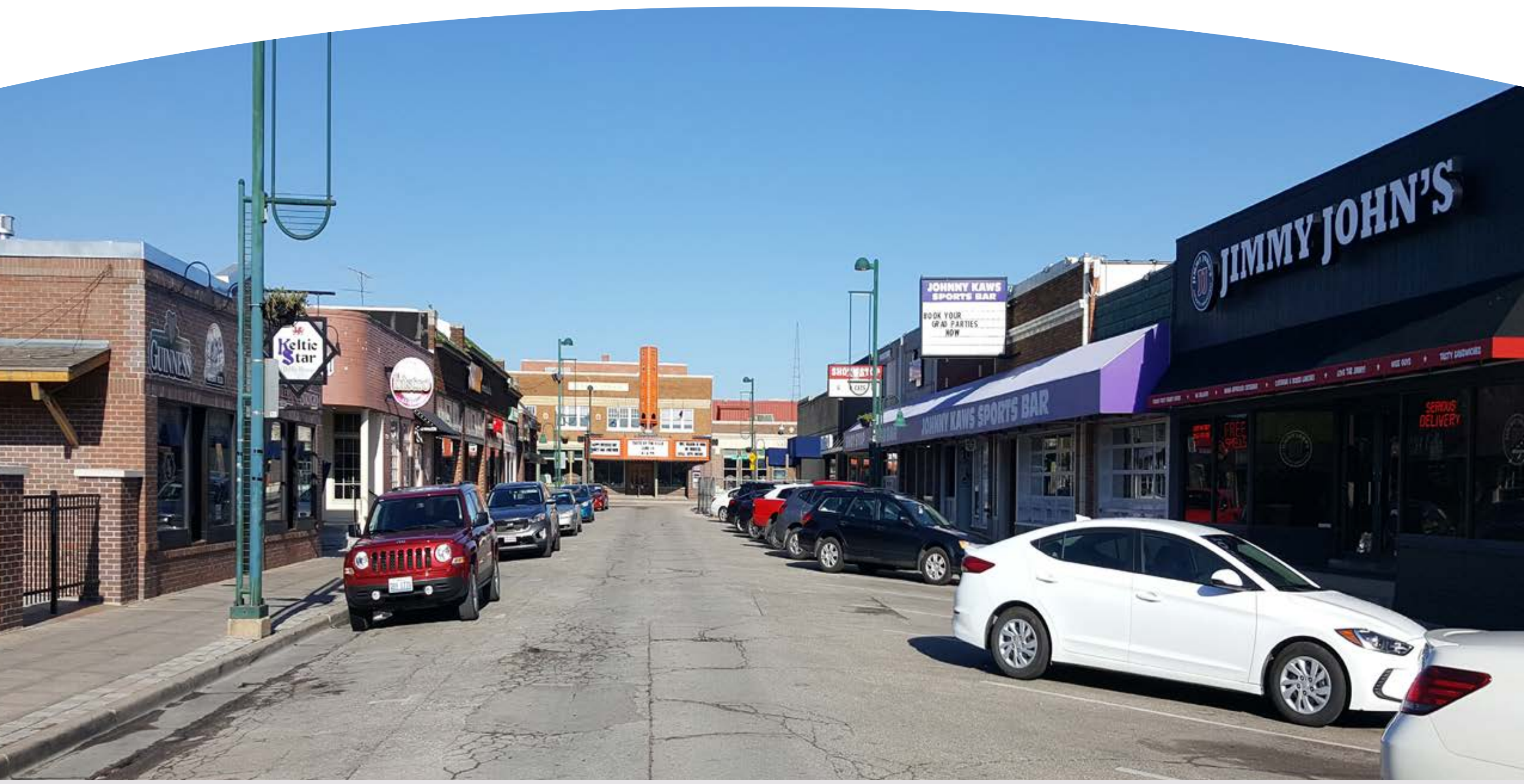
Aggieville Infrastructure Analysis

Summary Report
January 2018

Prepared For
The City of Manhattan, Kansas



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City of Manhattan Kansas

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January, 2018
Olsson Project No. 017-2698

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OLSSON® ASSOCIATES

January 30, 2018

Jason Hilgers, Deputy City Manager
City of Manhattan
1101 Poyntz Ave.
Manhattan, Kansas 66502

RE: Aggieville Infrastructure Analysis

Dear Jason,

Attached you will find the Aggieville Infrastructure Analysis Summary Report. This report provides a detailed analysis of the current infrastructure of Aggieville to help you develop recommended improvements that will alleviate parking challenges and further develop Aggieville into a vibrant attraction well into the future.

The report was prepared by Olsson Associates, with consultation from New Boston Creative Group and Walker Parking Consultants. Our study is outlined in the following sections – land-use, utility, stormwater, parking infrastructure, and public involvement/steering committees. It is our intention that this report will serve as a thorough analysis for the improvement needs of Aggieville and sensible recommendations going forward.

Thank you for the opportunity to work with you on this project. If you have any questions, please do not hesitate to contact me, 785.539.6900 or mbachamp@olssonassociates.com.

Sincerely,

Mark Bachamp, PE

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SECTION 1: INTRODUCTION

The economic vitality of any district relies on it's efficiency to accommodate visitors and consumers. The Aggieville district of Manhattan, Kansas is no exception. This popular urban district of Manhattan is home to many bars and restaurants that caters to both the student population of Kansas State University(KSU) and the resident population of Manhattan.

The purpose of this report is to analyze the current infrastructure of Aggieville and understand what can be done to further the city's initiative to further develop Aggieville into a vibrant, mixed-use attraction that offers diverse shopping, dining, entertainment, and residential opportunities.

Currently, this popular district is suffering from insufficient parking/access. The goal of the Aggieville Infrastructure Analysis project is to develop recommendations that will alleviate the underserved parking needs with a long-term solution.

This report is broken up into the following sections that will illustrate the project team's process and recommendations:

- Utility Analysis
- Model and Intersection Analysis
- Parking Infrastructure Analysis
- Public Involvement

Through this process existing conditions have been documented, parking management strategies have been suggested, and long-term solution opportunities have been identified.

Moro Street in Aggieville

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SECTION 2: LAND USE SUMMARY

2.1 Introduction

This section profiles the existing business uses and dwelling units in the Aggieville district, as well as five future scenarios estimating various levels of commercial and residential growth in the area.

Data made available by the City of Manhattan included:

- Existing dwelling units and commercial square footage by business use and
- Initial low, medium, and high growth scenarios from an infrastructure impact analysis

The City's data was used to identify the spread of uses across the entire district. The final five growth scenarios included are the original three based on input from the Aggieville Steering Committee. Two additional scenarios apply minor changes to the original scenarios. The Original High scenario expects the highest amount of new dwelling units, whereas, the New Option scenario uses a combination of the Low, Medium and High scenarios, but doubles the amount of new service/office space. All five scenarios and their expected totals are included in **Table 2.1**.

Table 2.1: Scenario Summary

Scenario	Dwelling Units	Retail SqFt	Fast Casual SqFt	Eating/ Drinking SqFt	Drinking SqFt	Service/ Office SqFt	Vacant SqFt
Existing	226	48,309	92,363	17,376	44,875	75,628	13,644
New Option	366	73,590	116,531	41,544	44,875	307,945	-
Original High	1,126	73,590	116,531	41,544	44,875	191,081	-
High	715	73,590	116,531	41,544	44,875	191,081	-
Medium	536	73,590	116,531	41,544	44,875	191,081	-
Low	366	63,295	103,927	27,699	44,875	174,872	-

The map below, **Figure 2.1**, details the ratio of uses for each individual block of the district and includes an identification number in the top right-hand corner of each block. These numbers coincide with the identification numbers listed in the growth scenario summary **Tables 2.2** through **2.8** on the following pages.

Figure 2.1: Existing Businesses and Number of Dwelling Units

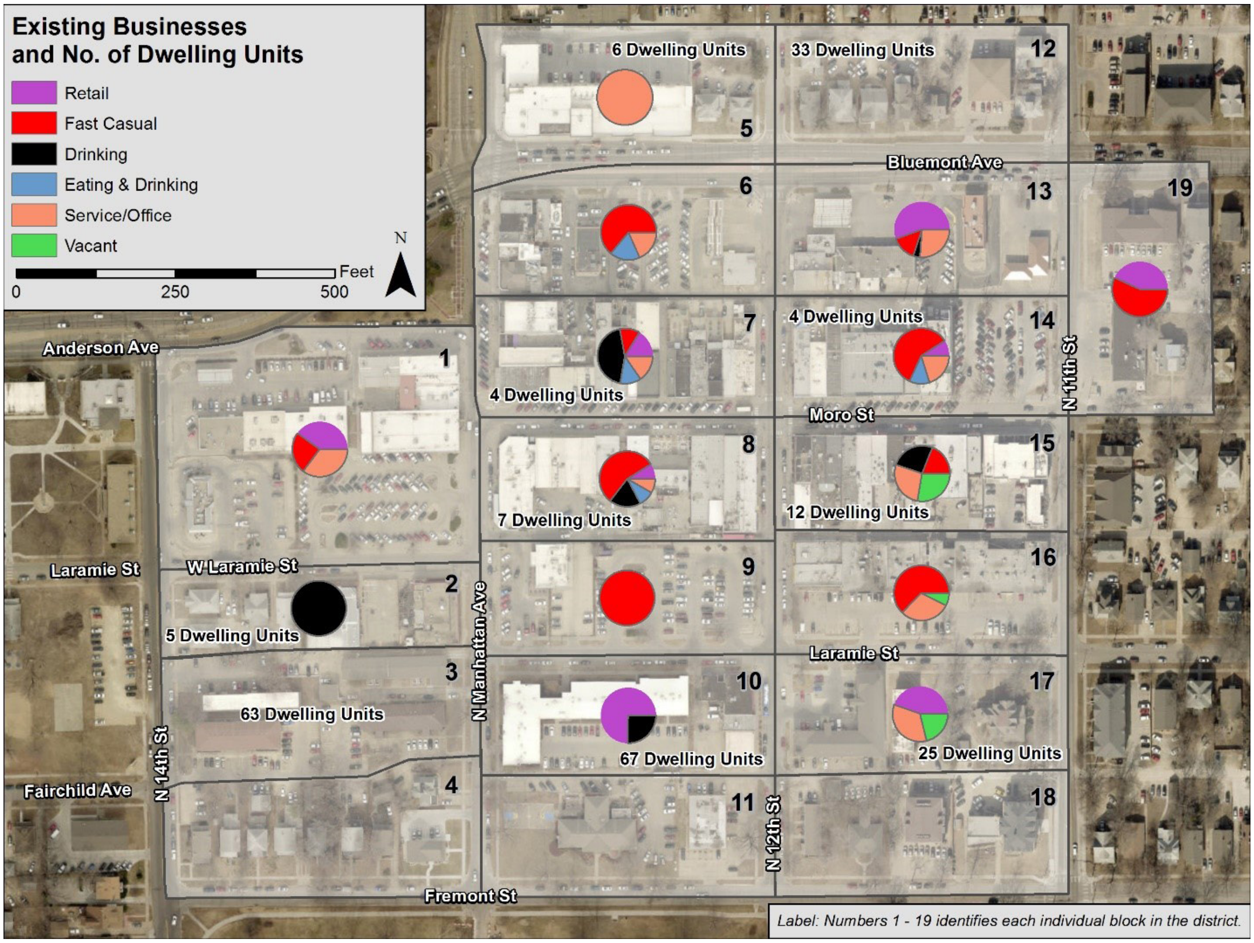


Table 2.2: Existing Scenario

Block #	Dwelling Units	Commercial SqFt	Retail SqFt	Fast Casual SqFt	Eating/ Drinking SqFt	Drinking SqFt	Service/ Office SqFt	Vacant SqFt
1	-	37,279	14,775	9,495	-	-	13,009	-
2	5	7,724	-	-	-	7,724	-	-
3	63	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-
5	6	21,109	-	-	-	-	21,109	-
6	-	13,929	-	8,671	2,874	-	2,384	-
7	4	45,582	7,112	5,322	6,648	19,714	6,787	-
8	7	42,700	3,604	23,642	4,648	7,500	3,307	-
9	-	3,520	-	3,520	-	-	-	-
10	67	4,934	3,655	-	-	1,279	-	-
11	-	-	-	-	-	-	-	-
12	33	-	-	-	-	-	-	-
13	-	14,859	8,211	2,188	-	610	3,850	-
14	4	23,546	2,053	13,762	3,206	-	4,526	-
15	12	31,084	-	6,041	-	8,048	8,372	8,624
16	-	25,576	-	16,272	-	-	7,378	1,926
17	25	14,388	6,386	-	-	-	4,908	3,094
18	-	-	-	-	-	-	-	-
19	-	5,964	2,514	3,450	-	-	-	-
Total	**226**	**292,215**	**48,309**	**92,363**	**17,376**	**44,875**	**75,628**	**13,644**

Table 2.3: New Option Growth Scenario

Block #	Dwelling Units	Commercial SqFt	Retail SqFt	Fast Casual SqFt	Eating/ Drinking SqFt	Drinking SqFt	Service/ Office SqFt	Vacant SqFt
1	-	60,010	18,524	12,996	3,767	-	24,724	-
2	14	34,772	4,302	4,317	4,575	7,724	13,854	-
3	126	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-
5	6	21,609	-	-	-	-	21,609	-
6	-	29,844	2,582	11,214	5,290	-	10,757	-
7	4	45,049	7,212	5,292	5,883	19,714	6,948	-
8	7	42,161	3,654	23,508	4,114	7,500	3,385	-
9	-	35,976	5,165	8,683	5,493	-	16,635	-
10	67	4,986	3,707	-	-	1,279	-	-
11	-	-	-	-	-	-	-	-
12	84	134,270	1,633	1,639	1,737	-	129,261	-
13	-	31,291	10,909	4,768	2,747	610	12,258	-
14	4	23,236	2,082	13,684	2,837	-	4,633	-
15	12	39,873	-	6,007	-	8,048	25,818	-
16	-	57,741	4,796	20,993	5,101	-	26,851	-
17	42	17,688	6,476	-	-	-	11,212	-
18	-	-	-	-	-	-	-	-
19	-	5,980	2,549	3,431	-	-	-	-
		-						
Total	**366**	**584,486**	**73,590**	**116,531**	**41,544**	**44,875**	**307,945**	-

Table 2.4: Original High Growth Scenario

Block #	Dwelling Units	Commercial SqFt	Retail SqFt	Fast Casual SqFt	Eating/ Drinking SqFt	Drinking SqFt	Service/ Office SqFt	Vacant SqFt
1	84	54,149	18,524	12,996	3,767	-	18,862	-
2	106	27,787	4,302	4,317	4,575	7,724	6,870	-
3	246	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-
5	6	21,429	-	-	-	-	21,429	-
6	61	25,630	2,582	11,214	5,290	-	6,544	-
7	4	44,991	7,212	5,292	5,883	19,714	6,890	-
8	7	42,133	3,654	23,508	4,114	7,500	3,357	-
9	122	27,590	5,165	8,683	5,493	-	8,248	-
10	67	4,986	3,707	-	-	1,279	-	-
11	-	-	-	-	-	-	-	-
12	125	69,102	1,633	1,639	1,737	-	64,093	-
13	61	27,065	10,909	4,768	2,747	610	8,032	-
14	4	23,198	2,082	13,684	2,837	-	4,594	-
15	12	31,106	-	6,007	-	8,048	17,051	-
16	112	47,948	4,796	20,993	5,101	-	17,059	-
17	109	14,526	6,476	-	-	-	8,051	-
18	-	-	-	-	-	-	-	-
19	-	5,980	2,549	3,431	-	-	-	-
Total	**1,126**	**467,621**	**73,590**	**116,531**	**41,544**	**44,875**	**191,081**	-

Table 2.5: High Growth Scenario

Block #	Dwelling Units	Commercial SqFt	Retail SqFt	Fast Casual SqFt	Eating/ Drinking SqFt	Drinking SqFt	Service/ Office SqFt	Vacant SqFt
1	44	54,149	18,524	12,996	3,767	-	18,862	-
2	58	27,787	4,302	4,317	4,575	7,724	6,870	-
3	159	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-
5	6	21,429	-	-	-	-	21,429	-
6	32	25,630	2,582	11,214	5,290	-	6,544	-
7	4	44,991	7,212	5,292	5,883	19,714	6,890	-
8	7	42,133	3,654	23,508	4,114	7,500	3,357	-
9	64	27,590	5,165	8,683	5,493	-	8,248	-
10	67	4,986	3,707	-	-	1,279	-	-
11	-	-	-	-	-	-	-	-
12	98	69,102	1,633	1,639	1,737	-	64,093	-
13	32	27,065	10,909	4,768	2,747	610	8,032	-
14	4	23,198	2,082	13,684	2,837	-	4,594	-
15	12	31,106	-	6,007	-	8,048	17,051	-
16	59	47,948	4,796	20,993	5,101	-	17,059	-
17	69	14,526	6,476	-	-	-	8,051	-
18	-	-	-	-	-	-	-	-
19	-	5,980	2,549	3,431	-	-	-	-
Total	**715**	**467,621**	**73,590**	**116,531**	**41,544**	**44,875**	**191,081**	-

Table 2.6: Medium Growth Scenario

Block #	Dwelling Units	Commercial SqFt	Retail SqFt	Fast Casual SqFt	Eating/ Drinking SqFt	Drinking SqFt	Service/ Office SqFt	Vacant SqFt
1	26	54,149	18,524	12,996	3,767	-	18,862	-
2	36	27,787	4,302	4,317	4,575	7,724	6,870	-
3	123	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-
5	6	21,429	-	-	-	-	21,429	-
6	19	25,630	2,582	11,214	5,290	-	6,544	-
7	4	44,991	7,212	5,292	5,883	19,714	6,890	-
8	7	42,133	3,654	23,508	4,114	7,500	3,357	-
9	37	27,590	5,165	8,683	5,493	-	8,248	-
10	67	4,986	3,707	-	-	1,279	-	-
11	-	-	-	-	-	-	-	-
12	87	69,102	1,633	1,639	1,737	-	64,093	-
13	19	27,065	10,909	4,768	2,747	610	8,032	-
14	4	23,198	2,082	13,684	2,837	-	4,594	-
15	12	31,106	-	6,007	-	8,048	17,051	-
16	35	47,948	4,796	20,993	5,101	-	17,059	-
17	54	14,526	6,476	-	-	-	8,051	-
18	-	-	-	-	-	-	-	-
19	-	5,980	2,549	3,431	-	-	-	-
Total	**536**	**467,621**	**73,590**	**116,531**	**41,544**	**44,875**	**191,081**	-

Table 2.7: Low Growth Scenario

Block #	Dwelling Units	Commercial SqFt	Retail SqFt	Fast Casual SqFt	Eating/ Drinking SqFt	Drinking SqFt	Service/ Office SqFt	Vacant SqFt
1	-	51,998	18,292	12,362	3,055	-	18,290	-
2	14	18,010	2,263	2,211	2,211	7,724	3,600	-
3	126	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-
5	6	21,609	-	-	-	-	21,609	-
6	-	15,942	580	9,066	2,933	-	3,363	-
7	4	44,650	7,300	5,216	5,472	19,714	6,948	-
8	7	41,583	3,699	23,173	3,826	7,500	3,385	-
9	-	7,654	925	4,354	904	-	1,471	-
10	67	5,031	3,752	-	-	1,279	-	-
11	-	-	-	-	-	-	-	-
12	84	69,515	1,653	1,616	1,616	-	64,630	-
13	-	19,578	9,408	3,103	958	610	5,500	-
14	4	22,868	2,107	13,489	2,639	-	4,633	-
15	12	31,163	-	5,921	-	8,048	17,194	-
16	-	44,433	4,181	20,035	4,086	-	16,131	-
17	42	14,673	6,555	-	-	-	8,118	-
18	-	-	-	-	-	-	-	-
19	-	5,962	2,580	3,382	-	-	-	-
Total	**366**	**414,669**	**63,295**	**103,927**	**27,699**	**44,875**	**174,872**	-

SECTION 3: UTILITY ANALYSIS

3.1 Introduction

Olsson conducted an analysis of the existing water and sewer system in Manhattan's Aggieville shopping district. The Aggieville Infrastructure Analysis provided by Walker Parking Consultants (Walker), the February 2015 Central Basin Collection System Evaluation Report, and the City of Manhattan's existing water and sewer models were used as references for the analysis.

The purpose of this memo is to provide an overall analysis of the existing water and sewer infrastructure in and around the Aggieville shopping district to identify potential deficiencies in its ability to support sewer flows and to provide fire protection for future growth in the area. Analysis of the water system was confined to the Aggieville District, while the sewer system was analyzed both within Aggieville and the trunk sewer from the district to the sewer outfall.

3.1.1 Hydraulic Modeling

Sewer Model: The City of Manhattan provided a SewerGEMs sanitary sewer model to Olsson for use in this memo. Flows in the model were based upon data collected by the City of Manhattan during 2010 and 2011, as explained in the February 2015 Central Basin Collection System Evaluation Report.

Water Model: The City of Manhattan provided a WaterCAD water system model for use in this memo. The model has not been calibrated within the study area, and no flow testing or calibration was performed as a part of this study. Additionally, during the hydraulic analysis, it was determined that several water mains east of the immediate study area, in the area bound by Kearney Street and Houston Street, and from 4th to Manhattan, were missing from the model. Water mains were also missing within the study area. Therefore, a fire flow analysis was not performed in these locations as a part of this study. The City of Manhattan indicated that the model was populated with demands obtained from water meter information when the model was developed, by linking metering data to the nearest water main in the model.

3.1.2 Existing and Projected Future Land Uses

The existing and future densities of the Aggieville shopping district were provided by the Walker Infrastructure Analysis. The densities indicate the existing and future anticipated growth for the area. The growth is broken up into the following unit types:

- Retail
- Fast Casual Dining
- Eating/Drinking
- Drinking
- Vacant
- Service/Office
- Housing/Dwelling Units

Future growth assumed that all space that is currently vacant will convert to the Service/Office category, and that the restaurant space will be half Fast Casual Dining and half Eating/Drinking. The Existing and Projected Future Land Use are included in **Table 3.1**.

