Downtown Bozeman Parking Study

A Project Completed for the City of Bozeman Parking Commission and Downtown Bozeman Partnership

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EXECUTIVE SUMMARY

The City of Bozeman's downtown district possesses a number of parking resources. These include on-street parking, off-street parking lots, a parking garage, private (business) parking lots and alley parking. The City previously did not have a clear picture of the inventory of these resources; rather, only a general estimate of the number of available spaces existed. Additionally, turnover and occupancy rates for parking were unknown. While a general figure of 3,600 available parking spaces had been compiled by the City's Geographic Information Systems (GIS) Division, little was known about the distribution of parking resources in the downtown area, their use, and parking use patterns. In light of these questions the City of Bozeman's Parking Commission and the Downtown Bozeman Partnership chose to pursue a parking study, the results of which are presented in this report. The study area examined in this report was bordered by Mendenhall St., 5th Ave., Babcock St. and Broadway Ave. on the north, west, south and east sides, respectively.

Previous parking studies from comparable communities throughout the U.S. indicated that only limited information related to recommended or expected occupancy rates or similar metrics were available. This came mainly in the form of an 85 percent rule employed in Oregon City, and Springfield, Oregon. The only other baseline metric identified was the criteria that at least 50 percent of available parking assets be controlled or owned by a community. This was viewed as important in order to allow the community to manage parking in terms of allocation, changing demand, pricing, and enforcement.

An inventory conducted in July, 2010 found that a total of 5,034 parking stalls were available in the downtown study area. This represented an average of 162 stalls per block, although some blocks contained far more or less than this average. The majority of blocks had between 100 and 200 parking stalls of various types available. Publicly-owned stalls comprised approximately 48 percent of downtown parking inventory, while private stalls (i.e. business parking lots) comprised approximately 52 percent. This totaled to 2,426 public parking stalls and 2,608 private parking stalls in the downtown area. Maps that present this information were generated and are presented below in Figures 1 and 2.

A total of 1,007 (20.1 percent) stalls were recorded as being unrestricted (all on-street). Off-street privately owned stalls were available for patron use only. This private parking was comprised of 1,740 stalls, or approximately 35 percent of downtown parking. The breakdown of public parking restrictions is presented below in Figure 3. A total of 689 private off-street stalls required a permit. Finally, 125 stalls, or 2.5 percent of all available downtown parking was designated as handicapped accessible. GIS mapping was completed to graphically illustrate downtown parking assets and trends.

When occupancy rates were examined, a similar trend was observed between all of the block groups, both on weekdays and weekends. Occupancy steadily increased throughout the morning and reached the peak for the day during the noon hour. This coincided with the lunch hour when downtown restaurants were heavily frequented. Following this midday peak, occupancy rates for most blocks fell throughout the afternoon and evening hours.

Dwell time results indicated that vehicles remained parked for an average of between 38 minutes to 1 hour, based on the location examined. In general, the dwell times observed between on-

street and off-street parking did not greatly differ. Overall, dwell time results indicated that most vehicles parked as part of trips which were not necessarily brief in nature.

Results of the turnover rate analysis indicated that off-street parking facilities saw significantly lower turnover; rates for these lots ranged from 0.32 to 0.68. For reference, parking ratios less than 1.0 indicated that the parking being analyzed was not being fully used, while ratios of 1.0 or greater indicated that all stalls were being completely utilized each hour.. On-street parking exhibited higher turnover, with rates that ranged from 0.90 to 1.18. The reason for these differences was likely the result of the use of the parking itself. On-street stalls were more likely to be used by motorists who made brief stops at an adjacent business and resulted in multiple vehicles using a given stall per hour. Off-street lots were more likely to be used by longer-term parkers, with a space less likely to be filled immediately after a vehicle left.

Finally, parking demand calculations indicate there is ample parking in the downtown area, based on current inventory (5,034 stalls). The results of present demand indicated that periphery study area blocks had a surplus of parking, while some core blocks produced a deficit. However, it should be noted that the estimated parking demand for each block and land use may not have occurred simultaneously. Consequently, estimated demand deficits (or surpluses) may not necessarily exist in the patterns that were estimated. Overall however, the demand calculations indicated the existence of a parking surplus which provides headroom for future downtown growth.

Figure 1: Total parking stall inventory by block

Figure 2: Public and private parking stall inventory by block

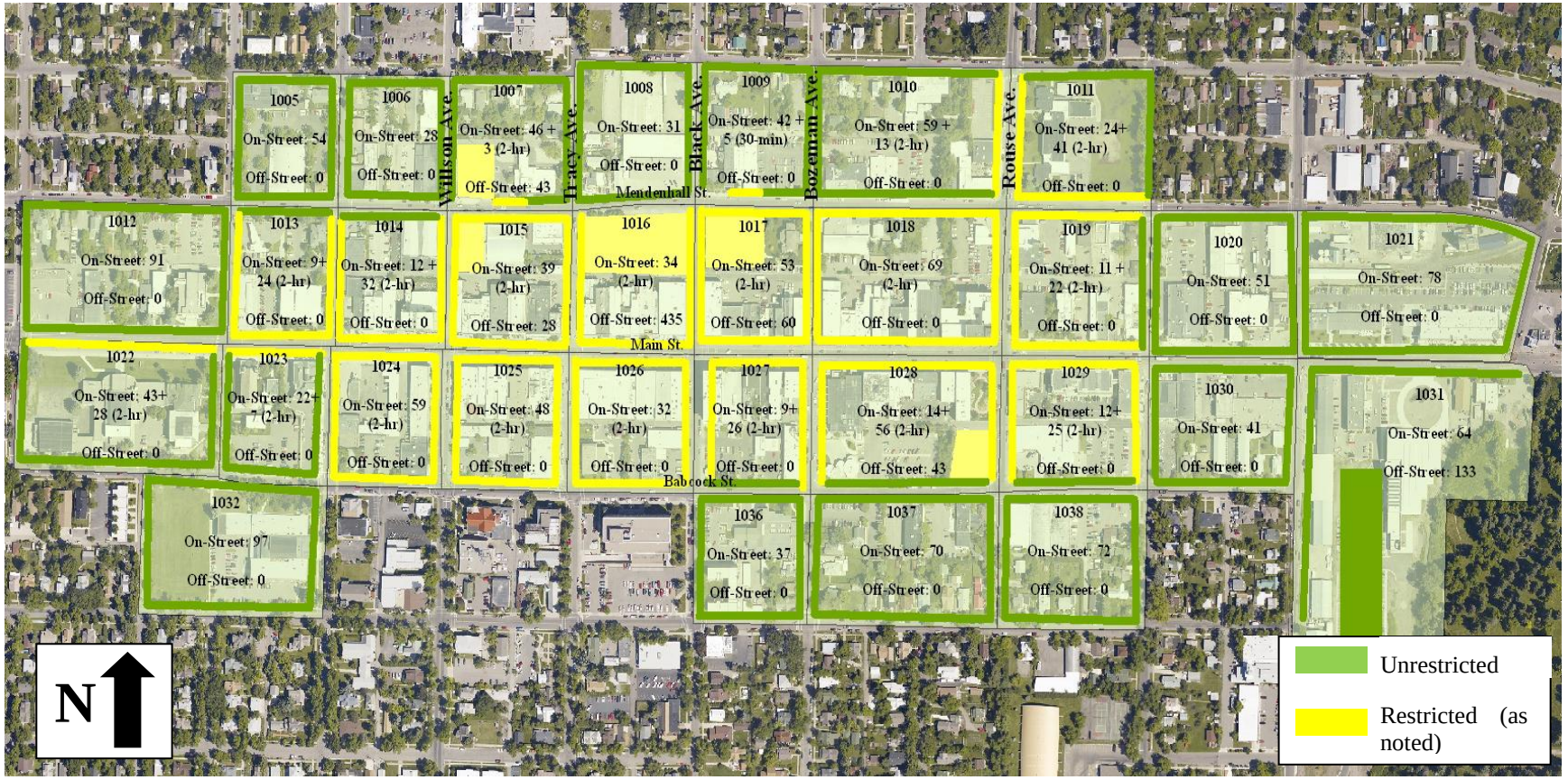

Figure 3: Public parking distribution

1. INTRODUCTION

The City of Bozeman's downtown district possesses a number of parking resources. These include on-street parking, off-street parking lots, a parking garage, private (business) parking lots and alley parking. The city did not have a clear picture of the inventory of these resources; rather, only a general estimate of the number of available spaces. Additionally, turnover and occupancy rates for available parking were unknown. While a general figure of 3,600 available parking spaces had been compiled by the City's Geographic Information Systems (GIS) Division, there was little knowledge about the distribution of parking resources in the downtown area, the use of these resources, and the patterns of parking use. Therefore, the City has relied primarily on documents such as the *Bozeman Unified Development Ordinance* (UDO) (1) in making decisions regarding issues such as redevelopment and parking needs.

In 2009, the City of Bozeman and the Downtown Bozeman Partnership retained a team of consultants to develop the Downtown Improvement Plan (2). This plan examined the issues facing downtown Bozeman and provided a series of recommendations and next steps that should be completed to guide development in the years to come. One of the next steps recommended by this plan was the completion of a parking inventory and use study for the downtown area. In part, such a recommendation was necessary based on the age of the previous parking studies, which had been conducted during 1992 and 2000 (3, 4).

Aside from the lack of concrete information regarding parking in downtown Bozeman and the recommendation to complete an inventory and use study, the City has noted that other cities in the state have recently conducted parking studies. Specifically, studies have been conducted by Billings (5) and Missoula (6). These studies have provided each community with a clearer picture of their current parking resources, how existing parking is performing, and what future parking needs might be. The pursuit of updated parking information by each of these cities indicates to Bozeman officials that the need exists for similar information to be compiled locally. Certainly the growth that Bozeman has experienced in recent years parallels, if not exceeds that of Billings and Missoula, necessitating the collection of updated parking information.

In light of the questions regarding the true number of parking spaces available in the downtown district, as well as the lack of information related to parking adequacy and use patterns, the City of Bozeman's Parking Commission and the Downtown Bozeman Partnership have chosen to pursue a parking study to address these knowledge gaps. Such a study would inventory all available parking within the downtown area as well as examine aspects related to parking such as dwell time, turnover, and occupancy rates. Additionally, the current state of the practice as related to parking management in city centers and downtown areas is of interest to the commission. In total, the collected information will provide the City with an accurate picture of the available parking in the downtown district, as well as how parking needs are met throughout the day.

The purpose of this document is to provide the Parking Commission and the Downtown Bozeman Partnership the results of such a parking study. The tasks presented in this document reflect those which discussions with Parking Commission members indicated were necessary and required. These results are intended to provide the City with answers to the questions of available parking inventory, turnover, and occupancy rates, as well as the state of the practice in managing parking resources in downtown areas.

1.1. Project Purpose

The 2009 Downtown Improvement Plan, which was adopted by the City of Bozeman with Commission Resolution No. 4230 (January 2010), states:

> "Parking plays a role in every aspect of downtown. Cooperative efforts should be made to maintain the availability of convenient public parking for customers, employees, and visitors throughout the downtown district. The variety of public parking resources – on-street spaces, surface lots, and the Bridger Park Garage – should be managed and maintained to provide a flexible assortment of parking options for all downtown patrons.
>
> The Bozeman Parking Commission, in coordination with the Downtown Bozeman Partnership, should conduct regular parking studies to determine and track the inventory of on-street, surface, and structured parking spaces in addition to usage patterns and trends."

To complete this Downtown Improvement Plan objective, the Bozeman Parking Commission and the Downtown Bozeman Partnership collaborated to conduct a downtown parking study financed by Downtown Tax Increment funds. The purpose of the study was defined as:

> "A comprehensive parking study would examine the existing and potential future parking needs with the downtown district as well as address parking operations to aid in optimizing the BPC parking system. The study would include a comprehensive inventory of the on- and off-street parking (public and private), land use inventory, and turnover and occupancy analysis."

1.2. Approach

A multi-faceted approach was employed in completing this work. Student data collectors from Montana State University were employed to collect field data, including parking stall inventory, as well as occupancy, turnover, and dwell time supporting data. These data elements were then employed to conduct the various analyses presented in the different chapters of this report. Analysis approaches included the generation of descriptive statistics, spreadsheet data analysis, development of illustrative tables and figures, and visual presentation or various results through GIS mapping. Additionally, a local and national review of parking studies and parking management documents was conducted to identify and summarize information that will be of interest to the Parking Commission.

1.3. Report Outline

This report is divided into eight chapters. Chapter 1 has introduced the motivation for the project. Chapter 2 presents the state of the practice in parking management, while Chapter 3 presents the results of the downtown Bozeman parking inventory. Chapter 4 presents inventory information in a visual format through GIS mapping. Chapter 5 presents the results of occupancy rate analyses, while Chapter 6 presents dwell time and turnover results. Chapter 7 presents the results of parking demand studies, while Chapter 8 presents the conclusions and recommendations of this project.

2. RECOMMENDED PARKING PRACTICES

Before examining downtown Bozeman's parking inventory and characteristics, it will be helpful to understand the "state of the practice" with regards to parking practice both locally (i.e. Montana communities) and nationally. By synthesizing current practices, the Parking Commission can better understand how other communities are managing their city center/downtown parking resources. This information could then be considered and applied in present and future decisions related to parking assets in downtown Bozeman. The following sections summarize existing guidance and metrics employed in other communities with downtowns of similar size and character to Bozeman, as well as guidance documents of importance to practitioners. The information provided in the following sections was identified through a search of online tools such as the Transportation Research Information Service (TRIS), and Google. Recent results (2006 – present) were employed when looking at parking studies from similar communities to ensure that the most recent trends were reported. Besides major Montana towns and cities, communities with a population of approximately 50,000[1] or less were considered, as were smaller communities with a downtown character and function similar to Bozeman (i.e. tourist-based or university towns).

2.1. Current Bozeman Requirements

Before discussing parking studies completed elsewhere in Montana and recommended practice in similar communities, it would be beneficial to present the current requirements for parking in Bozeman. The guiding document for parking practices in Bozeman is the *Bozeman Unified Development Ordinance* (UDO) (1). This document, specifically Chapter 18.46, provides information on the number of required parking spaces to ensure provision of off-street motor vehicle parking, bicycle parking, and other transportation access facilities in rough proportion to the generalized parking and transportation demands of different land uses (1). In addition to discussing design aspects, the UDO provides specifies the number of parking spaces required for different land uses.

Of specific interest to this project are the space requirements set forth regarding nonresidential land uses. Specifications of relevance to this project are presented in Table 2-1. The code notes that depending on the location in the city, adjustment to parking requirements may be desired. Examples of allowable reductions in requirements are presented in Table 2-2. Of note is that the provision of parking spaces in excess of 125 percent of the minimum number of spaces required for the net floor area is not permitted. Finally, the code notes that, within the B-3 zoning district where all or part of the required parking spaces cannot be provided for a proposed land use through ownership or lease, an owner may satisfy the requirements through a cash-in-lieu payment to the City Finance Department (1).

[1] While Bozeman's population is less than 40,000, the threshold of approximately 50,000 was employed to allow for the studies of additional communities to be identified.

Table 2-1: Current Bozeman parking space requirements (1)

Use Type	**Off-Street or Off-Road Parking Spaces Required**
Automobile sales	1 space per 200 square feet of indoor floor area; plus 1 space per 20 outdoor vehicle display spaces
Automobile service and/or repair station	2 spaces per service stall, but no less than 4 spaces
Bank, financial institutions	1 space per 300 square feet of floor area
Bowling alley	2 spaces per alley; plus 2 spaces per billiard table
Church	1 space per six persons of maximum occupancy load (as identified in the International Building Code) for main assembly hall, public assembly areas and classrooms
Community or recreation center	1 space per 200 square feet of floor area
Health and Exercise Establishment	1 space per 200 square feet of floor area; plus 3 spaces per court
Day care centers	1 space per staff member plus 1 space per 15 children permitted
Furniture stores over 20,000 square feet	3 spaces per 1,000 square feet of floor area
Medical and dental offices	4 spaces for each full time equivalent doctor or dentist; plus 1 space for each full time equivalent employee
Offices (except medical and dental)	1 space per 250 square feet of floor area
Restaurants, cafes, bars and similar uses	1 space per 50 square feet of indoor public serving area; plus 1 space per 100 square feet of outdoor (patio) area
Retail store and service establishments	1 space per 300 square feet of floor area
Schools Elementary and/or Junior High	1.5 spaces for each classroom, library, lecture hall and cafeteria; plus 1 space for each 3 fixed seats in the area of public assembly, or 1 space for each 25 square feet of area available for public assembly if fixed seats are not provided
Theater, Auditorium or similar	1 space per 4 seats based upon place of assembly design capacity
Warehousing, storage or handling of bulk goods	1 space per 1,000 square feet of floor area devoted to storage of goods; plus appropriate spaces to support accessory office or retail sales facilities at 1 space per 350 square feet of floor area

Table 2-2: Allowable reductions in parking space requirements (1)

Use	Allowable Reduction
Retail	40 percent
Restaurant	50 percent
Office	20 percent
Transit proximity	10 percent
Parking structure proximity	15 percent
All Others	30 percent
Residential	1 space per dwelling in zone B-3 (rather than 1 space per bedroom)

The allowable reductions are greatest in the study area, the B-3 zoning district. In addition to establishing the overall required number of parking spaces for different land uses, the code also establishes disabled accessible parking space requirements. These requirements are based on the total number of spaces in the lot, and are presented in Table 2-3. Accessible parking spaces count towards satisfying City of Bozeman required number of parking stalls. As one would expect, such spaces are to be designated as reserved by signage and pavement markings, with a space width of at least 13 feet.

Table 2-3: Disabled parking space requirements (1)

Total Parking in Lot	Required Minimum Number of Accessible Spaces	Total Parking in Lot	Required Minimum Number of Accessible Spaces
1 to 25	1	201 to 300	7
26 to 50	2	301 to 400	8
51 to 75	3	401 to 500	9
76 to 100	4	501 to 1000	2 percent of total
101 to 150	5	1001 and over	20 plus 1 for each 100 over 1000
151 to 200	6		

The code continues by discussing the joint use of parking facilities. Such parking would serve two or more individual land uses without conflict or encroachment, provided that a traffic impact study shows that adequate parking exists to meet the demand of potential uses (1). Finally, off-site parking is discussed, with the code indicating that such parking shall not be located more than 1,000 feet from the entrance of the land use it serves.

2.2. Past Bozeman Parking Studies

The earliest information to the project team regarding downtown Bozeman's parking inventory came from the *Bozeman Transportation Plan* of 1981 (7). While the work supporting this document did not include a comprehensive parking study, it did detail basic parking inventory

information. The study area was bordered by Lamme St., Olive St. Wallace Ave. and 5th Ave, and contained a total of 3,987 parking stalls[2]. This document also broke the inventory down further, examining the "Core" downtown area, bordered by Mendenhall St., Babcock St., Rouse Ave. and 3rd Ave. This area contained a parking inventory of 1,087 parking spaces. Based on the limited information collected, only one recommendation was made regarding parking; this was to develop short-term parking in the downtown Core area.

As part of the *Bozeman Urban Transportation Plan 1993 Update*, a parking inventory and utilization study was conducted during the summer of 1992 (3). The parking inventory was completed for the downtown area bordered by Beall St., Church Ave., Curtiss St. and 5th Ave. This area included a total parking stall inventory of 5,030 spaces, with 3,024 spaces located off-street and 2,006 located on-street. The city-owned lots contained 276 spaces, while all off-street lots in the area contained 2,748 spaces. On-street parking spaces consisted of 1,475 stalls with no restrictions and 467 2-hour restricted stalls. The study area also contained 45 handicapped accessible and 31 loading zone spaces.

The utilization study performed as part of the work examined four city-owned lots collectively, all off-street lots in the study area and all on-street spaces in the study area. Utilization in city-owned lots during the daytime averaged 49 percent during July and 51 percent during September. Utilization in city-owned lots during the evening averaged 34 percent during July and 66 percent in September. Utilization in all off-street lots averaged 50 percent during the daytime and 25 percent during the evening. On-street parking utilization averaged 53 percent during the daytime and 33 percent during the evening.

Based on the parking inventory and utilization study results, the document presented a number of short and long term recommendations, including:

- Short term
    - Increase enforcement for on-street parking
    - Restructure parking fines
    - Revise on-street and city-owned lot signage
    - Eliminate 2-hour restrictions in city-owned lots
    - Relax or remove the 2-hour restriction for on-street parking in areas where supply is lightly used
    - Provide appropriate number of handicapped spaces in city-owned lots
    - Restripe public lots to maximize spaces and encourage private owners to do the same
    - Use income from fines to maintain and improve public lots
    - Install effective lighting in public lots
    - Develop a map of downtown parking for public use
    - Conduct a study to determine the amount of additional parking needed
- Long term

[2] Note that the study area examined in this report was bordered by Mendenhall St., 5th Ave., Babcock St. and Broadway Ave. on the north, west, south and east sides, respectively.

- Construct a parking structure
- Develop additional parking lots along the downtown fringe

The 2001, the *Greater Bozeman Area Transportation Plan 2001 Update* also contained parking inventory and utilization information for the downtown area (4). Once again, this area was bordered by Beall St., Church Ave., Curtiss St. and 5th Ave. This area included a total parking stall inventory of 5,053 spaces, with 3,022 spaces located off-street and 2,031 located on-street. This represented a decrease of two off-street spaces and an increase of 25 on-street spaces from the 1992 figures. City-owned lots contained 292 spaces, an increase of 16 spaces from 1992. On-street parking spaces consisted of 1,500 stalls (an increase of 25 spaces) with no restrictions and 470 2-hour restricted stalls.

The utilization study performed as part of the work examined five city-owned lots collectively, all off-street lots in the study area and all on-street spaces in the study area. Utilization in city-owned lots during the daytime averaged 72 percent, while evening utilization averaged 55 percent. Utilization in all off-street lots averaged 60 percent during the daytime and 42 percent during the evening. On-street parking utilization averaged 57 percent during the daytime and 47 percent during the evening. Unlike the 1992 plan, this document did not offer any recommendations to address any existing parking issues in the downtown area.

Finally, while not part of an official study on the part of the City of Bozeman, additional work was completed by an undergraduate researcher at the Western Transportation Institute in 2004 (8). This work consisted of a correlation study that examined parking generation and land use patterns in Bozeman, Billings and Great Falls. The work involved on-site interviews with persons in parking areas to determine the number of places they had visited after parking. Of interest to this project were the findings specific to downtown Bozeman. It was found that in downtown Bozeman, parkers visited an average of 2.8 places (i.e. businesses, etc.).

2.3. Montana Studies and Practices

In examining current practices related to managing parking, it is useful to consider what other communities in Montana are doing or have had recommended to them through parking studies. To this end, larger communities throughout Montana were contacted to determine whether they had recently completed a parking study and what, if any parking management practices they presently employed. These communities included Billings, Missoula, Great Falls, Helena, and Kalispell, which represent larger cities with more complex parking assets and issues.

The City of Billings recently completed a downtown parking study in January, 2010 (5). This study consisted of a parking inventory, a turnover and occupancy analysis, and recommendation of parking strategies to consider in the present and future. The study found that the downtown area had adequate parking to meet present needs, although some parking shortages did occur in specific areas during different times of day. Future downtown development was viewed as driving a need to consider additional parking.

Results of interest included the finding that peak occupancy rates in the study area ranged between 64 and 66 percent, on average. These peaks occurred during the noon hour on two collection dates. Some areas of the downtown core had occupancies exceeding 90 percent during this period. Downtown parking structures were found to have rates ranging between 73 and 80 percent. An analysis of demand found that there was an overall parking stall surplus in the

downtown area, although some individual blocks had parking deficits during various times of the day.

To address present and future parking concerns, a number of parking management strategies were recommended to the City of Billings. Recommended strategies included:

- Anti-shuffling ordinances to prevent parkers from evading hourly restrictions by continually changing stalls throughout the day[3].
- Addition of parking meters in areas of high demand.
- Handheld enforcement technologies3.
- Transportation alternatives to reduce downtown parking, such as park and ride programs, bike racks on busses3, etc.
- Improved parking signage to alert motorists to the location of facilities3.
- Residential permits to prevent overflow parking in residential areas3.
- Revised parking pricing, raising currently low prices in high-demand areas to encourage use of off-street, long-term parking facilities.
- New parking assets to meet future growth needs[4].

All of these strategies were identified to address current and anticipated problems through parking management approaches. Some require no or low cost (ex. ordinances), while others require significant investment (new parking). While the parking study does not identify any specific parking management "best practices" employed by the City of Billings, it does indicate one best practice employed nationally is to have at least 50 percent of available public parking be occupied throughout the day (5).

As part of its greater downtown master plan, Missoula completed a parking inventory, occupancy analysis and evaluation of overall parking supply and demand (6) in 2008. The inventory concluded that present parking facilities were adequate to meet current needs. The occupancy analysis found that peak occupancy for all parking in the downtown area occurred at noon, with a rate of 66 percent. Off-street parking occupancy peaked at 2:00 p.m. with a rate of 63 percent occupancy, while on-street parking had a peak occupancy rate of 71 percent at noon. The majority of study blocks had a parking stall surplus during their peak periods, although some blocks did experience small deficits. Finally, a parking turnover analysis found that parking durations ranged between 30 minutes and 9 hours, with an average duration of 1 hour and 28 minutes. The overall turnover rate was 5.45 vehicles per stall over the course of an 8[5] hour study period.

While the Missoula study does not identify any parking management best practices that are or could be employed per se, it does present a series of strengths, weaknesses and opportunities that are of interest. These include:

[3] Presently employed in Bozeman.

[4] The parking structure was constructed to meet anticipated 2015 demand.

[5] The report does not indicate how a vehicle duration of 9 hours was measured in the observed range during an 8 hour study period.

- Strengths
  - Strategically placed parking assets[6]
  - Direct control of the parking system by the Missoula Parking Commission6.
  - Vertically integrated parking management responsibilities.
  - Well maintained facilities6.
  - Clear presentation of operating hours/restrictions6.
  - The historic recognition of the need for parking planning studies6.
- Weaknesses
  - Lack of web-based parking information6.
  - A lack of parking system guiding principles to direct management and policy development.
  - Public perception of downtown parking availability is erroneous6.
- Opportunities
  - Safety enhancements could be made to parking assets (structures) as needed.
  - Assess new technologies as they become available.
  - Explore customer service and parking amenity programs.
  - Expand customer feedback avenues.
  - Employ varying parking rates based on location.
  - Develop criteria and design guidelines for future parking structures.

These topics do not represent best practices, but they do provide an indication of different aspects of parking management that could be taken into consideration not only in Missoula, but in other communities as well.

Personal contacts made with the cities of Great Falls, Helena, and Kalispell indicated that no formal downtown parking studies/inventories had been performed in recent years. Interestingly, it was found during the course of this review that the City of Great Falls does not manage the parking facilities that it owns. Rather, the enforcement (and collection of tickets) and management of downtown public parking facilities is conducted by the Standard Parking Corporation. This approach was unique among the Montana cities examined by this work. Standard Parking has periodically evaluated operations of the parking resources it manages for the city, but this has not consisted of any in-depth study.

2.4. National Studies and Practices

In addition to parking studies completed in and management practices of Montana, the same information from other communities throughout the United States was also of interest. Of course, it is not possible to review and summarize parking studies and management practices from the large population of available communities throughout the country. Rather, the approach employed for this work was to identify recent studies (2006-present) completed by communities of similar size and nature to Bozeman which had made their parking studies available online. As one might expect, there is not a great deal of information available in terms of completed or

[6] Characteristic of Bozeman.

published parking studies for communities the size of Bozeman. The communities that were identified and whose reports were obtained are presented in the following paragraphs.

The community of Atascadero, California, (population 28,000) completed a parking study in 2006 (9). As part of that work, a series of recommended practices were identified, including:

- Improve signage.
- Work with local businesses to provide long term parking for employees as needed.
- Utilize existing parking assets before adding to supply.
- Conduct a downtown land use survey to aid in parking planning.

While this list is not comprehensive, it does provide solutions to problems and challenges faced by many communities.

The city of LaCrosse, Wisconsin, (population 51,000) completed a downtown parking study in 2009 (10). As part of the study, several parking management strategies were identified, including:

- Formation of a parking advisory committee to assist in guiding parking policy.
- Increased pricing (when applicable) in high parking demand locations.
- Meter on-street parking to place a premium on such assets.
- Limit on-street parking duration to two hours maximum.
- Work with employers to encourage employees to park further from a business, leaving closer parking stalls open for customers.

While some of these strategies may seem intuitive, they are often overlooked for various reasons. However, each of them represents an aspect related to parking management that should be revisited over time or as conditions change.

The city of Meadville, Pennsylvania, (population 14,000), although much smaller than Bozeman, possesses similar traits, particularly a compact downtown core with a variety of land uses and parking assets. As part of a 2008 parking study, a number of current and recommended parking management practices were documented, including:

- Contract monthly parking permits to assign parking stalls.
- Maintain facilities using public works staff.
- Avoid setting parking fines that are only slightly higher than the cost of one day's parking.
- Market exiting parking supply (11).

The assignment of parking fines is perhaps the most important recommendation from this report. If a fine is set too low, a motorist may be more likely to violate existing restrictions, as only a minimal cost will be incurred compared to any applicable rate.

Menlo Park, California, (population 30,000) completed a parking study in 2010. While current or recommended parking management practices were not explicitly discussed, the report did offer one insight of interest. Based on existing parking conditions, the report indicated that it would be beneficial to analyze existing time restrictions placed on stalls to determine whether alternatives

might increase use and effectiveness of a particular parking asset (12). This is an interesting concept, as time restrictions placed on parking stalls may not necessarily be revisited with any regularity, if ever, once initially assigned.

