CITY OF LEDUC
DOWNTOWN PARKING STUDY

FINAL REPORT

APRIL 10, 2019

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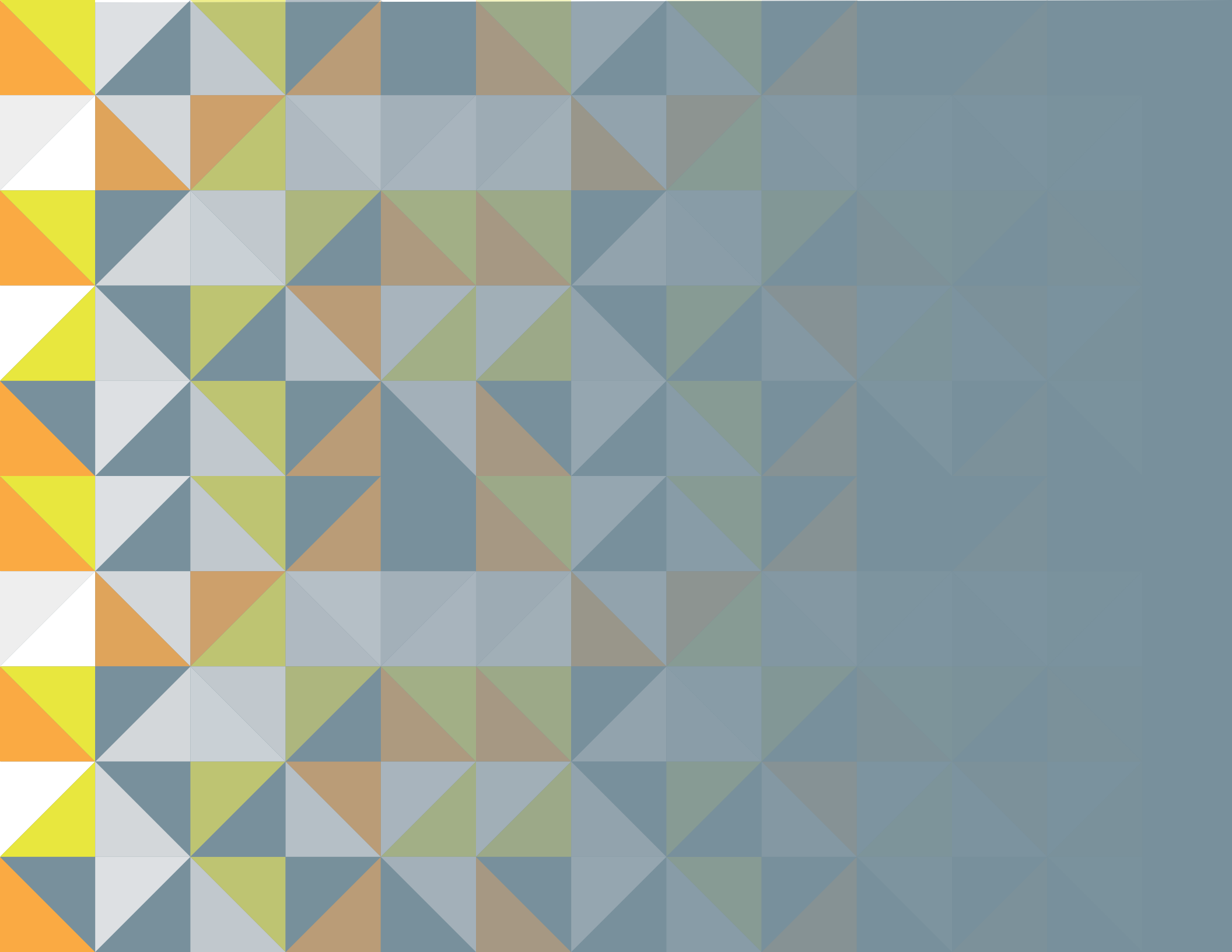

AUTHORS' DECLARATION

TERMS OF USE

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BACKGROUND

In January 2019, the City of Leduc secured the services of the University of Alberta's School of Urban & Regional Planning Graduate students to complete a parking study for downtown Leduc, which is one of the twelve identified priority action items within Leduc's Downtown Master Plan (2012). The intention of this study is to provide an understanding of the role that parking supply and management practices in downtown Leduc have in fostering the advancement of the vision for downtown Leduc.

The main objectives and deliverables of this study were as follows:

- Provide an academic literature review of parking management strategies and best practices;
- Provide an assessment of the effectiveness of current state parking supply and demand, and the associated parking management strategies in downtown Leduc;
- Provide a set of context sensitive short-term and long-term recommendations for parking management strategies in downtown Leduc resulting from an analysis of the parking usage data collected; and,
- Disseminate the results and recommendations of this study to the relevant members of the City of Leduc's Administration, Leduc's Downtown Business Association, and Leduc's City Council (Committee of the Whole).

RECOMMENDATIONS

A series of contextually sensitive recommendations have been developed for parking management strategies in downtown Leduc. The recommended strategies are as follows:

- Create a communications and education campaign to establish and reinforce optimal and preferred parking behaviours;
- Add additional parking stall in the North East portion of the study area to accommodate existing demand and parking patterns;
- Introduce a number of rapid parking stalls (15 minutes or less) in strategic areas along 50 Avenue;
- Conduct ongoing analysis of parking behaviours in downtown Leduc on a consistent schedule;
- Establish a consistent and targeted approach to parking enforcement in downtown Leduc;
- Conduct a transportation network analysis to capture and understand the spatial and temporal movement of vehicles and people to and within Downtown Leduc;
- Consider establishing a pay-for-parking program when the City of Leduc reaches a certain population threshold (60,000 people); and,
- Consider, in the long term, rezoning the paved parking lot at 49 Street and 49 Avenue to enable a condominium development, with the inclusion of a shared parking program within the site's underground parking.

ANALYSIS

A multi-phased analysis of parking behaviours was conducted to establish these recommendations.

PHASE 1

The first phase of analysis centred on a spatial analysis of the current parking conditions in downtown Leduc. Through this spatial analysis, the total number of parking stalls (934), both public and private, was identified along with the average number parking stalls per business (8). The 934 parking stalls were then further analyzed, which showed that 64% of the parking stalls were located within 25m of a business, and 98% of the parking stalls are located within 50m of a business. Further, 32%, 81%, and 99% of the parking stalls are located within 50 metres, 100 metres, and 200 metres of 50th Avenue respectively.

This phase also included an analysis of the wayfinding signage related to parking in downtown Leduc, and the analysis showed that the number and location of signs was sufficient. The issue is that the design of the signage is not necessarily clear and in some instances can be confusing. Furthermore, the signs do not have a cohesive aesthetic.

PHASE 2

The second phase of analysis centres on usage and duration data associated with parking behaviors in downtown Leduc. Through the analysis of the occupancy data, it has been concluded that **Leduc does not have an overall parking supply issue**. Parking occupancy is classified into three categories:

- Parking which has failed, over 85% occupancy;
- Parking which is optimal, between 70% and 85% occupancy; and,
- Parking which is underutilized, under 70% occupancy.

Some specific parts of the study area do fail (12%), however most parts are underutilized (55%) and one third (33%) of the study area functions within optimal range, the analysis showed that the duration of stay average is generally low in most areas, with only one area that was observed having an average duration that approached the 2 hour maximum.

METHODOLOGY

The data used to conduct the analysis and develop a set of recommendations was done through the utilization of an Unmanned Aerial Vehicle (UAV) to ensure that high-quality data is being collected, and to address the fragmented nature of the study area as well as issues related to the privacy of users of the area.

The raw data for occupancy was captured by photographing the entire study area at 50 feet by Unmanned Aerial Vehicle (UAV) every 30 minutes. The UAV was used to capture images from 8:00 am to 6:00 pm on Wednesday March 13th and 8:00 am to 6:00 pm on Saturday March 16th.

To supplement the UAV images, rich duration data was collected by clocking in and out times for vehicles in various parts of the study area. This data was collected in 6 pre-determined regions throughout the study area. Data was collected over 5 days, and primarily over the 10:30 - 2:30 period of the day.

STUDY FINDINGS DISSEMINATION

The results of this study will be disseminated to the City of Leduc's Administration on April 10, 2019, Leduc's Downtown Business Association on May 10, 2019, and Leduc's City Council on May 13, 2019.

PROJECT DELIVERABLES

The project has developed a number of deliverables, which are as follows:

UAV IMAGERY

EXCEL FILES OF PROCESSED DATA

INTERIM REPORT AND PRESENTATION

FINAL REPORT AND PRESENTATION


1.0

RECOMMENDATIONS

1.0 RECOMMENDATIONS

1.1 COMMUNICATION & EDUCATION CAMPAIGN

A branded, robust, and multi-pronged communication and education campaign should be developed and implemented to achieve community and stakeholder buy-in, community and stakeholder ownership of parking management in downtown Leduc, and to influence and reinforce desired parking behaviours of the users of downtown Leduc.

RATIONALE

The communication and education campaign will seek to achieve the following:

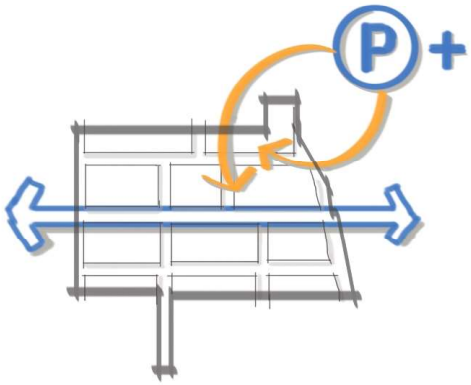
- **Remind and reinforce the practice of parking on the peripheral edges of downtown Leduc for longer-term stays.**
- **Inform users of the downtown of regularly underutilized parking locations, as well as areas that are often at, or near capacity.**
- **Identify areas where "rapid parking" is available along Main Street.**

ACTIONS:

Actions for the implementation of the multi-pronged communication and education campaign include, but are not limited to, the following:

- **Creating a downtown Leduc Parking Map.**
- **Developing a sub-page on Leduc.ca that details parking locations, conditions, and average weekday / weekend occupancies.**
- **Improving the wayfinding signage for parking locations in downtown Leduc.**

1.2 ADD PARKING STALLS IN THE NORTH-EAST PORTION OF THE STUDY AREA



Additional parking is required to relieve demand in the north-east portion of the study area. To accommodate this demand 48a St. (between 50 Ave. and 51 Ave.) should be converted into a one-way street and angle parking installed along its western edge. If possible, the City of Leduc should pursue a lease agreement for the private lot near 51 Ave. and 47 St. and reconfigure the lot to make more efficient use of the land.

RATIONALE

12% of the parking within the study area fails (over 85% occupancy) and these parking occupancy failures are concentrated in the north-east portion of the study area.

The most intense demand was observed along 48A St. which reaches 136% capacity at its peak. The public parking lot immediately north is in a sustained state of failure (over 85% capacity) from 9:00 am. to 2:00 pm. The public parking lot immediately east along 47 St. reaches over 100% capacity multiple times between 9:00 am. to 4:30 pm. A total of 13 new stalls are required to accommodate the excess demand from these failed areas.

Making 48A St. a one-way street with angle parking along the west side would add 8 public stalls. Leasing 1/2 of the land area in the private lot would open enough space to add an additional 9 public stalls for a total of 17. The recommendation to lease 1/2 of the private lot depends on the owner's willingness to reconfigure their existing stalls to utilize the empty space in the center of the lot.

Turning 48A St. into a one way would also make it consistent with the existing configuration of 49 St. (between 50 Ave. and 51 Ave.) one block to the west. This consistency may improve the parking experience in the study area but public engagement and a technical study are required to confirm this assumption.

1.2 ADD PARKING STALLS IN THE NORTH-EAST PORTION OF THE STUDY AREA (CONT)

ACTIONS:

Actions for adding stalls to the north-east portion of the study area could include, but are not limited to, the following:

To convert 48A St. the following phases are recommended:

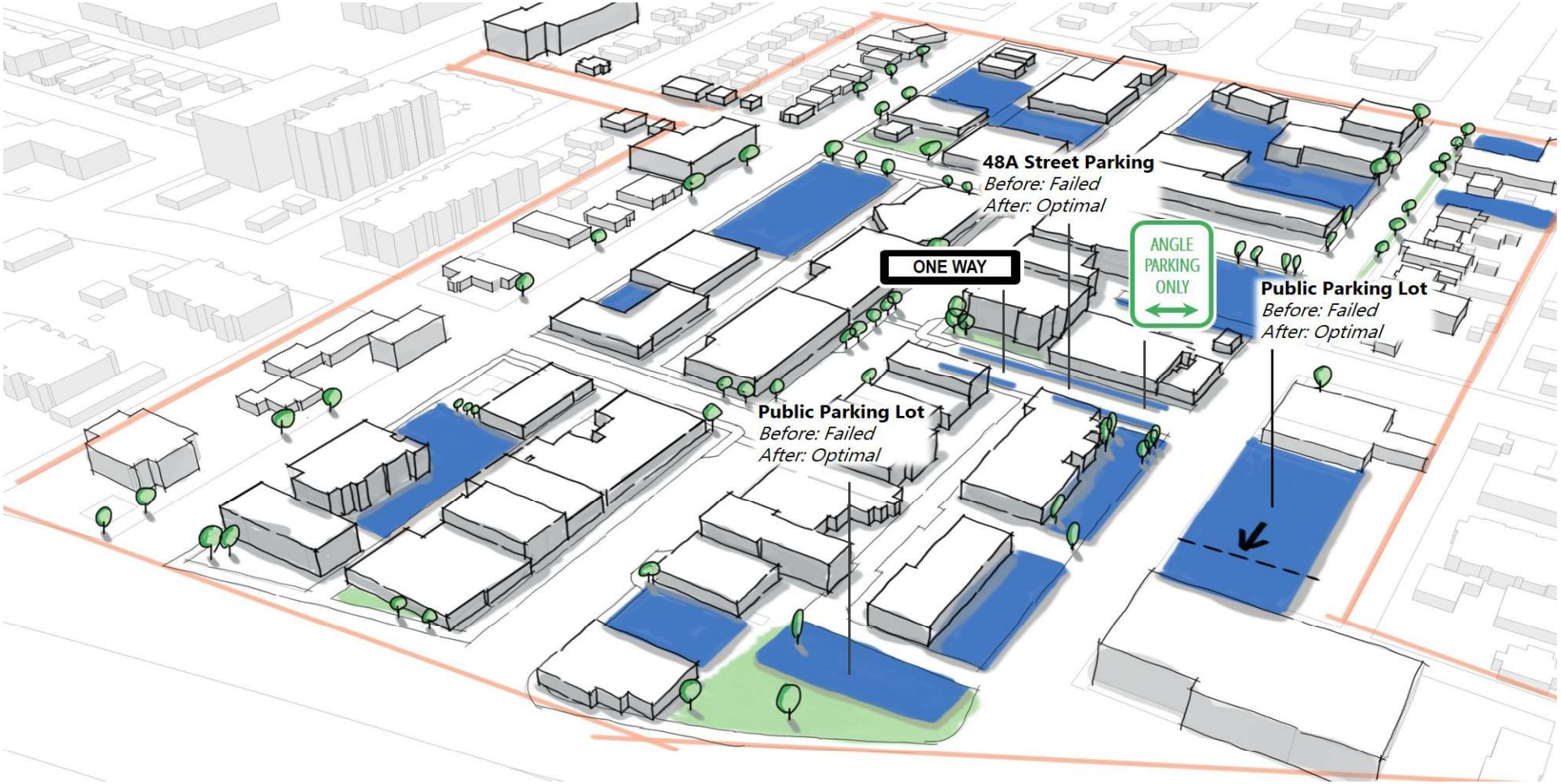
- **Conduct a technical study to determine the feasibility of converting 48A St. (between 50 Ave. and 51 Ave.) from two-way traffic to one-way traffic and to determine the optimal direction (north or south).**
- **Conduct public engagement to determine the feasibility of converting 48A St (between 50 Ave. and 51 Ave.) from two-way traffic to one-way traffic.**
- **Convert 48A St. from two-way traffic to one-way traffic and convert the existing "in-line" stalls on its west edge to parallel stalls.**

To expand the public lot at 48A St. and 51 Ave., the following phases are recommended:

- **Conduct a technical study to determine the feasibility of expanding and reconfiguring the existing public lot at 48A St. and 51 Ave. into the adjacent private lot on its eastern edge.**
- **Secure a lease with the current owner of the private lot.**
- **Reconfigure the parking stalls in the existing public lot to accommodate vehicle circulation in the expanded lot.**

The predicted outcome of this recommendation is shown in the map on page 12.

