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Classifying and Mapping Accessible Mobility on Post-Secondary Campuses

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ABSTRACT

Mobility impairment is one of the leading causes of disability and an increasing number of students using mobility aids (e.g. wheelchairs) on campuses face numerous navigational barriers that hinder their achievement of higher education (Statistics Canada, 2017; Canadian Human Rights Commission, 2017). However, there is a lack of information in both public resources and legislation regarding what and where these barriers are. The purpose of this research is to better understand barriers and aids to mobility that persons with disability encounter outdoors on campus grounds. We identify key outdoor accessible mobility (AM) features, establish a methodology for their classification, and assess the grounds of three post-secondary institutions in Calgary, Canada for their degree of accessibility. Preliminary findings show that campuses are far from the ideal of universal design and inclusion.

1. Introduction

This research seeks to assess and understand aspects of the exterior built environment that could present barriers to persons with mobility-related disabilities. These barriers most impact people who use an assistive device to navigate places, such as a wheelchair.

According to the 2017 Canadian Survey on Disability, 22% of the Canadian population aged 15 years and over had one or more disabilities (Statistics Canada, 2017). Mobility-related disabilities are the third most prevalent type of disability as they affect 9.6% of the population; this means that over 2.6 million Canadians require the use of an assistive device, such as a walker, wheelchair, or scooter (Statistics Canada, 2017).

Of the 6.2 million Canadians with disability, 13.1% are youth aged 15 to 24 years (Statistics Canada, 2017). The median ages of college and university students are 21.6 and 23.8 years respectively, which means that a significant number of young adults attending post-secondary institutions may also have disabilities (Statistics Canada, 2010).

The built environment, which includes post-secondary campuses, is often not adapted to the needs of persons with mobility issues. Inadequate design commonly results in the urban landscape lacking accessibility, and therefore undermining the “degree to which an environment can be approached, entered, operated in, or used safely and with dignity by people with disabilities” (Welage and Liu, 2011). Many places lack accessible mobility (AM) features (e.g. sidewalk curb cuts, wheelchair ramps). As such, people with mobility-related disabilities are denied free and independent access to public spaces essential for pursuing education (e.g. campuses), due to barriers in the pedestrian network (e.g. high curbs, stairs) (Ferreira and Sanches, 2007; Imrie and Kumar, 1998). It is therefore unsurprising that persons with disability are less likely to hold a Bachelor’s degree than those without disability (US Bureau of Labor Statistics, 2015).

In order for students with mobility-related disabilities to successfully pursue higher education, it is important that the campus be physically accessible (Hill, 1992). For most students, deciding which post-secondary institution to attend is mostly based on ranking, location, and tuition. For students with physical disabilities however, one key consideration is whether sufficient accommodations exist for navigating campus with an assistive device.

Canadian news magazine, Maclean's, is one of the oldest and most prominent publishers of annual university rankings (Honey, 2015). Maclean's ranking methodology includes weighting factors such as the amount of research funding or major awards won by students or faculty, cost of tuition, reputational surveys, and student satisfaction (Maclean's, 2018b). A "Build Your Own Ranking" tool even allows users to select factors such as "Great Parties" and "Great Food" (Maclean's, 2018a). Meanwhile, there is no information available on how accessible a college or university campus is. The Christopher and Dana Reeve Foundation (2018) recommends prospective applicants with disability to visit campuses beforehand to find out whether appropriate wheelchair accommodations exist. However, to visit each campus in person is a costly and impractical endeavor, and one that is otherwise unneeded for students without disabilities (Piro, 2017).

While the ultimate goal of this research project is to develop a methodology for calculating campus accessibility scores — both indoors and outdoors — and incorporate these into university rankings, this paper focuses exclusively on identifying, classifying, and quantifying outdoor features in the built environment that impact wheelchair accessibility. In doing so, this research deepens the understanding of the scope of accessibility inequities in the built environment and can also inform accessibility standards that will be a key part of the proposed Accessible Canada Act (Government of Canada, 2018).

2. Methods and Data

A classification system for barriers and aids to mobility was created and used for data collection. Comprehensive spatial datasets featuring these barriers and aids were created for three post-secondary campuses in the City of Calgary. Statistical and geospatial methods were being applied to assess and compare the extent to which each campus meets existing accessibility guidelines.