Oregon City, Oregon, (population 32,000) completed a downtown parking study in 2009. As a result of this work, several parking management strategies were recommended, including:

- Adopt the 85 percent rule for parking utilization, which recognizes that when parking occupancy exceeds 85 percent capacity, parking supply becomes constrained.
- Adopt parking rate ranges based on location and demand.
- Reduce or eliminate 15 minute, 30 minute, 4 hour and 8 hour parking restrictions, replacing them with 2 hour restrictions.
- Reevaluate permit pricing based on existing occupancies.
- Develop uniform signage.
- Develop incentives for private development of publically available parking.
- Monitor parking utilization frequently (13).

Most noteworthy of these strategies is the 85 percent rule, as it indicates a threshold that should be considered when examining the occupancy of parking areas.

Springfield, Oregon, (population 58,000) developed a number of strategies as part of its downtown parking study (14). These included:

- Develop criteria for decision making in establishment of loading zones and 15, 30, 60, 90-minute and No-Limit stalls.
- Adopt the 85 percent rule to direct parking management strategies.
- Develop a residential parking permit zone policy in residential areas affected by spillover from commercial parking.
- Negotiate shared use and/or lease agreements with owners of strategically placed existing private surface lots.
- Develop incentives for private development of publically available parking.
- Acquire strategically located land parcel(s) for use as future public off-street parking in the downtown.
- Define the priority purpose/use for parking in each parking zone or area.

Once again, note the use of the 85 percent rule, as well as the definition of parking uses and priorities for a given area.

Redmond, Washington, (population 46,000) conducted a downtown parking study in 2008 (15). As a result of this study, several parking management strategies were identified for implementation, including:

- Strategically locate 2 hour or by permit zones.
- Implement an employee permit program.
- Improve signage and communications.

- Establish a decision-making point that indicates a review of the parking system is undertaken.

Note that the final point ties in with the establishment of the 85 percent rule identified in previous studies. This decision-making criterion would alert parking management to the need to review the current status of parking performance and determine if changes are required.

Valparaiso, Indiana (population 28,000), home of Valparaiso University, completed a downtown parking study in 2010 (16). This work included the development of a parking management plan, with strategies of interest including:

- Encourage turnover through increased enforcement.
- Implement warning tickets for first time offender or out of town visitors.
- Promote parking options.

The implementation of warning tickets for out of town visitors is an aspect of parking management that might be of interest in a high tourism area. Of course, the converse to this type of approach is that word about this program might spread, with motorists intentionally violating parking restrictions because they know they will only receive a warning.

The Village of Westmont, Illinois, (population 25,000) completed a downtown parking study in 2008 (17). As part of this work, several parking management strategies were identified for consideration, including:

- Community control over at least 50 percent of available parking assets.
- Develop a shared use parking policy to serve adjacent buildings during different times of day.
- Route enforcement officers such that they complete a full circuit of downtown every two hours.
- Minimize surface lots between buildings.
- Improve signage.
- Employ marketing strategies when changes to the parking system occur.

While many of these strategies reflect those of previously discussed studies, the shared use policy has not yet been touched upon. Such a policy might be beneficial in cases where two adjacent businesses experience different customer traffic peaks and limited parking is available.

2.5. Guidance Documents

A number of documents provide guidance related to parking rates for different land uses, parking management strategies, and other information of interest. This guidance has been developed by the Institute of Transportation Engineers (ITE), the Transportation Research Board (TRB), the American Planning Association (APA) and other entities. The following sections discuss these documents and the guidance they provide.

The foremost guidance document identified and employed by this work is ITE's *Parking Generation* guide (18). This guide provides parking data, including ratios, for a variety of building and land uses based on characteristics associated with the use (namely building square footages, number of employees, number of attendees, etc.) that can be used in estimating parking demand. In general, parking demand ratios have been developed for a variety of classifications,

including transportation terminals, industrial, residential, lodging, recreational, institutional, medical, office, retail and services, with ratios presented for specific types of uses under each of these categories. While this document provides information related to parking demand, it does not discuss other aspects of parking such as management practices and so forth. The contents of this document are employed in later portions of this work to determine current and future peak period parking demand on each block in downtown Bozeman. The specific rates employed from this reference are presented in Chapter 7.

In addition to *Parking Generation*, ITE also provides guidance and information through supplementary documents. The first such document is the *Transportation Planning Handbook* (19). Of interest to this project, the document discusses parking demand and generation rates, as well as parking management strategies. It is stressed that parking is a function of land use, with the primary input factor being square footage. The use of number of employees to determine parking needs should be avoided, as this factor tends to be variable over time. Based on the square footage input, this document provides parking generation rates for a number of different land uses, including the following which may be pertinent to this work:

- General offices – 3.55/1000 ft^2
- Church – 0.68/attendee
- Light industry – 2.87/1000 ft^2
- Family restaurant – 12.26/1000 ft^2
- General commercial – 3.3/1000 ft^2
- Bank – 6.02/1000 ft^2

These rates are provided for reference and comparison purposes; more recent ITE parking generation rates have been developed, resulting in differences between those presented here and those employed during later analysis in Chapter 7. Of importance to the downtown Bozeman study conducted here is the absence of a mixed use generation rate by this reference, as well as public use areas, such as parks and libraries. Note that the publication date for this document was 1999, and these rates should be considered for reference purposes only, as they are likely to have changed over the following 11 years.

The *Transportation Planning Handbook* continues by providing parking management strategies broken down by categories. These included pricing, on-street supply, enforcement, off-street supply and marketing. A sampling of the recommended management practices related to these includes:

- Pricing
    - Rate increases and decreases
    - Differential rates
    - Subsidies
    - Discount programs
- On-street supply
    - Change mix of long and short term parking
    - Permit programs
    - Regulations
- Enforcement
    - Ticketing and fines
- Off-street supply

    - Zoning requirements
    - Constrain supply
    - Restrictions
    - Preferential parking
    - Change mix of long and short term parking
- Marketing
    - Advertising
    - Convenience programs (19)

The second supplemental reference document from ITE is the traffic *Engineering Handbook* (20). This document discusses primarily design elements in parking (dimensions, location, etc.) and does not provide guidance on parking generation rates or management strategies. However, it is a useful reference when considering the different physical factors that contribute to the provision of parking.

The Eno Foundation for Transportation has published a book entitled *Parking* which discusses parking policy, land use issues and development (21). This reference, although dated, presents a detailed model for predicting peak parking needs. The model predicts peak parking demand as:

$$D = \frac{NKRP*pr}{O}$$

Where:

D = parking demand (stalls)
N = size of activity measured in appropriate units (square feet, attendees, etc.)
K = proportion of destinations that occur at any one time
R = person destinations per day per unit of activity
P = proportion of people arriving by car
O = average vehicle occupancy
pr = proportion of persons with primary destination at the designated study location

While the equation and process to determine parking demand is data intensive, it may be of interest in specific scenarios where a new development is planned and space for parking is at a premium. In such a case, a more accurate estimate such as that generated via this model may be required as opposed to the rough figures generated by other approaches.

Intended for use by communities with populations below 50,000, *The Parking Handbook for Small Communities* provides information on planning, developing and managing downtown parking (22). This document lays out the steps to collect and analyze current and future parking conditions, including the creation of parking models. It also provides a discussion on how the effectiveness of existing parking may be increased (a corollary to parking management best practices). The approaches to increase effectiveness include:

- Parking restrictions
- Enforcement
- Metering
- Rates, fees and fines
- Public support for enforcement

- Better utilization of off-street parking

As part of the Transit Cooperative Research Program (TCRP), the Transportation Research Board has published a document titled *Parking Management and Supply: Traveler Response to Transportation System Changes* (23). This document discusses how travelers respond to differences in the supply and availability of vehicle parking, and, of interest to this project, provides information on different types of parking management strategies. Among the parking management strategies identified were:

- Minimum or maximum parking requirements for developers.
- Employer/institutional parking management by owners.
- Residential parking management to restrict non-resident parking.
- On-street commercial area management, including time restrictions.
- Peripheral parking, which seeks to move parking from the downtown core to its edges.
- Park and ride, providing outlying parking areas.

While the focus of this document was on mid and large sized urban areas, many of the findings with respect to changes made in these management strategies are easily transferable to a small community setting.

The American Planning Association has published a document titled *Parking Management Best Practices*, which summarizes a number of different strategies that may be employed in managing parking assets (24). Among the strategies identified that are relevant to this project were:

- Shared parking
- Regulated parking
- Establish more accurate and flexible standards
- Implement smart growth policies
- Improve pricing methods
- Provide financial incentives
- Improve user information and marketing
- Improve enforcement and control
- Address spillover problems

While many of these strategies have already been identified by previous documents, this list does contain new additions, such as addressing spillover problems. The inclusion of such items broadens the sphere of strategies that may be considered when making future decisions. Note that this information has also been compiled by the same author and presented in a report by the Victoria Transport Policy Institute (British Colombia), titled *Parking Management: Strategies, Evaluation and Planning* (25). Note that neither document provides guidance on parking rates.

One final reference of interest comes from the Oregon Department of Transportation, which led an effort to develop a parking management document titled *Parking Management Made Easy* (26). This document lays out the process for Oregon communities on how they can identify whether they have a parking problem (parking inventory and occupancy study). Included in this

discussion is the specification of a 90 percent rule for parking utilization, which recognizes that when parking inventory exceeds 90 percent capacity, parking supply becomes constrained. Interestingly, this criterion differs from that (the 85 percent rule) employed in recent Oregon community parking studies discussed previously. One can assume that the use of an 85 percent threshold was based on conservative practice.

2.6. Chapter Summary

This chapter has summarized information pertaining to parking studies completed in Montana cities, parking studies completed in communities nationally comparable to Bozeman (with an focus on any guidelines or management practices employed or recommended) and existing parking management guidance documents (with a focus on parking generation rates and management practices). Locally, recent Montana parking studies provided some insight into management practices that have been recommended as the result of studies. Aside from this information, the individual findings provide some comparison points when examining the results of the Bozeman parking study, namely occupancy rates.

In examining the reports of previous parking studies throughout the U.S., it was noted that only limited information related to recommended or expected occupancy rates or similar metrics were provided. This came mainly in the form of the 85 percent rule cited in the Oregon City, and Springfield, Oregon, reports (13, 14). The only other baseline metric identified by the parking studies was the criteria that at least 50 percent of available parking assets be controlled or owned by a community (17). This was viewed as important in order to allow the community to manage parking in terms of allocation, changing demand, pricing, and enforcement. Studies from throughout the U.S. did provide a number of different parking management practices that should be considered. Among the practices identified were:

- Improve signage.
- Work with local businesses to provide long term parking for employees as needed.
- Utilize existing parking assets before adding to supply.
- Formation of a parking advisory committee to assist in guiding parking policy.
- Work with employers to encourage employees to park further from a business, leaving closer parking stalls open for customers.
- Avoid setting parking fines that are only slightly higher than the cost of one day's parking.
- Market exiting parking supply.
- Adopt parking rate ranges based on location and demand.
- Develop incentives for private development of publically available parking.
- Develop a residential parking permit zone policy in residential areas affected by spillover from commercial parking.
- Negotiate shared use and/or lease agreements with owners of strategically placed existing private surface lots.
- Define the priority purpose/use for parking in each parking zone or area.
- Establish a decision-making point that indicates a review of the parking system is undertaken.

- Implement warning tickets for first time offender or out of town visitors.
- Employ marketing strategies when changes to the parking system occur.

In reviewing guidance documents for information on parking generation rates and management strategies, the ITE Parking Generation manual provided a number of recommended rates for various types of land uses. Other reference material provided baseline guidance regarding occupancy/utilization, recommending that a 90 percent rule be employed for parking utilization, differing slightly from the 85 percent rule identified previously. Note that this guidance, as well as that provided by individual communities, did not differentiate between land uses; rather, one threshold was indicated for all available parking. Finally, the materials reviewed identified a number of parking management practices which matched those identified by local parking studies.

3. PARKING INVENTORY

The foremost rationale for this project was that a comprehensive inventory of downtown Bozeman's parking resources did not exist. While the Parking Commission did have an inventory of city-owned parking facilities, the number, ownership and restrictions of other downtown parking resources were unknown. Consequently, the first task during this project was the completion of such an inventory. The inventory itself was completed for the entire area encompassed by the downtown Tax Increment Finance District (TIF). This area is presented in Figure 3-1 and encompasses the areas inside the yellow and black border. The study area examined in this report was bordered by Mendenhall St., 5th Ave., Babcock St. and Broadway Ave. on the north, west, south and east sides, respectively. The area for this study included City of Bozeman GIS Blocks 1005 through 1032 and 1036 through 1038.

3.1. Methodology

The methodology employed in inventorying downtown parking assets was basic. A student data collector walked each downtown block in the study area and recorded the various parking assets observed by their different characteristics on a data collection sheet (displayed in Figure 3-2). A parking stall was defined as being represented by pavement markings; in cases where such markings were not present, the data collector identified a stall as consisting of a space approximately every 20 feet. Upon completion of the inventory, the information recorded on the data sheets was transferred to an Excel spreadsheet for further analysis and classification.

Data collection occurred on July 27, 28, and 29, 2010 (Tuesday, Wednesday, and Thursday). Data was collected for a total of 31 downtown block groups. No difficulties were encountered during the course of data collection, with all areas being accessible to the student performing the collection. The field inventory data collected included:

- Number of spaces
- Type of parking (on-street, off-street)
- Ownership of parking (public, private)
- Fees for parking (free, pay, permit)
- Access point/side of street – collected for internal identification and reference purposes
- Restrictions (handicapped, time, loading zone)

The following sections provide a summary of the inventory and a breakdown of the various parking assets that are present in downtown Bozeman based on the data collected.

3.2. Overview of Parking Assets

Table 3-1 presents a summary of all parking assets recorded in downtown Bozeman. As the table indicates, a total of 5,034 parking stalls were available in the downtown study area. This presents an average of 162 stalls per block, although some blocks contain far more or less than this average. The majority of blocks had between 100 and 200 parking stalls of various types available. The exceptions to this were Block 1010 (203 stalls, mainly private business lot), Block 1012 (271 stalls, mainly private business and on-street parking), Block 1016 (479 stalls, including the city parking garage), Block 1028 (216 stalls, including business parking and a city lot) and Block 1031 (304 stalls, including the library). While the overall downtown parking

inventory figure is of interest, it does not present the full picture of the different types of parking assets that are available. Consequently, the following sections will provide discussion and detail related to the different parking assets identified during the course of the parking inventory study.

It is important to keep in mind when examining the parking inventory and distribution of assets by block, that the location of a parking stall is important. An available parking space on the edge of the downtown area may remain available because of its location, while a parking space closer to the downtown core is more valuable and in higher demand. This reflects the tendency of motorists to park in a location which is closest to their trip destination. Consequently, as most downtown businesses are centrally located, the parking assets on the fringe of the downtown area may see lower use than those at its core.

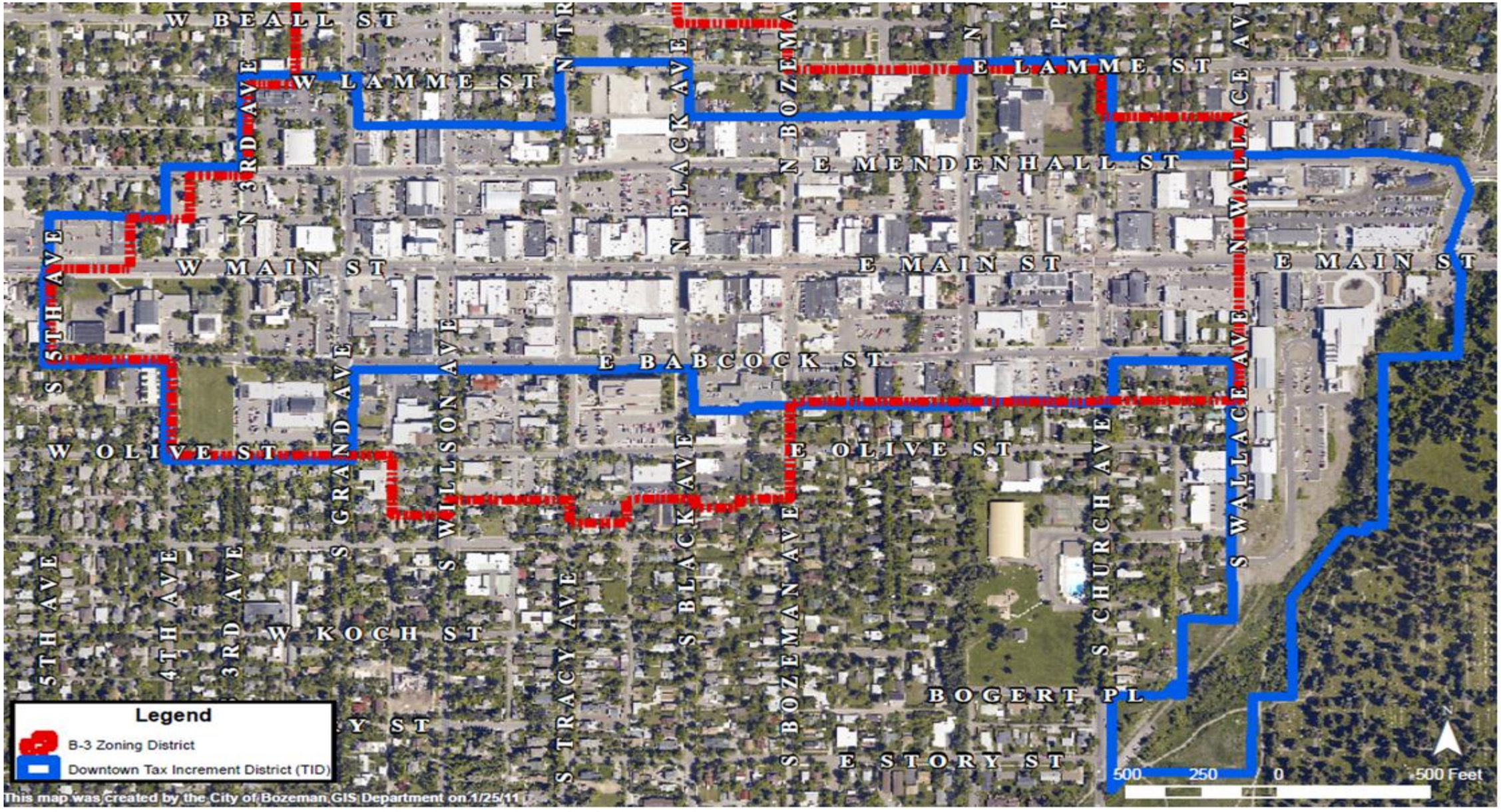

Figure 3-1: Downtown inventory area, image courtesy of City of Bozeman Geographical Information Systems Department

City of Bozeman Downtown Parking Inventory Block Number _____ Date _____

Bordering Streets _____

Collector _____

	Type				Ownership			Fees			Access	Restrictions			Notes
No. Of Spaces	On street	Off Street Lot	Off Street Garage	Alley	Public	Private	Private/ Business	Free	Meter/ Pay	Permit	Point/ Side	Handi-capped	Time restricted	Loading zone	

Figure 3-2: Parking inventory data collection sheet

Table 3-1: Overall inventory of downtown Bozeman parking assets

Type	1038	1037	1036	1032	1031	1030	1029	1028	1027	1026	1025	1024	1023	1022	1021	1020	1019	1018	1017	1016	1015	1014	1013	1012	1011	1010	1009	1008	1007	1006	1005	Total
On-street, Public, Free, No time restriction	72	70	36	96	64	40	12	14	9	0	0	0	21	43	78	51	9	0	0	0	0	12	9	90	24	58	40	31	46	28	54	**1007**
On-street, Public, Free, No time restriction, Handicapped	0	0	1	1	0	1	0	0	0	0	0	0	1	0	0	0	2	0	0	0	0	0	0	1	0	1	2	0	0	0	0	**10**
On-street, Public, Free, Time restricted (2 hrs)	0	0	0	0	0	0	25	55	26	32	47	58	7	28	0	0	22	69	52	32	39	32	24	0	41	13	0	0	3	5	0	**610**
On-street, Public, Free, Time restricted (2 hrs), Handicapped	0	0	0	0	0	0	0	1	0	3	1	1	0	0	0	0	0	3	1	2	0	3	2	0	0	0	0	0	0	0	0	**17**
On-street, Public, Free, Time restricted (30 min)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	**5**
On-street, Public, Free, Time restricted (15 min)	0	0	0	0	0	0	0	0	0	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**18**
Off-street Parking Garage (Including Handicapped)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	435	0	0	0	0	0	0	0	0	0	0	0	**435**
Off-street lot, Private/Business, Time restricted (1 hr)	0	0	0	0	0	0	0	0	58	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**58**
Off-street lot, Private/Business, Time restricted (2 hr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27	0	0	0	0	0	0	0	0	0	0	0	0	0	**27**
Off-street lot, Private/Business, Time restricted (1 hr), Handicapped	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**2**
Off-street lot, Public, Free, No time restriction	0	0	0	0	133	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**133**
Off-street lot, Public, Free, Time restricted	0	0	0	0	0	0	0	41	0	0	0	0	0	0	0	0	0	0	58	0	26	0	0	0	0	0	0	0	41	0	0	**166**
Off-street lot, Public, Free, Time restricted, Handicapped	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0	2	0	0	**8**
Off-street lot, Private/Business	52	56	47	66	73	50	86	75	0	41	51	103	76	0	0	105	48	76	31	0	0	50	49	164	19	84	36	0	32	69	108	**1647**
Off-street lot, Private/Business, Permit required	0	45	2	0	0	36	0	25	0	6	14	0	5	50	148	8	53	22	5	0	23	0	36	6	0	39	59	96	0	7	4	**689**
Off-street lot, Private/Business, Handicapped	2	2	2	3	7	3	4	3	0	2	0	1	2	0	7	2	4	0	0	0	3	2	2	6	1	4	0	0	1	1	4	**68**
Off-street lot, Private/Business, Loading zone	0	0	1	3	7	0	0	0	5	0	0	0	0	2	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0	**22**
Alley parking, Private/Business	0	0	0	0	20	2	2	0	0	5	0	0	3	0	0	14	0	0	21	10	3	0	0	2	0	3	8	0	0	0	0	**93**
Alley parking, Private/Business, Handicapped	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**2**
Alley parking, Public, Free, time restricted (2 hr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	**13**
On-street, Free, Loading Zone	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	**4**
Total	**126**	**173**	**89**	**169**	**304**	**135**	**131**	**216**	**100**	**107**	**113**	**163**	**115**	**123**	**233**	**180**	**138**	**197**	**183**	**479**	**96**	**101**	**122**	**271**	**85**	**203**	**150**	**127**	**125**	**110**	**170**	**5034**

3.3. Public and Private Parking Assets

Table 3-2 presents summary statistics for the publicly and privately owned parking assets in the downtown area. As shown, public stalls comprise approximately 48 percent of downtown parking inventory, while private stalls (i.e. business parking lots) comprise approximately 52 percent. The majority of public parking is on-street, comprising 1,667 stalls or approximately 33 percent of all available downtown stalls (5,034). Off-street public parking stalls (742) consisted primarily of the downtown parking garage, as well as four surface lots throughout the area. Interestingly, 17 stalls were observed to be publically owned alley and/or loading zones.

As one would expect, no private on-street parking stalls were observed. Off-street stalls consisted almost entirely of business parking lots (approximately 49 percent of all downtown stalls recorded), with 2,491 stalls recorded. Note that this parking is only available to patrons of the business that provides it. A lesser number of stalls (117) were recorded as private alley and/or loading zones (approximately 2 percent of all downtown inventory). All of these observed characteristics were expected.

Table 3-2: Public and Private parking assets

	Public	Private
On-Street (1667 stalls)	1667 stalls (33.1%)	0 stalls (0.0%)
Off-Street (3233 stalls)	742 stalls (14.7%)	2491 stalls (49.3%)
Other (alley/loading zone) (134 stalls)	17 stalls (0.3%)	117 stalls (2.3%)
Total	2426 stalls (48.4%)	2608 stalls (51.6%)

3.4. Parking Restrictions

Table 3-3 presents a summary of public and private parking restrictions. Note that public parking is comprised of both on- and off-street parking, while private parking consists solely of off-street stalls. All public parking stalls inventoried by this work were free when within the posted time restriction, while a portion of private parking stalls required a permit (689 stalls). A determination of whether such permits required payment or were distributed free to business employees by their employer was beyond the scope of this work. The percentages displayed are related to the total downtown parking stalls inventoried (5,034). Also, the reader should note that the total stalls presented in the table do not total to the number of inventoried downtown stalls. Rather, 3,143 stalls are identified in this table, comprising 62 percent of all parking spaces inventoried. The reason for this discrepancy is that the 1,740 private parking lot stalls identified by the inventory, while not having a time limit restriction, were intended for patron use only. Additionally, 151 alley/loading zone parking stalls were excluded from this characterization for conciseness.

As the table indicates, 1,007 stalls (20.1 percent) of downtown parking were identified as being unrestricted. An additional 1,740 business parking stalls were identified as free of cost and time restraints, but they were intended for customers only. Consequently, these stalls are in fact restricted to some extent.

Only public on-street parking was subject to a 15 minute restriction, although this applied to only 18 stalls. As a portion of all downtown parking stalls available, this restriction applied to an insignificant portion of the population. The same is true of the half-hour time restriction for

public on-street parking, which applied to only 5 stalls. The 2-hour time restriction for public on-street parking only applied to 610 stalls, or approximately 37percent of the total 1,667 public on-street spaces available downtown.

Off-street public parking only had 2-hour time restrictions in place. The parking structure comprised the majority of stalls in this group (425, excluding handicapped stalls). As a whole, off-street public parking with a 2-hour restriction comprised 604 available stalls, or approximately 12 percent of the 5,034 inventoried downtown parking stalls.

Private parking with a 1-hour time restriction totaled 58 off-street s, while 27 stalls had a 2-hour time restriction. Each of these categories represents an insignificant total of all available downtown parking available. A total of 689 private off-street stalls required a permit. In essence, these stalls were not available for general public parking. This totaled approximately 13.5 percent of all downtown parking inventory, which, while not a large figure, still represents a somewhat significant proportion of available parking.

Finally, Table 3-3 summarizes the total inventory of handicapped parking stalls available downtown. A total of 125 stalls or 2.5 percent of all available downtown parking is designated handicapped. The majority of this parking is free of time restrictions, although some stalls did have a 1- or 2-hour time limit. Approximately 36 percent of all handicapped stalls were public (45 stalls), while the remaining 64 percent (80 stalls) were provided in private lots.

Table 3-3: Summary of Parking Restrictions

	Public				
	None	15 min	1/2 hr	2 hr	Handicapped
On-street	1007 stalls (20.1%)	18 stalls (0.4%)	5 stalls (0.1%)	610 stalls (12.1%)	27 stalls (0.5%)
Off-street	0 stalls (0.0%)	0 stalls (0.0%)	0 stalls (8.4%)	604 stalls (12.0%)	18 stalls (0.4%)
	Private				
	None	1 hr	2 hr	Permit	Handicapped
Off-street	0 stalls (0.0%)	58 stalls (1.2%)	27 stalls (0.5%)	689 stalls (13.5%)	80 stalls (1.5%)

Figure 3-3 further illustrates the distribution of public parking facilities (on- and off-street) in the downtown study area. Narrow borders around the block correspond to on-street parking (with the quantities of parking under each restriction noted). Off-street public parking is illustrated by the solid shapes inside the respective blocks that possess such facilities. Off-street parking includes all surface lots and the parking garage. Note the distribution of parking restrictions (primarily 2-hour restrictions) centered about the downtown core. These restrictions apply to both on- and off-street parking (excluding off-street parking contract permit holders). The only exception of off-street parking that was not restricted[7] was the library lot, located in block 1031.

[7] In one sense, the library lot is unrestricted in that it does not have a time limit imposed on parkers. In a different sense, parking is restricted to library patrons only. Given the location of the library in proximity to Lindley Park, it is possible that some motorists are using the lot when visiting the park. As the restrictions referred to in this document pertain to time limitations and permit requirements (both of which are absent in the case of the library), this parking lot has been classified as “unrestricted”.