Table 3.1: Existing and Future Land Use

Scenario	Retail (ft^2)	Fast Casual (ft^2)	Eating/Drinking (ft^2)	Drinking (ft^2)	Service/ Office (ft^2)	Total (ft^2)	Number of Dwelling Units
Existing	48,309	92,363	17,376	44,875	75,628	278,551	226
Future	73,590	116,531	41,544	44,875	191,081	467,621	1,126

3.2 Sanitary Sewer System Analysis

3.2.1 Projected Wastewater Flows

3.2.1.1 Projected Average Day Wastewater Demands

To estimate the wastewater flows from the new facilities, the anticipated square footage depicted in the previous table is used to approximate the number of persons that will occupy the new facilities after their construction. The International Fire Code, Table 1004.1.2, utilized by the City of Manhattan, was used as a guideline to estimate the occupancy of each building type, as indicated in **Table 3.2**.

Table 3.2: 2015 International Fire Code-Maximum Floor Area Allowances per Occupant

Function of Space	International Fire Code Classification	Occupant Load Factor (floor area in square feet per occupant)
Retail	Mercantile	60 ft^2/person
Fast Casual	Unconcentrated Assembly (Tables & Chairs)	15 ft^2/person
Eating/Drinking	Unconcentrated Assembly (Tables & Chairs)	15 ft^2/person
Drinking	Unconcentrated Assembly (Tables & Chairs)	15 ft^2/person
Service/Office	Business Area	100 ft^2/person

For the restaurant space, it was assumed that 40% of the total area was utilized for kitchen/food prep, and the remaining was dining room space. For the locations that are anticipated to be bars only, 80% of the square footage is assumed to be seating area. Occupancy from the apartments/dwelling units were calculated assuming 2.5 persons per dwelling unit. Occupancy for the Retail category was assumed to use 100% of the calculated square footage.

Occupancies for the current and anticipated future land use are calculated in **Table 3.3**.

Table 3.3: Current Occupancy Calculations

Function of Space	Total Area	Percent of Area Occupied	Occupied Area (ft2)	Occupancy Load Factor	Occupancy
Retail	48,309	100%	48,309	60 ft^2/person	805
Fast Casual	92,363	60%	55,418	15 ft^2/person	3,695
Eating/Drinking	17,376	60%	10,426	15 ft^2/person	695
Drinking	44,875	80%	35,900	15 ft^2/person	2,393
Service/Office	75,628	100%	75,628	100 ft^2/person	756
Dwelling Units (226)	n/a	n/a	n/a	2.5 persons/unit	565
				Total Capacity	8,909

Next, the projected future occupancies are calculated, **Table 3.4**, based upon the additional square footage anticipated from projections:

Table 3.4: Future Occupancy Calculations

Function of Space	Projected Future Total Area	Percent of Area Occupied	Occupied Area (ft2)	Occupancy Load Factor	Occupancy
Retail	73,590	100%	73,590	60 ft^2/person	1,227
Fast Casual	116,531	60%	69,919	15 ft^2/person	4,661
Eating/Drinking	41,544	60%	24,926	15 ft^2/person	1,662
Drinking	44,875	80%	35,900	15 ft^2/person	2,393
Service/Office	191,081	100%	191,081	100 ft^2/person	1,911
Dwelling Units (1,126)	n/a	n/a	n/a	n/a	2,815
				Total Capacity	14,669

Wastewater Engineering, Treatment and Reuse, Fourth Edition (Metcalf & Eddy, 2004), was used to estimate wastewater flows for the existing and new wastewater demands in the Aggieville district. The flows in Metcalf and Eddy are listed in gallons per day (gpd), while the flows in the wastewater model are in gallons per minute (gpm). Flows converted between gpd and gpm can vary widely, depending upon how many hours per day you assume the flows occur. Wastewater flows from the retail and restaurants would likely only occur during working hours, and wastewater from the dwelling units would likely occur in the mornings and evenings during the week, and spread throughout the day on the weekends. Prior to adding demands from the new facilities, the flows from existing facilities, using the Metcalf and Eddy flowrates were calculated for each of the usage types and compared to what was in the wastewater model assuming an 8, 12, and 24-hour day. When comparing the three durations, using a 24-hour day most closely matched the numbers in the sewer model, therefore a 24-hour day was assumed for existing and future flows within the wastewater model. The calculations are displayed in **Table 3.5**.

Table 3.5: Calculated Wastewater Flowrates

				Current Flows			Projected Future Flows		
Function of Space	**Source (Metcalf & Eddy)**	**Unit**	**Flowrate (gal/unit-day)**	**Existing Occupancy Capacity**	**Wastewater Flows (gpd)**	**Flow (gpm)**	**Future Occupancy**	**Flow (gpd)**	**Flow (gpm)**
Retail	Public Lavatory	User	4	805	3,221	2	1,227	4,906	3
Fast Casual	Restaurant (conventional)	Customer	8	3,695	29,556	21	4,661	37,290	26
Eating/ Drinking	Restaurant-With bar/cocktail lounge	Customer	10	695	6,950	5	1,662	16,618	12
Drinking	Bar/Cocktail Lounge	Seat	20	2,393	47,867	33	2,393	47,867	33
Service/ Office	Office	Employee	13	756	9,832	7	1,911	24,841	17
Dwelling Units	Household	Resident	100	565	56,500	39	2,815	281,500	195
Totals				**9,918**	**153,925**	**107**	**14,669**	**413,021**	**287**

As depicted in **Table 3.5**, using textbook wastewater demands, the total daily wastewater demands were determined to be 153,925 gpd, or 107 gpm Using the same assumptions, with the projected future occupancy, the average day demands are anticipated to be 413,021 gpd or 287 gpm.

3.2.1.2 Projected Peak Demands

The metered wastewater flow from the sewer study was used to estimate peak wastewater demands anticipated from future growth. This is accomplished by dividing the peak flows at dry conditions by the average flows at dry conditions to determine a peaking factor for the area. The average/peak flows observed in the Aggieville area are summarized in **Table 3.6**.

Table 3.6: Average Peak Flows

Q_{ave}, dry weather conditions (gpm)	111
Q_{peak}, dry weather conditions (gpm)	143
$Q_{Peak}/Q_{Average}$	1.3

3.2.2 Comparison of Calculated Flows to Model Flows

The wastewater model shows that there are currently three sanitary sewer mains that serve the Aggieville district. The layout of both the internal Aggieville sewer mains and the trunk lines between Aggieville and the outfall are displayed in **Appendix A**.

The northern sewer main, which will be referred to in this study as Sewer Main A, is an 8-inch line that begins at N. Manhattan Avenue and travels east along an alley between Bluemont Avenue and Moro Street. It leaves the Aggieville district at N. 11th Street and continues east, eventually feeding into a 24-inch sanitary sewer along Tuttle Creek Boulevard.

The next sewer main, referred to as Sewer Main B, begins as a 12-inch line that crosses beneath N. Manhattan Avenue near the intersection of N. Manhattan Avenue and Laramie Street. Immediately east of the road, it transitions to an 8-inch line and continues east along an alley between Moro Street and Laramie Street. It leaves the Aggieville district at N. 11th Street and continues east, eventually feeding into an 18-inch sanitary sewer along N. 4th Street.

The southern sewer main, referred to as Sewer Main C, is an 8-inch line that begins at N. Manhattan Avenue and travels east along an alley between Laramie Street and Fremont Street. It leaves the Aggieville district at N. 11th Street and continue east, eventually feeding into the same 18-inch sanitary sewer as Sewer Main B.

The February 2015 report indicates that the City of Manhattan installed two rainfall gauges and eight flow meters within the Central Basin and collected flow data between November 2010 and June 2011. The results of the flow monitoring were used to develop and calibrate the sanitary sewer model for the February 2015 report. The model was developed as an extended period simulation to analyze the existing dry and wet weather flows over a 48-hour period. Table 3.7 provides the existing average and peak flows for the Aggieville area as reported by the model. The calculated average and peak flow values are included in the table for comparison.

Table 3.7: Calculated Flows vs. Modeled Flows

Model Flows		
Model Sewer Main	**Average Flows, Dry Weather (gpm)**	**Peak Flows, Wet Weather (gpm)**
A	50	66
B	57	72
C	4	5
Totals (gpm)	**111**	**143**
Calculated Flows		
Existing Average Flow (gpm)		107
Peaking Factor		1.3
Existing Peak Flow (gpm)		139
Future Average Flow (gpm)		**287**
Future Peak Flow		373

The model indicates the total wastewater flow for the Aggieville area is 111 gpm at average/dry weather conditions, and 313 gpm at peak/wet weather conditions. The peaking factor and flow assumptions discussed earlier are used to predict the flows anticipated from the new development.

The February 2015 report recommended rerouting flows from the upper portion of the interceptor between Moro and Laramie to the interceptor that runs south along 14th Street to the Poyntz Avenue interceptor. This improvement has since been constructed, and was included in all flow scenarios performed for this study.

3.2.3 Sanitary Sewer Analysis - Current Average Dry Weather

The sewer model was used to evaluate the available capacity within the sewer mains that serve the Aggieville district. A sewer main is determined to be at full capacity when its depth to diameter ratio (d/D) is 85% or greater. **Table 3.8** summarizes the capacities of the three sewer branches that serve Aggieville. The d/D values reported in the tables for all of the wastewater analyses were determined by inputting the new wastewater demands into the model, and stepping through the relevant Extended Period Simulation (EPS) within the model, which applies different scale factors to the demands depending upon the time of day. The highest d/D value for this scenario reported in the model is included in **Table 3.8**.

Table 3.8: Wastewater Capacities at Current Average Dry Weather Conditions

Label	Size (in)	Maximum d/D (%)	Available Capacity (gpm)
Sewer Main A			
18-2602 18-2601	8	0	440
18-2601 18-2598	8	29	374
Sewer Main B			
18-2702 18-2698	12	4	794
18-2698 18-2696	8	14	257
18-2696 18-2695	8	21	251
Sewer Main C			
18-2772 18-2771	8	0	338
18-2771 18-2770	8	6	333

The hydraulic model indicates that the existing sewer lines within the Aggieville district have adequate capacity available to handle the current average dry weather flows. The hydraulic model is used to identify the limiting pipes, or the mains within the district that have the least remaining capacity available for the sections analyzed in **Table 3.8**. The limiting pipes are summarized in Table 3.9 and illustrated in **Appendix A**.

Table 3.9: Limiting Pipe Segments in Study Area - Current Average Dry Weather Conditions

Section	Sewer Main	Remaining Capacity (gpm)
Sewer Main A	18-2601 18-2598	374
Sewer Main B	18-2696 18-2695	251
Sewer Main C	18-2771 18-2770	333

3.2.4 Internal Aggieville Sanitary Sewer Analysis - Current Average Wet Weather Conditions

The previous analysis, using current average flows, was repeated for the current average wet weather conditions. The wet weather flows are based on a SCS Type II, 10-year, 24-hour design storm, which repeats the scenario, but accounts for infiltration/inflow into the sewer system during wet weather conditions. The current capacities of the Aggieville sewer lines under maximum current average wet weather flows are summarized in **Table 3.10.**

Table 3.10: Internal Aggieville Capacities at Current Average Wet Weather Conditions

Label	Size (in)	Maximum d/D (%)	Available Capacity (gpm)
Sewer Main A			
18-2602 18-2601	8	0	440
18-2601 18-2598	8	32	360
Sewer Main B			
18-2702 18-2698	12	16	774
18-2698 18-2696	8	29	236
18-2696 18-2695	8	33	218
Sewer Main C			
18-2772 18-2771	8	0	338
18-2771 18-2770	8	21	320

After running the sewer model again under the current average wet weather flows scenario, it was determined that at current average, wet weather conditions, none of the mains are at or over capacity. The limiting pipes are summarized in **Table 3.11** and illustrated in **Appendix A**.

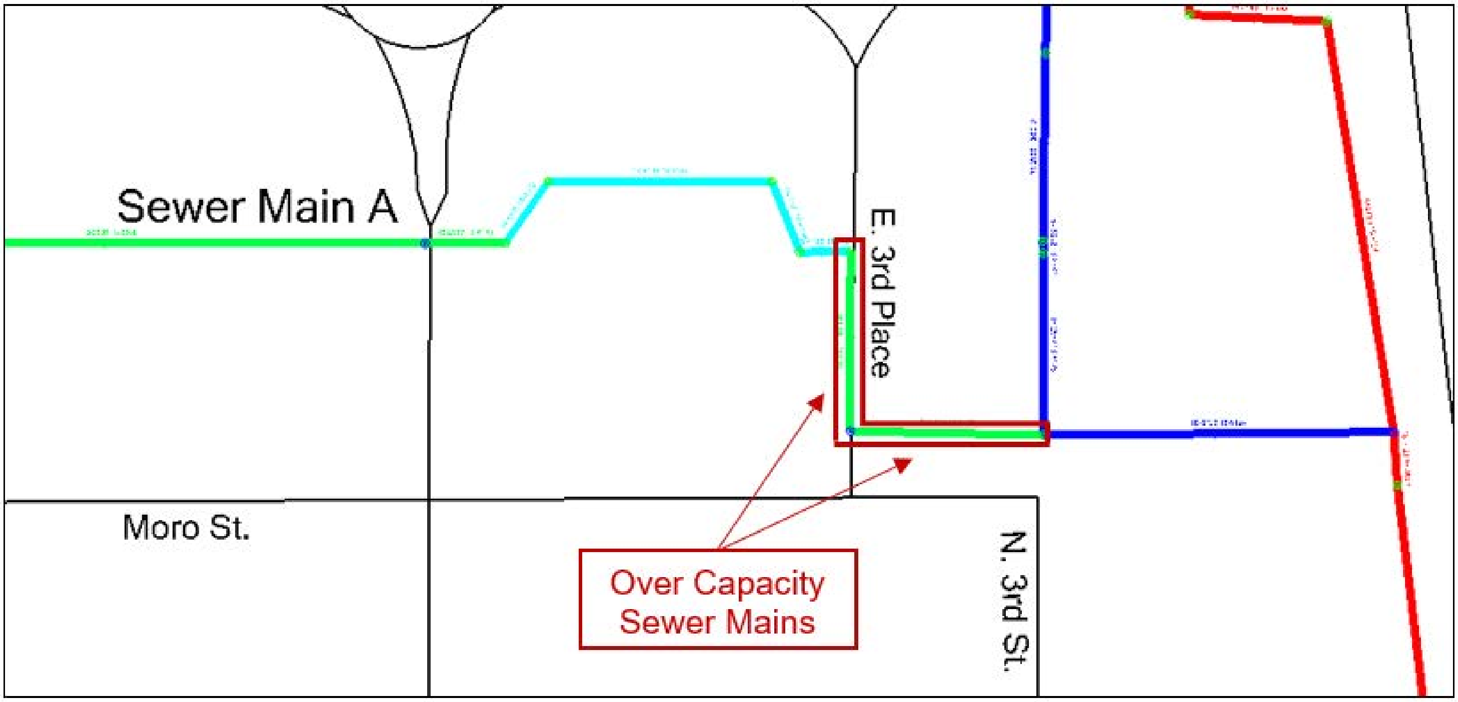
Table 3.11: Limiting Pipe Segments in Study Area - Current Average Wet Weather Conditions

Section	Sewer Main	Remaining Capacity (gpm)
Sewer Main A	18-2601 18-2598	360
Sewer Main B	18-2696 18-2695	218
Sewer Main C	18-2771 18-2770	320

3.2.5 Trunk Sewer Analysis – Current Average Dry/Wet Weather Conditions from Aggieville to Outfall

In addition to evaluating the available capacity within the Aggieville district, the capacities of the sewer lines that convey flows from Aggieville to the outfall were evaluated. At current average, dry weather conditions, none of the trunk sewer mains were shown to be at or above capacity. At current average wet weather conditions, the only portion of sewer line close to or at capacity is a section of 8-inch sewer line connecting Sewer Main A to the Sewer Main A Trunk Line (see **Figure 3.1** and **Appendix A**). The first segment of line starts at Manhole 18-5121 and extends south along E. Third Place to Manhole 18-5196. At the peak hour, this segment is determined to be 71% full within the model. The second segment starts at Manhole 18-5196 and extends east north of Moro Street to Manhole 18-5123. This segment is 86% full. The sewer then transitions to an 18-inch diameter line which has capacity to receive the flows.

Figure 3.1: Over Capacity Sewer at Average Wet Weather Conditions



3.2.6 Internal Aggieville Sewer Analysis - Future Average Dry Weather Conditions

Next, the hydraulic model was used to simulate the future anticipated flows within the sewer system to determine their effect on the existing mains within Aggieville. The calculated existing average flow is 107 gpm and the anticipated future average flow is 287 gpm (Table 5), an increase of 180 gpm. The additional flow volume was divided evenly between the nodes representing sewer manholes within Aggieville and added to the current demands. The sewer model was then run with the new flows in place, and the sewer mains were analyzed for their new available capacity. **Table 3.12** provides a comparison of the wastewater capacities of the sewer main with the maximum existing and future average dry weather flows.

Table 3.12: Comparison of Wastewater Capacities at Existing and Future Average Dry Weather Conditions

Label	Existing d/D (%)	Existing Available Capacity (gpm)	Future d/D (%)	Future Available Capacity (gpm)
Sewer Main A				
18-2602 18-2601	0	440	0	440
18-2601 18-2598	29	374	39	314
Sewer Main B				
18-2702 18-2698	4	794	22	736
18-2698 18-2696	14	257	39	199
18-2696 18-2695	21	251	53	136
Sewer Main C				
18-2772 18-2771	0	338	0	338
18-2771 18-2770	6	333	33	275

The hydraulic model indicates that all of the sewer lines within Aggieville have adequate capacity available to handle the future average flows during dry weather conditions. The limiting pipes are summarized in **Table 3.13** and illustrated in **Appendix A**.

Table 3.13: Limiting Pipe Segments in Study Area - Future Average Dry Weather Conditions

Section	Sewer Main	Remaining Capacity (gpm)
Sewer Main A	18-2601 18-2598	314
Sewer Main B	18-2696 18-2695	136
Sewer Main C	18-2771 18-2770	275

The capacities of the sewer lines that convey flows from Aggieville to the outfall were also evaluated and found to have adequate capacity to handle the future average dry weather flows.

3.2.7 Internal Sewer Analysis - Future Peak Wet Weather Conditions within Aggieville

The peaking factor of 1.3 calculated previously will be used to estimate peak wastewater flows from the future developments in the Aggieville District. The flows from future development are summarized in **Table 3.14**.

Table 3.14: Projected Peak Flows

Average Flows-Projected (gpm)	287
Peaking Factor	1.3
Peak Flows-Projected (gpm)	373

The additional flow peak volume was divided evenly between the Aggieville nodes and added to the current demands. The sewer model was then run with the new flows in place, and the sewer mains were analyzed for their new available capacity. **Table 3.15** lists the future wastewater capacities of the sewer mains with the maximum peak wet weather flows.

Table 3.15: Wastewater Capacities at Future Peak Wet Weather Conditions

Label	Size (in)	Maximum d/D (%)	Available Capacity (gpm)
Sewer Main A			
18-2602 18-2601	8	0	440
18-2601 18-2598	8	44	287
Sewer Main B			
18-2702 18-2698	12	26	705
18-2698 18-2696	8	45	168
18-2696 18-2695	8	65	81
Sewer Main C			
18-2772 18-2771	8	0	338
18-2771 18-2770	8	39	248

The hydraulic model indicates that all the existing sewer lines within the Aggieville district have adequate capacity available to handle the calculated future peak wet weather conditions. Since the hydraulic model determined that the internal Aggieville sewer mains were capable of handling peak flows during wet weather, no further analyses were performed. The limiting pipes are summarized in **Table 3.16** and illustrated in **Appendix A**.

Table 3.16: Limiting Pipe Segments in Study Area - Future Peak Wet Weather Conditions

Section	Sewer Main	Remaining Capacity (gpm)
Sewer Main A	18-2601 18-2598	287
Sewer Main B	18-2696 18-2695	81
Sewer Main C	18-2771 18-2770	248

3.2.8 Trunk Sewer Analysis - Future Peak Wet Weather Conditions from Aggieville to Outfall

The analysis on the trunk sewer that carries flows from Aggieville to the outfall was repeated at future peak flows, wet weather conditions. Since the model previously showed that these lines were deficient in being able to carry average day flows during wet weather conditions, the analyses for future average/dry weather and future peak/dry were not performed, and instead, the worst-case scenario (future peak/wet weather) was performed. This analysis determined that two portions of sewer line are above capacity at the future peak wet weather flow conditions.

The first portion is the 8-inch sewer line connecting Sewer Main A to the Sewer Main A Trunk Line that was discussed above for being at capacity at current average wet weather flow conditions. In the Future Peak Flow/ Wet Weather scenario, these segments are shown to be full and have no remaining capacity.

The second portion is part of the 8-inch sewer line connecting Sewer Main B to the Sewer Main B Trunk Line (see **Appendix A**). The sewer line extends east from Manhole 18-2693 at N. 10th Street to Manhole 18-2687 at N 4th Street and has no remaining capacity. At 4th Street the sewer line transitions to a 10-inch followed by 18-inch line, which provide adequate capacity.

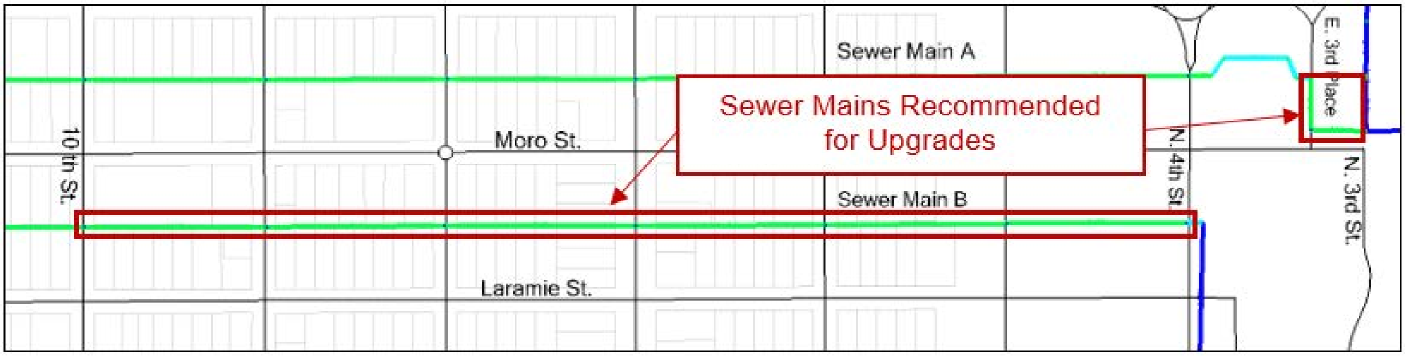
3.2.9 Recommended Improvements

To adequately carry wastewater from Aggieville to the outfall, the segment of 8-inch sewer line connecting Sewer Main A to the Sewer Main A trunk line should be upsized to a 10-inch diameter pipe or larger. Upsizing the sewers to 10-inch mains is determined within the model to result in 38% and 46% of remaining capacity at future peak wet weather flows. The upgrade should be installed between Manholes 18- 5121 and 18-5123 and would be approximately 270 feet long.