2.1 Classification System

We began by identifying and classifying barriers and aids to accessible mobility (AM). AM features were classified into five categories: transportation (e.g. parking stalls), routes (e.g. sidewalks), ramps, intersections (e.g. curbs), and building entrances (Welage and Liu, 2011). The categories are consistent with interviews of wheelchair users reporting that common barriers are narrow sidewalks, no ramps, no curb cuts, and poor sidewalk surfaces (Kasemsuppakorn et al., 2015). Table 1 outlines how each AM feature (e.g. parking stall, door) was classified based on criteria derived from three existing accessible design frameworks: The City of Calgary's Access Design Standards (City of Calgary, 2016), the Rick Hansen Foundation Accessibility Certification (Rick Hansen Foundation, 2019) program, and the Americans with Disability Act (US Department of Justice 2010). Figure 1 in the appendix shows example photographs of these AM features.

Table 1: List of AM features and their respective vector data models and criteria for classification; the appendix contains photos of each AM feature as examples.

AM feature	Vector data model used	Criteria	Classification	Photo
Parking stall	Point	Within 50 m of barrier-free building entrance; signage; sufficient width; and, near sidewalk curb ramp or access aisle	Accessible	A
		If any criterion for "Accessible" classification is unmet	Inaccessible	B
Parking lot	Polygon	Meets minimum number of required accessible parking spaces (RHFAC, 2019)	Accessible	N/A
		If any criterion for "Accessible" classification is unmet	Inaccessible	N/A
Parking payment machine or transit ticket machine	Point	Operable parts' height between 0.91 m and 1.1 m	Accessible	N/A
		If any criterion for "Accessible" classification is unmet	Inaccessible	C
Door and gate	Point	Automatic; door width ≥ 0.85 m; and, does not lead to steps only	Accessible	D
		If any criterion for "Accessible" classification is unmet	Inaccessible	E
Sidewalk or trail	Line	Width is ≥ 1.5 m; and, no criteria for "Moderately Accessible" and "Inaccessible" classifications are met	Fully accessible	F
		Width is between 1.5 m and 0.92 m with passing spaces; or, unlevel or cracked surface; and, no criterion for "Inaccessible" classification is met	Moderately accessible	G
		Width is ≤ 0.91 m; width is between 1.5 m and 0.91 m with no passing spaces; grate openings or level changes are ≥ 13 mm within path of travel; or, severely unlevel or cracked surface	Inaccessible	H
Steps or ramp	Line	Ramp with handrails and edge protection on both sides	Fully accessible	I
		Curved or circular ramp; or, ramp with missing handrails and or edge protection	Moderately accessible	J
		Steps not accompanied by a ramp	Inaccessible	K
Curb cut	Point	Aligned with direction of travel; wholly contained within markings; and, matches curb ramp on other side of road	Fully accessible	L
		Bull-nosed; or, projects into vehicular traffic lanes, parking spaces, etc.	Moderately accessible	M
		Does not exist and direction of travel encounters curb	Inaccessible	N

2.2 Data Modelling and Set-up

ArcGIS Desktop software was used to create a feature class for each identified AM feature. Some features were further itemised to have a more precise dataset. For example, doors were divided into four separate classes: entry doors, exit-only doors, unknown doors, and gates. Additional layers were created to represent other relevant information, such as areas under construction and service areas. Attachment functionality was enabled for each layer to store pictures of observations during data collection. Table 1 also lists the vector data model used to represent each feature class. Layers were projected to the Web Mercator coordinate system to be published as hosted layers in ArcGIS Online, a cloud-based mapping platform, and added to a web map.

2.3 Data Collection

Data was collected in July 2018 for three post-secondary campuses in Calgary: University of Calgary (UofC), Southern Alberta Institute of Technology (SAIT), and Mount Royal University (MRU). ESRI's Collector application was used to access the web map and collect data on a GPS-enabled cellular device. The grounds of each campus were gridded and surveyed to map, classify, and photograph the previously identified barriers and aids to mobility on-the-fly. The presence of some AM features was recorded as being at a fixed point, such as doors and curb cuts, while others were recorded as a line along the length of a sidewalk, such as a staircase or cracked and unlevel sidewalk surface. After choosing which new feature to collect and placing it on the map, selections using drop-down menus (previously set for each layer using domains and sub-types in ArcGIS Desktop) were made regarding the feature's access rating (e.g. inaccessible) and barrier type (e.g. steps only without accompanying ramp), and any additional comments were written in the *Notes* field. At the end, the *Extract Data* tool in ArcGIS Online was used to package and export the collected data to ArcGIS Pro for mapping.

2.4 Visualizing Accessible Mobility

Once data collection was complete, the next phase was to map the data to better visualize overall accessibility on campus. To do so, curb cuts were generalized into point representations of street crossings and a choropleth of building footprints was created representing the proportion of accessible doors per building; also included in the visualizations were inaccessible and moderately accessible sidewalks and parking lots. Other AM features were not included in the maps as they were better described qualitatively or represented quantitatively in a chart.