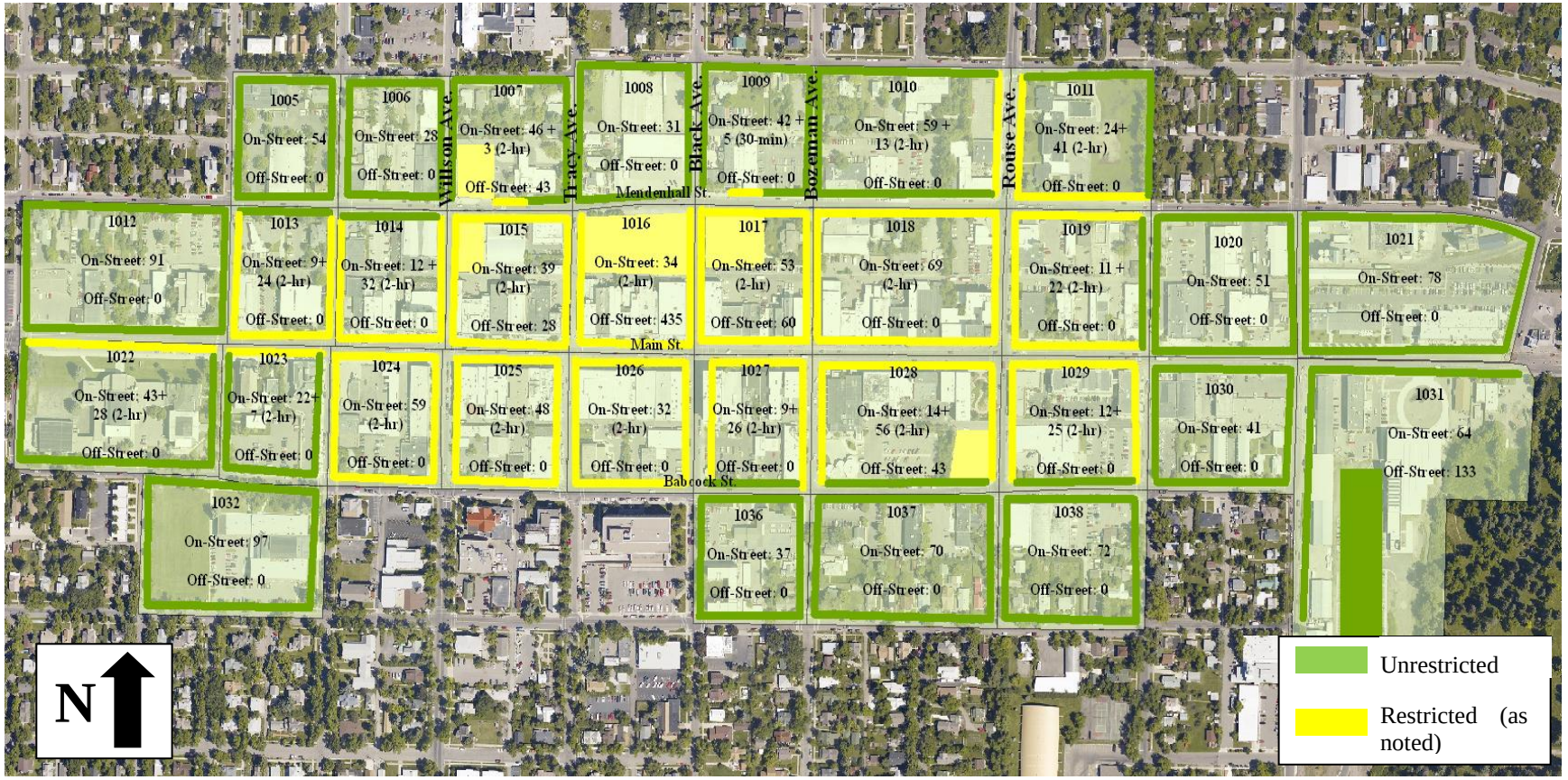

Figure 3-3: Public parking distribution

3.5. Chapter Summary

This chapter has discussed the collection and characterization of downtown parking stall inventory data. Data collection occurred on July 27, 28, and 29, 2010, for a total of 31 downtown block groups. A data collector walked each downtown block in the study area and recorded the various parking assets observed by their different characteristics on a data collection sheet. Characteristics recorded included number of spaces, type of parking (on-street, off-street), ownership, fees and restrictions.

The inventory found that a total of 5,034 parking stalls were available in the downtown study area. This represents an average of 162 stalls per block, although some blocks contain far more or less than this average. The majority of blocks had between 100 and 200 parking stalls of various types available. Publicly-owned stalls comprised approximately 48 percent of downtown parking inventory, while private stalls (i.e. business parking lots) comprised approximately 52 percent. This totaled to 2,426 public parking stalls and 2,608 private parking stalls in the downtown area.

In examining parking restrictions, 1,007 stalls (20.1 percent) of downtown parking were unrestricted. Private parking for businesses comprised of 1,740 stalls (including those for patron use only), or approximately 35 percent of downtown parking. A total of 689 private off-street stalls were recorded as requiring a permit. Finally, a total of 125 stalls or 2.5 percent of all available downtown parking is designated handicapped.

While the city controls less than 50 percent of all available downtown parking, this should not be considered problematic. As the results of the occupancy rate studies presented in a later chapter illustrate, at no time were all downtown parking assets close to capacity. As a result, there appears to be ample capacity to absorb any increases in parking need/demand in the immediate future.

4. GEOGRAPHIC INFORMATION SYSTEMS MAPPING

One useful approach to understanding the parking inventory data collected is through mapping. The development of various maps allows for an understanding of the distribution and location of various types of parking assets through downtown Bozeman. This includes the total number of stalls per block, the breakdown of public versus private ownership, restrictions, and so forth.

To accomplish the mapping portion of this work, GIS were employed. GIS is a mapping tool which allows for the presentation of various map-based information. For this work, ArcView GIS was used in developing the maps presented in the following sections.

In addition to mapping the various features associated with downtown parking, shapefiles were created for future use and analysis by city personnel. Shapefiles are shape-based features (lines, points, polygons) which represent a physical feature. In this work, existing shapefiles generated by the City of Bozeman's GIS Office, specifically block groups, were used as the base shapefile, with parking inventory added to the file based on the characteristics recorded in the field.

4.1. Total Stalls

The first map generated by this portion of the work was a representation of the total parking inventory on each block. Figure 4-1 presents the total number of spaces identified by the field inventory on each block, with the block number presented at the top of each block in bold and the total available parking stalls listed toward its center. Note that in general, each block possesses a fairly high number of stalls, with only three blocks containing (slightly) less than 100 stalls.

Figure 4-1: Total parking stall inventory by block

4.2. Public and Private Ownership by Block

The map presented in Figure 4-2 presents the distribution of publicly and privately owned parking stalls in the study area. Of interest is that all blocks contain at least some stalls from each ownership group. No discernable trends have been observed regarding the distribution of public versus private ownership by block (ex., higher public ownership in the center of the study area versus private at the periphery).

4.3. Handicapped Parking by Block

The map presented in Figure 4-3 presents the distribution of accessible stalls provided throughout the study area. Note that no distinction has been made regarding public and private ownership, as all accessible stalls recorded in the inventory were unrestricted in terms of public use (aside for a limited number of stalls having a time restriction). As the figure indicates, all blocks, with the exception of 1008 and 1022, contain at least a minimum of one accessible stall. Block 1008 contains the former Kenyon Noble property, as well as other assorted businesses (ex., auto repair), so it is not entirely out of place that the block contains no accessible stalls. This block also contains a large number of stalls requiring parking permits, as will be seen in the following section. Block 1022 is home to Willson School, so it is a bit more surprising that this block has no accessible parking. However, the data collector noted no pavement markings or signage to indicate that accessible parking was present on this block.

Figure 4-2: Public and private parking stall inventory by block

Figure 4-3: Handicapped stall inventory by block

4.4. Permit Parking by Block

As the inventory noted, several parking locations throughout the downtown study area required permits. In some cases, these permits were required for longer-duration (2+ hours) parking in city-owned lots. In other cases, permits were required by businesses to restrict parking to employees only. The distribution of permit-required stalls is presented in Figure 4-5. Block 1008, which as discussed previously had no accessible stalls, contained the second largest number of permit stalls in the study area. The largest number of permit stalls observed was 148 in Block 1021. This block contains several private businesses, which explains this high figure.

4.5. On-Street and Off-Street Parking

Being a downtown area, the blocks examined in this study contain a significant proportion of on-street parking. Of course, off-street parking was also available in large numbers, as discussed previously. The distribution of on-street and off-street parking by block is presented in Figure 4-5. Interestingly, all of the blocks of the downtown area contain at least a minimum of on-street parking stalls. All such stalls are free to the public and generally are unrestricted.

Figure 4-4: Permit-required parking by block

Figure 4-5: Public and private on-street and off-street parking stalls (total) by block

4.6. City-Owned Parking Lots

As part of the overall inventory, the individual parking assets owned by the city are of interest, namely off-street parking lots. Figure 4-6 illustrates the location of downtown city-owned lots as well as the total inventory of those lots, broken down by standard and accessible stalls. A total of 622 off-street stalls are maintained by the city and presented in this figure. This represents a significant quantity of parking near the center of the downtown area.

4.7. Occupancy Rates by Block

While discussed later in Chapter 5, the visual presentation of occupancy rates observed throughout the downtown area is also of interest. Occupancy rates measure the level of utilization of a parking area for a specific period of time. Figure 4-7 presents the peak occupancy rates observed on both a weekday (Wednesday, August 11, 2010) and weekend (Saturday, September 11, 2010) for ten block groups in the downtown area. These groups were selected by the Parking Commission as being of the greatest interest. As the figure indicates, weekday observations of peak occupancy generally were above 50 percent and exceeded 80 percent in some cases. This indicates that when the highest observed use during the data collection period occurred, over half of the total available stalls on a block were occupied. As one would expect, weekend occupancy peaks were generally lower than those observed on the weekday. Of course, the exception to this was the occupancy rates of blocks 1025 and 1028. These occupancies were likely higher on weekends for these blocks because of the proximity of parking to downtown attractions. Note that the peak occupancy rates presented only represent the highest *observed* peak. It is possible that higher occupancies occurred during another time period throughout the day when data collection activities were not taking place.

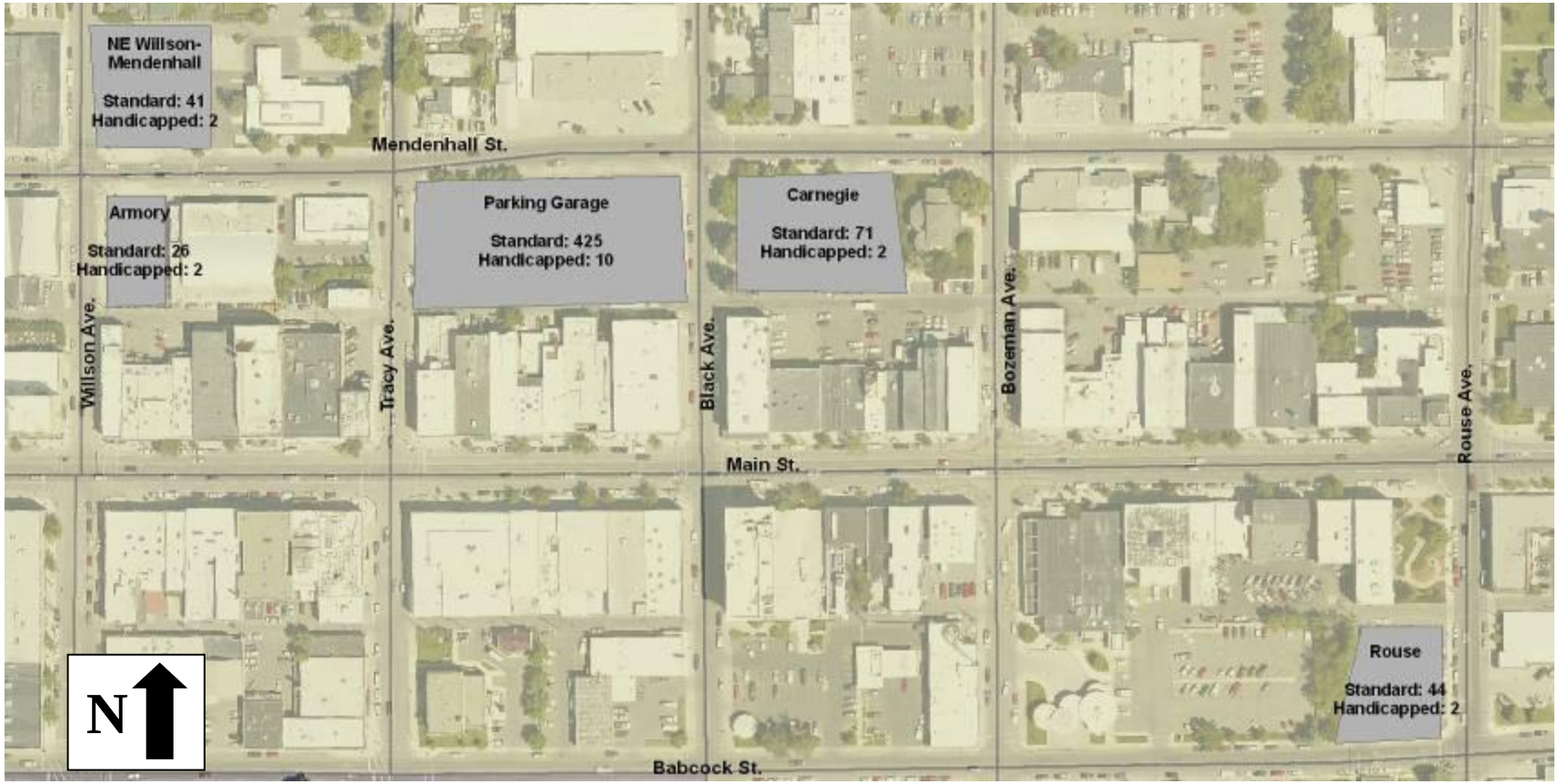

Figure 4-6: Off-street public parking

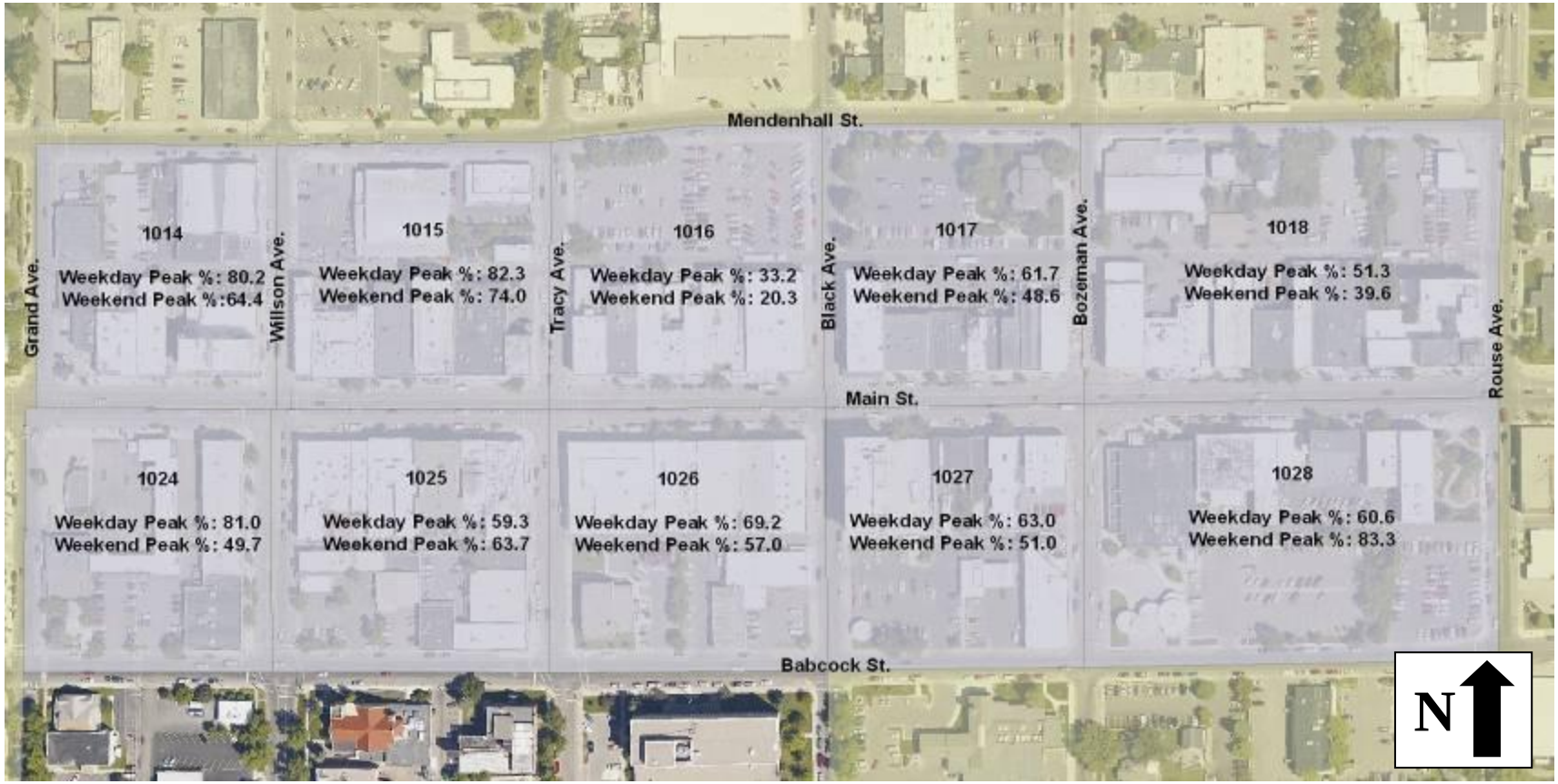

Figure 4-7: Parking occupancy rates

4.8. Dwell Times by Block

Although discussed in detail in Chapter 6, a map of observed dwell times in city-owned lots (excluding the parking garage) and two segments of on-street parking was of interest. As Figure 4-8 illustrates, the lots of interest were those in the northeast and southeast corners of the Mendenhall St. and Willson Ave. intersection, the "Carnegie" lot, located at the corner of Mendenhall St. and Black Ave, the "Rouse" lot located at the corner of Babcock St. and Rouse Ave., on-street parking on the north side of Main St. between Willson Ave. and Black Ave., and on-street parking on the west side of Tracy Ave. between Babcock St. and Mendenhall St. All of these lots and locations were selected by the Parking Commission, with data collected on various weekdays between late August and early October, 2010.

The map presents average dwell times for each of the lots and on-street parking areas. Note that that on-street parking denoted by slender grey rectangles represents continuous study segments, with gaps occurring at the location of the Main St. and Tracy Ave. intersection. As the map indicates, the average dwell time for these parking areas ranged from 38 minutes to 1 hour. In general, these averages suggested that on-street versus off-street parking functioned in a similar manner, as no significant differences were observed in terms of the dwell times of vehicles parked in lots compared to those which parked on-street.

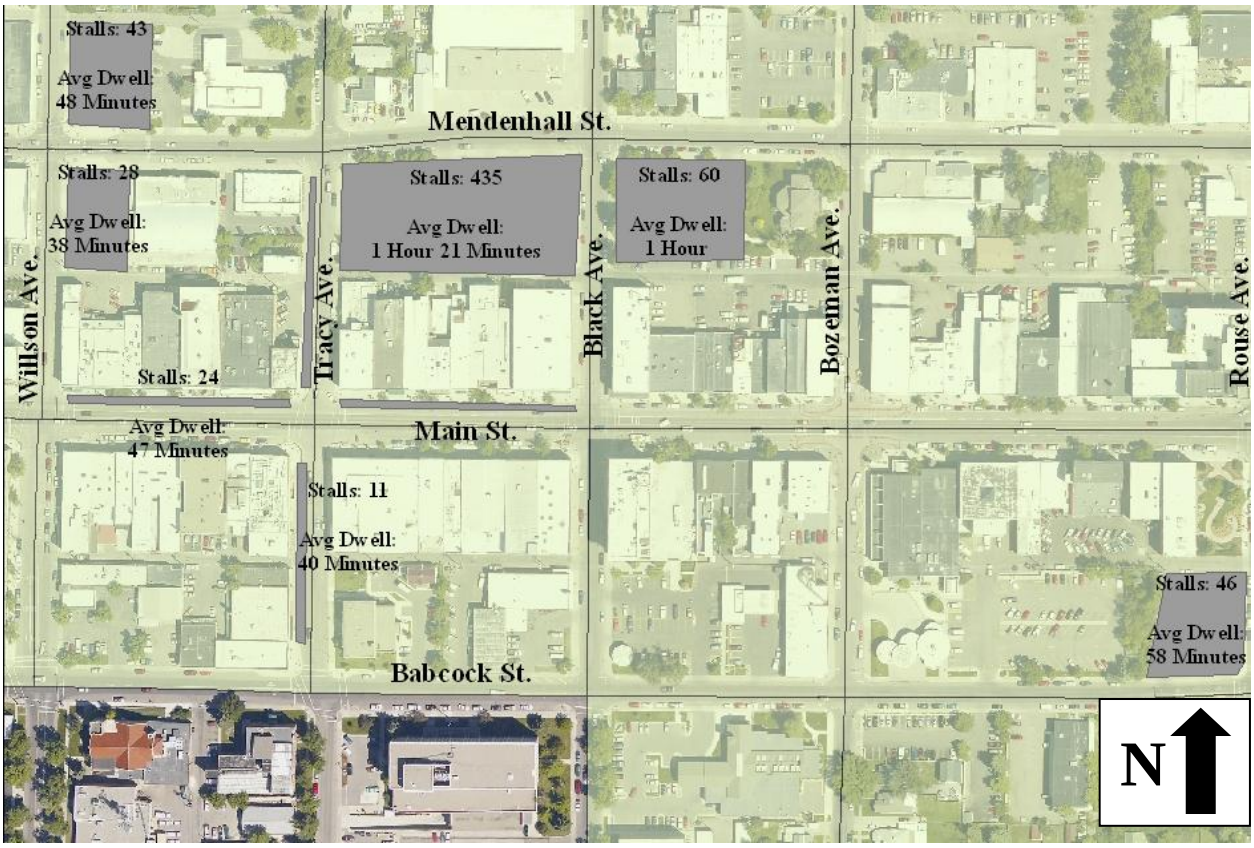

Figure 4-8: Off-street public parking dwell times

4.9. Chapter Summary

This chapter has presented the results of various parking inventory items in a map-based manner. These maps, which present data at the block level, included the total number of stalls available, public and private ownership, accessible stalls, permit parking stalls, on- and off-street stalls, city-owned lot information, occupancy rates and dwell times. In presenting this information on maps, the reader may better understand the distribution of various parking assets on a block by block basis in the downtown area.

5. OCCUPANCY RATES

Occupancy rates are a measure of the level of utilization of a parking area for a specific period of time. They help in understanding how parking demand fluctuates during the course of a day for a particular block or parking lot. To collect the data to support this metric, field data collectors made manual observations and recordings of the vehicles parked in the blocks of interest at given time intervals. Using these observations, occupancy rate was computed as:

$$OR = \frac{N_T}{P_S} * 100$$

Where:

OR = Occupancy rate, spaces/hour

N_T = total number of parked vehicles observed

P_S = total number of legal parking stalls

Occupancy rate data was collected and estimations have been developed for three dates: Wednesday, August 11; Saturday, September 11; and Thursday, September 16, 2010. In the case of the last date, occupancy data was recorded for both the Northeast and Southeast parking lots at the intersection of Mendenhall St. and Willson Ave. These lots were examined at the request of the Parking Commission.

5.1. Block Level Occupancy Rates

Of primary interest to the Parking Commission were the occupancy rates for the heart of the downtown area. These blocks included 1014, 1015, 1016, 1017, 1018, 1024, 1025, 1026, 1027, and 1028. The following sections will discuss the occupancy rate findings for each of these block groups in detail.

5.1.1. Block 1014

Block 1014 is bordered by Mendenhall St., Willson Ave., Main St. and Grand Ave. on its north, east, south and west sides, respectively. Table 5-1 presents both the number of vehicles parked during each observation period on Wednesday, August 11 and Saturday, September 11, 2010, as well as the resulting occupancy rate for the block. Block 1014 had a total of 101 parking spaces. As the results indicate, the block saw a general increase in occupancy rates on each collection date as the day progressed. This is further illustrated in Figure 5-1. The peak observed rate was approximately 80 percent occupancy at noon on Wednesday, August 11, 2010. The corresponding time on Saturday, September 11, 2010 produced a 20 percent lower occupancy rate, although this can be attributed to that data being collected on a Saturday as opposed to a Wednesday. The general trend observed for this block on each date was an increase in occupancy rates throughout the afternoon and early evening hours. This suggests that more vehicles are parking for downtown trip purposes, such as evening dining, than morning activities.

Table 5-1: Block 1014 parking observations and occupancy rates

Wednesday, August 11, 2010			Saturday, September 11, 2010		
Time	**Parked Vehicles**	**Occupancy Rate**	**Time**	**Parked Vehicles**	**Occupancy Rate**
7:00 AM	23	22.8%	7:20 AM	22	21.8%
8:00 AM	27	26.7%	9:10 AM	28	27.7%
9:00 AM	38	37.6%	10:15 AM	43	42.6%
10:00 AM	49	48.5%	12:10 PM	60	59.4%
11:00 AM	71	70.3%	2:00 PM	52	51.5%
12:00 PM	81	80.2%	3:30 PM	45	44.6%
1:00 PM	72	71.3%	4:05 PM	63	62.4%
2:00 PM	71	70.3%	5:25 PM	61	60.4%
3:30 PM	75	74.3%	6:55 PM	57	56.4%
4:40 PM	66	65.3%	8:20 PM	65	64.4%
5:50 PM	63	62.4%			
7:05 PM	66	65.3%			
8:30 PM	60	59.4%			

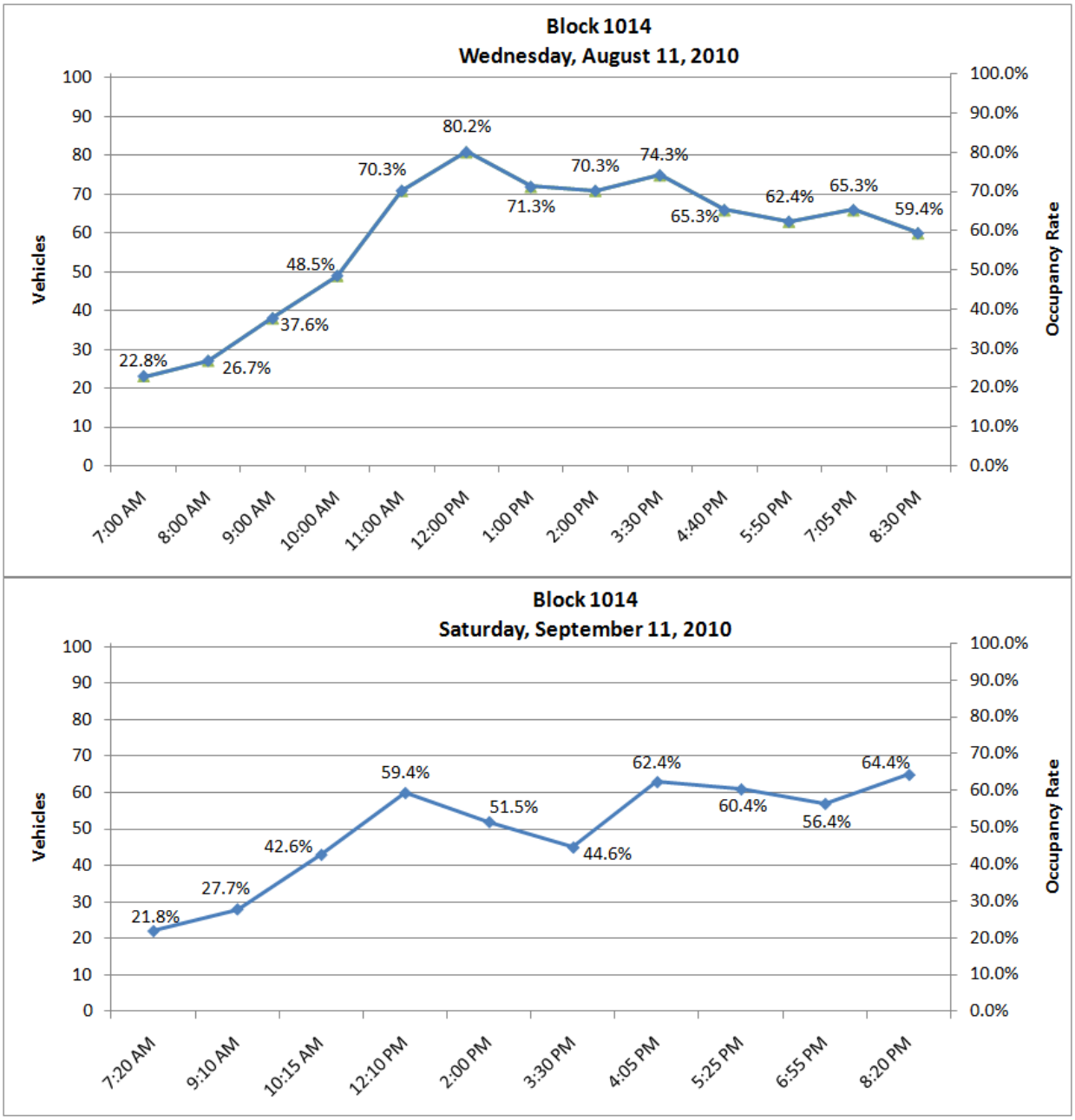

Figure 5-1: Block 1014 vehicle observations versus occupancy rates

5.1.2. Block 1015

Block 1015 is bordered by Mendenhall St., Tracy Ave., Main St. and Willson Ave. on its north, east, south and west sides, respectively. Table 5-2 presents both the number of vehicles parked during each observation period on Wednesday, August 11 and Saturday, September 11, 2010, as well as the resulting occupancy rate for the block. Block 1015 had a total of 96 parking spaces, including 28 in a city-owned public lot. This block saw a gradual increase in occupancy rates on both data collection dates. This is illustrated in Figure 5-2. Interestingly, a larger noontime rate was observed on the Saturday data collection as compared to Wednesday. Conversely, the largest rate observed overall was during the 7:00 p.m. hour on Wednesday. On both dates, occupancy

rates generally rose throughout the afternoon, peaking in the early evening. This once again suggests that more vehicles are parking for downtown trip purposes, such as evening dining, than morning activities.