Similarly, the segment of over-capacity 8-inch sewer line connecting Sewer Main B to the Sewer Main B trunk line should be upgraded to a 10-inch diameter or larger main between N. 10th Street and N. 4th Street, approximately 2,400 feet of new sewer line.. Both sections are sewer main recommended for upgrades are shown in **Figure 3.2**.

The preceding findings were determined using an existing hydraulic model that is approximately six years old. While the analyses presented previously identified potential deficiencies in the sewer system, it is recommended that the assumptions stated previously are verified by repeating flow metering and rainfall analysis in the vicinity prior to making major changes in the sewer system.

Figure 3.2: Sewer Mains Recommended for Upgrades



3.3 Water System Fire Flow Analysis

3.3.1 Projected Water Demands

The Metcalf and Eddy textbook referenced previously in this report indicates that wastewater flows are typically anywhere from 60-90% of water demands. Since the calculated wastewater flows matched those included in the calibrated sanitary sewer model, the wastewater flows are used to estimate the water demands from the future users in the area. Average Daily water demands were estimated by multiplying the projected wastewater demands by 1.25, which assumes that 80% of the water used goes to wastewater. The current and projected water demands are summarized in **Table 3.17** below.

Table 3.17: Water Demands Summary

	Calculated Wastewater Flows (gpm)	Calculated Water Demands (gpm)
Existing Average	107	134
Existing Peak	302	378
Future Average	287	359
Future Peak	362	452

To check the accuracy of the calculated water demands in comparison with the demands input into the existing water model, which was populated with demands from water meter information, a report was generated from the hydraulic model to determine the average demands for the study area. The Manhattan water model reports average day demands of 133 gpm in the Aggieville area, which closely matches the demand of 134 gpm calculated in the preceding table. KDHE standards indicate that to determine peak hour demand in a water system, the maximum day demand should be multiplied by a factor of 2.0, or the average day should be multiplied by a factor of 4.0. since average day demands were calculated for this study, a peaking factor of 4.0 was applied to the average day demands to simulate peak hour demands. The water demands input into the model are summarized Table **3.18** and **3.19**.

Table 3.18: Model Water Demands Summary for Existing Average and Peak Demands

Node	Existing Average Demand (gpm)	Static Pressure (psi)	Peaking Factor	Existing Peak Demand (gpm)	Static Pressure (psi)
J-2183	34	78	4.0	136	76
J-2374	20	76	4.0	80	74
J-2370	4	74	4.0	16	73
J-2387	9	74	4.0	36	72
J-2391	6	74	4.0	24	73
J-2399	2	79	4.0	8	77
J-1137	4	79	4.0	16	78
J-2382	3	76	4.0	12	74
J-2383	14	77	4.0	56	74
J-2121	37	81	4.0	148	80
Total:	**133**	**N/A**	**N/A**	**532**	**N/A**

To simulate the effects of the future water demands on the Aggieville water mains, the additional anticipated water demands were input into the hydraulic model. the future demands were calculated earlier to be approximately 2.7 times the existing demands, so each of the nodes in the study area were multiplied by this factor to approximate the effects of the new development. The results are displayed in the following table.

Table 3.19: Model Water Demands Summary for Future Average and Peak Demands

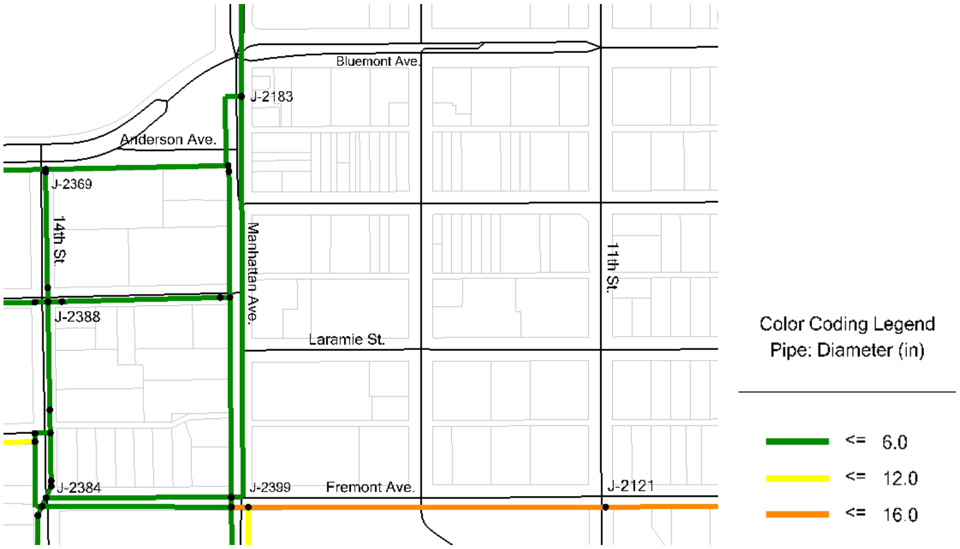
Node	Current Average Demand (gpm)	Future/ Current Peaking factor	Future Average Demand (gpm)	Static Pressure (psi)	Peak Hour/ Average Day Factor	Future Peak Demand (gpm)	Static Pressure (psi)
J-2183	34	2.7	92	77	4.0	367	71
J-2374	20	2.7	54	75	4.0	216	70
J-2370	4	2.7	11	73	4.0	43	70
J-2387	9	2.7	24	73	4.0	97	69
J-2391	6	2.7	16	73	4.0	65	70
J-2399	2	2.7	5	78	4.0	22	75
J-1137	4	2.7	11	79	4.0	43	76
J-2382	3	2.7	8	75	4.0	32	70
J-2383	14	2.7	38	75	4.0	151	71
J-2121	37	2.7	100	81	4.0	400	78
		Total:	**359**	**N/A**		**1,436**	**N/A**

3.3.2 Fire Flow Analysis

With current and estimated future water demands in place, the hydraulic model was used to perform a fire flow analysis of the water mains that serve the Aggieville Shopping District.

The water mains surrounding Aggieville mainly consist of 6-inch mains with a 16-inch main traveling along Fremont Street from N. Manhattan Avenue and N. 11th Street. When setting up the fire flow analysis, it was determined that a good portion of the distribution system was missing from the hydraulic model, both within and directly east of Aggieville, See **Figure 3.3** below for the water mains included in the hydraulic model at the time of the Olsson analysis.

Figure 3.3: Existing Water Main Layout



To provide adequate fire protection, a water system must be capable of providing the fire flow requirement for the building type while maintaining a residual pressure of 20 psi. Commercial districts generally require 2,000 to 3,000 gpm. This analysis is conservative, as the new buildings would likely have sprinklers systems in place, requiring a lower demand and residual pressure, and this analysis assumes that fire protection would be provided from street hydrants. A fire flow analysis with existing average and peak demands is summarized in **Table 3.20**, which indicates the existing water system static pressures, along with the fire flow that the model indicates is available at each node while retaining a residual pressure of 20 psi.

Table 3.20: Fire Flow Analysis Results with Existing Demands

			Existing Average Day Demand		Existing Peak Day Demand	
Hydrant	**Hydrant Location**	**Main Size (in.)**	**Static Pressure (psi)**	**Available Fire Flow (gpm) @ 20 psi residual**	**Static Pressure (psi)**	**Available Fire Flow (gpm) @ 20 psi residual**
J-2183	N. Manhattan Ave. and Anderson Ave.	6	78	2,697	76	2,542
J-2369	N. 14th St. and Anderson Ave.	6	76	3,228	73	3,083
J-2388	N. 14th St. and W. Laramie St.	6	74	3,573	72	3,422
J-2399	N. Manhattan Ave. and Fremont St.	6	79	6,548	77	6,382
J-2384	N. 14th St. and Fremont St.	6	76	4,589	75	4,517
J-2121	N. 11th St. and Fremont St.	16	81	10,963	80	10,705

As indicated in the preceding table, the water model indicates that the fire hydrants in the Aggieville can provide fire flows of over 2,500 gpm in all of the simulated locations, while maintaining a minimum pressure of 20 psi at existing average and peak day demands. The preceding analysis was repeated with future average and peak day demands, summarized in **Table 3.21**.

Table 3.21: Fire Flow Analysis Results

			Future Average Day Demand		Future Peak Day Demand	
Hydrant	**Hydrant Location**	**Main Size (in.)**	**Static Pressure (psi)**	**Available Fire Flow (gpm) @ 20 psi residual**	**Static Pressure (psi)**	**Available Fire Flow (gpm) @ 20 psi residual**
J-2183	N. Manhattan Ave. and Anderson Ave.	6	77	2,610	71	2,179
J-2369	N. 14th St. and Anderson Ave.	6	74	3,146	70	2,742
J-2388	N. 14th St. and W. Laramie St.	6	73	3,488	69	3,077
J-2399	N. Manhattan Ave. and Fremont St.	6	78	6,455	75	5,972
J-2384	N. 14th St. and Fremont St.	6	76	4,547	73	4,326
J-2121	N. 11th St. and Fremont St.	16	81	10,816	78	10,114

As indicated in the preceding table, at future average day conditions, the hydraulic model indicates that all the simulated locations were able to provide a 2,500 gpm fire flow while maintaining a residual pressure of 20 psi. however, at future peak day demands, one location, near the intersection of Manhattan and Anderson Avenues was determined to be slightly deficient in providing adequate fire flows.

The hydraulic model was updated to show the existing 6-inch water main in Manhattan Avenue from Anderson to Kearney as a new 8-inch water main, with a C-factor of 120. With the upsized main in place, the fire flow capabilities increased to approximately 3,500 gpm. As indicated previously, the majority of the mains in Aggieville are 6-inch in diameter, which tie into a 16-inch main. The current standard in Manhattan is to provide 8-inch mains where fire protection is to be provided. The hydraulic model showed several mains in the vicinity with low roughness factors, typically indicative of older mains with high corrosion/tuberculation present. The City should consider upsizing the older mains in the vicinity to new 8-inch mains to meet the standard.

While this analysis is focused generally on fire flow capabilities of the existing infrastructure, it is important to understand that the static pressures in the water system are indicative of the pressures at ground level. Generally, for every two feet of additional height, the static pressure will decrease by approximately one psi, therefore, when planning for taller buildings, the static pressure could potentially be much lower at the upper levels of the new buildings, depending upon the final building height.

3.3.3 Recommendations

Per the results of the hydraulic model, the existing mains within the Aggieville district are indicated to be capable of providing adequate fire flow at current and future average day conditions, without construction of additional mains in the system. Using future peak day demand calculations, one location in the hydraulic model was determined to be slightly deficient in providing the needed fire flow, but was determined to meet fire flow needs when upsized to an 8-inch main.

As indicated previously, the water model used in this study has not been within the study area, and is missing a good portion of the water distribution system mains within and east of the immediate study area. Since there were several mains missing from the model, the preceding results may not be completely representative of the present conditions in the water system. To do a full analysis of the system, it is recommended that the analysis be repeated after updating the hydraulic model to include all of the existing water mains, and current demands, and recalibrating. While the one location that was determined to be deficient in providing fire flow capacities was able to be improved by upsizing its immediate main to an 8-inch main, an up-to-date, calibrated, hydraulic model would allow for additional options to be explored, such as looping into other nearby water mains.

While the majority of the system was determined to be capable of providing the needed fire flows, the mains within the hydraulic model had very low C-factors, in the 70 range. This is typical of older mains that have high corrosion/tuberculation present. These older mains should start to be replaced with 8-inch mains, which is the standard size that Manhattan specifies for locations that provide fire protection.

3.4 Summary

3.4.1 Sanitary Sewer System

No capacity issues were identified within the gravity sewer system within the Aggieville district at either current or future wastewater demand conditions, at either wet or dry weather conditions. A new relief sewer routes flows from a previously overloaded 8-inch sewer in the district to a 12-inch interceptor in 14th Street, which allows for additional capacity in the area.

3.4.2 Water System

Commercial fire flow requirements are typically 2,000 to 3,000 gpm while maintaining a residual pressure of 20 psi. All locations modeled in the existing system showed capabilities of 2,500 gpm or greater at current and future average demands. At future peak conditions, one hydrant located near the intersection of N. Manhattan Avenue and Anderson Avenue (J-2183) could not provide 2,500 gpm of fire flow.

During the study, it was determined that the hydraulic model did not include several water mains within and directly east of the Aggieville area, therefore, the analyses performed in this study may not accurately reflect the conditions within the distribution system. It is recommended that the hydraulic model be updated to include the mains that are missing from the model, recalibrated using new fire flow tests, and the preceding analyses be repeated.

It is also recommended that these analyses be repeated once the actual fire flow needs of the new facilities may be calculated with more accuracy. The fire flow simulations presented in this study are conservative, as they assume that fire protection is provided from ground fire hydrants rather than sprinkler systems, which will likely be in place within the new buildings, and require a lower flow and residual pressure.

While the hydraulic model determined that the system is able to provide adequate fire flow capabilities for the majority of the study area, the mains within the model have low C-factors, representative of older mains with high corrosion/tuberculation present. The City should consider a plan to upsize mains currently under the City of Manhattan’s standard of using 8-inch diameter mains where fire protection is provided.

SECTION 4: STORMWATER ANALYSIS

4.1 Introduction

Olsson Associates (Olsson) in association with the City of Manhattan, KS, is working to provide an analysis of the existing stormwater system in Manhattan's Aggieville shopping district. The Aggieville Infrastructure Analysis provided by Walker Parking Consultants (Walker), the March 2017 Aggieville Community Vision Plan, and the City of Manhattan's existing stormwater models provided by Amec Foster Wheeler were used as a basis for the analysis.

The purpose of this memo is to provide an overall analysis of the existing stormwater infrastructure within the Aggieville shopping district for its ability to support stormwater flows based on future development in the area. Additionally, the study included analysis of the main stormsewer trunk lines running through and downstream of the Aggieville district.

4.2 Data Collection

The City of Manhattan provided Olsson with the existing stormsewer information in GIS format. The data was reviewed and used to create a hydraulic model. The Hydraflow Storm Sewers Extension for Autodesk AutoCAD Civil 3D software was used for the hydraulic analysis. LIDAR data was obtained from Riley County and used to delineate the existing drainage areas for the Aggieville district.

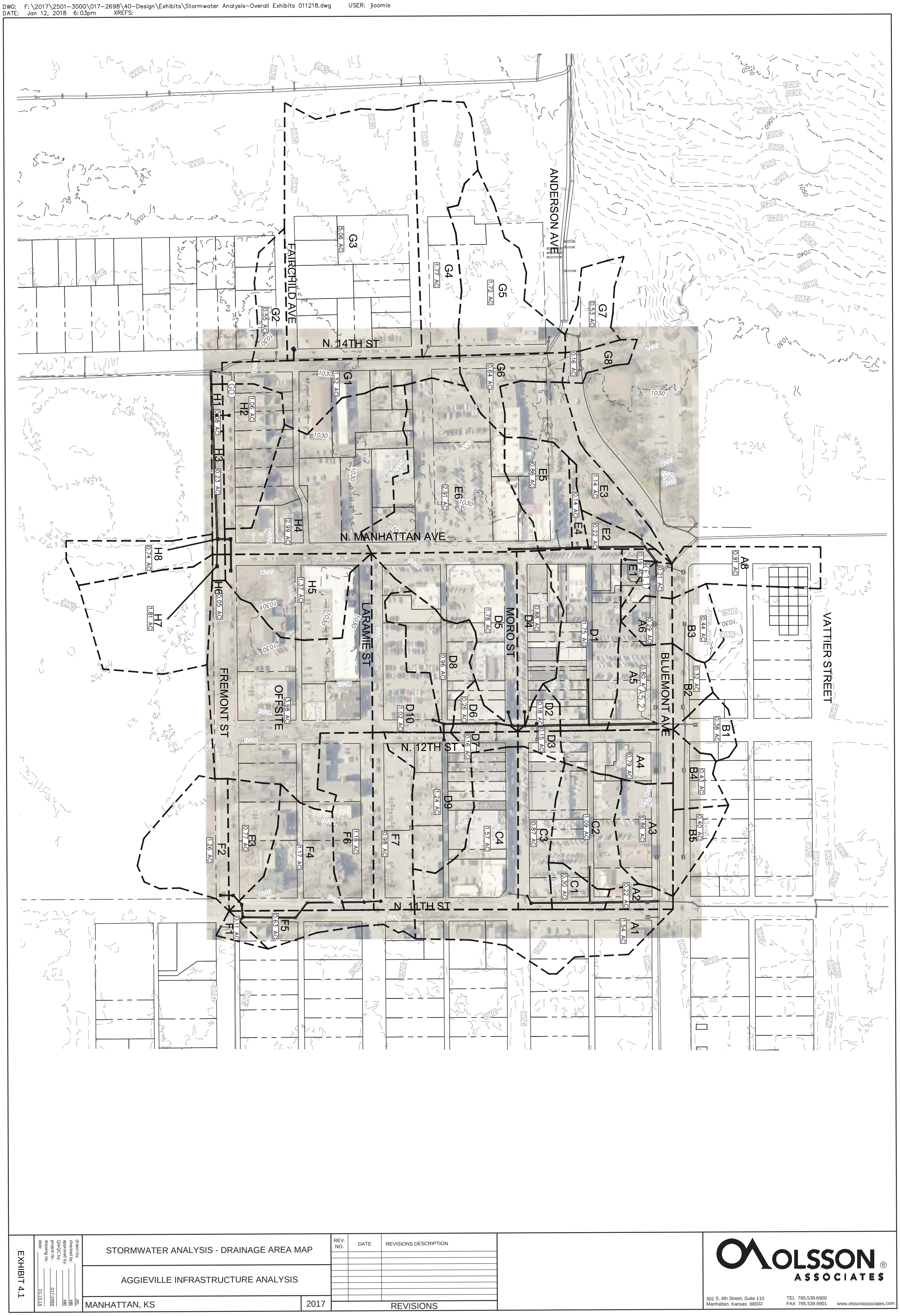
4.3 Hydrology and Hydraulics

The existing drainage areas were grouped into eight basins. These basins represent the separate stormsewer systems that connect to the main trunk lines running through and downstream of Aggieville. Two trunk lines were identified in the analysis: a 54" reinforced concrete pipe (RCP) running east along the south side of Bluemont Avenue, and a 60" RCP running south along N. 14th Street. Additionally, basin F drains to a 24" RCP that begins at the intersection of N. 11th Street and Fremont Street and runs east along Fremont Street.

The eight basins were delineated into sub-basins, with each sub-basin draining to an inlet along the lateral stormsewer systems. The sub-basins can be identified in **Figure 4.1**. While the analysis was limited to the strormsewer located within or along the streets making up the Aggieville district, some sub-basins outside Aggieville were delineated to account for areas draining to inlets along the outside streets of the district.

Additionally, it was identified that approximately four acres along N. 12th Street drain south out of the district without being captured by any storm sewer. This sub-basin can be identified in Exhibit 4.1 labeled as "Offsite." A preliminary analysis was performed to identify the viability of extending storm sewer to the Fremont and N. 12th Street intersection. However, it was determined that underground storm sewer could not reach the intersection from Basin F or H due to existing pipe depth limitations.

Figure 4.1: Drainage Area Map



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As it stands today, the Aggieville district is fully developed. Therefore, the existing conditions are effectively the same as future conditions, and an analysis was performed for future conditions using the *Aggieville Community Vision Plan* as a reference. Using this plan for future land use, a runoff coefficient ("C") was assigned to each sub-basin using Table C of the *City of Manhattan Stormwater Management Criteria*. The land use and corresponding runoff coefficients used in the analysis can be found in **Table 4.1.**

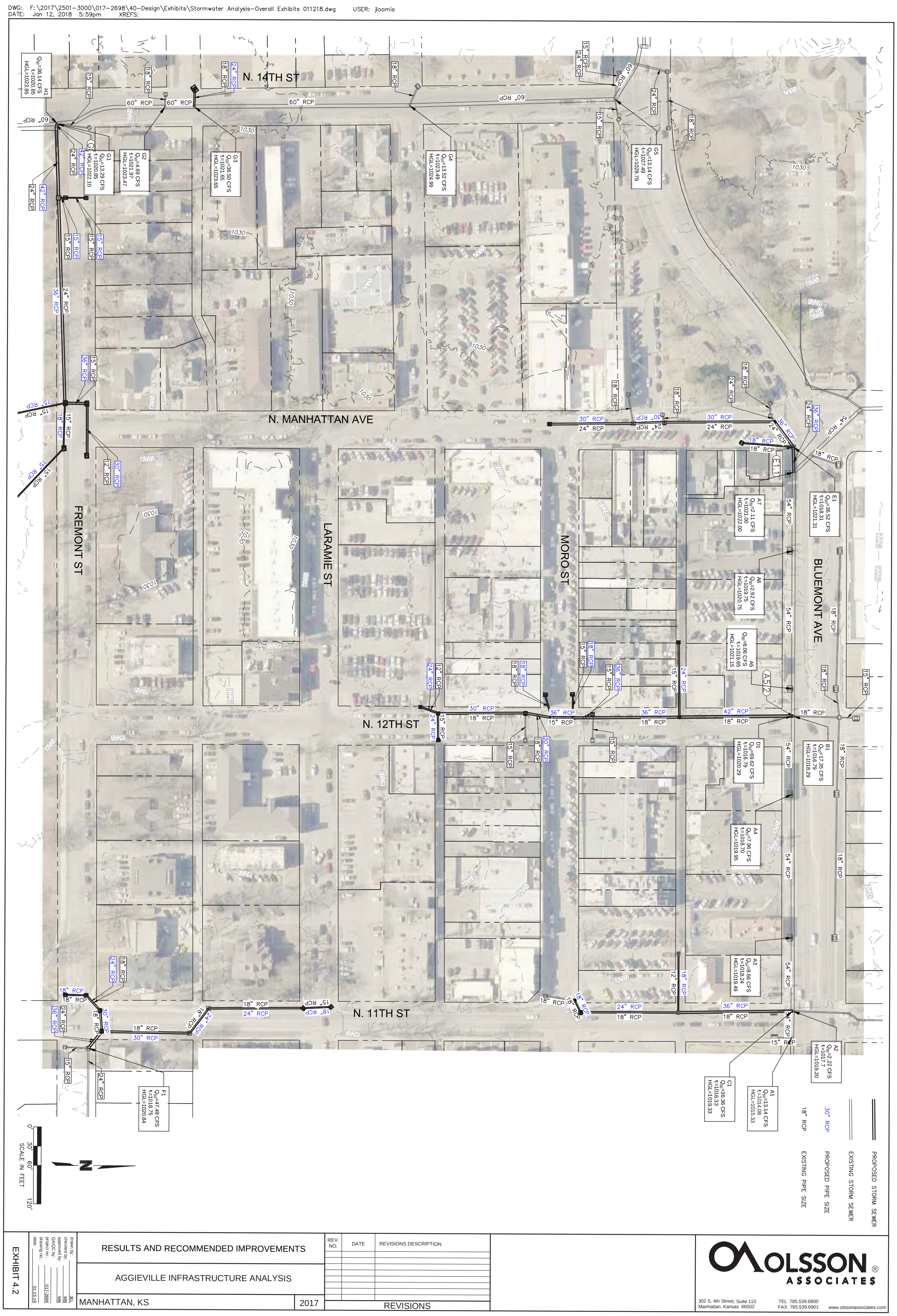
Table 4.1: Land Use Runoff Coefficients

Future Land Use	"C"
Central Business District	0.85
Residential High Density	0.72
Developed Parks and Recreation	0.33

Using LIDAR topographic information, time of concentrations were calculated for each sub-basin. It was assumed that future drainage patterns would be consistent with existing conditions. After the drainage area, runoff coefficient, and time of concentration was calculated for each sub-basin, peak runoff rates were generated using the Rational Method.