FIGURE 1: ADDING PARKING STALLS CONFIGURATION



1.3 INTRODUCE RAPID PARKING STALLS

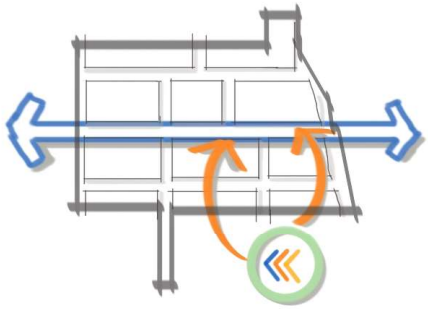
15 min. maximum parking should be added to 50 Ave. to accommodate the use time that was observed in the area. At least 1 stall per block, located on both the North and South sides of 50 Ave., will provide a stall for those who are only planning to be at their destination for a short time.

RATIONALE

If a user's intention is to carry out a quick visit on main street and there is no parking immediately near that site location, the visitor will likely perceive that there is not enough parking. Adding parking, which addresses this particular use, may contribute to a more enjoyable main street experience.

Two locations along Main Street were observed on two separate days for four hours (10:30 am. - 2:30 pm.). The theme of short stay parking emerged throughout this data as 57% of the parking events were for 15 minutes or less. It is clear that a significant proportion of individuals currently visiting downtown do so for a single task and a duration under 15 minutes.

Providing Rapid Parking Stalls caters the space to this use, providing these individuals with a space that will turn over quickly.



ACTIONS

- **Identify suitable stalls on main street to be used as Rapid Parking stalls.**
- **Mark these stalls with signs that separate them from the general, 2 hour parking supply - Rapid Parking - 15 min. maximum.**

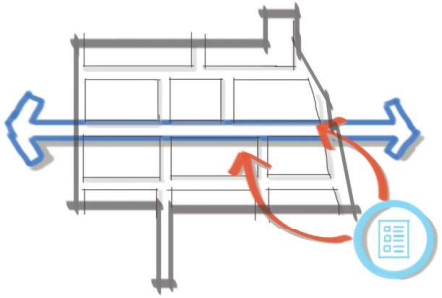
1.4 TARGETED AND CONSITENT ENFORCEMENT

RATIONALE

Enforcement of parking restrictions is an effective way to establish and reinforce optimal parking behaviours of the patrons of downtown Leduc.

ACTIONS

- **Explore developing a coordinated and consistent enforcement strategy with the intention of targeting locations that have been identified as 'failed' parking areas (over 85% occupancy), as well as areas of high importance such as Main Street, to ensure that time restrictions are being followed.**



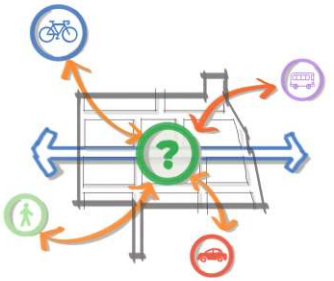
1.5 NETWORK ANALYSIS

RATIONALE

For this study, both micro and macro parking behavior of people visiting the Downtown was observed. However, where people were coming from, or the relationship between their origin and destination in terms of transportation choice could not be identified. A fine grained network analysis can assist with informing future decisions on how people choose to arrive to the Downtown.

ACTIONS

- **Identify the availability of different transportation types to visitors of Downtown Leduc.**
- **Use information developed out of a transportation network analysis to inform future transportation and parking decisions in the Downtown.**



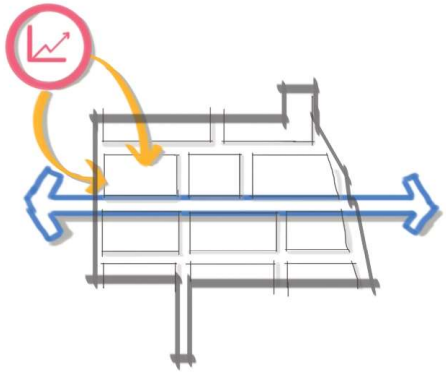
1.6 ONGOING ANALYSIS

Frequent collection of data and analysis of parking trends should occur and be used to inform future development decisions in Leduc's main Downtown area.

RATIONALE

The information provided in this report is a snapshot of a particular time. While it reflects the current trends in Leduc's occupancy and duration rates, it does not reflect future trends. For example, the Edmonton Metro Region Board Growth Report forecasts a population of 49,600 - 68,000 by the year 2044. Leduc's 2018 census identified a municipal population of 32,448. If the forecasted growth numbers are realized, there will be an impact on downtown parking.

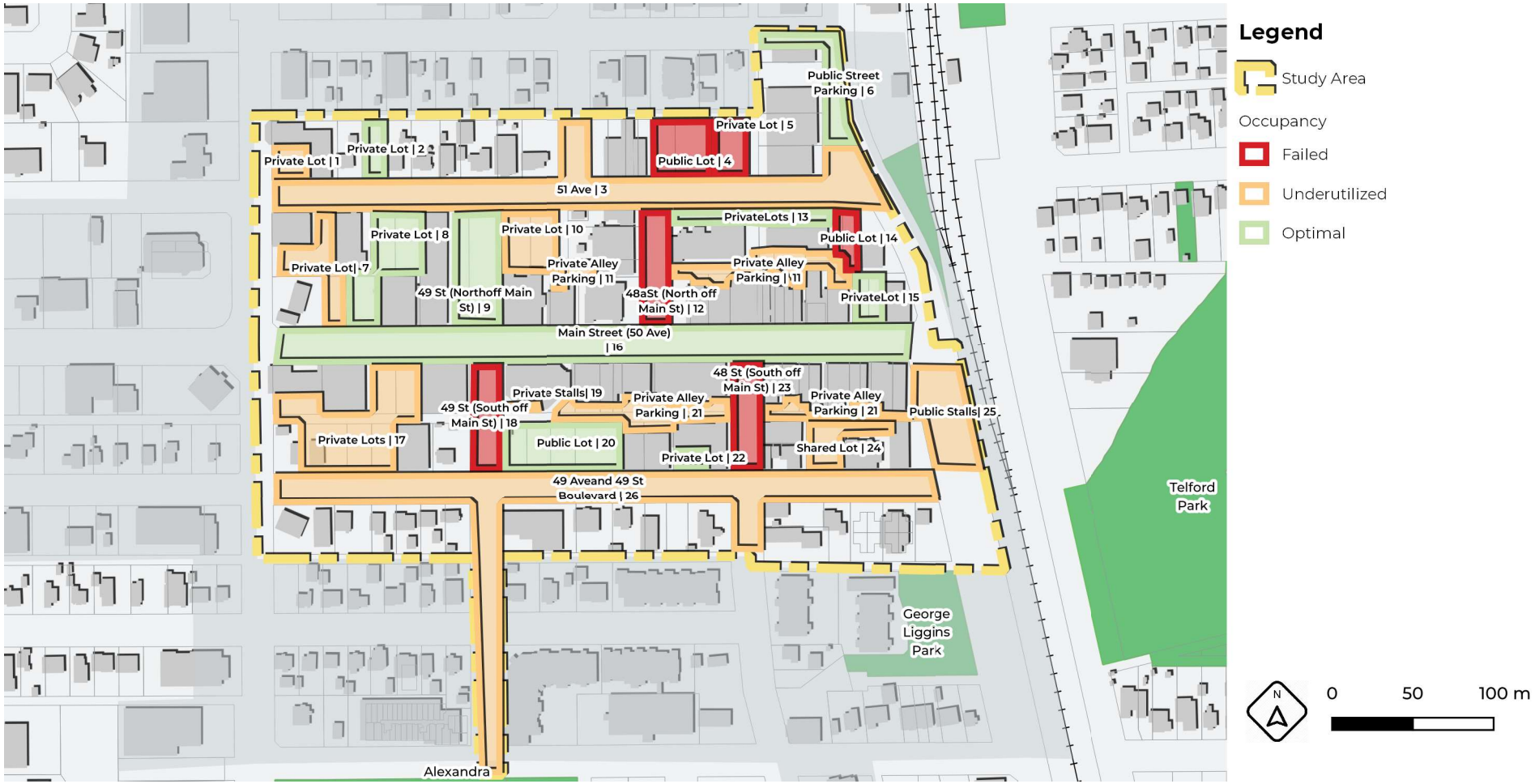
Ongoing data collection and analysis will allow for the municipality to track the changes in use (duration and occupancy) on a general and micro-region standpoint. This data will be helpful in understanding how parking preferences are changing and what affects the initiatives introduced by the municipality regarding parking are having. Data accrued on a regular basis will help Leduc to make informed decisions regarding future downtown parking needs.



ACTIONS

- **Establish a procedure and frequency for the regular collection of parking data. It is recommended that a similar procedure as outlined in this report be implemented in order to use this data as a baseline for future comparison.**
- **Yearly data, collected in the Summer, consisting of occupancy and duration data for the downtown region, would be ideal.**
- **Close attention should be given to the areas identified as 'failure' in this report (see map below) and also those areas where the municipality introduces strategies to address parking related issues.**

FIGURE 2: FAILED, OPTIMAL & UNDERUTILIZED PARKING LOCATIONS



1.7 PRICING PARKING

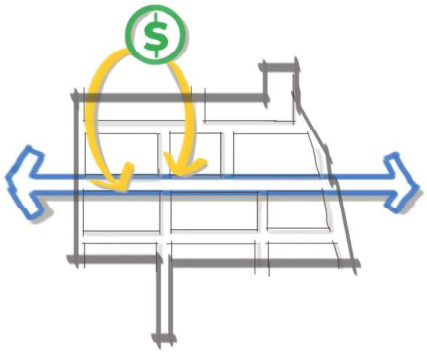
If Leduc realizes the EMRB forecasted growth, and if residential growth in the downtown area occurs (as is targeted in the Leduc Downtown Master Plan, pg. 41), then a system to charge for parking would be a reasonable way to manage parking in the area.

RATIONALE

At this point in time, pricing parking does not make sense as a strategy for managing parking in Leduc (neither the occupancy nor the duration data demonstrates such a need). Should Leduc reach the population of Medicine Hat (63, 260), a municipality that prices parking, it would be more financially efficient to price parking than to add additional stalls (at a scale that would likely be necessary to alleviate any potential parking problems in the downtown area).

The literature demonstrates that pricing parking is the most effective parking management tool. Passing the cost of parking on to the user of the parking stall ensures that the cost of parking is not subsidized and encourages the driver to consider the choice they are making.

This recommendation does not have a clear timeline. It will be dependent upon various factors: population, development patterns, trends in vehicle use and ownership, and political will. Should Leduc find itself in a situation where a majority of the downtown area is at or near parking failure (over 85% occupancy), this approach would need to be considered.



ACTIONS

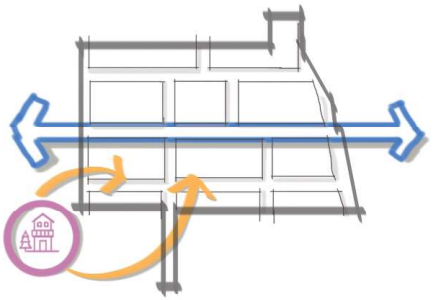
- **Based on population growth, downtown development, and available parking data, identify the areas that may benefit from pricing parking.**
- **Research the most relevant system for pricing parking. Currently, the literature indicates that technology should be used to manage the pricing (ex. Pay from your mobile phone), that curb parking should be priced at a premium rate, and that funds garnered from the pricing of parking should be used toward improvements in that general area.**

1.8 FUTURE DOWNTOWN CONDO DEVELOPMENT

The results of this study indicate that a parcel of land with four-story apartment building and underground parking would bring double the number of people downtown every day compared to a surface parking lot built on the same piece of land. It is recommended that future development in the study area should consist of low-rise apartments with underground parking, and that future expansion of the public parking supply should be located below these buildings. It is also recommended to make the public parking lot at 49 Ave. and 49 St. available for condo or apartment development, subject to strict conditions that any development on that parcel will contain at least 120 bedrooms and that 67 public parking stalls be made available for permanent lease by the City of Leduc.

RATIONALE

The public parking lot on the north-east corner of 49 Ave. and 49 St. has 67 stalls and hosts 118 cars per day. The four-story condominium with underground parking at 4806 48 Ave. occupies an identical parcel and has 120 bedrooms. Assuming that each car and each bedroom is occupied by a single person, they bring an equal number of people downtown on a daily basis. These assumptions are based on observations made during the parking study and census dwelling statistics. Both parcels of land may bring the same number of people downtown, but local residents may bring more overall businesses downtown because their homes are within walking distance.



If a condo identical to the one at 4806 48 Ave. was built on the public parking lot at 49 Ave. and 49 St., the existing 67 parking stalls in that lot should be replaced by underground parking. This means the recommended development would contain 67 public stalls that host 118 cars (118 people) per day and an additional 120 bedrooms (120 people) per day. This development would double the number of people this parcel of land brings to downtown every day.

This is a low-risk opportunity to promote the kind of development that is called for in the Downtown Master Plan. The city is only required to rezone the parking lot, place conditions on its sale, and wait for an interested developer. It would be recommended to place a restrictive covenant on the parcel's title to ensure that a minimum of 67 parking stalls are permanently available for public use.

1.8 FUTURE DOWNTOWN CONDO DEVELOPMENT (CONT)

ACTIONS

- Rezone the four parcels that make up this lot. The zoning should support four-story buildings and underground parking. Leduc's MUN or MUC zones are recommended to align development with the goals of the Downtown Master Plan.
- Place conditions on the sale of the lot that require: consol idation of the four parcels, construction of a 120 bedroom development, and shared underground parking.
- Place a restrictive covenant on the parcel's title to ensure that a minimum of 67 parking stalls are permanently available for public use.
- Sell the parcel to a developer who is willing to replace the existing 67 public parking stalls with parkade parking inside the building footprint. Any such development would require at least two levels of parking, one to replace the surface level parking and one for residents of the building.

ACTIONS CONT.