For now, only curb cuts located at intersections between roads and sidewalks were generalized and included in the maps, and not the isolated curb cuts found in parking lots or service areas, for example. This was done to focus exclusively on the accessibility of street crossings that are vital to navigational connectivity. Points representing street crossings were mapped as fully accessible if only fully accessible curb cuts were present at the intersection; as moderately accessible if at least one curb cut at the intersection was only moderately accessible; and, as inaccessible if any curb cut at the intersection was found to be missing.

Footprints for campus buildings were manually digitized and had the proportion of accessible entry doors out of the total number of entry doors added as values to a new attribute table field. Choropleth cartographic techniques were implemented using graduated color symbology with four equal interval classes to represent the proportion of accessible entrances per building, and an additional fifth class to assign a unique color to buildings with no accessible entrances at all.

Lastly, the NAD 1983 UTM Zone 11N coordinate system in the transverse Mercator projection was used in order to preserve distance in length calculations (e.g. for the length of inaccessible and moderately accessible sidewalks).

3. Results

This project resulted in the creation of a comprehensive spatial dataset of barriers and aids at the UofC, SAIT, and MRU campuses with over 3,900 features mapped.

Figures 2 to 4 in the appendix are maps visualizing findings on accessible entrances per building, the distribution and accessibility of street crossings, accessibility of parking lots, and inaccessible and moderately accessible sidewalks for each campus. There are no apparent patterns in the spatial distributions of these AM features across campuses. However, although sidewalks impacted by barriers are dispersed mostly randomly over campuses, it is noteworthy to mention that several sections of city sidewalks on campus perimeters are only moderately accessible. Also, there are several segments of both moderately accessible and inaccessible sidewalks near the East Residences at MRU.

All gates (e.g. to the SAIT C-train station and UofC community garden), unknown (locked doors usually located in service areas) and exit-only (e.g. emergency exits) doors, parking payment machines and transit ticket vending machines are inaccessible on all three campuses.

Figure 5 in the appendix quantitatively summarizes the classification of AM features on campuses. For example, 75% of buildings at MRU have zero accessible entrances, as do 28% of buildings at UofC and 22% at SAIT. The highest proportion of inaccessible and moderately accessible sidewalks were found at MRU, which had 4638 metres of sidewalks impacted by some type of barrier; this is considerably higher than 1362 metres of inaccessible and moderately accessible sidewalks at SAIT, and 816 metres at UofC. On average, it was calculated that approximately 61% of AM features at MRU are inaccessible, 53% at SAIT, and 49% at UofC. Therefore, MRU is the least accessible and UofC is the most accessible amongst the three campuses assessed based on existing accessibility guidelines. However, this is only a comparative generalization because all three campuses are far from the ideals of a fully accessible built environment.

4. Conclusion

The results so far from mapping AM features reveal that there are significant barriers that limit a person with mobility impairment from easily navigating campus grounds. This preliminary work provides a methodological basis for the classification of features as barriers and aids with varied levels of accessibility according to specific guidelines. Understanding the patterns of accessible mobility revealed by this research helps provide a deeper understanding of inequities in the built environment that likely extend across urban areas all over the world.

Several areas of further research can be investigated. Firstly, AM features identified and classified by this work are only a fraction of the barriers that persons with disability face on a daily basis. One example of another variable that should be assessed for its role in accessibility is the topographic gradient of campus areas, in addition to mapping AM features located indoors. Secondly, barriers and aids to mobility are perceived differently by individuals in terms of what and how impactful they are. Future work will therefore involve crowdsourcing information from wheelchair users to incorporate real-world experiences into the classification system. Lastly, methodology for calculating an overall accessibility for each campus needs to be investigated and implemented for a better at-a-glance metric of accessibility.

Some applications of this research can include incorporating the comprehensive spatial datasets of AM features for UofC, SAIT, and MRU into digital, map-based smart city applications (e.g. Google Maps) for accessible route planning. The data can also inform decision making to create more inclusive and accessible campuses by prioritizing the elimination of identified and mapped barriers.

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References

Canadian Human Rights Commission (2017). Left Out: Challenges faced by persons with disabilities in Canada's schools [PDF file]. Retrieved from https://www.chrc-ccdp.gc.ca/eng/file/14904/download?token=ZlyFcWmB

Christopher and Dana Reeve Foundation (2018). Choosing a college to best fit your child's needs [Web]. Retrieved from https://www.christopherreeve.org/living-with-paralysis/for-parents/higher-education

City of Calgary (2016). *Access Design Standards: Advisory Committee on Accessibility* [PDF file]. Retrieved from http://www.calgary.ca/PDA/pd/Docu ments/development/access_design_standards.pdf?noredirect=1