Using the hydrology information and runoff rates, the stormsewer system was analyzed to determine the necessary capacity for future development. Each lateral storm system within the Aggieville district was designed to convey the 50-year design storm. Results and recommended improvements can be found in the following section. An overall results and recommendations map can be found on **Figure 4.2**.

Figure 4.2: Results and Recommended Improvements



4.4 Results and Recommended Improvements

4.4.1 Basins A and B

Basins A and B are located on Bluemont Avenue and consist of the curb inlets and pipes connecting to the Bluemont trunk line. The locations of the inlets pipes are shown in **Figure 4.3**. A summary of the results and any recommended improvements can be found in **Tables 4.2 and 4.3**.

Figure 4.3: Basins A and B Map

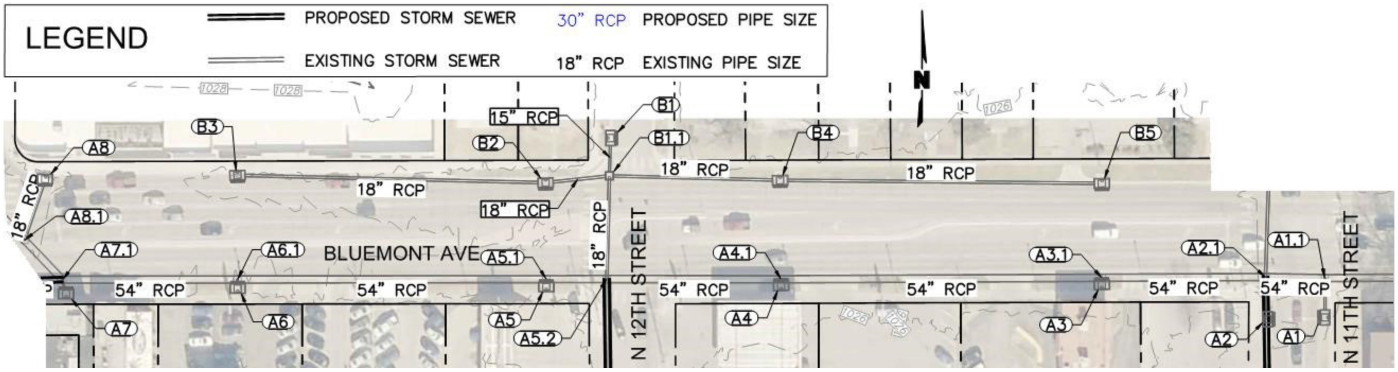


Table 4.2: Basin A Results

Pipe ID	50-YR Cumulative Flow (cfs)	Length (ft)	Existing Pipe Size (in)	Upgrade Needed?	Proposed RCP Size (in)
A1-A1.1	13.1	57.5	15	No	-
A2-A2.1	2.2	29.5	18	No	-
A3-A3.1	8.7	4.9	15	No	-
A4-A4.1	8.0	4.6	15	No	-
A5-A5.1	8.1	5.4	18	No	-
A6-A6.1	2.9	6.4	12	No	-
A7-A7.1	2.1	10.4	12	No	-
A8-A8.1	7.4	44.8	18	No	-

Table 4.3: Basin B Results

Pipe ID	50-YR Cumulative Flow (cfs)	Length (ft)	Existing Pipe Size (in)	Upgrade Needed?	Proposed RCP Size (in)
B1.1-A5.2	17.4	72.0	18	No	-
B1-B1.1	3.8	26.4	15	No	-
B2-B1.1	7.0	44.8	18	No	-
B4-B1.1	7.5	119.1	18	No	-
B3-B2	4.4	215.1	18	No	-
B5-B4	4.0	224.6	18	No	-

Per the results of the hydraulic modeling, the existing stormsewer within Basins A and B are indicated to be capable of providing adequate capacity for the 50-year design storm based on future conditions.

4.4.2 Basin C

Basin C is located on N. 11th Street and consists of the lateral storm system that ties to the Bluemont trunk line. The basin drains the west side of N. 11th Street as well as most of Moro Street between N. 11th and N. 12th Streets. The locations of the inlets and pipes are shown in **Figure 4.4**. A summary of the results and any recommended improvements can be found in **Table 4.4**.

Figure 4.4: Basin C Map

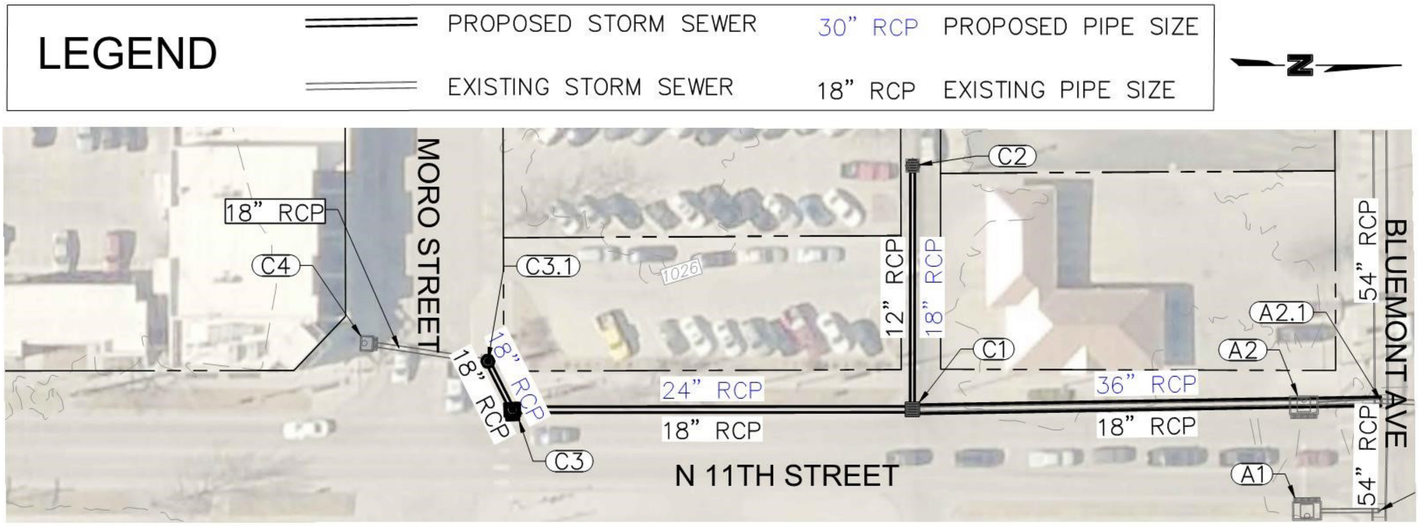


Table 4.4: Basin C Results

Pipe ID	50-YR Cumulative Flow (cfs)	Length (ft)	Existing Pipe Size (in)	Upgrade Needed?	Proposed RCP Size (in)
C1-A2.1	36.3	178.4	18	Yes	36
C2-C1	11.0	92.3	12	Yes	18
C3-C1	23.7	152.3	18	Yes	24
C3.1-C3	15.3	20.5	18	Yes	18
C4-C3.1	15.4	46.5	18	No	-

Per the hydraulic modeling, four pipes within Basin C need upgraded to provide adequate capacity for the 50-year design storm based on future conditions. Approximately 444 linear feet of RCP would be required to upgrade the system.

4.4.3 Basin D

Basin D is located on N. 12th Street and consists of the lateral storm system that ties to the Bluemont trunk line. The basin drains N. 12th Street up to Laramie Street as well as Moro Street between N. 12th Street and N. Manhattan Ave. The locations of the inlets and pipes are shown in **Figure 4.5**. A summary of the results and any recommended improvements can be found in **Table 4.5**.

Figure 4.5: Basin D Map

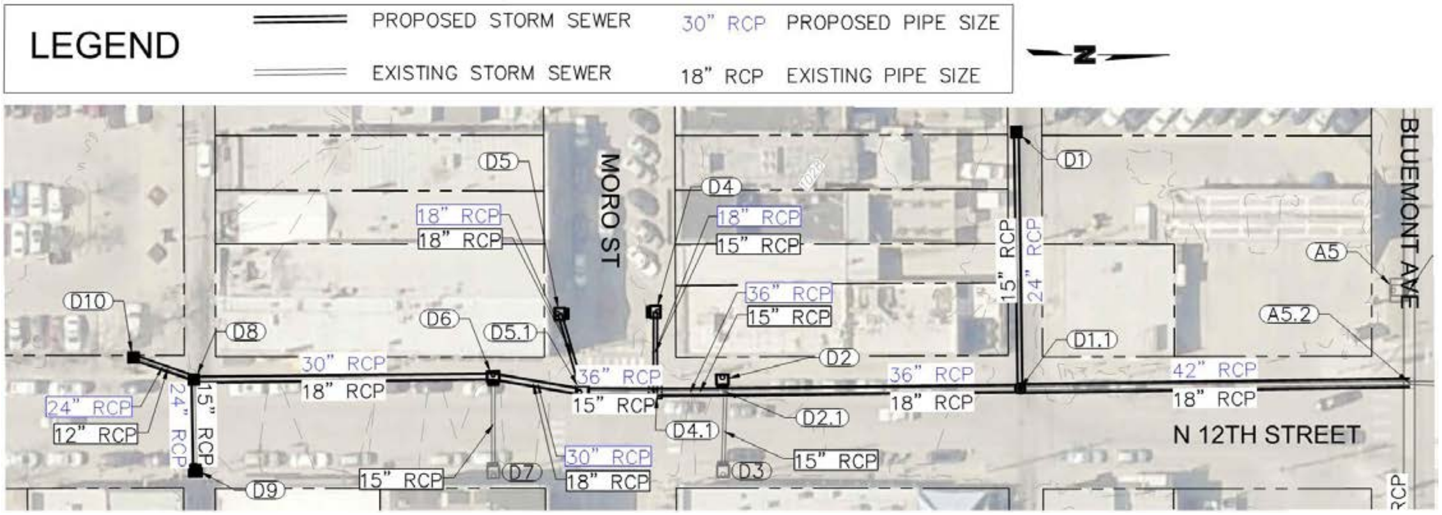


Table 4.5: Basin D Results

Pipe ID	50-YR Cumulative Flow (cfs)	Length (ft)	Existing Pipe Size (in)	Upgrade Needed?	Proposed RCP Size (in)
D1.1-A5.2	69.6	177.3	18	Yes	42
D1-D1.1	17.6	116.5	15	Yes	24
D2.1-D1.1	56.0	134.2	18	Yes	36
D2-D2.1	1.8	5.7	15	Yes	15
D3-D2.1	1.5	36.1	15	No	-
D4.1-D2.1	53.4	31.9	15	Yes	36
D4-D4.1	8.9	36.5	15	Yes	18
D5.1-D4.1	46.1	33.1	15	Yes	36
D5-D5.1	16.7	37.0	18	Yes	18
D6-D5.1	31.2	41.3	18	Yes	30
D7-D6	1.6	43.5	15	No	-
D8-D6	28.2	136.3	18	Yes	30
D9-D8	11.8	41.1	15	Yes	24
D10-D9	10.3	27.8	2x12	Yes	24

Per the hydraulic modeling, 12 pipes within Basin D need upgraded to provide adequate capacity for the 50-year design storm based on future conditions. Approximately 819 linear feet of RCP would be required to upgrade the system.

4.4.4 Basin E

Basin E is located on N. Manhattan Ave and consists of the lateral storm system that ties to the Bluemont trunk line. The basin drains N. Manhattan Ave up to Laramie Street as well as Fairchild Ave and Triangle Park. The locations of the inlets and pipes are shown in **Figure 4.6**. A summary of the results and any recommended improvements can be found in **Table 4.6**.

Figure 4.6: Basin E Map

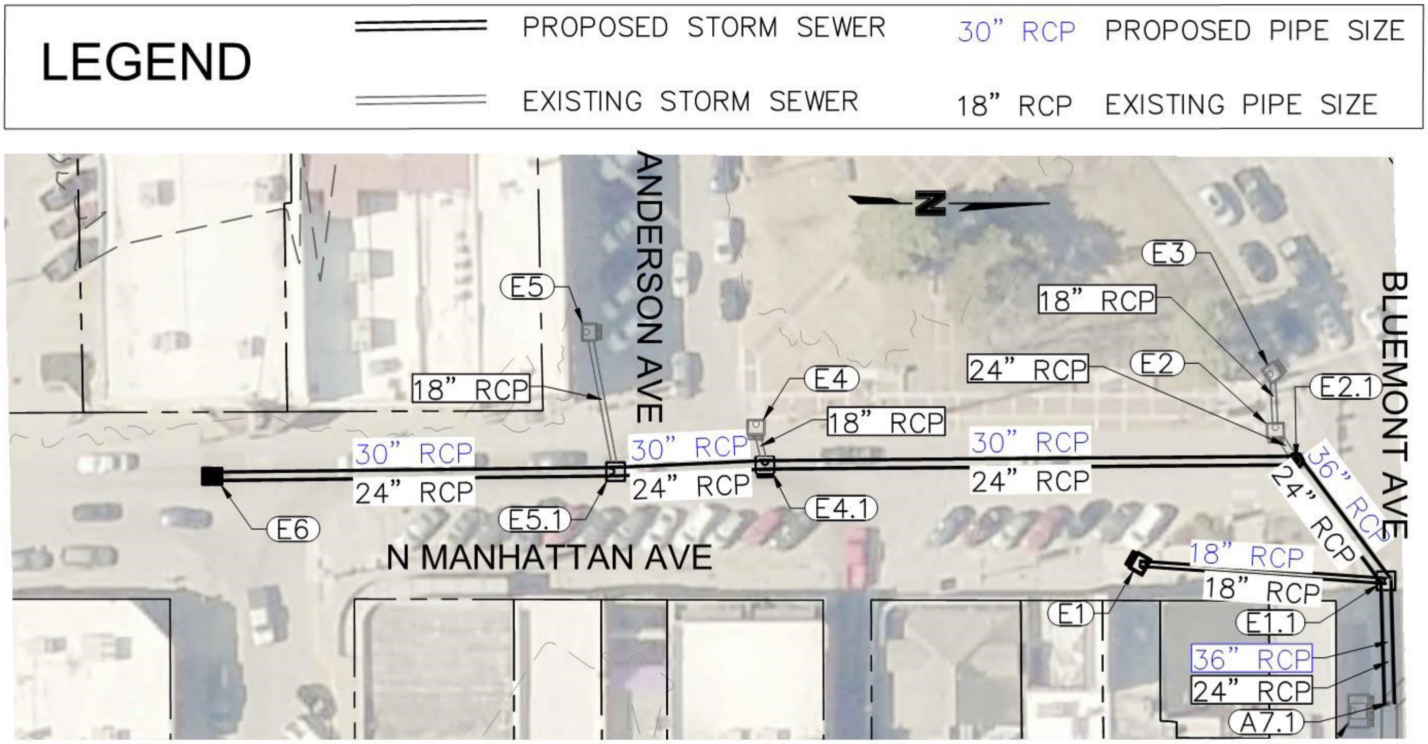


Table 4.6: Basin E Results

Pipe ID	50-YR Cumulative Flow (cfs)	Length (ft)	Existing Pipe Size (in)	Upgrade Needed?	Proposed RCP Size (in)
E1.1-A7.1	36.52	39.6	24	Yes	36
E1-E1.1	1.91	79.9	18	Yes	18
E2.1-E1.1	35.38	48.6	24	Yes	36
E2-E2.1	7.35	11.8	24	No	-
E3-E2	6.75	18.8	18	No	-
E4.1-E2.1	34.76	172	24	Yes	30
E4-E4.1	0.7	12.4	18	No	-
E5.1-E4.1	34.37	48.4	24	Yes	30
E5-E5.1	8.36	45.9	18	No	-
E6-E5.1	27.4	130.6	24	Yes	30

Per the hydraulic modeling, six pipes within Basin E need upgraded to provide adequate capacity for the 50-year design storm based on future conditions. Approximately 519 linear feet of RCP would be required to upgrade the system.

4.4.5 Basin F

Basin F is located on N. 11th Street and consists of the lateral storm system that ties to the 24" RCP running east on Fremont Street. The basin drains N. 11th Street up to Laramie Street as well as Fremont Street up to N. 12th Street and a portion of City Park. The locations of the inlets and pipes are shown in **Figure 4.7**. A summary of the results and any recommended improvements can be found in **Table 4.7**.

Figure 4.7: Basin F Map

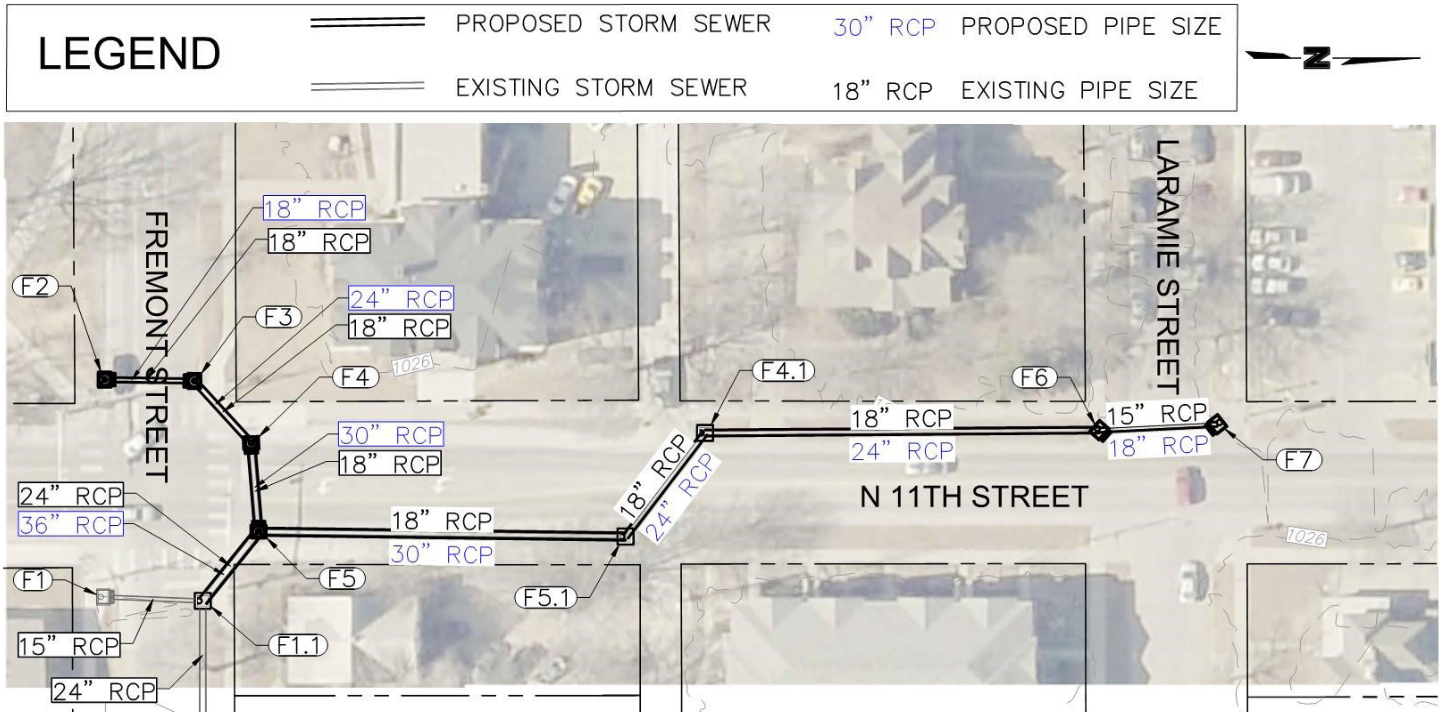


Table 4.7: Basin F Results

Pipe ID	50-YR Cumulative Flow (cfs)	Length (ft)	Existing Pipe Size (in)	Upgrade Needed?	Proposed RCP Size (in)
F1-F1.1	0.94	37.2	15	No	-
F5-F1.1	47.49	33.3	24	Yes	36
F5.1-F5	18.24	137	18	Yes	30
F4.1-F5.1	18.38	48.8	18	Yes	24
F6-F4.1	18.81	147.1	18	Yes	24
F7-F6	9.47	44.1	15	Yes	18
F4-F5	25.87	33.3	18	Yes	30
F3-F4	16.26	31.5	18	Yes	24
F2-F3	10.56	33.4	18	Yes	18

Per the hydraulic modeling, eight pipes within Basin F need upgraded to provide adequate capacity for the 50-year design storm based on future conditions. Approximately 546 linear feet of RCP would be required to upgrade the system.