Table 5-2: Block 1015 parking observations and occupancy rates

Wednesday, August 11, 2010			Saturday, September 11, 2010		
Time	**Parked Vehicles**	**Occupancy Rate**	**Time**	**Parked Vehicles**	**Occupancy Rate**
7:12 AM	22	22.9%	7:35 AM	24	25.0%
8:10 AM	20	20.8%	9:20 AM	41	42.7%
9:10 AM	35	36.5%	10:30 AM	55	57.3%
10:10 AM	47	49.0%	12:20 PM	71	74.0%
11:10 AM	67	69.8%	2:25 PM	66	68.8%
12:10 PM	67	69.8%	3:45 PM	52	54.2%
1:10 PM	72	75.0%	4:15 PM	53	55.2%
2:10 PM	70	72.9%	5:35 PM	56	58.3%
3:40 PM	73	76.0%	7:05 PM	60	62.5%
4:40 PM	66	68.8%	8:30 PM	54	56.3%
6:01 PM	65	67.7%			
7:15 PM	79	82.3%			
8:45 PM	72	75.0%			

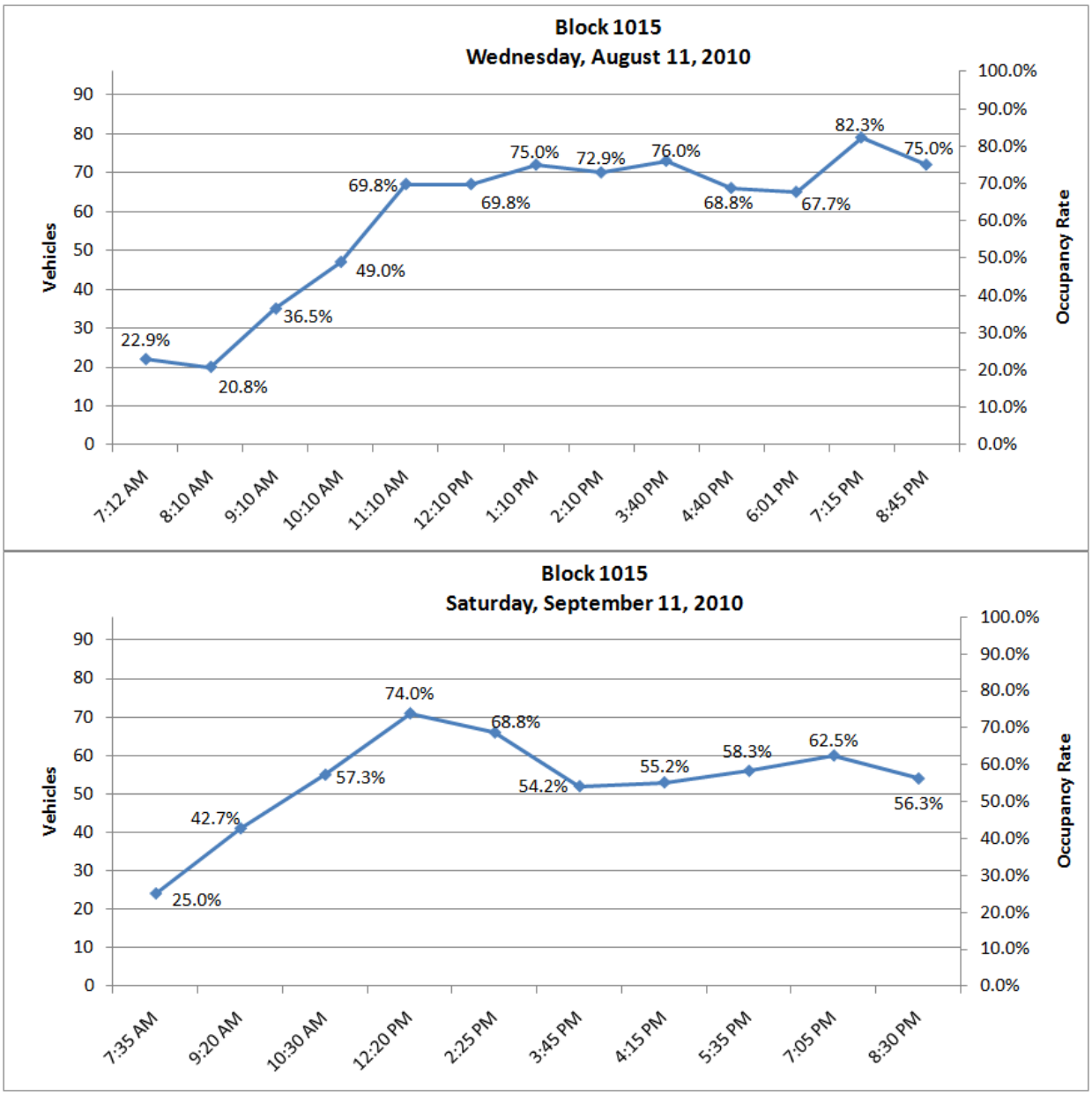

Figure 5-2: Block 1015 vehicle observations versus occupancy rates

5.1.3. Block 1016

Block 1016 is bordered by Mendenhall St., Black Ave., Main St. and Tracy Ave. on its north, east, south and west sides, respectively. Table 5-3 presents both the number of vehicles parked during each observation period on Wednesday, August 11 and Saturday, September 11, 2010, as well as the resulting occupancy rate for the block. Block 1016 had a total of 479 parking spaces, including 435 stalls in the city's parking garage. Similar to the other block groups examined thus far, block 1016 saw a gradual increase in occupancy rates throughout the morning and culminating at approximately noon. Interestingly, occupancy rates following these peaks fell steadily throughout the afternoon, reaching levels comparable to those observed during the early morning period. This is illustrated in Figure 5-3. The nature of this trend seems to indicate that

the parking on this block (on weekdays) is predominantly work-related, as evidenced by the drop in occupancy following normal business hours. On weekends, occupancy on this block was quite low. Of course, one must bear in mind that the observed number of vehicles and resulting occupancy rates all appear lower given the large parking capacity contained within the block itself. Note that the occupancy rates observed on this block are lower than those observed elsewhere due to the inclusion of the parking garage stalls in this analysis.

Table 5-3: Block 1016 parking observations and occupancy rates

Wednesday, August 11, 2010			Saturday, September 11, 2010		
Time	**Parked Vehicles**	**Occupancy Rate**	**Time**	**Parked Vehicles**	**Occupancy Rate**
7:17 AM	37	7.7%	7:45 AM	46	9.6%
8:15 AM	66	13.8%	9:25 AM	49	10.2%
9:20 AM	102	21.3%	10:40 AM	79	16.5%
10:20 AM	131	27.3%	12:25 PM	97	20.3%
11:20 AM	140	29.2%	2:35 PM	71	14.8%
12:20 PM	152	31.7%	3:34 PM	68	14.2%
1:20 PM	159	33.2%	4:25 PM	52	10.9%
2:20 PM	154	32.2%	5:40 PM	47	9.8%
3:45 PM	135	28.2%	7:15 PM	50	10.4%
4:50 PM	139	29.0%	8:30 PM	44	9.2%
6:11 PM	75	15.7%			
7:25 PM	63	13.2%			
9:00 PM	51	10.6%			

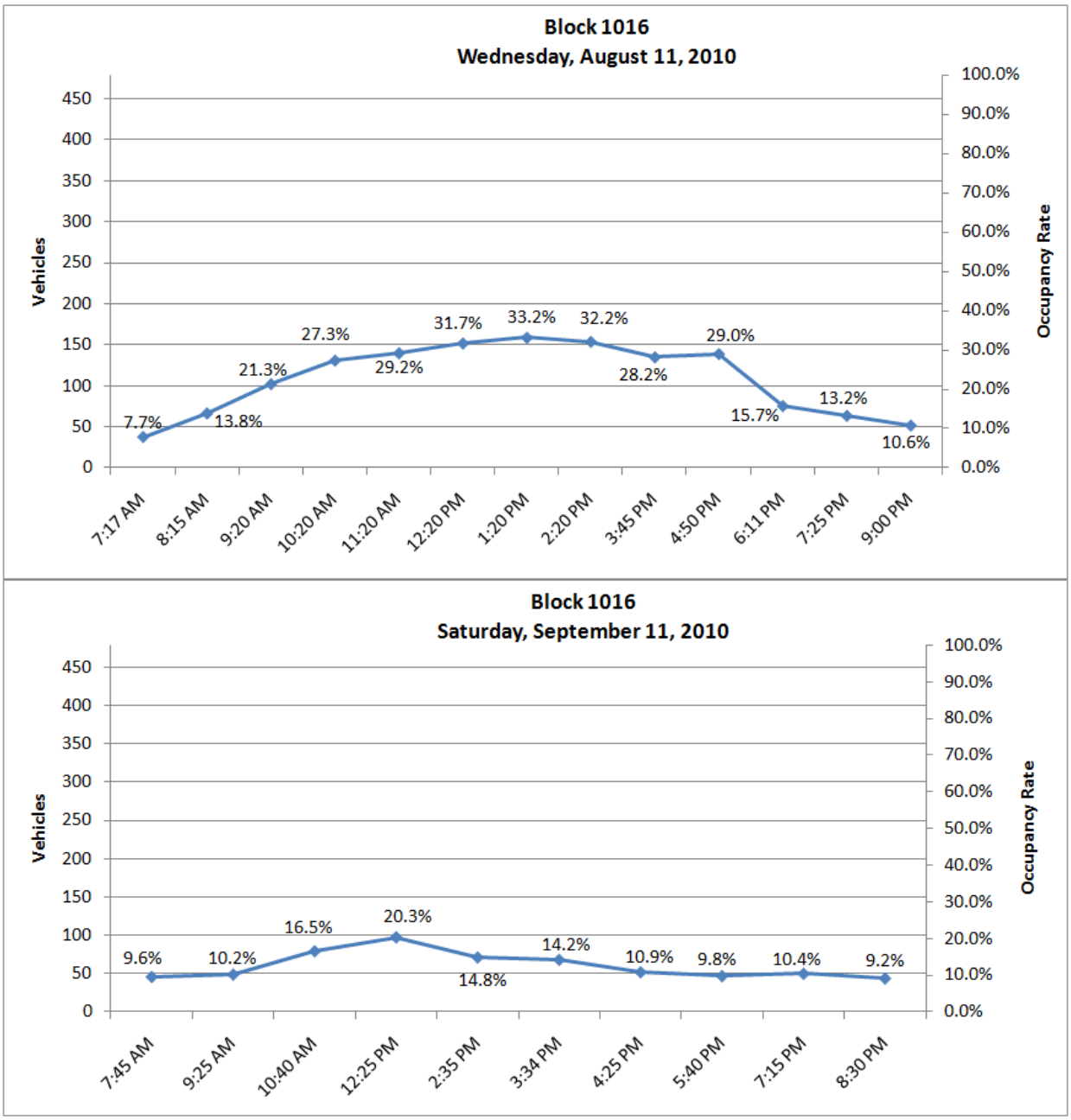

Figure 5-3: Block 1016 vehicle observations versus occupancy rates

5.1.4. Block 1017

Block 1017 is bordered by Mendenhall St., Bozeman Ave., Main St. and Black Ave. on its north, east, south and west sides, respectively. Table 5-4 presents both the number of vehicles parked during each observation period on Wednesday, August 11 and Saturday, September 11, 2010, as well as the resulting occupancy rates for the block. Block 1017 had a total of 183 parking spaces, including 73 stalls in a city-owned public lot. Similar to the other block groups, Block 1017 saw a gradual increase in occupancy rates throughout the morning and culminating at approximately 12:30 p.m. Occupancy rates following these peaks fell steadily throughout the afternoon, before once again climbing briefly in the early evening (7:00 hour). This is illustrated in Figure 5-4.

Overall, occupancy rates tended to be higher on the weekday collection date as opposed to the weekend. Just as with other block groups, it would appear that the parking occupancy on this block corresponds generally to lunch and dinner periods.

Table 5-4: Block 1017 parking observations and occupancy rates

Wednesday, August 11, 2010			Saturday, September 11, 2010		
Time	**Parked Vehicles**	**Occupancy Rate**	**Time**	**Parked Vehicles**	**Occupancy Rate**
7:30 AM	20	10.9%	8:00 AM	33	18.0%
8:25 AM	42	23.0%	9:35 AM	51	27.9%
9:30 AM	79	43.2%	10:55 AM	79	43.2%
10:30 AM	78	42.6%	12:40 PM	89	48.6%
11:30 AM	87	47.5%	2:45 PM	71	38.8%
12:30 PM	109	59.6%	3:25 PM	67	36.6%
1:30 PM	113	61.7%	4:30 PM	59	32.2%
2:30 PM	87	47.5%	5:30 PM	51	27.9%
4:00 PM	95	51.9%	7:20 PM	77	42.1%
5:00 PM	86	47.0%	8:40 PM	71	38.8%
6:13 PM	86	47.0%			
7:37 PM	101	55.2%			
9:10 PM	79	43.2%			

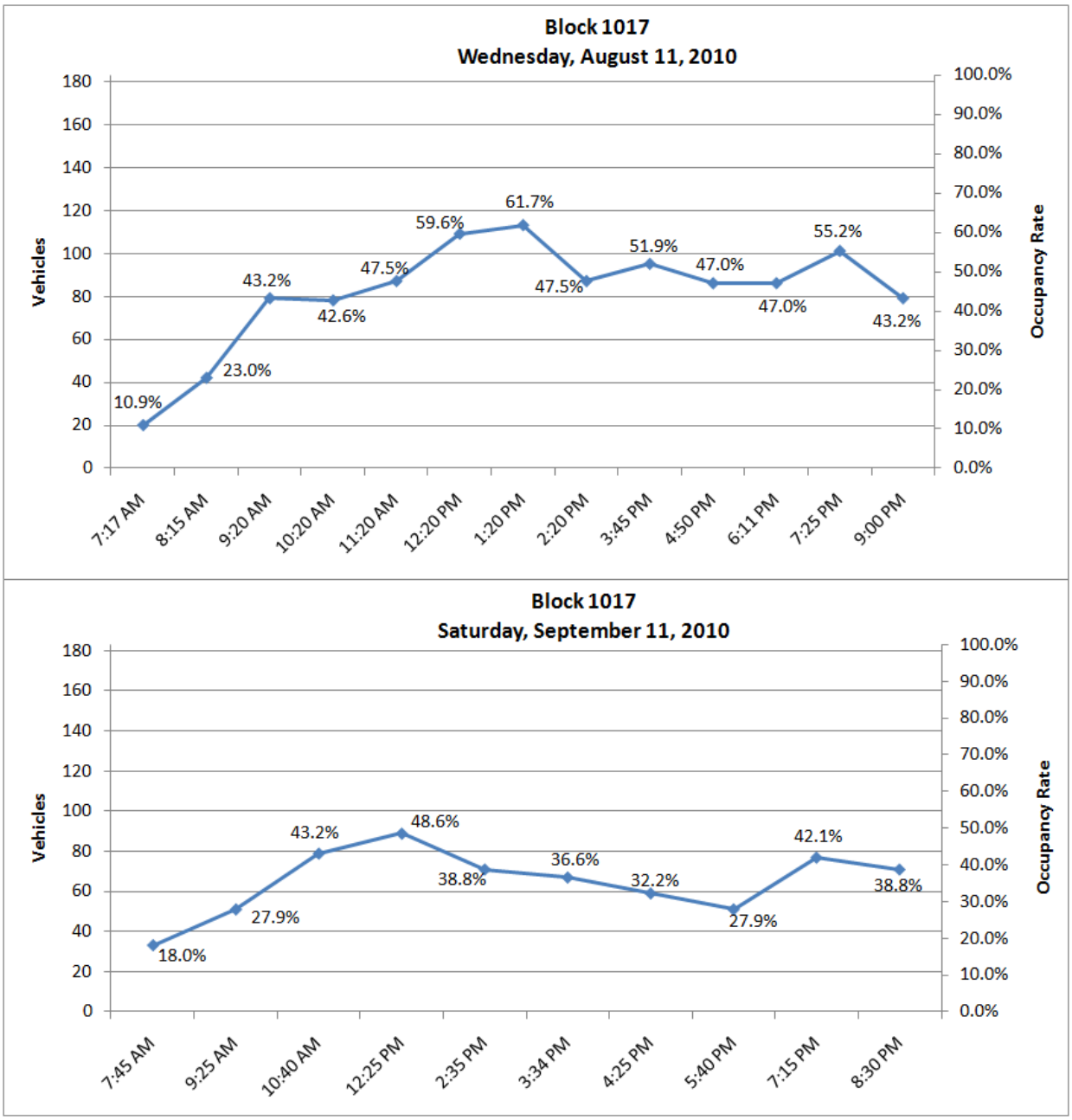

Figure 5-4: Block 1017 vehicle observations versus occupancy rates

5.1.5. Block 1018

Block 1018 is bordered by Mendenhall St., Rouse Ave., Main St. and Bozeman Ave. on its north, east, south and west sides, respectively. Table 5-5 presents both the number of vehicles parked during each observation period on Wednesday, August 11, and Saturday, September 11, 2010, as well as the resulting occupancy rates for the block. Block 1018 had a total of 197 parking spaces. Similar to the other block groups, Block 1018 saw a gradual increase in occupancy rates throughout the morning and culminating during the noon hour. Occupancy rates following these peaks fluctuated throughout the afternoon, but never again exceeded the peak occupancies of the noon hour on either date. Figure 5-5 graphically depicts the occupancy rate

trends for this block. Note that occupancy rates tended to be lower during the weekend observation compared to the weekday. It should also be noted that the overall occupancy rates on this block tended to be lower than the previous blocks examined. This is likely due to the fact that this block does not host any public parking lots as previous blocks had. Additionally, this block is somewhat near the fringe of the downtown area, and is thus less likely to draw in vehicles on trips to visit downtown businesses, even on weekends.

Table 5-5: Block 1018 parking observations and occupancy rates

Wednesday, August 11, 2010			Saturday, September 11, 2010		
Time	**Parked Vehicles**	**Occupancy Rate**	**Time**	**Parked Vehicles**	**Occupancy Rate**
7:45 AM	39	19.8%	8:36 AM	30	15.2%
8:30 AM	75	38.1%	9:49 AM	37	18.8%
9:40 AM	79	40.1%	11:05 AM	68	34.5%
10:40 AM	85	43.1%	12:45 PM	78	39.6%
11:40 AM	98	49.7%	2:55 PM	60	30.5%
12:40 PM	101	51.3%	3:20 PM	61	31.0%
1:40 PM	93	47.2%	4:50 PM	70	35.5%
2:40 PM	96	48.7%	5:55 PM	63	32.0%
4:10 PM	94	47.7%	7:27 PM	66	33.5%
5:10 PM	64	32.5%	8:45 PM	69	35.0%
6:43 PM	74	37.6%			
7:47 PM	79	40.1%			
9:23 PM	86	43.7%			

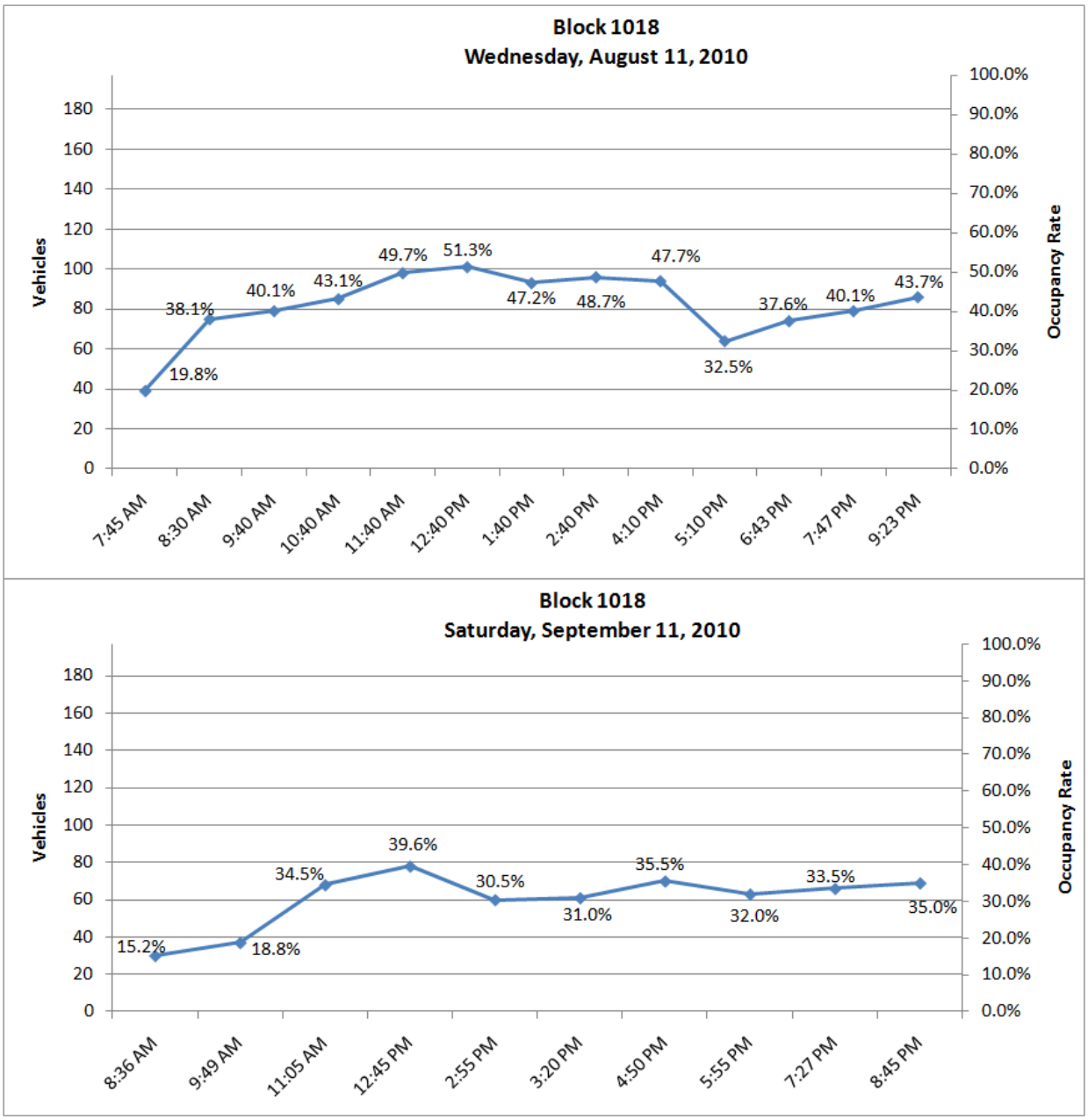

Figure 5-5: Block 1018 vehicle observations versus occupancy rates

5.1.6. Block 1024

Block 1024 is bordered by Main St., Willson Ave., Babcock St. and Grand Ave. on its north, east, south and west sides, respectively. Table 5-6 presents both the number of vehicles parked during each observation period on Wednesday, August 11, and Saturday, September 11, 2010, as well as the resulting occupancy rates for the block. Block 1024 had a total of 163 parking spaces. Unfortunately, the data collector for this block on Wednesday, August 11, 2010, misunderstood the collection interval instruction, hence the data gap exhibited between approximately 9:00 a.m. and noon on that date. On this date, a peak occupancy was observed during the noon hour, similar to that of other blocks. Following this peak, occupancy fluctuated throughout the

afternoon, never significantly exceeding 50 percent. Following 5:00 p.m., occupancy dropped slightly lower, indicating that this block might be serving some evening activity parking needs.

The trends observed on Saturday, September 11, 2010, showed that occupancy steadily increased throughout the morning, peaking during the noon hour. Following this peak, occupancy rates dropped somewhat throughout the afternoon, before increasing once again during the early evening. This early evening increase once again suggests that the block may be serving the parking needs of evening trips. Figure 5-6 graphically depicts the occupancy rate trends for this block on each date. Note that occupancy rates tended to be lower during the weekend observation compared to the weekday, with the exception of the early evening hours.

Table 5-6: Block 1024 parking observations and occupancy rates

Wednesday, August 11, 2010			Saturday, September 11, 2010		
Time	**Parked Vehicles**	**Occupancy Rate**	**Time**	**Parked Vehicles**	**Occupancy Rate**
7:02 AM	22	13.5%	7:25 AM	19	11.7%
8:48 AM	70	42.9%	9:13 AM	41	25.2%
12:08 PM	132	81.0%	10:17 AM	51	31.3%
2:57 PM	59	36.2%	12:19 PM	81	49.7%
3:52 PM	83	50.9%	2:00 PM	67	41.1%
4:50 PM	91	55.8%	3:47 PM	61	37.4%
6:02 PM	70	42.9%	4:05 PM	58	35.6%
7:05 PM	62	38.0%	5:02 PM	63	38.7%
8:10 PM	63	38.7%	5:58 PM	66	40.5%
9:12 PM	64	39.3%	6:58 PM	69	42.3%
			20:16	67	41.1%

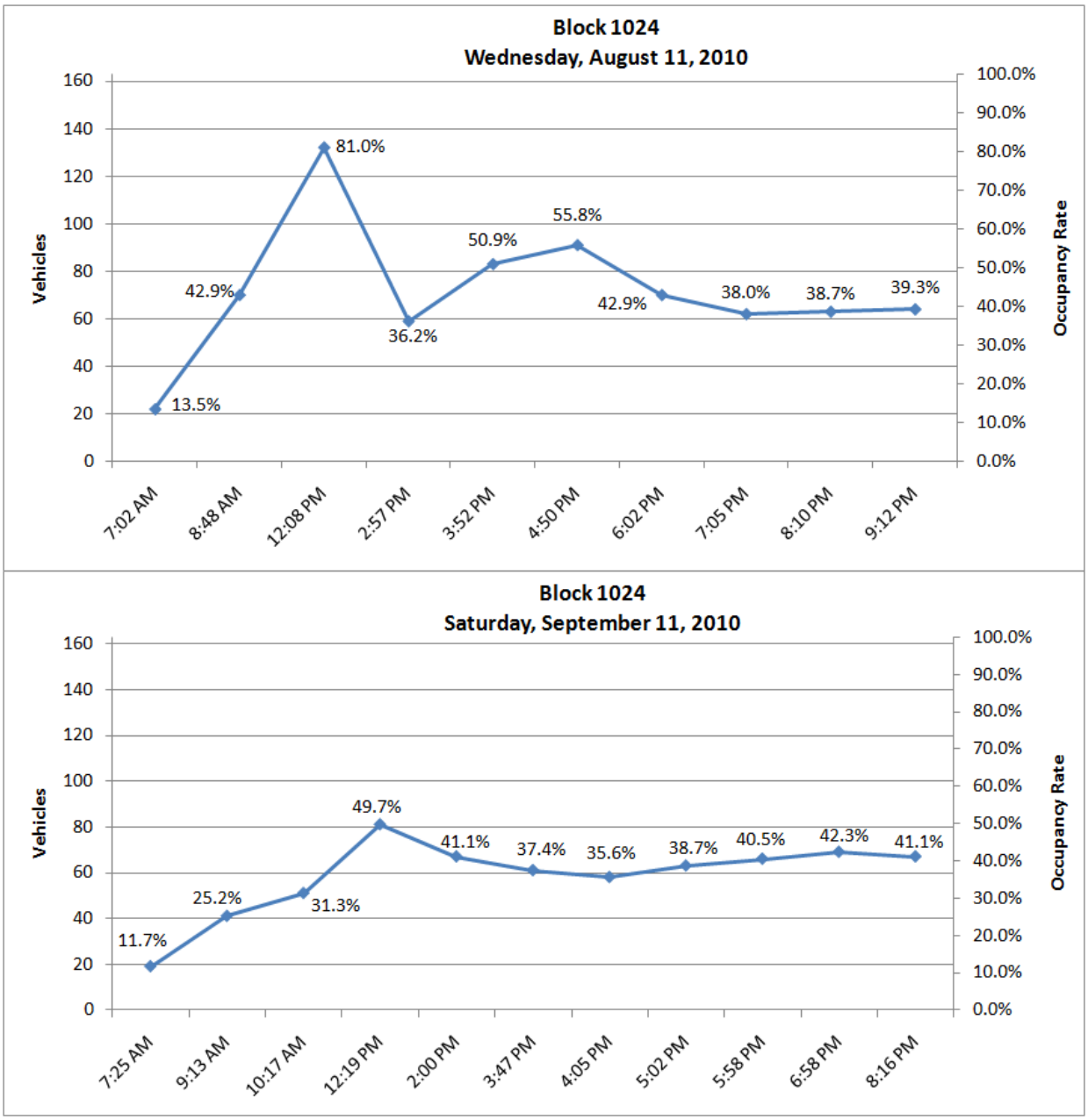

Figure 5-6: Block 1024 vehicle observations versus occupancy rates

5.1.7. Block 1025

Block 1025 is bordered by Main St., Tracy Ave., Babcock St. and Willson Ave. on its north, east, south and west sides, respectively. Table 5-7 presents both the number of vehicles parked during each observation period on Wednesday, August 11, and Saturday, September 11, 2010, as well as the resulting occupancy rates for the block. Block 1025 had a total of 113 parking spaces. The data collector for this block on Wednesday, August 11, 2010, misunderstood the collection interval instructions, hence the data gap exhibited between approximately 9:30 a.m. and 12:30 p.m. on that date. On this date, peak occupancy was observed during the noon hour, similar to that of other blocks. Following this peak, occupancy remained high throughout the afternoon, never significantly falling below 50 percent. Following 5:00 p.m., occupancy dropped

slightly lower, although the observed rates indicated that this block is likely serving evening activity parking needs.

The trends observed on Saturday, September 11, 2010, showed that occupancy steadily increased throughout the morning, peaking during the noon hour. Interestingly, the observed peak exceeded that of the weekday. Following this peak, occupancy rates dropped somewhat during the early afternoon, before increasing during the late afternoon and early evening. This early evening increase once again suggests that the block may be serving the parking needs of evening trips. Figure 5-7 graphically depicts the occupancy rate trends for this block on each date.