Ferreira, M. A. G., & Sanches, S. da P. (2007). Proposal of a sidewalk accessibility index. *Journal of Urban and Environmental Engineering*, *1*(1), 1–9. https://doi.org/10.4090/juee.2007.v1n1.001009

Government of Canada (2018). Proposed Accessible Canada Act – Summary of the Bill [Web]. Retrieved from https://www.canada.ca/en/employment-social-development/programs/accessible-people-disabilities/act-plain-language-summary.html

Hill, J.L. (1992). Accessibility: Students with Disabilities in Universities in Canada. *The Canadian Journal of Higher Education, 22*(1), 48-83. Retrieved from http://journals.sfu.ca/cjhe/index.php/cjhe/article/view/183122/183098

Honey, K. (2015). 2016 Maclean's University Rankings: A letter from the editor. *Maclean's*. Retrieved from https://www.macleans.ca/education/macleans-university-rankings-a-letter-from-the-editor/

Imrie, R., & Kumar, M. (1998). Focusing on Disability and Access in the Built Environment. *Disability and Society, 13(3),* 357-374. https://doi.org/10.1080/09687599826687

Kasemsuppakorn, P., Karimi, H. A., Ding, D., & Ojeda, M. A. (2015). Understanding route choices for wheelchair navigation. *Disability and Rehabilitation: Assistive Technology*, *10*(3), 198–210. https://doi.org/10.3109/17483107.2014.898160

Maclean's (2018a). Build Your Own Ranking. Retrieved from https://www.macleans.ca/education-hub/build-your-own-university-ranking/

Maclean's (2018b). University Rankings 2018: Methodology. Retrieved from https://www.macleans.ca/education/unirankings/university-rankings-2018-methodology/

Piro, V. (2017). Applying to College as a Wheelchair User. *Inside Higher Ed*. Retrieved from https://www.insidehighered.com/views/2017/04/06/challenges-wheelchair-users-face-when-visiting-colleges-essay

Rick Hansen Foundation (2019). Accessibility Resources [Web]. Retrieved from https://www.rickhansen.com/become-accessible/accessibility-resources

Statistics Canada (2010). Trends in the Age Composition of College and University Students and Graduates [Web]. Retrieved from https://www150.statcan.gc.ca/n1/pub/81-004-x/2010005/article/11386-eng.htm

Statistics Canada (2017). A demographic, employment and income profile of Canadians with disabilities aged 15 years and over, 2017 [Web]. Retrieved from https://www150.statcan.gc.ca/n1/pub/89-654-x/89-654-x2018002-eng.htm

US Bureau of Labor Statistics (2015). People with a disability less likely to have completed a bachelor's degree [Web]. Retrieved from https://www.bls.gov/opub/ted/2015/people-with-a-disability-less-likely-to-have-completed-a-bachelors-degree.htm

US Department of Justice (2010). 2010 ADA Standards for Accessible Design [PDF file]. Retrieved from https://www.ada.gov/regs2010/2010ADAStandards/2010ADAStandards.pdf

Welage, N., & Liu, K. P. Y. (2011). Wheelchair accessibility of public buildings: A review of the literature. *Disability and Rehabilitation: Assistive Technology*, *6*(1), 1–9. https://doi.org/10.3109/17483107.2010.522680