4.4.6 Basin G

Basin G is located on N. 14th Street and consists of the curb inlets and pipes that tie into the N. 14th Street trunk line. The basin drains N. 14th Street from Anderson Ave to Fremont Street as well as Fairchild Ave and Laramie Street. The locations of the inlets and pipes are shown in **Figures 4.8**. A summary of the results and any recommended improvements can be found in **Table 4.8**.

Figure 4.8: Basin G Map

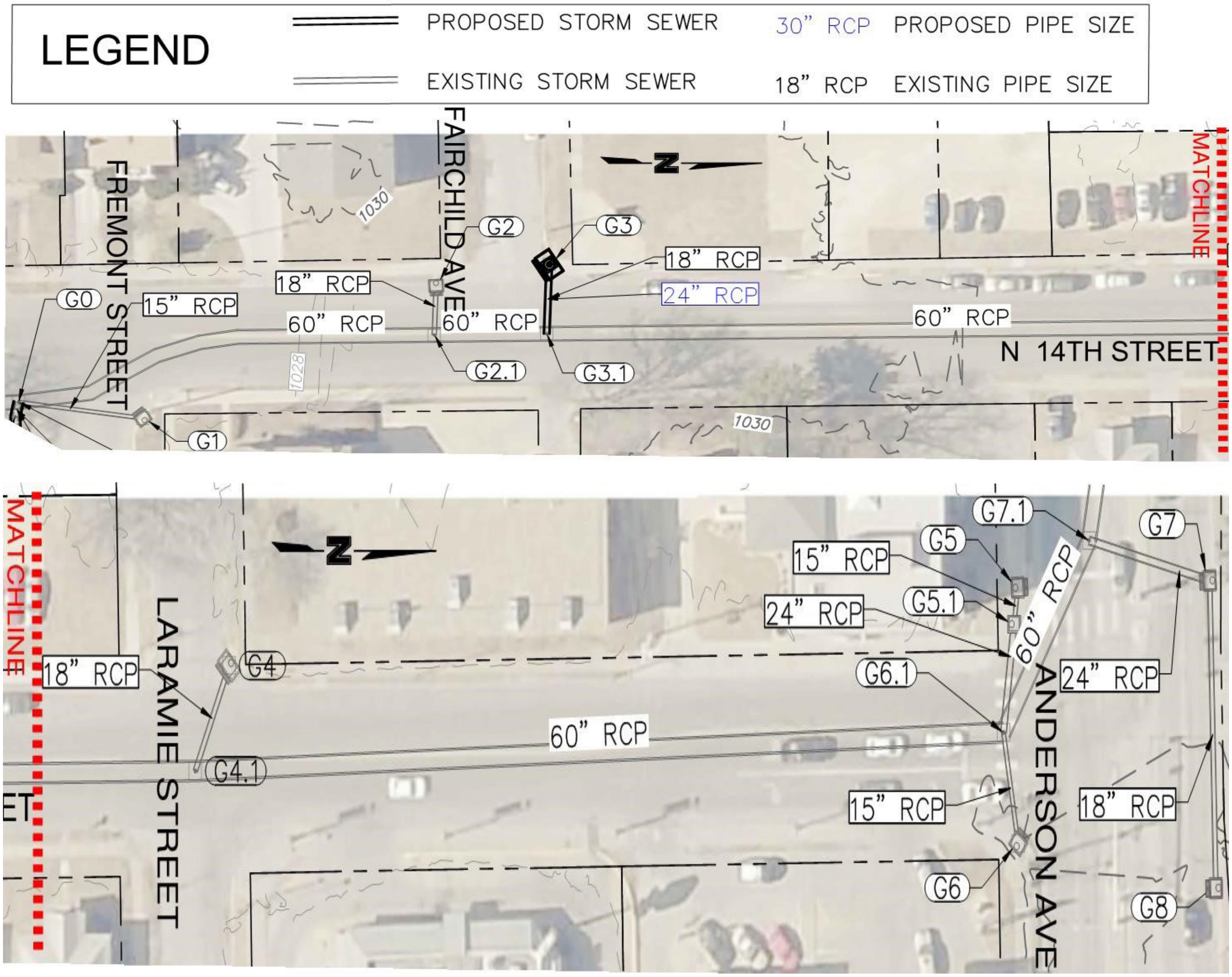


Table 4.8: Basin G Results

Pipe ID	50-YR Cumulative Flow (cfs)	Length (ft)	Existing Pipe Size (in)	Upgrade Needed?	Proposed RCP Size (in)
G1-G0	13.29	50.7	15	No	-
G2-G2.1	4.69	19.9	18	No	-
G3-G3.1	36.5	28	18	Yes	24
G4-G4.1	13.52	33	18	No	-
G5.1-G6.1	13.12	31.2	24	No	-
G5-G5.1	13.14	10.6	15	No	-
G6-G6.1	6.45	32.3	15	No	-
G7-G7.1	5.21	49.2	24	No	-
G8-G7	1.36	88.1	18	No	-

Per the hydraulic modeling, one pipe within Basin F needs upgraded to provide adequate capacity for the 50-year design storm based on future conditions. Approximately 28 linear feet of RCP would be required to upgrade the system.

4.4.7 Basin H

Basin H is located on Fremont Street and consists of the lateral storm system that ties into the Street N. 14th Street trunk line. The basin drains Fremont Street and N. Manhattan Ave up to Laramie Street. The locations of the inlets and pipes are shown in **Figure 4.9**. A summary of the results and any recommended improvements can be found in **Table 4.9**.

Figure 4.9: Basin H Map

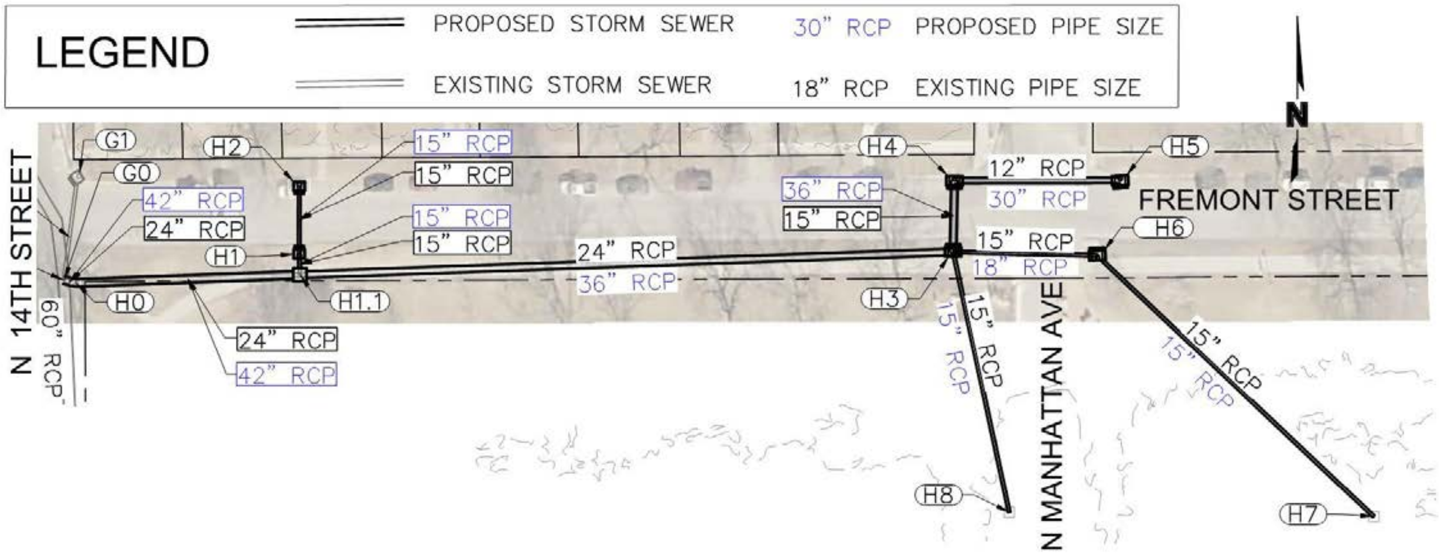


Table 4.9: Basin H Results

Pipe ID	50-YR Cumulative Flow (cfs)	Length (ft)	Existing Pipe Size (in)	Upgrade Needed?	Proposed RCP Size (in)
H0-G0	36.14	6.1	24	Yes	42
H1.1-H0	36.63	109.7	24	Yes	42
H1-H1.1	11.43	10.2	15	Yes	15
H2-H1	10.67	33.2	15	Yes	15
H3-H1.1	31.51	319.8	24	Yes	36
H4-H3	37.75	34.9	15	Yes	36
H5-H4	13.42	81	12	Yes	30
H6-H3	4.27	70.5	15	Yes	18
H7-H6	4.1	186	15	Yes	15
H8-H3	2.89	130.2	15	Yes	15

Per the hydraulic modeling, 10 pipes within Basin H need upgraded to provide adequate capacity for the 50-year design storm based on future conditions. Pipes H8-H3 and H7-H6 contained incomplete GIS information and could not be modeled accurately. For the sake of consistency within the basin, it was assumed that those pipes would need upgraded as well. Approximately 982 linear feet of RCP would be required to upgrade the system.

4.5 Summary

The analysis identified approximately 3,300 linear feet of stormsewer pipes in need of upgrade based on future development of the Aggieville district for the 50-year design storm. **Table 4.10** shows the breakdown of proposed pipe needed separated by pipe size and length. An overall recommended improvements map can be found on **Figure 4.2** above.

Table 4.10: Pipe Sizes and Lengths for Upgrade

Proposed Pipe Size (in)	RCP Needed (LF)
15	365
18	414
24	593
30	780
36	854
42	293

SECTION 5: PARKING INFRASTRUCTURE ANALYSIS

5.1 Introduction

Aggieville recently approved The Aggieville Community Vision Plan, a document that describes the community's vision for the future of Aggieville. This plan identifies the potential for growth and redevelopment in Aggieville, particularly in the form of infill residential and commercial development. Since completion of this plan, The City of Manhattan has identified the need to conduct an infrastructure analysis. One of the first phases of this infrastructure analysis is to determine and identify what parking related infrastructure is necessary to support the Community Vision Plan. The focus of this study will:

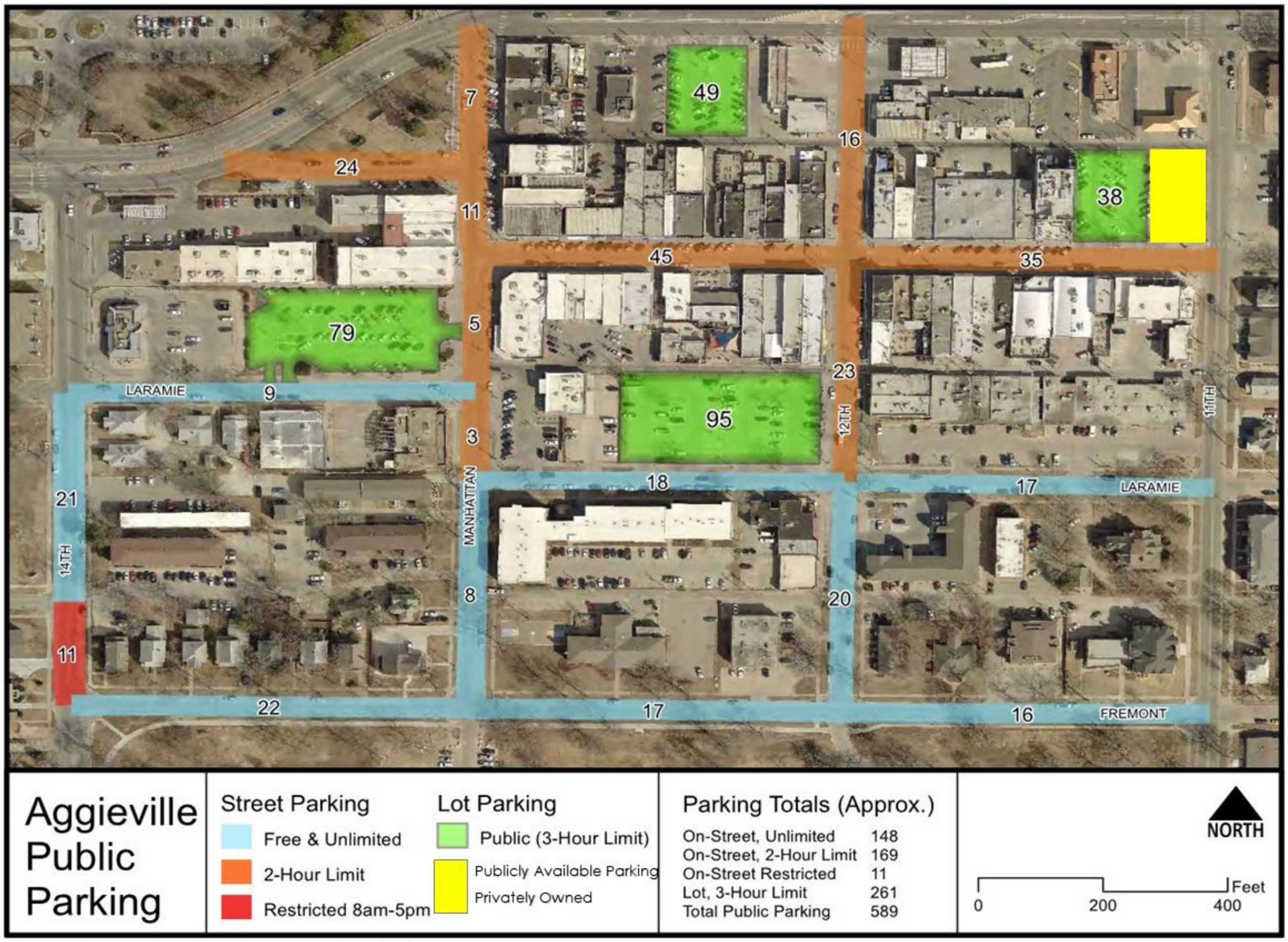
- Restate the current parking demand conditions in Aggieville. This is only intended to be a benchmark in addition to the parking demand study conducted as part of the Community Vision Plan to confirm parking demand conditions have not changed.
- Identify to what order of magnitude parking infrastructure (parking supply) will be needed based on various conceptual development scenarios.
- Identify construction cost ranges for constructing, operating and maintaining structured parking infrastructure.
- Identify funding strategies to construct public parking infrastructure.
- Identify parking management strategies for Aggieville that meets the needs of all parker types.

5.2 Existing Parking Supply and Demand

Key Takeaway: Aggieville currently generates parking demand close to the usable capacity of overall parking supply on a regular basis, with peaks occurring on weekdays and lunchtime and on weekend nights. Certain sub-areas—particularly the Bluemont/Anderson Corridor and the Historic Core—frequently generate parking demand in excess of the usable capacity within the sub-area. The result of the high utilization of the parking supply will limit Aggieville's ability to redevelop and grow without building additional parking supply.

At present, the Aggieville's publicly-available parking supply is comprised of 595 stalls—334 on-street stalls (56% of total public inventory) and 261 stalls located across four lots (44% of total public inventory). While the actual supply is 595 spaces, we recommend taking a 10% reduction in order to account for driver frustration in finding the last available spaces, double parked vehicles, construction, etc. This results in a total of 535 perceived usable public spaces in Aggieville. The majority of the on-street inventory (73%) is time-limited, with 2-hour restrictions in most of the busier on-street areas and 3-hour restrictions in all four public lots. 25% of the inventory is fully unrestricted; 2% of the inventory (11 stalls on N. 14th between Laramie and Fremont) are restricted to certain user groups between 8 AM and 5 PM. The following figure (**Figure 5.1**) shows the locations, inventories, and restrictions of Aggieville's public parking inventory.

Figure 5.1: Parking Supply



Source: Manhattan Area Transportation Study

5.3 Parking Demand

The City of Manhattan previously completed a parking demand study as part of the Community Vision Plan. A snapshot of the current (fall 2017) parking conditions was completed by City Staff in order to verify that the peak parking days and times were still accurate. This was counted on Thursday, September 14, 2017 and Saturday, September 16, 2017 by City Staff.

The current parking demand is accommodated by existing inventory with peak parking demand occurring on a weekday (observed on a Thursday) at noon, with an overall utilization of 82%. A secondary peak occurs on a weekend (observed on a Saturday) night, with an overall utilization of 77%. The following figure, **Figure 5.2** shows overall occupancy as compared to usable capacity (90%)[1] and system capacity (100%). At peak, there is a functional surplus (90% of the existing supply less the number of vehicles parked in the system at peak) of 51 stalls.

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[1] "Usable capacity" is the rate of utilization at which a parking system will be functionally full—meaning that most users, particularly first-time visitors and others unfamiliar with the system, will have trouble locating a vacant parking spot. This generally results in excessive circulation of the system, added traffic congestion, and can result in visitors leaving the area altogether.

Figure 5.2: Parking Utilization

Source: Parking Occupancy Counts Collected: Thursday, September 14, 2017 and Saturday 16, 2017 by City Staff

5.4 Demand By Sub-Area

Pursuant to the Aggieville Community Vision Plan, three distinctive sub-areas are identified: the Historic Core, the Bluemont/Anderson Corridor, and the Laramie Corridor. These can be seen in **Figure 5.3**. Of the three areas, the Historic Core and Bluemont/Anderson Corridor regularly generate parking demand greater than the usable capacity of the parking supply within their sub-area. The following figure, **Figure 5.4,** shows the parking occupancy within each sub-area during all periods observed, as compared to usable capacity and system capacity.

Figure 5.3: Sub-Areas of Aggieville

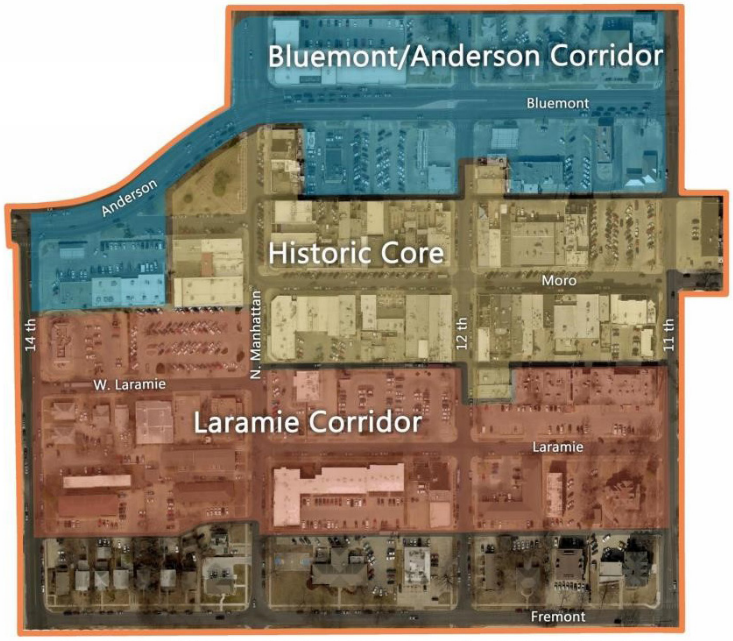
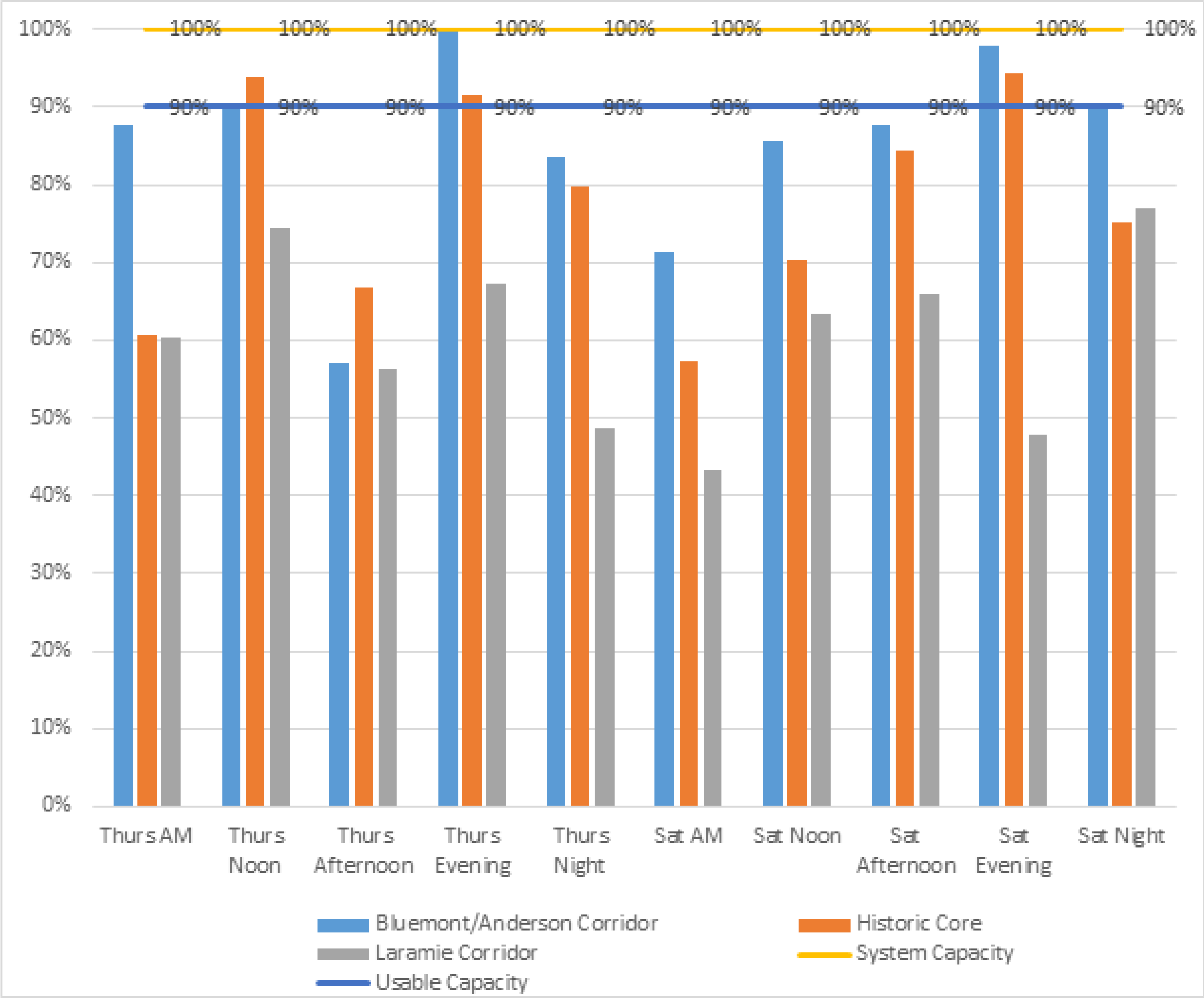


Figure 5.4: Parking Demand by Sub-Area



Source: Parking Occupancy Counts Collected: Thursday, September 14, 2017 and Saturday, September 16, 2017

5.5 Demand in Time-Limited Vs. Unrestricted Spaces

Demand in time-limited stalls is considerably higher, for the most part, than demand in unrestricted stalls; this can be attributed primarily to the proximity of time-limited stalls to areas that draw a high amount of parking demand (e.g. key commercial hubs). This differential is especially pronounced at high-demand periods (e.g. Thursday noon and evening, and Saturday night). The following figure, **Figure 5.5**, shows this comparison as observed during data collection. Parking in Aggieville is currently enforced Monday through Friday from 8 a.m. until 5 p.m.

