Walkshed



Legend

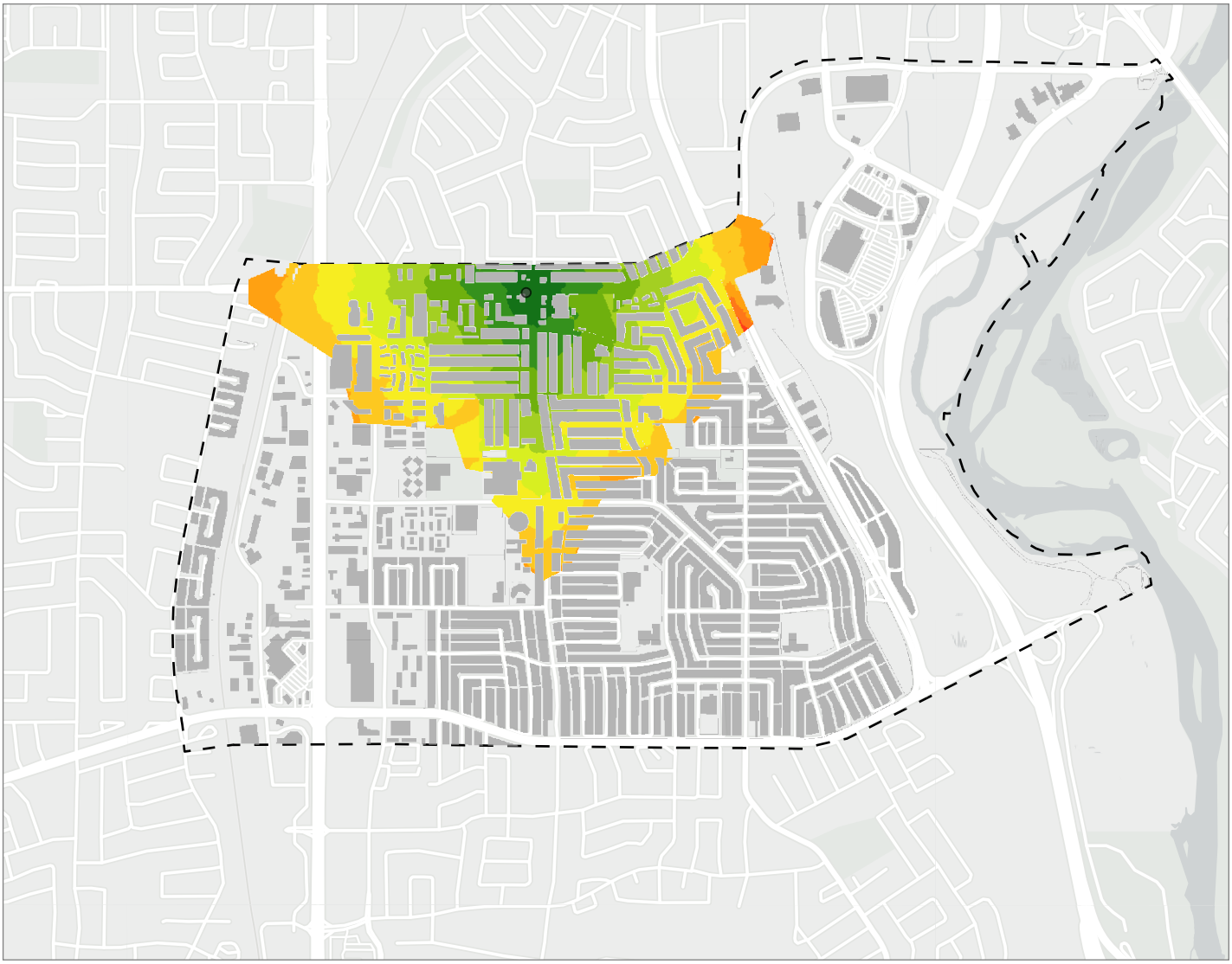
- LRT Station
- Barrier

Low Cost — High Cost

N

1.5km

BRT Cost Path Walkshed



Legend

- Fairmount BRT Station
- Barrier
- Low Cost — High Cost

N

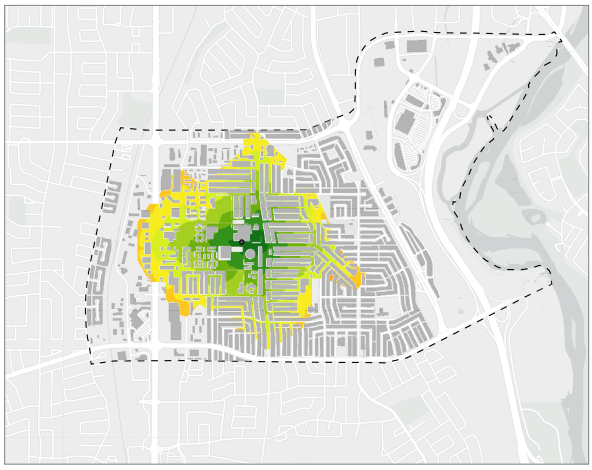
1.5km

Alice M. Curtis Cost Path Walkshed

Legend
- Alice M. Curtis Elementary School
- Barrier
- Low Cost – High Cost

N
1.5km

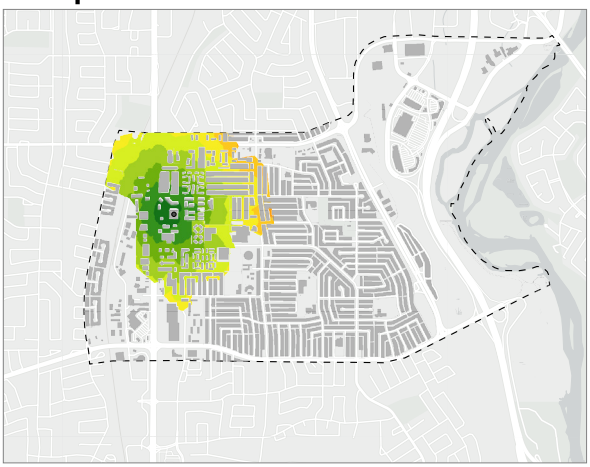
Beaverbrook Cost Path Walkshed



Legend
- Lord Beaverbrook High School
- Barrier
- Low Cost – High Cost

N
1.5km

Co-op Cost Path Walkshed



Legend
- Macleod Trail Co-op
- Barrier
- Low Cost – High Cost

N
1.5km

St. Matthew Cost Path Walkshed

Legend
- St. Matthew School
- Barrier
- Low Cost – High Cost

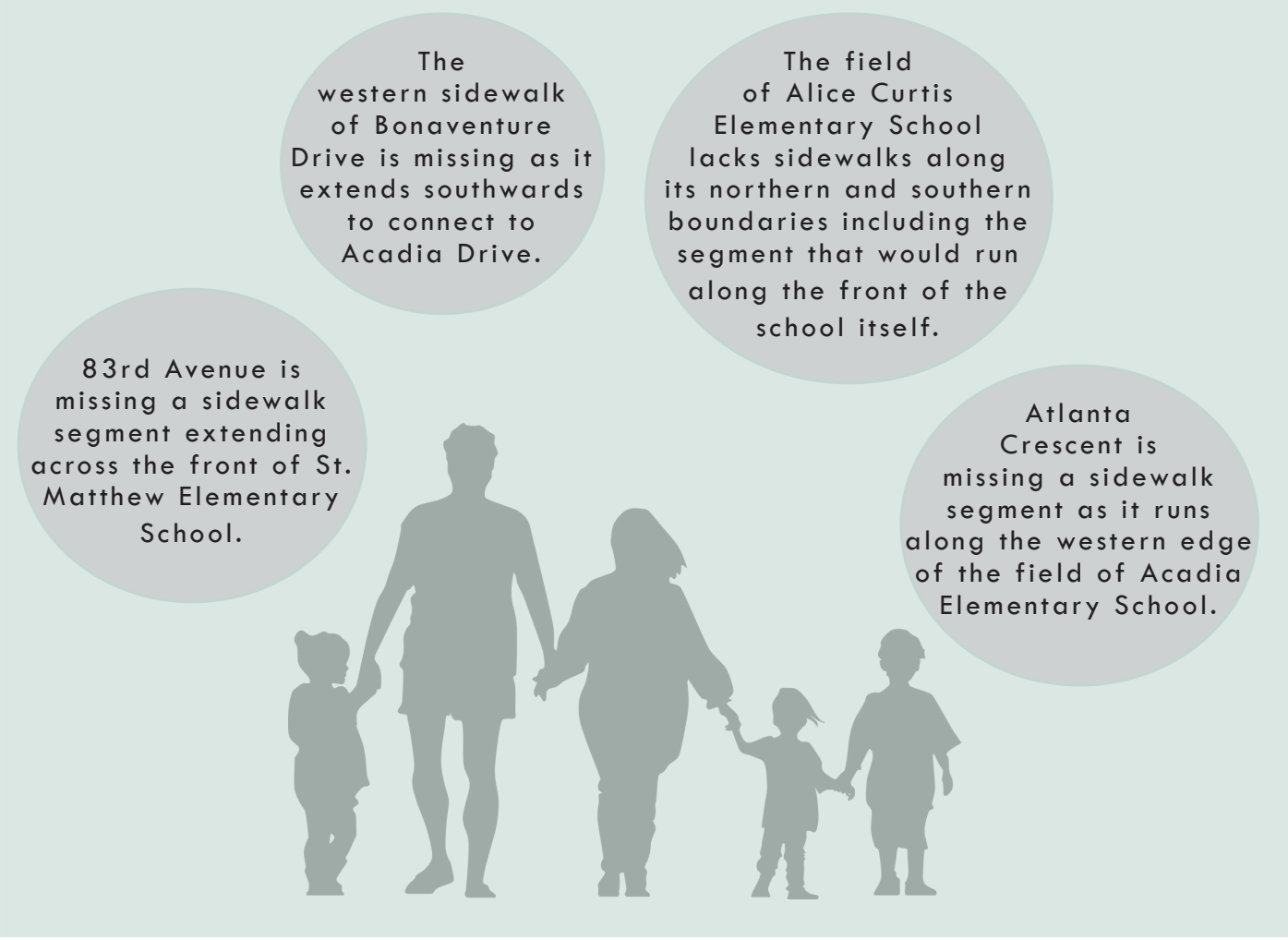