Appendix

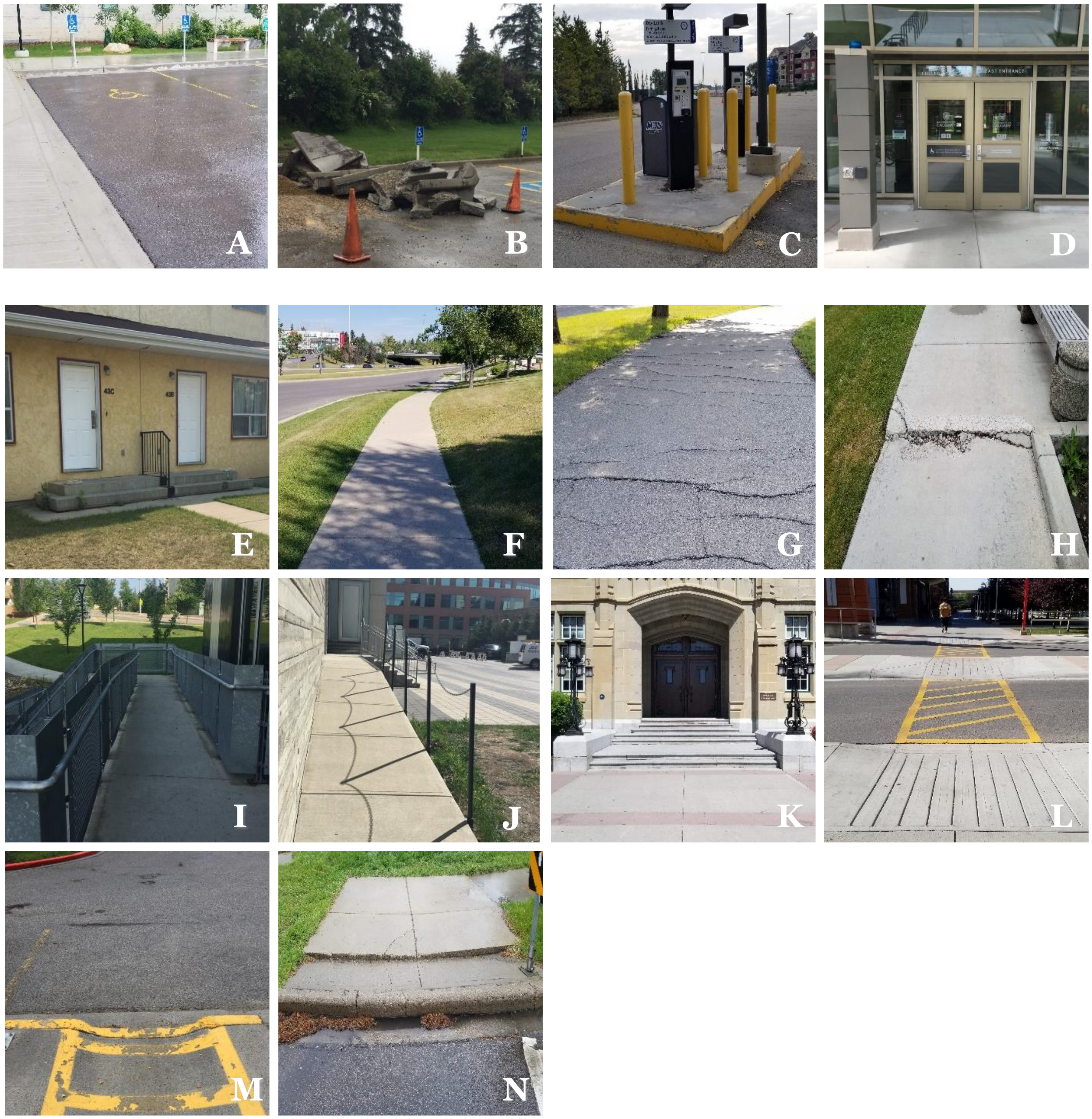

Figure 1: Photographs of AM features as listed in Table 1: accessible parking stall (A), inaccessible parking stall (B), inaccessible parking payment machines (C), accessible doors (D), inaccessible doors (E), fully accessible sidewalk (F), moderately accessible sidewalk (G), inaccessible sidewalk (H), accessible ramp (I), moderately accessible ramp (J), inaccessible steps (K), fully accessible curb cut (L), moderately accessible curb cut (M), inaccessible curb cut (N).