Figure 5.5: Time Limited vs. Unrestricted Demand

Source: Parking Occupancy Counts Collected: Thursday, September 14, 2017 and Saturday, September 16, 2017

5.6 Future Parking Demand Modeling

Key Takeaway: The Aggieville Community Vision Plan identified growth and redevelopment, with a particular emphasis on residential and commercial land uses. Several scenarios were modeled from an infrastructure standpoint, each with varying land use densities—low growth, medium growth, and high growth. In any scenario, the existing public parking infrastructure is not sufficient to accommodate new demand; thus, resulting in the need for additional parking infrastructure. The growth scenarios identified a systemwide supply deficient between 800 and 1,500 stalls because of the growth.

This analysis modeled several growth scenarios within Aggieville to evaluate the impacts of various land use scenarios on parking infrastructure needs. Based on the limited sufficiency of the existing parking infrastructure, this analysis has determined that any additional development within the Aggieville will require additional parking infrastructure—either in the form of publicly-available and publicly-funded parking, private parking constructed as part of a specific new development, or a combination thereof.

5.6.1 Methodology

To determine future parking needs by growth scenario, Walker used its Shared Parking Model, which assesses typical peak parking needs in a mixed-use environment, where parking infrastructure is a shared resource. The following factors are incorporated in this model and analysis:

- **Base parking ratios by land use**: Parking demand ratios by land use on a granular level (e.g. community retail v. big-box retail, sit-down restaurants v. counter service restaurants, etc.) derived from Urban Land Institute (ULI) and Institute of Transportation Engineers (ITE) statistics and Walker's own research database.
- **Hourly, weekly, and monthly demand distribution patterns:** Parking distribution patterns by land use on an hourly, weekly, and monthly basis, derived from ULI/ITE statistics and from Walker's research database.
- **Adjustments for uses of non-single occupancy vehicle modes of transportation and walk-ins:** Specific assumptions about how the usage of non-single occupancy vehicle modes impacts parking demand by land use and user group (e.g. visitors v. employees). This factor also considers demand for land uses within Aggieville by users who are already parked in Aggieville (e.g. residents and office employees). The reduction in evening and overnight parking impacts seen from transportation network companies (TNC) such as Uber and Lyft are considered into this are of the model. The parking demand counts taken this year reflect those reductions. Additional, the utilization of the bus system for the surrounding Manhattan area is reflected in this area of the model.

5.6.2 Parking Demand By Growth Scenario

The parking demand models include densities by land use, projected peak demand, and projected parking deficiency by growth scenario. In all scenarios, Walker has assumed, based on input from City Staff, that all four-public surface lots within Aggieville would be eliminated in concert with new development. This elimination would result in a total loss of 261 stalls, which would need to be returned to the system. As such, **Table 5.1** has been included in the resulting deficiencies for each scenario. As shown in the figure below, these growth scenarios result in an additional parking supply need between roughly 800 and 1,500 stalls (including replacement of the existing 261 public surface lot stalls). As noted previously, new development is required to provide its own off-street parking pursuant to City zoning code, and therefore at least part of the deficiency would likely be accommodated in private infrastructure.

Surface Parking in Aggieville

Table 5.1: Parking Demand and Supply Deficiency with Office Component

Scenario	Residential	Retail	Counter Service Restaurant	Full-Service Restaurant/ Bar	Office	Projected Peak Demand	System-wide
Existing	226 Units	127,007 SF	90,531 SF	59,178 SF	15,710 SF	485	51
Low	366 Units (140 New)	110,948 SF (-16,059 Loss)	118,854 SF (28,323 New)	75,497 SF (16,319 New)	48,783 SF (33,073 New)	1,009	(-735)
Medium	536 Units (310 New)	131,317 SF (4,310 New)	140,699 SF (50,618 New)	62,251 SF (3,073 New)	57,726 SF (42,016 New)	1,420	320
High	705 Units (479 New)	131,317 SF (4,310 New)	140,699 SF (50,618 New)	62,251 SF (3,073 New)	57,726 SF (42,016 New)	1,760	320
Note: For each land use type, the total number of projected density is listed first, followed by the projected new density.							

5.6.3 Potential Impacts From Autonomous Vehicles

Automobile and technology companies are promising to make fully autonomous vehicles (AVs) available for consumer purchase within the next three to five years. Many expect the biggest impact on parking could be from subscription-based ride-hailing, sometimes called e-hailing, provided by Transportation Network Companies (TNCs), such as Uber and Lyft that may equip fleets with AVs. These services, along with public transportation, taxis, bike-sharing programs, and car-sharing programs are known as mobility-as-a-service (MaaS). For some land use types and geographic areas, TNCs are already reducing parking demand. Uber and Lyft, among others, have announced plans to shift from using drivers' personal vehicles to directly owning fleets with AVs and operating completely driverless fleets.

Another significant impact could come from private ownership of AVs. Consumers may opt to reduce the number of vehicles owned per household in recognition of the possibility that a car could more easily transport multiple family members to and from different places once a driver is no longer needed. Auto manufacturers, tech companies and Wall Street are investing hundreds of billions of dollars in TNCs and AVs. While there are many technological and other hurdles to be overcome, the consensus seems to be that AVs will become available to and adopted by mainstream consumers.

It is estimated that by 2030, 20% of new cars sold in the U.S. could be fully autonomous. How does this assumption provide insight into changes and timeline of AV adoption and absorption? There are an estimated 265 million registered passenger vehicles in the U.S. today, an estimated 17.5 million new passenger vehicles were sold in 2016 to U.S. consumers, and the average age of cars on U.S. roads is about eleven and one half years. Therefore, AVs are expected to represent a small percentage of the total number of cars on U.S. roads in 2030.

The first issue in planning for the future is understanding the potential impact on parking demand and the timeline. We estimate that the realistic overall maximum reduction, nationally, in parking is about 40% at a high disruption scenario, and as low as 10% in a low disruption scenario. The impact at a specific site will be dependent on density; it will be greater in the urban core, and much lower in rural areas.

Given that the life of a parking structure is 50 years or longer and in anticipation of the impacts of AVs, TNCs, and MaaS, it is important to now plan parking structures with the ability to withstand changing conditions. It is also important to quantify the effects of TNCs on parking planning and design.

Although fully-autonomous vehicles are expected to soon be available for consumer purchase, it is not expected that fully-AVs will be a majority of the vehicle population for decades (whether personally-owned or provided as a MaaS by transportation network companies or others). The most realistic estimate is a reduction of about a 40% in parking demand within the next 30 years. However, since parking structures have an expected life of 50 years or longer, developers and parking owners should be thinking about tomorrow's possibilities, today. Ultimately, parking should be planned with flexibility and the capability to accommodate the potential increase in the number of AVs, as well as infrastructure to support TNCs.

5.7 Parking Management

Key Takeaway: Parking management is an integral part of Aggieville's parking system. Its intent is to maximize the use of public parking supply to effectively, efficiently, and equitably serve all user groups. Specifically, the goal is to provide frequent turnover of the on-street parking spaces and utilize the off-street parking for longer durations of stay. We have identified two strategies to consider which will achieve these goals.

In most cases, implementing a parking management solution should be the first step for any holistic parking solution. Managing the parking supply ensures that the supply can be used efficiently, and slows the need for additional inventory, resulting in cost savings (considering the comparatively high cost of building new parking over managing existing parking). Key goals for management of Aggieville's parking system include:

- Efficient, effective, and equitable parking for all user groups, including:
    - Diners
    - Shoppers
    - Employees
    - Business owners
    - Residents
    - Other visitors
- Frequent turnover of high-demand on-street spaces
- Prioritization of short-term (60- to 90-minute parking) on-street and long-term parking off-street

At present, Aggieville employs enforced 2-hour time-limited parking in high-demand on-street areas along Anderson Avenue, N. Manhattan Avenue, Moro Street, and N 12th Street, and 3-hour time-limited parking in its four public lots. All other parking within Aggieville is unrestricted. The high demand for time-limited spaces, combined with limited enforcement of time limits, can create an environment in which on-street spaces don't turn over often throughout the day, and customers, visitors, and others have difficulty finding a space to park. To mitigate these impacts, Walker has identified two possible parking management frameworks: a paid parking solution, and an increase and expanded enforcement strategy. Both solutions are discussed below.

5.7.1 Strategy 1: Paid Parking

One strategy to achieve the goals discussed above is to implement a paid parking solution that would entail the following:

- Replace existing time-limited parking with paid on-street parking using credit-card enabled meters with no time limit. Expand paid on-street parking area as required by increases in density and corresponding increases in parking demand.
- Implement a universal on-street parking time-limit (2 hours proposed, in keeping with existing time limits) in peripheral areas (where parking is presently unrestricted).
- Utilize a graduated pricing strategy for on-street meters (e.g. $1 for first 2 hours and $1 for each additional hour, or a 15- to 30-minute grace period at the start of each session. The actual pricing structure should be further evaluated.
- Prioritize regular enforcement of time-limited areas.

5.7.1.1 Benefits of Parking Meters

There are several benefits to smart parking meter technology:

- **Payment Options:** Smart meters that offer alternative payment options to coins can improve customer service, enhance compliance, and increase revenues. Users would still be able to pay with coins (a standard option in most smart meter models) to maximize comfort for all users, including seniors who may be unfamiliar or distrusting of credit card options.
- **Complex Rate Structures:** Smart meters offer the ability to include a grace period, implement a graduated rate (e.g. free for the first hour and paid each additional hour), or allow validations using codes.
- **Audit Control:** Smart meter technology tracks each payment, including the date and time of purchase, how much time was purchased, how it was paid for, and what amount was paid. Therefore, audits are a simple process.
- **Maintenance:** Every smart meter is equipped with self-diagnostic software that enables them to “report” maintenance issues via wireless communication, so any issues can be quickly remedied.

Parking Meter with Credit Card Reader

5.7.2 Strategy 2: Expanded Time Limits and Enforcement

Time limits are an enforcement-based strategy to increase turnover (as opposed to a market-based strategy, like paid parking with no time limits). At present, time limits are utilized as the primary parking management strategy in Aggieville, with 169 time-limited on-street stalls (note that while public surface lot parking is also time-limited, it is assumed that this inventory will likely be diminished or eliminated entirely as Aggieville grows).

An alternative strategy is to expand the existing time-limited zones to include the entire parking system, and increase enforcement activity to increase compliance. Again, this is an enforcement-based strategy wherein no active revenue is realized, and all revenue derived from the parking system comes from fines associated with non-compliance. The major benefits of a time-limited system over a paid parking system are that Aggieville's parkers are already familiar with time-limited systems and therefore a rigorous public outreach strategy would not be needed (as it would be with paid parking), and that it maintains the perception that parking is ultimately "free" to end users.

If an expanded time-limited system is pursued, Walker recommends a universal time limit of 2 hours, with no exceptions granted to ensure that the parking system's rules and regulations are equitably enforced. As deemed necessary following implementation of the expanded time-limited system, Aggieville could consider Resident Parking Permit programs (RPPs) and Employee Parking Permit programs (EPPs) in applicable areas. Such permits would allow permit-holders to circumvent the time limits. Of course, this program should only be available in areas that do not presently generate high visitor parking demand, and should be continually reevaluated as development patterns expand or change. With hangtags or another physical permit, this program could be enforced manually. This and other enforcement options are discussed further in the Enforcement section below.

Finally, the City could consider enforcing by zone, rather than by space, in time limited areas. This would bolster prevention of the "employee shuffle" and other issues that arise with the current enforcement system. License plate identification technology would be used enforcement system (discussed in the Enforcement section) zones could be geo-fenced, and license plates present in the same zone for more than two hours would warrant a warning or ticket. This would be much more challenging to enforce with a manual system and Walker does not suggest that staff attempt to accomplish this; however, language describing this policy and the corresponding zones could be adopted in City ordinance and included on time limit signage throughout Aggieville to discourage violations.

5.7.2.1 Enforcement

At present, enforcement is conducted manually, and it is difficult with current staffing levels to enforce effectively and catch all violations. The current system would be strained if the time limit zone were expanded to include currently unrestricted areas. As such, if this method of parking management is pursued, Walker recommends that the City consider scaling up to digital enforcement using mobile License Plate Recognition (LPR) technology.

Limited Street Parking in Aggieville

Mobile LPR utilizes vehicle-mounted cameras that read and record license plates as an enforcement vehicle is driven on roadways, surface lots, garages, etc. A processor is installed in the vehicle's trunk or in the floor, and a laptop is installed on the dashboard, between the front seats. The LPR cameras use a series of algorithms to convert the photographic images of license plates into text data. System software then compares the plate numbers with previous enforcement session(s) and/or databases of paid or permitted license plates, to determine if the vehicle has overstayed the time limit, if it has paid, or otherwise has a right to park in that location at that time.

Another camera option, 'electronic chalking', captures the images of valve stems on tires to determine if the vehicle has moved over the course of time. A discussion of LPR's ability to integrate with payment options applicable in a multi-space meters if a paid parking strategy were implemented.

While enforcing, mobile LPR can collect parking occupancy and frequency of visit data, as well as limited duration of stay data. Each time the mobile LPR vehicle drives past a parked vehicle, it time-stamps the image and the location, using GPS technology to identify the locations of the parking spaces and can sort the data by parking facility, street or by customized zones. Note that the system won't know the exact time that the vehicle parked or exited – it only knows that the vehicle was parked in a specific location at the time of enforcement. Throughout multiple tours, the system software calculates the total time that the vehicle was observed as parked, up until it is observed to have moved. Handheld LPR is an alternative to mobile (vehicle-mounted) LPR; however, Walker does not recommend pursuing this option as staff time is not significantly reduced (though accuracy can be).

Mobile LPR units cost roughly $45,000 per unit. It is worth noting that such units could, of course, could be utilized for areas in the City outside of Aggieville, and therefore could be shared Citywide and help reach enforcement goals within all of Manhattan.

Moro Street in Aggieville

5.8 Funding and Financing

Key Takeaway: Most parking system solutions have an associated cost. For comparatively cheaper endeavors, such as the operation and maintenance of the parking system, Walker recommends that the City more formalize the parking system for the Aggieville system, through which to collect revenues and pay for regular and certain capital expenses; other sources could be existing budgeting mechanisms, like allocations from the General Fund or existing capital improvement plan budgets. For costlier changes, like building new infrastructure, the City could use traditional financing, or pursue an alternative funding strategy, such as public private partnerships (P3), tax increment financing (TIF), or other options.

Building new structured parking is a costly compared to constructing surface parking—implementing parking management solutions also requires funding, but to a much lesser extent. The parking management solutions included in this report will require some upfront capital cost, in the form of new equipment and technology, staffing resources, signage, third party assistance, and other items. Often, these costs can be covered using budgeting mechanisms already in place; allocation of the General Fund or other funds, inclusion in a capital improvement plan, etc. A primary recommended step in terms of funding immediate and ongoing needs for the Aggieville parking system is to create a separate enterprise fund through which to collect revenues and pay for regular and certain capital expenses.

Conversely, building new structured parking will require a much larger, and more dedicated, funding source. This section first includes information about typical costs associated with building and maintaining structures to provide an order-of-magnitude basis for obtaining funding. Secondly, this section provides information regarding various funding sources, with a focus on alternative sources beyond traditional commercial loans or bond financing.

5.8.1 Costs to Construct and Maintain Structured Parking

The following section discusses cost ranges to construct and maintain structured parking. Such costs are an essential component to understand when considering new parking infrastructure.

5.81.1 Construction Cost

Costs to build structured parking can vary greatly, depending on the type of construction, the size and shape of the site, the number of stalls, and whether activation of the ground floor (such as including a retail wrap along street frontage) is included, among other factors. Generally, construction costs in the Manhattan area for above-grade parking range from $15,000 to $20,000 per space. This range excludes certain costs, such as soft costs (architectural design or site development entitlements), as well as land acquisition costs and demolition costs or existing structures. These cost ranges assume an above-grade structure; below-grade parking typically adds a significant cost premium, variable based on site configuration, soil conditions, size and number of parking levels provided below-grade, water table level, and ventilation and other utility needs.

The construction cost ranges for the growth scenarios is shown in the **Table 5.2**, below. These cost ranges include rebuilding the parking supply required to reconstructed from the existing four surface lots which are understood to be developed on.

Table 5.2: Cost Ranges for Constructing Structured Parking to Support Growth and Redevelopment

		Construction Cost	
Growth Scenario	Spaces Constructed	$15,000	$20,000
Low	800	$ 12,000,000	$ 16,000,000
Medium	1,200	$ 18,000,000	$ 24,000,000
High	1,500	$ 22,500,000	$ 30,000,000

5.8.1.2 Operations and Maintenance Cost

Operations and maintenance costs, or O&M, are the standard costs required for standard garage function, including labor, general cleaning and maintenance, administration, and insurance, among other items. Depending on the garage's size, type of construction, type of operation (free to end users or gated with a payment system, for example), and maintenance plan, annual per space O&M costs can generally range from $300 to $500. The range of O&M costs shown generally includes the following components:

- **Labor (including employee income tax, benefits, and uniforms):** Even in structures with fully-automated parking access and revenue control systems (PARCS), some labor is generally required. For garages that do not require an attendant or extensive in-person monitoring, Walker generally assumes a facility manager and custodian will be assigned to the structure, and allocate 25% of their total annual labor hours working in the structure. Of course, if an attendant or other personnel are required, potential labor costs will be increased.
- **General Maintenance:** Floor cleaning/repair, lighting repair, and other annually-required minor repair and maintenance items. This item may fluctuate depending on the operator's specific maintenance plan.
- **Administration:** General administration of the facility, including cost of supplies.
- **Garage Keepers and General Liability Insurance:** Insurance required for garage operators to limit liability for potential damage to customers' vehicles, among other potential liability issues.
- **Reserves for Replacement/Long-Term Sinking Fund:** Walker recommends that a per-space figure of $125 be allocated each year to pay for large-scale maintenance and structural repair items not accounted for in the general maintenance budget. This is because even the best designed and constructed parking facility requires structural maintenance. For example, expansion joints will need to be replaced and concrete invariably deteriorates over time and needs to be repaired to ensure safety and to prevent further deterioration. The structural maintenance cost typically represents the largest portion of the total maintenance budget. Property owners tend to grossly underestimate the structural maintenance cost and do not budget adequately for timely corrective actions that must be performed to cost-effectively extend the service life of the structure. The cost of structural maintenance is relatively small considering the comparatively high expenditures associated with the failure to perform proper maintenance on a timely basis.

The parking system operation costs for each of the growth scenarios is shown in **Table 5.3**. These parking system costs include the management of the on-street parking spaces in addition to those that would be provided in off-street parking structures.

Table 5.3: Cost Ranges for Operating Parking System in Aggieville

		Yearly O&M Cost	
Growth Scenario	**Spaces Managed**	**$300**	**$500**
Low	1,134	$ 240,000	$ 400,000
Medium	1,534	$ 360,000	$ 600,000
High	1,834	$ 450,000	$ 750,000

5.8.2 Funding Construction of Parking
Many municipalities utilize more traditional funding routes, such as commercial loans or bond financing, to finance parking infrastructure. However, this section focuses on various alternative strategies which could be available for financing the construction of new parking.

5.8.2.1 Tax Increment Financing
Generally, Tax Increment Financing (TIF) is a financing technique used to revitalize areas deemed ripe for development, generally referred to as "urban renewal" areas. Different municipalities structure TIF in different ways; however, generally municipalities sell bonds to finance land and infrastructure costs within a designated area, and sell land to prospective developers. Following development, the "increment" between the original land assessment value and the new assessment value is used to off the initial bond debt.

Examples of TIFs are numerous throughout the country; they are generally more successful when enacted for greenfield or underutilized areas where a variety of development—particularly residential, commercial, and retail development with high assessment value potential—is slated to occur.

5.8.2.2 Public Private Partnerships (P3) Development and Cost Sharing
Public-Private Partnerships, also known as PPPs or P3s, are joint ventures between the public and private sectors wherein governments leverage the financing capacity and expertise of the private sector to accomplish a public purpose. The private sector partner often benefits for the arrangement by receiving land or other assets at a discounted price (or a long-term lease) and/or some sort of secured revenue stream with which to retire debt. The largest and most complicated P3's are asset monetization agreements such as the 99-year City of Chicago parking and toll road concession deals. However, P3's covers a huge gamete of possible arrangements between the public and private sector.

The most common examples of P3's related to parking are the lease back arrangements where the private party (an LLC, for example) enters into a ground lease for a development site. The private party designs, builds, and finances 100 percent of the project. The private party then leases the parking structure — or a publicly-available part of the garage--- back to the public entity. The public entity pays rent over the term of the lease. At the end of the lease, assuming all debt obligations have been met, the asset then reverts to the institution for a very small fee, which is typically $1.

5.8.2.3 Lease Agreements

Lease agreements involve a private entity holding a lease agreement for public parking resources owned by a municipality. In many cases, lease agreements are rejected as a potential cost recovery mechanism in favor of more traditional methods, such as Public Private Partnership (P3) development and cost sharing, tax-increment financing, and others.

5.8.2.4 Business Improvement Districts

Some municipalities and county governments use business improvement districts (“BIDs”) and parking tax districts to generate income to fund parking facility capital improvements and operating expenses. Both business improvement districts and parking tax districts can be used to finance the acquisition of land; the construction, operation, and maintenance of surface parking lots and parking structures; as well as the costs of engineers, attorneys and other professionals needed to complete infrastructure projects.