Table 5-7: Block 1025 parking observations and occupancy rates

Wednesday, August 11, 2010			Saturday, September 11, 2010		
Time	**Parked Vehicles**	**Occupancy Rate**	**Time**	**Parked Vehicles**	**Occupancy Rate**
7:18 AM	34	30.1%	7:31 AM	36	31.9%
9:22 AM	43	38.1%	9:18 AM	53	46.9%
12:30 PM	67	59.3%	10:25 AM	64	56.6%
3:04 PM	56	49.6%	12:25 PM	72	63.7%
4:03 PM	60	53.1%	2:10 PM	55	48.7%
4:57 PM	61	54.0%	3:40 PM	37	32.7%
6:10 PM	50	44.2%	4:10 PM	59	52.2%
7:15 PM	49	43.4%	5:08 PM	58	51.3%
8:10 PM	48	42.5%	6:04 PM	45	39.8%
9:12 PM	29	25.7%	7:07 PM	46	40.7%
			8:25 PM	47	41.6%

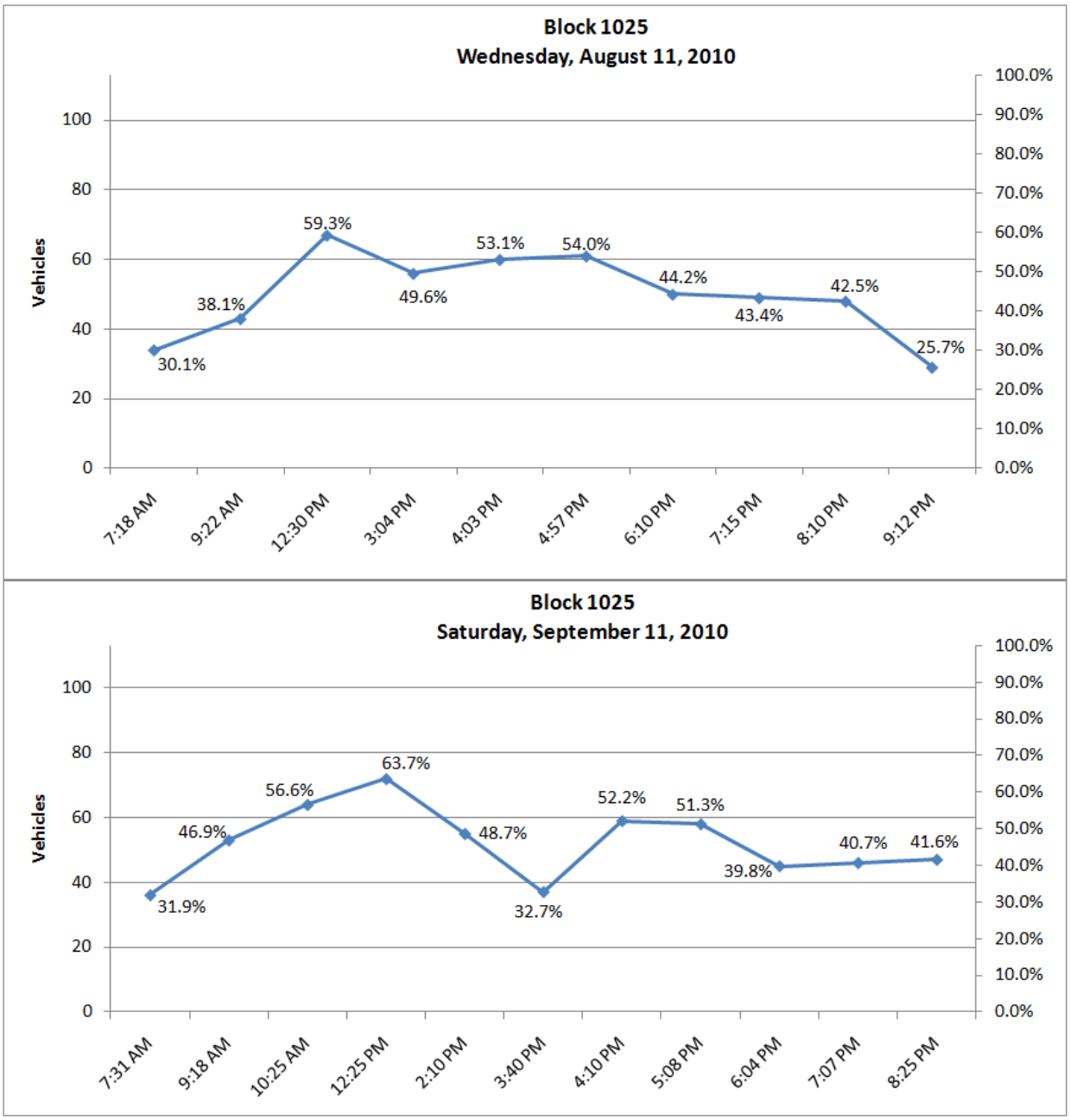

Figure 5-7: Block 1025 vehicle observations versus occupancy rates

5.1.8. Block 1026

Block 1026 is bordered by Main St., Black Ave., Babcock St. and Tracy Ave. on its north, east, south and west sides, respectively. Table 5-8 presents both the number of vehicles parked during each observation period on Wednesday, August 11 and Saturday, September 11, 2010, as well as the resulting occupancy rates for the block. Block 1026 had a total of 107 parking spaces. The data collector for this block on Wednesday, August 11, 2010, misunderstood the collection interval instructions, hence the data gap exhibited between approximately 10:00 a.m. and 1:00 p.m. on that date. On this date, peak occupancy was observed at 1:00 p.m., which was likely the result of noon hour lunch traffic. Following this peak, occupancy remained high throughout the

afternoon, tapering off after 5:00 p.m. The trends observed on Saturday, September 11, 2010, showed that occupancy increased throughout the morning, peaking during the noon hour. Following this peak, occupancy rates dropped during the afternoon, and fell greatly after 5:00 p.m. Figure 5-8 graphically depicts the occupancy rate trends for this block on each date.

Table 5-8: Block 1026 parking observations and occupancy rates

Wednesday, August 11, 2010			Saturday, September 11, 2010		
Time	**Parked Vehicles**	**Occupancy Rate**	**Time**	**Parked Vehicles**	**Occupancy Rate**
7:40 AM	31	29.0%	7:38 AM	16	15.0%
9:58 AM	55	51.4%	9:25 AM	28	26.2%
1:00 PM	74	69.2%	10:33 AM	42	39.3%
3:00 PM	64	59.8%	12:30 PM	61	57.0%
4:12 PM	69	64.5%	2:30 PM	41	38.3%
5:05 PM	51	47.7%	3:33 PM	44	41.1%
6:19 PM	28	26.2%	4:21 PM	33	30.8%
7:25 PM	27	25.2%	5:17 PM	33	30.8%
8:31 PM	23	21.5%	6:13 PM	15	14.0%
9:27 PM	20	18.7%	7:15 PM	17	15.9%
			8:31 PM	12	11.2%

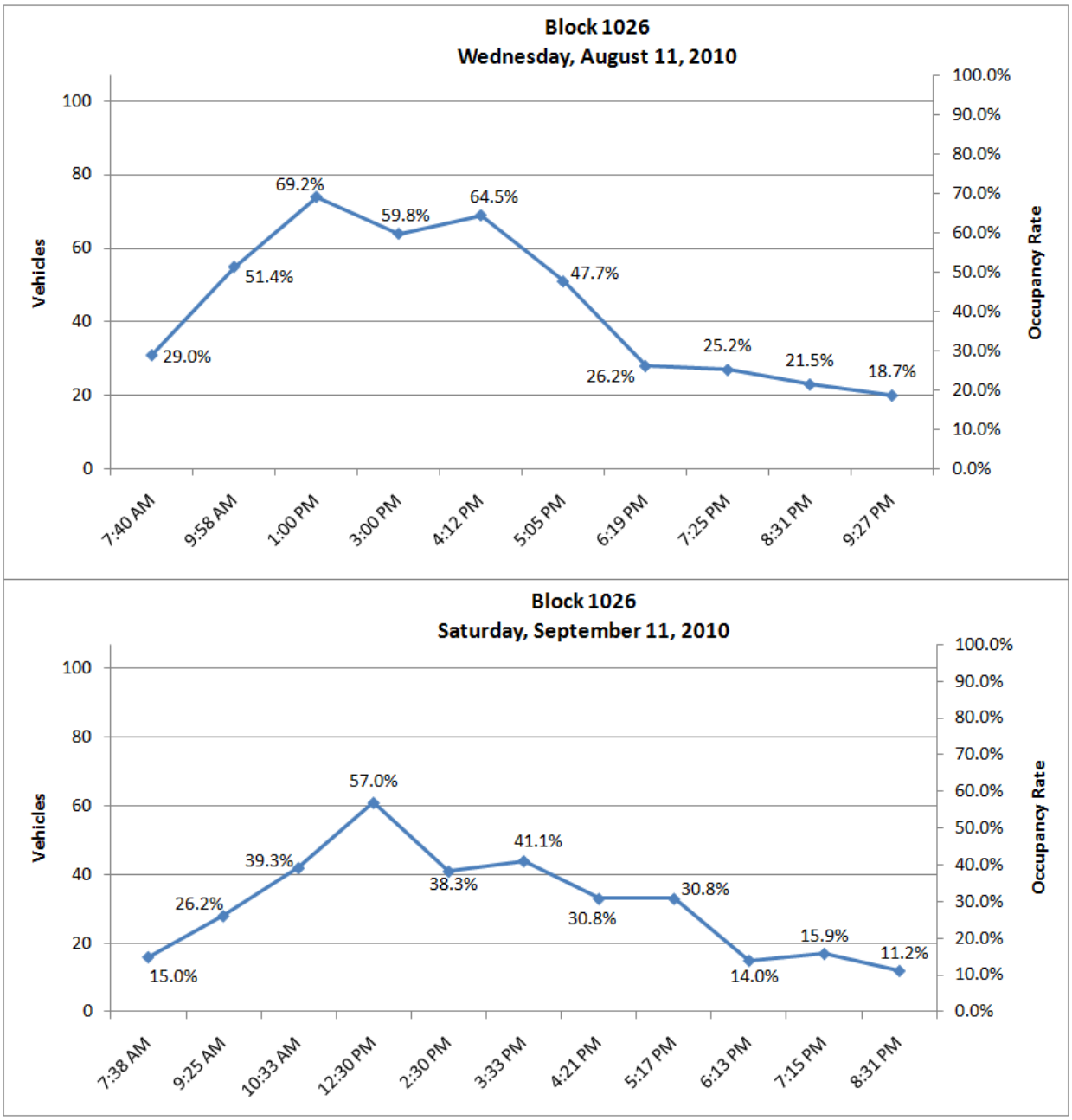

Figure 5-8: Block 1026 vehicle observations versus occupancy rates

5.1.9. Block 1027

Block 1027 is bordered by Main St., Bozeman Ave., Babcock St. and Black Ave. on its north, east, south and west sides, respectively. Table 5-9 presents both the number of vehicles parked during each observation period on Wednesday, August 11, and Saturday, September 11, 2010, as well as the resulting occupancy rates for the block. Block 1027 had a total of 100 parking spaces. The data collector for this block on Wednesday, August 11, 2010, misunderstood the collection interval instructions, hence the data gap exhibited between approximately 10:00 a.m. and 1:40 p.m. on that date. On this date, peak occupancy was observed at approximately 1:40 p.m., which was likely the result of residual parking from the noon lunch period. Following this peak,

occupancy remained high throughout the afternoon, falling only after 5:00 p.m. The trends observed on Saturday, September 11, 2010, showed that occupancy actually peaked at 10:40 a.m., and remained stable when observed again at 12:38 p.m. Occupancy rates steadily dropped during the afternoon and evening following this peak. Figure 5-9 graphically depicts the occupancy rate trends for this block on each date.

Table 5-9: Block 1027 parking observations and occupancy rates

Wednesday, August 11, 2010			Saturday, September 11, 2010		
Time	**Parked Vehicles**	**Occupancy Rate**	**Time**	**Parked Vehicles**	**Occupancy Rate**
7:52 AM	27	27.0%	7:44 AM	10	10.0%
10:11 AM	58	58.0%	9:31 AM	30	30.0%
1:40 PM	63	63.0%	10:40 AM	51	51.0%
3:21 PM	52	52.0%	12:38 PM	50	50.0%
4:20 PM	52	52.0%	2:40 PM	41	41.0%
5:12 PM	36	36.0%	3:28 PM	39	39.0%
6:27 PM	36	36.0%	4:29 PM	36	36.0%
7:33 PM	34	34.0%	5:25 PM	30	30.0%
8:37 PM	28	28.0%	6:21 PM	22	22.0%
9:34 PM	23	23.0%	7:22 PM	22	22.0%
			8:37 PM	20	20.0%

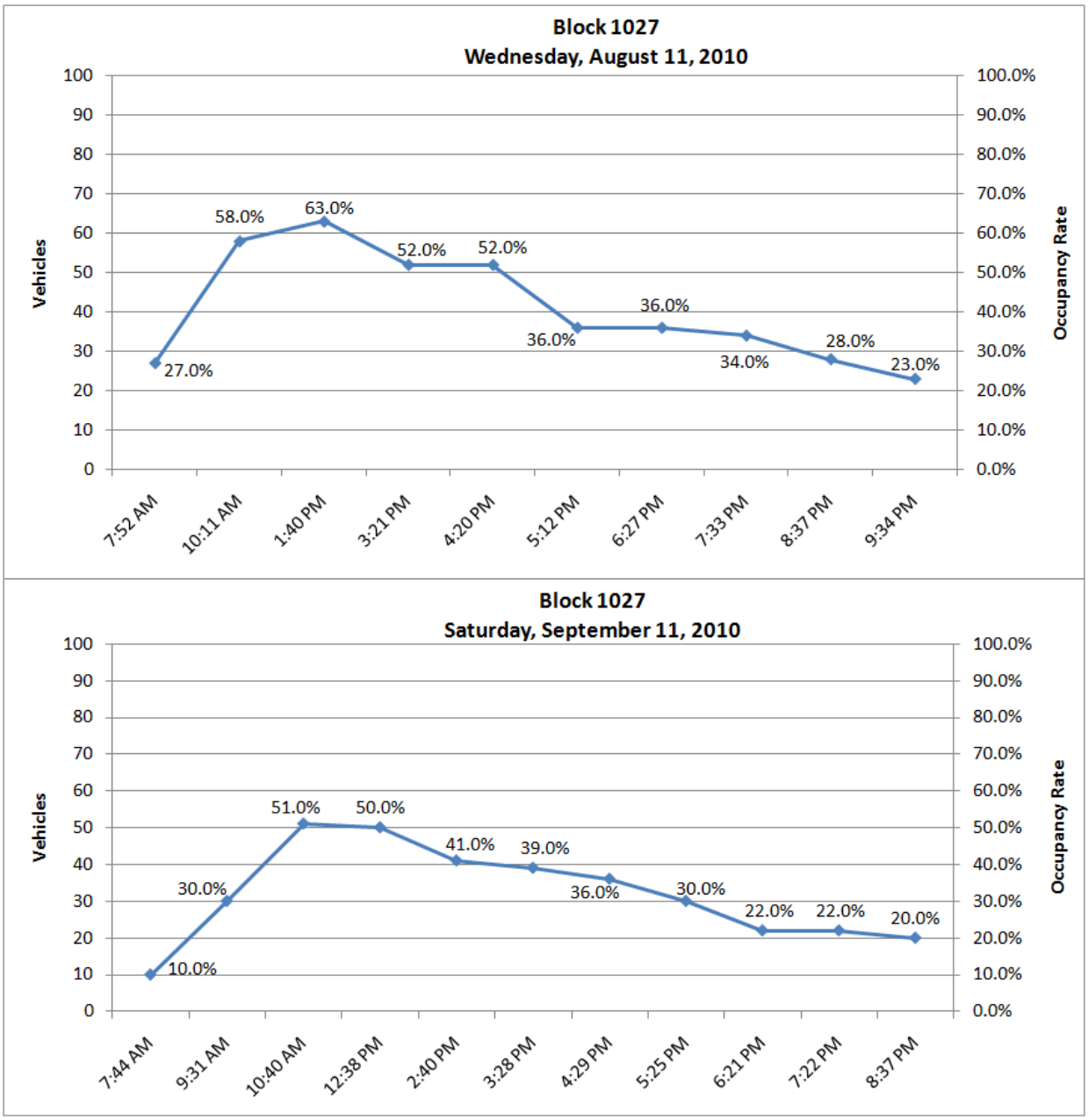

Figure 5-9: Block 1027 vehicle observations versus occupancy rates

5.1.10. Block 1028

Block 1028 is bordered by Main St., Black Ave., Babcock St. and Rouse Ave. on its north, east, south and west sides, respectively. Table 5-10 presents both the number of vehicles parked during each observation period on Wednesday, August 11, and Saturday, September 11, 2010, as well as the resulting occupancy rates for the block. Block 1028 had a total of 216 parking spaces. The data collector for this block on Wednesday, August 11, 2010, misunderstood the collection interval instructions, hence the data gap exhibited between approximately 10:30 a.m. and 2:10 p.m. on that date. On that date, peak occupancy was observed at approximately 2:10 p.m. Unlike previous block groups, it is believed that this peak was not related to the midday lunch period, which has exhibited a peak in the other block groups examined. Following this peak, occupancy

fell throughout the afternoon and early evening. The trends observed on Saturday, September 11, 2010, showed that occupancy peaked at approximately 6:30 p.m. This overall peak occurring in the early evening on a weekend is likely the result of the presence of various restraints and bars on and neighboring this block attracting patrons, combined with ample parking. Following this peak, occupancy rates remained higher than those observed during the day for the remainder of the evening. Figure 5-10 graphically depicts the occupancy rate trends for this block on each date.

Table 5-10: Block 1028 parking observations and occupancy rates

Wednesday, August 11, 2010			Saturday, September 11, 2010		
Time	**Parked Vehicles**	**Occupancy Rate**	**Time**	**Parked Vehicles**	**Occupancy Rate**
8:04 AM	86	39.8%	7:50 AM	56	25.9%
10:30 AM	121	56.0%	9:38 AM	79	36.6%
2:10 PM	131	60.6%	10:45 AM	87	40.3%
3:21 PM	108	50.0%	12:44 PM	87	40.3%
4:30 PM	97	44.9%	2:46 PM	98	45.4%
5:20 PM	93	43.1%	3:18 PM	93	43.1%
6:31 PM	105	48.6%	4:34 PM	82	38.0%
7:39 PM	81	37.5%	5:30 PM	112	51.9%
8:41 PM	81	37.5%	6:26 PM	180	83.3%
9:39 PM	60	27.8%	7:28 PM	150	69.4%
			8:43 PM	123	56.9%

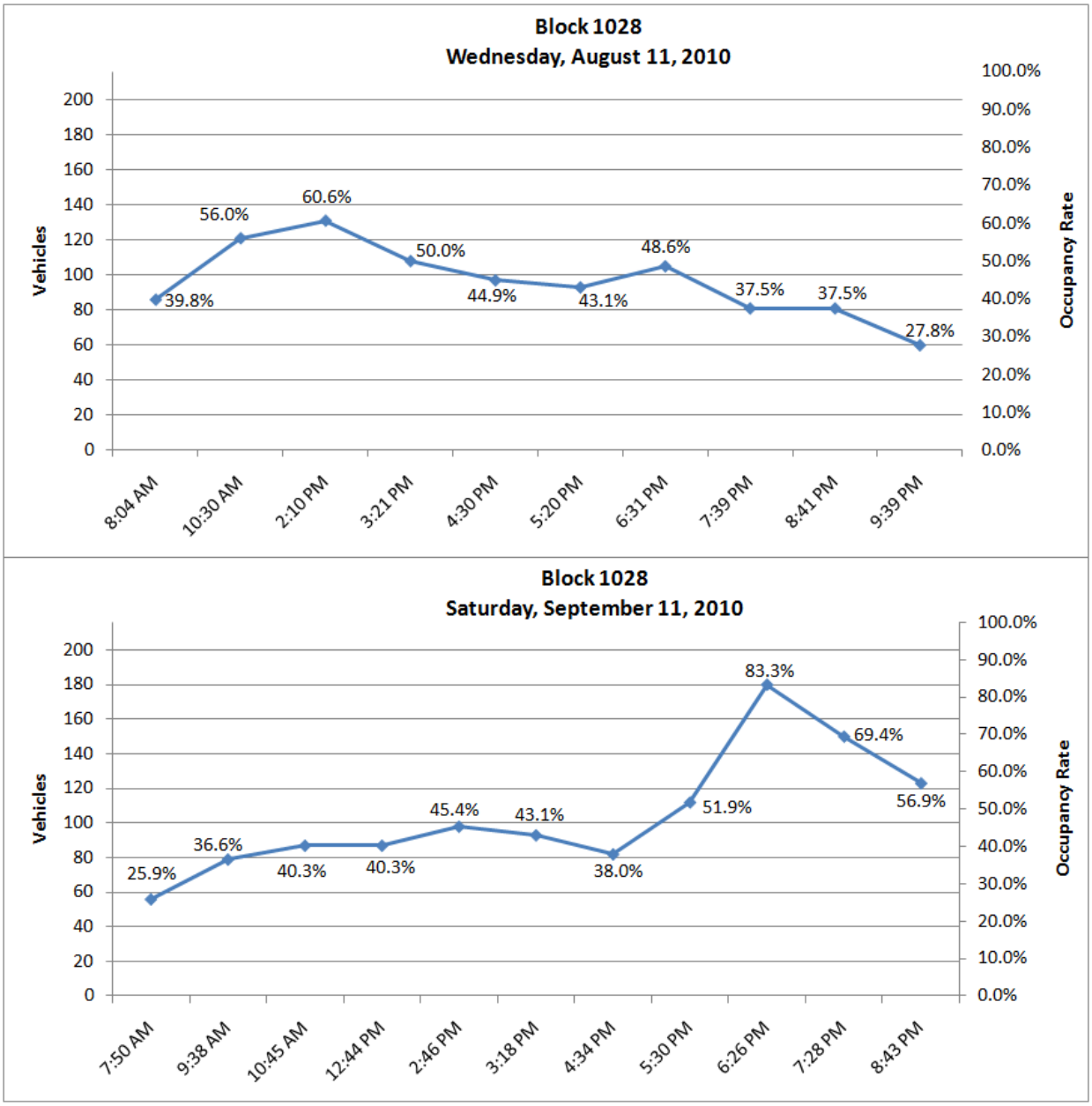

Figure 5-10: Block 1028 vehicle observations versus occupancy rates

5.2. Lot-Specific Occupancy Rates

In addition to examining block-level occupancy rates, the Bozeman Parking Commission was also interested in the individual occupancy rates of two specific city-owned lots. These were the two lots located in the northeast and southeast corners of the Mendenhall St. and Willson Ave. intersection. The northeast lot was located in Block 1007, while the southeast lot was located in Block 1015. The following sections discuss the results of the occupancy rates observed for each of these specific parking lots.

5.2.1. Southeast Corner Lot (Block 1015)

Data to support the calculation of occupancy rates was collected on three dates: August 11, September 11, and September 16, 2010 (Wednesday, Saturday, and Thursday, respectively). With the exception of the September 11 effort, data were collected on weekdays. The first two collection dates coincided with the overall block-level occupancy data collection effort. The final data collection date coincided with occupancy data collection efforts for the northeast Mendenhall St. and Willson Ave. lot, located in Block 1007. This lot did not have data collected on the previous dates, as it was not included in the downtown blocks of interest. As data was being collected for the adjacent lot in Block 1007, it was reasonable to collect additional data for the southeast lot as well for analysis purposes. This specific lot contained 28 stalls.

Table 5-11: Southeast lot parking observations and occupancy rates

Wednesday, August 11, 2010			Saturday, September 11, 2010			Thursday, September 16, 2010		
Time	**Parked Vehicles**	**Occupancy Rate**	**Time**	**Parked Vehicles**	**Occupancy Rate**	**Time**	**Parked Vehicles**	**Occupancy Rate**
7:12	0	0.0%	7:35	9	32.1%	7:00	4	14.3%
8:10	4	14.3%	9:20	11	39.3%	8:00	3	10.7%
9:10	5	17.9%	10:30	13	46.4%	9:00	7	25.0%
10:10	13	46.4%	12:20	25	89.3%	10:00	11	39.3%
11:10	19	67.9%	2:25	22	78.6%	11:00	20	71.4%
12:10	24	85.7%	3:45	25	89.3%	12:00	25	89.3%
1:10	22	78.6%	4:15	16	57.1%	1:00	25	89.3%
2:10	18	64.3%	5:35	22	78.6%	2:00	21	75.0%
3:40	22	78.6%	7:05	24	85.7%	3:00	15	53.6%
4:40	20	71.4%	8:30	23	82.1%	4:00	15	53.6%
6:01	24	85.7%				5:00	20	71.4%
7:15	25	89.3%				6:00	27	96.4%
8:45	26	92.9%				7:00	28	100.0%
						8:00	28	100.0%
						9:00	14	50.0%
						10:00	14	50.0%

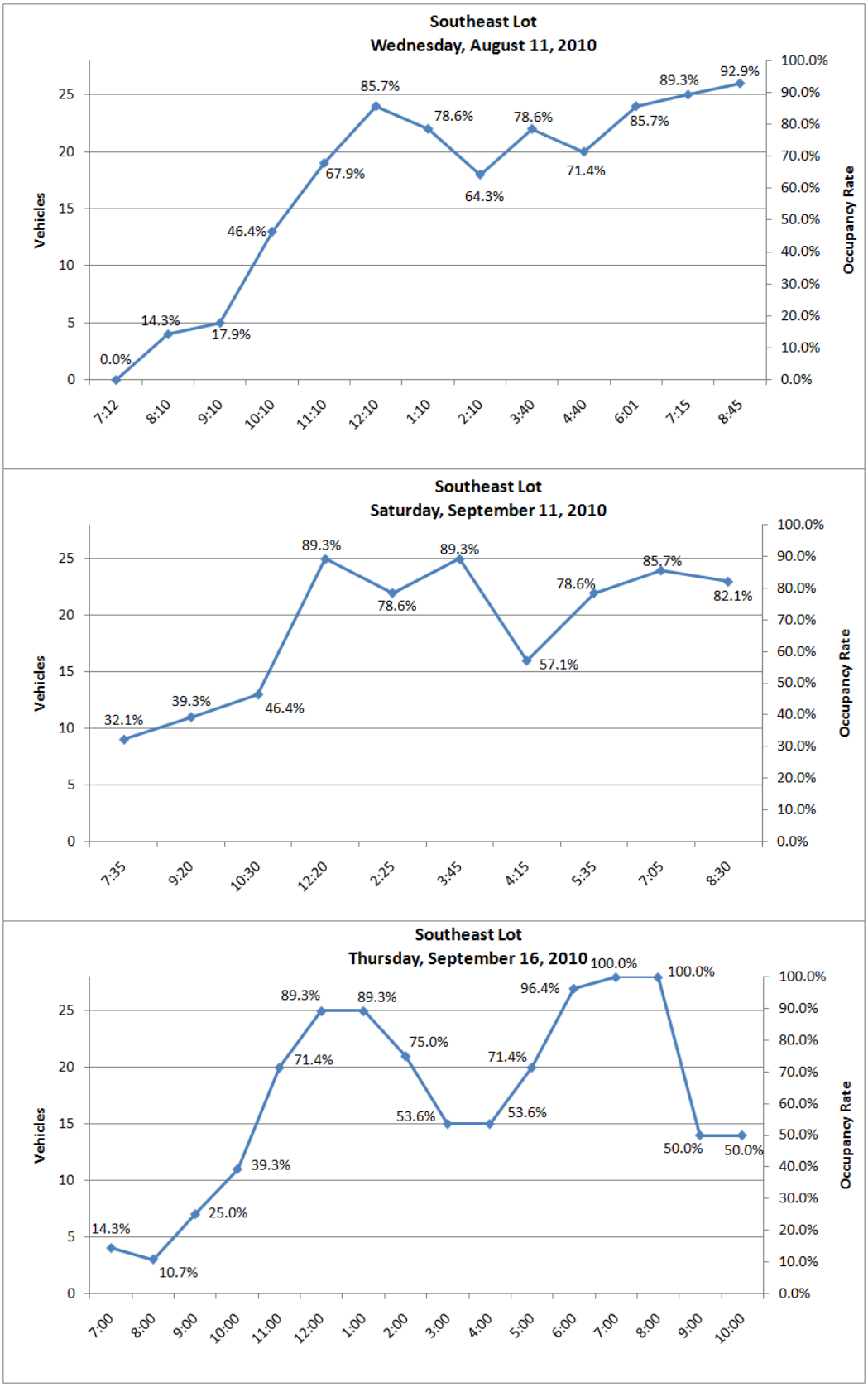

Figure 5-11: Southeast lot vehicle observations versus occupancy rates

5.2.2. Northeast Corner Lot (Block 1007)

Data for the northeast corner lot was collected on Thursday, September 16, 2010. As discussed previously, this lot was not part of the ten downtown blocks collected for the originally contracted occupancy and dwell time studies. Rather, it was collected at the request of the Parking Commission. This lot contained 43 stalls.

Table 5-12: Northeast lot parking observations and occupancy rates

Thursday, September 16, 2010		
Time	**Parked Vehicles**	**Occupancy Rate**
7:00	5	11.4%
8:00	7	15.9%
9:00	13	29.5%
10:00	13	29.5%
11:00	8	18.2%
12:00	29	65.9%
1:00	36	81.8%
2:00	23	52.3%
3:00	22	50.0%
4:00	11	25.0%
5:00	10	22.7%
6:00	11	25.0%
7:00	17	38.6%
8:00	25	56.8%
9:00	20	45.5%
10:00	14	31.8%

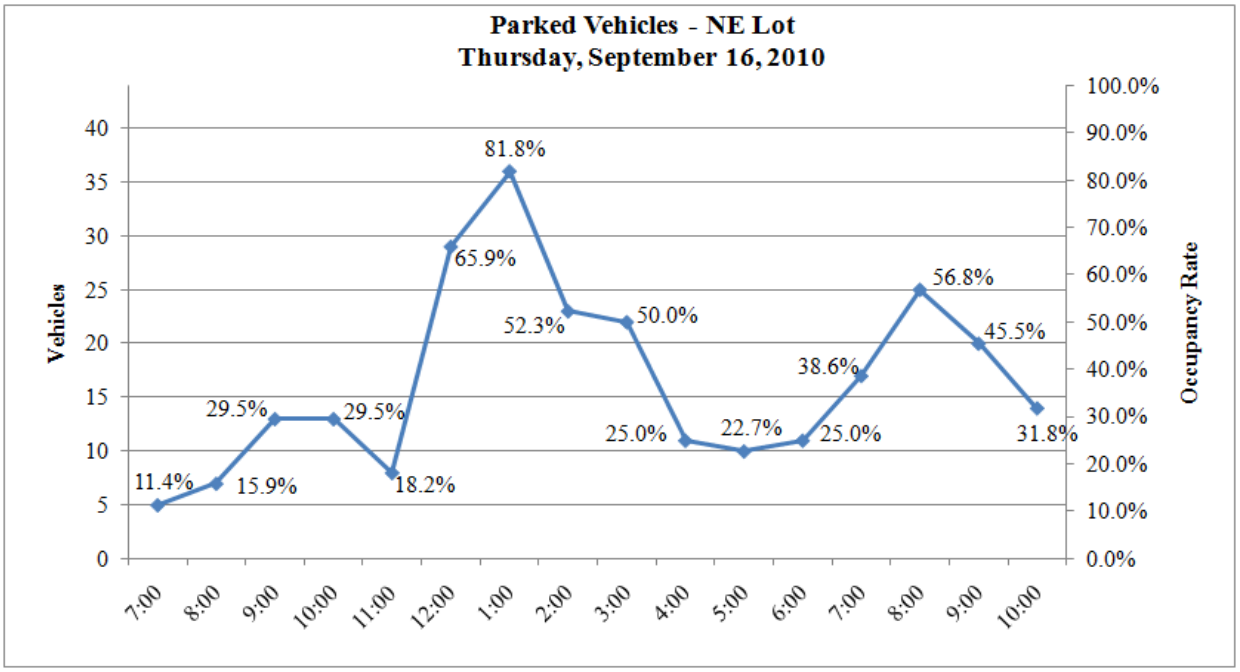

Figure 5-12: Northeast lot vehicle observations versus occupancy rates

As both Table 5-12 and Figure 5-12 indicate, the northeast corner lot at Mendenhall St. and Willson Ave. experienced a peak occupancy or 81.8 percent at approximately 1:00 p.m. The overall trend observed for this lot match those of other lots and blocks discussed throughout this chapter. Occupancy fluctuates throughout the morning, increasing at noon and peaking at 1:00 p.m., coinciding with the end of the lunch hour period. Following this peak, occupancy drops off throughout the afternoon before once again slightly peaking during the early evening at 8:00 p.m.