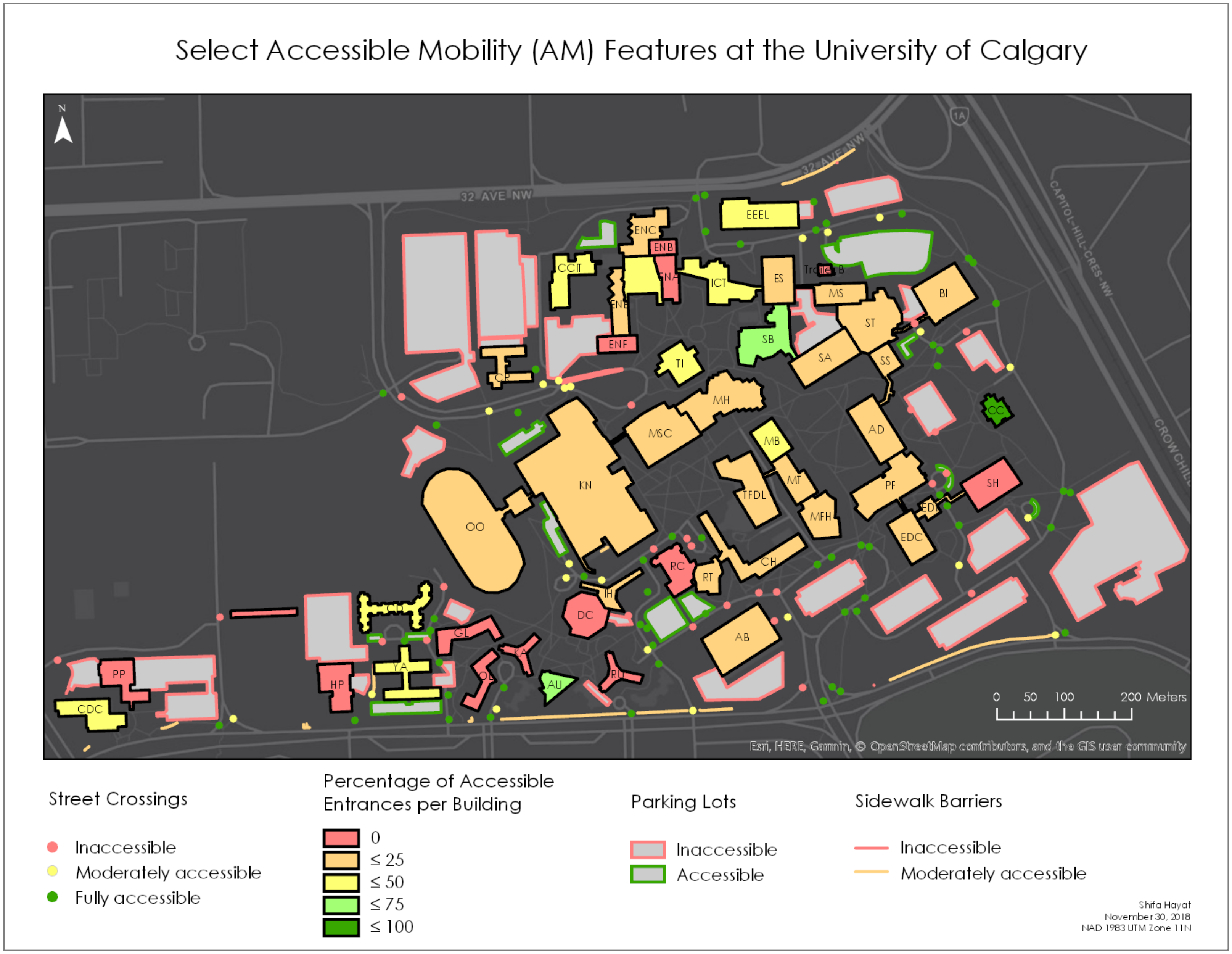

Figure 2: Map of AM features at the University of Calgary (UofC).