To generally support development that is at least four-stories tall with underground parking and to support shared public-private parking in those developments to meet future parking demand, the following steps are recommended:

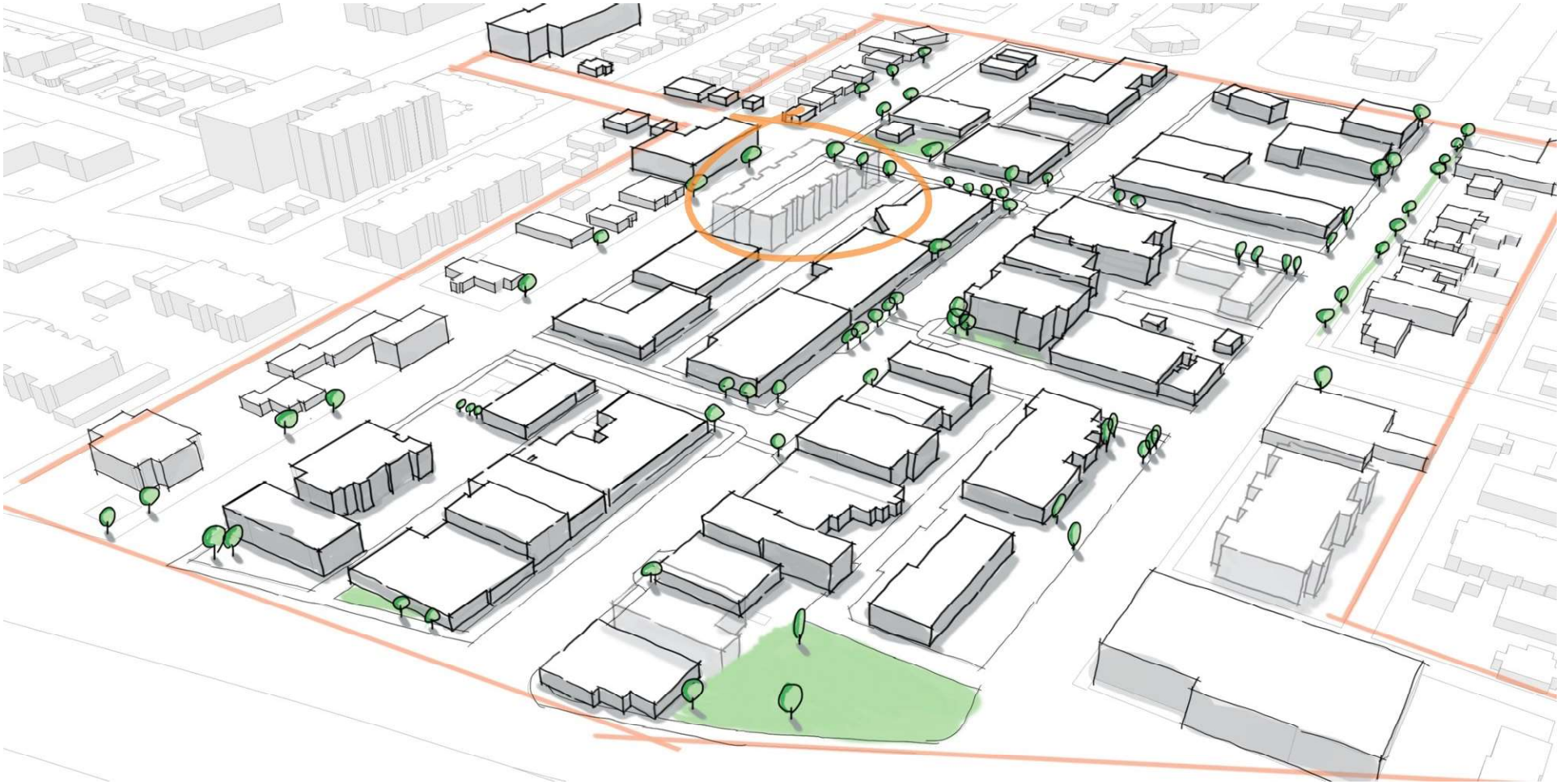
For sites that are not required to expand public parking supply:

- Consider rezoning parcels south of 49th Ave. and north of 51 Ave. that currently contain single detached homes from CBD and RSD to MUN or MUC.

For sites the city wishes to use for expanding public parking supply:

- In addition to rezoning these lots to MUN or MUC, consider purchasing and consolidating target lots. Ownership of consolidated lots would give the city leverage to require construction of a shared parking agreement on the City's terms.

FIGURE 3: LOCATION OF POTENTIAL CONDO DEVELOPMENT




2.0

ANALYSIS

2.0 ANALYSIS

2.1 PHASE ONE: SPATIAL ANALYSIS OF PARKING CONDITIONS

2.1.1 CURRENT INVENTORY

METRIC	RESULTS	RELEVANCE
Total number of stalls	934	Total parking stock in area
Avg. number of stalls per business	8	Baseline information
Total number of public stalls	479	City of Leduc has direct control
Total numer of private customer stalls	351	Parking stock held by private owners
Total number of private staff stalls	104	Parking stock held by private owners
Average number of staff stalls per business	1	Staff may park here if other areas are n/a
Ration of public and private parking	51% public / 49% private	City of Leduc has control of 53%
Total number of handicap stalls	15	Parking requirements regulated under MGA

FIGURE 4: PARKING STALL INVENTORY

2.1.2 PARKING STALL BUFFER ANALYSIS

Using a geographic information system (GIS), a buffer of varying size was placed first around businesses and then around the main street corridor. A buffer is a zone, set at a specific distance, around another map feature. This spatial analysis provides us with a sense of Leduc's parking supply, as it currently exists, in relation to distances to businesses and to main street.

This analysis does not take into account stall occupancy or duration of stay, nor does it provide number of parking stalls on a per businesses basis. It instead, simply outlines the parking supply that is within a reasonable distance of the project area.

The results of the buffer analysis are as follows:

- Applying a 25 metre buffer to the Downtown businesses demonstrates that 64% (602 stalls) of the parking inventory of the downtown area is within this distance of the business es.
- A 50 metre buffer includes 97.6% (912 stalls) of the parking inventory within the downtown area. This demonstrates that the vast majority of parking is within close proximity to the downtown businesses (page 26).
- A majority of businesses are located along 50 Ave., when a 50 metre buffer is applied, 32.2% (301 stalls) of the parking spaces are accounted for. These stalls are primarily on-street, angled parking (page 27).
- When increased to 100 metres, 81.4% (761 stalls) of the parking inventory is accounted for, which includes many of the larger, off-street lots adjacent to 49 Ave.and 51 Ave (page 28).
- 98.5% (920 stalls) of the parking inventory are accounted for within 200 metres of Main Street (page 29).

FIGURE 5: 25 METRE BUSINESS BUFFER

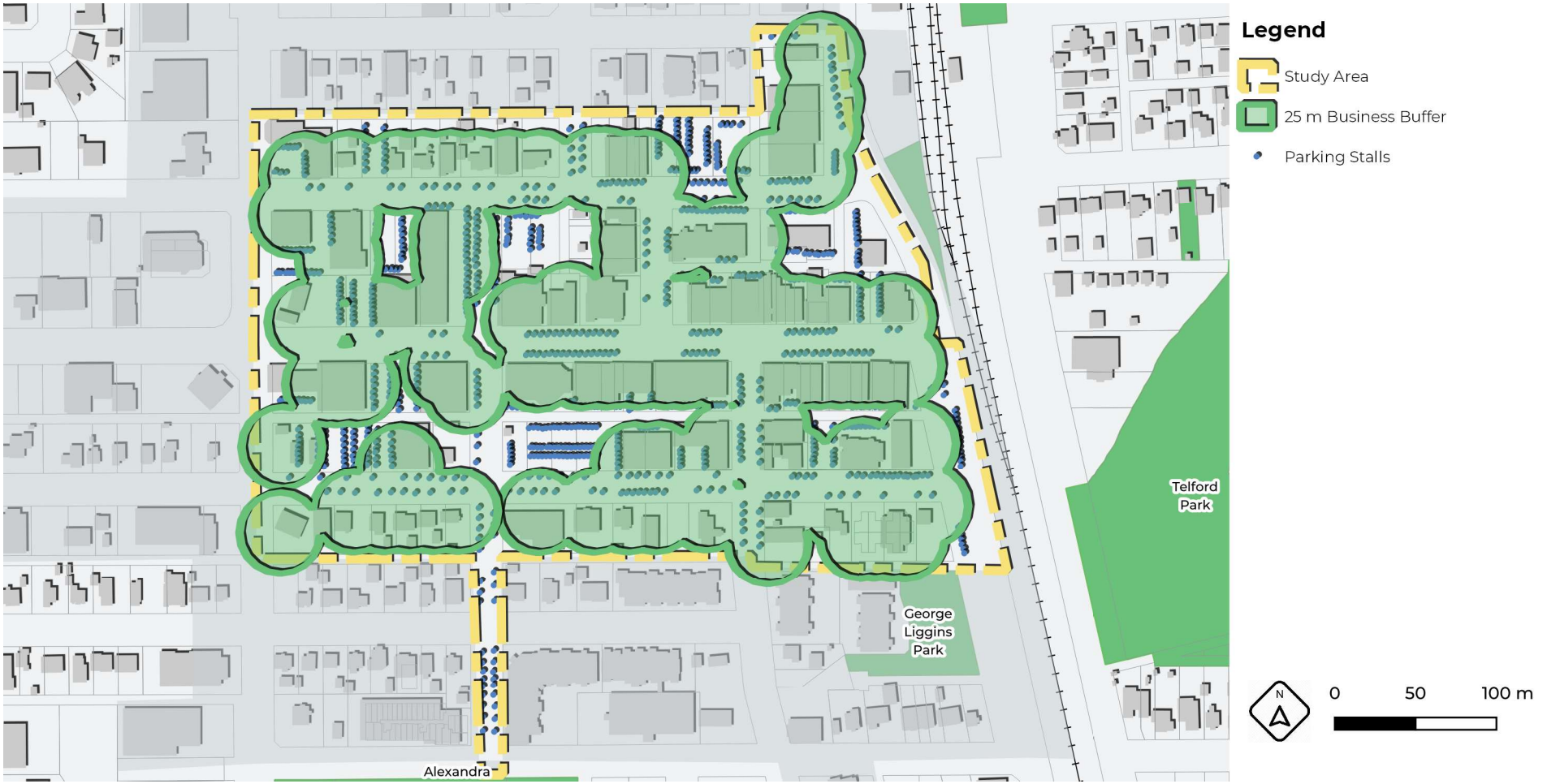


FIGURE 6: 50 METRE BUSINESS BUFFER

FIGURE 7: 50 METRE MAIN STREET BUFFER

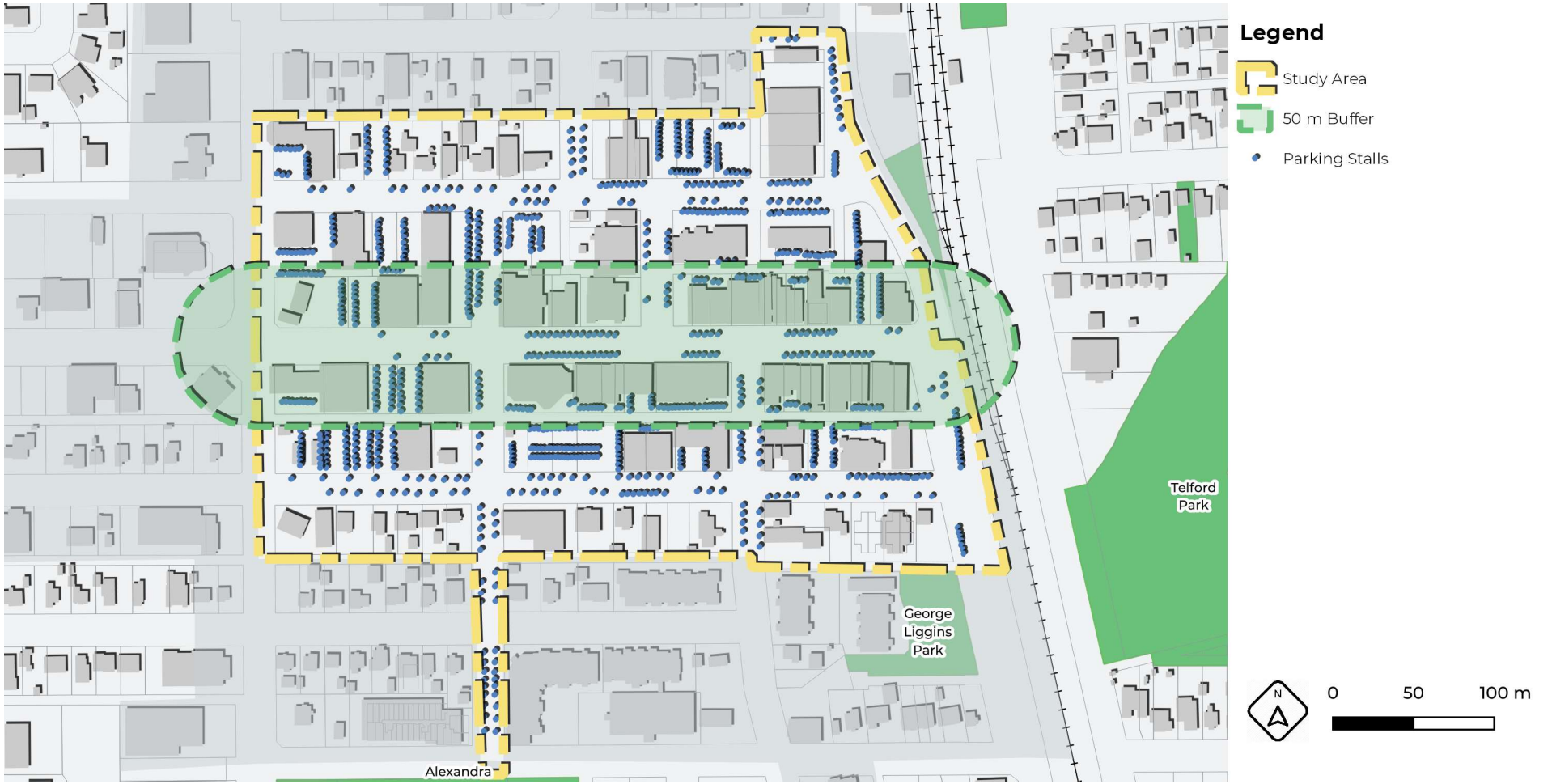
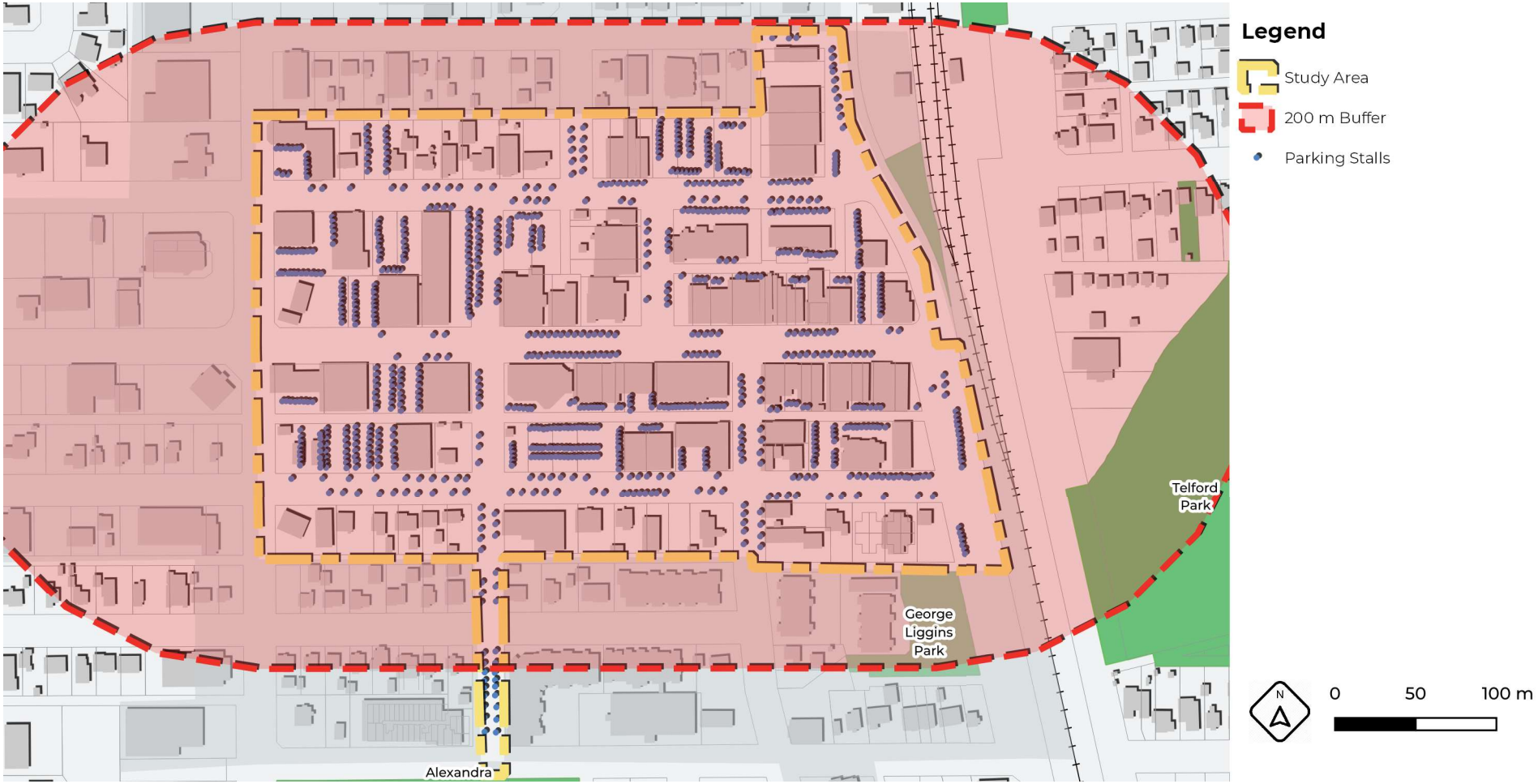


FIGURE 8: 100 METRE MAIN STREET BUFFER

FIGURE 9: 200 METRE MAIN STREET BUFFER



2.1.2 PARKING STALL BUFFER ANALYSIS (CONT)

For reference, the Town of Okotoks parking study stated that a 600 metre distance was a "reasonable" walking distance for a parking spot. Conversely, the Town of Beaumont study determined 200 metre to be the optimal distance. When compared to these amounts, Leduc's distance to parking spots is far less, offering little barrier to accessing businesses from parking supply. Based on distance from stall to business, Leduc is well situated to provide a convenient experience to its residents.