N
1.5km

DISCUSSION

Major friction points were identified at busy intersections surrounding the community, along the Macleod Trail corridor, and in the apartment complexes on the west side of the community. Other minor friction points include missing sidewalk segments throughout the community, and missing transit stop amenities in the east side of Acadia.

Sidewalk Connectivity

Through the creation of the sidewalk dataset we identified several areas in Acadia with a lack of adequate sidewalk infrastructure. In their current state, these areas act as friction points to active transportation and could be corrected by completing the sidewalk network in these areas to increase connectivity.



The 3 missing sidewalks located at the 3 schools stand out. In a community with such a high density of schools, a large proportion of the pedestrian traffic throughout the community may be children travelling to and from these locations. With these schools as major pedestrian hubs within Acadia, efforts should be made to ensure adequate infrastructure is in place to support such pedestrian traffic.

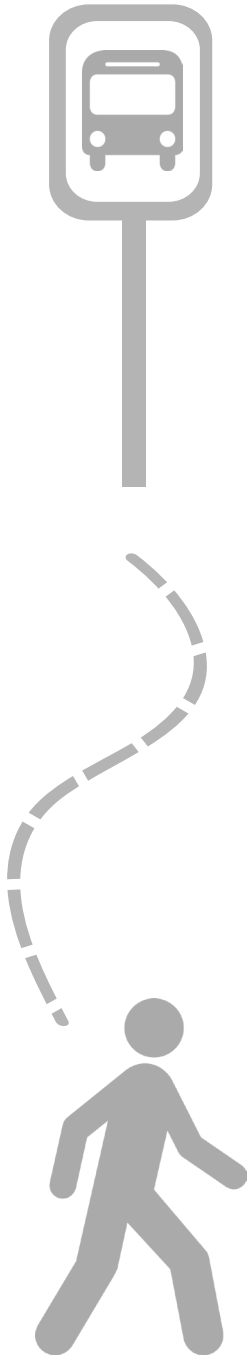
Insights from the Walkshed Analysis

The walksheds from the Heritage and Southland LRT stations near Acadia indicate poor connectivity across Macleod Trail, restricting access from Acadia to the stations. From the community, it is only possible to cross the tracks at the stations themselves, leaving areas midway between Heritage and Southland Drives outside of a reasonable walking range.