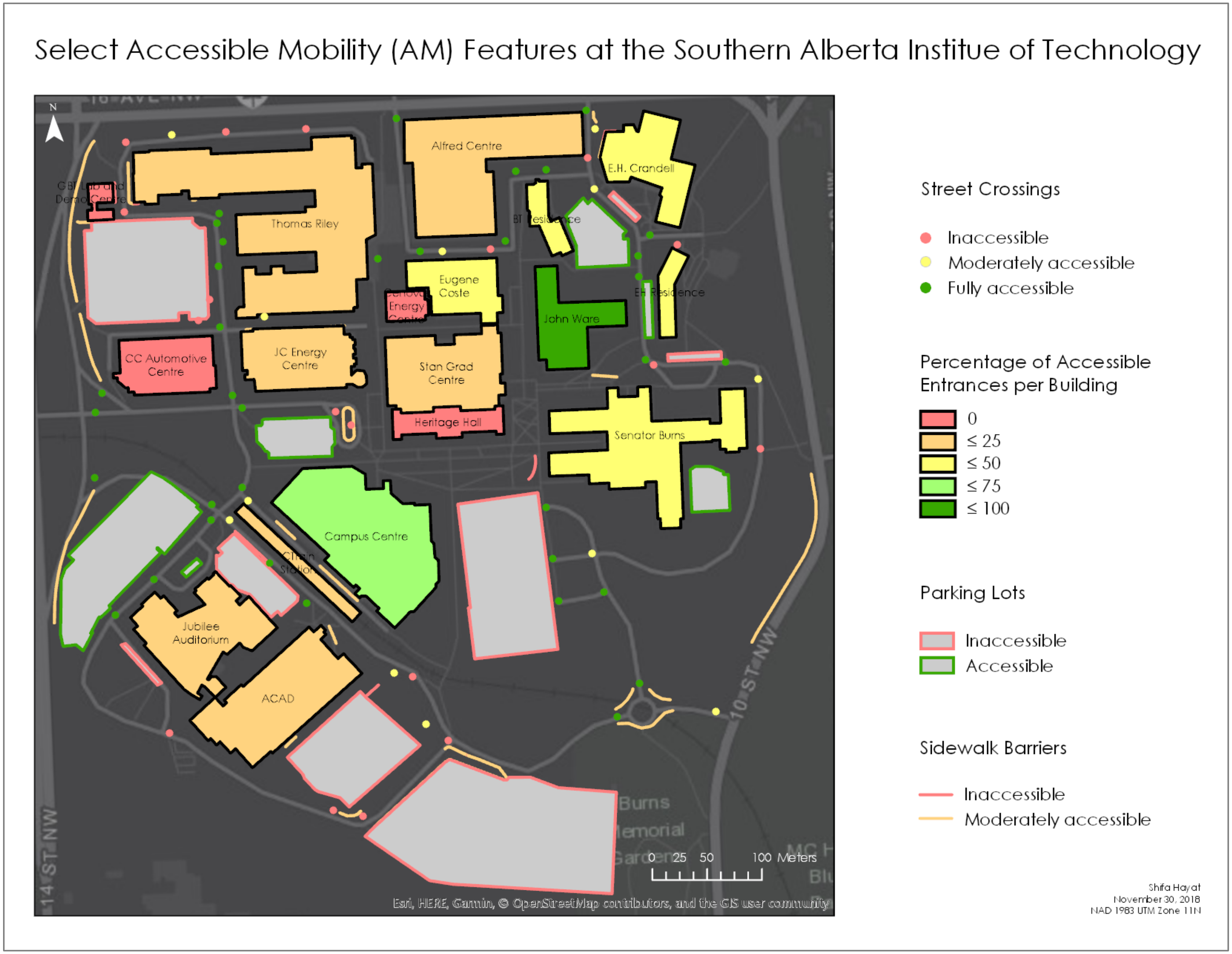

Figure 3: Map of AM features at the Southern Alberta Institute of Technology (SAIT).

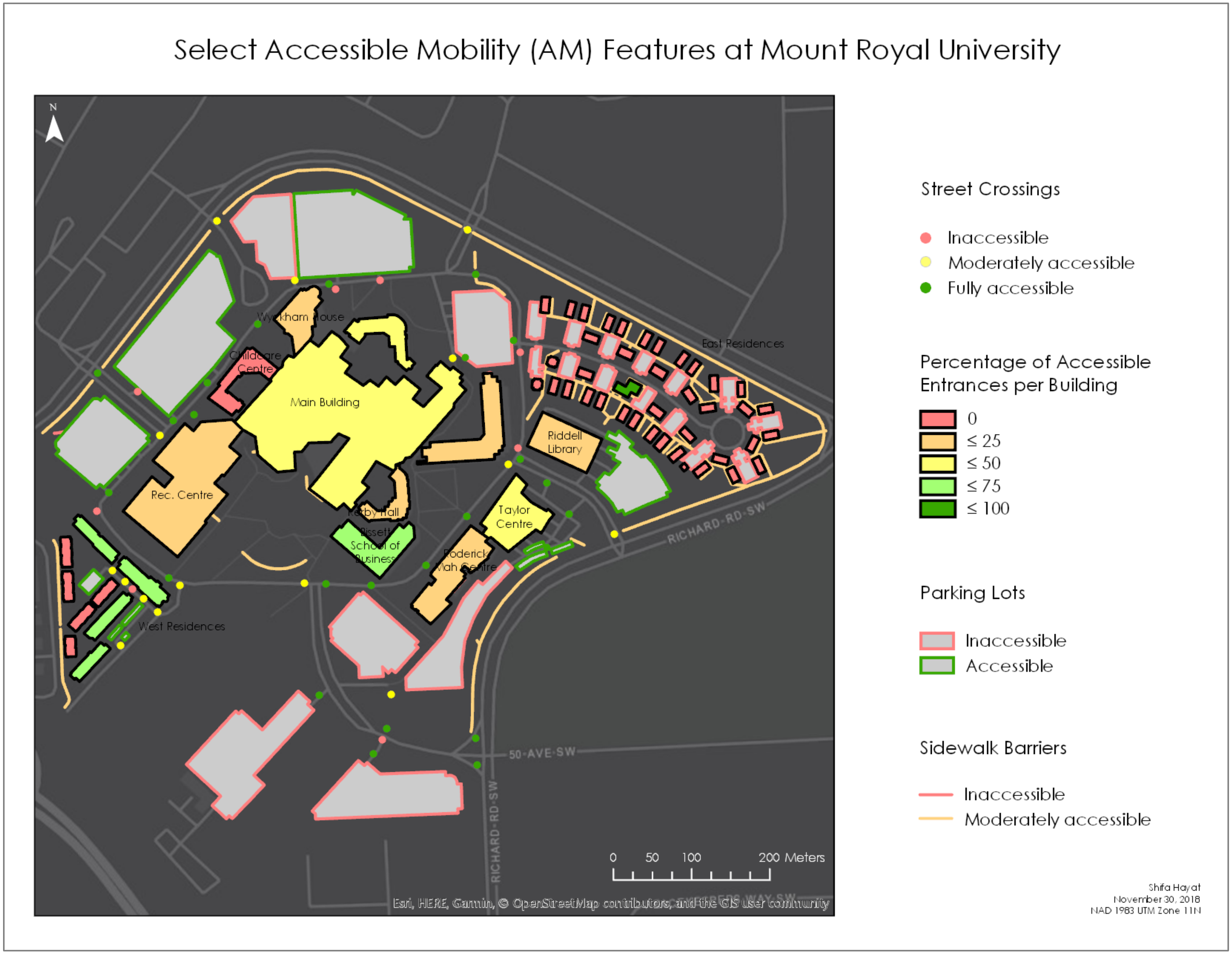

Figure 4: Map of AM features at Mount Royal University (MRU).