Given that some of the best practices consider different distances as a 'reasonable' walking distance, an additional analysis on walking distances was conducted. The additional analysis took into account a time factor and applied distances based on intervals of 1 minute, 2 minutes, and 3 minutes to understand the time it takes a pedestrian to walk from parking locations to Main Street. For reference, a pedestrian can usually walk a distance of 80 metres in 1 minute.

Using the intersection of 48A St. and 50 Ave as an example destination point, three buffers of 80 metres, 160 metres, and 240 metres were applied (which correspond to 1 minute, 2 minutes, and 3 minutes walking time, respectively).

The results from the analysis show 16.2% (152 stalls) of the parking inventory is accounted for in a 1 minute walk, 66.8% (624 stalls) are within a 2 minute walk, and all of the parking is within a three minute walk of the intersection.

FIGURE 10: WALKING DISTANCE MAP

2.1.3 WAYFINDING

While parking supply is located within a suitable distance to the businesses, the wayfinding experience provide challenges to accessing it. It was identified that the number and location of signs was sufficient. Signs are placed throughout the study area and within a sufficient distance of the parking areas they are pointing towards.

The issue is that the design of the signage is not necessarily clear and in some instances can be confusing. Furthermore, currently the signs do not have a cohesive aesthetic. Redesigning the signs could improve clarity and create a consistent visual experience throughout the downtown area.

Located on Main St., 49th St. and 50th Ave. The sign does not define the type of parking available and the opposing arrows may be confusing.

Same lot and sign but this one faces outward, at the entrance, toward the street.

Located on Main St., 49th St. and 50th Ave. The sign does not define the type of parking available and the opposing arrows may be confusing.

Located at 48a St. and 51st Ave. The sign does not define the type of parking available and the multiple arrows may be confusing.

2.2 PHASE TWO: ANALYSIS OF USAGE AND DURATION DATA

2.2.1 OCCUPANCY

Through the analysis of the occupancy data, it has been concluded that **Leduc does not have an overall parking supply issue**. Some specific parts of the study area do fail (12%), over 85% occupancy, however most parts are underutilized (55%), below 70% occupancy, and exactly one third (33%) of the study area functions within optimal range, which is defined as 70%-85% of all stalls being occupied during peak hours.

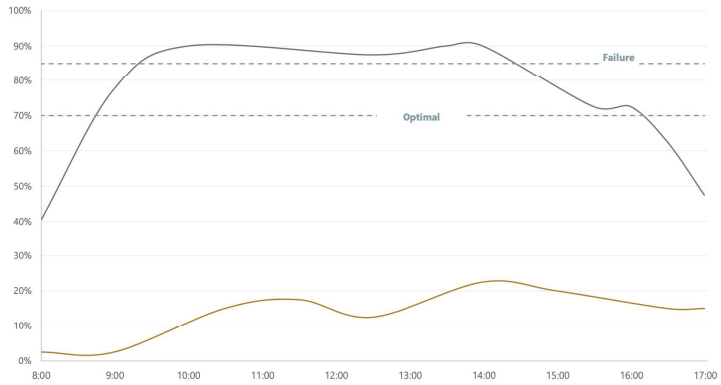
Looking more closely at specific parts of the study area they generally show very different occupancy patterns. The built form in the study area can make it challenging for visitors to walk directly from some parking areas to the business they are visiting. Specifically, the mid-block breaks that feed into Main Street (49 St., 48A St., and 48 St.) are up to 115 meters apart and the east-west alleys that are set back a half-block from Main Street are often obstructed on one end by buildings. This results in a fragmented pedestrian environment which may encourage drivers to seek parking as close as possible to the business they are visiting. As a result, each part of the study area was found to have very unique occupancy behaviours.

The tables on the following page provide an example of each of the three categories observed.

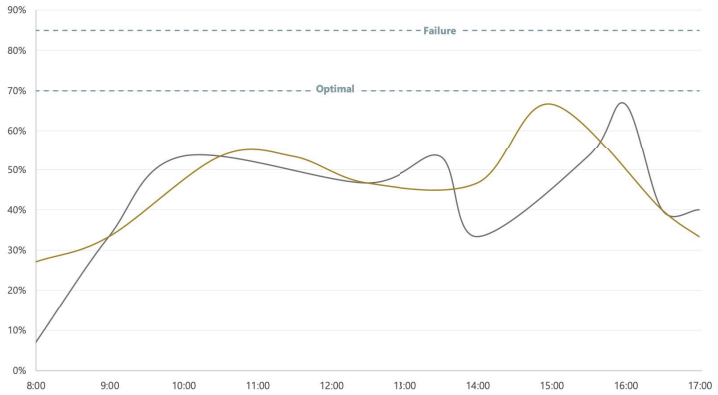
These categories are: Failed, Optimal, Underutilized. The remaining tables for each of the lots can be found in Appendix 1.

- Public Lot 4, which failed, is comprised of 40 stalls and had a peak occupancy of 90%
- Public Lot 2, which is optimal, is comprised of 16 stalls and had a peak occupancy of 75%
- Private Lot 1, which is underutilized, is comprised of 15 stalls and had a peak occupancy of 67%

PUBLIC LOT (4)



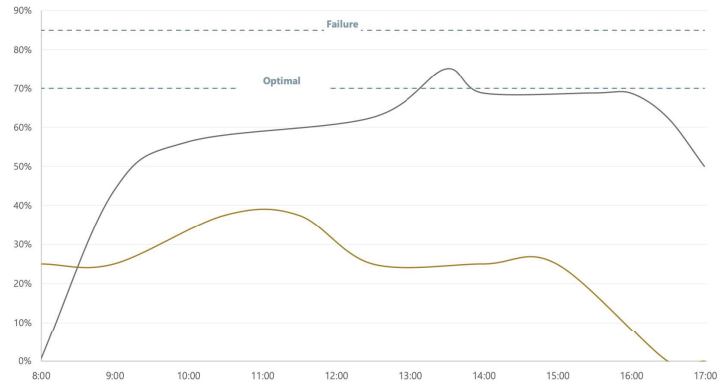
PRIVATE LOT (1)



Wednesday

Saturday

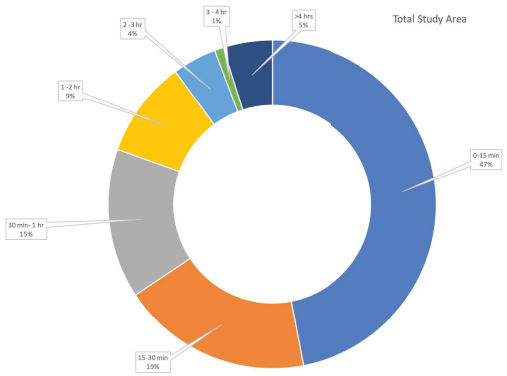
PRIVATE LOT (2)



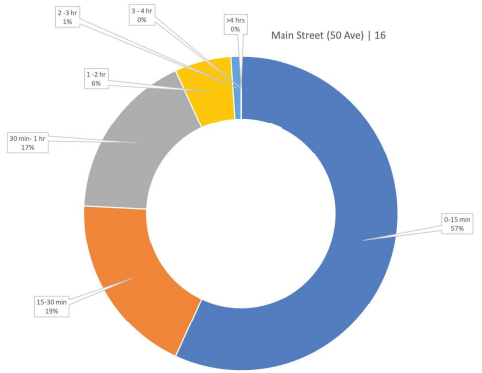
2.2.2 DURATION

Six areas were selected as representative of the broader study area, which are shown on the next page. These areas were observed on either a Wednesday or a Saturday for 4 hours each, spanning 10:30 am. - 2:30 pm. The most significant finding from this observation is that the duration of stay average is generally low in most areas. Only one area that was observed had an average duration that approached the 2 hour maximum (Area 4, which is in fact unregulated).

If the whole study area is considered, it can be shown that the predominant amount of duration is 0-15 min. This trend was observed in each of the identified areas. It is clear that at this point in time, a vast majority of those who are visiting the downtown area are only doing so for short periods, completing an errand before leaving for another destination.



Previous to the study it was hypothesized that cars were parking on the main street for a duration that exceeds the 2 hour maximum. What has been demonstrated in the data is that this is not the case. The vast majority of the cars observed were of a duration less than 2 hours. Only 1% of those who parked on main street had a duration of more than 2 hours.



What the graph below (and the additional graphs in Appendix 2) demonstrate is that those who park for a duration of 2 hours or more are doing so in the unregulated parking areas. The parking system in Leduc appears to be working as it should be: shorter duration near the businesses in the 2 hour maximum areas, while longer duration occurs in the unregulated lots off of Main Street.

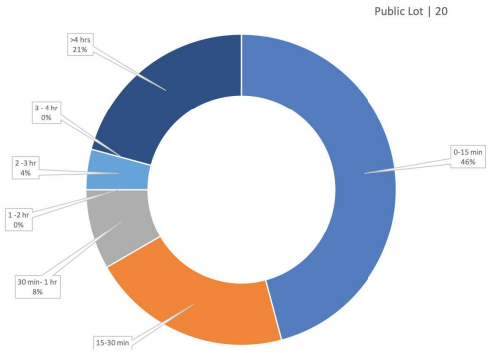
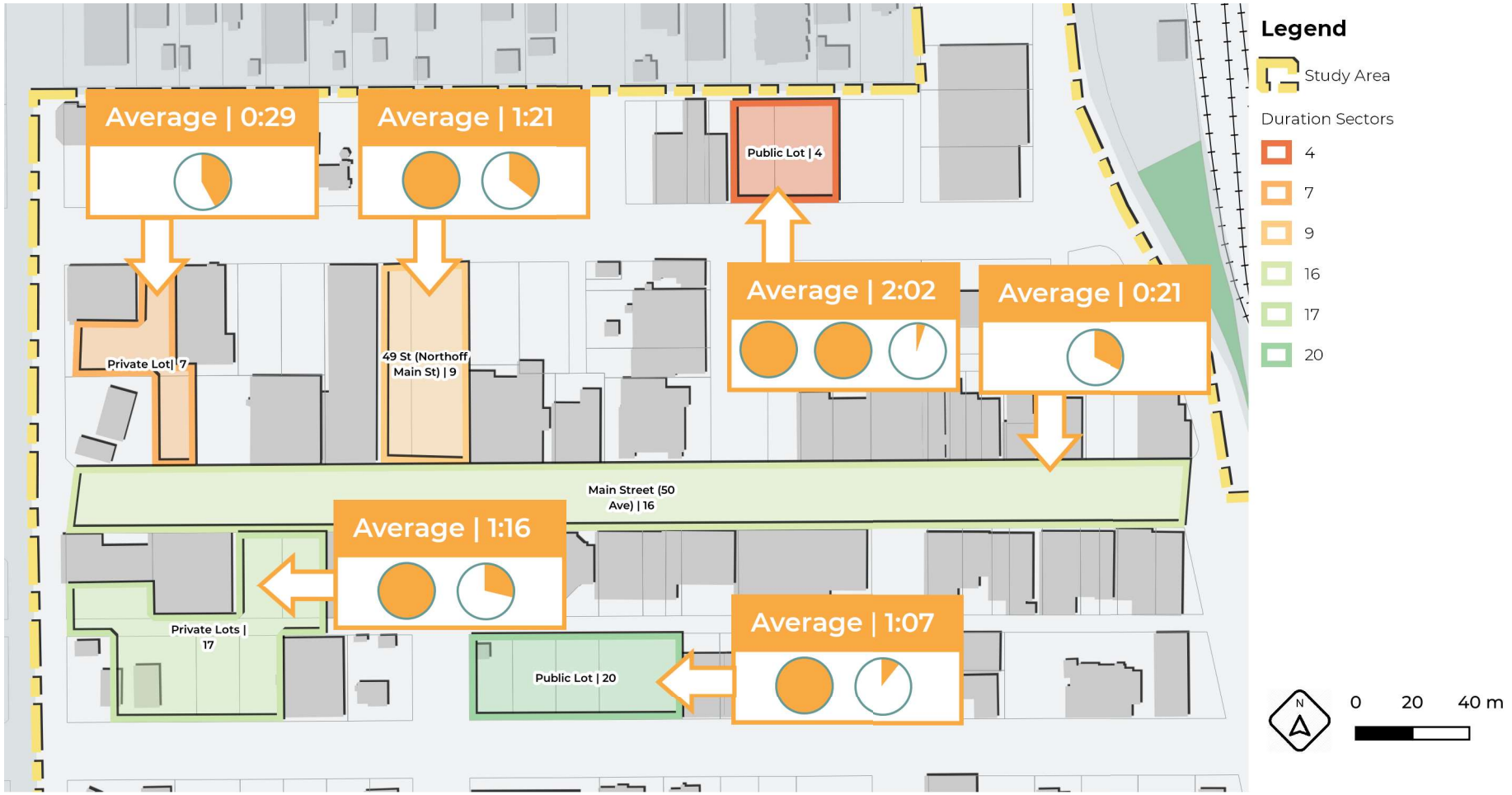


FIGURE 11: DURATION OF STAY FOR SIX SELECTED AREAS




3.0

METHODOLOGY

3.0 METHODOLOGY

3.1 DATA COLLECTION

3.1.1 KEY CONSIDERATIONS

From the outset of the parking study, it was recognized that high quality raw data would provide more robust parking management strategies to the City of Leduc. With 934 parking stalls in the fragmented study area, it was also recognized that it would be necessary to develop a methodology for capturing utilization and duration-of-stay data in an efficient manner across the large number of stalls. Common practice in parking studies of this size is to collect license plate information on foot, but there are significant limitations with this approach such as freedom of information, efficiency and the likelihood that this method would create conflict with members of the public who see their license plate being recorded.

KEY CONISDERATIONS

- The quality of the data being collected
- The size of the study area, as well as the fragmented nature of the over 900 parking stalls within the study area
- The privacy of invidiauls parking within the study area during the data collection period

3.1.2 UNMANNED AERIAL VEHICLE (UAV)

It was determined that a technological approach will be employed for the data collection portion of the project to ensure that the key considerations are being captured. A number of technology-assisted data collection methods were explored, with the outcome of Unmanned Aerial Vehicle (UAV) photography being the preferred approach.

This approach was selected due to its fullfilment of the key considerations associated with the collection of data:

- Utilization data will be able to be collected on a frequent interval for the entire study area as opposed to the projected manual count interval of 1 hour.
- Utilizing a technological approach such as a UAV reduces the possibility of human error associated with fatigue.
- Due to the planned flight altitudes the photos will not capture personally sensitive information like faces or license plates.

To employ this approach, funding was secured to procur the services of an external UAV operator.

3.1.3 UAV OPERATOR

The study area falls within the controlled airspace of Edmonton International Airport (EIA) and as such the UAV operator was required to fly under the instructions of EIA's Air Traffic Control. Given the sensitivity associated with flying a UAV within the controlled airspace of a major international airport, heightened scrutiny was applied when selecting an external UAV operator.

An extensive search was conducted whereby multiple operators were reviewed. Ultimately, Canadrone was the company selected to provide contracted UAV services for the data collection portion of this study for the following reasons:

- Canadrone is licensed to file the flight plan required to operate a drone in controlled airspace, referred to in the industry as an SFOC (Special Flight Operations Certificate).
- Canadrone possesses liability insurance which is an additional requirement for operating in controlled airspace.
- Canadrone flies the SenseFly Albris quad-rotor UAV. This drone is recognized by Transport Canada as compliant under their "complex" category of operating regulations, meaning that it is safe to use in conditions where reliability and control are important factors.
- Canadrone has previous experience flying within controlled airspaces near major international airport.