5.3. Chapter Summary

In general, a similar trend in occupancy rates was observed between all of the block groups examined, both on a weekdays and weekends. Occupancy would steadily increase throughout the morning and reach the peak for the day during the noon hour. This was not surprising, as it coincided with the lunch hour when downtown restaurants were likely to be heavily frequented. Following this midday peak, occupancy rates for most blocks would fall throughout the afternoon and evening hours. The exceptions to this observation were Blocks 1015, 1017 and 1018 on weekdays and Blocks 1014, 1017, 1024 and 1028 on weekends. These blocks were adjacent to many restaurant and bar establishments, explaining these late day increases in occupancy.

When the individual city lots on the northeast and southeast corners of the Mendenhall St. and Willson Ave. intersection were examined, a similar trend to the block level was observed. Occupancy rates would climb throughout the morning and peak at approximately noon. The exception to this was the southeast corner lot, which experienced a second, often higher peak during the early evening hours. In fact, 100 percent occupancy was achieved in this lot on Thursday, September 16, 2010, between 8:00 p.m. and 10:00 p.m.

Recall from Chapter 2 that one best practice for parking management is the guideline that at least 50 percent of available public parking be occupied throughout the day. While discussion at the block level regarding this metric is not possible, as public and private parking observations were

aggregated together, it is possible to touch upon the lots on the northeast and southeast corners of Mendenhall St. and Willson Ave. The southeast corner lot remained above 50 percent occupancy throughout most of the day upon reaching this threshold during the late morning. The northeast lot only reached this threshold during peak periods (i.e. the noon hour and early evening). Consequently, this northeast lot may be considered underutilized at present when the 50 percent threshold is employed.

6. DWELL TIME AND TURNOVER ANALYSIS

Dwell time is a determination of the length of time that vehicles spend in parking spaces. The benefit of the dwell time metric is that it provides an indication of overall parking capacity. Based on the preferences of the Parking Commission, the dwell times for four city-owned lots and two on-street parking areas were examined. These included:

- Mendenhall St. and Willson Ave. northeast corner lot owned by the city (block 1007);
- Mendenhall St. and Willson Ave. southeast corner lot owned by the city (block 1015);
- Mendenhall St. and Black Ave. southeast corner lot owned by the city and referred to as the Carnegie lot (block 1017);
- Babcock St. and Rouse Ave. northwest corner lot owned by the city (block 1028);
- Tracy Ave. on-street parking , west side of the street between Mendenhall St. and Babcock St. (blocks 1015 and 1025); and
- Main St. on-street parking , north side of the street between Black Ave. and Willson Ave. (blocks 1015 and 1016);

The following sections discuss the data collection process employed to collect dwell time data and the results generated from that data for each site of interest.

6.1. Dwell Time Data Collection

The methodology employed in collecting dwell time data was straightforward. As stated, the parking commission indicated interest in obtaining the dwell times for four city-owned lots and two on-street parking areas. Data collectors were deployed to each site of interest on various dates (specific dates and times are indicated in the following subsections) to manually observe and collect data over a period of six hours. A six hour period was employed based on engineering judgment, as it would provide a sufficient sample size of observed dwell times.

To collect dwell time data, collection personnel monitored parking lot entrances and on-street spaces, noting the last three digits of an entering or exiting vehicle's license plate, general vehicle characteristics (make, model, color), and the time that a vehicle entered or left the lot or parking space. These data were then entered into spreadsheets for analysis. Note that vehicles already present at the beginning or end of data collection efforts were excluded from analysis, as large sample sizes (70+ observations) of observed dwell times were obtained for each lot or area of interest.

6.2. Dwell Time Analysis Methodology

A basic methodology was employed in analyzing dwell time. The first step was establishing the duration a vehicle remained parked in the lot. This was accomplished by subtracting the observed exit time from the observed entry time (delta). As noted in the prior section, vehicles that were already present at the beginning or remaining at the end of data collection efforts were excluded from analysis. Once the dwell time duration for vehicles was determined, descriptive statistics were generated for each site. These included the mean, median, mode, standard deviation and the minimum and maximum dwell times observed. Additionally, histograms were generated for each lot of interest, displaying the frequency of observations for vehicle dwell time

durations (by five minute intervals). The results of the analysis performed for each lot are presented in the following sections.

6.3. Dwell Time Results

6.3.1. Mendenhall St. and Willson Ave. Northeast Lot

This lot, which is owned by the city, is located in Block 1007 and contains 43 stalls. Dwell time data for the site was collected on two separate dates: Tuesday, August 17, and Thursday, September 16, 2010. August data was collected between 10:00 a.m. and 4:00 p.m., while September data was collected between 11:00 a.m. and 5:00 p.m., based on the availability of collection personnel. The August data collection was performed under the original scope of the project, while the September data collection was performed at the request of the city to provide supplemental information regarding discussions related to parking specific to the vicinity of the Mendenhall St. and Willson Ave. intersection.

Descriptive statistics for the August data collection effort are presented in Table 6-1. The mean (average) observed dwell time at the site was 46 minutes, with a standard deviation (i.e. variation from the mean) of 41 minutes. The median (middle of the range of observations) was 38 minutes, while the mode (value of highest number of observations) was 8 minutes. The minimum observed dwell time was 3 minutes, while the maximum was 3 hours and 50 minutes. Also included in the table are descriptive statistics pertaining to vehicles which remained parked in the lot for over two hours. Note that the lot has a two hour time limit unless the vehicle has a permit, hence the inclusion of this data.

Table 6-1: Mendenhall St. and Willson Ave. northeast lot descriptive statistics (August 17, 2010)

	All observations	2+ Hours
Sample size	90	4
Mean	0:46	2:51
Median	0:38	2:45
Mode	0:08	N/A
Standard Deviation	0:41	0:46
Minimum Obs.	0:03	2:04
Maximum Obs.	3:50	3:50

Figure 6-1 presents a frequency distribution of dwell time durations at five minute intervals. As the data plotted in this figure indicates, the highest frequencies of vehicle dwell times were in the 10 and 15 minute categories. This indicates that the majority of dwell times at the site were between 10 and 20 minutes during the August data collection. The frequency distribution itself exhibits a somewhat positive skew, with the bulk of dwell time observations falling to the left of the distribution. In general, the observed frequency distribution illustrates what was determined through the mean dwell time that most vehicles parking in this lot were remaining for less than one hour.

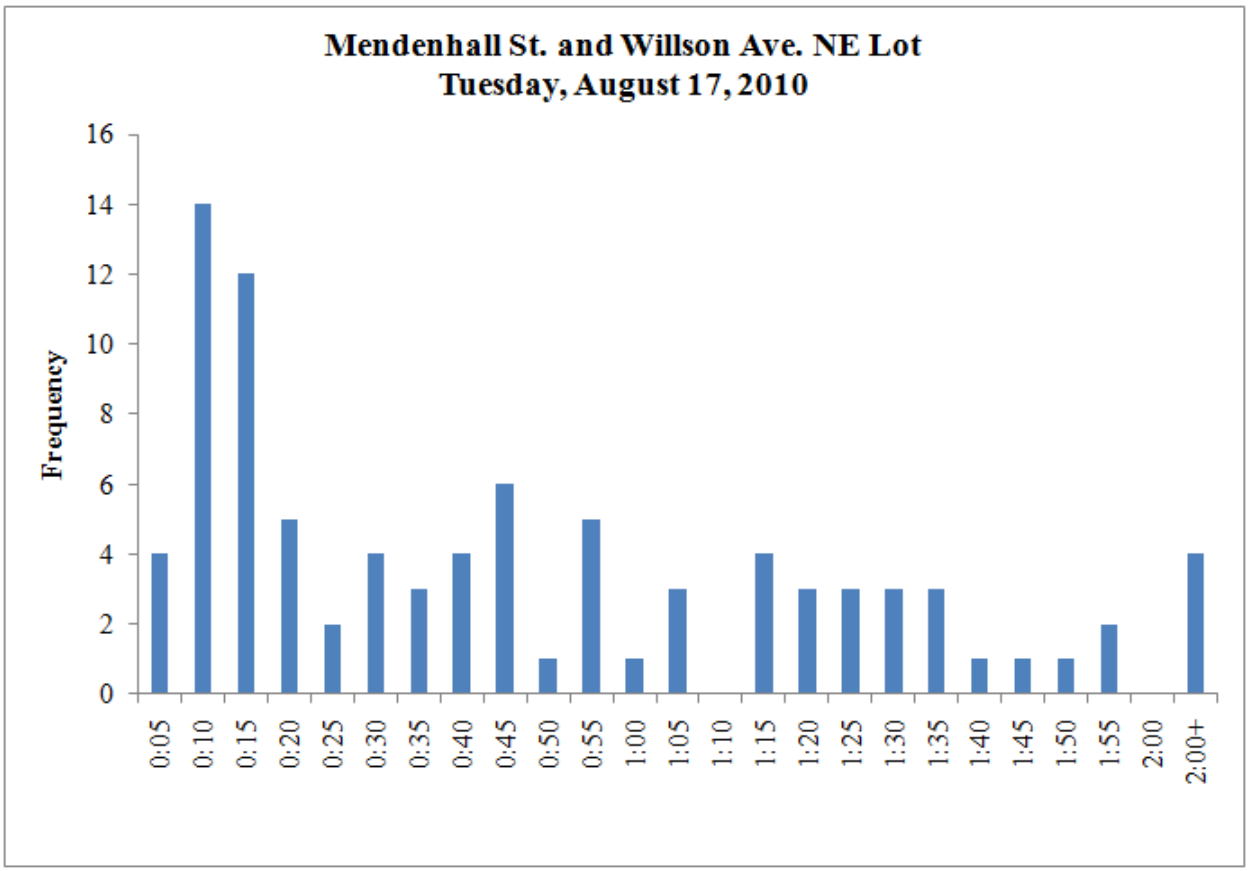

Figure 6-1: Mendenhall St. and Willson Ave. northeast lot dwell time frequencies

Descriptive statistics for the September data collection effort are presented in Table 6-2. The mean (average) observed dwell time at the site was 48 minutes, which closely matches the observation of the August data. The standard deviation was 42 minutes, the median was 38 minutes, and the mode was 6 minutes. The minimum observed dwell time was 2 minutes, while the maximum was 3 hours and 13 minutes. In general, all of these values are similar to those of the August data. Also included in the table are descriptive statistics pertaining to vehicles which remained parked in the lot for over 2 hours.

Table 6-2: Mendenhall St. and Willson Ave. northeast lot descriptive statistics (Thursday, September 16, 2010)

	All observations	2+ Hours
Sample size	105	8
Mean	0:48	2:24
Median	0:38	2:13
Mode	0:06	2:02
Standard Deviation	0:42	0:26
Minimum Obs.	0:02	2:02
Maximum Obs.	3:13	3:13

Figure 6-2 presents a frequency distribution of dwell time durations from the September data collection at five minute intervals. Once again, the highest frequencies of vehicle dwell times were in the 10 and 15 minute categories, indicating that the majority of dwell times at the site

were between 10 and 20 minutes. The frequency distribution itself exhibits less of a definitive distribution. While a somewhat positive skew exists to the left of the distribution, the observed dwell time frequencies occurring in the middle make the overall distribution trend less pronounced compared to August. What this figure does illustrate is that just as was the case with the August data, most vehicles remained in the lot less than one hour in September.

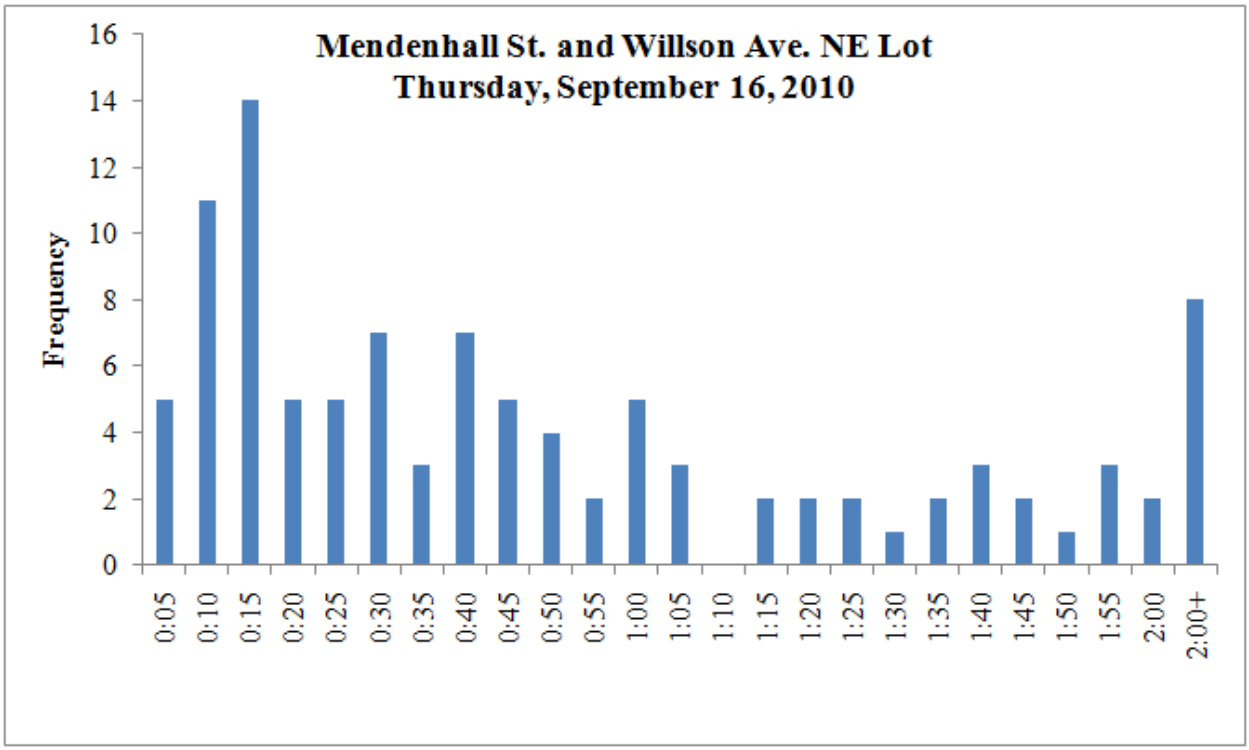

Figure 6-2: Mendenhall St. and Willson Ave. northeast lot dwell time frequencies

In examining the data specific to vehicles parked for greater than 2 hours on both dates (i.e. exceeding the posted time restriction), it is evident that only a limited number of vehicles remained in the lot for longer than 2 hours (a total of 12). This would seem to indicate that there are not a large number permit-holders parking in this lot. The field data collectors did not note any of these vehicles present for more than two hours as being ticketed on either date.

Overall, the dwell time results for the Mendenhall St. and Willson Ave. northeast lot indicate that most vehicles remain parked for under one hour. The mean dwell time for the August data was 46 minutes, while the mean dwell time in September was 48 minutes, underscoring this observation. At no time was the lot observed to be at capacity. While not displayed in this section, a peak in entering vehicles are observed between 11:50 and 12:30 was observed, which coincides with patrons arriving for lunch downtown.

6.3.2. Mendenhall St. and Willson Ave. Southeast Lot

This lot, which is owned by the city, is located in Block 1015, directly south of the previously discussed lot and contains 28 stalls. Dwell time data for the site was collected on Thursday, September 23. The data was collected between 11:45 a.m. and 5:45 p.m., based on the availability of collection personnel. This portion of the data collection was performed at the request of the city beyond the original project scope to provide supplemental information

regarding discussions related to parking specific to the vicinity of the Mendenhall St. and Willson Ave. intersection.

Descriptive statistics for the site are presented in Table 6-3. The mean (average) observed dwell time at the site was 38 minutes, with a standard deviation (i.e. variation from the mean) of 33 minutes. The median (middle of the range of observations) was 27 minutes, while the mode (value of highest number of observations) was 8 minutes. The minimum observed dwell time was 4 minutes, while the maximum was 5 hours and 54 minutes. Also included in the table are descriptive statistics pertaining to vehicles which remained parked in the lot for over two hours.

Table 6-3: Mendenhall St. and Willson Ave. southeast lot descriptive statistics

	All observations	2+ Hours
Sample size	114	4
Mean	0:38	2:24
Median	0:27	2:17
Mode	0:08	N/A
Standard Deviation	0:33	0:20
Minimum Obs.	0:04	2:08
Maximum Obs.	2:54	2:54

Figure 6-3 presents a frequency distribution of dwell time durations at five minute intervals. As the data plotted in this figure indicates, the highest frequencies of vehicle dwell times were in the 10 and 20 minute categories. This indicates that the majority of dwell times at the site were between 10 and 25 minutes on the September data collection date. The frequency distribution itself exhibits a somewhat positive skew, with the bulk of dwell time observations falling to the left and center of the distribution. In general, the observed frequency distribution illustrates what was determined through the mean dwell time that most vehicles parking in this lot were remaining for less than one hour and fifteen minutes.

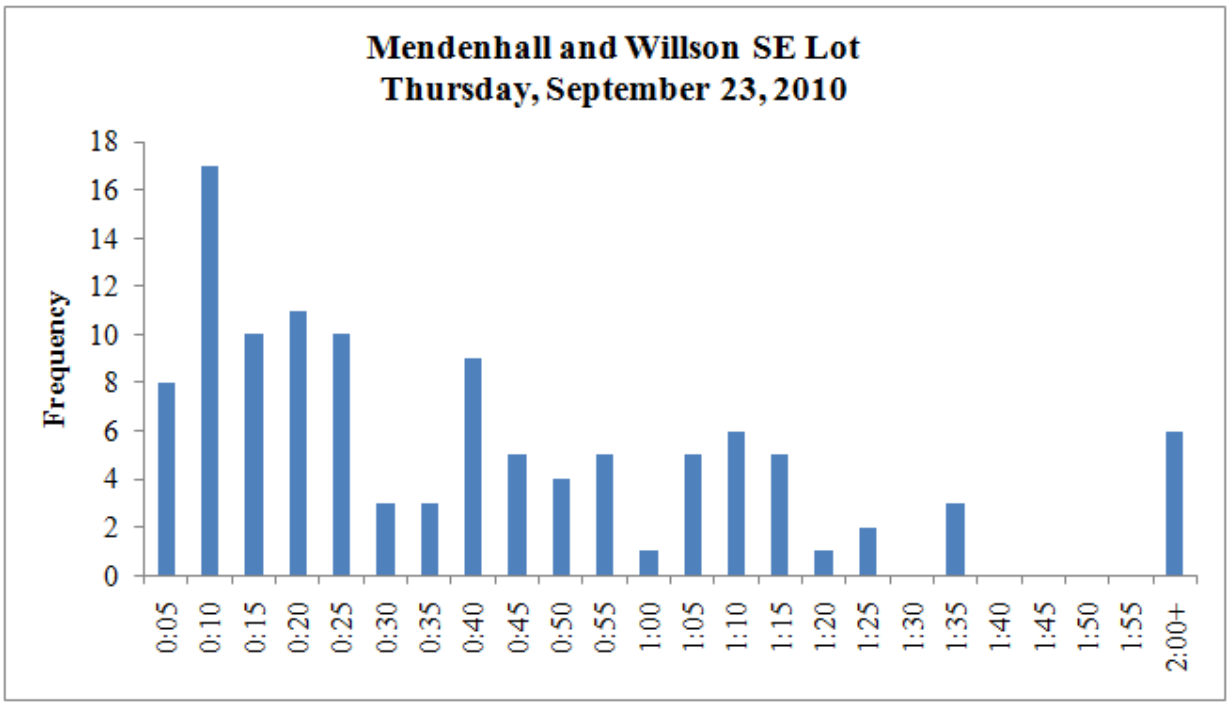

Figure 6-3: Mendenhall St. and Willson Ave. southeast lot dwell time frequencies

In general, the results of the dwell time analysis for the southeast lot at the Mendenhall St. and Willson Ave. intersection indicated that this lot may be used by (slightly) shorter term parkers when compared to the lot located across the street (northeast corner). This is evidenced by the mean dwell time for the lot, which was 38 minutes, compared to 46+ minutes for the northeast lot. Of course, the sample size of southeast lot observations was slightly larger (114 observations), which may have contributed to the slightly smaller mean dwell time value.

6.3.3. Mendenhall St. and Black Ave. Southeast Lot

This lot, which is owned by the city, is located in Block 1017 and also referred to as the Carnegie lot, containing 60 stalls. Note that this total does not include the 13 alley stalls adjacent to the lot, which also are city-owned. Dwell time data for the site was collected on Wednesday, August 11th. The data was collected between 10:00 a.m. and 4:00 p.m., based on the availability of collection personnel. This portion of the data collection was performed under the original project scope.

The mean observed dwell time at the site was one hour. The standard deviation was 39 minutes, the median was 55 minutes, and the mode was 1 hour and 6 minutes. The minimum observed dwell time was 3 minutes, while the maximum was 3 hours and 54 minutes. In general, all of these values are in line with what has been observed in other downtown lots.

Also included in the table are descriptive statistics pertaining to vehicles which remained parked in the lot for over 2 hours. As indicated, ten vehicles were observed to remain in the lot for over two hours, exceeding the posted restriction. Five of the vehicles observed to exceed two hours received tickets (one vehicle received two tickets), indicating that not all vehicles remaining in the lot longer than two hours had permits. The lot itself was observed to briefly reach capacity at 12:38; however, exiting vehicles soon after freed up capacity once again.

Table 6-4: Mendenhall St. and Black Ave. southeast lot descriptive statistics

	All observations	2+ Hours
Sample size	127	10
Mean	1:00	2:35
Median	0:55	2:26
Mode	1:06	N/A
Standard Deviation	0:39	0:35
Minimum Obs.	0:03	2:01
Maximum Obs.	3:54	3:54

Figure 6-4 presents a frequency distribution of dwell time durations at five minute intervals. As the data plotted in this figure indicates, the highest frequencies of vehicle dwell times were in the 35 and 55 minute, as well as 1 hour and 5 minute and 1 hour and 10 minute categories. This indicates that the majority of vehicles at the site remained for longer durations compared to other sites. The frequency distribution itself exhibits the appearance of a bell-shaped curve, although this does not mean that the data is in fact normally distributed.

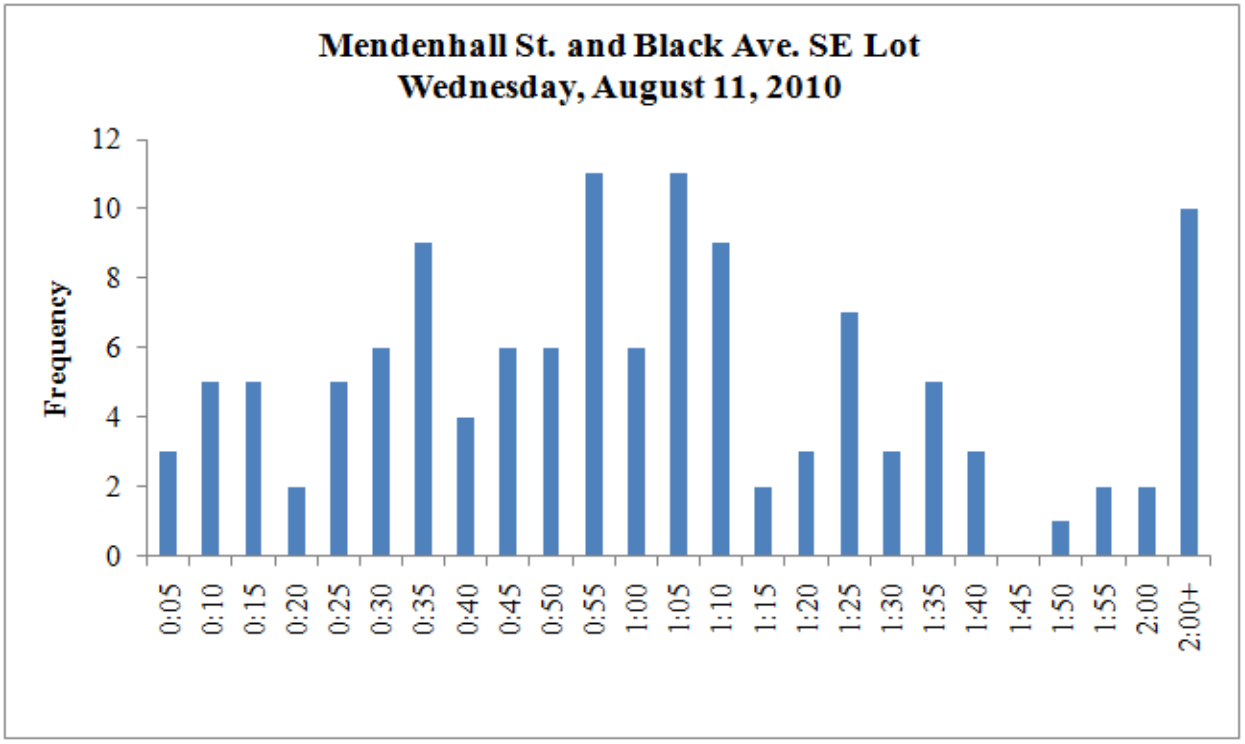

Figure 6-4: Mendenhall St. and Black Ave. southeast lot dwell time frequencies

Overall, the data collected for this site indicate that it is used by vehicles for longer periods of time, as exhibited through the average dwell time of one hour. This is likely due to its centralized location near downtown, which makes the lot convenient to vehicles visiting the area for various purposes.

6.3.4. Babcock St. and Rouse Ave. Northwest Lot

This lot, which is owned by the city, is located in Block 1028 and contains 43 stalls. Dwell time data for the site was collected on Friday, October 8. The data was collected between 10:00 a.m. and 4:00 p.m., based on the availability of collection personnel. This portion of the data collection was performed under the original project scope.

The mean observed dwell time at the site was 58 minutes. The standard deviation was 54 minutes, the median was 50 minutes, and the mode was 6 minutes. The minimum observed dwell time was 3 minutes, while the maximum was 3 hours and 54 minutes. In general, all of these values, while slightly higher, are in line with what has been observed in other downtown lots. Also included in the table are descriptive statistics pertaining to vehicles which remained parked in the lot for over 2 hours. As indicated, five vehicles were observed to remain in the lot for over two hours.

Table 6-5: Babcock St. and Rouse Ave. northwest lot descriptive statistics

	All observations	2+ Hours
Sample size	91	5
Mean	0:58	3:37
Median	0:50	3:26
Mode	0:06	N/A
Standard Deviation	0:54	1:30
Minimum Obs.	0:01	2:01
Maximum Obs.	5:52	5:52

Figure 6-5 presents a frequency distribution of dwell time durations at five minute intervals. As the data plotted in this figure indicates, the highest frequencies of vehicle dwell times were in the 10 minute, 25 minute, one hour and 25 minute and one hour and 40 minute categories. In general, it appears that this lot experiences a great variability in parking dwell times overall. The frequency distribution itself does not exhibit the characteristics of any discernable distribution.