BIDs, which are most often formed at the request of their member businesses, typically address a wide variety of issues, not all related to parking. Common issues addressed include marketing, transit, beautification, signage, lighting, parking, street and public space maintenance, unarmed security patrols, “customer service representatives” or “ambassadors” to provide information and assistance to tourists and shoppers, etc. The collection of assessments tends to be applied uniformly on a square foot, gross receipts, or assessed value basis because benefits are universally recognized by all property owners. Typically, no exemptions or tax credits are provided to property owners who provide all or a portion of their required parking.

5.8.2.5 Parking In-Lieu Fees

Some communities incorporate an in-lieu fee program as an alternative to traditional developer-constructed parking requirements. In some communities, these alternatives replace the need for off-street parking requirements; in others, they supplement it. These programs essentially allow a developer to pay a fee into a fund in return for not having to build parking. The funds are then used by the City to construct parking or to pay down existing debt service.

Key benefits of in-lieu fees over solely developer-provided parking include:

- Better location and design of parking facilities (from the City’s perspective).
- Fewer parking requirement variance requests.
- Shared use of all public parking resources.

Disadvantages include:

- Lack of on-site, owner-controlled parking may hinder a developer’s ability to sell or lease a site.
- No guaranteed or reserved parking for any user.
- May result in lower supply, particularly if the required in-lieu fee only pays for one or fewer parking spaces.

5.8.2.6 Developer/Business/Occupier Fee

This financing structure generates revenue through a fee imposed on developers, businesses, or other occupiers in exchange for the use of public parking stalls. Such public stalls can be "credited" towards fulfilling off-street parking requirements in lieu of constructing dedicated parking.

Parking in-lieu fees, a similar revenue mechanism for public parking infrastructure, allow, encourage, or require that developers pay a fee to the city in lieu of constructing private parking, and are a more common financing structure than a developer/business/occupier fee (see above). However, this fee structure does not explicitly associate fees with infrastructure replacement costs, as is typically the case with a parking in-lieu fee.

5.8.2.7 Sales Tax Allocation

Financing via sales tax allocation requires that a certain percentage of municipal sales tax revenue be allocated specifically to an expenditure (in this case, operation, maintenance, and capital expense repayment for the proposed parking structure).

In many cases, jurisdictions (including both municipalities and counties) choose to implement this financing option through an increase in sales tax via voter referendum (e.g. a "one-cent" or "penny" sales tax increase). This method ensures that an allocation of sales tax revenue will not impact projects and services already being funded by this revenue source. Such "one-cent" sales tax allocations are commonly tied to infrastructural improvements, though in general potential uses are broader than parking alone, and may include public park maintenance, transportation infrastructure improvements like road widening, sidewalk or bike lane installation, or utility improvements.

5.9 Parking Infrastructure Options

The low, medium and high growth scenarios previously discussed will require structured parking be constructed to support growth and redevelopment in Aggieville. Again, it is not known now if all the parking required will be provided solely by the City or if a combination of publicly available and privately provided parking will ultimately be delivered. It is likely that the later will be the result once redevelopment begins to occur.

Depending on the growth, one or two public parking structures would be required to support the future parking needs. The Community Vision Plan identifies the existing four exiting public parking lots would be redeveloped; therefore, the 261-existing off-street parking supply would have to be reconstructed in addition to the net new parking demand generated from growth. The Community Vision Plan identified two primary locations for constructing public parking. These sites are show in the figure below. Each site location provides access to most all areas in Aggieville within a three-minute walk. The Community Vision Plan identified the potential locations for new structured parking garages in a reconfigured option from those of the existing City parking parcels, shown as blue dashed boxes in the **Figure 5.6**. We understand this was intentional to meet the Community Vision Plans planning objectives though the actual reorganization, and purchase of these parcels has yet to be determined. The site footprints outlined by the red boxes support the construction of efficient structured parking.

Figure 5.6: Parking Structure Sites

5.9.1 Parking Site 1

Site one offers the opportunity to construct the greatest parking supply while following the objectives outlined in the Community Vision Plan. The parking garage located on this site is capable of being wrapped with occupiable space along W. Laramie Street and along N. 14th Street. Lining the garage with occupiable space masks the view of the garage and provides an opportunity to best maximize the buildable space on the site. An efficient two bay wide parking capacity based on this footprint can range from 500-800 parking spaces. The massing of this structure size results in four to six stories.

A wider, three-bay parking garage could be constructed in this area of Aggieville when a greater parking capacity is required under a high growth scenario. The wider footprint for this option would require the footprint of the parking garage to be located along N. 14th Street, thus eliminating the full height lining of the parking with occupiable space. This is required in order not to impact the iconic Rally House building at the south-west corner of N. Manhattan Avenue and Anderson Avenue. This option allows the parking garage to be built in phases, whereas, the first two bays could be constructed and the third bay of parking be constructed when the highest level of growth occurs.

Figure 5.7: Structured Parking Footprint Options

A massing concept developed by the City is show which represents the scale of this five-story parking concept which totals 600 parking spaces wrapped by occupiable building space along W. Laramie Street.

Figure 5.8: Site 1 - 5 Story Structured Parking Massing

5.9.2 Parking Site 2

The second site identified for structured parking is located at the north-east corner of Moro Street and N. 11th Street. This second public parking structure would be required if a medium to high growth development scenario were to occur. This second structure would be constructed to distribute the parking supply across Aggieville. The Community Vision Plan identifies limiting the height of structures along Moro Street to maintain it architectural character. In addition, the plan identifies ground floor occupiable space, primarily along Moro Street and wrapping the corer at N. 11th Street.

The site size, retail space requirements and height restrictions limit the parking capacity of this facility to around 300 spaces if constructed three stories tall. A City generated massing of this concept is shown below. Though the parking capacity is not significant, the site provides an opportunity to add a second parking garage in the medium or high growth scenario. The parking capacity is also distributed in Aggieville as compared to a single structure.

Figure 5.9: Site 2 - Structured Parking Footprint

Figure 5.10: Site 2 - 3 Story Structured Parking Massing

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SECTION 6: PUBLIC INVOLVEMENT AND STEERING COMMITTEES

6.1 Introduction

The project team conducted five steering committee meetings and four focus group meetings over the course of this project. These groups were made up of property owners, bar/restaurant owners, retail/service business owners, and neighborhood residents. These meetings were to facilitate communication about the Aggieville Infrastructure Analysis process and to get input from the community. The following section is a brief summary of important takeaways from the survey conducted during these meetings. All Survey responses can be found in **Appendix B**.

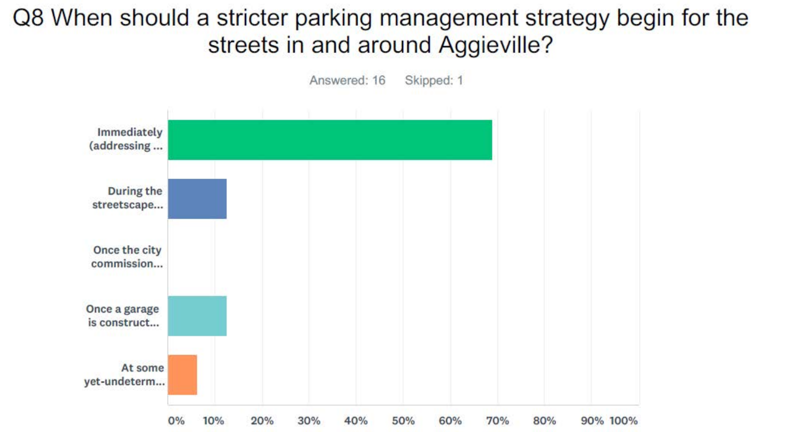
6.2 Survey Summary

The Aggieville Analysis Steering Committee was primarily made up of Manhattan City Staff (35 percent) and a collection of property owners, business owners, Kansas State University representatives and residents. Of this group, 100 percent of respondents support the redevelopment of Aggieville (**Figure B.2** in **Appendix B**). This group also believed that the redevelopment process could no be accomplished without additional parking capacity (94 percent).

The group was very consistent, and in agreement through the rest of the survey. All respondents believed that there would be at least some need for public investment in parking in order to spark interest in redevelopment from private developers (**Figure B.4** in **Appendix B**). One-hundred percent of respondents also agreed with the recommendation of constructing a garage consisting of 500 to 600 parking stalls (**Figure B.6** in **Appendix B**).

The last two important findings consist of the committees feelings on stricter parking maintenance and enforcement. While most respondents (94 percent) believed that there was a need for stricter strategies of maintaining parking on the streets of Aggieville (**Figure B.7** in **Appendix B**), there was dissension when this stricter strategy should be. This dissension can be seen in **Figure 6.1.** Most respondents (69 percent) believed that it should begin immediately , and that it should be focused on the existing two hour and three hour restrictions with a $15 fine. Twelve percent believed that it should begin during the streetscape design, to allow for alternative parking management strategies and infrastructure. The remaining twelve percent believed that stricter strategies should be implemented once a new garage is constructed and operational.

Figure 6.1: Survey Question 8



ANSWER CHOICES	RESPONSES	
Immediately (addressing the existing 2HR and 3HR restrictions with a $15 fine)	68.75%	11
During the streetscape design, to allow for alternative parking management strategies and infrastructure	12.50%	2
Once the city commission approves a final parking garage design and plan	0.00%	0
Once a garage is constructed and operational	12.50%	2
At some yet-undetermined point in the future	6.25%	1
TOTAL		16

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SECTION 7: SUMMARY

7.1 Introduction

Through the collection of existing data, utility analysis, model and intersection analysis, parking infrastructure analysis, and public involvement, the project team has identified potential long-term solutions to the increasing demand for parking in Aggieville. The following is a summary of the project team's process and findings.

7.2 Utility Analysis

This sections provided an overall analysis of the existing infrastructure within the Aggieville shopping district for it's ability to support sewer flows and to provide fire protection from future growth in the area.

7.2.1 Sanitary Sewer System

No capacity issues were identified within the gravity sewer system within the Aggieville district at either current or future wastewater demand conditions, at either wet or dry weather conditions. A new relief sewer routes flows from a previously overloaded 8-inch sewer in the district to a 12-inch interceptor in 14th Street, which allows for additional capacity in the area.

In addition to evaluating the sewer mains within the Aggieville District, the mains outside of the district were evaluated for their ability to carry the additional flows projected from the new development. The hydraulic model identified a short segment near 3rd & Moro Streets that was already at 86% capacity with current wastewater flows under wet weather conditions. Under wet weather conditions, and calculated peak wastewater demands, approximately 270 feet of 8-inch sewer needs to be upsized to a minimum of 10-inches in diameter beginning on East Third Place, approximately 180 feet north of Moro Street, traveling south along East Third Street to approximately 50 feet south of Moro Street, then east to North 3rd Street. Another stretch of sewer was identified to be upsized along the alley between Moro and Laramie Street, from 10th Street to 4th Street, approximately 2,400 feet long.

7.2.2 Water System

Commercial fire flows requirements are typically 2,000-3,000 gpm while maintaining a residual pressure of 20 psi. All locations in the existing system were modeled to show capabilities of 2,500 gpm or greater at both existing and future average and peak conditions. As the model was not developed by Olsson Associates, and since it has not been calibrated recently, it is highly recommended that flow testing be performed in the vicinity to calibrate the model to current conditions and verify the calculations performed in this memo. It is also recommended that these analyses be repeated once the actual fire flow needs of the new facilities are able to be calculated with more accuracy. It should also be noted that the fire flow simulations are conservative, as they assume that fire protection is provided from ground fire hydrants, rather than sprinkler systems, which will most likely be in place on the new buildings.

7.3 Parking Infrastructure Analysis

Aggieville currently generates parking demand close to the usable capacity of overall parking supply on a regular basis, with peaks occurring on weekdays and lunchtime and on weekend nights. Certain sub-areas - particularly the Bluemont/Anderson Corridor and the Historic Core - frequently generate parking demand in excess of the usable capacity within the sub-area. The result of the high utilization of the parking supply will limit Aggieville's ability to redevelop and grow without building additional parking supply.

7.3.2 Future Parking Supply Needs

The Community Vision Plan identifies growth in housing, retail, office, and quick-serve and sit-down restaurants. Low, medium and high growth scenarios were developed for these land use mixes to identify target ranges for the parking capacity required to support growth. The scenario modeling resulted in a need to construct between 800 and 1,500 parking spaces. While this model does not show the split between publicly and privately constructed parking, it identifies a level of parking supply required to support this growth. Once actual development projects are identified, the parking demand model can quickly be revised to account for "real" projects. The future additional parking supply will likely be combination of publicly available and privately provided.

7.3.3 Parking Future Infrastructure

Depending on the growth, one of two public parking structures would be required to support the future parking needs. The Community Vision Plan identifies four exiting public parking lots for redevelopment; therefore, the 261-existing off-street parking spaces are assumed to have to be reconstructed in addition to the net new parking demand generated from growth. The Community Vision Plan identified two primary locations for constructing public parking and are confirmed by this study to be the two best locations. Each site location provides access to most areas in Aggieville within a three-minute walk. The actual reorganization, and purchase of these parcels has yet to be determined. The site footprints were determined to be capable of support the construction of efficient structured parking.

Site one offers the opportunity to construct the greatest parking supply while adhering to the intent of the Community Vision Plan. The parking garage is wrapped with occupiable space to mask the structured parking facility. This also best utilizes the buildable space on these parcels. The parking capacity based on the footprint shown below can range from 500-800 parking spaces and four to six stories in height. This results in a construction cost ranging from $7.5M to $16M at a cost per space of $15,000 to $20,000.

The benefit of a second parking structure is to distribute the parking supply around the ten blocks of Aggieville as well as to limit the overall massing of building one structure. The Community Vision Plan identifies a second structured parking site at the north-west corner of Moro Street and N. 11th Street. The Community Vision Plan's intent is to keep the building height along Moro Street low; therefore, the parking capacity on this site is limited to around 200 spaces which results in constructing three total stories. Ground floor retail could also be incorporated on the ground floor of the structure at the corner of Moro Street and N. 11th Street. Constructing a facility of this size ranges between $3M-$4M at a cost per space of $15,000 to $20,000. Refer to **Figure 3.6**, found in **Section 3**, to see the two sites.

7.3.4 Parking Management

At present, Aggieville employs enforced 2-hour time-limited parking in high-demand on-street areas along Anderson Avenue, N. Manhattan Avenue, Moro Street, and N 12th Street, and 3-hour time-limited parking in its four public lots. All other parking within Aggieville is unrestricted. The high demand for time-limited spaces, combined with limited enforcement of time limits, can create an environment in which on-street spaces do not turn over often throughout the day, and customers, visitors, and others have difficulty finding a space to park. To mitigate these impacts, Walker has identified two possible parking management frameworks: a paid parking solution, and an increase and expanded enforcement strategy. Both solutions are discussed below.

The goal for parking management is Aggieville should be to provide frequent turnover of the on-street parking spaces and utilize the off-street parking for longer durations of stay. Its intent is to maximize the use of public parking supply to effectively, efficiently, and equitably serve all user groups. Parking management should be integral part of Aggieville's parking system. We have identified two strategies to consider which will achieve these goals.

One strategy to achieve these goals is to implement a paid parking solution that would entail the following:

- Replace existing time-limited parking with paid on-street parking using credit-card enabled meters with no time limit. Expand paid on-street parking area as required by increases in density and corresponding increases in parking demand.
- Implement a universal on-street parking time-limit (2 hours proposed, in keeping with existing time limits) in peripheral areas (where parking is presently unrestricted).
- Utilize a graduated pricing strategy for on-street meters (e.g. $1 for first 2 hours and $1 for each additional hour, or a 15- to 30-minute grace period at the start of each session. The actual pricing structure should be further evaluated.
- Prioritize regular enforcement of time-limited areas.

Time limits and enforcement is an alternative strategy to increase turnover (as opposed to a market-based strategy, like paid parking with no time limits). At present, time limits are utilized as the primary parking management strategy in Aggieville, with 169 time-limited on-street stalls (note that while public surface lot parking is also time-limited, it is assumed that this inventory will likely be diminished or eliminated entirely as Aggieville grows).

This strategy expands on the existing time-limited zones to include the entire parking system in Aggieville, and increase enforcement activity to increase compliance. Again, this is an enforcement-based strategy wherein no active revenue is realized, and all revenue derived from the parking system comes from fines associated with non-compliance. The major benefits of a time-limited system over a paid parking system are that Aggieville's parkers are already familiar with time-limited systems and therefore a rigorous public outreach strategy would not be needed (as it would be with paid parking), and that it maintains the perception that parking is ultimately "free" to end users.