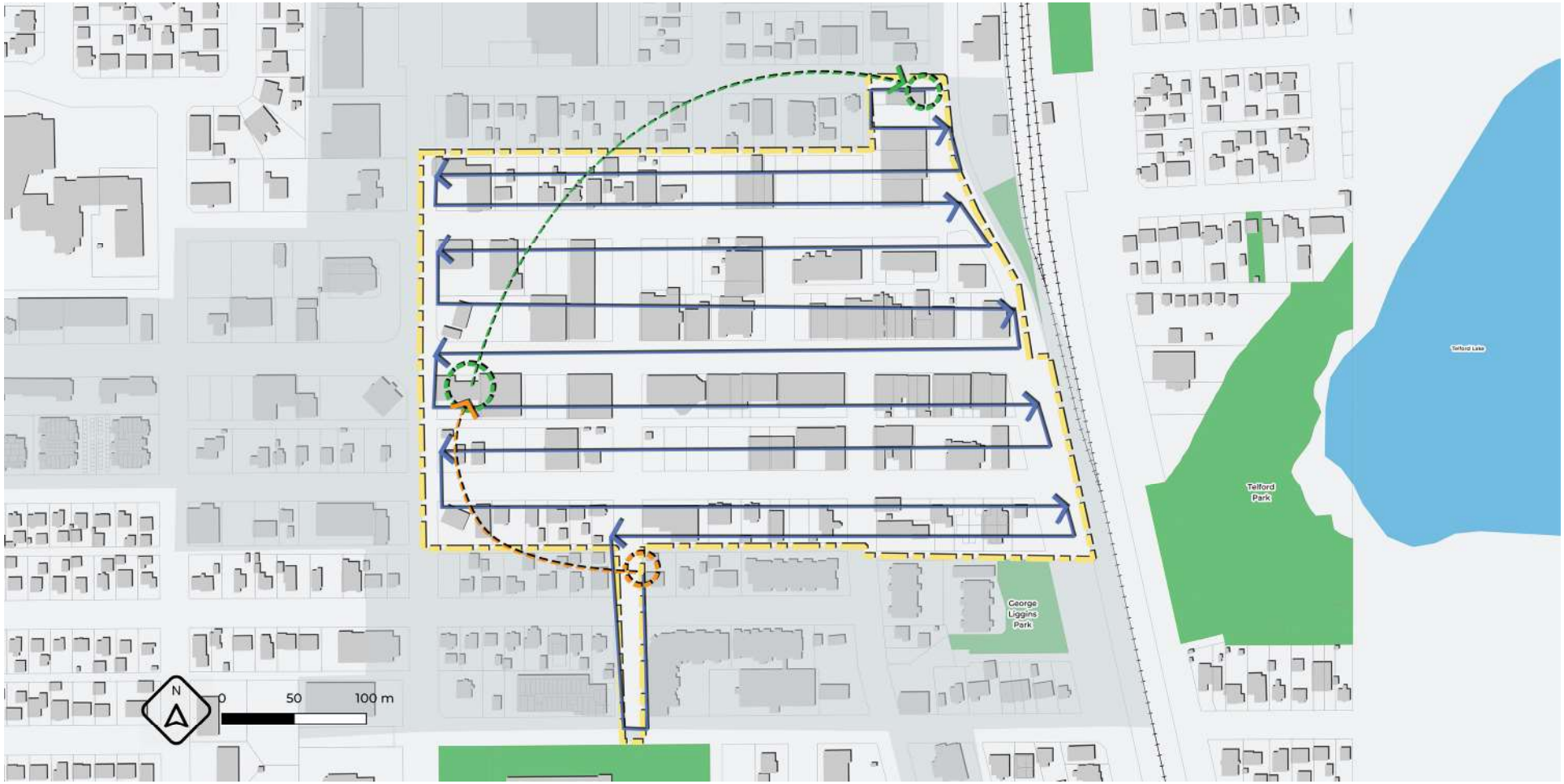
3.1.4 COLLECTION PROCESS

UAV IMAGES

The raw data for occupancy was captured by photographing the entire study area by Unmanned Aerial Vehicle (UAV) every 30 minutes. The UAV was used to capture images from 8:00 am. to 5:00 pm. on Wednesday March 13th and 8:00 am. to 5:00 pm. on Saturday March 16th. On each of these days the weather was ideal, and those images that were captured are clear. The hours described above reflect a combination of available daylight, maximum battery life of the UAV, and average business hours within the study area.

Edmonton International Airport restricted the UAV to 50' of altitude. Canadrone, the company contracted for the drone imagery, optimized their flight route in response and were still able to fly the study area every 30 minutes, taking 160 photos each complete flight of the study area. Part of the optimization strategy included reducing the overlap between photos from 70%, which is the recommended overlap for stitching photos together, down to 20% to ensure the drone could complete a full lap in under 30 minutes. Canadrone communicated this strategy the day prior to our first flight and we agreed that under the circumstances it was the best possible solution.

FIGURE 12: UAV IMAGE CAPTURE FLIGHT PATH



3.1.4 COLLECTION PROCESS (CONT)

STOPWATCH DATA

Rich duration data was collected by clocking in and out times for vehicles in various parts of the study area. Representative areas were identified within the study area, these areas were observed for up to 4 hours. This duration was chosen because it amounts to twice the enforced maximum parking time limit and represented approximately half of the working day. Cars that are observed for the entirety of this 4 hour period represented vehicles that were misusing the parking area and created congestion in the area.

This stopwatch data provided the most precise duration data possible. It was impossible to collect this sort of rich data for every stall in the study area. While the data points were less than could have been collected by surveying the whole parking area or utilizing the UAV images for this task, neither of these options provide the quality of data that was collected by observing cars in specific areas. Based on this data, it was possible to draw general conclusions for the area as a whole.

This data was collected in 6 pre-determined regions throughout the study area. These regions were primarily informed by the ability to track the area from a stationary location. Data was collected over 5 days, and primarily over the 10:30 - 2:30 period of the day.

This time was selected because the initial hypothesis was that lunch hour and shoulder times would be the busiest periods of the day. Observation was based around observing as many stalls as could be accurately managed and was not focused on collecting data for all of the stalls in the study region. Quality of duration data was more important to the study than quantity of data points.

FIGURE 13: STOPWATCH DATA AREAS

3.1.5 LIMITATIONS

On Wednesday March 13th, Canadrone made it known to the study team that the drone was experiencing some technical issues. These issues were not corrected for the March 16th flight and were unanticipated. Canadrone is awaiting information from the manufacturer of the Drone that may help them to understand the reason for the technical difficulties. The effects of these issues were not fully realized until the study team received the images and identified significant gaps within the images captured.

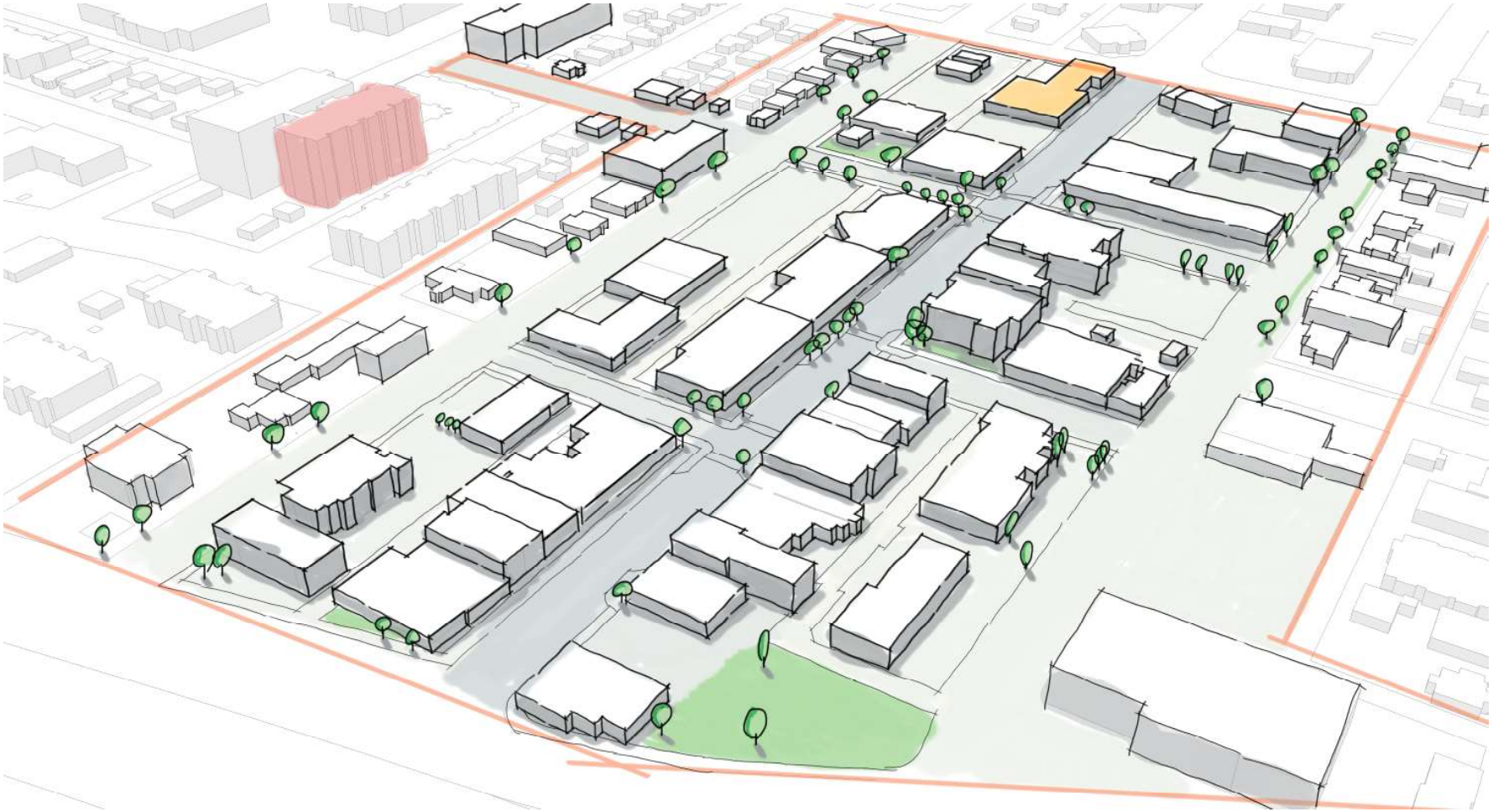
The drone flew 40 complete missions, 20 on March 13 (8:00 am to 6:00 pm) and 20 on March 16 (8:00 am to 6:00 pm). On both days the UAV sent information to the pilot's computer after each lap to confirm that all images were recorded successfully, however when the SD card was pulled and the images transferred it became apparent that some laps did not have all 160 images recorded. Specifically, 12 of the 20 flights from March 12 were usable and 13 of the 20 flights from March 16 were usable. For reference, 6 of these 40 completed missions provided an area capture rate of 11% - 15%. At this point, the cause appeared to be related to uplink interference possibly coming from the telecommunication antennas on Summit Square Apartments. This is the first time Canadrone has experienced this specific issue and they have contacted the UAV manufacturer for an explanation.

Theses errors ensured that the data collected from the images was not consistent. As a result, we were only able to utilize the drone imagery as a means to calculate the occupancy of the parking areas at various points throughout the days. This was much more limited than we had previously planned. To address this limitation, we collected stopwatch data. This is a suitable data replacement - while it provides less data points (the drone images would have allowed for duration calculations for the area as a whole), the data that has been collected is much more precise than the drone imagery could have provided.

The image on the next page depicts the take-off location in orange and the building that may have caused interference in red.

Rooftop telecommunication antennas on Summit Square Apartments, Leduc, AB

FIGURE 14: UAV TAKE-OFF LOCATION / TELECOMMUNICATION INTERFERENCE



3.2 DATA PROCESSING

The 160 images that made up one complete study area of pictures were organized into their proper flight order. These images formed a map that was used to guide the analysis of the drone imagery. Drone images were analyzed by 26 pre-determined regions and the occupancy for these regions was recorded in an excel table. This provided the occupancy at specific times during the day, for the complete study area, and for the specific regions. In total 19 flights were analyzed, providing us the occupancy amount for multiple times throughout the study period. The table below shows the 19 flights that were used to analyze occupancy for the study area with 10 on Wednesday, March 13 and 9 on Saturday, March 16.

An overlay of the current parking arrangement in Leduc was created in ArcGis with information from Leduc as well as Google Maps. This overlay provided a visual rendering of each parking stall that was analyzed by this study. Each stall was assigned a unique number, ranging from 1 to 934. The overlay was utilized as a guide for data processing and collection, and will be provided to Leduc as a deliverable.

The stopwatch data, capturing duration time, was inputted directly into an Excel sheet. The Excel sheet recorded in and out time relative to specific stalls. This data was combined into one table and organized in order to ensure usability. Duration was calculated based on the in and out times that were provided. Those cars that were not witnessed entering or exiting were documented as open ended and incorporated into the overall data set. For example, upon arrival, a white car was observed as already parked and is observed for 1 hour before it leaves. With this, it can be stated with certainty that the car was parked for at least 1 hour. As such, data was organized in such a way as to demonstrate the maximum hours that we could account for: at least 4 hours, at least 3 hours, etc.

	8:00	8:30	9:00	9:30	10:00	10:30	11:00	11:30	12:00	12:30	13:00	13:30	14:00	14:30	15:00	15:30	16:00	16:30	17:00	17:30
MARCH 13	X		X		X					X		X	X			X	X	X	X	
MARCH 16	X		X			X		X		X			X		X			X	X	

3.3 DATA ANALYSIS

3.3.1 SPATIAL ANALYSIS OF CURRENT PARKING CONDITIONS

During this analysis the focus was on spatial characteristics of the existing parking stock. This included quantity of stalls, ownership and walking distance between parking stalls and local businesses. Vehicle movement was beyond the scope of this study.

Stalls were identified first through information provided by Leduc and augmented with Google maps. Over the course of the study, this data was verified, corrected, and augmented.

3.3.2 ANALYSIS OF USAGE AND DURATION

Data was organized according to the region that organized the collection of data. General findings were derived from a basic analysis of this data, such as average usage and average duration. A more complex analysis was carried out by combining the duration and occupancy data. Patterns were observed, noted, and used to inform recommendations. .

Much of this analysis was visualized in graphs and tables, presented in the analysis section of this report. This analysis contributed new data sets utilized in ArcGis for spatial analysis, allowing conclusions to be drawn as well as the visualization of certain data in a more effective way.

3.3.3 SPATIAL ANALYSIS OF USAGE AND DURATION

In this final phase of data analysis, the results of the previous two phases were combined in order to identify patterns. The data for all 26 occupancy regions and the duration data for the 6 which were selected as representative duration sectors was overlaid on the parking area in GIS. By spatially analyzing this data it was possible to understand how the regions interact with one another, providing an understanding of the parking situation in general area and specific areas.

This spatial analysis provided the clearest understanding of Leduc's parking situation. From this analysis it was possible to come to informed recommendations to address the experience and perception of parking shortage in Leduc's downtown. Several images were also generated to communicate the findings that were accrued through this study.


4.0

LITERATURE REVIEW

4.0 LITERATURE REVIEW

A review of academic literature associated with parking management was conducted. The finds of this literature review found that parking management focused around the following themes:

FREE PARKING

While the cost of parking may not be directly paid for by the one using the stall, the cost is absorbed somewhere else. This cost is manifest in several ways, including time spent locating a stall, opportunity cost in terms of other uses for the land, eroding the pursuing of alternative modes of transportation, and increased development costs.

Authors: Shoup (2018a), Shoup (2005), Manville & Shoup (2018), and Marsden (2014)

PAYING FOR PARKING

The literature demonstrates that paying for parking is the most effective way to manage parking. Passing the cost of parking on to the user of the parking stall ensures that the cost of parking is not subsidized and encourages the driver to consider the choice they are making.