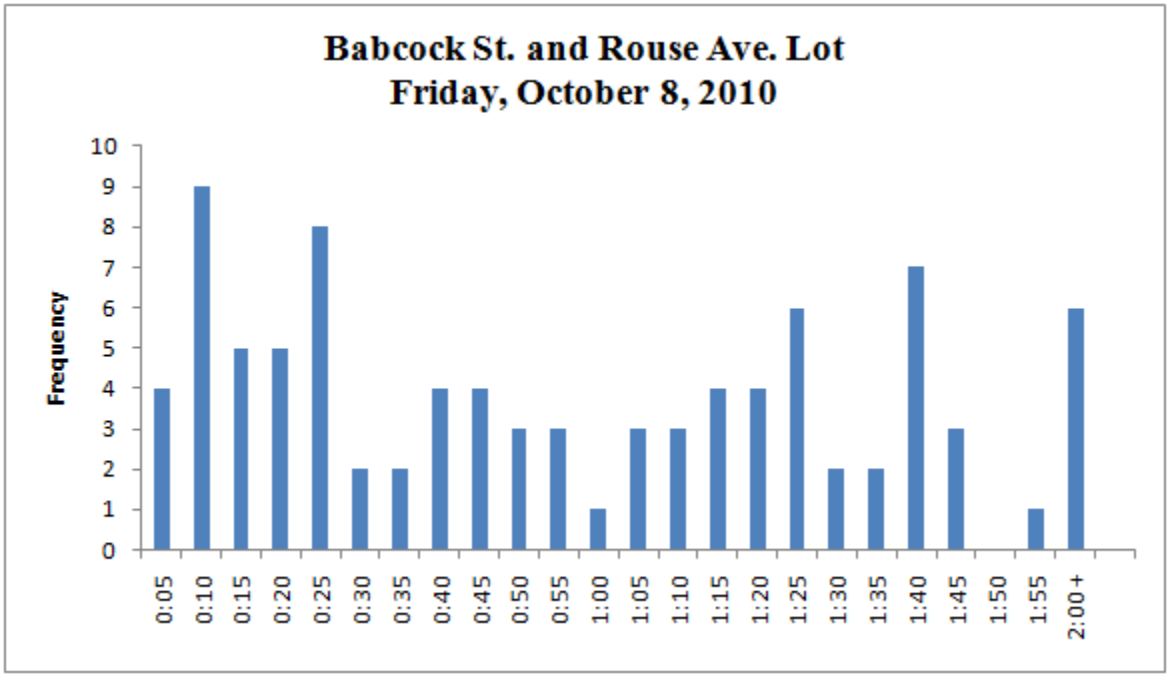

Figure 6-5: Babcock St. and Rouse Ave. northwest lot dwell time frequencies

Overall, the data collected for this site indicate that it is used by vehicles for both short and long periods of time, as exhibited through the frequency distribution. Given the location of this lot at the boundary of the downtown area, it seems reasonable to conclude that vehicles visit the lot for various purposes, resulting in various parking durations.

6.3.5. Tracy Ave. On-Street Parking

This portion of the dwell time analysis examined the on-street parking on the west side of Tracy Ave. between Mendenhall St. and Babcock St. This parking was located adjacent to blocks 1015 and 1025 and was comprised of 11 stalls. Dwell time data for the site was collected on Tuesday, August 24. The data was collected between 10:00 a.m. and 4:00 p.m., based on the availability of

collection personnel. This portion of the data collection was performed under the original project scope.

The mean observed dwell time at the site was 40 minutes. The standard deviation was 39 minutes, the median was 31 minutes, and the mode was 23 minutes. The minimum observed dwell time was 1 minute, while the maximum was 3 hours and 1 minute. All of these values are slightly lower than observations made for the downtown parking lots, but are still in line with what could be expected.

Also included in the table are descriptive statistics pertaining to vehicles which remained parked on-street for over 2 hours. As indicated, seven vehicles were observed to remain parked for over two hours, exceeding the posted restriction. None of these vehicles were observed to receive a ticket.

Table 6-6: Tracy Ave. on-street parking descriptive statistics

	All observations	2+ Hours
Sample size	78	7
Mean	0:40	2:17
Median	0:31	2:09
Mode	0:23	N/A
Standard Deviation	0:39	0:20
Minimum Obs.	0:01	2:03
Maximum Obs.	3:01	3:01

Figure 6-6 presents a frequency distribution of dwell time durations at five minute intervals. As the data plotted in this figure indicates, the highest frequencies of vehicle dwell times were in the 5 and 10 minute categories. This is not surprising given that on-street parking was being examined. Drivers utilizing such parking stalls could be expected to be making brief trips to downtown locations (i.e. errands), resulting in short dwell times. The frequency distribution itself exhibits a positive skew to the left, with dwell time observations tapering off on the right of the distribution, further illustrating the brief nature of parking behaviors using the observed stalls.

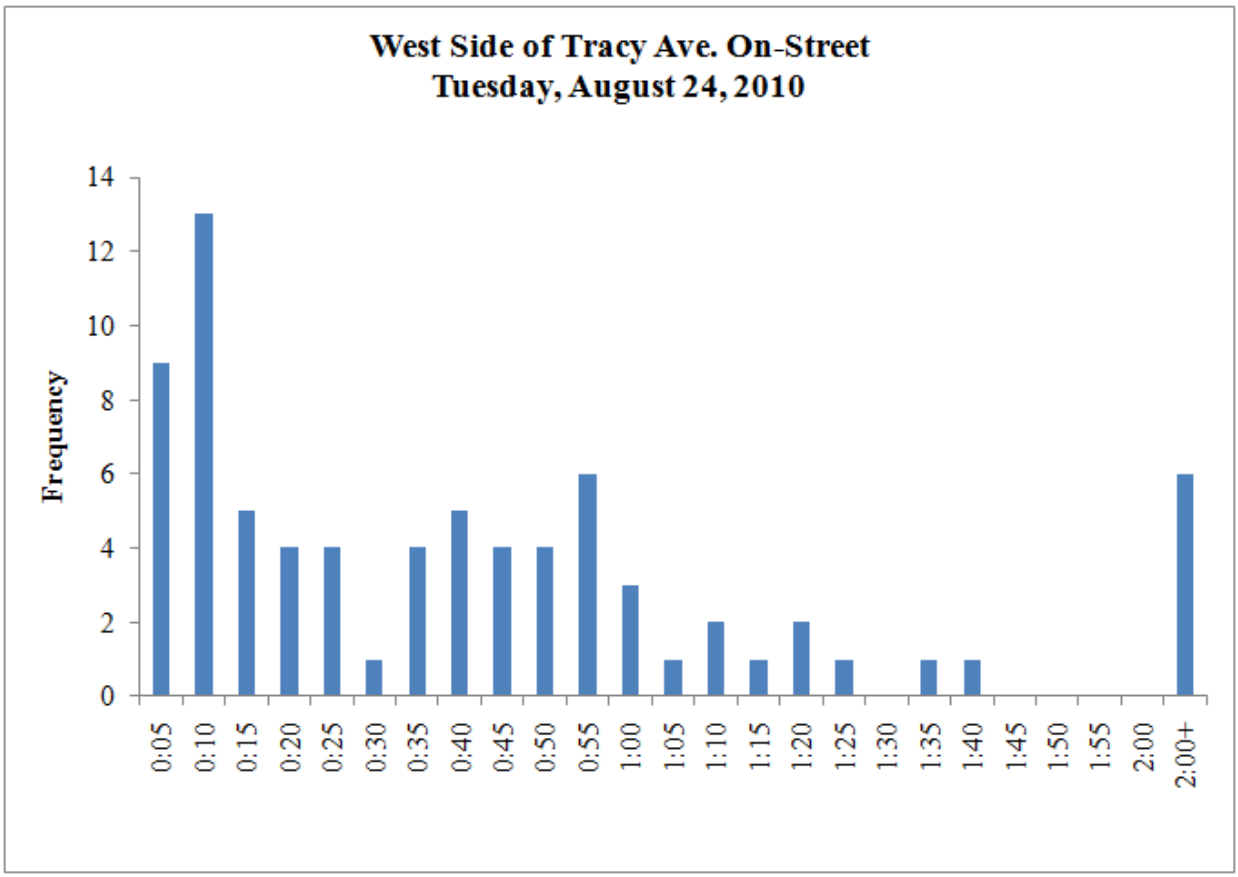

Figure 6-6: Tracy Ave. on-street dwell time frequencies

Overall, the data collected for this site indicate that it is used by vehicles for brief periods of time, as exhibited through the frequency distribution. This is likely due to the nature of trip utilizing these parking spaces. Such trips are likely brief in nature (errands and such); longer downtown visits are likely to result in a driver parking their vehicle in an off-street parking lot.

6.3.6. Main St. On-Street Parking

This portion of the dwell time analysis examined the on-street parking on the north side of Main St. between Black Ave. and Willson Ave. This parking was located adjacent to blocks 1015 and 1016 and was comprised of 24 stalls. Dwell time data for the site was collected on Monday, August 23. The data was collected between 10:00 a.m. and 4:00 p.m., based on the availability of collection personnel. This portion of the data collection was performed under the original project scope.

Table 6-7 presents a summary of the descriptive statistics for dwell times for Main St. on-street parking. The mean observed dwell time at the site was 47 minutes. The standard deviation was 42 minutes, the median was 36 minutes, and the mode was 19 minutes. The minimum observed dwell time was 1 minute, while the maximum was 3 hours and 40 minutes. The mean dwell time was in line with observations made for the downtown parking lots. This suggests that Main St. on-street parking functions in a similar manner to off-street parking lots, as opposed to the trend observed on Tracy Ave.

Also included in the table are descriptive statistics pertaining to vehicles which remained parked in the lot for over 2 hours. As indicated, seven vehicles were observed to remain parked for over two hours, exceeding the posted restriction. None of these vehicles were observed to receive a ticket.

Table 6-7: Main St. on-street parking descriptive statistics

	All observations	2+ Hours
Sample size	129	7
Mean	0:47	2:54
Median	0:36	2:59
Mode	0:19	N/A
Standard Deviation	0:42	0:40
Minimum Obs.	0:01	2:02
Maximum Obs.	3:40	3:40

Figure 6-7 presents a frequency distribution of dwell time durations at five minute intervals. As the data plotted in this figure indicates, the highest frequencies of vehicle dwell times were in the 20 minute category. This would suggest that on Main St., on-street parking is being used for downtown visits that are of medium time duration. The frequency distribution itself exhibits a positive skew to the left, with dwell time observations tapering off on the right of the distribution. There are some intermittent waves in longer-duration dwell time frequencies observed throughout the course of distribution, suggesting that the trip purposes behind on-street parking for this case vary considerably.

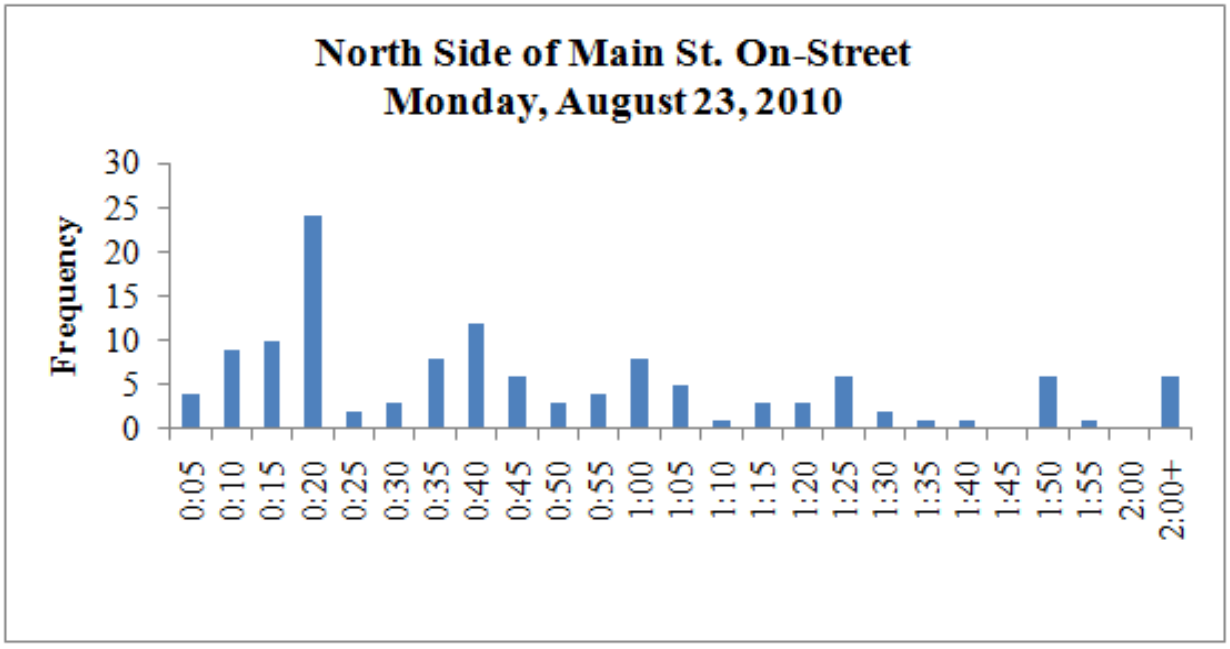

Figure 6-7: Main St. on-street dwell time frequencies

Overall, the data collected for Main St. on-street parking indicate that parking is being used for varying durations of time. This is likely due to the differing nature of trips utilizing these parking spaces. The mean observed dwell time for this case was similar to that observed for off-street parking lots, suggesting that each parking type is utilized in a similar manner.

6.3.7. Parking Garage

The final dwell time analysis examined the new downtown parking garage. This structure is located in block 1016 and contains 435 stalls (including 10 that are handicapped accessible). Dwell time data for this site was provided by the City of Bozeman from electronic records collected at the garage itself. The data examined was collected on August 11, 2010 between 10:00 a.m. and 4:00 p.m. to coincide with other dwell time data collection efforts being performed by field staff.

Table 6-8 presents a summary of the descriptive statistics for the parking garage dwell times. The mean observed dwell time at the site was 1 hour and 21 minutes. The standard deviation was 1 hour, the median was 1 hour and 9 minutes, and the mode was 41 minutes. The minimum observed dwell time was 2 minutes, while the maximum was 3 hours and 57 minutes. The mean dwell time was in line with expectations, as the parking garage was more likely to be used by long term parkers (including those who had contracts with the city to park long-term). This suggests that the parking structure is, to an extent, serving to remove vehicles that are parking long-term from public surface lots in the downtown area.

Also included in the table are descriptive statistics pertaining to vehicles which remained parked in the garage for over 2 hours. These 14 vehicles consisted of contract parkers. Note that these results do not factor in vehicles parked under contract that were present before the analysis period began or those which entered during the analysis period but did not exit the garage prior to its end.

Table 6-8: Downtown parking garage descriptive statistics

	All observations	2+ Hours
Sample size	64	14
Mean	1:21	2:56
Median	1:09	2:49
Mode	0:41	2:21
Standard Deviation	1:00	0:37
Minimum Obs.	0:02	2:00
Maximum Obs.	3:57	3:57

Figure 6-8 presents a frequency distribution of dwell time durations at five minute intervals. As the data plotted in this figure indicates, the highest frequencies of vehicle dwell times were in the 2 hour plus category. This was expected, as the parking garage is more likely to service long-term parking needs as opposed to short trips. Overall, the frequency distribution fluctuates, exhibiting no discernable trend. Higher frequencies of duration were observed in the 5 minute, 20 minute, 45 minute, 55 minute, and 1 hour and 15 minute categories, further underscoring the random nature of parking durations in the garage.

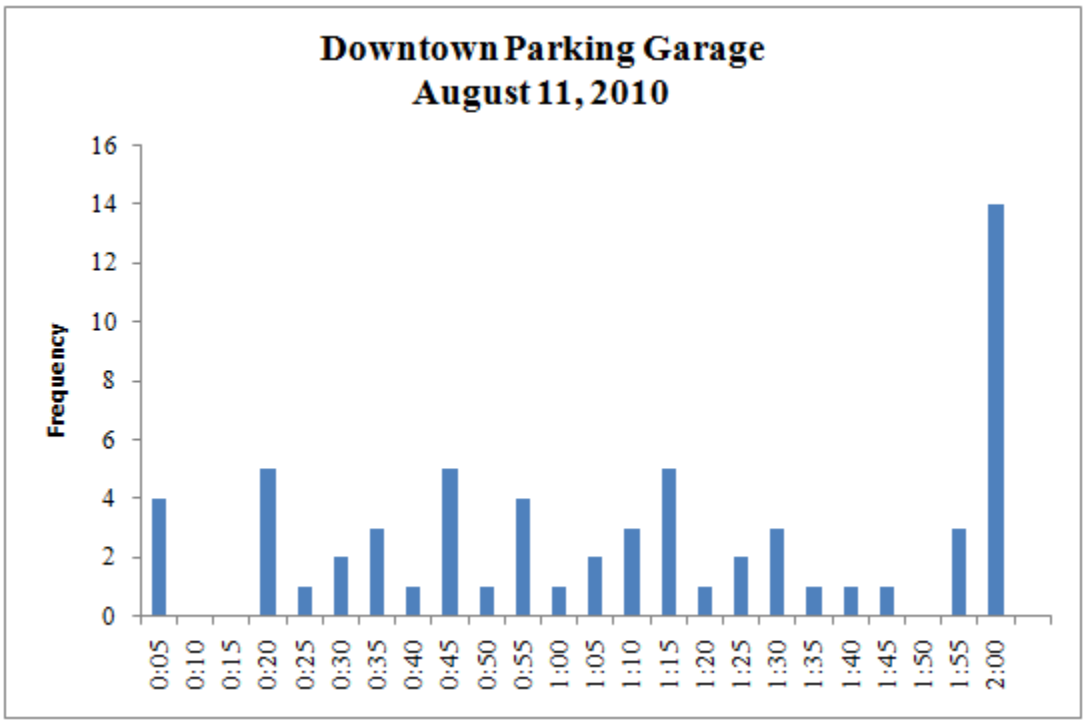

Figure 6-8: Downtown parking garage dwell time frequencies

Overall, the data collected for the parking garage indicate that it is being used for longer duration parking. This is beneficial to the other public surface lots in the downtown area, as it frees up stalls for shorter-term parking in them. The mean observed dwell time for the parking garage was higher than observed for other downtown parking facilities, which was expected.

6.4. Turnover Rate

In addition to examining the dwell time for each of the lots/areas discussed in the previous sections, the turnover rate for these parking assets was also of interest. The parking turnover rate refers to the number of individual vehicles which occupy a particular space over a specific period of time, in the case of this work, one hour. Turnover is computed as:

$$TR = \frac{N_T}{P_S * T_S} \quad (27)$$

Where:

TR = parking turnover rate, vehicles/stall/hour

N_T = total number of parked vehicles observed

P_S = total number of legal parking stalls

T_S = total duration of study period, in hours

6.4.1. Turnover Rate Results

Results of the occupancy rate calculations are presented in Table 6-9. As shown, stalls in off-street parking facilities had a tendency to turn over at a significantly lower rate than on-street stalls. A rate of 1.0 would indicate that a stall was used by one vehicle per hour, while a rate of

2.0 would indicate two vehicles per hour had used a stall. Conversely, a turnover rate of 0.50 would indicate that a stall was used by a single vehicle for a period of duration greater than one hour. An acceptable parking turnover rate will vary depending on the land uses being served, the locale and traffic mix and other factors.

As the results indicate, off-street parking stalls were typically occupied by between 0.34 and 0.40 vehicles per hour. While this does not mean that less than one vehicle (i.e. a fractional vehicle) occupied each stall in a specific lot each hour, it does indicate that the stalls were not at capacity over the duration of the study period (six hours at all sites). Interestingly, only the Mendenhall St. and Willson Ave southeast corner lot exceeded a rate of 0.50. This may be attributed to the location of the lot itself near many downtown businesses, which draws in motorists who are only planning a brief stop at said businesses compared to other off-street lots.

On-street parking stalls showed significantly higher occupancy rates, ranging from 0.90 to 1.18. This indicates that the available stalls were being utilized by more vehicles per hour compared to their off-street counterparts. Of course, these higher rates were driven by the limited number of stalls being examined combined with higher demand/accessibility. As these stalls are located in the heart of the downtown district, it stands to reason they would see higher usage by motorists, particularly those who would use the spots briefly while on short trips.

Table 6-9: Turnover rate results

Location	Observed Vehicles	Stalls	Study Duration (hrs)	Turnover Rate	Date
Mendenhall and Black	127	58	6	**0.36**	8/11/2010
Mendenhall and Willson NE	90	44	6	**0.34**	8/17/2010
Mendenhall and Willson NE	105	44	6	**0.40**	9/16/2010
Mendenhall and Willson SE	114	28	6	**0.68**	9/23/2010
Tracy on-street	78	11	6	**1.18**	8/24/2010
Main on-street	129	24	6	**0.90**	8/23/2010
Rouse and Babcock NW	91	48	6	**0.32**	10/8/2010
Parking Garage	64*	435	6	**0.02**	8/11/2010

* This figure does not include vehicles parked long-term under contract that were already present at the start of the study period, nor vehicles that arrived during the study period and remained parked after its conclusion.

6.5. Chapter Summary

This chapter examined the dwell time characteristics and turnover rates for four off-street parking lots and two on-street parking areas in downtown Bozeman. A summary of dwell time results is presented in Table 6-10, with a histogram of mean values presented in Figure 6-9. Dwell time results indicated that vehicles remained parked for an average of 38 minutes to 1 hour and 21 minutes. In general, the dwell times observed between on-street and off-street parking did not greatly differ, with the exception of dwell time in the parking garage. These results would seem to indicate that most vehicles parking are doing so as part of trips which are not necessarily brief in nature. However, this is not entirely the case, as shown by the parking garage dwell time, as well as evidenced by the turnover rate analysis findings for on-street parking.

Table 6-10: Summary of dwell time results

Site	Sample size	Mean	Median	Mode	Standard Deviation	Minimum	Maximum
Mendenhall-Willson NE Lot August 17, 2010	90	0:46	0:38	0:08	0:41	0:03	3:50
Mendenhall-Willson NE Lot September 16, 2010	105	0:48	0:38	0:06	0:42	0:02	3:13
Mendenhall-Willson SE Lot	114	0:38	0:27	0:08	0:33	0:04	2:54
Mendenhall-Black SE Lot	127	1:00	0:55	1:06	0:39	0:03	3:54
Babcock-Rouse NW Lot	91	0:58	0:50	0:06	0:54	0:01	5:52
Tracy on-street	78	0:40	0:31	0:23	0:39	0:01	3:01
Main on-street	129	0:47	0:36	0:19	0:42	0:01	3:40
Parking garage	64	1:21	1:09	0:41	1:00	0:02	3:57

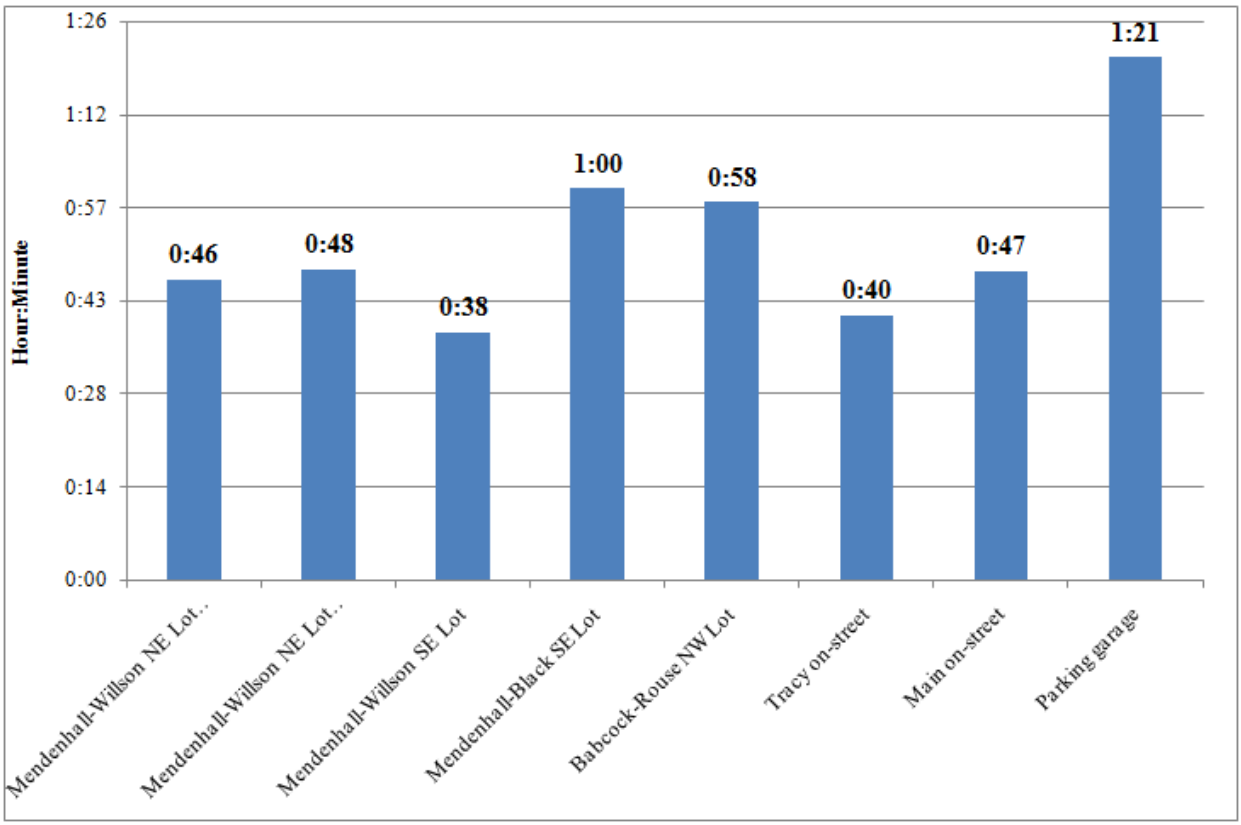

Figure 6-9: Dwell time mean values

Results of the turnover rate analysis indicated that off-street parking facilities see significantly lower turnover, with rates for these lots ranging from 0.02 to 0.68. The parking garage exhibited extremely low turnover, which was expected given the high number of spaces available, as well as the nature of parking it services (long-term). On-street parking exhibited higher turnover, with rates for these areas ranging from 0.90 to 1.18. The reason for these differences is likely the result of the use of the parking itself. On-street stalls are more likely to be used by motorists making brief stops at an adjacent business, resulting in multiple vehicles using a given stall per

hour. Off-street lots are more likely to be used by longer-term parkers, producing less turnover during the course of an hour.

7. PARKING DEMAND CALCULATION

In addition to understanding the current performance of parking assets in downtown Bozeman (occupancy rates, dwell time, and turnover), the Parking Commission was interested in examining current parking demand as calculated using information provided by the ITE *Parking Generation* guide (18). The following sections present the methodology employed and results of this analysis. The reader should note that the information provided in this chapter represents estimates of current parking demand in downtown Bozeman and is based on a series of assumptions. These assumptions include the uses and square footages of each building, as well as the parking generation rate applicable to each building (in some cases where an applicable rate for a specific type was unavailable). Consequently, there is an element of uncertainty in the estimates presented due to these limitations. Even if exact building use and square footage information were available from the city, the forecasting performed using ITE factors represent an approximate science. Care should be exercised in applying the numbers presented here as the amount, duration, and timing of parking demand can vary significantly depending on the mix of land uses supported by the parking.

7.1. Methodology

Parking demand ratios developed and reported by ITE through the Parking Generation manual were employed for the different building/land uses in the study area. The results of the use of these ratios were summed together to determine the parking demand for each block. In total, three pieces of information were required to complete the parking demand calculations:

- The inventory of downtown parking supplies.
- The square footage and use of downtown buildings. The exceptions to this were the elementary school (number of students) and the bowling alley (number of lanes).
- Appropriate ITE parking generation rates.

Contact with city personnel indicated that no existing databases contained information regarding building square footage. Therefore, the gross square footage of downtown buildings was collected through measurements using ArcView GIS and a high-resolution aerial photo provided by the City. Additionally, Google street-view images and site visits (as needed) were used to determine the total number of stories and structure layout of buildings. The overhead outline of the building was measured (length and width) on the aerial photo, with distinctions made whether a specific portion of the building was single or multi-story. Once all square footages for a building were completed, they were summed up and entered into a spreadsheet along with the specific building use (such as the case with banks) or general use (provided by the City) for later analysis. Note that while this method was open to error (over or underestimation of building square footage), in the absence of any government database providing specific building dimensions, it was the only realistic option available.

Once the necessary information was assembled, it was possible to compute the current expected peak parking demand for the different blocks in the study area. Note that, while the peak parking requirements by each land use are computed and aggregated together with other building/land uses on the block, the peak parking demand for all uses may not necessarily occur simultaneously. For example, a restaurant is likely to see peak parking needs at noon and in the early evening, while a bank on the same block may experience a peak parking demand at 2:00

p.m. The combined parking demand estimated for each of these uses on the same block may indicate that a parking deficit exists, when in reality, there may be a slight parking surplus, as their respective demands occur at different times throughout the day. The location of such surpluses will vary, with areas on the periphery of downtown more likely to see lower parking demand and the presence of a surplus. The peak demands presented here are not for a specific time of day (i.e. 1:00 p.m.); rather, they are for the highest demand point during a day.

The process to calculate the expected peak period parking demand for the blocks and their building/land uses were as follows. The gross square footage for each building/land use was divided by 1000 (the ITE parking ratios are based on 1000 ft^2 increments) and multiplied by the appropriate ratio for the use of interest. Note that the City of Bozeman parking rate is only applied to 85% of the gross square footage, whereas this work applied the ITE rate to the full measured footage. In the B-3 zoning district (including the study area of this report) the first 3,000 square feet of the building has an assessed rate of zero spaces by the city. However, as the ITE parking generation rates were employed in this work, the methodology recommended by that organization was used, which did not factor such adjustments[8].

The various ITE ratios employed in this process for each building/land use are presented in Table 7-1. This table also presents corresponding metrics, when available, as specified by the Bozeman UDO (1). Note that Table 7-1 presents maximum requirements and does not take into account the reduction factors presented earlier in Table 2-2. The square footages measured for various downtown buildings (or the alternative metric employed, such as number of students, bowling lanes, and individual residences) are presented in Table 7-2. Note that the predominant downtown buildings were mixed use (business and apartments) and commercial, each with over 400,000 square feet of space, as well as administrative uses (offices) with over 100,000 square feet of space.

The ratios were selected using professional judgment and general knowledge on the nature of the business for the respective block. The resulting number of parking spaces demanded was then subtracted from the available supply for that block. The result was an indication of whether a parking surplus or deficit was present for that block. Only a parking demand calculation for the present was developed. An estimate of future parking demand was not feasible for two reasons. First, accurate square footage information for both present, as well as projected future building/land uses was not known, which limits the reliability of estimates generated. Second, a rate of growth related to downtown trips could not be reliably established, given the nature of the tourism trade that frequents the downtown area. Note that the parking demand figures that have been calculated for the present time do not account for a specific time of year; rather, they represent the average demand that may be expected based on observation made for comparable uses.