Walkshed distances of 400 metres from bus stops show that nearly all of Acadia is within walking distance of a stop. There are some under served areas, such as the mobile home park, small areas in the south-east and some apartment complexes along Bonaventure Drive.

One important aspect to note regarding bus stop services is the lack of bus stop amenities within the north-eastern portion of Acadia. There is a large area where no bus stop benches or shelters are available.

Comparing this to demographic data shows bus stops lacking amenities are concentrated in an area of Acadia that also has a high concentration of residents over the age of 65. This could be a significant barrier to this group using public transit.



The space occupied by the townhouse complexes and commercial complexes on Bonaventure Drive and Macleod Trail are not pedestrian friendly and inhibit east-west movement through these areas. Access to the LRT stations being limited to crossings on Macleod Trail at Southland and Heritage Drive could also be alleviated by an additional crossing or bridge between the two intersections.

Insights from the Cost Path Analysis

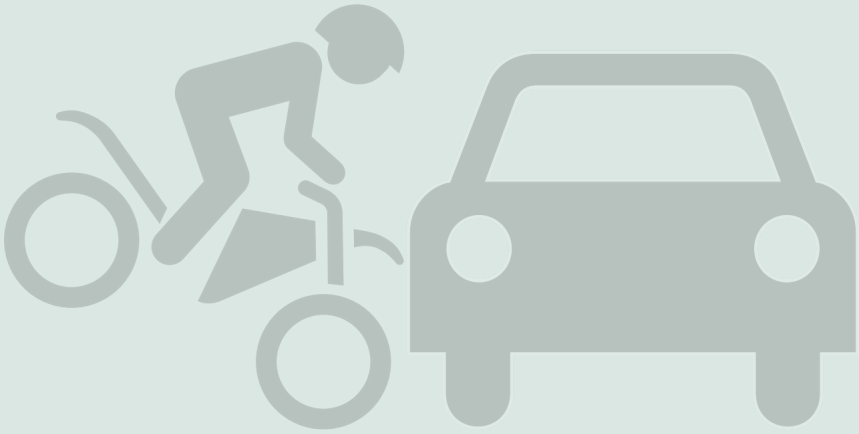
While the Walkscore results for Acadia show that the eastern side of Acadia has a much lower Walkscore than the western side, our analysis reveals many points of concern regarding pedestrian travel in the western side of the community as well. This could be a result of a lack of designated pedestrian surfaces through high density residential and commercial spaces.

The cost path maps allow us to differentiate areas that have limited accessibility due to physical barriers rather than distance alone, such as the barrier highlighted in the Co-op cost-shed map. The abrupt end of the cost shed on the west side of Co-op while the cost accumulated was still relatively low indicates that there is a major barrier that will prohibit movement to the west from this location.

Pedestrian Safety Friction Points

The highest collision densities in Acadia were found at intersections of the major roads surrounding the community. Additionally, the intersection of Fairmount Drive and Acadia Drive, adjacent to Lord Beaverbrook High School, has been the location of several recorded collisions in Acadia.

The location of the new Bus Rapid Transit station at the intersection of Heritage Drive and Fairmount Drive also has a high density of recorded pedestrian-vehicle collisions.



Last Remarks

Through our research, we have located several barriers to making active transportation a preferred means of getting around in Acadia, as well between the community and surrounding areas.

High-volume roads bounding Acadia on all sides, as well as LRT and freight rail tracks on the west restrict the number of access points to and from the neighbourhood. At these locations, there is often conflict with motor vehicles, as seen in the clustering of pedestrian-vehicle collisions along Macleod Trail and at major intersections.

Other barriers to mobility include the poor accessibility through the large apartment complexes on the western side of the neighbourhood bordering the commercial area along Macleod Trail, and missing sidewalk segments throughout the community, particularly around schools.

Major and potentially costly improvements would likely be required to significantly improve the pedestrian experience at major intersections and along large arterial roads. However, smaller and more affordable improvements could be made within the community by completing missing sidewalk segments and improving access through high density residential blocks.

Improvements to the community's walkability and in turn, transit access, have the potential to improve its residents' quality of life by promoting healthier lifestyles, reducing air pollution, and facilitating spontaneous social interactions.

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