Authors: Bates (2014), Goodman (2018), Klein (2018), Kobus (2013), Manville (2014), Shoup (2018b), and Shoup (2018c)

THE NEED FOR PARKING

The research shows that parking begets the need for more parking as more parking is added to an area without being managed by pricing it, it can actually create an environment that is more congested because it will attract more vehicles and erode other modes of transportation.

Authors: Fraser (2018), McCahill (2018), Shoup (2018c), Shoup (2018d), and Weinberger (2018)

MINIMUM PARKING REQUIREMENT

Parking requirements can add to the development price which gets shifted to those who buy or rent that development. In residential areas, this can place a burden on the renter/owner that they cannot shoulder as housing becomes more expensive as a result. Minimum requirements for developments identify parking as the primary issue of importance. These parking requirements tend to neglect location in favour of particular building attributes (size & type). Thus, they are not relevant to the particular parking needs of an area (ex. A restaurant vs a convenience store). Instead of parking minimums, maximums should be established. This will limit the amount of parking that a development can have.

Authors: Gabbe (2018), Goodman (2018), McDonnel (2018), Shoup (2014), Shoup (2018d), and Shoup (2018e)

TYPE OF PARKING

Street parking provides more overall value than off-street parking. This is because it is of the highest demand, provides an efficient land use and cost, helps to regulate traffic speeds and induce lower speeds which together create a more pedestrian friendly area.

Author: Marshall (2014)

REVITALIZATION AND PARKING

Reducing or constraining the amount of parking within an area can lead to revitalization of that area. The land that was once used for parking or may have been required for such can now be used to toward ends that are more productive.

Authors: Zack (2018) and Melia (2014)

PARKING BEHAVIOUR

While it may seem daunting to address the various challenges that contribute to a congested traffic and parking area, the reality is you do not have to change the behaviour of everyone all at once. It is the behaviour of those who want to park right beside their destination that needs to be addressed in order to alleviate parking and parking related congestion.

Authors: Sattayhatewa (2003) and Brooke (2014)

PARKING MANAGEMENT

Managing parking is the tension between having enough spots available to people that they will not have to cruise around looking for one (contributing to congestion) but not having so much that there is underuse (which is a waste of resources). The most prudent approach is to utilize a contingency-based approach, meaning that the amount dedicated to the project and area is conservative, but many strategies are in place to address demand issues if they arise. Parking management strategies must be inline with the objectives of the municipality and must be context aware.

Authors: Goodman (2018), Litman (2008), Litman (2016), Litman (2018) Rye & Koglin (2014), Shoup (2018a), and Shoup (2018d)

PARKING MANAGEMENT PRINCIPLES

Parking management principles: These ten general principles can help guide planning decision to support parking management: consumer choice, user information, sharing, efficient utilization, flexibility, prioritization, pricing, peak management, quality vs. quantity, and comprehensive analysis.

Author: Litman (2016)

APPENDICES

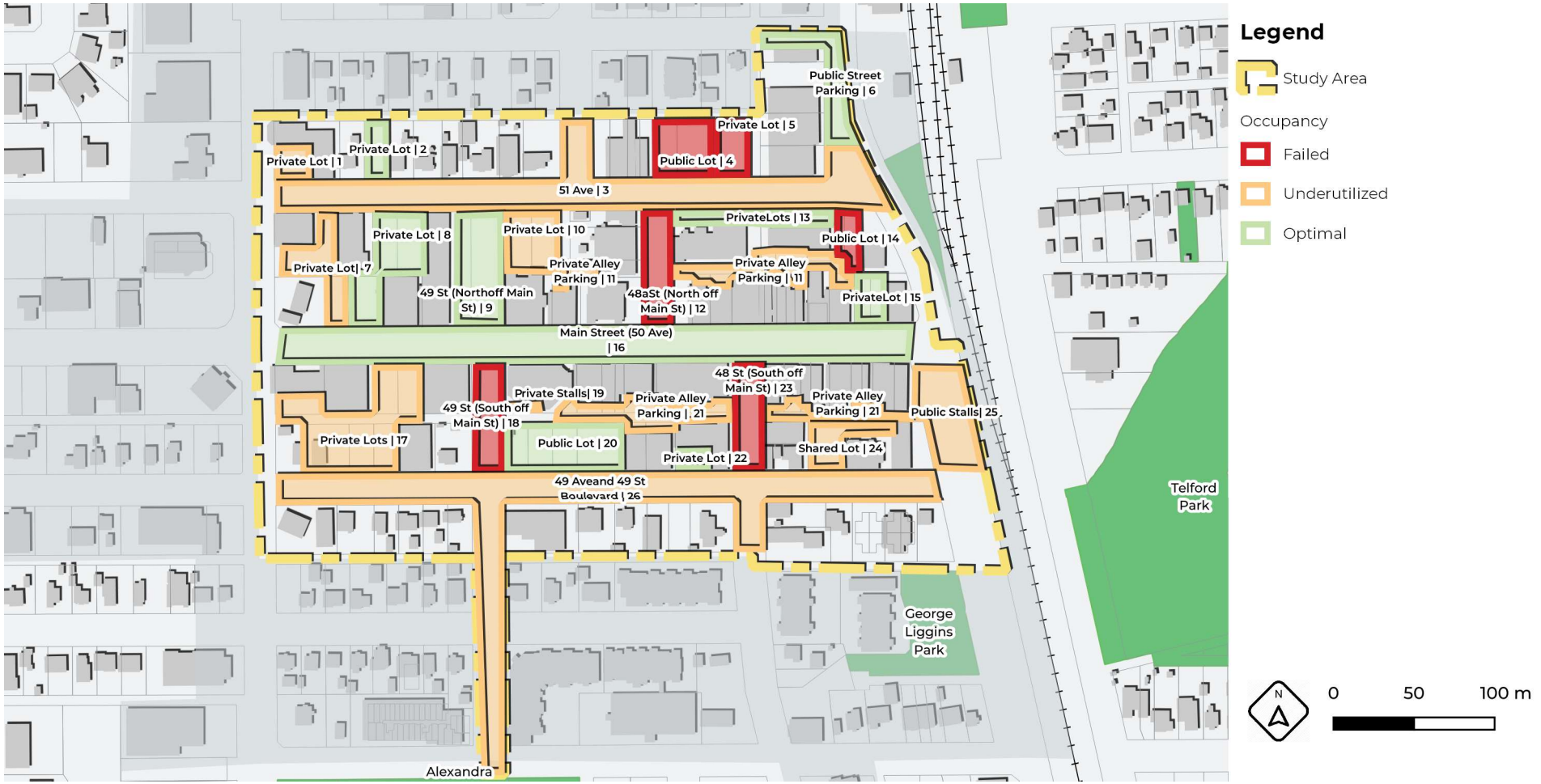
APPENDIX 1: OCCUPANCY DATA

To show how parking functioned in different parts of the study area it was divided into 26 different sectors and occupancy rates were measured in each sector. This appendix contains a map showing the sector locations and an occupancy graph and summary table for each sector.

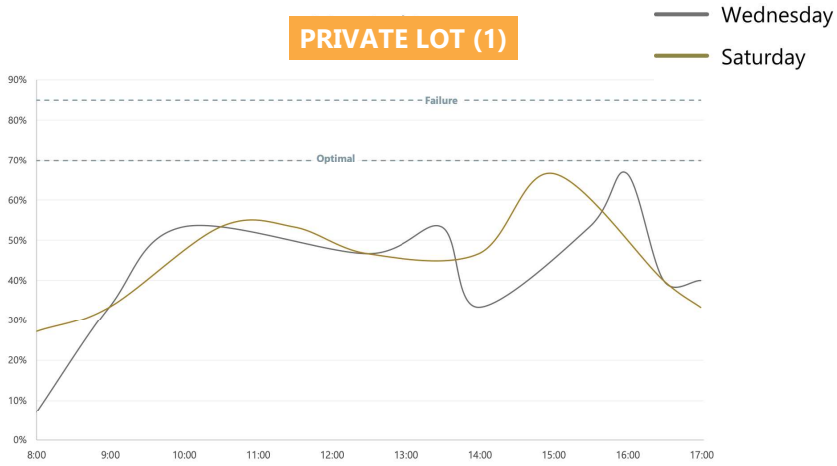
Each of the 26 graphs show occupancy data for Wednesday, March 13 and Saturday, March 16 . Each graph also displays "Failure" and the "Optimal" thresholds to show how each sector is performing.

The failure threshold is set at 85% and the optimal threshold is set at 70%. These thresholds are based on industry standards and findings in the literature review. The summary table for each sector shows the empty stall count, the peak (maximum) occupancy observed, and the functionality of the sector (failed, optimal, or underutilized).

FIGURE 15: OCCUPANCY AREA STATUS

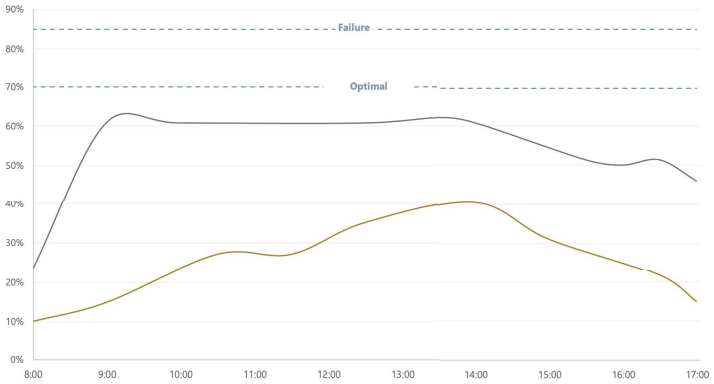


PRIVATE LOT (1)



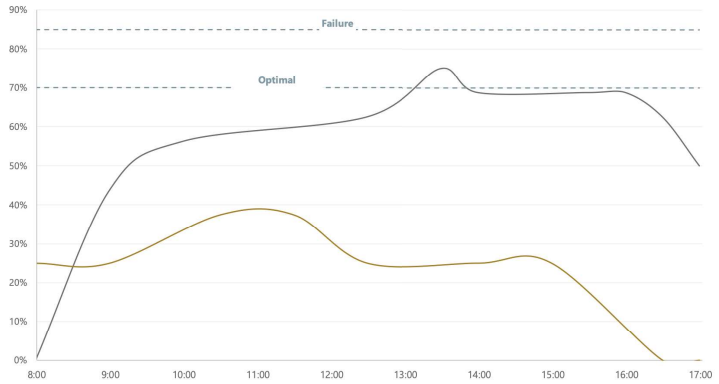
# OF STALLS	PEAK OCCUPANCY	FUNCTIONALITY
15	67%	UNDERUTILIZED

51 AVE (3)



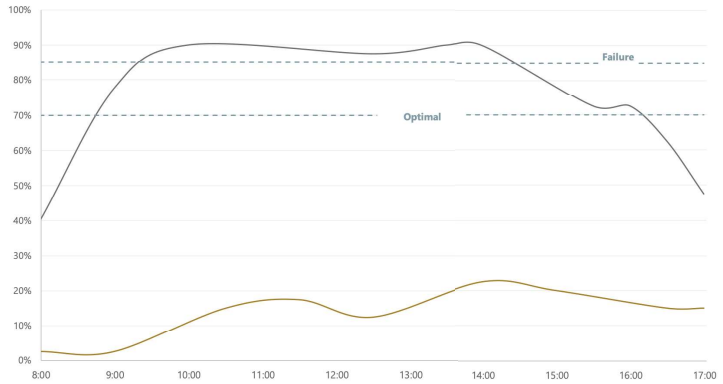
# OF STALLS	PEAK OCCUPANCY	FUNCTIONALITY
74	62%	UNDERUTILIZED

PRIVATE LOT (2)



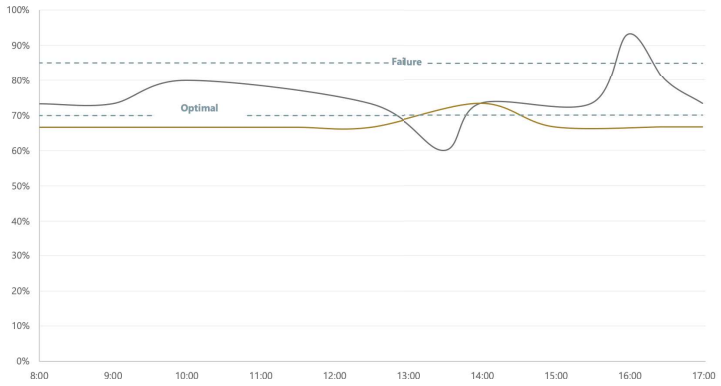
# OF STALLS	PEAK OCCUPANCY	FUNCTIONALITY
16	75%	OPTIMAL

PUBLIC LOT (4)



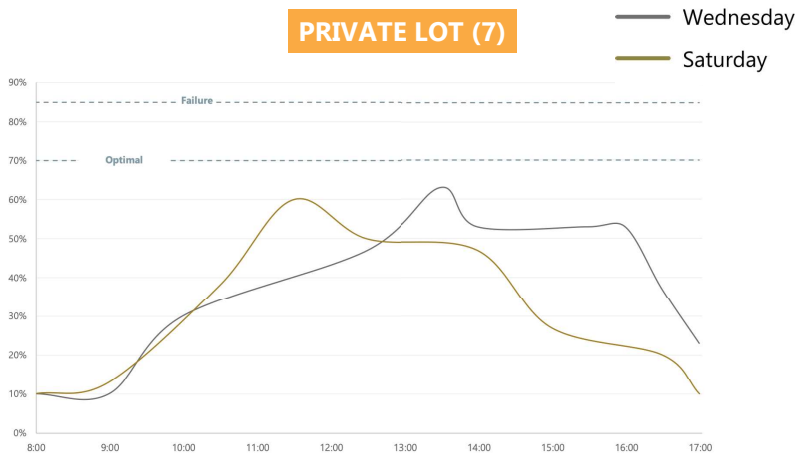
# OF STALLS	PEAK OCCUPANCY	FUNCTIONALITY
40	90%	FAILED

PRIVATE LOT (5)



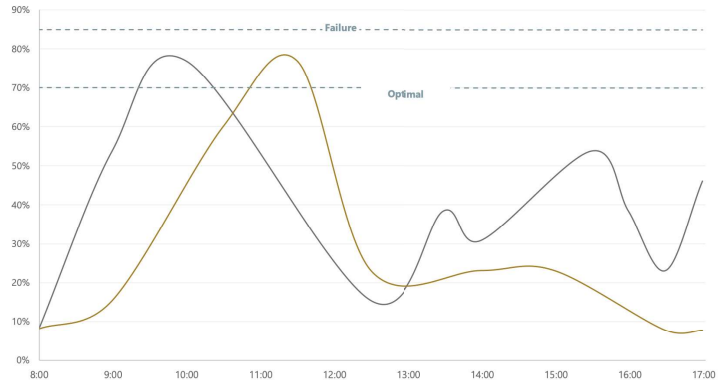
# OF STALLS	PEAK OCCUPANCY	FUNCTIONALITY
15	93%	FAILED

PRIVATE LOT (7)



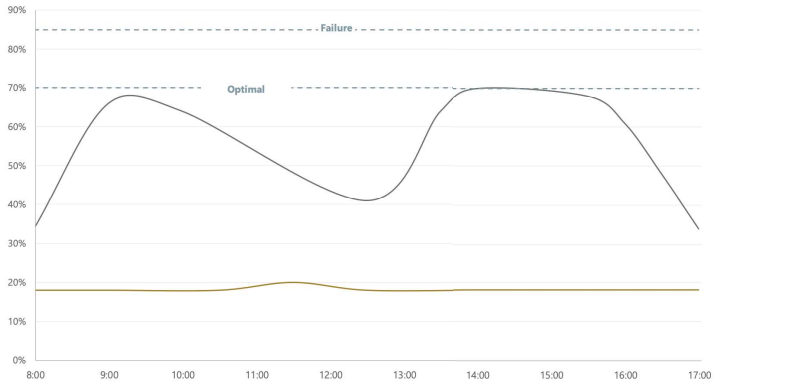
# OF STALLS	PEAK OCCUPANCY	FUNCTIONALITY
30	63%	UNDERUTILIZED