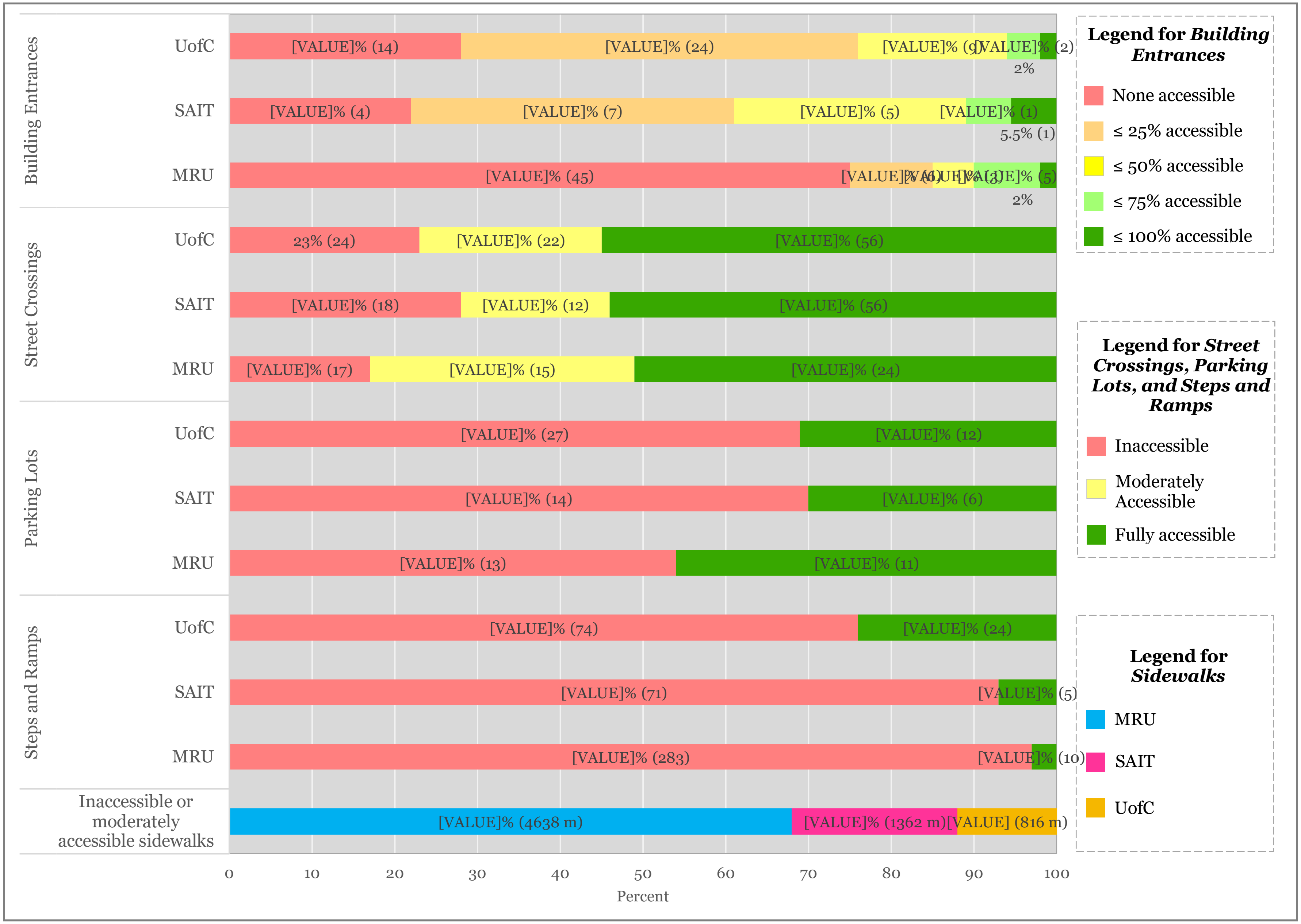

Figure 5: Results summarizing the classification of AM features mapped at the University of Calgary (UofC), Southern Alberta Institute of Technology (SAIT), and Mount Royal University (MRU).