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APPENDIX A - SEWER ANALYSIS

Figure A.1: Existing Sanitary Sewer Main Layout

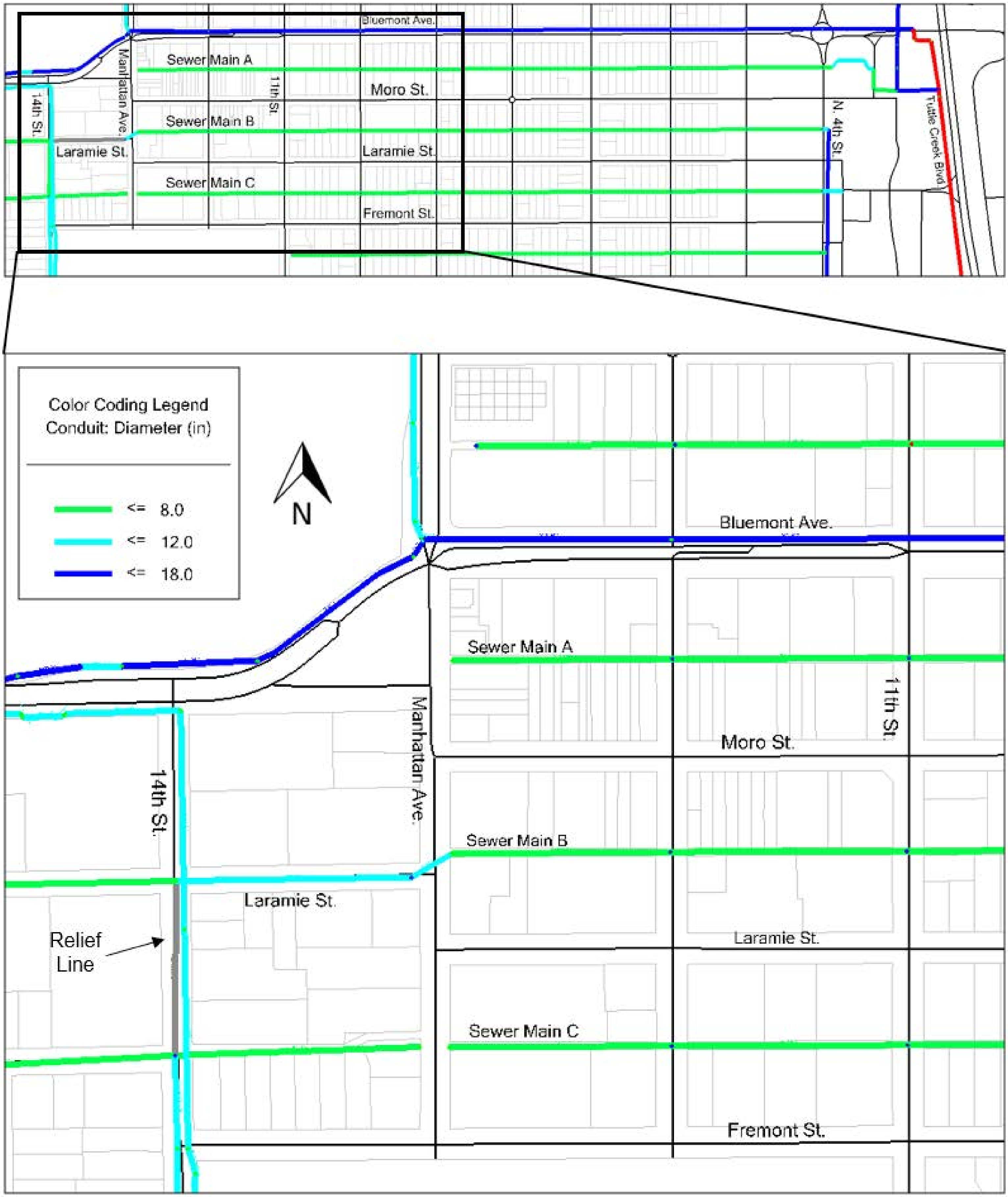


Figure A.2: Existent Sanitary Sewer Trunk Line Layout

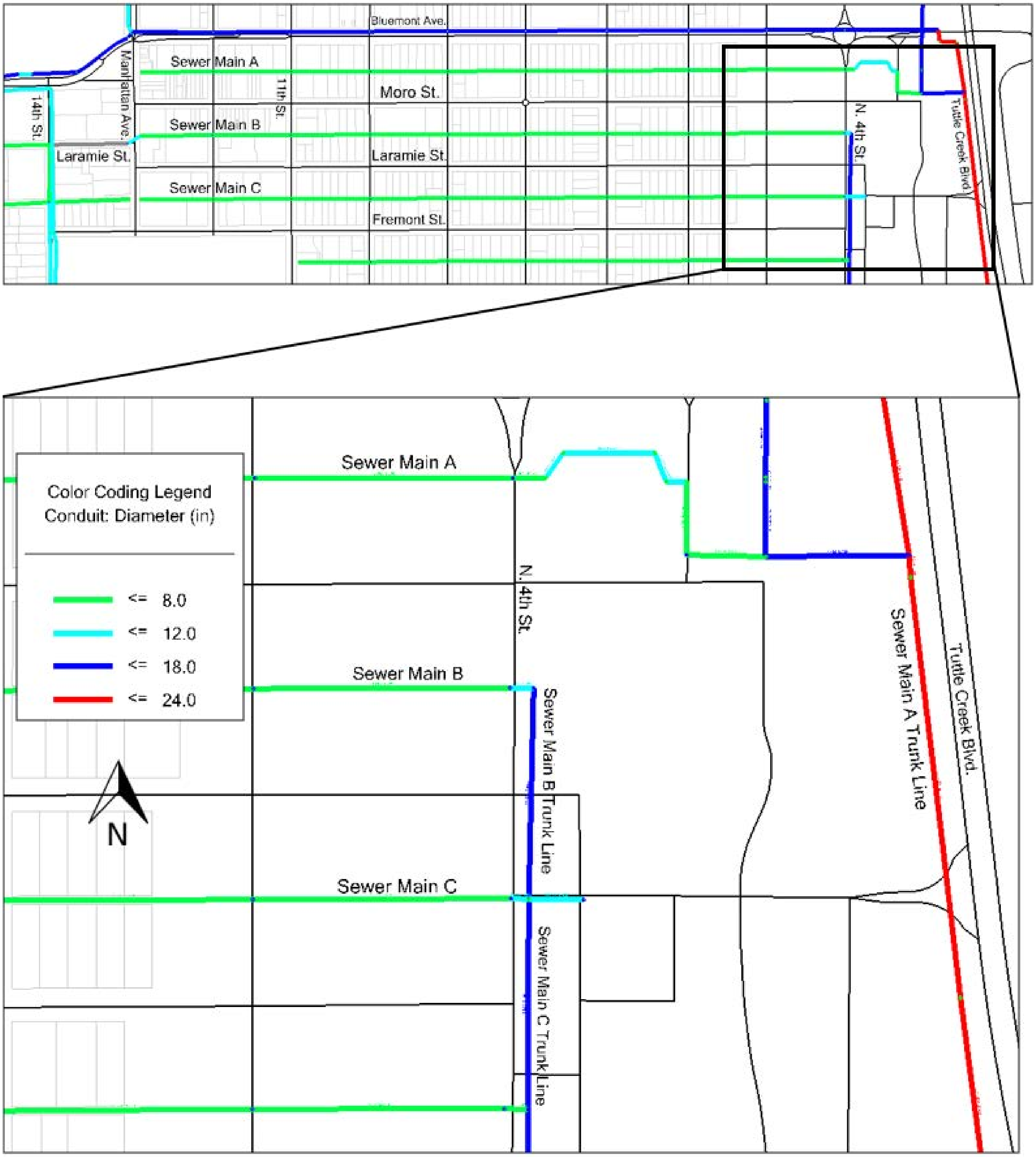
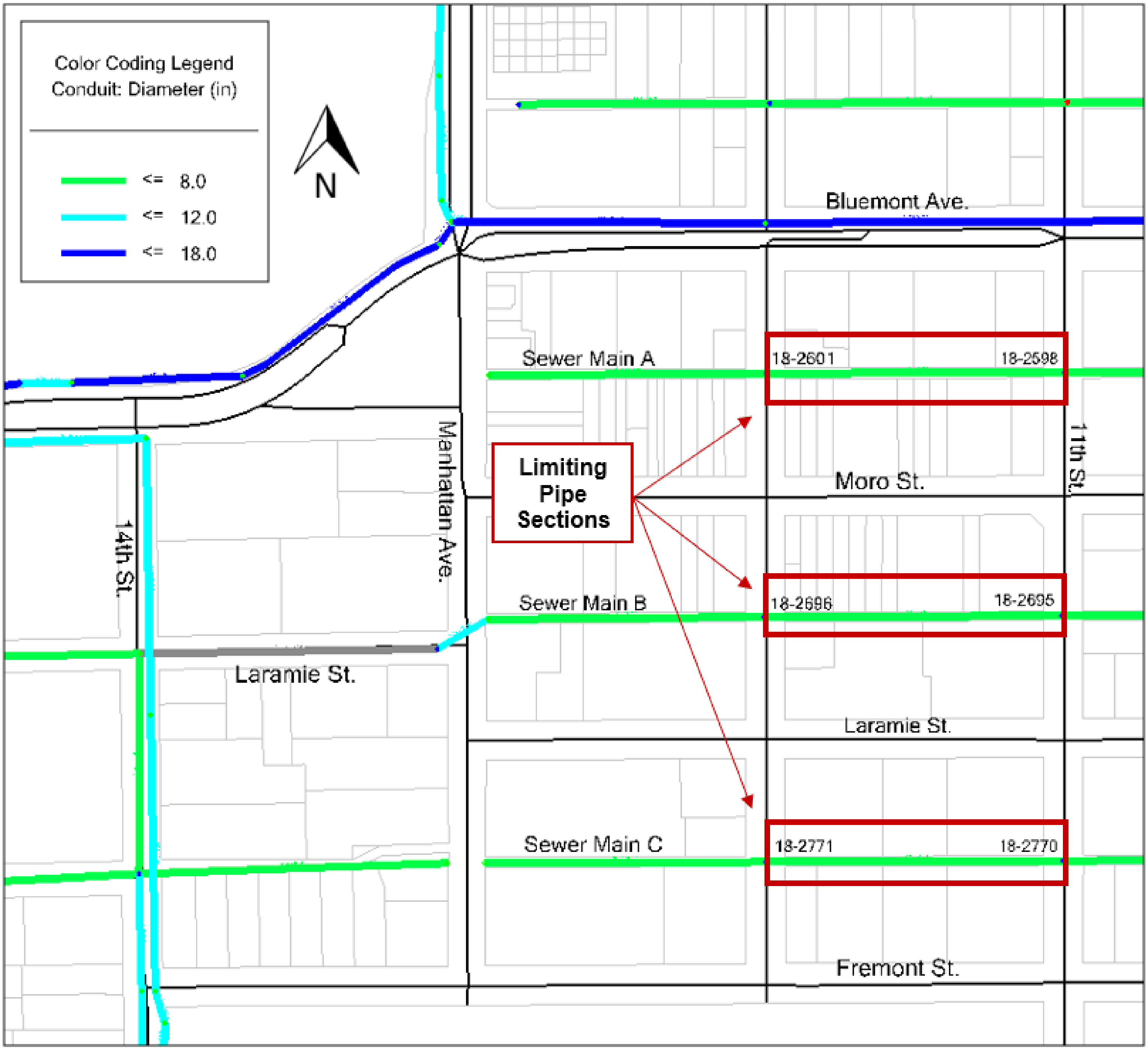


Figure A.3: Limiting Pipe Sections in Study Area



APPENDIX B - PUBLIC INVOLVEMENT

Figure B.1: Survey Question 1

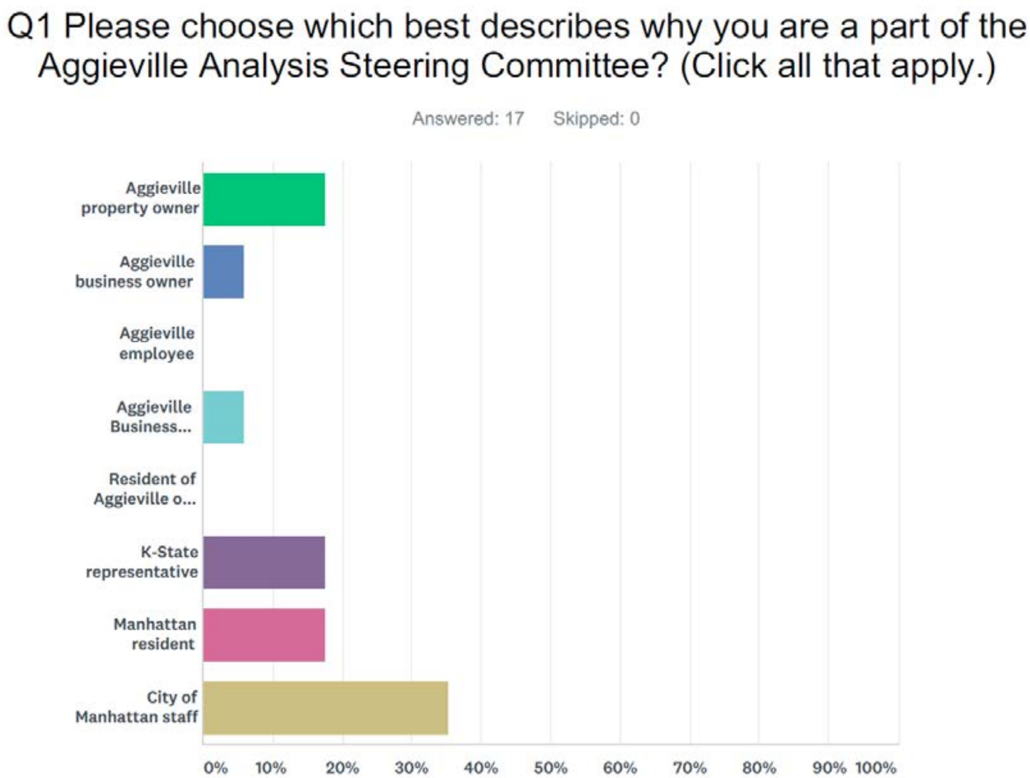


Figure B.2: Survey Question 2

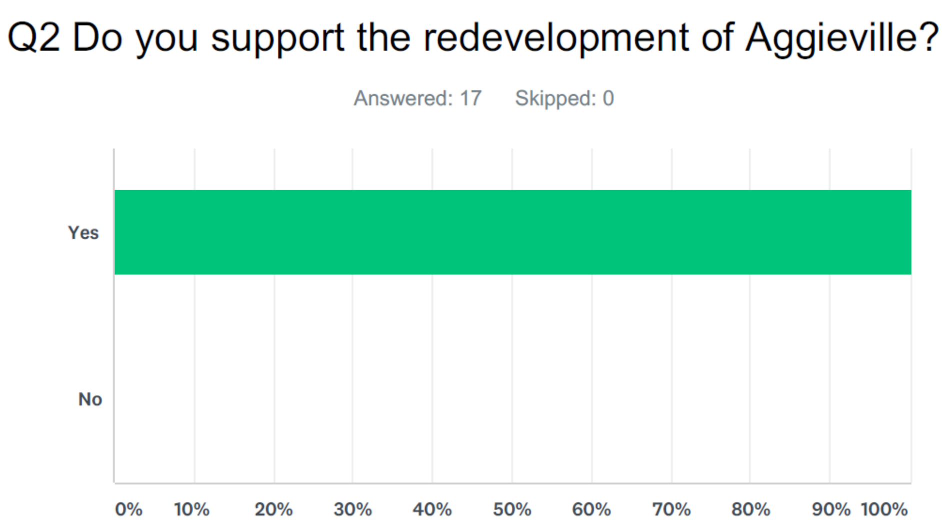


Figure B.3: Survey Question 3

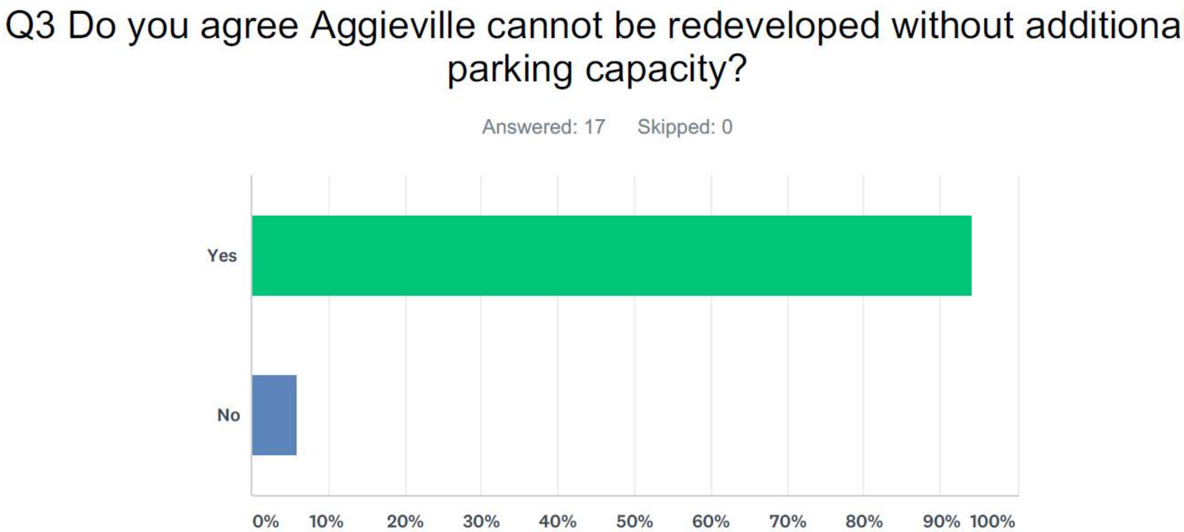


Figure B.4: Survey Question 4

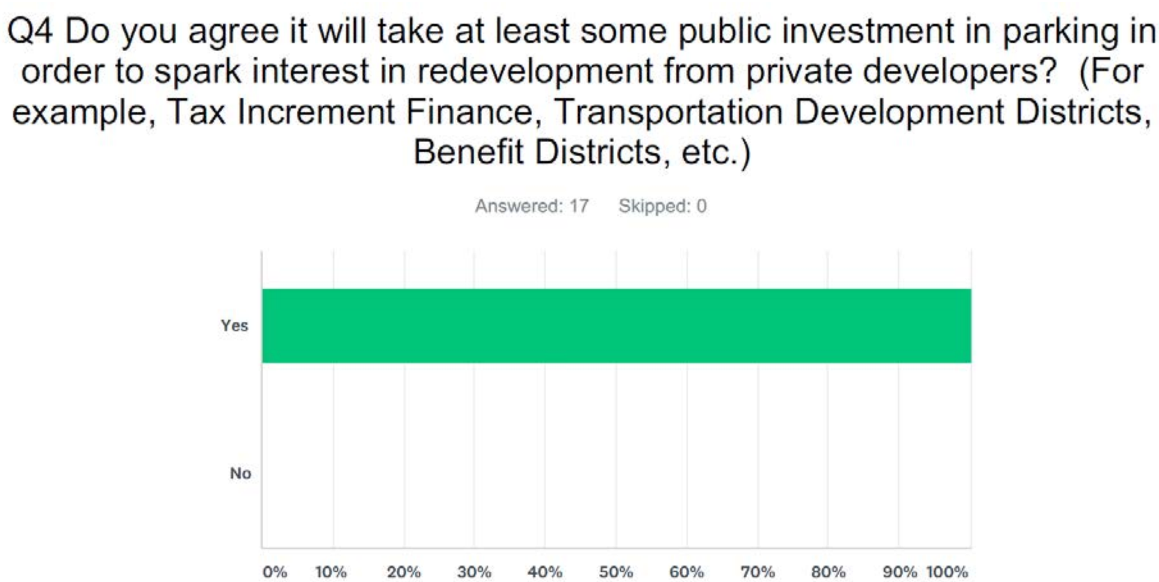
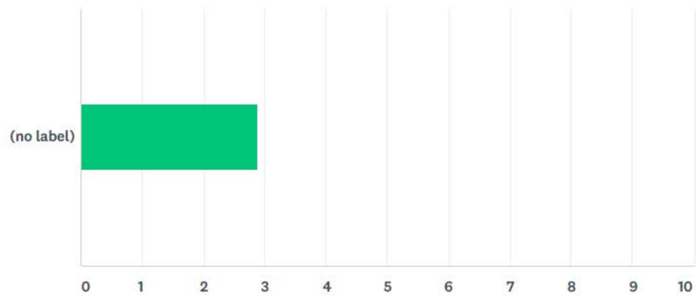


Figure B.5: Survey Question 5

Q5 The consulting team has provided an overview of different possible growth scenarios for the Aggieville district, ranging from low to high growth. To summarize, these are: Low Growth — An increase of approx. 140 residential units and 61,657 sq. ft. of commercial space; would require about 500 to 800 additional parking spaces Medium Growth — An increase of approx. 310 residential units and 99,567 sq. ft. of commercial space; would require about 1200 additional parking spaces High Growth — An increase of approx. 479 residential units and 99,567 sq. ft. of commercial space; would require about 1500 additional parking spaces Which of these growth scenarios do you think the city should use as a model for future Aggieville planning? (Choose one.)

Answered: 17 Skipped: 0



	LOW GROWTH	BETWEEN LOW AND MEDIUM GROWTH	MEDIUM GROWTH	BETWEEN MEDIUM AND HIGH GROWTH	HIGH GROWTH	TOTAL	WEIGHTED AVERAGE
(no label)	5.88% 1	41.18% 7	23.53% 4	17.65% 3	11.76% 2	17	2.88

Figure B.6: Survey Question 6

Q6 The consulting team has recommended to the steering committee that the first step is to construct a garage consisting of 500 to 600 stalls, with the ability to expand. Do you support this recommendation?

Answered: 17 Skipped: 0

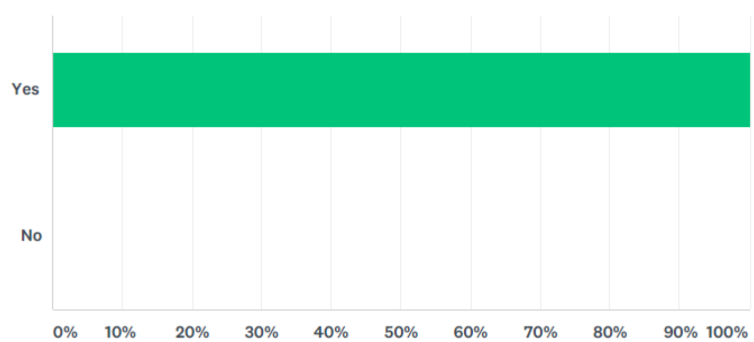


Figure B.7: Survey Question 7

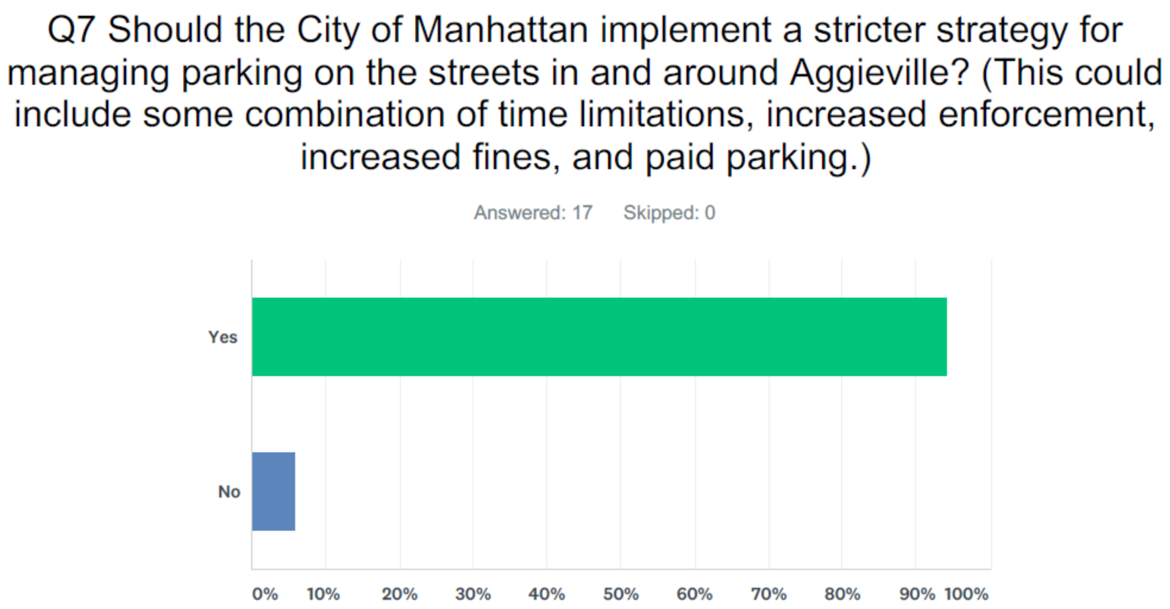
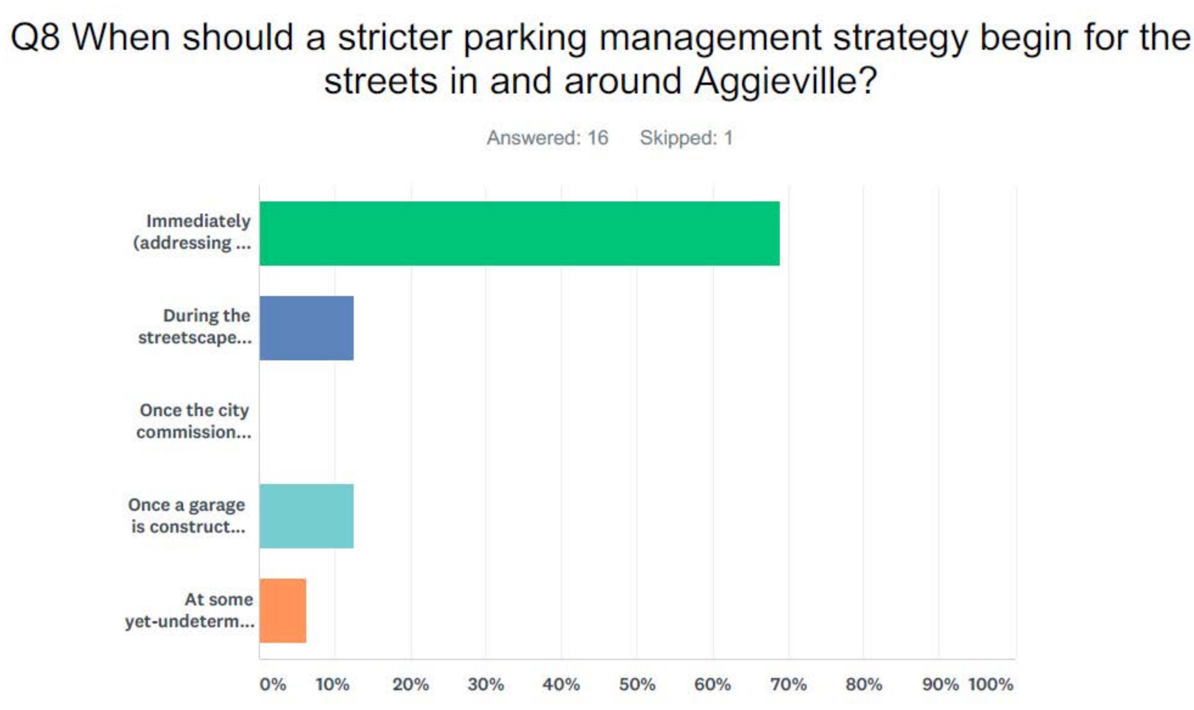


Figure B.8: Survey Question 8



ANSWER CHOICES	RESPONSES	
Immediately (addressing the existing 2HR and 3HR restrictions with a $15 fine)	68.75%	11
During the streetscape design, to allow for alternative parking management strategies and infrastructure	12.50%	2
Once the city commission approves a final parking garage design and plan	0.00%	0
Once a garage is constructed and operational	12.50%	2
At some yet-undetermined point in the future	6.25%	1
TOTAL		16