PUBLIC STREET PARKING (6)



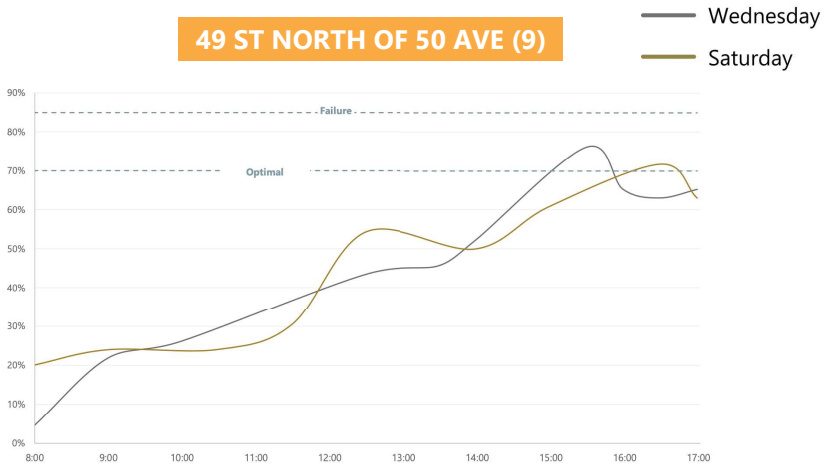
# OF STALLS	PEAK OCCUPANCY	FUNCTIONALITY
13	77%	OPTIMAL

PRIVATE LOT (8)



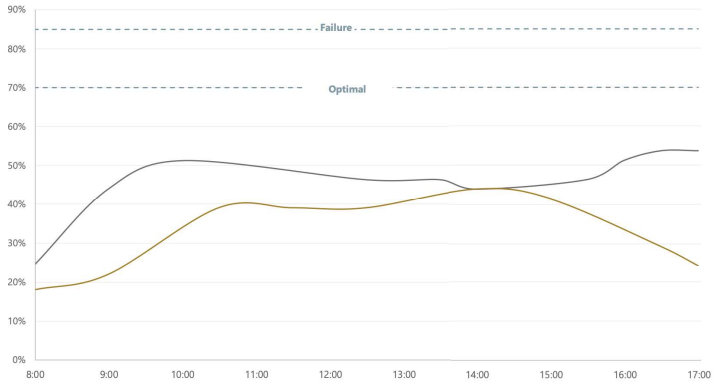
# OF STALLS	PEAK OCCUPANCY	FUNCTIONALITY
44	70%	OPTIMAL

49 ST NORTH OF 50 AVE (9)



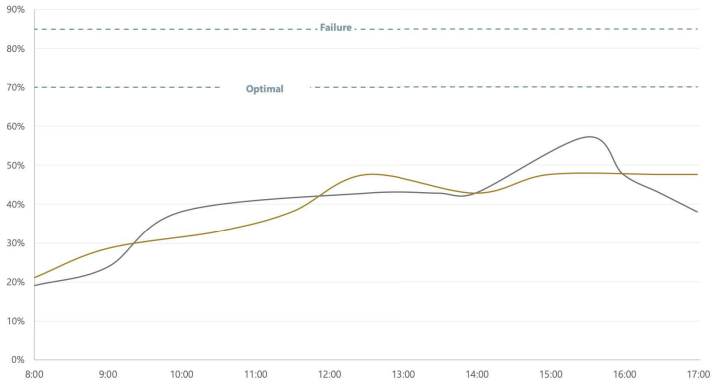
# OF STALLS	PEAK OCCUPANCY	FUNCTIONALITY
46	75%	OPTIMAL

PRIVATE ALLEY PARKING (11)



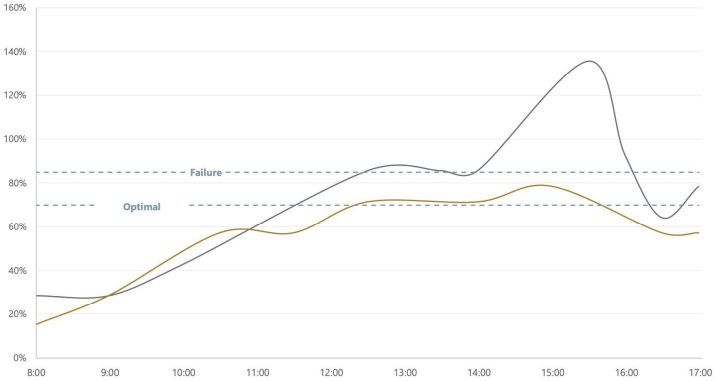
# OF STALLS	PEAK OCCUPANCY	FUNCTIONALITY
46	54%	UNDERUTILIZED

PUBLIC LOT (10)



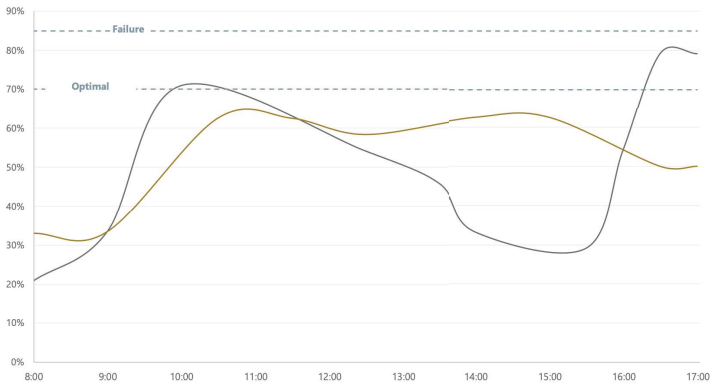
# OF STALLS	PEAK OCCUPANCY	FUNCTIONALITY
21	57%	UNDERUTILIZED

48A ST. NORTH OF 50 AVE (12)



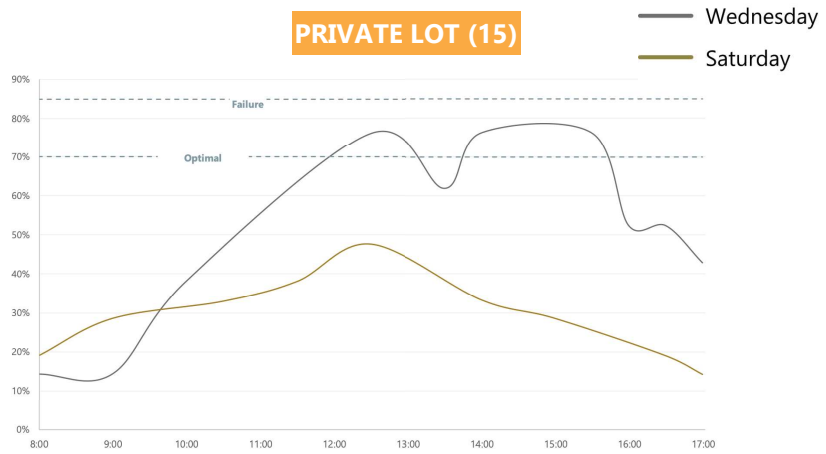
# OF STALLS	PEAK OCCUPANCY	FUNCTIONALITY
14	136%	FAILED

PRIVATE LOT (13)



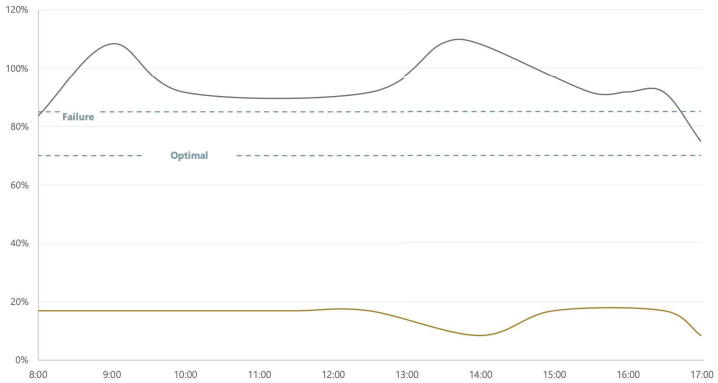
# OF STALLS	PEAK OCCUPANCY	FUNCTIONALITY
24	79%	OPTIMAL

PRIVATE LOT (15)



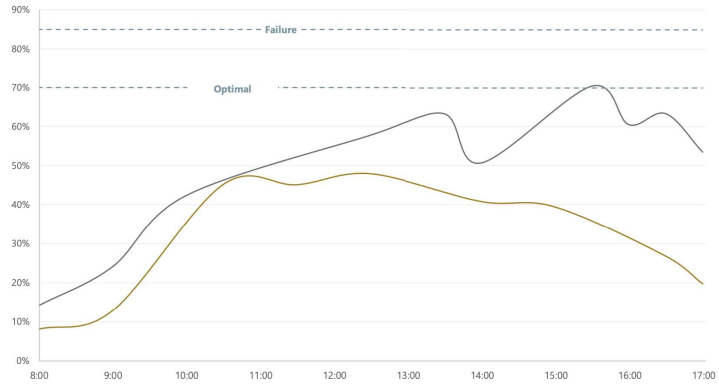
# OF STALLS	PEAK OCCUPANCY	FUNCTIONALITY
21	76%	OPTIMAL

PUBLIC LOT (14)



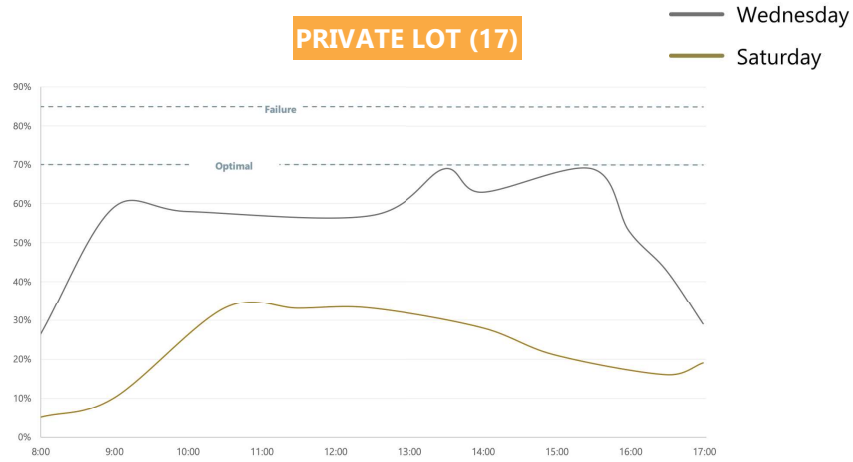
# OF STALLS	PEAK OCCUPANCY	FUNCTIONALITY
12	108%	FAILED

MAIN STREET - 50 AVE (16)



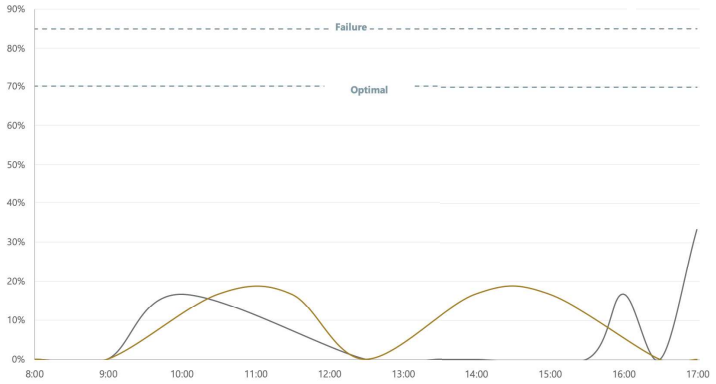
# OF STALLS	PEAK OCCUPANCY	FUNCTIONALITY
71	70%	OPTIMAL

PRIVATE LOT (17)



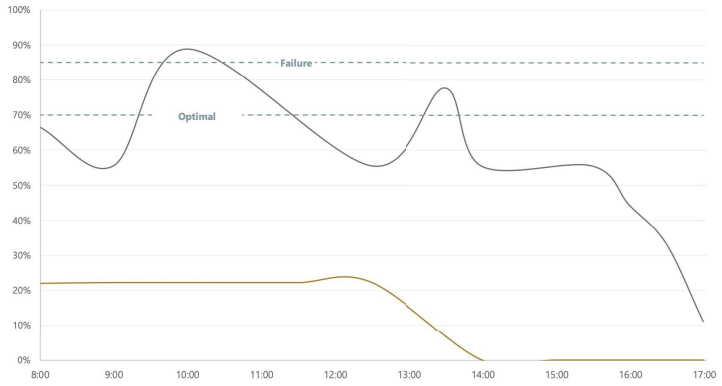
# OF STALLS	PEAK OCCUPANCY	FUNCTIONALITY
100	69%	UNDERUTILIZED

PRIVATE LOT (17)



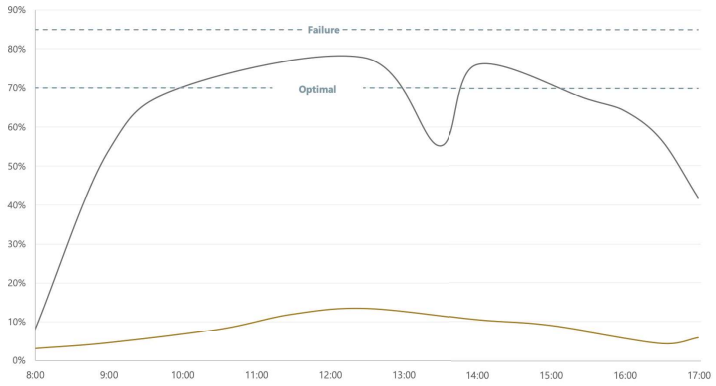
# OF STALLS	PEAK OCCUPANCY	FUNCTIONALITY
6	33	UNDERUTILIZED

49 ST SOUTH OF 50 AVE (18)



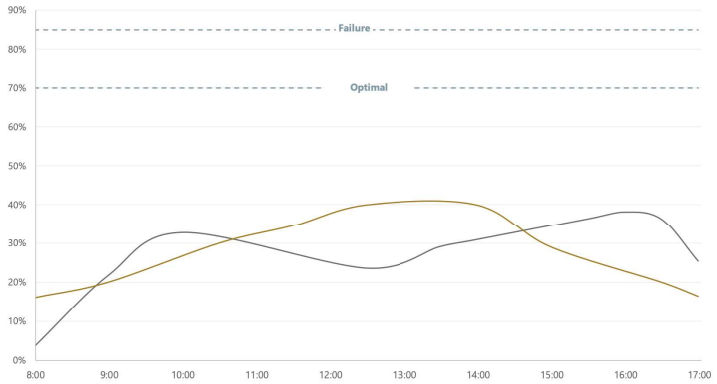
# OF STALLS	PEAK OCCUPANCY	FUNCTIONALITY
9	89%	FAILED

PUBLIC LOT (20)



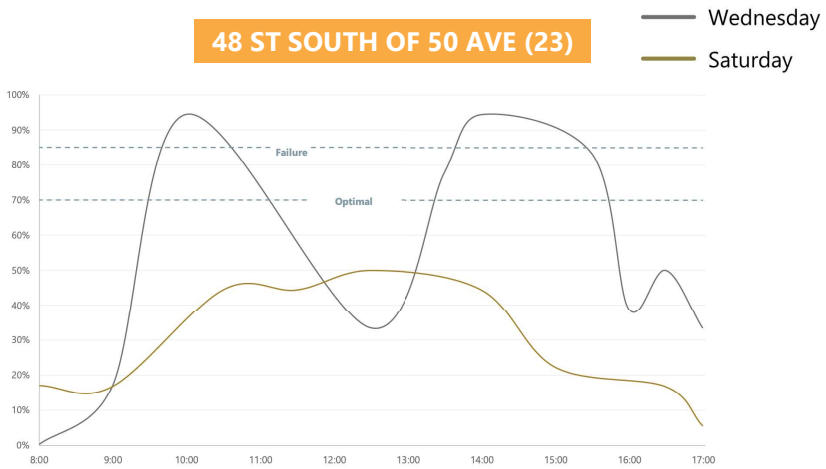
# OF STALLS	PEAK OCCUPANCY	FUNCTIONALITY
67	78%	OPTIMAL

PRIVATE ALLEY PARKING (19)