Before proceeding to a discussion of the parking demand results, a few clarifying points are necessary. First, ongoing reconstruction on the lots where the March 5, 2009, explosion occurred could not be accounted for in the building square footages estimated for that block (1018). Consequently, the computed parking demand for this block is likely to be lower than what would actually be observed once construction is completed. Second, parking demand calculations have

[8] The ITE methodology was employed in generating parking demand estimates as it a widely employed and accepted approach which relies on straightforward data inputs.

been computed assuming that occupied properties (land uses) remain occupied by the same use as when they were recorded by the city. Finally, parking demand does not take into consideration the availability of parking on a block at a given time of day.

Table 7-1: ITE parking generation ratios for peak demand based on use

Building/Land use	ITE Parking Rate per 1000 sq. ft.	City of Bozeman UDO Parking Rate
Commercial (1)	1.13	3.3 (per 1000 sq. ft.)
Administrative	2.84	4.0 (per 1000 sq. ft.)
Mixed use (2)	1.23	N/A
Public Facility (3)	0.98	N/A
Bank	4.00	3.3 (per 1000 sq. ft.)
Restaurant (4)	10.60	20.0 (per 1000 sq. ft.)
Vacant (5)	0.00	0.00
Elementary School (6)	0.17	1.5 spaces per classroom
Auto Repair	2.14	No less than 4 spaces
Single Family Residential	1.83	Varies by number of bedrooms
Courthouse	3.02	N/A
Community Center (7)	0.98	N/A
Church	8.37	1 space per six persons
Emerson Cultural Center (8)	0.98	5.0 (per 1000 sq. ft.)
Bowling Alley	3.13	2 spaces per alley
Duplex	1.62	Varies by number of bedrooms
Light Mfg.	0.75	1.0 (per 1000 sq. ft.)
Library	2.61	N/A
Apartments	1.23	Varies by number of bedrooms
Fire Station (9)	3.02	N/A

(1) While the records provided by the City indicate a series of building uses as “commercial”, ITE provides no parking generation ratio for such a general classification. As a result, this work assumes that commercial uses are best represented by ITE’s rate for an apparel store, which reflects the boutique or specialized nature of many downtown businesses.

(2) For building uses listed by the City as “mixed use”, it was assumed that the main floor of the building was occupied by a commercial business, while the remaining majority of area was occupied by apartments or professional offices. As ITE does not provide a parking generation ratio for mixed use such as that found in downtown Bozeman, the apartment ratio was employed to be conservative, given the likelihood that many mixed use buildings serve as apartment housing. The City itself addresses mixed uses by applying parking ratios to the disaggregated uses within the building.

(3) Public facilities employed ITE’s museum ratio, as this represented the nature of such uses in downtown Bozeman (i.e. the Pioneer Museum).

(4) Restaurants were assumed to all be of the ITE high-turnover, sit-down category and based on square footage. City of Bozeman requirement is for serving area only.

(5) Vacant buildings and land uses were assumed to generate no parking demand.
(6) Hawthorne Elementary School was assumed to have an enrollment of 325 students, based on school district records.
(7) ITE provides no ratio for a building use such as that of the old high school (listed here as a community center). The museum ratio was employed for this use, although it is likely that the resulting parking demand is higher than what exists for this block based on site observations.
(8) ITE provides no ratio for a building use like the Emerson Cultural Center, so the museum ratio was employed for this category.
(9) ITE provides no ratio for fire stations. As a result, the ratio for governmental offices (the same as applied for the courthouse) has been used, although it is likely that this ratio overestimates parking demand.

7.2. Results

Estimated present parking demand is presented in Table 7-3. As one would expect based on their square footages, mixed use, commercial and administrative building uses generated the highest demands for parking. Overall, the results of demand calculations indicated that parking surpluses exist in some areas of the downtown district, while other blocks did not possess a surplus for all combined peak demands (assuming they were to occur simultaneously). Of course, the calculated parking demands represent estimated figures which have resulted from the assumptions previously discussed. Consequently, the results should be viewed as informational in nature and not as an absolute calculation of the true number of surplus stalls available at any given time. As discussed earlier, demand is driven to an extent by the land use being served, and some land uses experience peak demands during times of day when other, neighboring or shared uses do not. For example, a restaurant will see increased parking demand at approximately noon and during the early evening, while a bank may see parking demand during the mid morning and afternoon.

The results of present demand indicated that most individual blocks have a surplus of parking. This cumulative surplus represents headroom to accommodate future parking demand growth in the downtown area. The availability of such a surplus is important as the entire lifespan of each building in the downtown area being serviced by parking, its surrounding land uses, and their interaction over time cannot be accounted for. Only blocks 1014, 1015, 1025, 1026 and 1027 showed a parking deficit. It is interesting to note that the deficit blocks of 1015, 1025, 1026 and 1027 are all in the immediate vicinity of the parking garage (block 1016), which could address such parking shortages. The parking deficit on blocks 1025 and 1026 was a combined 14 stalls, which should be considered inconsequential. However, the estimated deficits on blocks 1014 (65 stalls), 1015 (76 stalls) and 1027 (97 stalls) are much larger and warrant discussion. All parking surpluses and deficits are graphically illustrated in Figure 7-1. Blocks with a surplus of parking were shaded green, while those estimated at or approaching a deficit were shaded red. Note that blocks estimated to be at 85 percent capacity were considered deficit blocks for the purposes of this map. As this figure indicates, the distribution of blocks that have or are near a parking deficit is centered around the downtown core. However, several of these blocks are immediately adjacent to the parking garage, which can serve as a “safety valve” to relieve parking deficits as they arise.

The predominant building uses on Block 1014 were commercial and mixed, totaling over 90,000 square feet. It is likely that much of the estimated square footage on this block is used for other

purposes (ex., apartments or offices) for which appropriate parking ratios could not be assigned. As a result, the parking deficit on this block is likely overestimated. Additionally, parking demand was calculated for all peak periods on the block, and these individual peaks do not necessarily coincide with one another. This is evidenced by the results of the occupancy study presented in Chapter 5, which indicated that the peak occupancy on this block occurred on a weekday and was 81.8 percent (1:00 p.m.). Given the proximity of the city parking garage and public lots to this block, even if an overestimation has not been made, any parking deficit was likely to have been offset by those adjacent facilities.

The predominant building uses on Block 1015 were commercial and restaurant. The commercial use was estimated to generate a demand of 70 stalls, while the restaurant use would generate a demand of 67 stalls. Obviously, the restaurant demand (and most of the commercial demand) will not likely occur all at once, so the resulting parking deficit that has been calculated for this block is not likely to exist. This is further evidenced by the findings of Chapter 5, which indicated peak occupancy of stalls on the block was 82.3 percent on a weekday (7:15 p.m.). Even if a deficit did occur, the proximity of the city parking garage and public lots to this block would have offset it. Of course, note that the observed peak occupancy of 82.3 percent is approaching the 85 percent threshold when parking facilities may be considered effectively full.

Block 1027's predominant building uses were mixed use (44,100 ft^2), banking and administrative (19,500 ft^2 each). The mixed use buildings estimated parking demand was 54 stalls, administrative 55 stalls, and banking 78 stalls. It would appear that the bank parking demand is likely overestimated, although without an individual parking generation study for this specific site, the true demand ratio is unknown. As with other blocks that had estimated deficits, the peak demand for all uses was not likely to occur simultaneously. Consequently, a true parking deficit is not likely on this block. The absence of such a deficit at present is further evidenced by the results discussed in Chapter 5, which showed that the peak occupancy for this block was 63.0 percent on a weekday (1:40 p.m.).

One final note to bear in mind when reviewing the parking demand results is that some parking facilities, while generally classified as having no restrictions, are indeed restricted to some extent. For example, bank parking is generally restricted to customers only. Consequently, the surplus of parking that this generally represents is not in fact a true surplus. However, accounting for the presence of such specific restrictions and determining the relationship between them and parking demand were beyond the scope of this work.

To better understand the relationships between parking surpluses and deficits and how location may play a role, Figure 7-2 was generated to illustrate the dimensions of each block in the downtown area (general lengths and acreages). Note that the dimensions presented correspond to the North-South by East-West face of each block and are only general measurements (i.e. not exact in accuracy). In examining this map, the reader should consider that past studies have indicated that the average distance a person is willing to walk to their destination after parking is a maximum of 1000 feet. Developing a map that illustrates the various 1000 foot distances from the various parking assets on each block was not feasible here given the various locations of parking stalls and potential destinations. However, the map presented in Figure 7-2 does provide an indication that a good deal of public parking is provided in the immediate vicinity of the downtown core, particularly now that the parking garage is available. Public parking availability, aside from on-street spaces, decreases the further east on Main St. one travels, although many businesses in that area provide their own parking.

Table 7-2: Summary of downtown building square footage (estimated) by use

Block	Commercial	Administrative	Mixed use	Public Facility	Bank	Restaurant	Vacant	Elementary School	Auto Repair	Single Family Residential	Courthouse	Community Center	Church	Emerson Cultural	Bowling Alley	Duplex	Light Mfg	Library	Apartments	Fire Station
1005	3,446	35,636								1										
1006	14,700	10,000																		
1007					8,115															
1008							23,028		3,446	1										
1009			12,160																	
1010	3,650	22,922							5,875											
1011								325												
1012	20,270			12,224		6,390					28,050									
1013		4,472		8,004	21,730															
1014	47,280	6,840	42,362			3,864														
1015	61,730	9,126	7,000			6,350	18,920													
1016		10,728	65,200			4,480														
1017	18,900		28,610	5,400		3,375														
1018	40,888	8,030	51,184																	
1019	8,876	2,380				6,040	14,280		4,572										9,600	7,450
1020	38,506				15,620															
1021				36,960		11,005											26,033			
1022												94,379								
1023					11,760								6,858							
1024	13,726	1,395	19,000				17,400													
1025	23,177		76,340																	
1026	80,750		10,400	9,975																
1027	8,250	19,500	44,100		19,500															
1028	19,200		50,360		19,600	2,275														
1029	17,090		60,412																	
1030	11,288								15,788	4									7,888	
1031	16,518						7,655										33,128	52,300		
1032														73,238						
1036			16,750																	
1037	11,500	7,636								1										
1038	7,280														25	4,052				
Totals	**467,025**	**138,665**	**483,878**	**72,563**	**96,325**	**43,779**	**81,283**	**325**	**29,681**	**7**	**28,050**	**94,379**	**6,858**	**73,238**	**25**	**4,052**	**59,161**	**52,300**	**17,488**	**7,450**

Table 7-3: Current downtown parking demand by block

Block	Commercial	Administrative	Mixed use	Public Facility	Bank	Restaurant	Vacant	Elementary School	Auto Repair	Single Family Residential	Courthouse	Community Center	Church	Emerson Cultural	Bowling Alley	Duplex	Light Mfg	Library	Apartments	Fire Station	Stalls	Surplus (Deficit)
ITE Rate	1.13	2.84	1.23	0.98	4.00	10.60	0.00	0.17	2.14	1.83	3.02	0.98	8.37	0.98	3.13	1.62	0.75	2.61	1.23	3.02		
1005	4	101	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	170	63
1006	17	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	110	65
1007	0	0	0	0	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	125	93
1008	0	0	0	0	0	0	0	0	7	2	0	0	0	0	0	0	0	0	0	0	127	118
1009	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	150	135
1010	4	65	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	203	121
1011	0	0	0	0	0	0	0	55	0	0	0	0	0	0	0	0	0	0	0	0	85	30
1012	23	0	0	12	0	68	0	0	0	0	85	0	0	0	0	0	0	0	0	0	271	84
1013	0	13	0	8	87	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	122	15
1014	53	19	52	0	0	41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	101	(65)
1015	70	26	9	0	0	67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	96	(76)
1016	0	30	80	0	0	47	0	0	0	0	0	0	0	0	0	0	0	0	0	0	479	321
1017	21	0	35	5	0	36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	183	85
1018	46	23	63	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	197	65
1019	10	7	0	0	0	64	0	0	10	0	0	0	0	0	0	0	0	0	12	22	138	13
1020	44	0	0	0	62	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	180	74
1021	0	0	0	36	0	117	0	0	0	0	0	0	0	0	0	0	20	0	0	0	233	61
1022	0	0	0	0	0	0	0	0	0	0	0	92	0	0	0	0	0	0	0	0	123	31
1023	0	0	0	0	47	0	0	0	0	0	0	0	57	0	0	0	0	0	0	0	115	11
1024	16	4	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	163	120
1025	26	0	94	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	113	(7)
1026	91	0	13	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	107	(7)
1027	9	55	54	0	78	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100	(97)
1028	22	0	62	0	78	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	216	30
1029	19	0	74	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	131	37
1030	13	0	0	0	0	0	0	0	34	7	0	0	0	0	0	0	0	0	10	0	135	71
1031	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	137	0	0	304	124
1032	0	0	0	0	0	0	0	0	0	0	0	0	0	72	0	0	0	0	0	0	169	97
1036	0	0	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	89	68
1037	13	22	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	173	136
1038	8	0	0	0	0	0	0	0	0	0	0	0	0	0	78	7	0	0	0	0	126	33
Totals	**528**	**394**	**595**	**71**	**385**	**464**	**0**	**55**	**64**	**13**	**85**	**92**	**57**	**72**	**78**	**7**	**44**	**137**	**22**	**22**	**5,034**	**1,849**

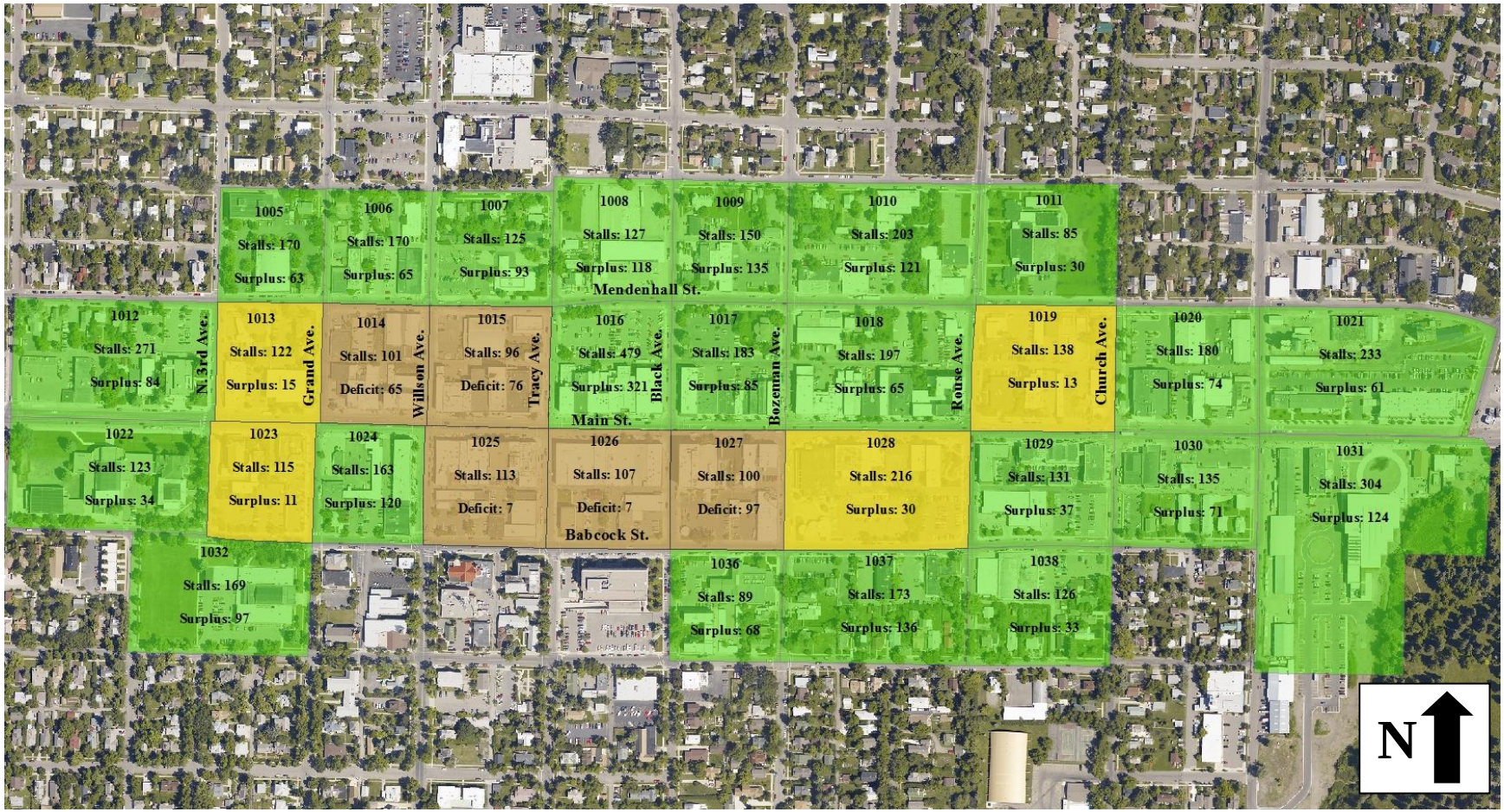

Figure 7-1: Parking surpluses and deficits by block

Figure 7-2: General block dimensions

7.3. Chapter Summary

This chapter has presented the results of an estimation of current parking demand study for downtown Bozeman. Parking demand was calculated through the use of ratios provided by ITE's *Parking Generation* guide. This document provided parking demand ratios for a variety of building/land uses based on the square footage of a building or other use metrics. In the case of this work, building/land uses were identified by the City of Bozeman's database, while building square footages were estimated through measurements of aerial photographs from the city in ArcView GIS. It should be noted that although this study used reasonable assumptions and practices in estimating future demand there was uncertainty due to the inherent limitations in available data such as building usage. Care should be exercised in applying the future numbers as the amount, duration, and timing of parking demand can vary significantly depending on the mix of land uses supported by the parking.

The results of present demand indicated that most individual blocks have a surplus of parking. The availability of such a surplus is important as the entire lifespan of each building in the downtown area, its surrounding land uses, and their interaction over time cannot be accounted for when estimating parking demand. Therefore, a surplus represents headroom to accommodate future parking demand growth in the downtown area. Blocks 1014, 1015, 1025, 1026 and 1027, were estimated to have varying deficits. In reality, these deficits did not likely exist, as parking demands were calculated for peak periods of each use, which were not likely to occur simultaneously on a block. Indeed, when occupancy rates for each of these blocks were examined, it was found that at no time during the study period were all spaces occupied on any block.

Despite the finding that a parking surplus exists overall, at times it may be perceived there is a parking deficit. This perception is likely the result of a lack of available parking in the immediate vicinity of trip destinations during certain periods of the day (e.g. noon). The tendency for motorists to look for parking immediately adjacent to their destination and give up when none is available, rather than trying another nearby parking location, is likely at play here.

Of course, in some instances, a block may have a surplus of parking at first glance (and by the figures compiled here), but because of parking restrictions, that parking is unavailable to many motorists. For example, there may be parking available in a bank parking lot, but use of that parking is restricted to bank customers. In other words, the public cannot park in that lot (technically, as they could be towed by the owner) when making a trip to a business across the street. Such restrictions likely further fuel the public perception that there is a parking deficit downtown.

What can be done to address these perceptions, other than to inform the public that adequate parking is available and provide an indication of its location, is not readily clear. Once perceptions have been set, they are difficult to change quickly. In the case of downtown Bozeman, the addition of the parking garage has added parking capacity, yet some downtown visitors still perceive a shortage of available parking. Whether this perception is the result of historical observations before the garage opened or more recent experiences is not clear. What is clear is that steps need to be taken to educate the public on the availability (and perhaps location) of downtown parking assets in order to combat this misperception. The form that such a public information campaign takes is beyond the scope of this project.

8. CONCLUSIONS AND RECOMMENDATIONS

This project has performed a number of different tasks examining parking in downtown Bozeman. This included a review of current guidance/practice, an inventory of downtown Bozeman parking stalls, GIS mapping, an evaluation of occupancy rates at the block level, and dwell time and turnover analysis for selected city-owned parking lots. Based on the work completed during this project, a number of conclusions and recommendations have been drawn. The following sections present the conclusions of this work, along with recommendations.

8.1. Summary of Findings

Recent parking studies completed in Montana cities (Billings and Missoula) provided some insight into management practices that have been recommended to other communities. Aside from this information, the individual findings provided comparison points when examining the results of the Bozeman parking study, namely occupancy rates.

The reports of previous parking studies throughout the U.S. found that only limited information related to recommended or expected occupancy rates or similar metrics were provided. This came mainly in the form of the 85 percent rule cited in the Oregon City, and Springfield, Oregon, reports (13, 14). The only other baseline metric identified by the parking studies was the criteria that at least 50 percent of available parking assets be controlled or owned by a community (17). This was viewed as important to allow the community to manage parking in terms of allocation, changing demand, pricing, and enforcement. Studies from throughout the U.S. did provide a number of different parking management practices that should be considered. Among the practices identified were:

- Improve signage.
- Work with local businesses to provide long term parking for employees as needed.
- Utilize existing parking assets before adding to supply.
- Formation of a parking advisory committee to assist in guiding parking policy.
- Work with employers to encourage employees to park further from a business, leaving closer parking stalls open for customers.
- Avoid setting parking fines that are only slightly higher than the cost of one day's parking.
- Market exiting parking supply.
- Adopt parking rate ranges based on location and demand.
- Develop incentives for private development of publically available parking.
- Develop a residential parking permit zone policy in residential areas affected by spillover from commercial parking.
- Negotiate shared use and/or lease agreements with owners of strategically placed existing private surface lots.
- Define the priority purpose/use for parking in each parking zone or area.
- Establish a decision-making point that indicates a review of the parking system is undertaken.
- Implement warning tickets for first time offender or out of town visitors.

- Employ marketing strategies when changes to the parking system occur.

In reviewing guidance documents for information on parking generation rates and management strategies, the ITE *Parking Generation* guide provided a number of recommended demand ratios for various types of land uses. Other reference material provided baseline guidance recommended that a 90 percent rule be employed for parking utilization, which differed slightly from the 85 percent rule identified previously. Note that this guidance, as well as that provided by individual communities, did not differentiate between land uses; rather, one threshold was indicated for all available parking. An additional piece of guidance identified was that at least 50 percent of available public parking be occupied throughout the day. Finally, the materials reviewed identified a number of parking management practices which matched those cited in the previous paragraph.

Downtown parking stall inventory data was collected on July 27, 28, and 29, 2010 (a Tuesday, Wednesday, and Thursday, respectively) for a total of 31 downtown block groups. A data collector walked each downtown block in the study area and recorded the various parking assets observed by their different characteristics on a data collection sheet. Characteristics recorded included number of spaces, type of parking (on-street, off-street), ownership, fees and restrictions.

The inventory found that a total of 5,034 parking stalls were available in the downtown study area. This represents an average of 162 stalls per block, although some blocks contain far more or less than this average. The majority of blocks had between 100 and 200 parking stalls of various types available. Publicly-owned stalls comprised approximately 48 percent of downtown parking inventory, while private stalls (i.e., business parking lots) comprised approximately 52 percent. This totaled to 2,426 public parking stalls and 2,608 private parking stalls in the downtown area.

A total of 1,007 (20.1 percent) stalls were recorded as being unrestricted (all on-street). Off-street privately owned stalls were available for patron use only. This private parking was comprised of 1,740 stalls, or approximately 35 percent of downtown parking. A total of 689 private off-street stalls were recorded as requiring a permit. Finally, a total of 125 stalls or 2.5 percent of all available downtown parking is designated handicapped accessible.

GIS mapping was employed to visually illustrate downtown parking assets for the study area. Maps presented data at the block level, and included the total number of stalls available, public and private ownership, handicapped stalls, permit parking stalls, on- and off-street stalls, city-owned lot information, occupancy rates and dwell times. This mapping provided the reader with a visual presentation of the data to better understand the distribution of various parking assets and performance on a block-by-block basis in the downtown area.

When examined, occupancy rates shared a similar trend between all block groups, both on weekdays and weekends (recall the inventory data and occupancy data were collected on different dates). Occupancy steadily increased throughout the morning and reached its peak for the day during the noon hour. This coincided with the lunch hour when downtown restaurants were likely to be heavily frequented. Following the midday peak, occupancy rates for most blocks fell throughout the afternoon and evening hours. The exceptions to this observation were blocks 1015, 1017 and 1018 on weekdays and blocks 1014, 1017, 1024 and 1028 on weekends. These blocks were adjacent to many restaurant and bar establishments, which explained late day increases in occupancy.

When the individual city lots on the northeast and southeast corners of the Mendenhall St. and Willson Ave. intersection were examined, a similar occupancy rate trend to the block level was observed. Occupancy rates climbed throughout the morning and peaked at approximately noon. The exception to this was the southeast corner lot, which experienced a second, often higher peak during the early evening hours. In fact, 100 percent occupancy was achieved in this lot on Thursday, September 16, 2010 between 8:00 p.m. and 10:00 p.m.

Dwell time results indicated that vehicles remained parked for an average of 38 minutes to 1 hour and 21 minutes. In general, the dwell times observed between on-street and off-street parking did not greatly differ; only the parking garage exhibited somewhat unique dwell times (high) which were expected. These results indicated that most of the vehicles observed to park were doing so as part of trips which were not necessarily brief in nature. However, this was not entirely the case, as evidenced by the turnover rate analysis findings for on-street parking.

Results of the turnover rate analysis indicated that off-street parking facilities saw significantly lower turnover, with rates for these lots ranging from 0.02 to 0.68. Recall that parking ratios less than 1.0 indicated that the parking being analyzed was not being fully used, while ratios of 1.0 or greater indicated that all stalls were being completely utilized each hour. On-street parking exhibited higher turnover, with rates ranging from 0.90 to 1.18. The reason for these differences was likely the result of the use of the parking itself. On-street stalls were more likely to be used by motorists making brief stops at an adjacent business, resulting in multiple vehicles using a given stall per hour. Off-street lots were more likely to be used by longer-term parkers, particularly the parking garage, with their space less likely to be filled immediately after they leave, producing less turnover during the course of an hour.

The results of present demand indicated that most individual blocks have a surplus of parking. The availability of such a surplus is important as the entire lifespan of each building in the downtown area, its surrounding land uses, and their interaction over time cannot be accounted for when estimating parking demand. Therefore, a surplus represents headroom to accommodate future parking demand growth in the downtown area. The presence of surpluses was confirmed by the occupancy rate measurements observed in the downtown core. Peak occupancy rates ranged between 33.2 percent and 83.3 percent; blocks experiencing high occupancy rates generally did so for only one hour per day. Blocks 1014, 1015, 1025, 1026 and 1027, were estimated to have varying deficits. In reality, these deficits did not likely exist, as parking demands were calculated for peak periods of each use, which were not likely to occur simultaneously on a block. Indeed, when occupancy rates for each of these blocks were examined, it was found that at no time during the study period were all spaces occupied on any block.

8.2. Recommendations

Based on the work completed, the project team has developed a series of recommendations for the Parking Commission to consider. Note that these recommendations reflect the views of the researchers and are presented for consideration and discussion purposes only and do not constitute mandatory changes.

In terms of inventory, it appears that the city possess an adequate number of publicly-owned stalls. Of course, this may change in the future, and so, consideration should be given to conducting future parking studies as needed in the future. The need for and location of future

parking in the downtown area should also continually remain on the slate of Parking Commission discussions.

One challenge during the course of the inventory was the ability to accurately identify parking stalls due to the condition of pavement markings. This was true of both public and private parking stalls. While the city cannot address private stall pavement marking conditions, consideration should be given to maintaining clear, consistent markings for both on- and off-street parking. For example, the condition of markings in the parking lot on the southeast corner of Mendenhall St. and Willson Ave. was such that the student data collector had difficulty determining whether 28 or 29 stalls were present. While it is recognized that the maintenance of parking stall pavement markings is difficult and cannot occur on a frequent basis, consideration should be given to repainting them when they reach a specific point of deterioration.

While the results of the occupancy rate and dwell time analysis did not indicate any problems at present, it is possible that issues may arise in the future. This is particularly true if growth in tourism traffic visiting downtown occurs. As the analysis indicated, some blocks and lots in the downtown area saw significant increases in occupancy near lunch and dinner hours. While adequate parking capacity exists in the downtown area to absorb these peaks at present, occupancy rates and dwell times may need to be revisited in the future. One way to gauge whether future analysis will be needed might be through the observations of enforcement personnel. Given that they observe parking on a frequent basis, it should be possible to determine, over time, whether parking occupancies and dwell times have changed in a significant way.

As part of this work, an inventory spreadsheet for the downtown area has been created. This spreadsheet, which was presented in Figure 4-1, allows for the recording of parking based on a series of characteristics. Based on the provision of this spreadsheet to the city, it is recommended that it is maintained in the future. When parking is removed (i.e., for building construction), the net amount of parking lost should be deducted from the inventory spreadsheet for that particular block. Similarly, when parking is added through renovations, etc., the net amount gained should be added to the inventory spreadsheet. If this recording is performed as changes incrementally occur, it should not represent an added burden to parking staff. However, being aware of when such changes occur may present a challenge. Possible approaches to identifying when changes to parking are occurring may be through alerts from zoning or building permit staff, as well as on-site observations by parking enforcement personnel.

Based on the identification of best practices, one possible recommendation to consider in the future would be to employ marketing when major changes to the parking system occur. For example, if a major new parking area is built, or a parking area is removed entirely, alerting the public to such changes would be beneficial.

As indicated in Chapter 7, one of the challenges encountered in calculating current parking demand was the lack of available information regarding the specific uses and square footages of downtown buildings. A formal collection of such data was beyond the scope of this project, and estimated building square footages, as well as general land use classifications were employed in calculating demand. However, the development of a GIS database which contains accurate square footage data, as well as specific building uses would greatly facilitate the completion of future parking demand estimation.

While not a recommendation that the Parking Commission needs to consider, the parking demand portion of this work indicated that a need exists to develop parking demand ratios for mixed use buildings such as those predominant in downtown Bozeman. At present, ITE does not offer guidance related to such uses, which is surprising given their widespread existence across the country. What little discussion is provided by ITE is related to large suburban mixed use developments which host only businesses and not housing.

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