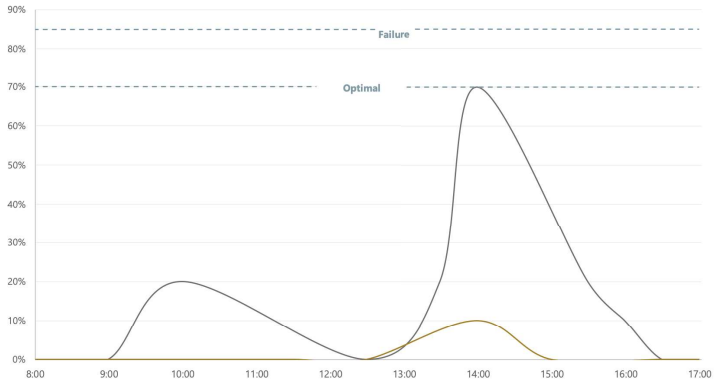
# OF STALLS	PEAK OCCUPANCY	FUNCTIONALITY
55	40%	UNDERUTILIZED

48 ST SOUTH OF 50 AVE (23)



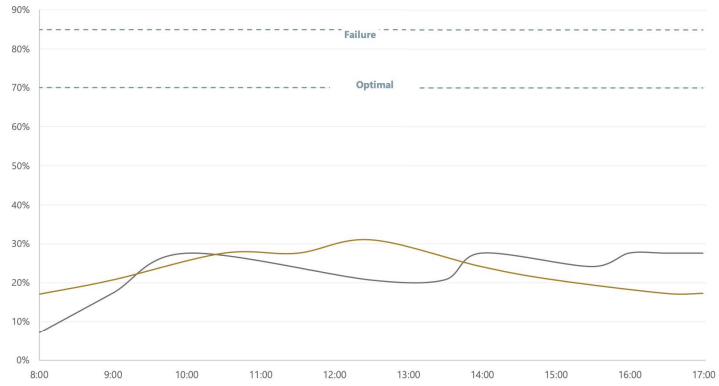
# OF STALLS	PEAK OCCUPANCY	FUNCTIONALITY
18	94%	FAILED

PRIVATE LOT (20)



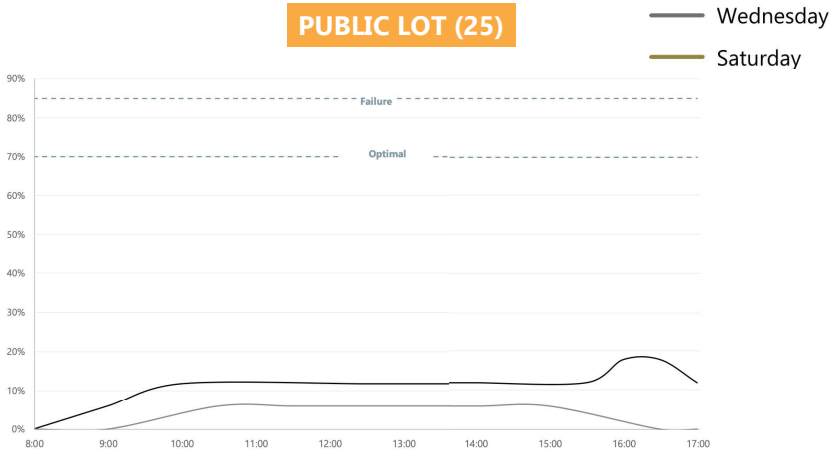
# OF STALLS	PEAK OCCUPANCY	FUNCTIONALITY
10	70%	OPTIMAL

SHARED LOT (24)



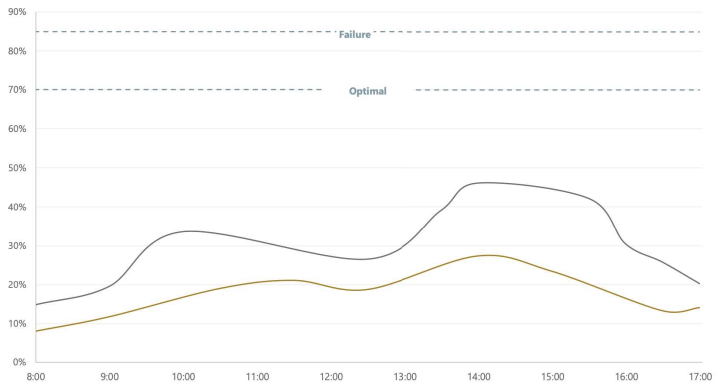
# OF STALLS	PEAK OCCUPANCY	FUNCTIONALITY
10	70%	UNDERUTILIZED

PUBLIC LOT (25)



# OF STALLS	PEAK OCCUPANCY	FUNCTIONALITY
17	18%	UNDERUTILIZED

49 ST AND 49 AVE BLVD (26)



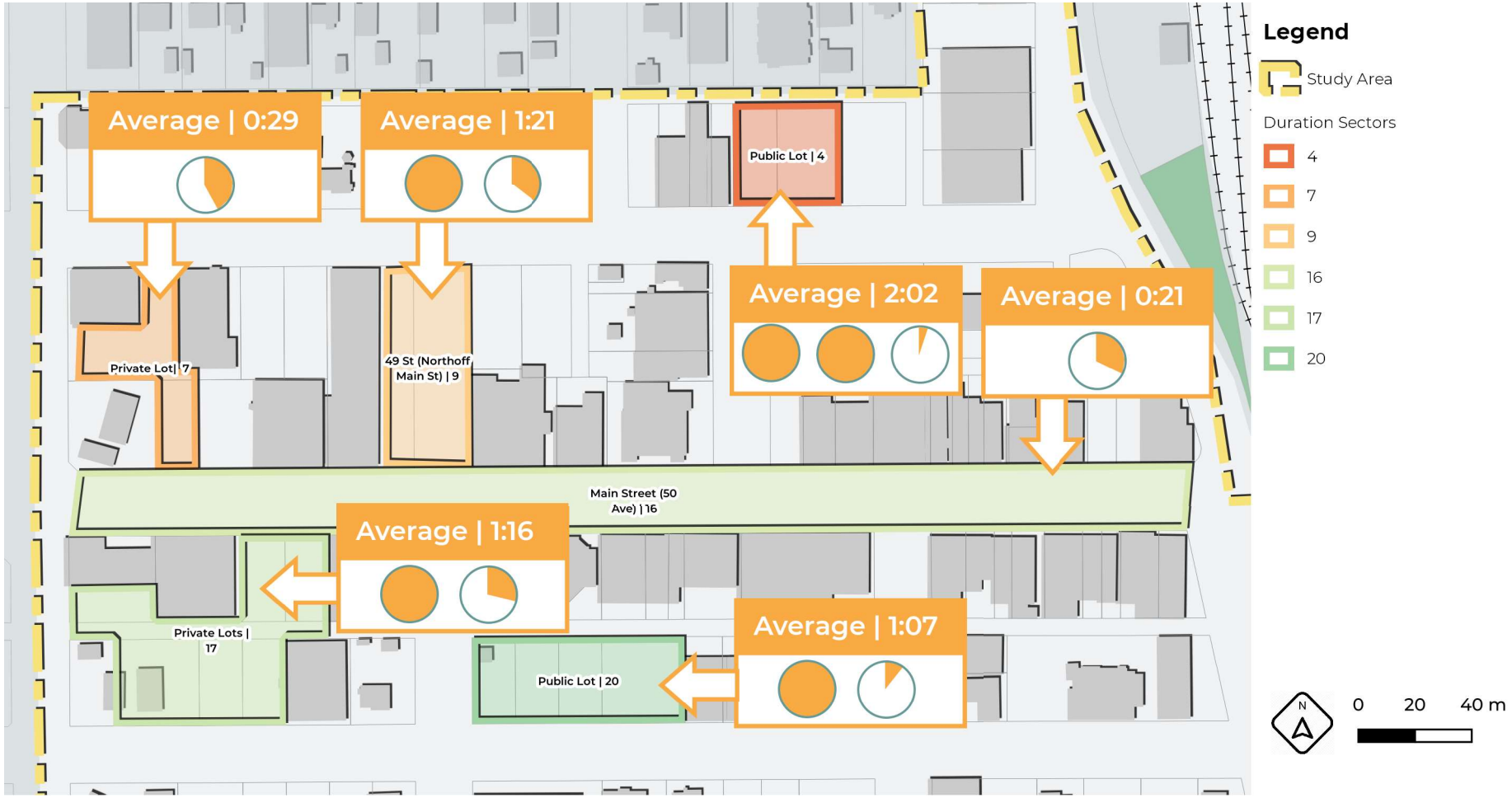
# OF STALLS	PEAK OCCUPANCY	FUNCTIONALITY
128	46%	UNDERUTILIZED

APPENDIX 2: DURATION DATA

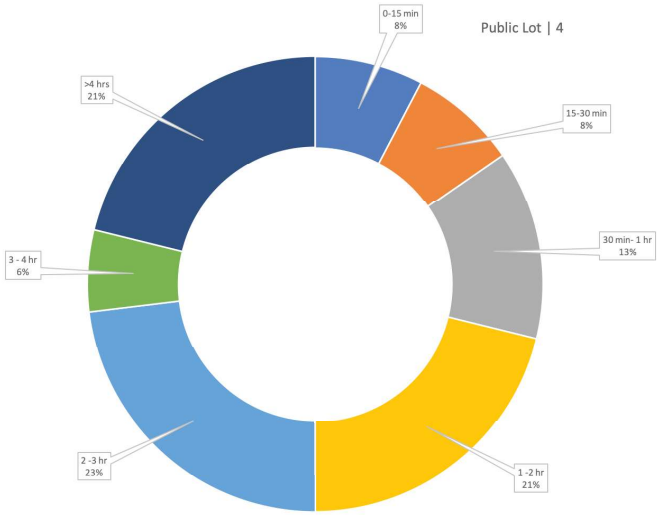
To measure duration of stay (turnover) 6 representative sectors in the study area were selected and the vehicle activity was recorded with a stopwatch. This appendix contains two maps, with the first showing where the 6 representative areas are located, and the second one showing how these overlap with the lot names that have been used throughout this report. Below the maps is a donut chart for each sector showing the percentage of vehicles that park for 0-15 minutes, 15-30 minutes, 30 minutes-1 hour, 1-2 hours, 2-3, hours, 3-4 hours, and over 4 hours.

FIGURE 16: STOP WATCH DATA LOCATIONS

FIGURE 17: AVERAGE DURATION FOR STOP WATCH DATA LOCATIONS

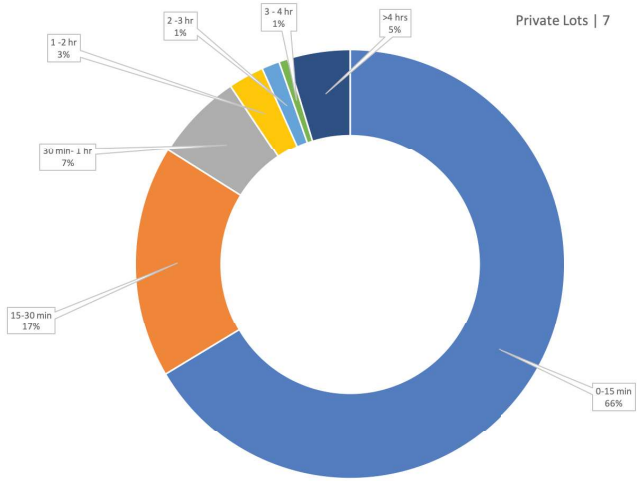


AREA 4



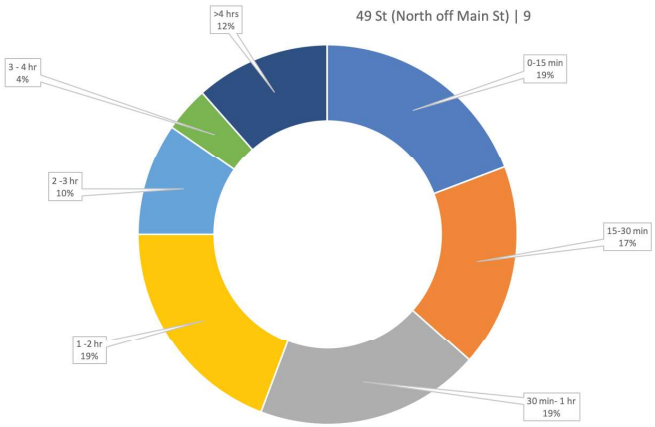
MOST OFTEN DURATION	0-15 MIN
AVERAGE	21 MIN

AREA 7



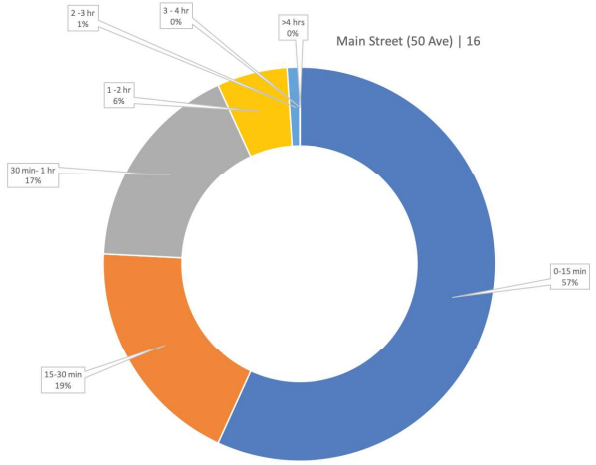
MOST OFTEN DURATION	0-15 MIN
AVERAGE	1 HR AND 7 MIN

AREA 9



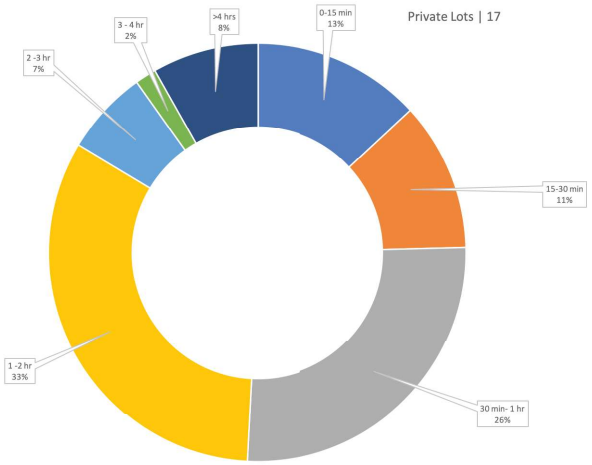
MOST OFTEN DURATION	0-15 MIN, 15 - 30 MIN, 1 - 2 HRS
AVERAGE	1 HR AND 21 MIN

AREA 16



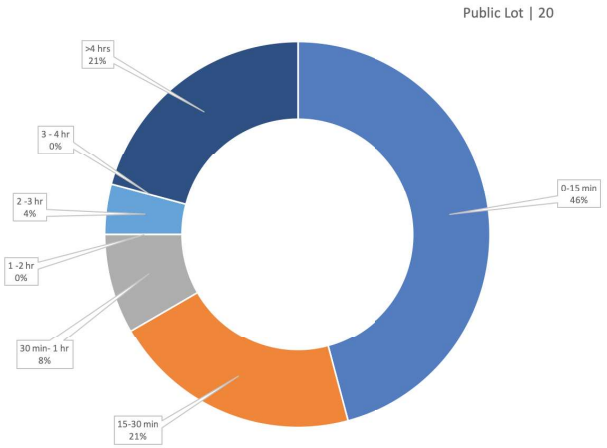
MOST OFTEN DURATION	2 - 3 HRS
AVERAGE	2 HRS AND 2 MIN

AREA 17



MOST OFTEN DURATION	1 - 2 HRS
AVERAGE	1 HR AND 17 MIN

AREA 20



MOST OFTEN DURATION	0 - 15 MIN
AVERAGE	29 MIN

APPENDIX 3: STALL CONFIGURATIONS

The distribution of on-street versus off street parking and the distribution of angle, parallel, and perpendicular parking is shown in the maps below:

FIGURE 18: OFF-STREET AND ON-STREET PARKING

FIGURE 19: ANGLED, PARALLEL & PERPENDICULAR PARKING

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